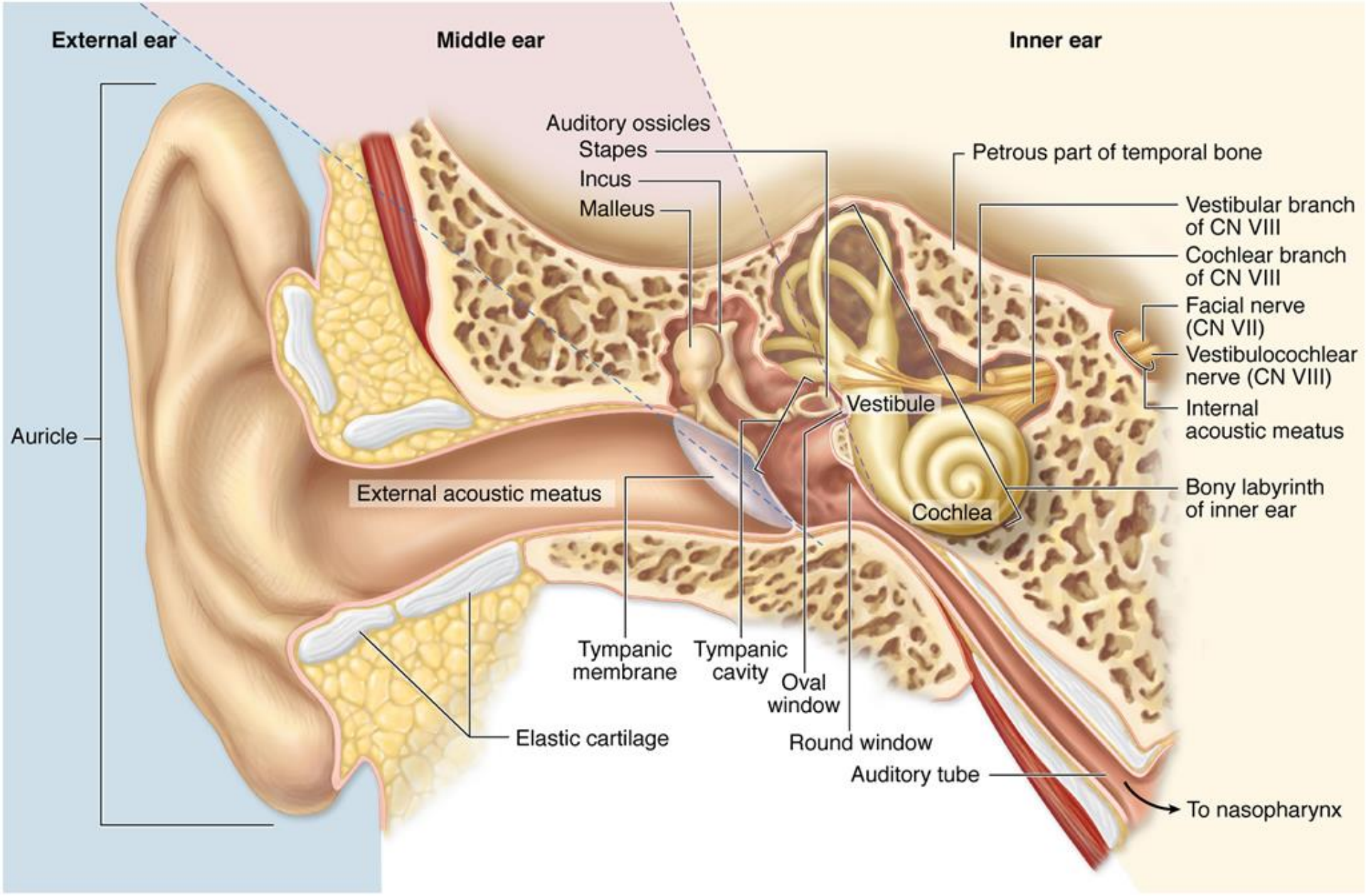
Bony and membranous labyrinth. Vestibular system.

János Hanics M.D.

The position of the inner ear



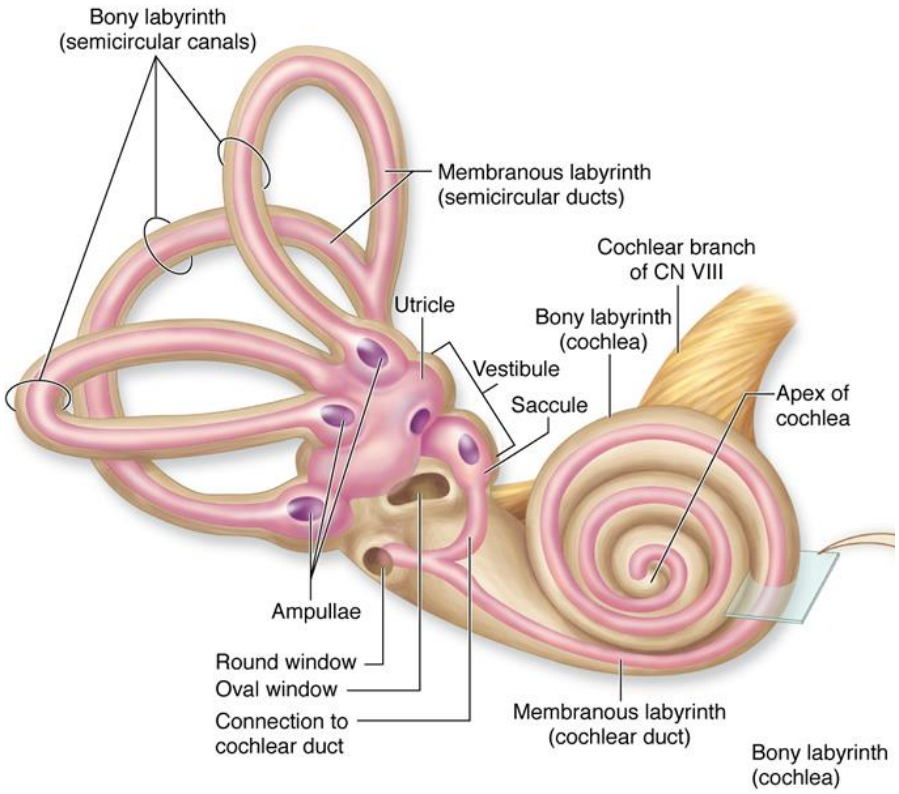
The labyrinth of the inner ear

- **Continuous cavity system in the petrous part of temporal bone**

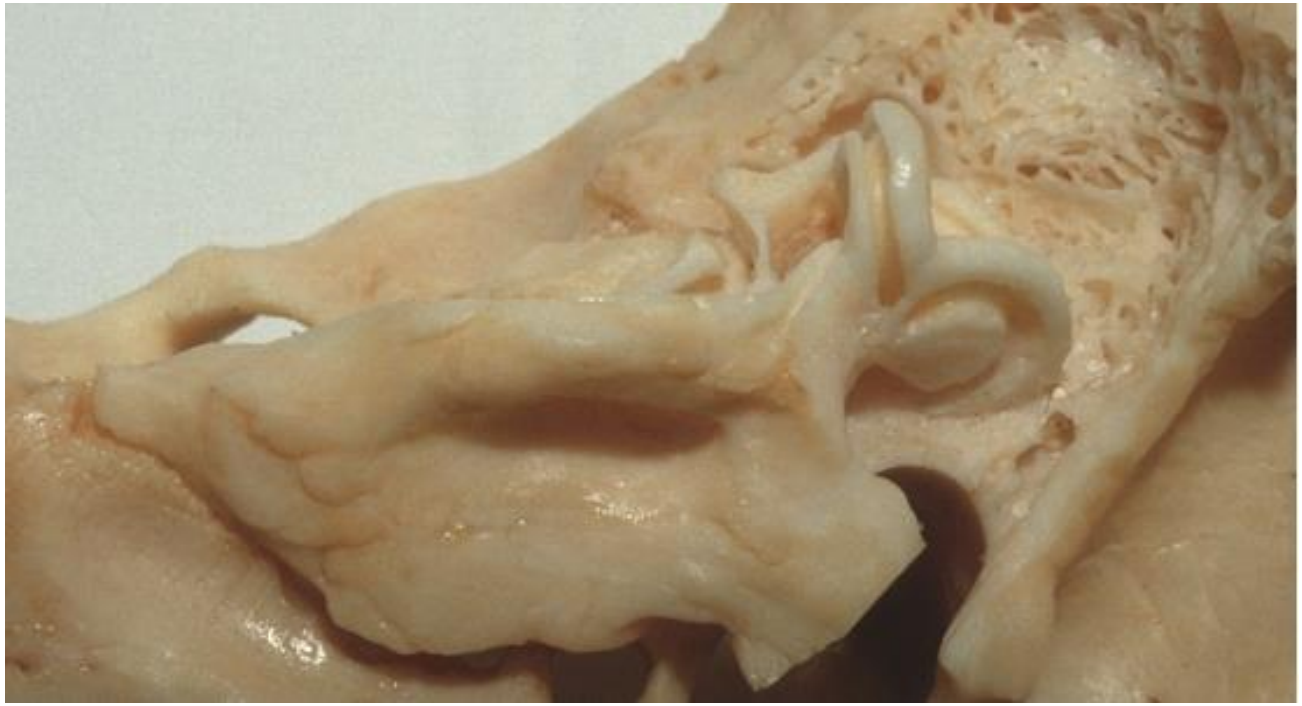
-**„Cavity in cavity”:**

-**1) bony labyrinth - *labyrinthus osseus* – which contains the similar shape**

-**2) membranous labyrinth – *labyrinthus membranaceus***



Walls of the bony labyrinth

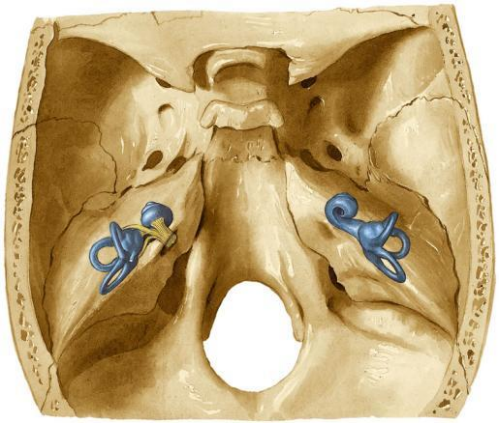


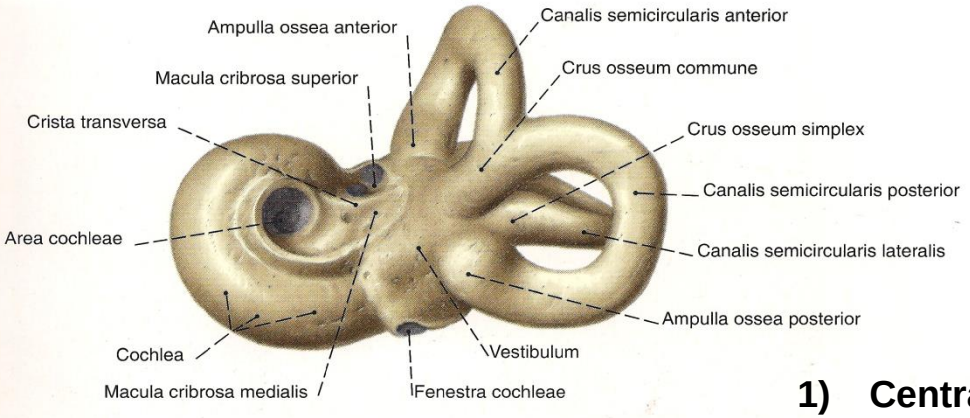
The main mass of petrous part of the temporal bone consisted from spongious bony substance.

However the wall of the labyrinth formed from compact bone like a shell.

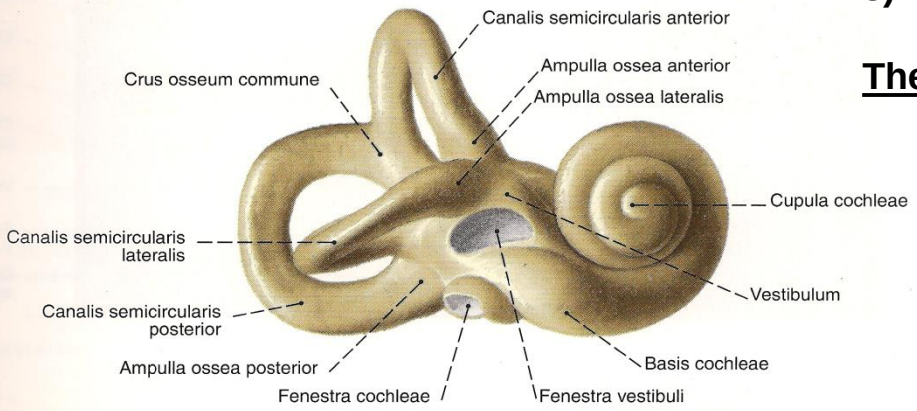
After the remove of the spongious bone, the wall of the labyrinth exhibit the typical well known shape.

