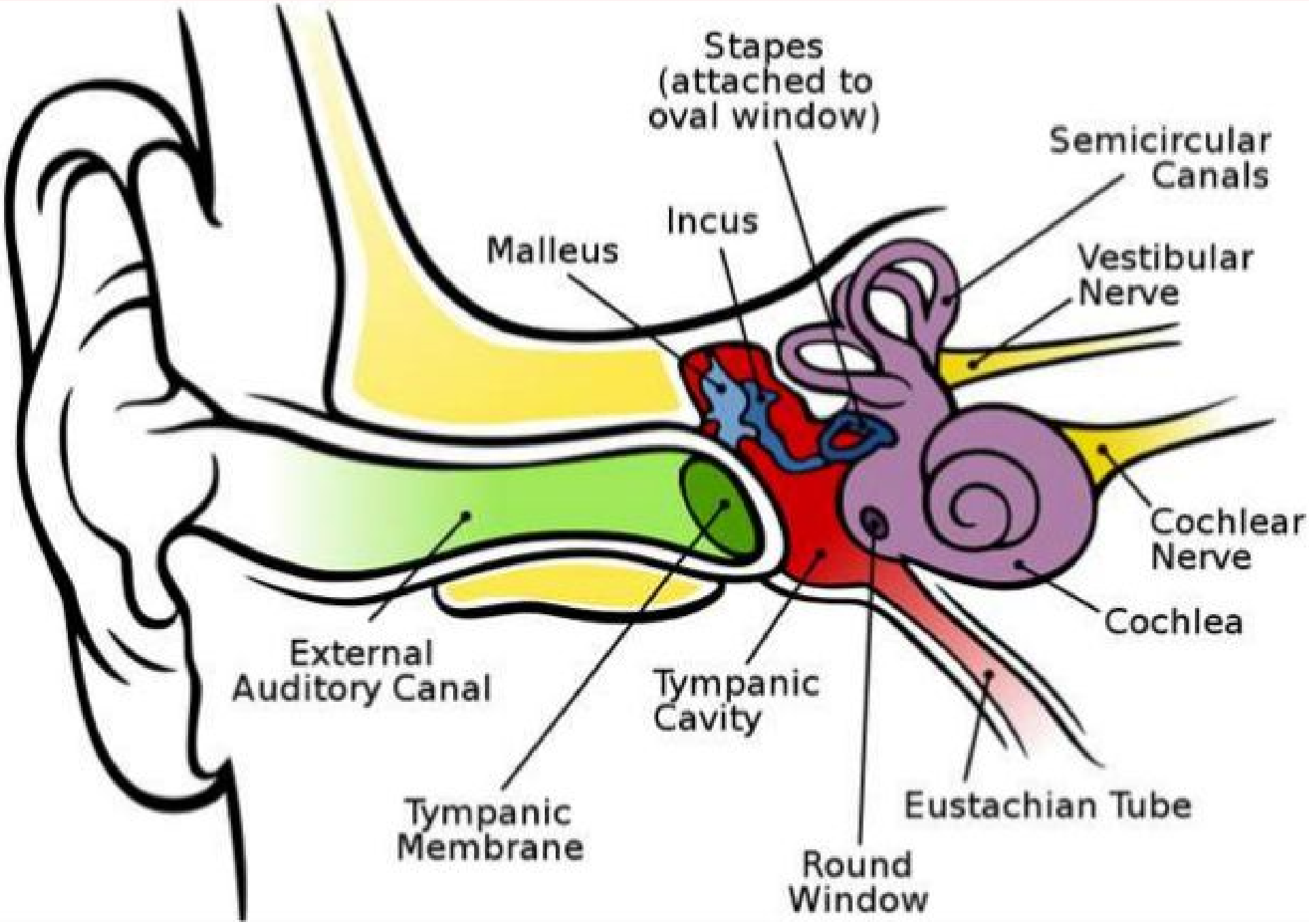
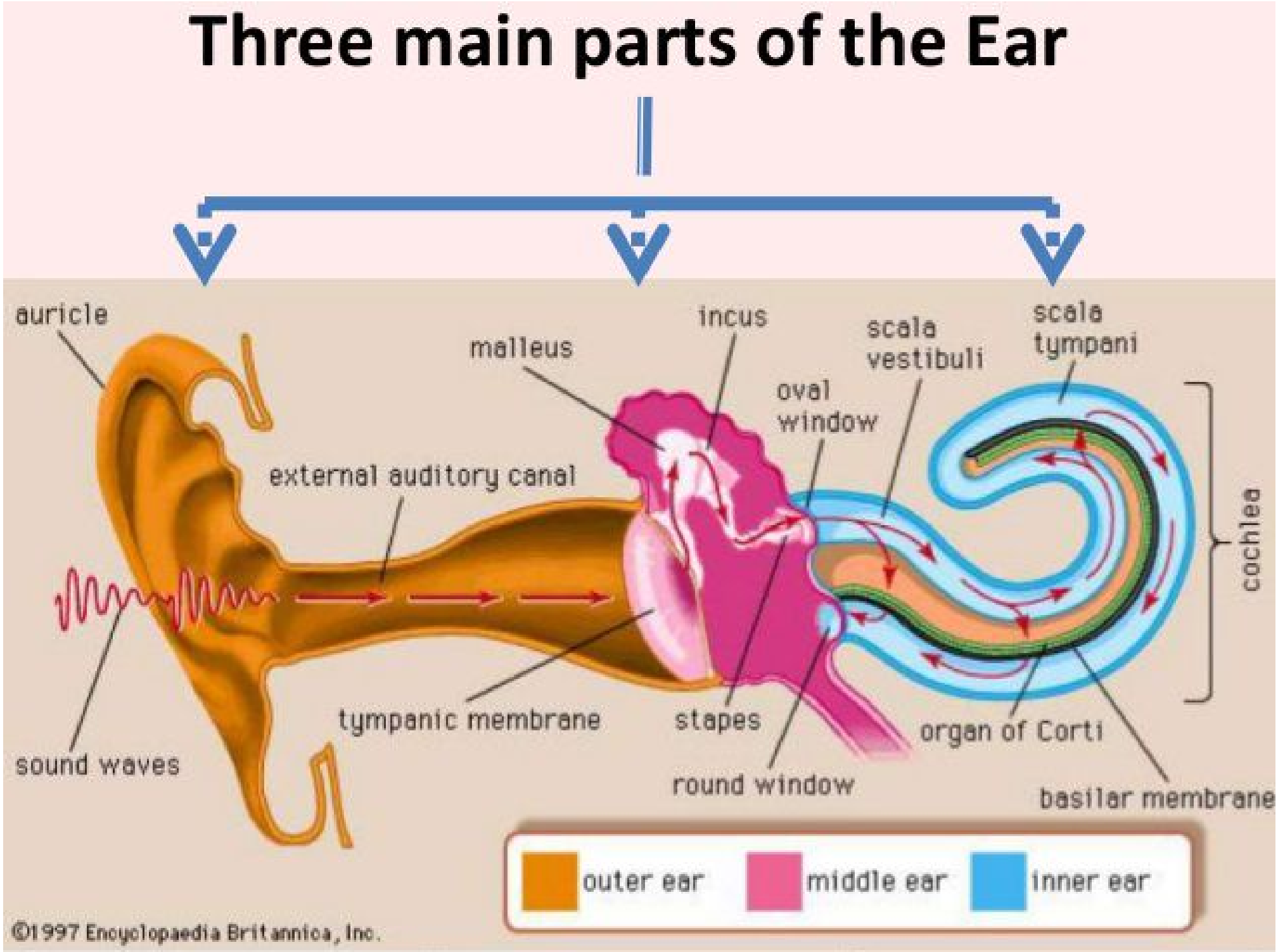
Study of Human Ear

