Human Biology Proposal of Study

My interest in Human Biology, and ultimately my career goal to become a physician, directly stems from my personal and academic interests. I was born with unilateral microtia, a congenital deformity that causes the lack of an external ear and varying degrees of deafness. My condition has shaped my entire life and has ignited a passion within me to pursue a career in reconstructive medicine. I hope to use innovative technologies stemming from the current scientific community, such as building live cartilage through tissue engineering, to improve upon the pioneering surgical procedures that Dr. Burt Brent of Woodside, California artfully used to recreate my ear out of my rib cartilage. With this technology, cartilage from live cells could build ears indistinguishable from those natural at birth. Additionally, I hope to conduct different types of auditory research, especially in regenerative hearing, throughout my career. Last summer, I interned at the House Research Institute in Los Angeles, an institution entirely devoted to hearing research. I designed a project that studied the effects of sound conditioning and restraint stress as a way to prevent hearing loss in mice. This summer, I will be continuing my current work in the Heller Lab at Stanford with funding through HB-Rex; our hypothesis for this research is that local signaling cues in the regions medial and lateral to the Organ of Corti direct ectopic hair cells to take on characteristics of inner and outer hair cells, and that FGF signaling is involved and required for this process. Since I have a physical attachment to auditory function, I have a developed a passionate academic interest to study otology.

I chose the Human Biology major as a means to pursue my goals because it promotes interdisciplinary depth across Stanford departments and allows for a personally designed focus of study. I particularly enjoy the Core classes offered by HumBio, as the distinguished lecturing professors are highly engaged and involved with the students. Coming in as a pre-medical
student, I really benefit from the relationships drawn and explanations made to the chemistry and biology labs offered at Stanford. The structure and organization of the major allows for flexibility and freedom of study, so I can choose the classes that I find most interesting and relevant to my growth as a student. Finally, I intend to pursue Honors in my senior year, and the Human Biology major will give me this opportunity to challenge myself and grow as an aspiring biomedical scientist.

I chose A Multi-Disciplinary Approach to Understanding Auditory Function, a subset of bio-medical science, as my Area of Concentration because it naturally expands upon my personal and academic interests. The classes in my Area of Concentration introduce a variety of scientific topics, including biochemical, genetic, and mechanical principles that are either directly applicable or can be applied to otology. My concentration includes widely applicable studies of stem cells and genetics to very specific studies of the inner ear. Together, these classes will prepare me well for more in-depth studies of the human organism in medical school.

I will take The Biology of Stem Cells (Human Biology 157, R. Nusse & M. Fuller) this Spring quarter because the course studies the role of stem cells in development and treatment of human disease. In addition to Professor Nusse, my Human Biology Faculty Advisor, and Professor Fuller, distinguished biologists, ethicists, and legal professors will guest lecture. Stem cells are directly applicable to my Area of Concentration as these cells are studied in regenerative medicine and tissue engineering. For example, the Bonassar Lab at Cornell University is currently using a variation of 3D printing to produce external “ears” using live tissue. This class also sparks my intellectual interest because I find the pathway of differentiation of stem cells into all the body cell types extremely amazing.
I plan to take Introduction to Medical Genetics (Gene 272, L. Hudgins & K. Ormond), an upper-level genetics class, during my senior year. I chose this class because I believe the concepts presented will prepare me to be a better molecular biologist and pre-medical student. The class will cover the principles of medical genetics, including taking a family history, examining inheritance of genes, and several mathematical principles (Bayes theorem, population genetics) of medical genetics. Medical genetics is directly applicable to understanding the basis for congenital hearing loss and why certain people's hair cells are more resilient to damaging sound exposure.

