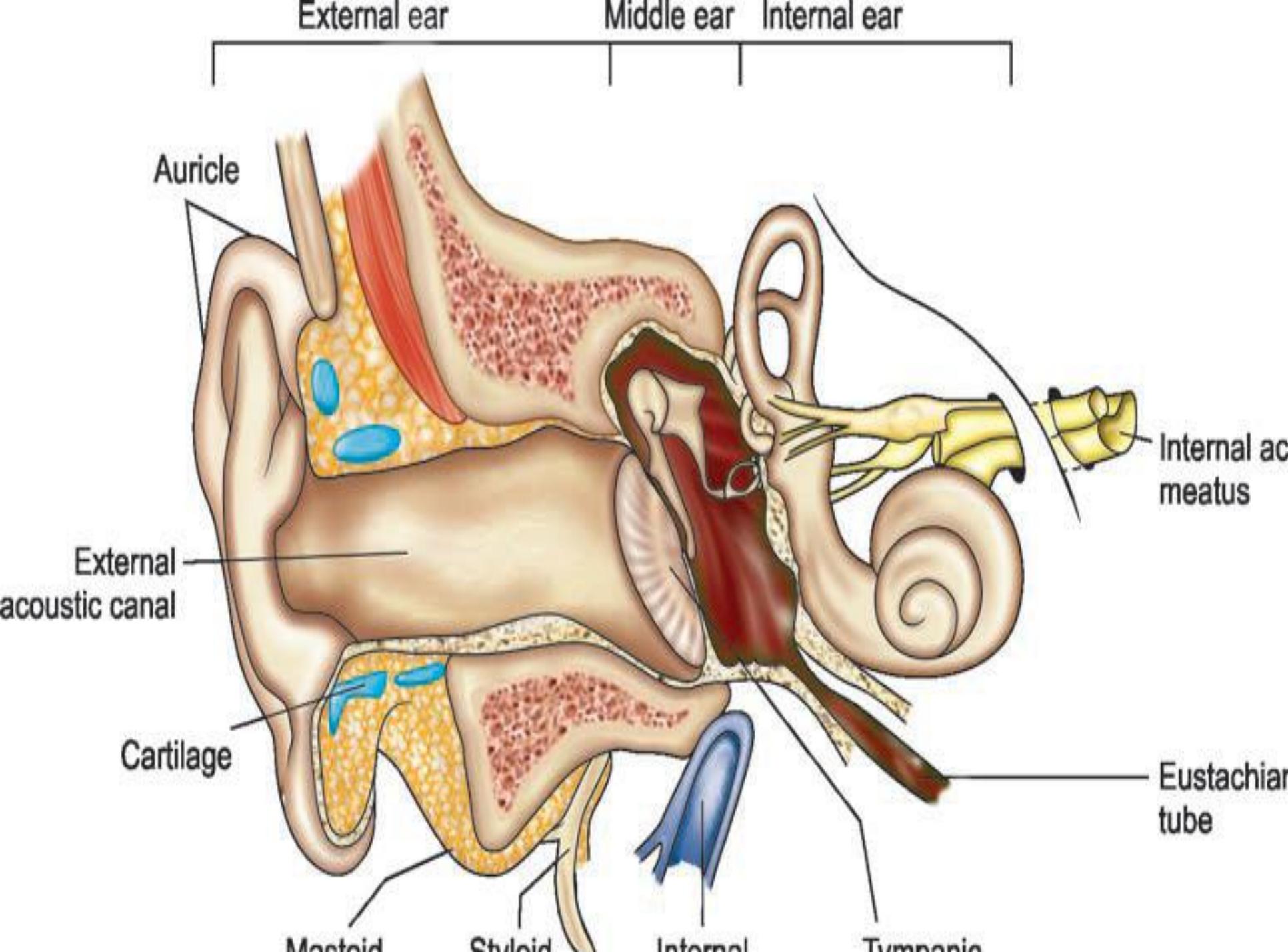


EAR

ear is divided into three parts (Fig.)

1. External ear
2. Middle ear
3. Internal ear



Anatomy of External Ear

The external ear is divided into **auricle (pinna)** and **external acoustic or auditory canal (EAC)**. The tympanic membrane separates external ear from the middle ear

Auricle

The auricle is made up of (except its lobule) a framework of a single piece of yellow elastic cartilage (Fig).which is covered with skin. The skin is adherent to the perichondrium on its lateral surface while it is comparatively loose on the medial surface. Epithelium is squamous keratinizing. Sebaceous glands and hair follicles are found in the subcutaneous tissue. Adipose tissue is present only in the lobule. There are various elevations and depressions, which can be seen on the lateral surface of pinna

