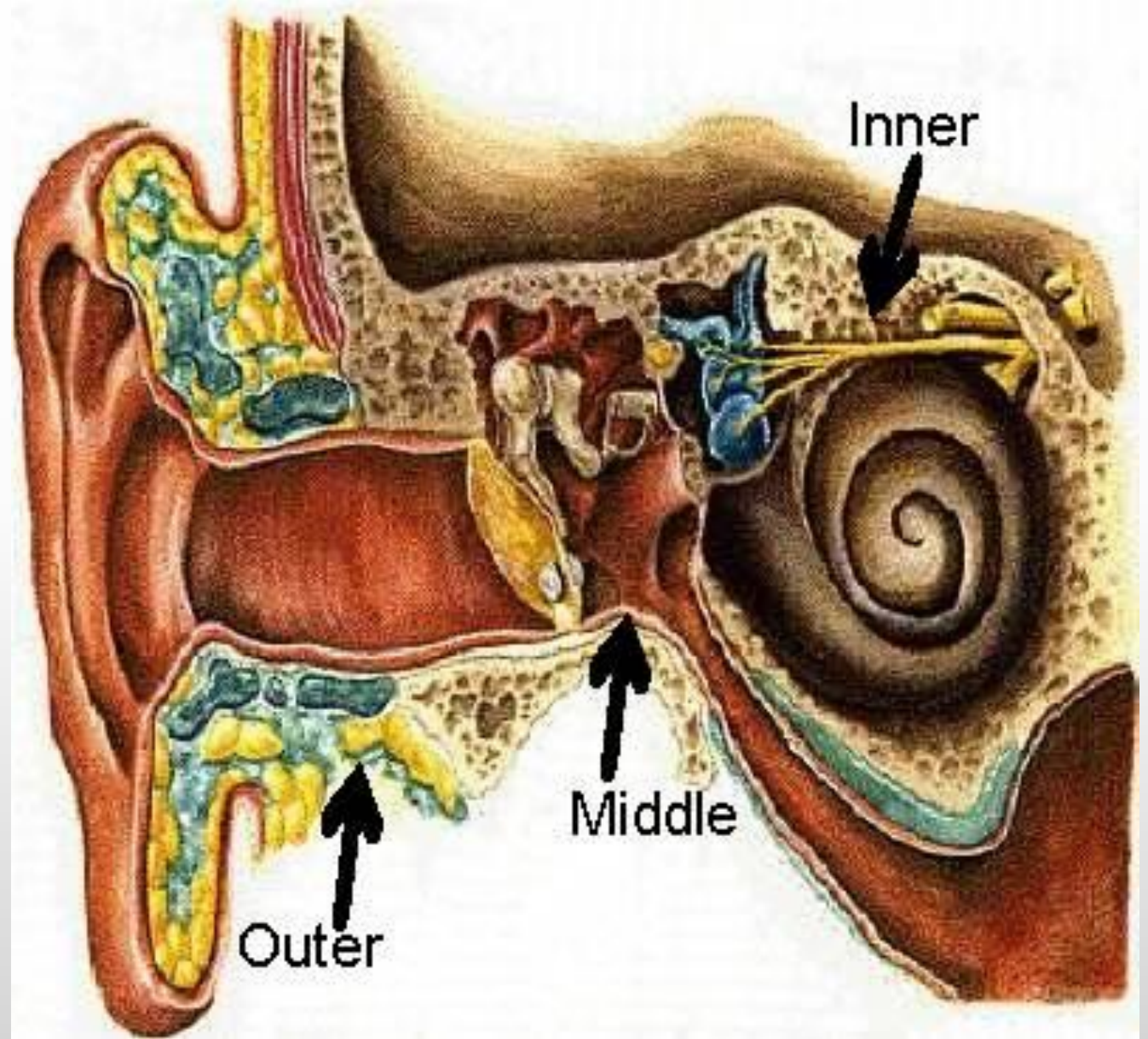


ANATOMY OF EAR

Basic Ear Anatomy

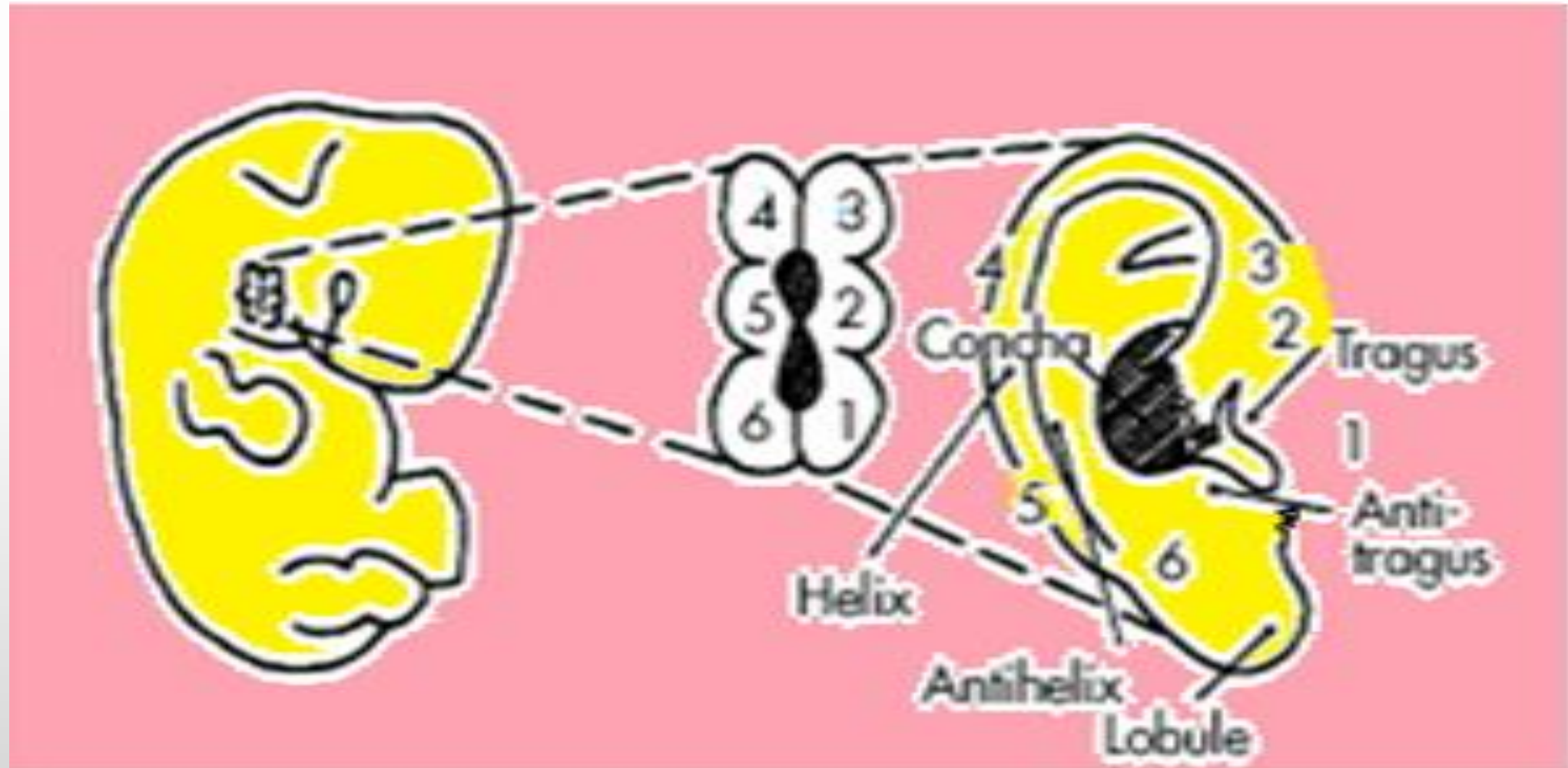
- Expected outcomes
 - To understand the hearing mechanism
 - To be able to identify the structures of the ear



Development of Ear

1. Pinna develops from 1st & 2nd Branchial arch (Hillocks of His). Starts at 6 Weeks & is complete by 20 weeks.
2. E.A.M. develops from dorsal end of 1st branchial arch starting at 6-8 weeks and is complete by 28 weeks.
3. Middle Ear development
 - Malleus & Incus develop between 6-8 weeks from 1st & 2nd branchial arch.

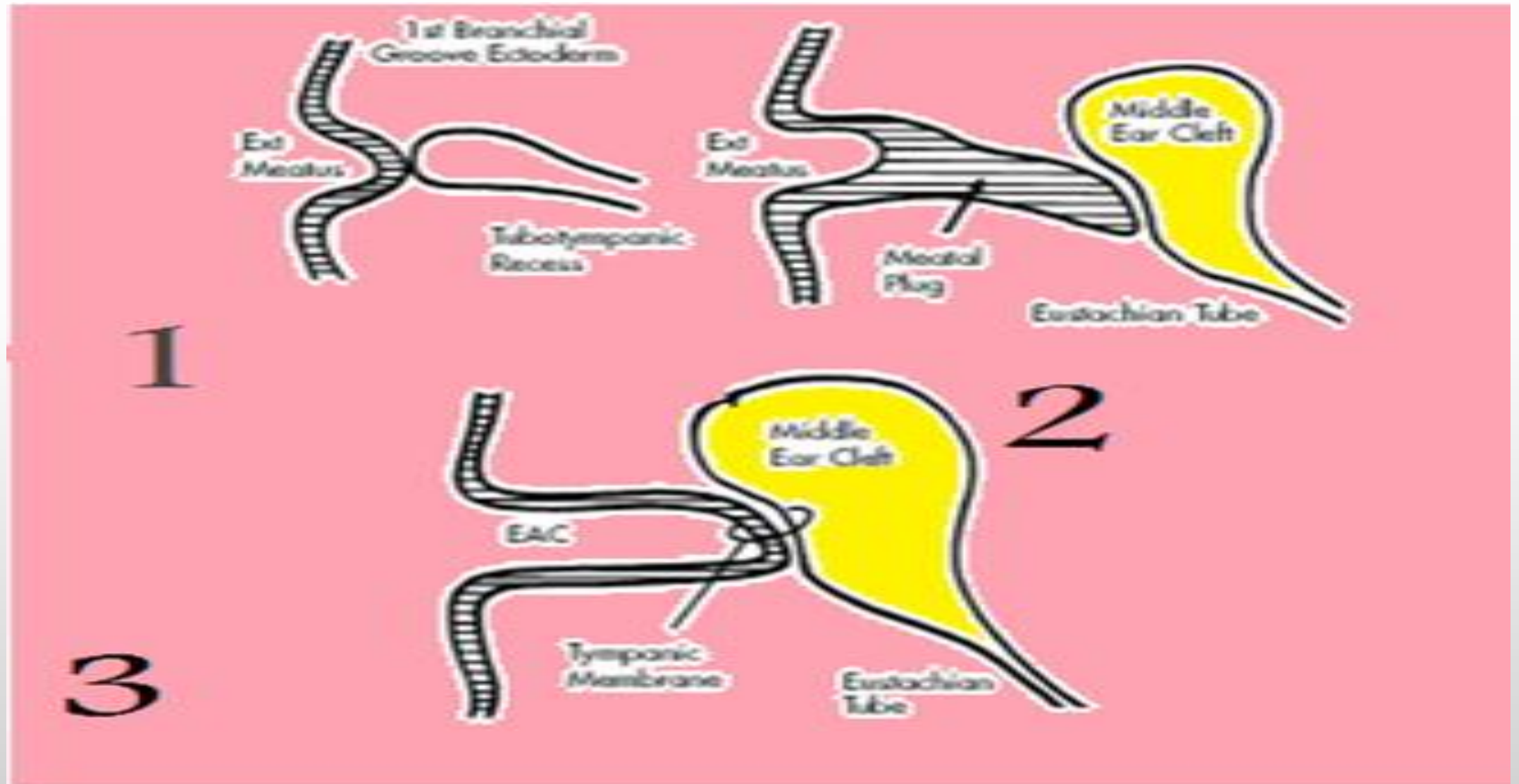
Branchial arches & Development of Ear



Dev. contd----

- T.M at 28 weeks from all 3 germinal layers.
- Foot plate of stapes develops from otic capsule b/w 6-8 weeks.
- Inner ear develops from otic capsule starting at 5 weeks & is complete by 25 weeks.
- Development of external/middle/inner ear is independent of each other.

Development of ear



External Ear

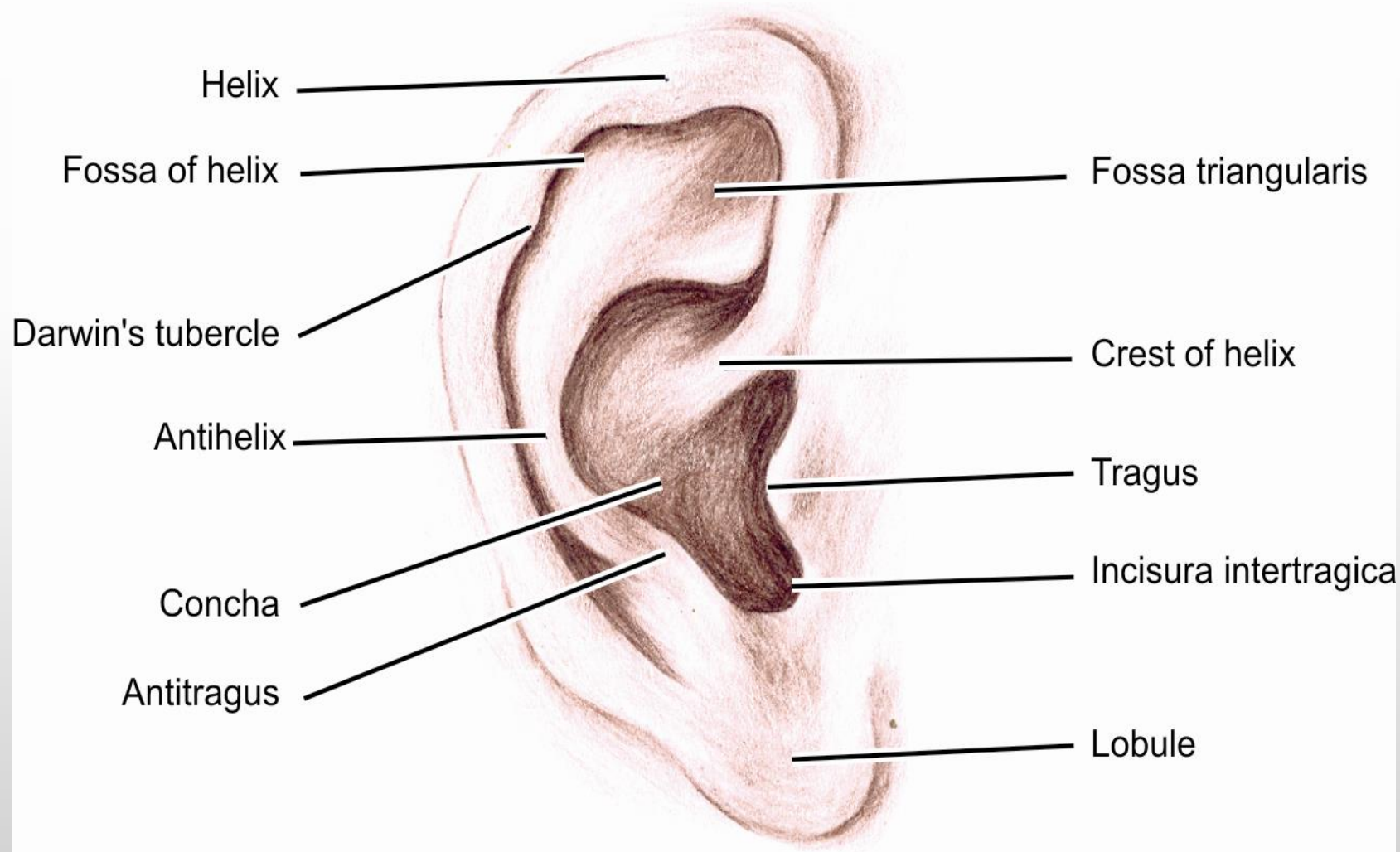
- It consists of
 - Pinna and External auditory meatus.

Pinna

- It is made up of fibro elastic cartilage covered by skin and connected to the surrounding parts by ligaments and muscles.
- Various landmarks on the pinna are helix, antihelix, lobule, tragus, concha, scaphoid fossa and triangular fossa
- Pinna has two surfaces i.e. medial or cranial surface and a lateral surface .
- Cyma concha lies between crus helix and crus antihelix. It is an important landmark for mastoid antrum.

Anatomy of external ear

- Landmarks of pinna



Anatomy of external ear

- **Bat-Ear is the most common congenital anomaly of pinna** in which antihelix has not developed and excessive conchal cartilage is present.
- **Corrections of Pinna defects are done at 6 years of age.**

Ligaments and muscles of pinna

- There are both extrinsic and intrinsic ligaments and muscles.
- Extrinsic muscles are anterior, posterior and superior auricularis.
- Intrinsic muscles are **helicis major** and **helicis minor**, **tragicus** and **anti tragicus**.
- Both groups are supplied by **branches of facial nerve**.

Sensory nerve supply of pinna

Lateral surface

- Upper two- third is supplied by **Auriculotemporal nerve** (branch of fifth nerve).
- Lower one-third by **Greater Auricular nerve** (C2, C3)

Medial or Cranial surface of the pinna

- Lower two-third is supplied by **Greater Auricular nerve**.
- Upper one-third by the **Lesser Occipital nerve**.
- **Arnold's nerve (a branch of Vagus nerve) also called Alderman's nerve** & another nerve branch of Facial nerve supplies concha on the lateral surface of pinna.

Supply--contd

Blood supply of pinna

- Posterior auricular branch of **external carotid**
- Anterior auricular branch of **superficial temporal** artery
- A branch of **occipital artery**.
- Veins corresponding to the arteries drain into **external jugular** and **common facial vein**.

Lymphatic supply

- They drain into parotid group, upper deep cervical and **preauricular & postauricular** lymph nodes.

External Acoustic Meatus

- At birth only cartilaginous meatus is present because the bony part develops from tympanic ring which is incompletely formed at that time i.e. **bony part of meatus is absent in newborn.**
- Its length is **24 mm, outer one-third (8 mm) being cartilaginous and inner two-thirds (16 mm) bony.** The canal forms a mild S-shaped curve directed medially, upwards and forwards and then medially, backward and downward.

Contd----

- The canal has **two constrictions in the EAC**
 - one, near the medial end of cartilaginous part and the other 5 mm short of tympanic membrane in the osseous part called **isthmus**.
- **Floor and anterior wall of meatus are longer** than the roof and posterior part due to oblique position of tympanic membrane .
- **Anterior, inferior and posterior** bony walls are formed by **tympanic part** of temporal bone.
- Roof and part of **posterior wall** are formed by **squamous part** of temporal bone.

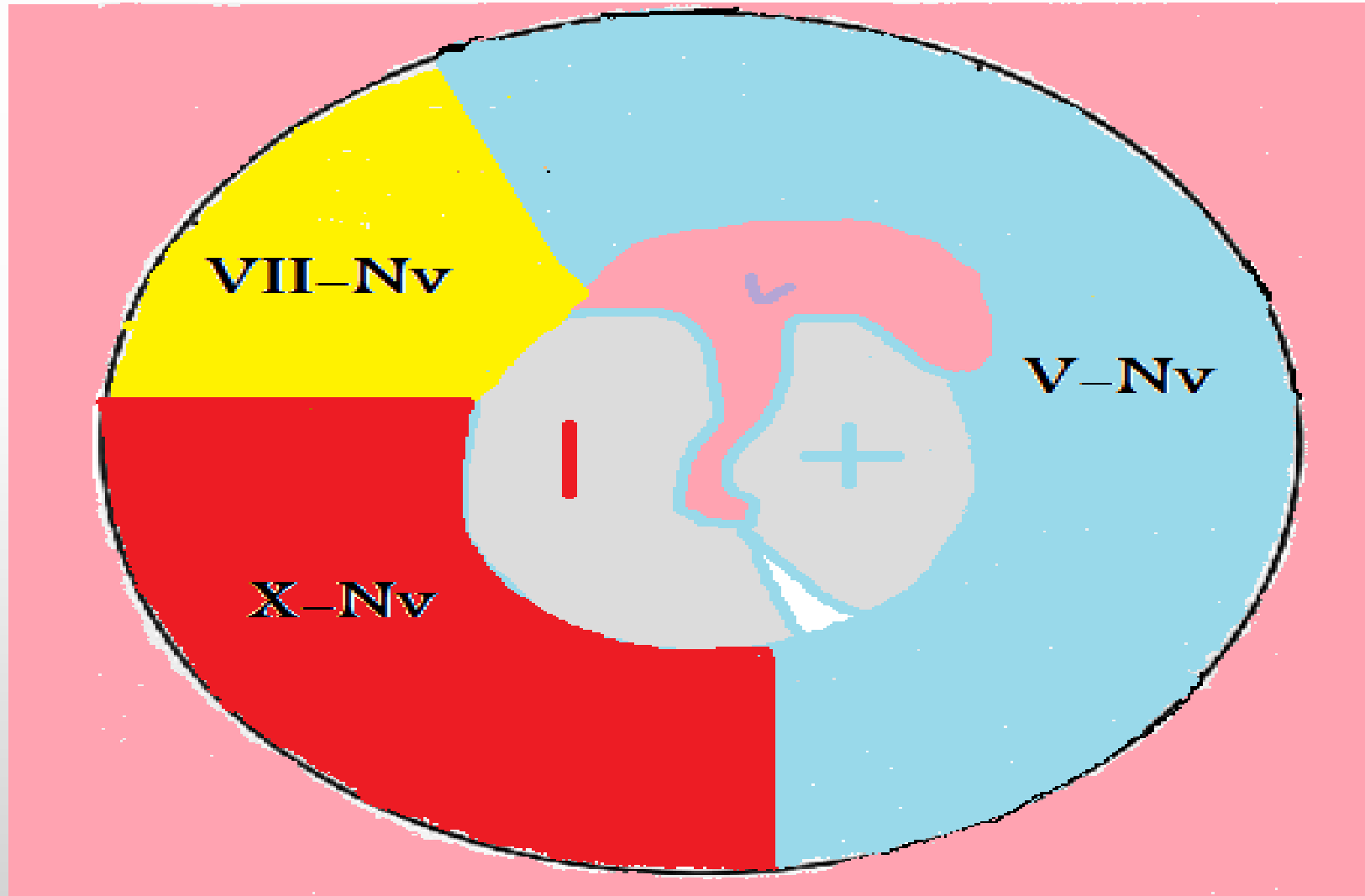
Anatomy of external ear

- **Foramen of Luschke** is a deficiency in antero-inferior part of bony meatus. It closes around 4 years of age.
- **Fissures of Santorini** are deficiencies seen in cartilaginous portion of external auditory canal (EAC) through which infection of mastoid and parotid gland can spread to the meatus.
- Important relations include:
 - **Condylod process** of mandible is in close relation to anterior wall.
 - **Middle cranial fossa** lies above the osseous meatus.
 - **Mastoid air cells** are posterior to it

Nerve supply of Meatus

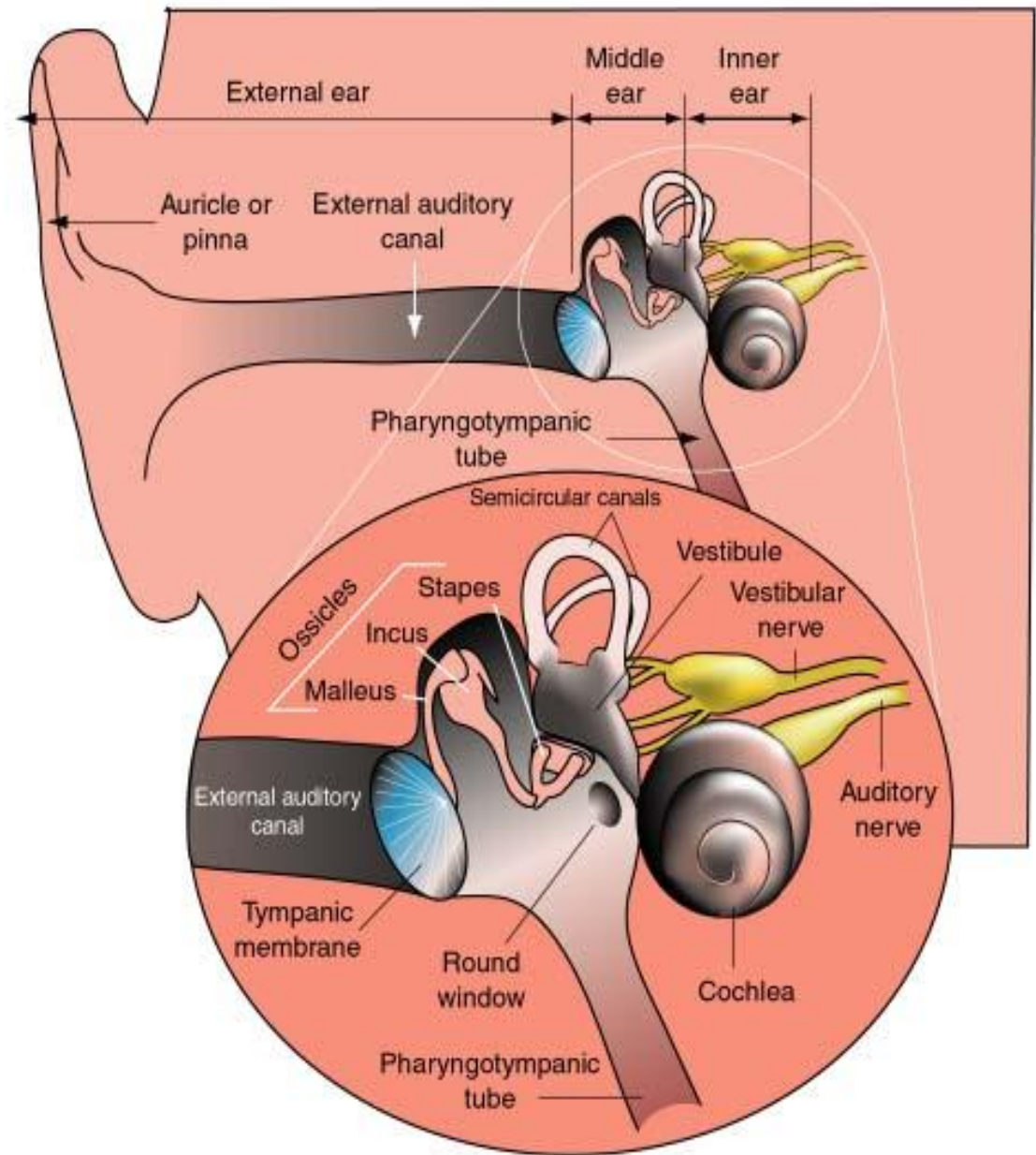
- Anterior and superior walls comes through *Auriculotemporal branch* of Mandibular nerve,
- Posterior and inferior walls are supplied by Auricular branch of Vagus (*Arnold's nerve*).
- A sensory branch of the facial nerve (*nerve of Wrisberg*) may supply a part of the posterior wall of meatus.

