

Stanford University



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FOREWORD

MESSAGE FROM THE VICE PROVOST AND DEAN OF RESEARCH OF STANFORD UNIVERSITY

To: The Stanford Academic Community

This Biosafety Manual represents the institutional practices and procedures for the safe use and handling of biological materials, recombinant DNA and synthetic nucleic acids at Stanford University. The Administrative Panel on Biosafety and the Biosafety Manager have revised this document based on the latest government regulatory requirements, guidelines and current professional standards. It is designed to inform the laboratory worker of good work practices and safe procedures which are found in most biosafety manuals; however, this manual also emphasizes the regulatory requirements that must be followed and the need for all related research to be conducted in a responsible manner.

The Environmental Health and Safety Office, through the Biosafety Manager, is responsible for monitoring individual principal investigators and laboratory facilities for adherence to the practices and procedures described in this manual. However, it is the responsibility of each principal investigator to ensure that all lab workers are familiar with the contents of this manual and that these workers and employees are trained to recognize potential related hazards prior to initiation of the research work. Your cooperation with the Administrative Panel on Biosafety and the Environmental Health and Safety Office is essential to comply with the regulatory requirements that our University must follow in order to continue the success of our research endeavors.

If you have any questions regarding this document, please call the Research Compliance Administrator at 723-4697 or the Biosafety Manager at 725-1473.

Sincerely,

Ann Arvin
Vice Provost and Dean of Research

MAJOR UPDATES FOR 2014

Major updates to the 2014 Biosafety Manual include the following:

Addition of synthetic nucleic acid molecules (sNA) to the NIH Guidelines

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This revision of the Biosafety Manual was prepared under the auspices of the Administrative Panel on Biosafety (APB) by the Office of Environmental Health and Safety (EH&S) after careful review of pertinent federal and state government regulatory documents, along with reference guidelines from the Centers for Disease Control and the National Institutes of Health.

This manual will:

- Address the most commonly asked questions from faculty, staff and students on general Biosafety, pathogens, and recombinant DNA (rDNA) or synthetic nucleic acid (sNA) issues;
- Provide information about training, safe work practices, safety equipment and personal protective equipment; and,
- Provide guidance for investigators who need to submit an application for review by the Administrative Panel on Biosafety.

Due to the ever-changing regulatory environment that we all live and work in, updates to this manual will be made as needed; these changes will also be made on the EH&S Biosafety web site (<http://ehs.stanford.edu/researchlab/bio/>).

Please feel free to comment on this manual. If you have questions regarding this manual, please call the Biological Safety Manager at Environmental Health and Safety Department, 725-1473.

Sincerely,

Ann Arvin, M.D.
Vice Provost and Dean of Research

David Relman, M.D.
Chair, Administrative Panel on Biosafety

Mark Holodniy, M.D.
Co-Chair, Administrative Panel on Biosafety

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Recombinant DNA and Synthetic Nucleic Acids: Regulations and Guidelines

We wish to suggest a structure for the salt of deoxyribose nucleic acid (D.N.A.). This structure has novel features which are of considerable biological interest..... It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material.

Watson and Crick (1953), Nature 171, pg 737

The use of recombinant DNA (rDNA) and synthetic nucleic acids (sNA) are regulated by the National Institutes of Health (NIH); the guidelines can be found in the publication NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules (**NIH GUIDELINES**) ([OBA - NIH Guidelines](http://osp.od.nih.gov/office-biotechnology-activities/biosafety/nih-guidelines)) (<http://osp.od.nih.gov/office-biotechnology-activities/biosafety/nih-guidelines>; a copy of the current guidelines is in [Appendix A](#)). These guidelines are the official guide to all rDNA and sNA work done at Stanford. It is important to realize that following these guidelines is the responsibility of **all** investigators at Stanford University and not solely that of investigators that are funded by NIH.

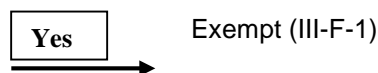
Exempt rDNA/sNA

The guidelines specify a number of different categories of rDNA/sNA molecules. One of the most important categories is the Exempt category. Experiments that qualify for this category do not need approval by the Stanford University Institutional Biosafety Committee (the Administrative Panel on Biosafety [APB], see Chapter 4). To determine if your experiments are **exempt**, you can check Section III, Category F in the NIH Guidelines (online or in [Appendix A](#)); a short reference guide is presented in Table 1 and 2.

Table 1. Recombinant and Synthetic Nucleic Acid Molecules (NIH guidelines).

If your experiment is in an exempt category, APB approval is not necessary. If your experiment does not fall within the exempt categories, you **MUST** have current APB approval.

Is your synthetic nucleic acid designed to: (1) neither replicate nor generate nucleic acids that can replicate in any living cell, and (2) not integrate into DNA, and (3) not produce a toxin that is lethal for vertebrates at an LD50 of less than 100 nanograms per kilogram body weight?



| | | |
|---|-----------------------------------|------------------|
| Is your recombinant or synthetic nucleic acid molecule not in an organism, cell or virus and not been modified or manipulated to render it capable of penetrating cellular membranes? | <input type="checkbox"/> Yes → | Exempt (III-F-2) |
| Is your recombinant or synthetic nucleic acid molecule solely from a single source that exists contemporaneously in nature? | <input type="checkbox"/> Yes → | Exempt (III-F-3) |
| Is your recombinant or synthetic nucleic acid molecule solely from a prokaryotic host and propagated in the same host or transferred to another host by naturally occurring means? | <input type="checkbox"/> Yes → | Exempt (III-F-4) |
| Is your recombinant or synthetic nucleic acid molecule from a eukaryotic host and propagated in the same host? | <input type="checkbox"/> Yes → | Exempt (III-F-5) |
| Is your recombinant or synthetic nucleic acid molecule from species that naturally exchange DNA? | <input type="checkbox"/> Yes → | Exempt (III-F-6) |
| Does your genomic DNA contains a transposable element that does not contain any recombinant and/or synthetic nucleic acids? | <input type="checkbox"/> Yes → | Exempt (III-F-7) |
| Recombinant or synthetic nucleic acid molecule which does not present a significant risk to health or the environment, as determined by the NIH* | <input type="checkbox"/> Yes → | Exempt (III-F-8) |

*The NIH has determined that rDNA/sNA from infectious agents of BL-2 (see [Appendix B](#)) or above is **not exempt** and must receive Biosafety approval. Additionally, certain **cloning vectors**, i.e. Adeno- or Sindbis-based vectors, or amphotropic MMLV based vectors, are some examples of rDNA that are non-exempt.

Non-Exempt rDNA/sNA

If your experiment does not fall within the exempt categories (Table 2), you **MUST** obtain APB approval.

Table 2. Experiments requiring APB approval.

| Approval required for experiments involving: (Specific NIH Guideline Section) | Further Information and Examples: |
|--|--|
| 1. Deliberate transfer of a drug resistance trait to microorganisms that are not known to acquire the trait naturally <u>if</u> such acquisition could compromise the ability to control disease agents in humans, veterinary medicine or agriculture. (III-A-1-a) | <ul style="list-style-type: none"> Transferring a drug resistance trait that is used, had previously been used, may be used (including outside the U.S.), or that is related to other drugs that are used to treat or control disease agents. Examples include transfer of: erythromycin resistance into <i>Borrelia burgdorferi</i>; pyrimethamine resistance into <i>Toxoplasma gondii</i>; chloramphenicol resistance into <i>Rickettsia conorii</i>; tetracycline resistance into <i>Porphyromonas gingivalis</i>. |

| Approval required for experiments involving: (Specific NIH Guideline Section) | Further Information and Examples: |
|--|---|
| 2. Cloning of DNA, RNA or synthetic nucleic acid molecules encoding toxins lethal to vertebrates at an LD50 of <100ug/kg body weight. (III-B-1) | <ul style="list-style-type: none"> • Cloning toxins (or using plasmids that express toxins with low LD50s). • Examples include: botulinum, tetrodotoxin, ricin, T-2, saxitoxin, abrin, tetanus, <i>Shigella dysenteriae</i> neurotoxin, pertussis, <i>Staph aureus</i> Beta, shigatoxin, and conotoxins. |
| 3. Transfer of recombinant or synthetic nucleic acid molecules, or DNA or RNA derived from recombinant or synthetic nucleic acid molecules into human research participants. (III-C-1) | <ul style="list-style-type: none"> • Use of recombinant or synthetic nucleic acid molecules, or DNA or RNA derived from recombinant or synthetic nucleic acid molecules, that meet ANY of the following four criteria: <ul style="list-style-type: none"> ○ Contain >100nt, or ○ Possess biological properties that enable genome integration, or ○ Have the potential to replicate in a cell, or ○ Can be translated or transcribed. • Examples include: use of a defective adenoviral vector to deliver the CFTR gene intranasally to patients with Cystic Fibrosis; introduction of an HSV-TK transduced cell line into patients with epithelial ovarian carcinoma; introduction of a shRNA delivered in a plasmid, bacterial or viral vector. |
| 4. Risk Group 2, Risk Group 3, Risk Group 4 or Restricted Agents used as Host-Vector Systems. (III-D-1) | <ul style="list-style-type: none"> • The introduction of recombinant or synthetic nucleic acid molecules into Risk Group 2, 3, 4, or Restricted Agents that meet ANY of the following criteria: <ul style="list-style-type: none"> ○ Have the potential to replicate in a cell, or ○ Possess biological properties that enable genome integration, or ○ Produce a toxin lethal to vertebrates at an LD50 of <100ug/kg body weight. • Examples include: Adenovirus, Herpes virus, Lentivirus, Amphotropic or VSV-g pseudotyped Murine Retrovirus, Human Retrovirus, Vaccinia virus Vesicular Stomatitis virus, and Adeno-Associated virus with helper virus. |
| 5. DNA from Risk Group 2, Risk Group 3, Risk Group 4 or Restricted Agents cloned into nonpathogenic prokaryotic or lower eukaryotic host-vector systems. (III-D-2) | <ul style="list-style-type: none"> • Transfer of DNA from Risk Group 2, 3, 4, or Restricted Agents into nonpathogenic prokaryotes or lower eukaryotes. • Use of pathogens or defective pathogens as vectors. • Examples include: Adenovirus, Herpes virus, Lentivirus, Amphotropic or VSV-g pseudotyped Murine Retrovirus, Human Retrovirus, Vaccinia virus Vesicular Stomatitis virus, and Adeno-Associated virus with helper virus. |
| 6. Infectious DNA or RNA viruses or defective DNA or RNA viruses in the presence of helper virus in tissue culture systems. (III-D-3) | <ul style="list-style-type: none"> • rDNA experiments involving Risk Group 2, 3, or 4 pathogens. • rDNA experiments involving $\leq 2/3$ of the genome from eukaryotic viruses in the presence of a helper virus. • Examples include: HIV, HTLV-I & II, West Nile Virus, and Lymphocytic Choriomeningitis Virus. |
| 7. Whole animals, including transgenic animals. (III-D-4) | <ul style="list-style-type: none"> • Experiments utilizing any of the following that may lead to transmissible infection either directly or indirectly as a result of complementation or recombination in the animal: <ul style="list-style-type: none"> ○ > 2/3 of eukaryotic viral genome, or ○ Animals containing sequences from viral vectors, or ○ Stable integration of recombinant or synthetic nucleic acid molecules, or nucleic acids derived therefrom, into the germline. • Use of viable recombinant or synthetic nucleic acid molecule-modified Risk Group 2, 3, 4 or Restricted Agent microorganisms tested on whole animals. |

| Approval required for experiments involving: (Specific NIH Guideline Section) | Further Information and Examples: |
|---|---|
| 8. Whole plants. (III-D-5) | <ul style="list-style-type: none"> Experiments involving exotic infectious agents when recombinant or synthetic nucleic acid molecule techniques are associated with whole plants. Experiments with plants involving cloned genomes of readily transmissible exotic infectious agents. Experiments with plants involving readily transmissible exotic infectious agents (i.e. soybean rust fungus <i>Phakopsora pachyrhizi</i>, maize streak or other viruses) in the presence of their specific arthropod vectors. Experiments involving plants or their associated organisms and the introduction of sequences encoding potent vertebrate toxins. Experiments involving microbial pathogens of insects, arthropods or small animals associated with plants if the recombinant or synthetic nucleic acid molecule-modified organism can detrimentally impact the ecosystem. |
| 9. Large-scale DNA work. (III-D-6) | <ul style="list-style-type: none"> ≥ 10 liters of culture combined. Examples include: Use of ≥10 L fermentor; growing up to five 2 L flasks of rDNA culture (i.e. <i>E. coli</i> K-12). |
| 10. Influenza virus. (III-D-7) | <ul style="list-style-type: none"> Experiments with Influenza virus shall be conducted at the BSL containment corresponding to the Risk Group of the virus that was the source of the majority of segments. Experiments that alter antiviral susceptibility may increase containment level requirements. Examples of BSL3 influenza work: 1957-1968 Human H2N2, Highly pathogenic avian influenza H5N1 strains within the Goose/Guangdong/06-like H5 lineage (HPAI H5N1), 1918 H1N1. |

Viral Vectors and Transgenes

All vectors are not the same. More importantly, the class of gene insert can change the Biosafety level of the construct. It is also important to realize that obtaining a cloning/expression vector from a commercial source does not mean it is automatically exempt or a BSL-1. Table 3 lists many of the more common viral vectors in combination with different classes of inserts and their associated BSL level.

Table 3. Viral vectors and transgene containment.

| Gene transfer vector ^a | Host range ^b | Insert or gene function ^c | Laboratory containment level ^d |
|--|--------------------------------|---|---|
| MMLV based— <i>gag</i> , <i>pol</i> , and <i>env</i> deleted | Ecotropic | S, E, M, G, CC, T, MP, DR, R, TX, O _v , O _c | BSL-1* |
| | Amphotropic, VSV-G pseudotyped | S, E, M, MP, DR, T, G | BSL-2 |
| | | O _v , O _c , R, CC TX | BSL2+ BSL-3 |
| Herpesvirus based—nonlytic | Broad host range | S, E, M, MP, DR, T, G O _v , O _c , R, CC | BSL-2 BSL2+ |
| | | TX | BSL-3 |

| Gene transfer vector ^a | Host range ^b | Insert or gene function ^c | Laboratory containment level ^d |
|---|--|--|---|
| Lentivirus based— HIV, SIV, EIAV, FIV, etc.; <i>gag, pol,</i> <i>env, nef,</i> and <i>vpr</i> deleted | Ecotropic, amphotropic, VSV-G pseudotyped | S, E, M, MP, DR, T, G O _v , O _c , R, CC TX | BSL-2 BSL2+ BSL-3 |
| Adenovirus based— serotypes 2, 5 and 7; E1 and E3 or E4 deleted | Broad host range, infective for many cell types | S, E, M, T, MP, DR, R, G, CC O _v , O _c TX | BSL-2 BSL2+ BSL-3 |
| Alphavirus based— SFV, SIN | Broad host range | S, E, M, T, MP, DR, R, G, CC O _v , O _c TX | BSL-2 BSL2+ BSL-3 |
| Baculovirus based | Broad mammalian host cell range | S, E, M, T, MP, DR, R, G, CC O _v , O _c TX | BSL-1* BSL2 BSL-2+/BSL- 3 |
| AAV based— <i>rep, cap</i> defective | Broad host range; infective for many cell types, including neurons | S, E, M, T, MP, DR, G O _v , O _c , R, CC TX | BSL-1* BSL2 BSL-2+/BSL- 3 |
| Poxvirus based— canarypox, Vaccinia ^e | Broad host range | S, E, M, T, DR, MP, CC, R, G O _v , O _c TX | BSL-2 BSL2+ BSL-3 |

^aRefers to the parental or wild-type virus and some of the common deletions used in viral vectors. MMLV, Moloney murine leukemia virus; SIV, simian immunodeficiency virus.

^bRefers to ability of vector to infect cells from a range of species. Ecotropic generally means able to infect only cells of the species originally isolated from or identified in. Please note that the ecotropic host for HIV and HSV would be human cells, but the ecotropic host for MMLV would be murine cells. Amphotropic and VSV-G-pseudotyped virus host range includes human cells.

^cShown are general categories of cellular genes and functions. Please note that there are differences in the containment level for the same class depending on whether the viral vector integrates into the recipient genome at a high rate. The general categories are as follows: S, structural proteins (actin, myosin, etc.); E, enzymatic proteins (serum proteases, transferases, oxidases, phosphatases, etc.); M, metabolic enzymes (amino acid metabolism, nucleotide synthesis, etc.); G, cell growth, housekeeping; CC, cell cycle, cell division; DR, DNA replication, chromosome segregation, mitosis and meiosis; MP, membrane proteins, ion channels, G-coupled protein receptors, transporters, etc.; T, tracking genes such as those for green fluorescent proteins and luciferases and photoreactive genes; TX, active subunit genes for toxins such as ricin, botulinum toxin and Shiga and Shiga-like toxins; R, regulatory genes for transcription and cell activators such as cytokines, lymphokines and tumor suppressors; O_v and O_c, oncogenes identified via transforming potential of viral and cellular analogs, or mutations in tumor suppressor genes resulting in a protein that inhibits/moderates the normal cellular wild-type proteins. This does not include SV40 T antigen. SV40 T-antigen-containing cells should not be considered more hazardous than the intact virus. SV40 is considered a risk level 1 agent (the lowest level) according to the *NIH Guidelines*. The prevalence of SV40 infection in the U.S. population due to contaminated polio vaccine does not seem to have caused a statistically significant increase in the rate of cancers. However, the data from the various studies on SV40 association with cancer are equivocal (Strickler et al. 1998; Butel and Lednicky, 1999; Dang-Tan et al., 2004).

^dThis is a general assessment of containment levels for laboratory construction and use of these vectors for nonproduction quantities only based on the 4th edition of BMBL. This table cannot cover every potential use within a research or laboratory settings; as information is gained, risk assessments and containment levels may be changed. Local IBCs should use all available information and their best judgment to determine appropriate containment levels. BSL-1* refers to the containment level based on parent virus risk group. However, most procedures involving the

handling and manipulation of the viral vectors are done at BSL-2 to protect cell cultures and viral stocks from contamination.

^eCertain specific strains of poxviruses, such as MVA, NYVAC, ALVAC and TROVAC, are considered low-risk agents and can be handled at BSL-1 in certain cases.

From Biological Safety Principles and Practices, 4th ed., pg. 524, D.O. Fleming and D.L. Hunt, Ed, ASM Press, 2006.

Human Gene Transfer

Protocols involving the use of rDNA/sNA for gene transfer into humans, whether done directly in the subject or *in vitro* and subsequently put into the subject, must be submitted to both the APB and the Stanford University Institutional Review Board (IRB) for Medical Human Subjects. Current Federal Regulations call for submission of the protocol to the Recombinant Advisory Committee (RAC) and Food and Drug Administration (FDA) prior to submission to the local institution's panels. For additional information concerning Stanford University's IRB panels, please access the panel's web site at <http://researchcompliance.stanford.edu/>.

Transgenic Plants

Experiments to genetically engineer plants by rDNA/sNA methods may require registration with the APB (BL2-P or higher, see [OBA - NIH Guidelines \[Appendix A\]](#) and [Appendix C](#) for additional information). To prevent release of transgenic plant materials to the environment, the guidelines provide specific plant biosafety containment recommendations for experiments involving the creation and/or use of genetically engineered plants.

Plant Biosafety levels are categorized into BL1-P to BL4-P (Table 4).

Table 4. Plant biosafety levels.

From Practical Guide to Containment: Plant Biosafety in Research Greenhouses, Revised Edition,, page 13, ,D. Adair and R. Irwin,

| CRITERIA | TRANSGENIC PLANTS | TRANSGENIC MICROBES | | TRANSGENIC INSECTS/ANIMALS/ ASSOC. MICROBES |
|--|-------------------|---------------------|------------|---|
| | | Exotic | Non-Exotic | |
| Not a noxious weed or cannot outcross with one | BL1-P | | | |
| Not easily disseminated | | | BL1-P | |
| No detriment to environment | | BL2-P or BL1-P+ | BL1-P | BL2-P or BL1-P+ |

| CRITERIA | TRANSGENIC PLANTS | TRANSGENIC MICROBES | | TRANSGENIC INSECTS/ANIMALS/ ASSOC. MICROBES |
|--|-------------------|---------------------|-----------------|---|
| | | Exotic | Non-Exotic | |
| Noxious weed or can interbreed with weeds | BL2-P or BL1-P+ | | | |
| Contains complete genome of non-EIA* | BL2-P or BL1-P+ | | | |
| Contains genome of EIA | BL3-P or BL2-P+ | | | |
| Treated with an EIA | BL3-P or BL2-P+ | | | |
| Detriment to environment | | BL3-P-4** | BL2-P or BL1-P+ | BL3-P or BL2-P+ |
| Involves EIA with detriment to environment | BL3-P or BL2-P+ | | | |
| May reconstitute genome of infectious agent <i>in planta</i> | BL3-P or BL2-P+ | | | |
| Contains Vertebrate Toxin | BL3-P | BL3-P | BL3-P | |

*EIA—Exotic Infectious Agent

**BL4-P containment is recommended only for experiments with readily transmissible exotic infectious agents whether transgenic or not, such as air-borne fungi or viruses *in the presence of their arthropod vectors* that have the potential of being serious pathogens of major US crops.

The Sciences gain by mutual support. When, as the result of my first communications on the fermentations in 1857-1858, it appeared that the ferments, properly so-called, are living beings, that the germs of microscopic organisms abound in the surface of all objects, in the air and in water; that the theory of spontaneous generation is chimerical; that wines, beer, vinegar, the blood, urine and all the fluids of the body undergo none of their usual changes in pure air, both medicine and surgery received fresh stimulation.

Louis Pasteur, **Germ Theory and its Applications to Medicine and Surgery, 1878**

Laboratories that work with infectious agents pose risks to people within and near them. Infections have been contracted in connection with laboratory work throughout the history of microbiology (a dubious distinction). Studies have illustrated that laboratory-acquired infections are not confined to any one kind of lab or group of people, and that the incidence of infection among untrained and ancillary workers is high, averaging approximately one-third of all acquired infections.

Biosafety Level Classification

Stanford University follows the categorizing of infectious agents into levels as described in [Biosafety in Microbiological and Biomedical Laboratories \(BMBL\), 5th edition](#), written and published by the Centers for Disease Control (CDC) and NIH. The BMBL describes combinations of microbiological practices, laboratory facilities, and safety equipment in combination with four biosafety levels for various agents infectious to humans. The descriptions of biosafety levels (BSL) 1 – 4 parallel those in the NIH Guidelines for research involving recombinant DNA. Biosafety levels are also described for infectious disease activities that involve laboratory animals. It is important to note that the guidelines presented in the BMBL are considered minimal for containment, and will be customized as needed.

The BSL categories are divided up by risk of disease combined with availability of preventive and therapeutic treatments. The four groups are shown in Table 1. For the list of agents and their categories, see [Appendix B](#) or go to <http://www.absa.org/riskgroups/index.html>.

Table 1. Basis for the classification of biohazardous agents by biosafety level.

| | |
|-------|---|
| BSL 1 | Agents that are not associated with disease in healthy adult humans |
| BSL 2 | Agents that are associated with human disease which is rarely serious and for which preventive or therapeutic interventions are <i>often</i> available |
| BSL 3 | Agents that are associated with serious or lethal human disease for which preventive or therapeutic interventions <i>may be</i> available (high individual risk but low community risk) |
| BSL 4 | Agents that are likely to cause serious or lethal human disease for which preventive or therapeutic interventions are <i>not usually</i> available (high individual risk and high community risk) |

Laboratory facility requirements

Each BSL has its own corresponding requirements for the laboratory facilities (Table 2).

Table 2. Summary of laboratory facilities for BSL 1 – 4.

| BSL | Agents | Practices | Safety Equipment (Primary Barriers) | Facilities (Secondary Barriers) |
|-----|--|--|--|--|
| 1 | Not associated with disease in healthy adults | Standard Microbiological Practices | As needed to allow for good microbiological practices | Open bench top Sink required |
| 2 | Associated with human disease, hazard = percutaneous injury, ingestion, mucous membrane exposure | BSL-1 practice plus: Limited access Biohazard warning signs “Sharps” precautions Biosafety manual defining any needed waste decontamination or medical surveillance policies | Primary barriers: Class I or II BSC or other physical containment devices used for all manipulations of agents that cause splashes or aerosols of infectious materials PPE: laboratory coats; gloves; face protection as needed | BSL-1 plus: Autoclave available |

| BSL | Agents | Practices | Safety Equipment (Primary Barriers) | Facilities (Secondary Barriers) |
|------------|---|---|---|--|
| 3 | Indigenous or exotic agents with potential for aerosol transmission; disease may have serious or lethal consequences | BSL-2 practices plus: Controlled access Decontamination of all waste Decontamination of lab clothing before laundering Baseline serum | Primary barriers: Class I or II BSC or other physical containment devices used for all open manipulations of agents PPE: protective lab clothing, gloves, respiratory protection as needed | BSL-2 plus: Physical separation from access corridors Self-closing, double-door access Exhausted air not recirculated Negative airflow into laboratory |
| 4 | Dangerous/exotic agents which pose high risk of life-threatening disease, aerosol-transmitted lab infections, or related agents with unknown risk of transmission | BSL-3 practices plus: Clothing change before entering Shower on exit All material decontaminated on exit from facility | Primary barriers: All procedures conducted in a Class III BSC, or Class I or II BSC <u>in combination with</u> full-body, air-supplied, positive pressure personnel suit | BSL-3 plus: Separate building or isolated zone Dedicated supply and exhaust, vacuum and decon systems Other requirements outlined in the text of the BMBL |

The physical requirements described in Table 2 will be used in conjunction with additional protective mechanisms (see Chapter 7) to achieve personnel and environmental safety.

Biosafety Level Work Practice Requirements

Each BSL is associated with work practices that address the potential risks (Table 3). Along with practices for BSL1, 2 and 3, is a list of practices labeled as BSL-2+. This category is used for BSL-2 agents that are worked with using BSL-3 practices.

Table 3. Biosafety level work practice requirements.

| Work Practices | BSL-1 | BSL-2 | BSL-2+ | BSL-3 |
|--|--|---|---|---|
| Public access | Not recommended | Limit access to lab while BSL-2 work is being conducted | Restricted | Not permitted |
| Bench-top work | Permitted | Permitted only for low-risk procedures | Not permitted for biohazardous materials | Not permitted for biohazardous materials |
| Decontamination | Daily and following any spill | Daily and following any spill | Daily; immediately following work with biohazardous materials, and following any spill | Daily; immediately following work with biohazardous materials, and following any spill |
| Eating, drinking applying lip balm, etc. | Permitted only in designated clean areas | Permitted only in approved and designated clean areas | Not permitted at any time; Food or drink may not be brought into or through lab | Not permitted at any time; Food or drink may not be brought into or through lab |
| Lab coats | Recommended | Required when work with BSL-2 is being conducted | Required (wraparound disposable preferable) | Required (wraparound disposable required) |
| Personal Protective Equipment | Based on risk assessment | Required: Wear appropriate combinations of special protective clothing for all activities with biohazardous materials | Required: Wear appropriate combinations of special protective clothing for all activities with biohazardous materials | Required: Wear appropriate combinations of special protective clothing plus NIOSH N95 respirators or equivalent for all activities with biohazardous materials |
| Biological Safety Cabinet (BSC) | Not required | Required for all aerosol generated processes | Required for all work with biohazardous agents | Required for all work with biohazardous agents |
| Storage Equipment | No Biohazard signs required | Biohazard signs required, all equipment must be labeled with contents | Biohazard signs required, all equipment must be labeled with contents | Biohazard signs required, all equipment must be labeled with contents |

| Work Practices | BSL-1 | BSL-2 | BSL-2+ | BSL-3 |
|----------------------------|---|---|---|---|
| Physical containment | Decontaminate equipment immediately after use | Use physical containment devices during procedures that have a high potential to create aerosols* when using biohazardous material; Decontaminate immediately after use | Use physical containment devices (centrifuge safety cup, sealed centrifuge rotor) for all activities using biohazardous material; Open containers in a BSC; Decontaminate immediately after use | Use physical containment devices (centrifuge safety cup, sealed centrifuge rotor) for all activities using biohazardous material; Open containers in a BSC; Decontaminate immediately after use |
| Hand-washing facilities | Required | Required | Required (foot, elbow, or electronic activation preferable) | Required (foot, elbow, or electronic activation required) |
| Pipetting | Only mechanical device | Only mechanical device | Only mechanical device | Only mechanical device |
| HEPA-filtered vacuum lines | Recommended | Required | Required | Required |

*Procedures include but not limited to: centrifuging, grinding, blending, vigorous shaking or mixing, sonic disruption, opening containers of biohazardous materials after above procedures.

Tissue Culture, Human and Primate Tissue

The potential laboratory hazards associated with human cells and tissues include the bloodborne pathogens Hepatitis B virus (HBV), Hepatitis C virus (HCV), and Human Immunodeficiency Virus (HIV), as well as agents such as *Mycobacterium tuberculosis* that may be present in human lung tissues. Other non-human primate cells and tissues also present risks to laboratory workers, as do cells transformed with viral agents such as SV-40, EBV, or HBV, cells carrying viral genomic material and tumorigenic human cells. All are potential hazards due to the possibility of self-inoculation.

Cultured cells which are known to contain or be contaminated with a biohazardous agent (e.g. bacteria or virus) are classified in the same BSL as the agent. Cell lines which do not contain known human or animal pathogens are designated BSL-1. The following list contains human or primate cells that are to be handled using BSL-2 practices and containment:

1. Cells from blood, lymphoid cells, and neural tissue
2. All primary cell lines
3. Secondary (immortalized) cell lines
4. Cell lines exposed to or transformed by a human or primate oncogenic virus
5. Pathogen deliberately introduced or known endogenous contaminant
6. Fresh or frozen tissue explants

Note that this list is not conclusive and individual cases will be determined as they occur.

Universal Precautions

Additionally, all human blood, blood products, unfixed human tissue and certain body fluids should be handled with universal precautions and BSL-2 practices. **Universal precautions** is the concept of treating all human/primate blood and other body fluids, tissues and cells (including cell lines) as if they were known to be infectious for bloodborne pathogens. Universal precautions include frequent hand washing, no mouth pipetting, no food or drink in the lab and proper disposal of biohazardous/medical waste, as well as the use of **engineering controls** and **personal protective equipment (PPE)**. Engineering controls include biosafety cabinets, ventilation systems, closed top centrifuge rotors, etc.; these are the primary methods to control exposure. PPE such as gloves, lab coats, and eye protection or face shields must be selected and used as appropriate. All material should be treated as medical waste (see Chapter 9).

Areas subject to Universal Precautions must have appropriate **signs** posted on doors and equipment; these signs can be obtained from EH&S (723.0448). Additional information on Universal Precautions is presented in Figure 1.



STANFORD UNIVERSITY

ENVIRONMENTAL HEALTH & SAFETY

UNIVERSAL PRECAUTIONS

INTRODUCTION:

Human or non-human primate primary cells, cell lines, organ cultures and body fluids may contain adventitious viruses and/or other opportunistic pathogens or zoonotic agents. Since it is extremely difficult to screen for every pathogen, all of the above materials must be handled with Universal Precautions and treated as though they are contaminated with HIV, HBV, HCV, or other bloodborne pathogens by utilizing Biosafety Level 2 (BSL-2) practices and procedures.

TRAINING REQUIREMENTS:

The following training programs must be completed in order to work with materials listed above:

- Biosafety (EHS-1500 or as part of EHS-4875 – Life Sciences Research Laboratory Safety Training)
- Bloodborne pathogens (EHS-1800) and the annual refresher (EHS-1801)
- [Exposure Control Plan](#) – Tier III training in conjunction with your PI

See [the Stanford University Training Advisor](#) for information on additional required trainings for working in your area.

PRACTICES AND PROCEDURES:

To minimize potential exposure to pathogens, use a combination of engineering controls, work practice controls and personal protective equipment (PPE):

Engineering Controls

- Use a Biosafety Cabinet when possible for all aerosol-generating procedures
- Use additional physical containment devices during procedures with high potential to create aerosols (e.g. centrifugation, blending, homogenization etc.)
- Use a needleless system or engineered sharps
- Use HEPA filtered vacuum lines

Work Practice Controls

- Post biohazard universal precautions signs on doors and equipment



- Limit lab access while work is being conducted
- Properly dispose of biohazardous/medical waste into appropriate waste containers

2013

- Wash hands after completion of work and before leaving laboratory
- Decontaminate equipment daily and following any spill
- Eating, drinking, applying lip balm or contact lenses only permitted in approved non-research areas
- No mouth pipetting

Personal Protective Equipment (PPE)

- Wear appropriate street clothing - long pants and closed toed shoes
- Wear lab coat, gloves (nitrile or latex), safety glasses (or goggles) and face shield where splash potential exists

SHARPS:

- Engineered sharps: commonly used sharps (e.g. scalpels, syringes, needles, glass pipets) that have physical attributes or mechanisms that decrease the risk of injury
- Cal/OSHA requires any laboratory using human or primate blood, blood products, cell lines, tissues or other potentially infectious materials to use needleless systems and/or engineered sharps
- If a PI/supervisor decides that a non-compliant sharp is necessary for a certain procedure, **the reason must be documented**; additional information can be found in the BBP exposure control plan

RESOURCES:

These requirements are based on the Division of Occupational Safety and Health (Cal/OSHA) [Bloodborne Pathogens Standard](#) (T8 CCR 5193) and the CDC publication, [Biosafety in Microbiological and Biomedical Laboratories \(BMBL\) 5th Edition](#).

For information on the types and use of Biosafety cabinets, including what not to do, see [Biosafety Cabinet Use and Safety](#).

Additional information, including videos on how to work in a Biosafety cabinet, can be found on the [Biosafety web page](#) under Equipment, Biosafety Cabinets.

Contact Biosafety at Stanford University EH&S with questions (723-0448)

Figure 1. Stanford Universal Precautions.

Select Agents and Toxins

Select Agents and Toxins are a collection of designated infectious agents and toxins that, by their nature, have the potential to pose a severe threat to public health and safety; this threat has resulted in the creation of a number of legislative acts.

Initiated with the [Antiterrorism and Effective Death Penalty Act of 1996](#), and bolstered by the [USA Patriot Act](#) of 2001, and the [Public Health Security and Bioterrorism Preparedness and Response Act of 2002](#), the Select Agents and Toxins program oversees the transfer, possession, and use of biological agents (viruses, bacteria) and toxins that have the potential to be a severe threat to public or environmental health. Possession of the specified agents or toxins without registration carries severe civil and criminal penalties. Possession of Select Agents or Toxins over exempt amounts is not allowed at Stanford at this time and would require prior approval from the Vice Provost and Dean of Research and registration with the NSAR Program. The application and further information may be found on the National Select Agents Registry (NSAR) website: www.selectagents.gov.

The list of Select Agents is constantly changing; a copy of the list of as June 2014 is in [Appendix D](#); the list can be found in its most updated form at http://ehs.stanford.edu/researchlab/bio/docs/select_agent_list.pdf.

Stanford University is currently not registered for possession of select agents. For use of any biological select agent, contact the Biosafety Program.

Stanford University Select Toxins Program

Possession of small quantities of select toxins may be exempt from registration with the NSAR program. The Stanford Select Toxins Program summarizes the University's requirements for possession of NSAR Select Toxins under the exempt quantities. For additional information please go to the EH&S web site ([Select Agent Toxins at Stanford University](#)).

Requirements for Research with Prions and Prion-Like Proteins

Per NIH guidelines (<http://osp.od.nih.gov/office-biotechnology-activities/biosafety/nih-guidelines>) and the Stanford University Administrative Panel on Biosafety policy (see [Chapter 4, Charge to the APB](#)), the APB

requires researchers to have an approved APB protocol and follow specific guidelines for working with prions and prion-like proteins.

For APB oversight, prions and prion-like proteins are defined as proteins (human or animal) that fall into one of the below categories:

1. Proteins that are highly associated with proteinopathies, including, but not limited to
 - a. Major prion protein/PrP/CD230 (Creutzfeldt-Jakob Disease [CJD], variant Creutzfeldt-Jakob Disease [vCJD], Kuru, fatal familial insomnia, bovine spongiform encephalopathy, Gerstmann-Straussler-Scheinker syndrome),
 - b. Alpha-synuclein (Parkinson's disease),
 - c. Tau, beta-amyloid (Alzheimer's disease),
 - d. Tau, RNA-binding protein *Fused in Sarcoma* (FUS) (Frontotemporal lobar dementias),
 - e. Polyglutamine-containing proteins (polyQ) (Huntington's disease),
 - f. Superoxide dismutase 1 (SOD1); transactivation response element (TAR) DNA-binding protein-43 (TDP-43); RNA-binding protein *Fused in Sarcoma* (FUS); Ubiquilin (ALS/Lou Gehrig's disease).
2. Proteins that confer a disease state that is transmissible from cell to cell.
3. Proteins that have a fibrillar or aggregated form that has been shown to "seed" a pathology associated with a disease.

Specific *in vitro* or *in vivo* work with such proteins is classified as BSL2 or ABSL2 and **requires** an APB-approved protocol. This includes, but is not limited to, the following types of work:

1. Synthesis, use or production of protein in high concentration
2. Generation or use of mutated proteins
3. Generation or use of fibrillar or misfolded forms of proteins

APB protocols must include established prion disinfection/decontamination and destruction/disposal protocols, or specific Standard Operating Procedures (SOPs). These SOPs must be provided for review by the APB. If necessary, contact Biosafety for appropriate methods. Refer to the following references for established infection control guidelines for disinfection/decontamination:

1. World Health Organization Infection Control Guidelines
http://www.who.int/csr/resources/publications/bse/WHO_CDS_CSRAPH_2000_3/en/
2. Centers for Disease Control Prion Diseases
<http://www.cdc.gov/ncidod/dvrd/prions/index.htm>
3. Biosafety in Microbiology and Biomedical Laboratories
http://www.cdc.gov/biosafety/publications/bmbl5/BMML5_sect_VIII_h.pdf
4. Biosafety Manual (see [Chapter 9, Waste and Decontamination](#))

Good sense is the most evenly distributed thing in the world, for all people suppose themselves so well provided with it that even those who are the most difficult to satisfy in every other respect never seem to desire more than they have. It is not likely that everyone is mistaken; rather this attitude reveals that the ability to judge and distinguish the true from the false, which is properly what one calls good sense or reason, is in fact naturally equally distributed among all people. Thus the diversity of our opinions does not result from some of us being more reasonable than others, but solely from the fact that we conduct our thoughts along different paths, and consider different things. . . .

René Descartes: *Discourse on Method* (1637)

The NIH has mandated the presence of an Institutional Biosafety Committee for all organizations that come under NIH regulations. At Stanford University, this committee is called the **Administrative Panel on Biosafety (APB)**; the charge of the panel is as follows:

Charge To The Administrative Panel On Biosafety

(revised September 2013)

General Charge

The Administrative Panel on Biosafety reviews all University research and teaching activities involving the use of biohazardous agents and recombinant DNA molecules and synthetic nucleic acid (sNA) molecules that require approval ("biosafety activities"), as defined below. Through these reviews, the Panel ensures that the activities described in the previous sentence and the related facilities are in compliance with applicable University policies and external regulations.

The Panel advises the University and recommends policies to guide investigators and the Department of Environmental Health & Safety (EH&S) in carrying out the University's Biosafety Program in the acquisition, use, training, transfer, storage, disposal, and emergency response procedures for all biosafety activities. The Panel's objective shall be to ensure that such activities meet standards of good practices consistent with safety of personnel and the general public in ways that best facilitate relevant research or teaching activities of the University.

The Panel is responsible for reviewing all University projects conducted by Stanford faculty, staff, students and/or visiting scientists which involve biosafety activities at Stanford facilities. In addition, the Panel may be asked by the University administration to review research protocols on behalf of other institutions with which Stanford has formal affiliation agreements. Under Stanford's current "Institutional Biosafety Committee" agreement with the Veterans Affairs Palo Alto Health Care System (VAPAHCS), the Panel shall review all biosafety protocols from Stanford researchers located at the VAPAHCS and from VAPAHCS researchers not otherwise affiliated with Stanford University.

The Panel shall function so as to discharge the University's obligations placed upon the Panel by current governmental requirements, including those described in the NIH Guidelines, the Centers for Disease Control and Prevention (CDC) Guidelines, and Occupational Health & Safety Administration (OSHA) Regulations. To this end, the Panel shall assist protocol directors in meeting their responsibilities.

All biosafety activities involving the use of Biosafety Level 2 or 3 agents AND/OR non-exempt recombinant DNA AND/OR synthetic nucleic acid molecules as defined by the National Institutes of Health (NIH) shall be reviewed by the Panel regardless of the source of funding for the project. The Panel may approve research protocols with or without modifications, or withhold approval of all or any portion of a protocol. The Panel may delegate review and approval of protocols that meet specific requirements to a voting member of the panel. This subset of protocols must be agreed upon by the full Panel and approved by the Dean of Research.

All human subject protocols involving gene transfer, as defined in the NIH Recombinant DNA Research Guidelines, shall be reviewed by the Panel in coordination with the Administrative Panel on Human Subjects in Medical Research (see Review Process for Biosafety and Human Subjects Gene Transfer Experiments).

The Panel shall assess suspected or alleged violations of protocols, external regulations, or University policies which involve biosafety activities. Activities in which serious or continuing violations occur may be suspended by the Panel or the Institutional Biosafety Officer. In such cases, the Panel will immediately notify the affected investigator(s), the relevant school dean, the Vice Provost and Dean of Research, appropriate University officers and others as required by University policies and external regulations.

Upon request, the Panel shall review and comment on proposed external regulations dealing with biosafety. When appropriate, the Panel will formulate draft policies and procedures for approval by the appropriate University bodies and promulgation by the Vice Provost and Dean of Research.

Definitions

Biohazardous Agents:

- A. Infectious/pathogenic agents classified in the following categories: Biosafety level 2, 3, and 4
- B. Other agents that have the potential for causing disease in healthy individuals, animals, or plants.

Recombinant DNA Molecules:

- A. Molecules which are constructed outside living cells by joining natural or synthetic DNA segments to DNA molecules that can replicate in a living cell or,
- B. DNA molecules that result from the replication of those described in "A" above.

Synthetic Nucleic Acid Molecules:

- A. Can replicate or generate nucleic acids that can replicate in a living cell and/or
- B. Are designed to integrate into DNA and/or
- C. Produce a toxin with a LD50<100ng/kg body weight.

Synthetic nucleic acids that are deliberately transferred into one or more human subjects and:

- A. Are >100 nucleotides and/or
- B. Can integrate into the genome and/or
- C. Can replicate in a cell and/or
- D. Can be transcribed or translated.

Gene Transfer:

Delivery of exogenous genetic material (DNA or RNA) to somatic cells for the purpose of modifying those cells.

eProtocol Workflow:
submission,
review, revision
and approval

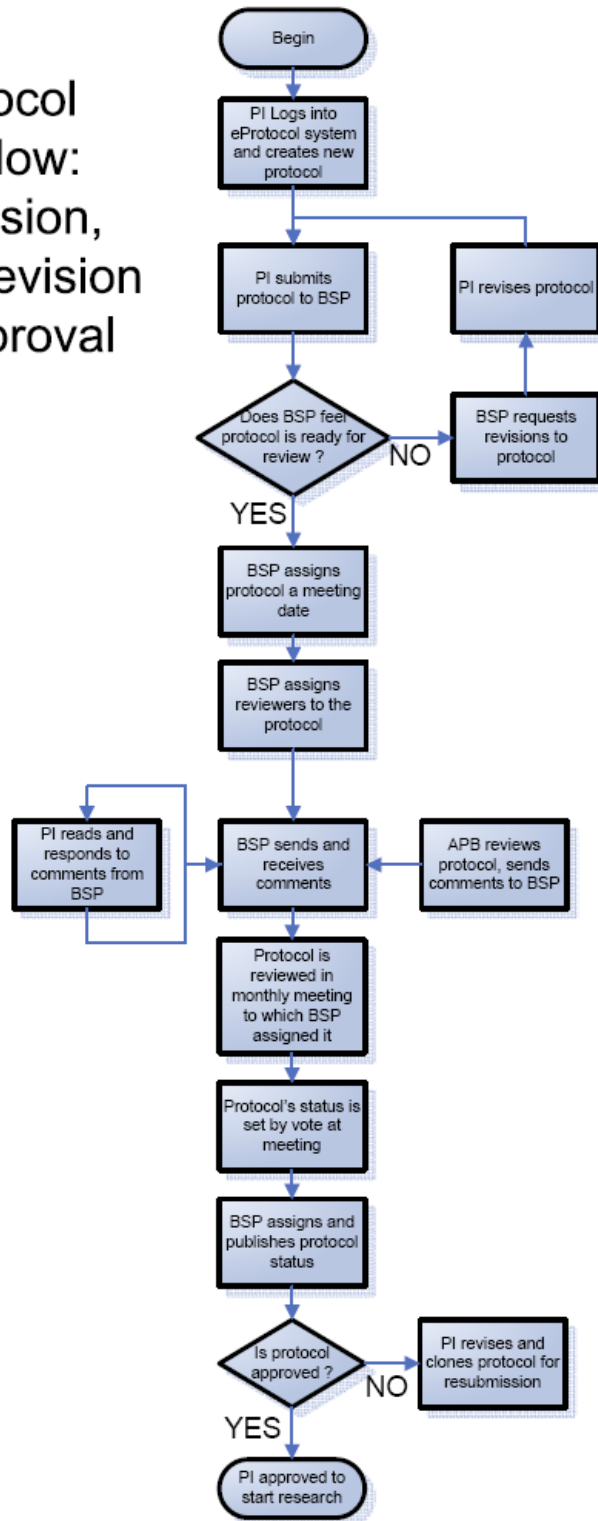


Figure 1. eProtocol Biosafety workflow.

The APB Review Process

At Stanford University, research involving rDNA/sNA and/or Biohazardous Agents is regulated by the NIH and comes under review of the Stanford University Administrative Panel on Biosafety (APB).

Research that involves the use of non-exempt materials as defined by the NIH (see Chapter 2) and clinical research that requires Institutional Biosafety Committee approval **MUST** be reviewed and approved by the APB prior to work being done. The APB uses the eProtocol system for submission and tracking of protocol.

The flow chart in Figure 1 illustrates the eProtocol Biosafety workflow.

Renewals and Amendments

Duration of approval for BSL- 2 projects is for three years, with a requirement for annual updates; BSL-3 and Clinical projects are approved for one year. Annual updates and revisions of projects are done through eProtocol Biosafety.

For information about eProtocol Biosafety, go to: <https://eprobio.stanford.edu/>.

Life happens – be prepared.

Fortune cookie, 2001

Stanford University offers numerous training courses and materials for employees of all levels and backgrounds. A basic list of required trainings for laboratory workers is shown in Figure 1 (a hard copy of this poster is available through EH&S):

The course entitled Biosafety (EHS—1500—WEB), available through Stanford University Axess, provides the **basic Tier I level** training in Biosafety. Note: Laboratory workers in the Stanford University School of Medicine are required to complete Biosafety (EHS—1500—WEB), Chemical Safety for Laboratories (EHS—1900—WEB), and Compressed Gas Safety (EHS—2200—WEB). Alternatively, the course entitled Life Sciences Research Laboratory Safety Training (EHS—4875—WEB), which covers Biosafety, Chemical Safety and Compressed Gas Safety, can be completed.

For personnel who will be handling **bloodborne pathogens (BBP)**, which includes but is not limited to human or non-human primate blood, blood products or cells (primary or cell lines), Hepatitis B, Hepatitis C, and HIV, **Tier II level training is mandatory** and is available under Bloodborne Pathogens (EHS—1600—WEB). This course is entirely web based and requires annual updates (EHS—1601—WEB), also available through Stanford University Axess. To help determine if a worker is at risk for contact with BBP, please use the questions listed below:

Will the person:

- Work with human blood, blood products or body fluids?
- Work with unfixed human cells (**including tissue culture cells and cell lines**), human tissues or organs?
- Work with non-human primates (NHP) or NHP blood, blood products or body fluids?
- Work with unfixed NHP cells (including tissue culture cells and cell lines), NHP tissues or organs?
- Work with bloodborne pathogens (e.g. HIV, Hepatitis B, Hepatitis C or other infectious agents able to be spread via blood)?
- Work with animals or animal tissues that have been infected with a BBP?

REQUIRED TRAINING FOR LABORATORY WORKERS

These courses are designed to ensure compliance with applicable external regulatory requirements.

| Course title and STARS number: | Must be taken by all who: | Notes on taking the course: |
|--|---|--|
| General Safety, Injury Prevention (IIPP) and Emergency Preparedness EHS-4200-WEB | ...work at Stanford University | Register and launch through http://axess.stanford.edu |
| Life Sciences Research Lab Safety EHS-4875-WEB | ...work in life sciences research laboratories in the SOM, as well as others working with biological agents, hazardous chemicals and compressed gases** | Register and launch through http://axess.stanford.edu |
| Biosafety EHS-1500-WEB | ...work with biological agents** | Register and launch through http://axess.stanford.edu |
| Chemical Safety for Laboratories EHS-1900-WEB | ...work with chemicals** | Register and launch through http://axess.stanford.edu |
| Compressed Gas Safety EHS-2200-WEB | ...work with compressed gas cylinders** | Register and launch through http://axess.stanford.edu |
| Laboratory Ergonomics EHS-4800 | ...perform repetitive tasks such as microscope use, pipetting, and miscellaneous hand tool use | This is a classroom course. Register through http://axess.stanford.edu |
| Computer Workstation Ergonomics EHS-3400-WEB | ...use a computer routinely | Register and launch through http://axess.stanford.edu |
| Bloodborne Pathogens EHS-PROG-1600 EHS-PROG-1601 (Recert) | ...work with human and/or non-human primate blood, blood products, cells (including tissue culture) or other potentially infectious material | BBP training must be taken annually. Register and launch through http://axess.stanford.edu Everyone who must take BBP must also create and/or update an Exposure Control Plan annually. |
| Radiation Safety Training EHS-5250 | ...work with radioactive materials | This is a classroom course. To register, call 723-3202 |
| Laser Safety EHS-PROG-4820 EHS-PROG-4821 (Recert) | ...work with Class 3 or 4 lasers | Must be taken every 3 years. Register and launch through http://axess.stanford.edu |
| DOT: Excepted Quantities EHS-PROG-2650 EHS-PROG-2651 (Recert) | ...who are required to identify, package and air ship small quantities of hazardous chemical materials | Must be taken every two years. Register and launch through http://axess.stanford.edu |
| DOT: Shipping Dangerous Biological Goods or Dry Ice EHS-PROG-2700 EHS-PROG-2701 (Recert) | ...package and/or ship dangerous biological materials, or who package and/or ship any packages containing DRY ICE | Must be taken every two years. Register and launch through http://axess.stanford.edu |
| Cryogenic and Dry Ice Safety EHS-2480 | ...work with cryogenic liquids and/or dry ice | This is a classroom course. To register, call 723-0448 |
| Orientation for Lab Safety Coordinators EHS-5200 | ...who are assigned safety/compliance tasks by their PI or lab supervisor | This is a classroom course. To register, call 723-0448 |
| Controlled Substances EHS-2125-WEB | ...work with controlled substances | Register and launch through http://axess.stanford.edu |
| Fire Extinguisher Training EHS-3825 (classroom) EHS-3850-WEB | ...work at Stanford University | To register for classroom, call 723-0448. Register and launch through http://axess.stanford.edu |
| Other courses as necessary | This is not a complete list of safety training courses that you may be required to take | Please go to http://trainingadvisor.stanford.edu for help identifying the safety training that is required for your work. |

** EHS-4875-WEB contains all content in the three courses EHS-1500-WEB, EHS-1900-WEB, and EHS-2200-WEB. Take EHS-4875 if you work in a School of Medicine research laboratory, or else in a research laboratory involved with biological agents, hazardous chemicals AND compressed gases. If you do not work in a School of Medicine research laboratory BUT work with only one or two of the Biological, Chemical or Compressed Gas categories, you should *instead* take the separate courses.

For questions call: 723-0448

Revised July 2014

Figure 1. Stanford training courses for laboratory workers.

- Perform tasks which may potentially result in exposure to human or animal blood, body fluids, organs, or tissues which are infected with the hepatitis B virus or other bloodborne pathogens?
- Handle sharp instruments such as knives, needles, scalpels, or scissors which have been used by others working with human blood or other potentially infectious materials to include human organs, tissue or body fluids OR used by others working with similar body parts and fluids from animals infected with the hepatitis B virus or other bloodborne pathogens?

The course entitled Biosafety (EHS—1500—WEB), available through Stanford University Axess, provides the **basic Tier I level** training in Biosafety. Note: Laboratory workers in the Stanford University School of Medicine are required to complete Biosafety (EHS—1500—WEB), Chemical Safety for Laboratories (EHS—1900—WEB), and Compressed Gas Safety (EHS—2200—WEB). Alternatively, the course entitled Life Sciences Research Laboratory Safety Training (EHS—4875—WEB), which covers Biosafety, Chemical Safety and Compressed Gas Safety, can be completed.

For personnel who will be handling **bloodborne pathogens (BBP)**, which includes but is not limited to human or non-human primate blood, blood products or cells (primary or cell lines), Hepatitis B, Hepatitis C, and HIV, **Tier II level training is mandatory** and is available under Bloodborne Pathogens (EHS—1600—WEB). This course is entirely web based and requires annual updates (EHS—1601—WEB), also available through Stanford University Axess. To help determine if a worker is at risk for contact with BBP, please use the questions listed below:

Will the person:

- Work with human blood, blood products or body fluids?
- Work with unfixed human cells (**including tissue culture cells and cell lines**), human tissues or organs?
- Work with non-human primates (NHP) or NHP blood, blood products or body fluids?
- Work with unfixed NHP cells (including tissue culture cells and cell lines), NHP tissues or organs?
- Work with bloodborne pathogens (e.g. HIV, Hepatitis B, Hepatitis C or other infectious agents able to be spread via blood)?
- Work with animals or animal tissues that have been infected with a BBP?
- Perform tasks which may potentially result in exposure to human or animal blood, body fluids, organs, or tissues which are infected with the hepatitis B virus or other bloodborne pathogens?
- Handle sharp instruments such as knives, needles, scalpels, or scissors which have been used by others working with human blood or other potentially infectious materials to include human organs, tissue or body fluids OR used by others working with similar body parts and fluids from animals infected with the hepatitis B virus or other bloodborne pathogens?

If the answer to **ANY** of the above questions is yes, then the worker is considered to be at occupational risk of contracting Hepatitis B or other bloodborne pathogens. All workers at risk **MUST** take the Bloodborne Pathogen Training. Registration and completion of the appropriate above mentioned courses are required within the first month of work at Stanford University. **Additionally, the worker must complete Bloodborne Pathogens Part II: Exposure Control Plan** (see Chapter 6) in conjunction with their supervisor. Supervisors or PIs who oversee workers that are required to take Bloodborne Pathogens training are themselves required to take Bloodborne Pathogens training even if they will not be potentially exposed to bloodborne pathogens.

Tier III training is conducted by the PI or laboratory supervisor. This will be a combination of the [Stanford University Local Exposure Control Plan](#) (if appropriate, see Chapter 6) and training suitable for each individual. In a laboratory environment, the type of experiments being conducted, nature of the material used, and the equipment used would determine the required types of training. **Written documentation of Tier III training must be recorded and retained by the PI.**

According to the NIH Office of Biotechnology Activities, the PI is responsible for the following (http://osp.od.nih.gov/sites/default/files/resources/InvestigatorEducationalBrochureRecombinant%20DNA_0.pdf):

- Be adequately trained in good microbiological techniques
- Provide laboratory research staff with protocols describing potential biohazards and necessary precautions
- Instruct and train laboratory staff in: (i) the practices and techniques required to ensure safety, and (ii) the procedures for dealing with accidents
- Inform the laboratory staff of the reasons and provisions for any precautionary medical practices advised or requested (e.g. vaccinations or serum collection)
- Supervise laboratory staff to ensure that the required safety practices and techniques are employed
- Correct work errors and conditions that may result in the release of recombinant DNA or synthetic nucleic acid (sNA) materials
- Ensure integrity of physical and biological containment
- Comply with permit and shipping requirements for recombinant or synthetic nucleic acid molecules
- Adhere to APB-approved emergency plans for handling accidental spills and personnel contamination

If required, training and certification for shipping of dangerous biological materials and/or dry ice must be completed. Additional information on this is found in Chapter 8.

6

Bloodborne Pathogens, Aerosol Transmissible Diseases & Medical Surveillance

This is the story of Leeuwenhoek, the first of the microbe hunters. It is the tale of the bold and persistent and curious explorers and fighters of death who came after him.....some of them who were too bold have died – done to death by the immensely small assassins they were studying – and these have passed to an obscure small glory.

Paul De Kruif, Microbe Hunters (1926), Harcourt, Brace and Co., pub, pg. 3

Bloodborne Pathogens

In 1993, CAL/OSHA published the Bloodborne Pathogens Rule (Title 8 CCR GISO 5193); the fundamental premise of this rule is an approach to infection control termed *Universal Precautions*. *Universal Precautions* assumes that all human blood, blood products, and certain body fluids are contaminated with HIV, HBV, HCV, or other bloodborne pathogens and that these materials be handled accordingly.

The Bloodborne Pathogens Standard (29 CFR, Bloodborne Pathogens. - 1910.1030) applies to all occupational exposure to blood or other potentially infectious materials. **Blood** means human blood, human blood components, and products made from human blood. **Bloodborne Pathogens** means pathogenic microorganisms that are present in human blood and can cause disease in humans. These pathogens include, **but are not limited to**, hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus (HIV). Additionally, “**Other Potentially Infectious Materials**” (OPIM) are included under this standard. OPIM means (1) The following human body fluids: semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures, any body fluid that is visibly contaminated with blood, and all body fluids in situations where it is difficult or impossible to differentiate between body fluids; (2) Any unfixed tissue or organ, including cells and cell lines, (other than intact skin) from a human (living or dead); and (3) HIV-containing cell or tissue cultures, organ cultures, and HIV- or HBV-containing culture medium or other solutions; and blood, organs, or other tissues from experimental animals infected with HIV, HBV or HCV. The above additionally applies to Non-human primate materials.

The following are specific actions Stanford University has taken to minimize exposures to bloodborne pathogens:

Bloodborne Pathogen Training program – All Stanford University faculty, staff, and students who have potential exposure to blood or blood products shall be trained annually (see Chapter 5). Additionally, PIs who oversee personnel with potential exposure to blood or blood products shall themselves be trained annually (see Chapter 5).

Bloodborne Pathogens Part II: Exposure Control Plan – The [Stanford University Institutional Exposure Control Plan](#) (Institutional ECP) is designed to comply with the California OSHA Bloodborne Pathogens Standard (8 CCR • 5193). The Institutional ECP addresses issues related to the elimination or minimization of Stanford University personnel exposure to human blood/bloodborne pathogens (BBPs)/other potentially infectious materials (OPIM). **Principal Investigators (PIs) and supervisors should refer to the Institutional ECP as a resource for exposure control background, issues and regulatory procedures.**

Bloodborne Pathogens Part II: Local Bloodborne Pathogen Exposure Control Plan – The BBP Part II: Local ECP ([Appendix E](#)) is designed to aid the PI/Supervisor in completing requirements for the BBP Standard. **It is the responsibility of the PI/Supervisor to review the Local ECP with input from employees covered by the Bloodborne Pathogen Standard**, with the goal of minimizing personnel exposure to bloodborne pathogens (BBPs) in blood or other potentially infectious materials (OPIMs).

Use the Local ECP to:

- Guide identification of procedures and materials in the laboratory that have the possibility of exposing personnel to BBPs (Local ECP [Appendix A](#))
- Review methods of compliance to ensure a safe work environment and document training (Local ECP [Appendix B](#))
- Determine appropriate engineering and work practice controls, including appropriate use of safety sharps (Local ECP [Appendix C](#))
- Review requirements for reporting and documenting sharps injuries
- Ensure participation in the Stanford University Medical Surveillance Program

→ **The Local ECP shall be completed and reviewed by the PI/Supervisor and personnel annually and/or as needed by job changes. Upon review, complete Local ECP Appendixes A and B; complete**

Appendix C as needed. The completed Local ECP shall be located in the laboratory for reference and documentation of compliance.

See the Stanford University [Biosafety](#) home page for additional information and links.

Hepatitis B vaccine program – University employees with potential for any exposure to blood or body fluids as a part of their work at Stanford University will be offered Hepatitis B vaccine at no cost to the employee. While Stanford University encourages employees to be vaccinated, accepting vaccination is not a condition of employment. Employees and students (including post-doctoral fellows, graduate students, and medical students) that are offered the vaccine are required to either accept the vaccine or sign a declination form (available in [Appendix F](#)).

School of Medicine personnel must follow requirements found at: [SoM HepB Vaccination](#)

For additional information about the Hepatitis B vaccine and occupational exposure to the virus, see [Occupational Exposure to Hepatitis B Virus \(HBV\)](#) by the Stanford University Occupational Health Center or contact the Stanford University Occupational Health Center ([SUOHC](#)) for additional information (650.725.5308).

Aerosol Transmissible Diseases

The [Stanford University Institutional Aerosol Transmissible Disease Program](#) (Institutional ATD) is designed to comply with the California OSHA Aerosol Transmissible Disease Standard ([Title 8, Section 5199](#)). The Institutional ATD addresses issues related to the elimination, minimization and protection of Stanford University personnel to airborne transmissible diseases from both humans and animals (zoonotic diseases). **Principal Investigators (PIs) and supervisors should refer to the Institutional ATD as a resource for exposure control background, issues and regulatory procedures.**

Research Laboratories

The [Stanford University Local Aerosol Transmissible Disease Biosafety Plan- Laboratories](#) (Local ATD-Labs) is specifically directed towards research laboratory workers.

The ATD requires laboratories to adopt standard biosafety practices to protect laboratory workers when handling materials containing pathogens that may be spread through aerosols and which can cause serious disease. In addition, the employer is required to develop, implement, and annually review, a written ATD Biosafety Plan (Plan). The **Stanford University Administrative Panel on Biosafety** (APB) includes, as part of its charge and following the Biosafety in Microbiological and Biomedical Laboratories ([BMBL](#)),

oversight of issues covered within the California OSHA Aerosol Transmissible Disease (ATD) standard. As such, an approved APB protocol shall cover most requirements for laboratories.

Additional information along with the plans and forms are located on the [Biosafety](#) webpage under Safety/Medical Monitoring, Aerosol Transmissible Disease Program.

The completed Plan includes the Local ATD document along with approved APB protocol(s). Review the Plan annually or when changes are made (new personnel, agents, SOPs, etc.). The Plan shall be filed in a central location within the laboratory/work place for all personnel to access and to be made readily available to authorities in event of a regulatory inspection of the facility.

Department of Public Safety

The [Stanford University Local Aerosol Transmissible Disease Biosafety Plan - Department of Public Safety](#) (Local ATD - DPS) supplements the [Stanford University Institutional Aerosol Transmissible Disease Program](#) for the DPS. The Local ATD-DPS addresses how to eliminate or minimize exposure to materials containing pathogens that may be spread through aerosols and which can cause serious disease. The Local ATD-DPS addresses health and safety issues specific to the jobs and procedures being used by personnel and constitutes a Tier III training for these topics.

The ATD Standard requires the use of feasible engineering and work practice controls to limit exposure to aerosols, and, when necessary, the provision of personal protective equipment and respirators. **The Local ATD - DPS constitutes a written Biosafety Plan (BSP), which shall be implemented and reviewed annually.**

Additional information along with the plans and forms are located on the [Biosafety](#) webpage under Safety/Medical Monitoring, Aerosol Transmissible Disease Program.

Review the Plan annually or when changes are made (new personnel, procedures, etc.). The Plan, including training documentation, shall be filed in a central location within the work place for all personnel to access and to be made readily available to authorities in event of a regulatory inspection of the facility.

Zoonotic: On-site and Field studies

[The Stanford University Local Transmissible Diseases Plan - Zoonotic \(Local ATD - Zoonotic\)](#) supplements the Stanford University Institutional Aerosol Transmissible Disease Program for employees with exposure to animals. The Local ATD-Zoonotic addresses how to eliminate or minimize exposure to materials containing pathogens that may be spread through aerosols and which can cause serious disease. The Local ATD- Zoonotic addresses health and safety issues specific to the jobs and procedures being used by

personnel and constitutes a Tier III training for these topics. The ATD Standard requires the use of feasible engineering and work practice controls to limit exposure to aerosols, and, when necessary, the provision of personal protective equipment and respirators. **The Local ATD - Zoonotic constitutes a written Biosafety Plan (BSP), which shall be implemented and reviewed annually.**

On-site Research

The **Stanford University Administrative Panel on Biosafety** (APB) includes, as part of its charge and following the Biosafety in Microbiological and Biomedical Laboratories ([BMBL](#)), oversight of issues covered within the California OSHA Aerosol Transmissible Disease (ATD) standard. As such, an approved APB protocol shall cover requirements for researchers with potential exposure to Zoonotic diseases (ABSL-2 or above).

The completed Plan includes the Local ATD-Zoonotic document along with approved APB protocol(s). The Plan shall be filed in a central location within the laboratory/work place for all personnel to access and to be made readily available to authorities in event of a regulatory inspection of the facility.

Additional information along with the plans and forms are located on the [Biosafety](#) webpage under Safety/Medical Monitoring, Aerosol Transmissible Disease Program.

Field Studies

For work with wildlife likely containing zoonotic Aerosol Transmissible Pathogens, such as:

- Capture, sampling, transportation or disposal of wild birds or other wildlife for research purposes.
- Disposal of such wildlife remains or waste by employees.

The Local ATD-Zoonotic includes how to establish, implement, and maintain effective procedures for preventing employee exposure to zoonotic aerosol transmissible pathogens; once complete, this shall be kept, along with updates and training records, in a location available for reference by personnel and regulators.

Complete and review the Plan (use information and training materials provided with the Plan) with all applicable employees; document training on sheet provided. Review the Plan annually or when changes are made (new personnel, procedures, etc.). The Plan shall be filed in a central location within the laboratory/work place for all personnel to access and to be made readily available to authorities in event of a regulatory inspection of the facility.

Additional information along with the plans and forms are located on the [Biosafety](#) webpage under Safety/Medical Monitoring, Aerosol Transmissible Disease Program.

Vaccinations

Vaccinations are available for many etiologic agents used in the laboratory. The Stanford University Occupation Health Center (SUOHC) medical staff, in conjunction with the Administrative Panel on Biosafety (APB) and the Biosafety Officer, will make the recommendation for the use of vaccinations on a case-by-case basis.

Medical Surveillance

Medical surveillance may be required for both those workers who use biohazardous agents, as well as any animal handler who must tend to animals inoculated with etiologic agents. Some animals may be infected with agents not related to the research, such as sheep whose body fluid may contain *Coxiella burnetii*, the causative agent for Q-fever. The Department of Comparative Medicine will work with the Biosafety Officer and the Stanford University Occupational Health Center to identify animal handlers who may be at risk for occupational exposure to infectious microorganisms in the course of their duties.

Procedures for receiving a medical examination:

- A. Each University School/Department shall administer the Medical Surveillance program for its employees. The supervisor shall identify employees who may be at risk for occupational exposure to biological agents. The SUOHC staff can assist the supervisor if a medical examination is appropriate.
- B. The Department/School will schedule a medical appointment with:

Stanford University Occupational Health Clinic

Environmental Safety Facility (ESF)

480 Oak Road, Room B15

Stanford, CA 94305-8007

Phone: (650) 725-5308

<http://ehs.stanford.edu/researchlab/IH/SUOHC/index.html>

- C. Upon completion of the medical examination, the participant will be notified by the examining physician to review the results. Appropriate referrals will be made at this time in the event of abnormal findings. EH&S will receive one copy of the medical clearance form from the Occupational Health Clinic. This form will describe the participant's ability to work with biological agents, work in the particular environment or other condition that initiated the examination. The Occupational Health Clinic will also send a copy of the clearance form to the requesting department.
- D. If there is a restriction indicated on the clearance form that inhibits an individual's ability to complete a job, then the supervisor shall notify the Biosafety Officer to discuss a remedial course of action.
- E. Medical records will be kept at the Occupational Health Clinic for the duration of the individual's participation in the Medical Surveillance Program at Stanford University. A copy of the medical surveillance clearance form will be kept by the department and at EH&S.

Laboratory Animal Occupational Health Program (LAOHP)

Mandated by federal requirements and external laboratory animal care accreditation agencies, the primary goal of the LAOHP is to evaluate and, if necessary, address potential health risks to personnel that may be associated with their use of animals in the research environment. University policy requires that all faculty, staff, visiting scholars, and students who work directly with vertebrate animals, unfixed animal tissues or body fluids, and those who work in animal housing areas must participate in the LAOHP. Continuing authorization to use animals is contingent upon your participation in the program. For information on how to enroll, please see the [LAOHP page](#) on the Environmental Health & Safety (EH&S) web site.



Biosafety is a two-way path involving the creation of a safe working environment for all personnel and ensuring that the work being done does not impact the environment. It is essential to understand that the most important factor in biosafety is the laboratory worker. Good work practice, facility design, training, and protective clothing all fall to the wayside in the presence of a worker who is ignorant or uncaring of proper work procedures.

There are obvious dangers to working with infectious agents/rDNA/sNA. Pathogens can infect a host through a number of routes, and it is important to be aware that a laboratory-acquired infection may not follow the same route as a naturally occurring one. The following are some of the more common accidents that can result in infection, listed in decreasing order of occurrence:

- Spills and splashes
- Needle and syringe sticks
- Sharp objects (including glass)
- Animal bite or scratch
- Mouth pipetting

Universal Precautions

The concept of universal precautions is to treat all human/primate blood and other body fluids, tissues and cells as if they were known to be infectious for BBPs. Universal Precautions includes frequent handwashing, no mouth pipetting, no food or drink in the lab and proper disposal of biohazardous/medical waste, as well as the use of engineering controls and Personal Protective Equipment (PPE). Engineering controls include items such as biosafety cabinets, ventilation systems, closed top centrifuge rotors, etc.; these are the primary methods to control exposure. PPE such as gloves, lab coats, eye protection, face shields or others must be selected and used as appropriate. See also Chapter 3.

Safety Engineered and Needleless Sharps

Manufacturers have developed “engineered sharps”. These are commonly used items (e.g. scalpels, syringes, needles) that have various mechanical devices to vastly decrease the occurrence of injuries due to sharps. CAL-OSHA **requires** any laboratory using human or primate blood, blood products, cell lines, tissues or other potentially infectious materials to use needleless systems/and or engineered sharps. If a PI/supervisor decides that a non-compliant sharp is necessary for a certain procedure, the reason must be documented in Appendix C of the Local Exposure Control Plan (ECP).

Biological Safety/Biosafety Cabinets

Biological safety cabinets (BSC) are designed to provide three types of protection:

- Protection for personnel from material inside the cabinet
- Protection for the material inside of the cabinet from personnel and the environment
- Protection for the environment from the material inside of the cabinet

There are three types of BSCs, Class I, II, and III. Class I are designed to provide personnel and environmental protection only. The material (research experiment) inside the cabinet is not protected and thus subject to contamination. The use of Class I BSCs is not advised at Stanford; talk to biosafety if you feel you need to purchase one.

Class II cabinets meet requirements for the protection of personnel, product and the environment. There are four types of Class II cabinets (A, B1, B2, and B3), each differentiated according to the method by which air volumes are recirculated or exhausted.

Class II, type A: The Class II, type A biosafety cabinet does not have to be vented, which makes it suitable for use in laboratory rooms which cannot be ducted. This cabinet is acceptable for use of low to moderate risk agents in the absence of volatile toxic chemicals and volatile radionuclides.

Class II, type B1: The Class II, type B1 biosafety cabinet must be vented. 30% of the air is exhausted from the cabinet while 70% is recirculated back into the room. This cabinet may be used with etiologic agents treated with minute quantities of toxic chemicals and trace amounts of radionuclides required as an adjunct to microbiological studies if work is done in the directly exhausted portion of the cabinet, or if the chemicals or radionuclides will not interfere with the work when recirculated in the downflow air.

Class II, type B2: The Class II, type B2 biosafety cabinet must be totally exhausted. 100% of the air from the cabinet is exhausted through a dedicated duct. This cabinet may be used with etiologic agents treated with toxic chemicals and radionuclides required as an adjunct to microbiological studies.

Class II, type B3: The Class II, type B3 biosafety cabinet must be vented. 70% of the air is exhausted from the cabinet while 30% is recirculated. This cabinet may be used with etiologic agents treated with minute quantities of toxic chemicals and trace quantities of radionuclides that will not interfere with work if recirculated in the downflow air.

Class III cabinets are gas-tight, designed for use with high-risk (BSL-4) agents. There are no Class III cabinets at Stanford University.

Liquid waste

A vacuum flask system is required to provide protection to the central building vacuum system or vacuum pump and to personnel who service the equipment. Figure 1 illustrates a proper set-up for handling liquid waste. Additionally, flasks A and B must be placed in secondary containment.

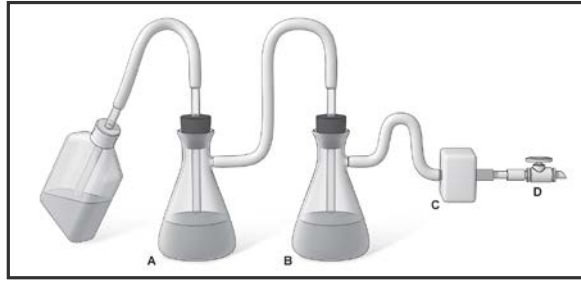


Figure 1. Liquid Waste. The left suction flask (A) is used to collect the contaminated fluids into a suitable decontamination solution; the right flask (B) serves as a fluid overflow collection vessel. An in-line HEPA filter (C) is used to protect the vacuum system (D) from microorganisms.

Stanford University has taken a strong stance against the use of gas burners or alcohol flames in biosafety cabinets. The use of such devices is not only extremely dangerous, but can also inactivate manufacturer's warranties. There are many alternatives to the use of burners: microincinerator, disposable tissue culture supplies, etc. Please consult with the biosafety manager if you have any questions.

Installation and maintenance of BSCs

Installation of cabinets must be done by certified professionals. Stanford University has a contract with a certified company for installation, cabinet certification (must be done annually), decontamination and any other needs that may arise. Arrangements and payment for any of the above work must be scheduled by the PI or the department. For more information go to the Equipment tab, Biosafety Cabinets tab on the Biosafety web site (<http://web.stanford.edu/dept/ehs/prod/researchlab/bio/index.html>).

Signs and Hazard Communication

All laboratories that are approved by the Stanford APB must have a sign on the outside of the door indicating that biohazardous material is used within the room. Investigators who are using BSL2 or 3 agents or rDNA/sNA are required by the NIH to post a sign that incorporates the universal biohazard symbol on the outer laboratory door (Figure 2). The sign must include the agent name, biosafety level, and specific requirements for entry, the PI's name and spaces for two phone numbers of laboratory staff in case contact must be made. Biohazard signs are available through EH&S.

The Bloodborne Pathogen Standard also requires that red-orange coded biohazard labels be placed on storage freezers, refrigerators, any laboratory equipment used with BSL2 or 3 agents, shipping containers,

medical waste containers or any surface which may be reasonably anticipated to encounter surface contamination from biohazardous materials. These labels are available through EH&S.



Figure 2. Universal biohazard symbol.

For information regarding Universal Precaution signs, see Chapter 3.

Exposures

If an exposure or injury occurs during work hours and it is not a medical emergency, personnel should go to the Stanford University Occupational Health Center (SUOHC). After hours and on weekends, personnel should go to the Stanford Hospital Emergency Department. Detailed information is available [on the SUOHC web page](#).

For any Exposure Incident, the following steps shall be taken:

- 1 Care for personnel -
 - a. If there has been a needlestick/puncture, wash the affected area with antiseptic soap and warm water for 15 minutes.
 - b. For a mucous membrane exposure, flush the affected area for 15 minutes using an eyewash.
- 2 If medical attention is needed, go to the Stanford University Occupational Health Clinic (non-life threatening incidents) or to the Stanford Hospital Emergency Department for medical emergencies or after hours. If a spill has occurred, contain and initiate clean up (see below).
- 3 Notify PI, manager or supervisor to initiate accident or exposure incident report.
- 4 Notify Biosafety (725.1473) of incident. After hours call 723.0448 and leave a message.

Reporting form: if an accident involving a sharps occurs with potential exposure to blood borne pathogens, complete an [SU-17](#).

Sharps Injury Report: If a sharps was involved, you will also need a [Sharps Injury Report Form](#)

Spill Response

The following procedures are provided as a guideline to biohazardous/rDNA/sNA spill cleanup. If the spill is considered too large or too dangerous for laboratory personnel to safely clean up, secure the entire laboratory and call EH&S (723.0448) immediately for assistance.

Bleach is recommended as a standard disinfectant; however, other disinfectants may be used, provided they are effective against the particular agents. Disinfectants must be used at the appropriate dilution for the required minimum contact time.

1. Inside the Biosafety Cabinet

- a. Wait at least five minutes to allow the BSC to contain aerosols.
- b. Wear laboratory coat, safety glasses and gloves during cleanup.
- c. Allow BSC to run during cleanup.
- d. Apply disinfectant and allow a minimum of 20 minutes contact time.
- e. Wipe up spillage with disposable disinfectant-soaked paper towels. Do not place your head in the cabinet to clean the spill; keep your face behind the viewscreen.
- f. Wipe the walls, work surfaces, and any equipment in the cabinet with disinfectant-soaked paper towels.
- g. Discard contaminated disposable materials using appropriate biohazardous waste disposal procedures.
- h. Place contaminated reusable items in biohazard bags or autoclavable pans with lids before autoclaving.
- i. Expose non-autoclavable materials to disinfectant (20 minutes contact time) before removal from the BSC.
- j. Remove protective clothing used during cleanup and place in a biohazard bag for removal
- k. Run BSC 10 minutes after cleanup before resuming work or turning BSC off.
- l. Wash hands with soap prior to leaving area.

Note: If the spill overflows the drain pan/catch basin under the work surface into the interior of the BSC, notify EH&S. A more extensive decontamination of the BSC may be required.

2. In the laboratory, outside the Biosafety Cabinet

- a. Evacuate Room – insure all personnel are accounted for and that doors are closed. Put notice on door informing personnel of spill and not to enter. Allow spill to settle (30 min.).
- b. Assemble clean-up materials (disinfectant, paper towels, biohazard bags and forceps).
- c. Put on appropriate PPE, including lab coat, shoe covers, gloves and eye/face protection.
- d. Initiate cleanup with disinfectant as follows:
 - i. Place paper towels or other absorbent material over spill area
 - ii. Carefully pour disinfectant around the edges of the spill and then onto the paper towels. Avoid splashing or generating aerosol droplets.
 - iii. Allow disinfectant to remain in contact with spill for at least 20 minutes
 - iv. Apply more paper towels to wipe up spill
 - v. Clean spill area with fresh towels soaked in disinfectant.
 - vi. Dispose of all towels or absorbent materials using appropriate biohazardous waste disposal procedures. If any sharp objects are present, use forceps and discard in a sharps container.
 - vii. Remove protective clothing and segregate for disposal or cleaning.
 - viii. Wash hands with soap prior to leaving area.

