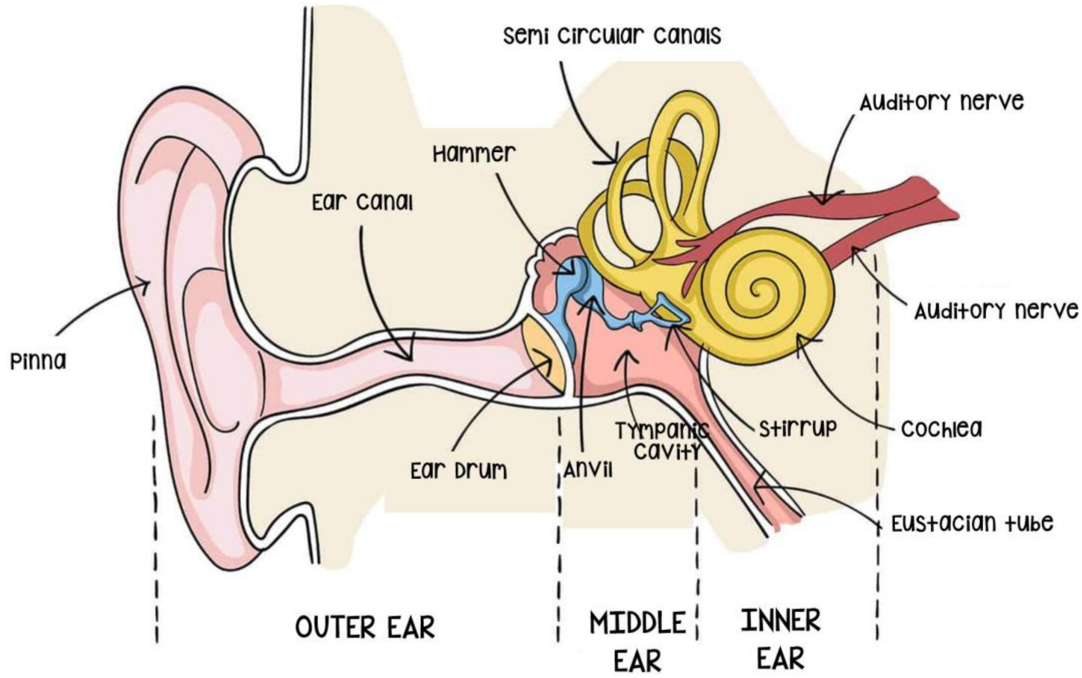
1 HOW WE HEAR SOUND

1.1 ANATOMY OF THE HUMAN EAR

The ear is quite a phenomenal instrument, and being in the audio industry, it plays a vital role in our existence within this business. Our ears are arguably our most important tool and much of our training in music production centers around learning how to use them well.



Our ears are the only part of our senses that work on mechanical principles, through means of physical movements. (our senses of smell, taste and vision work on chemical reactions)

The ear is made up of three main parts, and those are the:

- Outer ear,
- Middle ear
- Inner ear.

The outer ear
This made up of the pinna and the ear canal.

- **Pinna**

The pinna is the part of the ear that sticks out the side of our heads. It is curve shaped with ridges in it and points towards the front of our head. This pert of our ear is designed to capture sound waves and reflects them towards the ear canal, where the sound is channeled the ear drum.

The curved shape of our outer ears changes the characteristics of the sound wave reaching us depending on whether it comes from the front, to the side, behind, up or below us. This helps the brain to distinguish the direction from which the sound is coming from.

- **The ear canal**

The ear canal is the pipe like portion that goes from the pinna into our heads to the eardrum and the sound reflected into the ear from the pinna is directed down the canal into the ear drum.

The middle ear.

The middle ear is made is made up of the eardrum and the ossicles.

- The eardrum

The eardrum is a thin shaped piece of skin that lies between the ear canal and the middle ear. The ear drum vibrates back and forth in response to sound waves hitting its surfaces, very much like the diaphragm on a condenser microphone.

The rest of the ear is involved with transmitting this information picked up by the eardrum.
The information picked up by the eardrum is then transmitted to the inner ear by the ossicles.

