# Stanford Initiative to Cure Hearing Loss

*The goal of the Stanford Initiative to Cure Hearing Loss (SICHL) is to invent treatments that repair the damaged inner ear in order to restore lost hearing, quiet tinnitus and improve balance.*

Stanford MEDICINE | Stanford Initiative to Cure Hearing Loss

*Otolaryngology—Head & Neck Surgery*

INITIATIVE TO CURE HEARING LOSS

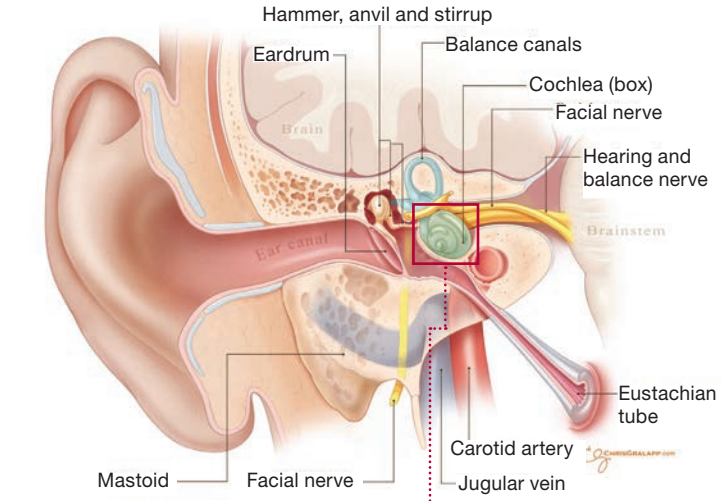
Stanford MEDICINE | School of Medicine

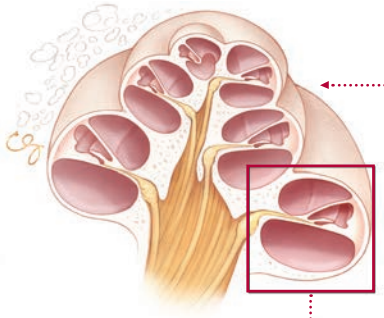
**The inner ear has two parts:** the cochlea for hearing and the vestibular system for balance. Both contain specialized cells, called hair cells, whose purpose is to sense sound and movement. When hair cells become damaged or die, hearing loss, ringing in the ears (tinnitus), or vertigo may result. Today's medical science offers no solutions for the vast majority of inner ear diseases. Unfortunately, once a hair cell dies, our bodies cannot regenerate it. But here at Stanford, we are working on solutions that overcome this problem.

- Two out of every 1,000 babies in the United States are born deaf or hard-of-hearing. Close to a million children in America have hearing loss.
- Health experts estimate that one in three adults over the age of 65 has developed a debilitating hearing loss. The numbers continue to increase as the population grows older. Almost 50 percent of American seniors experience some form of hearing impairment.
- Occupational exposure, amplified music, and military service contribute to hearing loss.

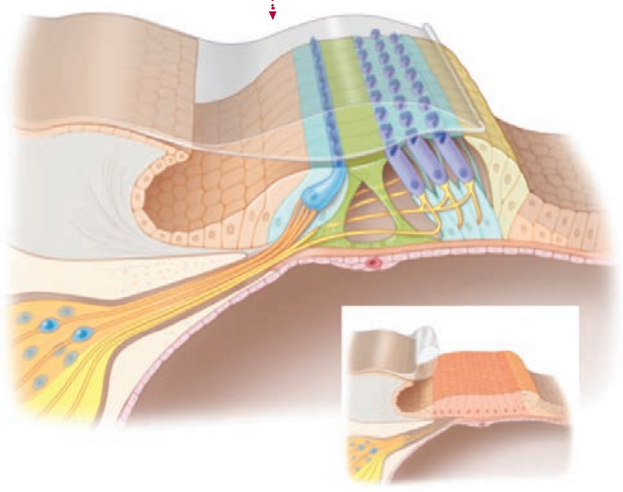
Approximately 36 million American adults—17 percent of the entire population—report some degree of hearing loss.

- Undiagnosed and/or untreated hearing loss in children can lead to a delay in spoken language and can have a significant impact on academic achievement.
- According to WHO, in developing countries adults with hearing loss have a much higher rate of unemployment and a higher percentage of those employed are in lower grades of employment than the general workforce.
- Untreated hearing loss, resulting in less access to vital services and exclusion from social situations, can have a significant impact on everyday life. Loss of hearing can lead to social isolation, loneliness and frustration, particularly in older adults, and has been linked to an increase in depression.
- Hair cell dysfunction also causes tinnitus and balance disorders.