External auditory
meatus

Scaphoid fossa

Triangular fossa

Cymba conchae

Auricular (Darwin's)
tubercle

Concha

Helix

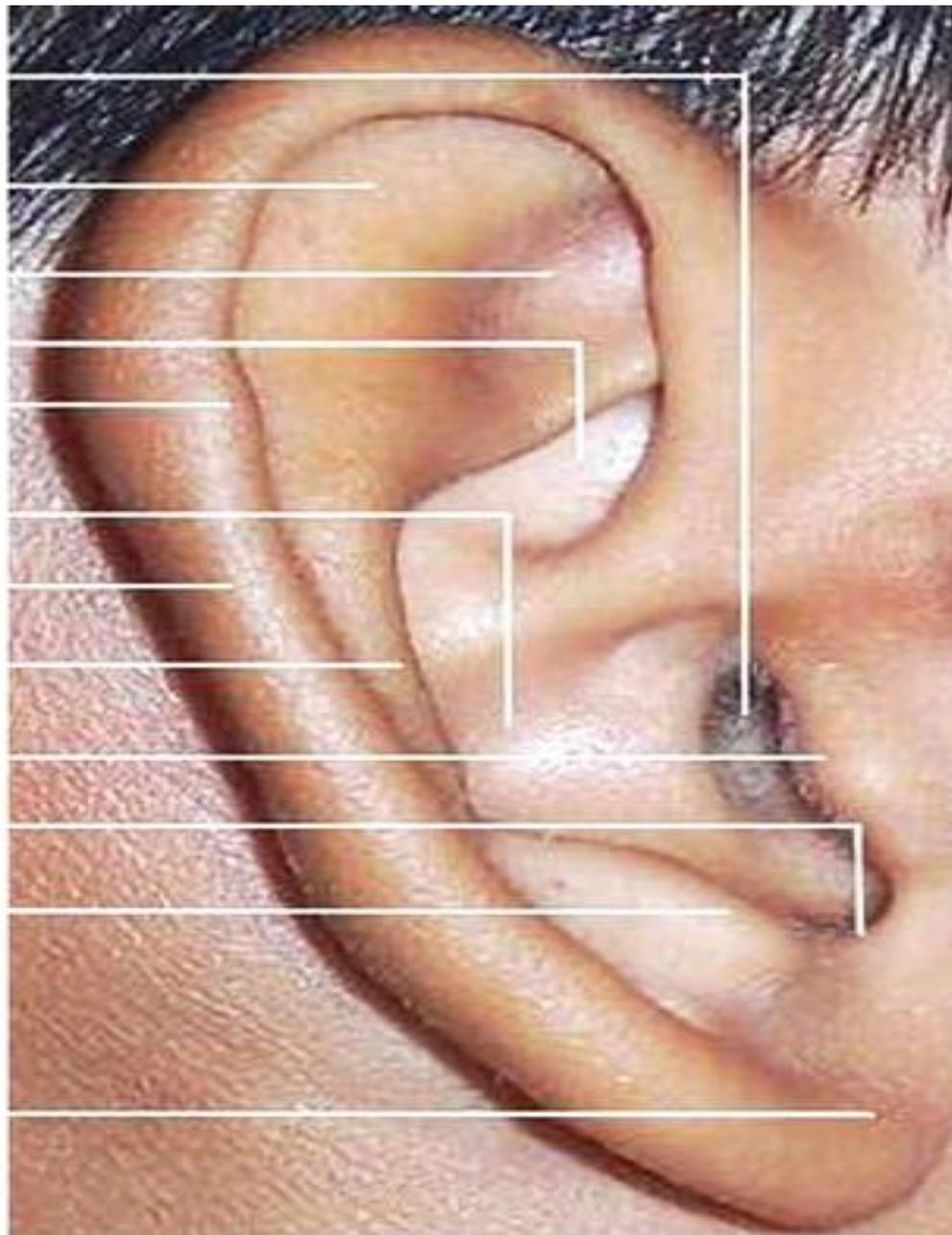
Antihelix

Tragus

Intertragic notch

Antitragus

Lobule



Incisura Terminalis: This area is devoid of cartilage and lies between the tragus and crus of the helix.

Endaural incision: It is made in incisura terminalis for the surgery of EAC and middle ear. It does not cut through the auricular cartilage.

