Audition

process in which audible variations in air pressure (compressions) result in molecules to be displaced forward leaving a corresponding area of lower pressure.

Sound waves have 2 features:

a. Amplitude or intensity: peak to trough; perceived as differences in loudness

b. Frequency or pitch: number of compressions per second, its unit is hertz (1 cycle/second)

Physiological Anatomy of Hearing System:

Hearing System divided into 4 parts (by function):

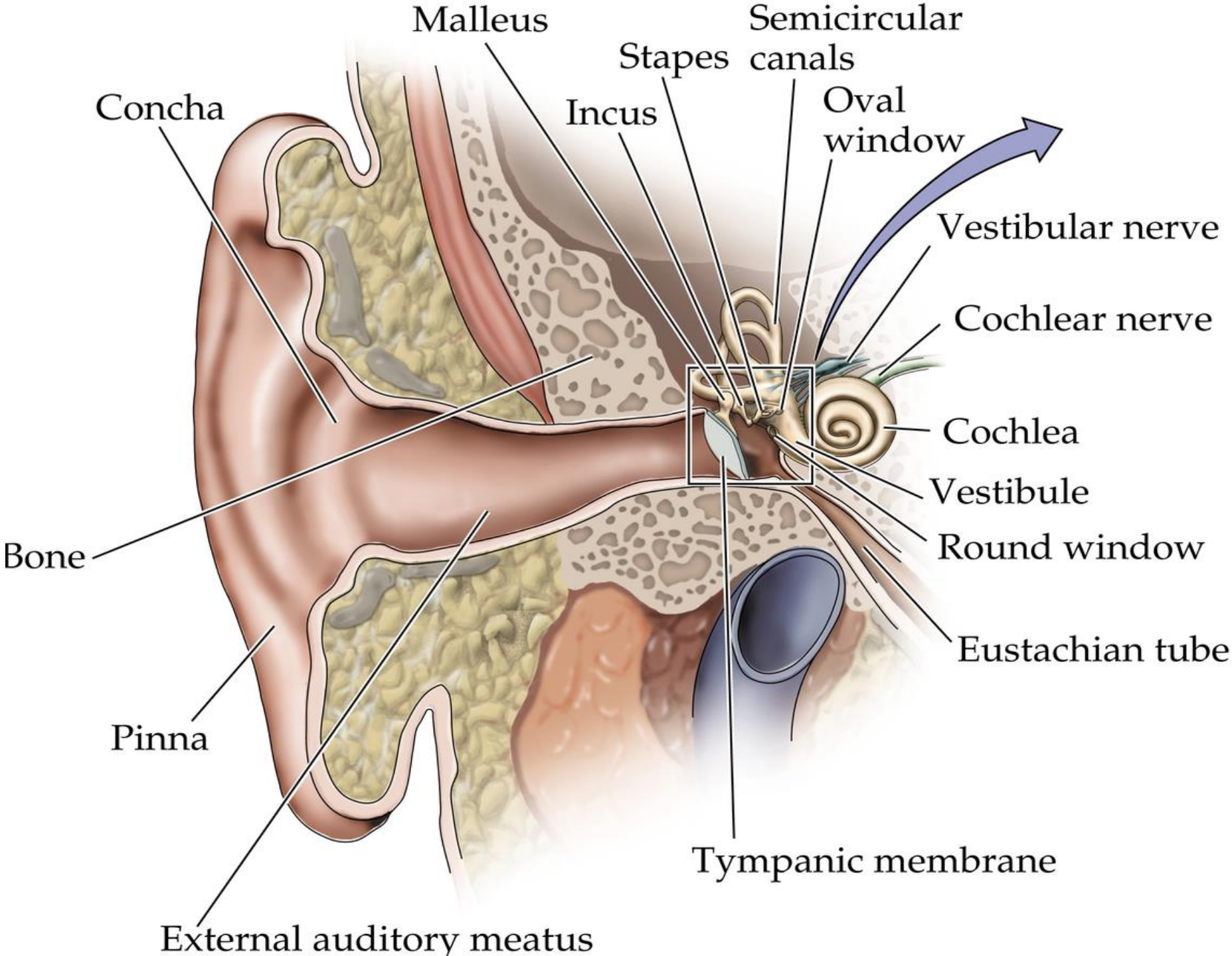
- **Outer Ear**
- **Middle Ear**
- **Inner Ear**
- **Central Auditory Nervous System**

External ear

- It`s formed by:

- the auricle (or pinna), a funnel shaped outer ear made of skin and cartilage.
- the external auditory meatus, 2.5 cm tube.

- Functions:
- 1- Collection of sound stimuli.
- 2- Amplify sound pressure at the tympanic membrane.
- 3- Sound localization.
- 4- Protective function: Wax, Keep air moist & warm.


Malleus
Semicircular canals
Stapes
Concha
Incus
Oval window
Vestibular nerve
Cochlear nerve
Cochlea
Vestibule
Bone
Round window
Eustachian tube
Pinna
Tympanic membrane
External auditory meatus

Middle ear

■ is air-filled cavity, contains:

1-the tympanic membrane

2-the auditory ossicles (malleus, incus, and stapes).