***The human cochlea*** *(left) has 2-1/4 turns. The Organ of Corti (box) is the location of the sound sensing hair cells.*



***Normal Organ of Corti*** *with one row of inner and three rows of outer hair cells.*

***Inset:*** *Organ of Corti in deafness lacks hair cells, but the hearing nerve remains.*

# Faculty

Stanford has assembled an interdisciplinary team of scientists, engineers, and physicians drawing upon expertise from many different domains for the shared purpose of curing hearing loss.

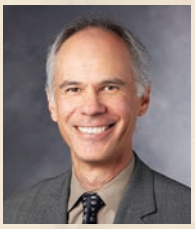
By sustaining a research culture that encourages translational medicine—a close inter-relationship between basic science investigators and the surgeons and physicians working directly with patients—Stanford continues to lay the groundwork for previously unimaginable ways to treat and prevent disease.

**Robert Jackler, MD**
The Edward C. and Amy H. Sewall Professor and Chair of Otolaryngology – Head & Neck Surgery and Professor of Neurosurgery and of Surgery

**Matthew Fitzgerald, PhD**
Chief of Audiology and Hearing Devices and Assistant Professor of Otolaryngology – Head & Neck surgery

**Stefan Heller, PhD**
The Edward C. and Amy H. Sewall Professor III in the School of Medicine and Professor of Otolaryngology – Head & Neck Surgery and of Molecular and Cellular Physiology

**Nicolas Grillet, PhD**
Assistant Professor of Otolaryngology – Head & Neck Surgery



**Nikolas H. Blevins, MD**
The Larry and Sharon Malcolmson Professor in the School of Medicine and Professor of Otolaryngology – Head & Neck Surgery and Chief of the Division of Otology and Neurotology

**Mirna Mustapha, PhD**
Assistant Professor of Otolaryngology – Head & Neck Surgery

**Kay Chang, MD**
Associate Professor of Otolaryngology – Head & Neck Surgery and of Pediatrics

**John S. Oghalai, MD**
Professor of Otolaryngology – Head & Neck Surgery and of Pediatrics

**Alan G. Cheng, MD**
Associate Professor of Otolaryngology – Head & Neck Surgery and Pediatrics

**Anthony Ricci, PhD**
The Edward C. and Amy H. Sewall Professor II in the School of Medicine and Professor of Otolaryngology – Head & Neck Surgery and of Molecular and Cellular Physiology

# The Impact of Hearing Loss

*Our ability to communicate is at the core of what it means to be human, to share ideas, to enjoy friendship, to teach our children. Hellen Keller, who was both deaf and blind, had a unique perspective about hearing loss. She said, "Blindness separates us from things … but deafness separates us from people."*

Hearing loss is a huge problem: 5% of the world's population and 1/3 of seniors over 65 experience serious hearing loss. Today people are living longer – they want full lives, and rightly so! Hearing loss can make it impossible to enjoy a restaurant dinner with family, an evening at the theater, or even to hear the laughter of children. Hearing loss is a major issue for children as well, affecting nearly 1,000,000 children in the U.S. alone. Hearing loss at birth or early childhood can have a significant impact on speech and language development and without intervention can have consequences for education as well.

## What Can We Do to Treat People with Hearing Loss Today?

The good news is that with modern microsurgery, we can cure a wide variety of middle ear problems that occur with the eardrum and its 3 little bones – a big success of 20th century technology.

The bad news is that inner ear hearing loss, by far the most prevalent type, remains incurable today.

The exciting news is that based upon recent, revolutionary scientific advances, it is clear that hearing loss can be cured and we at Stanford are leading the effort.

## Dispelling the Myth of "Nerve" Deafness:

It is a common misconception that hearing loss is due to "nerve deafness." It is actually from the loss of a tiny population of sound sensing hair cells in the inner ear. In humans, damaged hair cells are lost forever – they do not regenerate. In the early 2000's, the scientific leader of SICHL, Stanford Professor Stefan Heller, became world famous for the discovery of stem cells in the deaf inner ear which could be coaxed through clever molecular manipulations to form new hair cells. With his scientific vision and Professor Robert Jackler's leadership, we assembled the world's leading inner ear regeneration team at Stanford.