3. Inside a centrifuge

- a. Clear area of all personnel.
- b. Wait 30 minutes for aerosol to settle before attempting to cleanup spill.
- c. If a spill is identified after the centrifuge lid is opened, carefully close the lid, evacuate the laboratory and close the laboratory door. Remain out of laboratory for at least 30 minutes. Put notice on door informing personnel of spill and not to enter.
- d. Wear a laboratory coat, safety glasses and gloves during cleanup.
- e. Remove rotors and buckets to nearest BSC for cleanup.
- f. Thoroughly disinfect inside of centrifuge.
- g. Discard contaminated disposable materials using appropriate biohazardous waste disposal procedures.
- h. Wash hands with soap prior to leaving area.

4. Outside the laboratory

- a. To prevent a spill, transport labeled biohazardous material in an unbreakable, well-sealed primary container placed inside of a second unbreakable, lidded container (cooler, plastic pan or pail) labeled with the biohazard symbol, biosafety level and contact information.
- b. Should a spill occur in a public area, do not attempt to clean it up without appropriate PPE.

- c. Secure the area, keeping all people well clear of the spill.
- d. Call EHS at 724.0448 to assist in cleanup.
- e. Stand by during spill response and cleanup activity and provide assistance only as requested or as necessary.
- f. Wash hands with soap prior to leaving area.

Reporting

It is the responsibility of all Stanford personnel to report any exposures or unauthorized research using biohazardous agents and/or recombinant and synthetic nucleic acid material to the Biosafety Manager (esegal@stanford.edu, 725.1473). Initial reporting must be done at the earliest time possible, and within 24 hours of the incident; a more detailed report is to be submitted within 10 days. See the [Recombinant and Synthetic Nucleic Acid Molecule Incident Reporting Template](#) for additional information.

Beam me up, Scotty.

Captain James T. Kirk, Star Trek

If only it could work that way.... However, until we have a transporter, transportation of biohazardous goods requires a bit more planning and training.

Shipping of Biohazardous Goods Within Stanford University

Transport of biohazardous goods within Stanford University requires the use of proper secondary containment. Secondary containers can be a variety of items but must be leak-proof and have tight fitting covers. All containers must be labeled with a Biohazard sticker or label, biosafety level and contact information.

Shipping of Biohazardous Goods Off Stanford University

Transport of biohazardous goods off Stanford University requires training and certification prior to shipping. Federal (FAA, 49 CFR) and international agencies (ICAO, the branch of the United Nations that governs all international civil aviation matters, IATA, the International Air Transport Association) have in place numerous regulations for shipping of dangerous goods by surface or air. **Training is mandatory for shippers (the person sending out the package) and handlers (the people who transport the package)** and is based on these regulations. Non-conformance of these regulations can result in a fine and/or imprisonment. Stanford personnel located at Stanford facilities can take training by completing the Biological Shipping Training Course--EHS-2700, DOT: Shipping Biological Goods or Dry Ice, available through the STARS system via <http://axess.stanford.edu>.

Note that training certification is only valid for two years or until regulatory changes are implemented and **MUST** be re-taken at that time if needed.

What is a Dangerous (Biohazardous) Good?

According to the regulations, dangerous goods “are articles or substances which are capable of posing a significant risk to health, safety or to property when transported”. For biological material, the flow chart shown below in Figure 1 indicates which materials are regulated and which are not.

Note: Dry Ice is considered a Dangerous Good. Training and certification is required, and the package must be labeled and shipped

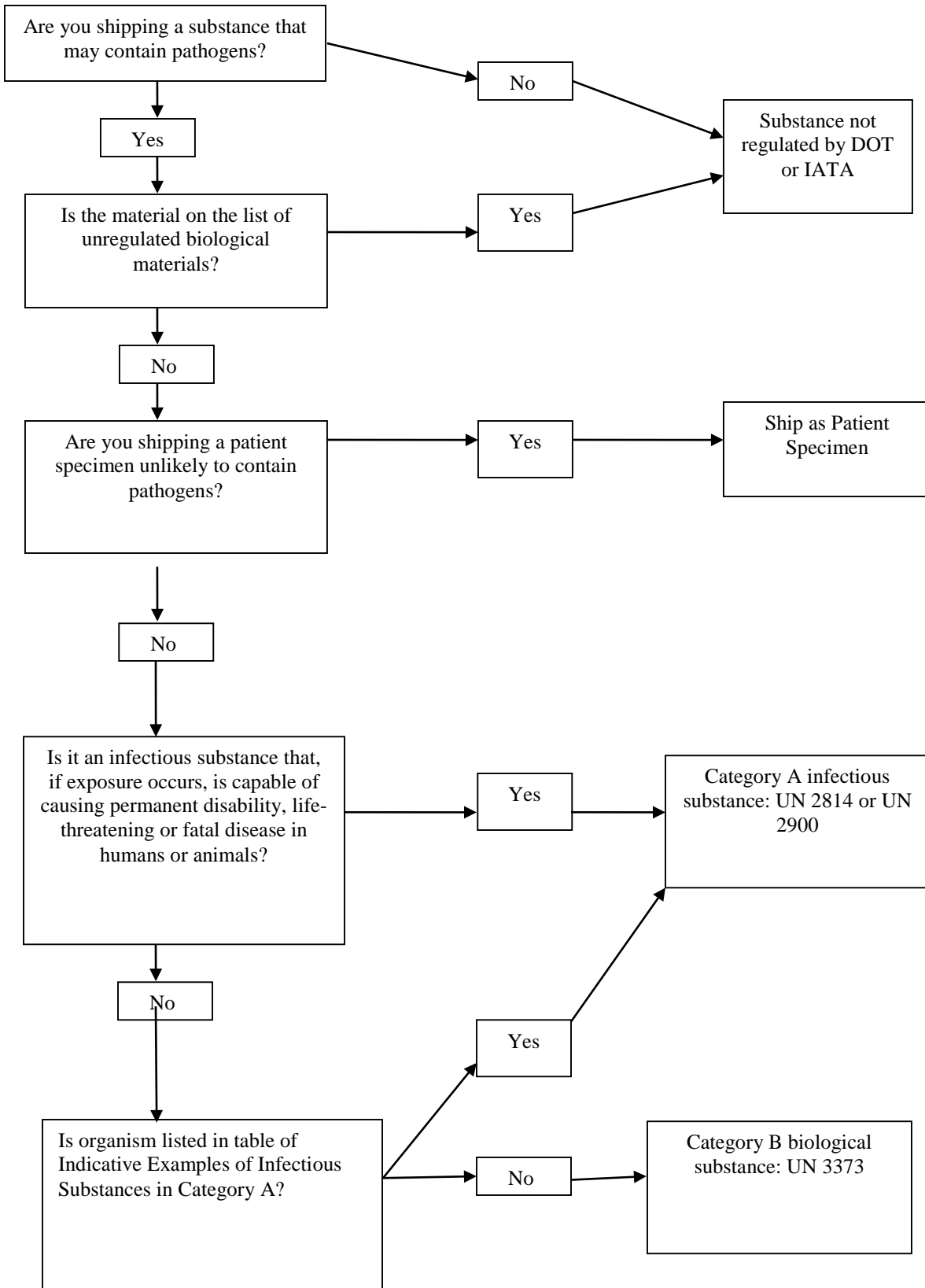
Export Controls Related to Biologicals and Toxins

The [Commerce Department](#), along with other federal agencies, regulates shipping of biologicals and toxins outside the U.S. **All** select agents and many biological agents and toxins are controlled for export, and require US government authorization in the form of an export license before they may be shipped internationally. Stanford University’s [Export Controls Website](#) identifies those agents and toxins requiring a license for export.

Stanford’s Export Control Officer **must** be contacted before any export-controlled biological or toxin is shipped abroad so that an export license can be obtained. **Note:** the export licensing process can take up to two months so plan well in advance. All other exports of biologicals need to be documented with the [appropriate export certification](#) signed by the responsible PI or researcher. An [Export Controls Decision Tree](#) is available to assist PIs and researchers with selecting the appropriate certification, as is Stanford’s Export Control Officer.

Please see Stanford’s Export Controls Website for additional details.

FIGURE 1. A FLOW CHART FOR CLASSIFICATION OF INFECTIOUS SUBSTANCES



FOR TRAINING TO BECOME CERTIFIED FOR SHIPPING OF BIOLOGICAL GOODS, COMPLETE DOT: SHIPPING DANGEROUS BIOLOGICAL GOODS EHS-2700 (STARS)

Importation of Biohazardous Goods onto Stanford University

The Federal Government, in its shipping and transportation standards, defines etiologic agents as microorganisms that cause disease in humans including the following: bacteria, bacterial toxins, viruses, fungi, rickettsia, protozoans, and parasites and prions. These disease-causing microorganisms may also be referred to as infectious agents or infectious substances, and the materials, such as body fluids and tissues that contain them, are referred to as infectious materials. When a package of infectious material is being imported into the United States, it must have an importation permit approved by the CDC. Organisms such as mosquitoes that might transmit infectious diseases to other humans are called vectors. Vectors may require permits from agencies such as the CDC, USDA or the California Department of Public Health.

It is important to obtain a CDC permit PRIOR to requesting an etiologic specimen from a source outside the United States. The Stanford University Administrative Panel on Biosafety will request that the Principal Investigator indicate the source of any agents used in experiments at Stanford during the application process. If the investigator intends to obtain the agent from outside the United States, a copy of the CDC permit will be requested by the APB as part of the APB review of the application.

Items Requiring Permits

Etiologic agents: It is impractical to list all of the several hundred species of etiologic agents. In general, an import permit is needed for any infectious agent known to cause disease in man. This includes, but is not limited to, bacteria, viruses, rickettsia, parasites, yeasts, and molds. In some instances, agents which are suspected of causing human disease also require a permit.

Biological materials: Unsterilized specimens of human and animal tissue (including blood), body discharges, fluids, excretions or similar material, when known or suspected of being infected with disease transmissible to man require a permit under these provisions in order to be imported.

Animals: Any animal known or suspected of being infected with any disease transmissible to man. Importation of turtles of less than 4 inches in shell length and all non-human primates requires an importation permit issued by the Division of Quarantine. Telephone 404-718-2077 for further information.

Insects: Any living insect, or other living arthropod, known or suspected of being infected with any disease transmissible to man. Also, if alive, any fleas, flies, lice, mites, mosquitoes, or ticks, even if uninfected. This includes eggs, larvae, pupae, and nymphs as well as adult forms.

Snails: Any snails capable of transmitting schistosomiasis. No mollusks are to be admitted without a permit from either Centers for Disease Control or the Department of Agriculture. Any shipment of mollusks with a permit from either agency will be cleared immediately.

Bats: All live bats. Bats may also require a permit from the U.S. Department of Interior, Fish and Wildlife Services.

If you are not certain if the agents you intend to use require a CDC importation permit, please call the Biosafety Officer at 725.1473 for assistance in making the determination.

A permit request form can be obtained by contacting the CDC automated fax service. Call (1.888.232.3299), have your own fax number ready and request document # 101000.

Import Permits for Etiologic Agents

CDC-Office of Health and Safety

Biosafety Branch

<http://www.cdc.gov/od/eaipp/>

importpermit@cdc.gov

Letters of Authorization

After a review of an “application to import an etiological agent”, the issuing officer may issue a “letter of authorization” rather than an importation permit. The letter of authorization is issued for materials that are judged to be non-infectious, but which might be construed to be infectious by U.S. customs inspection personnel.

Letters of Authorization may be issued for items such as formalin fixed tissues, sterile cell cultures, clinical materials such as human blood, serum, plasma, urine, or cerebrospinal fluid, or other tissues or materials of human origin when there is no evidence or indication that such materials contain an infectious agent.

A copy of a Letter of Authorization should be attached to the package, and also should be furnished to the courier or importation broker. Letters of Authorization are in effect for two years.

Other Permits

United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) permits are required for infectious agents of livestock and biological materials containing animal, particularly livestock material.

Tissue (cell) culture techniques customarily use bovine material as a stimulant for cell growth, tissue culture materials, and suspensions of cell growth. Tissue culture materials and suspensions of cell culture used to grow viruses or other etiologic agents and which contain growth stimulants of bovine or other livestock origin are, therefore, controlled by the USDA due to the potential risk of introduction of exotic animal diseases into the U.S. Further information may be obtained at <http://www.aphis.usda.gov/permits/> or by calling the USDA/APHIS at 1-888-272-3181.

United States Department of Interior (USDI) permits are required for certain live animals and all live bats. Go to <http://www.fws.gov/permits/ImportExport/ImportExport.html> or call 800-358-2104 for further information.

Exports of Infectious Materials

The export of infectious material may require a license from the Department of Commerce. Call (202) 482-0896 for further information.

Further Information from the CDC

Centers for Disease Control and Prevention

Public Inquiries/OHS

Mailstop F05

1600 Clifton Road

Atlanta, GA 30333

U.S.A

<http://www.cdc.gov/od/ohs/feedback.htm>



Think Red. Not just because it's the Stanford color. Think Red bags. Red sharps containers. Red is the color of biosafety and thus Red is the color for biohazardous waste.

Medical Waste

Biohazardous waste includes all laboratory waste that may contain any biohazardous material or were in contact with said material. Additionally, any blood or components of blood or body fluids are to be disposed of as biohazardous waste, as are human or non-human primate cell lines. All biohazardous waste must be disposed of in red bags marked with the biohazard symbol; these bags must be secondarily contained in a puncture resistant outer container and covered with a tight fitting lid. Biohazard stickers must be present on all four sides of the container and the top of the lid.

In accordance with the California Medical Waste Management Act, Health and Safety Code, Chapter 6.1, medical waste is defined as including, but not limited to the following:

1. Human or animal specimens or cultures from medical and pathological laboratories.
2. Cultures and stocks of infectious agents from research and industrial laboratories.
3. Wastes from the production of bacteria, viruses, or the use of spores, discarded live and attenuated vaccines, and culture dishes and devices used to transfer, inoculate, and mix cultures.

Additionally, medical waste can include:

1. Waste containing any biological specimens sent to the laboratory for analysis.


















2. Human specimens or tissues removed at surgery or autopsy, which are suspected by the attending physician and surgeon or dentist of being contaminated with infectious agents known to be contagious to humans.
3. Animal parts, tissues, fluids or carcasses suspected by the attending veterinarian of being contaminated with infectious agents contagious to humans.
4. Waste, which at the point of transport from the generator's site, at the point of disposal, or thereafter, contains recognizable blood, fluid blood products, containers or equipment containing blood that is fluid, or blood from animals known to be infected with diseases which are communicable to humans.
5. Waste containing discarded materials contaminated with excretion, exudate or secretions from humans who are required to be isolated by the infection control staff, the attending physician and surgeon, the attending veterinarian or local health officer to protect others from highly communicable disease, or isolated animals known to be infected with disease which are highly communicable to humans.

Please note, however, that the California Medical Waste Management Act has as exceptions to the definition of medical waste:

1. Waste generated in food processing or biotechnology that does not contain an infectious agent (defined as BL-2 or above).
2. Waste generated in biotechnology that does not contain human blood or blood products or animal blood or blood products suspected of being contaminated with infectious agents known to be communicable to humans
3. Urine, feces, saliva, sputum, nasal secretions, sweat, tears or vomitus, unless it contains fluid blood.

These exemptions would include tissue culture materials that are not known or suspected of being infected. The biotechnology exemption permits the above items to be disposed of as non-red bag (non-biohazardous) waste. Note that these materials should be inactivated with an appropriate disinfectant to avoid contamination elsewhere in the laboratory.

An overview of Medical Waste Disposal for Stanford University is on the following chart (Figure 1); this chart is available in hard copy from EH&S:

|  Biohazardous and Medical Waste Disposal Guidelines  | |
|---|--|
| ITEMS REQUIRING DISPOSAL | PROPER DISPOSAL METHOD |
| SHARPS  All: Blades (scalpels, razors) Pasteur pipets Hypodermic needles with attached: •Syringes (barrels and plungers) •Tubing Never remove needles from syringes! | Sharps Container  → Biohazard waste |
| CULTURES AND DISPOSABLES  Contaminated: Petri dishes Disposable culture & tissue flasks Materials (paper towels, kim wipes, etc.) Contaminated liquid waste in container See below for disposing of blood and body fluids. If culture is NOT Biohazardous (BSL-1) | Red bag in hard-sided leak proof container with biohazard symbols on all sides and top → Biohazard waste Container with liquid removed → Decontaminate liquid → Dispose liquid into sewer using running water  Regular trash  |
| PIPETETS  Contaminated Pipette Tips Disposable Pipets Non-contaminated Pipette Tips Disposable Pipets | Red bag in hard-sided leak proof container with biohazard symbols on all sides and top → Biohazard waste Regular trash  |
| GLASS  Contaminated Broken and unbroken glass Non-contaminated Broken and unbroken glass | Sharps container  → Biohazard waste Broken glass container  → Recycling |
| BLOOD & BODY FLUIDS  All: human blood animal blood blood elements body fluids liquid & semi-liquid materials | Dilute with bleach 1:10 (final concentration = 0.5% sodium hypochlorite) → Dispose into sewer using running water  or Autoclave (do not add bleach if autoclaving)  |
| ANIMAL BODIES  All: Contaminated Animal carcasses & body parts Uncontaminated Animal carcasses & body parts Radioactive Animal carcasses & body parts <small>Version 2, 2009</small> | Red bag in hard-sided leak proof container with biohaz symbol → Research Animal Facility (RAF) refrigerators Black bag → (RAF) refrigerators Label bag exterior with approved radiation sticker → (RAF) radioactive freezer |
| CHEM AND RAD  All: Biohazardous material with chemical contamination Biohazardous material with radioactive contamination | Call EH&S Chem Waste 5.7520 Call EH&S Radiation Waste 3.3765 |
| Do not use needle clippers or cardboard pipet envelopes for sharps disposal. | |
| For biohazardous waste, do not use orange or clear autoclave bags. | |

For additional information contact Biosafety Office 725.1473

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Figure 1. Biohazardous and medical waste guidelines.

Sharps Waste

Sharps waste means any device having rigid corners, edges or protuberances capable of cutting or piercing, including, but not limited to, all of the following:

1. Hypodermic needles, attachments (syringes or tubing), and blades
2. Broken glass/plastic items, such as Pasteur pipettes and blood vials contaminated with medical waste
3. Teeth, both intact and fragmented

It is extremely important to remember: DO NOT clip, bend, shear or separate needles from syringes and do not recap needles – these are the times that you are most likely to get injured.

All sharps waste must be placed in an approved sharps container that is constructed of rigid, hard plastic and labeled with the universal biohazard symbol. Do not overfill the container. The lid of the sharps container must be shut and the container labeled with the room number prior to disposal. Glass pipettes that have come into contact with biohazardous waste must be discarded as sharps waste and not in broken glass containers.

Mixed Waste

Waste can often involve a mixture of medical and non-medical waste. Mixed waste is categorized as medical waste EXCEPT for the following:

1. A mixture of medical waste and hazardous chemical waste is categorized as hazardous chemical waste and is subject to the statutes and regulations applicable to hazardous chemical waste.
2. A mixture of medical waste and radioactive waste is categorized as radioactive waste and is subject to the statutes and regulations applicable to radioactive waste.
3. A mixture of medical waste, hazardous chemical waste, and radioactive waste is categorized as radioactive waste and is subject to the statutes and regulations applicable to radioactive waste.

Mixed chemical and biohazardous sharps waste will be placed into a sharps container that is labeled as chemical sharps waste. Any mixed chemical and biohazardous waste must be properly identified and

labeled with a Hazardous Waste Tag. Information on the Stanford University Chemical Waste programs can be found at: <http://ehs.stanford.edu/enviro/waste/index.html> or call EH&S, 723.5069.

All mixed radioactive-biohazardous waste must be properly segregated prior to disposal. Mixed radioactive and biohazardous non-sharps waste will be packed in a yellow bag labeled with the universal radiation symbol and/or radiation symbol. Mixed radioactive and medical sharps waste will be placed in a sharps container labeled with the universal radiation label. Mixed radioactive waste is picked up by Radiation Safety waste technicians and transported to the EH&S radioactive waste accumulation area for packaging and disposal. Call 725-1408 for pick up and information regarding mixed radioactive-biohazardous waste.

Animal Carcasses

After proper euthanasia of laboratory animals (Department of Laboratory Animal Medicine Euthanasia Procedures), uncontaminated/non-infectious animal carcasses shall be placed in black bags and brought to the appropriate Research Animal Facility (RAF) refrigerators. Contaminated/infected carcasses shall be placed in a red biohazard bag, the bag shall be labeled with the APLAC number and biohazardous agent, put in a hard-sided leak proof container that is labeled with the biohazard symbol and brought to the RAF biohazard refrigerators.

Autoclave Waste

Unless otherwise stated, **at Stanford University autoclaving materials prior to medical waste disposal is not necessary**. Exceptions to this are users of BSL-3 biohazardous agents.

Any laboratory medical waste which is being autoclaved shall be placed in an autoclavable red bag. This bag shall have the Universal Biohazard Symbol on the outside. The top of the bag shall be secured with indicator tape that will change color after the attainment of sterilization. Be sure that the autoclavable red bag can withstand the autoclave cycle without melting. Autoclaved bags in the School of Medicine shall be placed in a red bag for disposal as medical waste. Call 723-6336 or 725-1473 if you have any questions. See autoclave procedures below.

Decontamination

Place an absorbent material (paper towel, bench diaper) over the contaminated surface, then add liquid disinfectant; this will prevent spread of contamination. Allow sufficient contact time after applying the disinfectant. If the contact time is too brief, the surface will not be thoroughly disinfected. When cleaning a spill of concentrated material or if the disinfectant must act on an uneven surface, allow extra time for the disinfectant to act. Avoid using concentrated or undiluted solutions of your disinfectant to "speed up" the inactivation process. The surface that is being disinfected may be adversely affected by strong chemicals. This is especially significant when working with bleach, which is a very strong corrosive. Some disinfectants will leave a residue of chemicals behind. Rinse the cleaned area with distilled water to avoid adverse effects on your experiment. This is especially important in tissue culture rooms where a cell line can be wiped out by disinfectant residue left on equipment.

The following list of disinfectants, their efficiencies, contact times and recommended dilutions are general guidelines—please follow specific manufacturer's recommendations if available.

Quaternary Ammonium Compounds are commonly used in floor cleaning solutions. Quaternary ammonium compounds are effective in inactivating most vegetative bacteria, fungi, and lipid containing viruses. Quaternary ammonium compounds are NOT effective when used to disinfect *Mycobacterium tuberculosis* (TB), bacterial spores, and many viruses such as HBV.

Recommended contact time: 10 minutes

Recommended Working Dilution: 0.1-2.0%

Recommended for: cleaning optical instruments and administrative areas in the vicinity of a laboratory.

Ethanol is commonly used on equipment whose surfaces are susceptible for corrosion if other disinfectants are applied. Ethyl alcohol is effective in inactivating most vegetative bacteria, fungi, and lipid containing viruses. Ethanol is NOT effective when used to disinfect HBV, *Mycobacterium tuberculosis* (TB) and bacterial spores.

Recommended contact time: 10 minutes

Recommended Working Dilution: 70-85%

Recommended for: Stainless steel surfaces. CAUTION: Do not use 70% ethanol to clean a Class II, type A recirculating biosafety cabinet. The vapors from ethanol are flammable and the lower explosive limit (LEL) for ethanol is easily attained.

Phenolics are commonly used to decontaminate surfaces such as lab bench tops. Phenolics are effective in inactivating vegetative bacteria, fungi, TB, lipid containing viruses and have some effect on HBV. However, phenolics will not inactivate bacterial spores.

Recommended contact time: 10 minutes

Recommended Working Dilution: 1.0-5.0%

Recommended for: an alternative to bleach as a broad-spectrum disinfectant for bench tops, floors, and metal surfaces. Phenolics will not corrode metal surfaces as readily as bleach.

Iodine-containing compounds or iodophors are commonly used to decontaminate metal surfaces or equipment. Iodophors are effective in inactivating vegetative bacteria, fungi, TB and lipid containing viruses and have some effect on HBV. However, iodophors will not inactivate bacterial spores.

Recommended contact time: 10 minutes

Recommended Working Dilution: 25-1600 ppm, 0.47%

Recommended for: biosafety cabinets, dental equipment, bench tops, floors and lab equipment in general.

Chlorine compounds such as bleach are commonly used in the lab because of the relative ease in accessibility and low cost. Chlorine (hypochlorite) compounds are effective in inactivating vegetative bacteria, fungi, lipid and non-lipid viruses, *Coxiella burnetii* and TB.

Chlorine compounds have some effect in inactivating bacterial spores.

Recommended contact time: 30 minutes

Recommended Working Dilution: 500 ppm (1:10 dilution of household bleach, 5% hypochlorite ion)

Recommended for: floors, spills (inactivating liquid specimens), bench tops and contaminated clothing. Do not use bleach on electronic equipment, optical equipment or unpainted stainless steel. Undiluted bleach and other disinfectants must not go down the drain.

Paraformaldehyde and formaldehyde are often used to decontaminate large pieces of laboratory equipment, such as biosafety cabinets (but only by professionals!). Paraformaldehyde/formaldehyde will inactivate vegetative bacteria, fungi, lipid and non-lipid viruses, HBV, TB, *Coxiella burnetii*, and bacterial spores. However, paraformaldehyde and formaldehyde are registered carcinogens in the State of California and are very toxic to use without the accessibility of a vented fume hood and/or personal protective equipment. **DO NOT USE PARAFORMALDEHYDE OR FORMALDEHYDE IN THE LAB TO DECONTAMINATE EQUIPMENT.** The approved biosafety cabinet contractor will use paraformaldehyde to decontaminate your biosafety cabinet prior to changing the HEPA filters. Be sure to avoid the biosafety cabinet while this operation is in effect!

Glutaraldehyde is often used to disinfect hospital instruments. Glutaraldehyde will inactivate vegetative bacteria, fungi, lipid and non-lipid viruses, HBV, TB, *Coxiella burnetii*, and bacterial spores. However, glutaraldehyde is very toxic to use without the accessibility of a vented fume hood and/or personal protective equipment. **DO NOT USE GLUTARALDEHYDE IN THE LAB TO DECONTAMINATE EQUIPMENT.**

Ethylene Oxide is often used to disinfect hospital instruments. Ethylene Oxide will inactivate vegetative bacteria, fungi, lipid and non-lipid viruses, HBV, TB, *Coxiella burnetii*, and bacterial spores. However, Ethylene oxide is a registered carcinogen in the State of California and is very toxic to use without mechanically generated ventilation exhaust and personal protective equipment. **DO NOT USE ETHYLENE OXIDE IN THE LAB TO DECONTAMINATE EQUIPMENT.**

Anyone working with prions or other Spongiform encephalopathies that may be present in brain tissue must call the Biosafety Manager, 725.1473. Slow viruses such as Kuru are included in this group. Prions and prion-like proteins (see [Chapter 3 for a definition of prion-like proteins](#)) are highly resistant to conventional decontamination, and laboratories are strongly encouraged to use only disposable equipment. Specific procedures for decontamination and disposal must be followed when working with prions and prion-like proteins. Contact Biosafety for further information, or visit the following sites for information on protocols:

1. World Health Organization (WHO) Infection Control Guidelines
http://www.who.int/csr/resources/publications/bse/WHO_CDS_CSRAPH_2000_3/en/
2. Centers for Disease Control (CDC) Prion Diseases
<http://www.cdc.gov/ncidod/dvrd/prions/index.htm>
3. Biosafety in Microbiology and Biomedical Laboratories (BMBL)
http://www.cdc.gov/biosafety/publications/bmbl5/BMBL5_sect_VIII_h.pdf

Bleach solutions (sodium hypochlorite) (<http://www.cdc.gov/mmwr/preview/mmwrhtml/su6101a1.htm>)

- Hypochlorite solutions are classified as irritants and corrosives. Undiluted bleach solution is corrosive to stainless steel, and thorough rinsing must follow its use in the BSC and stainless steel sinks to remove the residue. **Do not autoclave bleach solutions.**
- Never mix different chlorine solutions or store them with cleaning products containing ammonia, ammonium chloride, or phosphoric acid. Combining these chemicals could result in release of chlorine gas, which can cause nausea, eye irritation, tearing, headache, and shortness of breath. These symptoms may last for several hours. A worker exposed to an unpleasantly strong odor after mixing of a chlorine solution with a cleaning product should leave the room or area immediately and remain out of the area until the fumes have cleared completely (see Section 9.1).
- To be an effective disinfectant, working bleach solutions must contain >0.5% but <2% sodium hypochlorite. Hypochlorite concentration in household bleach varies by manufacturer. Many household bleach solutions contain 5.25% sodium hypochlorite, and a 1:10 dilution (5,000 ppm Cl) will produce a 0.53% hypochlorite solution. Use of bleach solutions with lower hypochlorite concentrations might not provide the proper level of disinfection. Prepare a fresh 1:10 household bleach solution regularly.

Autoclaves

A steam autoclave is a device designed to sterilize cultures, media, surgical instruments and medical waste. Autoclaves will sterilize on the basis of:

- Length of time in the cycle
- Temperature
- Contact
- Pressure
- Steam

Unless otherwise stated, at Stanford University autoclaving materials prior to medical waste disposal is **NOT** necessary. Exceptions to this are users of BSL-3 biohazardous agents.

An autoclave is suitable for the treatment of certain types of medical waste but not all types.

The following items of medical waste **must not** be autoclaved:

1. Items of medical waste which are mixed with volatile chemical solvents or radioactive materials (this waste must be handled as either chemical waste or radioactive waste).
2. Pathological waste (pathological waste is handled as follows: animal carcasses are placed in a red bag and taken to the pathological waste freezers in the Research Animal Facility; human body parts are placed in a red bag and disposed of as medical waste without autoclaving.).

The following items of medical waste can be autoclaved:

1. Microbiological waste such as cultures of human or animal specimens from medical or pathological laboratories.
2. Cultures and stocks of microbiological specimens.
3. Waste contaminated with biohazardous materials such as contaminated paper towels or contaminated surgical gloves.

Considerations for effective autoclaving:

1. Do not overload the autoclave bag. The autoclave steam and heat cannot penetrate to the interior of an overloaded bag. The outer contents of the bag will be sterilized but the inner part of the bag will essentially be unaffected by the autoclave cycle.
2. Do not put sharp objects, such as broken glass that can puncture the bag.

3. Do not overload the autoclave.
4. Do not mix autoclave bags and other items to be autoclaved in the same autoclave cycle. Liquid media requires a shorter cycle, often 15-20 minutes while autoclavable medical waste requires a minimum of 30 minutes in order to be effectively sterilized.
5. To help ensure non-variability of sterilization, try to use a consistent loading pattern of materials within the autoclave (amount of material and location within autoclave).
6. Record autoclave conditions achieved for each cycle that is used to decontaminate medical waste. Validate autoclave effectiveness once every month (test strips are a recommended method and easily available). Retain records in an accessible location.

Safety considerations for autoclave attendants:

1. Wear personal protective equipment to include heat-resistant gloves, goggles or safety glasses and a lab coat.
2. Use caution when opening the autoclave door. Allow superheated steam to exit.
3. Use caution when handling a bag in case sharp objects have been inadvertently placed in the bag. Never lift a bag from the bottom of the bag to load into the chamber. Handle the bag from the top.
4. Watch out for pressurized containers. Superheated liquids may spurt from sealed containers. Never seal a container of liquid with a cork that may cause a pressurized explosion inside the autoclave.
5. Agar plates will melt and the agar will become liquefied. Avoid coming in contact with this molten liquid. Use a secondary autoclavable tray to catch any potential leakage from the bag that would otherwise leak into the autoclave.
6. Glassware may crack or shatter if cold liquid comes in contact with this superheated glassware. If glass breaks in the autoclave, use tongs, forceps, or other mechanical means to recover the fragments; make certain that the autoclave has been cooled down to avoid surface burns.
7. Use an absorbent liner for glass vessels containing liquid. Never put autoclave bags or glassware directly in contact with the bottom of the autoclave.

To autoclave waste, follow the below procedures:

1. Place waste as generated in an autoclavable red bag
2. Put autoclave tape loosely around the top of the bag and place the bag in a secondary container such as an autoclave pan
3. Set the cycle for 30 minutes, 121°F at 20 PSI (or alternate required conditions depending on waste)
4. Document the conditions achieved during the cycle

5. After autoclaving, the autoclaved red bag must be disposed of as red bag waste

A variety of factors must be taken into consideration prior to purchasing an autoclave; additional information concerning autoclave purchases is available on the web at:

http://www.cdc.gov/hicpac/Disinfection_Sterilization/13_0Sterilization.html.

...those who pass their lives shut up in houses and offices are not often strong. Their muscles are not thick and hard, and their blood is not rich. But, worse than that, they make their brains and their nerves work too hard; they fatigue their heads and become irritable, or nervous, as it is called, being excited to gayety or anger without sufficient cause. Sometimes, indeed, their brains become altogether deranged, and are no longer able to act properly; the persons are then insane, or lunatic. It is by no means true, however, that the professions and sedentary occupations furnish all of the cases of insanity....

Paul Bert, First Steps in Scientific Knowledge (1886), J.B. Lippincott, Pub, Part VI, Pg 65.

Laboratories which utilize biological materials must notify the Biosafety program prior to terminating work to ensure that the laboratory has been decontaminated and that the biological material has been secured or properly disposed. If the principal investigator intends to cease work, he or she must notify Biosafety at least 60 days prior to the set departure/closing date. This will allow Biosafety to consult with the principal investigator and perform a walkthrough of the lab to provide recommendations on the most expeditious way to prepare for the move and the final termination of the biohazardous work in the lab. A final lab deactivation inspection will be scheduled accordingly.

Lab Close Out Procedures

1. Biosafety cabinets must be decontaminated and the outer surfaces cleaned with a suitable disinfectant; decontamination must be done by a certified professional. Currently, Stanford University contracts with an outside vendor for this; call the vendor (number is found at <http://ehs.stanford.edu/researchlab/bio/index.html>) to schedule an appointment. The Principal Investigator should present a receipt verifying that the paraformaldehyde decontamination procedure has been completed by the contracted biosafety cabinet certifier.
2. Storage freezers should be emptied and the surfaces should be decontaminated with a suitable disinfectant. The former contents must be decontaminated by autoclaving or disposed of in a red bag. Cryostats and liquid nitrogen storage equipment must also be emptied and contents properly disposed of. If the Principal Investigator intends to stay at Stanford but not continue the APB approved project, then only the biological agents that were approved for use on the application need to be disposed.

3. Account for all specimens stored outside the lab room. Specimens stored in a cold room or an incubator in an adjacent tissue culture room should be autoclaved or disposed of in a red bag.
4. Medical waste such as used sharps containers or red bags must be disposed of and the storage areas for the medical waste cleaned with a suitable disinfectant.
5. Any biohazard labels must be removed from surfaces. The outer surface of all equipment and any work surface must be decontaminated with a suitable disinfectant.
6. The Biohazard /Universal Precautions signs must be removed from door.

Disposal of Used Lab Equipment

Used laboratory equipment, such as incubators, refrigerators and freezers must be thoroughly decontaminated prior to disposal or release to surplus property. Laboratory equipment that was used in conjunction with biological research may have residual contamination resulting from chemicals and/or radioactive materials.

1. Wear appropriate personal protective equipment. At a minimum wear gloves, lab coat, safety glasses with side shields or goggles and a respirator if chemical vapors/odors are anticipated (contact EH&S for respirator information).
2. Remove all specimens and/or laboratory materials.
3. Remove all biohazard labels or stickers from the front of the equipment.
4. Clean the surface of the equipment for any radioactive contamination (if applicable). Schedule a wipe test with Health Physics to ensure that the equipment is free from residual radioactive contamination. Call Health Physics, 723.3201 for more information.
5. Be sure that the equipment surface can be safely cleaned with a chemical disinfectant. Make sure that the equipment was not used to store water reactive chemicals, corrosives or strong oxidizers that may incompatibly react during the decontamination process.

6. Apply a chemical disinfectant to the surface of the equipment and allow the disinfectant time to inactivate potential contamination.
7. Ensure that the surface is rinsed to remove the disinfectant.
8. Put the cleaning waste (paper towel, sponge) in a red bag and treat as biohazardous waste.
9. Dispose of PPE properly and wash hands thoroughly.

Do not open internal compartments of equipment for decontamination. If the internal compartments of a piece of equipment are grossly contaminated with biohazardous material, label or tag the equipment as potentially biohazardous. Notify the Biosafety Manager and a decision will be made whether the equipment is safe for disposal.

When the equipment is ready for pick up, prepare a certificate with your department's letterhead addressed to the Director of Surplus Property, Material Management, stating that you have decontaminated the equipment designated for removal in accordance with these guidelines (Chapter 10 of the Stanford University Biosafety Manual). You need not send a copy to the Biosafety Manager or EH&S. Please call the Biosafety Manager at 5.1473 if you have any questions.

**Appendix A: NIH Guidelines for
Research Involving Recombinant DNA
Molecules (November 2013)**

**NOTICE PERTINENT TO THE NOVEMBER 2013 REVISIONS
OF THE
NIH GUIDELINES FOR RESEARCH INVOLVING
RECOMBINANT OR SYNTHETIC NUCLEIC ACID MOLECULES
(NIH GUIDELINES)**

Summary of Amendments:

Major Actions

None

Minor Actions:

Additions to Appendix B. Classification of Human Etiologic Agents on the Basis of Hazard

- [Appendix B-II-A](#). Risk Group 2 (RG2) - Bacterial Agents Including Chlamydia
 - *Pseudomonas aeruginosa*
- [Appendix B-III-D](#). Risk Group 3 (RG3) – Viruses and Prions
 - Coronaviruses
 - Middle East respiratory syndrome coronavirus (MERS-CoV)

**NIH GUIDELINES FOR RESEARCH
INVOLVING
RECOMBINANT OR SYNTHETIC
NUCLEIC ACID MOLECULES
(NIH GUIDELINES)**

November 2013

**DEPARTMENT OF HEALTH AND HUMAN SERVICES
National Institutes of Health**

Visit the OBA Web site at:

<http://oba.od.nih.gov>

**For current information on Guidelines, Protocols, Principal Investigators, Meetings,
and information about upcoming Gene Therapy Policy Conferences**

These *NIH Guidelines* shall supersede all earlier versions until further notice.

FEDERAL REGISTER NOTICES

Effective June 24, 1994, Published in Federal Register, July 5, 1994 ([59 FR 34472](#))
Amendment Effective July 28, 1994, Federal Register, August 5, 1994 ([59 FR 40170](#))
Amendment Effective April 17, 1995, Federal Register, April 27, 1995 ([60 FR 20726](#))
Amendment Effective December 14, 1995, Federal Register, January 19, 1996 ([61 FR 1482](#))
Amendment Effective March 1, 1996, Federal Register, March 12, 1996 ([61 FR 10004](#))
Amendment Effective January 23, 1997, Federal Register, January 31, 1997 ([62 FR 4782](#))
Amendment Effective September 30, 1997, Federal Register, October 14, 1997 ([62 FR 53335](#))
Amendment Effective October 20, 1997, Federal Register, October 29, 1997 ([62 FR 56196](#))
Amendment Effective October 22, 1997, Federal Register, October 31, 1997 ([62 FR 59032](#))
Amendment Effective February 4, 1998, Federal Register, February 17, 1998 ([63 FR 8052](#))
Amendment Effective April 30, 1998, Federal Register, May 11, 1998 ([63 FR 26018](#))
Amendment Effective April 29, 1999, Federal Register, May 11, 1999 ([64 FR 25361](#))
Amendment Effective October 2, 2000, Federal Register, October 10, 2000 ([65 FR 60328](#))
Amendment Effective December 28, 2000 Federal Register, January 5, 2001 ([66 FR 1146](#))
Amendment Effective December 11, 2001 Federal Register, December 11, 2001 ([66 FR 64051](#))
Amendment Effective December 19, 2001 Federal Register, November 19, 2001 ([66 FR 57970](#))
Amendment Effective January 10, 2002 Federal Register, December 11, 2001 ([66 FR 64052](#))
Amendment Effective January 24, 2002 Federal Register, November 19, 2001 ([66 FR 57970](#))
Amendment Effective September 22, 2009 Federal Register, September 22, 2009 ([74 FR 48275](#))
Amendment Effective January 19, 2011 Federal Register, January 19, 2011 ([76 FR 3150](#))
Amendment Effective May 12, 2011 Federal Register, May 12, 2011 ([76 FR 27653](#))
Amendment Effective October 11, 2011 Federal Register, October 11, 2011 ([76 FR 62816](#))
Amendment Effective February 21, 2013 Federal Register, February 21, 2013 ([78 FR 12074](#))
Amendment Effective March 5, 2013 Federal Register, September 5, 2012 ([77 FR 54584](#))
Amendment Effective November 6, 2013 Federal Register, November 6, 2013 ([78 FR 66751](#))

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SECTION I. SCOPE OF THE NIH GUIDELINES**Section I-A. Purpose**

The purpose of the *NIH Guidelines* is to specify the practices for constructing and handling: (i) recombinant nucleic acid molecules, (ii) synthetic nucleic acid molecules, including those that are chemically or otherwise modified but can base pair with naturally occurring nucleic acid molecules, and (iii) cells, organisms, and viruses containing such molecules.

Section I-A-1. Any nucleic acid molecule experiment, which according to the *NIH Guidelines* requires approval by NIH, must be submitted to NIH or to another Federal agency that has jurisdiction for review and approval. Once approvals, or other applicable clearances, have been obtained from a Federal agency other than NIH (whether the experiment is referred to that agency by NIH or sent directly there by the submitter), the experiment may proceed without the necessity for NIH review or approval. (See exception in [Section I-A-1-a](#) regarding requirement for human gene transfer protocol registration.)

Section I-A-1-a. For experiments involving the deliberate transfer of recombinant or synthetic nucleic acid molecules, or DNA or RNA derived from recombinant or synthetic nucleic acid molecules, into human research participants (human gene transfer), no research participant shall be enrolled (see definition of enrollment in [Section I-E-7](#)) until the RAC review process has been completed (see [Appendix M-I-B, RAC Review Requirements](#)); Institutional Biosafety Committee (IBC) approval (from the clinical trial site) has been obtained; Institutional Review Board approval has been obtained; and all applicable regulatory authorization(s) have been obtained.

For a clinical trial site that is added after the RAC review process, no research participant shall be enrolled (see definition of enrollment in [Section I-E-7](#)) at the clinical trial site until the following documentation has been submitted to NIH OBA: (1) IBC approval (from the clinical trial site); (2) Institutional Review Board approval; (3) Institutional Review Board-approved informed consent document; and (4) curriculum vitae of the Principal Investigator(s) (no more than two pages in biographical sketch format); and (5) NIH grant number(s) if applicable.

Section I-B. Definition of Recombinant and Synthetic Nucleic Acid Molecules

In the context of the *NIH Guidelines*, recombinant and synthetic nucleic acids are defined as:

- (i) molecules that a) are constructed by joining nucleic acid molecules and b) that can replicate in a living cell, i.e., recombinant nucleic acids;
- (ii) nucleic acid molecules that are chemically or by other means synthesized or amplified, including those that are chemically or otherwise modified but can base pair with naturally occurring nucleic acid molecules, i.e., synthetic nucleic acids, or
- (iii) molecules that result from the replication of those described in (i) or (ii) above.

Section I-C. General Applicability

Section I-C-1. The *NIH Guidelines* are applicable to:

Section I-C-1-a. All recombinant or synthetic nucleic acid research within the United States (U.S.) or its territories that is within the category of research described in either [Section I-C-1-a-\(1\)](#) or [Section I-C-1-a-\(2\)](#).

Section I-C-1-a-(1). Research that is conducted at or sponsored by an institution that receives any support for recombinant or synthetic nucleic acid research from NIH, including research performed directly by NIH. An individual who receives support for research involving recombinant or synthetic nucleic acids must be associated with or sponsored by an institution that assumes the responsibilities assigned in the *NIH Guidelines*.

Section I-C-1-a-(2). Research that involves testing in humans of materials containing recombinant or synthetic nucleic acids developed with NIH funds, if the institution that developed those materials sponsors or participates in those projects. Participation includes research collaboration or contractual agreements, not mere provision of research materials.

Section I-C-1-b. All recombinant or synthetic nucleic acid research performed abroad that is within the category of research described in either Section I-C-1-b-(1) or Section I-C-1-b-(2).

Section I-C-1-b-(1). Research supported by NIH funds.

Section I-C-1-b-(2). Research that involves testing in humans of materials containing recombinant or synthetic nucleic acids developed with NIH funds, if the institution that developed those materials sponsors or participates in those projects. Participation includes research collaboration or contractual agreements, not mere provision of research materials.

Section I-C-1-b-(3). If the host country has established rules for the conduct of recombinant or synthetic nucleic acid molecule research, then the research must be in compliance with those rules. If the host country does not have such rules, the proposed research must be reviewed and approved by an NIH-approved Institutional Biosafety Committee or equivalent review body and accepted in writing by an appropriate national governmental authority of the host country. The safety practices that are employed abroad must be reasonably consistent with the *NIH Guidelines*.

Section I-D. Compliance with the *NIH Guidelines*

As a condition for NIH funding of recombinant or synthetic nucleic acid molecule research, institutions shall ensure that such research conducted at or sponsored by the institution, irrespective of the source of funding, shall comply with the *NIH Guidelines*.

Information concerning noncompliance with the *NIH Guidelines* may be brought forward by any person. It should be delivered to both NIH/OBA and the relevant institution. The institution, generally through the Institutional Biosafety Committee, shall take appropriate action. The institution shall forward a complete report of the incident recommending any further action to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985, 301-496-9838/301-496-9839 (fax) (for non-USPS mail, use zip code 20817).

In cases where NIH proposes to suspend, limit, or terminate financial assistance because of noncompliance with the *NIH Guidelines*, applicable DHHS and Public Health Service procedures shall govern.

The policies on compliance are as follows:

Section I-D-1. All NIH-funded projects involving recombinant or synthetic nucleic acid molecules must comply with the *NIH Guidelines*. Non-compliance may result in: (i) suspension, limitation, or termination of financial assistance for the noncompliant NIH-funded research project and of NIH funds for other recombinant or synthetic nucleic acid molecule research at the institution, or (ii) a requirement for prior NIH approval of any or all recombinant or synthetic nucleic acid molecule projects at the institution.

Section I-D-2. All non-NIH funded projects involving recombinant or synthetic nucleic acid molecule conducted at or sponsored by an institution that receives NIH funds for projects involving such techniques must comply with the *NIH Guidelines*. Noncompliance may result in: (i) suspension, limitation, or termination of NIH funds for recombinant or synthetic nucleic acid molecule research at the institution, or (ii) a requirement for prior NIH approval of any or all recombinant or synthetic nucleic acid molecule projects at the institution.

Section I-E. General Definitions

The following terms, which are used throughout the *NIH Guidelines*, are defined as follows:

Section I-E-1. An "institution" is any public or private entity (including Federal, state, and local government agencies).

Section I-E-2. An "Institutional Biosafety Committee" is a committee that: (i) meets the requirements for membership specified in [Section IV-B-2, Institutional Biosafety Committee \(IBC\)](#), and (ii) reviews, approves, and oversees projects in accordance with the responsibilities defined in [Section IV-B-2, Institutional Biosafety Committee \(IBC\)](#).

Section I-E-3. The "Office of Biotechnology Activities (OBA)" is the office within the NIH that is responsible for: (i) reviewing and coordinating all activities relating to the *NIH Guidelines*, and (ii) performing other duties as defined in [Section IV-C-3, Office of Biotechnology Activities \(OBA\)](#).

Section I-E-4. The "Recombinant DNA Advisory Committee" is the public advisory committee that advises the Department of Health and Human Services (DHHS) Secretary, the DHHS Assistant Secretary for Health, and the NIH Director concerning recombinant or synthetic nucleic acid molecule research. The RAC shall be constituted as specified in [Section IV-C-2, Recombinant DNA Advisory Committee \(RAC\)](#).

Section I-E-5. The "NIH Director" is the Director of the National Institutes of Health, or any other officer or employee of NIH to whom authority has been delegated.

Section I-E-6. "Deliberate release" is defined as a planned introduction of recombinant or synthetic nucleic acid molecule-containing microorganisms, plants, or animals into the environment.

Section I-E-7. "Enrollment" is the process of obtaining informed consent from a potential research participant, or a designated legal guardian of the participant, to undergo a test or procedure associated with the gene transfer experiment.

Section I-E-8. A "serious adverse event" is any event occurring at any dose that results in any of the following outcomes: death, a life-threatening event, in-patient hospitalization or prolongation of existing hospitalization, a persistent or significant disability/incapacity, or a congenital anomaly/birth defect. Important medical events that may not result in death, be life-threatening, or require hospitalization also may be considered a serious adverse event when, upon the basis of appropriate medical judgment, they may jeopardize the human gene transfer research subject and may require medical or surgical intervention to prevent one of the outcomes listed in this definition.

Section I-E-9. An adverse event is "associated with the use of a gene transfer product" when there is a reasonable possibility that the event may have been caused by the use of that product.

Section I-E-10. An "unexpected serious adverse event" is any serious adverse event for which the specificity or severity is not consistent with the risk information available in the current investigator's brochure.

SECTION II. SAFETY CONSIDERATIONS

Section II-A. Risk Assessment

Section II-A-1. Risk Groups

Risk assessment is ultimately a subjective process. The investigator must make an initial risk assessment based on the Risk Group (RG) of an agent (see [Appendix B, Classification of Human Etiologic Agents on the Basis of Hazard](#)). Agents are classified into four Risk Groups (RGs) according to their relative pathogenicity for healthy adult humans by the following criteria: (1) Risk Group 1 (RG1) agents are not associated with disease in healthy adult humans. (2) Risk Group 2 (RG2) agents are associated with human disease which is rarely serious and for which preventive or therapeutic interventions are *often* available. (3) Risk Group 3 (RG3) agents are associated with serious or lethal human disease for which preventive or therapeutic interventions *may be* available. (4) Risk Group 4 (RG4) agents are likely to cause serious or lethal human disease for which preventive or therapeutic interventions are *not usually* available.

Section II-A-2. Criteria for Risk Groups

Classification of agents in [Appendix B, Classification of Human Etiologic Agents on the Basis of Hazard](#), is based on the potential effect of a biological agent on a healthy human adult and does not account for instances in which an individual may have increased susceptibility to such agents, e.g., preexisting diseases, medications, compromised immunity, pregnancy or breast feeding (which may increase exposure of infants to some agents).

Personnel may need periodic medical surveillance to ascertain fitness to perform certain activities; they may also need to be offered prophylactic vaccines and boosters (see [Section IV-B-1-f, Responsibilities of the Institution, General Information](#)).

Section II-A-3. Comprehensive Risk Assessment

In deciding on the appropriate containment for an experiment, the first step is to assess the risk of the agent itself. [Appendix B, Classification of Human Etiologic Agents on the Basis of Hazard](#), classifies agents into Risk Groups based on an assessment of their ability to cause disease in humans and the available treatments for such disease. Once the Risk Group of the agent is identified, this should be followed by a thorough consideration of how the agent is to be manipulated. Factors to be considered in determining the level of containment include agent factors such as: virulence, pathogenicity, infectious dose, environmental stability, route of spread, communicability, operations, quantity, availability of vaccine or treatment, and gene product effects such as toxicity, physiological activity, and allergenicity. Any strain that is known to be more hazardous than the parent (wild-type) strain should be considered for handling at a higher containment level. Certain attenuated strains or strains that have been demonstrated to have irreversibly lost known virulence factors may qualify for a reduction of the containment level compared to the Risk Group assigned to the parent strain (see [Section V-B, Footnotes and References of Sections I-IV](#)).

While the starting point for the risk assessment is based on the identification of the Risk Group of the parent agent, as technology moves forward, it may be possible to develop an organism containing genetic sequences from multiple sources such that the parent agent may not be obvious. In such cases, the risk assessment should include at least two levels of analysis. The first involves a consideration of the Risk Groups of the source(s) of the sequences and the second involves an assessment of the functions that may be encoded by these sequences (e.g., virulence or transmissibility). It may be prudent to first consider the highest Risk Group classification of all agents that are the source of sequences included in the construct. Other factors to be considered include the percentage of the genome contributed by each parent agent and the predicted function or intended purpose of each contributing sequence. The initial assumption should be that all sequences will function as they did in the original host context.

The Principal Investigator and Institutional Biosafety Committee must also be cognizant that the combination of certain sequences in a new biological context may result in an organism whose risk profile could be higher than that of the contributing organisms or sequences. The synergistic function of these sequences may be one of the key attributes to consider in deciding whether a higher containment level is warranted, at least until further assessments can be carried out. A new biosafety risk may occur with an organism formed through combination of sequences from a number of organisms or due to the synergistic effect of combining transgenes that results in a new phenotype.

A final assessment of risk based on these considerations is then used to set the appropriate containment conditions for the experiment (see [Section II-B, Containment](#)). The appropriate containment level may be equivalent to the Risk Group classification of the agent or it may be raised or lowered as a result of the above considerations. The Institutional Biosafety Committee must approve the risk assessment and the biosafety containment level for recombinant or synthetic nucleic acid experiments described in [Sections III-A, Experiments that Require Institutional Biosafety Committee Approval, RAC Review, and NIH Director Approval Before Initiation](#); [III-B, Experiments that Require NIH/OBA and Institutional Biosafety Committee Approval Before Initiation](#); [III-C, Experiments that Require Institutional Biosafety Committee and Institutional Review Board Approvals and NIH/OBA Registration Before Initiation](#); [III-D, Experiments that Require Institutional Biosafety Committee Approval Before Initiation](#).

Careful consideration should be given to the types of manipulation planned for some higher Risk Group agents. For example, the RG2 dengue viruses may be cultured under the Biosafety Level (BL) 2 containment (see [Section II-B](#)); however, when such agents are used for animal inoculation or transmission studies, a higher containment level is recommended. Similarly, RG3 agents such as Venezuelan equine encephalomyelitis and yellow fever viruses should be handled at a higher containment level for animal inoculation and transmission experiments.

Individuals working with human immunodeficiency virus (HIV), hepatitis B virus (HBV) or other bloodborne pathogens should consult the applicable [Occupational Safety and Health Administration \(OSHA\)](#) regulation, 29 CFR 1910.1030, and OSHA publication 3127 (1996 revised). BL2 containment is recommended for activities

involving all blood-contaminated clinical specimens, body fluids, and tissues from all humans, or from HIV- or HBV-infected or inoculated laboratory animals. Activities such as the production of research-laboratory scale quantities of HIV or other bloodborne pathogens, manipulating concentrated virus preparations, or conducting procedures that may produce droplets or aerosols, are performed in a BL2 facility using the additional practices and containment equipment recommended for BL3. Activities involving industrial scale volumes or preparations of concentrated HIV are conducted in a BL3 facility, or BL3 Large Scale if appropriate, using BL3 practices and containment equipment.

Exotic plant pathogens and animal pathogens of domestic livestock and poultry are restricted and may require special laboratory design, operation and containment features not addressed in *Biosafety in Microbiological and Biomedical Laboratories* (see [Section V-C, Footnotes and References of Sections I through IV](#)). For information regarding the importation, possession, or use of these agents see [Sections V-G and V-H, Footnotes and References of Sections I through IV](#).

Section II-B. Containment

Effective biological safety programs have been operative in a variety of laboratories for many years. Considerable information already exists about the design of physical containment facilities and selection of laboratory procedures applicable to organisms carrying additional recombinant or synthetic nucleic acid molecules (see [Section V-B, Footnotes and References of Sections I-IV](#)). The existing programs rely upon mechanisms that can be divided into two categories: (i) a set of standard practices that are generally used in microbiological laboratories; and (ii) special procedures, equipment, and laboratory installations that provide physical barriers that are applied in varying degrees according to the estimated biohazard. Four biosafety levels are described in [Appendix G, Physical Containment](#). These biosafety levels consist of combinations of laboratory practices and techniques, safety equipment, and laboratory facilities appropriate for the operations performed and are based on the potential hazards imposed by the agents used and for the laboratory function and activity. Biosafety Level 4 provides the most stringent containment conditions, Biosafety Level 1 the least stringent.

Experiments involving recombinant or synthetic nucleic acid molecules lend themselves to a third containment mechanism, namely, the application of highly specific biological barriers. Natural barriers exist that limit either: (i) the infectivity of a vector or vehicle (plasmid or virus) for specific hosts, or (ii) its dissemination and survival in the environment. Vectors, which provide the means for recombinant or synthetic nucleic acid molecule and/or host cell replication, can be genetically designed to decrease, by many orders of magnitude, the probability of dissemination of recombinant or synthetic nucleic acid molecule outside the laboratory (see [Appendix I, Biological Containment](#)).

Since these three means of containment are complementary, different levels of containment can be established that apply various combinations of the physical and biological barriers along with a constant use of standard practices. Categories of containment are considered separately in order that such combinations can be conveniently expressed in the *NIH Guidelines*.

Physical containment conditions within laboratories, described in [Appendix G, Physical Containment](#), may not always be appropriate for all organisms because of their physical size, the number of organisms needed for an experiment, or the particular growth requirements of the organism. Likewise, biological containment for microorganisms described in [Appendix I, Biological Containment](#), may not be appropriate for all organisms, particularly higher eukaryotic organisms. However, significant information exists about the design of research facilities and experimental procedures that are applicable to organisms containing additional recombinant or synthetic nucleic acid molecules that are either integrated into the genome or into microorganisms associated with the higher organism as a symbiont, pathogen, or other relationship. This information describes facilities for physical containment of organisms used in non-traditional laboratory settings and special practices for limiting or excluding the unwanted establishment, transfer of genetic information, and dissemination of organisms beyond the intended location, based on both physical and biological containment principles. Research conducted in accordance with these conditions effectively confines the organism.

For research involving plants, four biosafety levels (BL1-P through BL4-P) are described in [Appendix P, Physical and Biological Containment for Recombinant or Synthetic Nucleic Acid Molecule Research Involving Plants](#). BL1-P is designed to provide a moderate level of containment for experiments for which there is convincing biological evidence that precludes the possibility of survival, transfer, or dissemination of recombinant or synthetic nucleic acid molecules into the environment, or in which there is no recognizable and

predictable risk to the environment in the event of accidental release. BL2-P is designed to provide a greater level of containment for experiments involving plants and certain associated organisms in which there is a recognized possibility of survival, transmission, or dissemination of recombinant or synthetic nucleic acid molecule containing organisms, but the consequence of such an inadvertent release has a predictably minimal biological impact. BL3-P and BL4-P describe additional containment conditions for research with plants and certain pathogens and other organisms that require special containment because of their recognized potential for significant detrimental impact on managed or natural ecosystems. BL1-P relies upon accepted scientific practices for conducting research in most ordinary greenhouse or growth chamber facilities and incorporates accepted procedures for good pest control and cultural practices. BL1-P facilities and procedures provide a modified and protected environment for the propagation of plants and microorganisms associated with the plants and a degree of containment that adequately controls the potential for release of biologically viable plants, plant parts, and microorganisms associated with them. BL2-P and BL3-P rely upon accepted scientific practices for conducting research in greenhouses with organisms infecting or infesting plants in a manner that minimizes or prevents inadvertent contamination of plants within or surrounding the greenhouse. BL4-P describes facilities and practices known to provide containment of certain exotic plant pathogens.

For research involving animals, which are of a size or have growth requirements that preclude the use of conventional primary containment systems used for small laboratory animals, four biosafety levels (BL1-N through BL4-N) are described in [Appendix Q, Physical and Biological Containment for Recombinant or Synthetic Nucleic Acid Molecule Research Involving Animals](#). BL1-N describes containment for animals that have been modified by stable introduction of recombinant or synthetic nucleic acid molecules, or DNA derived therefrom, into the germ-line (transgenic animals) and experiments involving viable recombinant or synthetic nucleic acid molecule-modified microorganisms and is designed to eliminate the possibility of sexual transmission of the modified genome or transmission of recombinant or synthetic nucleic acid molecule-derived viruses known to be transmitted from animal parent to offspring only by sexual reproduction. Procedures, practices, and facilities follow classical methods of avoiding genetic exchange between animals. BL2-N describes containment which is used for transgenic animals associated with recombinant or synthetic nucleic acid molecule-derived organisms and is designed to eliminate the possibility of vertical or horizontal transmission. Procedures, practices, and facilities follow classical methods of avoiding genetic exchange between animals or controlling arthropod transmission. BL3-N and BL4-N describe higher levels of containment for research with certain transgenic animals involving agents which pose recognized hazard.

In constructing the *NIH Guidelines*, it was necessary to define boundary conditions for the different levels of physical and biological containment and for the classes of experiments to which they apply. These definitions do not take into account all existing and anticipated information on special procedures that will allow particular experiments to be conducted under different conditions than indicated here without affecting risk. Individual investigators and Institutional Biosafety Committees are urged to devise simple and more effective containment procedures and to submit recommended changes in the *NIH Guidelines* to permit the use of these procedures.

SECTION III. EXPERIMENTS COVERED BY THE NIH GUIDELINES

This section describes six categories of experiments involving recombinant or synthetic nucleic acid molecules: (i) those that require Institutional Biosafety Committee (IBC) approval, RAC review, and NIH Director approval before initiation (see [Section III-A](#)), (ii) those that require NIH/OBA and Institutional Biosafety Committee approval before initiation (see [Section III-B](#)), (iii) those that require Institutional Biosafety Committee and Institutional Review Board approvals and RAC review before research participant enrollment (see [Section III-C](#)), (iv) those that require Institutional Biosafety Committee approval before initiation (see [Section III-D](#)), (v) those that require Institutional Biosafety Committee notification simultaneous with initiation (see [Section III-E](#)), and (vi) those that are exempt from the *NIH Guidelines* (see [Section III-F](#)).

Note: *If an experiment falls into Sections III-A, III-B, or III-C and one of the other sections, the rules pertaining to Sections III-A, III-B, or III-C shall be followed. If an experiment falls into Section III-F and into either Sections III-D or III-E as well, the experiment is considered exempt from the NIH Guidelines.*

Any change in containment level, which is different from those specified in the *NIH Guidelines*, may not be initiated without the express approval of NIH/OBA (see [Section IV-C-1-b-\(2\)](#) and its subsections, *Minor Actions*).

Section III-A. Experiments that Require Institutional Biosafety Committee Approval, RAC Review, and NIH Director Approval Before Initiation (See [Section IV-C-1-b-\(1\)](#), Major Actions).**Section III-A-1. Major Actions under the NIH Guidelines**

Experiments considered as *Major Actions* under the *NIH Guidelines* cannot be initiated without submission of relevant information on the proposed experiment to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax), the publication of the proposal in the *Federal Register* for 15 days of comment, review by RAC, and specific approval by NIH. The containment conditions or stipulation requirements for such experiments will be recommended by RAC and set by NIH at the time of approval. Such experiments require Institutional Biosafety Committee approval before initiation. Specific experiments already approved are included in [Appendix D, Major Actions Taken under the NIH Guidelines](#), which may be obtained from the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax).

Section III-A-1-a. The deliberate transfer of a drug resistance trait to microorganisms that are not known to acquire the trait naturally (see [Section V-B, Footnotes and References of Sections I-IV](#)), if such acquisition could compromise the ability to control disease agents in humans, veterinary medicine, or agriculture, will be reviewed by the RAC.

Consideration should be given as to whether the drug resistance trait to be used in the experiment would render that microorganism resistant to the primary drug available to and/or indicated for certain populations, for example children or pregnant women.

At the request of an Institutional Biosafety Committee, NIH/OBA will make a determination regarding whether a specific experiment involving the deliberate transfer of a drug resistance trait falls under Section III-A-1-a and therefore requires RAC review and NIH Director approval. An Institutional Biosafety Committee may also consult with NIH/OBA regarding experiments that do not meet the requirements of Section III-A-1-a but nonetheless raise important public health issues. NIH/OBA will consult, as needed, with one or more experts, which may include the RAC.

Section III-B. Experiments That Require NIH/OBA and Institutional Biosafety Committee Approval Before Initiation

Experiments in this category cannot be initiated without submission of relevant information on the proposed experiment to NIH/OBA. The containment conditions for such experiments will be determined by NIH/OBA in consultation with *ad hoc* experts. Such experiments require Institutional Biosafety Committee approval before initiation (see [Section IV-B-2-b-\(1\), Institutional Biosafety Committee](#)).

Section III-B-1. Experiments Involving the Cloning of Toxin Molecules with LD₅₀ of Less than 100 Nanograms per Kilogram Body Weight

Deliberate formation of recombinant or synthetic nucleic acid molecules containing genes for the biosynthesis of toxin molecules lethal for vertebrates at an LD₅₀ of less than 100 nanograms per kilogram body weight (e.g., microbial toxins such as the botulinum toxins, tetanus toxin, diphtheria toxin, and *Shigella dysenteriae* neurotoxin). Specific approval has been given for the cloning in *Escherichia coli* K-12 of DNA containing genes coding for the biosynthesis of toxic molecules which are lethal to vertebrates at 100 nanograms to 100 micrograms per kilogram body weight. Specific experiments already approved under this section may be obtained from the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax).

Section III-B-2. Experiments that have been Approved (under Section III-A-1-a) as Major Actions under the NIH Guidelines

Upon receipt and review of an application from the investigator, NIH/OBA may determine that a proposed experiment is equivalent to an experiment that has previously been approved by the NIH Director as a Major Action, including experiments approved prior to implementation of these changes. An experiment will only be considered equivalent if, as determined by NIH/OBA, there are no substantive differences and pertinent

information has not emerged since submission of the initial III-A-1-a experiment that would change the biosafety and public health considerations for the proposed experiments. If such a determination is made by NIH/OBA, these experiments will not require review and approval under Section III-A.

Section III-C. Experiments that Require Institutional Biosafety Committee and Institutional Review Board Approvals and RAC Review Before Research Participant Enrollment

Section III-C-1. Experiments Involving the Deliberate Transfer of Recombinant or Synthetic Nucleic Acid Molecules, or DNA or RNA Derived from Recombinant or Synthetic Nucleic Acid Molecules, into One or More Human Research Participants

Human gene transfer is the deliberate transfer into human research participants of either:

1. Recombinant nucleic acid molecules, or DNA or RNA derived from recombinant nucleic acid molecules, or
2. Synthetic nucleic acid molecules, or DNA or RNA derived from synthetic nucleic acid molecules, that meet any one of the following criteria:
 - a. Contain more than 100 nucleotides; or
 - b. Possess biological properties that enable integration into the genome (e.g., *cis* elements involved in integration); or
 - c. Have the potential to replicate in a cell; or
 - d. Can be translated or transcribed.

No research participant shall be enrolled (see definition of enrollment in [Section I-E-7](#)) until the RAC review process has been completed (see [Appendix M-I-B, RAC Review Requirements](#)).

In its evaluation of human gene transfer proposals, the RAC will consider whether a proposed human gene transfer experiment presents characteristics that warrant public RAC review and discussion (See [Appendix M-I-B-2](#)). The process of public RAC review and discussion is intended to foster the safe and ethical conduct of human gene transfer experiments. Public review and discussion of a human gene transfer experiment (and access to relevant information) also serves to inform the public about the technical aspects of the proposal, meaning and significance of the research, and any significant safety, social, and ethical implications of the research.

Public RAC review and discussion of a human gene transfer experiment may be: (1) initiated by the NIH Director; or (2) initiated by the NIH OBA Director following a recommendation to NIH OBA by: (a) three or more RAC members; or (b) a Federal agency other than NIH. After a human gene transfer experiment is reviewed by the RAC at a regularly scheduled meeting, NIH OBA will send a letter, unless NIH OBA determines that there are exceptional circumstances, within 10 working days to the NIH Director, the Principal Investigator, the sponsoring institution, and other DHHS components, as appropriate, summarizing the RAC recommendations.

For a clinical trial site that is added after the RAC review process, no research participant shall be enrolled (see definition of enrollment in [Section I-E-7](#)) at the clinical trial site until the following documentation has been submitted to NIH OBA: (1) Institutional Biosafety Committee approval (from the clinical trial site); (2) Institutional Review Board approval; (3) Institutional Review Board-approved informed consent document; (4) curriculum vitae of the Principal Investigator(s) (no more than two pages in biographical sketch format); and (5) NIH grant number(s) if applicable.

In order to maintain public access to information regarding human gene transfer protocols (including protocols that are not publicly reviewed by the RAC), NIH OBA will maintain the documentation described in Appendices M-I through M-V. The information provided in response to [Appendix M](#) should not contain any confidential commercial information or trade secrets, enabling all aspects of RAC review to be open to the public.

Note: For specific directives concerning the use of retroviral vectors for gene delivery, consult [Appendix B-V-1, Murine Retroviral Vectors](#).

Section III-D. Experiments that Require Institutional Biosafety Committee Approval Before Initiation

Prior to the initiation of an experiment that falls into this category, the Principal Investigator must submit a registration document to the Institutional Biosafety Committee which contains the following information: (i) the source(s) of DNA; (ii) the nature of the inserted DNA sequences; (iii) the host(s) and vector(s) to be used; (iv) if an attempt will be made to obtain expression of a foreign gene, and if so, indicate the protein that will be produced; and (v) the containment conditions that will be implemented as specified in the *NIH Guidelines*. For experiments in this category, the registration document shall be dated, signed by the Principal Investigator, and filed with the Institutional Biosafety Committee. The Institutional Biosafety Committee shall review and approve all experiments in this category prior to their initiation. Requests to decrease the level of containment specified for experiments in this category will be considered by NIH (see [Section IV-C-1-b-\(2\)-\(c\)](#), *Minor Actions*).

Section III-D-1. Experiments Using Risk Group 2, Risk Group 3, Risk Group 4, or Restricted Agents as Host-Vector Systems (See [Section II-A](#), Risk Assessment)

Section III-D-1-a. Experiments involving the introduction of recombinant or synthetic nucleic acid molecules into Risk Group 2 agents will usually be conducted at Biosafety Level (BL) 2 containment. Experiments with such agents will usually be conducted with whole animals at BL2 or BL2-N (Animals) containment.

Section III-D-1-b. Experiments involving the introduction of recombinant or synthetic nucleic acid molecules into Risk Group 3 agents will usually be conducted at BL3 containment. Experiments with such agents will usually be conducted with whole animals at BL3 or BL3-N containment.

Section III-D-1-c. Experiments involving the introduction of recombinant or synthetic nucleic acid molecules into Risk Group 4 agents shall be conducted at BL4 containment. Experiments with such agents shall be conducted with whole animals at BL4 or BL4-N containment.

Section III-D-1-d. Containment conditions for experiments involving the introduction of recombinant or synthetic nucleic acid molecules into restricted agents shall be set on a case-by-case basis following NIH/OBA review. A U.S. Department of Agriculture - [Animal and Plant Health Inspection Service](#) (USDA/APHIS) permit is required for work with plant or animal pathogens (see [Section V-G and V-M](#), *Footnotes and References of Sections I-IV*). Experiments with such agents shall be conducted with whole animals at BL4 or BL4-N containment.

Section III-D-2. Experiments in Which DNA From Risk Group 2, Risk Group 3, Risk Group 4, or Restricted Agents is Cloned into Nonpathogenic Prokaryotic or Lower Eukaryotic Host-Vector Systems

Section III-D-2-a. Experiments in which DNA from Risk Group 2 or Risk Group 3 agents (see [Section II-A](#), *Risk Assessment*) is transferred into nonpathogenic prokaryotes or lower eukaryotes may be performed under BL2 containment. Experiments in which DNA from Risk Group 4 agents is transferred into nonpathogenic prokaryotes or lower eukaryotes may be performed under BL2 containment after demonstration that only a totally and irreversibly defective fraction of the agent's genome is present in a given recombinant. In the absence of such a demonstration, BL4 containment shall be used. The Institutional Biosafety Committee may approve the specific lowering of containment for particular experiments to BL1. Many experiments in this category are exempt from the *NIH Guidelines* (see [Section III-F](#), *Exempt Experiments*). Experiments involving the formation of recombinant or synthetic nucleic acid molecules for certain genes coding for molecules toxic for vertebrates require NIH/OBA approval (see [Section III-B-1](#), *Experiments Involving the Cloning of Toxin Molecules with LD₅₀ of Less than 100 Nanograms Per Kilogram Body Weight*) or shall be conducted under NIH specified conditions as described in [Appendix F](#), *Containment Conditions for Cloning of Genes Coding for the Biosynthesis of Molecules Toxic for Vertebrates*.

Section III-D-2-b. Containment conditions for experiments in which DNA from restricted agents is transferred into nonpathogenic prokaryotes or lower eukaryotes shall be determined by NIH/OBA following a case-by-case review (see [Section V-L](#), *Footnotes and References of Sections I-IV*). A U.S. Department of Agriculture permit is required for work with plant or animal pathogens (see [Section V-G](#), *Footnotes and References of Sections I-IV*).

Section III-D-3. Experiments Involving the Use of Infectious DNA or RNA Viruses or Defective DNA or RNA Viruses in the Presence of Helper Virus in Tissue Culture Systems

Caution: Special care should be used in the evaluation of containment levels for experiments which are likely to either enhance the pathogenicity (e.g., insertion of a host oncogene) or to extend the host range (e.g., introduction of novel control elements) of viral vectors under conditions that permit a productive infection. In such cases, serious consideration should be given to increasing physical containment by at least one level.

Note: Recombinant or synthetic nucleic acid molecules or nucleic acid molecules derived therefrom, which contain less than two-thirds of the genome of any eukaryotic virus (all viruses from a single Family (see [Section V-J](#), *Footnotes and References of Sections I-IV*) being considered identical (see [Section V-K](#), *Footnotes and References of Sections I-IV*), are considered defective and may be used in the absence of helper under the conditions specified in [Section III-E-1](#), *Experiments Involving the Formation of Recombinant or Synthetic Molecules Containing No More than Two-Thirds of the Genome of any Eukaryotic Virus*.

Section III-D-3-a. Experiments involving the use of infectious or defective Risk Group 2 viruses (see [Appendix B-II](#), *Risk Group 2 Agents*) in the presence of helper virus may be conducted at BL2.

Section III-D-3-b. Experiments involving the use of infectious or defective Risk Group 3 viruses (see [Appendix B-III-D](#), *Risk Group 3 (RG3) - Viruses and Prions*) in the presence of helper virus may be conducted at BL3.

Section III-D-3-c. Experiments involving the use of infectious or defective Risk Group 4 viruses (see [Appendix B-IV-D](#), *Risk Group 4 (RG4) - Viral Agents*) in the presence of helper virus may be conducted at BL4.

Section III-D-3-d. Experiments involving the use of infectious or defective restricted poxviruses (see [Sections V-A and V-L](#), *Footnotes and References of Sections I-IV*) in the presence of helper virus shall be determined on a case-by-case basis following NIH/OBA review. A U.S. Department of Agriculture permit is required for work with plant or animal pathogens (see [Section V-G](#), *Footnotes and References of Sections I-IV*).

Section III-D-3-e. Experiments involving the use of infectious or defective viruses in the presence of helper virus which are not covered in [Sections III-D-3-a](#) through [III-D-3-d](#) may be conducted at BL1.

Section III-D-4. Experiments Involving Whole Animals

This section covers experiments involving whole animals in which the animal's genome has been altered by stable introduction of recombinant or synthetic nucleic acid molecules, or nucleic acids derived therefrom, into the germ-line (transgenic animals) and experiments involving viable recombinant or synthetic nucleic acid molecule-modified microorganisms tested on whole animals. For the latter, other than viruses which are only vertically transmitted, the experiments may *not* be conducted at BL1-N containment. A minimum containment of BL2 or BL2-N is required.

Caution - Special care should be used in the evaluation of containment conditions for some experiments with transgenic animals. For example, such experiments might lead to the creation of novel mechanisms or increased transmission of a recombinant pathogen or production of undesirable traits in the host animal. In such cases, serious consideration should be given to increasing the containment conditions.

Section III-D-4-a. Recombinant or synthetic nucleic acid molecules, or DNA or RNA molecules derived therefrom, from any source except for greater than two-thirds of eukaryotic viral genome may be transferred to any non-human vertebrate or any invertebrate organism and propagated under conditions of physical containment comparable to BL1 or BL1-N and appropriate to the organism under study (see [Section V-B](#), *Footnotes and References of Sections I-IV*). Animals that contain sequences from viral vectors, which do not lead to transmissible infection either directly or indirectly as a result of complementation or recombination in animals, may be propagated under conditions of physical containment comparable to BL1 or BL1-N and appropriate to the organism under study. Experiments involving the introduction of other sequences from eukaryotic viral genomes into animals are covered under [Section III-D-4-b](#), *Experiments Involving Whole Animals*. For experiments involving recombinant or synthetic nucleic acid molecule-modified Risk Groups 2, 3, 4, or restricted organisms, see [Sections V-A, V-G, and V-L](#), *Footnotes and References of Sections I-IV*. It is important that the investigator demonstrate that the fraction of the viral genome being utilized does not lead to productive infection. A U.S. Department of Agriculture permit is required for work with plant or animal

pathogens (see [Section V-G](#), *Footnotes and References of Sections I-IV*).

Section III-D-4-b. For experiments involving recombinant or synthetic nucleic acid molecules, or DNA or RNA derived therefrom, involving whole animals, including transgenic animals, and not covered by [Section III-D-1](#), *Experiments Using Human or Animal Pathogens (Risk Group 2, Risk Group 3, Risk Group 4, or Restricted Agents as Host-Vector Systems)*, or [Section III-D-4-a](#), the appropriate containment shall be determined by the Institutional Biosafety Committee.

Section III-D-4-c. Exceptions under [Section III-D-4](#), *Experiments Involving Whole Animals*

Section III-D-4-c-(1). Experiments involving the generation of transgenic rodents that require BL1 containment are described under [Section III-E-3](#), *Experiments Involving Transgenic Rodents*.

Section III-D-4-c-(2). The purchase or transfer of transgenic rodents is exempt from the *NIH Guidelines* under [Section III-F](#), *Exempt Experiments* (see [Appendix C-VII](#), *The Purchase or Transfer of Transgenic Rodents*).

Section III-D-5. Experiments Involving Whole Plants

Experiments to genetically engineer plants by recombinant or synthetic nucleic acid molecule methods, to use such plants for other experimental purposes (e.g., response to stress), to propagate such plants, or to use plants together with microorganisms or insects containing recombinant or synthetic nucleic acid molecules, may be conducted under the containment conditions described in [Sections III-D-5-a](#) through [III-D-5-e](#). If experiments involving whole plants are not described in [Section III-D-5](#) and do not fall under [Sections III-A](#), [III-B](#), [III-D](#) or [III-F](#), they are included in [Section III-E](#).

NOTE - For recombinant or synthetic nucleic acid molecule experiments falling under [Sections III-D-5-a](#) through [III-D-5-d](#), physical containment requirements may be reduced to the next lower level by appropriate biological containment practices, such as conducting experiments on a virus with an obligate insect vector in the absence of that vector or using a genetically attenuated strain.

Section III-D-5-a. BL3-P (Plants) or BL2-P + biological containment is recommended for experiments involving most exotic (see [Section V-M](#), *Footnotes and References of Sections I-IV*) infectious agents with recognized potential for serious detrimental impact on managed or natural ecosystems when recombinant or synthetic nucleic acid molecule techniques are associated with whole plants.