Nerve supply of Meatus



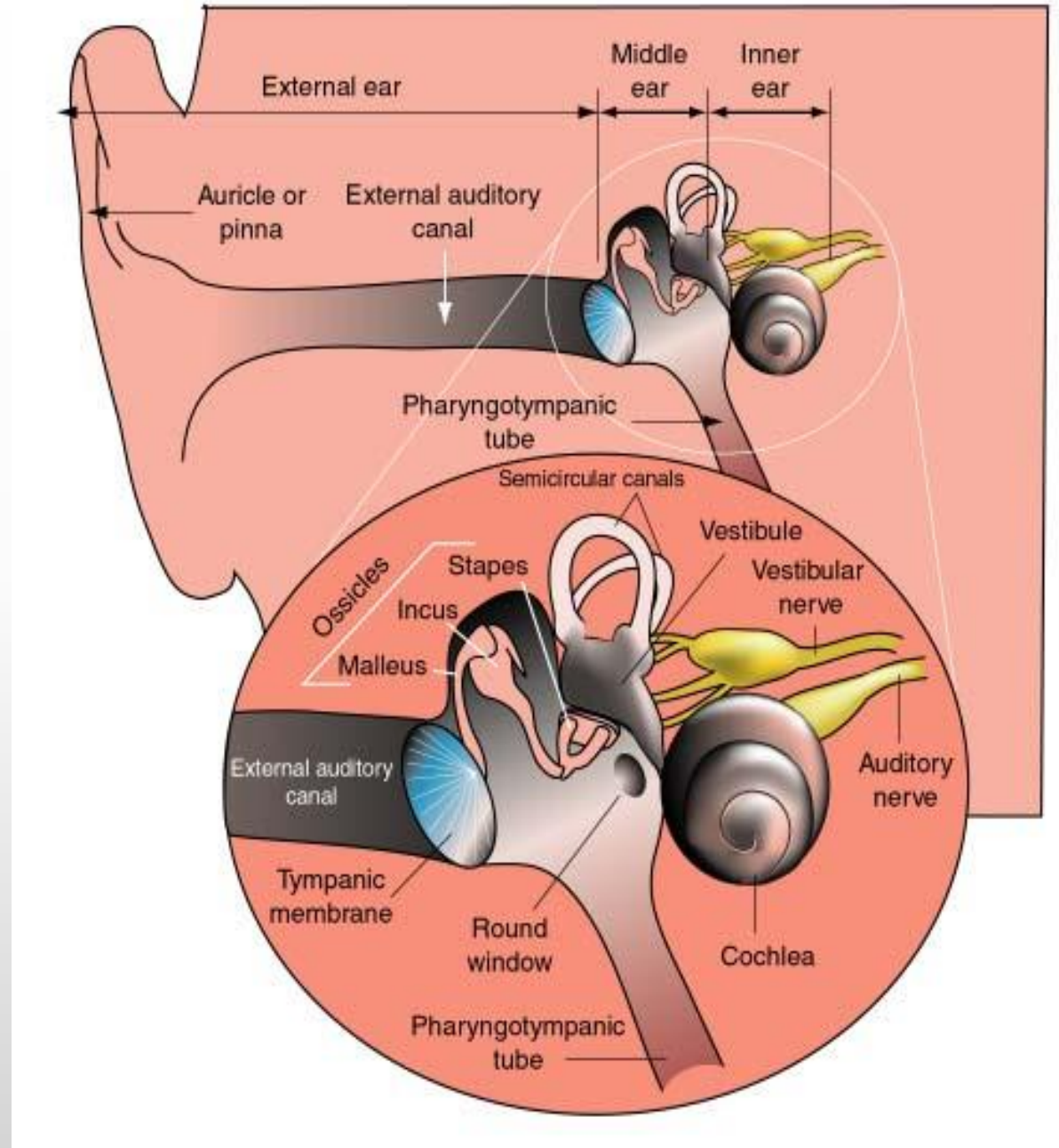
BASIC EAR ANATOMY

- Made up of three regions
- External ear
 - Pinna or auricle
 - External auditory canal
- Middle ear
 - Tympanic membrane
 - Malleus, incus and stapes
 - Eustachian tube or pharyngotympanic tube



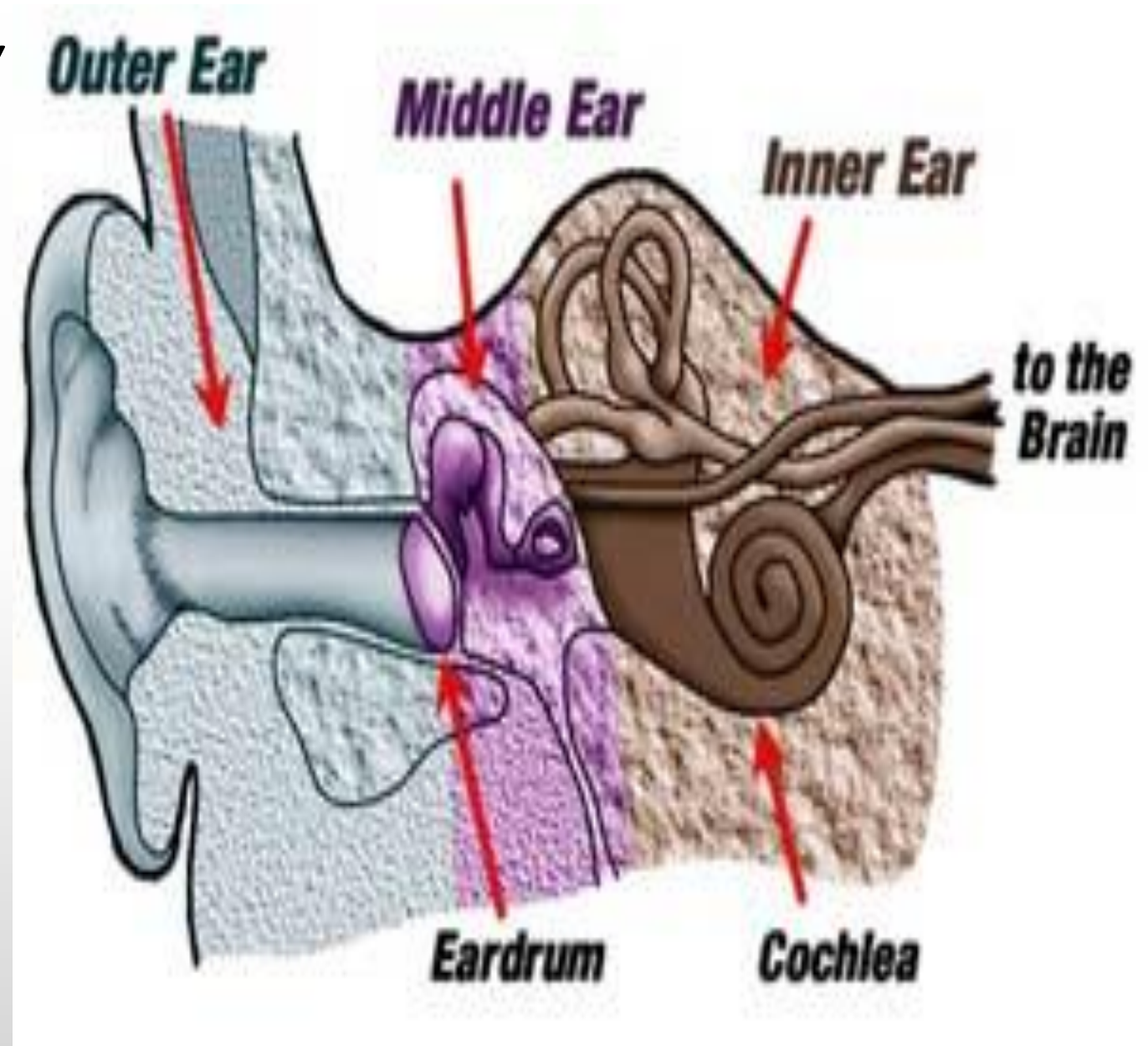
Basic ear anatomy

- Inner ear
- Bony & membranous labyrinth
- Vestibule
 - Semi-circular canals
 - Cochlea
 - Vestibular nerve
 - Auditory nerve



BASIC EAR ANATOMY

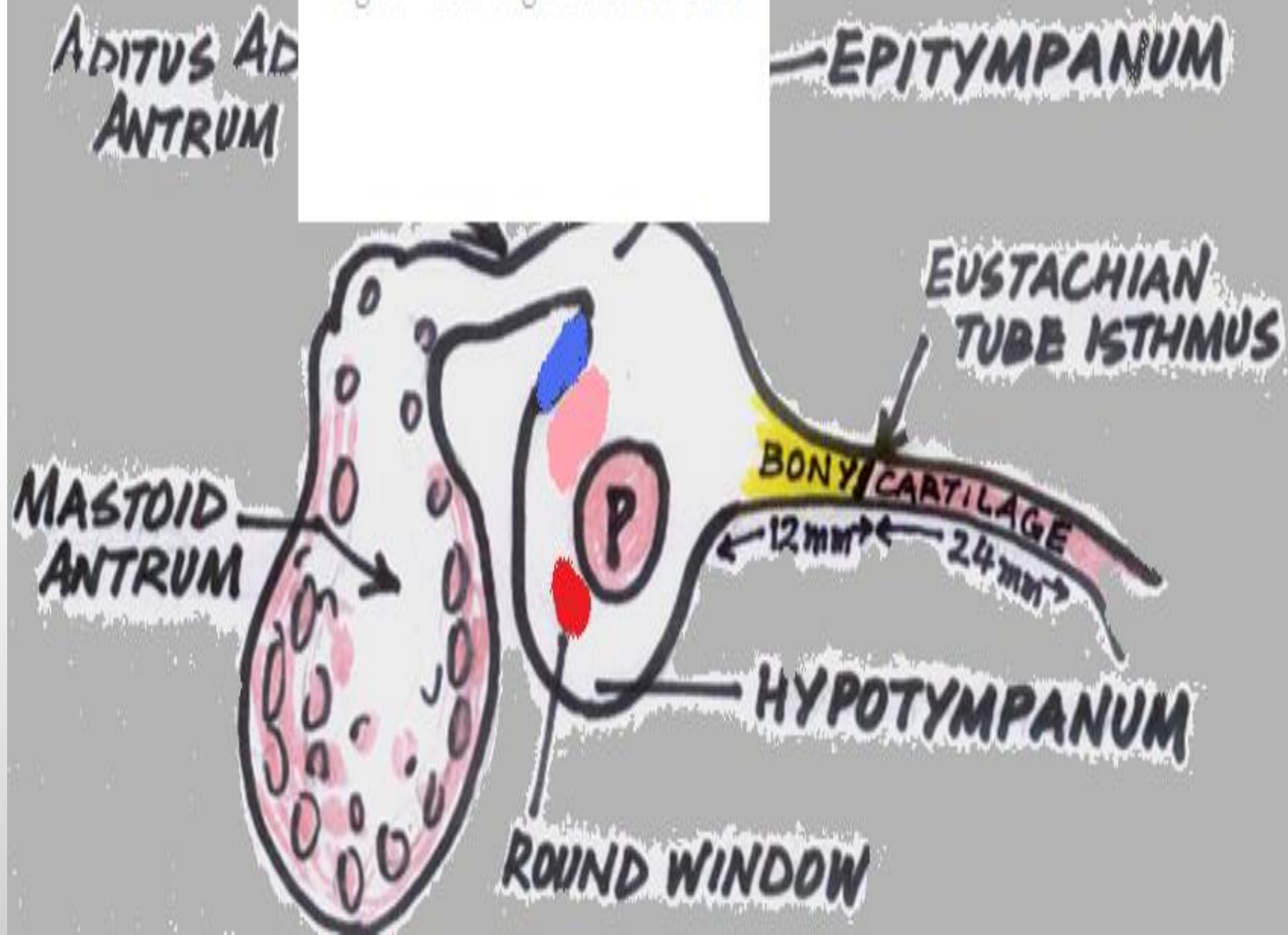
- Hearing mechanism
 - Outer ear – acoustic to kinetic energy
 - MIDDLE EAR – CAUSES INCREASE IN KINETIC ENERGY (x18)
 - Inner ear – kinetic to hydraulic energy then hydraulic to electrical energy



Middle Ear Cleft

- Consists of
 - Eustachian Tube
 - Tympanic cavity
 - Mastoid antrum
 - Aditus ad antrum
 - Mastoid air cells
- Lined by columnar ciliated and pavement epithelium

Fig.1. Showing Middle Ear Cleft

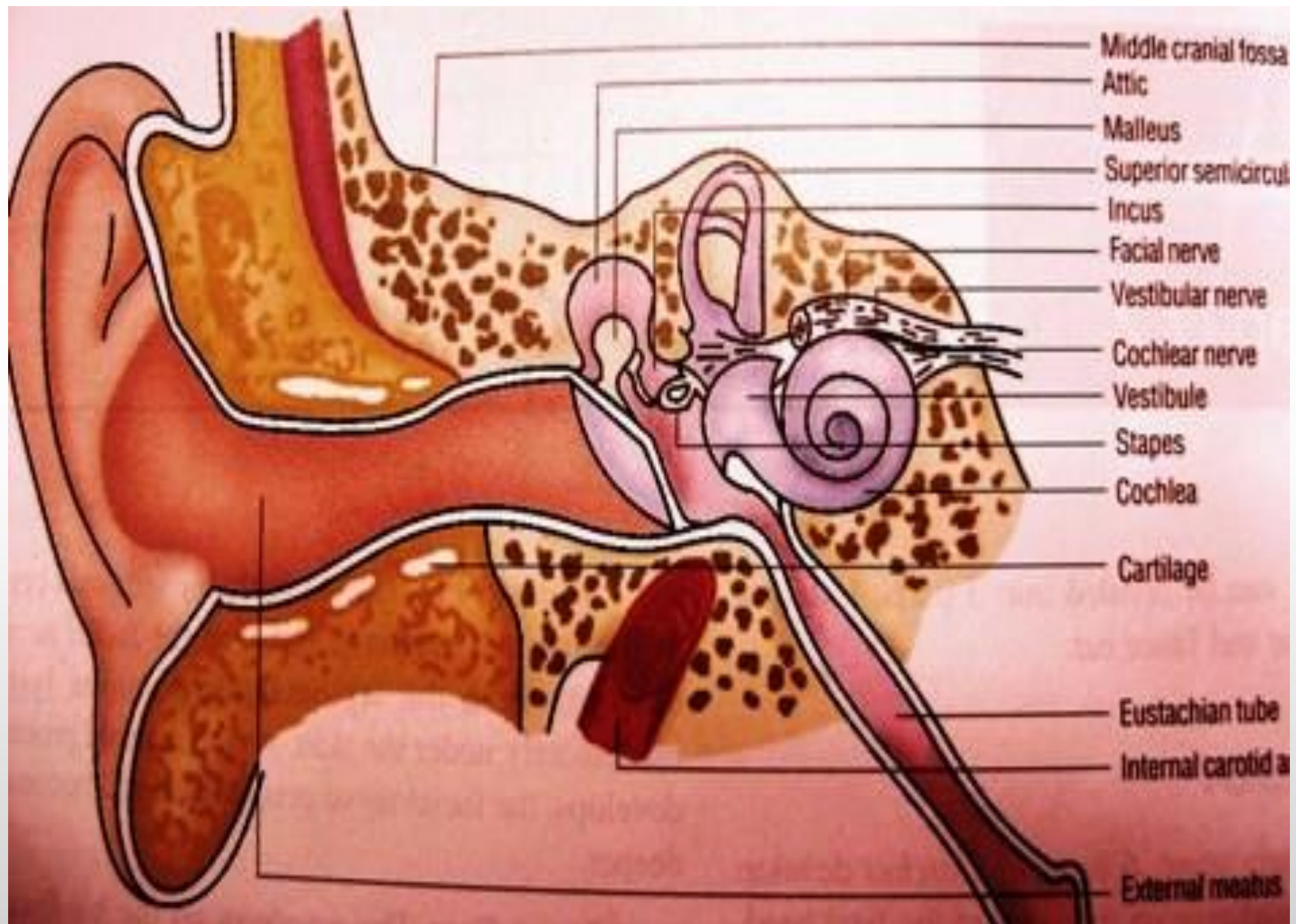


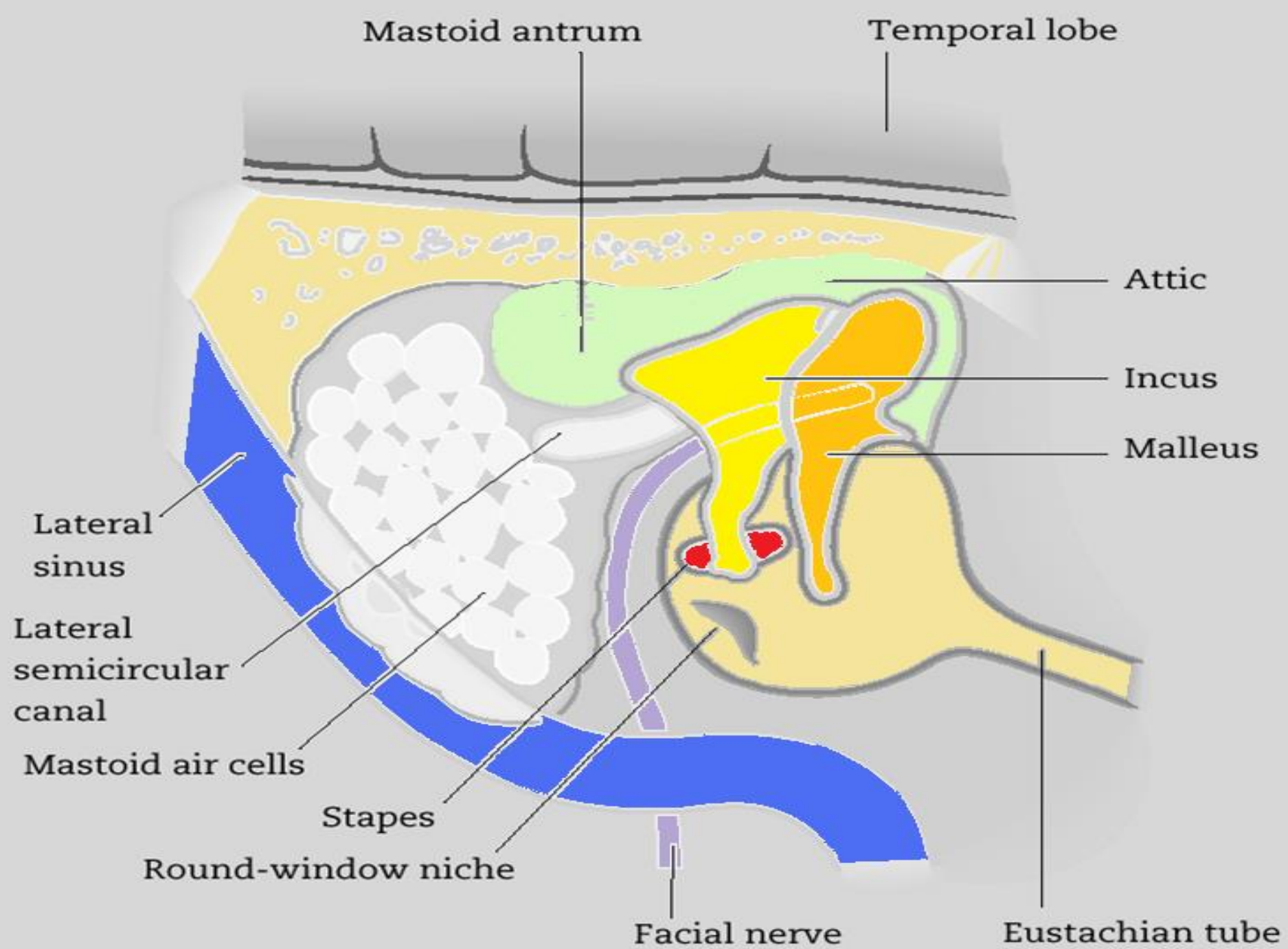
Tympanic Cavity

- Connected anteriorly to nasopharynx via the auditory(ET) tube.
- Connected posteriorly with mastoid air cells via mastoid antrum.
- A six-walled cavity
 - 15 mm antero-posteriorly
 - 2-6 mm from side to side
 - 15 mm in height
 - All the walls are bony, except the lateral wall (tympanic membrane)



Fig 1.4a . Showing dimensions of Middle Ear Space





Walls of the middle ear

- Lateral wall
 - It separates the middle ear from the external ear.
 - Formed by:
 - The tympanic membrane with bones above and below.
 - The outer attic wall or **scutum** (part of the squamous temporal bone) forms the upper part of the lateral wall of the attic (epitympanum).

The Tympanic Membrane or the eardrum

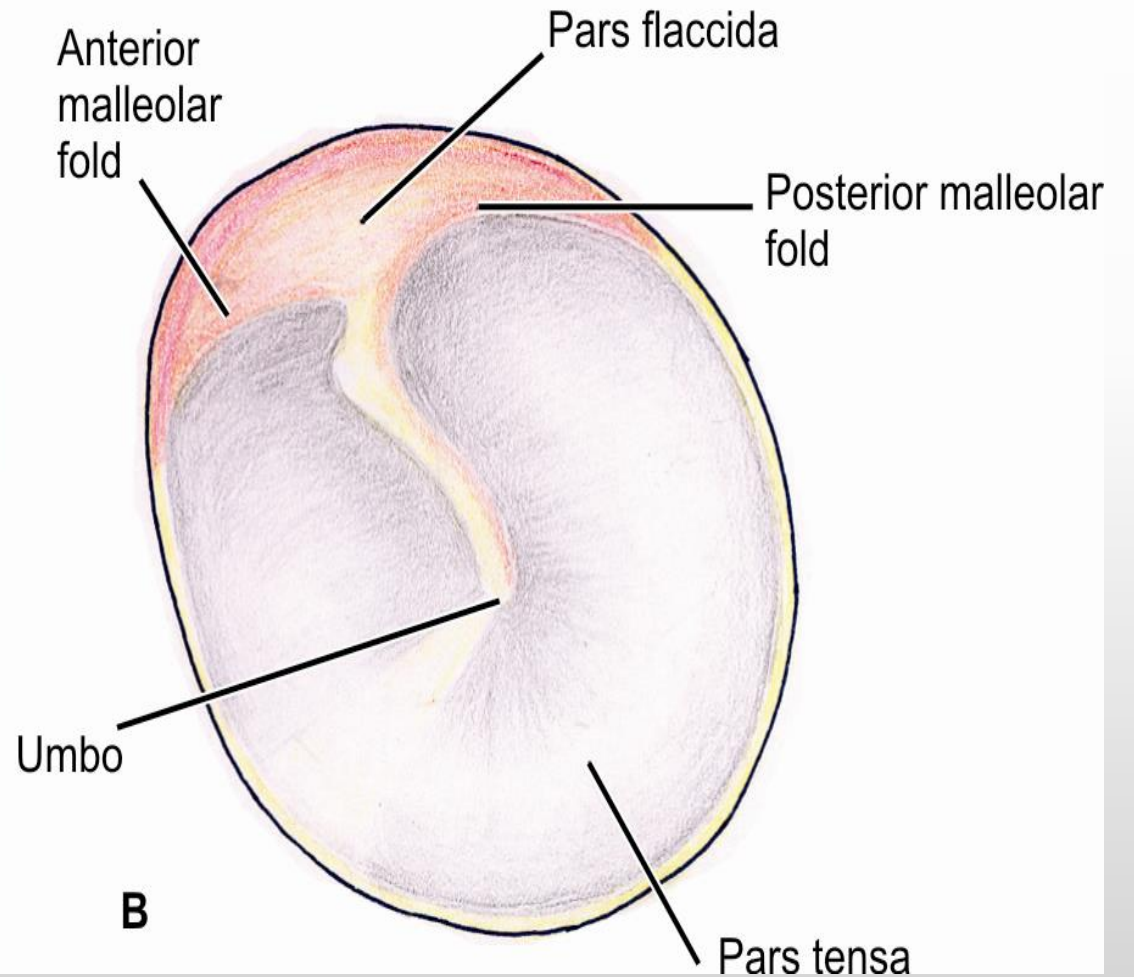
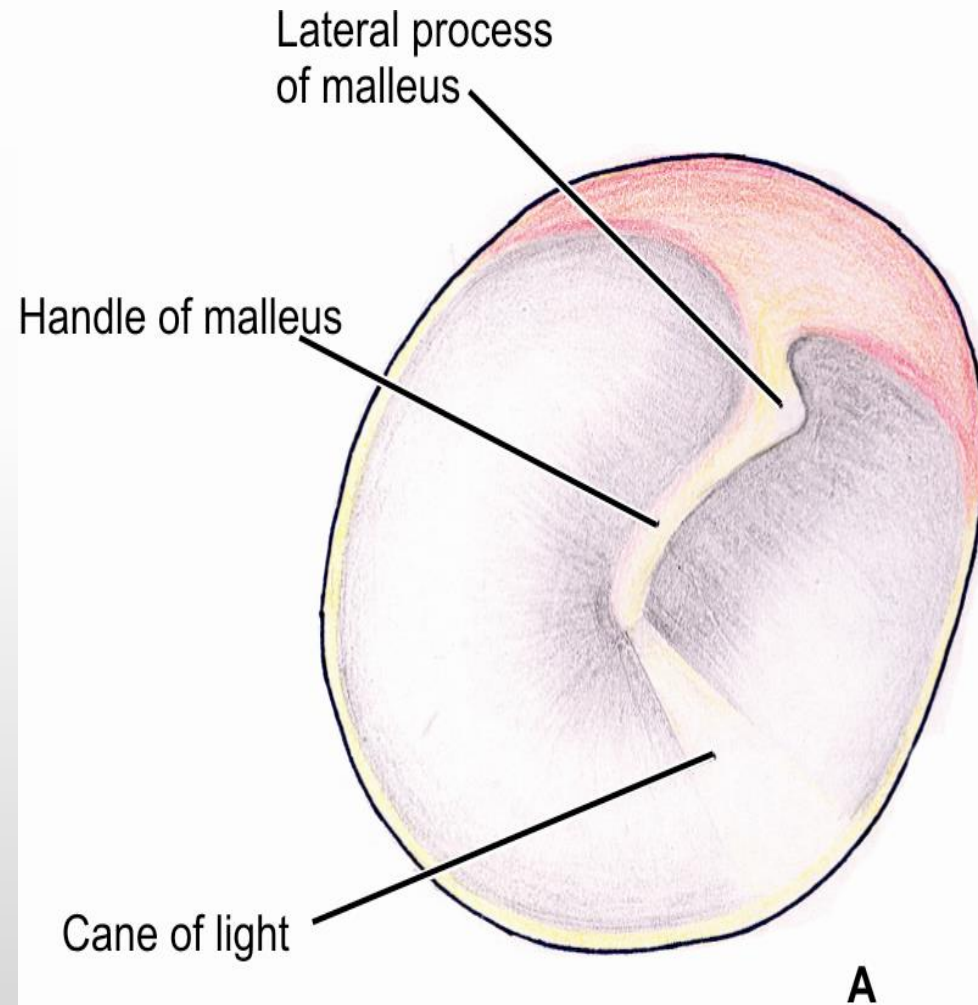
- Roughly circular
- Almost transparent with a capillary blood supply
- Joins meatus around its circumference (annular)
- separates the tympanic cavity from the bottom of the external acoustic meatus
- oval in form, somewhat broader above than below
- Its longest diameter is downward and forward, and measures from 9 to 10 mm.; its shortest diameter measures from 8 to 9 mm