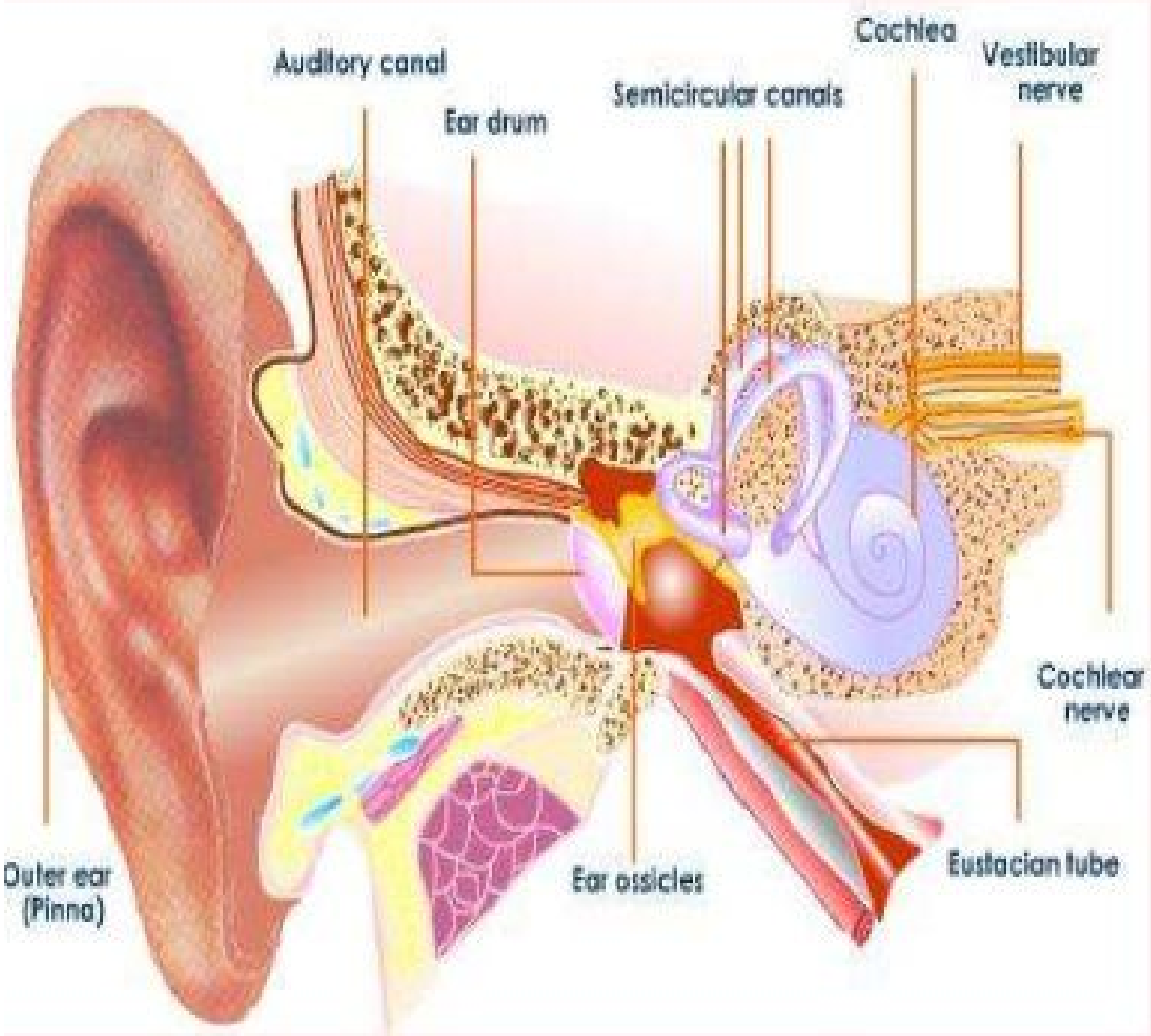


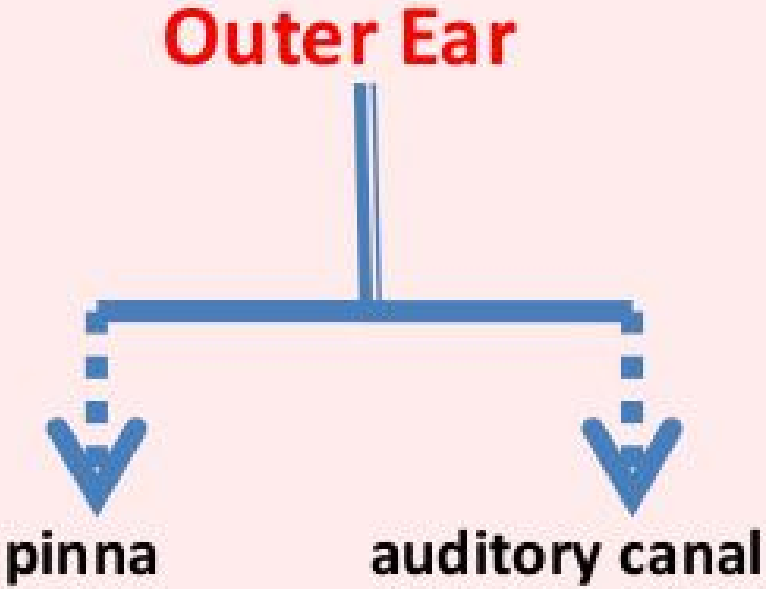
- The ear is the sensory organ of sound.
- The sense of hearing is sensitive to the sound stimuli.
- Every structure of the ear has their own functions and are very important