The stapes inserts into the oval window (membrane between the middle ear and the inner ear)

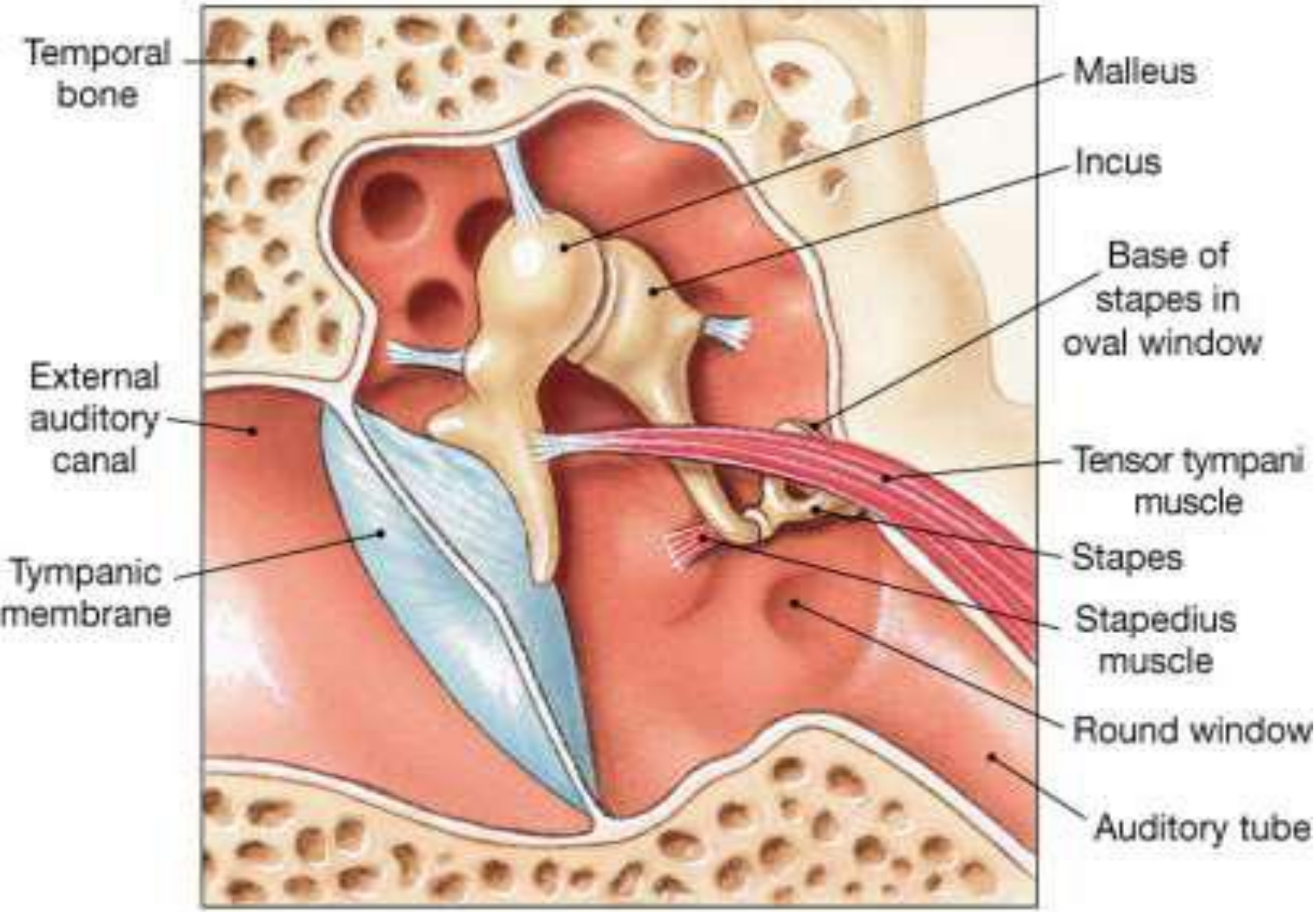
3- Two muscles;

-Tensor tympani muscle ,stiffens tympanic membrane

–Stapedius muscle, reduces extra-movement of stapes at oval window .

…. Contracts in response to loud sounds; (the Acoustic Reflex)

4-Auditory (eustachian) tube communicates the middle ear with nasopharynx, Usually is closed, but it opens during chewing, swallowing & yawning to equalizes pressure on both sides of tympanic membrane.