- The ossicles.

The ossicles are made up of the three tiniest bones in our body, and they are called the hammer, anvil and stirrup.

The one side of the hammer is connected to the centre of the eardrum and the other side to the anvil. The anvil in turn is connected to the stirrup. The faceplate of the stirrup rests against the oval window on the cochlea.

The bones act as mechanical levers and are used to amplify the sound waves picked up by the eardrum and to transfer these signals to the oval window of the inner ear, which in turn sends these impulses through the fluid of the inner ear.

- Eustachian tube

This is a tube running from the middle ear to the nasal cavity. This allows air to flow into the middle ear from your nose. Its purpose is to maintain the middle ear pressure, thus protecting the ear drum and allowing it to vibrate freely.

The inner ear

The inner ear is made up of the cochlea and the organ of corti, and is responsible for our sensory systems of balance and hearing.

- The cochlea

The cochlea consists of three tubes coiled in the shape of a snail shell and is filled with fluid. It is responsible for transforming the physical vibration caused by sound waves into electrical information that the brain can interpret as sound. As the stirrup moves backwards and forwards, it creates pressure waves in the cochlea which in turn stimulates the organ of corti.

- The organ of corti.

The organ of corti consists of thousands of tiny hair cells (nerve endings). The fluid in the inner ear stimulates these hair cells, which in turn, send electrical data through the cochlear nerve (auditory nerve) to the cerebral cortex (part of the human brain) the brain translates these impulses into sound, which is perceived in pitch and volume.

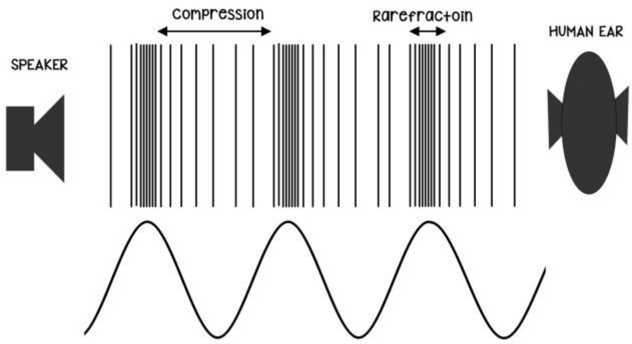
1.2 THE PROCESS OF SOUND TRANSMISSION AND PERCEPTION

The outer ear collects sound waves and then channels them through the ear canal to the ear drum. The ear drum vibrates, stimulates the ossicles (small bones) in the middle ear, which in turn amplify the signal and transmit it to the inner ear. The inner ear, which is filled with fluid, then stimulates tiny hair cells inside it which transmits electrical impulses along auditory nerves to the brain, which we then perceive as sound.

1. Sound enters your **outer ear**.
2. It travels down the ear canal and makes your **eardrum** vibrate.
3. That vibration goes through three tiny bones (hammer, anvil, stirrup).
4. Then into the **cochlea**, a spiral-shaped part filled with fluid.
5. Tiny hairs inside the cochlea turn the vibrations into signals that go to your brain.

1.3 HOW SOUND WAVES TRAVELS.

Sound waves are vibrations. Vibrations have to start somewhere. Vibrations may start from a shaking string, or from something being hit, or from moving air passing through something specifically shaped or flexible, such as air escaping from a balloon. An artificial sound may start in a computer but will need a vibrating speaker

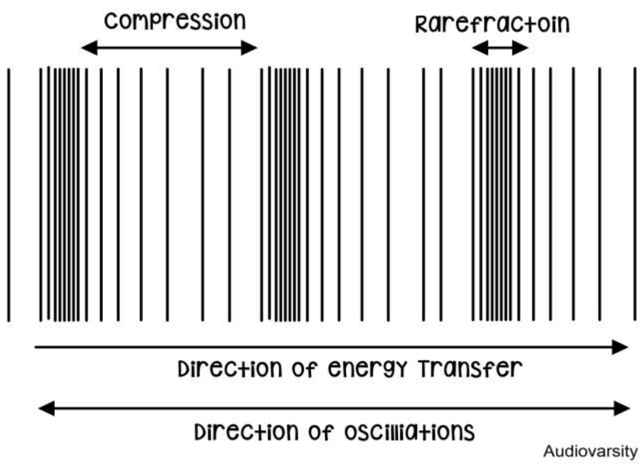


to be heard.

