Seventh lecture

Auditory Impulse Transmission

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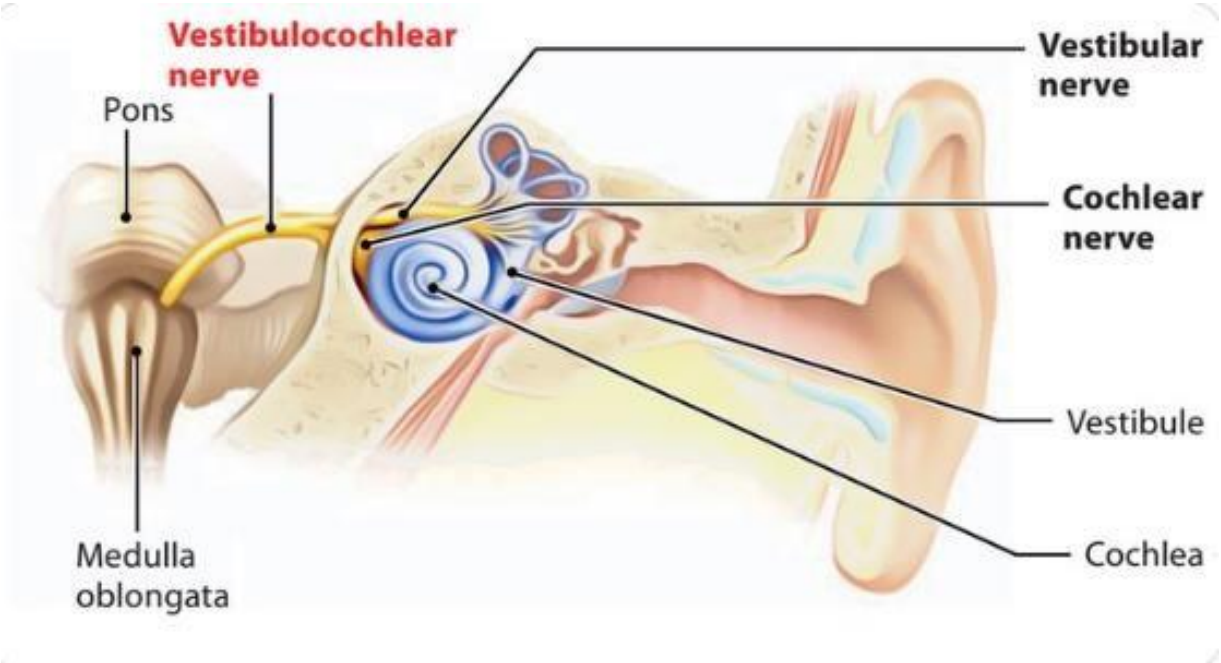
Auditory Impulse Transmission :

Vestibulocochlear Nerve :

Nerve in the human ear, serving the organs of equilibrium and of hearing. It consists of two anatomically and functionally distinct parts:

1- The cochlear nerve, distributed to the hearing organ .

2- The vestibular nerve, distributed to the organ of equilibrium .



The vestibular portion of the vestibulocochlear nerve originates in a group of nerve cells called the vestibular ganglion, in the internal acoustic, a channel in the temporal bone through which the facial and auditory nerves and some blood vessels run.

The sensory endings of this portion of the nerve are in the semicircular canal and in the utricle and saccule, the structures of the inner ear responsible for the sensation of equilibrium .

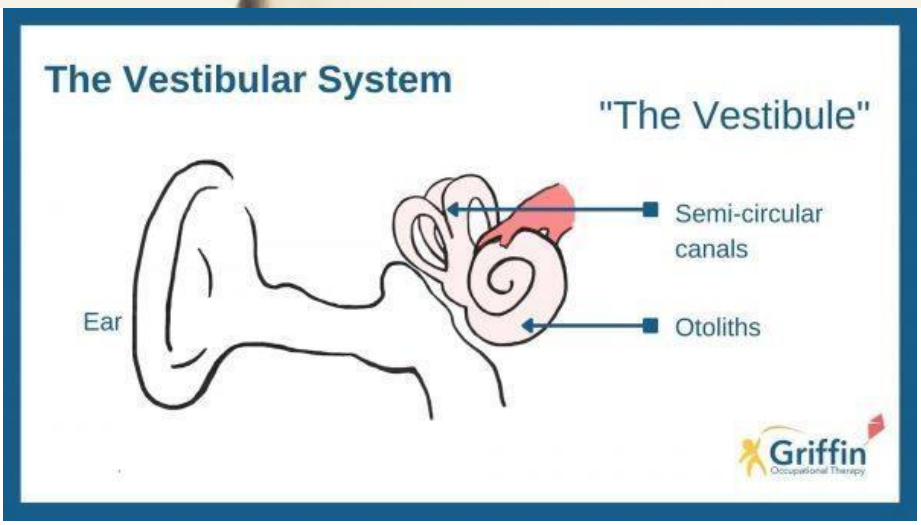
Vestibular System :