Parts of the bony labyrinth





666. ábra A csontos labyrinthus (labyrinthus osseus); a hártyás labyrinthus csontos köpenye a sziklacsontból kivésve, hátulról és felülről (jobb oldal, 300%).



667. ábra Ugyanaz, mint a fenti, oldalról és elölről (jobb oldal, 300%).

1) **Central cavity– <u>vestibule</u>**

2) **3 bony semicircular canal - <u>ant.; post.; lat.;</u>**

3) **<u>Cochlea</u>**

<u>They are continuous through the vestibule</u>

Bony semicircular canals (SC)

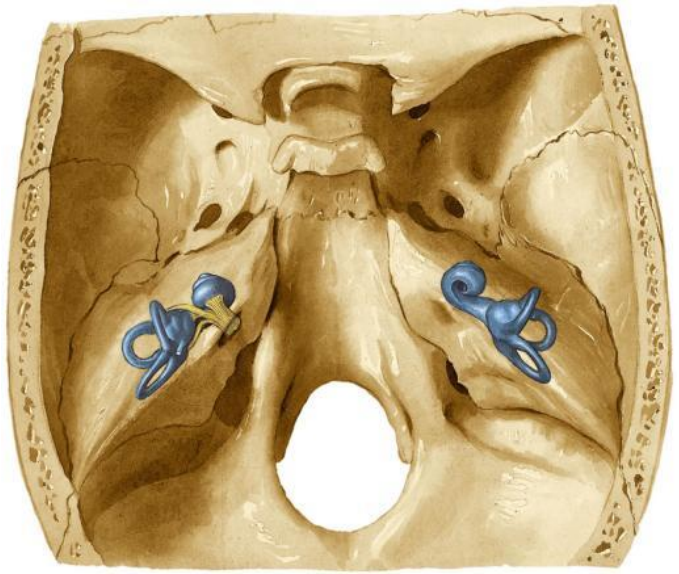
3 main plane:

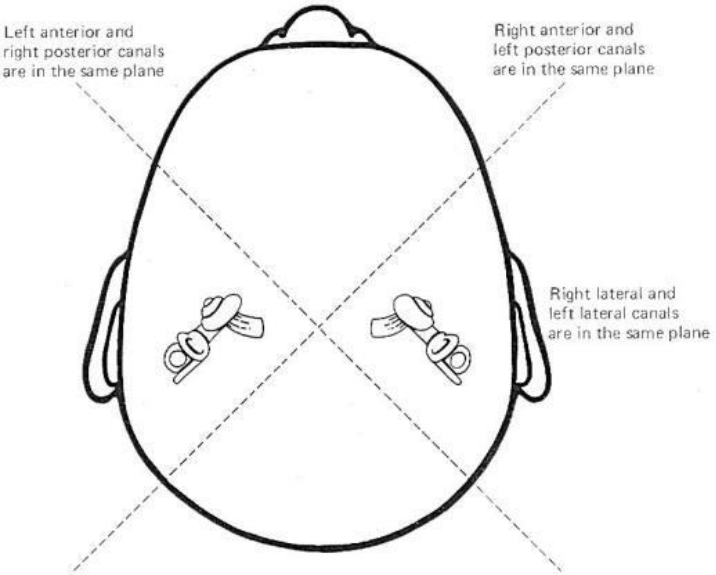
anterior - vertical , perpendicular with the axis of the pyramid

posterior – vertical parallel with the axis of the pyramid

lateralis - horizontal

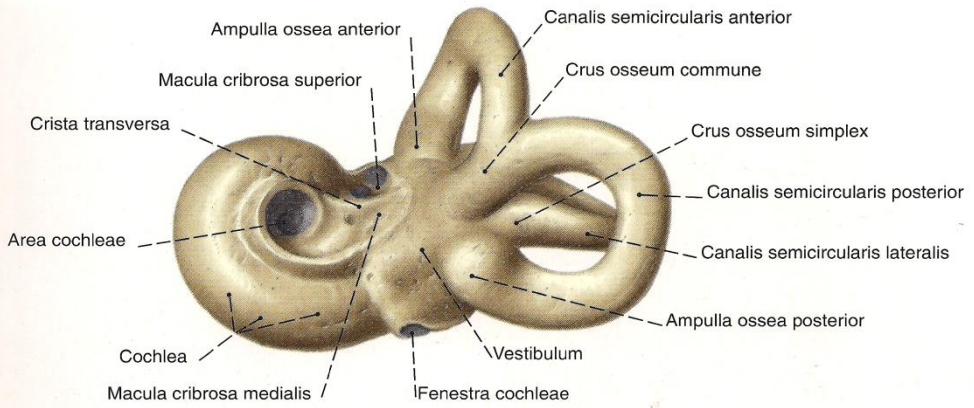
The anterior and posterior close 45° with the frontal and sagittal plane





The right anterior and left posterior SC, the left anterior and right posterior SC are pairs in the same plane – FUNCTIONAL PAIRS!!!
The plane of lateral SCs as appropriate is the same.

Parts of the bony semicircular canals



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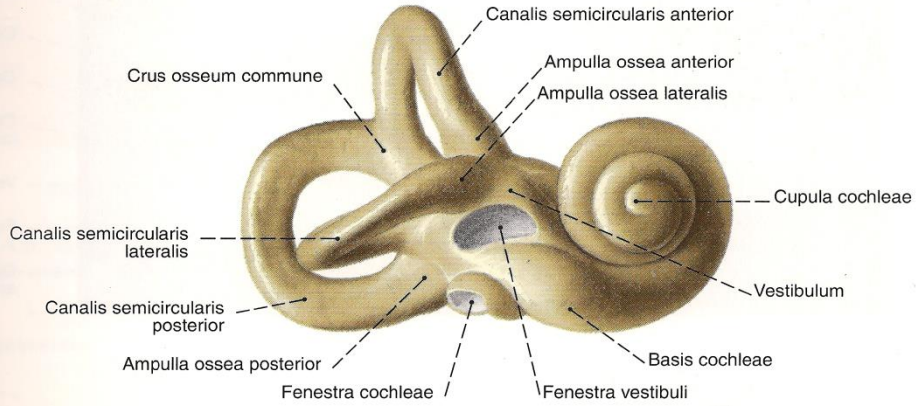
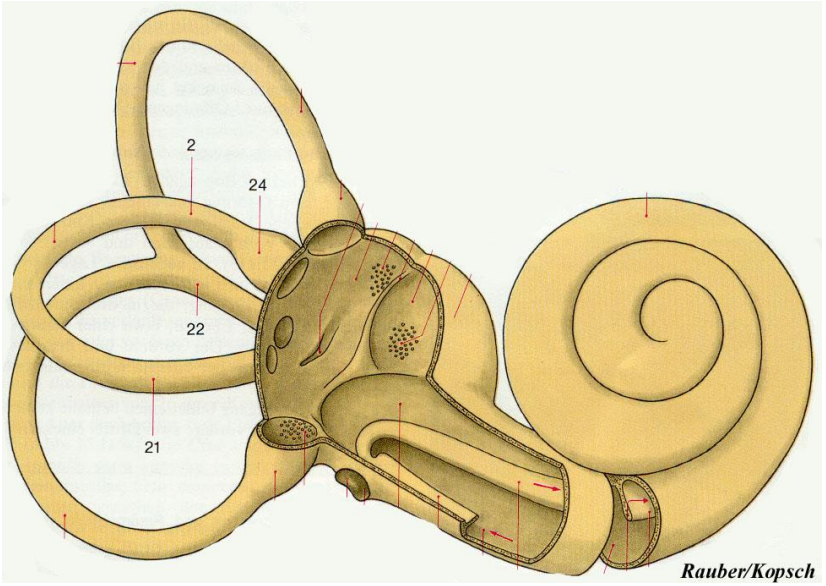


667. ábra Ugyanaz, mint a fenti, oldalról és elölről (jobb oldal, 300%).

The 3 bony semicircular canal with 5 crura - <u>crura ossea</u> – and with 5 openings open to the vestibule, (not 6, because the crus of the posterior and anterior opens commonly – <u>crus osseum cummune</u> .

Otherwise:
- <u>crus osseum simplex</u> (simple end)
- <u>crus osseum ampullare</u> (dilatation on the end)

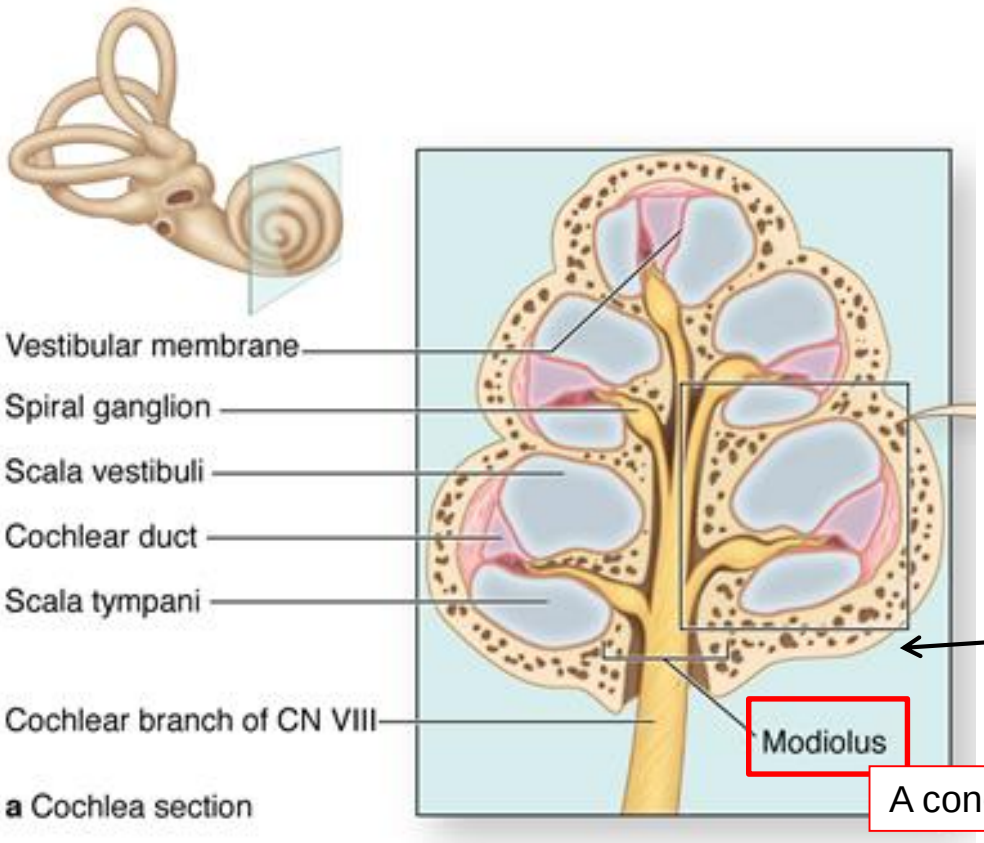
- Where can be found the ampullary end of the semicircular canals?- These are areas of the nerves exits!!!