Nerve Supply

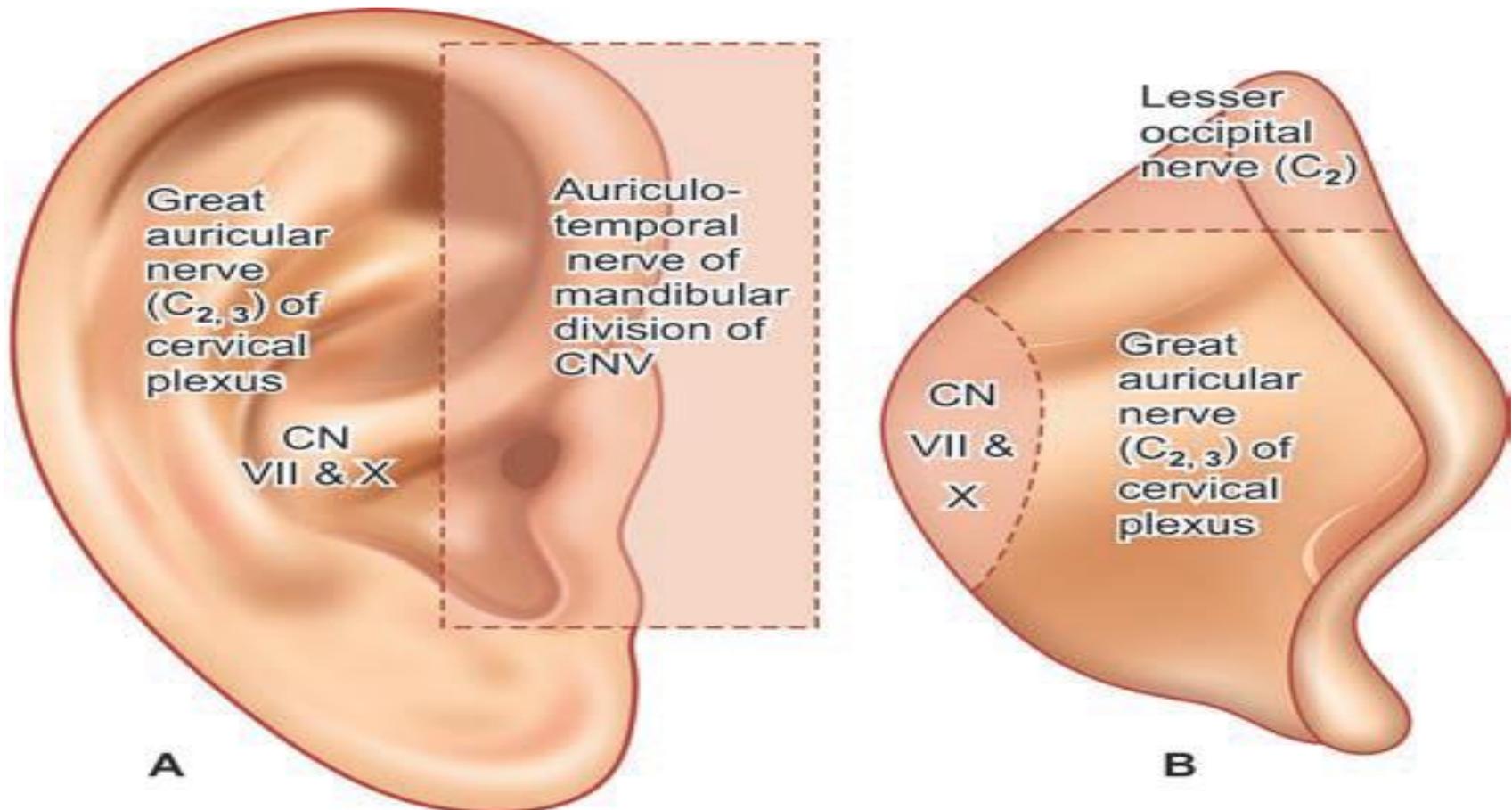
1. *Auriculotemporal nerve (CN V3)*: It is a branch of mandibular division of trigeminal nerve and supplies anterosuperior part of lateral surface of pinna including tragus and crus of helix.

2. *CN VII (facial nerve)*: It innervates the skin of lateral concha and antihelix, lobule and mastoid.

3. *CN X (vagus nerve)*: Its auricular branch (Arnold's nerve) supplies to concha and postauricular skin

4. *Greater auricular nerve (C_{2,3})*: This nerve of cervical plexus supplies most of the medial surface of auricle and posterior part of lateral surface and the postauricular region.

5. *Lesser occipital nerve (C₂)*: This nerve of cervical plexus supplies upper part of medial surface of auricle and



External auditory canal (EAC)

External auditory canal (EAC) measures about 24 mm and extends from the concha to the tympanic membrane. Its anterior wall is 6 mm longer than the posterior wall. EAC is usually divided into 2 parts: (1) cartilaginous and (2) bony. Its outer one-third (8 mm) is cartilaginous and its inner two-third (16 mm) is bony.

□ *Direction:* EAC is 'S' shaped and not straight. Its outer one-third cartilaginous part is directed upwards, backwards and medially while its inner two-third bony part is directed downwards, forwards and medially.

For examining the tympanic membrane, the pinna is pulled upwards, backwards and laterally, which brings the two parts of EAC in alignment.

Cartilaginous PART OF EAC

Cartilaginous EAC (8 mm): It is a continuation of the cartilage that forms the framework of the pinna.

Fissures of Santorini: Transverse slits in the floor of cartilaginous EAC called “fissures of Santorini” provide passages for infections and neoplasms to and from the surrounding soft tissue (especially parotid gland). The parotid and mastoid infections can manifest in the EAC.

Skin Glands: The skin of the cartilaginous canal (Fig. 6) is thick and contains ceruminous and pilosebaceous glands that secrete wax. The hydrophobic, slightly acidic (pH 6.0–6.5) cerumen is formed in this part of EAC

Hair follicles are present only in the outer cartilaginous canal and therefore furuncles (staphylococcal infection of hair follicles) are seen only in the cartilaginous EAC.

Bony part OF EAC

Bony EAC: It is mainly formed by the tympanic portion of temporal bone but roof is formed by the squamous part of the temporal bone (Fig. 7). In the anterosuperior region, squamous part articulates with tympanic bone (tympanosquamous suture). Inferiorly and medially squamous part joins with the lateral superior portion of the petrous bone (petrosquamous suture). Skin of the bony EAC is thin and continuous over the tympanic membrane skin is devoid of subcutaneous layer, hair follicles and ceruminous glands

Isthmus: Approximately 6 mm lateral to tympanic membrane, bony EAC has a narrowing called the isthmus.

Foreign body impacted medial to bony isthmus of EAC are difficult to remove.

Anterior recess.

: Anteroinferior part of the deep bony meatus, medial to the isthmus has a recess, which is called the anterior recess.

The anterior recess acts as a cesspool for discharge and debris.

Foramen of Huschke: In children and occasionally in adults, anteroinferior bony EAC may have a deficiency that is called foramen of Huschke.

Foramen of Huschke permits spread of infections to and from EAC and parotid

Relations of Bony EAC

Superior: Middle cranial fossa

Inferior: Parotid gland

Posterior: Mastoid antrum and air cells and the facial nerve

Anterior: Temporomandibular joint (TMJ)

Medial: Tympanic membrane

Lateral: Cartilaginous EAC

Acute mastoiditis causes sagging of posterosuperior part of deeper bony EAC because it is related with the mastoid antrum.