Three main parts of the Ear



Outer Ear


Auditory canal
Ear drum
Semicircular canals
Cochlea
Vestibular nerve
Cochlear nerve
Outer ear (Pinna)
Ear ossicles
Eustacian tube

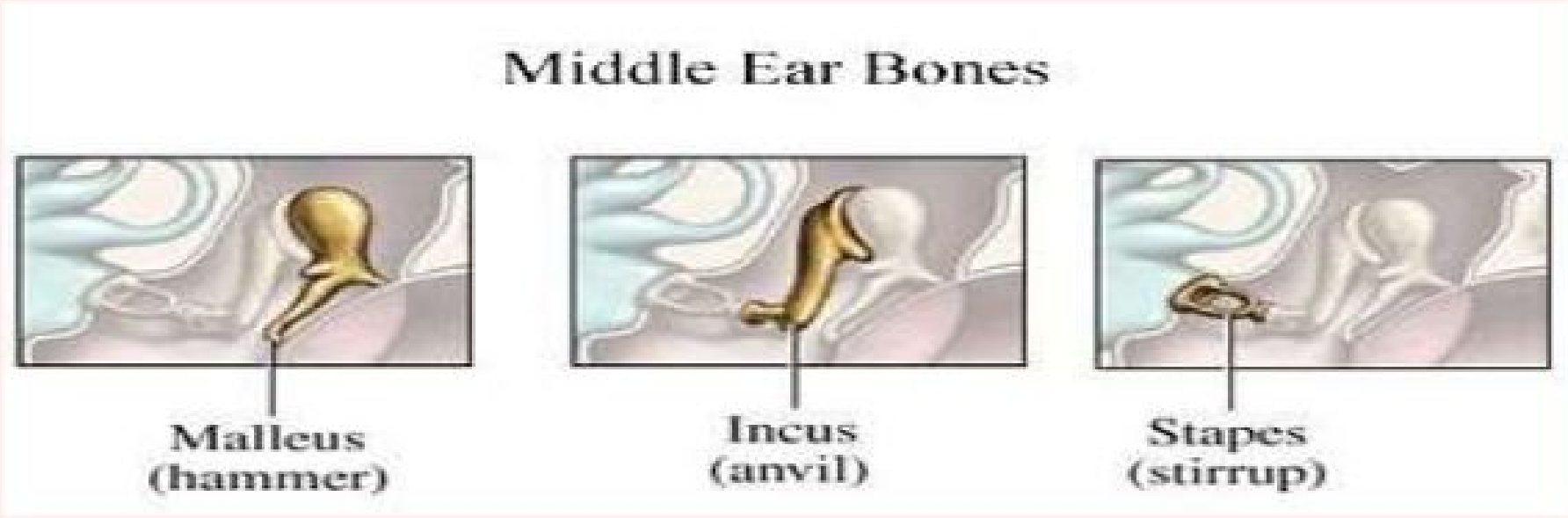

Outer Ear
pinna
auditory canal

Outer Ear

Structure	Function/Explanation
Pinna	Pinna is also called auricle or external ear, the flap like organ on either side of the head. Made of cartilage and skin and shaped like a funnel. It collects and directs sounds into the ear canal.
Auditory canal	Auditory canal is a tunnel or passageway that begins at the external ear and extends inward toward the eardrum. A long tube lined with hairs. It directs sounds to the eardrum.

Middle Ear


Middle ear

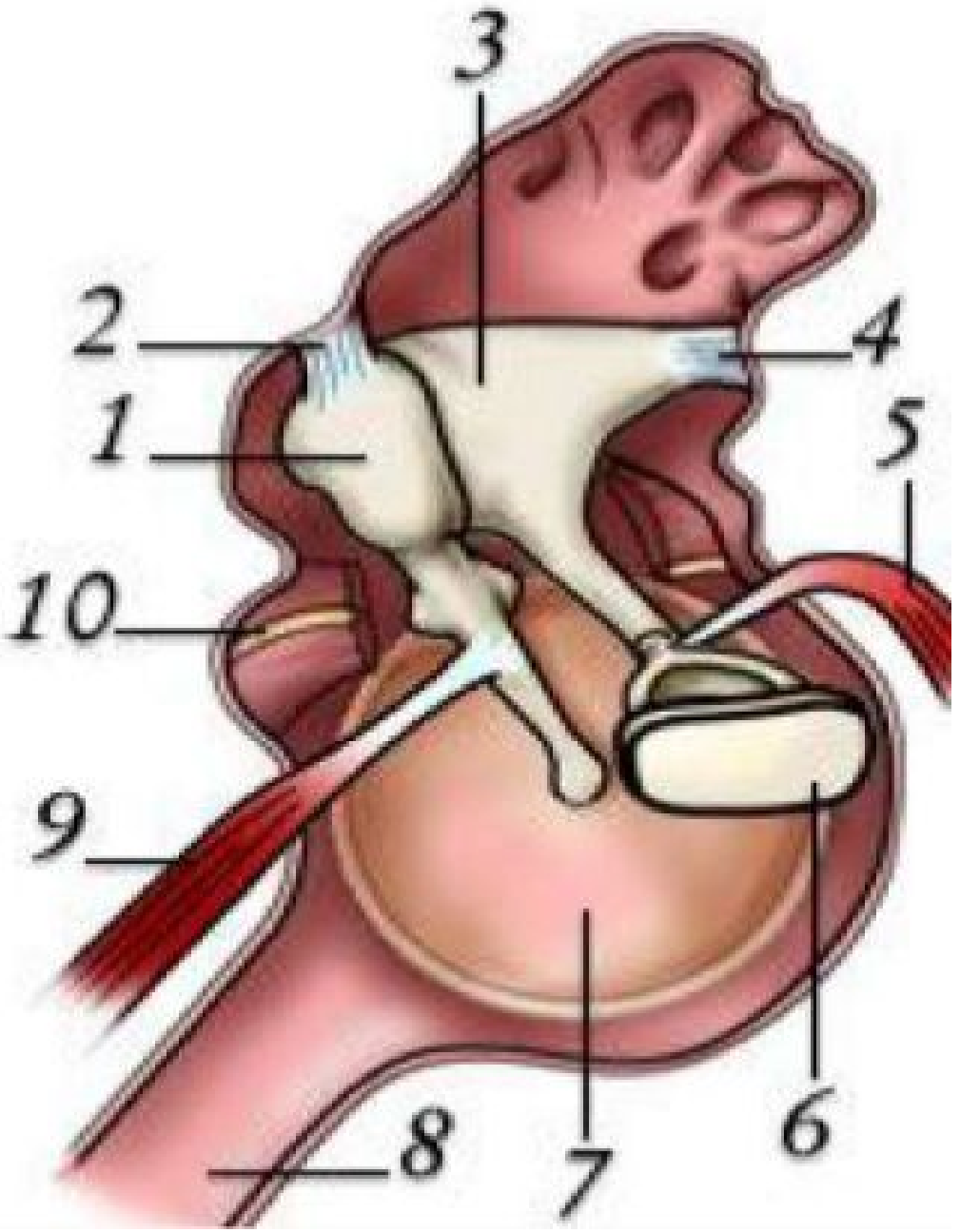

Middle Ear Bones
Malleus
(hammer)
Incus
(anvil)
Stapes
(stirrup)