*Members of the SICHL Research Team*

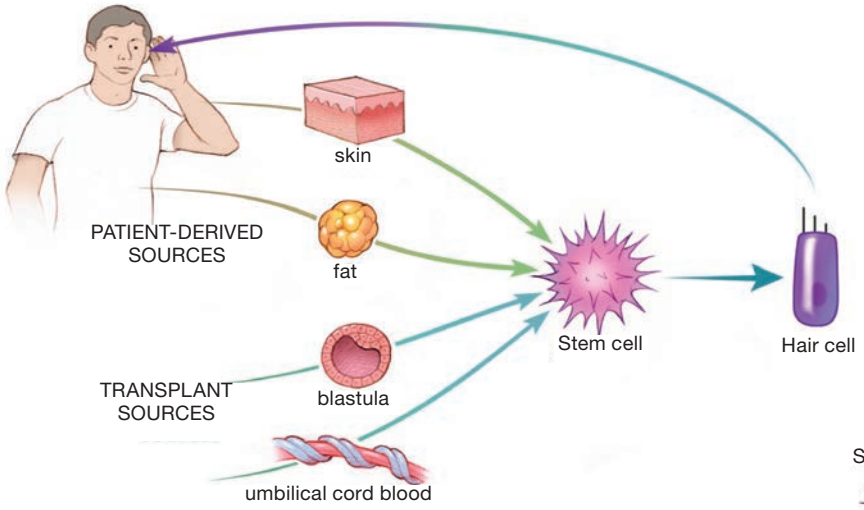
# Where are We Today in Our Quest

*The inner ear is a particularly favorable site for regeneration. Most solid organs which have failed become a collapsed lump of scar. In the deaf inner ear the architecture is preserved. The elegant cochlear spiral and the auditory nerve remain intact with only a*

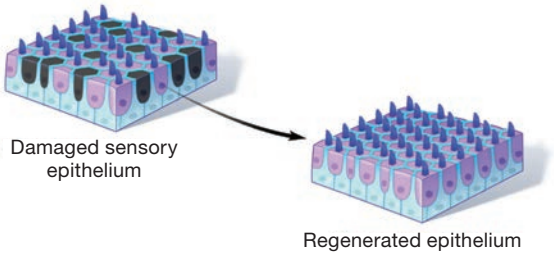
**Therapies:** SICHL is capitalizing on Stanford's network of collaborations to consolidate and advance promising hearing loss research investigations in four key areas: Stem Cell Therapy, Cellular Reprogramming, Molecular Therapy, and Rebuilding the Normal Vibratory and Electrical Characteristics of the Inner Ear.

**STEM CELL THERAPY** – SICHL researchers are developing biological methods to repair the damaged cochlea by regenerating inner ear hair cells from patients' own skin or blood cells that have been genetically reprogrammed to revert back to stem cells. Therapies such as these have the potential to restore natural hearing without need for any type of prosthesis.