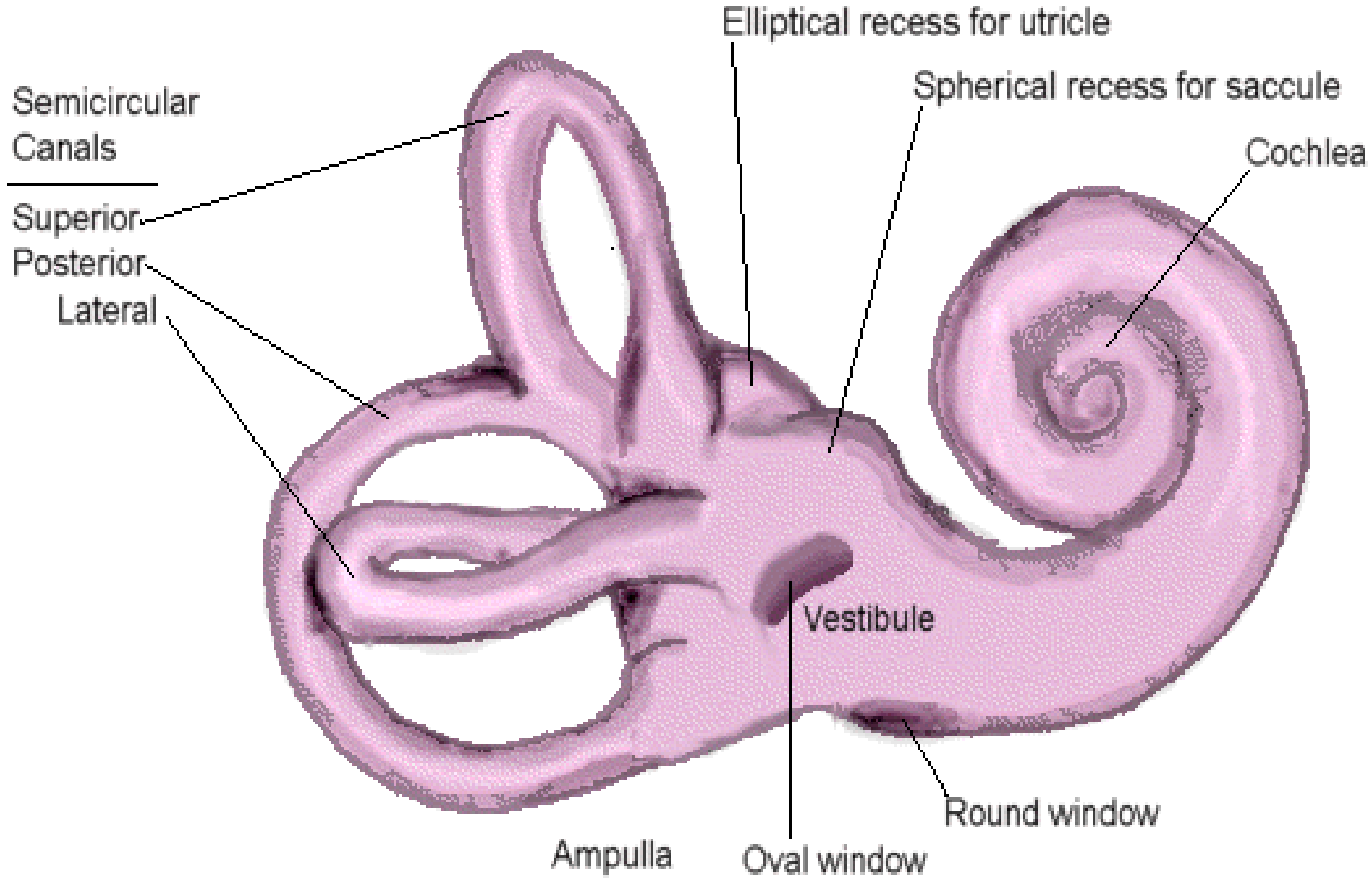

Temporal bone
Malleus
Incus
Base of stapes in oval window
External auditory canal
Tensor tympani muscle
Stapes
Tympanic membrane
Stapedius muscle
Round window
Auditory tube