Middle Ear

Structure	Function/Explanation
Eardrum	Eardrum also known as the tympanic membrane. semitransparent thin fibroelastic connective tissue membrane, covered by epidermis (external side) and a cuboidal mucous epithielium (inner side) .It vibrates and transmits sound waves to the ossicles.
Ossicles	Made up of three small bones which is the hammer *(Malleus)*, the anvil *(Incus)* and the stirrup *(stapes)*. It intensifies the vibrations of the sound waves by 22 times before transmitting to the oval window.
Eustachian tube	A narrow tube that joins the middle ear to the throat that balances the air pressure at both sides of the eardrum.
Oval window	An oval-shaped, thin membrane between the middle ear and the inner ear. It transmits sound vibrations from the middle ear to the inner ear.

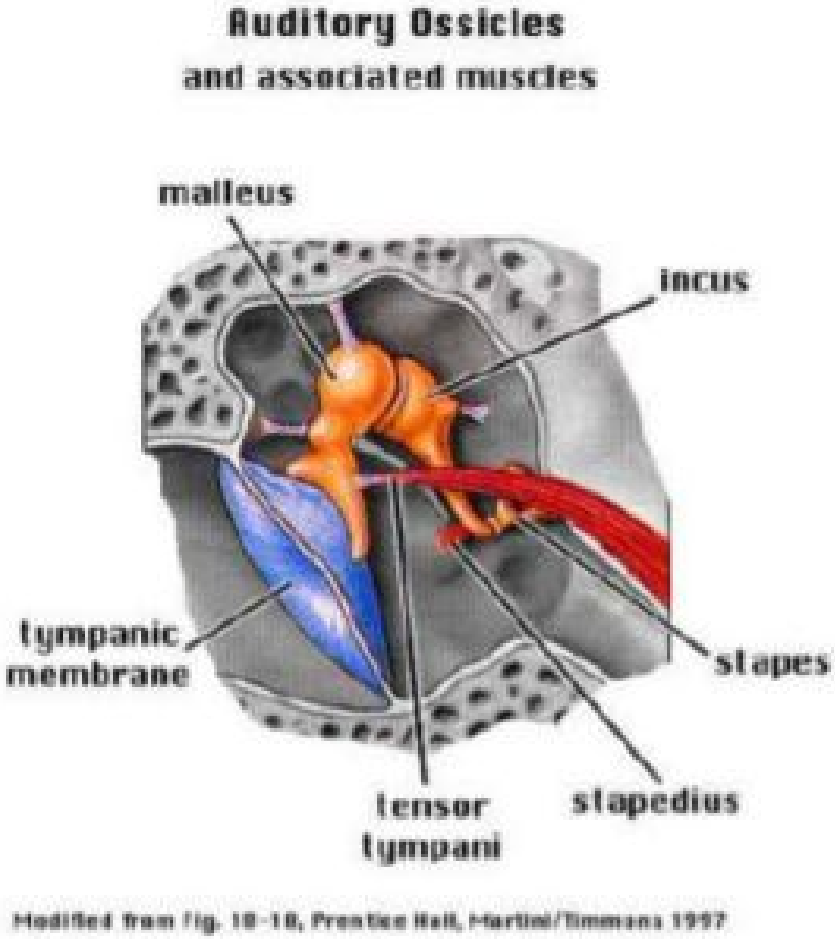
Bones & Muscles of Middle ear

- (1) Malleus ;
- (2) Malleus ligament ;
- (3) Incus ;
- (4) Incus ligament;
- (5) Stapes muscle (stapedius);
- (6) Stapes footplate;
- (7) Eardrum;
- (8) Eustachian tube;
- (9) Malleus muscle (tensor tympani);
- (10) Nerve (chorda tympani) sectioned.

