How we hear

For the auditory (hearing) system to work properly, a sound has to travel through the ear to the brain. Look at the illustration above to see how this happens.

1. The outer ear is made up of the part you can see on the side of your head (pinna) and the funnel-shaped auditory canal. The pinna gathers sound waves (vibrations) and channels them through the auditory canal to the eardrum ( tympanic membrane). This makes the eardrum vibrate, changing the sound waves into mechanical vibrations.

2. The vibrations are transferred to three tiny bones in the middle ear (maleus, incus and stapes – the Latin names for hammer, anvil and stirrup) in the air-filled space of the middle ear. These bones, collectively known as the ossicles, are arranged to augment the vibration.

3. The final ear bone (stapes) is attached to the snail-like cochlea (hearing organ) in the inner ear. The stapes vibrates against the oval window creating pressure waves in the fluid-filled cochlear canals.

4. The vibrations in the fluid-filled cochlear canals flex adjacent membranes.

5. When the basilar membrane is flexed, the fluid moves. This movement causes microscopic hair-like projections (known as stereocilia) on top of rows of hair cells in the organ of Corti to bend and sway.

6. The movements of the stereocilia produce electrical signals. The signals are sent to the brain through the auditory vestibular nerve (8th cranial nerve) where they are interpreted as sound.
The fluid in the cochlea is shared with the **vestibular (semi-circular) canals**. Hence hearing loss and vestibular impairment sometimes go together.

### Types and causes of hearing loss

Hearing loss is common, particularly as we age. It affects almost 15% of people age 45 to 64, over half of all seniors, and about two-thirds of those over 85.

There are three main types of hearing loss:

**Sensorineural hearing loss**
The most common type of hearing loss is sensorineural. It is a permanent hearing loss that happens when there is damage to either the tiny, hair-like cells in the cochlea (organ of hearing) or the nerve (8th cranial nerve) sending information to the brain about the loudness and clarity of sounds. Conditions that lead to sensorineural hearing loss include:

- congenital (present at birth) genetic syndromes
- age-related hearing loss (presbycusis)
- acoustic neuroma
- labyrinthitis
- Ménière’s disease
- far-advanced cholesteatoma
- Ramsay Hunt syndrome (RHS)
- secondary endolymphatic hydrops (SEH)
- autoimmune inner ear disease (AIED)
- exposure to extremely loud noises or noise exposure over a long time
- a side effect of medication (vestibular toxicity)
- infections such as meningitis, mumps, scarlet fever and measles
- head trauma

**Conductive hearing loss**
Conductive hearing loss is less common. It happens when there is an obstruction or damage to the outer or inner ear that prevents sound from being transferred to the inner ear. Conductive hearing loss may be temporary or permanent, depending on the cause. The causes of conduction hearing loss depend on which part of the ear they affect.

**Middle ear causes of conductive hearing loss**
- eardrum perforation
- thickening of the eardrum (tymanosclerosis)
- middle ear infection (otitis media) and/or fluid build up in the middle ear
- blockage of the Eustachian tube connecting the cavity in the middle ear to the nose and throat - during a head cold, this tube can become plugged
- otosclerosis
- cholesteatoma
- loose bones in the middle ear (ossicular chain discontinuity)

**Mixed hearing loss**
Mixed hearing loss is a combination of conductive and sensorineural hearing loss.
Symptoms of hearing loss

Common symptoms of hearing loss include:
- hearing speech but not understanding what is said
- feeling as though most people mumble
- difficulty hearing in the presence of background noise
- buzzing or ringing in the ears (tinnitus)
- continually asking people to repeat words or phrases
- preferring the TV or radio louder than others do
- finding some sounds abnormally loud

Treatment and management of hearing loss

Some types of conductive hearing loss may be medically treated, while others will require use of technology such as hearing aids.

Removal of excess earwax

Never use Q-tips or similar objects to clear the wax. Such objects fit easily into the ear and can puncture the eardrum. Use over-the-counter medications or drops of olive oil to soften the wax.

If this is not successful, a visit to a doctor or audiologist is the next step. The most common way medical professionals remove wax is by using water to flush it. This method may not be recommended if you have a history of ear infections. If you have vestibular problems, this method of removing excess wax may cause severe dizziness.

A qualified medical professional or specialized audiologist should remove the wax with an instrument that resembles a very small spoon, or it may be suctioned out with specialized equipment. If the wax has been previously softened with oil, it can be removed more easily.

Medication to treat hearing loss

- Middle ear infections may at first be treated with medication
- Sudden hearing loss, especially when the cause is unknown, but affecting the cochlea (inner ear) and/or the vestibular nerve (8th cranial nerve), is usually treated with corticosteroids.
- Corticosteroids may also be used to reduce cochlea hair cell swelling and inflammation after exposure to loud noise.
- Hearing loss secondary to a central nervous system disorder, such as multiple sclerosis, may be reversed with medical treatment of the disorder.
- Autoimmune inner ear disease is medically managed with long-term corticosteroids and other drugs.