The Tympanic Membrane

- Stiff (but flexible), diaphragm like structure
- Moves synchronously in response to variations in air pressures (sound waves)
- The tympanic membrane and its attached ossicles act as a **TRANSDUCER**, changing one form of energy into another form.
- The greater part of its circumference is thickened, forming a **fibrocartilaginous ring, fixed in the tympanic sulcus**

Tympanic Membrane

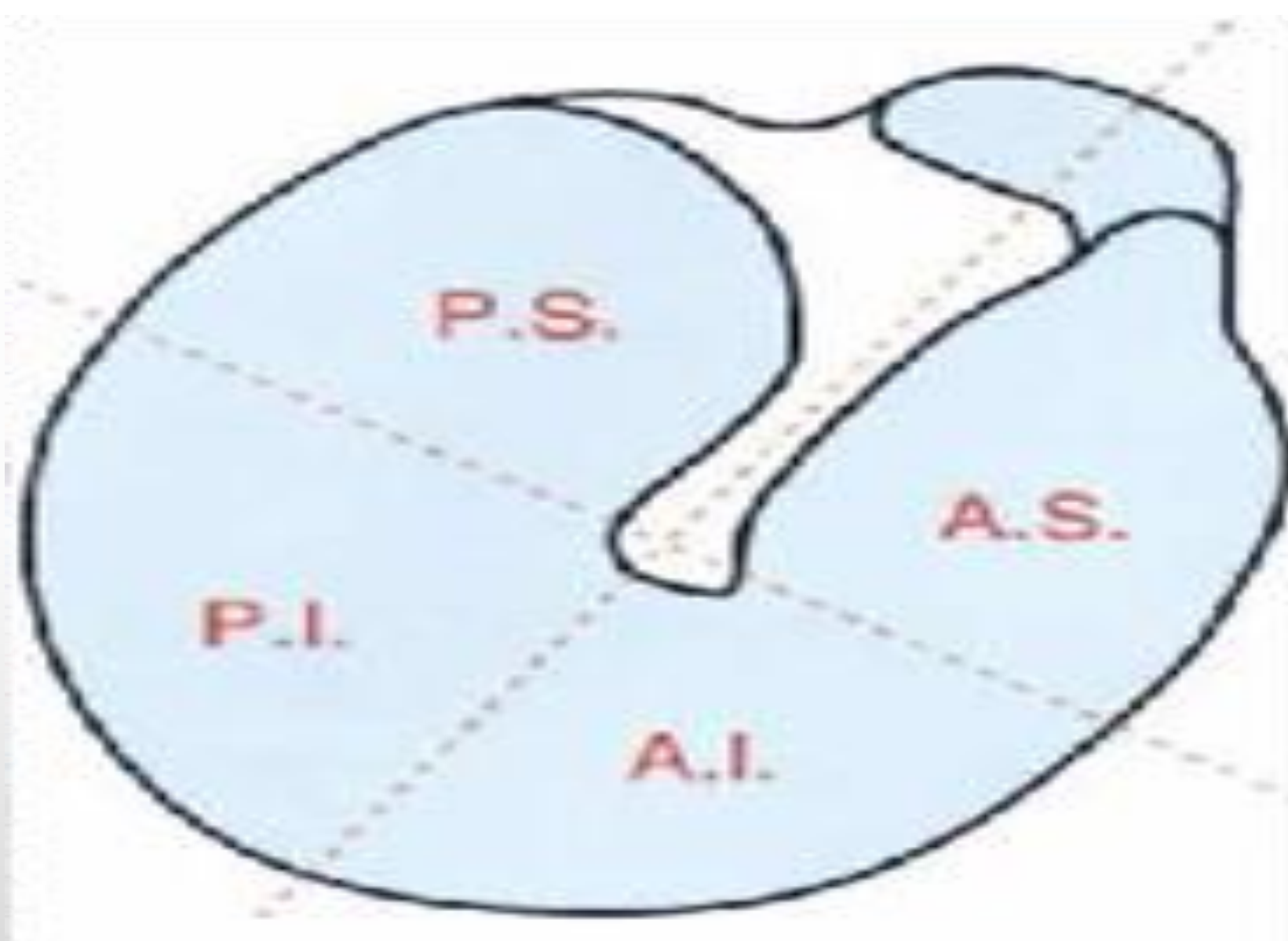


The Tympanic Membrane

- TM sits in a bony sulcus at the inner end of the meatus: *Sulcus Tympanicus*
- It is deficient above: Notch of Rivinus
- From the ends of this notch, the **anterior** and **posterior malleolar folds**, are prolonged to the lateral process of the malleus
- The tympanic membrane has 2 distinct zones.
- **Larger pars tensa**
 - Outer squamous epithelium
 - Middle tough and resilient fibrous layer
 - Inner diaphanous mucosal layer

The Tympanic Membrane

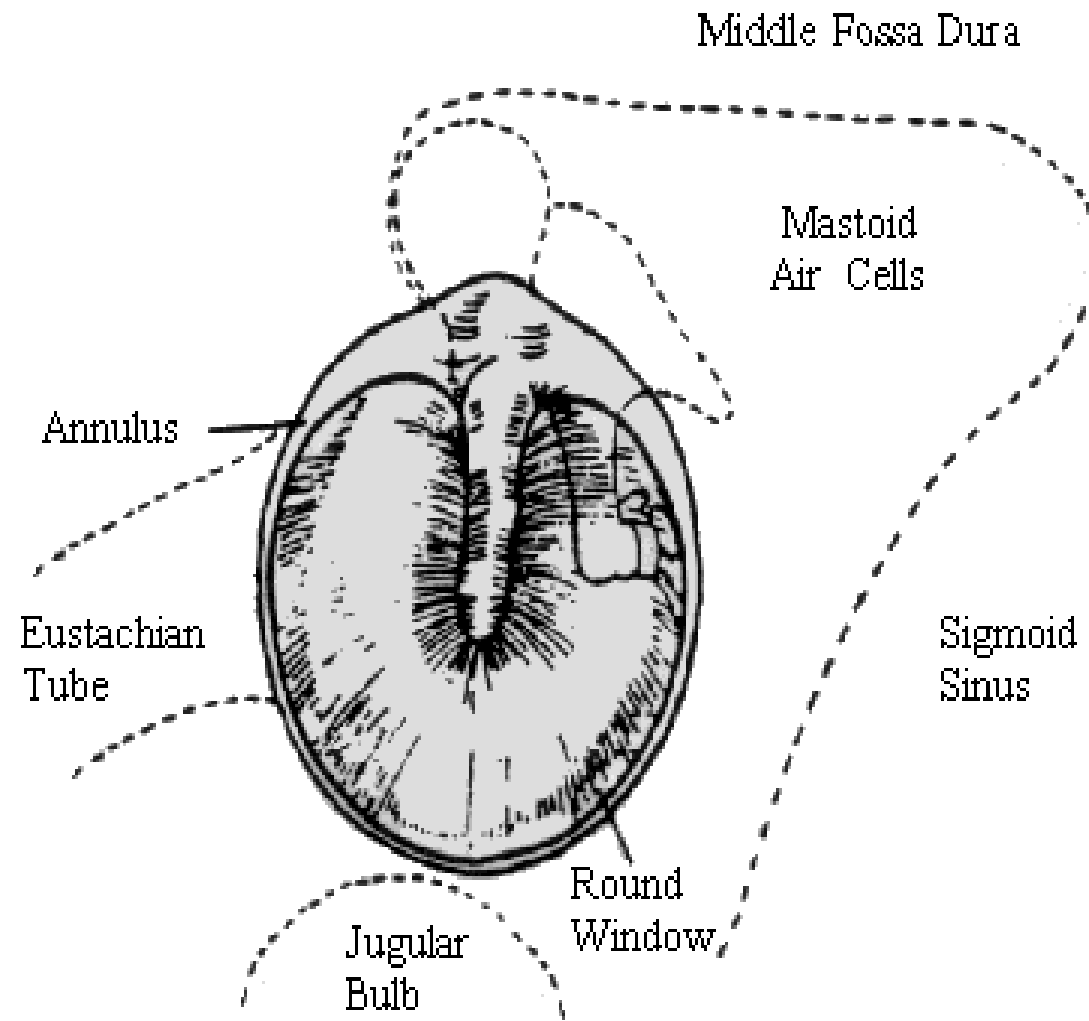
- The malleus is invested by the fibrous layer of the tympanic membrane, the lateral surface of the membrane is thus concave
- the most depressed part of this concavity is named the **umbo**.
- The fibrous layer thickens laterally to form the annulus, an incomplete ring which is attached to surrounding bone (so it is tense)
- Superior to the lateral process of the malleus, this ring is deficient, and this area is known as the pars flaccida (so p.f is flaccid)
- The fibrous layer has two types of fibers: circular and radial (merges with annulus)



The Tympanic Membrane

- Smaller pars flaccida,
 - lies superior to the suspensory ligaments of the malleus
 - lacks a fibrous layer.
 - Perforations here are more frequently associated with complications.
- The drum lies at an angle (55) to the floor of the ear canal, creating a vestibule, which can retain cerumen or debris and top of drum is closer to the outside than the bottom

Relations of the TM



- Medial - the middle ear.
- Lateral or exterior - the ear canal.
- Above – MCF
- Below – jugular bulb
- Ant – TM Joint
- Post - mastoid

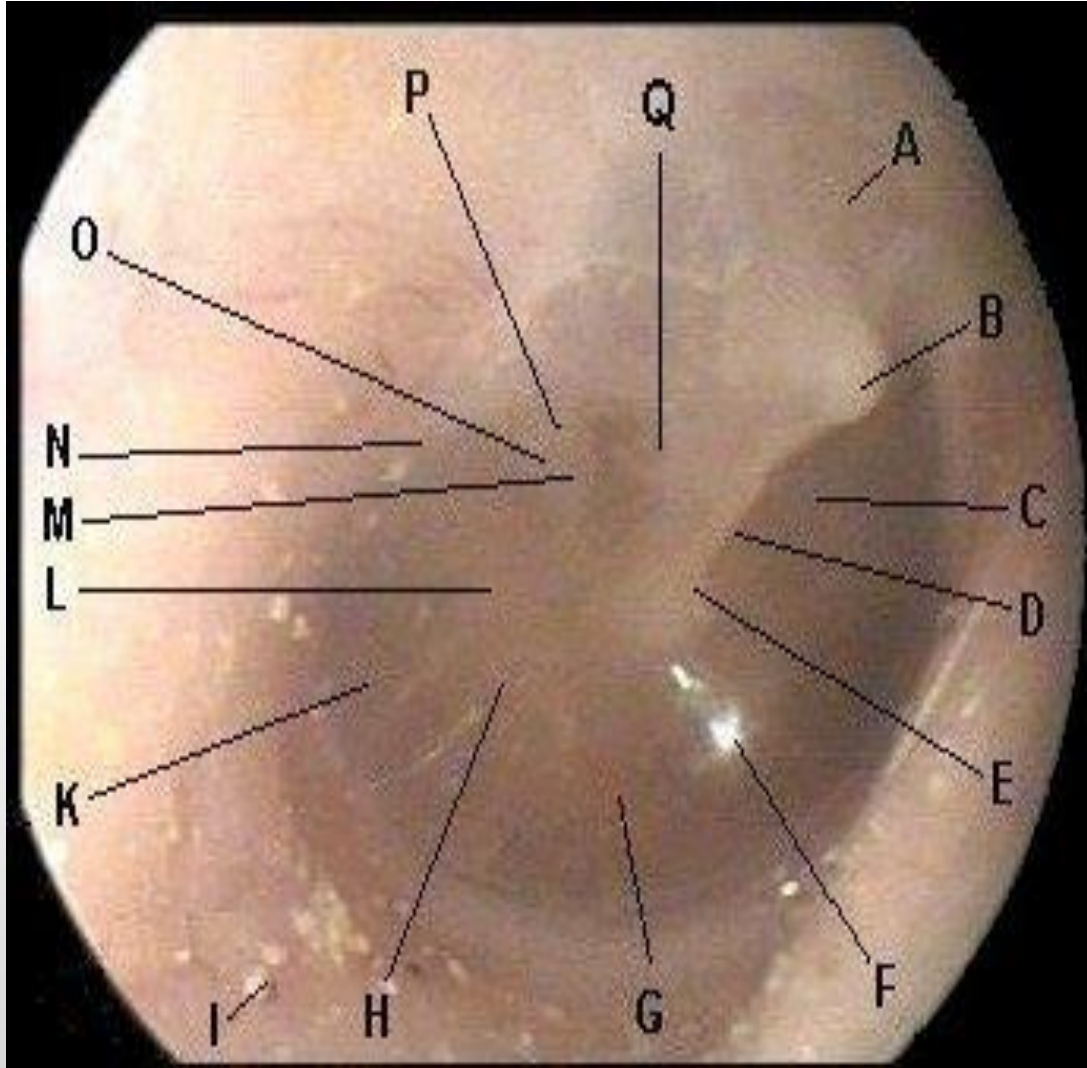
Blood supply

- Blood supply: Branches from the **external carotid artery**.
 - The deep auricular branch of the internal maxillary
 - The stylomastoid branch of the posterior auricular, and tympanic branch of the internal maxillary, distributed on the mucous surface.
- Venous drainage
 - The superficial **veins** open into the **external jugular**
 - The deep surface drain partly into the transverse sinus and veins of the dura mater, and partly into a plexus on the auditory tube

Nerve Supply

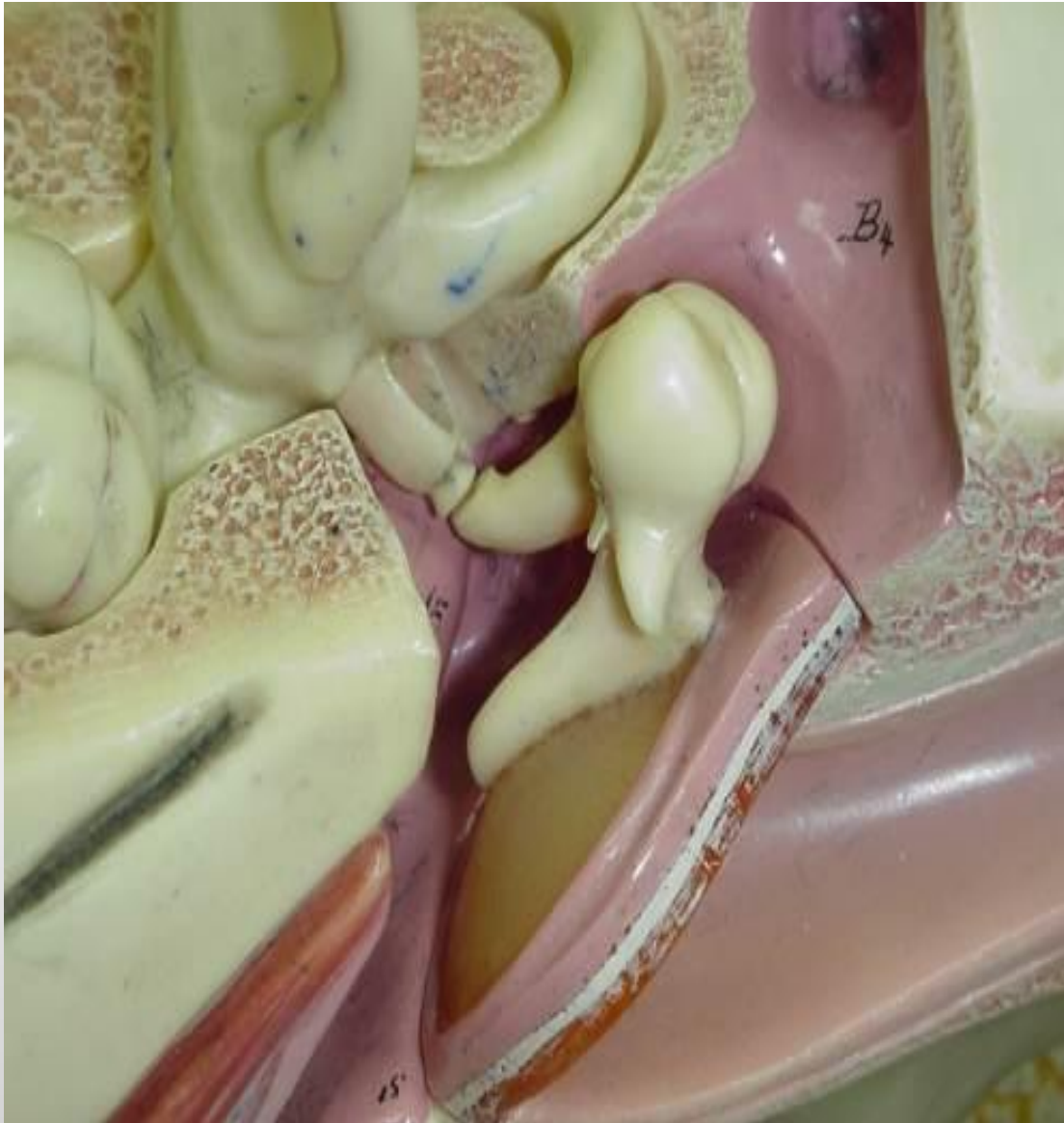
- Sensory only
- The inner surface: **Jacobson's** branch of the glossopharyngeal nerve
- The anterior ½ of the lateral surface: The **auriculotemporal nerve** branch of the mandibular
- The posterior ½ of the lateral surface: **Arnold's branch of the vagus nerve**

RECAP: Anatomy of the TM



- A – pars flaccida
- B – short process of malleus
- C – pars tensa
- D – manubrium of malleus
- E - umbo
- F – cone of light
- G – pars tensa
- H - promontory
- I - sand
- K – round window niche
- L – pars tensa
- M – incus (lenticular process)
- N - chorda
- O – IS joint
- P – incus (long process)
- Q – pars tensa

Middle Ear



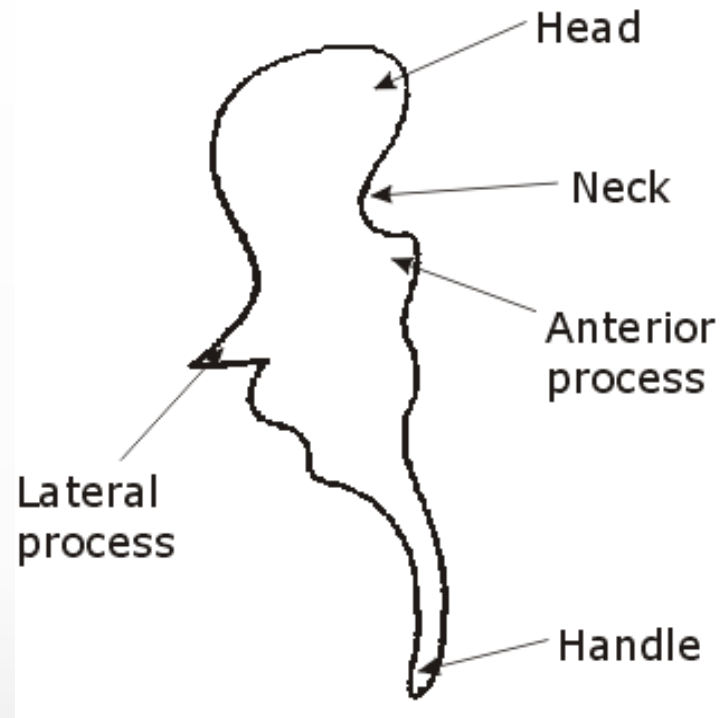
- **Tympanic Cavity**

- In **petrous portion of temporal bone**.
- Narrow and oblique
- between external ear & inner ear
- Tympanic cavity is directly internal to tympanic membrane.
- Epitympanic recess is space superior to tympanic membrane.

Tympanic Cavity

- Lined by mucous membrane : ciliated columnar epithelium except its postero-superior part that has flattened squamous epithelium.
- Contains:
 - 3 bones: malleus, incus, and stapes
 - 2 muscles: tensor tympani, and stapedius
 - 2 nerves: chorda tympani, and tympanic plexus

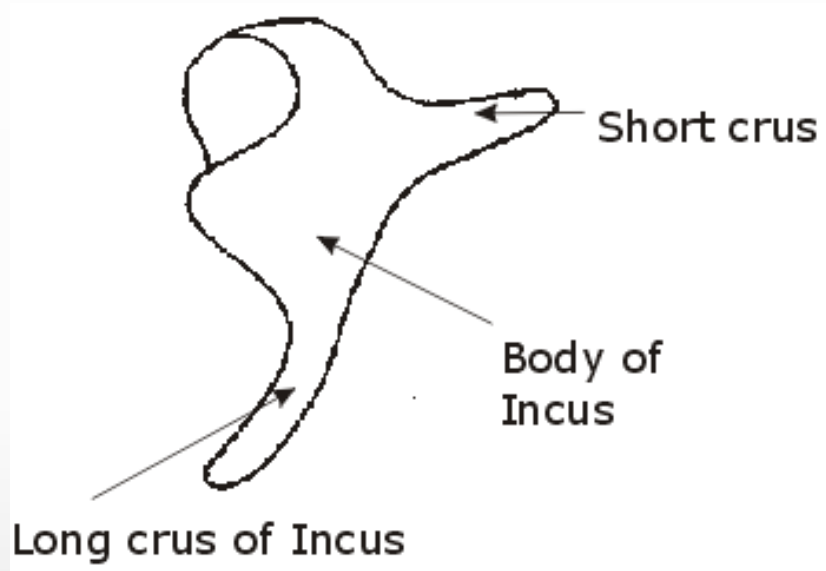
Ossicles - Malleus



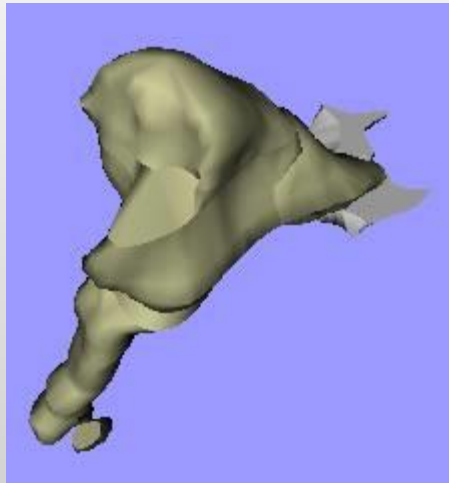
- Head lies in epitympanic recess.
- Articulates with incus
- Handle attached to TM.
- Chorda tympani nerve crosses medial surface of neck.



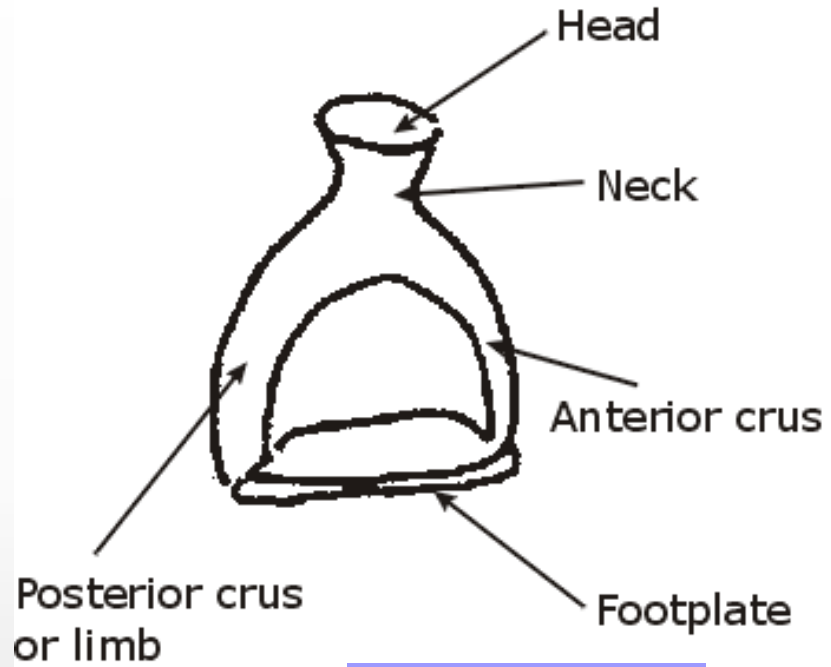
Incus



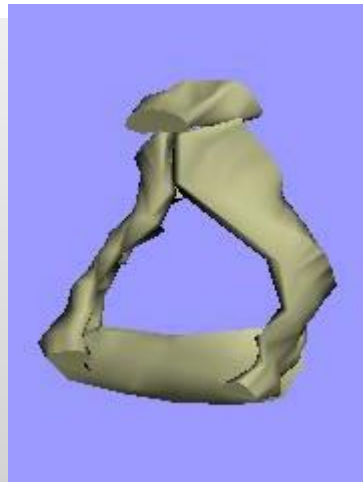
- Lies in epitympanic recess.
- Head articulates with head of malleus.
- Long process articulates with stapes.
- Short process connected by ligament to posterior wall.