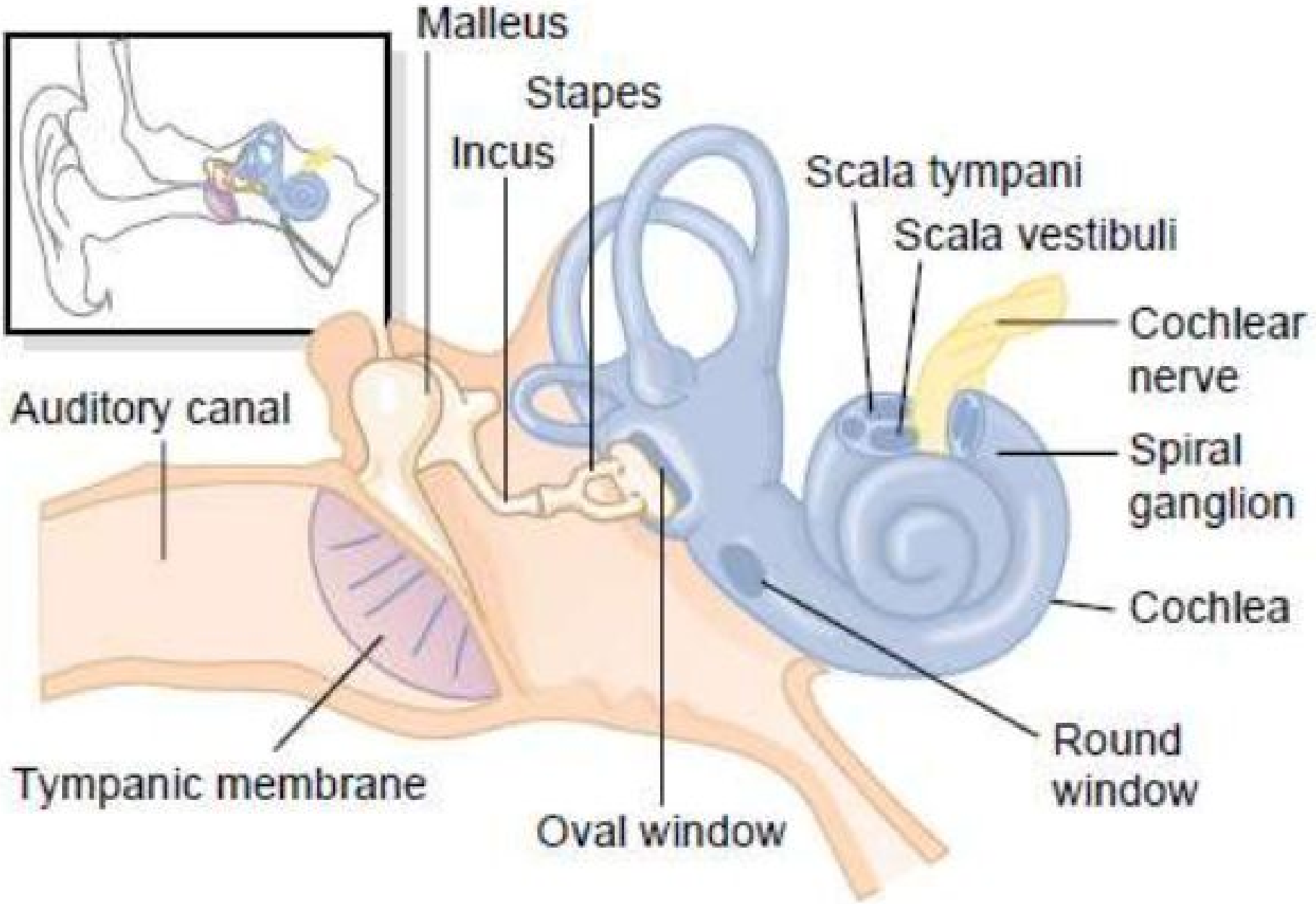


Muscles of the Middle Ear

- **Stapedius**
  - the **smallest skeletal muscle** in the human body.
  - **connects to the stapes** (the stirrup)
  - when it contracts, **it reduces the action of the stapes** (i.e., it reduces amplification)
  - **contracts just before speaking and chewing** because our own speaking and chewing actually could be loud enough to damage the sensitive mechanisms of the inner ear if the sounds were further amplified.
  - innervated by a branch of the Facial Nerve (CN VII).



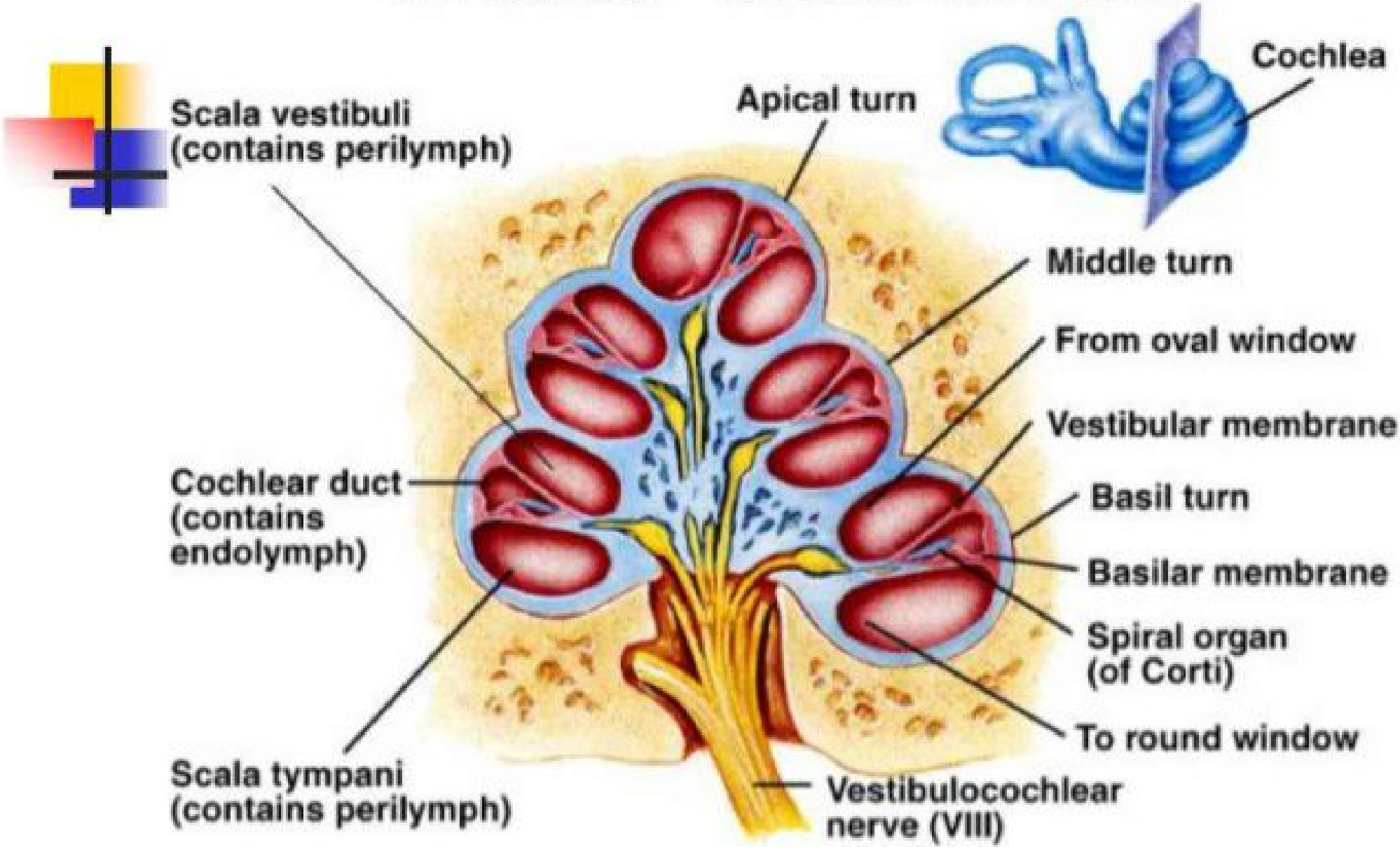
Inner ear


Malleus
Stapes
Incus
Scala tympani
Scala vestibuli
Cochlear nerve
Auditory canal
Spiral ganglion
Cochlea
Round window
Tympanic membrane
Oval window