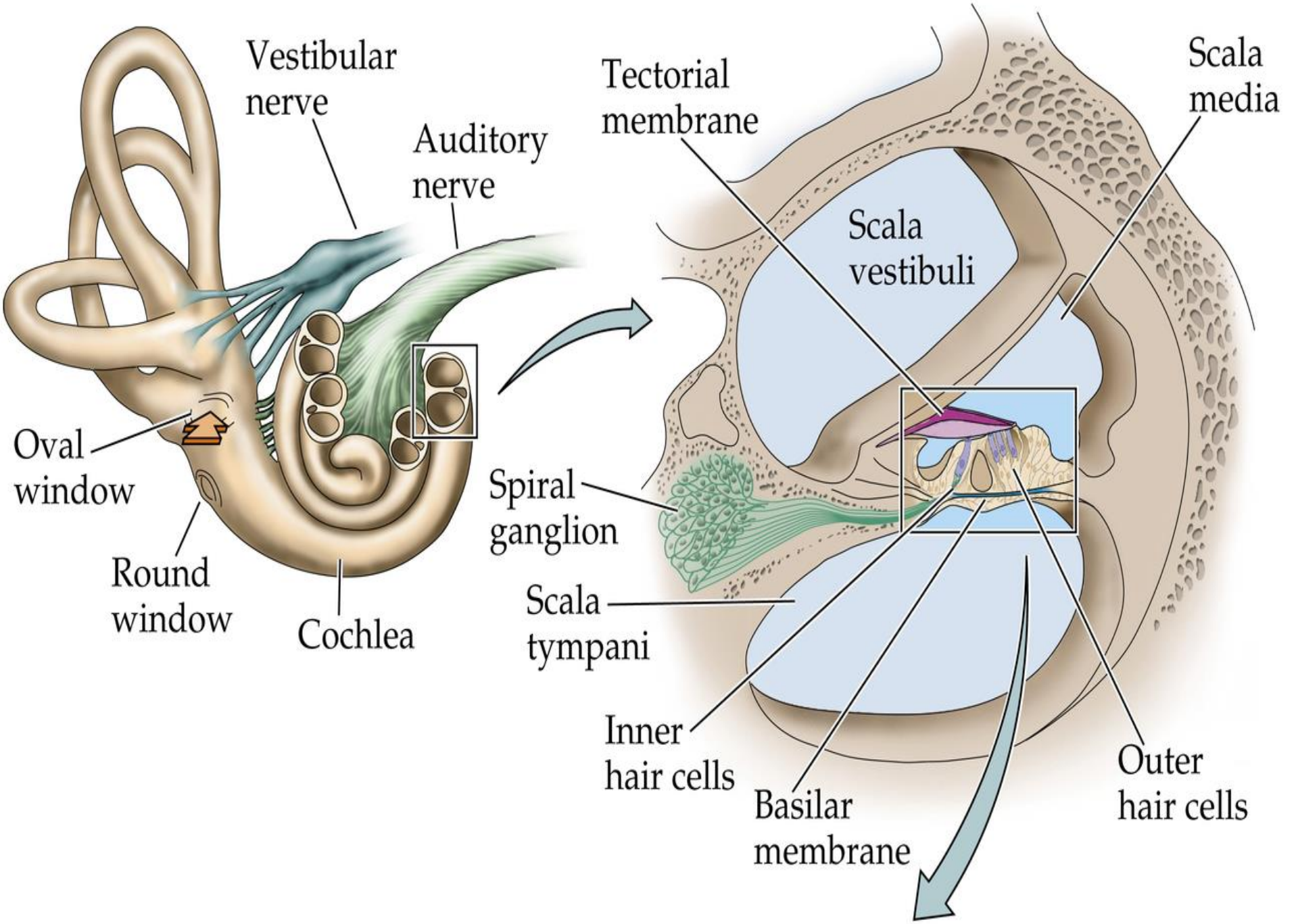
Inner ear

is fluid-filled cavity, consists of
1-a bony labyrinth (cochlea, semicircular canals, and vestibule)
2- membranous labyrinth.

- The fluid outside the ducts is perilymph while the fluid inside the ducts is endolymph.

Function: Hearing and equilibrium


Elliptical recess for utricle
Spherical recess for saccule
Semicircular Canals
Cochlea
Superior
Posterior
Lateral
Vestibule
Round window
Ampulla
Oval window


Vestibular nerve
Auditory nerve
Oval window
Round window
Cochlea
Tectorial membrane
Scala media
Scala vestibuli
Spiral ganglion
Scala tympani
Inner hair cells
Basilar membrane
Outer hair cells

Cochlea:

Its cross section reveals three chambers:
1-Scala vestibule 2- Scala tympani (filled with a fluid called perilymph) and
3- Scala media (filled with a fluid called endolymph rich in K^+ ions).
Vestibular membrane separates scala vestibule from scala media.
Basilar membrane separates scala media from scala tympani. And on it the organ of corti is located within the scala media.

Fluid is continuous between scala vestibuli and scala tympani by physical connection known as the helicotrema.
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Organ of Corti