Stapes

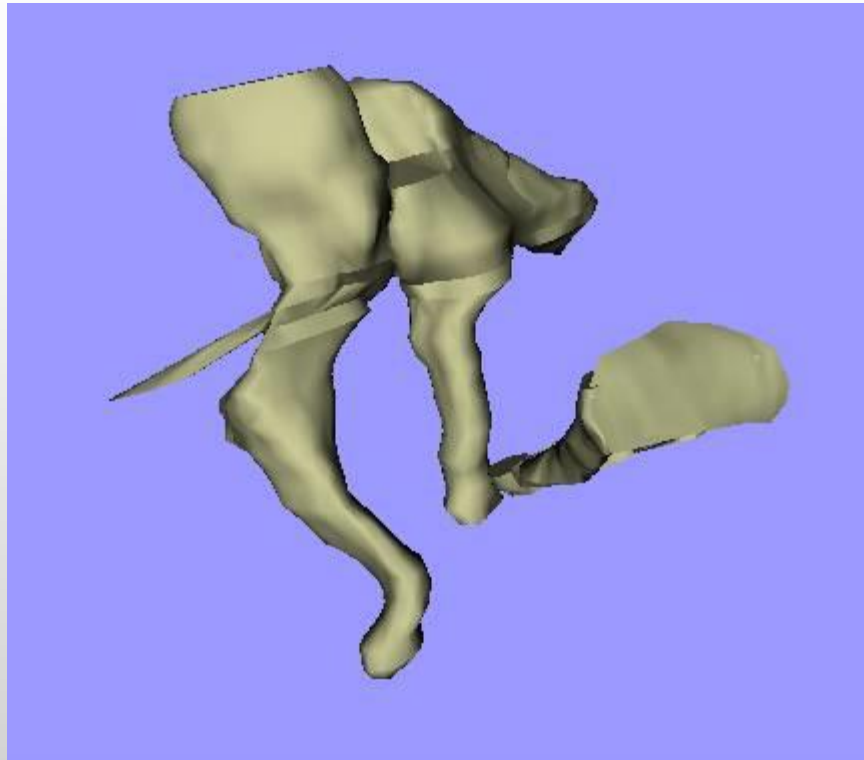


- Base fits into fenestra vestibuli (oval window).
- Head articulates with incus.



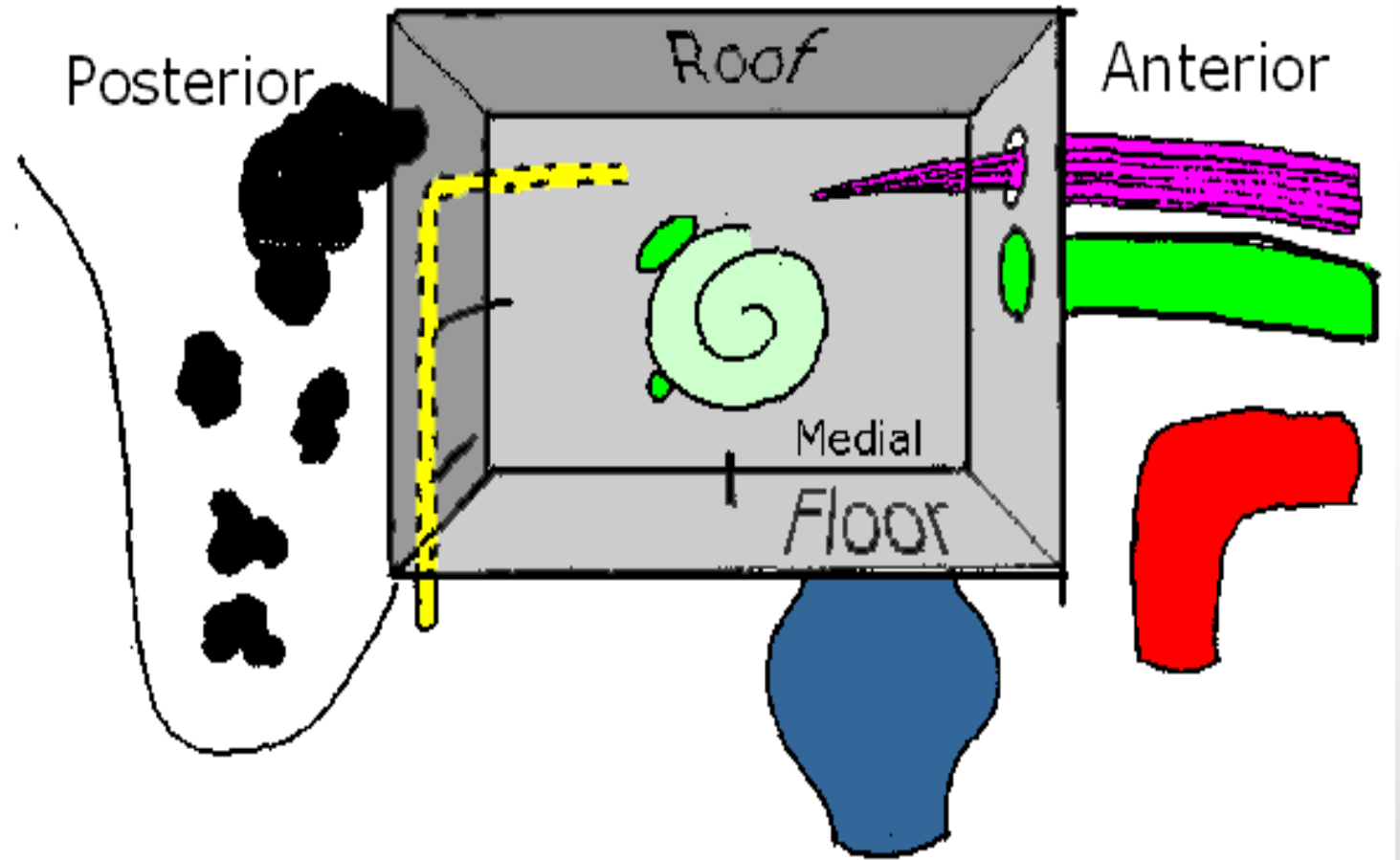
Articulation of the ossicles

- These bones form a chain across the tympanic cavity from the TM to fenestra vestibuli (oval window).
- Covered by mucous membrane that also lines the tympanic cavity.
- Transmits vibration movements of the TM to the inner ear.
- Functions to increase the force but decrease the amplitude.



Schematic view of the middle-ear (tympanic) cavity

- The TM (lateral wall) is removed to see the interior of ME
- RED: Internal carotid
- BLUE: Internal jugular vein
- PURPLE: Tensor tympani
- YELLOW: Facial nerve(VII) with nerve to stapedius & chorda tympani
- LIGHT GREEN: Cochlea
- DARK GREEN: Auditory tube, oval and round windows



Spaces

- Middle ear cleft is wider than the tympanic membrane, and is divided into spaces in reference to the annulus.
- Epitympanum –
 - superior to the tympanic membrane
 - Contains the body of the incus and the head of the malleus. Communicates with the mastoid via the aditus.

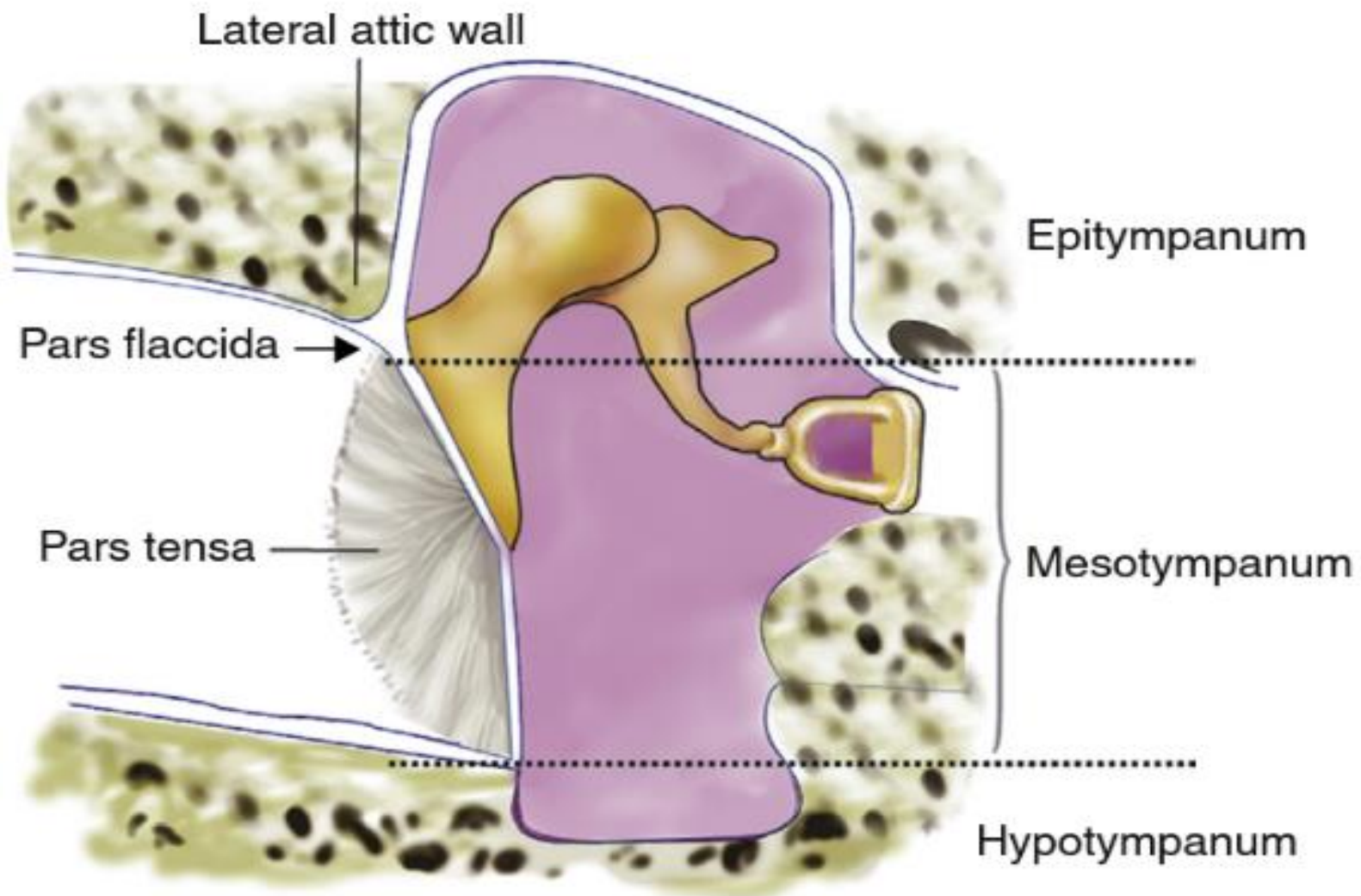


Figure 1.8 Divisions of middle ear into epi-, meso- and hypotympanum.

Prussak's space

- Also called **superior recess of tympanic membrane**. It lies between neck of malleus (internally) and pars flaccida (externally). It is bounded above by fibres of lateral malleolar fold and below by **lateral process of Malleus**
- Importance of this space: It is **most common site of cholesteatoma**. The cholesteatoma may extend to posterior mesotympanum under lateral incudal fold and infection here does not drain easily and causes attic pathology.

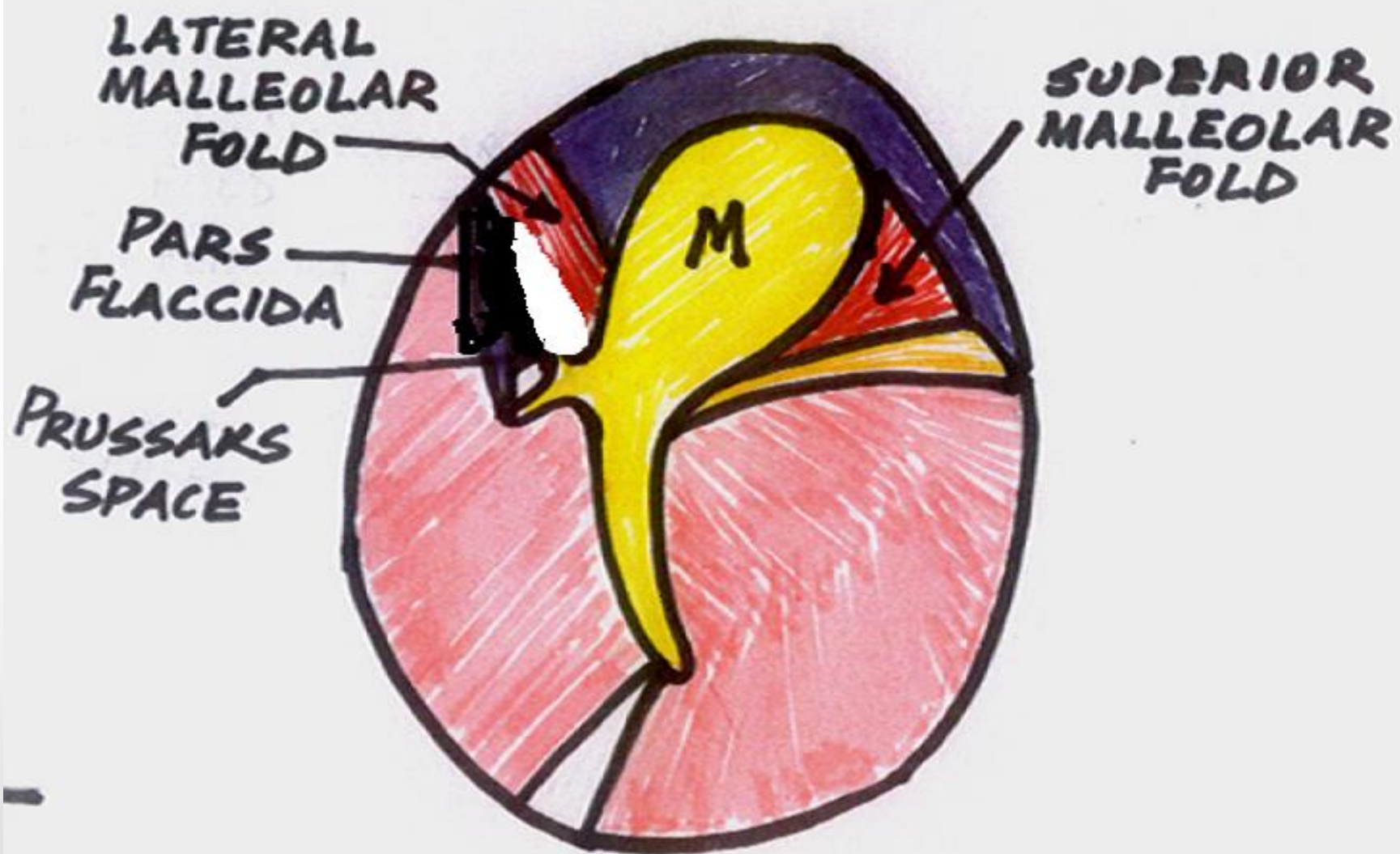


Fig 1.14a; Showing Boundaries of Prussaks Space

Mesotympanum

- On a level with the ear drum
- Oval and round windows, located posterosuperiorly on the medial wall, communicate with the inner ear
- The long process of the incus projects into the posterior quadrant to articulate with the stapes
- The facial nerve, usually covered by a bony canal, crosses the posterior superior quadrant superior to the stapes, then courses inferiorly between the middle ear and mastoid air cells.

Other parts of Tympanum

- **Protympanum** – Area of middle ear close to Eustachian Tube. This tube runs in close proximity to the carotid artery.
- **Hypotympanum** - the jugular bulb curves through the hypotympanum. It is usually covered by bone, but may be dehiscant and extend into the middle ear space.

Walls of the middle ear

Medial wall: It separates the middle ear from the inner ear.

Formed mainly by:

- The first **(basal) turn of the bony cochlea** (of the inner ear) It produces a central rounded bulge called the **promontory**.
- Two openings connect the middle ear (functionally) with the inner ear:
- **The oval window:** lies above and behind the promontory. It is closed by the footplate of stapes.
- **The round window:** lies below and behind the promontory. It is closed by the secondary tympanic membrane.
- The **horizontal part of the facial nerve:** runs in a bony canal above the oval window.

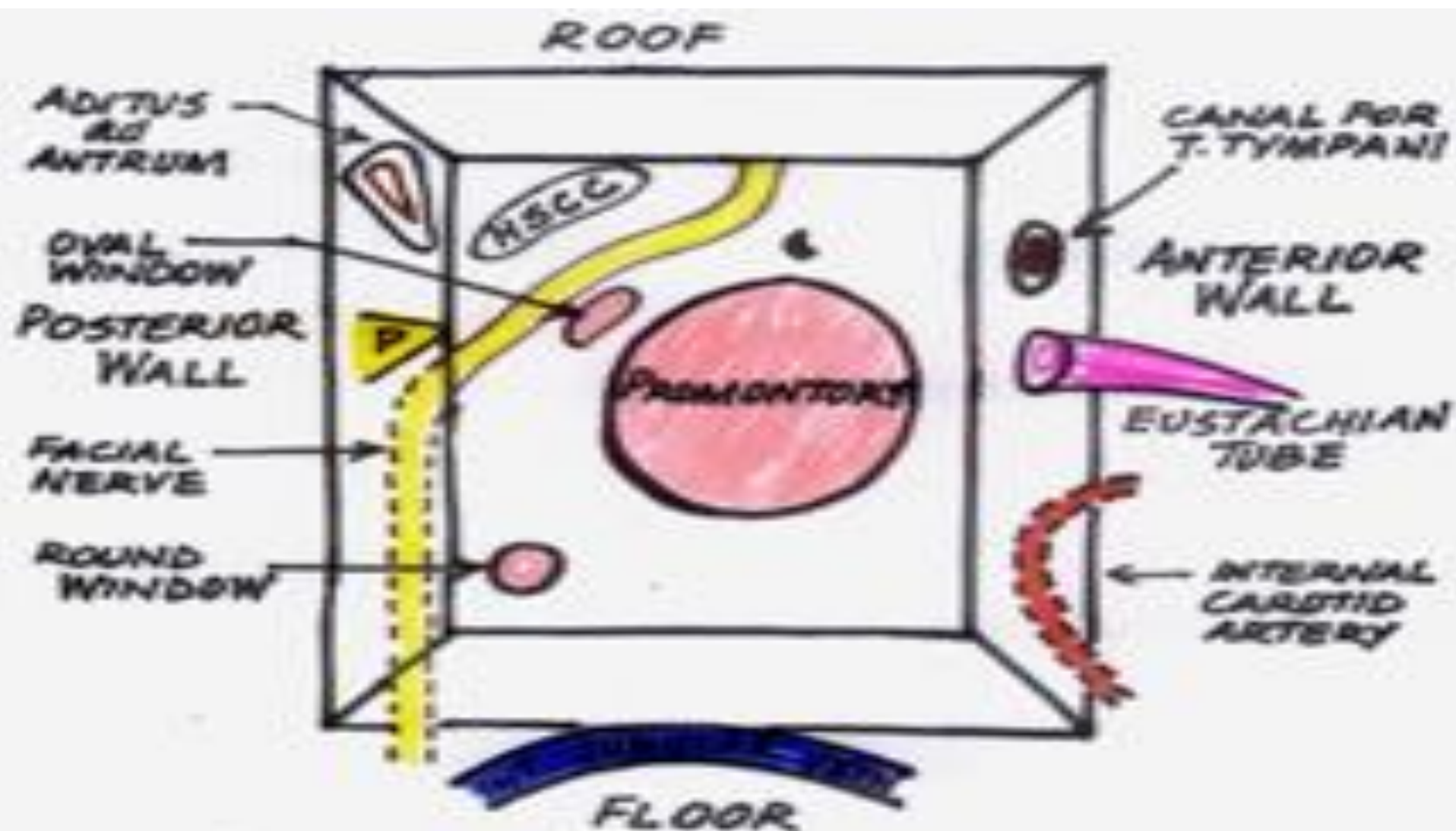
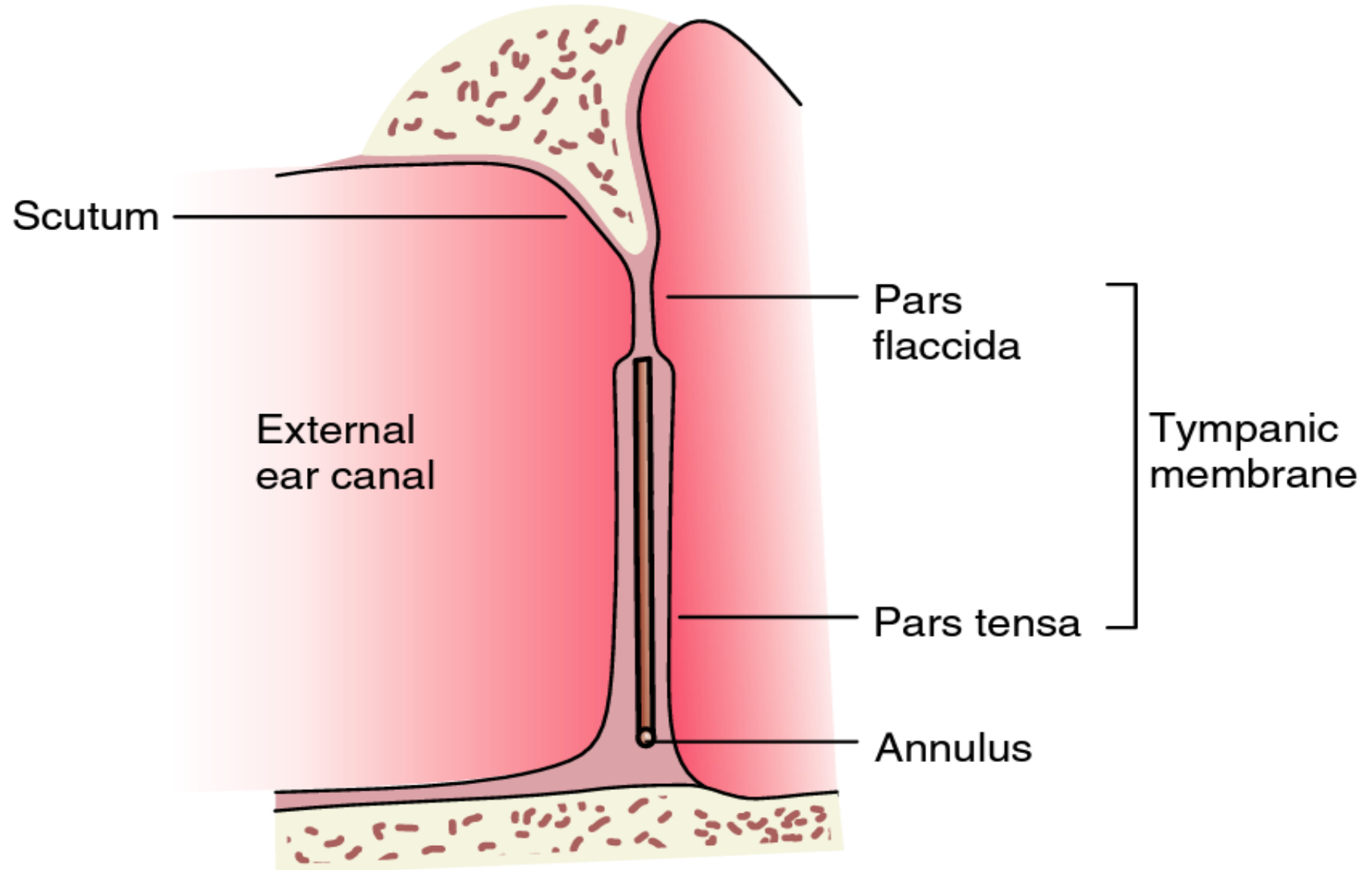


Fig 1.4a. Showing Walls of Middle Ear Cavity

Lateral Wall



Walls of the middle ear

- Superior wall
 - Separates the middle ear from the **middle cranial fossa** and temporal lobe of the brain.
 - It is a thin bony plate called the ***tegmen tympani***.
- Inferior wall
 - A thin bony plate separates the middle ear from the **bulb of internal jugular vein**.
 - Has a small aperture for the passage of the tympanic branch of the glossopharyngeal nerve

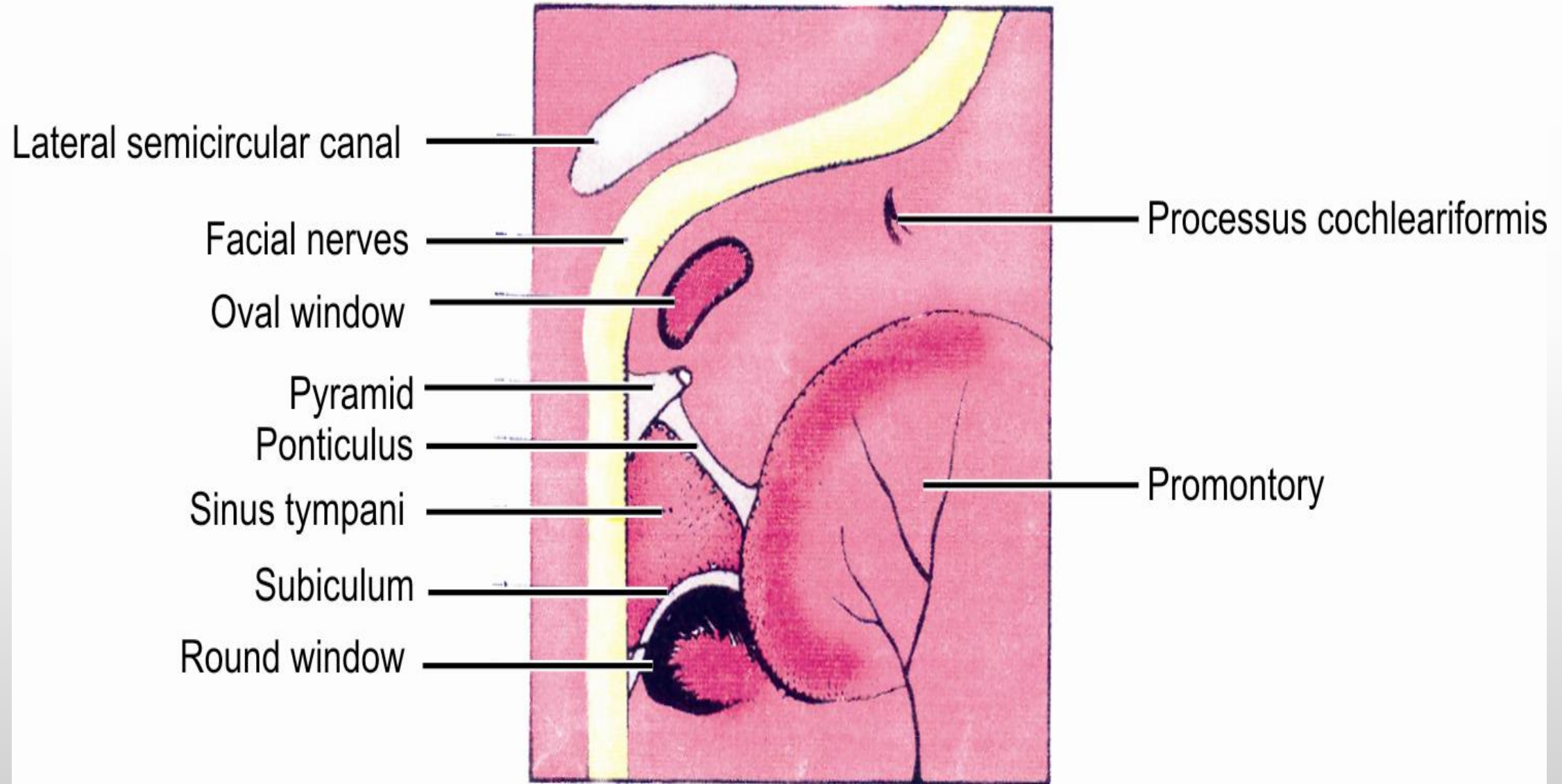
Walls of the middle ear

- Anterior wall
 - separates the middle ear from the internal carotid artery.
 - It has
 - Opening for the Eustachian tube
 - Canal for chorda tympani
 - Canal for tensor tympani muscle
 - Anterior malleolar ligament
 - Anterior tympanic artery