Inner Ear or Bony Labyrinth

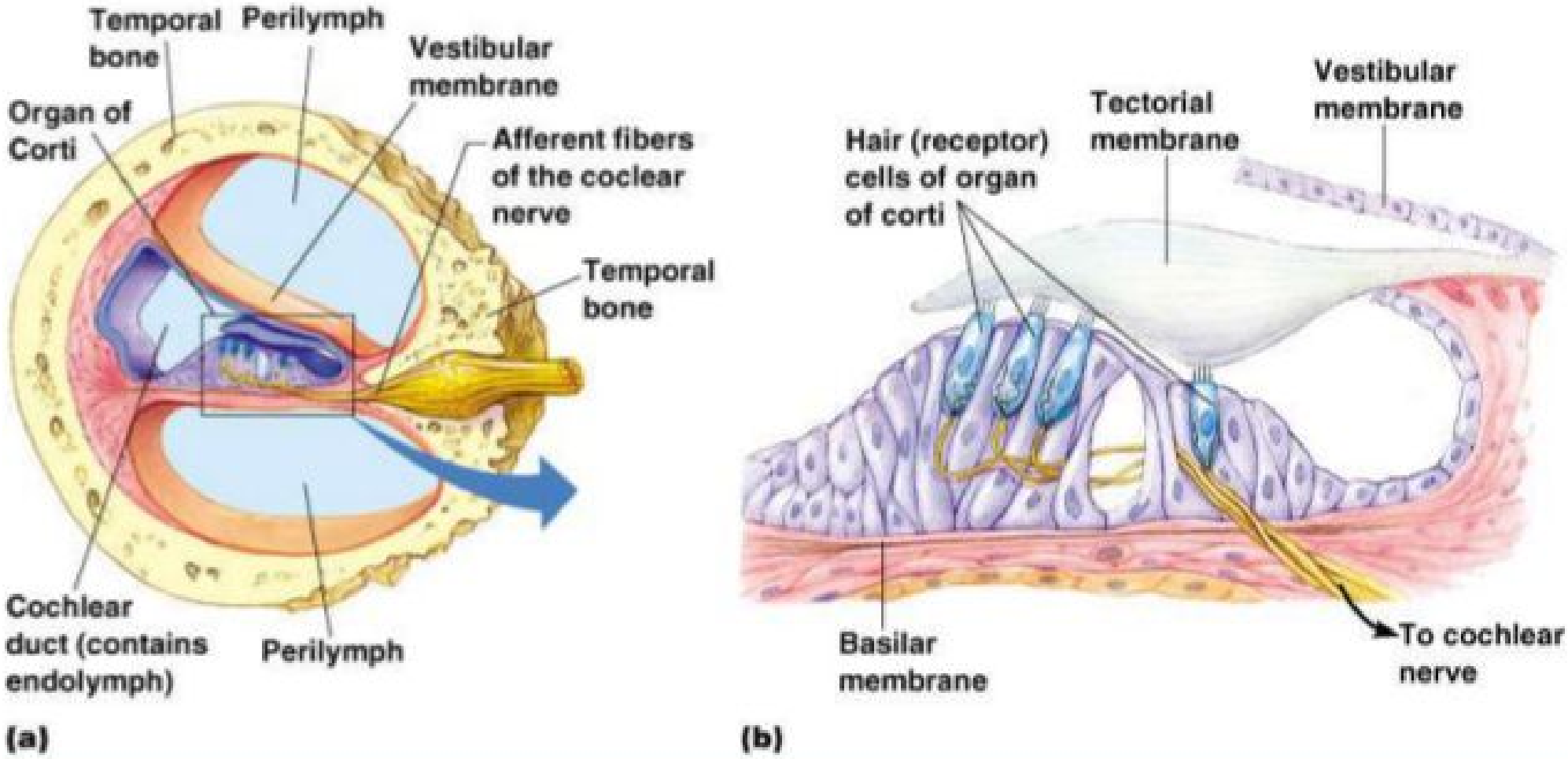
Structure	Function/Explanation
Cochlea	**Cochlea (bony labrynth) is a system of coiled tubes snail-like structure in the inner ear filled with fluid called *perilymph &endolymph.* It consists of three tubes (canals)** 1. Scala Vestibuli (Vestibular canal) 2. Scala media (cochlear canal) 3. Scala tympani (tympanic canal) And ORGAN OF CORTI (electromechanically sensitive hair cells)
Auditory nerve	**It carries the impulses to the brain which then interprets the impulses as sound.**
Semicircular Canals & Vestible	**For body balance.**

Cochlea—Cross Section



SENSORY CELLS FOR HEARING

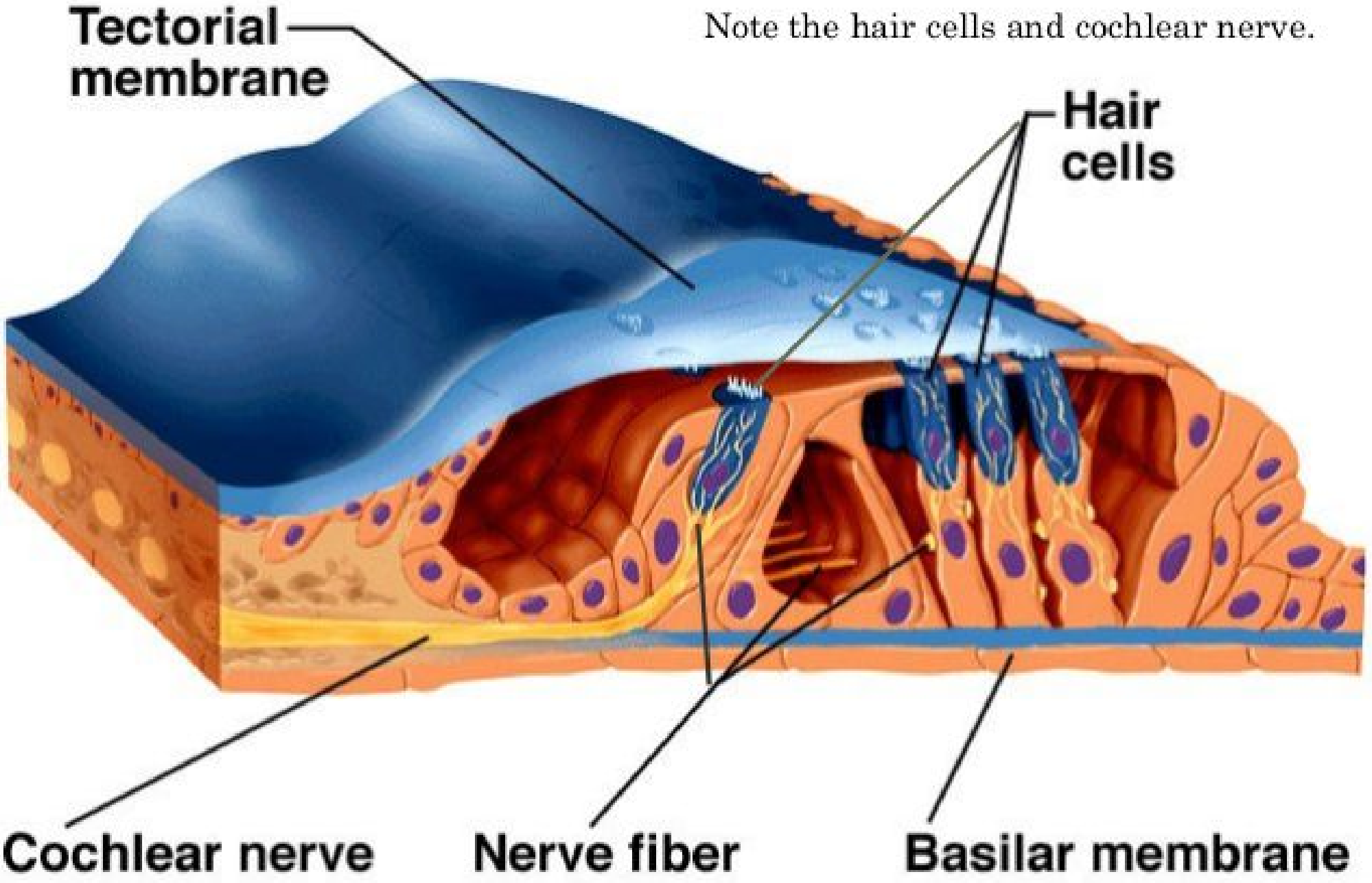
- Contains Glutamate (transmitter)
- Connected with Auditory nerve fibers