□ *Epithelial Migration*: The skin of EAC has a unique selfcleansing mechanism. This migratory process continues from the medial to lateral side. The sloughed epithelium is extruded out as a component of cerumen

Nerve Supply

Auriculotemporal nerve (CN V3):

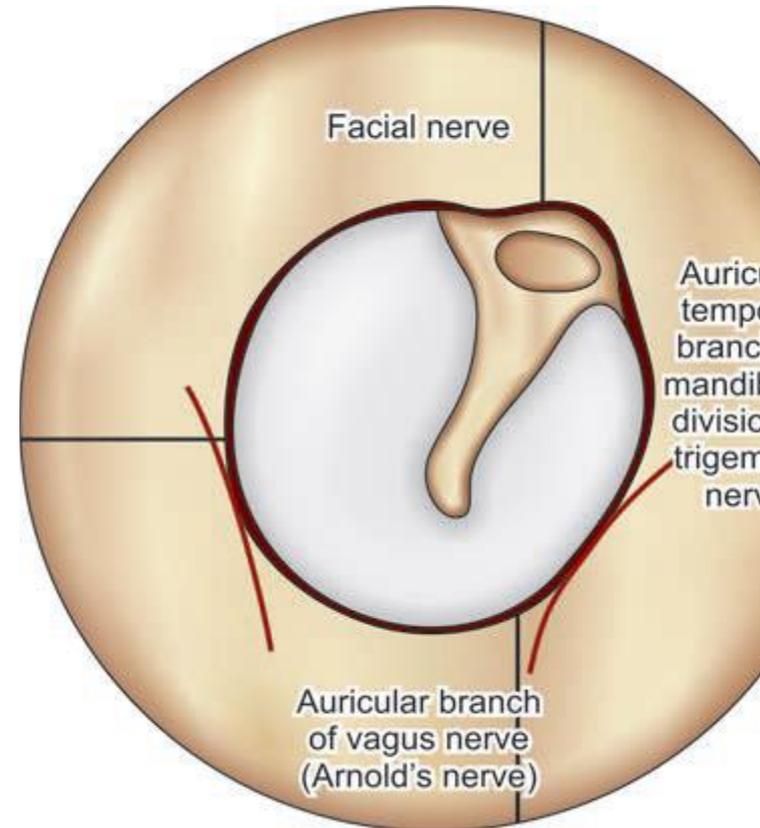
It is a branch of mandibular division of trigeminal nerve and supplies anterosuperior wall of external auditory canal.

CN X (vagus nerve):

Its auricular branch (Arnold's nerve) supplies to inferoposterior external auditory canal.

CN VII (facial nerve):

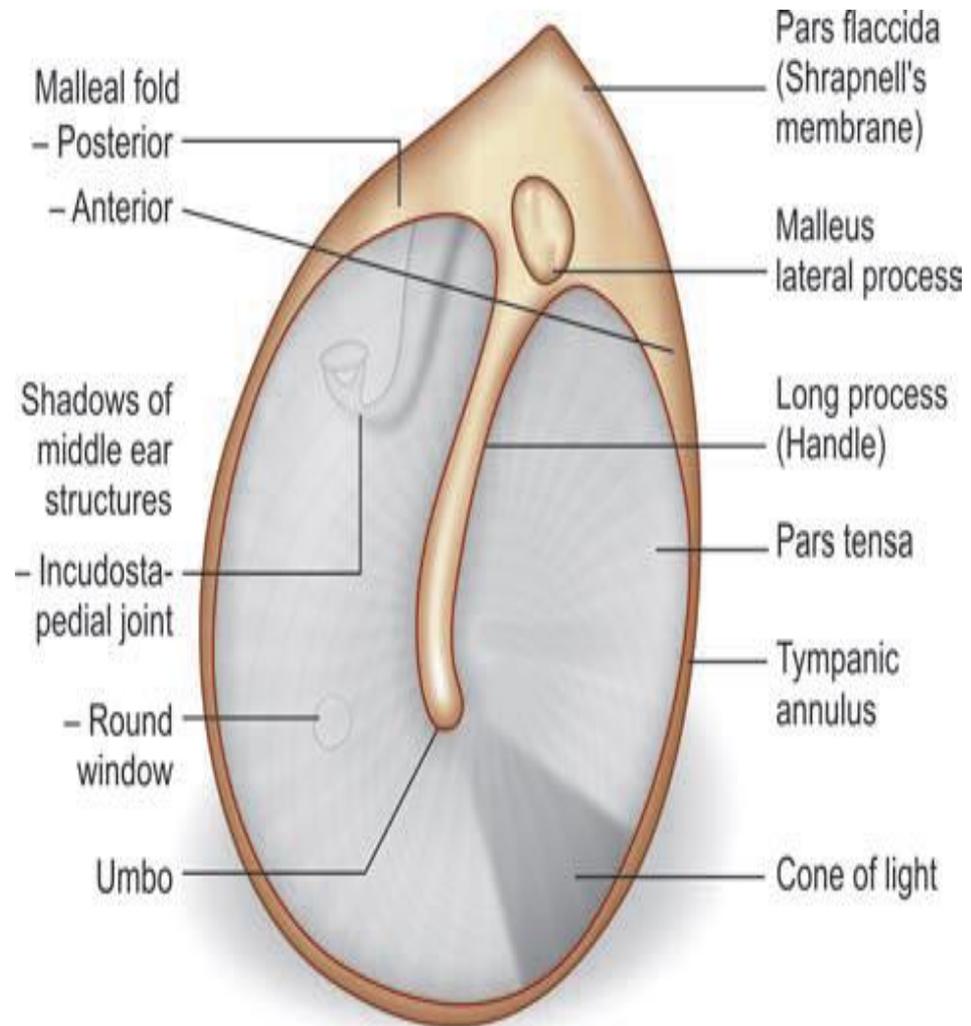
It innervates the skin of the mastoid and posterior external auditory canal.