Surgery to treat hearing loss

Surgical procedures (operations) may be used to correct hearing loss due to:
- Persistent middle ear infections – a tiny ear tube is inserted in a small hole made in the eardrum to equalize pressure and allow drainage of excess fluids. This is a common procedure, particularly for children. They tend to have more frequent ear infections than adults.
- Persistent (chronic) perforations of the eardrum.
- Congenital (from birth) absence of the ear canal, or failure of the ear canal to be open at birth.
- Congenital absence, malformation or dysfunction of structures in the middle ear.
- Otosclerosis – the stapes (stirrup-shaped bone in the middle ear) is replaced with an artificial part. This surgery is called a stapedectomy.
- Cholesteatomas (abnormal skin growth in the middle ear) and other chronic middle ear infections
- Inner ear fluid compartment rupture or leakage, after head trauma or sudden changes in air pressure, is sometimes treated with emergency surgery.
- Profound, irreversible hearing loss – a cochlear implant may be an option when conventional hearing aids are not enough. A cochlear implant bypasses damaged parts of the inner ear and stimulates the hearing nerve directly. An audiologist, along with an otolaryngologist (ear, nose and throat
doctor - ENT), can discuss the risks and benefits.

- **Acoustic neuroma** – if the tumour is small, it may be possible to remove it with surgery and preserve hearing.

### Hearing aids

People often resist getting hearing aids, also known as hearing instruments, and deny that they need them. Hearing aids are not a fashion statement like glasses. They cost in the range of $2000—$6000 per pair. There are many different types. A good choice depends on your type of hearing loss, what features you need depending on your lifestyle and listening situations as well as cost.

Most hearing aids are digital. Many contain a computer chip that can be sensitive to direction and frequency and can vary with changing conditions. For example, hearing aids can be made more sensitive to sound coming from the front, thus reducing background noise. They can also improve clarity (to a point) as well as increase volume.

### Speechreading (lip reading)

Speechreading is the ability to understand spoken words by observing a speaker’s lip, tongue and jaw movements as well as interpret the speaker’s facial expressions, gestures and body language. It is a skill that needs study, practice, patience and a sense of humour. Find speechreading courses in [More resources](#).

### Psychosocial effects of hearing loss

People with hearing loss are unable to hear clearly. They tend to withdraw from social interactions. They miss parts of conversations, resulting in confusion and frustration. Denial is common and family relationships are often strained when the sufferer ignores or misunderstands verbal communication.

The part of the brain that normally receives signals from the inner ear (auditory cortex) starts to shut down from lack of use and this can affect other parts of the brain. Poor hearing isolates people from their social network and has a negative effect on the brain. As with any other part of the body, the auditory system needs care and attention – and sometimes help – to carry out its mission.

### Age-related hearing loss

Age-related hearing loss (presbycusis) is the loss of hearing that gradually occurs in most of us as we age. One in three people age 65 and older has hearing loss.

Age-related hearing loss is usually so gradual that most people do not realize they have a problem. If you are over 50 it is a good idea to get your hearing screened by an audiologist.

The aging process – from the outer ear to the brain – influences all of the structures involved in hearing. The eardrum and the hearing bones become stiffer, the number of special hearing cells in the cochlea goes down, the impulses travel more slowly through the nerve and are also processed more slowly in the brain. As a result, sounds are less intense (not as loud) and are incomplete.

Other health conditions related to aging such as diabetes and cardio-vascular diseases also increase the chances of hearing loss.

If your hearing was extraordinary, later in life it will become average. Young people can hear sounds between 20 and 20,000 hertz (cycles per second); most human speech is between 400 and 4,000 hertz.

As you age, you cannot hear as wide a range of pitches as you did before. The sounds passing through your ears, and into your brain, are not as loud and not as clear. Almost everyone will find it harder to hear high-pitched sounds as they age. Men tend to suffer from hearing loss more than women.

High-pitched sounds include the consonant sounds in human speech. When the receptors in your ears no longer sense these sounds, your brain will simply stop listening for them.
You will, for example, you may no longer hear the sounds “s” and “f.” This is why it is important to get hearing aids sooner rather than later. If you delay getting hearing aids, it will take your brain time to get used to processing high-pitched sounds again.

Increased concentration and selective attention make up for volume loss. Analysis, memory and experience fill in the gaps using things like context, visual clues and stored knowledge. In other words, as you get older, you use more brainpower to compensate for hearing loss – exactly the kind of brainpower that has limits and could be used for other purposes.

View more hearing and hearing loss resources as well as sources used for this handout: https://bit.ly/2Xh4TYM

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