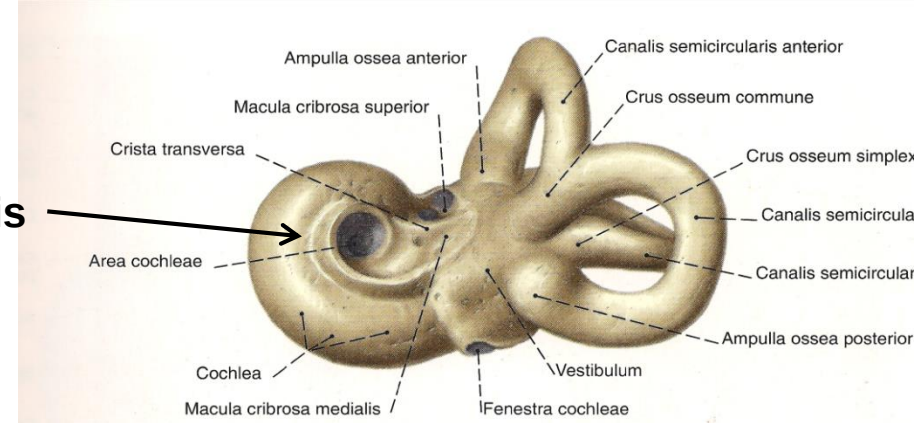
Cochlea

3 mm in diameter – similar to snail shell

2 and ¾ turning



Basis



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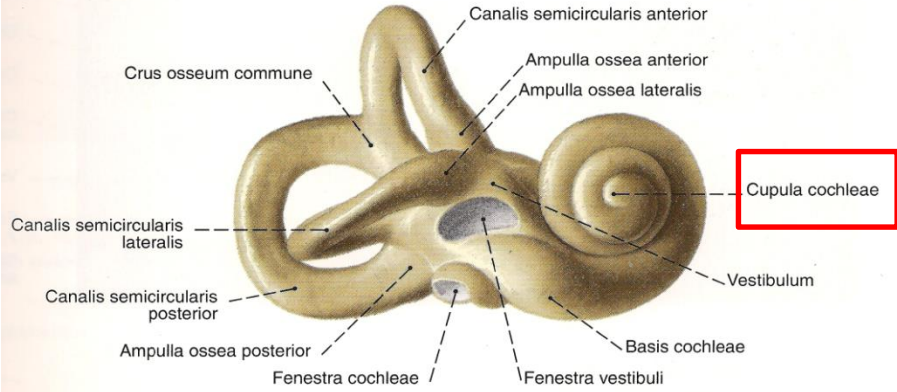

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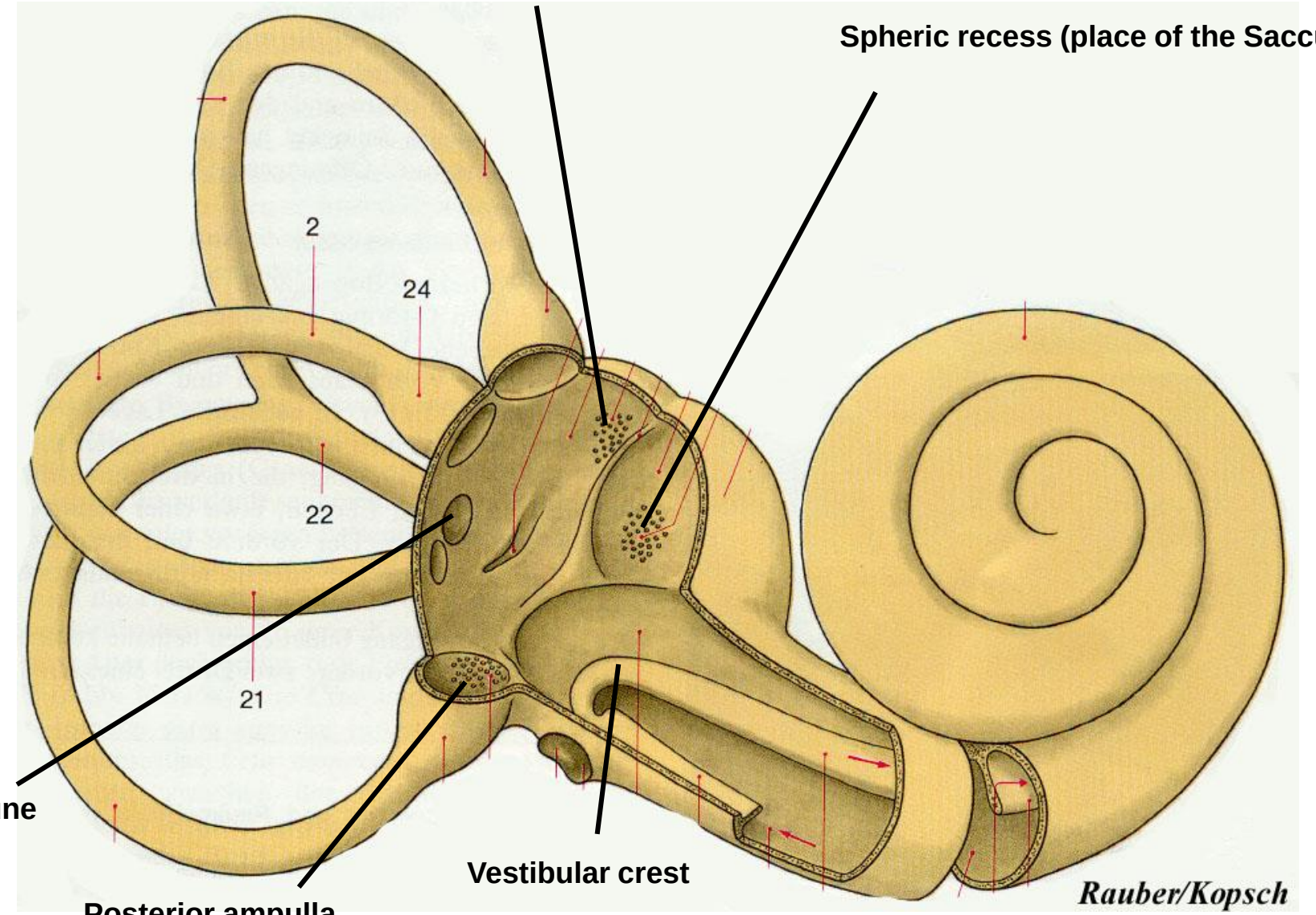
Basis – It looks to the fundus of the internal acoustic meatus

A cone like cavity in the axis

Vestibule

Pear-shape bony central cavity

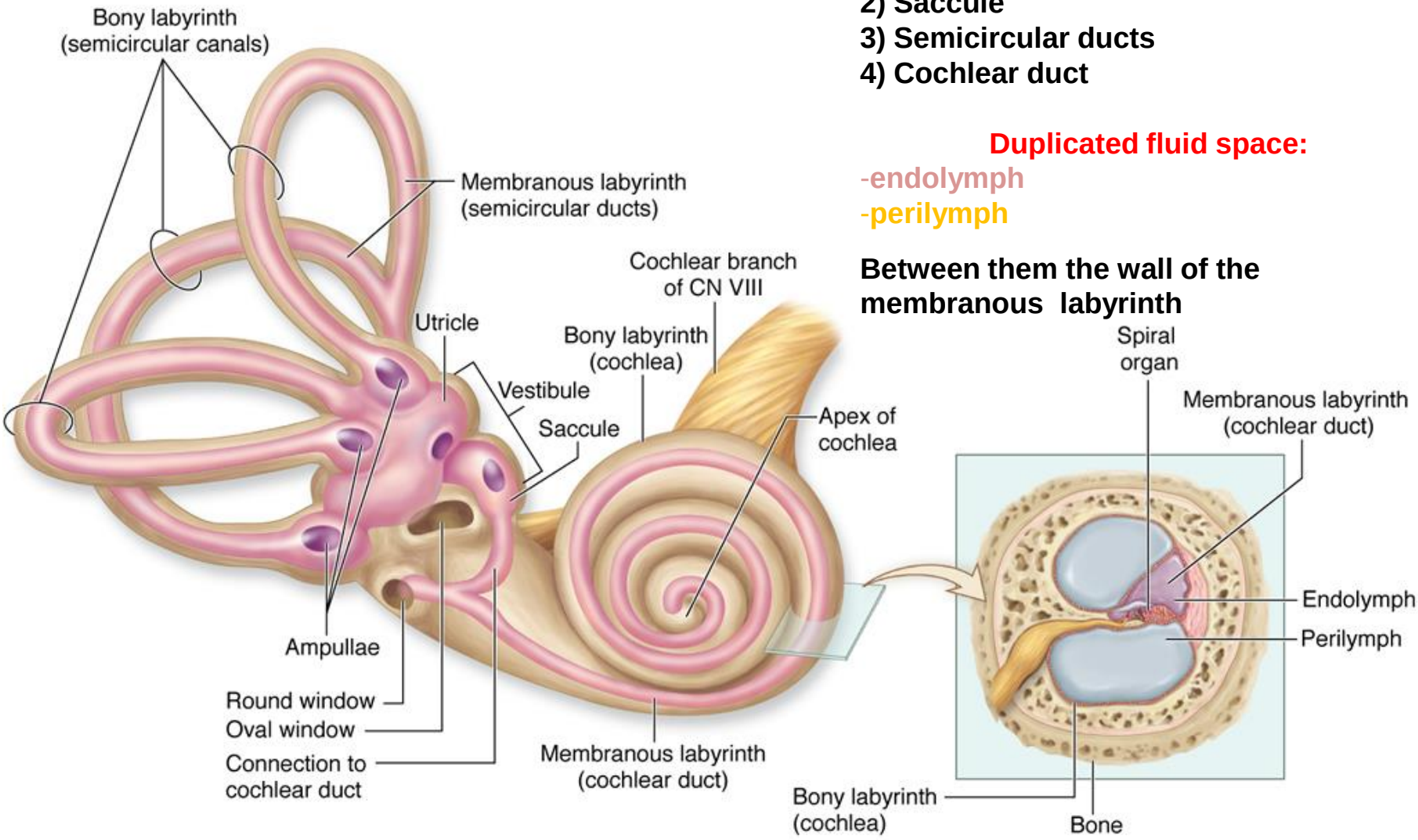


Parts of the membranous labyrinth

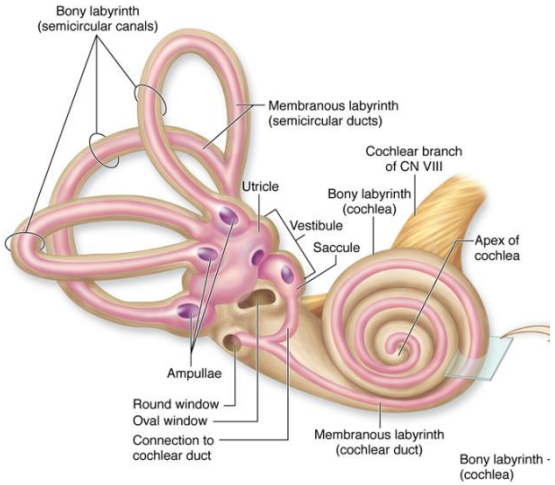
1) Utricle
2) Saccule
3) Semicircular ducts
4) Cochlear duct

Duplicated fluid space:
-endolymph
-perilymph

Between them the wall of the membranous labyrinth



Wall of the semicircular ducts

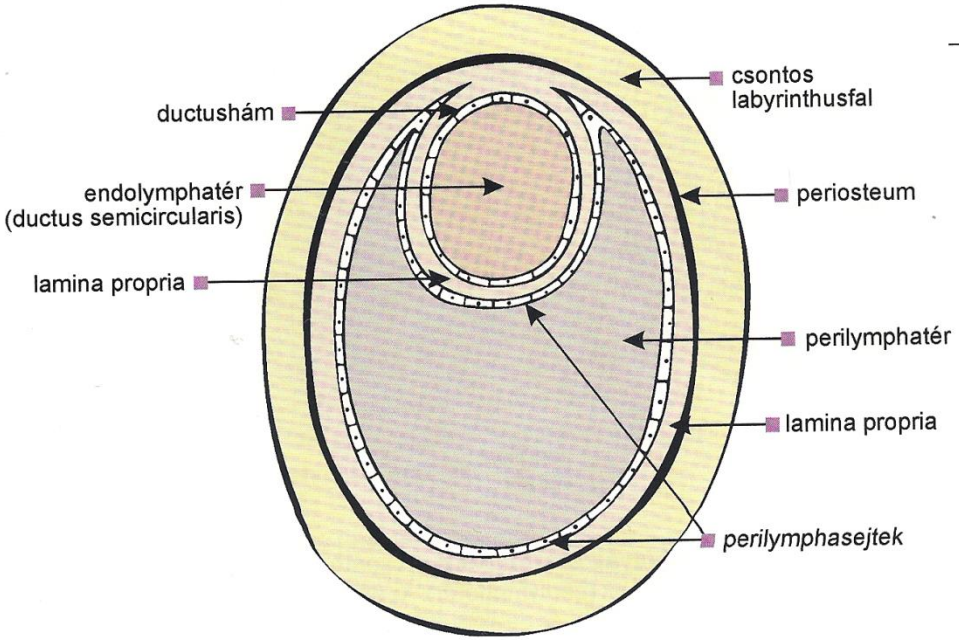


Perilymph cells – modified superficial fibroblasts of the periosteum - like sqamous cells cover the surface of the perilymphatic spaces

Anchoring connective tissue fibers in the perilymphatic space

Fine vascular net

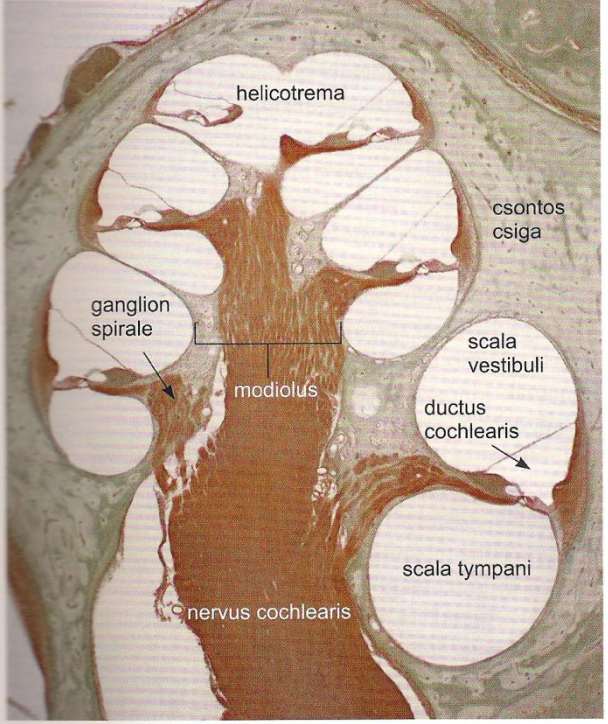
Ductus epithelium – squamous or low cuboidal epithelium



23-3. ábra

A félkörös ívjárat (crus simplex) keresztmetszete.

