



# Hair Cell Research

## WHAT ARE 'HAIR' CELLS?

There are almost nine million people in the UK alone with some degree of deafness and in 87% of cases that hearing loss results from damage to the inner ear (the cochlea).

This type of deafness is known as sensorineural deafness and it is characterised initially by a high frequency hearing loss, which affects the ability to hear and understand speech. Sensorineural deafness results mainly from damage to cells in the inner ear known as "hair" cells. These highly complex sensory cells, so called because of tiny bundles of hairs at their tips, detect the sound vibrations which are passed from the outside world, via the eardrum and the bones of the middle ear, to the cochlea. Here they are converted into electrical signals that can be understood and processed by the brain.

Similar hair cells in the vestibular or balance organ, also sited in the inner ear, play a key role in detecting head movements. When these cells are damaged the resultant loss of balance control can contribute to severe mobility problems.

With deafness the second most common disability in the UK after mobility disablement, it's clear that the inner ear, in particular the hair cells, are responsible for more disabling conditions than almost any other bodily system.

## WHAT CAUSES INNER EAR DAMAGE?

Age is the most common cause of inner ear damage and over half of all people over 60 are affected. With age, the eardrum loses its elasticity and the joints of the tiny middle ear bones begin to stiffen, restricting the transmission of sound waves from the outer ear to the cochlea. At the same time, the sensory hair cells begin to malfunction or die off.

Exposure to excessive noise also damages and kills hair cells, resulting in permanent hearing impairment. With almost 20% of all young people risking their hearing through regular exposure to hazardously loud noise (a threefold increase over the last 20 years), the number of people affected by permanent noise damage to hair cells appears to be increasing.

Hair cell damage can also be caused by 'ototoxic' agents, chemicals (including some therapeutically useful drugs) which can affect both the auditory (hearing) and vestibular (balance) portions of the ear.

## **IS THERE A TREATMENT FOR INNER EAR DAMAGE?**

At present, there is no medical way in which cochlear damage can be prevented or reversed. Consequently, for most people with a hearing loss, hearing aids and other technological aids are the only option.

## **HOW LIKELY IS A MEDICAL TREATMENT FOR INNER EAR DAMAGE?**

Only a few years ago, most scientists would have considered it unlikely that hair cell damage could ever be prevented or reversed by medical means. Today, many believe that it won't be too long before we find medical ways of preventing or slowing down some forms of hearing loss. One day, it might even be possible to reverse or "cure" deafness medically.

## **WHY IS DEAFNESS RESEARCH UK OPTIMISTIC THAT TREATMENTS FOR INNER EAR DAMAGE WILL BE FOUND?**

In humans, in common with all mammals, the ability to create new hair cells is lost before birth. However, in fish and amphibians, very similar cells are present and produced throughout life. In the late 1980's, scientists found that birds possessed the ability to replace hair cells, which were damaged by exposure to noise or ototoxic agents, resulting in almost complete cellular and functional recovery. This was the first time that warm blooded animals had been shown to possess this ability and it stimulated a great deal of scientific interest.

More recently, new techniques and the increase in genetic knowledge have led to a number of different lines of research which have raised expectations even further. One of the most significant developments was the discovery that hair cells in the mammalian vestibular or balance system, very similar to those in the hearing system, can be regenerated.

## **WHAT RESEARCH IS BEING CONDUCTED NOW?**

### **Regeneration of hair cells**

Deafness Research UK is supporting research which aims to identify and remove barriers to auditory hair cell regeneration. The ability of bird hair cells to regenerate has opened up a number of avenues of research that are trying to understand why this process can happen in birds and not in mammals. For example, one of our research teams is undertaking a study comparing the damage and repair of hair cells in birds and mammals, which will help identify what factors are involved in this process, and why hair cells cannot be regenerated in mammals.

Another of our teams is currently investigating the role of the gene connexin-43 that prevents new hair cell production in undamaged regions of the bird ear. It is hoped that blocking the effects of this gene in humans will aid in the eventual development of treatments to prevent or even reverse hair cell loss.

In a different line of research supported by Deafness Research UK, scientists are studying newts, amphibians capable of regenerating various body parts, with the aim of isolating chemicals that could stimulate the process in mammalian hair cells.

### **Development of hair cells**

Deafness Research UK scientists are looking at identifying the genes involved in the normal development of hair cells. Some of the genes involved in this process have already been identified, and research is continuing with the aim of controlling cell development and identifying ways of triggering the process when damage has occurred to hair cells. The discovery of many of the genes responsible for hereditary deafness is also opening up significant new lines of research, enabling scientists to identify and study the precise role of some of the proteins needed for the development and functioning of healthy hair cells.

One of the more immediate benefits of this genetic research could be the availability of genetic testing to identify people who are particularly susceptible to hearing loss and who might benefit from preventive therapies of this sort.

### **Preventing hair cell loss**

An alternative to replacing lost hair cells is to prevent their loss in the first place, which is proving to be a particularly promising line of investigation. Deafness Research UK researchers have found that exposure to some ototoxic agents causes cell death by triggering a biochemical 'cell suicide' programme and it is likely that noise, ageing and other ototoxic agents trigger the same process. Because the biochemical pathway is so precise, researchers believe it may be possible to step in to halt it, preventing destruction of the cells. In the laboratory, a number of chemical agents - some quite common, such as aspirin and antioxidants known to protect against damaging chemicals known as "free radicals" - have already been shown to be effective in achieving this.

Despite these developments and the significant progress that has been made in recent years, medical answers for deafness and other hearing problems remain some way off. However, with scientific and medical experts increasingly confident that one day they will become a reality, Deafness Research UK is committed to continuing its support for the research needed to bring them about.

## FURTHER INFORMATION

Contact the Deafness Research UK Information Service for further information about hair cell research.

If any of your questions concerning hair cell research have not been answered by reading this factsheet, contact the Deafness Research UK Information Service for further assistance. Our Information team will either answer your enquiry directly or refer it to one of our scientific or medical advisers.

Open: 9.00 a.m. to 5.00 p.m., Monday to Friday (a message can be left at other times).

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or click the 'ask question' option from our website homepage:

[www.deafnessresearch.org.uk](http://www.deafnessresearch.org.uk)

Deafness Research UK is the only national medical research charity dedicated to helping people with deafness, tinnitus or other hearing problems.

Scientists are now predicting that within the next ten to fifteen years there could be a cure for some forms of deafness and much more effective treatments for tinnitus. Deafness Research UK is at the forefront of this work.

You can support us by making a donation or joining the Deafness Research UK League of Friends. For more information call us on 0207833 1733 or write to:

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