

Lesson 38: The Ear

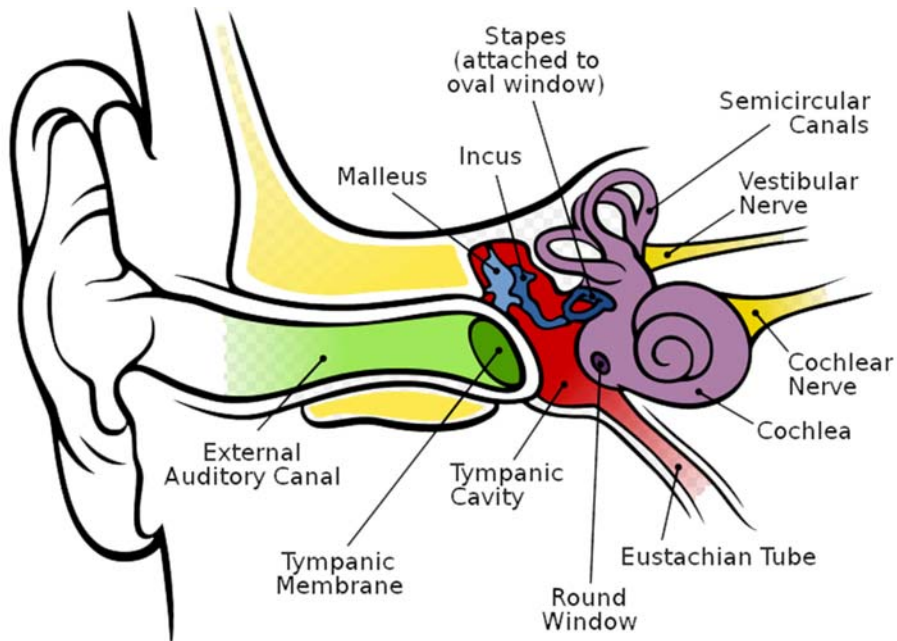


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The ear is a very important organ in the body that has two key functions. The first, of course, is hearing. The ear transfers sound wave energy into nerve impulse energy. First, the outer ear catches and slightly amplifies the sound as it narrows. The eardrum acts like a drum that causes the **malleus**, **incus**, and **stapes** bones to vibrate along the same patters. The stapes pushes on fluid in the **cochlea**, which transfers these fluctuating fluids waves to waves of tiny hairs in the **organ of corti**. The signals travel along the **vestibular cochlear nerve** and to the brain where they are processed. The second function of the ear is balance.

A defect in the eardrum or three inner ear bones is serious, but can be overcome by something called a **cochlear implant**. This is a microphone that connects directly to the cochlea and transfers the sound it hears to pulses which can be understood by the wearer's brain.

Decibel level - Sound is measured in decibels. The key thing to remember about the decibel level is that it is a logarithmic scale. Thus, 20 decibels is twice as loud as 10, and 30 decibels is 4 times (not 3) as loud as 10. 40 decibels is 8 times as loud as 10. Every time the decibel level increases by 10, the sound intensity doubles. Here are some decibel levels for common sounds.

Weakest sound heard	0 dB
Whisper Quiet Library	30 dB
Normal conversation (3-5')	60-70 dB
Truck Traffic	90 dB
Loud Rock Concert	115 dB
Pain	125 dB
Loudest recommended exposure (with protection) and gun blast	140 dB

It is important to note that there are generally three things that determine how much hearing damage there is— the intensity of the sound, the duration of the sound, and the background noise. The last one is interesting, and can be seen in cases of Eskimos with hearing loss. There was a famous study that found many Eskimos going deaf from their hunting guns, while the same didn't happen to soldiers or people who were witnesses to shootings. The reason is that when the background noise is loud or at least prevalent, muscles in your middle ear clamp down on the three bones to cause them to vibrate less for a given decibel level, thus muffling the sound. They do this so that the sound waves aren't so strong that they damage the ear. So what happened to the Eskimos? Alone in the frozen tundra, their ears were fine tuned to pick up the most minute sounds. When they shot their guns, their ears were not damped at all, causing damage. By the way, ears aren't the only things that sound can damage. If you happen to be near a really loud sound (over 200 dB), you could be in trouble. For instance, people on a nearby island when the volcano Krakatoa exploded were killed when the sound waves hit their chests. Other people 3000 miles away heard the explosion.



Sound Localization: So what benefit does having two ears have, and why are they on the opposite sides of our head? The answer has to do with figuring out where a sound is coming from. As you can see from the drawing below (The large circle is a head with two ears, the small circle is the location of the sound, and the lines are the path the sound takes to get to the ear) if we know trigonometry, and the different times the signal gets to the brain, we can calculate where the sound came from. That's exactly the calculation your brain does. This is a critical skill when facing multiple opponents.



Cauliflower Ear – Cauliflower ear is a common ailment in wrestlers and grapplers, and can be prevented by simply wearing special grappling headgear. Basically, the cartilage separates from the perichondrium after a blow or other trauma to the ear. This causes a bruise to form. At this point, a doctor can treat the injury. However, when the injury is left and never treated, a permanent scarring can form.

It's generally not necessary to wear head protection for grappling intermittently, but serious grapplers should invest in ear protection. Cauliflower ear can also occur from sparring, but helmets should always be worn in Taekwondo sparring.

Ears and Balance: You might have noticed that the semicircular canals in the ear anatomy diagram in the beginning of this lesson look like the XYZ 3 dimensional graph axes, and you'd be absolutely correct. These fluid-filled canals also have hair cells that detect the movement of the fluid. Because of their shape, they can detect angular rotation in all 3 dimensions. The **sacculus** and the **uticle** are in the middle, and they detect movement in a straight line, for instance going forward or stopping. Balance is critically important in martial arts. Problems in these areas can cause a student to lose balance. By training, we learn to compensate for any errors our body makes and we also learn to understand the signals from these organs better. Be wary of kicks to the head, aside from causing concussions, they can

also cause temporary loss of balance. As students get older, these hair cells die. So, just as older people lose their ability to hear, they also lose the ability to balance at a similar rate.