Section III-D-5-b. BL3-P or BL2-P + biological containment is recommended for experiments involving plants containing cloned genomes of readily transmissible exotic (see [Section V-M](#), *Footnotes and References of Sections I-IV*) infectious agents with recognized potential for serious detrimental effects on managed or natural ecosystems in which there exists the possibility of reconstituting the complete and functional genome of the infectious agent by genomic complementation *in planta*.

Section III-D-5-c. BL4-P containment is recommended for experiments with a small number of readily transmissible exotic (see [Section V-M](#), *Footnotes and References of Sections I-IV*) infectious agents, such as the soybean rust fungus (*Phakospora pachyrhizi*) and maize streak or other viruses in the presence of their specific arthropod vectors, that have the potential of being serious pathogens of major U.S. crops.

Section III-D-5-d. BL3-P containment is recommended for experiments involving sequences encoding potent vertebrate toxins introduced into plants or associated organisms. Recombinant or synthetic nucleic acid molecules containing genes for the biosynthesis of toxin molecules lethal for vertebrates at an LD₅₀ of <100 nanograms per kilogram body weight fall under [Section III-B-1](#), *Experiments Involving the Cloning of Toxin Molecules with LD₅₀ of Less than 100 Nanograms Per Kilogram Body Weight*, and require NIH/OBA and Institutional Biosafety Committee approval before initiation.

Section III-D-5-e. BL3-P or BL2-P + biological containment is recommended for experiments with microbial pathogens of insects or small animals associated with plants if the recombinant or synthetic nucleic acid molecule-modified organism has a recognized potential for serious detrimental impact on managed or natural ecosystems.

Section III-D-6. Experiments Involving More than 10 Liters of Culture

The appropriate containment will be decided by the Institutional Biosafety Committee. Where appropriate, [Appendix K, Physical Containment for Large Scale Uses of Organisms Containing Recombinant or Synthetic Recombinant or synthetic nucleic acid Molecules](#), shall be used. [Appendix K](#) describes containment conditions Good Large Scale Practice through BL3-Large Scale.

Section III-D-7. Experiments Involving Influenza Viruses

Experiments with influenza viruses generated by recombinant or synthetic methods (e.g., generation by reverse genetics of chimeric viruses with reassorted segments, introduction of specific mutations) shall be conducted at the biosafety level containment corresponding to the Risk Group of the virus that was the source of the majority of segments in the recombinant or synthetic virus (e.g., experiments with viruses containing a majority of segments from a RG3 virus shall be conducted at BL3). Experiments with influenza viruses containing genes or segments from 1918-1919 H1N1 (1918 H1N1), human H2N2 (1957-1968) and highly pathogenic avian influenza H5N1 strains within the Goose/Guangdong/96-like H5 lineage (HPAI H5N1), including, but not limited to, strains of HPAI H5N1 virus that are transmissible among mammals by respiratory droplets, as demonstrated in an appropriate animal model or clinically in humans (hereinafter referred to as mammalian-transmissible HPAI H5N1 virus), shall be conducted at BL3 enhanced containment (see [Appendix G-II-C-5, Biosafety Level 3 Enhanced for Research Involving Risk Group 3 Influenza Viruses](#)) unless indicated below.

Section III-D-7-a. Human H2N2 (1957-1968). Experiments with influenza viruses containing the H2 hemagglutinin (HA) segment shall be conducted at BL3 enhanced (see [Appendix G-II-C-5, Biosafety Level 3 Enhanced for Research Involving Risk Group 3 Influenza Viruses](#)). Experiments with the H2 HA gene in cold-adapted, live attenuated vaccine strains (e.g., A/Ann Arbor/6/60 H2N2) may be conducted at BL2 containment provided segments with mutations conferring temperature sensitivity and attenuation are not altered in the recombinant or synthetic virus. Experiments with Risk Group 2 influenza viruses containing genes from human H2N2 other than the HA gene can be worked on at BL2.

Section III-D-7-b. Highly Pathogenic Avian Influenza H5N1 strains within the Goose/Guangdong/96-like H5 lineage (HPAI H5N1). Experiments involving influenza viruses containing a majority of genes and/or segments from a HPAI H5N1 influenza virus shall be conducted at BL3 enhanced containment, (see [Appendix G-II-C-5, Biosafety Level 3 Enhanced for Research Involving Risk Group 3 Influenza Viruses](#)). Experiments involving influenza viruses containing a minority of genes and/or segments from a HPAI H5N1 influenza virus shall be conducted at BL3 enhanced unless a risk assessment performed by the IBC determines that they can be conducted safely at biosafety level 2 and after they have been excluded pursuant to [9 CFR 121.3\(e\)](#). OBA is available to IBCs to provide consultation with the RAC and influenza virus experts when risk assessments are being made to determine the appropriate biocontainment for experiments with influenza viruses containing a minority of gene/segments from HPAI H5N1. Such experiments may be performed at BL3 enhanced containment or containment may be lowered to biosafety level 2, the level of containment for most research with other influenza viruses. (USDA/APHIS regulations and decisions on lowering containment also apply.) In deciding to lower containment, the IBC should consider whether, in at least two animal models (e.g., ferret, mouse, Syrian golden hamster, cotton rat, non-human primates), there is evidence that the resulting influenza virus shows reduced replication and virulence compared to the parental RG3 virus at relevant doses. This should be determined by measuring biological indices appropriate for the specific animal model (e.g., severe weight loss, elevated temperature, mortality or neurological symptoms).

Section III-D-7-c. 1918 H1N1. Experiments involving influenza viruses containing any gene or segment from 1918 H1N1 shall be conducted at BL3 enhanced containment (see [Appendix G-II-C-5, Biosafety Level 3 Enhanced for Research Involving Risk Group 3 Influenza Viruses](#)).

Section III-D-7-d. Antiviral Susceptibility and Containment. The availability of antiviral drugs as preventive and therapeutic measures is an important safeguard for experiments with 1918 H1N1, HPAI H5N1, and human H2N2 (1957-1968). If an influenza virus containing genes from one of these viruses is resistant to both classes of current antiviral agents, adamantanes and neuraminidase inhibitors, higher containment may be required based on the risk assessment considering transmissibility to humans, virulence, pandemic potential, alternative antiviral agents if available, etc.

Experiments with 1918 H1N1, human H2N2 (1957-1968) or HPAI H5N1 that are designed to create resistance to neuraminidase inhibitors or other effective antiviral agents (including investigational antiviral agents being developed for influenza) would be subject to [Section III-A-1](#) (Major Actions) and require RAC review and NIH Director approval. As per [Section I-A-1](#) of the *NIH Guidelines*, if the agent is a Select Agent, the NIH will defer to the appropriate Federal agency (HHS or USDA Select Agent Divisions) on such experiments.

Section III-E. Experiments that Require Institutional Biosafety Committee Notice Simultaneous with Initiation

Experiments not included in Sections [III-A](#), [III-B](#), [III-C](#), [III-D](#), [III-F](#), and their subsections are considered in [Section III-E](#). All such experiments may be conducted at BL1 containment. For experiments in this category, a registration document (see [Section III-D](#), *Experiments that Require Institutional Biosafety Committee Approval Before Initiation*) shall be dated and signed by the investigator and filed with the local Institutional Biosafety Committee at the time the experiment is initiated. The Institutional Biosafety Committee reviews and approves all such proposals, but Institutional Biosafety Committee review and approval prior to initiation of the experiment is not required (see [Section IV-A](#), *Policy*). For example, experiments in which all components derived from non-pathogenic prokaryotes and non-pathogenic lower eukaryotes fall under [Section III-E](#) and may be conducted at BL1 containment.

Section III-E-1. Experiments Involving the Formation of Recombinant or Synthetic Nucleic Acid Molecules Containing No More than Two-Thirds of the Genome of any Eukaryotic Virus

Recombinant or synthetic nucleic acid molecules containing no more than two-thirds of the genome of any eukaryotic virus (all viruses from a single Family being considered identical [see [Section V-J](#), *Footnotes and References of Sections I-IV*]) may be propagated and maintained in cells in tissue culture using BL1 containment. For such experiments, it must be demonstrated that the cells lack helper virus for the specific Families of defective viruses being used. If helper virus is present, procedures specified under [Section III-D-3](#), *Experiments Involving the Use of Infectious Animal or Plant DNA or RNA Viruses or Defective Animal or Plant DNA or RNA Viruses in the Presence of Helper Virus in Tissue Culture Systems*, should be used. The DNA may contain fragments of the genome of viruses from more than one Family but each fragment shall be less than two-thirds of a genome.

Section III-E-2. Experiments Involving Whole Plants

This section covers experiments involving nucleic acid molecule-modified whole plants, and/or experiments involving recombinant or synthetic nucleic acid molecule-modified organisms associated with whole plants, except those that fall under [Section III-A](#), [III-B](#), [III-D](#), or [III-F](#). It should be emphasized that knowledge of the organisms and judgment based on accepted scientific practices should be used in all cases in selecting the appropriate level of containment. For example, if the genetic modification has the objective of increasing pathogenicity or converting a non-pathogenic organism into a pathogen, then a higher level of containment may be appropriate depending on the organism, its mode of dissemination, and its target organisms. By contrast, a lower level of containment may be appropriate for small animals associated with many types of recombinant or synthetic nucleic acid molecule-modified plants.

Section III-E-2-a. BL1-P is recommended for all experiments with recombinant or synthetic recombinant or synthetic nucleic acid molecule-containing plants and plant-associated microorganisms not covered in [Section III-E-2-b](#) or other sections of the *NIH Guidelines*. Examples of such experiments are those involving recombinant or synthetic nucleic acid molecule-modified plants that are not noxious weeds or that cannot interbreed with noxious weeds in the immediate geographic area, and experiments involving whole plants and recombinant or synthetic nucleic acid molecule-modified non-exotic (see [Section V-M](#), *Footnotes and References of Sections I-IV*) microorganisms that have no recognized potential for rapid and widespread dissemination or for serious detrimental impact on managed or natural ecosystems (e.g., *Rhizobium* spp. and *Agrobacterium* spp.).

Section III-E-2-b. BL2-P or BL1-P + biological containment is recommended for the following experiments:

Section III-E-2-b(1). Plants modified by recombinant or synthetic nucleic acid molecules that are noxious weeds or can interbreed with noxious weeds in the immediate geographic area.

Section III-E-2-b-(2). Plants in which the introduced DNA represents the complete genome of a non-exotic infectious agent (see [Section V-M](#), *Footnotes and References of Sections I-IV*).

Section III-E-2-b-(3). Plants associated with recombinant or synthetic nucleic acid molecule-modified non-exotic microorganisms that have a recognized potential for serious detrimental impact on managed or natural ecosystems (see [Section V-M](#), *Footnotes and References of Sections I-IV*).

Section III-E-2-b-(4). Plants associated with recombinant or synthetic nucleic acid molecule-modified exotic microorganisms that have no recognized potential for serious detrimental impact on managed or natural ecosystems (see [Section V-M](#), *Footnotes and References of Sections I-IV*).

Section III-E-2-b-(5). Experiments with recombinant or synthetic nucleic acid molecule-modified arthropods or small animals associated with plants, or with arthropods or small animals with recombinant or synthetic nucleic acid molecule-modified microorganisms associated with them if the recombinant or synthetic nucleic acid molecule-modified microorganisms have no recognized potential for serious detrimental impact on managed or natural ecosystems (see [Section V-M](#), *Footnotes and References of Sections I-IV*).

Section III-E-3. Experiments Involving Transgenic Rodents

This section covers experiments involving the generation of rodents in which the animal's genome has been altered by stable introduction of recombinant or synthetic nucleic acid molecules, or nucleic acids derived therefrom, into the germ-line (transgenic rodents). Only experiments that require BL1 containment are covered under this section; experiments that require BL2, BL3, or BL4 containment are covered under [Section III-D-4](#), *Experiments Involving Whole Animals*.

Section III-E-3-a. Experiments involving the breeding of certain BL1 transgenic rodents are exempt under [Section III-F](#), *Exempt Experiments* (See [Appendix C-VIII](#), *Generation of BL1 Transgenic Rodents via Breeding*).

Section III-F. Exempt Experiments

The following recombinant or synthetic nucleic acid molecules are exempt from the *NIH Guidelines* and registration with the Institutional Biosafety Committee is not required; however, other federal and state standards of biosafety may still apply to such research (for example, the Centers for Disease Control and Prevention (CDC)/NIH publication *Biosafety in Microbiological and Biomedical Laboratories*).

Section III-F-1. Those synthetic nucleic acids that: (1) can neither replicate nor generate nucleic acids that can replicate in any living cell (e.g., oligonucleotides or other synthetic nucleic acids that do not contain an origin of replication or contain elements known to interact with either DNA or RNA polymerase), and (2) are not designed to integrate into DNA, and (3) do not produce a toxin that is lethal for vertebrates at an LD50 of less than 100 nanograms per kilogram body weight. If a synthetic nucleic acid is deliberately transferred into one or more human research participants and meets the criteria of [Section III-C](#), it is not exempt under this Section.

Section III-F-2. Those that are not in organisms, cells, or viruses and that have not been modified or manipulated (e.g., encapsulated into synthetic or natural vehicles) to render them capable of penetrating cellular membranes.

Section III-F-3. Those that consist solely of the exact recombinant or synthetic nucleic acid sequence from a single source that exists contemporaneously in nature.

Section III-F-4. Those that consist entirely of nucleic acids from a prokaryotic host, including its indigenous plasmids or viruses when propagated only in that host (or a closely related strain of the same species), or when transferred to another host by well-established physiological means.

Section III-F-5. Those that consist entirely of nucleic acids from a eukaryotic host including its chloroplasts, mitochondria, or plasmids (but excluding viruses) when propagated only in that host (or a closely related strain of the same species).

Section III-F-6. Those that consist entirely of DNA segments from different species that exchange DNA by known physiological processes, though one or more of the segments may be a synthetic equivalent. A list of such exchangers will be prepared and periodically revised by the NIH Director with advice of the RAC after appropriate notice and opportunity for public comment (see [Section IV-C-1-b-\(1\)-\(c\)](#), *Major Actions*). See [Appendices A-I](#) through [A-VI](#), *Exemptions under Section III-F-6--Sublists of Natural Exchangers*, for a list of natural exchangers that are exempt from the *NIH Guidelines*.

Section III-F-7. Those genomic DNA molecules that have acquired a transposable element, provided the transposable element does not contain any recombinant and/or synthetic DNA.

Section III-F-8. Those that do not present a significant risk to health or the environment (see [Section IV-C-1-b-\(1\)-\(c\)](#), *Major Actions*), as determined by the NIH Director, with the advice of the RAC, and following appropriate notice and opportunity for public comment. See [Appendix C](#), *Exemptions under Section III-F-8* for other classes of experiments which are exempt from the *NIH Guidelines*.

SECTION IV. ROLES AND RESPONSIBILITIES

Section IV-A. Policy

The safe conduct of experiments involving recombinant or synthetic nucleic acid molecules depends on the individual conducting such activities. The *NIH Guidelines* cannot anticipate every possible situation. Motivation and good judgment are the key essentials to protection of health and the environment. The *NIH Guidelines* are intended to assist the institution, Institutional Biosafety Committee, Biological Safety Officer, and the Principal Investigator in determining safeguards that should be implemented. The *NIH Guidelines* will never be complete or final since all conceivable experiments involving recombinant or synthetic nucleic acid molecules cannot be foreseen. The utilization of new genetic manipulation techniques may enable work previously conducted using recombinant means to be accomplished faster, more efficiently, or at larger scale. These techniques have not yet yielded organisms that present safety concerns that fall outside the current risk assessment framework used for recombinant nucleic acid research. Nonetheless, an appropriate risk assessment of experiments involving these techniques must be conducted taking into account the way these approaches may alter the risk assessment. As new techniques develop, the *NIH Guidelines* should be periodically reviewed to determine whether and how such research should be explicitly addressed.

It is the responsibility of the institution and those associated with it to adhere to the intent of the *NIH Guidelines* as well as to their specifics. Therefore, each institution (and the Institutional Biosafety Committee acting on its behalf) is responsible for ensuring that all research with recombinant or synthetic nucleic acid molecules conducted at or sponsored by that institution is conducted in compliance with the *NIH Guidelines*. The following roles and responsibilities constitute an administrative framework in which safety is an essential and integral part of research involving recombinant or synthetic nucleic acid molecules. Further clarifications and interpretations of roles and responsibilities will be issued by NIH as necessary.

Section IV-B. Responsibilities of the Institution

Section IV-B-1. General Information

Each institution conducting or sponsoring recombinant or synthetic nucleic acid molecule research which is covered by the *NIH Guidelines* is responsible for ensuring that the research is conducted in full conformity with the provisions of the *NIH Guidelines*. In order to fulfill this responsibility, the institution shall:

Section IV-B-1-a. Establish and implement policies that provide for the safe conduct of recombinant or synthetic nucleic acid molecule research and that ensure compliance with the *NIH Guidelines*. As part of its general responsibilities for implementing the *NIH Guidelines*, the institution may establish additional procedures, as deemed necessary, to govern the institution and its components in the discharge of its responsibilities under the *NIH Guidelines*. Such procedures may include: (i) statements formulated by the institution for the general implementation of the *NIH Guidelines*, and (ii) any additional precautionary steps the institution deems appropriate.

Section IV-B-1-b. Establish an Institutional Biosafety Committee that meets the requirements set forth in Section IV-B-2-a and carries out the functions detailed in [Section IV-B-2-b](#).

Section IV-B-1-c. Appoint a Biological Safety Officer (who is also a member of the Institutional Biosafety Committee) if the institution: (i) conducts recombinant or synthetic nucleic acid molecule research at Biosafety Level (BL) 3 or BL4, or (ii) engages in large-scale (greater than 10 liters) research. The Biological Safety Officer carries out the duties specified in [Section IV-B-3](#).

Section IV-B-1-d. Appoint at least one individual with expertise in plant, plant pathogen, or plant pest containment principles (who is a member of the Institutional Biosafety Committee) if the institution conducts recombinant or synthetic nucleic acid molecule research that requires Institutional Biosafety Committee approval in accordance with [Appendix P, Physical and Biological Containment for Recombinant or Synthetic Nucleic Acid Molecule Research Involving Plants](#).

Section IV-B-1-e. Appoint at least one individual with expertise in animal containment principles (who is a member of the Institutional Biosafety Committee) if the institution conducts recombinant or synthetic nucleic acid molecule research that requires Institutional Biosafety Committee approval in accordance with [Appendix Q, Physical and Biological Containment for Recombinant or Synthetic Nucleic Acid Molecule Research Involving Animals](#).

Section IV-B-1-f. Ensure that when the institution participates in or sponsors recombinant or synthetic nucleic acid molecule research involving human subjects: (i) the Institutional Biosafety Committee has adequate expertise and training (using *ad hoc* consultants as deemed necessary), (ii) all aspects of [Appendix M](#) have been appropriately addressed by the Principal Investigator; and (iii) no research participant shall be enrolled (see definition of enrollment in [Section I-E-7](#)) in a human gene transfer experiment until the RAC review process has been completed (see [Appendix M-I-B, RAC Review Requirements](#)), Institutional Biosafety Committee approval has been obtained, Institutional Review Board approval has been obtained, and all applicable regulatory authorizations have been obtained. Institutional Biosafety Committee approval must be obtained from each institution at which recombinant or synthetic nucleic acids will be administered to human subjects (as opposed to each institution involved in the production of vectors for human application and each institution at which there is *ex vivo* transduction of recombinant or synthetic nucleic acid molecule material into target cells for human application).

Section IV-B-1-g. Assist and ensure compliance with the *NIH Guidelines* by Principal Investigators conducting research at the institution as specified in [Section IV-B-7](#).

Section IV-B-1-h. Ensure appropriate training for the Institutional Biosafety Committee Chair and members, Biological Safety Officer and other containment experts (when applicable), Principal Investigators, and laboratory staff regarding laboratory safety and implementation of the *NIH Guidelines*. The Institutional Biosafety Committee Chair is responsible for ensuring that Institutional Biosafety Committee members are appropriately trained. The Principal Investigator is responsible for ensuring that laboratory staff are appropriately trained. The institution is responsible for ensuring that the Principal Investigator has sufficient training; however, this responsibility may be delegated to the Institutional Biosafety Committee.

Section IV-B-1-i. Determine the necessity for health surveillance of personnel involved in connection with individual recombinant or synthetic nucleic acid molecule projects; and if appropriate, conduct a health surveillance program for such projects. The institution shall establish and maintain a health surveillance program for personnel engaged in large-scale research or production activities involving viable organisms containing recombinant or synthetic nucleic acid molecules which require BL3 containment at the laboratory scale. The institution shall establish and maintain a health surveillance program for personnel engaged in animal research involving viable recombinant or synthetic nucleic acid molecule-containing microorganisms that require BL3 or greater containment in the laboratory. The *Laboratory Safety Monograph* discusses various components of such a program (e.g., records of agents handled, active investigation of relevant illnesses, and the maintenance of serial serum samples for monitoring serologic changes that may result from the employees' work experience). Certain medical conditions may place a laboratory worker at increased risk in any endeavor where infectious agents are handled. Examples cited in the *Laboratory Safety Monograph* include gastrointestinal disorders and treatment with steroids, immunosuppressive drugs, or antibiotics. Workers with such disorders or treatment should be evaluated to determine whether they should be engaged in research with potentially hazardous organisms during their treatment or illness. Copies of the *Laboratory Safety Monograph*

are available from the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax).

Section IV-B-1-j. Report any significant problems, violations of the *NIH Guidelines*, or any significant research-related accidents and illnesses to NIH/OBA within thirty days, unless the institution determines that a report has already been filed by the Principal Investigator or Institutional Biosafety Committee. Reports shall be sent to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax).

Section IV-B-2. Institutional Biosafety Committee (IBC)

The institution shall establish an Institutional Biosafety Committee whose responsibilities need not be restricted to recombinant or synthetic nucleic acid molecule research. The Institutional Biosafety Committee shall meet the following requirements:

Section IV-B-2-a. Membership and Procedures

Section IV-B-2-a-(1). The Institutional Biosafety Committee must be comprised of no fewer than five members so selected that they collectively have experience and expertise in recombinant or synthetic nucleic acid molecule technology and the capability to assess the safety of recombinant or synthetic nucleic acid molecule research and to identify any potential risk to public health or the environment. At least two members shall not be affiliated with the institution (apart from their membership on the Institutional Biosafety Committee) and who represent the interest of the surrounding community with respect to health and protection of the environment (e.g., officials of state or local public health or environmental protection agencies, members of other local governmental bodies, or persons active in medical, occupational health, or environmental concerns in the community). The Institutional Biosafety Committee shall include at least one individual with expertise in plant, plant pathogen, or plant pest containment principles when experiments utilizing [Appendix P, Physical and Biological Containment for Recombinant or Synthetic Nucleic Acid Molecule Research](#)

Involving Plants, require prior approval by the Institutional Biosafety Committee. The Institutional Biosafety Committee shall include at least one scientist with expertise in animal containment principles when experiments utilizing [Appendix Q, Physical and Biological Containment for Recombinant or Synthetic Nucleic Acid Molecule Research Involving Animals](#), require Institutional Biosafety Committee prior approval. When the institution conducts recombinant or synthetic nucleic acid molecule research at BL3, BL4, or Large Scale (greater than 10 liters), a Biological Safety Officer is mandatory and shall be a member of the Institutional Biosafety Committee (see [Section IV-B-3, Biological Safety Officer](#)). When the institution participates in or sponsors recombinant or synthetic nucleic acid molecule research involving human research participants, the institution must ensure that: (i) the Institutional Biosafety Committee has adequate expertise and training (using *ad hoc* consultants as deemed necessary); (ii) all aspects of [Appendix M](#) have been appropriately addressed by the Principal Investigator; (iii) no research participant shall be enrolled (see definition of enrollment in [Section I-E-7](#)) in a human gene transfer experiment until the RAC review process has been completed (see [Appendix M-I-B, RAC Review Requirements](#)); and (iv) final IBC approval is granted only after the RAC review process has been completed (see [Appendix M-I-B, RAC Review Requirements](#)). Institutional Biosafety Committee approval must be obtained from the institution at which recombinant or synthetic nucleic acid molecule material will be administered to human research participants (rather than the site involved in manufacturing gene transfer products).

Note: Individuals, corporations, and institutions not otherwise covered by the *NIH Guidelines*, are encouraged to adhere to the standards and procedures set forth in [Sections I](#) through [IV](#) (see [Section IV-D, Voluntary Compliance](#)). The policy and procedures for establishing an Institutional Biosafety Committee under *Voluntary Compliance*, are specified in [Section IV-D-2, Institutional Biosafety Committee Approval](#).

Section IV-B-2-a-(2). In order to ensure the competence necessary to review and approve recombinant or synthetic nucleic acid molecule activities, it is recommended that the Institutional Biosafety Committee: (i) include persons with expertise in recombinant or synthetic nucleic acid molecule technology, biological safety, and physical containment; (ii) include or have available as consultants persons knowledgeable in institutional commitments and policies, applicable law, standards of professional conduct and practice, community attitudes, and the environment, and (iii) include at least one member representing the laboratory technical staff.

Section IV-B-2-a-(3). The institution shall file an annual report with NIH/OBA which includes: (i) a roster of all Institutional Biosafety Committee members clearly indicating the Chair, contact person, Biological Safety Officer (if applicable), plant expert (if applicable), animal expert (if applicable), human gene therapy expertise or *ad hoc* consultant (if applicable); and (ii) biographical sketches of all Institutional Biosafety Committee members (including community members).

Section IV-B-2-a-(4). No member of an Institutional Biosafety Committee may be involved (except to provide information requested by the Institutional Biosafety Committee) in the review or approval of a project in which he/she has been or expects to be engaged or has a direct financial interest.

Section IV-B-2-a-(5). The institution, that is ultimately responsible for the effectiveness of the Institutional Biosafety Committee, may establish procedures that the Institutional Biosafety Committee shall follow in its initial and continuing review and approval of applications, proposals, and activities.

Section IV-B-2-a-(6). When possible and consistent with protection of privacy and proprietary interests, the institution is encouraged to open its Institutional Biosafety Committee meetings to the public.

Section IV-B-2-a-(7). Upon request, the institution shall make available to the public all Institutional Biosafety Committee meeting minutes and any documents submitted to or received from funding agencies which the latter are required to make available to the public. If public comments are made on Institutional Biosafety Committee actions, the institution shall forward both the public comments and the Institutional Biosafety Committee's response to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax).

Section IV-B-2-b. Functions

On behalf of the institution, the Institutional Biosafety Committee is responsible for:

Section IV-B-2-b-(1). Reviewing recombinant or synthetic nucleic acid molecule research conducted at or sponsored by the institution for compliance with the *NIH Guidelines* as specified in [Section III, Experiments Covered by the NIH Guidelines](#), and approving those research projects that are found to conform with the *NIH Guidelines*. This review shall include: (i) independent assessment of the containment levels required by the *NIH Guidelines* for the proposed research; (ii) assessment of the facilities, procedures, practices, and training and expertise of personnel involved in recombinant or synthetic nucleic acid molecule research; (iii) ensuring that all aspects of [Appendix M](#) have been appropriately addressed by the Principal Investigator; (iv) ensuring that no research participant is enrolled (see definition of enrollment in [Section I-E-7](#)) in a human gene transfer experiment until the RAC review process has been completed (see [Appendix M-I-B, RAC Review Requirements](#)), Institutional Biosafety Committee approval (from the clinical trial site) has been obtained, Institutional Review Board approval has been obtained, and all applicable regulatory authorizations have been obtained; (v) for human gene transfer protocols selected for public RAC review and discussion, consideration of the issues raised and recommendations made as a result of this review and consideration of the Principal Investigator's response to the RAC recommendations; (vi) ensuring that final IBC approval is granted only after the RAC review process has been completed (see [Appendix M-I-B, RAC Review Requirements](#)); and (vii) ensuring compliance with all surveillance, data reporting, and adverse event reporting requirements set forth in the *NIH Guidelines*.

Section IV-B-2-b-(2). Notifying the Principal Investigator of the results of the Institutional Biosafety Committee's review and approval.

Section IV-B-2-b-(3). Lowering containment levels for certain experiments as specified in [Section III-D-2-a, Experiments in which DNA from Risk Group 2, Risk Group 3, Risk Group 4, or Restricted Agents is Cloned into Nonpathogenic Prokaryotic or Lower Eukaryotic Host-Vector Systems](#).

Section IV-B-2-b-(4). Setting containment levels as specified in [Sections III-D-4-b, Experiments Involving Whole Animals](#), and [III-D-5, Experiments Involving Whole Plants](#).

Section IV-B-2-b-(5). Periodically reviewing recombinant or synthetic nucleic acid molecule research conducted at the institution to ensure compliance with the *NIH Guidelines*.

Section IV-B-2-b-(6). Adopting emergency plans covering accidental spills and personnel contamination

resulting from recombinant or synthetic nucleic acid molecule research.

Note: The *Laboratory Safety Monograph* describes basic elements for developing specific procedures dealing with major spills of potentially hazardous materials in the laboratory, including information and references about decontamination and emergency plans. The NIH and the CDC are available to provide consultation and direct assistance, if necessary, as posted in the *Laboratory Safety Monograph*. The institution shall cooperate with the state and local public health departments by reporting any significant research-related illness or accident that may be hazardous to the public health.

Section IV-B-2-b-(7). Reporting any significant problems with or violations of the *NIH Guidelines* and any significant research-related accidents or illnesses to the appropriate institutional official and NIH/OBA within 30 days, unless the Institutional Biosafety Committee determines that a report has already been filed by the Principal Investigator. Reports to NIH/OBA shall be sent to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax).

Section IV-B-2-b-(8). The Institutional Biosafety Committee may not authorize initiation of experiments which are not explicitly covered by the *NIH Guidelines* until NIH (with the advice of the RAC when required) establishes the containment requirement.

Section IV-B-2-b-(9). Performing such other functions as may be delegated to the Institutional Biosafety Committee under [Section IV-B-2](#), *Institutional Biosafety Committee*.

Section IV-B-3. Biological Safety Officer (BSO)

Section IV-B-3-a. The institution shall appoint a Biological Safety Officer if it engages in large-scale research or production activities involving viable organisms containing recombinant or synthetic nucleic acid molecules.

Section IV-B-3-b. The institution shall appoint a Biological Safety Officer if it engages in recombinant or synthetic nucleic acid molecule research at BL3 or BL4. The Biological Safety Officer shall be a member of the Institutional Biosafety Committee.

Section IV-B-3-c. The Biological Safety Officer's duties include, but are not be limited to:

Section IV-B-3-c-(1). Periodic inspections to ensure that laboratory standards are rigorously followed;

Section IV-B-3-c-(2). Reporting to the Institutional Biosafety Committee and the institution any significant problems, violations of the *NIH Guidelines*, and any significant research-related accidents or illnesses of which the Biological Safety Officer becomes aware unless the Biological Safety Officer determines that a report has already been filed by the Principal Investigator;

Section IV-B-3-c-(3). Developing emergency plans for handling accidental spills and personnel contamination and investigating laboratory accidents involving recombinant or synthetic nucleic acid molecule research;

Section IV-B-3-c-(4). Providing advice on laboratory security;

Section IV-B-3-c-(5). Providing technical advice to Principal Investigators and the Institutional Biosafety Committee on research safety procedures.

Note: See the *Laboratory Safety Monograph* for additional information on the duties of the Biological Safety Officer.

Section IV-B-4. Plant, Plant Pathogen, or Plant Pest Containment Expert

When the institution conducts recombinant or synthetic nucleic acid molecule research that requires Institutional Biosafety Committee approval in accordance with [Appendix P](#), *Physical and Biological Containment for Recombinant or Synthetic Nucleic Acid Molecule Research Involving Plants*, the institution shall appoint at least one individual with expertise in plant, plant pathogen, or plant pest containment principles (who is a member of the Institutional Biosafety Committee).

Section IV-B-5. Animal Containment Expert

When the institution conducts recombinant or synthetic nucleic acid molecule research that requires Institutional Biosafety Committee approval in accordance with [Appendix Q, Physical and Biological Containment for Recombinant or Synthetic Nucleic Acid Molecule Research Involving Animals](#), the institution shall appoint at least one individual with expertise in animal containment principles (who is a member of the Institutional Biosafety Committee).

Section IV-B-6. Human Gene Therapy Expertise

When the institution participates in or sponsors recombinant or synthetic nucleic acid molecule research involving human subjects, the institution must ensure that: (i) the Institutional Biosafety Committee has adequate expertise and training (using *ad hoc* consultants as deemed necessary) and (ii) all aspects of [Appendix M, Points to Consider in the Design and Submission of Protocols for the Transfer of Recombinant or Synthetic Nucleic Acid Molecules into One or More Human Subjects \(Points to Consider\)](#), have been appropriately addressed by the Principal Investigator prior to submission to NIH/OBA.

Section IV-B-7. Principal Investigator (PI)

On behalf of the institution, the Principal Investigator is responsible for full compliance with the *NIH Guidelines* in the conduct of recombinant or synthetic nucleic acid molecule research. A Principal Investigator engaged in human gene transfer research may delegate to another party, such as a corporate sponsor, the reporting functions set forth in [Appendix M](#), with written notification to the NIH OBA of the delegation and of the name(s), address, telephone, and fax numbers of the contact. The Principal Investigator is responsible for ensuring that the reporting requirements are fulfilled and will be held accountable for any reporting lapses.

Section IV-B-7-a. General Responsibilities

As part of this general responsibility, the Principal Investigator shall:

Section IV-B-7-a-(1). Initiate or modify no recombinant or synthetic nucleic acid molecule research which requires Institutional Biosafety Committee approval prior to initiation (see Sections [III-A](#), [III-B](#), [III-C](#), [III-D](#), and [III-E, Experiments Covered by the NIH Guidelines](#)) until that research or the proposed modification thereof has been approved by the Institutional Biosafety Committee and has met all other requirements of the *NIH Guidelines*;

Section IV-B-7-a-(2). Determine whether experiments are covered by [Section III-E, Experiments that Require Institutional Biosafety Committee Notice Simultaneous with Initiation](#), and ensure that the appropriate procedures are followed;

Section IV-B-7-a-(3). Report any significant problems, violations of the *NIH Guidelines*, or any significant research-related accidents and illnesses to the Biological Safety Officer (where applicable), Greenhouse/Animal Facility Director (where applicable), Institutional Biosafety Committee, NIH/OBA, and other appropriate authorities (if applicable) within 30 days. Reports to NIH/OBA shall be sent to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax);

Section IV-B-7-a-(4). Report any new information bearing on the *NIH Guidelines* to the Institutional Biosafety Committee and to NIH/OBA (reports to NIH/OBA shall be sent to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax);

Section IV-B-7-a-(5). Be adequately trained in good microbiological techniques;

Section IV-B-7-a-(6). Adhere to Institutional Biosafety Committee approved emergency plans for handling accidental spills and personnel contamination; and

Section IV-B-7-a-(7). Comply with shipping requirements for recombinant or synthetic nucleic acid molecules (see [Appendix H, Shipment](#), for shipping requirements and the *Laboratory Safety Monograph* for technical recommendations).

Section IV-B-7-b. Information to Be Submitted by the Principal Investigator to NIH OBA

The Principal Investigator shall:

Section IV-B-7-b-(1). Submit information to NIH/OBA for certification of new host-vector systems;

Section IV-B-7-b-(2). Petition NIH/OBA, with notice to the Institutional Biosafety Committee, for proposed exemptions to the *NIH Guidelines*;

Section IV-B-7-b-(3). Petition NIH/OBA, with concurrence of the Institutional Biosafety Committee, for approval to conduct experiments specified in [Sections III-A-1, Major Actions Under the NIH Guidelines](#), and [III-B, Experiments that Require NIH/OBA and Institutional Biosafety Committee Approval Before Initiation](#);

Section IV-B-7-b-(4). Petition NIH/OBA for determination of containment for experiments requiring case-by-case review; and

Section IV-B-7-b-(5). Petition NIH/OBA for determination of containment for experiments not covered by the *NIH Guidelines*.

Section IV-B-7-b-(6). Ensure that all aspects of [Appendix M](#) have been appropriately addressed prior to submission of a human gene transfer experiment to NIH OBA, and provide a letter signed by the Principal Investigator(s) on institutional letterhead acknowledging that the documentation being submitted to NIH OBA complies with the requirements set forth in [Appendix M](#). No research participant shall be enrolled (see definition of enrollment in [Section I-E-7](#)) in a human gene transfer experiment until the RAC review process has been completed (see [Appendix M-I-B, RAC Review Requirements](#)); IBC approval (from the clinical trial site) has been obtained; Institutional Review Board (IRB) approval has been obtained; and all applicable regulatory authorization(s) have been obtained.

For a clinical trial site that is added after the RAC review process, no research participant shall be enrolled (see definition of enrollment in [Section I-E-7](#)) at the clinical trial site until the following documentation has been submitted to NIH OBA: (1) IBC approval (from the clinical trial site); (2) IRB approval; (3) IRB-approved informed consent document; (4) curriculum vitae of the Principal Investigator(s) (no more than two pages in biographical sketch format); and (5) NIH grant number(s) if applicable.

Section IV-B-7-c. Submissions by the Principal Investigator to the Institutional Biosafety Committee

The Principal Investigator shall:

Section IV-B-7-c-(1). Make an initial determination of the required levels of physical and biological containment in accordance with the *NIH Guidelines*;

Section IV-B-7-c-(2). Select appropriate microbiological practices and laboratory techniques to be used for the research;

Section IV-B-7-c-(3). Submit the initial research protocol and any subsequent changes (e.g., changes in the source of DNA or host-vector system), if covered under [Sections III-A, III-B, III-C, III-D, or III-E \(Experiments Covered by the NIH Guidelines\)](#), to the Institutional Biosafety Committee for review and approval or disapproval; and

Section IV-B-7-c-(4). Remain in communication with the Institutional Biosafety Committee throughout the conduct of the project.

Section IV-B-7-d. Responsibilities of the Principal Investigator Prior to Initiating Research

The Principal Investigator shall:

Section IV-B-7-d-(1). Make available to all laboratory staff the protocols that describe the potential biohazards and the precautions to be taken;

Section IV-B-7-d-(2). Instruct and train laboratory staff in: (i) the practices and techniques required to ensure safety, and (ii) the procedures for dealing with accidents; and

Section IV-B-7-d-(3). Inform the laboratory staff of the reasons and provisions for any precautionary medical practices advised or requested (e.g., vaccinations or serum collection).

Section IV-B-7-e. Responsibilities of the Principal Investigator During the Conduct of the Research

The Principal Investigator shall:

Section IV-B-7-e-(1). Supervise the safety performance of the laboratory staff to ensure that the required safety practices and techniques are employed;

Section IV-B-7-e-(2). Investigate and report any significant problems pertaining to the operation and implementation of containment practices and procedures in writing to the Biological Safety Officer (where applicable), Greenhouse/Animal Facility Director (where applicable), Institutional Biosafety Committee, NIH/OBA, and other appropriate authorities (if applicable) (reports to NIH/OBA shall be sent to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax);

Section IV-B-7-e-(3). Correct work errors and conditions that may result in the release of recombinant or synthetic nucleic acid molecule materials; and

Section IV-B-7-e-(4). Ensure the integrity of the physical containment (e.g., biological safety cabinets) and the biological containment (e.g., purity and genotypic and phenotypic characteristics).

Section IV-B-7-e-(5). Comply with reporting requirements for human gene transfer experiments conducted in compliance with the *NIH Guidelines* (see [Appendix M-I-C, Reporting Requirements](#)).

Section IV-C. Responsibilities of the National Institutes of Health (NIH)**Section IV-C-1. NIH Director**

The NIH Director is responsible for: (i) establishing the *NIH Guidelines*, (ii) overseeing their implementation, and (iii) their final interpretation. The NIH Director has responsibilities under the *NIH Guidelines* that involve OBA and RAC. OBA's responsibilities under the *NIH Guidelines* are administrative. Advice from RAC is primarily scientific, technical, and ethical. In certain circumstances, there is specific opportunity for public comment with published response prior to final action.

Section IV-C-1-a. General Responsibilities

The NIH Director is responsible for:

Section IV-C-1-a-(1). Promulgating requirements as necessary to implement the *NIH Guidelines*;

Section IV-C-1-a-(2). Establishing and maintaining RAC to carry out the responsibilities set forth in Section IV-C-2, *Recombinant DNA Advisory Committee* (RAC membership is specified in its [charter](#) and in [Section IV-C-2](#));

Section IV-C-1-a-(3). Establishing and maintaining NIH/OBA to carry out the responsibilities defined in [Section IV-C-3, Office of Biotechnology Activities](#);

Section IV-C-1-a(4). Conducting and supporting training programs in laboratory safety for Institutional Biosafety Committee members, Biological Safety Officers and other institutional experts (if applicable), Principal Investigators, and laboratory staff.

Section IV-C-1-a(5). Establishing and convening Gene Therapy Policy Conferences as described in [Appendix L, Gene Therapy Policy Conferences](#).

Section IV-C-1-b. Specific Responsibilities

In carrying out the responsibilities set forth in this section, the NIH Director, or a designee shall weigh each proposed action through appropriate analysis and consultation to determine whether it complies with the *NIH Guidelines* and presents no significant risk to health or the environment.

Section IV-C-1-b(1). Major Actions

To execute *Major Actions*, the NIH Director shall seek the advice of RAC and provide an opportunity for public and Federal agency comment. Specifically, the Notice of Meeting and *Proposed Actions* shall be published in the *Federal Register* at least 15 days before the RAC meeting. The NIH Director's decision/recommendation (at his/her discretion) may be published in the *Federal Register* for 15 days of comment before final action is taken. The NIH Director's final decision/recommendation, along with responses to public comments, shall be published in the *Federal Register*. The RAC and Institutional Biosafety Committee Chairs shall be notified of the following decisions:

Section IV-C-1-b(1)(a). Changing containment levels for types of experiments that are specified in the *NIH Guidelines* when a *Major Action* is involved;

Section IV-C-1-b(1)(b). Assigning containment levels for types of experiments that are not explicitly considered in the *NIH Guidelines* when a *Major Action* is involved;

Section IV-C-1-b(1)(c). Promulgating and amending a list of classes of recombinant or synthetic nucleic acid molecules to be exempt from the *NIH Guidelines* because they consist entirely of DNA segments from species that exchange DNA by known physiological processes or otherwise do not present a significant risk to health or the environment;

Section IV-C-1-b(1)(d). Permitting experiments specified by [Section III-A, Experiments that Require Institutional Biosafety Committee Approval, RAC Review, and NIH Director Approval Before Initiation](#);

Section IV-C-1-b(1)(e). Certifying new host-vector systems with the exception of minor modifications of already certified systems (the standards and procedures for certification are described in [Appendix I-II, Certification of Host-Vector Systems](#)). Minor modifications constitute (e.g., those of minimal or no consequence to the properties relevant to containment); and

Section IV-C-1-b(1)(f). Adopting other changes in the *NIH Guidelines*.

Section IV-C-1-b(2). Minor Actions

NIH/OBA shall carry out certain functions as delegated to it by the NIH Director (see [Section IV-C-3, Office of Biotechnology Activities](#)). *Minor Actions* (as determined by NIH/OBA in consultation with the RAC Chair and one or more RAC members, as necessary) will be transmitted to RAC and Institutional Biosafety Committee Chairs:

Section IV-C-1-b(2)(a). Changing containment levels for experiments that are specified in [Section III, Experiments Covered by the NIH Guidelines](#) (except when a *Major Action* is involved);

Section IV-C-1-b(2)(b). Assigning containment levels for experiments not explicitly considered in the *NIH Guidelines*;

Section IV-C-1-b-(2)-(c). Revising the *Classification of Etiologic Agents* for the purpose of these NIH Guidelines (see [Section V-A, Footnotes and References of Sections I-IV](#)).

Section IV-C-1-b-(2)-(d). Interpreting the NIH Guidelines for experiments to which the NIH Guidelines do not specifically assign containment levels;

Section IV-C-1-b-(2)-(e). Setting containment under [Sections III-D-1-d, Experiments Using Risk Group 2, Risk Group 3, Risk Group 4, or Restricted Agents as Host-Vector Systems](#), and [III-D-2-b, Experiments in which DNA from Risk Group 2, Risk Group 3, Risk Group 4, or Restricted Agents is Cloned into Nonpathogenic Prokaryotic or Lower Eukaryotic Host-Vector Systems](#);

Section IV-C-1-b-(2)-(f). Approving minor modifications of already certified host-vector systems (the standards and procedures for such modifications are described in [Appendix I-II, Certification of Host-Vector Systems](#));

Section IV-C-1-b-(2)-(g). Decertifying already certified host-vector systems;

Section IV-C-1-b-(2)-(h). Adding new entries to the list of molecules toxic for vertebrates (see [Appendix F, Containment Conditions for Cloning of Genes Coding for the Biosynthesis of Molecules Toxic for Vertebrates](#)); and

Section IV-C-1-b-(2)-(i). Determining appropriate containment conditions for experiments according to case precedents developed under [Section IV-C-1-b-\(2\)-\(c\)](#).

Section IV-C-2. Recombinant DNA Advisory Committee (RAC)

The RAC is responsible for carrying out the functions specified in the NIH Guidelines, as well as others specified in its charter or assigned by the Secretary of Health and Human Services or the NIH Director. The RAC membership and procedures, in addition to those set forth in the NIH Guidelines, are specified in the charter for the RAC which is filed as provided in the General Services Administration Federal Advisory Committee Management regulations, 41 CFR part 101-6, and is available on the OBA web site, <http://oba.od.nih.gov/oba/rac/RACCharter2009.pdf>. In the event of a conflict between the NIH Guidelines and the charter, the charter shall control.

The RAC will consist of not less than 15 voting members, including the Chair, appointed under the procedures of the NIH and the Department of Health and Human Services. The maximum number of voting members will be established in the charter of the RAC. At least a majority of the voting members must be knowledgeable in relevant scientific fields, e.g., molecular genetics, molecular biology, recombinant or synthetic nucleic acid molecule research, including clinical gene transfer research. At least 4 members of the RAC must be knowledgeable in fields such as public health, laboratory safety, occupational health, protection of human subjects of research, the environment, ethics, law, public attitudes or related fields. Representatives of the Federal agencies listed in the charter shall serve as non-voting members. Nominations for RAC members may be submitted to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax).

All meetings of the RAC shall be announced in the *Federal Register*, including tentative agenda items, 15 days before the meeting. Final agendas, if modified, shall be available at least 72 hours before the meeting. No item defined as a *Major Action* under [Section IV-C-1-b-\(1\)](#) may be added to an agenda following *Federal Register* publication.

RAC shall be responsible for:

Section IV-C-2-a. Advising the NIH Director on the following actions: (1) Adopting changes in the NIH Guidelines. (2) Assigning containment levels, changing containment levels, and approving experiments considered as *Major Actions* under the NIH Guidelines, i.e., the deliberate transfer of a drug resistance trait to microorganisms that are not known to acquire the trait naturally, if such acquisition could compromise the use of the drug to control disease agents in humans, veterinary medicine, or agriculture. (3) Promulgating and amending lists of classes of recombinant or synthetic nucleic acid molecules to be exempt from the NIH Guidelines because they consist entirely of DNA segments from species that exchange DNA by known physiological processes or otherwise do not present a significant risk to health or the environment. (4) Certifying new host-vector systems.

Section IV-C-2-b. Identifying novel human gene transfer experiments deserving of public discussion by the full RAC;

Section IV-C-2-c. Transmitting to the NIH Director specific comments/ recommendations about: (i) a specific human gene transfer experiment, or (ii) a category of human gene transfer experiments;

Section IV-C-2-d. Publicly reviewing human gene transfer clinical trial data and relevant information evaluated and summarized by NIH/OBA in accordance with the annual data reporting requirements;

Section IV-C-2-e. Identifying broad scientific, safety, social, and ethical issues relevant to gene therapy research as potential Gene Therapy Policy Conference topics;

Section IV-C-2-f. Identifying novel social and ethical issues relevant to specific human applications of gene transfer and recommending appropriate modifications to the *Points to Consider* that will provide guidance in the preparation of relevant Informed Consent documents; and

Section IV-C-2-g. Identifying novel scientific and safety issues relevant to specific human applications of gene transfer and recommending appropriate modifications to the *Points to Consider* that will provide guidance in the design and submission of human gene transfer clinical trials.

Section IV-C-3. Office of Biotechnology Activities (OBA)

OBA shall serve as a focal point for information on recombinant or synthetic nucleic acid molecule activities and provide advice to all within and outside NIH including institutions, Biological Safety Officers, Principal Investigators, Federal agencies, state and local governments, and institutions in the private sector. OBA shall carry out such other functions as may be delegated to it by the NIH Director. OBA's responsibilities include (but are not limited to) the following:

Section IV-C-3-a. Serving as the focal point for public access to summary information pertaining to human gene transfer experiments;

Section IV-C-3-b. Serving as the focal point for data management of human gene transfer experiments;

Section IV-C-3-c. Administering the annual data reporting requirements (and subsequent review) for human gene transfer experiments (see [Appendix M-I-C, Reporting Requirements](#));

Section IV-C-3-d. Transmitting comments/recommendations arising from public RAC discussion of a novel human gene transfer experiment to the NIH Director. RAC recommendations shall be forwarded to the Principal Investigator, the sponsoring institution, and other DHHS components, as appropriate.

Section IV-C-3-e. Collaborating with Principal Investigators, Institutional Biosafety Committees, Institutional Review Boards, and other DHHS components (including FDA and the [Office for Human Research Protections](#)), to ensure human gene transfer experiment registration compliance in accordance with [Appendix M-I, Requirements for Protocol Submission, Review, and Reporting-Human Gene Transfer Experiments](#) of the *NIH Guidelines*.

Section IV-C-3-f. Administering Gene Therapy Policy Conferences as deemed appropriate by the NIH Director (see [Appendix L, Gene Therapy Policy Conferences](#)).

Section IV-C-3-g. Reviewing and approving experiments in conjunction with *ad hoc* experts involving the cloning of genes encoding for toxin molecules that are lethal for vertebrates at an LD₅₀ of less than or equal to 100 nanograms per kilogram body weight in organisms other than *Escherichia coli* K-12 (see [Section III-B-1, Experiments Involving the Cloning of Toxin Molecules with LD₅₀ of Less than 100 Nanograms Per Kilogram Body Weight](#), [Appendix F, Containment Conditions for Cloning of Genes Coding for the Biosynthesis of Molecules Toxic for Vertebrates](#));

Section IV-C-3-h. Serving as the executive secretary of RAC;

Section IV-C-3-i. Publishing in the *Federal Register*.

Section IV-C-3-i-(1). Announcements of RAC meetings and tentative agendas at least 15 days in advance (Note: If the agenda for a RAC meeting is modified, OBA shall make the revised agenda available to anyone upon request in advance of the meeting);

Section IV-C-3-i-(2). Announcements of Gene Therapy Policy Conferences and tentative agendas at least 15 days in advance;

Section IV-C-3-i-(3). Proposed *Major Actions* (see [Section IV-C-1-b-\(1\)](#), *Major Actions*) at least 15 days prior to the RAC meeting; and

Section IV-C-3-j. Reviewing and approving the membership of an institution's Institutional Biosafety Committee, and where it finds the Institutional Biosafety Committee meets the requirements set forth in [Section IV-B-2](#), *Institutional Biosafety Committee (IBC)*, giving its approval to the Institutional Biosafety Committee membership.

Section IV-C-4. Other NIH Components

Other NIH components shall be responsible for certifying maximum containment (BL4) facilities, inspecting them periodically, and inspecting other recombinant or synthetic nucleic acid molecule facilities as deemed necessary.

Section IV-D. Voluntary Compliance

Section IV-D-1. Basic Policy - Voluntary Compliance

Individuals, corporations, and institutions not otherwise covered by the *NIH Guidelines* are encouraged to follow the standards and procedures set forth in [Sections I](#) through [IV](#). In order to simplify discussion, references hereafter to "institutions" are intended to encompass corporations and individuals who have no organizational affiliation. For purposes of complying with the *NIH Guidelines*, an individual intending to carry out research involving recombinant or synthetic nucleic acid molecules is encouraged to affiliate with an institution that has an Institutional Biosafety Committee approved under the *NIH Guidelines*.

Since commercial organizations have special concerns, such as protection of proprietary data, some modifications and explanations of the procedures are provided in [Sections IV-D-2](#) through [IV-D-5-b](#), *Voluntary Compliance*, in order to address these concerns.

Section IV-D-2. Institutional Biosafety Committee Approval - Voluntary Compliance

It should be emphasized that employment of an Institutional Biosafety Committee member solely for purposes of membership on the Institutional Biosafety Committee does not itself make the member an institutionally affiliated member. Except for the unaffiliated members, a member of an Institutional Biosafety Committee for an institution not otherwise covered by the *NIH Guidelines* may participate in the review and approval of a project in which the member has a direct financial interest so long as the member has not been, and does not expect to be, engaged in the project. [Section IV-B-2-a-\(4\)](#), *Institutional Biosafety Committee*, is modified to that extent for purposes of these institutions.

Section IV-D-3. Certification of Host-Vector Systems - Voluntary Compliance

A host-vector system may be proposed for certification by the NIH Director in accordance with the procedures set forth in [Appendix I-II](#), *Certification of Host-Vector Systems*. In order to ensure protection for proprietary data, any public notice regarding a host-vector system which is designated by the institution as proprietary under [Section IV-D](#), *Voluntary Compliance*, will be issued only after consultation with the institution as to the content of the notice.

Section IV-D-4. Requests for Exemptions and Approvals - Voluntary Compliance

Requests for exemptions or other approvals as required by the *NIH Guidelines* should be submitted based on the procedures set forth in [Sections I](#) through [IV](#). In order to ensure protection for proprietary data, any public notice regarding a request for an exemption or other approval which is designated by the institution as

proprietary under Section IV-D-5-a, *Voluntary Compliance*, will be issued only after consultation with the institution as to the content of the notice.

Section IV-D-5. Protection of Proprietary Data - Voluntary Compliance

Section IV-D-5-a. General

In general, the Freedom of Information Act requires Federal agencies to make their records available to the public upon request. However, this requirement does not apply to, among other things, "trade secrets and commercial or financial information that is obtained from a person and that is privileged or confidential." Under 18 U.S.C. 1905, it is a criminal offense for an officer or employee of the U.S. or any Federal department or agency to publish, divulge, disclose, or make known "in any manner or to any extent not authorized by law any information coming to him in the course of his employment or official duties or by reason of any examination or investigation made by, or return, report or record made to or filed with, such department or agency or officer or employee thereof, which information concerns or relates to the trade secrets, (or) processes...of any person, firm, partnership, corporation, or association." This provision applies to all employees of the Federal Government, including special Government employees. Members of RAC are "special Government employees."

In submitting to NIH for purposes of voluntary compliance with the *NIH Guidelines*, an institution may designate those items of information which the institution believes constitute trade secrets, privileged, confidential, commercial, or financial information. If NIH receives a request under the Freedom of Information Act for information so designated, NIH will promptly contact the institution to secure its views as to whether the information (or some portion) should be released. If NIH decides to release this information (or some portion) in response to a Freedom of Information request or otherwise, the institution will be advised and the actual release will be delayed in accordance with 45 Code of Federal Regulations, Section 5.65(d) and (e).

Section IV-D-5-b. Pre-submission Review

Any institution not otherwise covered by the *NIH Guidelines*, which is considering submission of data or information voluntarily to NIH, may request pre-submission review of the records involved to determine if NIH will make all or part of the records available upon request under the Freedom of Information Act.

A request for pre-submission review should be submitted to NIH/OBA along with the records involved to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax). These records shall be clearly marked as being the property of the institution on loan to NIH solely for the purpose of making a determination under the Freedom of Information Act. NIH/OBA will seek a determination from the responsible official under DHHS regulations (45 CFR Part 5) as to whether the records involved, (or some portion) will be made available to members of the public under the Freedom of Information Act. Pending such a determination, the records will be kept separate from NIH/OBA files, will be considered records of the institution and not NIH/OBA, and will not be received as part of NIH/OBA files. No copies will be made of such records.

NIH/OBA will inform the institution of the NIH Freedom of Information Officer's determination and follow the institution's instructions as to whether some or all of the records involved are to be returned to the institution or to become a part of NIH/OBA files. If the institution instructs NIH/OBA to return the records, no copies or summaries of the records will be made or retained by DHHS, NIH, or OBA. The NIH Freedom of Information Officer's determination will represent that official's judgment at the time of the determination as to whether the records involved (or some portion) would be exempt from disclosure under the Freedom of Information Act if at the time of the determination the records were in NIH/OBA files and a request was received for such files under the Freedom of Information Act.

SECTION V. FOOTNOTES AND REFERENCES OF SECTIONS I THROUGH IV

Section V-A. The NIH Director, with advice of the RAC, may revise the classification for the purposes of the *NIH Guidelines* (see [Section IV-C-1-b-\(2\)-\(e\)](#), *Minor Actions*). The revised list of organisms in each Risk Group is reprinted in [Appendix B](#), *Classification of Human Etiologic Agents on the Basis of Hazard*.

Section V-B. Section III, *Experiments Covered by the NIH Guidelines*, describes a number of places where judgments are to be made. In all these cases, the Principal Investigator shall make the judgment on these matters as part of his/her responsibility to "make the initial determination of the required levels of physical and biological containment in accordance with the *NIH Guidelines*" (see Section IV-B-7-c-(1)). For cases falling under Sections III-A through III-E, *Experiments Covered by the NIH Guidelines*, this judgment is to be reviewed and approved by the Institutional Biosafety Committee as part of its responsibility to make an "independent assessment of the containment levels required by the *NIH Guidelines* for the proposed research" (see Section IV-B-2-b-(1), *Institutional Biosafety Committee*). The Institutional Biosafety Committee may refer specific cases to NIH/OBA as part of NIH/OBA's functions to "provide advice to all within and outside NIH" (see Section IV-C-3). NIH/OBA may request advice from the RAC as part of the RAC's responsibility for "interpreting the *NIH Guidelines* for experiments to which the *NIH Guidelines* do not specifically assign containment levels" (see Section IV-C-1-b-(2)-(f), *Minor Actions*).

Section V-C. U.S. Department of Health and Human Services, Public Health Service, [Centers for Disease Control and Prevention](#) and the [National Institutes of Health](#). *Biosafety in Microbiological and Biomedical Laboratories*, 5th Edition, 2007. Copies are available from: Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20401-0001, Phone (202) 512-1800 [<http://www.gpo.gov/>].

Section V-D. *Classification of Etiologic Agents on the Basis of Hazard*, 4th Edition, July 1974, U.S. Department of Health, Education, and Welfare, Public Health Service, Centers for Disease Control, Office of Biosafety, Atlanta, Georgia 30333.

Section V-E. Chin, James ed., *Control of Communicable Diseases Manual*, 17th Edition, 2000. ISBN: 087553-242-X, American Public Health Association, 800 I Street, N.W., Washington, D.C. Phone: (202) 777-2742.

Section V-F. *World Health Organization Laboratory Biosafety Manual*, 2nd edition. 1993. WHO Albany, NY. Copies are available from: WHO Publication Centre, USA, (Q Corp) 49 Sheridan Avenue, Albany, New York 12210; Phone: (518) 436-9686 (Order # 1152213).

Section V-G. A U.S. Department of Agriculture permit, required for import and interstate transport of plant and animal pathogens, may be obtained from the U.S. Department of Agriculture, ATTN: [Animal and Plant Health Inspection Service \(APHIS\)](#), Veterinary Services, National Center for Import-Export, Products Program, 4700 River Road, Unit 40, Riverdale, Maryland 20737. Phone: (301) 734-8499; Fax: (301) 734-8226.

Section V-H. American Type Culture Collection Catalogues of plant viruses, animal viruses, cells, bacteria, fungi, etc. are available from American Type Culture Collection, 10801 University Boulevard, Manassas, VA 20110-2209. Phone: (703) 365-2700.

Section V-I. U.S. Department of Labor, [Occupational Safety and Health Administration](#), 29 CFR 1910.1030, *Bloodborne Pathogens*. See also, *Exposure to Bloodborne Pathogens*, OSHA 3127, 1996 (Revised).

Section V-J. As classified in the *Virus Taxonomy: The Classification and Nomenclature of Viruses. The Seventh Report of the International Committee on Taxonomy of Viruses*, Academic Press, 2000 (0123702003) San Diego, CA.

Section V-K. *i.e.*, the total of all genomes within a family shall not exceed two-thirds of the genome.

Section V-L. Organisms including alastrim, smallpox (variola) and whitepox may not be studied in the United States except at specified facilities. All activities, including storage of variola and whitepox, are restricted to the single national facility (World Health Organization Collaborating Center for Smallpox Research, [Centers for Disease Control and Prevention](#), Atlanta, Georgia).

Section V-M. In accordance with accepted scientific and regulatory practices of the discipline of plant pathology, an exotic plant pathogen (e.g., virus, bacteria, or fungus) is one that is unknown to occur within the U.S. (see Section V-G, *Footnotes and References of Sections I-IV*). Determination of whether a pathogen has a potential for serious detrimental impact on managed (agricultural, forest, grassland) or natural ecosystems should be made by the Principal Investigator and the Institutional Biosafety Committee, in consultation with scientists knowledgeable of plant diseases, crops, and ecosystems in the geographic area of the research.

APPENDIX A. EXEMPTIONS UNDER SECTION III-F-6--SUBLISTS OF NATURAL EXCHANGERS

Certain specified recombinant or synthetic nucleic acid molecules that consist entirely of DNA segments from different species that exchange DNA by known physiological processes, though one or more of the segments may be a synthetic equivalent are exempt from these *NIH Guidelines* (see [Section III-F-6, Exempt Experiments](#)). Institutional Biosafety Committee registration is not required for these exempt experiments. A list of such exchangers will be prepared and periodically revised by the NIH Director with advice from the RAC after appropriate notice and opportunity for public comment (see [Section IV-C-1-b-\(1\)-\(c\), NIH Director--Specific Responsibilities](#)). For a list of natural exchangers that are exempt from the *NIH Guidelines*, see Appendices A-I through A-VI, *Exemptions under Section III-F-6 Sublists of Natural Exchangers*. [Section III-F-6, Exempt Experiments](#), describes recombinant or synthetic nucleic acid molecules that are: (1) composed entirely of DNA segments from one or more of the organisms within a sublist, and (2) to be propagated in any of the organisms within a sublist (see *Classification of Bergey's Manual of Determinative Bacteriology*, 8th edition, R. E. Buchanan and N. E. Gibbons, editors, Williams and Wilkins Company; Baltimore, Maryland 1984). Although these experiments are exempt, it is recommended that they be performed at the appropriate biosafety level for the host or recombinant/synthetic organism (see *Biosafety in Microbiological and Biomedical Laboratories*, 5th edition, 2007, U.S. DHHS, Public Health Service, Centers for Disease Control and Prevention, Atlanta, Georgia, and NIH Office of Biosafety, Bethesda, Maryland).

Appendix A-I. Sublist A

Genus *Escherichia*
 Genus *Shigella*
 Genus *Salmonella* - including *Arizona*
 Genus *Enterobacter*
 Genus *Citrobacter* - including *Levinea*
 Genus *Klebsiella* - including *oxytoca*
 Genus *Erwinia*
Pseudomonas aeruginosa, *Pseudomonas putida*, *Pseudomonas fluorescens*, and *Pseudomonas mendocina*
Serratia marcescens
Yersinia enterocolitica

Appendix A-II. Sublist B

Bacillus subtilis
Bacillus licheniformis
Bacillus pumilus
Bacillus globigii
Bacillus niger
Bacillus nato
Bacillus amyloliquefaciens
Bacillus atterimus

Appendix A-III. Sublist C

Streptomyces aureofaciens
Streptomyces rimosus
Streptomyces coelicolor

Appendix A-IV. Sublist D

Streptomyces griseus
Streptomyces cyaneus
Streptomyces venezuelae

Appendix A-V. Sublist E

One way transfer of *Streptococcus mutans* or *Streptococcus lactis* DNA into *Streptococcus sanguis*

Appendix A-VI. Sublist F

Streptococcus sanguis
Streptococcus pneumoniae
Streptococcus faecalis
Streptococcus pyogenes
Streptococcus mutans

APPENDIX B. CLASSIFICATION OF HUMAN ETIOLOGIC AGENTS ON THE BASIS OF HAZARD

This appendix includes those biological agents known to infect humans as well as selected animal agents that may pose theoretical risks if inoculated into humans. Included are lists of representative genera and species known to be pathogenic; mutated, recombined, and non-pathogenic species and strains are not considered. Non-infectious life cycle stages of parasites are excluded.

This appendix reflects the current state of knowledge and should be considered a resource document. Included are the more commonly encountered agents and is not meant to be all-inclusive. Information on agent risk assessment may be found in the *Agent Summary Statements* of the CDC/NIH publication, *Biosafety in Microbiological and Biomedical Laboratories* (see [Sections V-C, V-D, V-E, and V-F](#), *Footnotes and References of Sections I through IV*). Further guidance on agents not listed in Appendix B may be obtained through: Centers for Disease Control and Prevention, Biosafety Branch, Atlanta, Georgia 30333, Phone: (404) 639-3883, Fax: (404) 639-2294; National Institutes of Health, Division of Safety, Bethesda, Maryland 20892, Phone: (301) 496-1357; National Animal Disease Center, U.S. Department of Agriculture, Ames, Iowa 50010, Phone: (515) 862-8258.

A special committee of the American Society for Microbiology will conduct an annual review of this appendix and its recommendation for changes will be presented to the Recombinant DNA Advisory Committee as proposed amendments to the *NIH Guidelines*.

Appendix B - Table 1. Basis for the Classification of Biohazardous Agents by Risk Group (RG)

| | |
|--------------------|---|
| Risk Group 1 (RG1) | Agents that are not associated with disease in healthy adult humans |
| Risk Group 2 (RG2) | Agents that are associated with human disease which is rarely serious and for which preventive or therapeutic interventions are <i>often</i> available |
| Risk Group 3 (RG3) | Agents that are associated with serious or lethal human disease for which preventive or therapeutic interventions <i>may be</i> available (high individual risk but low community risk) |
| Risk Group 4 (RG4) | Agents that are likely to cause serious or lethal human disease for which preventive or therapeutic interventions are <i>not usually</i> available (high individual risk and high community risk) |

Appendix B-I. Risk Group 1 (RG1) Agents

RG1 agents are not associated with disease in healthy adult humans. Examples of RG1 agents include asporogenic *Bacillus subtilis* or *Bacillus licheniformis* (see [Appendix C-IV-A](#), *Bacillus subtilis* or *Bacillus licheniformis* Host-Vector Systems, Exceptions); adeno-associated virus (AAV – all serotypes); and recombinant or synthetic AAV constructs, in which the transgene does not encode either a potentially tumorigenic gene product or a toxin molecule and are produced in the absence of a helper virus. A strain of *Escherichia coli* (see [Appendix C-II-A](#), *Escherichia coli* K-12 Host Vector Systems, Exceptions) is an RG1 agent if it (1) does not possess a complete lipopolysaccharide (*i.e.*, lacks the O antigen); and (2) does not carry any active virulence factor (*e.g.*, toxins) or colonization factors and does not carry any genes encoding these factors.

Those agents not listed in Risk Groups (RGs) 2, 3 and 4 are not automatically or implicitly classified in RG1; a risk assessment must be conducted based on the known and potential properties of the agents and their relationship to agents that are listed.

Appendix B-II. Risk Group 2 (RG2) Agents

RG2 agents are associated with human disease which is rarely serious and for which preventive or therapeutic interventions are often available.

Appendix B-II-A. Risk Group 2 (RG2) - Bacterial Agents Including Chlamydia

- Acinetobacter baumannii* (formerly *Acinetobacter calcoaceticus*)
- Actinobacillus*
- Actinomyces pyogenes* (formerly *Corynebacterium pyogenes*)
- Aeromonas hydrophila*
- Amycolata autotrophica*
- Archanobacterium haemolyticum* (formerly *Corynebacterium haemolyticum*)
- Arizona hinshawii* - all serotypes
- Bacillus anthracis*
- Bartonella henselae*, *B. quintana*, *B. vinsonii*
- Bordetella* including *B. pertussis*
- Borrelia recurrentis*, *B. burgdorferi*
- Burkholderia* (formerly *Pseudomonas* species) except those listed in Appendix B-III-A (RG3)
- Campylobacter coli*, *C. fetus*, *C. jejuni*
- Chlamydia psittaci*, *C. trachomatis*, *C. pneumoniae*
- Clostridium botulinum*, *C. chauvoei*, *C. haemolyticum*, *C. histolyticum*, *C. novyi*, *C. septicum*, *C. tetani*
- Coxiella burnetii* – specifically the Phase II, Nine Mile strain, plaque purified, clone 4
- Corynebacterium diphtheriae*, *C. pseudotuberculosis*, *C. renale*
- Dermatophilus congolensis*
- Edwardsiella tarda*
- Erysipelothrix rhusiopathiae*
- Escherichia coli* - all enteropathogenic, enterotoxigenic, enteroinvasive and strains bearing K1 antigen, including *E. coli* O157:H7
- **Francisella tularensis* specifically **F. tularensis* subspecies *novicida* [aka *F. novicida*], strain Utah 112; **F. tularensis* subspecies *holarctica* LVS; **F. tularensis* biovar *tularensis* strain ATCC 6223 (aka strain B38)
- Haemophilus ducreyi*, *H. influenzae*
- Helicobacter pylori*
- Klebsiella* - all species except *K. oxytoca* (RG1)
- Legionella* including *L. pneumophila*
- Leptospira interrogans* - all serotypes
- Listeria*
- Moraxella*
- Mycobacterium* (except those listed in Appendix B-III-A (RG3)) including *M. avium* complex, *M. asiaticum*, *M. bovis* BCG vaccine strain, *M. chelonae*, *M. fortuitum*, *M. kansasii*, *M. leprae*, *M. malmoense*, *M. marinum*, *M. paratuberculosis*, *M. scrofulaceum*, *M. simiae*, *M. szulgai*, *M. ulcerans*, *M. xenopi*
- Mycoplasma*, except *M. mycoides* and *M. agalactiae* which are restricted animal pathogens
- Neisseria gonorrhoeae*, *N. meningitidis*
- Nocardia asteroides*, *N. brasiliensis*, *N. otitiscaviarum*, *N. transvalensis*
- Pseudomonas aeruginosa*
- Rhodococcus equi*
- Salmonella* including *S. arizonae*, *S. choleraesuis*, *S. enteritidis*, *S. gallinarum-pullorum*, *S. meleagridis*, *S. paratyphi*, A, B, C, *S. typhi*, *S. typhimurium*
- Shigella* including *S. boydii*, *S. dysenteriae*, type 1, *S. flexneri*, *S. sonnei*
- Sphaerophorus necrophorus*
- Staphylococcus aureus*

* For research involving high concentrations, BL3 practices should be considered (See Appendix G-II-C-2. Special Practices (BL3)).

--*Streptobacillus moniliformis*

--*Streptococcus* including *S. pneumoniae*, *S. pyogenes*

--*Treponema pallidum*, *T. carateum*

--*Vibrio cholerae*, *V. parahaemolyticus*, *V. vulnificus*

--*Yersinia enterocolitica*

--*Yersinia pestis* specifically *pgm*⁽⁻⁾ strains (lacking the 102 kb pigmentation locus) and *lcr*⁽⁻⁾ strains (lacking the LCR plasmid)

Appendix B-II-B. Risk Group 2 (RG2) - Fungal Agents

--*Blastomyces dermatitidis*

--*Cladosporium bantianum*, *C. (Xylohypha) trichoides*

--*Cryptococcus neoformans*

--*Dactylaria galopava (Ochroconis gallopavum)*

--*Epidermophyton*

--*Exophiala (Wangiella) dermatitidis*

--*Fonsecaea pedrosoi*

--*Microsporium*

--*Paracoccidioides braziliensis*

--*Penicillium marneffei*

--*Sporothrix schenckii*

--*Trichophyton*

Appendix B-II-C. Risk Group 2 (RG2) - Parasitic Agents

--*Ancylostoma* human hookworms including *A. duodenale*, *A. ceylanicum*

--*Ascaris* including *Ascaris lumbricoides suum*

--*Babesia* including *B. divergens*, *B. microti*

--*Brugia filaria* worms including *B. malayi*, *B. timori*

--*Coccidia*

--*Cryptosporidium* including *C. parvum*

--*Cysticercus cellulosae* (hydatid cyst, larva of *T. solium*)

--*Echinococcus* including *E. granulosus*, *E. multilocularis*, *E. vogeli*

--*Entamoeba histolytica*

--*Enterobius*

--*Fasciola* including *F. gigantica*, *F. hepatica*

--*Giardia* including *G. lamblia*

--*Heterophyes*

--*Hymenolepis* including *H. diminuta*, *H. nana*

--*Isospora*

--*Leishmania* including *L. braziliensis*, *L. donovani*, *L. ethiopia*, *L. major*, *L. mexicana*, *L. peruviana*, *L. tropica*

--*Loa loa* filaria worms

--*Microsporidium*

--*Naegleria fowleri*

--*Necator* human hookworms including *N. americanus*

--*Onchocerca* filaria worms including, *O. volvulus*

--*Plasmodium* including simian species, *P. cynomolgi*, *P. falciparum*, *P. malariae*, *P. ovale*, *P. vivax*

--*Sarcocystis* including *S. sui hominis*

--*Schistosoma* including *S. haematobium*, *S. intercalatum*, *S. japonicum*, *S. mansoni*, *S. mekongi*

--*Strongyloides* including *S. stercoralis*

--*Taenia solium*

--*Toxocara* including *T. canis*

--*Toxoplasma* including *T. gondii*

--*Trichinella spiralis*

--*Trypanosoma* including *T. brucei brucei*, *T. brucei gambiense*, *T. brucei rhodesiense*, *T. cruzi*

--*Wuchereria bancrofti* filaria worms

Appendix B-II-D. Risk Group 2 (RG2) - Viruses

Adenoviruses, human - all types

Alphaviruses (Togaviruses) - Group A Arboviruses

- Chikungunya vaccine strain 181/25
- Eastern equine encephalomyelitis virus
- Venezuelan equine encephalomyelitis vaccine strains TC-83 and V3526
- Western equine encephalomyelitis virus

Arenaviruses

- Junin virus candid #1 vaccine strain
- Lymphocytic choriomeningitis virus (non-neurotropic strains)
- Tacaribe virus complex
- Other viruses as listed in the reference source (see [Section V-C, Footnotes and References of Sections I through IV](#))

Bunyaviruses

- Bunyamwera virus
- Rift Valley fever virus vaccine strain MP-12
- Other viruses as listed in the reference source (see [Section V-C, Footnotes and References of Sections I through IV](#))

Caliciviruses

Coronaviruses

Flaviviruses - Group B Arboviruses

- Dengue virus serotypes 1, 2, 3, and 4
- Japanese encephalitis virus strain SA 14-14-2
- Yellow fever virus vaccine strain 17D
- Other viruses as listed in the reference source (see [Section V-C, Footnotes and References of Sections I through IV](#))

Hepatitis A, B, C, D, and E viruses

Herpesviruses - except Herpesvirus simiae (Monkey B virus) (see [Appendix B-IV-D, Risk Group 4 \(RG4\) - Viral Agents](#))

- Cytomegalovirus
- Epstein Barr virus
- Herpes simplex* types 1 and 2
- Herpes zoster*
- Human herpesvirus types 6 and 7

Orthomyxoviruses

- Influenza viruses types A, B, and C (except those listed in [Appendix B-III-D, Risk Group 3 \(RG3\) - Viruses and Prions](#))
- Tick-borne orthomyxoviruses

Papilloma viruses

- All human papilloma viruses

Paramyxoviruses

- Newcastle disease virus
- Measles virus
- Mumps virus
- Parainfluenza viruses types 1, 2, 3, and 4
- Respiratory syncytial virus

Parvoviruses

--Human parvovirus (B19)

Picornaviruses

--Coxsackie viruses types A and B
 --Echoviruses - all types
 --Polioviruses - all types, wild and attenuated
 --Rhinoviruses - all types

Poxviruses - all types except Monkeypox virus (see [Appendix B-III-D, Risk Group 3 \(RG3\) - Viruses and Prions](#)) and restricted poxviruses including Alastrim, Smallpox, and Whitepox (see [Section V-L, Footnotes and References of Sections I through IV](#))

Reoviruses - all types including Coltivirus, human Rotavirus, and Orbivirus (Colorado tick fever virus)

Rhabdoviruses

--Rabies virus - all strains
 --Vesicular stomatitis virus non exotic strains: VSV-Indiana 1 serotype strains (e.g. Glasgow, Mudd-Summers, Orsay, San Juan) and VSV-New Jersey serotype strains (e.g. Ogden, Hazelhurst)

Rubivirus (Togaviruses)

--Rubella virus

Appendix B-III. Risk Group 3 (RG3) Agents

RG3 agents are associated with serious or lethal human disease for which preventive or therapeutic interventions *may be* available.

Appendix B-III-A. Risk Group 3 (RG3) - Bacterial Agents Including Rickettsia

--*Bartonella*
 --*Brucella* including *B. abortus*, *B. canis*, *B. suis*
 --*Burkholderia (Pseudomonas) mallei*, *B. pseudomallei*
 --*Coxiella burnetii* (except the Phase II, Nine Mile strain listed in [Appendix B-II-A, Risk Group 2 \(RG2\) - Bacterial Agents Including Chlamydia](#))
 --*Francisella tularensis* (except those strains listed in [Appendix B-II-A, Risk Group 2 \(RG2\) - Bacterial Agents Including Chlamydia](#))
 --*Mycobacterium bovis* (except BCG strain, see [Appendix B-II-A, Risk Group 2 \(RG2\) - Bacterial Agents Including Chlamydia](#)), *M. tuberculosis*
 --*Pasteurella multocida* type B -"buffalo" and other virulent strains
 --*Rickettsia akari*, *R. australis*, *R. canada*, *R. conorii*, *R. prowazekii*, *R. rickettsii*, *R. siberica*, *R. tsutsugamushi*, *R. typhi* (*R. mooseri*)
 --*Yersinia pestis* (except those strains listed in [Appendix B-II-A, Risk Group 2 \(RG2\) - Bacterial Agents Including Chlamydia](#))

Appendix B-III-B. Risk Group 3 (RG3) - Fungal Agents

--*Coccidioides immitis* (sporulating cultures; contaminated soil)
 --*Histoplasma capsulatum*, *H. capsulatum* var. *duboisii*

Appendix B-III-C. Risk Group 3 (RG3) - Parasitic Agents

None

Appendix B-III-D. Risk Group 3 (RG3) - Viruses and Prions

Alphaviruses (Togaviruses) - Group A Arboviruses

- Chikungunya virus (except the vaccine strain 181/25 listed in [Appendix B-II-D Risk Group2 \(RG2\) – Viruses](#))
- Semliki Forest virus
- St. Louis encephalitis virus
- Venezuelan equine encephalomyelitis virus (except the vaccine strains TC-83 and V3526, see [Appendix B-II-D \(RG2\) – Viruses](#))
- Other viruses as listed in the reference source (see [Section V-C, Footnotes and References of Sections I through IV](#))

Arenaviruses

- Flexal
- Lymphocytic choriomeningitis virus (LCM) (neurotropic strains)

Bunyaviruses

- Hantaviruses including Hantaan virus
- Rift Valley fever virus

Coronaviruses

- SARS-associated coronavirus (SARS-CoV)
- Middle East respiratory syndrome coronavirus (MERS-CoV)

Flaviviruses - Group B Arboviruses

- Japanese encephalitis virus (except those strains listed in [Appendix B-II-D Risk Group2 \(RG2\) - Viruses](#))
- West Nile virus (WNV)
- Yellow fever virus
- Other viruses as listed in the reference source (see [Section V-C, Footnotes and References of Sections I through IV](#))

Orthomyxoviruses

- Influenza viruses 1918-1919 H1N1 (1918 H1N1), human H2N2 (1957-1968), and highly pathogenic avian influenza H5N1 strains within the Goose/Guangdong/96-like H5 lineage (HPAI H5N1).