A sound wave is similar to a water wave but it travels in air as well as other mediums. Like water waves, sound waves do not physically travel but rather transfer energy. Think of a room filled with ping pong balls. You push one and it pushes the next, which pushes the next, etc. Sound travels in waves. The alternating wave movement creates air pressure.

1.4 THE MECHANISM: COMPRESSION AND RAREFACTION

Sound waves travel through a medium by creating areas of compression and



rarefaction.

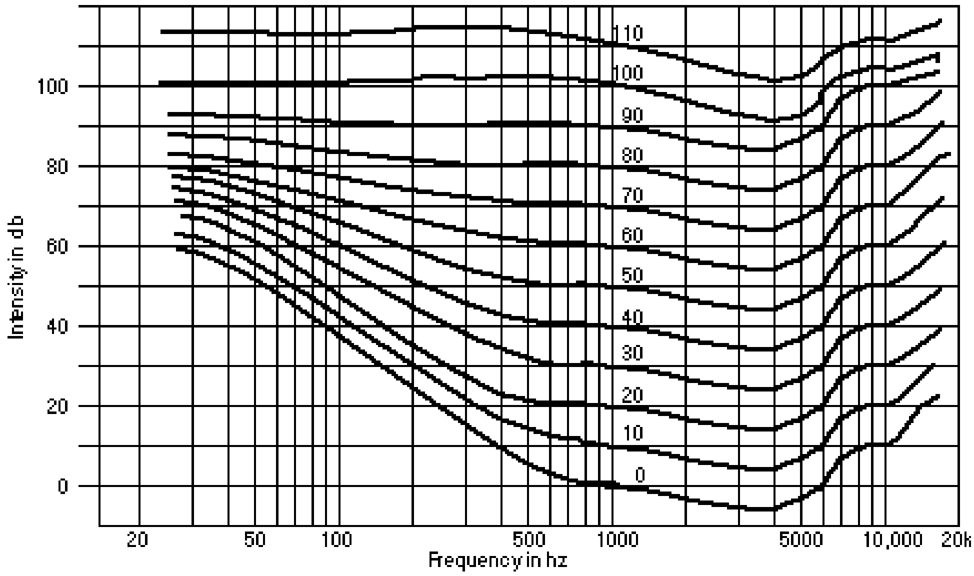
• Compression: This is a region where the particles of the medium are closer together than they normally are. It's a high-pressure area.

• Rarefaction: This is a region where the particles are farther apart than they normally are. It's a low-pressure area.

Imagine a loudspeaker cone vibrating. When the cone moves outward, it pushes the air molecules in front of it closer together, creating a compression. When the cone moves inward, it creates a space where the air molecules are more spread out, creating a rarefaction. This pattern of compression and rarefaction propagates outward from the source, carrying the sound energy.

1.5 VOLUME AND FREQUENCY PERCEPTION

The Fletcher-Munson curve demonstrates that our perception of frequencies is altered depending on the sound's loudness.



In the 1930's two scientists at Bell Labs named Harvey Fletcher and Wilden Munson came to the conclusion that the way humans hear specific frequencies is in fact much more complicated than anyone had previously thought.

They developed the Fletcher Munson Curve, which helps us to see how frequencies are perceived. Humans do not hear the entire frequency range at the same loudness level. Furthermore; as amplitude changes, so does our ears response to the frequency spectrum. In other words certain parts of the frequency spectrum (lows, mids, highs) may seem louder to us than others, and when amplitude (volume) increases or decreases our ears hear these frequencies at different loudness levels.

For example; as you turn your system louder, bass and treble sounds will increase while the mid-range frequencies will begin to get drown out.