Borders of the cochlear duct

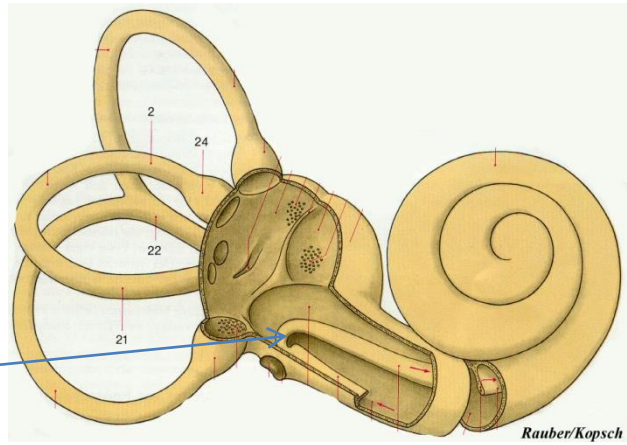


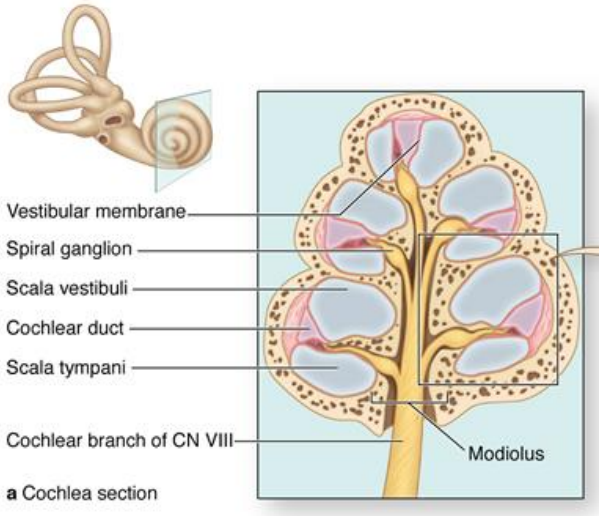
23-8. ábra

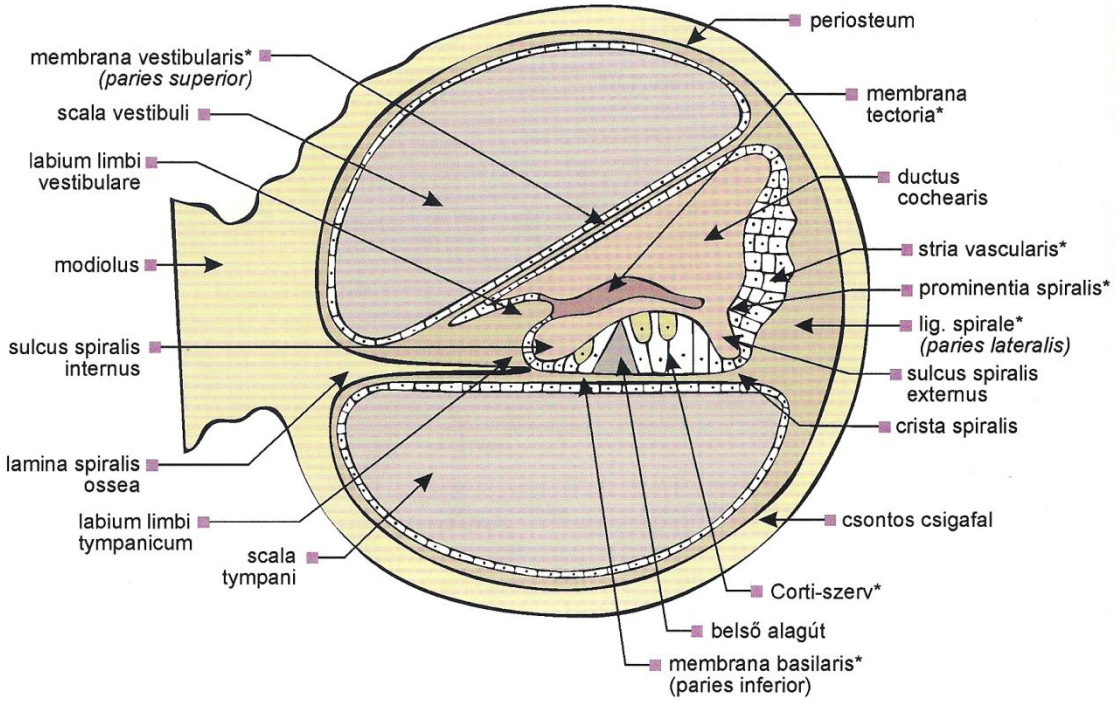
A csiga hosszmetszeti képe (macska belső fül, HE, 23×).

Both end is blind!!!
Through the reuniens duct connects with saccule

Vestibular crest



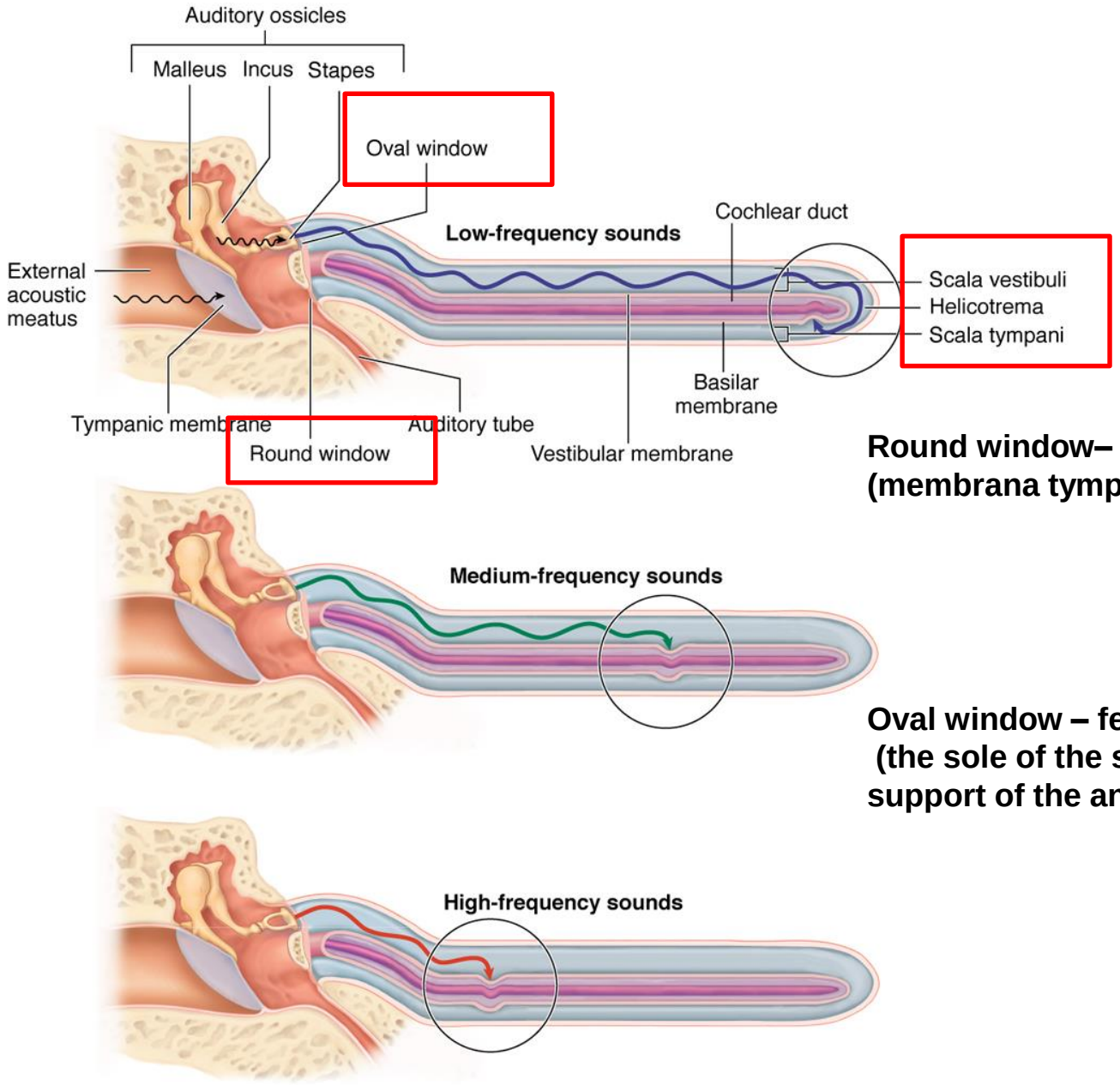




23-9. ábra

A csigajárat keresztmetszete. Az endolymphatér rózsaszín, a perilympha-tér halványkék. Az alagutat kitöltő folyadék (cortilympha) összetétele a perilymphához hasonló, ezért szintén kék színnel van feltüntetve. A ductus cochlearis falát alkotó képletek neveit csillaggal jelöltük meg.

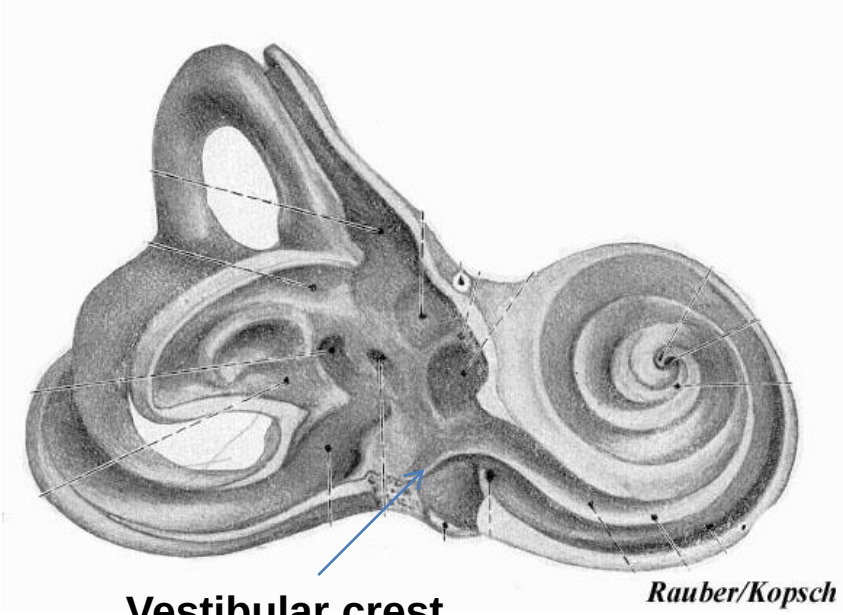
Scala vestibuli and scala tympani

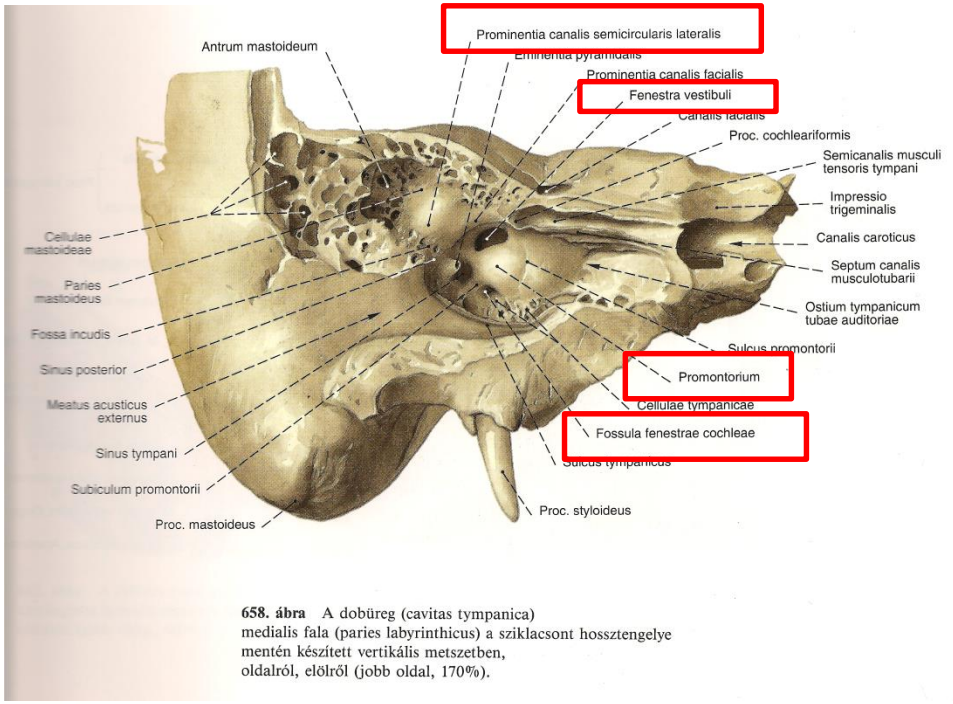


Round window– fenestra cochleae (membrana tympani secundaria close it)