It is composed of: Outer hair cells,

inner hair cell

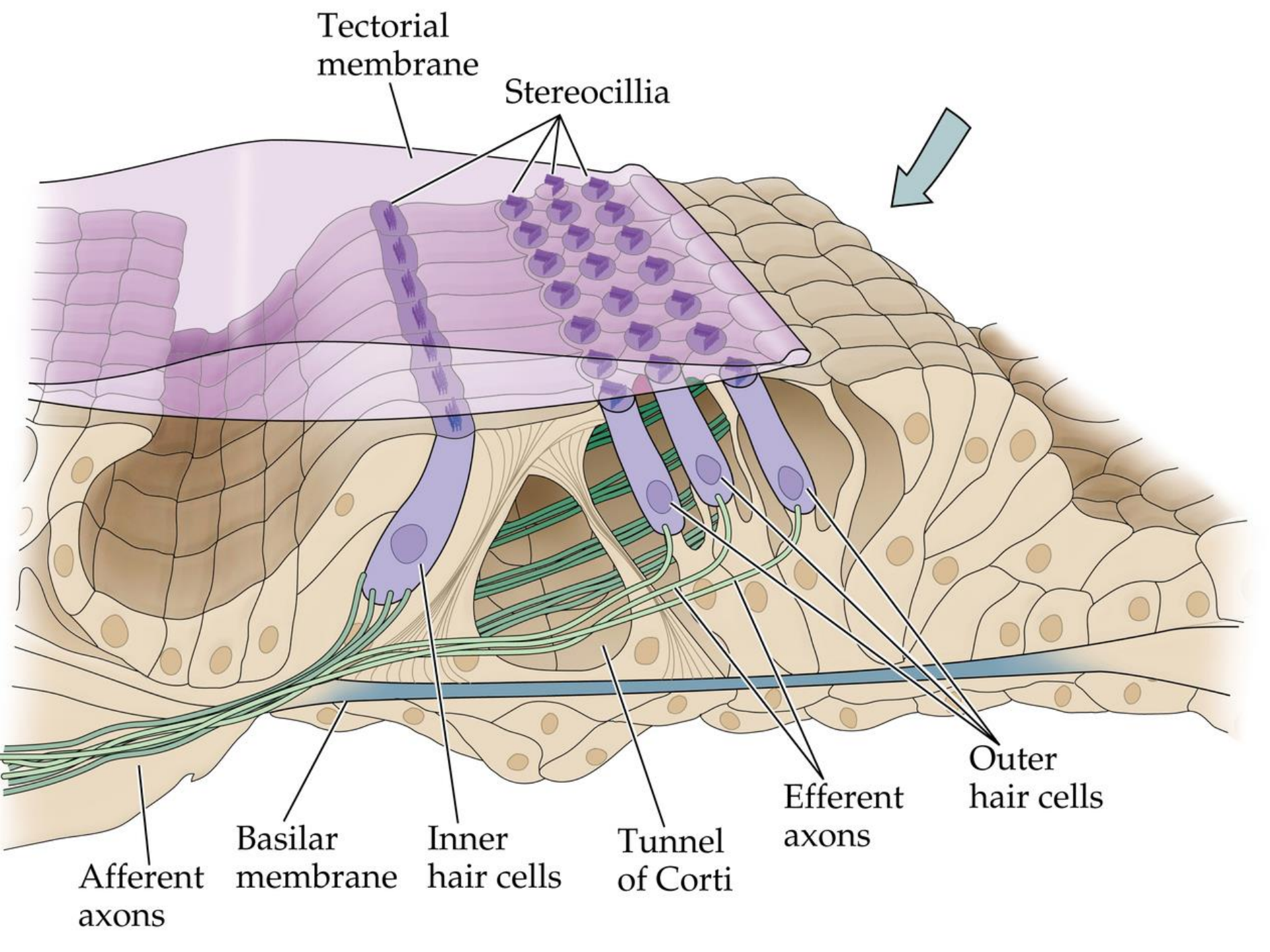
tectorial membrane

reticular membrane,

stereocilia and

spiral ganglion.

The hair cells with stereocilia are the auditory receptors. Auditory nerve fibers arise from the hair cells.


Tectorial membrane
Stereocillia
Outer hair cells
Efferent axons
Tunnel of Corti
Inner hair cells
Basilar membrane
Afferent axons

Central Auditory Nervous System

- **VIIIth Cranial Nerve or "Auditory Nerve"**
  - **Travels from cochlea through internal auditory meatus to skull cavity and brain stem**
  - **Carry signals from cochlea to primary auditory cortex, with continuous processing along the way**
- **Auditory Cortex**
  - **Wernicke's Area within Temporal Lobe of the brain**

How Sound Travels Through The Ear

Acoustic energy, in the form of sound waves, is channeled into the ear canal by the pinna. Sound waves hit the tympanic membrane and cause it to vibrate, like a drum, changing it into mechanical energy. The malleus, which is attached to the tympanic membrane, starts the ossicles into motion. The stapes moves in and out of the oval window of the cochlea creating a fluid motion, or hydraulic energy. The fluid movement causes membranes in the Organ of Corti to shear against the hair cells. This creates an electrical signal which is sent up the Auditory Nerve to the brain. The brain interprets it as sound!

IS HEARING IMPORTANT?

- Communication: hearing is essential to language
- Localisation: determination of location of unseen sound sources

WHAT IS REQUIRED FOR NORMAL HEARING?

- Adequate stimulus (sound)
- Conduction of stimulus to sensory organ of hearing
- Sensory transduction of stimulus at organ of hearing
- Neural transmission of the signal
- Central auditory processing of the signal at brain

Gustation

- Chemical sense.
- Organs of taste are tongue, pharynx and palate (epiglottis have some sensitivity).
- Nasal passages are located so that odors can enter through the nose or pharynx and contribute to the perception of flavor

Physiology of Taste - cont

Primary modalities of taste:

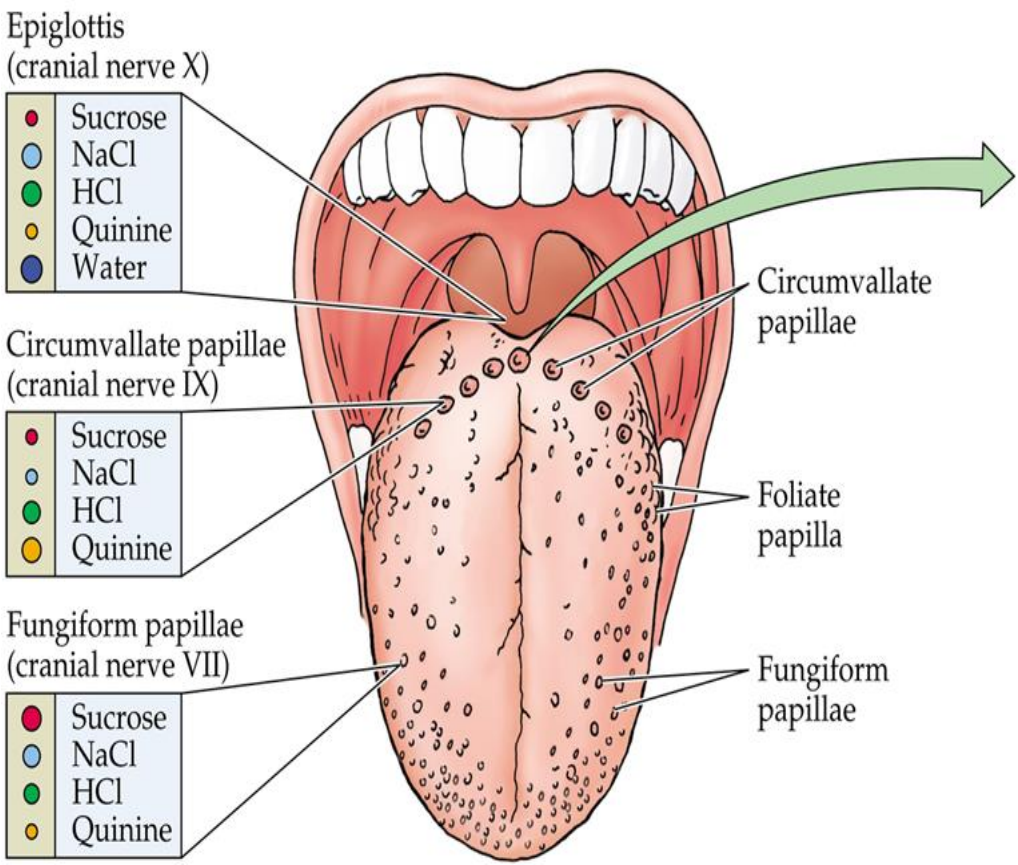
- Sour
- Salt
- Sweet
- Bitter
- umami (deliciousness), a taste associated with glutamate & other nucleotides has receptors located at the back of the pharynx.

Tongue is the primary organ of taste.

Most of which is receptive to all basic tastes but some regions are most sensitive to a given taste.

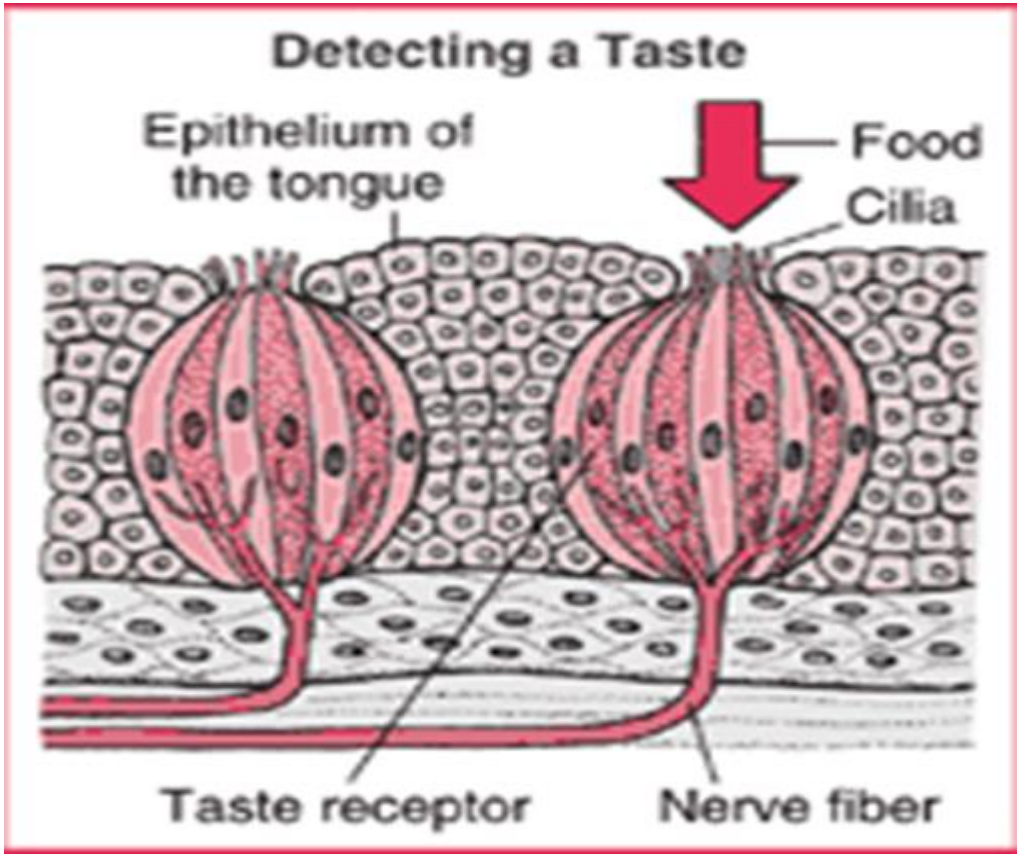
Receptors for bitter tastes are located across its back, sour on side closest to the back, salty on side more rostral than sour and sweet across front.