Tympanic membrane

Dimensions: Its dimensions are: 9–10 mm height and 8–9 mm width. It is 0.1 mm thick.

□ **Position:** Tympanic membrane (TM) is a partition wall between the EAC and the middle ear. It is positioned obliquely. It forms angle of 55° with deep EAC. Its posterosuperior part is more lateral than its anteroinferior part.



Tympanic membrane consists of two parts:

Pars tensa: It forms most of tympanic membrane (TM).

— Annulus tympanicus: TM is thickened in the periphery and forms a fibrocartilaginous ring called the annulus tympanicus that fits in the tympanic sulcus.

— Umbo: The central part of TM near the tip of malleus is tended inwards and is called the umbo.

— Cone of light: A bright cone of light radiating from the tip of malleus to the periphery in the anteroinferior quadrant is usually seen during otoscopy

Pars flaccida (*Shrapnell's membrane*): It is situated above the lateral process of malleus between the notch of Rivinus and the anterior and posterior malleal folds. It is not tense as pars tensa and may appear little pinkish.

Structure: Tympanic membrane consists of the following three layers

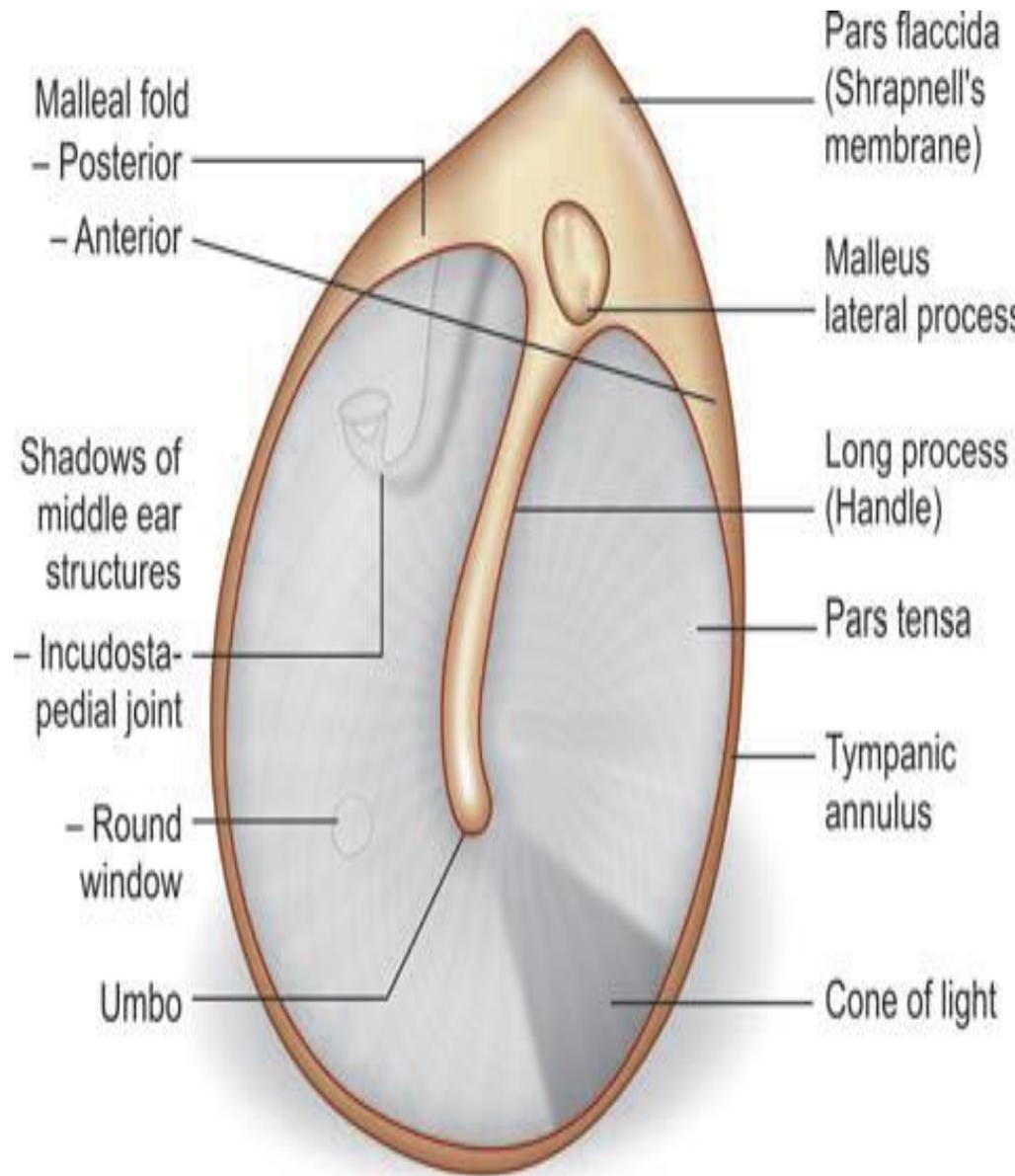
a. Outer epithelial layer. It is continuous with the EAC skin.