The vestibular system, in vertebrates, is a sensory system that provides the leading contribution to the sense of balance and spatial orientation for the purpose of coordinating movement with balance. Together with the cochlea, a part of the auditory system, it constitutes the labyrinth of the inner ear .

Vestibular system, apparatus of the inner ear involved in balance. The vestibular system consists of two structures of the bony labyrinth of the inner ear :

1- Vestibule (the otoliths) , which indicate linear accelerations .

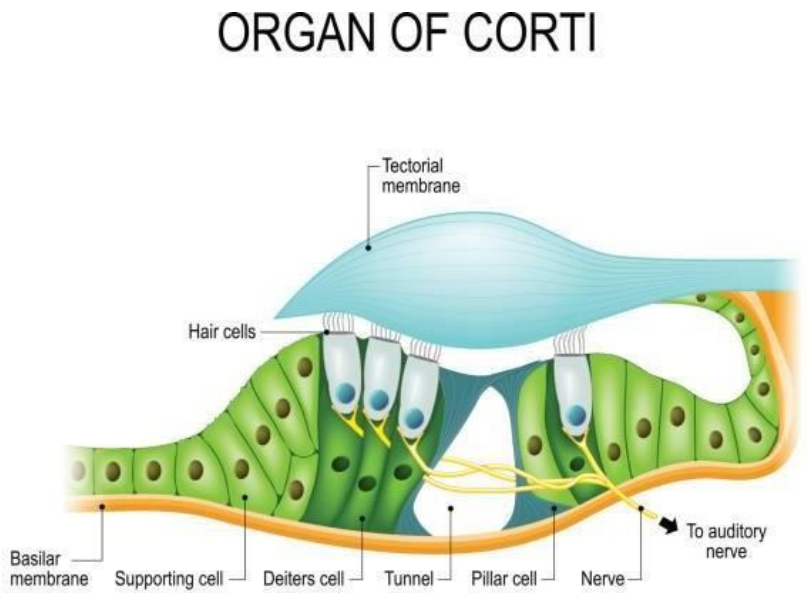
2- Semicircularcanals , and the structures of the membranous labyrinth contained within them .



Organ of Corti :

The organ of Corti contains sensory cells with hairlike projections, called hair cells, that are deformed by the progress of the wave. The hair cells trigger nerve impulses that travel along the cochlear nerve, a branch of the auditory nerve, to the brain, where they are interpreted as sound.

This highly varied strip of epithelial cells allows for transduction of auditory signals into nerve impulses' action potential. Transduction occurs through vibrations of structures in the inner ear causing displacement of cochlear fluid and movement of hair cells at the organ of Corti to produce electrochemical signals .



Function :

The function of the organ of Corti is to convert (transduce) sounds into electrical signals that can be transmitted to the brainstem through the auditory nerve.