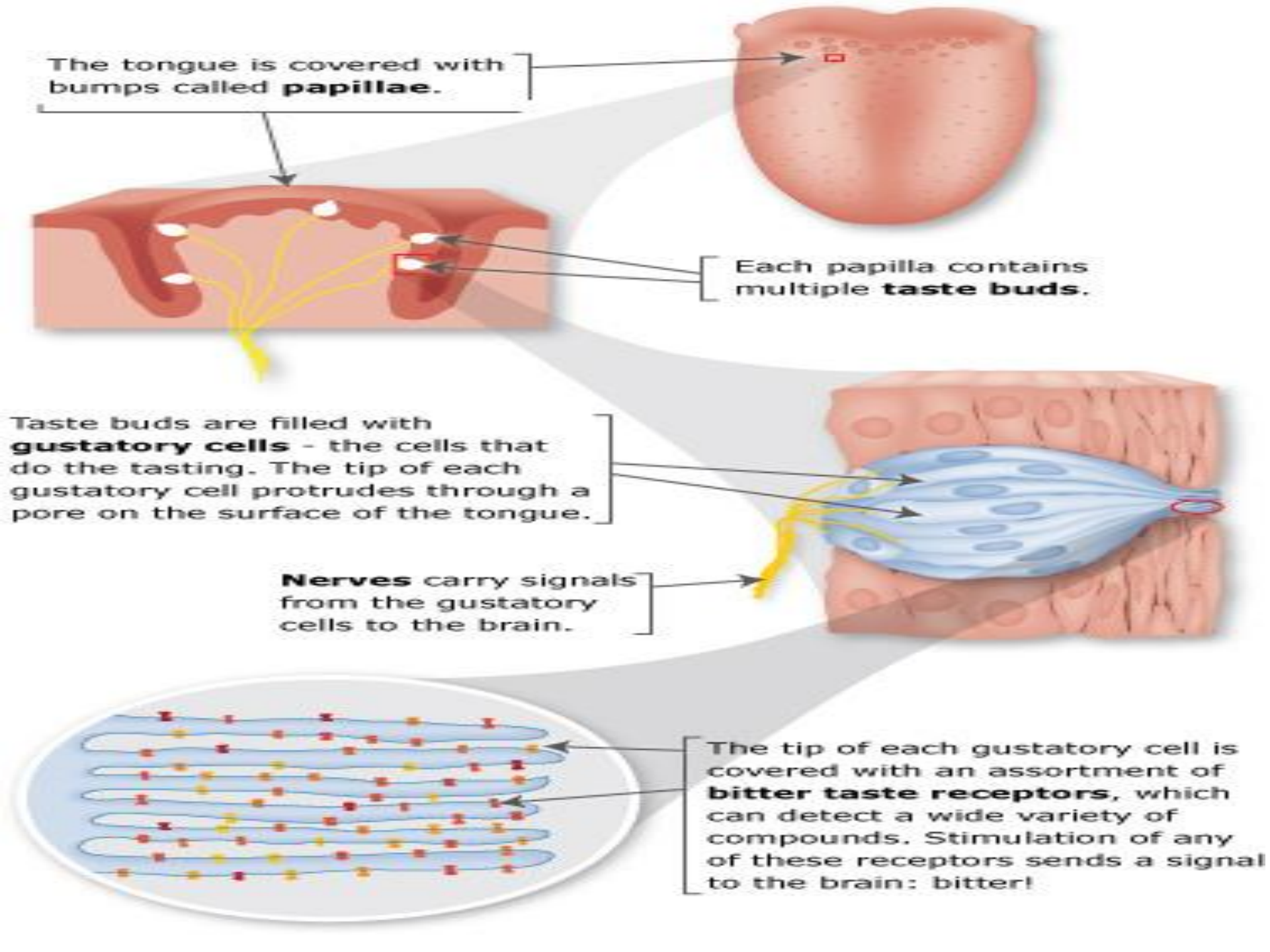
Each food activates a different combination of basic tastes. Most foods have a distinctive flavor as a result of their taste and smell occurring simultaneously



There are several types of small projections on the surface of tongue called papillae. Each papilla has one to several hundred taste buds. Each taste bud has 50-150 taste cells.