I intend to take Genomics, Bioinformatics and Medicine (Human Biology 158G, D. Brutlag) to take diagnostic, genomic, and novel therapeutic approaches to the molecular basis of inherited human disease. In addition, we will study the future of preventive medicine from personal genomics, pharmacogenomics, and clinical genomic perspectives. This class will also give a macro approach to a wide range of scientific topics that will potentially contribute to my primary interest—therapeutic treatment for ontological conditions. For example, finding a mechanism for expressing specific genes (such as Atoh1) targeted to the cochlea of the inner ear could regenerate hair cells, whose loss accounts for the majority of late-onset hearing loss.

To achieve a mechanical approach to auditory function, I will take the Introduction to Physiology and Biomechanics of Hearing (ME 266, S. Puria). As Professor Puria notes in the class description, over 30 million people suffer from some form of hearing impairment in the US alone. In order to devise better ways to help those suffering from hearing loss, it is important to take a biochemical and mechanical approach to understand the underlying principles of the auditory system. Acoustics, mechanics, and thermodynamics will be used to establish a foundational understanding of the complex auditory system. In addition to a wide range of
specific mechanical approaches, the class covers current and future regenerative therapies for mitigating hearing loss.

The Research Seminar on Computational Models of Sound Perception (Music 319, M. Slaney) studies all aspects of auditory perception with an emphasis on computational models. This seminar is offered every quarter, repeatable for credit, and covers music perception, signal processing, auditory models, speech, binaural hearing, basic psychoacoustics, and more.

As an aspiring reconstructive surgeon and research biologist, Creativity and Innovation (MS&E 277, L. Britos Cavagnaro) will introduce approaches to innovative thought and design. The class poses the positive and negative aspects of creativity and innovation in individuals, teams, and organizations. The class covers creativity tools using workshops, case studies, field trips, interesting guests, and challenges in working with a design team. As an artist who expresses myself primarily through music, I understand that creativity is vital to push the boundaries of what we think possible. I believe that this class will give me the tools to direct my artistic expression to design a project related to reconstructive surgery.

Finally, if offered, I will take Human and Machine Hearing (Psych 303, professor not listed) because it will expand upon my other auditory-specific studies. Topics include linear and nonlinear system theories applied to sound and hearing similar to the other courses in my Area of Concentration. However, it will also include studying features compatible with machine-learning systems, building systems that can extract information, and sample applications of machine hearing to speech, music, etc.

My foundation courses include several classes from my pre-medical studies and others that have influenced my decision to pursue a major in Human Biology. My first introductory seminar at Stanford, Self-Theories (C. Dweck), was also the first psychology class I had taken and it introduced...
me to how one’s mindset can affect their performance. Also included in my foundation is my current IntroSem, Law and the Biosciences (H. Greely), which has ignited an interest in the legal, ethical, and economic issues involved in biological sciences. Structure and Reactivity (P. Wender & J. Schwartz) introduced me to organic chemistry, which I found highly interesting, especially as the concepts are so intertwined with biology. The Core Molecular Biology Laboratory (W. Khalfan) applies many of the concepts surrounding cancer introduced in the Human Biology Core; moreover, this class has contributed to my laboratory skills and experimental design. The seminar Physicians and Human Rights (lecture series) offered by the medical school introduced me to the role of physicians in giving back to the community by contributed to global health. In addition, I plan to take the Introduction to Otolaryngology–Head and Neck Surgery (A. Messner), offered next winter, as I am interested in becoming an ENT physician. Finally, I will take Understanding Children’s Health Disparities (D. Barr) because it will offer an introduction to one of the United States’ biggest issues in pediatric care and health.

In conclusion, these courses will all contribute to my growth as an aspiring biological scientist and pre-medical student. For my internship, I will likely continue with a new research question in the Heller Lab that could potentially arise as a result of my studies this summer. I also intend to pursue Honors in Human Biology, which I hope to conduct with Dr. Heller after having several years of experience and having gained much laboratory independence. Hearing is extremely important to me, and I hope to take the knowledge gained through these courses to become a physician and give back to others through medicine. I know that leaving my Stanford undergraduate career having taken these classes and after putting in many hours through research will prepare me for medical school and beyond.