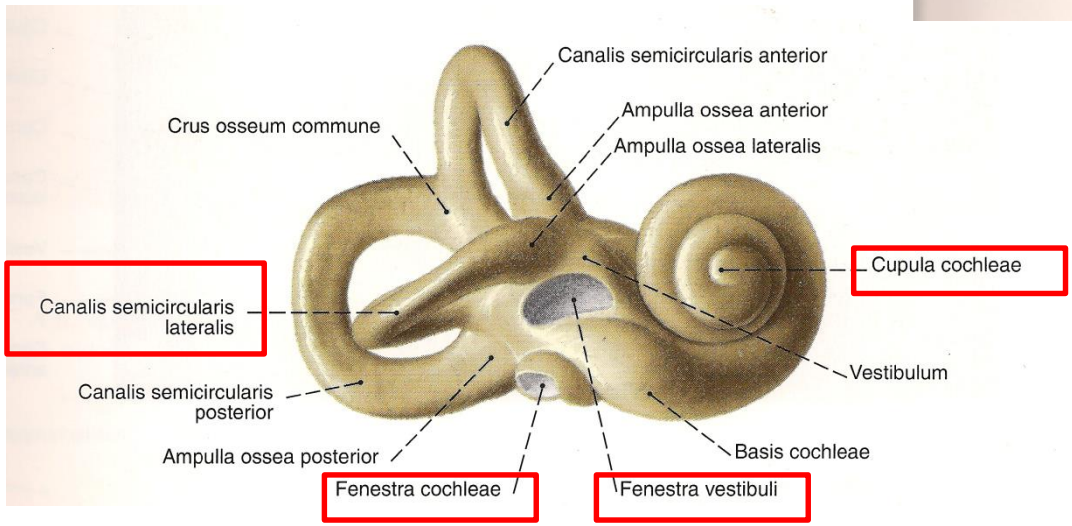
Oval window – fenestra vestibuli (the sole of the stapes fit it with the support of the anular ligament)

From the middle ear

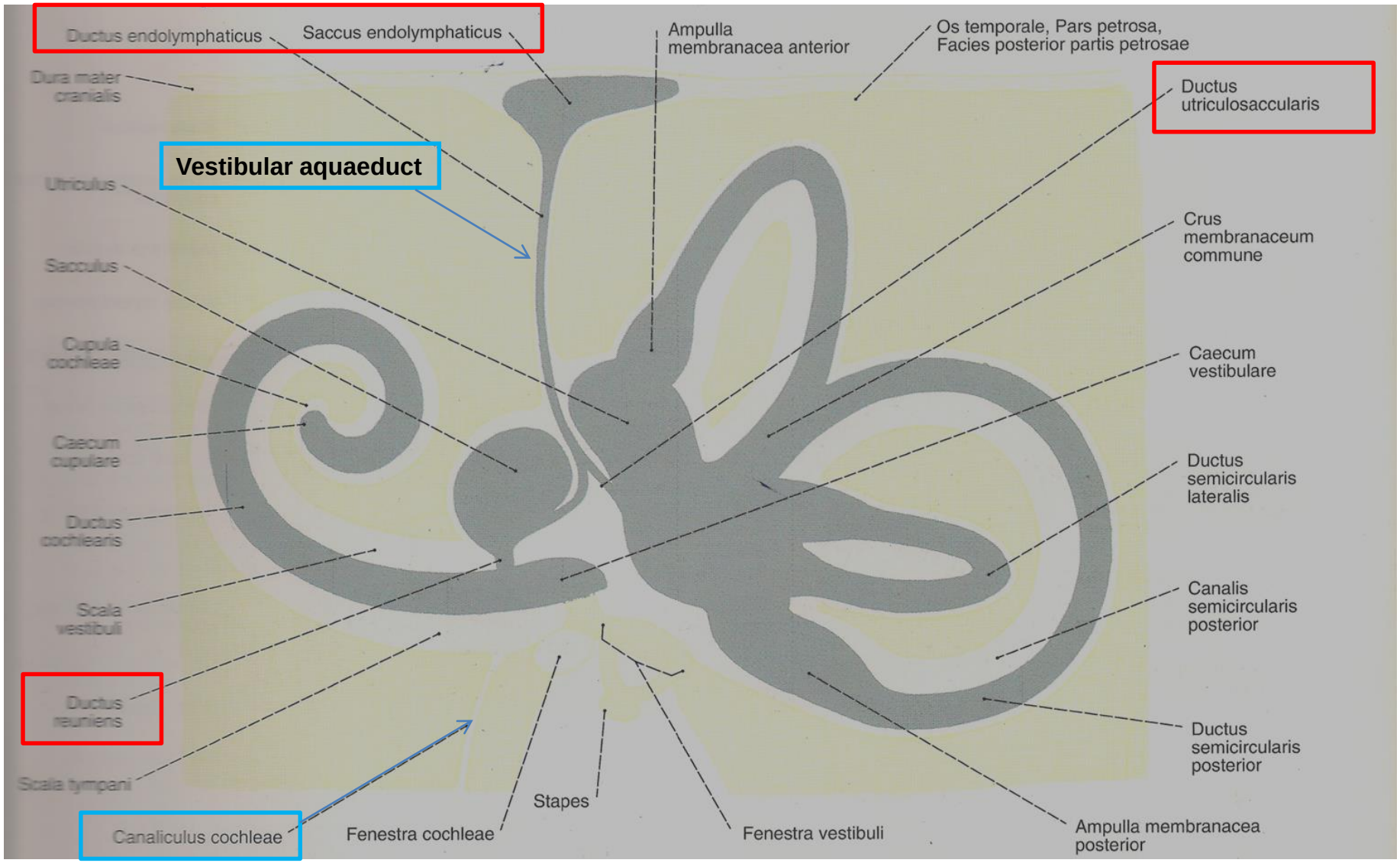




658. ábra A dobüreg (cavitas tympanica) medialis fala (paries labyrinthicus) a sziklacsont hossztengelye mentén készített vertikális metszetben, oldalról, elölről (jobb oldal, 170%).



Connections of the perilymphatic and endolymphatic spaces



Features of the perilymph and endolymph

-Endolymph:

- high K^+ conc. Similar to intracellula fluid
- produce by the supporting cells of membranous labyrinth and the stria vascularis of the cochlear duct.
- Absorption by the endolymphatic sac.

-Perilymph:

- Similar to the CSF.
- Production place are not defind.
- This space connects with the subarachnoid space (origin!!! Production?)

-<u>Perilymphatic flood gate</u>:

1) Vestibular aquaeduct – connects the vestibule with the posterior surface of the pyramid (contain the endolymphatic duct)

-2) Cochlear aquaeduct - It's aperture opens between the petrous fossula an jugular fossa, where it allegedly connects with subarachnoid space which follows the CN9.

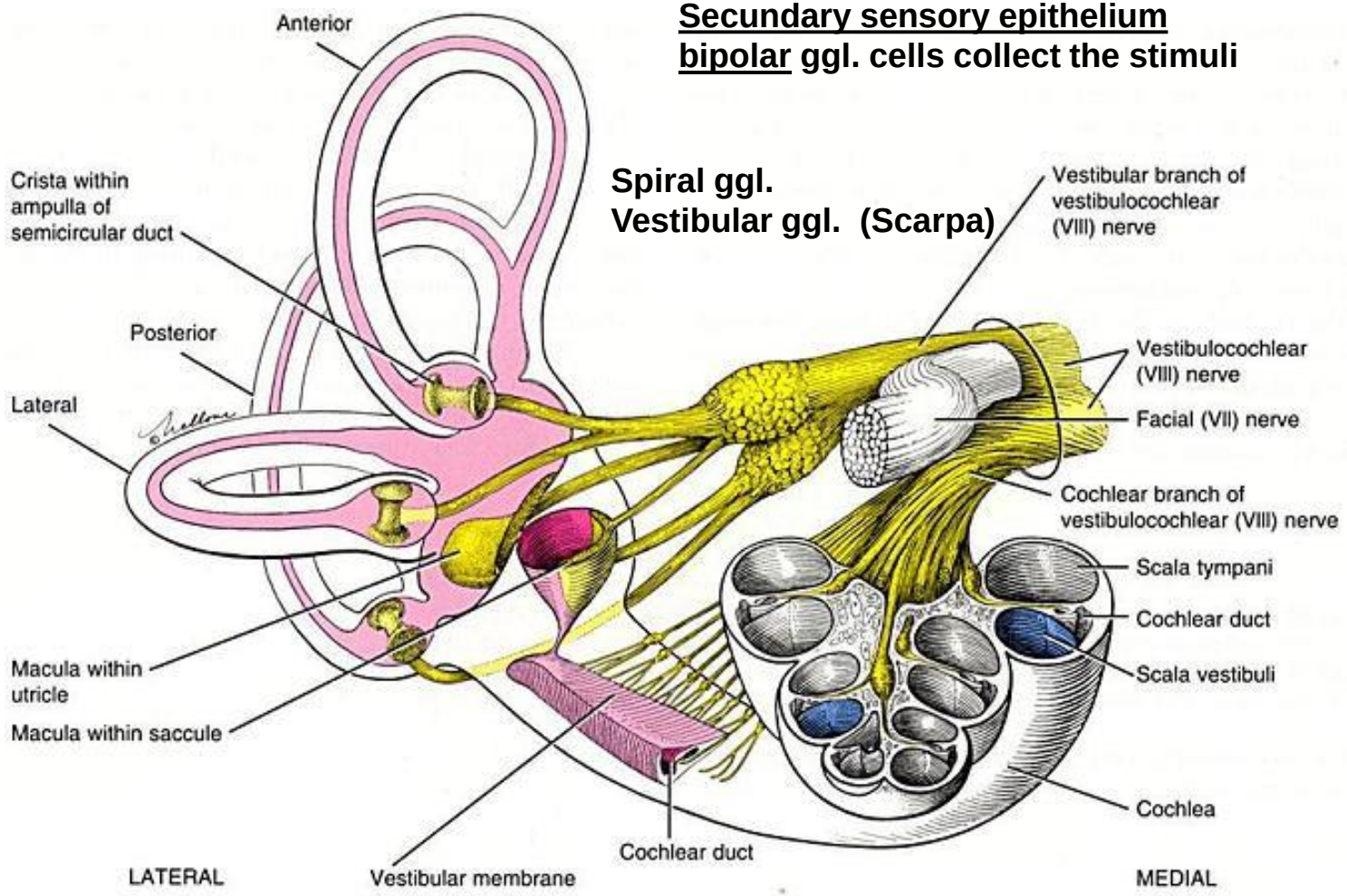
Sensor areas within the labyrinth

Hearing: Organ of Corti

Vestibular organ:
2 macula (one in saccule and one in utricle)
3 ampullary crest (within the ampullae)