Poxviruses

- Monkeypox virus

Prions

- Transmissible spongiform encephalopathies (TSE) agents (Creutzfeldt-Jacob disease and kuru agents)(see [Section V-C, Footnotes and References of Sections I through IV](#), for containment instruction)

Retroviruses

- Human immunodeficiency virus (HIV) types 1 and 2
- Human T cell lymphotropic virus (HTLV) types 1 and 2
- Simian immunodeficiency virus (SIV)

Rhabdoviruses

- Vesicular stomatitis virus (except those strains listed in [Appendix B-II-D Risk Group2 \(RG2\) - Viruses](#))

Appendix B-IV. Risk Group 4 (RG4) Agents

RG4 agents are likely to cause serious or lethal human disease for which preventive or therapeutic interventions are *not usually* available.

Appendix B-IV-A. Risk Group 4 (RG4) - Bacterial Agents

None

Appendix B-IV-B. Risk Group 4 (RG4) - Fungal Agents

None

Appendix B-IV-C. Risk Group 4 (RG4) - Parasitic Agents

None

Appendix B-IV-D. Risk Group 4 (RG4) - Viral Agents

Arenaviruses

--Guanarito virus

--Lassa virus

--Junin virus (except the candid #1 vaccine strain listed in [Appendix B-II-D Risk Group2 \(RG2\) – Viruses](#))

--Machupo virus

--Sabia

Bunyaviruses (Nairovirus)

--Crimean-Congo hemorrhagic fever virus

Filoviruses

--Ebola virus

--Marburg virus

Flaviruses - Group B Arboviruses

--Tick-borne encephalitis virus complex including Absetterov, Central European encephalitis, Hanzalova, Hypr, Kumlinge, Kyasanur Forest disease, Omsk hemorrhagic fever, and Russian spring-summer encephalitis viruses

Herpesviruses (alpha)

--Herpesvirus simiae (Herpes B or Monkey B virus)

Paramyxoviruses

--Equine Morbillivirus (Hendra virus)

Hemorrhagic fever agents and viruses as yet undefined

Appendix B-V. Animal Viral Etiologic Agents in Common Use

The following list of animal etiologic agents is appended to the list of human etiologic agents. None of these agents is associated with disease in healthy adult humans; they are commonly used in laboratory experimental work.

A containment level appropriate for RG1 human agents is recommended for their use. For agents that are infectious to human cells, e.g., amphotropic and xenotropic strains of murine leukemia virus, a containment level appropriate for RG2 human agents is recommended.

Baculoviruses

Herpesviruses

--Herpesvirus ateles

--Herpesvirus saimiri

--Marek's disease virus

--Murine cytomegalovirus

Papilloma viruses

--Bovine papilloma virus

--Shope papilloma virus

Polyoma viruses

- Polyoma virus
- Simian virus 40 (SV40)

Retroviruses

- Avian leukosis virus
- Avian sarcoma virus
- Bovine leukemia virus
- Feline leukemia virus
- Feline sarcoma virus
- Gibbon leukemia virus
- Mason-Pfizer monkey virus
- Mouse mammary tumor virus
- Murine leukemia virus

- Murine sarcoma virus
- Rat leukemia virus

Appendix B-V.1. Murine Retroviral Vectors

Murine retroviral vectors to be used for human transfer experiments (less than 10 liters) that contain less than 50% of their respective parental viral genome and that have been demonstrated to be free of detectable replication competent retrovirus can be maintained, handled, and administered, under BL1 containment.

APPENDIX C. EXEMPTIONS UNDER SECTION III-F-8

[Section III-F-8](#) states that exempt from these *NIH Guidelines* are "those that do not present a significant risk to health or the environment (see [Section IV-C-1-b-\(1\)-\(c\)](#), *NIH Director--Specific Responsibilities*), as determined by the NIH Director, with the advice of the RAC, and following appropriate notice and opportunity for public comment. See [Appendix C, Exemptions under Sections III-F-8](#), for other classes of experiments which are exempt from the *NIH Guidelines*." The following classes of experiments are exempt under [Section III-F-8](#):

Appendix C-I. Recombinant or Synthetic Nucleic Acid Molecules in Tissue Culture

Recombinant or synthetic nucleic acid molecules containing less than one-half of any eukaryotic viral genome (all viruses from a single family being considered identical -- see [Appendix C-IX-E, Footnotes and References of Appendix C](#)), that are propagated and maintained in cells in tissue culture are exempt from these *NIH Guidelines* with the exceptions listed in [Appendix C-I-A](#).

Appendix C-I-A. Exceptions

The following categories are not exempt from the *NIH Guidelines*: (i) experiments described in [Section III-B](#) which require NIH/OBA and Institutional Biosafety Committee approval before initiation, (ii) experiments involving DNA from Risk Groups 3, 4, or restricted organisms (see [Appendix B, Classification of Human Etiologic Agents on the Basis of Hazard](#), and [Sections V-G and V-L, Footnotes and References of Sections I through IV](#)) or cells known to be infected with these agents, (iii) experiments involving the deliberate introduction of genes coding for the biosynthesis of molecules that are toxic for vertebrates (see [Appendix F, Containment Conditions for Cloning of Genes Coding for the Biosynthesis of Molecules Toxic for Vertebrates](#)), and (iv) whole plants regenerated from plant cells and tissue cultures are covered by the exemption provided they remain axenic cultures even though they differentiate into embryonic tissue and regenerate into plantlets.

Appendix C-II. *Escherichia coli* K-12 Host-Vector Systems

Experiments which use *Escherichia coli* K-12 host-vector systems, with the exception of those experiments listed in [Appendix C-II-A](#), are exempt from the *NIH Guidelines* provided that: (i) the *Escherichia coli* host does not contain conjugation proficient plasmids or generalized transducing phages; or (ii) lambda or lambdoid or Ff bacteriophages or non-conjugative plasmids (see [Appendix C-IX-B, Footnotes and References of Appendix C](#)) shall be used as vectors. However, experiments involving the insertion into *Escherichia coli* K-12 of DNA from

prokaryotes that exchange genetic information (see [Appendix C-IX-C](#), *Footnotes and References of Appendix C*) with *Escherichia coli* may be performed with any *Escherichia coli* K-12 vector (e.g., conjugative plasmid). When a non-conjugative vector is used, the *Escherichia coli* K-12 host may contain conjugation-proficient plasmids either autonomous or integrated, or generalized transducing phages. For these exempt laboratory experiments, Biosafety Level (BL) 1 physical containment conditions are recommended. For large-scale fermentation experiments, the appropriate physical containment conditions need be no greater than those for the host organism unmodified by recombinant or synthetic nucleic acid molecule techniques; the Institutional Biosafety Committee can specify higher containment if deemed necessary.

Appendix C-II-A. Exceptions

The following categories are not exempt from the *NIH Guidelines*: (i) experiments described in [Section III-B](#) which require NIH/OBA and Institutional Biosafety Committee approval before initiation, (ii) experiments involving DNA from Risk Groups 3, 4, or restricted organisms (see [Appendix B](#), *Classification of Human*

Etiologic Agents on the Basis of Hazard, and [Sections V-G and V-L](#), *Footnotes and References of Sections I through IV*) or cells known to be infected with these agents may be conducted under containment conditions specified in [Section III-D-2](#) with prior Institutional Biosafety Committee review and approval, (iii) large-scale experiments (e.g., more than 10 liters of culture), and (iv) experiments involving the cloning of toxin molecule genes coding for the biosynthesis of molecules toxic for vertebrates (see [Appendix F](#), *Containment Conditions for Cloning of Genes Coding for the Biosynthesis of Molecules Toxic for Vertebrates*).

Appendix C-III. *Saccharomyces* Host-Vector Systems

Experiments involving *Saccharomyces cerevisiae* and *Saccharomyces uvarum* host-vector systems, with the exception of experiments listed in [Appendix C-III-A](#), are exempt from the *NIH Guidelines*. For these exempt experiments, BL1 physical containment is recommended. For large-scale fermentation experiments, the appropriate physical containment conditions need be no greater than those for the unmodified host organism; the Institutional Biosafety Committee can specify higher containment if deemed necessary.

Appendix C-III-A. Exceptions

The following categories are not exempt from the *NIH Guidelines*: (i) experiments described in [Section III-B](#) which require NIH/OBA and Institutional Biosafety Committee approval before initiation, (ii) experiments involving DNA from Risk Groups 3, 4, or restricted organisms (see [Appendix B](#), *Classification of Human Etiologic Agents on the Basis of Hazard*, and [Sections V-G and V-L](#), *Footnotes and References of Sections I through IV*) or cells known to be infected with these agents may be conducted under containment conditions specified in [Section III-D-2](#) with prior Institutional Biosafety Committee review and approval, (iii) large-scale experiments (e.g., more than 10 liters of culture), and (iv) experiments involving the deliberate cloning of genes coding for the biosynthesis of molecules toxic for vertebrates (see [Appendix F](#), *Containment Conditions for Cloning of Genes Coding for the Biosynthesis of Molecules Toxic for Vertebrates*).

Appendix C-IV. *Kluyveromyces* Host-Vector Systems

Experiments involving *Kluyveromyces lactis* host-vector systems, with the exception of experiments listed in [Appendix C-IV-A](#), are exempt from the *NIH Guidelines* provided laboratory-adapted strains are used (i.e. strains that have been adapted to growth under optimal or defined laboratory conditions). For these exempt experiments, BL1 physical containment is recommended. For large-scale fermentation experiments, the appropriate physical containment conditions need be no greater than those for the unmodified host organism; the Institutional Biosafety Committee may specify higher containment if deemed necessary.

Appendix C-IV-A Exceptions

The following categories are not exempt from the *NIH Guidelines*: (i) experiments described in [Section III-B](#), which require NIH/OBA and Institutional Biosafety Committee approval before initiation; (ii) experiments involving DNA from Risk Groups 3, 4, or restricted organisms (see [Appendix B](#), *Classification of Human Etiologic Agents on the Basis of Hazard*, and [Sections V-G and V-L](#), *Footnotes and References of Sections I through IV*) or cells known to be infected with these agents may be conducted under containment conditions specified in [Section III-D-2](#) with prior Institutional Biosafety Committee review and approval; (iii) large-scale experiments (e.g., more than 10 liters of culture), and (v) experiments involving the deliberate cloning of genes

coding for the biosynthesis of molecules toxic for vertebrates (see [Appendix F](#), *Containment Conditions for Cloning of Genes Coding for the Biosynthesis of Molecules Toxic for Vertebrates*).

Appendix C-V. *Bacillus subtilis* or *Bacillus licheniformis* Host-Vector Systems

Any asporogenic *Bacillus subtilis* or asporogenic *Bacillus licheniformis* strain which does not revert to a spore-former with a frequency greater than 10^{-7} may be used for cloning DNA with the exception of those experiments listed in Appendix C-V-A, *Exceptions*. For these exempt laboratory experiments, BL1 physical containment conditions are recommended. For large-scale fermentation experiments, the appropriate physical containment conditions need be no greater than those for the unmodified host organism; the Institutional Biosafety Committee can specify higher containment if it deems necessary.

Appendix C-V-A. Exceptions

The following categories are not exempt from the *NIH Guidelines*: (i) experiments described in [Section III-B](#) which require NIH/OBA and Institutional Biosafety Committee approval before initiation, (ii) experiments involving DNA from Risk Groups 3, 4, or restricted organisms (see [Appendix B](#), *Classification of Human Etiologic Agents on the Basis of Hazard*, and [Sections V-G and V-L](#), *Footnotes and References of Sections I through IV*) or cells known to be infected with these agents may be conducted under containment conditions specified in [Section III-D-2](#) with prior Institutional Biosafety Committee review and approval, (iii) large-scale experiments (e.g., more than 10 liters of culture), and (iv) experiments involving the deliberate cloning of genes coding for the biosynthesis of molecules toxic for vertebrates (see [Appendix F](#), *Containment Conditions for Cloning of Genes Coding for the Biosynthesis of Molecules Toxic for Vertebrates*).

Appendix C-VI. Extrachromosomal Elements of Gram Positive Organisms

Recombinant or synthetic nucleic acid molecules derived entirely from extrachromosomal elements of the organisms listed below (including shuttle vectors constructed from vectors described in [Appendix C](#)), propagated and maintained in organisms listed below are exempt from these *NIH Guidelines*.

Bacillus amyloliquefaciens
Bacillus amylosacchariticus
Bacillus anthracis
Bacillus atherimus
Bacillus brevis
Bacillus cereus
Bacillus globigii
Bacillus licheniformis
Bacillus megaterium
Bacillus natto
Bacillus niger
Bacillus pumilus
Bacillus sphaericus
Bacillus stearothermophilus
Bacillus subtilis
Bacillus thuringiensis
Clostridium acetobutylicum
Lactobacillus casei
Listeria grayi
Listeria monocytogenes
Listeria murrayi
Pediococcus acidilactici
Pediococcus damnosus
Pediococcus pentosaceus
Staphylococcus aureus
Staphylococcus carnosus
Staphylococcus epidermidis
Streptococcus agalactiae
Streptococcus anginosus

Streptococcus avium
Streptococcus cremoris
Streptococcus dorans
Streptococcus equisimilis
Streptococcus faecalis
Streptococcus ferus
Streptococcus lactis
Streptococcus ferns
Streptococcus mitior
Streptococcus mutans
Streptococcus pneumoniae
Streptococcus pyogenes

Streptococcus salivarius
Streptococcus sanguis
Streptococcus sobrinus
Streptococcus thermophilus

Appendix C-VI-A. Exceptions

The following categories are not exempt from the *NIH Guidelines*: (i) experiments described in [Section III-B](#) which require NIH/OBA and Institutional Biosafety Committee approval before initiation, (ii) experiments involving DNA from Risk Groups 3, 4, or restricted organisms (see [Appendix B, Classification of Human Etiologic Agents on the Basis of Hazard](#), and [Sections V-G and V-L, Footnotes and References of Sections I through IV](#)) or cells known to be infected with these agents may be conducted under containment conditions specified in [Section III-D-2](#) with prior Institutional Biosafety Committee review and approval, (iii) large-scale experiments (e.g., more than 10 liters of culture), and (iv) experiments involving the deliberate cloning of genes coding for the biosynthesis of molecules toxic for vertebrates (see [Appendix F, Containment Conditions for Cloning of Genes Coding for the Biosynthesis of Molecules Toxic for Vertebrates](#)).

Appendix C-VII. The Purchase or Transfer of Transgenic Rodents

The purchase or transfer of transgenic rodents for experiments that require BL1 containment (See [Appendix G-III-M, Footnotes and References of Appendix G](#)) are exempt from the *NIH Guidelines*.

Appendix C-VIII. Generation of BL1 Transgenic Rodents via Breeding

The breeding of two different transgenic rodents or the breeding of a transgenic rodent and a non-transgenic rodent with the intent of creating a new strain of transgenic rodent that can be housed at BL1 containment will be exempt from the *NIH Guidelines* if:

- (1) Both parental rodents can be housed under BL1 containment; and
- (2) neither parental transgenic rodent contains the following genetic modifications: (i) incorporation of more than one-half of the genome of an exogenous eukaryotic virus from a single family of viruses; or (ii) incorporation of a transgene that is under the control of a gammaretroviral long terminal repeat (LTR); and
- (3) the transgenic rodent that results from this breeding is not expected to contain more than one-half of an exogenous viral genome from a single family of viruses.

Appendix C-IX. Footnotes and References of Appendix C

Appendix C-IX-A. The NIH Director, with advice of the RAC, may revise the classification for the purposes of these *NIH Guidelines* (see [Section IV-C-1-b-\(2\)-\(b\), Minor Actions](#)). The revised list of organisms in each Risk Group is located in [Appendix B](#).

Appendix C-IX-B. A subset of non-conjugative plasmid vectors are poorly mobilizable (e.g., pBR322, pBR313). Where practical, these vectors should be employed.

Appendix C-IX-C. Defined as observable under optimal laboratory conditions by transformation, transduction, phage infection, and/or conjugation with transfer of phage, plasmid, and/or chromosomal genetic information. Note that this definition of exchange may be less stringent than that applied to exempt organisms under [Section III-F-6, Exempt Experiments](#).

Appendix C-IX-D. As classified in the *Third Report of the International Committee on Taxonomy of Viruses: Classification and Nomenclature of Viruses*, R. E. F. Matthews (ed.), Intervirology 12 (129-296), 1979.

Appendix C-IX-E. i.e., the total of all genomes within a Family shall not exceed one-half of the genome.

APPENDIX D. MAJOR ACTIONS TAKEN UNDER THE NIH GUIDELINES

As noted in the subsections of [Section IV-C-1-b-\(1\)](#), the Director, NIH, may take certain actions with regard to the *NIH Guidelines* after the issues have been considered by the RAC. Some of the actions taken to date include the following:

Appendix D-1. Permission is granted to clone foot and mouth disease virus in the EK1 host-vector system consisting of *E. coli* K-12 and the vector pBR322, all work to be done at the Plum Island Animal Disease Center.

Appendix D-2. Certain specified clones derived from segments of the foot and mouth disease virus may be transferred from Plum Island Animal Disease Center to the facilities of Genentech, Inc., of South San Francisco, California. Further development of the clones at Genentech, Inc., has been approved under BL1 + EK1 conditions.

Appendix D-3. The Rd strain of *Hemophilus influenzae* can be used as a host for the propagation of the cloned Tn 10 tet R gene derived from *E. coli* K-12 employing the non-conjugative *Hemophilus* plasmid, pRSF0885, under BL1 conditions.

Appendix D-4. Permission is granted to clone certain subgenomic segments of foot and mouth disease virus in HV1 *Bacillus subtilis* and *Saccharomyces cerevisiae* host-vector systems under BL1 conditions at Genentech, Inc., South San Francisco, California.

Appendix D-5. Permission is granted to Dr. Ronald Davis of Stanford University to field test corn plants modified by recombinant DNA techniques under specified containment conditions.

Appendix D-6. Permission is granted to clone in *E. coli* K-12 under BL1 physical containment conditions subgenomic segments of rift valley fever virus subject to conditions which have been set forth by the RAC.

Appendix D-7. Attenuated laboratory strains of *Salmonella typhimurium* may be used under BL1 physical containment conditions to screen for the *Saccharomyces cerevisiae* pseudouridine synthetase gene. The plasmid YEp13 will be employed as the vector.

Appendix D-8. Permission is granted to transfer certain clones of subgenomic segments of foot and mouth disease virus from Plum Island Animal Disease Center to the laboratories of Molecular Genetics, Inc., Minnetonka, Minnesota, and to work with these clones under BL1 containment conditions. Approval is contingent upon review of data on infectivity testing of the clones by a working group of the RAC.

Appendix D-9. Permission is granted to Dr. John Sanford of Cornell University to field test tomato and tobacco plants transformed with bacterial (*E. coli* K-12) and yeast DNA using pollen as a vector.

Appendix D-10. Permission is granted to Drs. Steven Lindow and Nickolas Panopoulos of the University of California, Berkeley, to release under specified conditions *Pseudomonas syringae*, pathovars (pv.) *syringae*, and *Erwinia herbicola* carrying *in vitro* generated deletions of all or part of the genes involved in ice nucleation.

Appendix D-11. Agracetus of Middleton, Wisconsin, may field test under specified conditions disease resistant tobacco plants prepared by recombinant DNA techniques.

Appendix D-12. Eli Lilly and Company of Indianapolis, Indiana, may conduct large-scale experiments and production involving *Cephalosporium acremonium* strain LU4-79-6 under less than Biosafety Level 1 - Large Scale (BL1-LS) conditions.

Appendix D-13. Drs. W. French Anderson, R. Michael Blaese, and Steven Rosenberg of the NIH, Bethesda,

Maryland, can conduct experiments in which a bacterial gene coding for neomycin phosphotransferase will be inserted into a portion of the tumor infiltrating lymphocytes (TIL) of cancer patients using a retroviral vector, N2. The marked TIL then will be combined with unmarked TIL, and reinfused into the patients. This experiment is an addition to an ongoing adoptive immunotherapy protocol in which TIL are isolated from a patient's tumor, grown in culture in the presence of interleukin-2, and reinfused into the patient. The marker gene will be used to detect TIL at various time intervals following reinfusion.

Approval is based on the following four stipulations: (i) there will be no limitation of the number of patients in the continuing trial; (ii) the patients selected will have a life expectancy of about 90 days; (iii) the patients give fully informed consent to participate in the trial; and (iv) the investigators will provide additional data before inserting a gene for therapeutic purposes. (Protocol #8810-001)

Appendix D-14. U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) may conduct certain experiments involving products of a yellow fever virus originating from the 17-D yellow fever clone at the Biosafety Level 3 containment level using HEPA filters and vaccination of laboratory personnel.

In addition, USAMRIID may conduct certain experiments involving vaccine studies of Venezuelan equine encephalitis virus at the Biosafety Level 3 containment level using HEPA filters and vaccination of laboratory personnel.

Appendix D-15. Drs. R. Michael Blaese and W. French Anderson of the NIH, Bethesda, Maryland, can conduct experiments in which a gene coding for adenosine deaminase (ADA) will be inserted into T lymphocytes of patients with severe combined immunodeficiency disease, using a retroviral vector, LASN. Following insertion of the gene, these T lymphocytes will be reinfused into the patients. The patients will then be followed for evidence of clinical improvement in the disease state, and measurement of multiple parameters of immune function by laboratory testing.

Approval is based on the following two stipulations: (i) that intraperitoneal administration of transduced T lymphocytes not be used before clearance by the Chair of the Recombinant DNA Advisory Committee; and (ii) that the number of research patients be limited to 10 at this time.

In addition to the conditions outlined in the initial approval, patients may be given a supplement of a CD-34+ enriched peripheral blood lymphocytes (PBL) which have been placed in culture conditions that favor progenitor cell growth. This enriched population of cells will be transduced with the retroviral vector, G1NaSvAd. G1NaSvAd is similar to LASN, yet distinguishable by PCR. LASN has been used to transduce peripheral blood T lymphocytes with the ADA gene. Lymphocytes and myeloid cells will be isolated from patients over time and assayed for the presence of the LASN or G1NaSvAd vectors. The primary objectives of this protocol are to transduce CD 34+ peripheral blood cells with the adenosine deaminase gene, administer these cells to patients, and determine if such cells can differentiate into lymphoid and myeloid cells *in vivo*. There is a potential for benefit to the patients in that these hematopoietic progenitor cells may survive longer, and divide to yield a broader range of gene-corrected cells. (Protocol #9007-002)

Appendix D-16. Dr. Steven A. Rosenberg of the National Institutes of Health, Bethesda, Maryland, can conduct experiments on patients with advanced melanoma who have failed all effective therapy. These patients will be treated with escalating doses of autologous tumor infiltrating lymphocytes (TIL) transduced with a gene coding for tumor necrosis factor (TNF). Escalating numbers of transduced TIL will be administered at three weekly intervals along with the administration of interleukin-2 (IL-2). The objective is to evaluate the toxicity and possible therapeutic efficacy of the administration of tumor infiltrating lymphocytes (TIL) transduced with the gene coding for TNF. (Protocol #9007-003)

Appendix D-17. Dr. Malcolm K. Brenner of St. Jude Children's Research Hospital of Memphis, Tennessee, can conduct experiments on patients with acute myelogenous leukemia (AML). Using the LNL6 retroviral vector, the autologous bone marrow cells will be transduced with the gene coding for neomycin resistance. The purpose of this gene marking experiment is to determine whether the source of relapse after autologous bone marrow transplantation for acute myelogenous leukemia is residual malignant cells in the harvested marrow or reoccurrence of tumor in the patient. Determining the source of relapse should indicate whether or not purging of the bone marrow is a necessary procedure. (Protocol #9102-004)

Appendix D-18. Dr. Malcolm K. Brenner of St. Jude Children's Research Hospital of Memphis, Tennessee, can conduct experiments on pediatric patients with Stage D (disseminated) neuroblastoma who are being treated with high-dose carboplatin and etoposide in either phase I/II or phase II trials. All the patients in these studies

will be subjected to bone marrow transplantation since it will allow them to be exposed to chemoradiation that would be lethal were it not for the availability of stored autologous marrow for rescue. The bone marrow cells of these patients will be transduced with the gene coding for neomycin resistance using the LNL6 vector. The purpose of this gene marking study is to determine whether the source of relapse after autologous bone marrow transplantation is residual malignant cells in the harvested marrow or residual disease in the patient. Secondly, it is hoped to determine the contribution of marrow autographs to autologous reconstitution. (Protocol #9105-005/9105-006)

Appendix D-19. Dr. Albert B. Deisseroth of the MD Anderson Cancer Center of Houston, Texas, can conduct experiments on patients with chronic myelogenous leukemia who have been reinduced into a second chronic phase or blast cells. The patients in these studies will receive autologous bone marrow transplantation. Using the LNL6 vector, the bone marrow cells will be transduced with the gene coding for neomycin resistance. The purpose of these marking studies is to determine if the origin of relapse arises from residual leukemic cells in the patients or from viable leukemic cells remaining in the bone marrow used for autologous transplantation. (Protocol #9105-007)

Appendix D-20. Drs. Fred D. Ledley and Savio L. C. Woo of Baylor College of Medicine of Houston, Texas, can conduct experiments on pediatric patients with acute hepatic failure who are identified as candidates for hepatocellular transplantation. Using the LNL6 vector, the hepatocytes will be transduced with the gene coding for neomycin resistance. The purpose of using a genetic marker is to demonstrate the pattern of engraftment of transplanted hepatocytes and to help determine the success or failure of engraftment. (Protocol #9105-008)

Appendix D-21. Dr. Steven A. Rosenberg of the National Institutes of Health, Bethesda, Maryland, can conduct experiments on patients with advanced melanoma, renal cell cancer, and colon carcinoma who have failed all effective therapy. In an attempt to increase these patients' immune responses to the tumor, the tumor necrosis factor gene or the interleukin-2 gene will be introduced into a tumor cell line established from the patient. These gene-modified autologous tumor cells will then be injected into the thigh of the patient. To further utilize the immune system of the patient to fight the tumor, stimulated lymphocytes will be cultured from either the draining regional lymph nodes or the injected tumor itself. The patients will be evaluated for antitumor effects engendered by the injection of the gene modified tumor cells themselves as well as after the infusion of the cultured lymphocytes. (Protocol #9110-010/9110-011)

Appendix D-22. Dr. James M. Wilson of the University of Michigan Medical Center of Ann Arbor, Michigan, can conduct experiments on three patients with the homozygous form of familial hypercholesterolemia. Both children and adults will be eligible for this therapy. In an attempt to correct the basic genetic defect in this disease, the gene coding for the low-density lipoprotein (LDL) receptor will be introduced into liver cells taken from the patient. The gene-corrected hepatocytes will then be infused into the portal circulation of the patient through an indwelling catheter. The patients will be evaluated for engraftment of these treated hepatocytes through a series of metabolic studies; three months after gene therapy, a liver biopsy will be taken and analyzed for the presence of recombinant derived RNA and DNA to document the presence of the gene coding for the normal LDL receptor. (Protocol #9110-012)

Appendix D-23. Dr. Michael T. Lotze of the University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania, can conduct experiments on 20 patients with metastatic melanoma who have failed conventional therapy. A gene transfer experiment will be performed, transducing the patients' tumor infiltrating lymphocytes (TILs) with the gene for neomycin resistance. Through the use of this gene marking technique, it is proposed to determine how long TIL cells can be detected *in vivo* in the peripheral blood of the patients, and how the administration of interleukin-2 and interleukin-4 affects localization and survival of TIL cells in tumor sites. (Protocol #9105-009)

Appendix D-24. Dr. Gary J. Nabel of the University of Michigan Medical School, Ann Arbor, Michigan, can conduct gene therapy experiments on twelve patients with melanoma or adenocarcinoma. Patient population will be limited to adults over the age of 18 and female patients must be postmenopausal or have undergone tubal ligation or orchiectomy. The patient's immune response will be stimulated by the introduction of a gene encoding for a Class I MHC protein, HLA-B7, in order to enhance tumor regression. DNA/liposome-mediated transfection techniques will be used to directly transfer this foreign gene into tumor cells. HLA-B7 expression will be confirmed *in vivo*, and the immune response stimulated by the expression of this antigen will be characterized. These experiments will be analyzed for their efficacy in treating cancer. (Protocol #9202-013)

Appendix D-25. Kenneth Cornetta of Indiana University, Indianapolis, Indiana, can conduct gene transfer

experiments on up to 10 patients with acute myelogenous leukemia (AML) and up to 10 patients with acute lymphocytic leukemia (ALL). The patient population will be limited to persons between 18 and 65 years of age. Using the LNL-6 vector, autologous bone marrow cells will be marked with the neomycin resistance gene. Gene marked and untreated bone marrow cells will be reinfused at the time of bone marrow transplantation. Patients

will then be monitored for evidence of the neomycin resistance gene in peripheral blood and bone marrow cells in order to determine whether relapse of their disease is a result of residual malignant cells remaining in the harvested marrow or inadequate ablation of the tumor cells by chemotherapeutic agents. Determining the source of relapse may indicate whether or not purging of the bone marrow is a necessary procedure for these leukemia patients. Further studies will be performed in order to determine the percentage of leukemic cells that contain the LNL-6 vector and the clonality of the marked cells. (Protocol #9202-014)

Appendix D-26. Dr. James S. Economou of the University of California, Los Angeles, can conduct gene transfer experiments on 20 patients with metastatic melanoma and 20 patients with renal cell carcinoma. These patients will be treated with various combinations of tumor-infiltrating lymphocytes and peripheral blood leukocytes, including CD8 and CD4 subsets of both types of cells. These effector cell populations will be given in combination with interleukin-2 (IL-2) in the melanoma patients and IL-2 plus alpha interferon in the renal cell carcinoma patients. The effector cells will be transduced with the neomycin resistance gene using either the LNL6 or G1N retroviral vectors. This "genetic marking" of the tumor-infiltrating lymphocytes and peripheral blood lymphocytes is designed to answer questions about the trafficking of these cells, their localization to tumors, and their *in vivo* life span. (Protocol #9202-015)

Appendix D-27. Drs. Philip Greenberg and Stanley R. Riddell of the Fred Hutchinson Cancer Research Center, Seattle, Washington, may conduct gene transfer experiments on 15 human immunodeficiency virus (HIV) seropositive patients (18-45 years old) undergoing allogeneic bone marrow transplantation for non-Hodgkin's lymphoma and 15 HIV-seropositive patients (18-50 years old) who do not have acquired immunodeficiency syndrome (AIDS)-related lymphoma and who are not undergoing bone marrow transplantation to evaluate the safety and efficacy of HIV-specific cytotoxic T lymphocyte (CTL) therapy. CTL will be transduced with a retroviral vector (HyTK) encoding a gene that is a fusion product of the hygromycin phosphotransferase gene (HPH) and the herpes simplex virus thymidine kinase (HSV-TK) gene. This vector will deliver both a marker gene and an ablatable gene in these T cell clones in the event that patients develop side effects as a consequence of CTL therapy. Data will be correlated over time, looking at multiple parameters of HIV disease activity. The objectives of these studies include evaluating the safety and toxicity of CTL therapy, determining the duration of *in vivo* survival of HIV-specific CTL clones, and determining if ganciclovir therapy can eradicate genetically modified, adoptively transferred CTL cells. (Protocol #9202-017)

Appendix D-28. Dr. Malcolm Brenner of St. Jude Children's Research Hospital, Memphis, Tennessee, can conduct gene therapy experiments on twelve patients with relapsed/refractory neuroblastoma who have relapsed after receiving autologous bone marrow transplant. In an attempt to stimulate the patient's immune response, the gene coding for Interleukin-2 (IL-2) will be used to transduce tumor cells, and these gene-modified cells will be injected subcutaneously in a Phase 1 dose escalation trial. Patients will be evaluated for an anti-tumor response. (Protocol #9206-018)

Appendix D-29. Drs. Edward Oldfield, Kenneth Culver, Zvi Ram, and R. Michael Blaese of the National Institutes of Health, Bethesda, Maryland, can conduct gene therapy experiments on ten patients with primary malignant brain tumors and ten patients with lung cancer, breast cancer, malignant melanoma, or renal cell carcinoma who have brain metastases. The patient population will be limited to adults over the age of 18. Patients will be divided into two groups based on the surgical accessibility of their lesions. Both surgically accessible and surgically inaccessible lesions will receive intra-tumoral injections of the retroviral Herpes simplex thymidine kinase (HS-tk) vector-producer cell line, G1TkSvNa, using a guided stereotaxic approach. Surgically accessible lesions will be excised seven days after stereotaxic injection, and the tumor bed will be infiltrated with the HS-tk producer cells. The removed tumor will be evaluated for the efficiency of transduction. Ganciclovir (GCV) will be administered beginning on the fifth postoperative day. In the case of surgically inaccessible lesions, the patients will receive intravenous therapy with GCV seven days after receiving the intra-tumoral injections of the retroviral HS-tk vector-producer cells. (Protocol #9206-019)

Appendix D-30. Dr. Albert D. Deisseroth of MD Anderson Cancer Center, Houston, Texas, can conduct gene transfer experiments on ten patients who have developed blast crisis or accelerated phase chronic myelogenous leukemia (CML). The retroviral vectors G1N and LNL6 which code for neomycin resistance will be used to transduce autologous peripheral blood and bone marrow cells that have been removed and stored at

the time of cytogenetic remission or re-induction of chronic phase in Philadelphia chromosome positive CML patients. Following reinduction of the chronic phase of CML and preparative chemotherapy, patients will be infused with the transduced autologous cells.

This protocol is designed to determine the cause of relapse of CML. If polyclonal CML neomycin marked blastic cells appear at the time of relapse, their presence will indicate that relapse arises from the leukemic CML blast cells present in the autologous cells infused following chemotherapy. If residual systemic disease contributes to relapse, the neomycin resistance gene will not be detected in the CML leukemic blasts at the time of relapse.

This study will compare the relative contributions of the peripheral blood and bone marrow to generate hematopoietic recovery after bone marrow transplantation and evaluate purging and selection of peripheral blood or bone marrow as a source of stem cells for transplant. The percentage of neomycin resistant CML cells which are leukemic will be determined by PCR analysis and detection of bcr-abl mRNA. (Protocol #9206-020)

Appendix D-31. Dr. Cynthia Dunbar of the National Institutes of Health, Bethesda, Maryland, can conduct gene transfer experiments on up to 48 patients with multiple myeloma, breast cancer, or chronic myelogenous leukemia. The retroviral vectors G1N and LNL6 will be used to transfer the neomycin resistance marker gene into autologous bone marrow and peripheral blood stem cells in the presence of growth factors to examine hematopoietic reconstitution after bone marrow transplantation. The efficiency of transduction of both short and long term autologous bone marrow reconstituting cells will be examined.

Autologous bone marrow and CD34+ peripheral blood stem cells will be enriched prior to transduction. Myeloma and CML patients will receive both autologous bone marrow and peripheral blood stem cell transplantation. These separate populations will be marked with both the G1N and LNL6 retroviral vectors. If short and long term marking experiments are successful, important information may be obtained regarding the biology of autologous reconstitution, the feasibility of retroviral gene transfer into hematopoietic cells, and the contribution of viable tumor cells within the autograft to disease relapse. (Protocol #9206-023/9206-024/9206-025)

Appendix D-32. Dr. Bernd Gansbacher of the Memorial Sloan-Kettering Cancer Center, New York, New York, can conduct gene therapy experiments on twelve patients over 18 years of age with metastatic melanoma who are HLA-A2 positive and who have failed conventional therapy. This is a phase I study to examine whether allogeneic HLA-A2 matched melanoma cells expressing recombinant human Interleukin-2 (IL-2) can be injected subcutaneously and used to create a potent tumor specific immune response without producing toxicity. By allowing the tumor cells to present the MHC Class I molecule as well as the secreted IL-2, a clonal expansion of tumor specific effector cells is expected. These effector populations may access residual tumor at distant sites via the systemic circulation. (Protocol #9206-021)

Appendix D-33. Dr. Bernd Gansbacher of the Memorial Sloan-Kettering Cancer Center, New York, New York, can conduct gene therapy experiments on twelve patients over 18 years of age with renal cell carcinoma who are HLA-A2 positive and who have failed conventional therapy. This Phase I study will examine whether allogeneic HLA-A2 matched renal cell carcinoma cells expressing recombinant human Interleukin-2 (IL-2) can be injected subcutaneously and used to create a potent tumor specific immune response without producing toxicity. By allowing the tumor cells to present the MHC Class I molecule as well as the secreted IL-2, a clonal expansion of tumor specific effector cells is expected. These effector populations may access residual tumor at distant sites via the systemic circulation. (Protocol #9206-022)

Appendix D-34. Dr. Michael T. Lotze, University of Pittsburgh, Pittsburgh, Pennsylvania, can conduct experiments on twenty patients with metastatic, and/or unresectable, locally advanced melanoma, renal cell carcinoma, breast cancer, or colon cancer who have failed standard therapy. Patients will receive multiple subcutaneous injections of autologous tumor cells combined with an autologous fibroblast cell line that has been transduced *in vitro* with the gene coding for Interleukin-4 (IL-4) to augment the *in vivo* antitumor effect. Patients will be monitored for antitumor effect by PCR analysis and multiple biopsy of the injection site. (Protocol #9209-033)

Appendix D-35. Dr. Friedrich G. Schuening, Fred Hutchinson Cancer Research Center, Seattle, Washington, can conduct human gene transfer experiments on patients \geq 18 years of age with breast cancer, Hodgkin's disease, or non-Hodgkin's lymphoma. A total of 10 patients per year will be enrolled in the studies over a period of four years. Patients will undergo autologous bone marrow transplantation with a selected population of Interleukin-3 (IL-3) or granulocyte colony-stimulating factor (G-CSF) stimulated CD34(+) peripheral blood

repopulating cells (PBRC) that have been transduced with the gene coding for neomycin resistance (neo^R) using the retroviral vector, LN. Patients will be continuously monitored for neo^R to determine the relative contribution

of autologous PBRCs to long-term hematopoietic reconstitution. Demonstration of long-term contribution of autologous PBRC to hematopoiesis will enable the use of PBRC alone for autologous transplants and suggest the use of PBRC as long-term carriers of therapeutically relevant genes. (Protocol #9209-027/9209-028)

Appendix D-36. Dr. Friedrich G. Schuening, Fred Hutchinson Cancer Research Center, Seattle, Washington, can conduct human gene transfer experiments on patients ≥ 18 years of age with breast cancer, Hodgkin's disease, or non-Hodgkin's lymphoma. A total of 5 patients per year will be enrolled in the study over a period of four years. Patients will undergo allogeneic bone marrow transplant with granulocyte colony-stimulating factor (G-CSF) stimulated CD34(+) PBRC harvested from an identical twin that have been transduced with neo^R using the retroviral vector, LN. Patients will be continuously monitored for neo^R to determine the relative contribution of G-CSF stimulated allogeneic PBRCs to long-term bone marrow engraftment. Demonstration of long-term contribution of allogeneic PBRC to hematopoiesis will enable the use of PBRC alone for allogeneic transplants and suggest the use of PBRC as long-term carriers of therapeutically relevant genes. (Protocol #9209-029)

Appendix D-37. Dr. Malcolm K. Brenner of St. Jude Children's Hospital, Memphis, Tennessee, and Dr. Bonnie J. Mills of Baxter Healthcare Corporation, Santa Ana, California, can conduct a multicenter uncontrolled human gene transfer experiment on 12 patients ≤ 21 years of age with Stage D Neuroblastoma in first or second marrow remission. Autologous bone marrow cells will be separated into two fractions, purged and unpurged. Each fraction will be transduced with the neo^R gene by either LNL6 or G1Na. Patients will be monitored by the polymerase chain reaction (PCR) for the presence of neo^R . The protocol is designed to evaluate the safety and efficacy of the Neuroblastoma Bone Marrow Purging System following high dose chemotherapy. (Protocol #9209-032)

Appendix D-38. Drs. Carolyn Keierleber and Ann Progulsk-Fox of the University of Florida, Gainesville, Florida, can conduct experiments involving the introduction of a gene coding for tetracycline resistance into *Porphyromonas gingivalis* at a physical containment level of Biosafety Level-2 (BL-2).

Appendix D-39. Dr. Scott M. Freeman of Tulane University Medical Center, New Orleans, Louisiana, can conduct experiments on patients with epithelial ovarian carcinoma who have clinical evidence of recurrent, progressive, or residual disease who have no other therapy available to prolong survival. Patients will be injected intraperitoneally with the irradiated PA-1 ovarian carcinoma cell line which has been transduced with the herpes simplex thymidine kinase (HSV-TK) gene. The patients will then receive ganciclovir therapy. Previous data indicates that HSV-TK+ tumor cells exhibit a killing effect on HSV-TK- cells when exposed to ganciclovir therapy. Patients will be evaluated for safety and side effects of this treatment. (Protocol #9206-016)

Appendix D-40. Dr. Michael J. Welsh, Howard Hughes Medical Institute Research Laboratories, University of Iowa College of Medicine, Iowa City, Iowa, may conduct experiments on 3 cystic fibrosis (CF) patients ≥ 18 years of age with mild to moderate disease. This Phase I study will determine the: (1) *in vivo* safety and efficacy of the administration of the replication-deficient type 2 adenovirus vector, Ad2/CFTR-1, to the nasal epithelium; (2) efficacy in correcting the CF chloride transport defect *in vivo*; and (3) effect of adenovirus vector dosage on safety and efficacy. (Protocol #9212-036)

Appendix D-41. Dr. Ronald G. Crystal, National Institutes of Health, Bethesda, Maryland, may conduct experiments on 10 cystic fibrosis (CF) patients ≥ 21 years of age. Patients will receive an initial administration of the replication-deficient type 5 adenovirus vector, AdCFTR, to their left nares. If no toxicity is observed from intranasal administration, patients will receive a single administration of AdCFTR to the respiratory epithelium of their left large bronchi. Five groups of patients (2 patients per group) will be studied based on increased dosage administration of AdCFTR. This study will determine the: (1) *in vivo* safety and efficacy of the administration of AdCFTR into the respiratory epithelium; (2) efficacy of the correction of the biologic abnormalities of CF in the respiratory epithelium; (3) duration of the biologic correction; (4) efficacy of the correction of the abnormal electrical potential difference of the airway epithelial sheet; (5) clinical parameters relevant to the disease process; and (6) if humoral immunity develops against AdCFTR sufficient to prevent repeat administration. (Protocol #9212-034)

Appendix D-42. Dr. Kenneth Culver, Iowa Methodist Medical Center, Des Moines, Iowa, and Dr. John Van Gilder, University of Iowa, Iowa City, Iowa, may conduct experiments on 15 patients ≥ 18 years of age with

recurrent malignant primary brain tumors or lung, melanoma, renal cell carcinoma, or breast carcinoma brain metastases who have failed standard therapy for their disease. Patient eligibility will be limited to those patients

who have measurable residual tumor immediately following the post-operative procedure as demonstrated by imaging studies. The number of patients treated will be equally divided between the Iowa Methodist Medical Center and the University of Iowa. If a positive response is observed in any of the first 15 patients, the investigators may submit a request to treat an additional 15 patients.

Following surgical debulking, patients will receive a maximum of 3 intralesional injections of the G1TkSvNa vector-producing cell line (VPC) to induce regression of residual tumor cells by ganciclovir (GCV) therapy. Patients who demonstrate stable disease for a minimum of 6 months following this treatment will be eligible for additional VPC injections and subsequent GCV therapy. (Protocol #9303-037)

Appendix D-43. Drs. Malcolm Brenner, Robert Krance, Helen E. Heslop, Victor Santana, and James Ihle, St. Jude Children's Research Hospital, Memphis, Tennessee, may conduct experiments on 35 patients ≥ 1 year and ≤ 21 years of age at the time of initial diagnosis of acute myelogenous leukemia (AML). The investigators will use the two retroviral vectors, LNL6 and G1Na, to determine the efficacy of the bone marrow purging techniques: 4-hydroxyperoxycyclophosphamide and interleukin-2 (IL-2) activation of endogenous cytotoxic effector cells, in preventing relapse from the reinfusion of autologous bone marrow cells. (Protocol #9303-039)

Appendix D-44. Drs. Helen E. Heslop, Malcolm Brenner, and Cliona Rooney, St. Jude Children's Research Hospital, Memphis, Tennessee, may conduct experiments of 35 patients ≤ 21 years of age who will be recipients of mismatched-related or phenotypically similar unrelated donor marrow grafts for leukemia. In this Phase I dose escalation study, spontaneous lymphoblastoid cell lines will be established that express the same range of Epstein-Barr Virus (EBV) encoded proteins as the recipient. These EBV-specific cell lines will be transduced with LNL6 or G1Na and readministered at the time of bone marrow transplant. This study will determine: (1) survival and expansion of these EBV-specific cell lines *in vivo*, (2) the ability of these adoptively transferred cells to confer protection against EBV infection, and (3) appropriate dosage and administration schedules. (Protocol #9303-038)

Appendix D-45. Drs. Robert W. Wilmott and Jeffrey Whitsett, Children's Hospital Medical Center, Cincinnati, Ohio, and Dr. Bruce Trapnell, Genetic Therapy, Inc., Gaithersburg, Maryland, may conduct experiments on 15 cystic fibrosis (CF) patients who have mild to moderate disease ≥ 21 years of age. The replication-deficient type 5 adenovirus vector, Av1CF2, will be administered to the nasal and lobar bronchial respiratory tract of patients. This study will demonstrate the: (1) expression of normal cystic fibrosis transmembrane conductance regulator (CFTR) mRNA *in vivo*, (2) synthesis of CFTR protein, and (3) correction of epithelial cell cAMP dependent Cl^- permeability. The pharmacokinetics of CFTR expression and ability to re-infect the respiratory tract with AvCF2 will be determined. Systemic and local immunologic consequences of Av1CF2 infection, the time of viral survival, and potential for recombination or complementation of the virus will be monitored. (Protocol #9303-041)

Appendix D-46. Dr. James M. Wilson of the University of Pennsylvania Medical Center, Philadelphia, Pennsylvania, may conduct experiments on 20 adult patients with advanced cystic fibrosis lung disease. An isolated segment of the patients' lung will be transduced with the E1 deleted, replication-incompetent adenovirus vector, Ad.CB-CFTR using a bronchoscope for gene delivery. Ad.CB-CFTR contains the human gene encoding the cystic fibrosis transmembrane conductance regulator (CFTR) protein. Pulmonary biopsies will be obtained by bronchoscopy at 4 days, 6 weeks, and 3 months following treatment. Patients will be monitored for evidence of CFTR gene transfer and expression, immunological responses to CFTR or adenovirus proteins, and toxicity. (Protocol #9212-035)

Appendix D-47. Dr. Hilliard F. Seigler of Duke University Medical Center, Durham, North Carolina, may conduct experiments on 20 patients with disseminated malignant melanoma. Autologous tumor cells will be transduced with a retroviral vector, pH γ -IFN, that contains the gene encoding human γ -IFN. Following lethal irradiation, the transduced cells will be readministered to patients for the purpose of generating cytotoxic T cells that are tumor specific along with the up-regulation of Class I major histocompatibility antigens. Patients will be monitored for clinical regression of tumors and generation of tumor-specific cytotoxic T lymphocytes. (Protocol #9306-043)

Appendix D-48. Drs. Stefan Karlsson and Cynthia Dunbar of the National Institutes of Health, Bethesda, Maryland, and Dr. Donald B. Kohn of the Children's Hospital of Los Angeles, Los Angeles, California, may conduct experiments on 10 patients with Gaucher disease. CD34(+) hematopoietic stem cells will be isolated

from bone marrow or from peripheral blood treated with granulocyte-colony stimulating factor. CD34(+) cells will

be transduced with a retrovirus vector, G1Gc, containing cDNA encoding human glucocerebrosidase and administered intravenously. Patients will be monitored for toxicity and glucocerebrosidase expression. (Protocol #9306-047)

Appendix D-49. Dr. Gary J. Nabel of the University of Michigan Medical Center, Ann Arbor, Michigan, may conduct experiments on 12 patients with AIDS to be divided into 4 experimental groups. CD4(+) lymphocytes will be isolated from peripheral blood and transduced with Rev M10, a transdominant inhibitory mutant of the *rev* gene of the human immunodeficiency virus (HIV). Transduction of the *rev* mutant will be mediated either by the retrovirus vector, PLJ-cREV M10, or by particle-mediated gene transfer of plasmid DNA. Patients will be monitored for survival of the transduced CD4(+) cells by polymerase chain reaction and whether Rev M10 can confer protection against HIV infection to CD4(+) cells. (Protocol #9306-049)

Appendix D-50. Dr. Gary J. Nabel of the University of Michigan Medical Center, Ann Arbor, Michigan, may conduct experiments on 24 patients with advanced cancer. Patients will undergo *in vivo* transduction with DNA/liposome complexes containing genes encoding the HLA-B7 histocompatibility antigen and beta-2 microglobulin in a non-viral plasmid. These DNA/liposome complexes will be administered either by intratumoral injection or catheter delivery. Patients will be monitored for enhanced immune responses against tumor cells, and safe and effective doses will be determined. (Protocol #9306-045)

Appendix D-51. Dr. John A. Barranger of the University of Pittsburgh, Pittsburgh, Pennsylvania, may conduct experiments on 5 patients with Gaucher disease. The CD34(+) hematopoietic stem cells will be isolated from peripheral blood and transduced *in vitro* with the retrovirus vector, N2-Sv-GC, encoding the glucocerebrosidase (GC) enzyme. Following reinfusion of the transduced cells, patients will be monitored by PCR analysis for GC expression in peripheral blood leukocytes. Patients currently receiving GC replacement therapy and who demonstrate clinical responsiveness will be withdrawn from exogenous GC therapy. Patients not previously treated with exogenous GC, will be monitored for clinical reversal of lipid storage symptoms. (Protocol #9306-046)

Appendix D-52. Dr. Robert Walker of the National Institutes of Health, Bethesda, Maryland, may conduct experiments on 12 HIV-infected patients who have a seronegative identical twin. CD4(+) and CD8(+) cells will be isolated from the seronegative twin and induced to polyclonal proliferation with anti-CD3 and interleukin-2. The enriched population of cells will be transduced with either LNL6 or G1Na, which contain the *neo^R* gene. The transduced cells will be expanded in tissue culture and administered to the HIV-infected twin. Patients will be monitored for immune function and the presence of marked cells. (Protocol #9209-026)

Appendix D-53. Dr. Corey Raffel of the Children's Hospital Los Angeles, Los Angeles, California, and Dr. Kenneth Culver of Iowa Methodist Medical Center, Des Moines, Iowa, may conduct experiments on 30 patients between 2 and 18 years of age with recurrent malignant astrocytoma. Fifteen patients will be accrued into this study initially. If at least one patient responds to therapy, an additional 14 patients will be treated. Patients with either surgically accessible or non-accessible tumors will be treated with the vector producing cell line (PA317) carrying the retrovirus vector, G1TKSvNa. This vector will transduce tumor cells *in vivo* with the *Herpes simplex* thymidine kinase (HS-tk) gene that renders the cells sensitive to killing by ganciclovir. Surgically accessible patients will undergo surgical debulking of their tumor followed by repeated administration of the HS-tk vector producer cells into the tumor bed. Children with unresectable tumors will undergo stereotaxic injection of vector producer cells into tumors. (Protocol #9306-050)

Appendix D-54. Dr. Jeffrey E. Galpin of the University of Southern California, Los Angeles, California, and Dr. Dennis A. Casciato of the University of California, Los Angeles, California, may conduct experiments on 15 HIV(+) asymptomatic patients. Patients will receive 3 monthly intramuscular injections of the retrovirus vector (N2IIIIBenv) encoding the HIV-1 IIIIB envelope protein. Patients will be monitored for acute toxicity, CD4 levels, HIV-specific CTL responses, and viral burdens. (Protocol #9306-048)

Appendix D-55. Drs. Charles Hesdorffer and Karen Antman of Columbia University College of Physicians and Surgeons, New York, New York, may conduct experiments on 20 patients with advanced breast, ovary, and brain cancer. CD34(+) hematopoietic stem cells will be isolated from bone marrow, transduced with the retrovirus vector, PHaMDR1/A, and readministered to patients. Patients will be monitored for the presence and expression of the MDR-1 gene. The investigators will determine whether MDR-1 expression increases following chemotherapy. (Protocol #9306-051)

Appendix D-56. Dr. Enzo Paoletti of Virogenetics Corporation, Troy, New York, may conduct experiments with poxvirus vectors NYVAC, ALVAC, and TROVAC at Biosafety Level 1.

Appendix D-57. Drs. Richard C. Boucher and Michael R. Knowles of the University of North Carolina, Chapel Hill, North Carolina, may conduct experiments on 9 patients (18 years old or greater) with cystic fibrosis to test for the safety and efficacy of an E1-deleted recombinant adenovirus containing the cystic fibrosis transmembrane conductance regulator (CFTR) cDNA, Ad.CB-CFTR. A single dose of 10^8 , 3×10^9 or 10^{11} pfu/ml will be administered to the nasal cavity of 3 patients in each dose group. Patients will be monitored by nasal lavage and biopsy to assess safety and restoration of normal epithelial function. (Protocol #9303-042)

Appendix D-58. Dr. Joyce A. O'Shaughnessy of the National Institutes of Health, Bethesda, Maryland, may conduct experiments on 18 patients (18-60 years old) with Stage IV breast cancer who have achieved a partial or complete response to induction chemotherapy. This study will determine the feasibility of obtaining engraftment of CD34(+) hematopoietic stem cells transduced by a retroviral vector, G1MD, and expressing a cDNA for the human multi-drug resistance-1 (MDR-1) gene following high dose chemotherapy, and whether the transduced MDR-1 gene confers drug resistance to hematopoietic cells and functions as an *in vivo* dominant selectable marker. Patients will be monitored for evidence of myeloprotection and presence of the transduced MDR-1 gene." (Protocol #9309-054)

Appendix D-59. Drs. Larry E. Kun, R. A. Sanford, Malcolm Brenner, and Richard L. Heideman of St. Jude Children's Research Hospital, Memphis, Tennessee, and Dr. Edward H. Oldfield of the National Institutes of Health, Bethesda, Maryland, may conduct experiments on 6 patients (3-21 years old) with progressive or recurrent malignant supratentorial tumors resistant to standard therapies. Mouse cells producing the retroviral vector containing the herpes simplex thymidine kinase gene (G1TKSVNa) will be instilled into the tumor areas via multiple stereotactically placed cannulas. Patients will be treated with ganciclovir to eliminate cells expressing the transduced gene. Patients will be monitored for central nervous system, hematologic, renal or other toxicities, and for anti-tumor responses by magnetic resonance imaging studies. (Protocol #9309-055)

Appendix D-60. The physical containment level may be reduced from Biosafety Level 3 to Biosafety Level 2 for a Semliki Forest Virus (SFV) vector expression system of Life Technologies, Inc., Gaithersburg, Maryland.

Appendix D-61. Dr. Albert B. Deisseroth of the University of Texas MD Anderson Cancer Center, Houston, Texas, may conduct experiments on 10 patients (≥ 16 to ≤ 60 years of age) with chronic lymphocytic leukemia. Autologous peripheral blood and bone marrow cells will be removed from patients following chemotherapy and marked by transduction with two distinguishable retroviral vectors, G1Na and LNL6, containing the neomycin resistance gene. The gene marked cells will be reinfused into patients to determine the efficiency of bone marrow purging and the origin of relapse following autologous bone marrow transplantation. (Protocol #9209-030)

Appendix D-62. Dr. Jonathan Simons of the Johns Hopkins Oncology Center, Baltimore, Maryland, may conduct experiments on 26 patients (≥ 18 years of age) with metastatic renal cell carcinoma to evaluate the safety and tolerability of intradermally injected autologous irradiated tumor cells transduced with the retrovirus vector, MFG, containing the human granulocyte-macrophage colony stimulating factor gene. Acute and long-term clinical toxicities and *in vitro* and *in vivo* induction of specific anti-tumor immune responses will be monitored. (Protocol #9303-040)

Appendix D-63. Dr. Albert B. Deisseroth of the University of Texas MD Anderson Cancer Center, Houston, Texas, may conduct experiments on 20 patients (≥ 18 and ≤ 60 years old) with ovarian cancer. A murine viral vector was constructed from the third generation of L series retroviruses with the insert of the human multi-drug resistance-1 (MDR-1) transduced gene. The investigators will assess the safety and feasibility of administering CD34 (+) autologous peripheral blood and bone marrow cells. Patients will be monitored for the presence of the MDR-1 gene and for the effect of gene transfer on hematopoietic function following the transplantation. (Protocol #9306-044)

Appendix D-64. Dr. Joseph Ilan of the Case Western Reserve University School of Medicine and University Hospital of Cleveland, Cleveland, Ohio, may conduct experiments on 12 patients (≥ 18 years of age) with advanced brain cancer. Human malignant glioma tumor cells will be cultured, transfected with Epstein-Barr virus (EBV)-based vector, anti-Insulin growth factor-I, lethally irradiated, and injected subcutaneously into

patients in an attempt to express antisense Insulin growth factor-1. Patients will be monitored for toxicity and immunologic responses to the vector. (Protocol #9306-052)

Appendix D-65. Drs. James S. Economou and John Glaspy of the University of California, Los Angeles, California, may conduct experiments on 30 patients (≥ 18 to ≤ 70 years of age) with metastatic melanoma. A human melanoma cell line (M-24) will be transduced with the retroviral vector, G1NaCvi2, expressing the human interleukin-2 (IL-2) gene. The IL-2 producing cells will be mixed with the patient's autologous tumor cells, irradiated, and injected subcutaneously in an attempt to enhance the tumor-specific immunologic response. Patients will be monitored for toxicity, *in vitro* and *in vivo* immunologic responses, and clinical anti-tumor effects. (Protocol #9309-058)

Appendix D-66. Drs. Peter Cassileth, Eckhard R. Podack, and Kasi Sridhar of the University of Miami, and Niramol Savaraj of the Miami Veterans Administration Hospital, Miami, Florida, may conduct experiments on 12 patients (≥ 18 years of age) with limited stage small cell lung cancer. Autologous tumor cells will be removed, expanded in culture, and transduced by lipofection with the BMG-Neo-hIL2 vector (derived from bovine papilloma virus). The objective of this protocol is to demonstrate the safety and efficacy of administering IL-2 transduced autologous tumor cells in an attempt to stimulate a tumor-specific cytotoxic T lymphocyte (CTL) response, and to determine the quantity and characteristics of the CTL that have been generated. (Protocol #9309-053)

Appendix D-67. Drs. Edward H. Oldfield and Zvi Ram of the National Institutes of Health, Bethesda, Maryland, may conduct experiments on 20 patients (≥ 18 years of age) with leptomeningeal carcinomatosis. The patients will receive intraventricular or subarachnoid injection of murine vector producing cells containing the retroviral vector, G1Tk1SvNa. Tumor cells expressing the herpes simplex thymidine kinase gene will be rendered sensitive to killing by subsequent administration of ganciclovir. Patients will be monitored for safety and anti-tumor response by magnetic resonance imaging (MRI) and cerebral spinal fluid cytological analysis. (Protocol #9312-059)

Appendix D-68. Drs. Tapas K. Das Gupta and Edward P. Cohen of the University of Illinois College of Medicine, Chicago, Illinois, may conduct experiments on 12 subjects who differ in at least 3 out of 6 alleles at the Class I histocompatibility locus (≥ 18 years of age) with Stage IV malignant melanoma. The subjects will be immunized with a lethally irradiated allogeneic human melanoma cell line transduced with the human interleukin-2 expressing retroviral vector, pZipNeoSv-IL-2. Subjects will be monitored for toxicity, induction of B and T cell antitumor responses *in vitro* and *in vivo*, and any clinical evidence of antitumor effect. (Protocol #9309-056)

Appendix D-69A. Dr. Michael J. Welsh of the Howard Hughes Medical Institute, Iowa City, Iowa, may conduct experiments on 20 patients (≥ 18 years of age) with cystic fibrosis. The investigator will administer increasing doses of either of the two adenovirus vectors, AD2/CFTR-1 or AD2-ORF6/PGK-CFTR, to the nasal epithelium of 10 patients (1 nostril) or maxillary sinus epithelium of 10 patients (1 maxillary sinus). Patients will be isolated for a period of 24 hours following vector administration; however, if 1 patient demonstrates secreted virus at 24 hours, the investigator will notify the Recombinant DNA Advisory Committee for reconsideration of the isolated period. Patients will be assessed for the safety and efficacy of multiply administration of adenovirus vectors encoding the cystic fibrosis transmembrane conductance regulator (CFTR) gene. (Protocol #9312-067)

Appendix D-69B. Dr. Richard Haubrich of the University of California at San Diego Treatment Center, San Diego, California, may conduct experiments on 25 human immunodeficiency virus (HIV)-infected, seropositive, asymptomatic subjects (≥ 18 to ≤ 65 years of age). Subjects will receive 3 monthly intramuscular injections of the retroviral vector, N2/IIIB *env/rev*, which encodes for HIV-1 IIIIB *env/rev* proteins. The objective of the study is to induce HIV-1-specific CD8(+) cytotoxic T lymphocyte and antibody responses in order to eliminate HIV-infected cells and residual virus. This Phase I/II study will evaluate acute toxicity, identify long-term treatment effects, and evaluate the disease progression. (Protocol #9312-062)

Appendix D-70. Dr. Mario Sznol of the National Institutes of Health, Frederick, Maryland, may conduct experiments on 50 subjects (≥ 18 years of age) with advanced stage melanoma. Subjects will receive subcutaneous injections of lethally irradiated allogeneic melanoma cells that have been transduced by lipofection with the plasmid DNA vector, CMV-B7, derived from bovine papilloma virus to express the human B7 antigen. The B7 antigen, which binds to the CD28 receptor of T cells, will serve as a co-stimulatory signal to elicit an antitumor immune response. Subjects will be monitored for induction of cytotoxic T lymphocyte, antitumor responses *in vitro* and *in vivo* and any clinical evidence of antitumor effect. (Protocol #9312-063)

Appendix D-71. Dr. Joseph Rubin of the Mayo Clinic, Rochester, Minnesota, may conduct experiments on 15 subjects with hepatic metastases from advanced colorectal cancer (≥ 18 years of age). Subjects will receive intratumoral hepatic injections of the plasmid DNA/lipid complex, pHLA-B7/ β -2 microglobulin, expressing a heterodimeric cell surface protein consisting of the HLA-B7 histocompatibility antigen and β -2 microglobulin. Subjects must be HLA-B7 negative. The objective of this study is to determine a safe and effective dose of the DNA/lipid complex. Subjects will be monitored for antigen-specific immune responses and *in vivo* HLA-B7 expression. (Protocol #9312-064)

Appendix D-72. Dr. Nicholas J. Vogelzang of the University of Chicago Medical Center, Chicago, Illinois, may conduct experiments on 15 subjects with metastatic renal cell carcinoma ≥ 18 years of age. Subjects will receive intratumoral injections of the plasmid DNA/liposome vector pHLA-B7/ β -2 microglobulin, expressing a heterodimeric cell surface protein consisting of the HLA-B7 histocompatibility antigen and β -2 microglobulin. Subjects must be HLA-B7 negative. Subjects will be monitored for antigen-specific immune responses and *in vivo* HLA-B7 expression. (Protocol #9403-071)

Appendix D-73. Dr. Evan M. Hersh of the Arizona Cancer Center and Drs. Emmanuel Akporiaye, David Harris, Alison T. Stopeck, Evan C. Unger, and James A. Warneke of the University of Arizona, Tucson, Arizona, may conduct experiments on 15 subjects with metastatic malignant melanoma ≥ 18 years of age. Subjects will receive intratumoral injections of the plasmid DNA/liposome vector, pHLA-B7/ β -2 microglobulin, expressing a heterodimeric cell surface protein consisting of the HLA-B7 histocompatibility antigen and β -2 microglobulin. Subjects must be HLA-B7 negative. Subjects will be monitored for antigen-specific immune responses and *in vivo* HLA-B7 expression. (Protocol #9403-072)

Appendix D-74. Dr. Ralph Freedman of MD Anderson Cancer Center, Houston, Texas, may conduct gene marking experiments on 9 subjects with ovarian carcinoma or peritoneal carcinomatosis (≥ 16 years of age). Autologous CD3(+)/CD8(+) tumor infiltrating lymphocyte derived T cells will be transduced with the retroviral vector G1Na that encodes for neo^R. Subjects will receive intraperitoneal administration of bulk expanded transduced and nontransduced T cells and recombinant interleukin-2. Previously documented tumor sites and normal tissues will be monitored for neo^R and the proportion of CD3(+)/CD8(+) T cells will be determined. (Protocol #9406-075)

Appendix D-75. Drs. Helen Heslop, Malcolm Brenner, and Robert Krance of St. Jude Children's Research Hospital, Memphis, Tennessee, may conduct gene marking experiments on 20 subjects undergoing autologous bone marrow transplantation for therapy of leukemia or solid tumor (< 21 years of age). The distinguishable retroviral vectors, LNL6 and G1Na (both encoding neo^R), will be used to determine the rate of reconstitution of untreated versus cytokine expanded CD34(+) selected autologous bone marrow cells. (Protocol #9406-076)

Appendix D-76. Drs. Albert Deisseroth, Gabriel Hortobagyi, Richard Champlin, and Frankie Holmes of MD Anderson Cancer Center, Houston, Texas, may conduct experiments on 10 fully evaluable subjects (maximum of 20 entered) with Stage III or IV breast cancer (≥ 18 and ≤ 60 years of age). Subjects will receive autologous CD34(+) peripheral blood cells that have been transduced with the retroviral vector, pVMDR-1, which encodes the multi-drug resistance gene. The objective of this study is to evaluate the safety and feasibility of transducing early hematopoietic progenitor cells with pVMDR-1 and to determine *in vivo* selection of chemotherapy resistant hematopoietic cells. (Protocol #9406-077)

Appendix D-77. Drs. Johnson M. Liu and Neal S. Young of the National Institutes of Health, Bethesda, Maryland, may conduct experiments on 6 patients with Fanconi anemia (≥ 5 years of age). Subjects will receive autologous CD34(+) cells that have been transduced with the retroviral vector, FACC, which encodes the normal Fanconi anemia complementation group C gene. The objective of this study is to determine whether autologous FACC transduced hematopoietic progenitor cells can be safely administered to subjects, the extent of engraftment, and correction of cell phenotype. (Protocol #9406-078)

Appendix D-78. Drs. Robert E. Sobol and Ivor Royston of the San Diego Regional Cancer Center, San Diego, California, may conduct experiments on 15 subjects with recurrent residual glioblastoma multi-forme (≥ 18 years of age). Subjects will receive subcutaneous injections of autologous tumor cells that have been lethally irradiated and transduced with the retroviral vector, G1NaCvi2.23, which encodes for interleukin-2. Subjects will be monitored *in vitro* for cellular and humoral antitumor responses and *in vivo* for antitumor activity. (Protocol #9406-080)

Appendix D-79. Dr. Alfred E. Chang of the University of Michigan Medical Center, Ann Arbor Michigan, may conduct gene marking experiments on 15 subjects with metastatic melanoma (≥ 18 years of age). Subjects will undergo adoptive immunotherapy of anti-CD3/interleukin-2 activated lymph node cells that have been primed *in vivo* with tumor cells that have been transduced with the retrovirus vector, GBAH4, encoding the gene for interleukin-4. The investigator will evaluate the antitumor efficacy and *in vivo* immunological reactivity in subjects receiving adoptively transferred T cells, and the *in vitro* immunological reactivities of the activated T cells that might correlate with their *in vivo* antitumor function. (Protocol #9312-065)

Appendix D-80. Dr. Robert Walker of the National Institutes of Health, Bethesda, Maryland, may conduct gene marking experiments on 40 HIV(+) subjects (≥ 18 years of age). The investigator may also enter an additional number of subjects (to be determined by the investigator) who will receive a single administration of 1×10^7 HIV-specific CD8(+) cells. The investigator will: (1) Assess the safety and tolerance of the adoptive transfer of anti-HIV cytotoxic, syngeneic, CD8(+) peripheral blood lymphocytes that have been transduced with the retrovirus vector, *rkat4svgF3e-*, that encodes for a universal chimeric T cell receptor. (2) Determine the longevity of the genetically marked CD8(+) lymphocytes in the subject's peripheral blood. (Protocol #9403-069)

Appendix D-81. Dr. Joseph Rosenblatt of the University of California, Los Angeles, California, and Dr. Robert Seeger of Children's Hospital, Los Angeles, California, may conduct gene transfer experiments on 18 subjects with neuroblastoma (≤ 21 years of age). Patients at high risk of relapse with minimal or no detectable disease following myeloablative therapy and autologous bone marrow transplantation, or patients with progressive or persistent disease despite conventional therapy will be serially immunized with autologous or allogeneic neuroblastoma cells transduced to express γ interferon. Cells will be transduced with the retroviral vector, pHuy-IFN, encoding the human gene for γ interferon and lethally irradiated prior to use as an immunogen. The objectives of the study are: (1) to determine the maximum tolerable dose of transduced cells; (2) to determine the local, regional, and systemic toxicities of injected cells; and (3) to determine the antitumor response *in vivo* as measured by standard clinical tests and immunocytologic evaluation of marrow metastases. (Protocol #9403-068)

Appendix D-82. Dr. Kenneth L. Brigham of Vanderbilt University, Nashville, Tennessee, may conduct gene transfer experiments on 10 subjects (≤ 21 years of age) in two different patient protocols (5 for each protocol). Both protocols will use the same DNA/liposome preparations to deliver a plasmid DNA construct, pCMV4-AAT, encoding human alpha-1 antitrypsin gene driven by a cytomegalovirus promoter. In patients scheduled for elective pulmonary resection, the DNA/liposome complexes will be instilled through a fiber optic bronchoscope into a subsegment of the lung. Tissues of the lung will be obtained at the time of surgery. Transgene expression will be assessed by immunohistochemistry, *in situ* hybridization, and Western and Northern blot analyses. The effect of DNA/liposome complex administration on the histological appearance of the lung will also be evaluated. In patients with alpha-1 antitrypsin deficiency, the DNA/liposome complexes will be instilled into the nostril. Transgene expression will be determined in cells obtained by nasal lavage and nasal scraping, and the time course of transgene expression will be measured. The secretion of the alpha-1 antitrypsin protein in nasal fluid will be determined. Histological appearance of nasal mucosa will also be examined. The study will assess safety and feasibility of gene delivery to the human respiratory tract. (Protocol #9403-070)

Appendix D-83. Dr. H. Kim Lyerly of Duke University Medical Center, Durham, North Carolina, may conduct gene transfer experiments on 20 subjects with refractory or recurrent metastatic breast cancer (≥ 18 years of age). Autologous breast cancer cells will be transduced with the DNA/liposome complex, pMP6-IL2, containing a plasmid DNA vector derived from adeno-associated virus (AAV) that expresses the gene for human interleukin-2. Subjects will receive 4 subcutaneous injections of lethally irradiated tumor cells transduced with the DNA/liposome complex prior to injection. The objective of this study is to: (1) evaluate the safety and toxicity of the treatment, (2) determine the immunological effects, (3) determine the duration of clinical responses, and (4) measure patient survival. (Protocol #9409-086)

Appendix D-84. Drs. Flossie Wong-Staal, Eric Poeschla, and David Looney of the University of California at San Diego, La Jolla, California, may conduct gene transfer experiments on 6 subjects (≥ 18 and ≤ 65 years of age) infected with human immunodeficiency virus-1 (HIV-1). Autologous CD4(+) T lymphocytes will be transduced *ex vivo* with the retroviral vector, pMJT, expressing a hairpin ribozyme that cleaves the HIV-1 RNA in the 5' leader sequence. The transduced cells will be expanded and reinfused into the patients. The objectives of the study are: (1) to evaluate safety of reinfusing the transduced lymphocytes, (2) to compare (*in vivo*) the kinetics and survival of ribozyme-transduced cells with that of cells transduced with a control vector, (3) to determine *in vivo* expression of the ribozyme sequences in transduced lymphocytes, (4) to determine whether host immune responses directed against the transduced cells will occur *in vivo*, and (5) to obtain preliminary

data on the effects of ribozyme gene therapy on *in vivo* HIV mRNA expression, viral burden and CD4(+) lymphocyte levels. (Protocol #9309-057)

Appendix D-85. Dr. Friedrich Schuening of the Fred Hutchinson Cancer Research Center, Seattle, Washington, may conduct gene transfer experiments on 10 subjects (≥ 18 years of age) with Type I Gaucher's disease. The peripheral blood repopulating cells (mobilized by patient pretreatment with recombinant granulocyte colony-stimulating factor) will be harvested and CD34(+) cells selected. CD34(+) cells will be transduced *ex vivo* with the retroviral vector, LgGC, that encodes human glucocerebrosidase cDNA. Following transduction, the transduced cells will be infused into the patient without myeloablative treatment. The primary endpoint of this study is to examine the safety of infusing CD34(+) cells transduced with the human glucocerebrosidase cDNA. Patients will be monitored for persistence and expression of the glucocerebrosidase gene in hematopoietic cells. (Protocol #9312-061)

Appendix D-86. Dr. Terence R. Flotte of the Johns Hopkins Children's Center, Baltimore, Maryland, may conduct gene transfer experiments on 16 subjects (≥ 18 years of age) with mild cystic fibrosis (CF). An adeno-associated virus (AAV) derived vector, encoding cystic fibrosis transmembrane conductance regulator (CFTR) gene, (tgAAVCF), will be administered to nasal (direct) and airway (bronchoscope) epithelial cells. This is a dose escalation study involving 8 cohorts. Each subject will receive both intranasal and bronchial administration of the adenoviral vector at 4 escalating doses. Nasal doses will range between 1×10^6 and 1×10^9 pfu. Lung administration will range between 1×10^7 and 1×10^{10} pfu. The primary goal of the study is to assess the safety of vector administration. Respiratory and nasal epithelial cells will be evaluated for gene transfer, expression, and physiologic correction. (Protocol #9409-083)

Appendix D-87. Drs. Jeffrey M. Isner and Kenneth Walsh of St. Elizabeth's Medical Center, Tufts University, Boston, Massachusetts, may conduct gene transfer experiments on 12 subjects (≥ 40 years of age) with peripheral artery disease (PAD). A plasmid DNA vector, phVEGF165, encoding the human gene for vascular endothelial growth factor (VEGF) will be used to express VEGF to induce collateral neovascularization. Percutaneous arterial gene transfer will be achieved using an angioplasty catheter with a hydrogel coated balloon to deliver the plasmid DNA vector to the artery. The objectives of the study are: (1) to determine the efficacy of arterial gene therapy to relieve rest pain and/or heal ischemic ulcers of the lower extremities in patients with PAD; and (2) to document the safety of the phVEGF arterial gene therapy for therapeutic angiogenesis. Subjects will undergo anatomic and physiologic examination to determine the extent of collateral artery development following phVEGF arterial gene therapy. (Protocol #9409-088)

Appendix D-88A. Dr. Ronald G. Crystal of New York Hospital-Cornell Medical Center, New York, New York, may conduct gene transfer experiments on 26 patients (≥ 15 years of age) with cystic fibrosis (CF). A replication deficient recombinant adenovirus vector will be used to transduce epithelial cells of the large bronchi with the E1/E3 deleted type 5 adenovirus vector, Ad₅CFTR.10, which encodes the human cystic fibrosis transmembrane conductance regulator (CFTR) gene. The objective of this study is to define the safety and pharmacodynamics of CFTR gene expression in airway epithelial cells following single administration of escalating doses to the vector. If single administration is determined to be safe, subjects will undergo repeat administration to localized areas of the bronchi. (Protocol #9409-085)

Appendix D-88B. Drs. Eric J. Sorscher and James L. Logan of the University of Alabama, Birmingham, Alabama, may conduct gene transfer experiments on 9 subjects (≥ 18 years of age) with cystic fibrosis (CF). The normal human cystic fibrosis transmembrane conductance regulator (CFTR) gene will be expressed by a plasmid DNA vector, pKCTR, driven by the simian virus-40 (SV40) early gene promoter. The CFTR DNA construct will be delivered by cationic liposome-based gene transfer to nasal epithelial cells. The objectives of the study are to: (1) evaluate the safety of lipid-mediated gene transfer to nasal epithelial cells (including local inflammation and mucosal tissue); and (2) evaluate efficacy as determined by correction of the chloride ion transport defect, and wild-type CFTR mRNA and protein expression. (Protocol #9312-066)

Appendix D-89. Dr. Steven M. Albelda of the University of Pennsylvania Medical Center, Philadelphia, Pennsylvania, may conduct gene transfer experiments on 12 subjects with advanced mesothelioma. The adenovirus vector encoding the *Herpes simplex* virus thymidine kinase (HSV-TK) gene, H5.020RSVTK, will be administered through a chest tube to the pleural cavity. Tumor biopsies will be assayed for gene transfer and expression. Subjects will be monitored for immunological responses to the adenovirus vector. Ganciclovir will be administered intravenously 14 days following vector administration. The primary objective of this Phase I study is to evaluate the safety of direct adenovirus vector gene delivery to the pleural cavity of patients with malignant melanoma. (Protocol #9409-090)

Appendix D-90. Drs. Jeffrey Holt and Carlos B. Arteaga of the Vanderbilt University, Nashville, Tennessee, may conduct gene transfer experiments on 10 female patients (over 18 years of age) with metastatic breast cancer. Patient effusions from pleura or peritoneum will be drained and the fluid will be replaced with supernatant containing the retroviral vectors, XM6:antimyc or XM6:antifos, which express *c-myc* and *c-fos* antisense sequences, respectively, under the control of a mouse mammary tumor virus promoter. The objectives of this study are to: (1) assess uptake and expression of the vector sequences in breast cancer cells present in pleural and peritoneal fluids, and determine if this expression is tumor specific, (2) assess the safety of localized administration of antisense retroviruses, and (3) monitor subjects for clinical evidence of antitumor response. (Protocol #9409-084)

Appendix D-91. Dr. Jack A. Roth of MD Anderson Cancer Center, Houston, Texas, may conduct gene transfer experiments on 14 non-small cell lung cancer subjects (≥ 18 and ≤ 80 years of age) who have failed conventional therapy and who have bronchial obstruction. LNSX-based retroviral vectors containing the β -actin promoter will be used to express: (1) the antisense RNA of the *K-ras* oncogene (LN-K-rasB), and (2) the wildtype *p53* tumor suppressor gene (LNp53B). Tumor biopsies will be obtained to characterize *K-ras* and *p53* mutations. Relative to their specific mutation, subjects will undergo partial endoscopic resection of the tumor bed followed by bronchoscopic administration of the appropriate retrovirus construct. The objective of this study is to evaluate the safety and efficacy of intralesional administration of LN-K-rasB and LNp53 retrovirus constructs. (Protocol #9403-031)