Walls of the middle ear

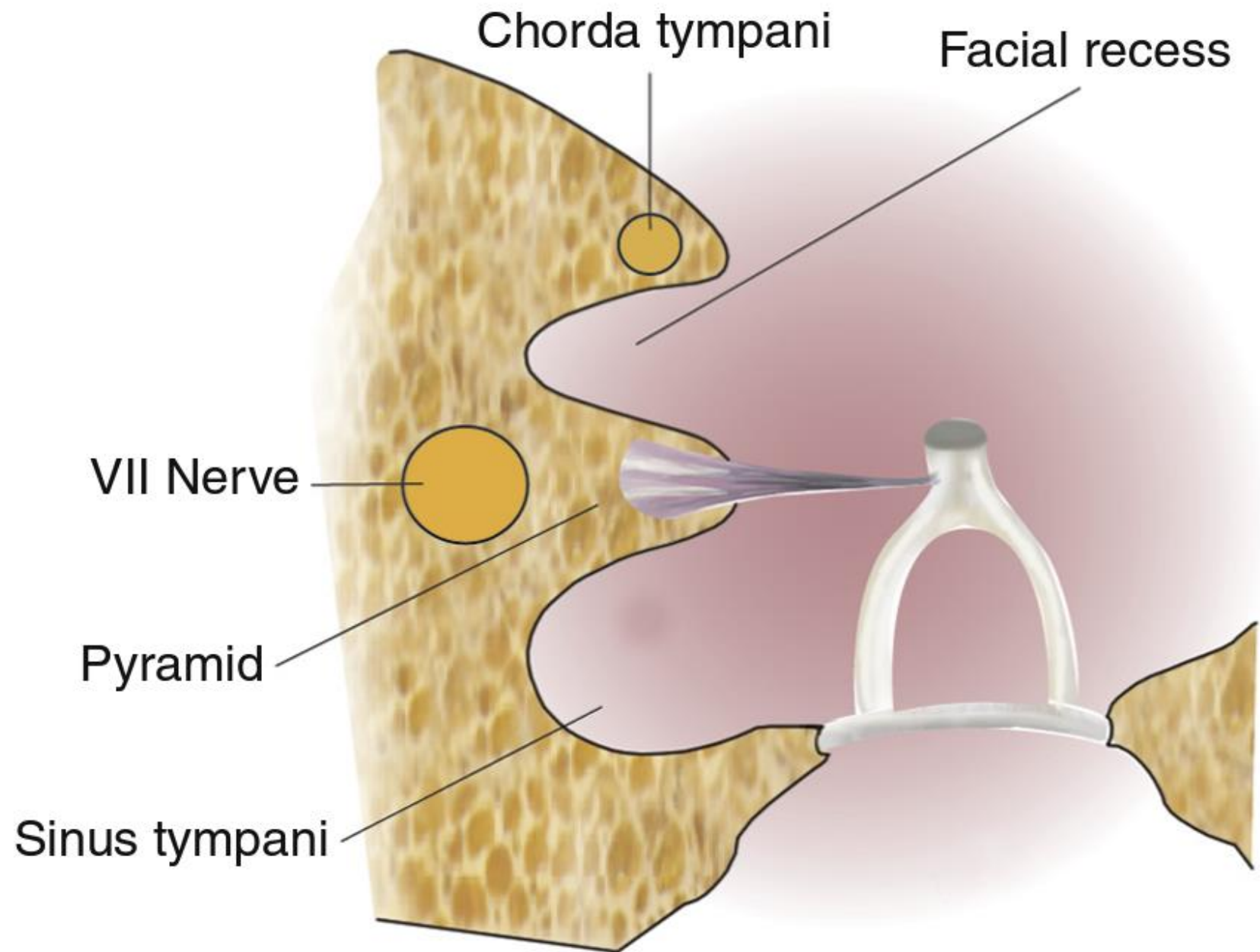
- Posterior wall
 - Separates the middle ear from the mastoid process.
 - It has an opening (**the aditus ad antrum**) which connects the epitympanum (attic) with the mastoid antrum.
 - The stapedius muscle enters the middle ear through this wall through a bony ridge (the **pyramid**).
 - The **vertical part of the facial nerve** runs in a bony canal in this wall.
 - **Sinus tympani and Facial recess**

Posterior Wall



*Facial recess

- Also called **Suprapyramidal recess**, is a groove which lies between pyramid and facial nerve and annulus of the tympanic membrane, or a collection of air cells lying lateral to facial nerve.
- The term was coined by House & Sheehy.
- It is bounded:
 - Medially by external genu of **facial nerve**
 - Laterally by **chorda tympani**
 - Superiorly by **fossa incudis**
 - Anterolaterally by tympanic membrane.



Contd----

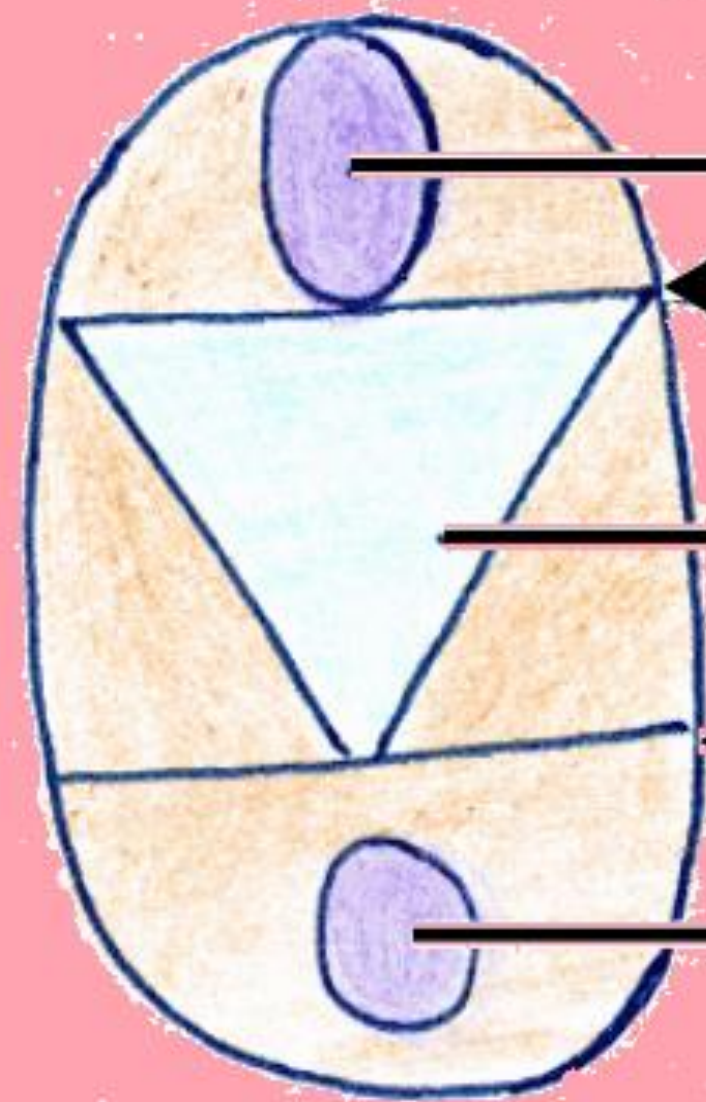
- Facial recess is superficial to sinus tympani & is separated from it by descending part of facial nerve
- Importance of this recess is
 - one can approach the middle ear from behind without disturbing posterior meatal wall.
 - This is one of the hidden areas where cholesteatoma can reoccur after surgery,
 - Ear may continue discharging if this area is not cleared during mastoid surgery

*Sinus Tympani

- Also called **Infrapyramidal recess or medial facial recess.**
- It is a depression behind promontory deep to the pyramid, continuous with the hypotympanum & its position is opposite to ampulla of posterior S.C.C.
- It starts at oval window and occupies a space deep to descending part of the facial nerve and pyramid and passes behind round window niche to hypotympanum.

**Sinus Tympani

- Sinus tympani is the most inaccessible area in the middle ear and mastoid because posterior SCC comes in the way.
- It is also described as a triangular space between **ponticulus** above and **subiculum** below. They are two bony spicules extending from the promontory on to the posterior wall superiorly and inferiorly respectively.
- Sinus tympani is bounded laterally by vertical segment of facial nerve and medially by medial wall of tympanum.



Oval window

Ponticulus

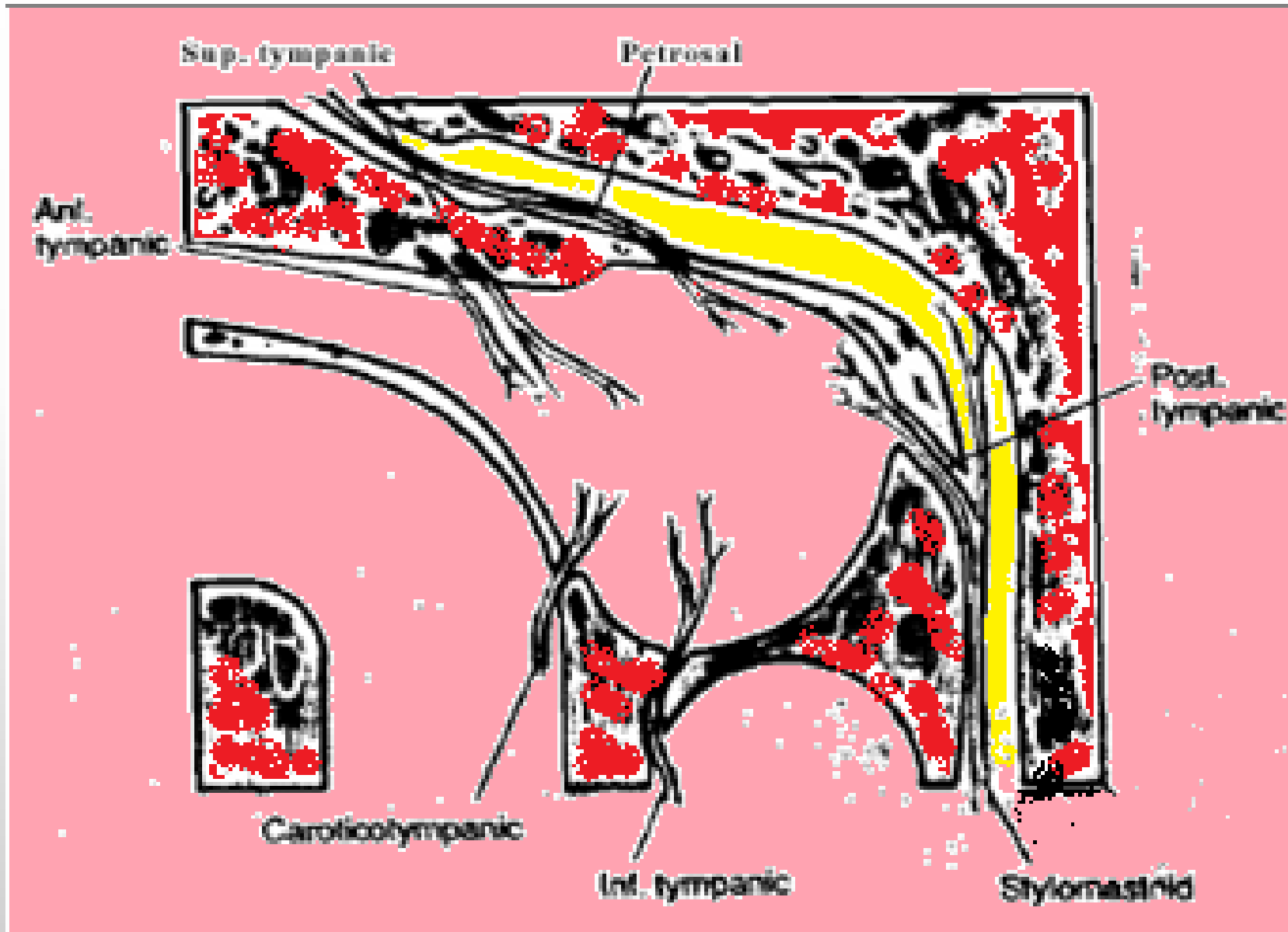
Sinus tympani

Subiculum

Round window

B

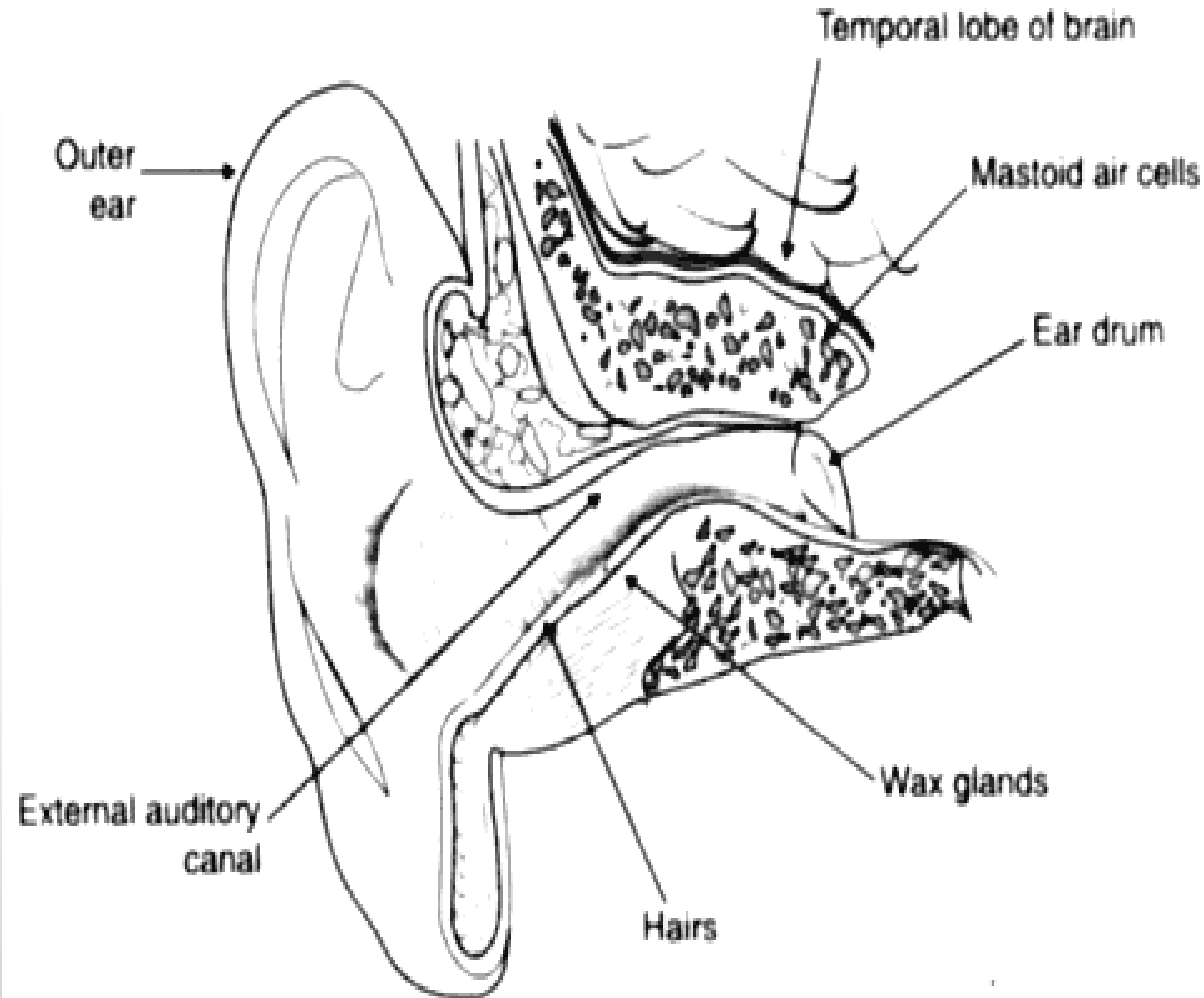
Blood Supply Middle Ear



Mastoid bone

The mastoid air cell system:

- Honeycomb of air cells
- Located behind, above and below the ear
- Cells lined by thin mucous membrane



The Mastoid air cells

- The largest air cell is the mastoid antrum, which lies behind the attic.
- The number and size of the other cells varies according to the degree of cellularity.
 - usually arranged in groups named after the anatomical structure they are near to e.g. *retrofacial, tip, perisinus, periantral, subdural, sinodural and zygomatic* air cells
- The mastoid process is absent in the newborn
 - Forms from traction on the squamous and petrosal parts of the temporal bone by cervical muscles, since the child starts to support his head.
- Functions of the mastoid air cells –
 - Pressure-regulating mechanism of the middle ear cavity
 - In decreasing the weight of the skull bones.

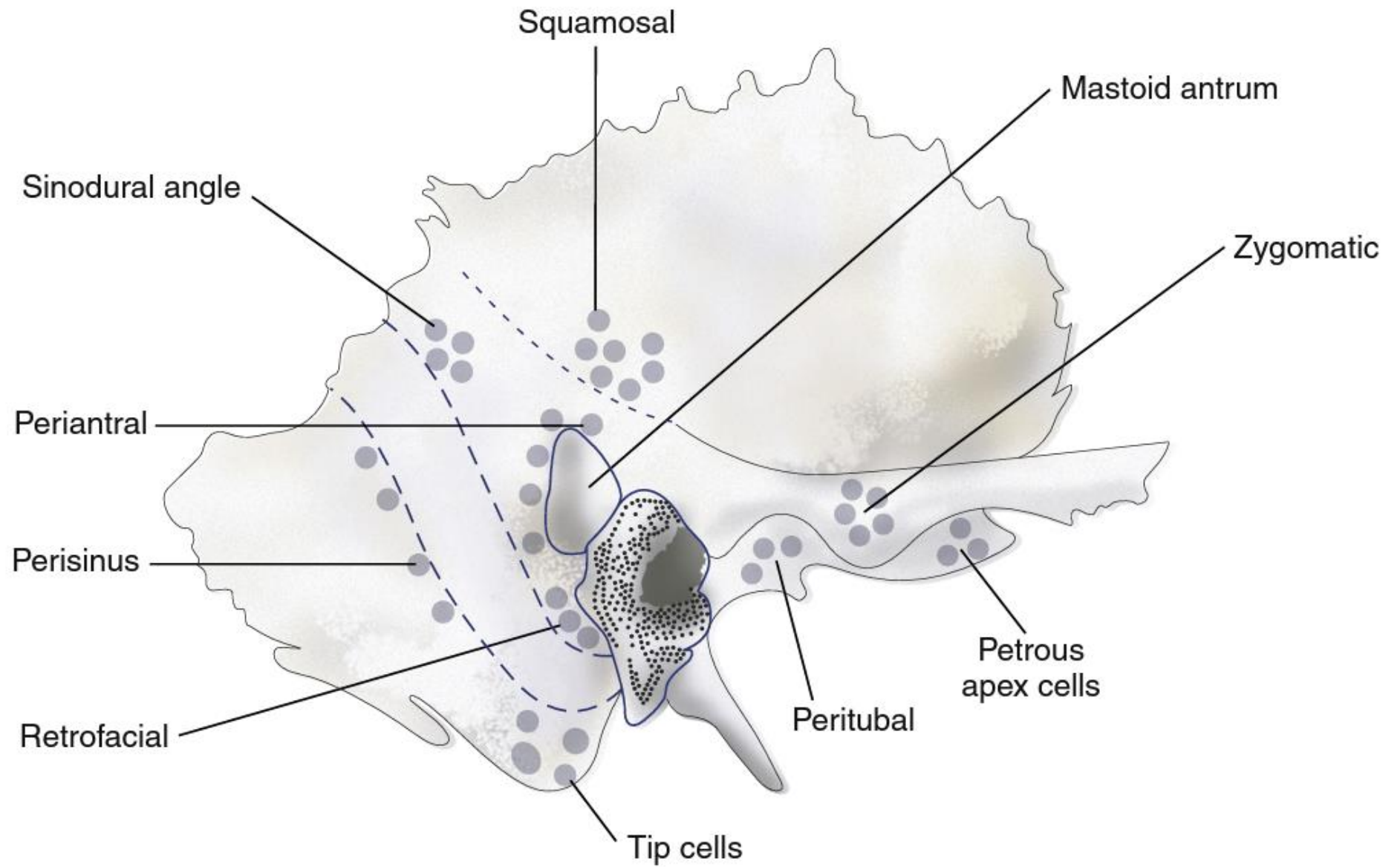
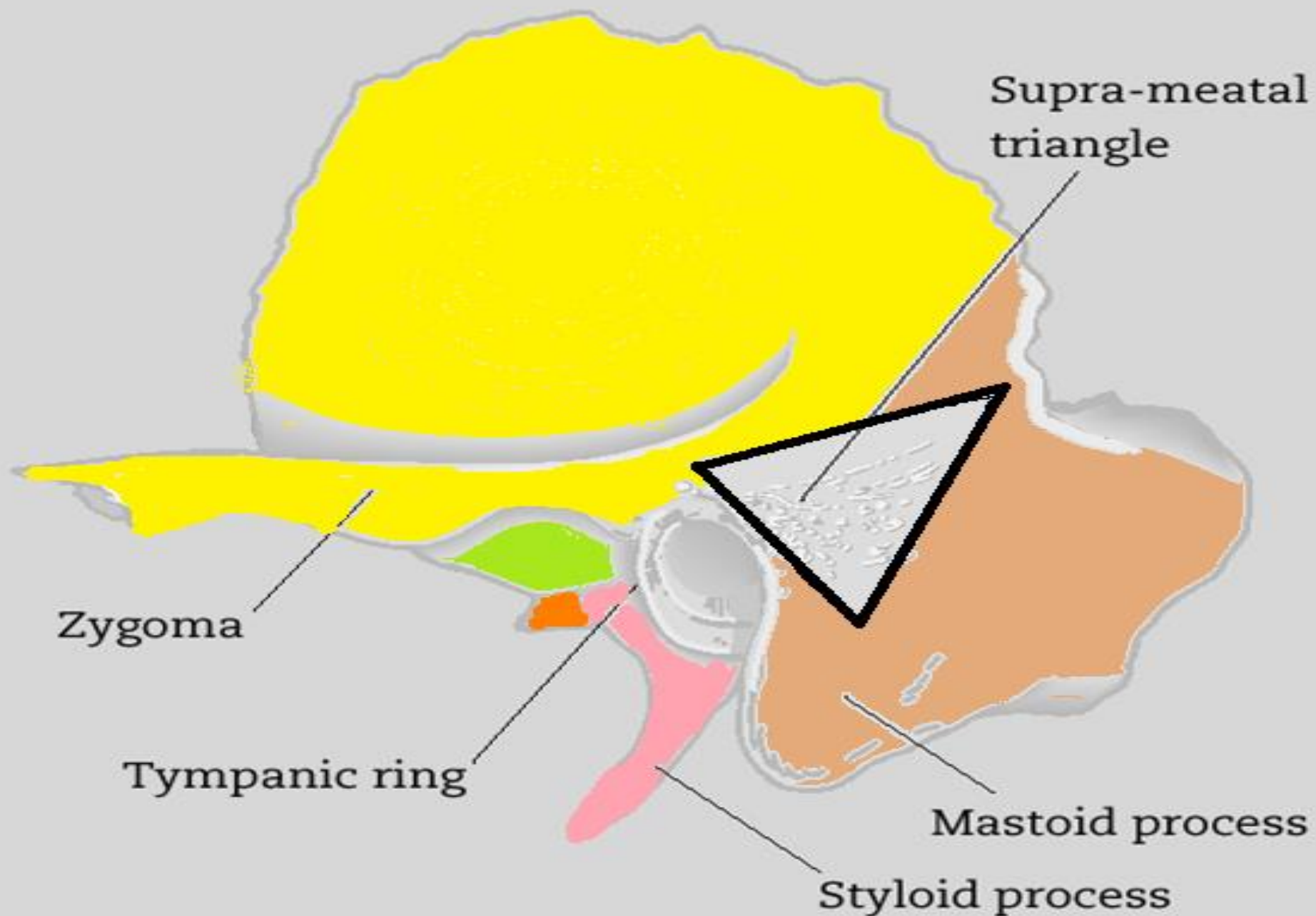
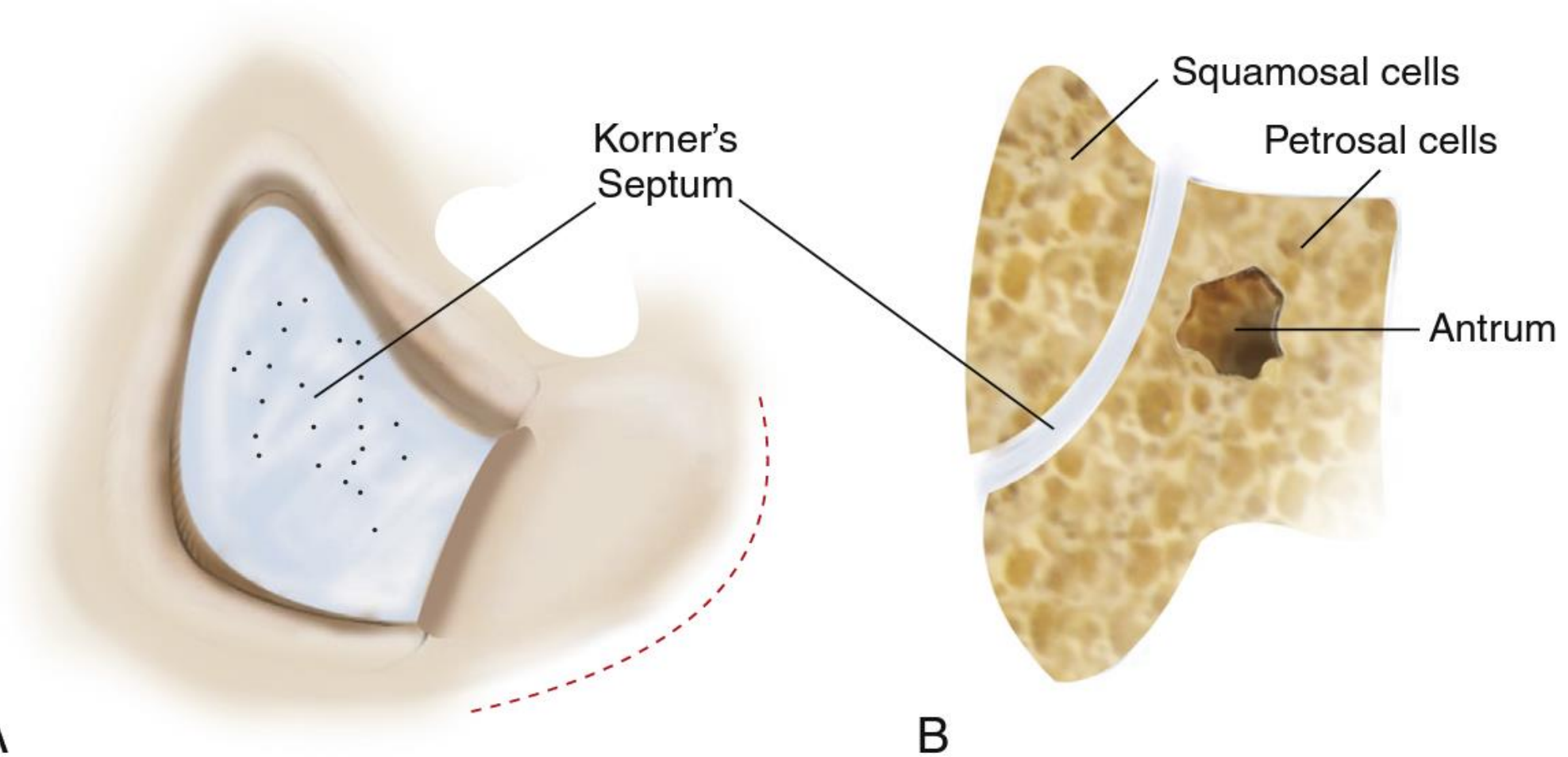


Figure 1.13 Air cells in the temporal bone.