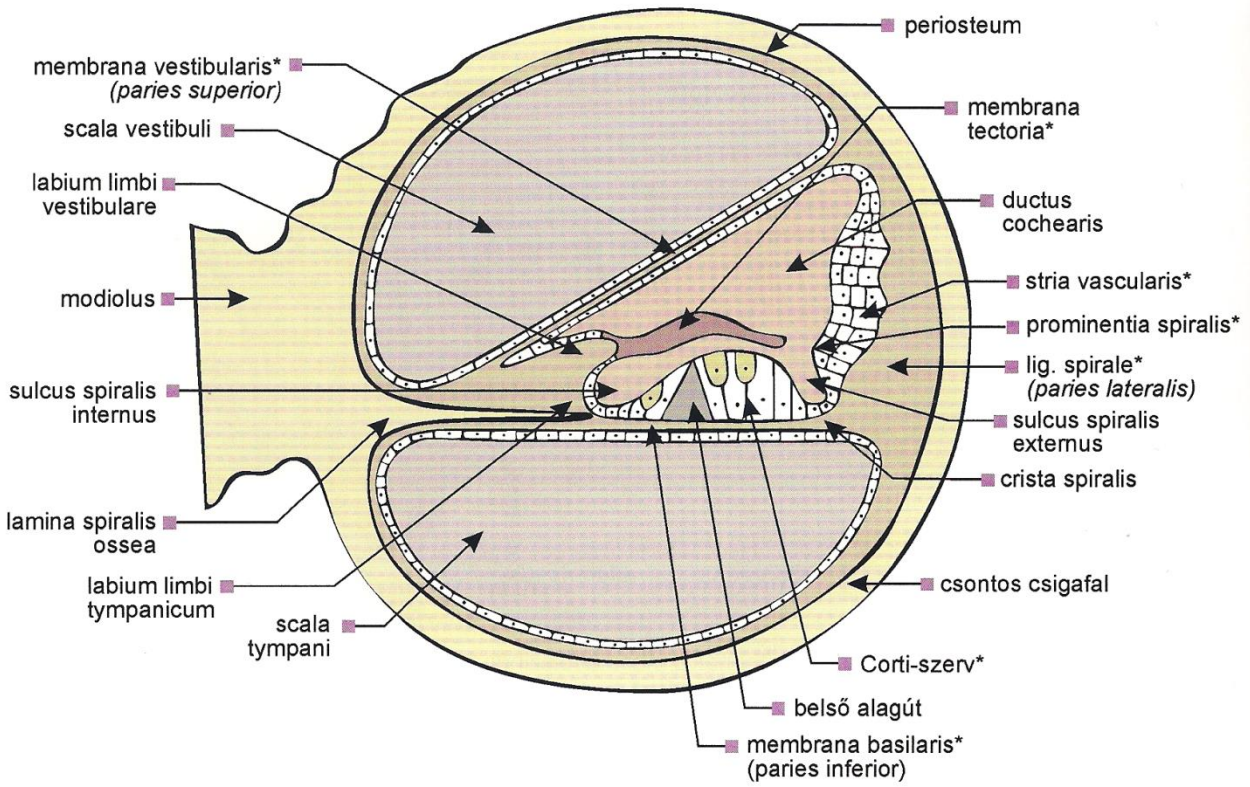
Common points:
Secundary sensory epithelium
bipolar ggl. cells collect the stimuli

Spiral ggl.
Vestibular ggl. (Scarpa)



(b) Parts of the vestibulocochlear (VIII) nerve of the right ear

Organ of Corti



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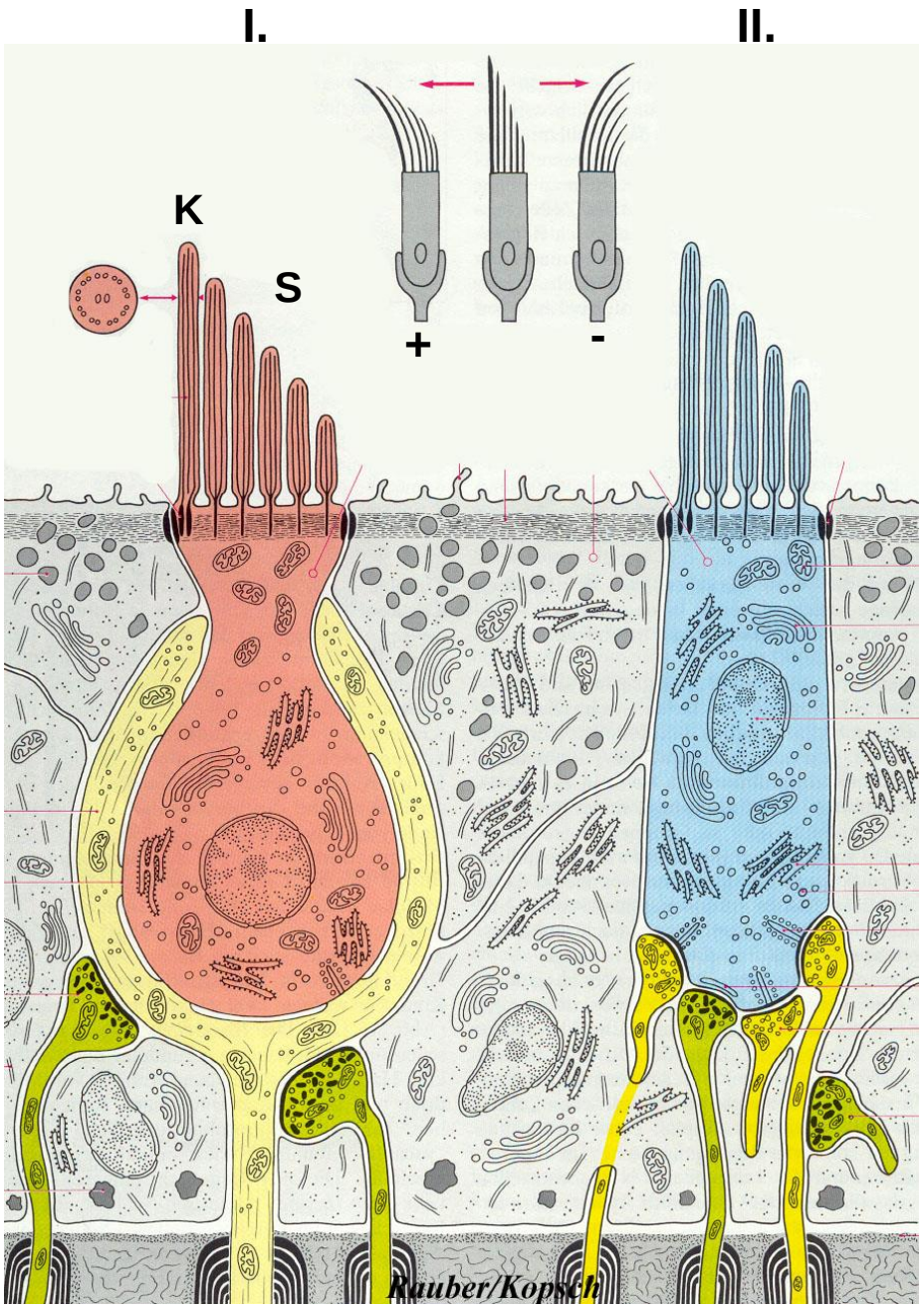
Structures of the end apparatus

Cellular elements of the macula and ampullary crest

- Kinocilium (9x2 +2) and 40-100 stereocilia, Like arrangement of pipe organ(1-100 μm)

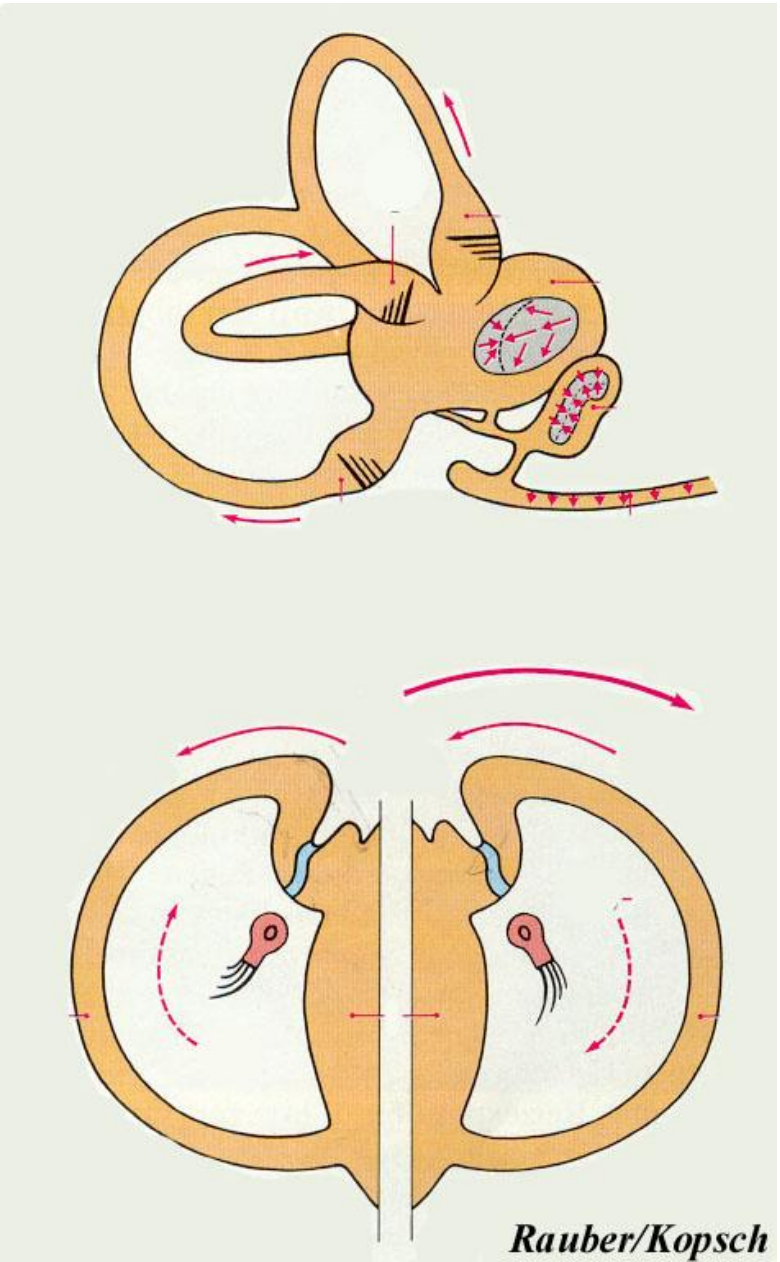
- Mechanoreceptors within the otolithmembrane or cupula

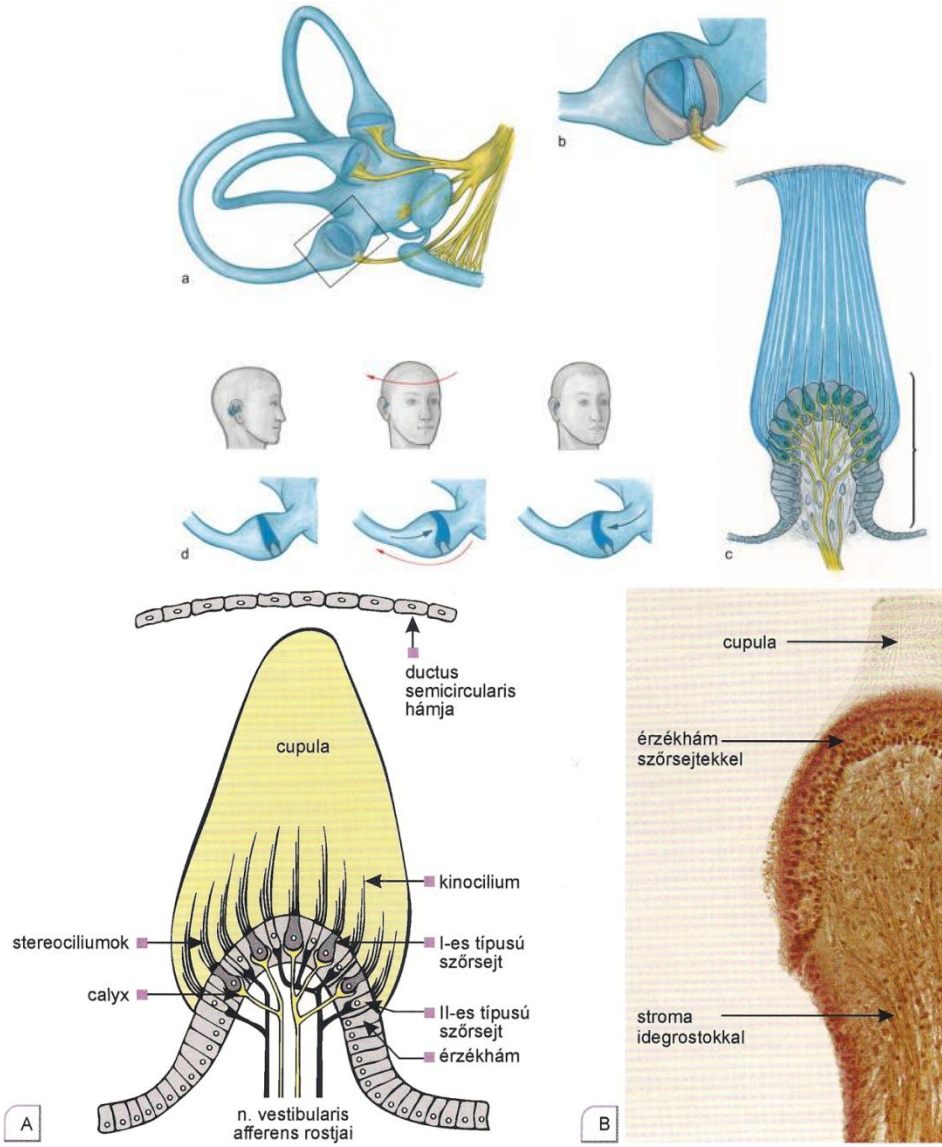
Supporting cells: irregular shape, nutrition, protection



Ampullary crest

Orientation of kinocilia within the ampulla!!!