Appendix D-92. Drs. Robert E. Sobol and Ivor Royston of the San Diego Regional Cancer Center, San Diego, California, may conduct gene transfer experiments on 12 subjects (≥ 18 years of age) with metastatic colon carcinoma. The autologous skin fibroblasts will be transduced with the retroviral vector, LNCX/IL-2, which encodes the gene for human interleukin-2 (IL-2). In this dose-escalation study, subjects will receive subcutaneous injections of lethally irradiated autologous tumor cells. The objectives of the study are to: (1) evaluate the safety of subcutaneous administration of LNCX/IL-2 transduced fibroblasts, (2) determine *in vivo* antitumor activity, and (3) monitor cellular and humoral antitumor responses. (Protocol #9312-060)

Appendix D-93. Dr. Michael Lotze of the University of Pittsburgh, Pittsburgh, Pennsylvania, may conduct gene transfer experiments on 18 subjects (≥ 18 years of age) with advanced melanoma, 6 with T-cell lymphoma, breast cancer, or head and neck cancer. Subjects should have accessible cutaneous tumors, and have failed standard therapy. Over 4 weeks, subjects will receive a total of 4 intratumoral injections of autologous fibroblasts transduced with the retrovirus vector, TFG-hIL-12-Neo. This vector, which consists of the murine MFG backbone, expresses both the p35 and p40 subunits of interleukin-12 (IL-12) and the *neo^R* selection marker. The objectives of the study are to: (1) define the local and systemic toxicity associated with peritumoral injections of gene-modified fibroblasts, (2) examine the local and systemic immunomodulatory effects of these injections, and (3) evaluate clinical antitumor efficacy. (Protocol #9406-081)

Appendix D-94. Drs. Evan Hersh, Emmanuel Akporiaye, David Harris, Alison Stopeck, Evan Unger, James Warneke, of the Arizona Cancer Center, Tucson, Arizona, may conduct gene transfer experiments on 25 subjects (≥ 18 years of age) with solid malignant tumors or lymphomas. A plasmid DNA/lipid complex designated as VCL-1102 (IL-2 Plasmid DNA/DMRIE/DOPE) will be used to transduce the human gene for interleukin-2 (IL-2). Patients with advanced cancer who have failed conventional therapy will undergo a procedure in which VCL-1102 is injected directly into the tumor mass to induce tumor-specific immunity. The objectives of the study are to: (1) determine safety and toxicity associated with escalating doses of VCL-1102; (2) confirm IL-2 expression in target cells; (3) determine biological activity and pharmacokinetics; and (4) determine whether IL-2 expression stimulates tumor regression in subjects with metastatic malignancies. (Protocol #9412-095)

Appendix D-95. Drs. Richard Morgan and Robert Walker of the National Institutes of Health, Bethesda, Maryland, may conduct gene transfer experiments on 48 human immunodeficiency virus (HIV) seropositive subjects (≥ 18 years of age). This Phase I/II study involves identical twins (one HIV seropositive and the other HIV seronegative). CD4(+) T cells will be enriched following apheresis of the HIV seronegative twin, induced to polyclonal proliferation with anti-CD3 and recombinant IL-2, transduced with either the LNL6/Neo^R or G1Na/Neo^R, and transduced with up to 2 additional retroviral vectors (G1RevTdSN and/or GCRTdSN(TAR)) containing potentially therapeutic genes (antisense TAR and/or transdominant Rev). These T cell populations will be expanded 10 to 1,000 fold in culture for 1 to 2 weeks and reinfused into the HIV seropositive twin. Subjects will receive up to 4 cycles of treatment using identical or different combinations of control and anti-HIV retrovirus vectors. The relative survival of these transduced T cell populations will be monitored by vector-

specific polymerase chain reaction, while the subjects' functional immune status is monitored by standard *in vitro* and *in vivo* assays. (Protocol #9503-103)

Appendix D-96. Dr. Harry L. Malech of the National Institutes of Health, Bethesda, Maryland, may conduct gene transfer experiments on 2 subjects ≥ 18 years of age (with or without concurrent serious infection), and 3 subjects ≥ 18 years of age (with or without concurrent serious infection) or minors 13-17 years of age who have concurrent serious infection who have chronic granulomatous disease (CGD). CGD is an inherited immune deficiency disorder in which blood neutrophils and monocytes fail to produce antimicrobial oxidants (p47^{phox} mutation) resulting in recurrent life-threatening infections. Subjects will undergo CD34(+) mobilization with granulocyte colony stimulating factor (G-CSF). These CD34(+) cells will be transduced with the retrovirus vector, MFG-S-p47^{phox}, which encodes the gene for normal p47^{phox}. The objectives of this study are to: (1) determine the safety of administering MFG-S-p47^{phox} transduced CD34(+) cells, and (2) demonstrate increased functional oxidase activity in circulating neutrophils. (Protocol #9503-104)

Appendix D-97. Drs. Chris Evans and Paul Robbins of the University of Pittsburgh, Pittsburgh, Pennsylvania, may conduct gene transfer experiments on 6 subjects (≥ 18 and ≤ 76 years of age) with rheumatoid arthritis. Rheumatoid arthritis is a chronic, progressive disease thought to be of autoimmune origin. A gene encoding an interleukin-1 receptor antagonist protein (IRAP) will be delivered to the rheumatoid metacarpal-phalangeal joints to determine the autoimmune reactions can be interrupted. The vector construct, DFG-IRAP, is based on the MFG murine retrovirus vector backbone, and encodes the human IRAP gene. Synovial fibroblasts will be generated from the rheumatoid arthritic joint tissue obtained from patients who are scheduled to undergo surgery. The fibroblasts will be transduced with the DFG-IRAP vector, and the transduced cells injected into the synovial space. The synovial fluid and joint material will be collected 7 days later to determine the presence and location of the transduced synovial fibroblasts and the level of IRAP in the joint fluid. (Protocol 9406-074)

Appendix D-98. Dr. R. Scott McIvor of the University of Minnesota, Minneapolis, Minnesota, may conduct gene transfer experiments on 2 children with purine nucleoside phosphorylase (PNP) deficiency. PNP deficiency results in severe T-cell immunodeficiency, an autosomal recessive inherited disease which is usually fatal in the first decade of life. Autologous peripheral blood lymphocytes will be cultured in an artificial capillary cartridge in the presence of anti-CD3 monoclonal antibody and interleukin-2 and transduced with the retroviral vector, LPNSN-2, encoding human PNP. Subjects will undergo bimonthly intravenous administration of transduced T cells for a maximum of 1 year. The objectives of the study are to determine: (1) the safety of intravenous administration of transduced T cells in children with PNP deficiency, (2) the efficiency of PNP gene transfer and duration of gene expression *in vivo*, and (3) the effect of PNP gene transfer on immune function. (Protocol #9506-110)

Appendix D-99. Drs. Nikhil C. Munshi and Bart Barlogie of the University of Arkansas School for Medical Sciences, Little Rock, Arkansas, may conduct gene transfer experiments on 21 subjects (>18 and <65 years of age) with relapsed or persistent multiple myeloma who are undergoing T cell depleted allogeneic bone marrow transplantation. Donor peripheral blood lymphocytes will be cultured *in vitro* with interleukin-2 and anti-CD3 monoclonal antibody. T cell depleted lymphocytes will be transduced with the retroviral construct, G1Tk1SvNa.7, which encodes the Herpes simplex virus thymidine kinase (HSV-TK) gene. The transduced cells will be reinfused. In this dose escalation study, 3 subjects will undergo cell-mediated gene transfer per cohort (maximum of 5 cohorts) until Grade III or IV Graft versus Host Disease (GVHD) is observed. A maximum of 6 additional patients may be entered at that maximum tolerated dose. The objectives of this study are to determine the: (1) safety of transduced donor cell infusions, (2) effectiveness of donor cell infusions in decreasing the effects of severe GVHD, (3) effectiveness of donor cell infusions in prolonging multiple myeloma remission, and (4) effectiveness of ganciclovir in eliminating donor cells for the purpose of preventing the depletion of erythrocytes. (Protocol #9506-107)

Appendix D-100. Dr. Wayne A. Marasco of Dana-Farber Cancer Institute, Boston, Massachusetts, may conduct gene transfer experiments on 6 subjects (≥ 18 and ≤ 65 years of age) with human immunodeficiency virus type-1 (HIV-1). Autologous lymphocytes from asymptomatic subjects will be transduced *ex vivo* with a retroviral vector, LNCs105, encoding the sFv105 antibody specific for the HIV-1 envelope protein. An identical aliquot will be simultaneously transduced with a control retroviral vector lacking the sFv105 cassette. Transduced cells will be reinfused into patients and the differential survival of both populations of CD4+ lymphocytes compared. The objective of the study is to determine whether the intracellular expression of a human single chain antibody against HIV-1 envelope glycoprotein gp160 that blocks gp160 processing and the production of infectious virions can safely prolong the survival of CD4(+) lymphocytes in HIV-1-infected subjects. (Protocol #9506-111)

Appendix D-101. Dr. Henry Dorkin of the New England Medical Center, Boston, Massachusetts, and Dr. Allen Lapey of Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts, propose to conduct gene transfer experiments on 16 subjects (≥ 18 years of age). An E1/partial E4-deleted, replication-deficient, type 2 adenovirus vector, AD2/CFTR-2, will be used to deliver the human cystic fibrosis transmembrane conductance regulator (CFTR) gene by aerosol administration (nebulization) to the lung of CF patients. Aerosol administration will be initiated only after initial safety data has been obtained from the lobar administration protocol (#9409-091). This is a single administration dose-escalation study in which subjects will receive between 8×10^6 and 2.5×10^{10} pfu. Subjects will be assessed for evidence of adverse, systemic, immune, inflammatory, or respiratory effects in response to AD2/CFTR-2. Subjects will be monitored for virus shedding and transgene expression. Health care workers present in the facility will be required to sign an Informed Consent document regarding the possibility of virus transmission. (Protocol #9412-074)

Appendix D-102. Drs. Charles J. Link and Donald Moorman of the Human Gene Therapy Research Institute, Des Moines, Iowa, may conduct gene transfer experiments on 24 female subjects (≥ 18 years of age) with refractory or recurrent ovarian cancer. Subjects will undergo intraperitoneal delivery (via Tenckhoff catheter) of the vector producing cells (VPC), PA317/LTKOSN.2. These VPC express the *Herpes simplex* virus thymidine kinase (HSV-TK) gene which confers sensitivity to killing by the antiviral drug, ganciclovir (GCV). The LTKOSN.2 retrovirus vector is based on the LXSIN backbone. Two weeks following intraperitoneal delivery of the VPC, subjects will receive 5 mg/kg intravenous GCV twice daily for 14 days. Subjects will receive between 1×10^5 and 1×10^8 VPC/kg in this dose escalation study. Subjects will be evaluated by X-ray and peritoneoscopy of the abdomen for evidence of clinical response. The objectives of this study are to determine the safety of intraperitoneal VPC administration. (Protocol #9503-100)

Appendix D-103. Dr. David T. Curiel of the University of Alabama, Birmingham, Alabama, may conduct gene transfer experiment of 15 subjects (≥ 18 years of age) with metastatic colorectal cancer. Subjects will receive intramuscular injection of the polynucleotide vaccine, pGT63, which is a plasmid DNA vector expressing carcinoembryonic antigen (CEA) and hepatitis B surface antigen (HBsAg). The objectives of the study are to: (1) characterize the immune response to CEA and HBsAg following a single intramuscular injection and following 3 consecutive intramuscular injections, and (2) determine the safety of intramuscular injection of the plasmid DNA vector at doses ranging between 0.1 to 1.0 milligrams (single dose) and 0.9 to 3.0 milligrams (total multidose). (Protocol #9506-073)

Appendix D-104. Dr. Chester B. Whitley of the University of Minnesota, Minneapolis, Minnesota, may conduct gene transfer experiments on two adult subjects (18 years of age or older) with mild Hunter syndrome (Mucopolysaccharidosis Type II). The autologous peripheral blood lymphocytes will be transduced *ex vivo* with the retroviral vector, L2SN, encoding the human cDNA for iduronate-2-sulfatase (IDS). The transduced lymphocytes will be reinfused into the patients on a monthly basis. The study will determine the frequency of peripheral blood lymphocyte transduction and the half-life of the infused cells. Evaluation of patients will include measurement of blood levels of IDS enzyme, assessment of metabolic correction by urinary glycosaminoglycan levels, clinical response of the disease, and monitoring for potential toxicity. This Phase I study is to demonstrate the safety of the L2SN-mediated gene therapy and to provide a preliminary evaluation of clinical efficacy. (Protocol #9409-087)

Appendix D-105. Drs. James Economou, John Gaspy, and William McBride of the University of California, Los Angeles, California, may conduct gene transfer experiments on 25 subjects (≥ 18 years of age) with metastatic melanoma. The protocol is an open label, Phase I trial to evaluate the safety and immunological effects of administering lethally irradiated allogeneic and autologous melanoma cells transduced with the retroviral vector, IL-7/HyTK, which encodes the gene for human interleukin-7 (IL-7). Subjects will receive 1×10^7 irradiated unmodified autologous tumor cells in combination with escalating doses of IL-7/HyTK transduced allogeneic melanoma cells (M24 cell line). The number of M24 cells administered will be adjusted based on the level of IL-7 expression. Subjects will receive 3 biweekly subcutaneous injections of M24 cells expressing 10, 100, or 1000 nanograms of IL-7/hour *in vivo*. A final cohort of 5 subjects will receive IL-7/HyTK transduced autologous cells. Subjects will be monitored for antitumor activity by skin tests, biopsy analysis, tumor-specific antibody activity, and cytotoxic T lymphocyte precursor evaluation. Non-immunologic parameters will also be monitored. (Protocol #9503-101)

Appendix D-106. Dr. Jack A. Roth, MD Anderson Cancer Center, may conduct gene transfer experiments on 42 subjects (≥ 18 years of age) with refractory non-small cell lung cancer (NSCLC). Subjects will receive direct intratumoral injection of a replication-defective type 5 adenovirus vector, AD5CMV-p53, to deliver the normal

human p53 tumor suppressor gene. The E1 region of AD5CMV-p53 has been replaced with a p53 expression cassette containing the human cytomegalovirus promoter (CMV). Subjects will be divided into 2 treatment groups: (1) 21 subjects will receive Ad5CMV-p53 alone, and (2) 21 subjects will receive Ad5CMV-p53 in combination with cisplatin. Following vector administration, subjects will be isolated for 96 hours during which time, assays will be conducted to demonstrate the lack of shedding of adenovirus vector. The objectives of this study are determine: (1) the maximum tolerated dose of AD5CMV-p53, (2) qualitative and quantitative toxicity related to vector administration, and (3) biologic activity.

Prior to administration, adenovirus vector stocks will be screened for p53 mutants using the SAOS osteosarcoma cell assay that was submitted by Dr. Roth on June 23, 1995. This biologic assay compares the activity of a standard stock of Adp53 vector to the activity of newly produced stocks. The standard stock of Adp53 will be defined as mediating cell death in 100% of SAOS cells (human osteosarcoma cell line with homozygous p53 deletion) at an MOI of 50:1 (titer > 5×10^{10}) on day 5 of culture. The sensitivity of the assay for detecting inactive (presumed mutant) Adp53 vector will be determined by adding increasing amounts of Adluc (control adenovirus vector containing the luciferase gene) to the Adp53 stock to determine the percentage of inactive vector required to decrease growth inhibition of SAOS cells mediated by Adp53. The test lot of Adp53 will be tested for its ability to inhibit SAOS in a 5 day assay. Significant loss of inhibitory activity compared with the standard would indicate an unacceptable level of inactive (presumed mutant) vector. (Protocol #9406-079)

Appendix D-107A. Dr. Gary Clayman, M.D. Anderson Cancer Center, Houston, Texas, may conduct gene transfer experiments on 21 subjects (≥ 18 years of age) with refractory squamous cell carcinoma of the head and neck. Subjects will receive direct intratumoral injection of a replication-defective type 5 adenovirus vector, AD5CMV-p53, to deliver the normal human p53 tumor suppressor gene. The E1 region of AD5CMV-p53 has been replaced with a p53 expression cassette containing the human cytomegalovirus promoter (CMV). Subjects will be divided into 2 treatment groups: (1) those with non-resectable tumors, and (2) those with surgically accessible tumors. Subjects will receive multiple injections of vector in each dose-escalation cohort. Following vector administration, subjects will be isolated for 48 hours during which time, assays will be conducted to demonstrate the lack of shedding of adenovirus vector. The objectives of the study are to determine: (1) the maximum tolerated dose of AD5CMV-p53, (2) qualitative and quantitative toxicity related to vector administration, and (3) biologic activity.

Prior to administration, adenovirus vector stocks will be screened for p53 mutants using the SAOS osteosarcoma cell assay that was submitted by Dr. Roth on June 23, 1995. This biologic assay compares the activity of a standard stock of Adp53 vector to the activity of newly produced stocks. The standard stock of Adp53 will be defined as mediating cell death in 100% of SAOS cells (human osteosarcoma cell line with homozygous p53 deletion) at an MOI of 50:1 (titer > 5×10^{10}) on day 5 of culture. The sensitivity of the assay for detecting inactive (presumed mutant) Adp53 vector will be determined by adding increasing amounts of Adluc to the Adp53 stock to determine the percentage of inactive vector required to decrease growth inhibition of SAOS cells mediated by Adp53. The test lot of Adp53 will be tested for its ability to inhibit SAOS in a 5 day assay. Significant loss of inhibitory activity compared with the standard would indicate an unacceptable level of inactive (presumed mutant) vector. (Protocol #9412-096)

Appendix D-107B. Drs. Bernard A. Fox and Walter J. Urba of Earle A. Chiles Research Institute, Providence Medical Center, Portland, Oregon, may conduct gene transfer experiments on 18 subjects (≥ 18 years of age) with metastatic renal cell carcinoma or melanoma. Autologous tumor cells will be surgically removed, transduced *in vitro* with the cationic liposome plasmid vector, VCL-1005, which encodes human leukocyte antigen (HLA)-B7 and beta-2 microglobulin. Subjects will receive subcutaneous injection of lethally irradiated transduced cells in one limb. The contralateral limb will be injected with lethally irradiated untransduced tumor cells in combination with Bacille Calmette-Guerin (BCG). Approximately 21 days following tumor cell injection, subjects will undergo lymphadenectomy for subsequent *in vitro* expansion of anti-CD3 activated lymphocytes. Activated lymphocytes will be adoptively transferred on approximately day 35 in combination with a 5-day course of interleukin-2 (IL-2). On approximately day 45, subjects will receive a second cycle of IL-2. The objectives of this study are to determine: (1) the safety of administering anti-CD3 activated antitumor effector T cells in draining lymph nodes, and (2) whether HLA-B7/ β -2 gene transfer augments the sensitization of anti-tumor effector T-cells in draining lymph nodes. (Protocol 9506-108)

Appendix D-108. Dr. Mitchell S. Steiner, University of Tennessee, Memphis, Tennessee, and Dr. Jeffrey T. Holt, Vanderbilt University School of Medicine, Nashville, Tennessee, may conduct gene transfer experiments on 15 male subjects (35 to 75 years of age) with metastatic prostate cancer. Malignant cells obtained from

advanced prostate cancer subjects have been demonstrated to express high levels of the protooncogene c-myc *in vivo*. The mouse mammary tumor virus (MMTV) long terminal repeat (LTR) is expressed at high levels in prostate tissue. Following removal of malignant cells via biopsy, subjects will receive a single transrectal ultrasound-guided intraprostate quadrant injection of the retrovirus vector, XM6:MMTV-antisense c-myc, for 4 consecutive days at the site of the original biopsy. The objectives of this Phase I study are to: (1) quantitatively assess the uptake and expression of XM6:MMTV-antisense c-myc by prostate cancer cells *in vivo*, (2) determine whether c-myc gene expression is prostate tumor-specific, (3) assess safety of intraprostate injection of XM6:MMTV-antisense c-myc, and (4) biologic efficacy (antisense inhibition of tumor growth). (Protocol #9509-123)

Appendix D-109. Drs. Ronald G. Crystal, Edward Hershowitz, and Michael Lieberman, New York Hospital-Cornell Medical Center, New York, New York, may conduct gene transfer experiments on 18 subjects (18 to 70 years of age) with metastatic colon carcinoma with liver metastases. In this Phase I dose-escalation study, subjects will receive computed tomography (CT)-guided intratumoral injections of the adenovirus vector, Ad_{gV}CD.10, into the same hepatic metastasis in 4 equal volumes (100 microliters), each with a separate entry into the liver. This dosage schedule will be performed on Days 1 and 7. 5-fluorocytosine (200 milligrams/kilogram/24 hours) will be administered orally in 4 equal doses starting on day 2 and continuing through the time of laparotomy. The objectives of this study are to: (1) determine the dose-dependent toxicity of direct administration of Ad_{gV}CD.10 to hepatic metastases combined with oral administration of 5-fluorocytosine, (2) quantitatively assess transfer and expression of the cytosine deaminase gene in target cells, and (3) determine the biologic effects of direct Ad_{gV}CD.10 administration to hepatic metastases. (Protocol #9509-125)

Appendix D-110. Drs. Andres Berchuck and H. Kim Lyerly of Duke University Medical Center, Durham, North Carolina, may conduct gene transfer experiments on 18 subjects (≥ 18 years of age) with refractory metastatic ovarian cancer. Autologous tumor cells obtained from ascites or surgically removed tumor will be transduced with the cationic liposome vector, PMP6A-IL2, that contains an adeno-associated virus derived plasmid DNA, a cytomegalovirus (CMV) promoter, and interleukin-2 (IL-2) complementary DNA (cDNA). In this dose-escalation study, subjects will undergo 4 cycles of intradermal injections (thigh or abdomen) of *ex vivo* transduced, lethally irradiated tumor cells in an attempt to induce an antitumor response. The objectives of the study are to evaluate: (1) the safety of intradermally injected transduced cells, and (2) antitumor response following therapy. (Protocol #9506-110)

Appendix D-111. Drs. Stephen L. Eck and Jane B. Alavi of the University of Pennsylvania Medical Center, Philadelphia, Pennsylvania, may conduct gene transfer experiments on 18 subjects (>18 years of age) with malignant glioma. The adenovirus vector encoding the *Herpes simplex virus thymidine kinase* (HSV-TK) gene, H5.020RSVTK, will be injected by a stereotactic guided technique into brain tumors. Afterwards, the patients will receive systemic ganciclovir (GCV) treatment. Patients eligible to undergo a palliative debulking procedure will receive the same treatment followed by resection on day 7, and a second dose of the vector intra-operatively. Brain tissues removed by resection will be analyzed for adenovirus infection, transgene expression, and signs of inflammation. The size and metabolic activity of tumors will be monitored by scanning with magnetic resonance imaging and positron emission tomography. The objective of the study is to evaluate the overall safety of this treatment and to gain insight into the parameters that may limit the general applicability of this approach. (Protocol #9409-089)

Appendix D-112. Drs. Robert Grossman and Savio Woo of the Baylor College of Medicine & Methodist Hospital, Houston, Texas, may conduct gene transfer experiments on 20 subjects (≥ 18 years of age) with refractive central nervous system malignancies. Subjects will receive stereotaxic injections of a replication-defective, type 5 E1/E3-deleted adenovirus vector, ADV/RSV-tk, to deliver the *Herpes simplex virus thymidine kinase* (HSV-TK) gene to tumor cells. Expression of the HSV-TK gene is driven by a Rous sarcoma virus long terminal repeat (RSV-LTR). Subjects will receive a single time-course of intravenous ganciclovir (GCV) (14 consecutive days) following vector administration. Following demonstration of safety with the initial starting dose of 1×10^8 particles in 5 subjects, additional cohorts will receive between 5×10^8 and 1.5×10^9 particles. Each cohort will be monitored for toxicity for one month before administration of the next higher dose to subsequent cohorts. Subjects will be monitored for evidence of clinical efficacy by magnetic resonance imaging and/or computer tomography scans. The primary objective of this Phase I study is to determine the safety of vector administration. (Protocol #9412-098)

Appendix D-113. Drs. Gabriel N. Hortobagyi, Gabriel Lopez-Berestein, and Mien-Chie Hung, of the University of Texas MD Anderson Cancer Center, Houston, Texas, may conduct gene transfer experiments on a maximum of 24 adult patients (12 for each cancer) with metastatic breast or ovarian carcinoma. Overexpression of the

HER-2/*neu* oncogene occurs in 30% of ovarian and breast cancers, and it is associated with enhanced metastatic potential, drug resistance, and poor survival. The E1A gene of the adenovirus type 5 functions as a tumor suppressor gene when transfected into cancer cells which overexpress the HER-2/*neu* oncogene. E1A expression induces down regulation of the level of the HER-2/*neu* oncoprotein by a transcriptional control mechanism. A plasmid, pE1A, encoding the adenovirus E1A gene with its own promoter will be administered as a DNA/lipid complex via the intraperitoneal or intrapleural route. The objectives of the study are: (1) to determine E1A gene transduction into malignant cells after the administration of E1A/lipid complex by intrapleural or intraperitoneal administration, (2) to determine whether E1A gene therapy can down-regulate HER-2/*neu* expression after intrapleural or intraperitoneal administration, (3) to determine the maximum biologically active dose (MBAD), or the maximum tolerated dose (MTD) of E1A/lipid complex, (4) to determine the toxicity and tolerance of E1A/lipid complex administered into the pleural or peritoneal space, and to assess the reversibility of such toxicity, and (5) to evaluate tumor response. (Protocol #9512-137)

Appendix D-114. Drs. Keith L. Black and Habib Fakhrai of the University of California, Los Angeles, California, may conduct gene transfer experiments on 12 subjects (≥ 18 years of age) with glioblastoma multiform. An Epstein-Barr virus (EBV) based plasmid vector, pCEP-4/TGF- $\beta 2$ antisense, encoding antisense RNA will be used to inhibit TGF- $\beta 2$ production. Tumor samples obtained from the patients at the time of clinically indicated surgery will be grown in culture to establish a cell line for each patient. The patients' tumor cells will be genetically altered with the pCEP-4/TGF- $\beta 2$ vector to inhibit their secretion of TGF- β . Following completion of the traditional post surgical radiation therapy, the first cohort of patients will receive, at 3 week intervals, 4 injections of 5×10^6 irradiated gene modified autologous tumor cells. Subsequently, in dose escalation studies, the second cohort will receive 1×10^7 cells, and the third cohort, 2×10^7 cells. The results of this Phase I trial will be used to assess the safety of this form of gene therapy and may provide preliminary data to evaluate the potential utility of TGF- $\beta 2$ antisense gene therapy in the management of gliomas. (Protocol #9512-138)

Appendix D-115. Dr. Ronald G. Crystal of New York Hospital-Cornell Medical Center, New York, New York, may conduct gene transfer experiments on a total of 21 (with an option for an additional 5) normal males and female subjects, age ≥ 18 years. Replication-deficient adenovirus (Ad) vector previously has been used in a number of human gene therapy strategies to transfer genes *in vivo* for therapeutic purposes. The purpose of this protocol is to characterize the local (skin), systemic (blood), and distant compartment (lung) immunity in normal individuals after intradermal administration of a replication deficient Ad5-based vector, named

Ad_{GV}CD.10, carrying the gene coding for the *E. coli* enzyme, cytosine deaminase (CD). Following intradermal administration of the vector to normal individuals, the skin, blood, and lung immune responses to the Ad vector and CD transgene will be evaluated over time. This vector has been safely administered intrahepatically ten times to five individuals with colon carcinoma. No adverse effects in Protocol #9509-125 have been observed. The present protocol will yield insights into normal human immune responses to both the Ad vector, as well as to a heterologous (i.e., non-human) gene product (CD). Note: This study is designed to answer basic biological questions regarding characterization of the immune responses to such vectors that have been previously documented. (Protocol #9701-171)

Appendix D-116. Dr. Daniel Rockey at Oregon State University and Dr. Walter Stamm at the University of Washington may conduct experiments to deliberately transfer a gene encoding tetracycline resistance from *Chlamydia suis* (a swine pathogen) into *C. trachomatis* (a human pathogen). This approval is specific to Drs. Rockey and Stamm and research with these resistant organisms may only occur under the conditions as specified by the NIH Director (72 FR 61661). This approval was effective as of September 24, 2007.

Appendix D-117. Dr. David Walker at the University of Texas Medical Branch may conduct experiments to deliberately introduce a gene encoding chloramphenicol resistance into *Rickettsia conorii*. This approval is specific to Dr. Walker and research with these resistant organisms may only occur under the conditions as specified by the NIH Director (73 FR 32719). This approval was effective as of April 7, 2008.

Appendix D-118. Dr. Harlan Caldwell at the Rocky Mountain Laboratories may conduct experiments to deliberately introduce a gene encoding tetracycline resistance into *Chlamydia trachomatis* serovar L2. This approval is specific to Dr. Caldwell and research with this resistant organism may only occur under the conditions as specified by the NIH Director (76 FR 27653). This approval was effective as of April 26, 2010.

APPENDIX E. CERTIFIED HOST-VECTOR SYSTEMS (See [Appendix I](#), Biological Containment)

While many experiments using *Escherichia coli* K-12, *Saccharomyces cerevisiae*, and *Bacillus subtilis* are currently exempt from the NIH Guidelines under [Section III-F, Exempt Experiments](#), some derivatives of these host-vector systems were previously classified as Host-Vector 1 Systems or Host-Vector 2 Systems. A listing of those systems follows:

Appendix E-I. *Bacillus subtilis***Appendix E-I-A. *Bacillus subtilis* Host-Vector 1 Systems**

The following plasmids are accepted as the vector components of certified *B. subtilis* systems: pUB110, pC194, pS194, pSA2100, pE194, pT127, pUB112, pC221, pC223, and pAB124. *B. subtilis* strains RUB 331 and BGSC 1S53 have been certified as the host component of Host-Vector 1 systems based on these plasmids.

Appendix E-I-B. *Bacillus subtilis* Host-Vector 2 Systems

The asporogenic mutant derivative of *Bacillus subtilis*, ASB 298, with the following plasmids as the vector component: pUB110, pC194, pS194, pSA2100, pE194, pT127, pUB112, pC221, pC223, and pAB124.

Appendix E-II. *Saccharomyces cerevisiae***Appendix E-II-A. *Saccharomyces cerevisiae* Host-Vector 2 Systems**

The following sterile strains of *Saccharomyces cerevisiae*, all of which have the ste-VC9 mutation, SHY1, SHY2, SHY3, and SHY4. The following plasmids are certified for use: Ylp1, YEp2, YEp4, Ylp5, YEp6, YRp7, YEp20, YEp21, YEp24, Ylp25, Ylp26, Ylp27, Ylp28, Ylp29, Ylp30, Ylp31, Ylp32, and Ylp33.

Appendix E-III. *Escherichia coli***Appendix E-III-A. *Escherichia coli* (EK2) Plasmid Systems**

The *Escherichia coli* K-12 strain chi-1776. The following plasmids are certified for use: pSC101, pMB9, pBR313, pBR322, pDH24, pBR325, pBR327, pGL101, and pHB1. The following *Escherichia coli*/S. *cerevisiae* hybrid plasmids are certified as EK2 vectors when used in *Escherichia coli* chi-1776 or in the sterile yeast strains, SHY1, SHY2, SHY3, and SHY4: Ylp1, YEp2, YEp4, Ylp5, YEp6, YRp7, YEp20, YEp21, YEp24, Ylp25, Ylp26, Ylp27, Ylp28, Ylp29, Ylp30, Ylp31, Ylp32, and Ylp33.

Appendix E-III-B. *Escherichia coli* (EK2) Bacteriophage Systems

The following are certified EK2 systems based on bacteriophage lambda:

| Vector | Host |
|---------------|------------------------------|
| λgt WESλB' | DP50 ^{supF} |
| λgt WESλB* | DP50 ^{supF} |
| λgt ZJ virλB' | <i>Escherichia coli</i> K-12 |
| λgtALO-λB | DP50 ^{supF} |
| Charon 3A | DP50 or DP50 ^{supF} |
| Charon 4A | DP50 or DP50 ^{supF} |
| Charon 16A | DP50 or DP50 ^{supF} |
| Charon 21A | DP50 ^{supF} |
| Charon 23A | DP50 or DP50 ^{supF} |
| Charon 24A | DP50 or DP50 ^{supF} |

Escherichia coli K-12 strains chi-2447 and chi-2281 are certified for use with lambda vectors that are certified for use with strain DP50 or DP50^{supF} provided that the *su*-strain not be used as a propagation host.

Appendix E-IV. *Neurospora crassa***Appendix E-IV-A. *Neurospora crassa* Host-Vector 1 Systems**

The following specified strains of *Neurospora crassa* which have been modified to prevent aerial dispersion:

In1 (inositol-less) strains 37102, 37401, 46316, 64001, and 89601. Csp-1 strain UCLA37 and csp-2 strains FS 590, UCLA101 (these are conidial separation mutants).

Eas strain UCLA191 (an "easily wettable" mutant).

Appendix E-V. *Streptomyces***Appendix E-V-A. *Streptomyces* Host-Vector 1 Systems**

The following *Streptomyces* species: *Streptomyces coelicolor*, *S. lividans*, *S. parvulus*, and *S. griseus*. The following are accepted as vector components of certified *Streptomyces* Host-Vector 1 systems: *Streptomyces* plasmids SCP2, SLP1.2, pJ101, actinophage phi C31, and their derivatives.

Appendix E-VI. *Pseudomonas putida***Appendix E-VI-A. *Pseudomonas putida* Host-Vector 1 Systems**

Pseudomonas putida strains KT2440 with plasmid vectors pKT262, pKT263, and pKT264.

APPENDIX F. CONTAINMENT CONDITIONS FOR CLONING OF GENES CODING FOR THE BIOSYNTHESIS OF MOLECULES TOXIC FOR VERTEBRATES**Appendix F-I. General Information**

Appendix F specifies the containment to be used for the deliberate cloning of genes coding for the biosynthesis of molecules toxic for vertebrates. The cloning of genes coding for molecules toxic for vertebrates that have an LD₅₀ of < 100 nanograms per kilograms body weight (e.g., microbial toxins such as the botulinum toxins, tetanus toxin, diphtheria toxin, *Shigella dysenteriae* neurotoxin) are covered under [Section III-B-1 \(Experiments Involving the Cloning of Toxin Molecules with LD₅₀ of Less than 100 Nanograms Per Kilogram Body Weight\)](#) and require Institutional Biosafety Committee and NIH/OBA approval before initiation. No specific restrictions shall apply to the cloning of genes if the protein specified by the gene has an LD₅₀ ≥ 100 micrograms per kilograms of body weight. Experiments involving genes coding for toxin molecules with an LD₅₀ of < 100 micrograms per kilograms and > 100 nanograms per kilograms body weight require Institutional Biosafety Committee approval and registration with NIH/OBA prior to initiating the experiments. A list of toxin molecules classified as to LD₅₀ is available from NIH/OBA. Testing procedures for determining toxicity of toxin molecules not on the list are available from the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax). The results of such tests shall be forwarded to NIH/OBA, which will consult with *ad hoc* experts, prior to inclusion of the molecules on the list (see [Section IV-C-1-b-\(2\)-\(c\), Minor Actions](#)).

Appendix F-II. Cloning of Toxin Molecule Genes in *Escherichia coli* K-12

Appendix F-II-A. Cloning of genes coding for molecules toxic for vertebrates that have an LD₅₀ of >100 nanograms per kilograms and <1000 nanograms per kilograms body weight (e.g., abrin, *Clostridium perfringens* epsilon toxin) may proceed under Biosafety Level (BL) 2 + EK2 or BL3 + EK1 containment conditions.

Appendix F-II-B. Cloning of genes for the biosynthesis of molecules toxic for vertebrates that have an LD₅₀ of >1 microgram per kilogram and <100 microgram per kilogram body weight may proceed under BL1 + EK1 containment conditions (e.g., *Staphylococcus aureus* alpha toxin, *Staphylococcus aureus* beta toxin, ricin, *Pseudomonas aeruginosa* exotoxin A, *Bordetella pertussis* toxin, the lethal factor of *Bacillus anthracis*, the *Pasteurella pestis* murine toxins, the oxygen-labile hemolysins such as streptolysin O, and certain neurotoxins

present in snake venoms and other venoms).

Appendix F-II-C. Some enterotoxins are substantially more toxic when administered enterally than parenterally. The following enterotoxins shall be subject to BL1 + EK1 containment conditions: cholera toxin, the heat labile toxins of *Escherichia coli*, *Klebsiella*, and other related proteins that may be identified by neutralization with an antiserum monospecific for cholera toxin, and the heat stable toxins of *Escherichia coli* and of *Yersinia enterocolitica*.

Appendix F-III. Cloning of Toxic Molecule Genes in Organisms Other Than *Escherichia coli* K-12

Requests involving the cloning of genes coding for toxin molecules for vertebrates at an LD₅₀ of <100 nanograms per kilogram body weight in host-vector systems other than *Escherichia coli* K-12 will be evaluated by NIH/OBA in consultation with *ad hoc* toxin experts (see [Sections III-B-1, Experiments Involving the Cloning of Toxin Molecules with LD₅₀ of Less than 100 Nanograms Per Kilogram Body Weight](#), and [IV-C-1-b-\(2\)-\(c\), Minor Actions](#)).

Appendix F-IV. Specific Approvals

An updated list of experiments involving the deliberate formation of recombinant or synthetic nucleic acid molecules containing genes coding for toxins lethal for vertebrates at an LD₅₀ of <100 nanograms per kilogram body weight is available from the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax).

APPENDIX G. PHYSICAL CONTAINMENT

Appendix G specifies physical containment for standard laboratory experiments and defines Biosafety Level 1 through Biosafety Level 4. For large-scale (over 10 liters) research or production, Appendix K (*Physical Containment for Large Scale Uses of Organisms Containing Recombinant or Synthetic Nucleic Acid Molecules*) supersedes Appendix G. [Appendix K](#) defines Good Large Scale Practice through Biosafety Level 3 - Large Scale. For certain work with plants, Appendix P (*Physical and Biological Containment for Recombinant or Synthetic Nucleic Acid Molecule Research Involving Plants*) supersedes Appendix G. [Appendix P](#) defines Biosafety Levels 1 through 4 - Plants. For certain work with animals, Appendix Q (*Physical and Biological Containment for Recombinant or Synthetic Nucleic Acid Molecule Research Involving Animals*) supersedes Appendix G. [Appendix Q](#) defines Biosafety Levels 1 through 4 - Animals.

Appendix G-I. Standard Practices and Training

The first principle of containment is strict adherence to good microbiological practices (see [Appendices G-III-A through G-III-J, Footnotes and References of Appendix G](#)). Consequently, all personnel directly or indirectly involved in experiments using recombinant or synthetic nucleic acid molecules shall receive adequate instruction (see [Sections IV-B-1-h, Responsibilities of the Institution--General Information](#), and [IV-B-7-d, Responsibilities of the Principal Investigator Prior to Initiating Research](#)). At a minimum, these instructions include training in aseptic techniques and in the biology of the organisms used in the experiments so that the potential biohazards can be understood and appreciated.

Any research group working with agents that are known or potential biohazards shall have an emergency plan that describes the procedures to be followed if an accident contaminates personnel or the environment. The Principal Investigator shall ensure that everyone in the laboratory is familiar with both the potential hazards of the work and the emergency plan (see [Sections IV-B-7-d, Responsibilities of the Principal Investigator Prior to Initiating Research](#) and [IV-B-7-e, Responsibilities of the Principal Investigator During the Conduct of the Research](#)). If a research group is working with a known pathogen for which there is an effective vaccine, the vaccine should be made available to all workers. Serological monitoring, when clearly appropriate, will be provided (see [Section IV-B-1-f, Responsibilities of the Institution--General Information](#)).

The *Laboratory Safety Monograph* (see [Appendix G-III-O, Footnotes and References of Appendix G](#)) and *Biosafety in Microbiological and Biomedical Laboratories* (see [Appendix G-III-A, Footnotes and References of Appendix G](#)) describe practices, equipment, and facilities in detail.

Appendix G-II. Physical Containment Levels

The objective of physical containment is to confine organisms containing recombinant or synthetic nucleic acid molecules and to reduce the potential for exposure of the laboratory worker, persons outside of the laboratory, and the environment to organisms containing recombinant or synthetic nucleic acid molecules. Physical containment is achieved through the use of laboratory practices, containment equipment, and special laboratory design. Emphasis is placed on primary means of physical containment which are provided by laboratory practices and containment equipment. Special laboratory design provides a secondary means of protection against the accidental release of organisms outside the laboratory or to the environment. Special laboratory design is used primarily in facilities in which experiments of moderate to high potential hazard are performed.

Combinations of laboratory practices, containment equipment, and special laboratory design can be made to achieve different levels of physical containment. Four levels of physical containment, which are designated as BL1, BL2, BL3, and BL4 are described. It should be emphasized that the descriptions and assignments of physical containment detailed below are based on existing approaches to containment of pathogenic organisms (see [Appendix G-III-A, Footnotes and References of Appendix G](#)). The National Cancer Institute describes three levels for research on oncogenic viruses which roughly correspond to our BL2, BL3, and BL4 levels (see [Appendix G-III-C, Footnotes and References of Appendix G](#)).

It is recognized that several different combinations of laboratory practices, containment equipment, and special laboratory design may be appropriate for containment of specific research activities. The *NIH Guidelines*, therefore, allow alternative selections of primary containment equipment within facilities that have been designed to provide BL3 and BL4 levels of physical containment. The selection of alternative methods of primary containment is dependent, however, on the level of biological containment provided by the host-vector system used in the experiment. Consideration will be given to other combinations which achieve an equivalent level of containment (see Sections [IV-C-1-b-\(1\), Major Actions](#) and [IV-C-1-b-\(2\), Minor Actions](#)).

Appendix G-II-A. Biosafety Level 1 (BL1) (See [Appendix G-III-M, Footnotes and References of Appendix G](#))

Appendix G-II-A-1. Standard Microbiological Practices (BL1)

Appendix G-II-A-1-a. Access to the laboratory is limited or restricted at the discretion of the Principal Investigator when experiments are in progress.

Appendix G-II-A-1-b. Work surfaces are decontaminated once a day and after any spill of viable material.

Appendix G-II-A-1-c. All contaminated liquid or solid wastes are decontaminated before disposal.

Appendix G-II-A-1-d. Mechanical pipetting devices are used; mouth pipetting is prohibited.

Appendix G-II-A-1-e. Eating, drinking, smoking, and applying cosmetics are not permitted in the work area. Food may be stored in cabinets or refrigerators designated and used for this purpose only.

Appendix G-II-A-1-f. Persons wash their hands: (i) after they handle materials involving organisms containing recombinant or synthetic nucleic acid molecules and animals, and (ii) before exiting the laboratory.

Appendix G-II-A-1-g. All procedures are performed carefully to minimize the creation of aerosols.

Appendix G-II-A-1-h. In the interest of good personal hygiene, facilities (e.g., hand washing sink, shower, changing room) and protective clothing (e.g., uniforms, laboratory coats) shall be provided that are appropriate for the risk of exposure to viable organisms containing recombinant or synthetic nucleic acid molecules.

Appendix G-II-A-2. Special Practices (BL1)

Appendix G-II-A-2-a. Contaminated materials that are to be decontaminated at a site away from the laboratory are placed in a durable leak-proof container which is closed before being removed from the laboratory.

Appendix G-II-A-2-b. An insect and rodent control program is in effect.

Appendix G-II-A-3. Containment Equipment (BL1)

Appendix G-II-A-3-a. Special containment equipment is generally not required for manipulations of agents assigned to BL1.

Appendix G-II-A-4. Laboratory Facilities (BL1)

Appendix G-II-A-4-a. The laboratory is designed so that it can be easily cleaned.

Appendix G-II-A-4-b. Bench tops are impervious to water and resistant to acids, alkalis, organic solvents, and moderate heat.

Appendix G-II-A-4-c. Laboratory furniture is sturdy. Spaces between benches, cabinets, and equipment are accessible for cleaning.

Appendix G-II-A-4-d. Each laboratory contains a sink for hand washing.

Appendix G-II-A-4-e. If the laboratory has windows that open, they are fitted with fly screens.

Appendix G-II-B. Biosafety Level 2 (BL2) (See [Appendix G-III-N](#), *Footnotes and References of Appendix G*)

Appendix G-II-B-1. Standard Microbiological Practices (BL2)

Appendix G-II-B-1-a. Access to the laboratory is limited or restricted by the Principal Investigator when work with organisms containing recombinant or synthetic nucleic acid molecules is in progress.

Appendix G-II-B-1-b. Work surfaces are decontaminated at least once a day and after any spill of viable material.

Appendix G-II-B-1-c. All contaminated liquid or solid wastes are decontaminated before disposal.

Appendix G-II-B-1-d. Mechanical pipetting devices are used; mouth pipetting is prohibited.

Appendix G-II-B-1-e. Eating, drinking, smoking, and applying cosmetics are not permitted in the work area. Food may be stored in cabinets or refrigerators designated and used for this purpose only.

Appendix G-II-B-1-f. Persons wash their hands: (i) after handling materials involving organisms containing recombinant or synthetic nucleic acid molecules and animals, and (ii) when exiting the laboratory.

Appendix G-II-B-1-g. All procedures are performed carefully to minimize the creation of aerosols.

Appendix G-II-B-1-h. Experiments of lesser biohazard potential can be conducted concurrently in carefully demarcated areas of the same laboratory.

Appendix G-II-B-2. Special Practices (BL2)

Appendix G-II-B-2-a. Contaminated materials that are to be decontaminated at a site away from the laboratory are placed in a durable leak-proof container which is closed before being removed from the laboratory.

Appendix G-II-B-2-b. The Principal Investigator limits access to the laboratory. The Principal Investigator has the final responsibility for assessing each circumstance and determining who may enter or work in the laboratory.

Appendix G-II-B-2-c. The Principal Investigator establishes policies and procedures whereby only persons who have been advised of the potential hazard and meet any specific entry requirements (e.g., immunization) may enter the laboratory or animal rooms.

Appendix G-II-B-2-d. When the organisms containing recombinant or synthetic nucleic acid molecules in use in the laboratory require special provisions for entry (e.g., vaccination), a hazard warning sign incorporating the universal biosafety symbol is posted on the access door to the laboratory work area. The hazard warning sign

identifies the agent, lists the name and telephone number of the Principal Investigator or other responsible person(s), and indicates the special requirement(s) for entering the laboratory.

Appendix G-II-B-2-e. An insect and rodent control program is in effect.

Appendix G-II-B-2-f. Laboratory coats, gowns, smocks, or uniforms are worn while in the laboratory. Before exiting the laboratory for non-laboratory areas (e.g., cafeteria, library, administrative offices), this protective clothing is removed and left in the laboratory or covered with a clean coat not used in the laboratory.

Appendix G-II-B-2-g. Animals not involved in the work being performed are not permitted in the laboratory.

Appendix G-II-B-2-h. Special care is taken to avoid skin contamination with organisms containing recombinant or synthetic nucleic acid molecules; gloves should be worn when handling experimental animals and when skin contact with the agent is unavoidable.

Appendix G-II-B-2-i. All wastes from laboratories and animal rooms are appropriately decontaminated before disposal.

Appendix G-II-B-2-j. Hypodermic needles and syringes are used only for parenteral injection and aspiration of fluids from laboratory animals and diaphragm bottles. Only needle-locking syringes or disposable syringe-needle units (i.e., needle is integral to the syringe) are used for the injection or aspiration of fluids containing organisms that contain recombinant or synthetic nucleic acid molecules. Extreme caution should be used when handling needles and syringes to avoid autoinoculation and the generation of aerosols during use and disposal. Needles should not be bent, sheared, replaced in the needle sheath or guard, or removed from the syringe following use. The needle and syringe should be promptly placed in a puncture-resistant container and decontaminated, preferably autoclaved, before discard or reuse.

Appendix G-II-B-2-k. Spills and accidents which result in overt exposures to organisms containing recombinant or synthetic nucleic acid molecules are immediately reported to the Institutional Biosafety Committee and NIH/OBA. Reports to NIH/OBA shall be sent to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax). Medical evaluation, surveillance, and treatment are provided as appropriate and written records are maintained.

Appendix G-II-B-2-l. When appropriate, considering the agent(s) handled, baseline serum samples for laboratory and other at-risk personnel are collected and stored. Additional serum specimens may be collected periodically depending on the agents handled or the function of the facility.

Appendix G-II-B-2-m. A biosafety manual is prepared or adopted. Personnel are advised of special hazards and are required to read and follow instructions on practices and procedures.

Appendix G-II-B-3. Containment Equipment (BL2)

Appendix G-II-B-3-a. Biological safety cabinets (Class I or II) (see [Appendix G-III-L, Footnotes and References of Appendix G](#)) or other appropriate personal protective or physical containment devices are used whenever:

Appendix G-II-B-3-a-(1). Procedures with a high potential for creating aerosols are conducted (see [Appendix G-III-O, Footnotes and References of Appendix G](#)). These may include centrifuging, grinding, blending, vigorous shaking or mixing, sonic disruption, opening containers of materials whose internal pressures may be different from ambient pressures, intranasal inoculation of animals, and harvesting infected tissues from animals or eggs.

Appendix G-II-B-3-a-(2). High concentrations or large volumes of organisms containing recombinant or synthetic nucleic acid molecules are used. Such materials may be centrifuged in the open laboratory if sealed beads or centrifuge safety cups are used and if they are opened only in a biological safety cabinet.

Appendix G-II-B-4. Laboratory Facilities (BL2)

Appendix G-II-B-4-a. The laboratory is designed so that it can be easily cleaned.

Appendix G-II-B-4-b. Bench tops are impervious to water and resistant to acids, alkalis, organic solvents, and moderate heat.

Appendix G-II-B-4-c. Laboratory furniture is sturdy and spaces between benches, cabinets, and equipment are accessible for cleaning.

Appendix G-II-B-4-d. Each laboratory contains a sink for hand washing.

Appendix G-II-B-4-e. If the laboratory has windows that open, they are fitted with fly screens.

Appendix G-II-B-4-f. An autoclave for decontaminating laboratory wastes is available.

Appendix G-II-C. Biosafety Level 3 (BL3) (See [Appendix G-III-P](#), *Footnotes and References of Appendix G*)

Appendix G-II-C-1. Standard Microbiological Practices (BL3)

Appendix G-II-C-1-a. Work surfaces are decontaminated at least once a day and after any spill of viable material.

Appendix G-II-C-1-b. All contaminated liquid or solid wastes are decontaminated before disposal.

Appendix G-II-C-1-c. Mechanical pipetting devices are used; mouth pipetting is prohibited.

Appendix G-II-C-1-d. Eating, drinking, smoking, storing food, and applying cosmetics are not permitted in the work area.

Appendix G-II-C-1-e. Persons wash their hands: (i) after handling materials involving organisms containing recombinant or synthetic nucleic acid molecules, and handling animals, and (ii) when exiting the laboratory.

Appendix G-II-C-1-f. All procedures are performed carefully to minimize the creation of aerosols.

Appendix G-II-C-1-g. Persons under 16 years of age shall not enter the laboratory.

Appendix G-II-C-1-h. If experiments involving other organisms which require lower levels of containment are to be conducted in the same laboratory concurrently with experiments requiring BL3 level physical containment, they shall be conducted in accordance with all BL3 level laboratory practices.

Appendix G-II-C-2. Special Practices (BL3)

Appendix G-II-C-2-a. Laboratory doors are kept closed when experiments are in progress.

Appendix G-II-C-2-b. Contaminated materials that are to be decontaminated at a site away from the laboratory are placed in a durable leak-proof container which is closed before being removed from the laboratory.

Appendix G-II-C-2-c. The Principal Investigator controls access to the laboratory and restricts access to persons whose presence is required for program or support purposes. The Principal Investigator has the final responsibility for assessing each circumstance and determining who may enter or work in the laboratory.

Appendix G-II-C-2-d. The Principal Investigator establishes policies and procedures whereby only persons who have been advised of the potential biohazard, who meet any specific entry requirements (e.g., immunization), and who comply with all entry and exit procedures entering the laboratory or animal rooms.

Appendix G-II-C-2-e. When organisms containing recombinant or synthetic nucleic acid molecules or experimental animals are present in the laboratory or containment module, a hazard warning sign incorporating the universal biosafety symbol is posted on all laboratory and animal room access doors. The hazard warning sign identifies the agent, lists the name and telephone number of the Principal Investigator or other responsible person(s), and indicates any special requirements for entering the laboratory such as the need for immunizations, respirators, or other personal protective measures.

Appendix G-II-C-2-f. All activities involving organisms containing recombinant or synthetic nucleic acid molecules are conducted in biological safety cabinets or other physical containment devices within the containment module. No work in open vessels is conducted on the open bench.

Appendix G-II-C-2-g. The work surfaces of biological safety cabinets and other containment equipment are decontaminated when work with organisms containing recombinant or synthetic nucleic acid molecules is finished. Plastic-backed paper toweling used on non-perforated work surfaces within biological safety cabinets facilitates clean-up.

Appendix G-II-C-2-h. An insect and rodent program is in effect.

Appendix G-II-C-2-i. Laboratory clothing that protects street clothing (e.g., solid front or wrap-around gowns, scrub suits, coveralls) is worn in the laboratory. Laboratory clothing is not worn outside the laboratory, and it is decontaminated prior to laundering or disposal.

Appendix G-II-C-2-j. Special care is taken to avoid skin contamination with contaminated materials; gloves should be worn when handling infected animals and when skin contact with infectious materials is unavoidable.

Appendix G-II-C-2-k. Molded surgical masks or respirators are worn in rooms containing experimental animals.

Appendix G-II-C-2-l. Animals and plants not related to the work being conducted are not permitted in the laboratory.

Appendix G-II-C-2-m. Laboratory animals held in a BL3 area shall be housed in partial-containment caging systems, such as Horsfall units (see [Appendix G-III-K](#), *Footnotes and References of Appendix G*), open cages placed in ventilated enclosures, solid-wall and -bottom cages covered by filter bonnets or solid-wall and -bottom cages placed on holding racks equipped with ultraviolet in radiation lamps and reflectors.

Note: Conventional caging systems may be used provided that all personnel wear appropriate personal protective devices. These protective devices shall include at a minimum wrap-around gowns, head covers, gloves, shoe covers, and respirators. All personnel shall shower on exit from areas where these devices are required.

Appendix G-II-C-2-n. All wastes from laboratories and animal rooms are appropriately decontaminated before disposal. For research involving mammalian-transmissible HPAI H5N1 virus, liquid effluents should be chemically disinfected or heat-treated, or collected and processed in a central effluent decontamination system. Decontamination of shower and toilet effluents is not required, provided appropriate practices and procedures are in place for primary containment of mammalian-transmissible HPAI H5N1 virus. Animal tissues, carcasses, and bedding originating from the animal room must be decontaminated by an effective and validated method (e.g., use of an autoclave) preferably before leaving the containment barrier. If waste must be transported, special practices should be developed for transport of infectious materials to designated alternate location(s) within the facility.

Appendix G-II-C-2-o. Vacuum lines are protected with high efficiency particulate air/HEPA filters and liquid disinfectant traps.

Appendix G-II-C-2-p. Hypodermic needles and syringes are used only for parenteral injection and aspiration of fluids from laboratory animals and diaphragm bottles. Only needle locking syringes or disposable syringe-needle units (i.e., needle is integral to the syringe) are used for the injection or aspiration of fluids containing organisms that contain recombinant or synthetic nucleic acid molecules. Extreme caution should be used when handling needles and syringes to avoid autoinoculation and the generation of aerosols during use and disposal. Needles should not be bent, sheared, replaced in the needle sheath or guard, or removed from the syringe following use. The needle and syringe should be promptly placed in a puncture-resistant container and decontaminated, preferably by autoclaving, before discard or reuse.

Appendix G-II-C-2-q. Spills and accidents which result in overt or potential exposures to organisms containing recombinant or synthetic nucleic acid molecules are immediately reported to the Biological Safety Officer, Institutional Biosafety Committee, and NIH/OBA. Reports to NIH/OBA shall be sent to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda,

MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax). Appropriate medical evaluation, surveillance, and treatment are provided and written records are maintained.

Appendix G-II-C-2-r. Baseline serum samples for all laboratory and other at-risk personnel should be collected and stored in accordance with institutional policy and at least for the time period in which the personnel continues to work with the agent at biosafety level 3 containment. Such samples must be collected and stored for laboratory and other at-risk personnel who will work with mammalian-transmissible HPAI H5N1 virus. Additional serum specimens may be collected periodically depending on the agents handled or the function of the laboratory.

Appendix G-II-C-2-s. A biosafety manual is prepared or adopted. Personnel are advised of special hazards and are required to read and follow the instructions on practices and procedures.

Appendix G-II-C-2-t. Alternative Selection of Containment Equipment (BL3)

Experimental procedures involving a host-vector system that provides a one-step higher level of biological containment than that specified may be conducted in the BL3 laboratory using containment equipment specified for the BL2 level of physical containment. Experimental procedures involving a host-vector system that provides a one-step lower level of biological containment than that specified may be conducted in the BL3 laboratory using containment equipment specified for the BL4 level of physical containment. Alternative combination of containment safeguards are shown in [Appendix G-Table 1, Possible Alternate Combinations of Physical and Biological Containment Safeguards](#).

Appendix G-II-C-3. Containment Equipment (BL3)

Appendix G-II-C-3-a. Biological safety cabinets (Class I, II, or III) (see [Appendix G-III-L, Footnotes and References of Appendix G](#)) or other appropriate combinations of personal protective or physical containment devices (e.g., special protective clothing, masks, gloves, respirators, centrifuge safety cups, sealed centrifuge rotors, and containment caging for animals) are used for all activities with organisms containing recombinant or synthetic nucleic acid molecules which pose a threat of aerosol exposure. These include: manipulation of cultures and of those clinical or environmental materials which may be a source of aerosols; the aerosol challenge of experimental animals; the harvesting of infected tissues or fluids from experimental animals and embryonate eggs; and the necropsy of experimental animals.

Appendix G-II-C-4. Laboratory Facilities (BL3)

Appendix G-II-C-4-a. The laboratory is separated from areas which are open to unrestricted traffic flow within the building. Passage through two sets of doors is the basic requirement for entry into the laboratory from access corridors or other contiguous areas. Physical separation of the high containment laboratory from access corridors or other laboratories or activities may be provided by a double-door clothes change room (showers may be included), airlock, or other access facility which requires passage through two sets of doors before entering the laboratory.

Appendix G-II-C-4-b. The interior surfaces of walls, floors, and ceilings are water resistant so that they can be easily cleaned. Penetrations in these surfaces are sealed or capable of being sealed to facilitate decontaminating the area.

Appendix G-II-C-4-c. Bench tops are impervious to water and resistant to acids, alkalis, organic solvents, and moderate heat.

Appendix G-II-C-4-d. Laboratory furniture is sturdy and spaces between benches, cabinets, and equipment are accessible for cleaning.

Appendix G-II-C-4-e. Each laboratory contains a sink for hand washing. The sink is foot, elbow, or automatically operated and is located near the laboratory exit door.

Appendix G-II-C-4-f. Windows in the laboratory are closed and sealed.

Appendix G-II-C-4-g. Access doors to the laboratory or containment module are self-closing.

Appendix G-II-C-4-h. An autoclave for decontaminating laboratory wastes is available preferably within the laboratory.

Appendix G-II-C-4-i. A ducted exhaust air ventilation system is provided. This system creates directional airflow that draws air into the laboratory from uncontaminated spaces surrounding the laboratory. The exhaust air is not recirculated to any other area of the building, is discharged to the outside, and is dispersed away from the occupied areas and air intakes. Personnel shall verify that the direction of the airflow (into the laboratory) is proper. The exhaust air from the laboratory room may be discharged to the outside without being filtered or otherwise treated unless research is being conducted with mammalian-transmissible HPAI H5N1 virus. For research with mammalian-transmissible HPAI H5N1 virus, exhaust air must be HEPA filtered and there must be sealed ductwork from the containment barrier to the filter. In addition, the air handling system shall be designed such that under failure conditions, the airflow will not be reversed and periodic verification, with annual verification of the HEPA filters, shall be performed. Finally, backup power shall be available for critical controls and instrumentation necessary to maintain containment.

Appendix G-II-C-4-j. The high efficiency particulate air/HEPA filtered exhaust air from Class I or Class II biological safety cabinets is discharged directly to the outside or through the building exhaust system. Exhaust air from Class I or II biological safety cabinets may be recirculated within the laboratory if the cabinet is tested and certified at least every twelve months. If the HEPA-filtered exhaust air from Class I or II biological safety cabinets is to be discharged to the outside through the building exhaust air system, it is connected to this system in a manner (e.g., thimble unit connection (see [Appendix G-III-L, Footnotes and References of Appendix G](#))) that avoids any interference with the air balance of the cabinets or building exhaust system.

Appendix G-II-C-5. Biosafety Level 3 Enhanced for Research Involving Risk Group 3 Influenza Viruses. (See Appendices G-II-C-2-n, G-II-C-2-r, and G-II-C-4-i for additional guidance for facilities, waste handling, and serum collection for research involving mammalian-transmissible HPAI H5N1 virus.

Appendix G-II-C-5-a. Containment, Practices, and Training for Research with Risk Group 3 Influenza Viruses (BL3 Enhanced).

Appendix G-II-C-5-a-(1). In addition to standard BL3 practices, the following additional personal protective equipment and practices shall be used: (1) Powered Air-purifying Respirators (PAPR) are worn. (2) Street clothes are changed to protective suit (e.g., wrap-back disposable gown, olefin protective suit). (3) Double gloves (disposable) are worn. For research with mammalian-transmissible HPAI H5N1 viruses, protective sleeves shall be worn over the gown while working in a biosafety cabinet. (4) Appropriate shoe coverings are worn (e.g., double disposable shoe coverings, single disposable shoe coverings if worn with footwear dedicated to BL3 enhanced laboratory use, or impervious boots or shoes of rubber or other suitable material that can be decontaminated). (5) Showers prior to exiting the laboratory should be considered depending on risk assessment of research activities, with the exception that showers prior to exiting the laboratory are required for all research with mammalian-transmissible HPAI H5N1 virus, including care of animals infected with mammalian-transmissible HPAI H5N1 virus. (6) For research with mammalian-transmissible HPAI H5N1 virus, prior to leaving containment, personal protective equipment shall be sprayed or wiped down with a disinfectant that has activity against influenza viruses. (7) In order to promote adherence to proper practices, including proper removal of personal protective equipment, and reporting of any loss of containment or exposures, at least two individuals should be in the laboratory at all times when research with mammalian-transmissible HPAI H5N1 virus involves experimental procedures with animals or sharps, or when procedures are being conducted whereby the generation of aerosols is reasonably anticipated. Removal of personal protective equipment should be observed.

Appendix G-II-C-5-a-(2). As proper training of laboratory workers is an essential component of biosafety, retraining and periodic reassessments (at least annually) in BL3 enhanced practices, especially the proper use of respiratory equipment, such as PAPRs, and clothing changes are required. For research with mammalian-transmissible HPAI H5N1 virus, laboratory workers shall be required to sign a document acknowledging their understanding of and intent to adhere to biosafety, biosecurity, and occupational health requirements. This document shall include a statement that the laboratory worker agrees to report any exposures or accidents, including those by other individuals in the lab.

Appendix G-II-C-5-a-(3). Reporting of all spills and accidents, even if relatively minor, is required as described in Appendix G-II-C-2-q.

Appendix G-II-C-5-a-(4). To avoid inadvertent cross contamination of 1918 H1N1, HPAI H5N1 or human H2N2 (1957-1968): (1) Containment facilities and practices appropriate for highest Risk Group virus shall be used at all times with lower Risk Group viruses, when studied in the same laboratory room. (2) Tissue cultures with these viruses shall be conducted at separate times (temporal spacing) in the same room. (3) Separate reagents shall be used to minimize risk of cross contamination. (4) A laboratory worker shall not perform concurrent influenza virus experiments that carry the risk of unintended reassortment among 1918 H1N1, human H2N2 (1957-1968), HPAI H5N1 and other human influenza viruses. (5) Two or more laboratory workers shall not perform within the same work area simultaneous influenza virus experiments that carry the risk of unintended segment reassortment between 1918 H1N1, or HPAI H5N1, or human H2N2 (1957-1968) and other human influenza viruses. (6) Between experiments good biosafety decontamination practices (e.g., surface and biosafety cabinet surface decontamination according to standard BL3 procedures) shall be used and there shall be a thirty minute wait period after decontamination before equipment is used for experiments with any other influenza A viruses. (7) Between experiments, in addition to decontamination of the work area, clothing changes and PAPR disinfection shall be performed prior to handling a different influenza virus in the same work area. (Shower-out capability may be required by [USDA/APHIS](#) for certain experiments with HPAI H5N1.)

Appendix G-II-C-5-a-(5). Continued susceptibility of the reassortant influenza viruses containing genes and/or segments from 1918 H1N1, HPAI H5N1, and human H2N2 (1957-1968) to antiviral agents shall be established by sequence analysis or suitable biological assays. After manipulation of genes that influence sensitivity to antiviral agents, susceptibility to these agents shall be reconfirmed. If susceptibility to neuraminidase inhibitors or other effective antiviral agents is lost as a result of genetic modification or serial passage of a mammalian-transmissible HPAI H5N1 virus, then any research with this antiviral agent resistant virus shall be stopped and research shall only proceed after review by the NIH (as outlined in [Section III-A-I-a](#)) or the appropriate federal regulatory agency.

Appendix G-II-C-5-b. Containment for Animal Research.

Guidance provided in [Appendix G-II-C](#) and [Appendix Q-II-C](#) is applicable with the following emphasis on standard BL3 or BL3-N containment or additional enhancements.

Appendix G-II-C-5-b-(1). Research with small animals shall be conducted in a class II biosafety cabinet. Small animals such as rodents (e.g. mice, hamsters, rats, guinea pigs) can be housed within a negative pressure BL3 animal suite using high-density individually vented caging (IVC) systems that independently supply high efficiency particulate air/HEPA-filtered and directional air circulation. Other animals (e.g. rabbits, ferrets) that are of a size or have growth or caging requirements that preclude the use of high-density IVC systems are to be housed in negative pressure bioisolators.

Appendix G-II-C-5-b-(2). Large animals such as non-human primates shall be housed in primary barrier environments according to BL3-N containment requirements (see [Appendix Q-II-C](#)).

Appendix G-II-C-5-b-(3). Specialized training and proven competency in all assigned practices and procedures shall be required for laboratory staff, including staff involved in animal care.

Appendix G-II-C-5-b-(4). For HPAI H5N1 research, the *NIH Guidelines* defer to [USDA/APHIS](#) recommendations for biocontainment practices for loose housed animals.

Appendix G-II-C-5-c. Occupational Health

A detailed occupational health plan shall be developed in advance of working with these agents in consultation, as needed, with individuals with the appropriate clinical expertise. In addition, the appropriate public health authority shall be consulted (e.g. local public health officials) on the plan and a mock drill of this plan shall be undertaken periodically. The plan shall include a description of the incident reporting system in place for incidents, which include any loss of containment, spills, accidents, or potential exposures. The plan must specify that all incidents must be reported immediately to the appropriate institutional authorities, and no later than 24 hours to the appropriate public health authorities (e.g., the [USDA](#), the [CDC](#), [NIH](#), local and state health authorities).

Appendix G-II-C-5-c-(1). Laboratory workers shall be provided with medical cards which include, at a minimum, the following information: characterization of the influenza virus to which they have been potentially exposed, and 24-hour contact numbers for the Principal Investigator and institution's occupational health care provider(s).

Appendix G-II-C-5-c-(2). A detailed occupational health plan shall include: (1) Unless there is a medical contraindication to vaccination (e.g. severe egg allergy) annual seasonal influenza vaccination as prerequisite for research to reduce risk of influenza like illness that would require isolation and testing to rule out infection with experimental viruses and raise the risk for possible co-infection with circulating influenza strains. (2) Virus specific vaccination, if available, should be offered and if a licensed HPAI H5N1 vaccine is available, and there are no medical contraindications, laboratory workers performing research with mammalian-transmissible HPAI H5N1 virus should be vaccinated. A post-vaccination serum sample shall be collected, assessed for immune response, and stored in accordance with institutional policy, at least for the time in which the laboratory worker continues to conduct HPAI H5N1 virus research. (3) Reporting of all respiratory symptoms and/or fever (i.e. influenza-like illnesses). For research involving mammalian-transmissible HPAI H5N1 virus, laboratory workers shall be actively monitored for influenza-like illness (i.e., fever and respiratory symptoms). (4) 24-hour access to a medical facility that is prepared to implement appropriate respiratory isolation to prevent transmission and is able to provide appropriate antiviral agents. Real-time reverse transcription-polymerase chain reaction (RT-PCR) assays should be used for virus detection and to discriminate these viruses from currently circulating human influenza viruses. For exposures to viruses containing genes from 1918 H1N1 or the HA gene from human H2N2 (1957-1968), specimens shall be sent to the CDC for testing (RT-PCR and confirmatory sequencing).

Appendix G-II-C-5-c-(3). In preparing to perform research with 1918 H1N1, human H2N2 (1957-1968), or HPAI H5N1, Principal Investigators should develop a clear plan specifying who will be contacted in the event of a potential exposure (during and after work hours) to conduct a risk assessment and make decisions as to the required response, including the need for and extent of isolation of the exposed worker. After any kind of potential exposure, a rapid risk assessment shall be performed by the Principal Investigator, health and biosafety officials and subsequent actions should depend on the appraised level of risk of respiratory infection for the individual and potential for transmission to others. A laboratory worker performing research with either an influenza virus containing the HA gene from human H2N2 or an influenza virus containing genes and/or segments from 1918 H1N1 or mammalian-transmissible HPAI H5N1 viruses, shall be informed in advance that, in the case of a *known* laboratory exposure with a high risk for infection, e.g., involving the upper or lower respiratory tract or mucous membranes, the laboratory worker will need to be isolated in a predetermined facility, rather than home isolation, until infection can be ruled out by testing (e.g., negative RT-PCR for 1918 H1N1 or human H2N2 (1957-1968), or HPAI H5N1) of appropriately timed specimens. Laboratory workers with a known laboratory exposure with high risk for infection during research with HPAI H5N1 virus strains that are not transmissible among mammals should be prepared to self-isolate (for example at home) until infection can be ruled out by testing (e.g., negative RT-PCR for HPAI H5N1) of appropriately timed specimens. The action taken for other types of exposures should be based on the risk assessment. In addition, based on the risk assessment: (1) treatment with appropriate antiviral agents shall be initiated, and (2) the appropriate public health authorities shall be notified.

Appendix G-II-C-5-c-(4). Influenza-like illness. If an individual has entered (within ten days) a laboratory conducting research with influenza viruses containing the human H2N2 HA gene or any gene from the 1918 H1N1 or HPAI H5N1 viruses, or housing animals exposed to such viruses, and the individual demonstrates symptoms and/or signs of influenza infection (e.g., fever/chills, cough, myalgias, headache), then he/she shall report by phone to the supervisor/Principal Investigator and other individuals identified in the occupational health plan. If needed, the person with influenza-like illness shall be transported, under the appropriate isolation conditions, to a healthcare facility that can provide adequate respiratory isolation, appropriate medical therapy, and testing to determine whether the infection is due to a recombinant or synthetic influenza virus. The appropriate public health authorities shall be informed whenever a suspected case is isolated.

Appendix G-II-C-5-c-(5). For 1918 H1N1 research, the use of antiviral agents (e.g., oseltamivir) for pre-exposure prophylaxis shall be discussed with laboratory workers in advance including a discussion of the data on the safety of long term exposure to these agents and their ability to reduce the risk of clinical disease and the limits of the data regarding protection of close contacts and the community.

Appendix G-II-C-5-c-(6). Antiviral agents for postexposure prophylaxis shall be provided only after medical evaluation. Home supplies shall not be provided in advance for research with 1918 H1N1, mammalian-transmissible HPAI H5N1 or influenza viruses containing the HA gene from human H2N2.

Appendix G-II-D. Biosafety Level 4 (BL4)

Appendix G-II-D-1. Standard Microbiological Practices (BL4)

Appendix G-II-D-1-a. Work surfaces are decontaminated at least once a day and immediately after any spill of viable material.

Appendix G-II-D-1-b. Only mechanical pipetting devices are used.

Appendix G-II-D-1-c. Eating, drinking, smoking, storing food, and applying cosmetics are not permitted in the laboratory.

Appendix G-II-D-1-d. All procedures are performed carefully to minimize the creation of aerosols.

Appendix G-II-D-2. Special Practices (BL4)

Appendix G-II-D-2-a. Biological materials to be removed from the Class III cabinets or from the maximum containment laboratory in a viable or intact state are transferred to a non-breakable, sealed primary container and then enclosed in a non-breakable, sealed secondary container which is removed from the facility through a disinfectant dunk tank, fumigation chamber, or an airlock designed for this purpose.

Appendix G-II-D-2-b. No materials, except for biological materials that are to remain in a viable or intact state, are removed from the maximum containment laboratory unless they have been autoclaved or decontaminated before exiting the facility. Equipment or material which might be damaged by high temperatures or steam is decontaminated by gaseous or vapor methods in an airlock or chamber designed for this purpose.

Appendix G-II-D-2-c. Only persons whose presence in the facility or individual laboratory rooms is required for program or support purposes are authorized to enter. The supervisor has the final responsibility for assessing each circumstance and determining who may enter or work in the laboratory. Access to the facility is limited by means of secure, locked doors; accessibility is managed by the Principal Investigator, Biological Safety Officer, or other person responsible for the physical security of the facility. Before entering, persons are advised of the potential biohazards and instructed as to appropriate safeguards for ensuring their safety. Authorized persons comply with the instructions and all other applicable entry and exit procedures. A logbook signed by all personnel indicates the date and time of each entry and exit. Practical and effective protocols for emergency situations are established.

Appendix G-II-D-2-d. Personnel enter and exit the facility only through the clothing change and shower rooms. Personnel shower each time they exit the facility. Personnel use the air locks to enter or exit the laboratory only in an emergency.

Appendix G-II-D-2-e. Street clothing is removed in the outer clothing change room and kept there. Complete laboratory clothing (may be disposable), including undergarments, pants and shirts or jump suits, shoes, and gloves, is provided and used by all personnel entering the facility. Head covers are provided for personnel who do not wash their hair during the exit shower. When exiting the laboratory and before proceeding into the shower area, personnel remove their laboratory clothing and store it in a locker or hamper in the inner change room. Protective clothing shall be decontaminated prior to laundering or disposal.

Appendix G-II-D-2-f. When materials that contain organisms containing recombinant or synthetic nucleic acid molecules or experimental animals are present in the laboratory or animal rooms, a hazard warning sign incorporating the universal biosafety symbol is posted on all access doors. The sign identifies the agent, lists the name of the Principal Investigator or other responsible person(s), and indicates any special requirements for entering the area (e.g., the need for immunizations or respirators).

Appendix G-II-D-2-g. Supplies and materials needed in the facility are brought in by way of the double-doored autoclave, fumigation chamber, or airlock which is appropriately decontaminated between each use. After securing the outer doors, personnel within the facility retrieve the materials by opening the interior doors or the autoclave, fumigation chamber, or airlock. These doors are secured after materials are brought into the facility.

Appendix G-II-D-2-h. An insect and rodent control program is in effect.

Appendix G-II-D-2-i. Materials (e.g., plants, animals, and clothing) not related to the experiment being conducted are not permitted in the facility.

Appendix G-II-D-2-j. Hypodermic needles and syringes are used only for parenteral injection and aspiration of fluids from laboratory animals and diaphragm bottles. Only needle-locking syringes or disposable syringe-needle units (i.e., needle is integral part of unit) are used for the injection or aspiration of fluids containing organisms that contain recombinant or synthetic nucleic acid molecules. Needles should not be bent, sheared, replaced in the needle sheath or guard, or removed from the syringe following use. The needle and syringe should be placed in a puncture-resistant container and decontaminated, preferably by autoclaving before discard or reuse. Whenever possible, cannulas are used instead of sharp needles (e.g., gavage).

Appendix G-II-D-2-k. A system is set up for reporting laboratory accidents, exposures, employee absenteeism, and for the medical surveillance of potential laboratory-associated illnesses. Spills and accidents which result in overt exposures to organisms containing recombinant or synthetic nucleic acid molecules are immediately reported to the Biological Safety Officer, Institutional Biosafety Committee, and NIH/OBA. Reports to the NIH/OBA shall be sent to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax). Written records are prepared and maintained. An essential adjunct to such a reporting-surveillance system is the availability of a facility for quarantine, isolation, and medical care of personnel with potential or known laboratory associated illnesses.

Appendix G-II-D-2-l. Laboratory animals involved in experiments requiring BL4 level physical containment shall be housed either in cages contained in Class III cabinets or in partial containment caging systems, such as Horsfall units (see [Appendix G-III-K](#), *Footnotes and References of Appendix G*), open cages placed in ventilated enclosures, or solid-wall and -bottom cages placed on holding racks equipped with ultraviolet irradiation lamps and reflectors that are located in a specially designed area in which all personnel are required to wear one-piece positive pressure suits.

Appendix G-II-D-2-m. Alternative Selection of Containment Equipment (BL4)

Experimental procedures involving a host-vector system that provides a one-step higher level of biological containment than that specified may be conducted in the BL4 facility using containment equipment requirements specified for the BL3 level of physical containment. Alternative combinations of containment safeguards are shown in Appendix G-Table 1, *Possible Alternate Combinations of Physical and Biological Containment Safeguards*.

Appendix G-II-D-3. Containment Equipment (BL4)

Appendix G-II-D-3-a. All procedures within the facility with agents assigned to Biosafety Level 4 are conducted in the Class III biological safety cabinet or in Class I or II biological safety cabinets used in conjunction with one-piece positive pressure personnel suits ventilated by a life-support system.

Appendix G-II-D-4. Laboratory Facilities (BL4)

Appendix G-II-D-4-a. The maximum containment facility consists of either a separate building or a clearly demarcated and isolated zone within a building. Outer and inner change rooms separated by a shower are provided for personnel entering and exiting the facility. A double-doored autoclave, fumigation chamber, or ventilated airlock is provided for passage of those materials, supplies, or equipment which are not brought into the facility through the change room.

Appendix G-II-D-4-b. Walls, floors, and ceilings of the facility are constructed to form a sealed internal shell which facilitates fumigation and is animal and insect proof. The internal surfaces of this shell are resistant to liquids and chemicals, thus facilitating cleaning and decontamination of the area. All penetrations in these structures and surfaces are sealed. Any drains in the floors contain traps filled with a chemical disinfectant of demonstrated efficacy against the target agent, and they are connected directly to the liquid waste decontamination system. Sewer and other ventilation lines contain high efficiency particulate air/HEPA filters.

Appendix G-II-D-4-c. Internal facility appurtenances, such as light fixtures, air ducts, and utility pipes, are arranged to minimize the horizontal surface area on which dust can settle.

Appendix G-II-D-4-d. Bench tops have seamless surfaces which are impervious to water and resistant to acids, alkalis, organic solvents, and moderate heat.

Appendix G-II-D-4-e. Laboratory furniture is simple and of sturdy construction; and spaces between benches, cabinets, and equipment are accessible for cleaning.

