

Cancer Biology

Courses offered by the Cancer Biology Program are listed under the subject code CBIO on the (<http://explorecourses.stanford.edu/CourseSearch/search?view=catalog&catalog=&page=0&q=CBIO&filter-catalognumber-CBIO=on>) Stanford Bulletin's (<http://explorecourses.stanford.edu/CourseSearch/search?view=catalog&catalog=&page=0&q=CBIO&filter-catalognumber-CBIO=on>) ExploreCourses web site (<http://explorecourses.stanford.edu/CourseSearch/search?view=catalog&catalog=&page=0&q=CBIO&filter-catalognumber-CBIO=on>).

The Cancer Biology Program at Stanford University is an interdisciplinary program leading to the Ph.D. degree. During the past three decades, understanding of cancer has increased with the discovery of oncogenes, tumor suppressor genes, pathways of DNA damage and repair, chromatin remodeling, cell cycle regulation, angiogenesis, and responses to hypoxia, and recent glimpses into the molecular basis of metastasis and cancer stem cell biology. In addition, methods of parallel analysis including gene expression arrays, protein arrays, and tissue arrays have begun to refine and redefine the taxonomy of cancer diagnosis. This explosion of basic and clinical science has resulted in the first successful cancer chemotherapies and immunotherapies based on the knowledge of specific molecular targets. Stanford presents a unique environment to pursue interdisciplinary cancer research because the schools of Medicine, Humanities and Sciences, and Engineering are located on a single campus.

The goal of the Cancer Biology Ph.D. program is to provide students with education and training that enables them to make significant contributions to this field. Course work during the first year is designed to provide a broad understanding of the molecular, genetic, cell biological, and pathological aspects of cancer. Students also learn about the current state of the epidemiology, clinical diagnosis, treatment, and prevention of human cancers. Equally important during the first year is a series of three rotations in research laboratories chosen by each student. By the beginning of the second year, each student chooses a research adviser and begins work on the dissertation project. A qualifying examination must be completed by the end of the second year. An annual Cancer Biology conference at Chaminade in Santa Cruz, California, provides students with an opportunity to present their research to one another and to faculty. The expected time to degree is four to five years.

Students are not limited to a single department in choosing their research adviser. The Cancer Biology Ph.D. program currently has approximately 65 graduate students located in basic science and clinical departments throughout the School of Medicine and the School of Humanities and Sciences.

Doctor of Philosophy in Cancer Biology

University requirements for the Ph.D. are described under the "Graduate Degrees (<http://exploreddegrees.stanford.edu/graduatedegrees>)" section of this bulletin.

A small number of applicants are admitted to the program each year. Applicants should have completed an undergraduate major in the biological sciences; applicants with undergraduate majors in physics, chemistry, or mathematics may be admitted if they complete background training in biology during the first two years of study. During the first year, each student is required to complete a minimum of three, one quarter laboratory rotations. Students must choose a dissertation adviser prior to the end of Summer Quarter, first year, but not before the end of Spring Quarter.

The requirements for the Ph.D. degree are as follows:

1. Training in biology equivalent to that of an undergraduate biology major at Stanford.
2. Completion of the following courses:

		Units
BIOS 200	Foundations in Experimental Biology (for students entering in 2012 or later. Students who entered in 2011 or earlier took GENE 203, Advanced Genetics.)	6
BIO 214	Advanced Cell Biology	4
CBIO 241	Cellular Basis of Cancer	4
Select one of the following:		
BIOMEDIN 214	Representations and Algorithms for Computational Molecular Biology	
BIOMEDIN 217	Translational Bioinformatics	
CSB 210	Cell Signaling	
GENE 211	Genomics	
GENE 212	Introduction to Biomedical Informatics Research Methodology	
SBIO 241	Biological Macromolecules	
CBIO 280	Cancer Biology Journal Club (required for first- and second-year graduate students in Autumn, Winter, and Spring quarters, totaling 6 units)	1
MED 255	The Responsible Conduct of Research	1

3. At least 6 units of additional cancer biology-related, graduate-level courses. Course work taken is determined in consultation with the student's adviser and/or the Program Director.
4. Presentation of research results at the annual Cancer Biology Conference on at least three occasions, at least one being an oral presentation.
5. Completion of a qualifying examination in Cancer Biology is required for admission to Ph.D. candidacy. The exam consists of an F31 NRSA-style written grant proposal not to exceed seven pages (excluding references) and an oral examination. The examining committee consists of three faculty members from the Cancer Biology Program and does not include the student's dissertation adviser. The composition of this committee is chosen by the student and dissertation adviser and must be submitted to and approved by the program director prior to the end of Autumn Quarter, second year. The qualifying examination must be taken prior to the end of Spring Quarter, second year. If necessary, one retake is permitted prior to the end of Summer Quarter, second year. After the qualifying examination has been completed, the student is required to form a dissertation reading committee that includes the student's adviser and three other members of the Academic Council with appropriate expertise. Each student is required to arrange annual meetings (more frequently, if necessary) of the dissertation reading committee, at which time progress during the past year and a plan of study for the coming year are presented orally and discussed. Completion of each annual committee meeting must be communicated in writing to the program director by the adviser by the end of Spring Quarter each year.