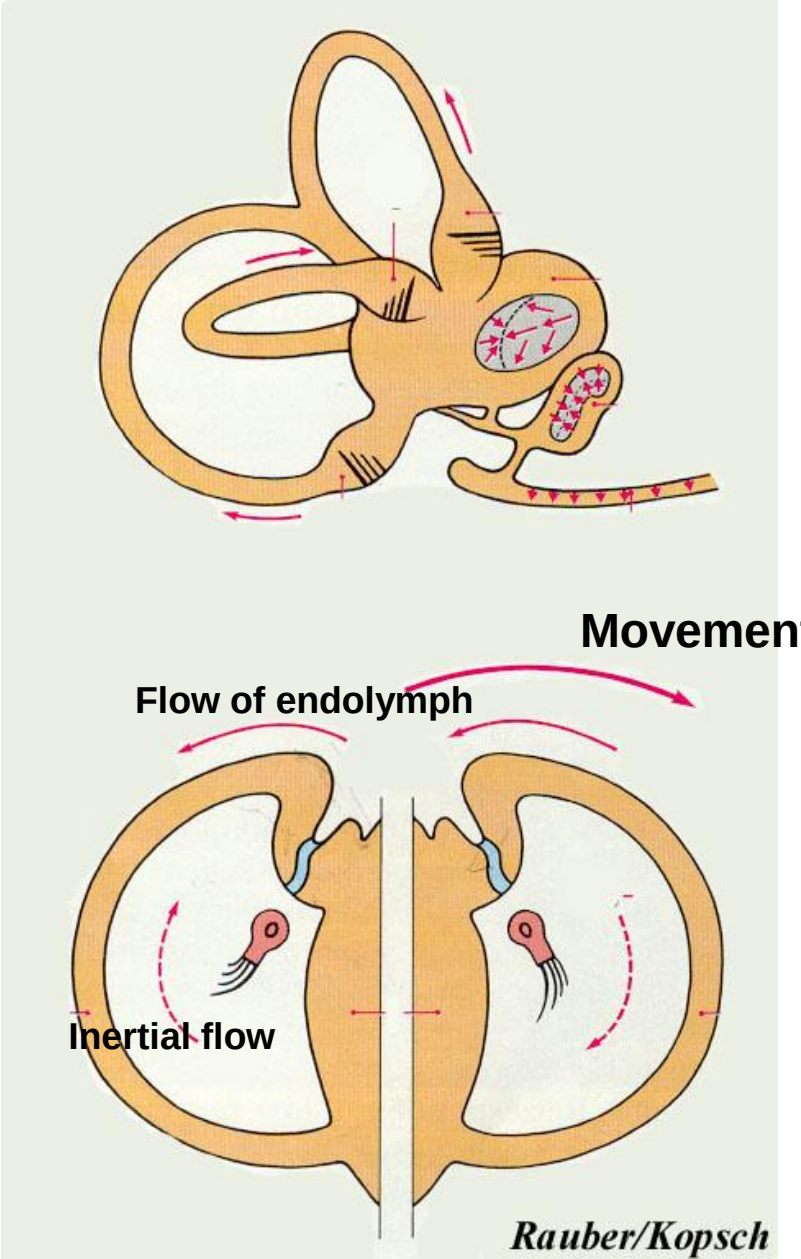


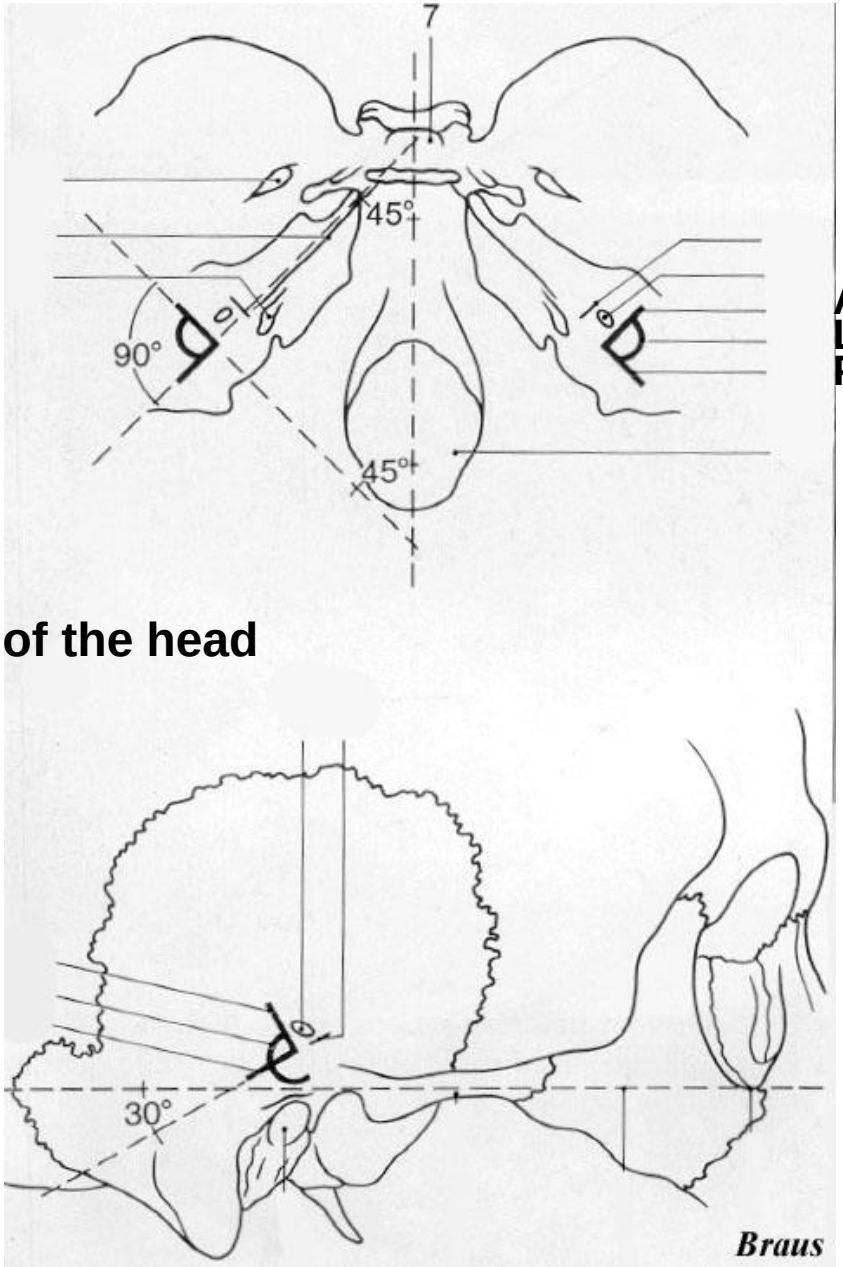


23-6. ábra

Crista ampullaris. A: Szerkezeti vázlat, **B:** fénymikroszkópos felvétel a szöveti szerkezet bemutatására (HE-festés, 150×)

Ampullary crest *in situ* – *the stimulus is the angular (rotational) acceleration*

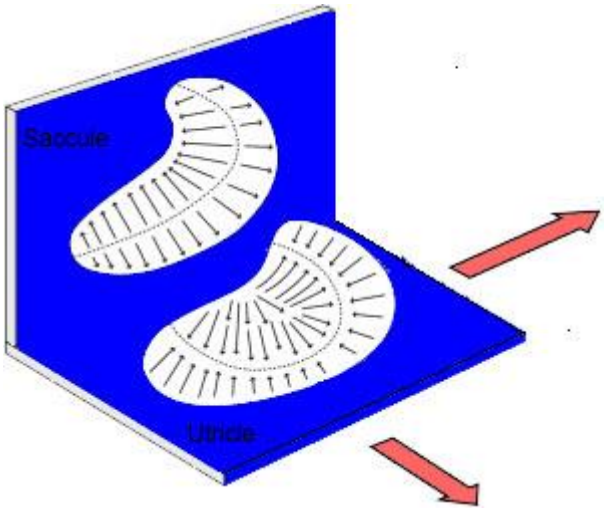


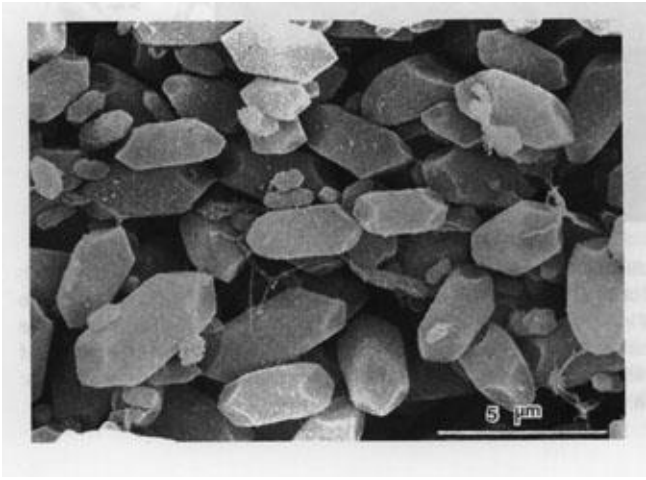


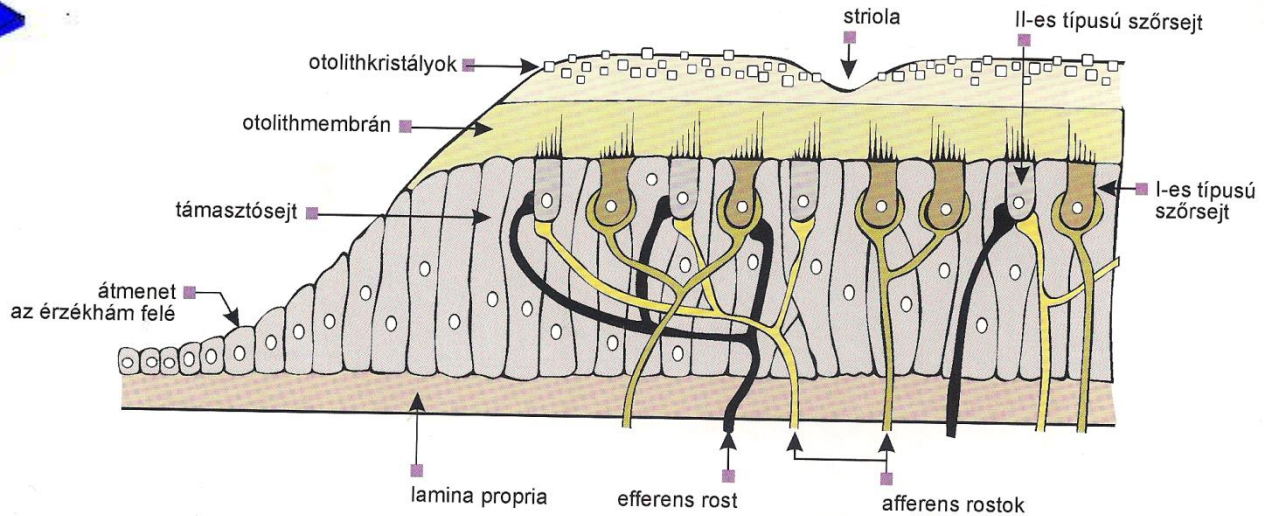
Movement of the head

Macula of the utricle and saccule

The orientation of kinocilia within the saccule utricle is opposite relative to striola!!!