b. Middle fibrous layer. It encloses the handle of malleus and consists of three types of fibers: radial, circular and parabolic. In comparison to pars tensa, this layer is very thin in pars flaccida and not organized into various fibers.

c. Inner mucosal layer: It is continuous with the middle ear mucosa

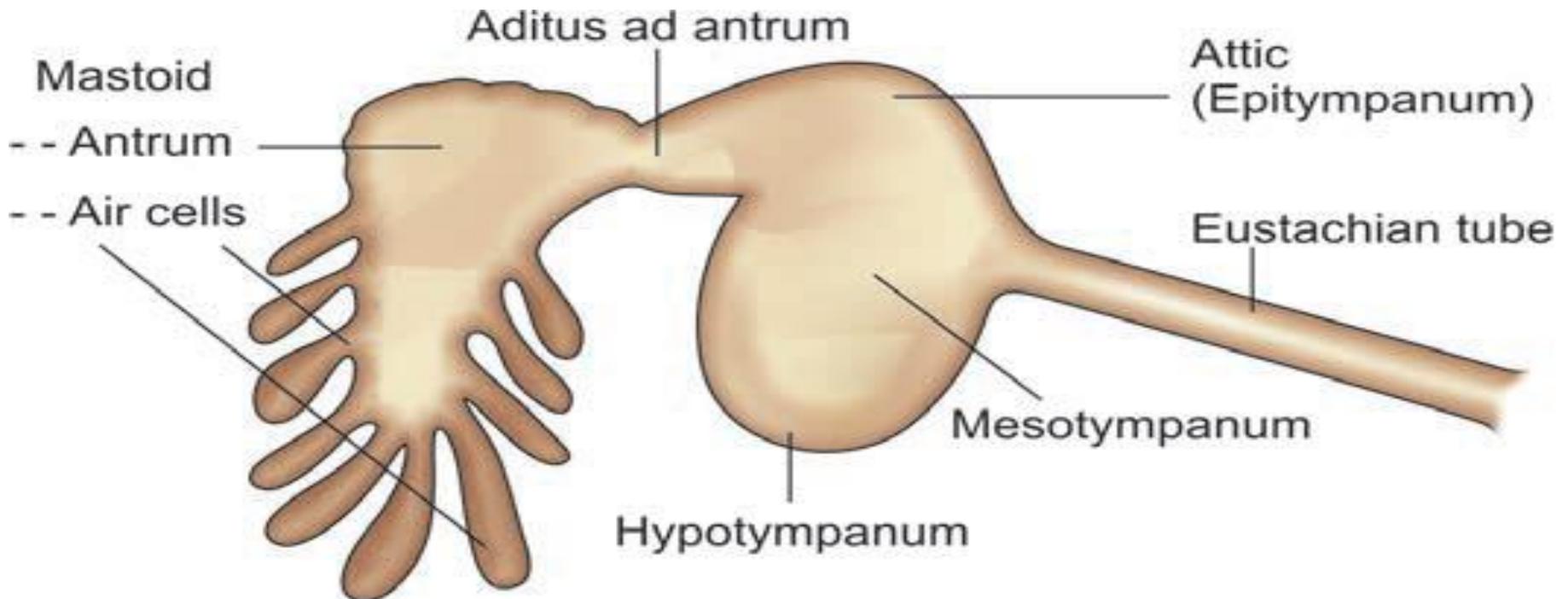
Otoscopy: Normal tympanic membrane is shiny and pearlygray in color. Its lateral surface is concave, which is more marked at the tip of malleus (umbo). Attic area lies above the lateral process of malleus and is slightly pinkish. Its transparency varies from person to person. Some middle ear structures can usually be seen through the membrane such as incudostapedial joint.

□ *Mobility (Seigalitzation):* A normal tympanic membrane is mobile, which can be tested with pneumatic otoscope or Siegel's speculum



Middle ear ANATOMY

The middle ear cleft (Fig.), which is lined by mucous membrane and filled with air, consists of the middle ear, eustachian tube, aditus ad antrum, mastoid antrum and mastoid air cells. Middle ear is a 1 to 2 cm³ air filled cavity that houses ossicles, stapedius and tensor tympani muscles and chorda tympani nerve and tympanic plexus.



Relations of Middle Ear Cleft

- ❑ **Roof:** Tegmen plate separates it from middle cranial fossa and its contents like meninges and temporal lobe of cerebrum.
- ❑ **Floor:** Jugular bulb
- ❑ **Medial:** Labyrinth. Lateral semicircular canal lie posterosuperior to facial nerve.
- ❑ **Posterior:** Sigmoid venous sinus
- ❑ **Anterior:** Petrous part of internal carotid artery lying in carotid canal
- ❑ **Posteromedial:** Posteromedial to mastoid air cells is situated cerebellum in the posterior cranial fossa.

Cranial nerves:

- a. CN V and CN VI: They lie close to the apex of the petrous pyramid.
- b. CN VII: The horizontal tympanic part is situated in the medial wall of middle ear, while vertical mastoid part runs between the middle ear and mastoid air cells system.

middle ear

The tympanum is traditionally divided into three parts:.