Mastoid bone

- Mac Ewen's (suprameatal) triangle
 - Bony surface marking of the mastoid antrum
 - Boundaries
 - Temporal line of supramastoid crest
 - Postero-superior bony meatal wall
 - Line drawn connecting the above two
- Citelli's angle: sinodural angle
- Korner's septum: petrosquamosal lamina

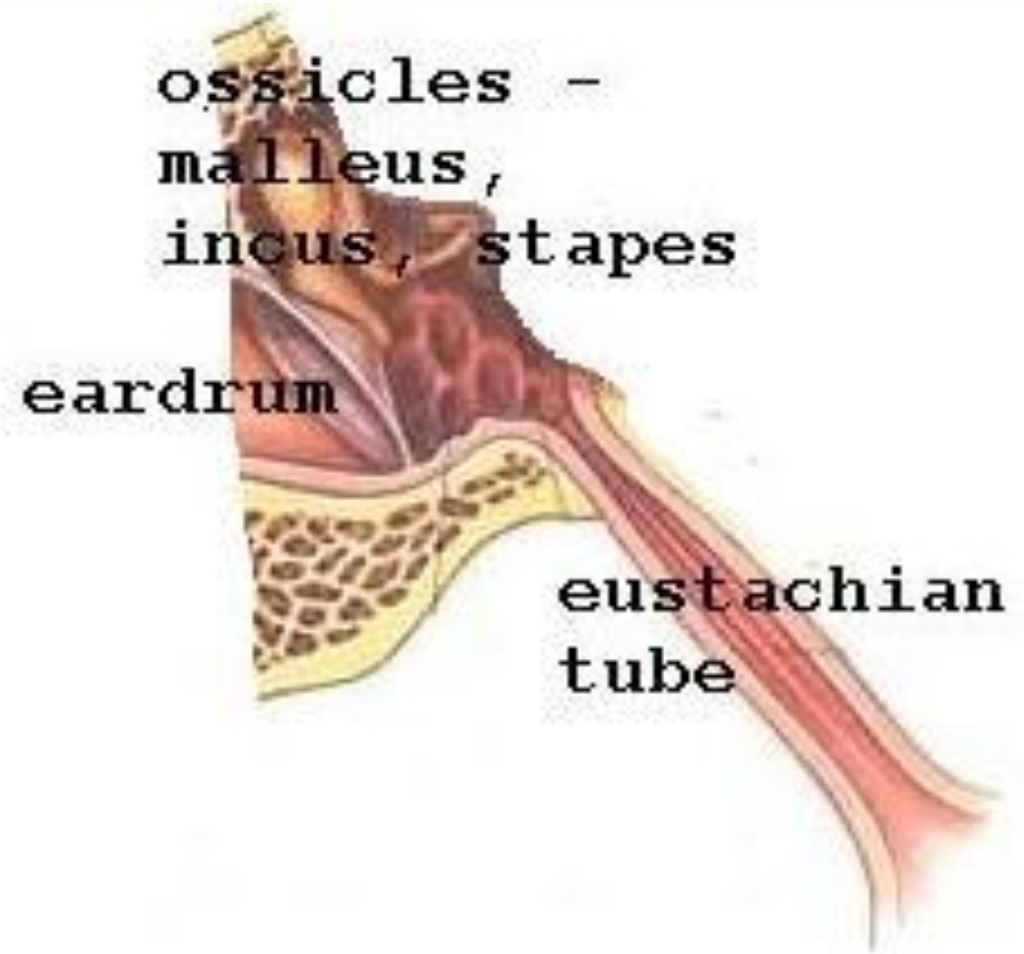




s septum (A) as seen on mastoid exploration, (B) in coronal section of mastoid; in its presence there
deep to it.

Eustachian tube or Pharyngotympanic tube

- Communicates the middle ear cavity with the nasopharynx
- Allows pressure to equalise between the atmosphere and the middle ear
- Allows mucous drainage
- Opens 1.5 cm behind the posterior end of the inferior turbinate



The Eustachian tube

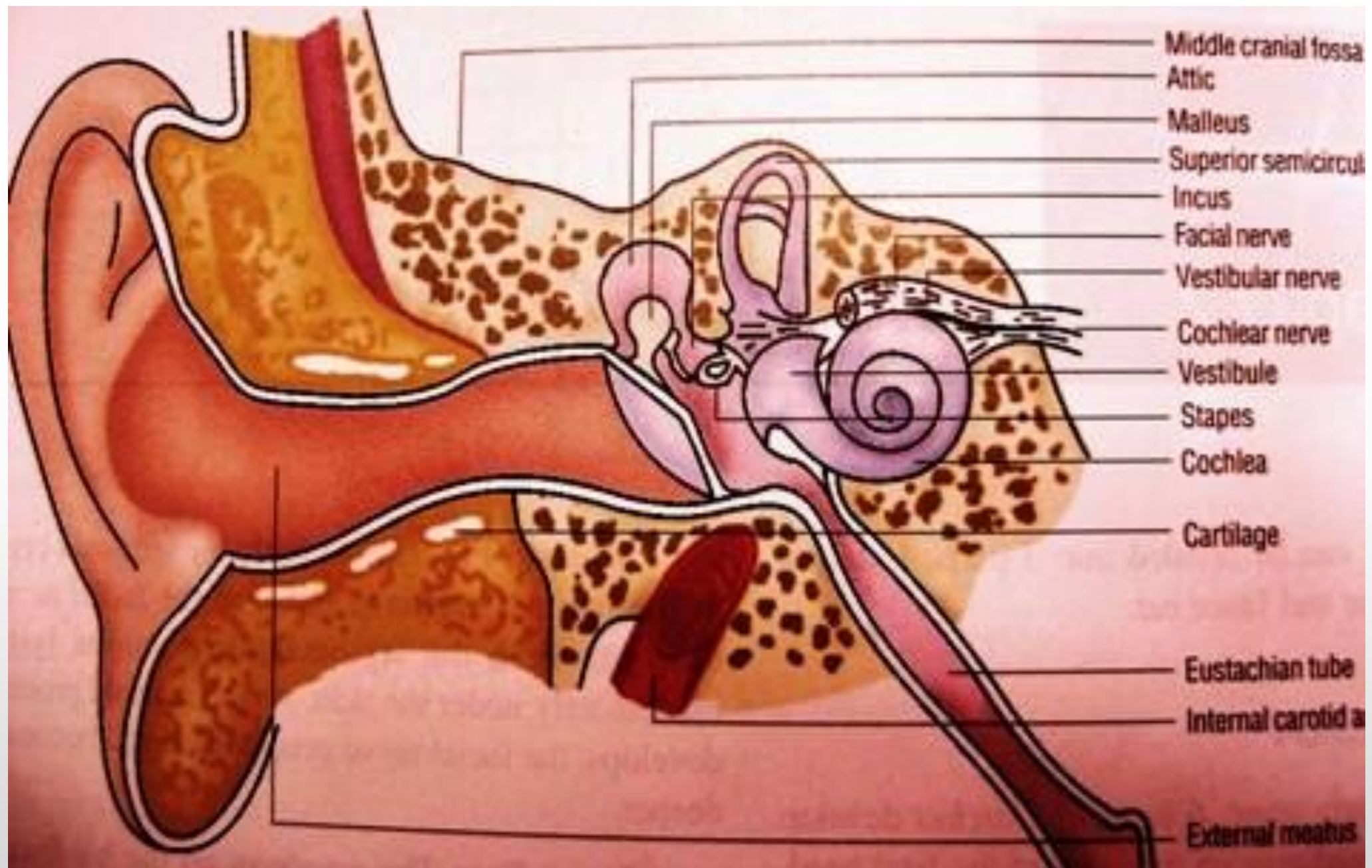
- Length 36 mm, directed medially, forwards and downwards.
- Forming an angle of about 45 degrees with the sagittal plane and 30 to 40 degrees with the horizontal plane
- Tube is shorter, wider, and more horizontal in children
- Lateral third is bony (12mm), while its medial two thirds are cartilaginous (24mm)
- Lined with ***ciliated columnar epithelium***
- The tube is closed at rest
- Opens by contraction of the **tensor veli palatini** muscle during swallowing and yawning to ventilate the middle ear

The Eustachian tube

- The base of the **cartilaginous portion** lies directly under the mucous membrane of the nasal part of the pharynx, and forms an elevation, the **torus tubarius or cushion**, behind the pharyngeal orifice of the tube
- **Fossa of Rosenmuller** lies behind this end. *Commonest site for nasopharyngeal malignancy*
- The diameter of the tube is not uniform throughout
 - greatest at the pharyngeal orifice, least at the junction of the bony and cartilaginous portions
 - again increased toward the tympanic cavity

The Eustachian tube

- The narrowest part of the tube is termed the **isthmus**
- **Blood supply**
 - Ascending pharyngeal artery
 - Artery of pterygoid canal
- **Venous drainage**
 - Pterygoid plexus

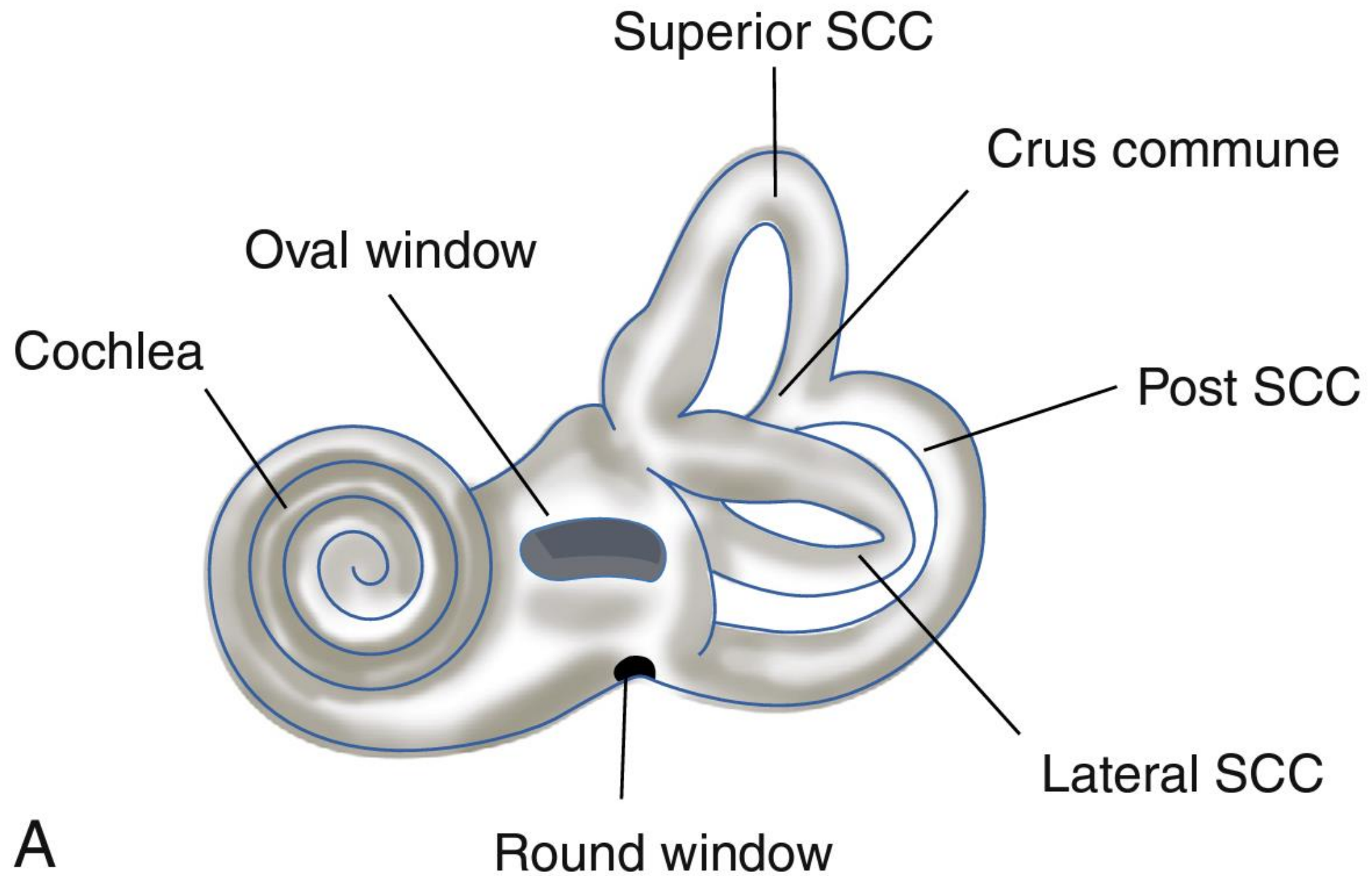


INTERNAL EAR

- It consists of a **bony labyrinth** contained within the petrous temporal bone along with the **membranous labyrinth**.
- **Otic capsule develops from 14 centers.**
- It serves the most important function of **hearing** and **equilibrium**.

Bony Labyrinth

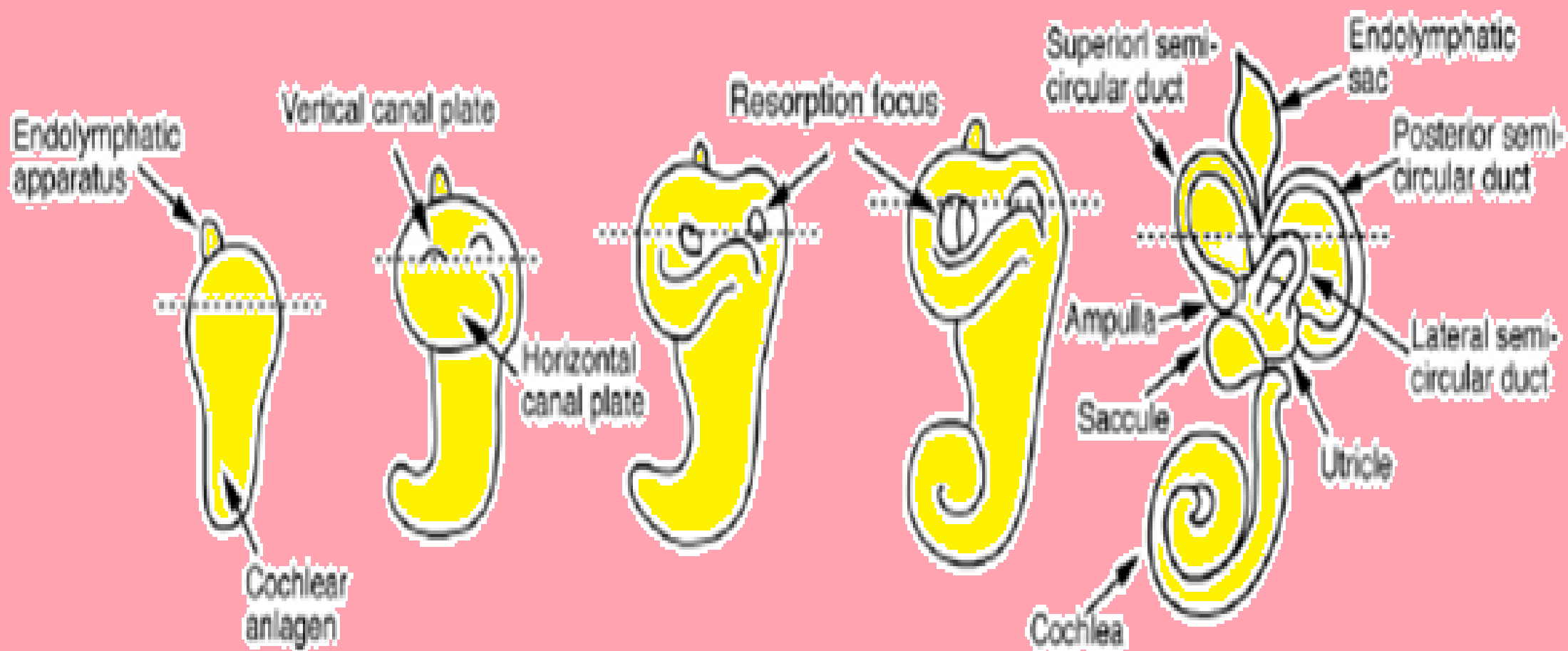
- It consists of:
 - Vestibule
 - Semicircular canals
 - Cochlea.



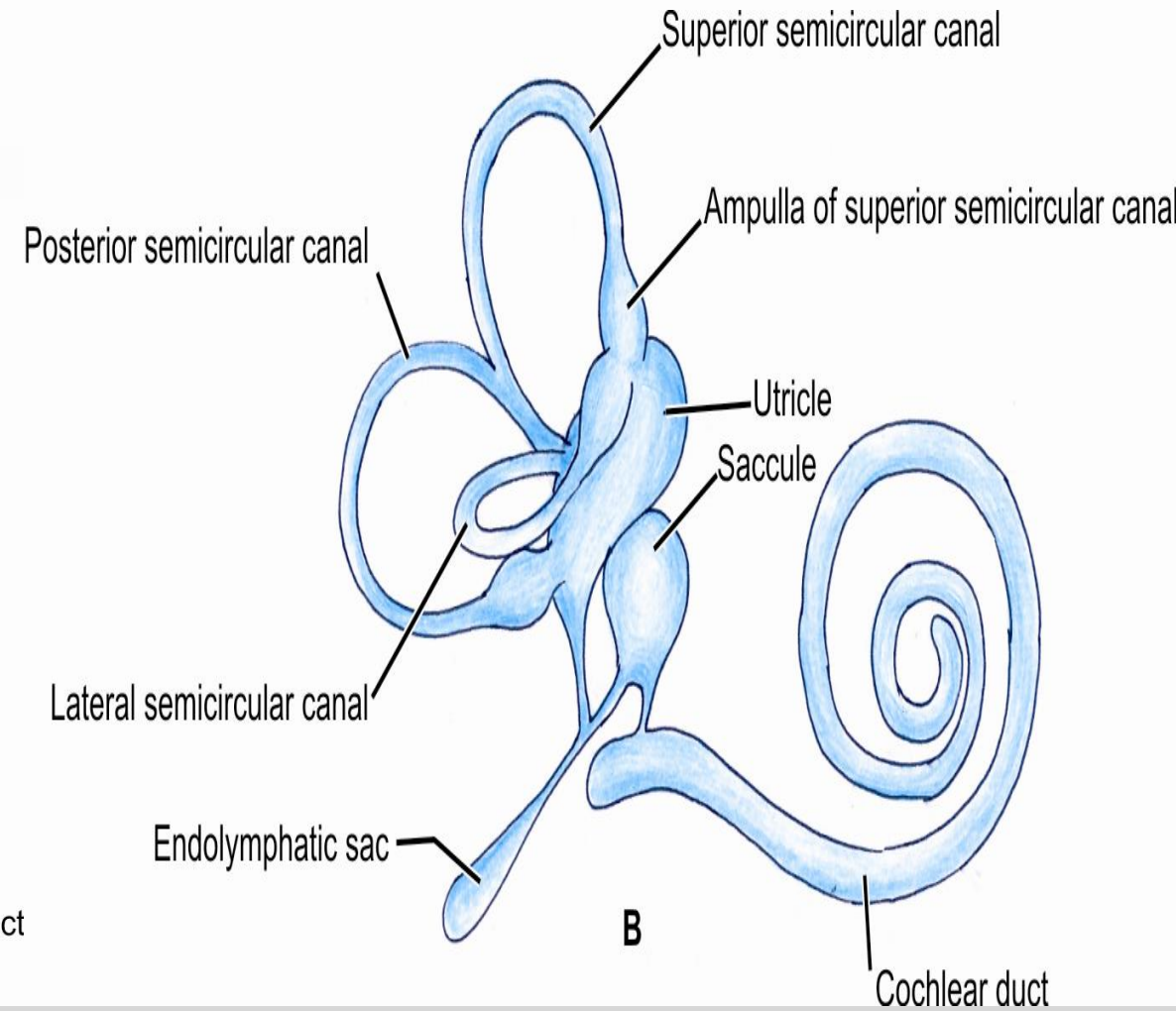
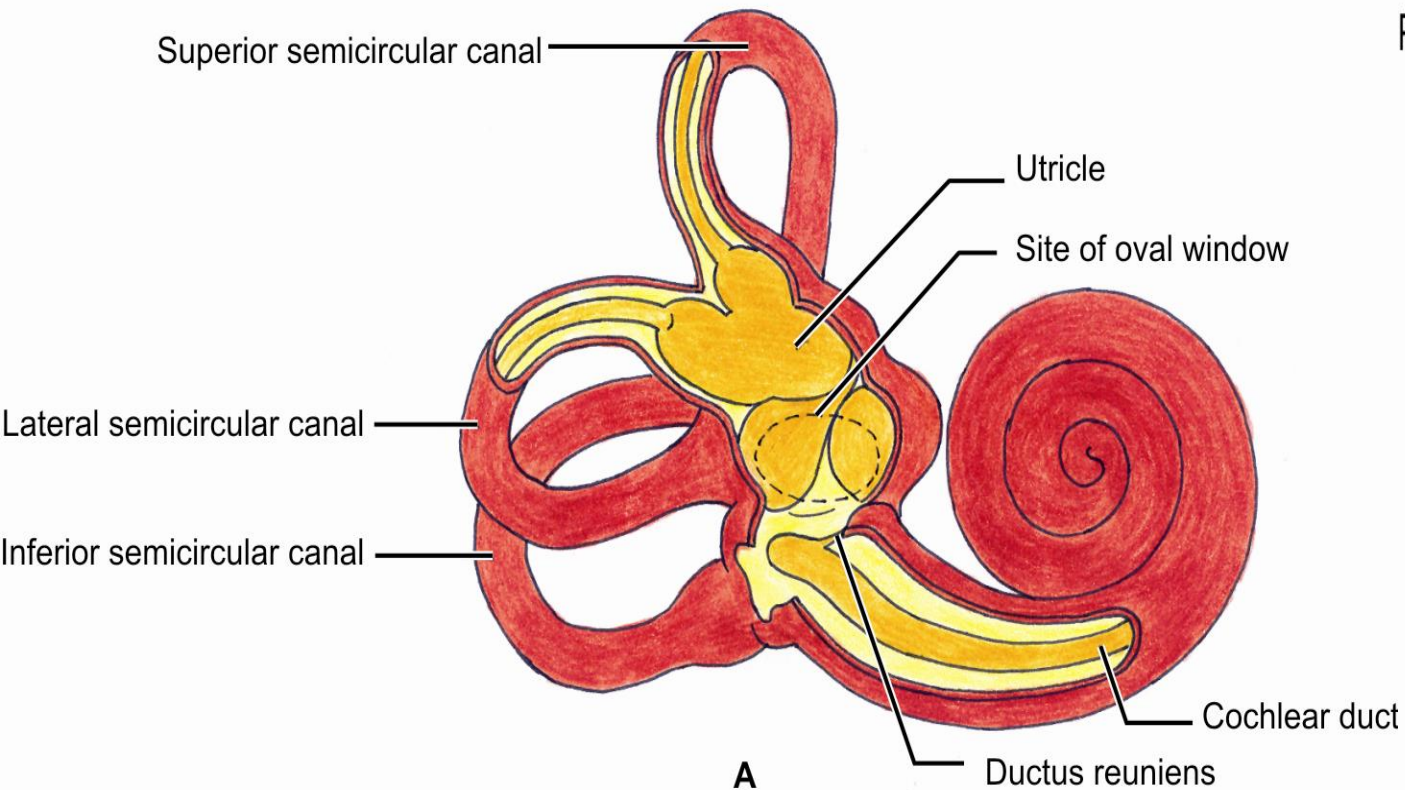
Development of Inner Ear

- Otic placode is an **ectodermal thickening** which invaginates to form **otic pit**, its mouth gets narrowed to form **otocyst** .
- Bony labyrinth develops from **mesoderm** around otocyst.
- Membranous labyrinth develops from **ectoderm** around otocyst in the 3rd week of fetal life and is complete by 16th week of I.U.L.
- Between 6-8 weeks S.C.C & utricle are fully formed. Cochlea is well developed by 20 weeks of gestation.