Appendix G-II-D-4-f. A foot, elbow, or automatically operated hand washing sink is provided near the door of each laboratory room in the facility.

Appendix G-II-D-4-g. If there is a central vacuum system, it does not serve areas outside the facility. In-line high efficiency particulate air/HEPA filters are placed as near as practicable to each use point or service cock. Filters are installed to permit in-place decontamination and replacement. Other liquid and gas services to the facility are protected by devices that prevent back-flow.

Appendix G-II-D-4-h. If water fountains are provided, they are foot operated and are located in the facility corridors outside the laboratory. The water service to the fountain is not connected to the back-flow protected distribution system supplying water to the laboratory areas.

Appendix G-II-D-4-i. Access doors to the laboratory are self-closing and locking.

Appendix G-II-D-4-j. Any windows are breakage resistant.

Appendix G-II-D-4-k. A double-door autoclave is provided for decontaminating materials passing out of the facility. The autoclave door which opens to the area external to the facility is sealed to the outer wall and automatically controlled so that the outside door can only be opened after the autoclave "sterilization" cycle has been completed.

Appendix G-II-D-4-l. A pass-through dunk tank, fumigation chamber, or an equivalent decontamination method is provided so that materials and equipment that cannot be decontaminated in the autoclave can be safely removed from the facility.

Appendix G-II-D-4-m. Liquid effluent from laboratory sinks, biological safety cabinets, floors, and autoclave chambers are decontaminated by heat treatment before being released from the maximum containment facility. Liquid wastes from shower rooms and toilets may be decontaminated with chemical disinfectants or by heat in the liquid waste decontamination system. The procedure used for heat decontamination of liquid wastes is evaluated mechanically and biologically by using a recording thermometer and an indicator microorganism with a defined heat susceptibility pattern. If liquid wastes from the shower room are decontaminated with chemical disinfectants, the chemical used is of demonstrated efficacy against the target or indicator microorganisms.

Appendix G-II-D-4-n. An individual supply and exhaust air ventilation system is provided. The system maintains pressure differentials and directional airflow as required to assure flows inward from areas outside of the facility toward areas of highest potential risk within the facility. Manometers are used to sense pressure differentials between adjacent areas maintained at different pressure levels. If a system malfunctions, the manometers sound an alarm. The supply and exhaust airflow is interlocked to assure inward (or zero) airflow at all times.

Appendix G-II-D-4-o. The exhaust air from the facility is filtered through high efficiency particulate air/HEPA filters and discharged to the outside so that it is dispersed away from occupied buildings and air intakes. Within the facility, the filters are located as near the laboratories as practicable in order to reduce the length of potentially contaminated air ducts. The filter chambers are designed to allow *in situ* decontamination before

filters are removed and to facilitate certification testing after they are replaced. Coarse filters and HEPA filters are provided to treat air supplied to the facility in order to increase the lifetime of the exhaust HEPA filters and to protect the supply air system should air pressures become unbalanced in the laboratory.

Appendix G-II-D-4-p. The treated exhaust air from Class I and II biological safety cabinets may be discharged into the laboratory room environment or the outside through the facility air exhaust system. If exhaust air from Class I or II biological safety cabinets is discharged into the laboratory the cabinets are tested and certified at six-month intervals. *The exhaust air from Class III biological safety cabinets is discharged, without recirculation through two sets of high efficiency particulate air/HEPA filters in series, via the facility exhaust air system.* If the treated exhaust air from any of these cabinets is discharged to the outside through the facility exhaust air system, it is connected to this system in a manner (e.g., thimble unit connection (see [Appendix G-III-L, Footnotes and References of Appendix G](#))) that avoids any interference with the air balance of the cabinets or the facility exhaust air system.

Appendix G-II-D-4-q. A specially designed suit area may be provided in the facility. Personnel who enter this area shall wear a one-piece positive pressure suit that is ventilated by a life-support system. The life-support system includes alarms and emergency backup breathing air tanks. Entry to this area is through an airlock fitted with airtight doors. A chemical shower is provided to decontaminate the surface of the suit before the worker exits the area. The exhaust air from the suit area is filtered by two sets of high efficiency particulate air/HEPA filters installed in series. A duplicate filtration unit, exhaust fan, and an automatically starting emergency power source are provided. The air pressure within the suit area is greater than that of any adjacent area. Emergency lighting and communication systems are provided. All penetrations into the internal shell of the suit are sealed. A double-doored autoclave is provided for decontaminating waste materials to be removed from the suit areas.

Appendix G - Table 1. Possible Alternate Combinations Of Physical And Biological Containment Safeguards

| Classification of Physical & Biological Containment | Alternate Physical Containment | | | Alternate Biological Containment |
|---|--------------------------------|----------------------|----------------------|----------------------------------|
| | Laboratory Facilities | Laboratory Practices | Laboratory Equipment | |
| BL3/HV2 | BL3 BL3 | BL3 BL3 | BL3 BL4 | HV2 HV1 |
| BL3/HV1 | BL3 BL3 | BL3 BL3 | BL3 BL2 | HV1 HV2 |
| BL4/HV1 | BL4 BL4 | BL4 BL4 | BL4 BL3 | HV1 HV2 |

BL - Biosafety Level

HV - Host-Vector System

Appendix G-III. Footnotes and References of Appendix G

Appendix G-III-A. *Biosafety in Microbiological and Biomedical Laboratories*, 5th edition, 2007, DHHS, Public Health Service, Centers for Disease Control and Prevention, Atlanta, Georgia, and National Institutes of Health, Bethesda, Maryland.

Appendix G-III-B. *Biosafety in Microbiological and Biomedical Laboratories*, 3rd edition, May 1993, U.S. DHHS, Public Health Service, Centers for Disease Control and Prevention, Atlanta, Georgia, and NIH, Bethesda, Maryland.

Appendix G-III-C. *National Cancer Institute Safety Standards for Research Involving Oncogenic Viruses*, U.S. Department of Health, Education, and Welfare Publication No. (NIH) 75-790, October 1974.

Appendix G-III-D. *National Institutes of Health Biohazards Safety Guide*, U.S. Department of Health, Education, and Welfare, Public Health Service, NIH, U.S. Government Printing Office, Stock No. 1740-00383, 1974.

Appendix G-III-E. A. Hellman, M. N. Oxman, and R. Pollack (eds.), *Biohazards in Biological Research*, Cold Spring Harbor Laboratory 1973.

Appendix G-III-F. N. V. Steere (ed.), *Handbook of Laboratory Safety*, 2nd edition, The Chemical Rubber Co., Cleveland, Ohio, 1971.

Appendix G-III-G. Bodily, J. L., "General Administration of the Laboratory," H. L. Bodily, E. L. Updyke, and J. O. Mason (eds.), *Diagnostic Procedures for Bacterial, Mycotic, and Parasitic Infections*, American Public Health Association, New York, 1970, pp. 11-28.

Appendix G-III-H. Darlow, H. M. (1969). "Safety in the Microbiological Laboratory," in J. R. Norris and D. W. Robbins (eds.), *Methods in Microbiology*, Academic Press, Inc., New York, pp. 169-204.

Appendix G-III-I. *The Prevention of Laboratory Acquired Infection*, C. H. Collins, E. G. Hartley, and R. Pilsworth, Public Health Laboratory Service, Monograph Series No. 6, 1974.

Appendix G-III-J. Chatigny, M. A., "Protection Against Infection in the Microbiological Laboratory: Devices and Procedures," in W. W. Umbreit (ed.), *Advances in Applied Microbiology*, Academic Press, New York, New York, 1961, 3:131-192.

Appendix G-III-K. Horsfall, F. L. Jr., and J. H. Baner, *Individual Isolation of Infected Animals in a Single Room*, J. Bact., 1940, 40, 569-580.

Appendix G-III-L. Biological safety cabinets referred to in this section are classified as Class I, Class II, or Class III cabinets. A Class I is a ventilated cabinet for personnel protection having an inward flow of air away from the operator. The exhaust air from this cabinet is filtered through a high efficiency particulate air/HEPA filter. This cabinet is used in three operational modes: (i) with a full-width open front, (ii) with an installed front closure panel (having four 6-inch diameter openings) without gloves, and (iii) with an installed front closure panel equipped with arm-length rubber gloves. The face velocity of the inward flow of air through the full-width open front is 75 feet per minute or greater. A Class II cabinet is a ventilated cabinet for personnel and product protection having an open front with inward air flow for personnel protection, and HEPA filtered mass recirculated air flow for product protection. The cabinet exhaust air is filtered through a HEPA filter. The face velocity of the inward flow of air through the full-width open front is 75 feet per minute or greater. Design and performance specifications for Class II cabinets have been adopted by the National Sanitation Foundation, Ann Arbor, Michigan. A Class III cabinet is a closed-front ventilated cabinet of gas tight construction which provides the highest level of personnel protection of all biosafety safety cabinets. The interior of the cabinet is protected from contaminants exterior to the cabinet. The cabinet is fitted with arm-length rubber gloves and is operated under a negative pressure of at least 0.5 inches water gauge. All supply air is filtered through HEPA filters. Exhaust air is filtered through two HEPA filters or one HEPA filter and incinerator before being discharged to the outside environment. National Sanitation Foundation Standard 49. 1976. Class II (Laminar Flow) Biohazard Cabinetry, Ann Arbor, Michigan.

Appendix G-III-M. Biosafety Level 1 is suitable for work involving agents of unknown or minimal potential hazard to laboratory personnel and the environment. The laboratory is not separated from the general traffic patterns in the building. Work is generally conducted on open bench tops. Special containment equipment is not required or generally used. Laboratory personnel have specific training in the procedures conducted in the laboratory and are supervised by a scientist with general training in microbiology or a related science (see [Appendix G-III-A, Footnotes and References of Appendix G](#)).

Appendix G-III-N. Biosafety Level 2 is similar to Level 1 and is suitable for work involving agents of moderate potential hazard to personnel and the environment. It differs in that: (1) laboratory personnel have specific training in handling pathogenic agents and are directed by competent scientists; (2) access to the laboratory is limited when work is being conducted; and (3) certain procedures in which infectious aerosols are created are conducted in biological safety cabinets or other physical containment equipment (see [Appendix G-III-A, Footnotes and References of Appendix G](#)).

Appendix G-III-O. Office of Research Safety, National Cancer Institute, and the Special Committee of Safety and Health Experts, *Laboratory Safety Monograph: A Supplement to the NIH Guidelines for Recombinant DNA Research*, NIH, Bethesda, Maryland 1978.

Appendix G-III-P. Biosafety Level 3 is applicable to clinical, diagnostic, teaching, research, or production facilities in which work is conducted with indigenous or exotic agents which may cause serious or potentially lethal disease as a result of exposure by the inhalation route. Laboratory personnel have specific training in handling pathogenic and potentially lethal agents and are supervised by competent scientists who are experienced in working with these agents. All procedures involving the manipulation of infectious material are conducted within biological safety cabinets or other physical containment devices or by personnel wearing appropriate personal protective clothing and devices. The laboratory has special engineering and design features. It is recognized, however, that many existing facilities may not have all the facility safeguards recommended for BL3 (e.g., access zone, sealed penetrations, and directional airflow, etc.). In these circumstances, acceptable safety may be achieved for routine or repetitive operations (e.g., diagnostic procedures involving the propagation of an agent for identification, typing, and susceptibility testing) in laboratories where facility features satisfy BL2 recommendations provided the recommended "Standard Microbiological Practices," "Special Practices," and "Containment Equipment" for BL3 are rigorously followed. The decision to implement this modification of BL3 recommendations should be made only by the Principal Investigator.

APPENDIX H. SHIPMENT

Recombinant or synthetic nucleic acid molecules contained in an organism or in a viral genome shall be shipped under the applicable regulations of the U.S. Postal Service (39 Code of Federal Regulations, Part 3); the Public Health Service (42 Code of Federal Regulations, Part 72); the U.S. Department of Agriculture (9 Code of Federal Regulations, Subchapters D and E; 7 CFR, Part 340); and/or the U.S. Department of Transportation (49 Code of Federal Regulations, Parts 171-179).

Note. A host-vector system may be proposed for certification by the NIH Director in accordance with the procedures set forth in Appendix I-II, *Certification of Host-Vector Systems*. In order to ensure protection for proprietary data, any public notice regarding a host-vector system which is designated by the institution as proprietary under [Section IV-D, Voluntary Compliance](#), will be issued only after consultation with the institution as to the content of the notice (see [Section IV-D-3, Certification of Host-Vector Systems - Voluntary Compliance](#)).

Appendix H-I. Host organisms or viruses will be shipped as etiologic agents, regardless of whether they contain recombinant or synthetic nucleic acid molecules, if they are regulated as human pathogens by the Public Health Service (42 Code of Federal Regulations, Part 72) or as animal pathogens or plant pests under the U.S. Department of Agriculture, Animal and Plant Health Inspection Service (Titles 9 and 7 Code of Federal Regulations, respectively).

Appendix H-II. Host organisms and viruses will be shipped as etiologic agents if they contain recombinant or synthetic nucleic acid molecules when: (i) the recombinant or synthetic nucleic acid molecule includes the complete genome of a host organism or virus regulated as a human or animal pathogen or a plant pest; or (ii)

the recombinant or synthetic nucleic acid molecule codes for a toxin or other factor directly involved in eliciting human, animal, or plant disease or inhibiting plant growth, and is carried on an expression vector or within the host chromosome and/or when the host organism contains a conjugation proficient plasmid or a generalized transducing phage; or (iii) the recombinant or synthetic nucleic acid molecule comes from a host organism or virus regulated as a human or animal pathogen or as a plant pest and has not been adequately characterized to demonstrate that it does not code for a factor involved in eliciting human, animal, or plant disease.

Appendix H-III. Footnotes and References of Appendix H

For further information on shipping etiologic agents contact: (i) The [Centers for Disease Control and Prevention](#), ATTN: Biohazards Control Office, 1600 Clifton Road, Atlanta, Georgia 30333, (404) 639-3883, FTS 236-3883; (ii) The U.S. Department of Transportation, ATTN: Office of Hazardous Materials Transportation, 400 7th Street, S.W., Washington, DC 20590, (202) 366-4545; or (iii) U.S. Department of Agriculture, ATTN: [Animal and Plant Health Inspection Service \(APHIS\)](#), Veterinary Services, National Center for Import-Export, Products Program, 4700 River Road, Unit 40, Riverdale, Maryland 20737. Phone: (301) 734-8499; Fax: (301) 734-8226.

APPENDIX I. BIOLOGICAL CONTAINMENT (See [Appendix E](#), *Certified Host-Vector Systems*)

Appendix I-I. Levels of Biological Containment

In consideration of biological containment, the vector (plasmid, organelle, or virus) for the recombinant or synthetic nucleic acid molecule and the host (bacterial, plant, or animal cell) in which the vector is propagated in the laboratory will be considered together. Any combination of vector and host which is to provide biological containment shall be chosen or constructed so that the following types of "escape" are minimized: (i) survival of the vector in its host outside the laboratory, and (ii) transmission of the vector from the propagation host to other non-laboratory hosts. The following levels of biological containment (host-vector systems) for prokaryotes are established. Appendices I-I-A through I-II-B describe levels of biological containment (host-vector systems) for prokaryotes. Specific criteria will depend on the organisms to be used.

Appendix I-I-A. Host-Vector 1 Systems

Host-Vector 1 systems provide a moderate level of containment. Specific Host-Vector 1 systems are:

Appendix I-I-A-1. *Escherichia coli* K-12 Host-Vector 1 Systems (EK1)

The host is always *Escherichia coli* K-12 or a derivative thereof, and the vectors include non-conjugative plasmids (e.g., pSC101, Co1E1, or derivatives thereof (see Appendices I-III-A through G, *Footnotes and References of Appendix I*) and variants of bacteriophage, such as lambda (see Appendices I-III-H through O, *Footnotes and References of Appendix I*). The *Escherichia coli* K-12 hosts shall not contain conjugation-proficient plasmids, whether autonomous or integrated, or generalized transducing phages.

Appendix I-I-A-2. Other Host-Vector 1 Systems

At a minimum, hosts and vectors shall be comparable in containment to *Escherichia coli* K-12 with a non-conjugative plasmid or bacteriophage vector. [Appendix I-II](#), *Certification of Host-Vector Systems*, describes the data to be considered and mechanism for approval of Host-Vector 1 systems.

Appendix I-I-B. Host-Vector 2 Systems (EK2)

Host-Vector 2 Systems provide a high level of biological containment as demonstrated by data from suitable tests performed in the laboratory. Escape of the recombinant or synthetic nucleic acid molecule either via survival of the organisms or via transmission of the recombinant or synthetic nucleic acid molecule to other organisms should be $< 1/10^8$ under specified conditions. Specific Host-Vector 2 systems are:

Appendix I-I-B-1. For *Escherichia coli* K-12 Host-Vector 2 systems (EK2) in which the vector is a plasmid, no more than $1/10^8$ host cells shall perpetuate a cloned DNA fragment under the specified non-permissive laboratory conditions designed to represent the natural environment, either by survival of the original host or as a consequence of transmission of the cloned DNA fragment.

Appendix I-I-B-2. For *Escherichia coli* K-12 Host-Vector 2 systems (EK2) in which the vector is a phage, no more than $1/10^8$ phage particles shall perpetuate a cloned DNA fragment under the specified non-permissive laboratory conditions designed to represent the natural environment, either as a prophage (in the inserted or plasmid form) in the laboratory host used for phage propagation, or survival in natural environments and transferring a cloned DNA fragment to other hosts (or their resident prophages).

Appendix I-II. Certification of Host-Vector Systems

Appendix I-II-A. Responsibility

Host-Vector 1 systems (other than *Escherichia coli* K-12) and Host-Vector 2 systems may not be designated as such until they have been certified by the NIH Director. Requests for certification of host-vector systems may be submitted to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax). Proposed host-vector systems will be reviewed by the RAC (see [Section IV-C-1-b-\(1\)-\(f\)](#), *Major Actions*). Initial review will be based on the construction, properties, and testing of the proposed host-vector system by a subcommittee composed of one or more RAC members and/or *ad hoc* experts. The RAC will evaluate the subcommittee's report and any other available information at the next scheduled RAC meeting. The NIH Director is responsible for certification of host-vector systems, following advice of the RAC. Minor modifications to existing host-vector systems (i.e., those that are of minimal or no consequence to the properties relevant to containment) may be certified by the NIH Director without prior RAC review (see [Section IV-C-1-b-\(2\)-\(f\)](#), *Minor Actions*). Once a host-vector system has been certified by the NIH Director, a notice of certification will be sent by NIH/OBA to the applicant and to the Institutional Biosafety Committee Chairs. A list of all currently certified host-vector systems is available from the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax). The NIH Director may rescind the certification of a host-vector system (see [Section IV-C-1-b-\(2\)-\(g\)](#), *Minor Actions*). If certification is rescinded, NIH will instruct investigators to transfer cloned DNA into a different system or use the clones at a higher level of physical containment level, unless NIH determines that the already constructed clones incorporate adequate biological containment. Certification of an host-vector system does not extend to modifications of either the host or vector component of that system. Such modified systems shall be independently certified by the NIH Director. If modifications are minor, it may only be necessary for the investigator to submit data showing that the modifications have either improved or not impaired the major phenotypic traits on which the containment of the system depends. Substantial modifications to a certified host-vector system requires submission of complete testing data.

Appendix I-II-B. Data to be Submitted for Certification

Appendix I-II-B-1. Host-Vector 1 Systems Other than *Escherichia coli* K-12

The following types of data shall be submitted, modified as appropriate for the particular system under consideration: (i) a description of the organism and vector; the strain's natural habitat and growth requirements; its physiological properties, particularly those related to its reproduction, survival, and the mechanisms by which it exchanges genetic information; the range of organisms with which this organism normally exchanges genetic information and the type of information is exchanged; and any relevant information about its pathogenicity or toxicity; (ii) a description of the history of the particular strains and vectors to be used, including data on any mutations which render this organism less able to survive or transmit genetic information; and (iii) a general description of the range of experiments contemplated with emphasis on the need for developing such an Host-Vector 1 system.

Appendix I-II-B-2. Host-Vector 2 Systems

Investigators planning to request Host-Vector 2 systems certification may obtain instructions from NIH/OBA concerning data to be submitted (see [Appendices I-III-N and O](#), *Footnotes and References of Appendix I*). In general, the following types of data are required: (i) description of construction steps with indication of source,

properties, and manner of introduction of genetic traits; (ii) quantitative data on the stability of genetic traits that contribute to the containment of the system; (iii) data on the survival of the host-vector system under non-permissive laboratory conditions designed to represent the relevant natural environment; (iv) data on transmissibility of the vector and/or a cloned DNA fragment under both permissive and non-permissive conditions; (v) data on all other properties of the system which affect containment and utility, including information on yields of phage or plasmid molecules, ease of DNA isolation, and ease of transfection or transformation; and (vi) in some cases, the investigator may be asked to submit data on survival and vector transmissibility from experiments in which the host-vector is fed to laboratory animals or one or more human subjects. Such *in vivo* data may be required to confirm the validity of predicting *in vivo* survival on the basis of *in vitro* experiments. Data shall be submitted 12 weeks prior to the RAC meeting at which such data will be considered by the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax). Investigators are encouraged to publish their data on the construction, properties, and testing of proposed Host Vector 2 systems prior to consideration of the system by the RAC and its subcommittee. Specific instructions concerning the submission of data for proposed *Escherichia coli* K-12 Host-Vector 2 system (EK2) involving either plasmids or bacteriophage in *Escherichia coli* K-12, are available from the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax).

Appendix I-III. Footnotes and References of Appendix I

Appendix I-III-A. Hersfield, V., H. W. Boyer, C. Yanofsky, M. A. Lovett, and D. R. Helinski, *Plasmid Co1E1 as a Molecular Vehicle for Cloning and Amplification of DNA*. Proc. Nat. Acad. Sci., 1974, 71, pp. 3455-3459.

Appendix I-III-B. Wensink, P. C., D. J. Finnegan, J. E. Donelson, and D. S. Hogness, *A System for Mapping DNA Sequences in the Chromosomes of Drosophila Melanogaster*. Cell, 1974, 3, pp. 315-335.

Appendix I-III-C. Tanaka, T., and B. Weisblum, *Construction of a Colicin El-R Factor Composite Plasmid in Vitro: Means for Amplification of Deoxyribonucleic Acid*. J. Bacteriol., 1975, 121, pp. 354-362.

Appendix I-III-D. Armstrong, K. A., V. Hersfield, and D. R. Helinski, *Gene Cloning and Containment Properties of Plasmid Col E1 and Its Derivatives*, Science, 1977, 196, pp. 172-174.

Appendix I-III-E. Bolivar, F., R. L. Rodriguez, M. C. Betlack, and H. W. Boyer, *Construction and Characterization of New Cloning Vehicles: I. Ampicillin-Resistant Derivative of PMB9*, Gene, 1977, 2, pp. 75-93.

Appendix I-III-F. Cohen, S. N., A. C. W. Chang, H. Boyer, and R. Helling. *Construction of Biologically Functional Bacterial Plasmids in Vitro*. Proc. Natl. Acad. Sci., 1973, 70, pp. 3240-3244.

Appendix I-III-G. Bolivar, F., R. L. Rodriguez, R. J. Greene, M. C. Batlack, H. L. Reyneker, H. W. Boyer, J. H. Cross, and S. Falkow, 1977, *Construction and Characterization of New Cloning Vehicles II. A Multi-Purpose Cloning System*, Gene, 1977, 2, pp. 95-113.

Appendix I-III-H. Thomas, M., J. R. Cameron, and R. W. Davis (1974). *Viable Molecular Hybrids of Bacteriophage Lambda and Eukaryotic DNA*. Proc. Nat. Acad. Sci., 1974, 71, pp. 4579-4583.

Appendix I-III-I. Murray, N. E., and K. Murray, *Manipulation of Restriction Targets in Phage Lambda to Form Receptor Chromosomes for DNA Fragments*. Nature, 1974, 51, pp. 476-481.

Appendix I-III-J. Ramback, A., and P. Tiollais (1974). *Bacteriophage Having EcoRI Endonuclease Sites Only in the Non-Essential Region of the Genome*. Proc. Nat. Acad. Sci., 1974, 71, pp. 3927-3820.

Appendix I-III-K. Blattner, F. R., B. G. Williams, A. E. Bleche, K. Denniston-Thompson, H. E. Faber, L. A. Furlong, D. J. Gunwald, D. O. Kiefer, D. D. Moore, J. W. Shumm, E. L. Sheldon, and O. Smithies, *Charon Phages: Safer Derivatives of Bacteriophage Lambda for DNA Cloning*, Science 1977, 196, pp. 163-169.

Appendix I-III-L. Donoghue, D. J., and P. A. Sharp, *An Improved Lambda Vector: Construction of Model Recombinants Coding for Kanamycin Resistance*, Gene, 1977, 1, pp. 209-227.

Appendix I-III-M. Leder, P., D. Tiemeier and L. Enquist (1977), *EK2 Derivatives of Bacteriophage Lambda Useful in the Cloning of DNA from Higher Organisms: The λ gt WES System*, Science, 1977, 196, pp. 175-177.

Appendix I-III-N. Skalka, A., *Current Status of Coliphage AEK2 Vectors*, Gene, 1978, 3, pp. 29-35.

Appendix I-III-O. Szybalski, W., A. Skalka, S. Gottesman, A. Campbell, and D. Botstein, *Standardized Laboratory Tests for EK2 Certification*, Gene, 1978, 3, pp. 36-38.

APPENDIX J. BIOTECHNOLOGY RESEARCH SUBCOMMITTEE

The National Science and Technology Council's Committee on Fundamental Science determined that a subcommittee should be continued to identify and coordinate Federal research efforts, identify research needs, stimulating international cooperation, and assess national and international policy issues concerning biotechnology sciences. The primary emphasis will be on scientific issues to increase the overall effectiveness and productivity of the Federal investment in biotechnology sciences, especially regarding issues which cut across agency boundaries. This subcommittee is called the Biotechnology Research Subcommittee.

Membership of the Biotechnology Research Subcommittee will include Federal agencies that support biotechnology research. Agencies represented are: U.S. Department of Agriculture, Department of Commerce, Department of Defense, Department of Energy, Department of Health and Human Services, Department of Interior, Department of Justice, Department of State, Department of Veterans Affairs, Agency for International Development, Environmental Protection Agency, National Aeronautics and Space Administration, and National Science Foundation. The Biotechnology Research Subcommittee will function in an advisory capacity to the Committee on Fundamental Science, the Director of the Office of Science and Technology Policy, and the Executive Office of the President. The Biotechnology Research Subcommittee will review the scientific aspects of proposed regulations and guidelines as they are developed.

The primary responsibilities of the Biotechnology Research Subcommittee are to: (i) describe and review current Federal efforts in biotechnology research; (ii) identify and define the priority areas for future Federal biotechnology research, including areas needing greater emphasis, describing the role of each agency in those areas, and delineate where interagency cooperation would enhance progress in the biotechnology sciences, with an emphasis on integrated research efforts, where appropriate; (iii) assess major international efforts in the biotechnology sciences and develop mechanisms for international collaboration. For example, activities of the U.S.-European Community Task Force on Biotechnology have been coordinated through the Biotechnology Research Subcommittee; (iv) identify and review national and international policy issues (such as public education) associated with biotechnology; and (v) provide reviews, analyses, and recommendations to the Chairs of the Committee on Fundamental Science on scientific issues related to regulations and the applications of biotechnology research and biotechnology policies and issues.

In 1990, the Biotechnology Research Subcommittee replaced the Biotechnology Sciences Coordinating Committee. Both the Biotechnology Research Subcommittee and the Biotechnology Sciences Coordinating Committee previously functioned under the Federal Coordinating Council on Science, Engineering, and Technology (FCCSET). While regulatory issues became the primary focus of the Biotechnology Sciences Coordinating Committee, the Biotechnology Research Subcommittee focuses on scientific issues, although it will still provide scientific support for regulatory responsibilities.

APPENDIX K. PHYSICAL CONTAINMENT FOR LARGE SCALE USES OF ORGANISMS CONTAINING RECOMBINANT OR SYNTHETIC NUCLEIC ACID MOLECULES

Appendix K specifies physical containment guidelines for large-scale (greater than 10 liters of culture) research or production involving viable organisms containing recombinant or synthetic nucleic acid molecules. It shall apply to large-scale research or production activities as specified in [Section III-D-6, *Experiments Involving More than 10 Liters of Culture*](#). It is important to note that this appendix addresses only the biological hazard associated with organisms containing recombinant or synthetic nucleic acid molecules. Other hazards accompanying the large-scale cultivation of such organisms (e.g., toxic properties of products; physical, mechanical, and chemical aspects of downstream processing) are not addressed and shall be considered separately, albeit in conjunction with this appendix.

All provisions shall apply to large-scale research or production activities with the following modifications: (i) Appendix K shall supersede [Appendix G, *Physical Containment*](#), when quantities in excess of 10 liters of culture are involved in research or production. [Appendix K-II](#) applies to Good Large Scale Practice; (ii) the institution shall appoint a Biological Safety Officer if it engages in large-scale research or production activities involving viable organisms containing recombinant or synthetic nucleic acid molecules. The duties of the Biological Safety Officer shall include those specified in [Section IV-B-3, *Biological Safety Officer*](#); (iii) the institution shall establish and maintain a health surveillance program for personnel engaged in large-scale research or production activities involving viable organisms containing recombinant or synthetic nucleic acid molecules which require Biosafety Level (BL) 3 containment at the laboratory scale. The program shall include: pre assignment and periodic physical and medical examinations; collection, maintenance, and analysis of serum specimens for monitoring serologic changes that may result from the employee's work experience; and provisions for the investigation of any serious, unusual, or extended illnesses of employees to determine possible occupational origin.

Appendix K-I. Selection of Physical Containment Levels

The selection of the physical containment level required for recombinant or synthetic nucleic acid molecule research or production involving more than 10 liters of culture is based on the containment guidelines established in [Section III, *Experiments Covered by the NIH Guidelines*](#). For purposes of large-scale research or production, four physical containment levels are established. The four levels set containment conditions at those appropriate for the degree of hazard to health or the environment posed by the organism, judged by experience with similar organisms unmodified by recombinant or synthetic nucleic acid molecule techniques and consistent with Good Large Scale Practice. The four biosafety levels of large-scale physical containment are referred to as Good Large Scale Practice, BL1-Large Scale, BL2-Large Scale, and BL3-Large Scale. Good Large Scale Practice is recommended for large-scale research or production involving viable, non-pathogenic, and non-toxic recombinant or synthetic strains derived from host organisms that have an extended history of safe large-scale use. Good Large Scale Practice is recommended for organisms such as those included in [Appendix C, *Exemptions under Section III-F-8*](#), which have built-in environmental limitations that permit optimum growth in the large-scale setting but limited survival without adverse consequences in the environment. BL1-Large Scale is recommended for large-scale research or production of viable organisms containing recombinant or synthetic nucleic acid molecules that require BL1 containment at the laboratory scale and that do not qualify for Good Large Scale Practice. BL2-Large Scale is recommended for large-scale research or production of viable organisms containing recombinant or synthetic nucleic acid molecules that require BL2 containment at the laboratory scale. BL3-Large Scale is recommended for large-scale research or production of viable organisms containing recombinant or synthetic nucleic acid molecules that require BL3 containment at the laboratory scale. No provisions are made for large-scale research or production of viable organisms containing recombinant or synthetic nucleic acid molecules that require BL4 containment at the laboratory scale. If necessary, these requirements will be established by NIH on an individual basis.

Appendix K-II. Good Large Scale Practice (GLSP)

Appendix K-II-A. Institutional codes of practice shall be formulated and implemented to assure adequate control of health and safety matters.

Appendix K-II-B. Written instructions and training of personnel shall be provided to assure that cultures of viable organisms containing recombinant or synthetic nucleic acid molecules are handled prudently and that the work place is kept clean and orderly.

Appendix K-II-C. In the interest of good personal hygiene, facilities (e.g., hand washing sink, shower, changing room) and protective clothing (e.g., uniforms, laboratory coats) shall be provided that are appropriate for the risk of exposure to viable organisms containing recombinant or synthetic nucleic acid molecules. Eating, drinking, smoking, applying cosmetics, and mouth pipetting shall be prohibited in the work area.

Appendix K-II-D. Cultures of viable organisms containing recombinant or synthetic nucleic acid molecules shall be handled in facilities intended to safeguard health during work with microorganisms that do not require containment.

Appendix K-II-E. Discharges containing viable recombinant or synthetic organisms shall be handled in accordance with applicable governmental environmental regulations.

Appendix K-II-F. Addition of materials to a system, sample collection, transfer of culture fluids within/between systems, and processing of culture fluids shall be conducted in a manner that maintains employee's exposure to viable organisms containing recombinant or synthetic nucleic acid molecules at a level that does not adversely affect the health and safety of employees.

Appendix K-II-G. The facility's emergency response plan shall include provisions for handling spills.

Appendix K-III. Biosafety Level 1 (BL1) - Large Scale

Appendix K-III-A. Spills and accidents which result in overt exposures to organisms containing recombinant or synthetic nucleic acid molecules are immediately reported to the Laboratory Director. Medical evaluation, surveillance, and treatment are provided as appropriate and written records are maintained.

Appendix K-III-B. Cultures of viable organisms containing recombinant or synthetic nucleic acid molecules shall be handled in a closed system (e.g., closed vessel used for the propagation and growth of cultures) or other primary containment equipment (e.g., biological safety cabinet containing a centrifuge used to process culture fluids) which is designed to reduce the potential for escape of viable organisms. Volumes less than 10 liters may be handled outside of a closed system or other primary containment equipment provided all physical containment requirements specified in [Appendix G-II-A, Physical Containment Levels--Biosafety Level 1](#), are met.

Appendix K-III-C. Culture fluids (except as allowed in Appendix K-III-D) shall not be removed from a closed system or other primary containment equipment unless the viable organisms containing recombinant or synthetic nucleic acid molecules have been inactivated by a validated inactivation procedure. A validated inactivation procedure is one which has been demonstrated to be effective using the organism that will serve as the host for propagating the recombinant or synthetic nucleic acid molecules. Culture fluids that contain viable organisms or viral vectors intended as final product may be removed from the primary containment equipment by way of closed systems for sample analysis, further processing or final fill.

Appendix K-III-D. Sample collection from a closed system, the addition of materials to a closed system, and the transfer of culture fluids from one closed system to another shall be conducted in a manner which minimizes the release of aerosols or contamination of exposed surfaces.

Appendix K-III-E. Exhaust gases removed from a closed system or other primary containment equipment shall be treated by filters which have efficiencies equivalent to high efficiency particulate air/HEPA filters or by other equivalent procedures (e.g., incineration) to minimize the release of viable organisms containing recombinant or synthetic nucleic acid molecules to the environment.

Appendix K-III-F. A closed system or other primary containment equipment that has contained viable organisms containing recombinant or synthetic nucleic acid molecules shall not be opened for maintenance or other purposes unless it has been sterilized by a validated sterilization procedure except when the culture fluids contain viable organisms or vectors intended as final product as described in [Appendix K-III-C](#) above. A validated sterilization procedure is one which has been demonstrated to be effective using the organism that will serve as the host for propagating the recombinant or synthetic nucleic acid molecules.

Appendix K-III-G. Emergency plans required by [Sections IV-B-2-b-\(6\)](#), *Institutional Biosafety Committee*, and [IV-B-3-c-\(3\)](#), *Biological Safety Officer*, shall include methods and procedures for handling large losses of culture on an emergency basis.

Appendix K-IV. Biosafety Level 2 (BL2) - Large Scale

Appendix K-IV-A. Spills and accidents which result in overt exposures to organisms containing recombinant or synthetic nucleic acid molecules are immediately reported to the Biological Safety Officer, Institutional Biosafety Committee, NIH/OBA, and other appropriate authorities (if applicable). Reports to NIH/OBA shall be sent to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax). Medical evaluation, surveillance, and treatment are provided as appropriate and written records are maintained.

Appendix K-IV-B. Cultures of viable organisms containing recombinant or synthetic nucleic acid molecules shall be handled in a closed system (e.g., closed vessel used for the propagation and growth of cultures) or other primary containment equipment (e.g., Class III biological safety cabinet containing a centrifuge used to process culture fluids) which is designed to prevent the escape of viable organisms. Volumes less than 10 liters may be handled outside of a closed system or other primary containment equipment provided all physical containment requirements specified in [Appendix G-II-B, Physical Containment Levels--Biosafety Level 2](#), are met.

Appendix K-IV-C. Culture fluids (except as allowed in [Appendix K-IV-D](#)) shall not be removed from a closed system or other primary containment equipment unless the viable organisms containing recombinant or synthetic nucleic acid molecules have been inactivated by a validated inactivation procedure. A validated inactivation procedure is one which has been demonstrated to be effective using the organism that will serve as the host for propagating the recombinant or synthetic nucleic acid molecules. Culture fluids that contain viable organisms or viral vectors intended as final product may be removed from the primary containment equipment by way of closed systems for sample analysis, further processing or final fill.

Appendix K-IV-D. Sample collection from a closed system, the addition of materials to a closed system, and the transfer of cultures fluids from one closed system to another shall be conducted in a manner which prevents the release of aerosols or contamination of exposed surfaces.

Appendix K-IV-E. Exhaust gases removed from a closed system or other primary containment equipment shall be treated by filters which have efficiencies equivalent to high efficiency particulate air/HEPA filters or by other equivalent procedures (e.g., incineration) to prevent the release of viable organisms containing recombinant or synthetic nucleic acid molecules to the environment.

Appendix K-IV-F. A closed system or other primary containment equipment that has contained viable organisms containing recombinant or synthetic nucleic acid molecules shall not be opened for maintenance or other purposes unless it has been sterilized by a validated sterilization procedure except when the culture fluids contain viable organisms or vectors intended as final product as described in [Appendix K-IV-C](#) above. A validated sterilization procedure is one which has been demonstrated to be effective using the organisms that will serve as the host for propagating the recombinant or synthetic nucleic acid molecules.

Appendix K-IV-G. Rotating seals and other mechanical devices directly associated with a closed system used for the propagation and growth of viable organisms containing recombinant or synthetic nucleic acid molecules shall be designed to prevent leakage or shall be fully enclosed in ventilated housings that are exhausted through filters which have efficiencies equivalent to high efficiency particulate air/HEPA filters or through other equivalent treatment devices.

Appendix K-IV-H. A closed system used for the propagation and growth of viable organisms containing recombinant or synthetic nucleic acid molecules and other primary containment equipment used to contain operations involving viable organisms containing sensing devices that monitor the integrity of containment during operations.

Appendix K-IV-I. A closed system used for the propagation and growth of viable organisms containing the recombinant or synthetic nucleic acid molecules shall be tested for integrity of the containment features using the organism that will serve as the host for propagating recombinant or synthetic nucleic acid molecules.

Testing shall be accomplished prior to the introduction of viable organisms containing recombinant or synthetic nucleic acid molecules and following modification or replacement of essential containment features. Procedures and methods used in the testing shall be appropriate for the equipment design and for recovery and demonstration of the test organism. Records of tests and results shall be maintained on file.

Appendix K-IV-J. A closed system used for the propagation and growth of viable organisms containing recombinant or synthetic nucleic acid molecules shall be permanently identified. This identification shall be used in all records reflecting testing, operation, and maintenance and in all documentation relating to use of this equipment for research or production activities involving viable organisms containing recombinant or synthetic nucleic acid molecules.

Appendix K-IV-K. The universal biosafety sign shall be posted on each closed system and primary containment equipment when used to contain viable organisms containing recombinant or synthetic nucleic acid molecules.

Appendix K-IV-L. Emergency plans required by [Sections IV-B-2-b\(6\)](#), *Institutional Biosafety Committee*, and [IV-B-3-c\(3\)](#), *Biological Safety Officer*, shall include methods and procedures for handling large losses of culture on an emergency basis.

Appendix K-V. Biosafety Level 3 (BL3) - Large Scale

Appendix K-V-A. Spills and accidents which result in overt exposures to organisms containing recombinant or synthetic nucleic acid molecules are immediately reported to the Biological Safety Officer, Institutional Biosafety Committee, NIH/OBA, and other appropriate authorities (if applicable). Reports to NIH/OBA shall be sent to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax). Medical evaluation, surveillance, and treatment are provided as appropriate and written records are maintained.

Appendix K-V-B. Cultures of viable organisms containing recombinant or synthetic nucleic acid molecules shall be handled in a closed system (e.g., closed vessels used for the propagation and growth of cultures) or other primary containment equipment (e.g., Class III biological safety cabinet containing a centrifuge used to process culture fluids) which is designed to prevent the escape of viable organisms. Volumes less than 10 liters may be handled outside of a closed system provided all physical containment requirements specified in [Appendix G-II-C](#), *Physical Containment Levels--Biosafety Level 3*, are met.

Appendix K-V-C. Culture fluids (except as allowed in Appendix K-V-D) shall not be removed from a closed system or other primary containment equipment unless the viable organisms containing recombinant or synthetic nucleic acid molecules have been inactivated by a validated inactivation procedure. A validated inactivation procedure is one which has been demonstrated to be effective using the organisms that will serve as the host for propagating the recombinant or synthetic nucleic acid molecules. Culture fluids that contain viable organisms or viral vectors intended as final product may be removed from the primary containment equipment by way of closed systems for sample analysis, further processing or final fill.

Appendix K-V-D. Sample collection from a closed system, the addition of materials to a closed system, and the transfer of culture fluids from one closed system to another shall be conducted in a manner which prevents the release of aerosols or contamination of exposed surfaces.

Appendix K-V-E. Exhaust gases removed from a closed system or other primary containment equipment shall be treated by filters which have efficiencies equivalent to high efficiency particulate air/HEPA filters or by other equivalent procedures (e.g., incineration) to prevent the release of viable organisms containing recombinant or synthetic nucleic acid molecules to the environment.

Appendix K-V-F. A closed system or other primary containment equipment that has contained viable organisms containing recombinant or synthetic nucleic acid molecules shall not be opened for maintenance or other purposes unless it has been sterilized by a validated sterilization procedure except when the culture fluids contain viable organisms or vectors intended as final product as described in [Appendix K-V-C](#) above. A validated sterilization procedure is one which has been demonstrated to be effective using the organisms that will serve as the host for propagating the recombinant or synthetic nucleic acid molecules.

Appendix K-V-G. A closed system used for the propagation and growth of viable organisms containing recombinant or synthetic nucleic acid molecules shall be operated so that the space above the culture level will be maintained at a pressure as low as possible, consistent with equipment design, in order to maintain the integrity of containment features.

Appendix K-V-H. Rotating seals and other mechanical devices directly associated with a closed system used to contain viable organisms containing recombinant or synthetic nucleic acid molecules shall be designed to prevent leakage or shall be fully enclosed in ventilated housings that are exhausted through filters which have efficiencies equivalent to high efficiency particulate air/HEPA filters or through other equivalent treatment devices.

Appendix K-V-I. A closed system used for the propagation and growth of viable organisms containing recombinant or synthetic nucleic acid molecules and other primary containment equipment used to contain operations involving viable organisms containing recombinant or synthetic nucleic acid molecules shall include monitoring or sensing devices that monitor the integrity of containment during operations.

Appendix K-V-J. A closed system used for the propagation and growth of viable organisms containing recombinant or synthetic nucleic acid molecules shall be tested for integrity of the containment features using the organisms that will serve as the host for propagating the recombinant or synthetic nucleic acid molecules. Testing shall be accomplished prior to the introduction of viable organisms containing recombinant or synthetic nucleic acid molecules and following modification or replacement of essential containment features. Procedures and methods used in the testing shall be appropriate for the equipment design and for recovery and demonstration of the test organism. Records of tests and results shall be maintained on file.

Appendix K-V-K. A closed system used for the propagation and growth of viable organisms containing recombinant or synthetic nucleic acid molecules shall be permanently identified. This identification shall be used in all records reflecting testing, operation, maintenance, and use of this equipment for research production activities involving viable organisms containing recombinant or synthetic nucleic acid molecules.

Appendix K-V-L. The universal biosafety sign shall be posted on each closed system and primary containment equipment when used to contain viable organisms containing recombinant or synthetic nucleic acid molecules.

Appendix K-V-M. Emergency plans required by [Sections IV-B-2-b-\(6\)](#), *Institutional Biosafety Committee*, and [IV-B-3-c-\(3\)](#), *Biological Safety Officer*, shall include methods and procedures for handling large losses of culture on an emergency basis.

Appendix K-V-N. Closed systems and other primary containment equipment used in handling cultures of viable organisms containing recombinant or synthetic nucleic acid molecules shall be located within a controlled area which meets the following requirements:

Appendix K-V-N-1. The controlled area shall have a separate entry area. The entry area shall be a double-doored space such as an air lock, anteroom, or change room that separates the controlled area from the balance of the facility.

Appendix K-V-N-2. The surfaces of walls, ceilings, and floors in the controlled area shall be such as to permit ready cleaning and decontamination.

Appendix K-V-N-3. Penetrations into the controlled area shall be sealed to permit liquid or vapor phase space decontamination.

Appendix K-V-N-4. All utilities and service or process piping and wiring entering the controlled area shall be protected against contamination.

Appendix K-V-N-5. Hand washing facilities equipped with foot, elbow, or automatically operated valves shall be located at each major work area and near each primary exit.

Appendix K-V-N-6. A shower facility shall be provided. This facility shall be located in close proximity to the controlled area.

Appendix K-V-N-7. The controlled area shall be designed to preclude release of culture fluids outside the controlled area in the event of an accidental spill or release from the closed systems or other primary containment equipment.

Appendix K-V-N-8. The controlled area shall have a ventilation system that is capable of controlling air movement. The movement of air shall be from areas of lower contamination potential to areas of higher contamination potential. If the ventilation system provides positive pressure supply air, the system shall operate in a manner that prevents the reversal of the direction of air movement or shall be equipped with an alarm that would be actuated in the event that reversal in the direction of air movement were to occur. The exhaust air from the controlled area shall not be recirculated to other areas of the facility. The exhaust air from the controlled area may not be discharged to the outdoors without being high efficiency particulate air/HEPA filtered, subjected to thermal oxidation, or otherwise treated to prevent the release of viable organisms.

Appendix K-V-O. The following personnel and operational practices shall be required:

Appendix K-V-O-1. Personnel entry into the controlled area shall be through the entry area specified in Appendix K-V-N-1.

Appendix K-V-O-2. Persons entering the controlled area shall exchange or cover their personal clothing with work garments such as jump suits, laboratory coats, pants and shirts, head cover, and shoes or shoe covers. On exit from the controlled area the work clothing may be stored in a locker separate from that used for personal clothing or discarded for laundering. Clothing shall be decontaminated before laundering.

Appendix K-V-O-3. Entry into the controlled area during periods when work is in progress shall be restricted to those persons required to meet program or support needs. Prior to entry, all persons shall be informed of the operating practices, emergency procedures, and the nature of the work conducted.

Appendix K-V-O-4. Persons under 18 years of age shall not be permitted to enter the controlled area.

Appendix K-V-O-5. The universal biosafety sign shall be posted on entry doors to the controlled area and all internal doors when any work involving the organism is in progress. This includes periods when decontamination procedures are in progress. The sign posted on the entry doors to the controlled area shall include a statement of agents in use and personnel authorized to enter the controlled area.

Appendix K-V-O-6. The controlled area shall be kept neat and clean.

Appendix K-V-O-7. Eating, drinking, smoking, and storage of food are prohibited in the controlled area.

Appendix K-V-O-8. Animals and plants shall be excluded from the controlled area.

Appendix K-V-O-9. An effective insect and rodent control program shall be maintained.

Appendix K-V-O-10. Access doors to the controlled area shall be kept closed, except as necessary for access, while work is in progress. Service doors leading directly outdoors shall be sealed and locked while work is in progress.

Appendix K-V-O-11. Persons shall wash their hands when exiting the controlled area.

Appendix K-V-O-12. Persons working in the controlled area shall be trained in emergency procedures.

Appendix K-V-O-13. Equipment and materials required for the management of accidents involving viable organisms containing recombinant or synthetic nucleic acid molecules shall be available in the controlled area.

Appendix K-V-O-14. The controlled area shall be decontaminated in accordance with established procedures following spills or other accidental release of viable organisms containing recombinant or synthetic nucleic acid molecules.

Appendix K - Table 1. Comparison of Good Large Scale Practice (GLSP) and Biosafety Level (BL) - Large Scale (LS) Practice (See [Appendix K-VI-A](#), *Footnotes Of Appendix K*)

| CRITERION [See Appendix K-VI-B , <i>Footnotes of Appendix K</i>] | | GLSP | BL1-LS | BL2-LS | BL3-LS |
|--|--|--|---|--|--|
| 1. | Formulate and implement institutional codes of practice for safety of personnel and adequate control of hygiene and safety measures. | K-II-A | G-I | | |
| 2. | Provide adequate written instructions and training of personnel to keep work place clean and tidy and to keep exposure to biological, chemical or physical agents at a level that does not adversely affect health and safety of employees. | K-II-B | G-I | | |
| 3. | Provide changing and hand washing facilities as well as protective clothing, appropriate to the risk, to be worn during work. | K-II-C | G-II-A-1-h | G-II-B-2-f | G-II-C-2-i |
| 4. | Prohibit eating, drinking, smoking, mouth pipeting, and applying cosmetics in the work place. | K-II-C | G-II-A-1-d G-II-A-1-e | G-II-B-1-d G-II-B-1-e | G-II-C-1-c G-II-C-1-d |
| 5. | Internal accident reporting. | K-II-G | K-III-A | K-IV-A | K-V-A |
| 6. | Medical surveillance. | NR | NR | | |
| 7. | Viable organisms should be handled in a system that physically separates the process from the external environment (closed system or other primary containment). | NR | K-III-B | K-IV-B | K-V-B |
| 8. | Culture fluids not removed from a system until organisms are inactivated. | NR | K-III-C | K-IV-C | K-V-C |
| 9. | Inactivation of waste solutions and materials with respect to their biohazard potential. | K-II-E | K-III-C | K-IV-C | K-V-C |
| 10. | Control of aerosols by engineering or procedural controls to prevent or minimize release of organisms during sampling from a system, addition of materials to a system, transfer of cultivated cells, and removal of material, products, and effluent from a system. | Minimize <i>Procedure</i> K-II-F | Minimize <i>Engineer</i> K-III-B K-III-D | Prevent <i>Engineer</i> K-IV-B K-IV-D | Prevent <i>Engineer</i> K-V-B K-V-D |
| 11. | Treatment of exhaust gases from a closed system to minimize or prevent release of viable organisms. | NR | Minimize K-III-E | Prevent K-IV-E | Prevent K-V-E |
| 12. | Closed system that has contained viable organisms not to be opened until sterilized by a validated procedure. | NR | K-III-F | K-IV-F | K-V-F |
| 13. | Closed system to be maintained at as a low pressure as possible to maintain integrity of containment features. | NR | NR | NR | K-V-G |
| 14. | Rotating seals and other penetrations into closed system designed to prevent or minimize leakage. | NR | NR | Prevent K-IV-G | Prevent K-V-H |
| 15. | Closed system shall incorporate monitoring or sensing devices to monitor the integrity of containment. | NR | NR | K-IV-H | K-V-I |
| 16. | Validated integrity testing of closed containment system. | NR | NR | K-IV-I | K-V-J |
| 17. | Closed system to be permanently identified for record keeping purposes. | NR | NR | K-IV-J | K-V-K |
| 18. | Universal biosafety sign to be posted on each closed system. | NR | NR | K-IV-K | K-V-L |
| 19. | Emergency plans required for handling large losses of cultures. | K-II-G | K-III-G | K-IV-L | K-V-M |
| 20. | Access to the work place. | NR | G-II-A-1-a | G-II-B-1-a | K-V-N |
| 21. | Requirements for controlled access area. | NR | NR | NR | K-V-N&O |

NR = not required

Appendix K-VI. Footnotes of Appendix K

Appendix K-VI-A. This table is derived from the text in Appendices G (*Physical Containment*) and K and is not to be used in lieu of Appendices G and K.

Appendix K-VI-B. The criteria in this grid address only the biological hazards associated with organisms containing recombinant or synthetic nucleic acid. Other hazards accompanying the large-scale cultivation of such organisms (e.g., toxic properties of products; physical, mechanical, and chemical aspects of downstream processing) are not addressed and shall be considered separately, albeit in conjunction with this grid.

Appendix K-VII. Definitions to Accompany Containment Grid and Appendix K

Appendix K-VII-A. Accidental Release. An accidental release is the unintentional discharge of a microbiological agent (i.e., microorganism or virus) or eukaryotic cell due to a failure in the containment system.

Appendix K-VII-B. Biological Barrier. A biological barrier is an impediment (naturally occurring or introduced) to the infectivity and/or survival of a microbiological agent or eukaryotic cell once it has been released into the environment.

Appendix K-VII-C. Closed System. A closed system is one in which by its design and proper operation, prevents release of a microbiological agent or eukaryotic cell contained therein.

Appendix K-VII-D. Containment. Containment is the confinement of a microbiological agent or eukaryotic cell that is being cultured, stored, manipulated, transported, or destroyed in order to prevent or limit its contact with people and/or the environment. Methods used to achieve this include: physical and biological barriers and inactivation using physical or chemical means.

Appendix K-VII-E. De minimis Release. *De minimis* release is the release of: (i) viable microbiological agents or eukaryotic cells that does not result in the establishment of disease in healthy people, plants, or animals; or (ii) in uncontrolled proliferation of any microbiological agents or eukaryotic cells.

Appendix K-VII-F. Disinfection. Disinfection is a process by which viable microbiological agents or eukaryotic cells are reduced to a level unlikely to produce disease in healthy people, plants, or animals.

Appendix K-VII-G. Good Large Scale Practice Organism. For an organism to qualify for Good Large Scale Practice consideration, it must meet the following criteria [Reference: Organization for Economic Cooperation and Development, *Recombinant DNA Safety Considerations*, 1987, p. 34-35]: (i) the host organism should be non-pathogenic, should not contain adventitious agents and should have an extended history of safe large-scale use or have built-in environmental limitations that permit optimum growth in the large-scale setting but limited survival without adverse consequences in the environment; (ii) the recombinant or synthetic nucleic acid molecule-engineered organism should be non-pathogenic, should be as safe in the large-scale setting as the host organism, and without adverse consequences in the environment; and (iii) the vector/insert should be well characterized and free from known harmful sequences; should be limited in size as much as possible to the DNA required to perform the intended function; should not increase the stability of the construct in the environment unless that is a requirement of the intended function; should be poorly mobilizable; and should not transfer any resistance markers to microorganisms unknown to acquire them naturally if such acquisition could compromise the use of a drug to control disease agents in human or veterinary medicine or agriculture.

Appendix K-VII-H. Inactivation. Inactivation is any process that destroys the ability of a specific microbiological agent or eukaryotic cell to self-replicate.

Appendix K-VII-I. Incidental Release. An incidental release is the discharge of a microbiological agent or eukaryotic cell from a containment system that is expected when the system is appropriately designed and properly operated and maintained.

Appendix K-VII-J. Minimization. Minimization is the design and operation of containment systems in order that any incidental release is a *de minimis* release.

Appendix K-VII-K. Pathogen. A pathogen is any microbiological agent or eukaryotic cell containing sufficient genetic information, which upon expression of such information, is capable of producing disease in healthy people, plants, or animals.

Appendix K-VII-L. Physical Barrier. A physical barrier is considered any equipment, facilities, or devices (e.g., fermentors, factories, filters, thermal oxidizers) which are designed to achieve containment.

Appendix K-VII-M. Release. Release is the discharge of a microbiological agent or eukaryotic cell from a containment system. Discharges can be incidental or accidental. Incidental releases are *de minimis* in nature; accidental releases may be *de minimis* in nature.

APPENDIX L. GENE THERAPY POLICY CONFERENCES (GTPCS)

In order to enhance the depth and value of public discussion relevant to scientific, safety, social, and ethical implications of gene therapy research, the NIH Director will convene GTPCs at regular intervals. As appropriate, the NIH Director may convene a GTPC in conjunction with a RAC meeting. GTPCs will be administered by NIH/OBA. Conference participation will not involve a standing committee membership but rather will offer the unique advantage of assembling numerous participants who possess significant scientific, ethical, and legal expertise and/or interest that is directly applicable to a specific gene therapy research issue. At least one member of RAC will serve as Co-chair of each GTPC and report the findings of each GTPC to RAC at its next scheduled meeting. The RAC representative for each GTPC will be chosen based on the participant's area of expertise relative to the specific gene therapy research issue to be discussed. All RAC members will be invited to attend GTPCs. GTPCs will have representation from other Federal agencies, including FDA and OHRP. GTPCs will focus on broad overarching policy and scientific issues related to gene therapy research. Proposals for GTPC topics may be submitted by members of RAC, representatives of academia, industry, patient and consumer advocacy organizations, other Federal agencies, professional scientific societies, and the general public. GTPC topics will not be limited to discussion of human applications of gene therapy research, i.e., they may include basic research on the use of novel gene delivery vehicles, or novel applications of human gene transfer. The RAC, with the Director's approval, will have the primary responsibility for planning GTPC agendas. GTPC findings will be transmitted to the NIH Director and will be made publicly available. The NIH Director anticipates that this public policy forum will serve as a model for interagency communication and collaboration, concentrated expert discussion of novel scientific issues and their potential societal implications, and enhanced opportunity for public discussion of specific issues and potential impact of such applications on human health and the environment.

APPENDIX M. POINTS TO CONSIDER IN THE DESIGN AND SUBMISSION OF PROTOCOLS FOR THE TRANSFER OF RECOMBINANT OR SYNTHETIC NUCLEIC ACID MOLECULES INTO ONE OR MORE HUMAN RESEARCH PARTICIPANTS (POINTS TO CONSIDER)

Appendix M applies to research conducted at or sponsored by an institution that receives any support for recombinant or synthetic nucleic acid molecule research from NIH. Researchers not covered by the *NIH Guidelines* are encouraged to use Appendix M (see [Section I-C, General Applicability](#)).

The acceptability of human somatic cell gene transfer has been addressed in several public documents as well as in numerous academic studies. In November 1982, the President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research published a report, *Splicing Life*, which resulted from a two-year process of public deliberation and hearings. Upon release of that report, a U.S. House of Representatives subcommittee held three days of public hearings with witnesses from a wide range of fields from the biomedical and social sciences to theology, philosophy, and law. In December 1984, the Office of Technology Assessment released a background paper, *Human Gene Therapy*, which concluded that civic, religious, scientific, and medical groups have all accepted, in principle, the appropriateness of gene transfer of somatic cells in humans for specific genetic diseases. Somatic cell gene transfer is seen as an extension of present methods that might be preferable to other technologies. In light of this public support, RAC is prepared to consider proposals for somatic cell gene transfer.

RAC will not at present entertain proposals for germ line alterations but will consider proposals involving somatic cell gene transfer. The purpose of somatic cell gene transfer is to treat an individual patient, e.g., by inserting a properly functioning gene into the subject's somatic cells. Germ line alteration involves a specific attempt to introduce genetic changes into the germ (reproductive) cells of an individual, with the aim of changing the set of genes passed on to the individual's offspring.

The RAC continues to explore the issues raised by the potential of *in utero* gene transfer clinical research. However, the RAC concludes that, at present, it is premature to undertake any *in utero* gene transfer clinical trial. Significant additional preclinical and clinical studies addressing vector transduction efficacy, biodistribution, and toxicity are required before a human *in utero* gene transfer protocol can proceed. In addition, a more thorough understanding of the development of human organ systems, such as the immune and nervous systems, is needed to better define the potential efficacy and risks of human *in utero* gene transfer. Prerequisites for considering any specific human *in utero* gene transfer procedure include an understanding of the pathophysiology of the candidate disease and a demonstrable advantage to the *in utero* approach. Once the above criteria are met, the RAC would be willing to consider well rationalized human *in utero* gene transfer clinical trials.

Research proposals involving the deliberate transfer of recombinant or synthetic nucleic acid molecules, or DNA or RNA derived from such nucleic acid molecules, into human subjects (human gene transfer) will be considered through a review process involving both NIH/OBA and RAC. Investigators shall submit their relevant information on the proposed human gene transfer experiments to NIH/OBA. Submission of human gene transfer protocols to NIH will be in the format described in [Appendix M-I-A, Submission Requirements for Protocol Submission](#). Submission to NIH shall be for registration purposes and will ensure continued public access to relevant human gene transfer information conducted in compliance with the *NIH Guidelines*. Investigational New Drug (IND) applications should be submitted to FDA in the format described in 21 CFR, Chapter I, Subchapter D, Part 312, Subpart B, Section 23, *IND Content and Format*.

Institutional Biosafety Committee approval must be obtained from each institution at which recombinant or synthetic nucleic acid molecule material will be administered to human subjects (as opposed to each institution involved in the production of vectors for human application and each institution at which there is *ex vivo* transduction of recombinant or synthetic nucleic acid molecule material into target cells for human application).

Factors that may contribute to public discussion of a human gene transfer experiment by RAC include: (i) new vectors/new gene delivery systems, (ii) new diseases, (iii) unique applications of gene transfer, and (iv) other issues considered to require further public discussion. Among the experiments that may be considered exempt from RAC discussion are those determined not to represent possible risk to human health or the environment. Full, public RAC review and discussion of a human gene transfer experiment may be (1) initiated by the NIH Director; or (2) initiated by the NIH OBA Director following a recommendation to NIH OBA by: (a) three or more RAC members, or (b) a Federal agency other than NIH. An individual human gene transfer experiment that is recommended for full RAC review should represent novel characteristics deserving of public discussion. If it is determined that an experiment will undergo full RAC discussion, NIH/OBA will immediately notify the Principal Investigator. RAC members may forward individual requests for additional information relevant to a specific protocol through NIH/OBA to the Principal Investigator. In making a determination whether an experiment is novel, and thus deserving of full RAC discussion, reviewers will examine the scientific rationale, scientific context (relative to other proposals reviewed by RAC), whether the preliminary *in vitro* and *in vivo* safety data were obtained in appropriate models and are sufficient, and whether questions related to relevant social and ethical issues have been resolved. RAC recommendations on a specific human gene transfer experiment shall be forwarded to the NIH Director, the Principal Investigator, the sponsoring institution, and other DHHS components, as appropriate. Relevant documentation will be included in the material for the RAC meeting at which the experiment is scheduled to be discussed. RAC meetings will be open to the public except where trade secrets and proprietary information are reviewed (see [Section IV-D-5, Protection of Proprietary Data – Voluntary Compliance](#)). RAC prefers that information provided in response to Appendix M contain no proprietary data or trade secrets, enabling all aspects of the review to be open to the public.

Note: Any application submitted to NIH/OBA shall not be designated as 'confidential' in its entirety. In the event that a sponsor determines that specific responses to one or more of the items described in Appendix M should be considered as proprietary or trade secret, each item should be clearly identified as such. The cover letter (attached to the submitted material) shall: (1) clearly indicate that select portions of the application contain information considered as proprietary or trade secret, (2) a brief explanation as to the reason that each of these items is determined proprietary or trade secret.

Public discussion of human gene transfer experiments (and access to relevant information) shall serve to inform the public about the technical aspects of the proposals, meaning and significance of the research, and significant safety, social, and ethical implications of the research. RAC discussion is intended to ensure safe and ethical conduct of gene transfer experiments and facilitate public understanding of this novel area of biomedical research.

In its evaluation of human gene transfer proposals, RAC will consider whether the design of such experiments offers adequate assurance that their consequences will not go beyond their purpose, which is the same as the traditional purpose of clinical investigation, namely, to protect the health and well being of human subjects being treated while at the same time gathering generalizable knowledge. Two possible undesirable consequences of the transfer of recombinant or synthetic nucleic acid molecules would be unintentional: (i) vertical transmission of genetic changes from an individual to his/her offspring, or (ii) horizontal transmission of viral infection to other persons with whom the individual comes in contact. Accordingly, Appendices M-I through M-V request information that will enable RAC and NIH/OBA to assess the possibility that the proposed experiment(s) will inadvertently affect reproductive cells or lead to infection of other people (e.g., medical personnel or relatives).

Appendix M will be considered for revisions as experience in evaluating proposals accumulates and as new scientific developments occur. This review will be carried out periodically as needed.

Appendix M-I. Requirements for Protocol Submission, Review, and Reporting – Human Gene Transfer Experiments

Appendix M-I-A. Requirements for Protocol Submission

The following documentation must be submitted (see exemption in [Appendix M-VI-A, Footnotes of Appendix M](#)) in printed or electronic form to the: Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax), E-mail: rosenthg@od.nih.gov. NIH OBA will confirm receipt within three working days after receiving the submission. Investigators should contact OBA if they do not receive this confirmation.

1. A cover letter on institutional letterhead, signed by the Principal Investigator(s), that: (1) acknowledges that the documentation submitted to NIH OBA complies with the requirements set forth in Appendix M-I-A, *Requirements for Protocol Submission*; (2) identifies the Institutional Biosafety Committee (IBC) and Institutional Review Board (IRB) at the proposed clinical trial site(s) responsible for local review and approval of the protocol; and (3) acknowledges that no research participant will be enrolled (see definition of enrollment in [Section I-E-7](#)) until the RAC review process has been completed (see [Appendix M-I-B, RAC Review Requirements](#)); IBC approval (from the clinical trial site) has been obtained; IRB approval has been obtained; and all applicable regulatory authorizations have been obtained.
2. The scientific abstract.
3. The non-technical abstract.
4. The proposed clinical protocol, including tables, figures, and relevant manuscripts.
5. Responses to Appendices M-II through M-V, *Description of the Proposal, Informed Consent, Privacy and Confidentiality, and Special Issues*. Responses to Appendices M-II through M-V may be provided either as an appendix to the clinical protocol or incorporated in the clinical protocol. If responses to [Appendices M-II through M-V](#) are incorporated in the clinical protocol, each response must refer to the appropriate Appendix M-II through M-V.
6. The proposed informed consent document (see [Appendix M-III, Informed Consent](#)).
7. Curriculum vitae of the Principal Investigator(s) (no more than two pages in biographical sketch format).

Note: A human gene transfer experiment submitted to NIH OBA should not contain confidential commercial information or trade secrets, enabling all aspects of the review to be open to the public.

Appendix M-I-B. RAC Review Requirements**Appendix M-I-B-1. Initial RAC Review**

The initial RAC review process shall include a determination as to whether the human gene transfer experiment presents characteristics that warrant public RAC review and discussion. During the RAC's initial review, individual committee members may request additional information relevant to the protocol. NIH OBA will immediately notify the Principal Investigator(s) of RAC requests for additional information. In making a determination whether an experiment presents characteristics warranting public RAC review and discussion, reviewers will examine the scientific rationale, scientific content, whether the preliminary *in vitro* and *in vivo* safety data were obtained in appropriate models and are sufficient, and whether questions related to relevant social and ethical issues have been resolved. Other factors that may warrant public review and discussion of a human gene transfer experiment by the RAC include: (1) a new vector/new gene delivery system; (2) a new clinical application; (3) a unique application of gene transfer; and/or (4) other issues considered to require further public discussion.

Initial RAC review shall be completed within 15 working days of receipt of a complete submission (see [Appendix M-I-A, Requirements for Protocol Submission](#)). At the end of the 15-day review period, NIH OBA will notify the Principal Investigator(s) in writing about the results of the RAC's initial review. Two outcomes are possible: (1) the experiment does not present characteristics that warrant further review and discussion and is therefore exempt from public RAC review and discussion; or (2) the experiment presents characteristics that warrant public RAC review and discussion. Completion of the RAC review process is defined as: (1) receipt by the Principal Investigator(s) of a letter from NIH OBA indicating that the submission does not present characteristics that warrant public RAC review and discussion; or (2) receipt by the Principal Investigator(s) of a letter from NIH OBA after public RAC review that summarizes the committee's key comments and recommendations (if any).

If a human gene transfer protocol is submitted less than eight weeks before a scheduled RAC meeting and is subsequently recommended for public RAC review and discussion, the review of the protocol by the RAC will be deferred until the next scheduled RAC meeting. This eight-week period is needed to ensure adequate time for public notice and comment and thorough review by the committee members.

No research participant shall be enrolled (see definition of enrollment in [Section I-E-7](#)) in the human gene transfer experiment until: (1) the RAC review process has been completed; (2) Institutional Biosafety Committee (IBC) approval (from the clinical trial site) has been obtained; (3) Institutional Review Board (IRB) approval has been obtained; and (4) all applicable regulatory authorization(s) have been obtained.

For a clinical trial site that is added after the RAC review process, no research participant shall be enrolled (see definition of enrollment in [Section I-E-7](#)) at the clinical trial site until the following documentation has been submitted to NIH OBA: (1) IBC approval (from the clinical trial site); (2) IRB approval; (3) IRB-approved informed consent document; (4) curriculum vitae of the Principal Investigator(s) (no more than two pages in biographical sketch format); and (5) NIH grant numbers(s) if applicable.

Appendix M-I-B-2. Public RAC Review and Discussion

Public RAC review and discussion of a human gene transfer experiment may be: (1) initiated by the NIH Director; or (2) initiated by the NIH OBA Director following a recommendation to NIH OBA by: (a) three or more RAC members; or (b) a Federal agency other than NIH. In making a determination whether an experiment presents characteristics warranting public RAC review and discussion, reviewers will examine the scientific rationale, scientific content, whether the preliminary *in vitro* and *in vivo* safety data were obtained in appropriate models and are sufficient, and whether questions related to relevant social and ethical issues have been

resolved. Other factors that may warrant public review and discussion of a human gene transfer experiment by the RAC include: (1) a new vector/new gene delivery system; (2) a new clinical application; (3) a unique application of gene transfer; and/or (4) other issues considered to require further public discussion.

After a human gene transfer experiment is reviewed by the full RAC at a regularly scheduled meeting, NIH OBA will send a letter summarizing the RAC key comments and recommendations (if any) regarding the protocol to the NIH Director, the Principal Investigator, the sponsoring institution, and other DHHS components, as appropriate. Completion of RAC review is defined as receipt by the Principal Investigator(s) of a letter from NIH OBA summarizing the committee's findings. Unless NIH OBA determines that there are exceptional

circumstances, the RAC summary letter will be sent to the Principal Investigator(s) within 10 working days after the completion of the RAC meeting at which the experiment was reviewed.

RAC meetings will be open to the public except where trade secrets or confidential commercial information are reviewed. To enable all aspects of the protocol review process to be open to the public, information provided in response to Appendix M should not contain trade secrets or confidential commercial information. No application submitted to NIH OBA shall be designated as 'confidential' in its entirety. In the event that an investigator determines that specific responses to one or more of the items described in Appendix M should be considered as confidential commercial information or a trade secret, each item must be clearly identified as such. The cover letter (attached to the submitted material) shall: (1) clearly designate the information that is considered as confidential commercial information or a trade secret; and (2) explain and justify each designation.

Appendix M-I-C. Reporting Requirements

Appendix M-I-C-1. Initiation of the Clinical Investigation

No later than 20 working days after enrollment (see definition of enrollment in [Section I-E-7](#)) of the first research participant in a human gene transfer experiment, the Principal Investigator(s) shall submit the following documentation to NIH OBA: (1) a copy of the informed consent document approved by the Institutional Review Board (IRB); (2) a copy of the protocol approved by the Institutional Biosafety Committee (IBC) and IRB; (3) a copy of the final IBC approval from the clinical trial site; (4) a copy of the final IRB approval; (5) a brief written report that includes the following information: (a) how the investigator(s) responded to each of the RAC's recommendations on the protocol (if applicable); and (b) any modifications to the protocol as required by FDA; (6) applicable NIH grant number(s); (7) the FDA Investigational New Drug Application (IND) number; and (8) the date of the initiation of the trial. The purpose of requesting the FDA IND number is for facilitating interagency collaboration in the Federal oversight of human gene transfer research.

Appendix M-I-C-2. Additional Clinical Trial Sites

No research participant shall be enrolled (see definition of enrollment in [Section I-E-7](#)) at a clinical trial site until the following documentation has been submitted to NIH OBA: (1) Institutional Biosafety Committee approval (from the clinical trial site); (2) Institutional Review Board approval; (3) Institutional Review Board-approved informed consent document; (4) curriculum vitae of the Principal Investigator(s) (no more than two pages in biographical sketch format); and (5) NIH grant number(s) if applicable.

Appendix M-I-C-3. Annual Reports

Within 60 days after the one-year anniversary of the date on which the investigational new drug (IND) application went into effect, and after each subsequent anniversary until the trial is completed, the Principal Investigator (or delegate) shall submit the information set forth in (a), (b), and (c). When multiple studies are conducted under the single IND, the Principal Investigator (or delegate) may choose to submit a single annual report covering all studies, provided that each study is identified by its OBA protocol number.

(a) Clinical Trial Information. A brief summary of the status of each trial in progress and each trial completed during the previous year. The summary is required to include the following information for each trial: (1) the title and purpose of the trial; (2) clinical site; (3) the Principal Investigator; (4) clinical protocol identifiers, including the NIH OBA protocol number, NIH grant number(s) (if applicable), and the FDA IND application number; (5) participant population (such as disease indication and general age group, e.g., adult or pediatric); (6) the total number of participants planned for inclusion in the trial; the number entered into the trial to date; the number

whose participation in the trial was completed; and the number who dropped out of the trial with a brief description of the reasons; (7) the status of the trial, e.g., open to accrual of subjects, closed but data collection ongoing, or fully completed, and (8) if the trial has been completed, a brief description of any study results.

(b) Progress Report and Data Analysis. Information obtained during the previous year's clinical and non-clinical investigations, including: (1) a narrative or tabular summary showing the most frequent and most serious adverse experiences by body system; (2) a summary of all serious adverse events submitted during the past year; (3) a summary of serious adverse events that were expected or considered to have causes not associated with the use of the gene transfer product such as disease progression or concurrent medications; (4) if any deaths have occurred, the number of participants who died during participation in the investigation and causes

of death; and (5) a brief description of any information obtained that is pertinent to an understanding of the gene transfer product's actions, including, for example, information about dose-response, information from controlled trials, and information about bioavailability.

(c) A copy of the updated clinical protocol including a technical and non-technical abstract.

Appendix M-I-C-4. Safety Reporting

Principal Investigators must submit, in accordance with this section, Appendix M-I-C-4-a and [Appendix M-I-C-4-b](#), a written report on: (1) any serious adverse event that is both unexpected and associated with the use of the gene transfer product (i.e., there is reasonable possibility that the event may have been caused by the use of the product; investigators should not await definitive proof of association before reporting such events); and (2) any finding from tests in laboratory animals that suggests a significant risk for human research participants including reports of mutagenicity, teratogenicity, or carcinogenicity. The report must be clearly labeled as a "Safety Report" and must be submitted to the NIH Office of Biotechnology Activities (NIH OBA) and to the local Institutional Biosafety Committee within the timeframes set forth in [Appendix M-I-C-4-b](#).

Principal Investigators should adhere to any other serious adverse event reporting requirements in accordance with federal regulations, state laws, and local institutional policies and procedures, as applicable.

Principal Investigators may delegate to another party, such as a corporate sponsor, the reporting functions set forth in Appendix M, with written notification to the NIH OBA of the delegation and of the name(s), address, telephone and fax numbers of the contact(s). The Principal Investigator is responsible for ensuring that the reporting requirements are fulfilled and will be held accountable for any reporting lapses.

The three alternative mechanisms for reporting serious adverse events to the NIH OBA are: by e-mail to oba@od.nih.gov; by fax to 301-496-9839; or by mail to the Office of Biotechnology Activities, National Institutes of Health, MSC 7985, 6705 Rockledge Drive, Suite 750, Bethesda, Maryland 20892-7985.

Appendix M-I-C-4-a. Safety Reporting: Content and Format

The serious adverse event report must include, but need not be limited to: (1) the date of the event; (2) designation of the report as an initial report or a follow-up report, identification of all safety reports previously filed for the clinical protocol concerning a similar adverse event, and an analysis of the significance of the adverse event in light of previous similar reports; (3) clinical site; (4) the Principal Investigator; (5) NIH Protocol number; (6) FDA's Investigational New Drug (IND) Application number; (7) vector type, e.g., adenovirus; (8) vector subtype, e.g., type 5, relevant deletions; (9) gene delivery method, e.g., *in vivo*, *ex vivo* transduction; (10) route of administration, e.g., intratumoral, intravenous; (11) dosing schedule; (12) a complete description of the event; (13) relevant clinical observations; (14) relevant clinical history; (15) relevant tests that were or are planned to be conducted; (16) date of any treatment of the event; and (17) the suspected cause of the event. These items may be reported by using the recommended Adverse Event Reporting Template available on NIH OBA's web site at: http://oba.od.nih.gov/rdna/adverse_event_oba.html, the FDA MedWatch forms, or other means provided that all of the above elements are specifically included.

Reports from laboratory animal studies as delineated in [Appendix M-I-C-4](#) must be submitted in a narrative format.

Appendix M-I-C-4-b. Safety Reporting: Time frames for Expedited Reports

Any serious adverse event that is fatal or life-threatening, that is unexpected, and associated with the use of the gene transfer product must be reported to the NIH OBA as soon as possible, but not later than 7 calendar days after the sponsor's initial receipt of the information (i.e., at the same time the event must be reported to the FDA).

Serious adverse events that are unexpected and associated with the use of the gene transfer product, but are not fatal or life-threatening, must be reported to the NIH OBA as soon as possible, but not later than 15 calendar days after the sponsor's initial receipt of the information (i.e., at the same time the event must be reported to the FDA).

Changes in this schedule are permitted only where, under the FDA IND regulations [21 CFR 312(c)(3)], changes

in this reporting schedule have been approved by the FDA and are reflected in the protocol.

If, after further evaluation, an adverse event initially considered not to be associated with the use of the gene transfer product is subsequently determined to be associated, then the event must be reported to the NIH OBA within 15 days of the determination.

Relevant additional clinical and laboratory data may become available following the initial serious adverse event report. Any follow-up information relevant to a serious adverse event must be reported within 15 calendar days of the sponsor's receipt of the information. If a serious adverse event occurs after the end of a clinical trial and is determined to be associated with the use of the gene transfer product, that event shall be reported to the NIH OBA within 15 calendar days of the determination.

Any finding from tests in laboratory animals that suggests a significant risk for human research participants including reports of mutagenicity, teratogenicity, or carcinogenicity must be reported as soon as possible, but not later than 15 calendar days after the sponsor's initial receipt of the information (i.e., at the same time the event must be reported to the FDA).

Appendix M-I-C-5. Confidentiality

Data submitted in accordance with [Appendix M-I-C](#) that are claimed to be confidential commercial or trade secret information must be clearly labeled as such. Prior to making its determination about the confidentiality of data labeled confidential commercial or trade secret, the NIH will contact the Principal Investigator or delegate to ascertain the basis for the claim and subsequently will notify the Principal Investigator or delegate of its final determination regarding the claim.

If NIH determines that the data so labeled are confidential commercial or trade secret and that their public disclosure would promote an understanding of key scientific or safety issues, the NIH will seek agreement from the appropriate party to release such data. Public discussion of scientific and safety issues raised by data submitted in accordance with [Appendix M-I-C](#) is vital to informing both investigators and human subjects about the safety of gene transfer research.

To protect the privacy of participants in gene transfer research, any serious adverse event or annual reports submitted to NIH OBA must not contain any information that would identify the human research participants.