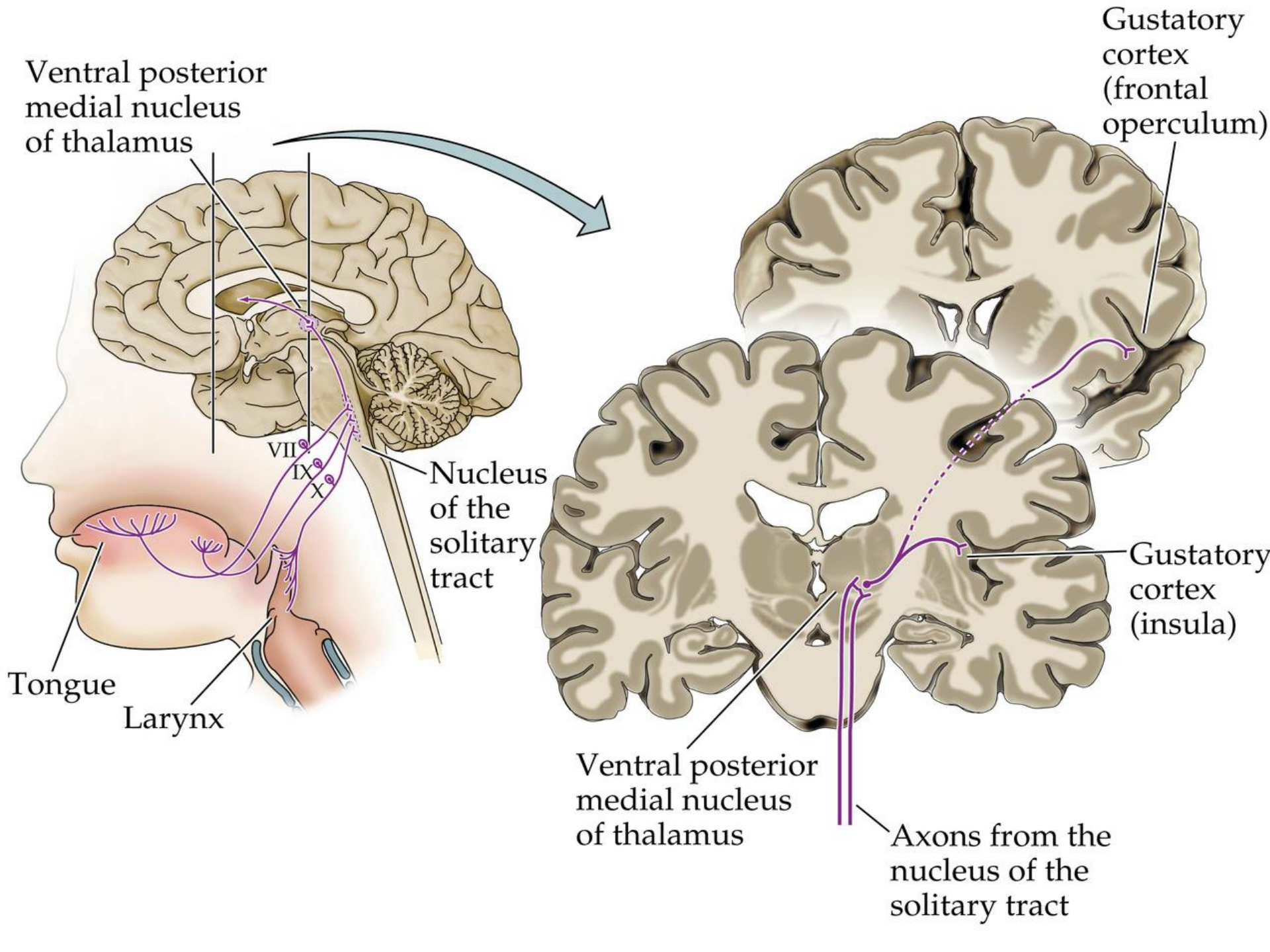
Taste cells are only 1% of the tongue epithelium. Taste receptor cells are not neurons. They form synapses with the endings of gustatory afferent axons near the bottom of the taste bud.




The tongue is covered with bumps called **papillae**.
Each papilla contains multiple **taste buds**.
Taste buds are filled with **gustatory cells** - the cells that do the tasting. The tip of each gustatory cell protrudes through a pore on the surface of the tongue.
Nerves carry signals from the gustatory cells to the brain.
The tip of each gustatory cell is covered with an assortment of **bitter taste receptors**, which can detect a wide variety of compounds. Stimulation of any of these receptors sends a signal to the brain: bitter!

Taste Neural Pathway

1. NT release from taste cells causes an AP in the gustatory afferent axon
2. Three different cranial nerves (VII, IX and X) innervate the taste buds and carry taste information from the tongue, palate, epiglottis. Efferent target of this information is gustatory nucleus in the medulla.
3. Information is relayed to the thalamus
4. Information then goes to the primary gustatory cortex (parietal lobe)


Ventral posterior medial nucleus of thalamus
Gustatory cortex (frontal operculum)
VII
IX
X
Nucleus of the solitary tract
Gustatory cortex (insula)
Tongue
Larynx
Ventral posterior medial nucleus of thalamus
Axons from the nucleus of the solitary tract

Taster Facts

- Women are more likely to be super tasters.
- Taste receptors reproduce themselves so if you burn your tongue they come back.
- Alcoholics tend to be non-tasters.
  - Alcohol and tobacco kills taste buds permanently and prematurely.
- Sensitivity to taste changes with age.
  - The number of taste buds deteriorates as we get older.
- Women develop more taste buds with menarche and lose taste buds with menopause.