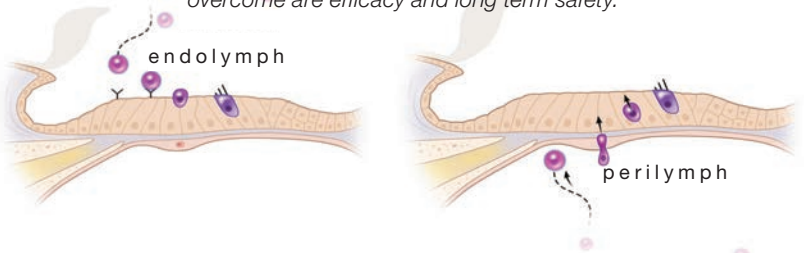
***Stem Cell Sources***



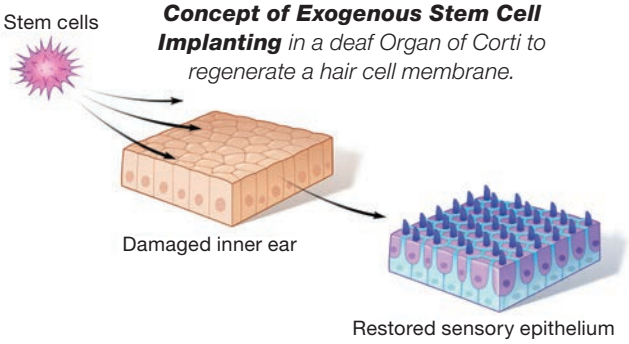

***Concept of Regeneration of Hair Cells*** *by stimulating supporting cells to differentiate into hair cells.*




***Stem Cell Transplantation*** *Current hurdles that need to be overcome are efficacy and long term safety.*




***Concept of Exogenous Stem Cell Implanting*** *in a deaf Organ of Corti to regenerate a hair cell membrane.*



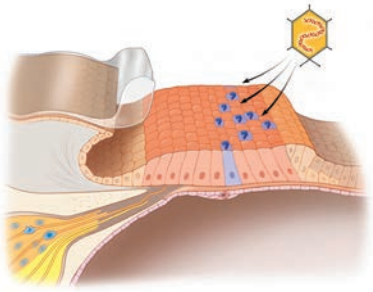

***Coaxing surviving inner ear cells to regenerate sensory hair cells***

*We are pursuing two strategies that occur naturally in birds*

# to Cure Hearing Loss?

*small population of hair cells missing. Major strides have been made in regenerating hair cells in the mouse and connecting them to the hearing nerve. The challenge before us is to refine the method and make it safe and effective in humans.*

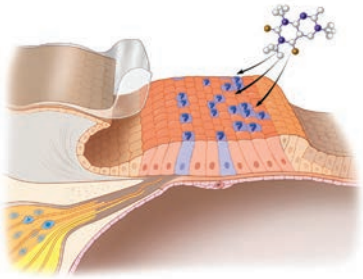
**CELLULAR REPROGRAMMING** – This innovative strategy for restoring hair cells is using genes that orchestrate embryonic development of the cochlea. New-generation harmless virus vectors temporarily introduce these genes.



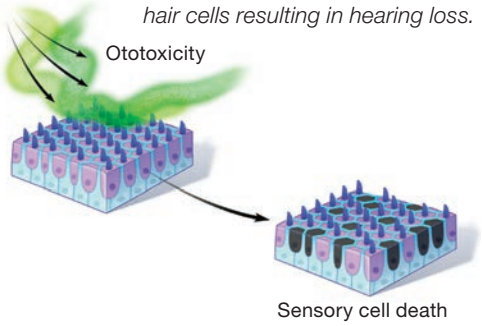
***Using a Virus Vector*** *to insert transformative genetic material into inner ear cells.*

**MOLECULAR THERAPY** – Novel drugs are being developed that could be used either to prevent the cochlea from losing hair cells or to initiate a self-repair program within the cochlea. Our researchers are also investigating specific targets in the inner ear that could be receptive to drug intervention.

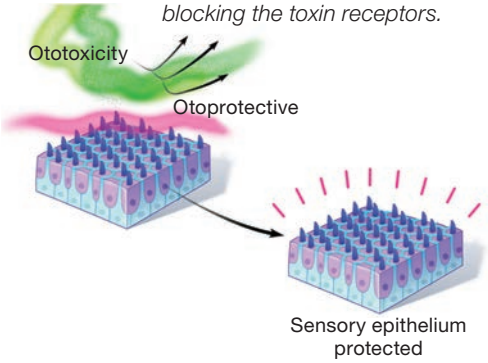
***Concept of Molecular Therapy*** *using molecular modulators to transform inner ear cells into hair cells.*



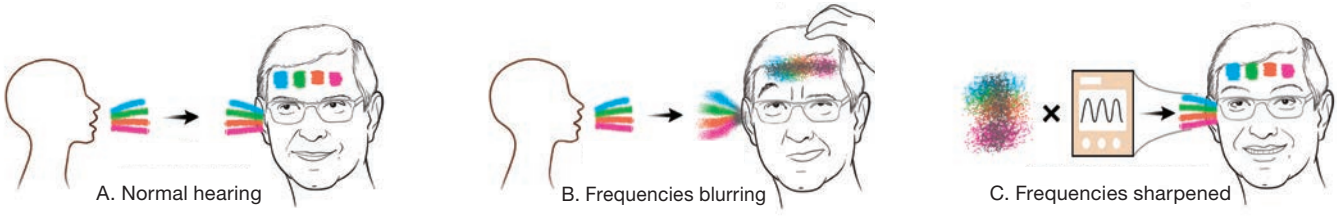
***Ototoxicity*** *is a process whereby some medications cause injury to hair cells resulting in hearing loss.*




***Concept of Protecting the Sensory Epithelium*** *by blocking the toxin receptors.*




**REBUILDING THE NORMAL VIBRATORY AND ELECTRICAL CHARACTERISTICS OF THE INNER EAR** – Stanford researchers are studying how the normal cochlea detects sound pressure waves. The research team has pioneered a new technology, Volumetric Optical Coherence Tomography Vibrometry, which permits non-invasive imaging within the cochlea. By studying normal-hearing and hearing-impaired animal models, researchers hope to improve speech recognition abilities for hearing-impaired patients.