Labyrinth is the first organ which develops before other organs have yet started forming in the embryo. Vestibular apparatus develops before cochlea.

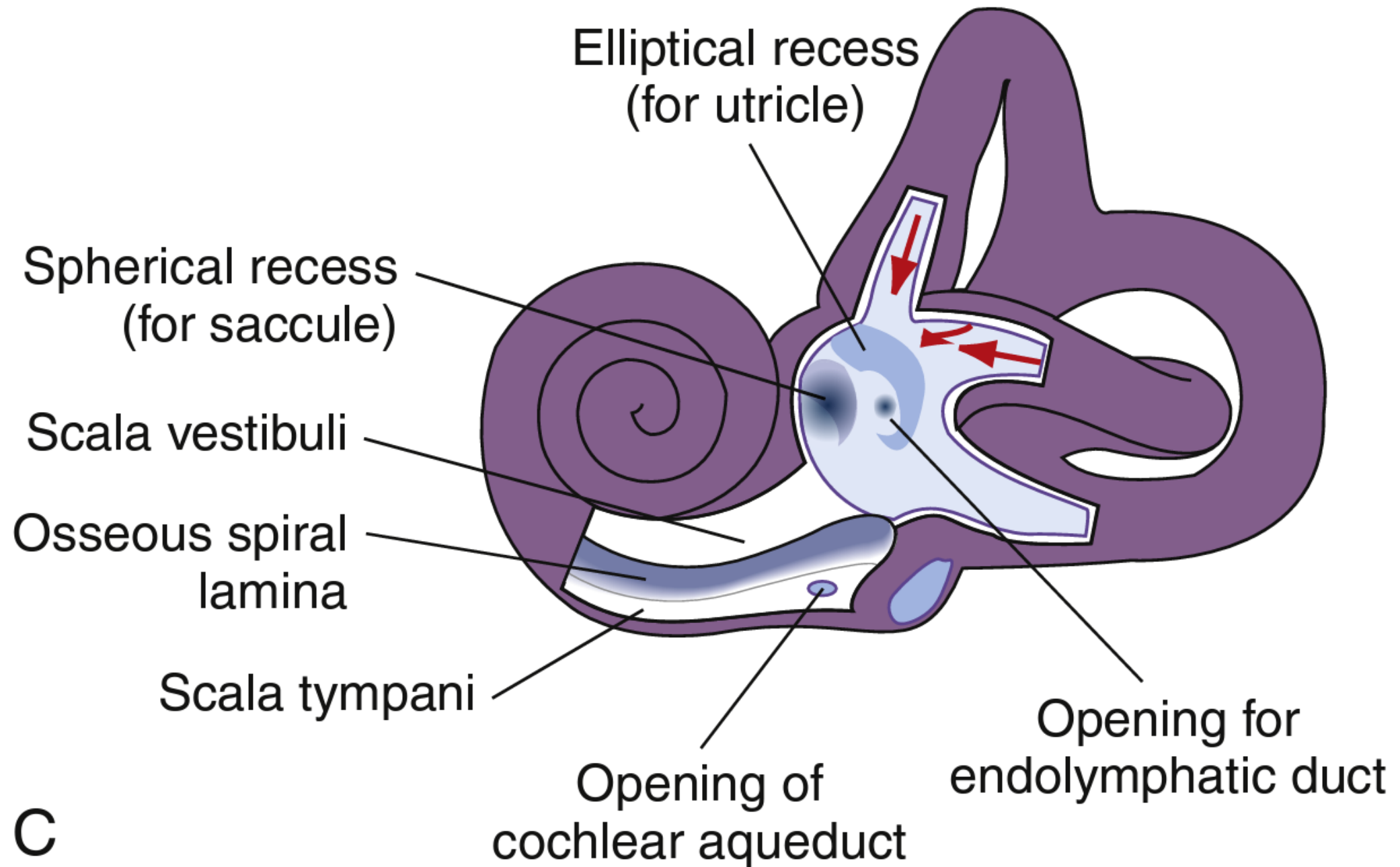


Membranous labyrinth



VESTIBULE

- Ovoid in shape measuring 5 mm × 3 mm & forms the **central part of bony labyrinth**.
- It has a spherical recess containing **Saccule**, a Cochlear recess for cochlear duct and an elliptical recess for **Utricle**.
- Opening of vestibular aqueduct lies below elliptical recess.
- Posterior part of vestibule has 5 openings of 3 semicircular canals.
- Lateral wall has the fenestra vestibuli or oval window. Its medial wall is related to internal acoustic meatus.



Cochlea

- **Fallop** (1561) described cochlea and labyrinth.
- It is shaped like a conical snail shell, measures 35 mm (long) × 5 mm (base to apex) and 9 mm across its base. Cochlea has a central conical axis called modiolus with a spiral canal of 2.5 to 2.75 turns around it.
- Apex of cochlea points towards anterosuperior part of medial wall of middle ear cavity and the base is towards the fundus of internal acoustic meatus.
- An osseous spiral lamina projects from the modiolus and divides the cochlear canal into upper **scala vestibuli** and lower **scala tympani**. Both the scalae are continuous with each other through helicotrema at the apex of cochlea.

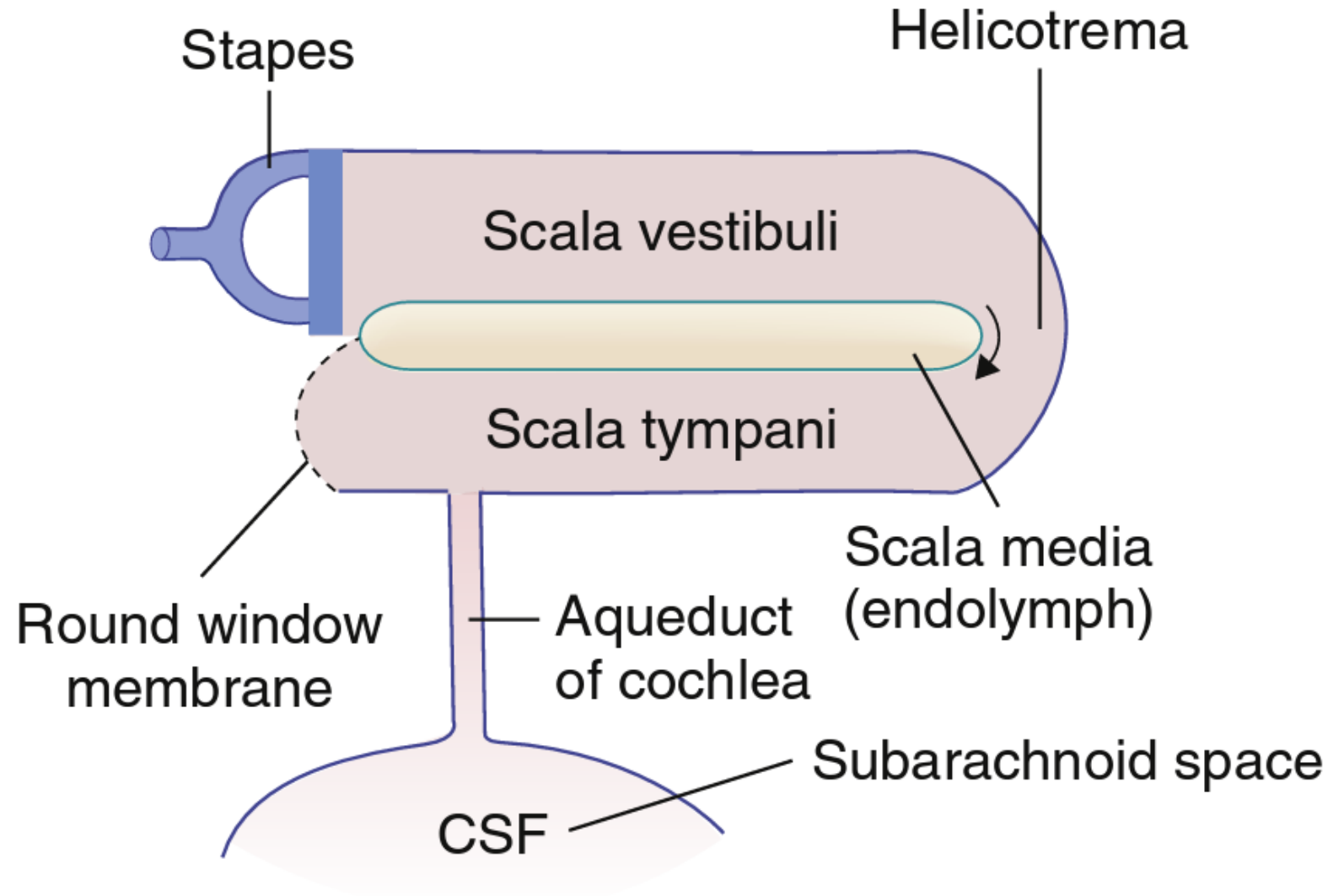
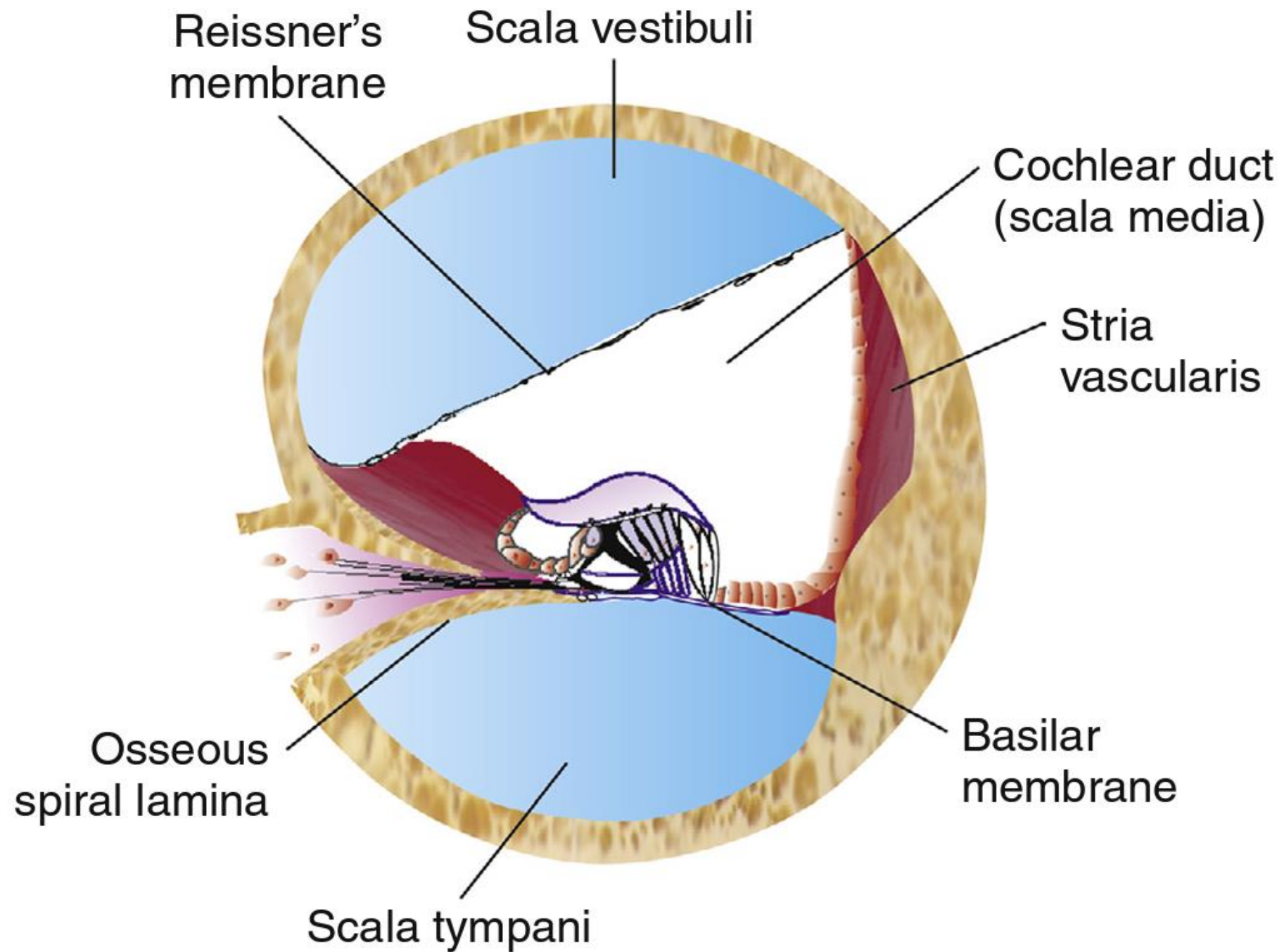


Figure 1.18 Diagrammatic representation of perilymphatic system. CSF passes into scala tympani through aqueduct of cochlea.

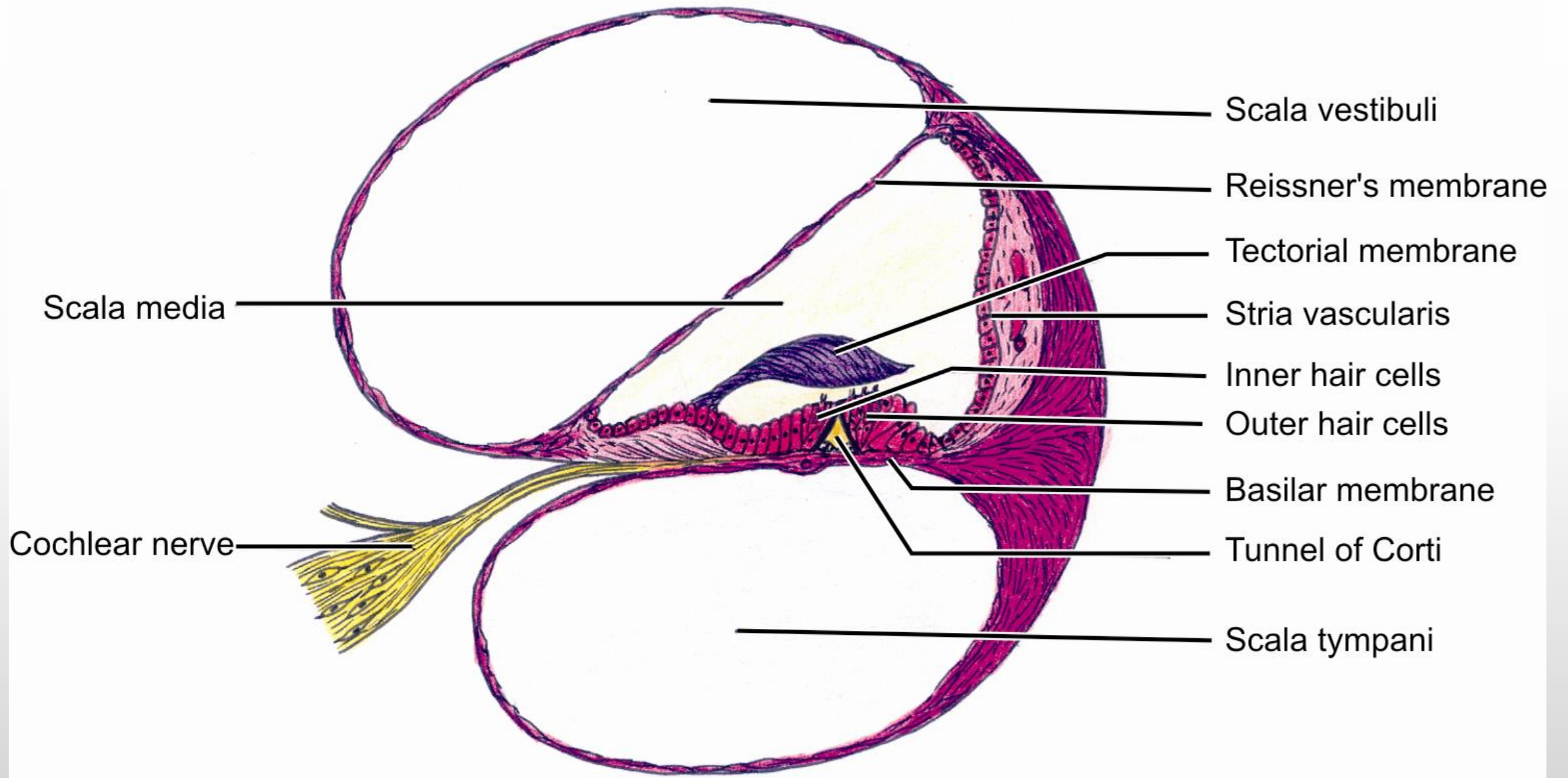
Cochlea has three openings at its base, i.e.

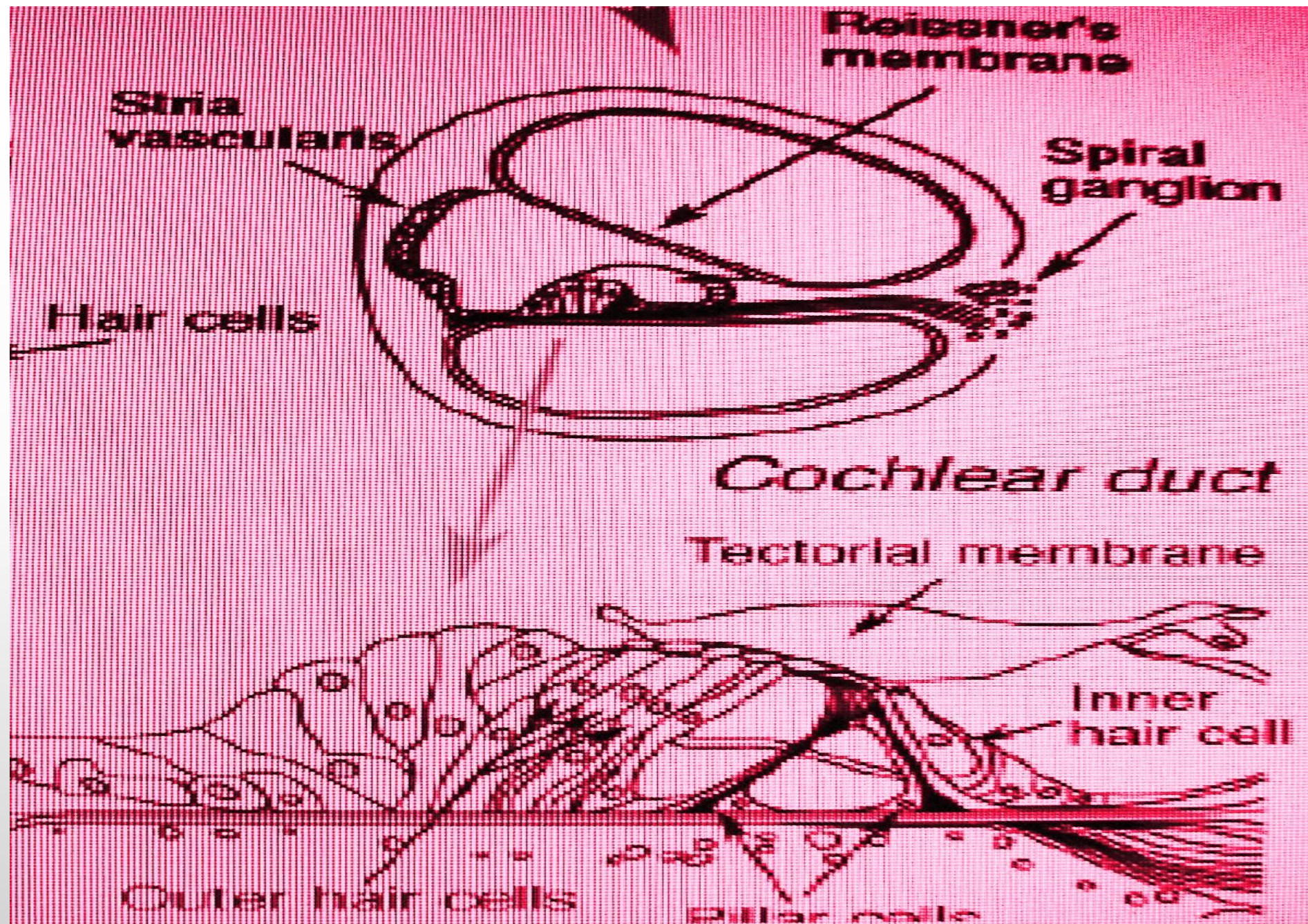
- Fenestra vestibule
- Fenestra cochleae
- Cochlear canaliculus which transmits a small vein to inferior petrosal **sinus**.
- The cochlear aqueduct is a bony channel connecting scala tympani with sub arachnoid space in posterior cranial fossa and vestibular aqueduct extends from vestibule to the posterior cranial fossa.
- Bony labyrinth contains perilymph which resembles cerebrospinal fluid (CSF) in its composition and is rich in sodium & poor in potassium



Cochlear duct (Scala media)

- The canal enclosed between scala vestibuli and scala tympani is the cochlear duct (or scala media). It lies within the bony cochlea and has the sensory area called organ of Corti which is triangular in cross-section
- The basilar membrane forms the horizontal limb of scala media, the Reissner's membrane forms the superior limb and the vertical limb of the triangle is formed by the stria vascularis and the spiral ligament.
- Basilar membrane stretches from the osseous spiral lamina to spiral ligament. Its total length is 35 mm and width is between 0.21 mm and 0.36 mm. It consists of two zones, i.e.
 - Zona arcuata which supports organ of Corti
 - Zona pectinata which is thicker and has 3 layers.
- Vestibular membrane also called Reissner's membrane lies well over the basilar membrane below the scala vestibuli.
- Cochlear duct is filled with a fluid called endolymph and the scala vestibuli and tympani are filled with perilymph.





ORGAN OF CORTI

- Organ of Corti consists of two rows of cells. (They were described in 1851 by Corti.)
 - External rod cells (4000)
 - Internal rod cells (6000).
- Inner-to-inner rods are inner hair cells (3500) in one row, while external-to-outer rods are 3 to 4 layers of outer hair cells (12000).
- Organ of Corti is covered by tectorial membrane.
- Supporting cells of Deiters are situated between the outer hair cells. Cells of Hensen lie outside the Deiters' cells.
- In addition to tunnel of Corti (between outer and inner rod cells), there is also an outer tunnel and space of Nuel (medial tunnel). These spaces are filled with cortilymph which resembles perilymph in composition.
- Remember, the organ of Corti has no direct blood supply and depends for its metabolic activity from diffusion of oxygen from stria vascularis. This arrangement provides acoustic insulation of hair cells

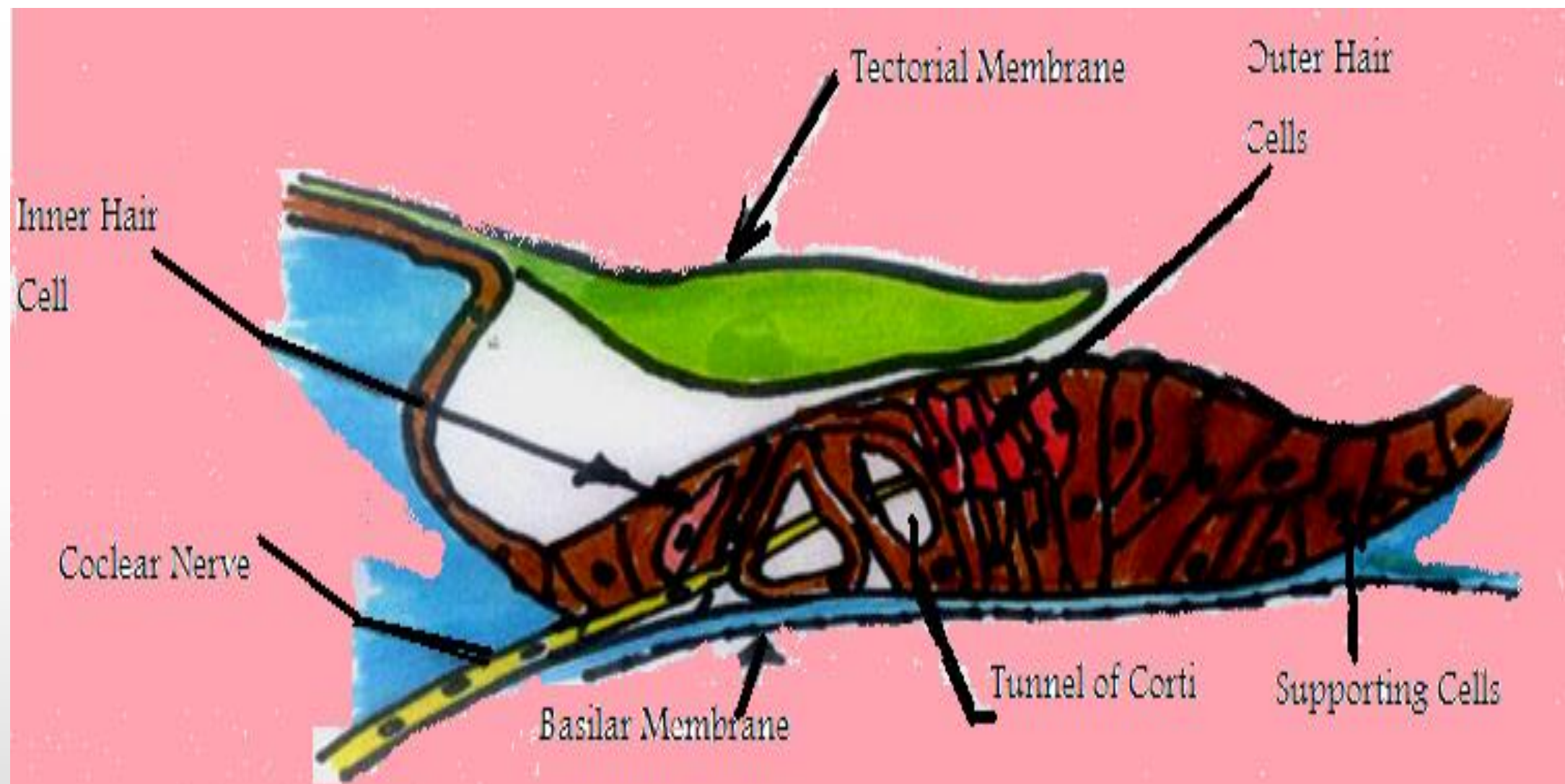


Fig 1.19a Showing Organ of Corti

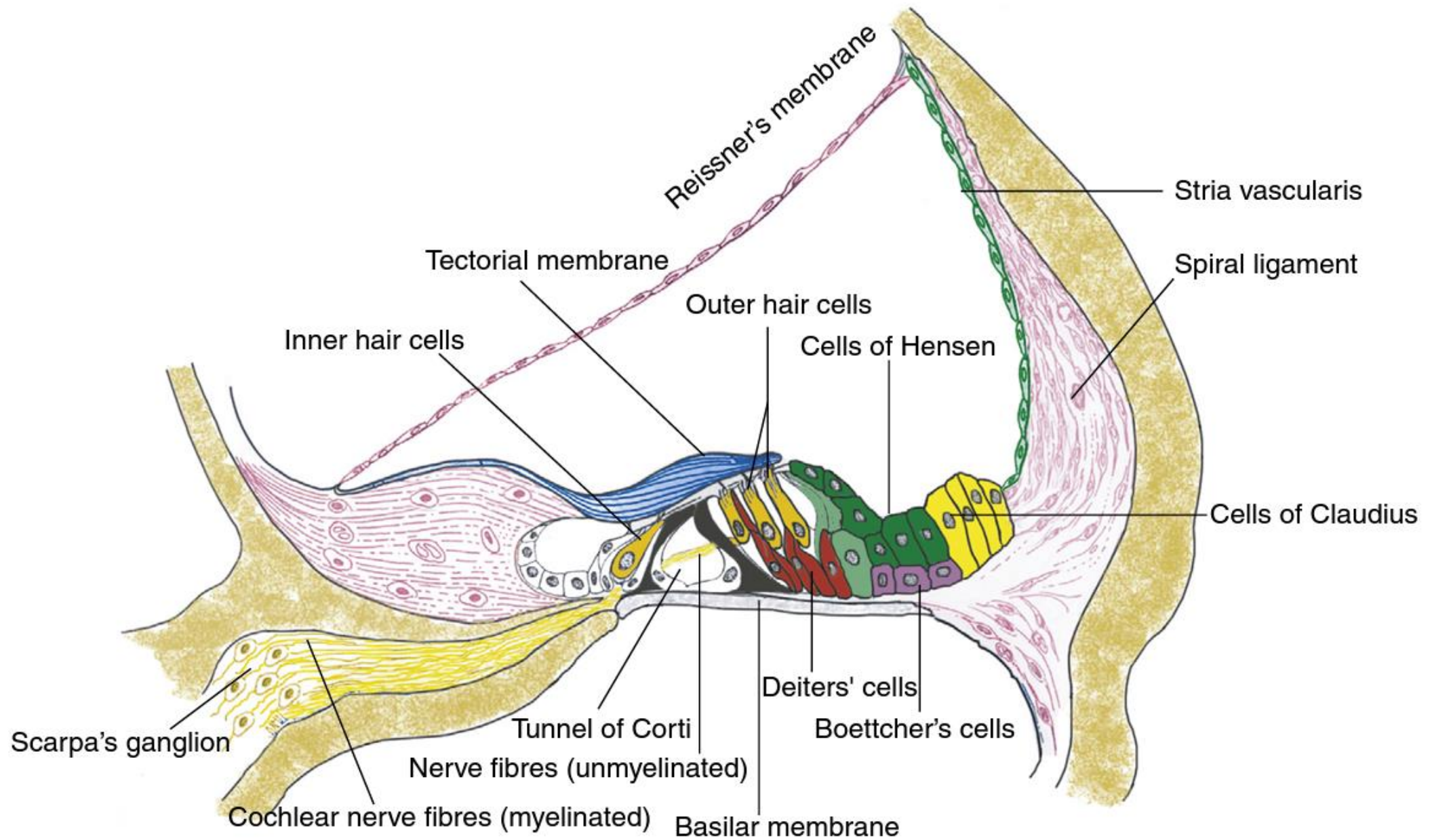


Figure 2.1 Structure of organ of Corti.