The major accomplishment of each successful Ph.D. student is the presentation of a written dissertation resulting from independent investigation that contributes to knowledge in the area of cancer biology. An oral examination is also required for the Ph.D. degree. In the Cancer Biology Program, a public seminar (one hour) is presented by the Ph.D. candidate, followed by a closed-door oral examination. The oral examination committee consists of at least four examiners (the members of the doctoral dissertation reading committee) and a chair. The oral examination chair must be from outside the Cancer Biology Program faculty and may not have a full or joint appointment in the adviser's or student's home department. However, a courtesy appointment does not affect eligibility. The oral examination chair may be from the same

department as any other member(s) of the examination committee. All members of the oral examination committee are normally members of the Academic Council, as the oral examination chair must be. With the prior approval of the program director or school dean, one of the examiners may be a person who is not a member of the Academic Council if that individual contributes expertise not otherwise available. Official responsibility for selecting the oral examination chair rests with the program. Cancer Biology delegates this to the student and dissertation adviser.

Program Director: Amato Giaccia (Radiation Oncology)

Committee on Cancer Biology: Steven Artandi (Medicine, Hematology), Jeffrey Axelrod (Pathology), Katrin Chua (Medicine, Endocrinology), Max Diehn (Radiation Oncology), Edward Graves (Radiation Oncology), Ashby Morrison (Biology), Sylvia Plevritis (Radiology), Jonathan Pollack (Pathology), Alejandro Sweet-Cordero (Pediatrics), Monte Winslow (Genetics)

Participating Departments and Faculty

Biochemistry: Philip Beachy (Professor), Mark Krasnow (Professor), Julia Salzman (Assistant Professor)

Bioengineering: Jennifer Cochran (Associate Professor), Jan Liphardt, (Associate Professor), Lei Stanley Qi (Assistant Professor)

Biology (School of Humanities and Sciences): Martha Cyert (Professor), Scott J. Dixon (Assistant Professor), Judith Frydman (Professor), Or Gozani (Associate Professor), Ashby Morrison (Assistant Professor), W. James Nelson (Professor), Jan M Skotheim (Assistant Professor), Tim Stearns (Professor)

Chemical And Systems Biology: James K. Chen (Associate Professor), Karlene Cimprich (Professor), James E. Ferrell (Professor), Tobias Meyer (Professor), Mary Teruel (Assistant Professor)

Dermatology: Howard Y. Chang (Professor), Paul A. Khavari (Professor), M. Peter Marinkovich (Associate Professor), Anthony Oro (Professor), Kevin Wang (Assistant Professor)

Developmental Biology: Margaret Fuller (Professor), Seung Kim (Professor), Stuart Kim (Professor), Roeland Nusse (Professor), Matthew Scott (Professor)

Genetics: Michael Bassik (Assistant Professor), Anne Brunet (Associate Professor), Michele Calos (Professor), Stanley Cohen (Professor), Monte Winslow (Assistant Professor)

Medicine/Endocrinology/Gerontology/Metabolism: Katrin Chua (Associate Professor), Andrew R. Hoffman (Professor)

Medicine/Gastroenterology and Hepatology: Christine Cartwright (Professor), Anson Lowe (Associate Professor)

Medicine/Hematology: Steven Artandi (Professor), Linda Boxer (Professor), Calvin Kuo (Professor), Ravindra Majeti (Assistant Professor)

Medicine/Oncology: Ash Alizadeh (Assistant Professor), Gilbert Chu (Professor), Michael Clarke (Professor), Dean Felsher (Associate Professor), James Ford (Associate Professor), Hanlee Ji (Assistant Professor), Ronald Levy (Professor), Beverly S. Mitchell (Professor; Director, Stanford Cancer Institute), Mark Pegram (Professor), Rajat Rohatgi (Assistant Professor), Branimir Sikic (Professor)

Microbiology and Immunology: Helen M. Blau (Professor), Peter Jackson (Professor), Garry Nolan (Professor)

Neurology and Neurological Sciences: Thomas Rando (Professor)

Neurology and Neurosurgery: Yoon-Jae Cho (Assistant Professor), Michelle Monje (Assistant Professor)

Neurosurgery: Albert J. Wong (Professor)

Orthopaedic Surgery: Nidhi Bhutani (Assistant Professor)

Otolaryngology: John Sunwoo (Assistant Professor)

Pathology: Jeff Axelrod (Professor), Sean Bendall (Assistant Professor), Matthew Bogoy (Professor), Michael Cleary (Professor), Gerald Crabtree (Professor), Edgar Engleman (Professor), Andrew Fire (Professor), Isabella Graef (Assistant Professor), Joseph Lipsick (Professor), Bingwei Lu (Associate Professor), Jonathan Pollack (Associate Professor), Irving Weissman (Professor; Virginia & D.K. Ludwig Professor for Clinical Investigation in Cancer Research, Professor of Developmental Biology), Marius Wernig (Assistant Professor)