# A High Probability of Success

*Dr. Robert Jackler, Department Chair*

## A Moonshot to Seek a Cure for Hearing Loss Would Have a High Probability of Success:

*When speaking of his moonshot, President Kennedy said we should do it, "...not because it is easy, but because it is hard...a challenge we are willing to accept."*

Here at Stanford, we feel the same way about our moonshot to cure hearing loss. We have compelling reasons to believe that our goal has an exceptional chance for success. Hearing loss, tinnitus and imbalance are major causes of human disability which we believe, can be conquered.

## Why is Stanford Best Prepared to Discover a Cure?

Stanford is a special place with unique characteristics which foster innovation and discovery. We are highly collaborative and enjoy a high degree of intellectual exchange – Expertise flows throughout the campus. We attract scientists and engineers from various disciplines to bring their methods to hearing research. At Stanford, our hearing scientists are part of a clinical department, which creates a laser focus on overcoming human disease.

Great ideas require not only inspiration but also great execution. We have over 100 researchers including faculty, scientists, students and technicians currently working to reach this goal and bring a cure into clinical trials.

## Why You May Want to Support Hearing Regeneration Research:

Rapid advances in bioscience and technology, many of which originated at Stanford, make it realistic to envision a cure within the foreseeable future. In laboratory animals, we can now regenerate inner ear hair cells, a tantalizing accomplishment, which we are working hard to adapt for human benefit.

In our moonshot to regenerate the inner ear, we have reached earth orbit and need a substantial boost to reach the moon. An investment in hearing regeneration research today is likely to have a tremendous return on investment – the prospect of categorically curing one of man's most common disabilities.

## **How to Participate** – Gifts to **SICHL** can be made in several ways:

**ONLINE** – Make a gift by visiting **hearinglosscure.stanford.edu** and clicking on the "make a gift" link

**BY MAIL OR FAX** – Print and complete the online donation form and return it with your gift to:
**Otolaryngology – Head & Neck Surgery** c/o Development Services
PO Box 20466
Stanford, CA 94309
650-725-2450 (fax)

**CALL US** – Contact **Medical Center Development** by calling **650-725-2504** to discuss a gift

*For further information on the Stanford Initiative to Cure Hearing Loss, please visit our website:* ***hearinglosscure.stanford.edu***

## Accelerating Our Quest for a Cure

We are seeking philanthropic partners to help accelerate our progress. Donor support will allow us to recruit the best and brightest researchers, to acquire more cutting-edge laboratory technology, and to pursue high risk/high reward investigations. These strategies will enable us to arrive at a cure in the shortest possible time.

The question is not if, but when. Will a baby girl born with hearing loss today benefit from this cure as a toddler, a teen, as a young adult?

Government grants are important – and we do very well in getting them – but they are not sufficient. Federal grants tend to fund incremental research, but not necessarily the most imaginative and visionary proposals. Both private and public support is needed if we are to accelerate our quest to invent a cure. Philanthropic support today can be leveraged by helping to reset the national research priorities.

## Opportunities to Invest in Curing Hearing Loss

Reaching our ambitious goal will only be possible through partnerships with visionary donors. We invite you to join other like-minded philanthropists by making your investment in SICHL.

## Giving Opportunities Include:

- **Seed Grant Funds** – These funds fuel pilot projects that can prove our innovative approaches. Gifts for seed grants can be leveraged to garner long-term federal grant support.
- **Technology and Laboratory Funds** – Access to the highest quality equipment expedites our research and enables our scientists to pursue the most creative experiments.
- **Facilities** – Our goal is to move all the SICHL labs into a new, state-of-the-art building by 2019 to facilitate collaboration within the team and with other related disciplines such as neuroscience, genetics and stem cell biology. Naming opportunities will be available for donors.
- **Faculty Support** – Endowed or expendable gifts to enable recruitment of talented researchers to join SICHL and to allow our research faculty to focus on high-risk, high-reward projects of the type needed for major discovery.
- **Trainee Support** – These funds provide specialized multi-year training in the field of hearing loss research, creating the next generation of world-class scientists.

*Dr. Stefan Heller, SICHL Research Director*


**Medical Center Development**
650-725-2504
medicalgiving.stanford.edu

**Stanford Ear Institute:**
med.stanford.edu/ohns/healthcare/earinstitute

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For further information on the Stanford Initiative to Cure Hearing Loss, and updates on the research, please visit our website:
**hearinglosscure.stanford.edu**

For the latest updates, join us via:

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