1. *Mesotympanum*: This is the portion of middle ear that lies at the level of pars tensa.

2. *Epitympanum (attic)*: This is the portion of middle ear that lies above the level of pars tensa and medial to Shrapnell's membrane and the bony lateral attic wall.

3. *Hypotympanum*: This is the portion of middle ear that lies below the level of pars tensa.

Protympanum: The portion of middle ear around the eustachian tube opening is termed as protympanum

Middle ear boundaries:

Middle ear has six boundaries: roof, floor, and medial, lateral, anterior and posterior walls.

1. Roof (Tegmental wall).

It is formed by tegmen tympani (a thin plate of bone), which extends posteriorly to form the roof of the aditus and antrum (tegmen antri). Tegmen tympani separates middle ear from the middle cranial fossa.

2. Floor (Jugular wall).

The floor, a thin plate of bone, separates tympanic cavity from the jugular bulb.

The floor of middle ear may be congenitally dehiscent. In such cases, jugular bulb projects into the middle ear and is at greater risk of injury during surgery because it is just covered by middle ear mucosa.

3. Anterior (carotid wall).

The anterior wall, a thin plate of bone, which separates the middle ear cavity from internal carotid artery, has following features:

- a. Eustachian tube:* It connects the middle ear with nasopharynx. It aerates and drains the middle ear. See chapter Disorders of Eustachian tube. Malfunctioning of eustachian tube is common cause of ear infections especially in children.
- b. Canal of tensor tympani muscle:* It is situated in the roof of eustachian tube.
- c. Canal for chorda tympani nerve.
- d. Attachment of anterior malleolar ligament

4. Posterior (mastoid wall)

It lies close to the mastoid air cells and presents following structures:

a. Pyramid: It is a bony projection through the summit of which appears the tendon of the stapedius muscle that is inserted to the neck of stapes.

b. Aditus ad antrum: It is an opening through which mastoid antrum opens into the attic. It lies above the pyramid. Its relations are following:

i. Medial: Bony prominence of the horizontal semicircular canal.

ii. Lateral: Fossa incudis, to which is attached the short process of incus.

iii. Inferior: Fallopiian canal for facial nerve.

c. Facial nerve: The vertical mastoid part of the fallopiian canal for facial nerve runs in the posterior wall just behind the pyramid.

d. Facial (suprapyramidal) recess (Fig. 15): This recess is a depression in the posterior wall lateral to the pyramid.

Its boundaries are following:

i. Medial: Vertical part of CN VII.

ii. Lateral: Chorda tympani (branch of 7th CN) and tympanic annulus.

iii. Superior: Fossa incudis, in which lies short process of incus.

e. Sinus (infrapyramidal) tympani. This deep recess lies medial to the pyramid. It is bounded by the subiculum below and the ponticulus above.

5. Medial (labyrinthine wall)

It is formed by the lateral wall of labyrinth. It presents following structures:

- a.** Promontory: It is a bony bulge which is due to the basal coil of cochlea.
- b.** Oval window (fenestra vestibuli): The footplate of stapes is placed in this window
- c.** Round window (fenestra cochleae): It is covered by the secondary tympanic membrane.
- d.** Horizontal tympanic part of fallopian canal for facial nerve: It lies above the oval window
- e.** Lateral semicircular canal: It lies above the fallopian canal, facial nerve.
- f.** Processus cochleariformis: It is a hook-like projection, which lies anterior to the oval window. The tendon of tensor tympani takes a turn on this process and then is inserted on the neck of malleus

6. *Lateral (membranous wall) .*

- a. Tympanic membrane: Lateral wall is formed mainly by the tympanic membrane. Some structures of the middle ear (such as long process of incus, incudostapedial joint, round window and eustachian tube) can be seen through the normal semitransparent tympanic membrane.
- b. Scutum: An upper part of epitympanum is formed by outer bony attic wall called scutum

ossicles

The ossicles conduct sound energy from the tympanic membrane to the oval window. There are three middle ear ossicles—malleus, incus and stapes.