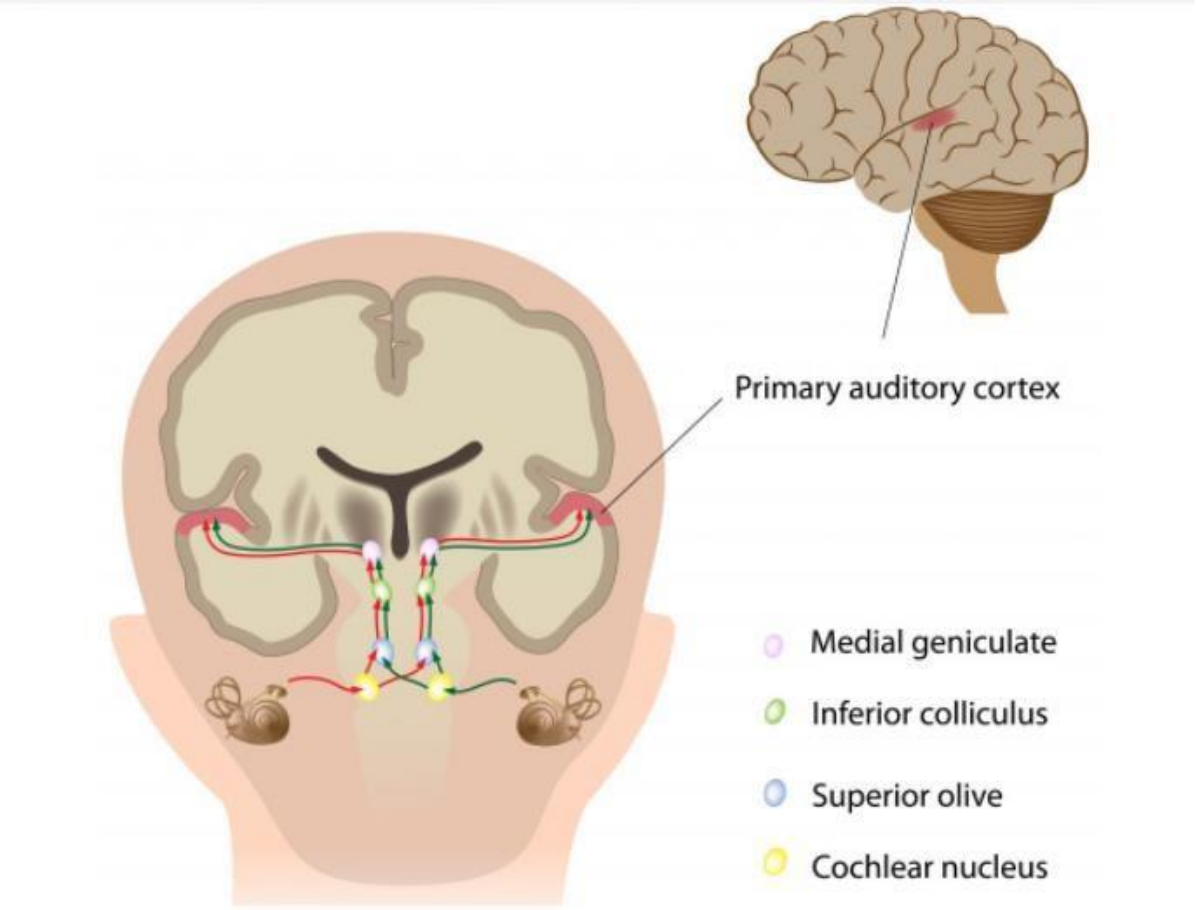
It is the auricle and middle ear that act as mechanical transformers and amplifiers so that the sound waves end up with amplitudes 22 times greater than when they entered the ear .

Auditory Pathway :

The auditory pathway conveys the special sense of hearing .

Information travels from the receptors in the organ of Corti of the inner ear (cochlear hair cells) to the central nervous system, carried by the vestibulocochlear nerve (CN VIII) .

This pathway ultimately reaches the primary auditory cortex for conscious perception. In addition, unconscious processing of auditory information occurs in parallel .



Medial Geniculate Nucleus (MGN) :

It is part of the auditory thalamus , represents influences the direction and maintenance of attention .

Inferior Colliculus : The inferior colliculus is a part of the midbrain that serves as a main auditory (sound) center for the body. It acts as the channel for almost all auditory signals in the human body. Its primary roles are signal integration, frequency recognition, and pitch discrimination. It also processes sensory signals .

Superior Olive : is a collection of brainstem nuclei that functions in multiple aspects of hearing and is an important component of the ascending and descending auditory pathways of the auditory system .

Cochlear nucleus : is the first integrative, or processing, stage in the auditory system. Information is brought to the nuclei via the cochlear nerve.

Components of The Auditory Pathway :

The auditory pathway is complex in that divergence and convergence of information happens at different stages .

