Stem Cells for the Treatment of Hearing Loss

The ears are sensitive instruments that can be permanently damaged by such ubiquitous sounds as the roar of a motorcycle engine, the bang of a firecracker, or the din of construction work.

The cells that collect sound information from the environment and send it to the brain are called hair cells. We are born with about 11,000 hair cells in each ear, and they need to last. We experience the slow progression of hearing loss as these fragile cells die due to excessive noises, exposure to certain drugs, and aging. As hair cells die, nearby brain cells that once carried sound information to the audio processing part of the brain also expire.

About a third of 65-year-olds identify as hearing impaired, a number that rises to half by age 75. The only available treatments for hearing loss are prosthetic devices, such as hearing aids and cochlear implants. These devices can improve hearing, but they don’t always meet patients’ expectations.
Harvard Stem Cell Institute (HSCI) investigators have made it their mission to develop new ways to prevent and treat hearing loss. Our researchers are quickly progressing in their goal to replace audio-assistive devices with biologically based therapies that treat the cause of the disease by protecting or replacing lost cells in the ear.

**Regeneration of Hair Cells**

HSCI scientists have discovered which stem cells can become hair cells as well as the molecules that bring about this change. Using this information, our researchers are developing techniques to grow hair cells in the laboratory and implant them into the ear.

Stem cells can also be used to screen for drugs that could stimulate the regeneration of hair cells. This method has already produced drugs capable of partially restoring hearing in deaf rats. The next steps are identifying the right mixture of drugs that will regenerate the largest number of hair cells and assessing ways that these drugs can be delivered to the ear. The success in rodent models will eventually lead to drug tests in human stem cells.

**Regeneration of Auditory Neurons**

HSCI scientists have also learned how to coax stem cells into becoming brain cells. Experiments on stem cell-derived auditory neurons show that they will form new connections with damaged hair cells in a laboratory dish.

Excitingly, our investigators then found that when the stem cell-derived auditory neurons were transported into deaf animals, the neurons helped to re-establish broken connections and animal hearing was improved. Further research needs to be done to increase the effect of this procedure, as well as to develop other ways to make brain cells.

Using this method in the clinic could allow an individual patient to receive his or her own stem cell-derived auditory neurons, preventing rejection by the immune system. The final step before application to the human ear will be to determine the best surgical approaches for cell transplantation.