Pediatrics/Cancer Biology: Matthew Porteus (Associate Professor), Julien Sage (Associate Professor), Alejandro Sweet-Cordero (Associate Professor)

Pediatrics/Cardiology: Marlene Rabinovitch (Professor)

Pediatrics/Endocrinology: Brian Feldman (Assistant Professor)

Pediatrics/Human Gene Therapy: Mark Kay (Professor)

Pediatrics/Hematology/Oncology: Harvey Cohen (Professor), Kathleen Sakamoto (Professor)

Pediatrics/Neonatal & Developmental Medicine: Christopher Contag (Professor)

Radiation Oncology/Radiation Biology: Laura Attardi (Associate Professor), Amato Giaccia (Professor; Director, Stanford University Cancer Biology Program)

Radiation Oncology/Radiation Physics: Edward Graves (Associate Professor)

Radiation Oncology/Radiation Therapy: Max Diehn (Assistant Professor), Susan Knox (Associate Professor), Albert Koong (Professor), Quynh-Thu Le (Professor)

Radiology/Diagnostic Radiology: Parag Mallick (Assistant Professor, Research), Sylvia Plevritis (Associate Professor), Jianghong Rao (Associate Professor)

Structural Biology: William Weis (Professor)

Urology: Donna Peehl (Professor, Research), Zijie Sun (Associate Professor)

Courses

CBIO 101. Cancer Biology. 4 Units.

Experimental approaches to understanding the origins, diagnosis, and treatment of cancer. Focus on key experiments and discoveries with emphasis on genetics, molecular biology, and cell biology. Topics include carcinogens, tumor virology, oncogenes, tumor suppressor genes, cell cycle regulation, angiogenesis, invasion and metastasis, cancer genomics, cancer epidemiology, and cancer therapies. Discussion sections based on primary research articles that describe key experiments in the field. Satisfies Central Menu Areas 1 or 2 for Bio majors. Prerequisite: Biology or Human Biology core or equivalent, or consent of instructor.

Same as: PATH 101

CBIO 240. Molecular Genetic Basis of Cancer. 4 Units.

Core course required for first-year Cancer Biology graduate students. Focus is on key experiments and classic primary research papers in cancer biology. Letter grade required. Undergraduates require consent of course director.

CBIO 241. Cellular Basis of Cancer. 4 Units.

Core course required for first-year Cancer Biology graduate students. Preference to graduate students; undergraduates require approval of course instructor to enroll. Focus is on key experiments and classic primary research papers in cancer biology, centering on cancer cellular biology.

CBIO 242. Scientific and Translational Basis for Clinical Cancer Therapy. 3 Units.

Required for first- and second-year medical students who wish to join the Cancer Biology Scholarly Concentration Program. Also open to advanced undergraduates with instructor consent; limited enrollment. The curriculum includes a sampling of recent biomedical research discoveries that led to the current cancer diagnosis and therapeutic treatments.

CBIO 243. Principles of Cancer Systems Biology. 3 Units.

Focus is on the study of cancer that integrates experimental and computational methods when synthesizing and testing biological hypothesis. Covers basic principles of cancer systems biology research with an emphasis on network biology and pathway analysis. Topics include reconstruction of regulatory networks from multi-omic data (gene expression, methylation, miRNA, CNV) from the Cancer Genome Atlas (TCGA), functional approaches to large scale sequencing, single cell systems analysis of the tumor microenvironment, oncogene-specific synthetic lethal interactions, signaling analysis of targeted drugs and cancer proteomics.

CBIO 260. Teaching in Cancer Biology. 1-10 Unit.

Practical experience in teaching by serving as a teaching assistant in a cancer biology course. Unit values are allotted individually to reflect the level of teaching responsibility assigned to the student.

CBIO 275. Tumor Immunology. 2 Units.

Tumor Immunology focuses on the mechanisms by which tumors can escape from and subvert the immune system and conversely on the ability of innate and adaptive arms of the immune system to recognize and eliminate tumors. Topics include: tumor antigens, tumor immunosurveillance and immunoeediting, tumor immunotherapy (including CAR-T and checkpoint antibodies) and cancer vaccines. Tracks the historical development of our understanding of modulating tumor immune response and discusses their relative significance in the light of current research findings. Prerequisite: for undergraduates, human biology or biology core.

Same as: IMMUNOL 275

CBIO 280. Cancer Biology Journal Club. 1 Unit.

Required of and limited to first- and second-year graduate students in Cancer Biology. Recent papers in the literature presented by graduate students. When possible, discussion relates to and precedes cancer-related seminars at Stanford. Attendance at the relevant seminar required.

CBIO 299. Directed Reading in Cancer Biology. 1-18 Unit.

Prerequisite: consent of instructor.

CBIO 399. Graduate Research. 1-18 Unit.

Students undertake investigations sponsored by individual faculty members. Cancer Biology Ph.D. students must register as soon as they begin dissertation-related research work.

CBIO 801. TGR Project. 0 Units.

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CBIO 802. TGR Dissertation. 0 Units.

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