There are two main components of the auditory pathway :

1.Primary (lemniscal) pathway :

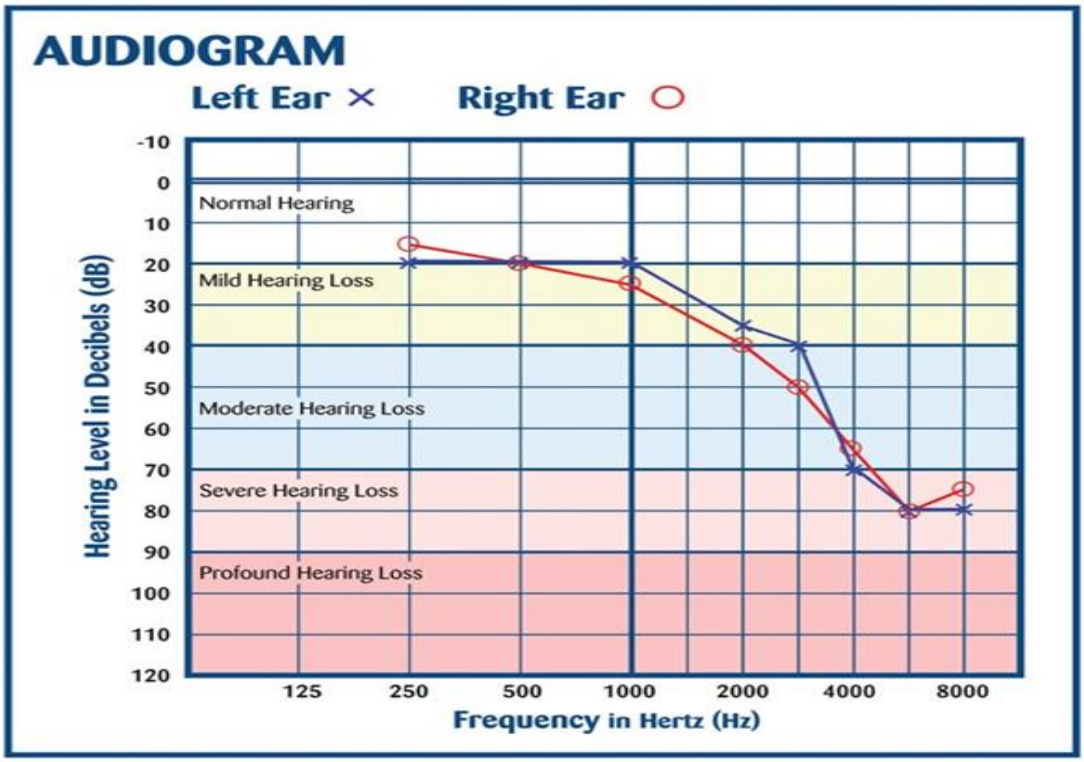
This is the main pathway through which auditory information reaches the primary auditory cortex (A1) .

2.Non-lemniscal pathway :

Mediating unconscious perception such as attention, emotional response, and auditory reflexes .

The Range of Sounds to Which We Respond; Neural Tuning Curves

Figure 12.8 shows the range of frequencies and intensities of sound to which the human auditory system responds. Our absolute threshold, the minimum level of sound that we can detect, is strongly dependent on frequency. At the level of pain, sound levels are about six orders of magnitude above the minimal audible threshold. Sound pressure level (SPL) is measured in decibels (dB). Decibels are a logarithmic scale, with each 6 dB increase indicating a doubling of intensity. The perceived loudness of a sound is related to its intensity. Sound frequencies are measured in Hertz (Hz), or cycles per second. Normally, we hear sounds as low as 20 Hz and as high as 20,000 Hz. The frequency of a sound is associated with its pitch. Hearing is best at about 3-4 kHz. Hearing sensitivity decreases at higher and lower frequencies, but more so at higher than lower frequencies. High-frequency hearing is typically lost as we age.



The neural code in the central auditory system is complex. Tonotopic organization is maintained throughout the auditory system. Tonotopic organization means that cells responsive to different frequencies are found in different places at each level of the central auditory system, and that there is a standard (logarithmic) relationship between this position and frequency. Each cell has a characteristic frequency (CF). The CF is the frequency to which the cell is maximally responsive. A cell will usually respond to other frequencies, but only at greater intensities. The neural tuning curve is a plot of the amplitude of sounds at various frequencies necessary to elicit a response from a central auditory neuron. The tuning curves for several different neurons are superimposed on the audibility curves in Figure 12.8. The depicted neurons have CFs that vary from low to high frequencies (and are shown with red to blue colors, respectively). If we recorded from all auditory neurons, we would basically fill the area within the audibility curves. When sounds are soft they will stimulate only those few neurons with that CF, and thus neural activity will be confined to one set of fibers or cells at one particular place. As sounds get louder they stimulate other neurons, and the area of activity will increase.