Appendix M-I-D. Safety Assessment in Human Gene Transfer Research

A working group of the RAC, the NIH Gene Transfer Safety Assessment Board, with staff support from the NIH OBA, will: 1) review in closed session as appropriate safety information from gene transfer trials for the purpose of assessing toxicity and safety data across gene transfer trials; 2) identify significant trends or significant single events; and 3) report significant findings and aggregated trend data to the RAC. It is expected that this process will enhance review of new protocols, improve the development, design, and conduct of human gene transfer trials, promote public understanding and awareness of the safety of human gene transfer research studies, and inform the decision-making of potential trial participants.

Appendix M-II. Description of the Proposal

Responses to this appendix should be provided in the form of either written answers or references to specific sections of the protocol or its appendices. Investigators should indicate the points that are not applicable with a brief explanation. Investigators submitting proposals that employ the same vector systems may refer to preceding documents relating to the vector sequence without having to rewrite such material.

Appendix M-II-A. Objectives and Rationale of the Proposed Research

State concisely the overall objectives and rationale of the proposed study. Provide information on the specific points that relate to whichever type of research is being proposed.

Appendix M-II-A-1. Use of Recombinant or Synthetic Nucleic Acid Molecules for Therapeutic Purposes

For research in which recombinant or synthetic nucleic acid molecules are transferred in order to treat a disease or disorder (e.g., genetic diseases, cancer, and metabolic diseases), the following questions should be addressed:

Appendix M-II-A-1-a. Why is the disease selected for experimental treatment by means of gene transfer a good candidate for such treatment?

Appendix M-II-A-1-b. Describe the natural history and range of expression of the disease selected for experimental treatment. What objective and/or quantitative measures of disease activity are available? In your view, are the usual effects of the disease predictable enough to allow for meaningful assessment of the results of gene transfer?

Appendix M-II-A-1-c. Is the protocol designed to prevent all manifestations of the disease, to halt the progression of the disease after symptoms have begun to appear, or to reverse manifestations of the disease in seriously ill victims?

Appendix M-II-A-1-d. What alternative therapies exist? In what groups of subjects are these therapies effective? What are their relative advantages and disadvantages as compared with the proposed gene transfer?

Appendix M-II-A-2. Transfer of Recombinant or Synthetic Nucleic Acid Molecules for Other Purposes

Appendix M-II-A-2-a. Into what cells will the recombinant or synthetic nucleic acid molecules be transferred? Why is the transfer of recombinant or synthetic nucleic acid molecules necessary for the proposed research? What questions can be answered by using recombinant or synthetic nucleic acid molecules?

Appendix M-II-A-2-b. What alternative methodologies exist? What are their relative advantages and disadvantages as compared to the use of recombinant or synthetic nucleic acid molecules?

Appendix M-II-B. Research Design, Anticipated Risks and Benefits**Appendix M-II-B-1. Structure and Characteristics of the Biological System**

Provide a full description of the methods and reagents to be employed for gene delivery and the rationale for their use. The following are specific points to be addressed:

Appendix M-II-B-1-a. What is the structure of the cloned DNA that will be used?

Appendix M-II-B-1-a-(1). Describe the gene (genomic or cDNA), the bacterial plasmid or phage vector, and the delivery vector (if any). Provide complete nucleotide sequence analysis or a detailed restriction enzyme map of the total construct.

Appendix M-II-B-1-a-(2). What regulatory elements does the construct contain (e.g., promoters, enhancers, polyadenylation sites, replication origins, etc.)? From what source are these elements derived? Summarize what is currently known about the regulatory character of each element.

Appendix M-II-B-1-a-(3). Describe the steps used to derive the recombinant or synthetic nucleic acid construct.

Appendix M-II-B-1-b. What is the structure of the material that will be administered to the research participant?

Appendix M-II-B-1-b-(1). Describe the preparation, structure, and composition of the materials that will be given to the human research subject or used to treat the subject's cells: (i) If recombinant or synthetic nucleic acid, what is the purity (both in terms of being a single nucleic acid species and in terms of other contaminants)? What tests have been used and what is the sensitivity of the tests? (ii) If a virus, how is it prepared from the recombinant or synthetic nucleic acid construct? In what cell is the virus grown (any special features)? What medium and serum are used? How is the virus purified? What is its structure and purity? What steps are being taken (and assays used with their sensitivity) to detect and eliminate any contaminating materials (for example,

VL30 RNA, other nucleic acids, or proteins) or contaminating viruses (both replication-competent or replication-defective) or other organisms in the cells or serum used for preparation of the virus stock including any contaminants that may have biological effects? (iii) If co-cultivation is employed, what kinds of cells are being used for co-cultivation? What steps are being taken (and assays used with their sensitivity) to detect and eliminate any contaminating materials? Specifically, what tests are being conducted to assess the material to be returned to the subject for the presence of live or killed donor cells or other non-vector materials (for example, VL30 sequences) originating from those cells? (iv) If methods other than those covered by Appendices M-II-B-1 through M-II-B-3, *Research Design, Anticipated Risks and Benefits*, are used to introduce new genetic information into target cells, what steps are being taken to detect and eliminate any contaminating materials? What are possible sources of contamination? What is the sensitivity of tests used to monitor contamination?

Appendix M-II-B-1-b-(2). Describe any other material to be used in preparation of the material to be administered to the human research subject. For example, if a viral vector is proposed, what is the nature of the helper virus or cell line? If carrier particles are to be used, what is the nature of these?

Appendix M-II-B-2. Preclinical Studies, Including Risk-Assessment Studies

Provide results that demonstrate the safety, efficacy, and feasibility of the proposed procedures using animal and/or cell culture model systems, and explain why the model(s) chosen is/are most appropriate.

Appendix M-II-B-2-a. Delivery System

Appendix M-II-B-2-a-(1). What cells are the intended target cells of the recombinant or synthetic nucleic acid molecules? What target cells are to be treated *ex vivo* and returned to the human subject, how will the cells be characterized before and after treatment? What is the theoretical and practical basis for assuming that only the target cells will incorporate the recombinant or synthetic nucleic acid?

Appendix M-II-B-2-a-(2). Is the delivery system efficient? What percentage of the target cells contain the added recombinant or synthetic nucleic acid?

Appendix M-II-B-2-a-(3). How is the structure of the added recombinant or synthetic nucleic acid sequences monitored and what is the sensitivity of the analysis? Is the added DNA extrachromosomal or integrated? Is the added recombinant or synthetic nucleic acid unrearranged?

Appendix M-II-B-2-a-(4). How many copies are present per cell? How stable is the added recombinant or synthetic nucleic acid both in terms of its continued presence and its structural stability?

Appendix M-II-B-2-b. Gene Transfer and Expression

Appendix M-II-B-2-b-(1). What animal and cultured cell models were used in laboratory studies to assess the *in vivo* and *in vitro* efficacy of the gene transfer system? In what ways are these models similar to and different from the proposed human treatment?

Appendix M-II-B-2-b-(2). What is the minimal level of gene transfer and/or expression that is estimated to be necessary for the gene transfer protocol to be successful in humans? How was this level determined?

Appendix M-II-B-2-b-(3). Explain in detail all results from animal and cultured cell model experiments which assess the effectiveness of the delivery system in achieving the minimally required level of gene transfer and expression.

Appendix M-II-B-2-b-(4). To what extent is expression only from the desired gene (and not from the surrounding DNA)? To what extent does the insertion modify the expression of other genes?

Appendix M-II-B-2-b-(5). In what percentage of cells does expression from the added recombinant or synthetic nucleic acid occur? Is the product biologically active? What percentage of normal activity results from the inserted gene?

Appendix M-II-B-2-b-(6). Is the gene expressed in cells other than the target cells? If so, to what extent?

Appendix M-II-B-2-c. Retrovirus Delivery Systems

Appendix M-II-B-2-c-(1). What cell types have been infected with the retroviral vector preparation? Which cells, if any, produce infectious particles?

Appendix M-II-B-2-c-(2). How stable are the retroviral vector and the resulting provirus against loss, rearrangement, recombination, or mutation? What information is available on how much rearrangement or recombination with endogenous or other viral sequences is likely to occur in the human subject's cells? What steps have been taken in designing the vector to minimize instability or variation? What laboratory studies have been performed to check for stability, and what is the sensitivity of the analyses?

Appendix M-II-B-2-c-(3). What laboratory evidence is available concerning potential harmful effects of the transfer (e.g., development of neoplasia, harmful mutations, regeneration of infectious particles, or immune responses)? What steps will be taken in designing the vector to minimize pathogenicity? What laboratory studies have been performed to check for pathogenicity, and what is the sensitivity of the analyses?

Appendix M-II-B-2-c-(4). Is there evidence from animal studies that recombinant or synthetic vector nucleic acid has entered untreated cells, particularly germ-line cells? What is the sensitivity of these analyses?

Appendix M-II-B-2-c-(5). Has a protocol similar to the one proposed for a clinical trial been conducted in non-human primates and/or other animals? What were the results? Specifically, is there any evidence that the retroviral vector has recombined with any endogenous or other viral sequences in the animals?

Appendix M-II-B-2-d. Non-Retrovirus Delivery/Expression Systems

If a non-retroviral delivery system is used, what animal studies have been conducted to determine if there are pathological or other undesirable consequences of the protocol (including insertion of DNA into cells other than those treated, particularly germ-line cells)? How long have the animals been studied after treatment? What safety studies have been conducted? (Include data about the level of sensitivity of such assays.)

Appendix M-II-B-3. Clinical Procedures, Including Research Participant Monitoring

Describe the experimental treatment that will be administered to the human subjects and the diagnostic methods that will be used to monitor the success or failure of the experimental treatment. If previous clinical studies using similar methods have been performed by yourself or others, indicate their relevance to the proposed study. Specifically:

Appendix M-II-B-3-a. Will cells (e.g., bone marrow cells) be removed from human subjects and treated *ex vivo*? If so, describe the type, number, and intervals at which these cells will be removed.

Appendix M-II-B-3-b. Will human subjects be treated to eliminate or reduce the number of cells containing malfunctioning genes (e.g., through radiation or chemotherapy)?

Appendix M-II-B-3-c. What treated cells (or vector/nucleic acid combination) will be given to human subjects? How will the treated cells be administered? What volume of cells will be used? Will there be single or multiple experimental treatments? If so, over what period of time?

Appendix M-II-B-3-d. How will it be determined that new gene sequences have been inserted into the subject's cells and if these sequences are being expressed? Are these cells limited to the intended target cell populations? How sensitive are these analyses?

Appendix M-II-B-3-e. What studies will be conducted to assess the presence and effects of the contaminants?

Appendix M-II-B-3-f. What are the clinical endpoints of the study? Are there objectives and quantitative measurements to assess the natural history of the disease? Will such measurements be used in human subject follow-up? How will subjects be monitored to assess specific effects of the treatment on the disease? What is the sensitivity of the analyses? How frequently will follow-up studies be conducted? How long will follow-up continue?

Appendix M-II-B-3-g. What are the major beneficial and adverse effects of the experimental treatment that you anticipate? What measures will be taken in an attempt to control or reverse these adverse effects if they occur? Compare the probability and magnitude of deleterious consequences from the disease if nucleic acid molecule transfer is not used.

Appendix M-II-B-3-h. If a treated human subject dies, what special post-mortem studies will be performed?

Appendix M-II-B-4. Public Health Considerations

Describe any potential benefits and hazards of the proposed gene transfer to persons other than the human subjects receiving the experimental treatment. Specifically:

Appendix M-II-B-4-a. On what basis are potential public health benefits or hazards postulated?

Appendix M-II-B-4-b. Is there a significant possibility that the added recombinant or synthetic nucleic acid will spread from the human subject to other persons or to the environment?

Appendix M-II-B-4-c. What precautions will be taken against such spread (e.g., subjects sharing a room, health-care workers, or family members)?

Appendix M-II-B-4-d. What measures will be undertaken to mitigate the risks, if any, to public health?

Appendix M-II-B-4-e. In light of possible risks to offspring, including vertical transmission, will birth control measures be recommended to subjects? Are such concerns applicable to health care personnel?

Appendix M-II-B-5. Qualifications of Investigators and Adequacy of Laboratory and Clinical Facilities

Indicate the relevant training and experience of the personnel who will be involved in the preclinical studies and clinical administration of recombinant or synthetic nucleic acid molecules. Describe the laboratory and clinical facilities where the proposed study will be performed. Specifically:

Appendix M-II-B-5-a. What professional personnel (medical and nonmedical) will be involved in the proposed study and what is their relevant expertise? Provide a two-page curriculum vitae for each key professional person in biographical sketch format (see [Appendix M-I-A, Requirements for Protocol Submission](#)).

Appendix M-II-B-5-b. At what hospital or clinic will the experimental treatment be given? Which facilities of the hospital or clinic will be especially important for the proposed study? Will subjects occupy regular hospital beds or clinical research center beds? Where will subjects reside during the follow-up period? What special arrangements will be made for the comfort and consideration of the research participants. Will the research institution designate an ombudsman, patient care representative, or other individual to help protect the rights and welfare of the research participant?

Appendix M-II-C. Selection of the Human Subjects

Estimate the number of human subjects to be involved in the proposed study. Describe recruitment procedures and eligibility requirements, paying particular attention to whether these procedures and requirements are fair and equitable. Specifically:

Appendix M-II-C-1. How many subjects do you plan to involve in the proposed study?

Appendix M-II-C-2. How many eligible subjects do you anticipate being able to identify each year?

Appendix M-II-C-3. What recruitment procedures do you plan to use?

Appendix M-II-C-4. What selection criteria do you plan to employ? What are the exclusion and inclusion criteria for the study?

Appendix M-II-C-5. How will subjects be selected if it is not possible to include all who desire to participate?

Appendix M-III. Informed Consent

In accordance with the Protection of Human Subjects (45 CFR Part 46), investigators should indicate how subjects will be informed about the proposed study and the manner in which their consent will be solicited. They should indicate how the Informed Consent document makes clear the special requirements of gene transfer research. If a proposal involves children, special attention should be paid to the Protection of Human Subjects (45 CFR Part 46), Subpart D, Additional Protections for Children Involved as Subjects in Research.

Appendix M-III-A. Communication About the Study to Potential Participants

Appendix M-III-A-1. Which members of the research group and/or institution will be responsible for contacting potential participants and for describing the study to them? What procedures will be used to avoid possible conflicts of interest if the investigator is also providing medical care to potential subjects?

Appendix M-III-A-2. How will the major points covered in [Appendix M-II, Description of Proposal](#), be disclosed to potential participants and/or their parents or guardians in language that is understandable to them?

Appendix M-III-A-3. What is the length of time that potential participants will have to make a decision about their participation in the study?

Appendix M-III-A-4. If the study involves pediatric or mentally handicapped subjects, how will the assent of each person be obtained?

Appendix M-III-B. Informed Consent Document

Submission of a human gene transfer experiment to NIH OBA must include a copy of the proposed informed consent document. A separate Informed Consent document should be used for the gene transfer portion of a research project when gene transfer is used as an adjunct in the study of another technique, e.g., when a gene is used as a "marker" or to enhance the power of immunotherapy for cancer.

Because of the relative novelty of the procedures that are used, the potentially irreversible consequences of the procedures performed, and the fact that many of the potential risks remain undefined, the Informed Consent document should include the following specific information in addition to any requirements of the DHHS regulations for the Protection of Human Subjects (45 CFR 46). Indicate if each of the specified items appears in the Informed Consent document or, if not included in the Informed Consent document, how those items will be presented to potential subjects. Include an explanation if any of the following items are omitted from the consent process or the Informed Consent document.

Appendix M-III-B-1. General Requirements of Human Subjects Research

Appendix M-III-B-1-a. Description/Purpose of the Study

The subjects should be provided with a detailed explanation in non-technical language of the purpose of the study and the procedures associated with the conduct of the proposed study, including a description of the gene transfer component.

Appendix M-III-B-1-b. Alternatives

The Informed Consent document should indicate the availability of therapies and the possibility of other investigational interventions and approaches.

Appendix M-III-B-1-c. Voluntary Participation

The subjects should be informed that participation in the study is voluntary and that failure to participate in the study or withdrawal of consent will not result in any penalty or loss of benefits to which the subjects are otherwise entitled.

Appendix M-III-B-1-d. Benefits

The subjects should be provided with an accurate description of the possible benefits, if any, of participating in the proposed study. For studies that are not reasonably expected to provide a therapeutic benefit to subjects, the Informed Consent document should clearly state that no direct clinical benefit to subjects is expected to occur as a result of participation in the study, although knowledge may be gained that may benefit others.

Appendix M-III-B-1-e. Possible Risks, Discomforts, and Side Effects

There should be clear itemization in the Informed Consent document of types of adverse experiences, their relative severity, and their expected frequencies. For consistency, the following definitions are suggested: side effects that are listed as mild should be ones which do not require a therapeutic intervention; moderate side effects require an intervention; and severe side effects are potentially fatal or life-threatening, disabling, or require prolonged hospitalization.

If verbal descriptors (e.g., "rare," "uncommon," or "frequent") are used to express quantitative information regarding risk, these terms should be explained.

The Informed Consent document should provide information regarding the approximate number of people who have previously received the genetic material under study. It is necessary to warn potential subjects that, for genetic materials previously used in relatively few or no humans, unforeseen risks are possible, including ones that could be severe.

The Informed Consent document should indicate any possible adverse medical consequences that may occur if the subjects withdraw from the study once the study has started.

Appendix M-III-B-1-f. Costs

The subjects should be provided with specific information about any financial costs associated with their participation in the protocol and in the long-term follow-up to the protocol that are not covered by the investigators or the institution involved.

Subjects should be provided an explanation about the extent to which they will be responsible for any costs for medical treatment required as a result of research-related injury.

Appendix M-III-B-2. Specific Requirements of Gene Transfer Research**Appendix M-III-B-2-a. Reproductive Considerations**

To avoid the possibility that any of the reagents employed in the gene transfer research could cause harm to a fetus/child, subjects should be given information concerning possible risks and the need for contraception by males and females during the active phase of the study. The period of time for the use of contraception should be specified.

The inclusion of pregnant or lactating women should be addressed.

Appendix M-III-B-2-b. Long-Term Follow-Up

To permit evaluation of long-term safety and efficacy of gene transfer, the prospective subjects should be informed that they are expected to cooperate in long-term follow-up that extends beyond the active phase of the study. The Informed Consent document should include a list of persons who can be contacted in the event that questions arise during the follow-up period. The investigator should request that subjects continue to provide a current address and telephone number.

The subjects should be informed that any significant findings resulting from the study will be made known in a timely manner to them and/or their parent or guardian including new information about the experimental procedure, the harms and benefits experienced by other individuals involved in the study, and any long-term effects that have been observed.

Appendix M-III-B-2-c. Request for Autopsy

To obtain vital information about the safety and efficacy of gene transfer, subjects should be informed that at the time of death, no matter what the cause, permission for an autopsy will be requested of their families. Subjects should be asked to advise their families of the request and of its scientific and medical importance.

Appendix M-III-B-2-d. Interest of the Media and Others in the Research

To alert subjects that others may have an interest in the innovative character of the protocol and in the status of the treated subjects, the subjects should be informed of the following: (i) that the institution and investigators will make efforts to provide protection from the media in an effort to protect the participants' privacy, and (ii) that representatives of applicable Federal agencies (e.g., the [National Institutes of Health](#) and the [Food and Drug Administration](#)), representatives of collaborating institutions, vector suppliers, etc., will have access to the subjects' medical records.

Appendix M-IV. Privacy

Indicate what measures will be taken to protect the privacy of subjects and their families as well as maintain the confidentiality of research data. These measures should help protect the confidentiality of information that could directly or indirectly identify study participants.

Appendix M-IV-A. What provisions will be made to honor the wishes of individual human subjects (and the parents or guardians of pediatric or mentally handicapped subjects) as to whether, when, or how the identity of a subject is publicly disclosed.

Appendix M-IV-B. What provisions will be made to maintain the confidentiality of research data, at least in cases where data could be linked to individual subjects?

Appendix M-V. Special Issues

Although the following issues are beyond the normal purview of local Institutional Review Boards, investigators should respond to the following questions:

Appendix M-V-A. What steps will be taken, consistent with Appendix M-IV, *Privacy*, to ensure that accurate and appropriate information is made available to the public with respect to such public concerns as may arise from the proposed study?

Appendix M-V-B. Do you or your funding sources intend to protect under patent or trade secret laws either the products or the procedures developed in the proposed study? If so, what steps will be taken to permit as full communication as possible among investigators and clinicians concerning research methods and results?

Appendix M-VI. Footnotes of Appendix M

Appendix M-VI-A. Human studies in which induction or enhancement of an immune response to a vector-encoded microbial immunogen is the major goal, such an immune response has been demonstrated in model systems, and the persistence of the vector-encoded immunogen is not expected, are exempt from [Appendix M-I, Requirements for Protocol Submission, Review and Reporting – Human Gene Transfer Experiments](#).

APPENDIX P. PHYSICAL AND BIOLOGICAL CONTAINMENT FOR RECOMBINANT OR SYNTHETIC NUCLEIC ACID MOLECULE RESEARCH INVOLVING PLANTS

Appendix P specifies physical and biological containment conditions and practices suitable to the greenhouse conduct of experiments involving recombinant or synthetic nucleic acid molecule-containing plants, plant-associated microorganisms, and small animals. All provisions of the *NIH Guidelines* apply to plant research activities with the following modifications:

Appendix P shall supersede [Appendix G \(Physical Containment\)](#) when the research plants are of a size, number, or have growth requirements that preclude the use of containment conditions described in [Appendix G](#). The plants covered in Appendix P include but are not limited to mosses, liverworts, macroscopic algae, and vascular plants including terrestrial crops, forest, and ornamental species.

Plant-associated microorganisms include viroids, virusoids, viruses, bacteria, fungi, protozoans, certain small algae, and microorganisms that have a benign or beneficial association with plants, such as certain *Rhizobium* species and microorganisms known to cause plant diseases. The appendix applies to microorganisms which are being modified with the objective of fostering an association with plants.

Plant-associated small animals include those arthropods that: (i) are in obligate association with plants, (ii) are plant pests, (iii) are plant pollinators, or (iv) transmit plant disease agents, as well as other small animals such as nematodes for which tests of biological properties necessitate the use of plants. Microorganisms associated with such small animals (e.g., pathogens or symbionts) are included.

The Institutional Biosafety Committee shall include at least one individual with expertise in plant, plant pathogen, or plant pest containment principles when experiments utilizing Appendix P require prior approval by the Institutional Biosafety Committee.

Appendix P-I. General Plant Biosafety Levels

Appendix P-I-A. The principal purpose of plant containment is to avoid the unintentional transmission of a recombinant or synthetic nucleic acid molecule-containing plant genome, including nuclear or organelle hereditary material or release of recombinant or synthetic nucleic acid molecule-derived organisms associated with plants.

Appendix P-I-B. The containment principles are based on the recognition that the organisms that are used pose no health threat to humans or higher animals (unless deliberately modified for that purpose), and that the containment conditions minimize the possibility of an unanticipated deleterious effect on organisms and ecosystems outside of the experimental facility, e.g., the inadvertent spread of a serious pathogen from a greenhouse to a local agricultural crop or the unintentional introduction and establishment of an organism in a new ecosystem.

Appendix P-I-C. Four biosafety levels, referred to as Biosafety Level (BL) 1 - Plants (P), BL2-P, BL3-P, and BL4-P, are established in [Appendix P-II, Physical Containment Levels](#). The selection of containment levels required for research involving recombinant or synthetic nucleic acid molecules in plants or associated with plants is specified in [Appendix P-III, Biological Containment Practices](#). These biosafety levels are described in [Appendix P-II, Physical Containment Levels](#). This appendix describes greenhouse practices and special greenhouse facilities for physical containment.

Appendix P-I-D. BL1-P through BL4-P are designed to provide differential levels of biosafety for plants in the absence or presence of other experimental organisms that contain recombinant or synthetic nucleic acid

molecules. These biosafety levels, in conjunction with biological containment conditions described in [Appendix P-III, Biological Containment Practices](#), provide flexible approaches to ensure the safe conduct of research.

Appendix P-I-E. For experiments in which plants are grown at the BL1 through BL4 laboratory settings, containment practices shall be followed as described in [Appendix G, Physical Containment](#). These containment practices include the use of plant tissue culture rooms, growth chambers within laboratory facilities, or experiments performed on open benches. Additional biological containment practices should be added by the Greenhouse Director or Institutional Biosafety Committee as necessary (see [Appendix P-III, Biological Containment Practices](#)), if botanical reproductive structures are produced that have the potential of being released.

Appendix P-II. Physical Containment Levels

Appendix P-II-A. Biosafety Level 1 - Plants (BL1-P)

Appendix P-II-A-1. Standard Practices (BL1-P)

Appendix P-II-A-1-a. Greenhouse Access (BL1-P)

Appendix P-II-A-1-a-(1). Access to the greenhouse shall be limited or restricted, at the discretion of the Greenhouse Director, when experiments are in progress.

Appendix P-II-A-1-a-(2). Prior to entering the greenhouse, personnel shall be required to read and follow instructions on BL1-P greenhouse practices and procedures. All procedures shall be performed in accordance with accepted greenhouse practices that are appropriate to the experimental organism.

Appendix P-II-A-1-b. Records (BL1-P)

Appendix P-II-A-1-b-(1). A record shall be kept of experiments currently in progress in the greenhouse facility.

Appendix P-II-A-1-c. Decontamination and Inactivation (BL1-P)

Appendix P-II-A-1-c-(1). Experimental organisms shall be rendered biologically inactive by appropriate methods before disposal outside of the greenhouse facility.

Appendix P-II-A-1-d. Control of Undesired Species and Motile Macroorganisms (BL1-P)

Appendix P-II-A-1-d-(1). A program shall be implemented to control undesired species (e.g., weed, rodent, or arthropod pests and pathogens), by methods appropriate to the organisms and in accordance with applicable state and Federal laws.

Appendix P-II-A-1-d-(2). Arthropods and other motile macroorganisms shall be housed in appropriate cages. If macroorganisms (e.g., flying arthropods or nematodes) are released within the greenhouse, precautions shall be taken to minimize escape from the greenhouse facility.

Appendix P-II-A-1-e. Concurrent Experiments Conducted in the Greenhouse (BL1-P)

Appendix P-II-A-1-e-(1). Experiments involving other organisms that require a containment level lower than BL1-P may be conducted in the greenhouse concurrently with experiments that require BL1-P containment, provided that all work is conducted in accordance with BL1-P greenhouse practices.

Appendix P-II-A-2. Facilities (BL1-P)

Appendix P-II-A-2-a. Definitions (BL1-P)

Appendix P-II-A-2-a-(1). The term "greenhouse" refers to a structure with walls, a roof, and a floor designed and used principally for growing plants in a controlled and protected environment. The walls and roof are usually constructed of transparent or translucent material to allow passage of sunlight for plant growth.

Appendix P-II-A-2-a-(2). The term "greenhouse facility" includes the actual greenhouse rooms or compartments for growing plants, including all immediately contiguous hallways and head-house areas, and is considered part of the confinement area.

Appendix P-II-A-2-b. Greenhouse Design (BL1-P)

Appendix P-II-A-2-b-(1). The greenhouse floor may be composed of gravel or other porous material. At a minimum, impervious (e.g., concrete) walkways are recommended.

Appendix P-II-A-2-b-(2). Windows and other openings in the walls and roof of the greenhouse facility may be open for ventilation as needed for proper operation and do not require any special barrier to contain or exclude pollen, microorganisms, or small flying animals (e.g., arthropods and birds); however, screens are recommended.

Appendix P-II-B. Biosafety Level 2 - Plants (BL2-P)

Appendix P-II-B-1. Standard Practices (BL2-P)

Appendix P-II-B-1-a. Greenhouse Access (BL2-P)

Appendix P-II-B-1-a-(1). Access to the greenhouse shall be limited or restricted, at the discretion of the Greenhouse Director, to individuals directly involved with the experiments when they are in progress.

Appendix P-II-B-1-a-(2). Personnel shall be required to read and follow instructions on BL2-P practices and procedures. All procedures shall be conducted in accordance with accepted greenhouse practices that are appropriate to the experimental organisms.

Appendix P-II-B-1-b. Records (BL2-P)

Appendix P-II-B-1-b-(1). A record shall be kept of experimental plants, microorganisms, or small animals that are brought into or removed from the greenhouse facility.

Appendix P-II-B-1-b-(2). A record shall be kept of experiments currently in progress in the greenhouse facility.

Appendix P-II-B-1-b-(3). The Principal Investigator shall report any greenhouse accident involving the inadvertent release or spill of microorganisms to the Greenhouse Director, Institutional Biosafety Committee, NIH/OBA and other appropriate authorities immediately (if applicable). Reports to the NIH/OBA shall be sent to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax). Documentation of any such accident shall be prepared and maintained.

Appendix P-II-B-1-c. Decontamination and Inactivation (BL2-P)

Appendix P-II-B-1-c-(1). Experimental organisms shall be rendered biologically inactive by appropriate methods before disposal outside of the greenhouse facility.

Appendix P-II-B-1-c-(2). Decontamination of run-off water is not necessarily required. If part of the greenhouse is composed of gravel or similar material, appropriate treatments should be made periodically to eliminate, or render inactive, any organisms potentially entrapped by the gravel.

Appendix P-II-B-1-d. Control of Undesired Species and Motile Macroorganisms (BL2-P)

Appendix P-II-B-1-d-(1). A program shall be implemented to control undesired species (e.g., weed, rodent, or arthropod pests and pathogens) by methods appropriate to the organisms and in accordance with applicable state and Federal laws.

Appendix P-II-B-1-d-(2). Arthropods and other motile macroorganisms shall be housed in appropriate cages. If macroorganisms (e.g., flying arthropods or nematodes) are released within the greenhouse, precautions shall be taken to minimize escape from the greenhouse facility.

Appendix P-II-B-1-e. Concurrent Experiments Conducted in the Greenhouse (BL2-P)

Appendix P-II-B-1-e-(1). Experiments involving other organisms that require a containment level lower than BL2-P may be conducted in the greenhouse concurrently with experiments that require BL2-P containment provided that all work is conducted in accordance with BL2-P greenhouse practices.

Appendix P-II-B-1-f. Signs (BL2-P)

Appendix P-II-B-1-f-(1). A sign shall be posted indicating that a restricted experiment is in progress. The sign shall indicate the following: (i) the name of the responsible individual, (ii) the plants in use, and (iii) any special requirements for using the area.

Appendix P-II-B-1-f-(2). If organisms are used that have a recognized potential for causing serious detrimental impacts on managed or natural ecosystems, their presence shall be indicated on a sign posted on the greenhouse access doors.

Appendix P-II-B-1-f-(3). If there is a risk to human health, a sign shall be posted incorporating the universal biosafety symbol.

Appendix P-II-B-1-g. Transfer of Materials (BL2-P)

Appendix P-II-B-1-g-(1). Materials containing experimental microorganisms, which are brought into or removed from the greenhouse facility in a viable or intact state, shall be transferred in a closed non-breakable container.

Appendix P-II-B-1-h. Greenhouse Practices Manual (BL2-P)

Appendix P-II-B-1-h-(1). A greenhouse practices manual shall be prepared or adopted. This manual shall: (i) advise personnel of the potential consequences if such practices are not followed, and (ii) outline contingency plans to be implemented in the event of the unintentional release of organisms.

Appendix P-II-B-2. Facilities (BL2-P)**Appendix P-II-B-2-a. Definitions (BL2-P)**

Appendix P-II-B-2-a-(1). The term "greenhouse" refers to a structure with walls, a roof, and a floor designed and used principally for growing plants in a controlled and protected environment. The walls and roof are usually constructed of transparent or translucent material to allow passage of sunlight for plant growth.

Appendix P-II-B-2-a-(2). The term "greenhouse facility" includes the actual greenhouse rooms or compartments for growing plants, including all immediately contiguous hallways and head-house areas and is considered part of the confinement area.

Appendix P-II-B-2-b. Greenhouse Design (BL2-P)

Appendix P-II-B-2-b-(1). A greenhouse floor composed of an impervious material. Concrete is recommended, but gravel or other porous material under benches is acceptable unless propagules of experimental organisms are readily disseminated through soil. Soil beds are acceptable unless propagules of experimental organisms are readily disseminated through soil.

Appendix P-II-B-2-b-(2). Windows and other openings in the walls and roof of the greenhouse facility may be open for ventilation as needed for proper operation and do not require any special barrier to exclude pollen or microorganisms; however, screens are required to exclude small flying animals (e.g., arthropods and birds).

Appendix P-II-B-2-c. Autoclaves (BL2-P)

Appendix P-II-B-2-c-(1). An autoclave shall be available for the treatment of contaminated greenhouse materials.

Appendix P-II-B-2-d. Supply and Exhaust Air Ventilation Systems (BL2-P)

Appendix P-II-B-2-d-(1). If intake fans are used, measures shall be taken to minimize the ingress of arthropods. Louvers or fans shall be constructed such that they can only be opened when the fan is in operation.

Appendix P-II-B-2-e. Other (BL2-P)

Appendix P-II-B-2-e-(1). BL2-P greenhouse containment requirements may be satisfied by using a growth chamber or growth room within a building provided that the external physical structure limits access and escape of microorganisms and macroorganisms in a manner that satisfies the intent of the foregoing clauses.

Appendix P-II-C. Biosafety Level 3 - Plants (BL3-P)**Appendix P-II-C-1. Standard Practices (BL3-P)****Appendix P-II-C-1-a. Greenhouse Access (BL3-P)**

Appendix P-II-C-1-a-(1). Authorized entry into the greenhouse shall be restricted to individuals who are required for program or support purposes. The Greenhouse Director shall be responsible for assessing each circumstance and determining those individuals who are authorized to enter the greenhouse facility.

Appendix P-II-C-1-a-(2). Prior to entering the greenhouse, personnel shall be required to read and follow instructions on BL3-P practices and procedures. All procedures shall be conducted in accordance with accepted greenhouse practices that are appropriate to the experimental organisms.

Appendix P-II-C-1-b. Records (BL3-P)

Appendix P-II-C-1-b-(1). A record shall be kept of experimental plants, microorganisms, or small animals that are brought into or removed from the greenhouse facility.

Appendix P-II-C-1-b-(2). A record shall be kept of experiments currently in progress in the greenhouse facility.

Appendix P-II-C-1-b-(3). The Principal Investigator shall report any greenhouse accident involving the inadvertent release or spill of microorganisms to the Biological Safety Officer, Greenhouse Director, Institutional Biosafety Committee, NIH/OBA, and other appropriate authorities immediately (if applicable). Reports to the NIH/OBA shall be sent to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax). Documentation of any such accident shall be prepared and maintained.

Appendix P-II-C-1-c. Decontamination and Inactivation (BL3-P)

Appendix P-II-C-1-c-(1). All experimental materials shall be sterilized in an autoclave or rendered biologically inactive by appropriate methods before disposal, except those that are to remain in a viable or intact state for experimental purposes; including water that comes in contact with experimental microorganisms or with material exposed to such microorganisms, and contaminated equipment and supplies.

Appendix P-II-C-1-d. Control of Undesired Species and Motile Macroorganisms (BL3-P)

Appendix P-II-C-1-d-(1). A program shall be implemented to control undesired species (e.g., weed, rodent, or arthropod pests and pathogens) by methods appropriate to the organisms and in accordance with applicable state and Federal laws.

Appendix P-II-C-1-d-(2). Arthropods and other motile macroorganisms shall be housed in appropriate cages. When appropriate to the organism, experiments shall be conducted within cages designed to contain the motile organisms.

Appendix P-II-C-1-e. Concurrent Experiments Conducted in the Greenhouse (BL3-P)

Appendix P-II-C-1-e-(1). Experiments involving organisms that require a containment level lower than BL3-P may be conducted in the greenhouse concurrently with experiments that require BL3-P containment provided that all work is conducted in accordance with BL3-P greenhouse practices.

Appendix P-II-C-1-f. Signs (BL3-P)

Appendix P-II-C-1-f-(1). A sign shall be posted indicating that a restricted experiment is in progress. The sign shall indicate the following: (i) the name of the responsible individual, (ii) the plants in use, and (iii) any special requirements for using the area.

Appendix P-II-C-1-f-(2). If organisms are used that have a recognized potential for causing serious detrimental impacts on managed or natural ecosystems, their presence should be indicated on a sign posted on the greenhouse access doors.

Appendix P-II-C-1-f-(3). If there is a risk to human health, a sign shall be posted incorporating the universal biosafety symbol.

Appendix P-II-C-1-g. Transfer of Materials (BL3-P)

Appendix P-II-C-1-g-(1). Experimental materials that are brought into or removed from the greenhouse facility in a viable or intact state shall be transferred to a non-breakable sealed secondary container. At the time of transfer, if the same plant species, host, or vector are present within the effective dissemination distance of propagules of the experimental organism, the surface of the secondary container shall be decontaminated. Decontamination may be accomplished by passage through a chemical disinfectant or fumigation chamber or by an alternative procedure that has demonstrated effective inactivation of the experimental organism.

Appendix P-II-C-1-h. Greenhouse Practices Manual (BL3-P)

Appendix P-II-C-1-h-(1). A greenhouse practices manual shall be prepared or adopted. This manual shall: (i) advise personnel of the potential consequences if such practices are not followed, and (ii) outline contingency plans to be implemented in the event of the unintentional release of organisms with recognized potential for serious detrimental impact.

Appendix P-II-C-1-i. Protective Clothing (BL3-P)

Appendix P-II-C-1-i-(1). Disposable clothing (e.g., solid front or wrap-around gowns, scrub suits, or other appropriate clothing) shall be worn in the greenhouse if deemed necessary by the Greenhouse Director because of potential dissemination of the experimental microorganisms.

Appendix P-II-C-1-i-(2). Protective clothing shall be removed before exiting the greenhouse and decontaminated prior to laundering or disposal.

Appendix P-II-C-1-j. Other (BL3-P)

Appendix P-II-C-1-j-(1). Personnel are required to thoroughly wash their hands upon exiting the greenhouse.

Appendix P-II-C-1-j-(2). All procedures shall be performed carefully to minimize the creation of aerosols and excessive splashing of potting material/soil during watering, transplanting, and all experimental manipulations.

Appendix P-II-C-2. Facilities (BL3-P)

Appendix P-II-C-2-a. Definitions (BL3-P)

Appendix P-II-C-2-a-(1). The term "greenhouse" refers to a structure with walls, roof, and floor designed and used principally for growing plants in a controlled and protected environment. The walls and roof are usually constructed of transparent or translucent material to allow passage of sunlight for plant growth.

Appendix P-II-C-2-a-(2). The term "greenhouse facility" includes the actual greenhouse rooms or compartments for growing plants, including all immediately contiguous hallways and head-house areas, and is

considered part of the confinement area. The need to maintain negative pressure should be considered when constructing or renovating the greenhouse.

Appendix P-II-C-2-b. Greenhouse Design (BL3-P)

Appendix P-II-C-2-b-(1). The greenhouse floor shall be composed of concrete or other impervious material with provision for collection and decontamination of liquid run-off.

Appendix P-II-C-2-b-(2). Windows shall be closed and sealed. All glazing shall be resistant to breakage (e.g., double-pane tempered glass or equivalent).

Appendix P-II-C-2-b-(3). The greenhouse shall be a closed self-contained structure with a continuous covering that is separated from areas that are open to unrestricted traffic flow. The minimum requirement for greenhouse entry shall be passage through two sets of self-closing locking doors.

Appendix P-II-C-2-b-(4). The greenhouse facility shall be surrounded by a security fence or protected by equivalent security measures.

Appendix P-II-C-2-b-(5). Internal walls, ceilings, and floors shall be resistant to penetration by liquids and chemicals to facilitate cleaning and decontamination of the area. All penetrations into these structures and surfaces (e.g., plumbing and utilities) shall be sealed.

Appendix P-II-C-2-b-(6). Bench tops and other work surfaces should have seamless surfaces that are impervious to water and resistant to acids, alkalis, organic solvents, and moderate heat.

Appendix P-II-C-2-b-(7). The greenhouse contains a foot, elbow, or automatically operated sink, which is located near the exit door for hand washing.

Appendix P-II-C-2-c. Autoclaves (BL3-P)

Appendix P-II-C-2-c-(1). An autoclave shall be available for decontaminating materials within the greenhouse facility. A double-door autoclave is recommended (not required) for the decontamination of materials passing out of the greenhouse facility.

Appendix P-II-C-2-d. Supply and Exhaust Air Ventilation Systems (BL3-P)

Appendix P-II-C-2-d-(1). An individual supply and exhaust air ventilation system shall be provided. The system maintains pressure differentials and directional airflow, as required, to assure inward (or zero) airflow from areas outside of the greenhouse.

Appendix P-II-C-2-d-(2). The exhaust air from the greenhouse facility shall be filtered through high efficiency particulate air-HEPA filters and discharged to the outside. The filter chambers shall be designed to allow *in situ* decontamination before filters are removed and to facilitate certification testing after they are replaced. Air filters shall be 80-85% average efficiency by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standard 52-68 test method using atmosphere dust. Air supply fans shall be equipped with a back-flow damper that closes when the air supply fan is off. Alternatively, a HEPA filter may be used on the air supply system instead of the filters and damper. The supply and exhaust airflow shall be interlocked to assure inward (or zero) airflow at all times.

Appendix P-II-C-2-e. Other (BL3-P)

Appendix P-II-C-2-e-(1). BL3-P greenhouse containment requirements may be satisfied using a growth chamber or growth room within a building provided that the location, access, airflow patterns, and provisions for decontamination of experimental materials and supplies meet the intent of the foregoing clauses.

Appendix P-II-C-2-e-(2). Vacuum lines shall be protected with high efficiency particulate air/HEPA or equivalent filters and liquid disinfectant traps.

Appendix P-II-D. Biosafety Level 4 - Plants (BL4-P)**Appendix P-II-D-1. Standard Practices (BL4-P)****Appendix P-II-D-1-a. Greenhouse Access (BL4-P)**

Appendix P-II-D-1-a-(1). Authorized entry into the greenhouse shall be restricted to individuals who are required for program or support purposes. The Greenhouse Director shall be responsible for assessing each circumstance and determining those individuals who are authorized to enter the greenhouse facility or work in the greenhouse during experiments.

Appendix P-II-D-1-a-(2). Access shall be managed by the Greenhouse Director, Biological Safety Officer, or other individual responsible for physical security of the greenhouse facility; and access limited by means of secure, locked doors.

Appendix P-II-D-1-a-(3). Prior to entering, individuals shall be advised of the potential environmental hazards and instructed on appropriate safeguards for ensuring environmental safety. Individuals authorized to enter the greenhouse facility shall comply with the instructions and all other applicable entry/exit procedures.

Appendix P-II-D-1-a-(4). Personnel shall enter and exit the greenhouse facility only through the clothing change and shower rooms and shall shower each time they exit the greenhouse facility. Personnel shall use the airlocks to enter or exit the laboratory only in an emergency. In the event of an emergency, every reasonable effort should be made to prevent the possible transport of viable propagules from containment.

Appendix P-II-D-1-a-(5). Prior to entering the greenhouse, personnel shall be required to read and follow instructions on BL4-P practices and procedures.

Appendix P-II-D-1-b. Records (BL4-P)

Appendix P-II-D-1-b-(1). A record shall be kept of all experimental materials brought into or removed from the greenhouse.

Appendix P-II-D-1-b-(2). A record shall be kept of experiments currently in progress in the greenhouse facility.

Appendix P-II-D-1-b-(3). A record shall be kept of all personnel entering and exiting the greenhouse facility, including the date and time of each entry.

Appendix P-II-D-1-b-(4). The Principal Investigator shall report any greenhouse accident involving the inadvertent release or spill of microorganisms to the Biological Safety Officer, Greenhouse Director, Institutional Biosafety Committee, NIH/OBA, and other appropriate authorities immediately (if applicable). Reports to the NIH/OBA shall be sent to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax). Documentation of any such accident shall be prepared and maintained.

Appendix P-II-D-1-c. Decontamination and Inactivation (BL4-P)

Appendix P-II-D-1-c-(1). All materials, except for those that are to remain in a viable or intact state for experimental purposes, shall be autoclaved prior to removal from the maximum containment greenhouse. Equipment or material that could be damaged by high temperatures or steam shall be decontaminated by alternative methods (e.g., gas or vapor sterilization) in an airlock or chamber designed for this purpose.

Appendix P-II-D-1-c-(2). Water that comes in contact with experimental microorganisms or with material exposed to such microorganisms (e.g., run-off from watering plants) shall be collected and decontaminated before disposal.

Appendix P-II-D-1-c-(3). Standard microbiological procedures shall be followed for decontamination of equipment and materials. Spray or liquid waste or rinse water from containers used to apply the experimental microorganisms shall be decontaminated before disposal.

Appendix P-II-D-1-d. Control of Undesired Species and Motile Macroorganisms (BL4-P)

Appendix P-II-D-1-d-(1). A chemical control program shall be implemented to eliminate undesired pests and pathogens in accordance with applicable state and Federal laws.

Appendix P-II-D-1-d-(2). Arthropods and other motile macroorganisms used in conjunction with experiments requiring BL4-P level physical containment shall be housed in appropriate cages. When appropriate to the organism, experiments shall be conducted within cages designed to contain the motile organisms.

Appendix P-II-D-1-e. Concurrent Experiments Conducted in the Greenhouse (BL4-P)

Appendix P-II-D-1-e-(1). Experiments involving organisms that require a containment level lower than BL4-P may be conducted in the greenhouse concurrently with experiments that require BL4-P containment provided that all work is conducted in accordance with BL4-P greenhouse practices. When the experimental microorganisms in use require a containment level lower than BL4-P, greenhouse practices reflect the level of containment required by the highest containment level microorganisms being tested.

Appendix P-II-D-1-f. Signs (BL4-P)

Appendix P-II-D-1-f-(1). A sign shall be posted indicating that a restricted experiment is in progress. The sign shall indicate the following: (i) the name of the responsible individual, (ii) the plants in use, and (iii) any special requirements for using the area.

Appendix P-II-D-1-f-(2). If organisms are used that have a recognized potential for causing serious detrimental impacts on managed or natural ecosystems, their presence shall be indicated by a sign posted on the greenhouse access doors.

Appendix P-II-D-1-f-(3). If there is a risk to human health, a sign shall be posted incorporating the universal biosafety symbol.

Appendix P-II-D-1-g. Transfer of Materials (BL4-P)

Appendix P-II-D-1-g-(1). Experimental materials that are brought into or removed from the greenhouse in a viable or intact state shall be transferred to a non-breakable, sealed, primary container then enclosed in a non-breakable, sealed secondary container. These containers shall be removed from the greenhouse facility through a chemical disinfectant, fumigation chamber, or an airlock designed for this purpose.

Appendix P-II-D-1-g-(2). Supplies and materials shall be brought into the greenhouse facility through a double-door autoclave, fumigation chamber, or airlock that is appropriately decontaminated between each use. After securing the outer doors, personnel within the greenhouse facility shall retrieve the materials by opening the interior door of the autoclave, fumigation chamber, or airlock. These doors shall be secured after the materials are brought into the greenhouse facility.

Appendix P-II-D-1-h. Greenhouse Practices Manual (BL4-P)

Appendix P-II-D-1-h-(1). A greenhouse practices manual shall be prepared or adopted. This manual shall include contingency plans to be implemented in the event of the unintentional release of experimental organisms.

Appendix P-II-D-1-i. Protective Clothing (BL4-P)

Appendix P-II-D-1-i-(1). Street clothing shall be removed in the outer clothing change room. Complete laboratory clothing (may be disposable) including undergarments, pants, and shirts, jump suits, shoes, and hats shall be provided and worn by all personnel entering the greenhouse facility.

Appendix P-II-D-1-i-(2). Personnel shall remove laboratory clothing when exiting the greenhouse facility and before entering the shower area. This clothing shall be stored in a locker or hamper in the inner change room.

Appendix P-II-D-1-i-(3). All laboratory clothing shall be autoclaved before laundering.

Appendix P-II-D-2. Facilities (BL4-P)**Appendix P-II-D-2-a. Greenhouse Design (BL4-P)**

Appendix P-II-D-2-a-(1). The maximum containment greenhouse facility shall consist of a separate building or a clearly demarcated and isolated area within a building. The need to maintain negative pressure should be considered when constructing or renovating the greenhouse facility.

Appendix P-II-D-2-a-(2). Outer and inner change rooms, separated by a shower, shall be provided for personnel entering and exiting the greenhouse facility.

Appendix P-II-D-2-a-(3). Windows shall be closed and sealed. All glazing shall be resistant to breakage (e.g., double-pane tempered glass or equivalent).

Appendix P-II-D-2-a-(4). Access doors to the greenhouse shall be self-closing and locking.

Appendix P-II-D-2-a-(5). The greenhouse facility shall be surrounded by a security fence or protected by equivalent security measures.

Appendix P-II-D-2-a-(6). The walls, floors, and ceilings of the greenhouse shall be constructed to form a sealed internal shell that facilitates fumigation and is animal and arthropod-proof. These internal surfaces shall be resistant to penetration and degradation by liquids and chemicals to facilitate cleaning and decontamination of the area. All penetrations into these structures and surfaces (e.g., plumbing and utilities) shall be sealed.

Appendix P-II-D-2-a-(7). Bench tops and other work surfaces shall have seamless surfaces impervious to water and resistant to acids, alkalis, organic solvents, and moderate heat.

Appendix P-II-D-2-a-(8). A double-door autoclave, fumigation chamber, or ventilated airlock shall be provided for passage of all materials, supplies, or equipment that are not brought into the greenhouse facility through the change room.

Appendix P-II-D-2-b. Autoclaves (BL4-P)

Appendix P-II-D-2-b-(1). A double-door autoclave shall be provided for the decontamination of materials removed from the greenhouse facility. The autoclave door, which opens to the area external to the greenhouse facility, shall be sealed to the outer wall and automatically controlled so that it can only be opened upon completion of the sterilization cycle.

Appendix P-II-D-2-c. Supply and Exhaust Air Ventilation Systems (BL4-P)

Appendix P-II-D-2-c-(1). An individual supply and exhaust air ventilation system shall be provided. The system shall maintain pressure differentials and directional airflow as required to assure inward (or zero) airflow from areas outside of the greenhouse. Differential pressure transducers shall be used to sense pressure levels. If a system malfunctions, the transducers shall sound an alarm. A backup source of power should be considered. The supply and exhaust airflow shall be interlocked to assure inward (or zero) airflow at all times. The integrity of the greenhouse shall have an air leak rate (decay rate) not to exceed 7 percent per minute (logarithm of pressure against time) over a 20-minute period at 2 inches of water gauge pressure. Nominally, this is 0.05 inches of water gauge pressure loss in 1 minute at 2 inches water gauge pressure.

Appendix P-II-D-2-c-(2). Exhaust air from the greenhouse facility shall be filtered through high efficiency particulate air/HEPA filters and discharged to the outside and dispersed away from occupied buildings and air intakes. Filter chambers shall be designed to allow *in situ* decontamination before filters are removed and to facilitate certification testing after they are replaced. HEPA filters shall be provided to treat air supplied to the greenhouse facility. HEPA filters shall be certified annually.

Appendix P-II-D-2-d. Other (BL4-P)

Appendix P-II-D-2-d-(1). Sewer vents and other ventilation lines contain high efficiency particulate air/HEPA filters. HEPA filters shall be certified annually.

Appendix P-II-D-2-d-(2). A pass-through dunk tank, fumigation chamber, or an equivalent method of decontamination shall be provided to ensure decontamination of materials and equipment that cannot be decontaminated in the autoclave.

Appendix P-II-D-2-d-(3). Liquid effluent from sinks, floors, and autoclave chambers shall be decontaminated by heat or chemical treatment before being released from the maximum containment greenhouse facility. Liquid wastes from shower rooms and toilets may be decontaminated by heat or chemical treatment. Autoclave and chemical decontamination of liquid wastes shall be evaluated by appropriate standard procedures for autoclaved wastes. Decontamination shall be evaluated mechanically and biologically using a recording thermometer and an indicator microorganism with a defined heat susceptibility pattern. If liquid wastes are decontaminated with chemical disinfectants, the chemicals used must have demonstrated efficacy against the target or indicator microorganisms.

Appendix P-II-D-2-d-(4). If there is a central vacuum system, it shall not serve areas outside of the greenhouse facility. In-line high efficiency particulate air/HEPA filters shall be placed as near as practicable to each use point or vacuum service cock. Other liquid and gas services to the greenhouse facility shall be protected by devices that prevent back-flow. HEPA filters shall be certified annually.

Appendix P-III. Biological Containment Practices

Appropriate selection of the following biological containment practices may be used to meet the containment requirements for a given organism. The present list is not exhaustive; there may be other ways of preventing effective dissemination that could possibly lead to the establishment of the organism or its genetic material in the environment resulting in deleterious consequences to managed or natural ecosystems.

Appendix P-III-A. Biological Containment Practices (Plants)

Appendix P-III-A-1. Effective dissemination of plants by pollen or seed can be prevented by one or more of the following procedures: (i) cover the reproductive structures to prevent pollen dissemination at flowering and seed dissemination at maturity; (ii) remove reproductive structures by employing male sterile strains, or harvest the plant material prior to the reproductive stage; (iii) ensure that experimental plants flower at a time of year when cross-fertile plants are not flowering within the normal pollen dispersal range of the experimental plant; or (iv) ensure that cross-fertile plants are not growing within the known pollen dispersal range of the experimental plant.

Appendix P-III-B. Biological Containment Practices (Microorganisms)

Appendix P-III-B-1. Effective dissemination of microorganisms beyond the confines of the greenhouse can be prevented by one or more of the following procedures: (i) confine all operations to injections of microorganisms or other biological procedures (including genetic manipulation) that limit replication or reproduction of viruses and microorganisms or sequences derived from microorganisms, and confine these injections to internal plant parts or adherent plant surfaces; (ii) ensure that organisms, which can serve as hosts or promote the transmission of the virus or microorganism, are not present within the farthest distance that the airborne virus or microorganism may be expected to be effectively disseminated; (iii) conduct experiments at a time of year when plants that can serve as hosts are either not growing or are not susceptible to productive infection; (iv) use viruses and other microorganisms or their genomes that have known arthropod or animal vectors, in the absence of such vectors; (v) use microorganisms that have an obligate association with the plant; or (vi) use microorganisms that are genetically disabled to minimize survival outside of the research facility and whose natural mode of transmission requires injury of the target organism, or assures that inadvertent release is unlikely to initiate productive infection of organisms outside of the experimental facility.

Appendix P-III-C. Biological Containment Practices (Macroorganisms)

Appendix P-III-C-1. Effective dissemination of arthropods and other small animals can be prevented by using one or more of the following procedures: (i) use non-flying, flight-impaired, or sterile arthropods; (ii) use non-motile or sterile strains of small animals; (iii) conduct experiments at a time of year that precludes the survival of escaping organisms; (iv) use animals that have an obligate association with a plant that is not present within the dispersal range of the organism; or (v) prevent the escape of organisms present in run-off water by chemical treatment or evaporation of run-off water.

APPENDIX Q. PHYSICAL AND BIOLOGICAL CONTAINMENT FOR RECOMBINANT OR SYNTHETIC NUCLEIC ACID MOLECULE RESEARCH INVOLVING ANIMALS

Appendix Q specifies containment and confinement practices for research involving whole animals, both those in which the animal's genome has been altered by stable introduction of recombinant or synthetic nucleic acid molecules, or DNA derived therefrom, into the germ-line (transgenic animals) and experiments involving viable recombinant or synthetic nucleic acid molecule-modified microorganisms tested on whole animals. The appendix applies to animal research activities with the following modifications:

Appendix Q shall supersede [Appendix G](#) (*Physical Containment*) when research animals are of a size or have growth requirements that preclude the use of containment for laboratory animals. Some animals may require other types of containment (see [Appendix Q-III-D](#), *Footnotes and References for Appendix Q*). The animals covered in Appendix Q are those species normally categorized as animals including but not limited to cattle, swine, sheep, goats, horses, and poultry.

The Institutional Biosafety Committee shall include at least one scientist with expertise in animal containment principles when experiments utilizing Appendix Q require Institutional Biosafety Committee prior approval.

The institution shall establish and maintain a health surveillance program for personnel engaged in animal research involving viable recombinant or synthetic nucleic acid molecule-containing microorganisms that require Biosafety Level (BL) 3 or greater containment in the laboratory.

Appendix Q-I. General Considerations

Appendix Q-I-A. Containment Levels

The containment levels required for research involving recombinant or synthetic nucleic acid molecules associated with or in animals is based on classification of experiments in [Section III](#), *Experiments Covered by the NIH Guidelines*. For the purpose of animal research, four levels of containment are established. These are referred to as BL1-Animals (N), BL2-N, BL3-N, and BL4-N and are described in the following appendices of Appendix Q. The descriptions include: (i) standard practices for physical and biological containment, and (ii) animal facilities.

Appendix Q-I-B. Disposal of Animals (BL1-N through BL4-N)

Appendix Q-I-B-1. When an animal covered by Appendix Q containing recombinant or synthetic nucleic acid molecules or a recombinant or synthetic nucleic acid molecule-derived organism is euthanized or dies, the carcass shall be disposed of to avoid its use as food for human beings or animals unless food use is specifically authorized by an appropriate Federal agency.

Appendix Q-I-B-2. A permanent record shall be maintained of the experimental use and disposal of each animal or group of animals.

Appendix Q-II. Physical and Biological Containment Levels

Appendix Q-II-A. Biosafety Level 1 - Animals (BL1-N)

Appendix Q-II-A-1. Standard Practices (BL1-N)

Appendix Q-II-A-1-a. Animal Facility Access (BL1-N)

Appendix Q-II-A-1-a-(1). The containment area shall be locked.

Appendix Q-II-A-1-a-(2). Access to the containment area shall be limited or restricted when experimental animals are being held.

Appendix Q-II-A-1-a-(3). The containment area shall be patrolled or monitored at frequent intervals.

Appendix Q-II-A-1-b. Other (BL1-N)

Appendix Q-II-A-1-b-(1). All genetically engineered neonates shall be permanently marked within 72 hours after birth, if their size permits. If their size does not permit marking, their containers should be marked. In addition, transgenic animals should contain distinct and biochemically assayable DNA sequences that allow identification of transgenic animals from among non-transgenic animals.

Appendix Q-II-A-1-b-(2) A double barrier shall be provided to separate male and female animals unless reproductive studies are part of the experiment or other measures are taken to avoid reproductive transmission. Reproductive incapacitation may be used.

Appendix Q-II-A-1-b-(3). The containment area shall be in accordance with state and Federal laws and animal care requirements.

Appendix Q-II-A-2. Animal Facilities (BL1-N)

Appendix Q-II-A-2-a. Animals shall be confined to securely fenced areas or be in enclosed structures (animal rooms) to minimize the possibility of theft or unintentional release.

Appendix Q-II-B. Biosafety Level 2 - Animals (BL2-N) (See [Appendix Q-III-A, Footnotes and References for Appendix Q](#))

Appendix Q-II-B-1. Standard Practices (BL2-N)**Appendix Q-II-B-1-a. Animal Facility Access (BL2-N)**

Appendix Q-II-B-1-a-(1). The containment area shall be locked.

Appendix Q-II-B-1-a-(2). The containment area shall be patrolled or monitored at frequent intervals.

Appendix Q-II-B-1-a-(3). The containment building shall be controlled and have a locking access.

Appendix Q-II-B-1-a-(4). The Animal Facility Director shall establish policies and procedures whereby only persons who have been advised of the potential hazard and who meet any specific entry requirements (e.g., vaccination) may enter the laboratory or animal rooms.

Appendix Q-II-B-1-a-(5). Animals of the same or different species, which are not involved in the work being performed, shall not be permitted in the animal area.

Appendix Q-II-B-1-b. Decontamination and Inactivation (BL2-N)

Appendix Q-II-B-1-b-(1). Contaminated materials that are decontaminated at a site away from the laboratory shall be placed in a closed durable leak-proof container prior to removal from the laboratory.

Appendix Q-II-B-1-b-(2). Needles and syringes shall be promptly placed in a puncture-resistant container and decontaminated, preferably by autoclaving, before discard or reuse.

Appendix Q-II-B-1-c. Signs (BL2-N)

Appendix Q-II-B-1-c-(1). When the animal research requires special provisions for entry (e.g., vaccination), a warning sign incorporating the universal biosafety symbol shall be posted on all access doors to the animal work area. The sign shall indicate: (i) the agent, (ii) the animal species, (iii) the name and telephone number of the Animal Facility Director or other responsible individual, and (iv) any special requirements for entering the laboratory.

Appendix Q-II-B-1-d. Protective Clothing (BL2-N)

Appendix Q-II-B-1-d-(1). Laboratory coats, gowns, smocks, or uniforms shall be worn while in the animal area or attached laboratory. Before entering non-laboratory areas (e.g., cafeteria, library, administrative offices),

protective clothing shall be removed and kept in the work entrance area.

Appendix Q-II-B-1-d-(2). Special care shall be taken to avoid skin contamination with microorganisms containing recombinant or synthetic nucleic acid molecules. Impervious and/or protective gloves shall be worn when handling experimental animals and when skin contact with an infectious agent is unavoidable.

Appendix Q-II-B-1-e. Records (BL2-N)

Appendix Q-II-B-1-e-(1). Any incident involving spills and accidents that result in environmental release or exposures of animals or laboratory workers to organisms containing recombinant or synthetic nucleic acid molecules shall be reported immediately to the Animal Facility Director, Institutional Biosafety Committee, NIH/OBA, and other appropriate authorities (if applicable). Reports to the NIH/OBA shall be sent to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax). Medical evaluation, surveillance, and treatment shall be provided as appropriate and written records maintained. If necessary, the area shall be appropriately decontaminated.

Appendix Q-II-B-1-e-(2). When appropriate and giving consideration to the agent handled, baseline serum samples shall be collected and stored for animal care and other at-risk personnel. Additional serum specimens may be collected periodically depending on the agent handled and the function of the animal facility.

Appendix Q-II-B-1-f. Transfer of Materials (BL2-N)

Appendix Q-II-B-1-f-(1). Biological materials removed from the animal containment area in a viable or intact state shall be transferred to a non-breakable sealed primary container and then enclosed in a non-breakable sealed secondary container. All containers, primary and secondary, shall be disinfected before removal from the animal facility. Advance approval for transfer of material shall be obtained from the Animal Facility Director. Packages containing viable agents may only be opened in a facility having an equivalent or higher level of physical containment unless the agent is biologically inactivated or incapable of reproduction.

Appendix Q-II-B-1-g. Other (BL2-N)

Appendix Q-II-B-1-g-(1). All genetically engineered neonates shall be permanently marked within 72 hours after birth, if their size permits. If their size does not permit marking, their containers should be marked. In addition, transgenic animals should contain distinct and biochemically assayable DNA sequences that allow identification of transgenic animals from among non-transgenic animals.

Appendix Q-II-B-1-g-(2). Needles and syringes shall be used only for parenteral injection and aspiration of fluids from laboratory animals and diaphragm bottles. Only needle-locking syringes or disposable syringe-needle units (i.e., needle is integral to the syringe) shall be used for the injection or aspiration of fluids containing organisms that contain recombinant or synthetic nucleic acid molecules. Extreme caution shall be used when handling needles and syringes to avoid autoinoculation and the generation of aerosols during use and disposal. Following use, needles shall not be bent, sheared, replaced in the needle sheath or guard, or removed from the syringe. Needles and syringes shall be promptly placed in a puncture-resistant container and decontaminated, preferably by autoclaving, before discard or reuse.

Appendix Q-II-B-1-g-(3). Appropriate steps should be taken to prevent horizontal transmission or exposure of laboratory personnel. If the agent used as a vector is known to be transmitted by a particular route (e.g., arthropods), special attention should be given to preventing spread by that route. In the absence of specific knowledge of a particular route of transmission, all potential means of horizontal transmission (e.g., arthropods, contaminated bedding, or animal waste, etc.) should be prevented.

Appendix Q-II-B-1-g-(4). Eating, drinking, smoking, and applying cosmetics shall not be permitted in the work area.

Appendix Q-II-B-1-g-(5). Individuals who handle materials and animals containing recombinant or synthetic nucleic acid molecules shall be required to wash their hands before exiting the containment area.

Appendix Q-II-B-1-g-(6). A double barrier shall be provided to separate male and female animals unless reproductive studies are part of the experiment or other measures are taken to avoid reproductive transmission.

Reproductive incapacitation may be used.

Appendix Q-II-B-1-g-(7). The containment area shall be in accordance with state and Federal laws and animal care requirements.

Appendix Q-II-B-1-g-(8). A biosafety manual shall be prepared or adopted. Personnel shall be advised of special hazards and required to read and follow instructions on practices and procedures.

Appendix Q-II-B-2. Animal Facilities (BL2-N)

Appendix Q-II-B-2-a. Animals shall be contained within an enclosed structure (animal room or equivalent) to minimize the possibility of theft or unintentional release and to avoid arthropod access. The special provision to avoid the entry or escape of arthropods from the animal areas may be waived if the agent in use is not known to be transmitted by arthropods.

Appendix Q-II-B-2-b. Surfaces shall be impervious to water and resistant to acids, alkalis, organic solvents, and moderate heat.

Appendix Q-II-B-2-c. The animal containment area shall be designed so that it can be easily cleaned.

Appendix Q-II-B-2-d. Windows that open shall be fitted with fly screens.

Appendix Q-II-B-2-e. An autoclave shall be available for decontamination of laboratory wastes.

Appendix Q-II-B-2-f. If arthropods are used in the experiment or the agent under study can be transmitted by an arthropod, interior work areas shall be appropriately screened (52 mesh). All perimeter joints and openings shall be sealed and additional arthropod control mechanisms used to minimize arthropod entry and propagation, including appropriate screening of access doors or the equivalent.

Appendix Q-II-C. Biosafety Level 3 - Animals (BL3-N) (See [Appendix Q-III-B, Footnotes and References for Appendix Q](#))

Appendix Q-II-C-1. Standard Practices (BL3-N)

Appendix Q-II-C-1-a. Animal Facility Access (BL3-N)

Appendix Q-II-C-1-a-(1). The containment area shall be locked.

Appendix Q-II-C-1-a-(2). The containment area shall be patrolled or monitored at frequent intervals.

Appendix Q-II-C-1-a-(3). The containment building shall be controlled and have a locking access.

Appendix Q-II-C-1-a-(4). The Animal Facility Director shall establish policies and procedures whereby only persons who have been advised of the potential hazard and who meet any specific entry requirements (e.g., vaccination) shall enter the laboratory or animal rooms.

Appendix Q-II-C-1-a-(5). Animal room doors, gates, or other closures shall be kept closed when experiments are in progress.

Appendix Q-II-C-1-b. Decontamination and Inactivation (BL3-N)

Appendix Q-II-C-1-b-(1). The work surfaces of containment equipment shall be decontaminated when work with organisms containing recombinant or synthetic nucleic acid molecules is finished. Where feasible, plastic-backed paper toweling shall be used on nonporous work surfaces to facilitate clean-up.

Appendix Q-II-C-1-b-(2). All animals shall be euthanized at the end of their experimental usefulness and the carcasses decontaminated before disposal in an approved manner.

Appendix Q-II-C-1-b-(3). Needles and syringes shall be promptly placed in a puncture-resistant container and decontaminated, preferably by autoclaving, before discard or reuse.

Appendix Q-II-C-1-b-(4). Special safety testing, decontamination procedures, and Institutional Biosafety Committee approval shall be required to transfer agents or tissue/organ specimens from a BL3-N animal facility to a facility with a lower containment classification.

Appendix Q-II-C-1-b-(5). Liquid effluent from containment equipment, sinks, biological safety cabinets, animal rooms, primary barriers, floor drains, and sterilizers shall be decontaminated by heat treatment before being released into the sanitary system. The procedure used for heat decontamination of liquid wastes shall be monitored with a recording thermometer. The effectiveness of the heat decontamination process system shall be revalidated every 30 days with an indicator organism.

Appendix Q-II-C-1-c. Signs (BL3-N)

Appendix Q-II-C-1-c-(1). When the animal research requires special provisions for entry (e.g., vaccination), a warning sign incorporating the universal biosafety symbol shall be posted on all access doors to the animal work area. The sign shall indicate: (i) the agent, (ii) the animal species, (iii) the name and telephone number of the Animal Facility Director or other responsible individual, and (iv) any special requirements for entering the laboratory.

Appendix Q-II-C-1-d. Protective Clothing (BL3-N)

Appendix Q-II-C-1-d-(1). Full protective clothing that protects the individual (e.g., scrub suits, coveralls, uniforms) shall be worn in the animal area. Clothing shall not be worn outside the animal containment area and shall be decontaminated before laundering or disposal. Personnel shall be required to shower before exiting the BL3-N area and wearing of personal clothing.

Appendix Q-II-C-1-d-(2). Special care shall be taken to avoid skin contamination with microorganisms containing recombinant or synthetic nucleic acid molecules. Impervious and/or protective gloves shall be worn when handling experimental animals and when skin contact with an infectious agent is unavoidable.

Appendix Q-II-C-1-d-(3). Appropriate respiratory protection shall be worn in rooms containing experimental animals.

Appendix Q-II-C-1-e. Records (BL3-N)

Appendix Q-II-C-1-e-(1). Documents regarding experimental animal use and disposal shall be maintained in a permanent record book.

Appendix Q-II-C-1-e-(2). Any incident involving spills and accidents that result in environmental release or exposure of animals or laboratory workers to organisms containing recombinant or synthetic nucleic acid molecules shall be reported immediately to the Biological Safety Office, Animal Facility Director, Institutional Biosafety Committee, NIH/OBA, and other appropriate authorities (if applicable). Reports to the NIH/OBA shall be sent to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax). Medical evaluation, surveillance, and treatment shall be provided as appropriate and written records maintained. If necessary, the area shall be appropriately decontaminated.

Appendix Q-II-C-1-e-(3). When appropriate and giving consideration to the agent handled, baseline serum samples shall be collected and stored for animal care and other at-risk personnel. Additional serum specimens may be collected periodically depending on the agent handled or the function of the facility.

Appendix Q-II-C-1-f. Transfer of Materials (BL3-N)

Appendix Q-II-C-1-f-(1). Biological materials removed from the animal containment laboratory in a viable or intact state shall be transferred to a non-breakable sealed primary container and then enclosed in a non-breakable sealed secondary container. All containers, primary and secondary, shall be disinfected before removal from the animal facility. Advance approval for transfer of material shall be obtained from the Animal Facility Director. Packages containing viable agents may be opened only in a facility having an equivalent or higher level of physical containment unless the agent is biologically inactivated or incapable of reproduction.

Appendix Q-II-C-1-f-(2). Special safety testing, decontamination procedures, and Institutional Biosafety Committee approval shall be required to transfer agents or tissue/organ specimens from a BL3-N animal facility to a facility with a lower containment classification.

Appendix Q-II-C-1-g. Other (BL3-N)

Appendix Q-II-C-1-g-(1). All genetically engineered neonates shall be permanently marked within 72 hours after birth, if their size permits. If their size does not permit marking, their containers should be marked. In addition, transgenic animals should contain distinct and biochemically assayable DNA sequences that allow identification of transgenic animals from among non-transgenic animals.

Appendix Q-II-C-1-g-(2). Appropriate steps should be taken to prevent horizontal transmission or exposure of laboratory personnel. If the agent used as the vector is known to be transmitted by a particular route (e.g., arthropods), special attention should be given to preventing spread by that route. In the absence of specific knowledge of a particular route of transmission, all potential means of horizontal transmission (e.g., arthropods, contaminated bedding, or animal waste) should be prevented.

Appendix Q-II-C-1-g-(3). Eating, drinking, smoking, and applying cosmetics shall not be permitted in the work area.

Appendix Q-II-C-1-g-(4). Individuals who handle materials and animals containing recombinant or synthetic nucleic acid molecules shall be required to wash their hands before exiting the containment area.

Appendix Q-II-C-1-g-(5). Experiments involving other organisms that require containment levels lower than BL3-N may be conducted in the same area concurrently with experiments requiring BL3-N containment provided that they are conducted in accordance with BL3-N practices.

Appendix Q-II-C-1-g-(6). Animal holding areas shall be cleaned at least once a day and decontaminated immediately following any spill of viable materials.

Appendix Q-II-C-1-g-(7). All procedures shall be performed carefully to minimize the creation of aerosols.

Appendix Q-II-C-1-g-(8). A double barrier shall be provided to separate male and female animals unless reproductive studies are part of the experiment or other measures are taken to avoid reproductive transmission. Reproductive incapacitation may be used.

Appendix Q-II-C-1-g-(9). The containment area shall be in accordance with state and Federal laws and animal care requirements.

Appendix Q-II-C-1-g-(10). All animals shall be euthanized at the end of their experimental usefulness and the carcasses decontaminated before disposal in an approved manner.

Appendix Q-II-C-1-g-(11). Personnel shall be required to shower before exiting the BL3-N area and wearing personal clothing.

Appendix Q-II-C-1-g-(12). Animals of the same or different species, which are not involved in the work being performed, shall not be permitted in the animal area.

Appendix Q-II-C-1-g-(13). Needles and syringes shall be used only for parenteral injection and aspiration of fluids from laboratory animals and diaphragm bottles. Only needle-locking syringes or disposable syringe-needle units (i.e., needle is integral to the syringe) shall be used for the injection or aspiration of fluids containing organisms that contain recombinant or synthetic nucleic acid molecules. Extreme caution shall be used when handling needles and syringes to avoid autoinoculation and the generation of aerosols during use and disposal. Following use, needles shall not be bent, sheared, replaced in the needle sheath or guard or removed from the syringe. The needles and syringes shall be promptly placed in a puncture-resistant container and decontaminated, preferably by autoclaving, before discard or reuse.

Appendix Q-II-C-1-g-(14). A biosafety manual shall be prepared or adopted. Personnel shall be advised of special hazards and required to read and follow instructions on practices and procedures.

Appendix Q-II-C-2. Animal Facilities (BL3-N)

Appendix Q-II-C-2-a. Animals shall be contained within an enclosed structure (animal room or equivalent) to minimize the possibility of theft or unintentional release and avoid arthropod access. The special provision to avoid the entry or escape of arthropods from the animal areas may be waived if the agent in use is not known to be transmitted by arthropods.

Appendix Q-II-C-2-b. The interior walls, floors, and ceilings shall be impervious to water and resistant to acids, alkalis, organic solvents, and moderate heat, to facilitate cleaning. Penetrations in these structures and surfaces (e.g., plumbing and utilities) shall be sealed.

Appendix Q-II-C-2-c. Windows in the animal facility shall be closed, sealed, and breakage resistant (e.g., double-pane tempered glass or equivalent). The need to maintain negative pressure should be considered when constructing or renovating the animal facility.

Appendix Q-II-C-2-d. An autoclave, incinerator, or other effective means to decontaminate animals and waste shall be available, preferably within the containment area. If feasible, a double-door autoclave is preferred and should be positioned to allow removal of material from the containment area.

Appendix Q-II-C-2-e. If arthropods are used in the experiment or the agent under study can be transmitted by an arthropod, the interior work area shall be appropriately screened (52 mesh). All perimeter joints and openings shall be sealed, and additional arthropod control mechanisms used to minimize arthropod entry and propagation, including appropriate screening, or the equivalent of access doors.

Appendix Q-II-C-2-f. Access doors to the containment area shall be self-closing.

Appendix Q-II-C-2-g. The animal area shall be separated from all other areas. Passage through two sets of doors shall be the basic requirement for entry into the animal area from access corridors or other contiguous areas. The animal containment area shall be physically separated from access corridors and other laboratories or areas by a double-door clothes change room, equipped with integral showers and airlock.

Appendix Q-II-C-2-h. Liquid effluent from containment equipment, sinks, biological safety cabinets, animal rooms, primary barriers, floor drains, and sterilizers shall be decontaminated by heat treatment before being released into the sanitary system. The procedure used for heat decontamination of liquid wastes shall be monitored with a recording thermometer. The effectiveness of the heat decontamination process system shall be revalidated every 30 days with an indicator organism.

Appendix Q-II-C-2-i. An exhaust air ventilation system shall be provided. This system shall create directional airflow that draws air into the animal room through the entry area. The building exhaust, or the exhaust from primary containment units, may be used for this purpose if the exhaust air is discharged to the outside and shall be dispersed away from occupied areas and air intakes. Personnel shall verify that the direction of the airflow (into the animal room) is proper.

Appendix Q-II-C-2-j. If the agent is transmitted by aerosol, then the exhaust air shall pass through a high efficiency particulate air/HEPA filter.

Appendix Q-II-C-2-k. Vacuum lines shall be protected with high efficiency particulate air/HEPA filters and liquid disinfectant traps.

Appendix Q-II-C-2-l. In lieu of open housing in the special animal room, animals held in a BL3-N area may be housed in partial-containment caging systems (e.g., Horsfall units or gnotobiotic systems, or other special containment primary barriers). Prudent judgment must be exercised to implement this ventilation system (e.g., animal species) and its discharge location.

Appendix Q-II-C-2-m. Each animal area shall contain a foot, elbow, or automatically operated sink for hand washing. The sink shall be located near the exit door.

Appendix Q-II-C-2-n. Restraining devices for animals may be required to avoid damage to the integrity of the animal containment facility.

Appendix Q-II-D. Biosafety Level 4 - Animals (BL4-N) (See [Appendix Q-III-C, Footnotes and References for Appendix Q](#))**Appendix Q-II-D-1. Standard Practices (BL4-N)****Appendix Q-II-D-1-a. Animal Facility Access (BL4-N)**

Appendix Q-II-D-1-a-(1). Individuals under 16 years of age shall not be permitted to enter the animal area.

Appendix Q-II-D-1-a-(2). The containment area shall be locked.

Appendix Q-II-D-1-a-(3). The containment area shall be patrolled or monitored at frequent intervals.

Appendix Q-II-D-1-a-(4). The containment building shall be controlled and have a locking access.

Appendix Q-II-D-1-a-(5). The Animal Facility Director shall establish policies and procedures whereby only persons who have been advised of the potential hazard and who meet any specific entry requirements (e.g., vaccination) may enter the laboratory or animal room.

Appendix Q-II-D-1-a-(6). Individuals shall enter and exit the animal facility only through the clothing change and shower rooms.

Appendix Q-II-D-1-a-(7). Personnel shall use the airlocks to enter or exit the laboratory only in an emergency.

Appendix Q-II-D-1-a-(8). Animal room doors, gates, and other closures shall be kept closed when experiments are in progress.

Appendix Q-II-D-1-b. Decontamination and Inactivation (BL4-N)

Appendix Q-II-D-1-b-(1). All contaminated liquid or solid wastes shall be decontaminated before disposal.

Appendix Q-II-D-1-b-(2). The work surfaces and containment equipment shall be decontaminated when work with organisms containing recombinant or synthetic nucleic acid molecules is finished. Where feasible, plastic-backed paper toweling shall be used on nonporous work surfaces to facilitate clean-up.

Appendix Q-II-D-1-b-(3). All wastes from animal rooms and laboratories shall be appropriately decontaminated before disposal in an approved manner.

Appendix Q-II-D-1-b-(4). No materials, except for biological materials that are to remain in a viable or intact state, shall be removed from the maximum containment laboratory unless they have been autoclaved or decontaminated. Equipment or material that might be damaged by high temperatures or steam shall be decontaminated by gaseous or vapor methods in an airlock or chamber designed for this purpose.