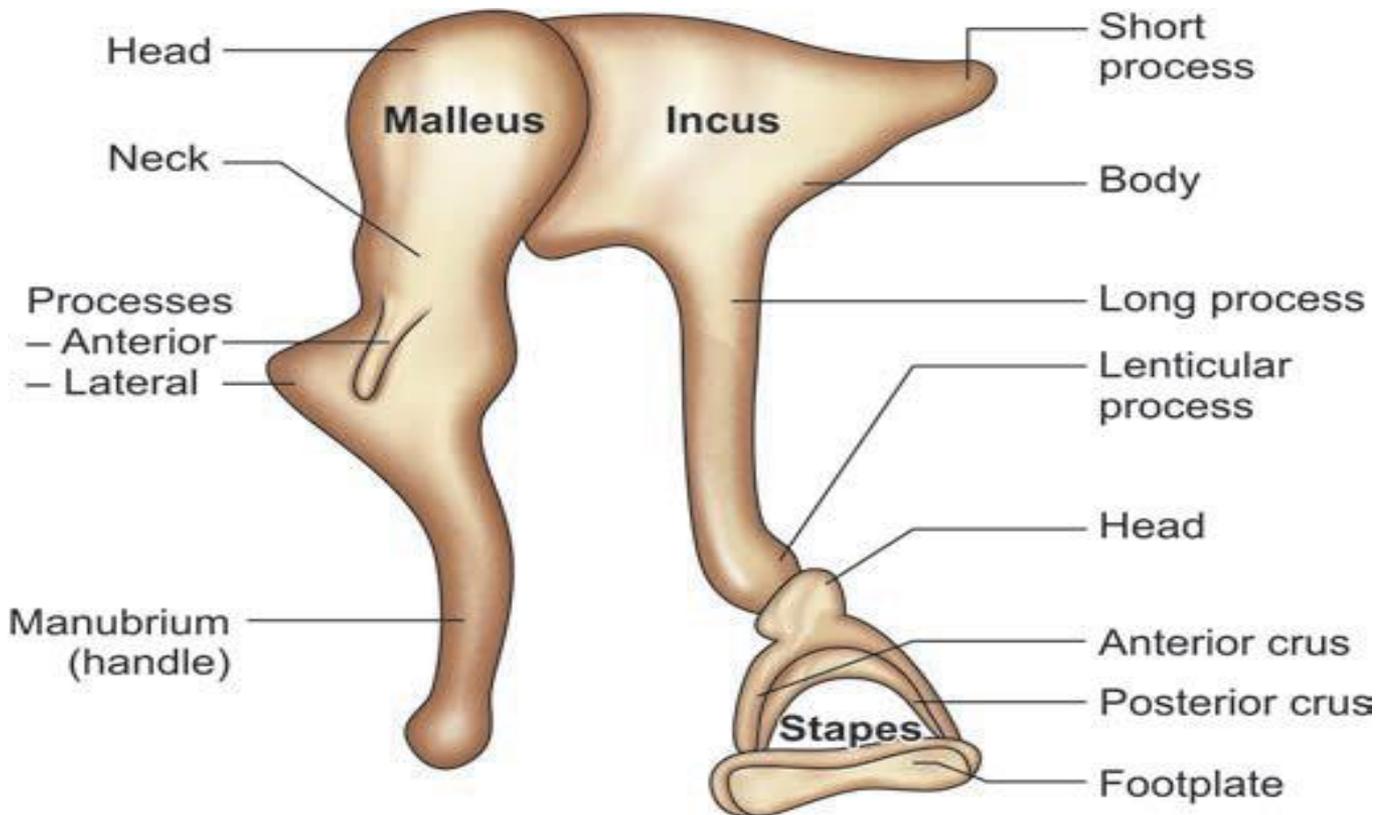
1. *Malleus (hammer)*: It consists of a head, neck, handle (manubrium), a lateral and an anterior process. It is the largest ossicle and measures 8 mm in length.

a. Head and neck: They lie in the attic.

b. Manubrium: It is embedded in the fibrous layer of the tympanic membrane.

c. Lateral process: It appears as a knob-like projection on the outer surface of the tympanic membrane and provides attachments to the anterior and posterior malleal folds.

- 2. Incus (anvil):** It consists of following parts:
- Body and short process: They lie in the attic.
 - Long process: It hangs vertically and forms incudostapedial joint with the head of stapes.
- 3. Stapes (stirrup):** This smallest bone of body measures about 3.5 mm. It consists of head, neck, anterior and posterior



middle ear muscles

There are two middle ear muscles: tensor tympani and the stapedius.

- 1. *Tensor tympani*:** It runs above the eustachian tube. Its tendon turns round the processus cochleariformis and passes laterally. It tenses the tympanic membrane.
 - a. Origin: Bony tunnel above the osseous part of eustachian tube.
 - b. Insertion: Just below the neck of malleus.
 - c. Nerve supply: It develops from the 1st branchial arch and is supplied by a branch of mandibular division of trigeminal nerve (CN V3).

2. Stapedius: On contraction it dampens the loud sounds and prevents noise trauma to the inner ear.

a. Origin: Conical cavity and canal within pyramid.

b. Insertion: It inserts to the neck stapes.

c. Nerve supply: It is developed from the second branchial arch and is supplied by a branch of CN VII (nerve to stapedius of facial nerve).

□ **Functions:** Acoustic reflex protects ear from loud sounds.

a. Dampening of middle ear mechanics: Loud sounds (80 dB and above) cause contraction of stapedius that limits stapes movement.

b. Gain control mechanism: Acoustic reflex keep cochlear input more constant and expand dynamic range.

c. Reduction in self generated noise: Stapedius muscle contracts with chewing and vocalization.

MASTOID ANTRUM

This air-containing space (9 mm height, 14 mm width and 7 mm depth) is situated in the upper part of mastoid. Its boundaries are following:

❑ **Roof:** It is formed by the tegmen antri, which separates mastoid antrum from the middle cranial fossa.

❑ **Lateral wall:** It is formed by a 1.5 cm thick plate of squamous part of temporal bone which is marked on the lateral surface of mastoid by suprameatal (Macewen's) triangle ❑

Medial wall: It is formed by the petrous bone and related to the

- Posterior semicircular canal
- Endolymphatic sac
- Dura of posterior cranial fossa

Posterior wall: It is formed by mastoid bone and communicates with mastoid air cells.



Floor: It is formed by mastoid bone and communicates with mastoid air cells

TYPES OF MASTOID CELLE

The mastoid consists of “honeycomb” air cells, which lie underneath the bony cortex. Depending on its development, three types of mastoid are described

a. Cellular (Well-pneumatized): Mastoid cells are well developed with thin intervening septa.

b. Diploeic: Mainly there are marrow spaces with few air cells.

c. Acellular (Sclerotic): There are neither cells nor marrow spaces.