Membranous Labyrinth

It lies within the osseous labyrinth and is filled with endolymphatic fluid

- Vestibulocochlear nerve fibres are distributed in the walls of membranous labyrinth. The membranous labyrinth is separated from the bony labyrinth by perilymphatic fluid.
- It has the following parts:
 - a. Utricle
 - b. Sacculle
 - c. Semicircular ducts

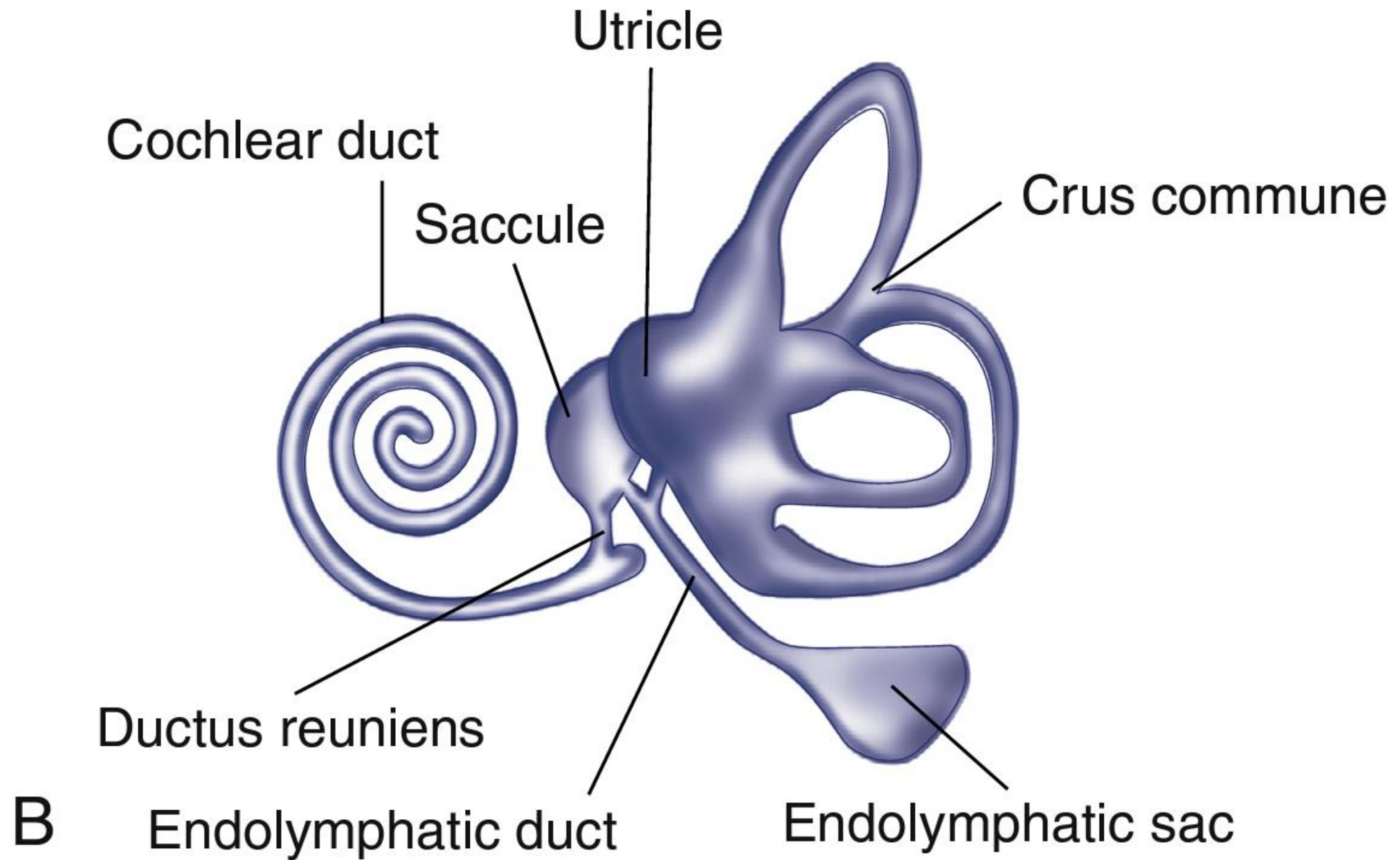
Structure of utricle, saccule and semicircular ducts

Each has three layers.

- i) External layer is fibrous and vascular,
- ii) Middle layer is vascular connective tissue and
- iii) Internal layer is simple epithelium varying from squamous to cuboidal with a basement membrane having light and dark cells.

Utricle

- It is an irregular oblong structure 2 to 5 mm in diameter. It occupies elliptical recess of the vestibule.
- The lateral wall and adjoining floor have a thickened area of 3 mm × 2 mm called utricular macula.
- It is innervated by utricular fibres of vestibular nerve.
- The Semicircular ducts open into the utricle through 5 ampullary ends.



Sacculle

- It is globular in shape of 1 to 1.5 mm in diameter and occupies the spherical recess near the opening of scala vestibuli.
- Its anterior wall has the macula set at right angle to the utricular macula.
- Sacculle is connected to the utricle through a Y-shaped tube, to the endolymphatic duct and sac. The sac lies under the dura mater on posterior surface of petrous bone.
- Ductus reuniens passes inferior from lower part of sacculle into the basal end of cochlea.

Semicircular canals

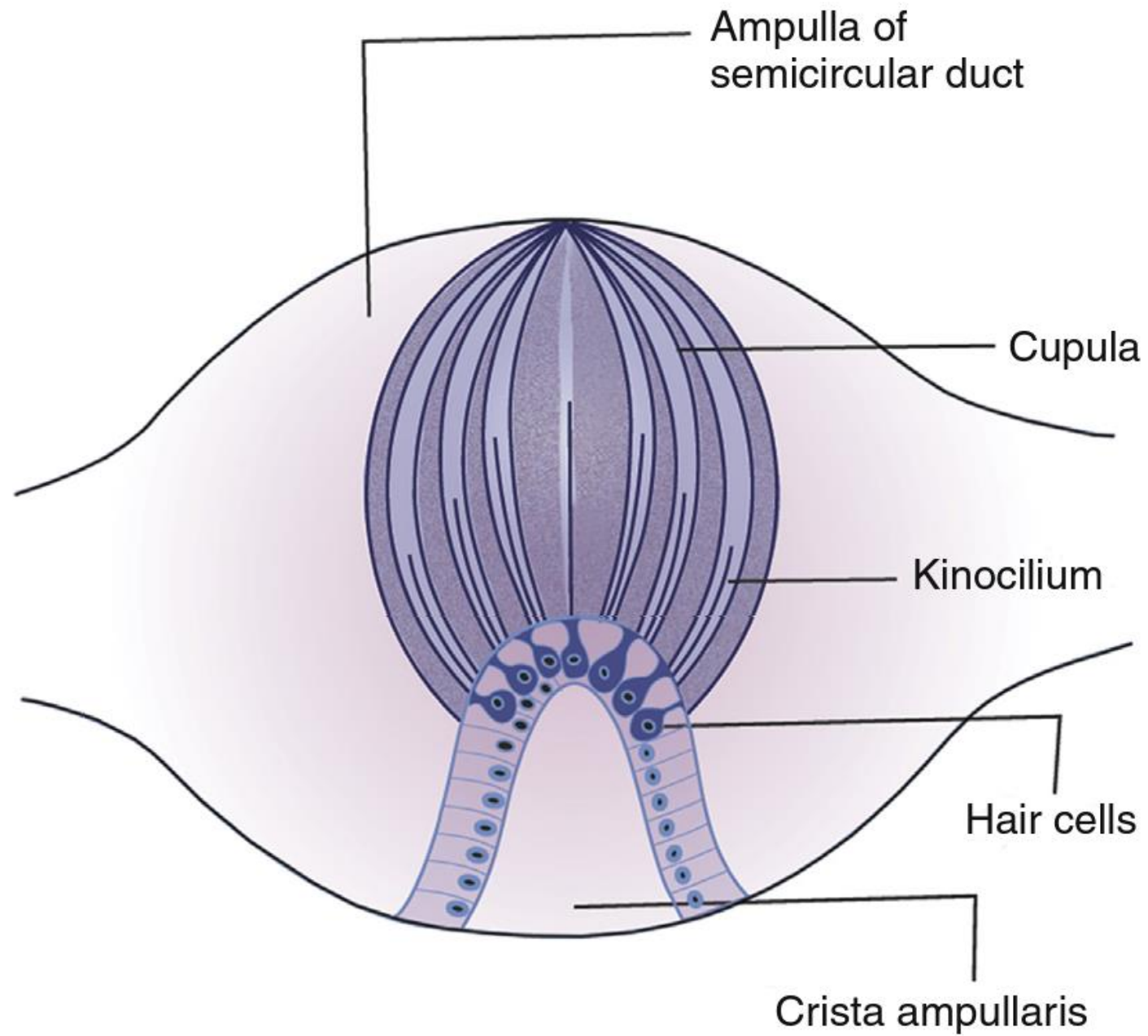
- There are 3 SCC's, i.e. Superior, Posterior and Lateral. These are all about 0.8 mm in diameter and have a terminal swelling called ampulla (2mm).
- These open into vestibule by 5 openings, the one common between anterior and posterior is called the crus commune.
- Their lengths are - Posterior SCC is 18 to 22 mm, Superior SCC is 15 to 20 mm and Lateral SCC is 12 to 15 mm long.
- The 3 canals lie at 90° to each other.
- Superior SCC is placed transverse to the long axis of petrous temporal and its upward convexity forms the Arcuate eminence.
- Posterior SCC runs parallel to posterior surface of petrous bone,
- Lateral SCC lies at 30° to the horizontal plane. After 30° flexion of head, the lateral canal becomes horizontal.
- *Remember that the two horizontal SCC's lie in the same plane, while superior SCC of one side is parallel with the posterior SCC of other side.*

Semicircular ducts

Semicircular ducts:

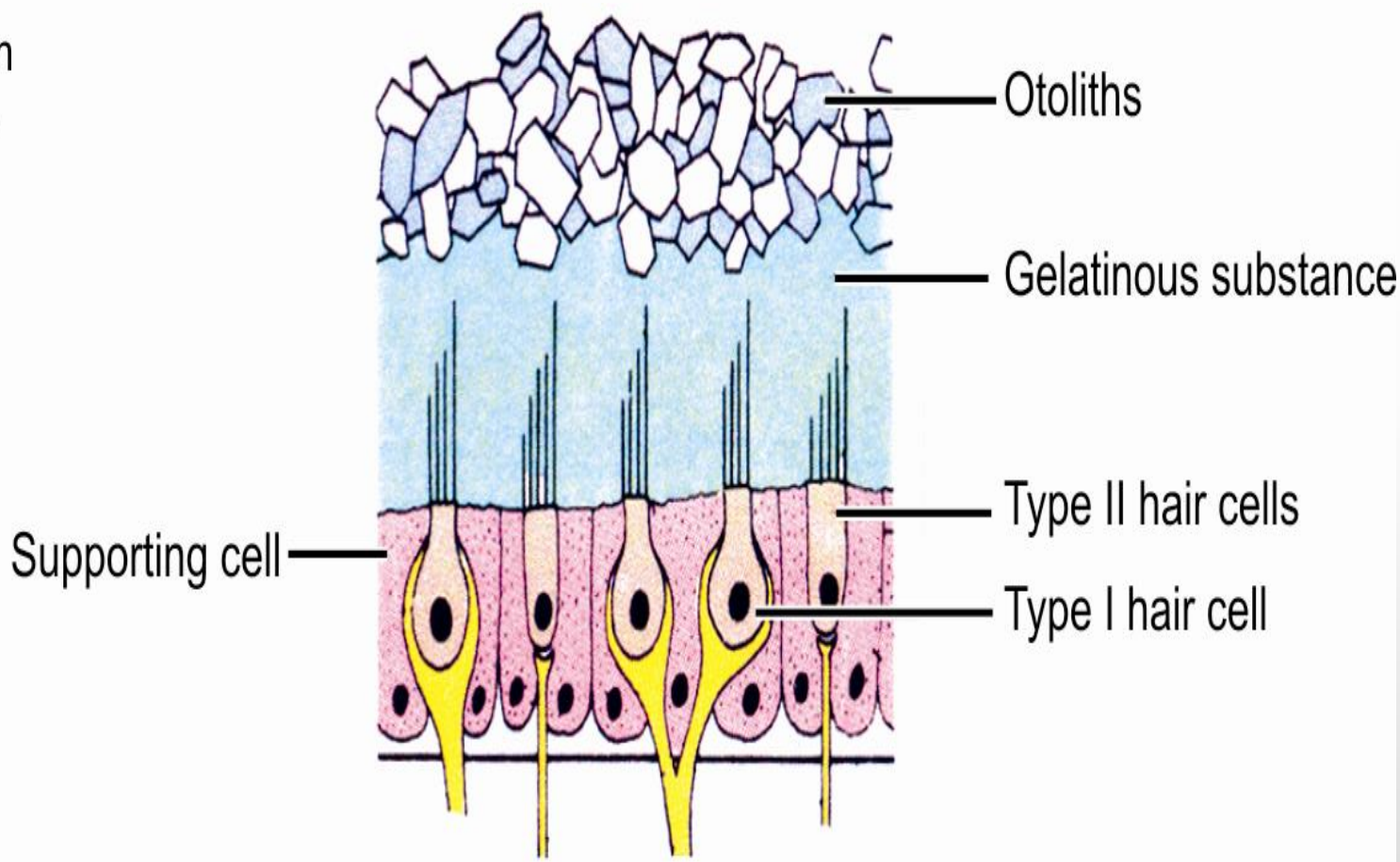
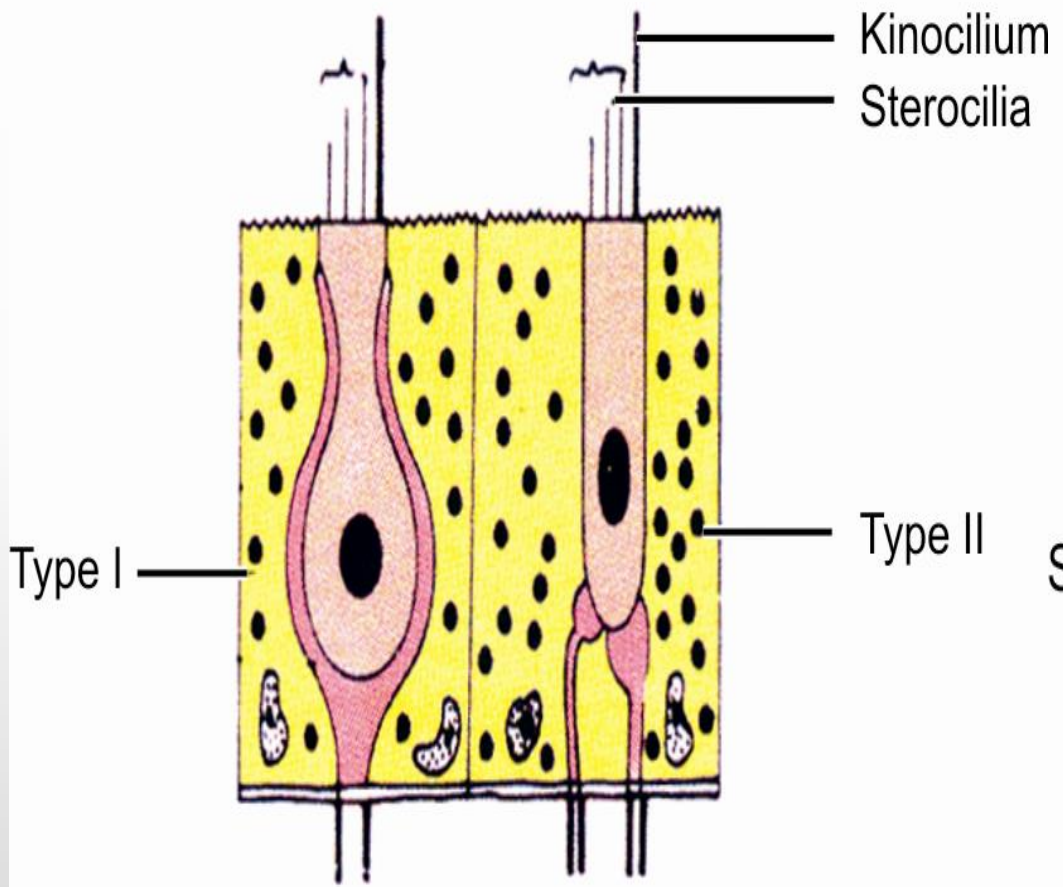
- These open into the utricle by 5 orifices, one being common to the medial end of anterior and posterior duct. In the ampullary end of each duct, there is a transverse elevation shaped like an hour glass called septum transversum.
- Its most prominent part is ampullary cristae which are the sensitive organs to the movements of endolymph. These cristae respond to pressure changes of endolymph while maculae respond to gravitational changes.

Donaldson's line is a land mark for endolymphatic sac & this line passes through H.S.S.C. and bisects Posterior S.C.C.



Sensory Epithelium

- In ampullary crests, the epithelium contains sensory hair cells of type I and type II and supporting cells of Hensen
- Type I cell is **pyriform** in shape and type II cell is **cylindrical**. Apical surface of both these cells carry 40 to 100 stereocilia or modified microvilli.
- A long kinocilium is also attached to each cell. These stereocilia and kinocilium are inserted into a gelatinous mass-like membrane called otolithic membrane containing many **otoliths or statoconia**
- **Macula** is the organ for static balance while **Ampullary crest** is the organ for kinetic balance (or responds to angular acceleration).
- Endolymph resembles intracellular fluid being rich in potassium and poor in sodium ions



Vestibulocochlear Nerve

- **Gallen** (200 AD) described the 8th cranial nerve (vestibulocochlear nerve).
- The VIIIth nerve divides deep in the internal acoustic meatus into anterior cochlear and posterior vestibular nerve.
- **Oorts anastomosis** is a vestibulo-cochlear anastomosis.

Cochlear nerve

- It divides into many filaments at the modiolar base and ultimately ends in inner hair cells (95%) and outer hair cells (5%).
- A vestibular branch of cochlear nerve supplies the vestibular end of cochlear duct.

Vestibular nerve

- It supplies maculae of utricle, saccule and ampulla of SC ducts.
- Scarpa's ganglion from where these fibers arise lies in the internal acoustic meatus.

Distal to the ganglion, it divides into superior, inferior and posterior vestibular branches.

- Superior branch supplies utricular macula and ampullary crest of anterior and lateral SC ducts.
- Inferior branch supplies saccular macula.
- Posterior supplies ampulla of posterior SC duct.

Arteries of Labyrinth:

- **Internal auditory artery** is a branch of Anterior Inferior Cerebellar Artery which itself arises from basilar artery. Internal auditory artery (labyrinthine artery) divides into a cochlear and a vestibular branch.
- **Stylomastoid branch** of occipital artery and **posterior auricular** artery also contribute.
- ***Veins:***
 - Cochlear vein and vestibular vein join to form the labyrinthine vein which ends in superior petrosal sinus or in transverse sinus.
 - A small vein from basal turn of cochlea also joins the internal jugular vein.

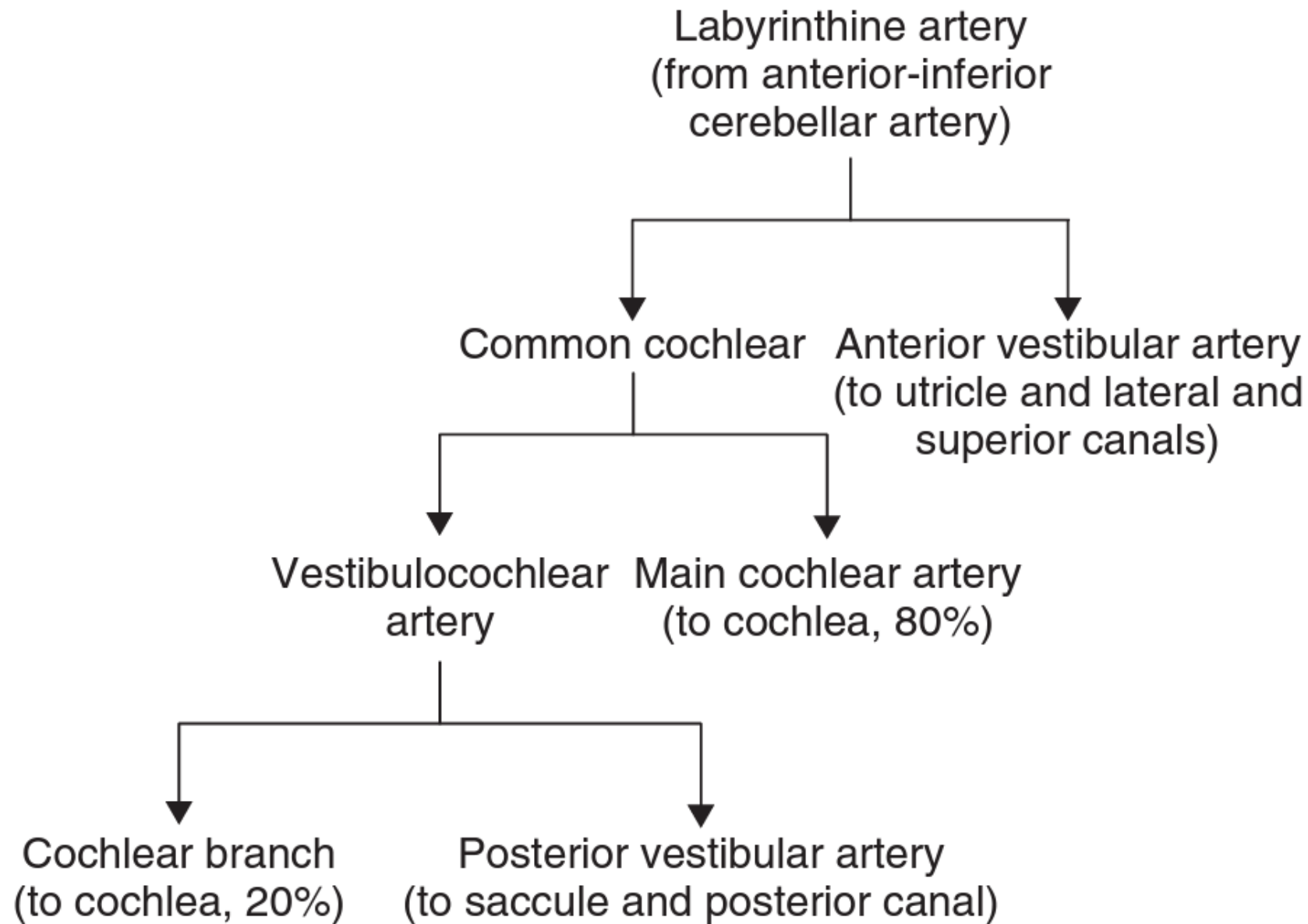


Figure 1.19 Divisions of the labyrinthine artery to supply various parts of labyrinth.



ANY QUESTIONS ?

NO
GOOD!!!