Appendix Q-II-D-1-b-(5). When ventilated suits are required, the animal personnel shower entrance/exit area shall be equipped with a chemical disinfectant shower to decontaminate the surface of the suit before exiting the area. A neutralization or water dilution device shall be integral with the chemical disinfectant discharge piping before entering the heat sterilization system. Entry to this area shall be through an airlock fitted with airtight doors.

Appendix Q-II-D-1-b-(6). Needles and syringes shall be promptly placed in a puncture-resistant container and decontaminated, preferably by autoclaving, before discard or reuse.

Appendix Q-II-D-1-b-(7). Supplies and materials needed in the animal facility shall be brought in by way of the double-door autoclave, fumigation chamber, or airlock that shall be appropriately decontaminated between each use.

Appendix Q-II-D-1-b-(8). An autoclave, incinerator, or other effective means to decontaminate animals and wastes shall be available, preferably within the containment area. If feasible, a double-door autoclave is preferred and should be positioned to allow removal of material from the containment area.

Appendix Q-II-D-1-b-(9). Liquid effluent from containment equipment, sinks, biological safety cabinets, animal rooms, primary barriers, floor drains, and sterilizers shall be decontaminated by heat treatment before being released into the sanitary system. Liquid wastes from shower rooms and toilets shall be decontaminated with chemical disinfectants or heat by methods demonstrated to be effective. The procedure used for heat decontamination of liquid wastes shall be monitored with a recording thermometer. The effectiveness of the heat decontamination process system shall be revalidated every 30 days with an indicator organism. Liquid wastes from the shower shall be chemically decontaminated using an Environmental Protection Agency-approved germicide. The efficacy of the chemical treatment process shall be validated with an indicator organism. Chemical disinfectants shall be neutralized or diluted before release into general effluent waste systems.

Appendix Q-II-D-1-c. Signs (BL4-N)

Appendix Q-II-D-1-c-(1). When the animal research requires special provisions for entry (e.g., vaccination), a warning sign incorporating the universal biosafety symbol shall be posted on all access doors to the animal work area. The sign shall indicate: (i) the agent, (ii) the animal species, (iii) the name and telephone number of the Animal Facility Director, or other responsible individual, and (iv) any special requirements for entering the laboratory.

Appendix Q-II-D-1-d. Protective Clothing (BL4-N)

Appendix Q-II-D-1-d-(1). Individuals shall enter and exit the animal facility only through the clothing change and shower rooms. Street clothing shall be removed and kept in the outer clothing change room. Complete laboratory clothing (may be disposable), including undergarments, pants, shirts, jump suits, and shoes shall be provided for all personnel entering the animal facility. When exiting the BL4-N area and before proceeding into the shower area, personnel shall remove their laboratory clothing in the inner change room. All laboratory clothing shall be autoclaved before laundering. Personnel shall shower each time they exit the animal facility.

Appendix Q-II-D-1-d-(2). A ventilated head-hood or a one-piece positive pressure suit, which is ventilated by a life-support system, shall be worn by all personnel entering rooms that contain experimental animals when appropriate. When ventilated suits are required, the animal personnel shower entrance/exit area shall be equipped with a chemical disinfectant shower to decontaminate the surface of the suit before exiting the area. A neutralization or water dilution device shall be integral with the chemical disinfectant discharge piping before entering the heat sterilization system. Entry to this area shall be through an airlock fitted with airtight doors.

Appendix Q-II-D-1-d-(3). Appropriate respiratory protection shall be worn in rooms containing experimental animals.

Appendix Q-II-D-1-e. Records (BL4-N)

Appendix Q-II-D-1-e-(1). Documents regarding experimental animal use and disposal shall be maintained in a permanent record book.

Appendix Q-II-D-1-e-(2). A system shall be established for: (i) reporting laboratory accidents and exposures that are a result of overt exposures to organisms containing recombinant or synthetic nucleic acid molecules, (ii) employee absenteeism, and (iii) medical surveillance of potential laboratory-associated illnesses. Permanent records shall be prepared and maintained. Any incident involving spills and accidents that results in environmental release or exposures of animals or laboratory workers to organisms containing recombinant or synthetic nucleic acid molecules shall be reported immediately to the Biological Safety Officer, Animal Facility Director, Institutional Biosafety Committee, NIH/OBA, and other appropriate authorities (if applicable). Reports to the NIH/OBA shall be sent to the Office of Biotechnology Activities, National Institutes of Health, 6705 Rockledge Drive, Suite 750, MSC 7985, Bethesda, MD 20892-7985 (20817 for non-USPS mail), 301-496-9838, 301-496-9839 (fax). Medical evaluation, surveillance, and treatment shall be provided as appropriate and written records maintained. If necessary, the area shall be appropriately decontaminated.

Appendix Q-II-D-1-e-(3). When appropriate and giving consideration to the agents handled, baseline serum samples shall be collected and stored for animal care and other at-risk personnel. Additional serum specimens may be collected periodically depending on the agents handled or the function of the facility.

Appendix Q-II-D-1-e-(4). A permanent record book indicating the date and time of each entry and exit shall be signed by all personnel.

Appendix Q-II-D-1-f. Transfer of Materials (BL4-N)

Appendix Q-II-D-1-f-(1). No materials, except for biological materials that are to remain in a viable or intact state, shall be removed from the maximum containment laboratory unless they have been autoclaved or decontaminated. Equipment or material that might be damaged by high temperatures or steam shall be decontaminated by gaseous or vapor methods in an airlock or chamber designed for this purpose.

Appendix Q-II-D-1-f-(2). Biological materials removed from the animal maximum containment laboratory in a viable or intact state shall be transferred to a non-breakable sealed primary container and then enclosed in a non-breakable sealed secondary container that shall be removed from the animal facility through a disinfectant dunk tank, fumigation chamber, or an airlock designed for this purpose. Advance approval for transfer of material shall be obtained from the Animal Facility Director. Such packages containing viable agents can only be opened in another BL4-N animal facility if the agent is biologically inactivated or incapable of reproduction. Special safety testing, decontamination procedures, and Institutional Biosafety Committee approval shall be required to transfer agents or tissue/organ specimens from a BL4-N animal facility to one with a lower containment classification.

Appendix Q-II-D-1-f-(3). Supplies and materials needed in the animal facility shall be brought in by way of the double-door autoclave, fumigation chamber, or airlock that shall be appropriately decontaminated between each use. After securing the outer doors, personnel within the animal facility retrieve the materials by opening the interior doors of the autoclave, fumigation chamber, or airlock. These doors shall be secured after materials are brought into the animal facility.

Appendix Q-II-D-1-g. Other (BL4-N)

Appendix Q-II-D-1-g-(1). All genetically engineered neonates shall be permanently marked within 72 hours after birth, if their size permits. If their size does not permit marking, their containers should be marked. In addition, transgenic animals should contain distinct and biochemically assayable DNA sequences that allow identification of transgenic animals from among non-transgenic animals.

Appendix Q-II-D-1-g-(2). Eating, drinking, smoking, and applying cosmetics shall not be permitted in the work area.

Appendix Q-II-D-1-g-(3). Individuals who handle materials and animals containing recombinant or synthetic nucleic acid molecules shall be required to wash their hands before exiting the containment area.

Appendix Q-II-D-1-g-(4). Experiments involving other organisms that require containment levels lower than BL4-N may be conducted in the same area concurrently with experiments requiring BL4-N containment provided that they are conducted in accordance with BL4-N practices.

Appendix Q-II-D-1-g-(5). Animal holding areas shall be cleaned at least once a day and decontaminated immediately following any spill of viable materials.

Appendix Q-II-D-1-g-(6). All procedures shall be performed carefully to minimize the creation of aerosols.

Appendix Q-II-D-1-g-(7). A double barrier shall be provided to separate male and female animals. Animal isolation barriers shall be sturdy and accessible for cleaning. Reproductive incapacitation may be used.

Appendix Q-II-D-1-g-(8). The containment area shall be in accordance with state and Federal laws and animal care requirements.

Appendix Q-II-D-1-g-(9). The life support system for the ventilated suit or head hood is equipped with alarms and emergency back-up air tanks. The exhaust air from the suit area shall be filtered by two sets of high efficiency particulate air/HEPA filters installed in series or incinerated. A duplicate filtration unit, exhaust fan, and an automatically starting emergency power source shall be provided. The air pressure within the suit shall be greater than that of any adjacent area. Emergency lighting and communication systems shall be provided. A

double-door autoclave shall be provided for decontamination of waste materials to be removed from the suit area.

Appendix Q-II-D-1-g-(10). Needles and syringes shall be used only for parenteral injection and aspiration of fluids from laboratory animals and diaphragm bottles. Only needle-locking syringes or disposable syringe-needle units (i.e., needle is integral to the syringe) shall be used for the injection or aspiration of fluids containing organisms that contain recombinant or synthetic nucleic acid molecules. Extreme caution shall be used when handling needles and syringes to avoid autoinoculation and the generation of aerosols during use and disposal. Following use, needles shall

not be bent, sheared, replaced in the needle sheath or guard, or removed from the syringe. The needles and syringes shall be promptly placed in a puncture-resistant container and decontaminated, preferably by autoclaving, before discard or reuse.

Appendix Q-II-D-1-g-(11). An essential adjunct to the reporting-surveillance system is the availability of a facility for quarantine, isolation, and medical care of personnel with potential or known laboratory-associated illnesses.

Appendix Q-II-D-1-g-(12). A biosafety manual shall be prepared or adopted. Personnel shall be advised of special hazards and required to read and follow instructions on practices and procedures.

Appendix Q-II-D-1-g-(13). Vacuum lines shall be protected with high efficiency particulate air/HEPA filters and liquid disinfectant traps.

Appendix Q-II-D-2. Animal Facilities (BL4-N)

Appendix Q-II-D-2-a. Animals shall be contained within an enclosed structure (animal room or equivalent) to minimize the possibility of theft or unintentional release and avoid arthropod access.

Appendix Q-II-D-2-b. The interior walls, floors, and ceilings shall be impervious to water and resistant to acids, alkalis, organic solvents, and moderate heat, to facilitate cleaning. Penetrations in these structures and surfaces (e.g., plumbing and utilities) shall be sealed.

Appendix Q-II-D-2-c. Windows in the animal facility shall be closed, sealed, and breakage resistant (e.g., double-pane tempered glass or equivalent).

Appendix Q-II-D-2-d. An autoclave, incinerator, or other effective means to decontaminate animals and wastes shall be available, preferably within the containment area. If feasible, a double-door autoclave is preferred and should be positioned to allow removal of material from the containment area.

Appendix Q-II-D-2-e. Access doors to the containment area shall be self-closing.

Appendix Q-II-D-2-f. All perimeter joints and openings shall be sealed to form an arthropod-proof structure.

Appendix Q-II-D-2-g. The BL4-N laboratory provides a double barrier to prevent the release of recombinant or synthetic nucleic acid molecule containing microorganisms into the environment. Design of the animal facility shall be such that if the barrier of the inner facility is breached, the outer barrier will prevent release into the environment. The animal area shall be separated from all other areas. Passage through two sets of doors shall be the basic requirement for entry into the animal area from access corridors or other contiguous areas. Physical separation of the animal containment area from access corridors or other laboratories or activities shall be provided by a double-door clothes change room equipped with integral showers and airlock.

Appendix Q-II-D-2-h. A necropsy room shall be provided within the BL4-N containment area.

Appendix Q-II-D-2-i. Liquid effluent from containment equipment, sinks, biological safety cabinets, animal rooms, primary barriers, floor drains, and sterilizers shall be decontaminated by heat treatment before being released into the sanitary system. Liquid wastes from shower rooms and toilets shall be decontaminated with chemical disinfectants or heat by methods demonstrated to be effective. The procedure used for heat decontamination of liquid wastes shall be monitored with a recording thermometer. The effectiveness of the heat decontamination process system shall be revalidated every 30 days with an indicator organism. Liquid

wastes from the shower shall be chemically decontaminated using an Environmental Protection Agency-approved germicide. The efficacy of the chemical treatment process shall be validated with an indicator organism. Chemical disinfectants shall be neutralized or diluted before release into general effluent waste systems.

Appendix Q-II-D-2-j. A ducted exhaust air ventilation system shall be provided that creates directional airflow that draws air into the laboratory through the entry area. The exhaust air, which is not recirculated to any other area of the building, shall be discharged to the outside and dispersed away from the occupied areas and air intakes. Personnel shall verify that the direction of the airflow (into the animal room) is proper.

Appendix Q-II-D-2-k. Exhaust air from BL4-N containment area shall be double high efficiency particulate air/HEPA filtered or treated by passing through a certified HEPA filter and an air incinerator before release to the atmosphere. Double HEPA filters shall be required for the supply air system in a BL4-N containment area.

Appendix Q-II-D-2-l. All high efficiency particulate air/HEPA filters' frames and housings shall be certified to have no detectable smoke [dioctylphthalate] leaks when the exit face (direction of flow) of the filter is scanned above 0.01 percent when measured by a linear or logarithmic photometer. The instrument must demonstrate a threshold sensitivity of at least 1×10^{-3} micrograms per liter for 0.3 micrometer diameter dioctylphthalate particles and a challenge concentration of 80-120 micrograms per liter. The air sampling rate should be at least 1 cfm (28.3 liters per minute).

Appendix Q-II-D-2-m. If an air incinerator is used in lieu of the second high efficiency particulate air/HEPA filter, it shall be biologically challenged to prove all viable test agents are sterilized. The biological challenge must be minimally 1×10^8 organisms per cubic foot of airflow through the incinerator. It is universally accepted if bacterial spores are used to challenge and verify that the equipment is capable of killing spores, then assurance is provided that all other known agents are inactivated by the parameters established to operate the equipment. Test spores meeting this criterion are *Bacillus subtilis* var. *niger* or *Bacillus stearothermophilis*. The operating temperature of the incinerator shall be continuously monitored and recorded during use.

Appendix Q-II-D-2-n. All equipment and floor drains shall be equipped with deep traps (minimally 5 inches). Floor drains shall be fitted with isolation plugs or fitted with automatic water fill devices.

Appendix Q-II-D-2-o. Each animal area shall contain a foot, elbow, or automatically operated sink for hand washing. The sink shall be located near the exit door.

Appendix Q-II-D-2-p. Restraining devices for animals may be required to avoid damage to the integrity of the containment animal facility.

Appendix Q-II-D-2-q. The supply water distribution system shall be fitted with a back-flow preventer or break tank.

Appendix Q-II-D-2-r. All utilities, liquid and gas services, shall be protected with devices that avoid back-flow.

Appendix Q-II-D-2-s. Sewer and other atmospheric ventilation lines shall be equipped minimally with a single high efficiency particulate/HEPA filter. Condensate drains from these type housings shall be appropriately connected to a contaminated or sanitary drain system. The drain position in the housing dictates the appropriate system to be used.

Appendix Q-III. Footnotes and References for Appendix Q

Appendix Q-III-A. If a recombinant or synthetic nucleic acid molecule is derived from a Class 2 organism requiring BL2 containment, personnel shall be required to have specific training in handling pathogenic agents and directed by knowledgeable scientists.

Appendix Q-III-B. Personnel who handle pathogenic and potentially lethal agents shall be required to have specific training and be supervised by knowledgeable scientists who are experienced in working with these agents. BL3-N containment also minimizes escape of recombinant or synthetic nucleic acid molecule-containing organisms from exhaust air or waste material from the containment area.

Appendix Q-III-C. Risk Group 4 and restricted microorganisms (see [Appendix B, Classification of Human Etiologic Agents on the Basis of Hazard](#), and [Sections V-G and V-L, Footnotes and References of Sections I through IV](#)) pose a high level of individual risk for acquiring life-threatening diseases to personnel and/or animals. To import animal or plant pathogens, special approval must be obtained from [U.S. Department of Agriculture, Animal and Plant Health Inspection Service \(APHIS\)](#), Veterinary Services, National Center for Import-Export, Products Program, 4700 River Road, Unit 40, Riverdale, MD 20737. Phone: (301) 734-8499; Fax: (301) 734-8226.

Laboratory staff shall be required to have specific and thorough training in handling extremely hazardous infectious agents, primary and secondary containment, standard and special practices, and laboratory design characteristics. The laboratory staff shall be supervised by knowledgeable scientists who are trained and experienced in working with these agents and in the special containment facilities.

Within work areas of the animal facility, all activities shall be confined to the specially equipped animal rooms or support areas. The maximum animal containment area and support areas shall have special engineering and design features to prevent the dissemination of microorganisms into the environment via exhaust air or waste disposal.

Appendix Q-III-D. Other research with non-laboratory animals, which may not appropriately be conducted under conditions described in [Appendix Q](#), may be conducted safely by applying practices routinely used for controlled culture of these biota. In aquatic systems, for example, BL1 equivalent conditions could be met by utilizing growth tanks that provide adequate physical means to avoid the escape of the aquatic species, its gametes, and introduced exogenous genetic material. A mechanism shall be provided to ensure that neither the organisms nor their gametes can escape into the supply or discharge system of the rearing container (e.g., tank, aquarium, etc.) Acceptable barriers include appropriate filtration, irradiation, heat treatment, chemical treatment, etc. Moreover, the top of the rearing container shall be covered to avoid escape of the organism and its gametes. In the event of tank rupture, leakage, or overflow, the construction of the room containing these tanks should prevent the organisms and gametes from entering the building's drains before the organism and its gametes have been inactivated.

Other types of non-laboratory animals (e.g., nematodes, arthropods, and certain forms of smaller animals) may be accommodated by using the appropriate BL1 through BL4 or BL1-P through BL4-P containment practices and procedures as specified in [Appendices G and P](#).

Appendix B: Biosafety Levels for Biological Agents

| Bacterial Agents | BSL |
|------------------------------------|------------|
| Actinetobacter calceticus | 2 |
| Actinobacillus sp. | 2 |
| Actinomyces sp. | 2 |
| Aeromaonas sp. | 2 |
| Arachnida propionica | 2 |
| Bacillus alvei | 2 |
| Bacillus anthracis* | 2 |
| Bacteroides sp. | 2 |
| Bartonella sp. | 3 |
| Bordetella sp. | 2 |
| Bordetella pertussis | 2 |
| Borrelia sp. | 2 |
| Brucella sp.* | 2/3 |
| Campylobacter fetus var. jejuni | 2 |
| Camplobacter sp. | 2 |
| Chlamydia psittaci | 2 |
| Chlamydia pneumoniae | 2/3 |
| Chlamydia trachomatis | 3 |
| Clostridium botulinum* | 2/3 |
| Clostridium tetani | 2 |
| Corynebacterium diphtheriae | 2 |
| Corynebacterium equi | 2 |
| Corynebacterium haemolyticum | 2 |
| Corynebacterium pseudotuberculosis | 2 |
| Corynebacterium pysogenes | 2 |
| Corynebacterium renale | 2 |
| Enterobacteriaceae all other | 2 |
| Erysipelothrix rhusiopathiae | 2 |
| Escherichia coli | 2 |
| Escherichia coli K12 derivative | 1 |
| Francisella tularensis* | 2/3 |
| Fusobacterium sp. | 2 |
| Haemophilus sp. | 2 |
| Klebsiella sp. | 2 |
| Legionella pneumophilia | 2/3 |
| Leptospira interrogans all servars | 2 |
| Listeria sp. | 2 |
| Moraxella sp. | 2 |
| Mycobacterium avium | 2 |
| Mycobacterium bovis | 3 |

| | |
|------------------------------|-----|
| Mycobacterium leprae | 2 |
| Mycobacterium sp. | 2 |
| Mycobacterium tuberculosis | 2/3 |
| Mycoplasma sp. | 2 |
| Neisseria gonorrhoeae | 2/3 |
| Neisseria meningitidis | 2/3 |
| Nocardia sp. | 2 |
| Pasteurella sp. | 2 |
| Pseudomonas mallei | 2/3 |
| Neisseria gonorrhoeae | 2/3 |
| Pseudomonas testoserone | 2 |
| Rotococcus (Coryne.) equi | 2 |
| Salmonella sp. | 2 |
| Salmonella typhi | 2/3 |
| Shigella sp. | 2 |
| Staphylococcus sp. | 2 |
| Streptococcus sp. | 2 |
| Streptocacillus moniliformis | 2 |
| Streptomyces somaliensis | 2 |
| Treponema pallidum | 2 |
| Vibrio sp. | 2 |
| Yersinia pestis* | 2/3 |

| Fungal Agents | BSL |
|---------------------------------|------------|
| Blastomyces dermatitides | 2 |
| Coccidioides immitis* | 2/3 |
| Cryptococcus neoformans | 2 |
| Epidermophyton - pathogenic sp. | 2 |
| Histoplasma capsulatum | 2/3 |
| Microsporium - pathogenic sp. | 2 |
| Paracoccidioides brasiliensis | 2 |
| Sporothrix schenckii | 2 |
| Trichophyton - pathogenic sp. | 2 |
| Candida albicans | 2 |
| Miscellaneous Molds | 2 |

| Parasitic Agents | BSL |
|-------------------------|------------|
| Anaplasma sp. | 2 |
| Ascaris sp. | 2 |
| Coccidia sp. | 2 |
| Cryptosporidia sp. | 2 |

| | |
|-------------------------|---|
| Echinococcus Granulosus | 2 |
| Ehrlichia sp. | 2 |
| Entamoeba sp. | 2 |
| Enterobius sp. | 2 |
| Fasciola sp. | 2 |
| Giardia sp. | 2 |
| Haemobartonella sp. | 2 |
| Hymenolepsis nana | 2 |
| Leishmania sp. | 2 |
| Leukocytozoon sp. | 2 |
| Naegleria sp. | 2 |
| Plasmodium sp. | 2 |
| Sarcocystis sp. | 2 |
| Schistosoma sp. | 2 |
| Strongyloides sp. | 2 |
| Taenia solium | 2 |
| Toxocara canis | 2 |
| Toxoplasma sp. | 2 |
| Trichinella spiralis | 2 |
| Trypanosoma sp. | 2 |

| Rickettsial Agents | BSL |
|-------------------------------|------------|
| Coxiella burnetii* | 2/3 |
| Rickettsia akari | 2/3 |
| Rickettsia australis | 2/3 |
| Rickettsia canada | 2/3 |
| Rickettsia conorii | 2/3 |
| Rickettsia prowazekii* | 2/3 |
| Rickettsia rickettsii* | 2/3 |
| Rickettsia siberica | 2/3 |
| Rickettsia tsutsugamushi | 2/3 |
| Rickettsia typhi (R. mooseri) | 2/3 |
| Rochalimaea quintana | 2 |
| Rochalimaea vinsonii | 2 |
| Spotted Fever Group - other | 2/3 |

| Viral Agents | BSL |
|-----------------------------|------------|
| Adenoviruses | 2 |
| Adenoviruses - animal - all | 2 |
| Aleutian Disease Virus | 2 |
| Arboviruses - certain | 2 |

| | |
|---|---|
| Arboviruses - certain | 3 |
| Arboviruses - certain | 4 |
| Arenaviruses - certain | 3 |
| Arenaviruses - certain | 4 |
| Avian Erthyroblastosis Virus | 2 |
| Avian Leucosis Virus | 2 |
| Avian Lymphomatosis Virus | 2 |
| Avian Myeloblastosis Virus | 2 |
| Bovine Encephalomyelitis Virus | 2 |
| Bovine Leukemia Virus | 2 |
| Bovine Respiratory Syncytial Virus | 2 |
| Bovine Rhinotracheitis (IBR) | 2 |
| Cache Valley Virus | 2 |
| Canine Hepatitis Virus | 2 |
| Canine Distemper Virus | 2 |
| Caprine Arthritis | 2 |
| Coxsackie A & B Viruses | 2 |
| Cytomegaloviruses | 2 |
| Encephalomyelitis Virus* | 2 |
| Echovirus | 2 |
| Dengue Virus | 2 |
| Encephalomyocarditis Virus | 2 |
| Epidemic Diarrhea Infant Mice | 2 |
| Epstein-Barr Virus | 2 |
| Feline Leukemia Virus | 2 |
| Feline Sarcoma Virus | 2 |
| Filoviruses | 2 |
| Flanders Virus | 2 |
| Gibbon Ape Lymphosarcoma | 2 |
| Hart Park Virus | 2 |
| Hemorrhagic Fever Agents* | 2 |
| Hepatitis A Virus, Hepatitis E Virus | 2 |
| Hepatitis B Virus, Hepatitis C Virus, Hepatitis D Virus | 2 |
| Herpesvirus - other | 2 |
| Herpesvirus ateles | 2 |
| Herpesvirus saimir | 2 |
| Herpesvirus Simiae (B-virus) | 3 |
| Human Herpesviruses | 2 |
| Hog Cholera Virus | 2 |
| Human T-Cell Leukemia Virus I & II | 2 |
| Infectious Bronchitis Virus | 2 |

| | |
|------------------------------------|-----|
| Influenza Virus | 2 |
| Influenza Virus Virulent Avian | 3 |
| K (Rate) Virus | 2 |
| Lactic Dehydrogenase Elevating | 2 |
| Langat Virus | 2 |
| Laryngotracheitis Virus | 2 |
| Lassa Virus* | 4 |
| Low Risk Oncogenic Viruses | 2 |
| Lymphocytic Choriomeningitis Virus | 2/3 |
| Marburg Virus* | 4 |
| Measles Virus | 2 |
| Meningopneumonitis Virus | 2 |
| Mouse Encephalomyelitis Virus | 2 |
| Mouse Hepatitis Virus | 2 |
| Mouse Leukemia Virus | 2 |
| Mouse Pneumonia Virus | 2 |
| Mumps Virus | 2 |
| Myxomatosis Virus | 2 |
| Newcastle Disease Virus | 2 |
| Newcastle Disease Virus (VVND) | 2 |
| Non-Defective Adenovirus 2SV40 HYB | 2 |
| Papilloma Virus Shope | 2 |
| Parainfluenza Virus | 2 |
| Poliovirus - all types | 2 |
| Polyoma Virus | 2 |
| Poxvirus alastrim | 2 |
| Poxvirus monkey pox | 3 |
| Poxvirus - Smallpox* | |
| Poxvirus sp. | 2 |
| Pseudorabies Virus | 2 |
| Rabies Virus | 2/3 |
| Reovirus sp. | 2 |
| Respiratory Syncytial Virus | 2 |
| Retroviruses, including HIV & SIV | 2/3 |
| Rhinovirus sp. | 2 |
| Rous Sarcoma Virus | 2 |
| Rubella Virus | 2 |
| Simian Virus - other | 2 |
| Simian T-Cell Leukemia Virus | 2 |
| Sindbis Virus | 2 |
| Slow Viruses | 2 |

| | |
|---|---|
| Tensaw Virus | 2 |
| Tick-Borne Encephalitis Complex | 4 |
| Transmissible Spongiform Encephalopathies (Creutzfeldt-Jakob, kuru, and related agents) | 2 |
| Turlock Virus | 2 |
| Vaccinia Virus | 2 |
| Venezuelan Equine Encephalitis* | 3 |
| Vesicular Stomatitis - lab adapted | 2 |
| Vesicular Stomatitis Virus | 3 |
| Woolly Monkey Fibrosarcoma | 3 |
| Yaba Virus | 2 |
| Yellow Fever Virus 17D Strain* | 2 |
| Yellow Fever Virus Except 17D* | 3 |

* - Select agents

Appendix C: Plant Biosafety

Biosafety Levels for Experiments involving Plants with rDNA/sNAs and microorganisms

Note: the following definition is used for the term “exotic plant pathogen” per NIH Guidelines:

In accordance with accepted scientific and regulatory practices of the discipline of plant pathology, an exotic plant pathogen (e.g., virus, bacteria, or fungus) is one that is unknown to occur within the U.S. (see [Section V-G](#), *Footnotes and References of Sections I-IV*). Determination of whether a pathogen has a potential for serious detrimental impact on managed (agricultural, forest, grassland) or natural ecosystems should be made by the Principal Investigator and the Institutional Biosafety Committee, in consultation with scientists knowledgeable of plant diseases, crops, and ecosystems in the geographic area of the research (**Section V-M**).

Biosafety Level 1- Plants (BL1-P)

BL1-P includes all experiments with recombinant or synthetic nucleic acid molecule-containing plants and plant-associated microorganisms not covered in [Section III-E-2-b](#) or other sections of the *NIH Guidelines*. Examples of such experiments include:

- those involving recombinant or synthetic nucleic acid molecule-modified plants that are not noxious weeds or
- plants that cannot interbreed with noxious weeds in the immediate geographic area, or
- experiments involving whole plants and recombinant or synthetic nucleic acid molecule-modified non-exotic or
- microorganisms that have no recognized potential for rapid and widespread dissemination or for serious detrimental impact on managed or natural ecosystems (e.g., *Rhizobium* spp. and *Agrobacterium* spp.) **Section III-E-2-a**.

Biosafety Level 2- Plants (BL2-P)

BL2-P includes:

- Experiments involving modification of plants by recombinant or synthetic nucleic acid molecules that are noxious weeds or can interbreed with noxious weeds in the immediate geographic area. **Section III-E-2-b(1)**.

- Experiments in which the introduced DNA represents the complete genome of a non-exotic infectious agent into plants. **Section III-E-2-b-(2).**
- Plants associated with recombinant or synthetic nucleic acid molecule-modified non-exotic microorganisms that have a recognized potential for serious detrimental impact on managed or natural ecosystems. **Section III-E-2-b-(3).**
- Plants associated with recombinant or synthetic nucleic acid molecule-modified exotic microorganisms that have no recognized potential for serious detrimental impact on managed or natural ecosystems. **Section III-E-2-b-(4).**
- Experiments with recombinant or synthetic nucleic acid molecule-modified arthropods or small animals associated with plants, or with arthropods or small animals with recombinant or synthetic nucleic acid molecule-modified microorganisms associated with them if the recombinant or synthetic nucleic acid molecule-modified microorganisms have no recognized potential for serious detrimental impact on managed or natural ecosystems. **Section III-E-2-b-(5).**

Biosafety Level 3- Plants (BL3-P)

BL3-P includes:

- Experiments involving most exotic (see [Section V-M](#), *Footnotes and References of Sections I-IV*) infectious agents with recognized potential for serious detrimental impact on managed or natural ecosystems when recombinant or synthetic nucleic acid molecule techniques are associated with whole plants. **Section III-D-5-a.**
- Experiments involving plants containing cloned genomes of readily transmissible exotic (see [Section V-M](#), *Footnotes and References of Sections I-IV*) infectious agents with recognized potential for serious detrimental effects on managed or natural ecosystems in which there exists the possibility of reconstituting the complete and functional genome of the infectious agent by genomic complementation *in planta*. **Section III-D-5-b.**
- Experiments involving sequences encoding potent vertebrate toxins introduced into plants or associated organisms. Recombinant or synthetic nucleic acid molecules containing genes for the biosynthesis of toxin molecules lethal for vertebrates at an LD₅₀ of <100 nanograms per kilogram body weight fall under [Section III-B-1](#), *Experiments Involving the Cloning of Toxin Molecules with LD₅₀ of Less than 100 Nanograms Per Kilogram Body Weight*, and require NIH/OBA and Institutional Biosafety Committee approval before initiation. **Section III-D-5-d.**
- Experiments with microbial pathogens of insects or small animals associated with plants if the recombinant or synthetic nucleic acid molecule-modified organism has a recognized potential for serious detrimental impact on managed or natural ecosystems. **Section III-D-5-e**

Biosafety Level 4- Plants (BL4-P)

BL4-P includes:

- Experiments with a small number of readily transmissible exotic (see [Section V-M](#), *Footnotes and References of Sections I-IV*) infectious agents, such as the soybean rust fungus (*Phakospora pachyrhizi*) and maize streak or other viruses in the presence of their specific arthropod vectors, that have the potential of being serious pathogens of major U.S. crops

Table 1. Containment Practices for Biosafety Level 1- 3 Plants

| | Biosafety Level 1-Plants (BL1 - P) |
|---|--|
| Greenhouse Access | <ul style="list-style-type: none">• Access to the greenhouse shall be limited or restricted, at the discretion of the Greenhouse Director, when experiments are in progress.• Prior to entering the greenhouse, personnel shall be required to read and follow instructions on BL1-P greenhouse practices and procedures.• All procedures shall be performed in accordance with accepted greenhouse practices that are appropriate to the experimental organism. |
| Records | <ul style="list-style-type: none">• A record shall be kept of experiments currently in progress in the greenhouse facility. |
| Decontamination and Inactivation | <ul style="list-style-type: none">• Experimental organisms shall be rendered biologically inactive by appropriate methods before disposal outside of the greenhouse facility. |

| | Biosafety Level 1-Plants (BL1 - P) |
|---|--|
| Control of Undesired Species and Motile Macroorganisms | <ul style="list-style-type: none"> • A program shall be implemented to control undesired species (e.g., weed, rodent, or arthropod pests and pathogens), by methods appropriate to the organisms and in accordance with applicable state and Federal laws. • Arthropods and other motile macroorganisms shall be housed in appropriate cages. If macroorganisms (e.g., flying arthropods or nematodes) are released within the greenhouse, precautions shall be taken to minimize escape from the greenhouse facility. |
| Concurrent Experiments Conducted in the Greenhouse | <ul style="list-style-type: none"> • Experiments involving other organisms that require containment level lower than BL1-P may be conducted in the greenhouse concurrently with experiments that require BL1-P containment, provided that all work is conducted in accordance with BL1-P greenhouse practices. |

| | Biosafety Level 2-Plants (BL2 - P) |
|--------------------------|--|
| Greenhouse Access | <ul style="list-style-type: none"> • Access to the greenhouse shall be limited or restricted, at the discretion of the Greenhouse Director, to individuals directly involved with the experiments when they are in progress. • Personnel shall be required to read and follow instructions on BL2-P practices and procedures. All procedures shall be conducted in accordance with accepted greenhouse practices that are appropriate to the experimental organisms. |
| Records | <ul style="list-style-type: none"> • A record shall be kept of experimental plants, microorganisms, or small animals that are brought into or removed from the greenhouse facility and shall be kept of experiments currently in progress in the greenhouse facility. • Principal Investigator shall report any greenhouse accident involving the inadvertent release or spill of microorganisms to the Greenhouse Director, Institutional Biosafety Committee, NIH/OBA and other appropriate authorities immediately (if applicable). Reports |

| | Biosafety Level 2-Plants (BL2 - P) |
|---|--|
| Decontamination and Inactivation | <ul style="list-style-type: none"> • Experimental organisms shall be rendered biologically inactive by appropriate methods before disposal outside of the greenhouse facility. |
| Control of Undesired Species and Motile Macroorganisms | <ul style="list-style-type: none"> • A program shall be implemented to control undesired species (e.g., weed, rodent, or arthropod pests and pathogens) by methods appropriate to the organisms and in accordance with applicable state and Federal laws. • Arthropods and other motile macroorganisms shall be housed in appropriate cages. If macroorganisms (e.g., flying arthropods or nematodes) are released within the greenhouse, precautions shall be taken to minimize escape from the greenhouse facility. |
| Concurrent Experiments Conducted in the Greenhouse | <ul style="list-style-type: none"> • Experiments involving other organisms that require a containment level lower than BL2-P may be conducted in the greenhouse concurrently with experiments that require BL2-P containment provided that all work is conducted in accordance with BL2-P greenhouse practices. |
| Other Practices | <ul style="list-style-type: none"> • A sign shall be posted indicating that a restricted experiment is in progress. The sign shall indicate the following: (i) the name of the responsible individual, (ii) the plants in use, and (iii) any special requirements for using the area. • Materials containing experimental microorganisms, which are brought into or removed from the greenhouse facility in a viable or intact state, shall be transferred in a closed non-breakable container. • A greenhouse practices manual shall be prepared or adopted. This manual shall: (i) advise personnel of the potential consequences if such practices are not followed, and (ii) outline contingency plans to be implemented in the event of the unintentional release of organisms. • An autoclave shall be available for the treatment of contaminated greenhouse materials. • If intake fans are used, measures shall be taken to minimize the ingress of arthropods. Louvers or fans shall be constructed such that they can only be opened when the fan is in operation. |

| | Biosafety Level 3-Plants (BL 3 - P) |
|---|--|
| Greenhouse Access | <ul style="list-style-type: none"> • Authorized entry into the greenhouse shall be restricted to individuals who are required for program or support purposes. The Greenhouse Director shall be responsible for assessing each circumstance and determining those individuals who are authorized to enter the greenhouse facility. • Prior to entering the greenhouse, personnel shall be required to read and follow instructions on BL3-P practices and procedures. All procedures shall be conducted in accordance with accepted greenhouse practices that are appropriate to the experimental organisms. |
| Records | <ul style="list-style-type: none"> • A record shall be kept of experimental plants, microorganisms, or small animals that are brought into or removed from the greenhouse facility and shall be kept of experiments currently in progress in the greenhouse facility. • The Principal Investigator shall report any greenhouse accident involving the inadvertent release or spill of microorganisms to the Biological Safety Officer, Greenhouse Director, Institutional Biosafety Committee, NIH/OBA, and other appropriate authorities immediately (if applicable). |
| Decontamination and Inactivation | <ul style="list-style-type: none"> • All experimental materials shall be sterilized in an autoclave or rendered biologically inactive by appropriate methods before disposal, except those that are to remain in a viable or intact state for experimental purposes; including water that comes in contact with experimental microorganisms or with material exposed to such microorganisms, and contaminated equipment and supplies. |

| | Biosafety Level 3-Plants (BL 3 - P) |
|---|--|
| Control of Undesired Species and Motile Macroorganisms | <ul style="list-style-type: none"> • A program shall be implemented to control undesired species (e.g., weed, rodent, or arthropod pests and pathogens) by methods appropriate to the organisms and in accordance with applicable state and Federal laws. • Arthropods and other motile macroorganisms shall be housed in appropriate cages. When appropriate to the organism, experiments shall be conducted within cages designed to contain the motile organisms. |
| Concurrent Experiments Conducted in the Greenhouse | <ul style="list-style-type: none"> • Experiments involving organisms that require a containment level lower than BL3-P may be conducted in the greenhouse concurrently with experiments that require BL3-P containment provided that all work is conducted in accordance with BL3-P greenhouse practices. |
| Other Practices | <ul style="list-style-type: none"> • A sign shall be posted indicating that a restricted experiment is in progress. The sign shall indicate the following: (i) the name of the responsible individual, (ii) the plants in use, and (iii) any special requirements for using the area. • If organisms are used that have a recognized potential for causing serious detrimental impacts on managed or natural ecosystems, their presence should be indicated on a sign posted on the greenhouse access doors. • Experimental materials that are brought into or removed from the greenhouse facility in a viable or intact state shall be transferred to a non-breakable sealed secondary container. At the time of transfer, if the same plant species, host, or vector are present within the effective dissemination distance of propagules of the experimental organism, the surface of the secondary container shall be decontaminated. Decontamination may be accomplished by passage through a chemical disinfectant or fumigation chamber or by an alternative procedure that has demonstrated effective inactivation of the experimental organism. • A greenhouse practices manual shall be prepared or adopted. This manual shall: (i) advise personnel of the potential consequences if such practices are not followed, and (ii) outline contingency plans to |

| | |
|--|---|
| | <p>Biosafety Level 3-Plants (BL 3 - P)</p> |
| | <p>be implemented in the event of the unintentional release of organisms with recognized potential for serious detrimental impact.</p> <ul style="list-style-type: none"> • Disposable clothing (e.g., solid front or wrap-around gowns, scrub suits, or other appropriate clothing) shall be worn in the greenhouse if deemed necessary by the Greenhouse Director because of potential dissemination of the experimental microorganisms. • Protective clothing shall be removed before exiting the greenhouse and decontaminated prior to laundering or disposal. • Personnel are required to thoroughly wash their hands upon exiting the greenhouse. • All procedures shall be performed carefully to minimize the creation of aerosols and excessive splashing of potting material/soil during watering, transplanting, and all experimental manipulations. • An autoclave shall be available for decontaminating materials within the greenhouse facility. A double-door autoclave is recommended (not required) for the decontamination of materials passing out of the greenhouse facility. • An individual supply and exhaust air ventilation system shall be provided. The system maintains pressure differentials and directional airflow, as required, to assure inward (or zero) airflow from areas outside of the greenhouse. • The exhaust air from the greenhouse facility shall be filtered through high efficiency particulate air-HEPA filters and discharged to the outside. |

Appendix D: Select Agents and Toxins

HHS AND USDA SELECT AGENTS AND TOXINS
7 CFR Part 331, 9 CFR Part 121, and 42 CFR Part 73

HHS SELECT AGENTS AND TOXINS

Abrin
 Botulinum neurotoxins*
 Botulinum neurotoxin producing species of *Clostridium**
 Conotoxins (Short, paralytic alpha conotoxins containing the following amino acid sequence X₁CCX₂PACGX₃X₄X₅X₆CX₇)¹
Coxiella burnetii
 Crimean-Congo haemorrhagic fever virus
 Diacetoxyscirpenol
 Eastern Equine Encephalitis virus³
 Ebola virus*
*Francisella tularensis**
 Lassa fever virus
 Lujo virus
 Marburg virus*
 Monkeypox virus³
 Reconstructed replication competent forms of the 1918 pandemic influenza virus containing any portion of the coding regions of all eight gene segments (Reconstructed 1918 Influenza virus)
 Ricin
Rickettsia prowazekii
 SARS-associated coronavirus (SARS-CoV)
 Saxitoxin
South American Haemorrhagic Fever viruses:
 Chapare
 Guanarito
 Junin
 Machupo
 Sabia
 Staphylococcal enterotoxins A,B,C,D,E subtypes
 T-2 toxin
 Tetrodotoxin
Tick-borne encephalitis complex (flavi) viruses:
 Far Eastern subtype
 Siberian subtype
 Kyasanur Forest disease virus
 Omsk hemorrhagic fever virus
 Variola major virus (Smallpox virus)*
 Variola minor virus (Alastrim)*
*Yersinia pestis**

OVERLAP SELECT AGENTS AND TOXINS

*Bacillus anthracis**
Bacillus anthracis Pasteur strain
Brucella abortus
Brucella melitensis
Brucella suis
*Burkholderia mallei**
*Burkholderia pseudomallei**
 Hendra virus
 Nipah virus
 Rift Valley fever virus
 Venezuelan equine encephalitis virus³

USDA SELECT AGENTS AND TOXINS

African horse sickness virus
 African swine fever virus
 Avian influenza virus³
 Classical swine fever virus
 Foot-and-mouth disease virus*
 Goat pox virus
 Lumpy skin disease virus
*Mycoplasma capricolum*³
*Mycoplasma mycoides*³
 Newcastle disease virus^{2,3}
 Peste des petits ruminants virus
 Rinderpest virus*
 Sheep pox virus
 Swine vesicular disease virus

USDA PLANT PROTECTION AND QUARANTINE (PPQ) SELECT AGENTS AND TOXINS

Peronosclerospora philippinensis (*Peronosclerospora sacchari*)
Phoma glycinicola (formerly *Pyrenochaeta glycinis*)
Ralstonia solanacearum
Rathayibacter toxicus
Sclerophthora rayssiae
Synchytrium endobioticum
Xanthomonas oryzae

*Denotes Tier 1 Agent

¹ C = Cysteine residues are all present as disulfides, with the 1st and 3rd Cysteine, and the 2nd and 4th Cysteine forming specific disulfide bridges; The consensus sequence includes known toxins α-MI and α-GI (shown above) as well as α-GIA, Ac1.1a, α-CnIA, α-CnIB; X₁ = any amino acid(s) or Des-X; X₂ = Asparagine or Histidine; P = Proline; A = Alanine; G = Glycine; X₃ = Arginine or Lysine; X₄ = Asparagine, Histidine, Lysine, Arginine, Tyrosine, Phenylalanine or Tryptophan; X₅ = Tyrosine, Phenylalanine, or Tryptophan; X₆ = Serine, Threonine, Glutamate, Aspartate, Glutamine, or Asparagine; X₇ = Any amino acid(s) or Des X and; "Des X" = "an amino acid does not have to be present at this position." For example if a peptide sequence were XCCHPA then the related peptide CCHPA would be designated as Des-X.

² A virulent Newcastle disease virus (avian paramyxovirus serotype 2) has an intracerebral pathogenicity index in day-old chicks (*Gallus gallus*) of 0.7 or greater or has an amino acid sequence at the fusion (F) protein cleavage site that is consistent with virulent strains of Newcastle disease virus. A failure to detect a cleavage site that is consistent with virulent strains does not confirm the absence of a virulent virus.

³ Select agents that meet any of the following criteria are excluded from the requirements of this part: Any low pathogenic strains of avian influenza virus, South American genotype of eastern equine encephalitis virus, west African clade of Monkeypox viruses, any strain of Newcastle disease virus which does not meet the criteria for virulent Newcastle disease virus, all subspecies *Mycoplasma capricolum* except subspecies *capripneumoniae* (contagious caprine pleuropneumonia), all subspecies *Mycoplasma mycoides* except subspecies *mycoides* small colony (Mmm SC) (contagious bovine pleuropneumonia), any subtypes of Venezuelan equine encephalitis virus except for Subtypes IAB or IC, and Vesicular stomatitis virus (exotic); Indiana subtypes VSV-IN2, VSV-IN3, provided that the individual or entity can verify that the agent is within the exclusion category.

9/10/13

Appendix E: Bloodborne Pathogens Part II: Exposure Control Plan

Stanford University
Bloodborne Pathogens Local Exposure Control Plan and Guidance

This Local Exposure Control Plan is specific to the laboratory indicated below and is supplemental to the institutional requirements outlined in the Stanford University Institutional Bloodborne Exposure Control Plan

| |
|--|
| Principal Investigator/ Supervisor: |
| Phone: |
| Email: |
| Department: |
| Building: |
| Room(s): |

Overview

This document introduces the PI/Supervisor to the purpose and use of the Stanford University Bloodborne Pathogens Local Exposure Control Plan (Local ECP). Included are guidance and instructions on how to complete the Local ECP, including forms required to be completed.

Keep the completed Local ECP, along with updates and training records, in a location available for reference by personnel and regulators.

Stanford University - Bloodborne Pathogens Local Exposure Control Plan

i. Purpose, Regulatory Driver and Scope

The California Occupational Safety and Health Administration (Cal-OSHA) [Bloodborne Pathogens Standard](#) (8 CCR • 5193) requires employers to establish an Exposure Control Plan (ECP), which provides methods and procedures to eliminate or minimize potential exposures of employees to human blood/bloodborne pathogens (BBP), or other potentially infectious materials (OPIM) or blood. Principal Investigators (PIs) and supervisors should refer to the [Stanford University Institutional Exposure Control Plan](#) as a resource for exposure control background, issues and regulatory procedures.

Stanford University Local Bloodborne Pathogen Exposure Control Plan:

The Stanford University Bloodborne Pathogens Local Exposure Control Plan supplements the [Stanford University Institutional Exposure Control Plan](#) for areas overseen by a PI/Supervisor, who is responsible for the health and safety of their supervised personnel. **The Local ECP addresses health and safety issues specific to the materials and procedures being used by research personnel and constitutes a Tier III training for these topics.**

PIs/supervisors with employees who may be exposed to human Bloodborne Pathogens (BBPs)/Other Potentially Infectious Materials (OPIM)/Blood must ensure personnel complete a Local ECP. Working with employees, use this document to:

- Guide identification of procedures and materials in the laboratory that have the possibility of exposing personnel to BBPs/OPIM
- Review methods of compliance to ensure a safe work environment
- Determine appropriate engineering and work practice controls
- Review requirements for reporting and documenting sharps injuries
- Ensure participation in the Stanford University Medical Surveillance Program

The Local ECP shall be completed and reviewed by the PI/Supervisor and personnel annually and/or as needed by job changes. The completed Local ECP shall be located in the laboratory (as a hard copy or on computer) for reference and documentation of compliance.

Elements of the Local ECP to be completed by the PI/Supervisor in collaboration with employees include:

1. PI/Supervisor to review ECP fundamentals with employees using the material presented in the Local ECP as a guide.
2. Laboratory Specific Information
 - a. Exposure Determination – identification of materials, job categories, tasks and procedures (Appendix A, provided at the end of Local ECP)
 - b. Methods of Compliance – training documentation, local ECP completion and reviews (Appendix B, provided at the end of Local ECP)
3. Reporting and Documentation of Injuries
 - a. Documentation of use of non-compliant sharps (Appendix C, provided at the end of Local ECP)
 - b. Incident reporting of sharps accidents
4. Medical Surveillance Program
 - a. Hepatitis B Declaration
 - b. Incident reporting of potential exposures

ii. Responsibilities

Principal Investigator/Supervisor Responsibilities

The PI/Supervisor has responsibility for the health and safety of laboratory personnel doing work in his/her laboratory. The PI/ Supervisor may delegate the implementation and management of safety duties for which he/she is responsible, but must make sure that any delegated safety duties are carried out.

| What to do | How to do it |
|---|--|
| 1. Identify use of BBPs or Other Potentially Infectious Materials (OPIM) in lab, implement and enforce safety procedures. | See Biosafety Website (Safety/Medical Monitoring, BBP) for more information, complete Appendix A. |
| 2. Complete local Exposure Control Plan with personnel. | Complete this document. |
| 3. Obtain Administrative Panel on Biosafety (APB) approval if needed. | See Biosafety website (APB) for more information. |
| 4. Train personnel to work with BBP/OPIM, maintain training records. | PI/Supervisor to provide Tier III training; complete Appendix B, refer to Stanford University Biosafety Manual (Chapter 5) |
| 5. Report BBP/OPIM exposure and sharps injuries. | See Biosafety website (Emergency Procedures/ Accidental Exposures) for more information. |
| 6. Discuss Hepatitis B Virus exposure and vaccination; submit completed Hep B Vaccine Declaration Form to SUOHC within 10 working days. | See Stanford University Hepatitis B Vaccine Declaration Form . |
| 7. Explain medical surveillance, consultation, examination available for personnel. | Refer to Stanford University Biosafety Manual (Chapter 6). |
| 8. Provide and maintain Personal Protective Equipment (PPE), engineering controls and safety equipment. | See Biosafety website (General Laboratory Safety) for more information, complete Appendix C as needed. |
| 9. Communicate potential hazards to laboratory visitors. | Refer to Stanford University Biosafety Manual (Chapter 7) |
| 10. Have Local ECP available to personnel and regulators. | Keep completed copy, along with annual updates and training records, available for reference. Include copy of Stanford University Institutional Exposure Control Plan , or know where to obtain one as needed. |

Laboratory Personnel Responsibilities

Laboratory personnel who work with Blood/BBP/OPIM have the responsibilities listed below. Consult with your PI/Laboratory Supervisor as you implement your responsibilities.

| What to do | How to do it |
|---|---|
| 1. Complete Local Exposure Control Plan with PI/Supervisor. | Complete this document. See Stanford University Institutional Exposure Control Plan for additional information as needed. |
| 2. Review and understand blood/BBP/OPIM hazards and hazards of laboratory procedures prior to conducting work. | See Biosafety website (Safety/Medical Monitoring, BBP) for more information, complete Appendix A. |
| 3. Complete all required health and safety training. | Complete Tier I (general laboratory safety), Tier II (BBP training) and Tier III (lab specific training by PI/Supervisor) and Appendix B. In addition, refer to Stanford University Biosafety Manual (Chapter 5). |
| 4. Use PPE, engineering controls and safety equipment. | See Biosafety website (General Laboratory Safety) for more information, complete Appendix C as needed. |
| 5. Confirm PI has APB approval for use of non-exempt biohazardous materials (if being used) and appropriate personnel are listed. | See Biosafety website (APB) for more information. |
| 6. If required by job responsibilities, participate in medical surveillance program. | Refer to Stanford University Biosafety Manual (Chapter 6). |
| 7. Promptly report accidents and unsafe conditions to PI/ Supervisor. | See Biosafety website (Emergency Procedures/Accidental Exposures) for more information. |

Environmental Health & Safety Responsibilities

| | |
|---------------------------------------|---|
| 1. Medical Services | EH&S will make provisions for all appropriate required medical services. |
| 2. General laboratory safety training | EH&S provides general laboratory safety Tier I training; see http://www.stanford.edu/dept/EHS/prod/training/index.html for additional information. |
| 3. Blood Borne Pathogen training | EH&S provides Tier II BBP training via a web based format, with mandatory annual updates (https://axess.stanford.edu/) |
| 4. Personal Protective Equipment | EH&S provides consultation or advice on PPE |
| 5. Sharps Injury Log | EH&S will maintain the OSHA Sharps Injury Log and carry out annual reviews of the Log; any identified trends or concerns will be reviewed at the University level by a group comprising of representation from EH&S, Stanford University Occupational Health & Safety, researchers and clinical users, as appropriate. Review will include, but not be limited to the following: <ol style="list-style-type: none"> 1. Area/Department involved 2. Type/model/brand of sharp 3. Task or procedure performed 4. Description of incident 5. Training |

Exposure Control Plan Guidance

This section provides direction for the following items:

- Guide identification of procedures and materials in the laboratory that have the possibility of exposing personnel to BBPs
- Review methods of compliance to ensure a safe work environment
- Determine appropriate engineering and work practice controls
- Review requirements for reporting and documenting sharps injuries
- Ensure participation in the Stanford University Medical Surveillance Program

Universal Precautions:

“Universal Precautions” is an approach to infection control whereby all human/primate blood and other human/primate body fluids, tissues and cells are treated as if known to be infectious for HIV, HBV, HCV, and other bloodborne pathogens (BBP’s).

Important definitions:

1. **Blood** means *human blood, human blood components, and products made from human blood.*
2. **Bloodborne Pathogens** means *pathogenic microorganisms that are present in human blood and can cause disease in humans. These pathogens include, but are not limited to, hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus (HIV).*
3. **“Other Potentially Infectious Materials” (OPIM)** are:
 - A. The following *human* body fluids: semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures, any body fluid that is visibly contaminated with blood, and all body fluids in situations where it is difficult or impossible to differentiate between body fluids.
 - B. Any *unfixed tissue (including primary cells and tissue culture cells lines) or organ (other than intact skin) from a human (living or dead).*
 - C. Any of the following, if known or reasonably likely to contain or be infected with bloodborne pathogens (including but not limited to HIV, HBV or HCV):
 - Cells, tissue, or organ cultures from humans or experimental animals (cell cultures)
 - Blood, organs, or other tissues from experimental animals (primary cells)
 - Culture medium or other solutions

Engineering, Work Practice Controls and PPE:

Engineering, work practice controls and PPE must be used to eliminate or minimize exposure to individuals.

Engineering and Work Practices

- 1) **Hand washing**
Personnel must wash their hands immediately upon removal of gloves and upon any contact with potential BBP materials.

2) Mouth pipetting

Mouth pipetting is prohibited.

3) No eating, drinking

Eating, drinking, smoking, applying cosmetics or lip balm, and handling contact lenses are not permitted in work areas. Food and drink are not to be placed or stored in areas (refrigerators, microwaves, etc.) where potential BBP/OPIM are kept or may be present.

4) Needles, sharps, and broken glass

Used needles and other sharps are not to be sheared, bent, broken, recapped, or resheathed by hand. Used needles are not to be removed from disposable syringes. Disposable sharps must not be reused. All sharps, contaminated or not, shall be disposed of in a puncture-resistant hard sided, labeled sharps container.

Broken glassware must not be directly handled with a gloved or bare hand. Use a mechanical tool (tongs, dustpan and broom) to collect the pieces into a hard-sided container labeled 'Broken glass' (non-contaminated). Contaminated broken glass must be placed in a puncture-resistant hard-sided container and disposed of as biohazardous waste (see [Stanford Bio/Medical Waste Guidelines](#)).

A) Safety Sharps

The Cal-OSHA BBP Standard requires any laboratory using human or primate blood, blood products, cell lines, tissues or other potentially infectious materials to use **Needleless Systems/and or engineered sharps ('safety sharps')**.

B) Documentation of use of non-safety sharps (Appendix C)

A sharps device without safety feature(s) may only be used if:

- Alternative products are not market-available
- Alternative products do not clearly improve safety
- Available product(s) jeopardize(s) patient safety

The evaluation process for the use of a **non-safety sharp** must be documented; any use of non-safety sharps must be re-evaluated and documented annually. Record the process using Appendix C and retain the document with the Local ECP (Appendix C provided at end of Local ECP).


5) Minimization of aerosols

Biological safety cabinets (Class I or II (A1, A2, B1, B2)) or other physical containment devices must be used whenever possible while performing operations capable of creating aerosols. If a biological safety cabinet cannot be used, the most effective means of minimizing exposure to aerosols is to contain them by using closed containers (sealed centrifuge rotors, capped test tubes, etc.).

6) Disinfection of work area and spill cleanups

The work area must be disinfected before and after handling BBP/OPIM. Non-laboratory personnel should not handle equipment that has been used with potential BBP's until it has been decontaminated. All spills must be cleaned up immediately and disinfected with a germicide by appropriate decontamination procedures determined by the laboratory supervisor. The laboratory supervisor or other laboratory personnel must immediately report laboratory accidents (major spills, injuries, illnesses) to EH&S (650.723.0448). For additional information see Spills under Reference information on the biosafety web page (<http://www.stanford.edu/dept/EHS/prod/researchlab/bio/>) then Safety/Medical Monitoring Exposure Control Plan.

7) Labeling and Communication

A biohazard warning sign incorporating the universal biohazard symbol  shall be posted on the access door to the laboratory work area. All BBP/OPIM must be stored in containers labeled with a biohazard symbol. Equipment where potentially infectious materials are stored or handled must also be labeled with the biohazard symbol. Placards are available from EH&S.

8) Limited Access

Access to a laboratory is limited or restricted by the laboratory supervisor when work is in progress. When work with blood or blood products is being performed, non-laboratory personnel (maintenance, administrative personnel) and non-authorized should be discouraged from entering. If they must enter a facility, the hazards of the work being performed must be fully explained.

9) Transportation on Campus

Specimens of blood or other potentially infectious materials shall be placed in a primary container that prevents leakage (capped test tube, centrifuge tube, etc.) during collection, handling, and storage. If the specimens are transported through hallways, the primary containers must be placed in a secondary container (bucket, non-breakable tube or container, cooler, etc.) which would contain the contents if the primary container if it were to leak or break.

10) Shipping of Samples

In compliance with the Department of Transportation regulations ([Biosafety - under Shipping](#)), personnel involved with shipping of biohazardous agents or potential BBPs **must have** documented training prior to shipping. Shipping training can be done online with "EHS-2700: DOT: Shipping Biological Goods or Dry Ice" available online at axess.stanford.edu.

11) Blood Collection

All human blood collection shall be performed in accordance with established phlebotomy procedures.

12) Biological Waste Disposal

Specific procedures for the disposal of biological materials are available from are found on the Medical Waste Poster ([Medical Waste Guide](#)) and can also be found in the [Stanford University Biosafety Manual](#) and on the [Biosafety](#) website.

13) HIV, HBV and HCV Research Laboratories

If PI/Supervisor cannot verify personnel experience and proficiency, they shall ensure personnel are provided necessary training prior to assigning work potentially involving HIV, HBV or HCV.

This section applies, in addition to the above requirements, to research laboratories engaged in the culture, production, concentration, experimentation, and manipulation of HIV, HBV and HCV.

- A. Laboratory doors shall be kept closed when work involving HIV, HBV or HCV is in progress.
- B. Access to the work area shall be limited to authorized persons.
- C. All activities involving OPIM shall be conducted in biological safety cabinets or other physical-containment devices within the containment module.
- D. Hypodermic needles and syringes shall be used only for parenteral injection and aspiration of fluids from animals and diaphragm bottles. All sharps (needles, blades, etc.) must have engineered sharps protection.
- E. **Written biosafety procedures shall be prepared and adopted into the local Exposure Control Plan; a copy of the approved APB protocol can be used for this purpose.** Personnel shall be advised of potential hazards, shall be required to read instructions on practices and procedures, and shall be required to follow them.
- F. Personnel shall have prior experience in the handling of human pathogens or tissue culture.

Personal Protective Equipment

Personnel must wear gloves, lab coat, and safety glasses whenever handling blood/BBPs/OPIM. In addition to above items, personnel must wear any additional PPE (booties, face shield, etc.) that is needed to prevent blood or other potentially infectious material from contaminating their street clothes, skin, eyes, mouth, or other mucous membranes under normal conditions. All PPE shall be removed prior to leaving the work place and placed in appropriate designated areas.

Personal protective equipment (PPE) will be provided without cost to all individuals who are at risk of occupational exposure to bloodborne pathogens. The protective equipment will be considered appropriate only if it does not permit blood or other potentially infectious materials to pass through or reach the individual's clothing, skin, eyes, mouth, or other mucous membranes during use. Consultation or advice on PPE is provided by Stanford University EH&S.

1) Eye protection

Protective eye wear must be worn in the laboratory when it is reasonably anticipated that blood or other potentially infected material may make contact with the mucous membranes of the eye. Face shields may be required in addition to protective eyewear if there is a potential for splashes, sprays, or aerosols.

2) Lab coats and protective clothing

Laboratory coats, gowns, smocks, etc. must be worn while in the laboratory. Protective clothing must be removed and left in the laboratory before leaving the lab. Wear appropriate street clothing (i.e. long pants, closed-toed shoes) in addition to PPE. Personnel are not permitted to take home any PPE, including lab coats, for laundering or cleaning.

3) Gloves

All personnel engaged in activities that may involve skin contact with potentially infectious fluids or tissues must wear gloves. Gloves are also required for laboratory workers with dermatitis or other lesions on the hands who may have direct or indirect contact with potentially infectious materials. Gloves must be replaced frequently and immediately if they become contaminated or damaged in any way. Gloves should be removed before touching common equipment (phone, computer, appropriate laboratory equipment) to prevent contamination.

Reporting and Documenting Incidents and Sharps Injuries

All incidents and sharps related injuries shall be reported immediately by completing a Stanford University Incident Investigation Report ([SU-17](#)) and a [Sharps Injury Report](#) (within 24 hours of the injury).

All incidents and sharps related injuries shall be reported immediately by completing a Stanford University Incident Investigation Report ([SU-17](#)) and a [Sharps Injury Report](#) (within 24 hours of the injury) both forms are additionally available on the Biosafety web site). Medical information will not be discussed or revealed to supervisors, personnel representatives, or other health care professionals who do not need the information.

Medical Surveillance Program

The PI/Supervisor, working with the employee, will explain medical surveillance participation and services available for personnel. EH&S provides required medical services and emergency service oversight. Any communication between the medical provider and the PI/Supervisor will be carried out in a manner that does not breach medical confidentiality

1) Hepatitis B Vaccination

All personnel covered by the Local ECP must complete the "Stanford University [Hepatitis B Vaccine Declaration Form](#)" and submit to the Stanford University Occupational Health Center (SUOHC) within 10 working days from start of potential exposure.

Hepatitis B Vaccine: A safe and effective vaccine is available for protection from [Hepatitis B](#). While Stanford University strongly encourages employees to be vaccinated, accepting vaccination is not a condition of employment. Immunization requires three injections of vaccine over a six-month period. This vaccine is available at no cost to all personnel that are potentially exposed to blood/OPIM. Post-vaccination serological testing to ensure that protective antibodies to Hepatitis B have developed is also provided at no cost following completion of the vaccination series or as medically indicated.

The PI/Supervisor will ensure that all personnel with potential for occupational exposure to BBP are offered the Hepatitis B (HBV) vaccination in a timely manner (within ten working days of initial assignment). The HBV vaccination will be offered to personnel as a prophylactic treatment or made available post-exposure. Hepatitis B immune globulin is also offered as a prophylactic within 24 hours of an occupational exposure.

HBV-related information, FAQs, and the declaration form are available online at: www.stanford.edu/dept/EHS/prod/researchlab/medsurv/.

To schedule a vaccination or a medical consult concerning exposure risk, and the risks and benefits of the vaccination, Stanford University students and employees can go to the:

Stanford University Occupational Health Center (SUOHC)
Environmental Safety Facility (ESF)
480 Oak Road, Room B15
Stanford, CA 94305-8007

Phone: (650) 725-5308
Fax: (650) 725-9218

If an at-risk employee declines the vaccination, the employee must sign a declination form. Employees who declined vaccination may request and obtain the vaccination at a later date at no cost.

2) Post-Exposure Evaluation and Follow-up

Any exposure (e.g. spill, needlestick, ingestion) resulting in direct, unprotected contact with human or primate blood, fluids, or tissue gives the employee the right to prompt medical evaluation and treatment with a qualified physician. These services will be provided at no cost to the employee.

What to do post-exposure: After any direct exposure to BBP, **immediately wash the affected area with soap and water.**

In the event that a Stanford University employee or student is accidentally exposed to human blood or blood products, **students and employees** should report to the Stanford University Occupational Health Center (SUOHC) (650.725.5308) at 480 Oak Road, Stanford, CA, 94305 or to **Stanford Hospital Emergency Room if it is an emergency or after normal business hours and weekends**, where an established medical protocol will be followed. This protocol is designed to provide the individual with the most appropriate medical procedures, consultation and supportive therapy. The exposed employee or student will be provided with a written opinion that will include:

- HBV vaccination status and recommendation
- Results of the post-exposure evaluation and follow-up discussion of any medical conditions resulting from exposure to blood or other potentially infectious materials which requires further evaluation or treatment
- All other findings or diagnoses shall remain confidential and will not be included in the written report.

Personnel may refuse post-exposure evaluation and follow-up from the SUOHC and instead be provided, without cost, a confidential medical evaluation and follow-up from an independent healthcare professional selected by the SUOHC.

Exposure to animal bites and scratches: It is important to report all bite wounds and scratches. Wounds must be cleansed immediately in your work area. Instructions for the proper cleaning of wounds will be given to you by your supervisor. **After you have cleansed the wound, go immediately to the Stanford University Occupational Health Center (650.725.5308) or to the Stanford Emergency Room after hours and on weekends.**

Instructions

The PI/Supervisor shall review the Local ECP with input from employees covered by BBP. After review, complete Appendixes A and B. A separate Appendix A can be used for each person, or attach a list of personnel that are determined to come under the same exposure determinations and procedures. Fill out Appendix C as needed. Keep completed appendixes with the Local ECP.

Review the completed Local ECP annually and/or when job descriptions or processes change.

Local Exposure Control Plan: The Local ECP will comprise of the following:

- Completed and updated Appendixes A (Exposure Determination), B (Training Documentation), and C (Non-compliant Sharps)
- An available copy of the Local ECP Guidance document

HIV, HBV and HCV Research Laboratories and Production Facilities shall include:

- Written biosafety procedures in the Exposure Control Plan (reference the appropriate approved protocol from the Stanford University Administrative Panel on Biosafety)

In addition, personnel should know where to access the [Stanford University Institutional Exposure Control Plan](#).

The PI/Supervisor will file the Local ECP in a central location within the laboratory or workplace. The PI/Supervisor, together with employees covered by the Local ECP, will review and revise the Local ECP annually and/or whenever changes in procedure or personnel occur. Documentation shall be maintained by PI/Supervisor for three (3) years.

Reviews: Annual and as needed

The following items shall be included in the review process:

- New or revised employee positions, new or modified tasks and procedures which affect occupational exposure
- Changes in technology that eliminate or reduce exposure to BBP (needleless systems, engineered sharps)
- Review and evaluate exposure incidents which occurred since previous update
- Review and respond to information indicating that the Local ECP is deficient in any area

To Complete Local ECP

For convenience an Excel spread sheet ([Local ECP Check Sheet](#)) is provided to assist in recording and documenting personnel names, positions, dates and information during completion of required ECP segments. Attach completed Check Sheet to appendices. The use of this sheet is optional.

1. Appendix A: Exposure Determination

The PI/Supervisor must identify procedures and materials in the laboratory that have the possibility of exposing personnel to BBPs (**Appendix A**). Note that this evaluation will not take into consideration the use of personal protective equipment (PPE).

2. Appendix B: Training Documentation

Laboratory personnel must receive general and laboratory-specific information and training at the time of initial assignment to the laboratory, and prior to assignments involving new exposure situations. Training must be documented and maintained by PI/Supervisor for three years.

All personnel with potential for occupational exposure to blood, BBP or OPIM must complete the following online training in the Stanford Training and Registration System (STARS) (available through axess.stanford.edu):

- EHS-1500 or EHS-4875: Biosafety (Initial)
- EHS-1600: Bloodborne Pathogens (EHS-1601 for annual updates)

To complete Bloodborne Pathogen training, the following must be done:

- Local Exposure Control Plan (after initial completion, review Local ECP annually or as required by job change)
- Specific Tier III training will be provided by the PI/Supervisor and includes specific safety training for each person's duties, specific equipment usage and procedures (**Appendix B**).

3. Appendix C: Non-compliant Sharp Documentation

The evaluation process for the use of a non-safety sharp must be documented (**Appendix C**); retain the document with the Local ECP. Any use of non-safety sharps must be re-evaluated and documented annually.

PI/Supervisor name _____

Location(s) (room, building) _____

Date _____

Instructions: Complete the following sections as they relate to employees covered by the local ECP and the nature of the work being carried out in your facility. Use a separate Information sheet for each combination of Exposure Determination, Job Categories, and Tasks and Procedures.

Employee Name (enter name(s) or use the [Local ECP Check Sheet](#)): _____

I. Exposure Determination – identification of materials, job categories, tasks and procedures

A. Identify all materials that may apply:

- | | |
|---|---|
| <input type="checkbox"/> Human tissues/cells/tissues/tissue culture cells | <input type="checkbox"/> Human fluids |
| <input type="checkbox"/> Non human primate cells/tissues/tissue culture cells | <input type="checkbox"/> Non human primate fluids |
| <input type="checkbox"/> Blood borne biological agents | <input type="checkbox"/> Human blood |

List agents: _____

2. Methods of Compliance – training documentation, local Exposure Control Plan completion and reviews

A. Job Categories in which personnel may reasonably have contact with BBP's (check off all that might apply).

- | | |
|---|--|
| <input type="checkbox"/> Principal Investigator | <input type="checkbox"/> Graduate Student |
| <input type="checkbox"/> Researcher | <input type="checkbox"/> Undergraduate Student |
| <input type="checkbox"/> LSRA/Technician | <input type="checkbox"/> Laboratory Worker |
| <input type="checkbox"/> Post-Doctoral Fellow | <input type="checkbox"/> Clinician |
| <input type="checkbox"/> Phlebotomist | <input type="checkbox"/> Nurse |
| <input type="checkbox"/> Other List jobs: _____ | |

Laboratory - specific training shall be provided by the PI/Supervisor and will include specific safety training for each person's duties, including specific equipment usage and procedures.

Training Provided: Identify the specific trainings completed/provided by the PI/Supervisor to the individual listed above.

- Laboratory-specific agent/material training (Tier III) by PI/Supervisor (Local Exposure Control Plan)

Review Provided: Confirm the following items were reviewed by you and the PI/Supervisor

- New or revised employee positions, new or modified tasks and procedures which affect occupational exposure
- Changes in technology that eliminate or reduce exposure to BBP (needleless systems, engineered sharps)
- Review and evaluate exposure incidents which occurred since previous update
- Review and respond to information indicating that the local ECP is deficient in any area

For employees responsible for direct patient care/donors (in addition to above):

- PI/Supervisor shall solicit input from non-managerial employees responsible for direct patient care/donors that are potentially exposed to BBP; include identification, evaluation and selection of effective engineering and work practice controls

By signing below, you indicate that you have:

- **Reviewed/updated the completed the Local Exposure Control Plan with your PI/Supervisor and understand the potential BBP hazards associated with your work.**
- **Reviewed any sharps exposures that had occurred within your work environment during the past year.**

PI/Supervisor signature _____ Date _____

Signatures of personnel involved in training/review (add additional page if necessary)

| | |
|-------|-------|
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |

Appendix C

Non-compliant Sharps Documentation

If the PI/Supervisor decides that a non-compliant sharp is necessary for a certain procedure, the reason must be documented; keep documentation with the completed Local ECP. Review annually.

The following exceptions apply to the required engineering controls (re [Bloodborne Pathogens Standard \(1910.1030 \(d\)\(3\)\(A\)1.-3\)](#)):

- **Market Availability:** The engineering control is not available in the marketplace.
- **Patient Safety:** The engineering control is not required if a licensed healthcare professional directly involved in a patient's care determines that use of the engineering control will jeopardize the patient's safety or the success of a medical, dental or nursing procedure involving the patient.
- **Safety Performance:** The engineering control is not required if the employer can demonstrate by means of objective product evaluation criteria that the engineering control is not more effective in preventing exposure incidents than the alternative used by the employer.
- **Availability of Safety Performance Information:** The engineering control is not required if the employer can demonstrate that reasonably specific and reliable information is not available on the safety performance of the engineering control for the employer's procedures, and that the employer is actively determining by means of objective product evaluation criteria whether use of the engineering control will reduce the risk of exposure incidents occurring in the employer's workplace.

Complete the below information if non-compliant sharps are in use (add additional pages as necessary).

Example

| Devise Information | Reason(s) for Exception | Name | Date (Initial Use and Annual Re-evaluation) |
|------------------------|--|----------------------------|---|
| <i>25g X 1" needle</i> | <i>Specific size needed for research use. Not available on market.</i> | <i>Leland Stanford Jr.</i> | <i>April 1, 2011</i> |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Appendix F: Hepatitis B Vaccine Declaration

HEPATITIS B VACCINE DECLARATION FORM

Please submit this completed form to the address or fax below

| | | | |
|---|----------------------------|--|--------------------|
| Name | SU/Student ID # (8 digits) | Email | |
| Daytime/work phone | Job Title | Department | Supervisor/PI Name |
| Stanford Work Location (check all that apply) | | Employment Status (select applicable box) | |
| <input type="checkbox"/> SHC/LPCH <input type="checkbox"/> Spectrum outpatient site <input type="checkbox"/> Stanford Blood Center <input type="checkbox"/> Vaden Student Health <input type="checkbox"/> SU Research Lab, APB/APLAC Protocol #: _____ <input type="checkbox"/> Other: | | <input type="checkbox"/> SU Faculty/Staff <input type="checkbox"/> SU Employed Student <input type="checkbox"/> Medical Student* <input type="checkbox"/> Undergraduate <input type="checkbox"/> Student Researcher* <input type="checkbox"/> Graduate <input type="checkbox"/> Volunteer/Visitor* <input type="checkbox"/> Postdoc | |

** Volunteers and students not engaged in employment or research activity may not be eligible for free vaccination.*

| | |
|---|--|
| STEP 1, SUPERVISOR/PI: | PLEASE COMPLETE TO CONFIRM EMPLOYEE HEPATITIS B VACCINATION ELIGIBILITY |
| "I certify that the above-named employee shall be offered Hepatitis B vaccination based upon potential workplace exposure to Bloodborne Pathogens" as listed on the next page . | |
| Name | Phone: |
| Signature | Date: |

| | |
|---|--|
| STEP 2, EMPLOYEE: | PLEASE SELECT AND COMPLETE ONE OF THE APPLICABLE SECTIONS BELOW |
| I. "I WOULD LIKE TO RECEIVE THE HEPATITIS B VACCINE SERIES" | |
| "Please contact me at the above phone number or email to schedule." | |
| <input type="checkbox"/> | Employee Signature |
| | Date: |

| | |
|---|--|
| <input type="checkbox"/> | II. "I DECLINE HEPATITIS B VACCINATION" |
| "I understand that due to my occupational exposure to blood or other potentially infectious materials (OPIM) that I may be at risk of acquiring hepatitis B virus (HBV) infection, a serious disease. Although I have been provided the opportunity to be vaccinated with hepatitis B vaccine at no charge* to myself, I decline vaccination at this time. If in the future I continue to have occupational exposure to blood or OPIM at Stanford and wish to be vaccinated, I can receive the Hepatitis B vaccination series at no charge* to myself." | |
| I have read and understood the above statement and am declining the hepatitis B vaccine series for the following reasons (<i>please check all which apply</i>): | |
| <input type="checkbox"/> To the best of my knowledge, I have completed the full Hepatitis B vaccine series (three shots). | |
| <input type="checkbox"/> I have undergone blood testing showing that I am immune to Hepatitis B. | |
| <input type="checkbox"/> I will send medical proof of vaccination and/or immunity along with this form | |
| <input type="checkbox"/> None of the above apply. I do not want to receive Hepatitis B vaccination. | |
| Please fax your Hepatitis B immunization records to SU Occupational Health at 650-725-9218 | |
| Employee Signature | Date: |
| <small>This 'Declination Statement' for the hepatitis B vaccine is provided in accordance with California Department of Industrial Relations and in accordance with CAL/OSHA. The link to this regulation: http://www.dir.ca.gov/tite8/5193a.html</small> | |

Occupational Health Services
480 Oak Rd, Stanford, CA 94305 T 650.725.5308 F 650.725.9218

HEPATITIS B VACCINE DECLARATION FORM

To determine if an individual must be included in the Bloodborne Pathogens Program, simply answer the following questions:

If the answer to **ANY** of the following questions is **YES**, then the worker is considered to be at occupational risk of contracting HBV or other bloodborne pathogens. Bloodborne pathogens are defined as pathogens for which blood can be a source of laboratory hazard or pathogen specimens, or are able to spread via blood.

Does the worker ever:

- (a) **handle human blood or blood products**, such as whole blood, plasma, serum, platelets, or white cells?
- (b) **handle human body fluids** such as semen, cerebrospinal fluid, vaginal secretions, joint fluid, pleural fluid, peritoneal fluid, pericardial fluid, or amniotic fluid?
- (c) **work with animals**, such as primates, that are **infected with hepatitis B or other bloodborne pathogens** OR perform tasks where such animals are housed?
- (d) **handle unfixed human tissue or organs, including tissue culture cells and cell lines?** (Tissues and organs soaked in chemical preservatives such as alcohol or formaldehyde are "fixed".)
- (e) **work with hepatitis B virus or other bloodborne pathogens** or with preparations, such as liquid solutions or powders containing the hepatitis B virus?
- (f) **handle blood, blood products, body fluids or unfixed tissues or organs** (including tissue culture cells and cell lines) of **animals infected with the hepatitis B virus or other bloodborne pathogens**?
- (g) **handle sharp instruments** such as knives, needles, scalpels, or scissors which have been used by others working with human blood or other potentially infectious materials to include human organs, tissue or body fluids OR used by others working with similar body parts and fluids from **animals infected with the hepatitis B virus or other bloodborne pathogens**?
- (h) **enter areas where other individuals work with human or animal blood, body fluid, tissues or organs** which are **infected with the hepatitis B virus or other bloodborne pathogens** AND perform tasks where these body substances may come into **contact** with the laboratory worker's unbroken skin, broken skin, or mucous membranes?
- (i) **perform tasks** which may potentially result in the lab worker's exposed skin or mucous membranes coming in **contact with human or animal blood, body fluids, organs, or tissues** which are **infected with the hepatitis B virus or other bloodborne pathogens**?

Appendix G: Stanford University Contact Information

Stanford University Contact Information

| Group | Phone |
|------------------------------------|--------------|
| Biosafety Manager | 725.1473 |
| Biological Waste (University) | 725.7529 |
| Biological Waste (Med School/Hosp) | 723.6896 |
| Health Physics | 723.3201 |
| Radioactive Waste | 725.1408 |
| Chemical Safety | 725.1474 |
| Chemical Waste Program | 725.7520 |
| EH&S main line | 723.0448 |
| EH&S emergency line | 725.9999 |
| Research Compliance Office | 723.4697 |
| School of Medicine Health & Safety | 723.6336 |
| Animal Care & Use | 723.4550 |