ORGAN OF CORTI

- Contains **hearing receptor cells** (hair cells)
- Above the **hair cells** is a tectorial membrane
- On upper surface of basilar membrane
- Different vibration frequencies move different regions of the basilar membrane and cause hair cells to shear against the tectorial membrane
- Depolarization of hair cells transmits impulse along the cochlear branch of the **vestibulo-cochlear sensory nerve**

Organ of Corti



SOUND

- Results from the motion of air molecules which oscillate.
- Sound waves travel in all directions from their source.
- Waves are characterized by frequency and intensity
  - Frequency
    - Measured in hertz (cycles per second).
    - Greater the frequency the higher the pitch.
  - Intensity:
    - Directly related to amplitude of sound waves.
    - Measured in decibels (db).

Vibration of Basilar Membrane and the Traveling Wave Theory

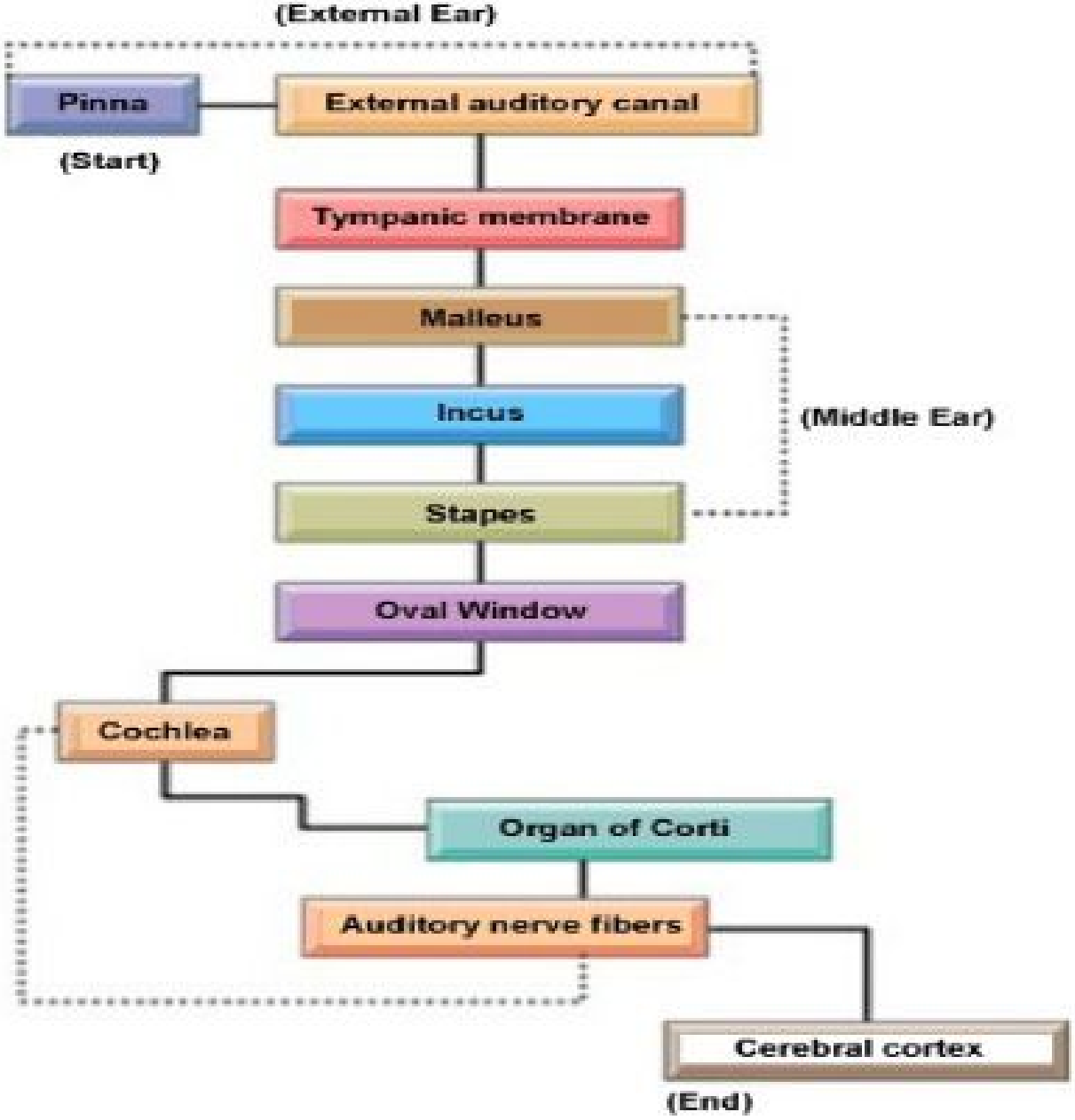
- Sound wave entering at the oval window is to cause the basilar membrane at the base of the cochlea to vibrate
- Different frequencies cause vibrations at different locations (places) along basilar membrane
- Higher frequencies at base, lower frequencies at top

MECHANICS OF HEARING

- sounds set up vibrations in air
- beat against the eardrum
- push a chain of tiny bones
- press fluid in inner ear against membranes
- set up forces that pull on hair cells
- stimulate neurons that send impulses to brain
- interpretation impulses
- hearing

THE PROCESS OF HEARING

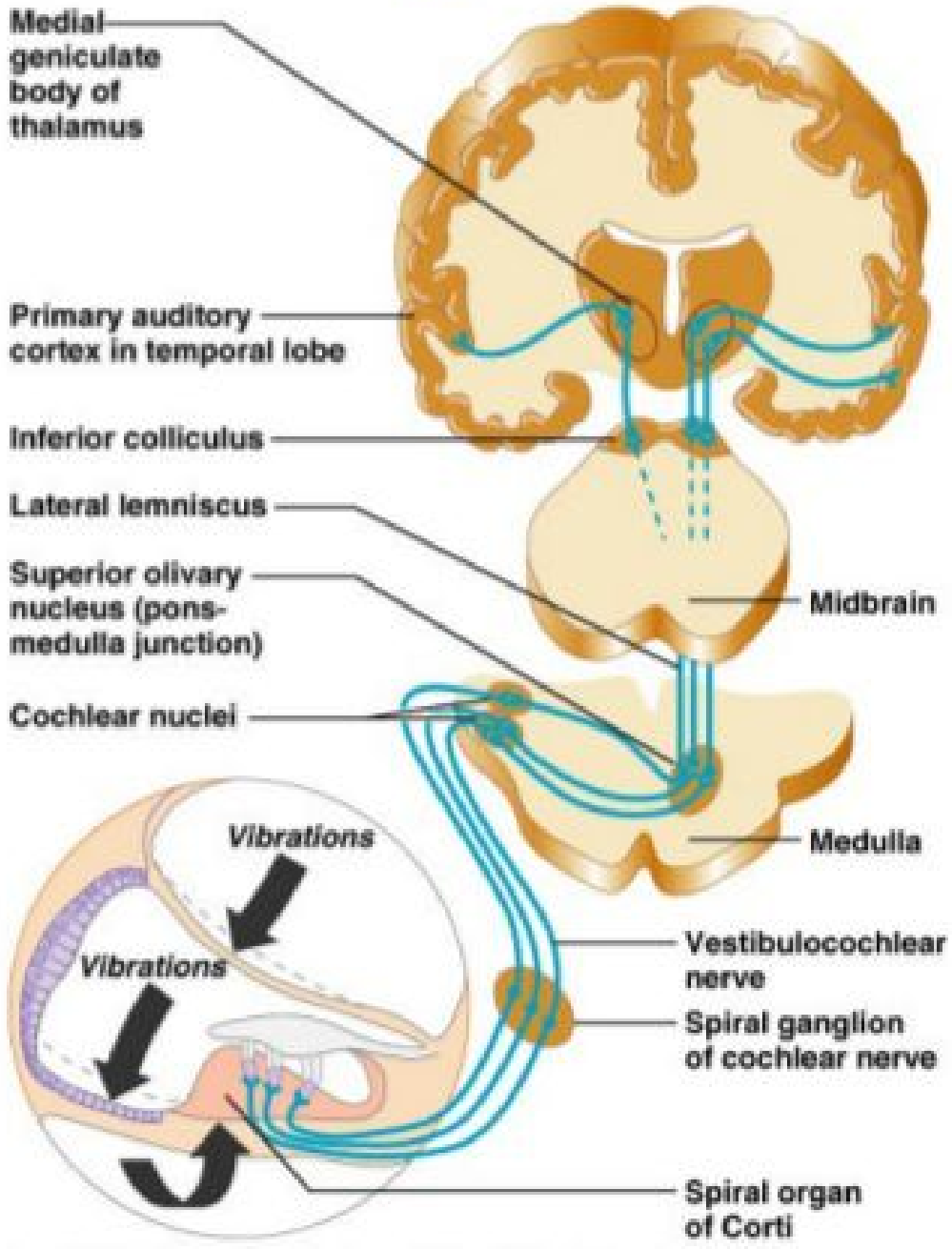
Pathway of Sound Vibrations



Transmission of sound:

Airborne sound → external auditory canal → tympanic membrane →hammer, anvil, stirrup → oval window → vestubularcochlear nerve → cochlear nuclei in medulla → superior olivary nucleus → up the lateral leminiscus → inferior colliculus → primary auditory cortex in the temporal lobe

Auditory Pathway



Processing of Auditory Information

A. Perceiving Pitch (Frequency)

location of vibration on the basilar membrane

B. Perceiving Differences in Loudness (Intensity)

amplitude increases, more hair cells of the basilar membrane (with same pitch) are activated

C. localizing Source of Sound

1. superior olivary nucleus - first point where sound from both ears come together
2. relative intensity - the amplitude of sound waves hitting the different ears
3. relative timing - the difference in timing in which a sound reaches both ears

Deafness

- **Hearing loss**- due to disease (ex. meningitus), damage, or age related
- **Conduction deafness**- prevention or blocking sounds from entering inner ear.
- Ear wax, ruptured ear drum, middle ear inflammation (otitis media), and otosclerosis (hardening of the ossicles of the ear)

- **Sensoneural deafness**- damage to the neural structures from any point from the cochlear hair cells to and including the auditory cortical cells
- Nerve deafness

Deafness

- **Tinnitus**- ringing or clicking sound in the absence of auditory stimuli
- 1st symptom of cochlear nerve degeneration
- May result from inflammation of the inner or middle ear
- Side effect from medicine
- Symptoms- vertigo, nausea, hearing loss

TYPES OF DEAFNESS

Conductive Deafness

- due to impaired sound transmission in external and middle ear
- impacts all sound frequencies
- Causes
  - plugging of the EAC with cerumen of foreign bodies
  - otitis externa and otitis media
  - perforation of eardrum
  - otosclerosis

Sensorineural Deafness

- due to loss of cochlear hair cells (common), problems with the nerves or within central auditory pathways (nerve deafness)
- impairs the ability to hear certain pitches (permanent)
- causes
  - aminoglycoside antibiotics (streptomycin and gentamycin)
  - prolonged exposure to noise
  - tumors and vascular damage

DIAGNOSTIC TECHNIQUES AND PROCEDURES

- **Audiometry**
  - The process of measuring how well an individual hears various frequencies of sound waves
- **Otoscopy**
  - The use of an otoscope to view and examine the tympanic membrane and various parts of the outer ear


Thank you