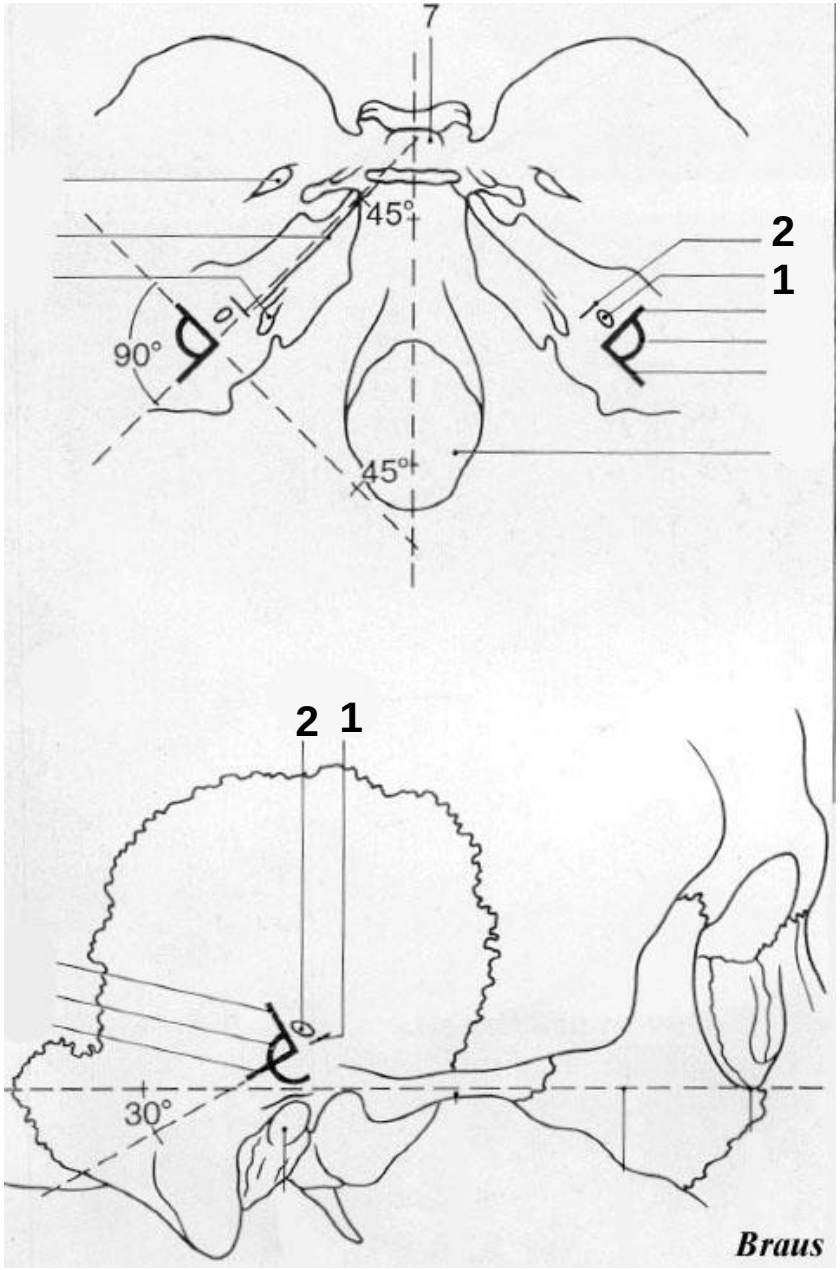
23-7. ábra

A macula utriculi szöveti szerkezete. A kinociliumok a macula felszínén végighúzódó bemélyedés (striola) felé néznek. A n. vestibularis afferens rostjai közvetlenül a szőrsejteken végződnek. Az efferens rostok a II-es típusú szőrsejtekkel közvetlenül, az I-es típusú szőrsejtekkel a calyxon keresztül synaptizálnak.

The macula *in situ – the stimulus is the linear acceleration*

1: macula utriculi

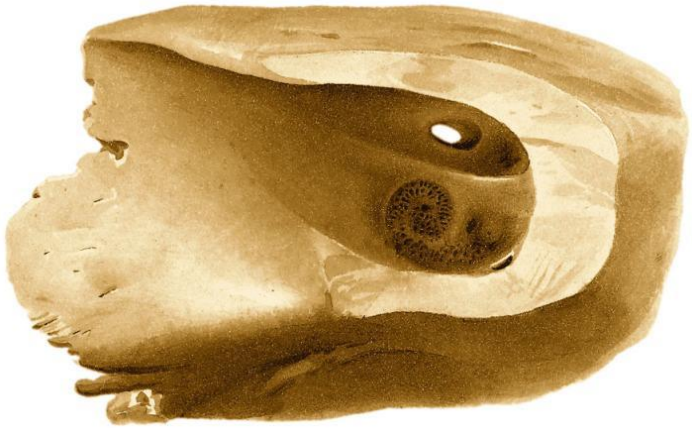
2: macula sacculi



excitability – position of the head

Additional information from proprioceptors

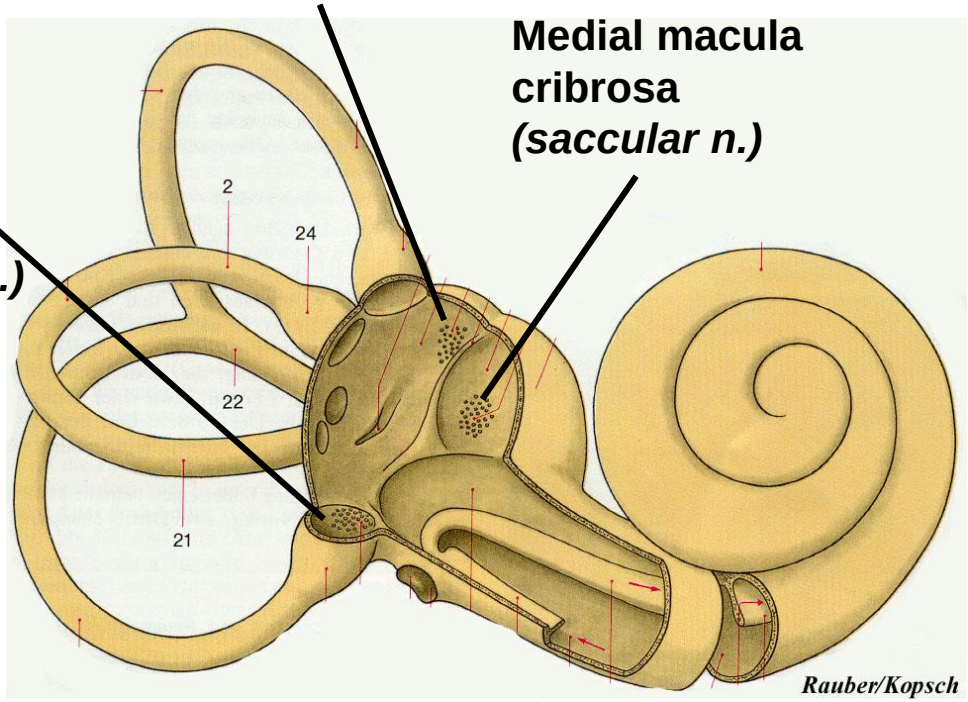
Maculae cribrosae and the vestibular nerve

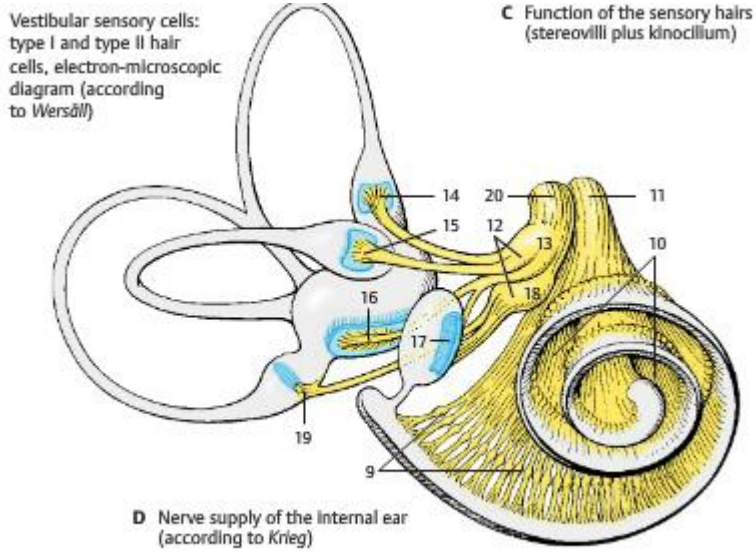


Superior macula cribrosa
(utricular n, ant. and lat. ampullar nn.)

Medial macula cribrosa
(saccular n.)

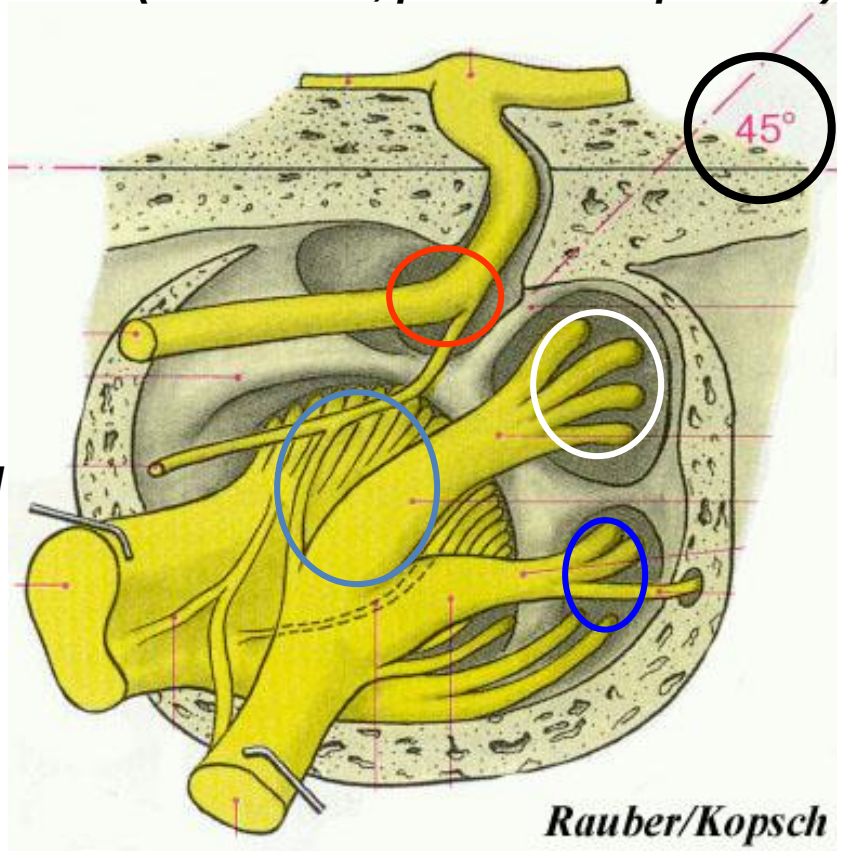
Inferior macula cribrosa
(posterior ampullar n.)

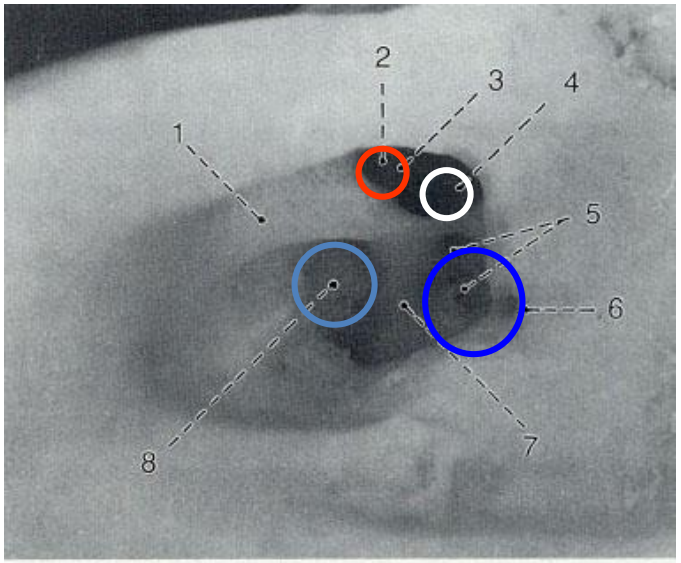


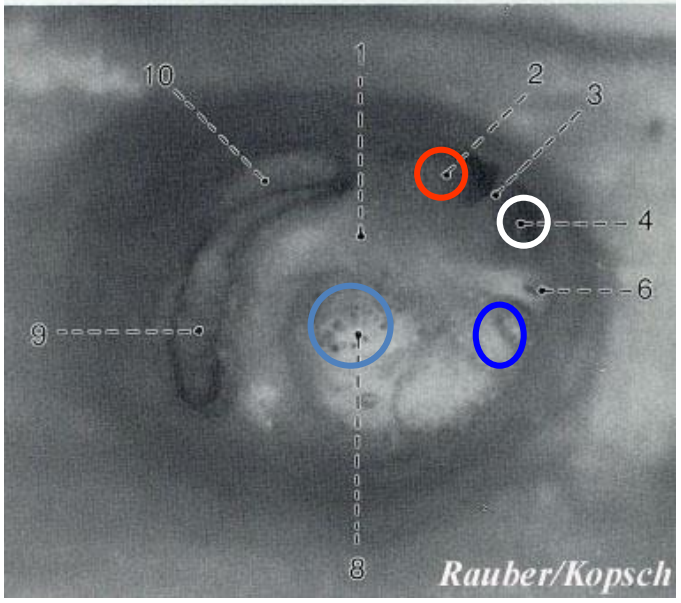


Internal acoustic meatus and the vestibulocochlear nerve

- Area of the facial n. – *facial n.*
- Supeior vestibular area – *utriculoampullar n.*
  (utricular n., ant. and lat. ampullar nn.)
- Tractus spiralis foraminosus – *cochlear n.*
- Inferior vestibular are and the singular foramen
  - *sacculoampullar n. (saccular n., posterior ampullar n.)*

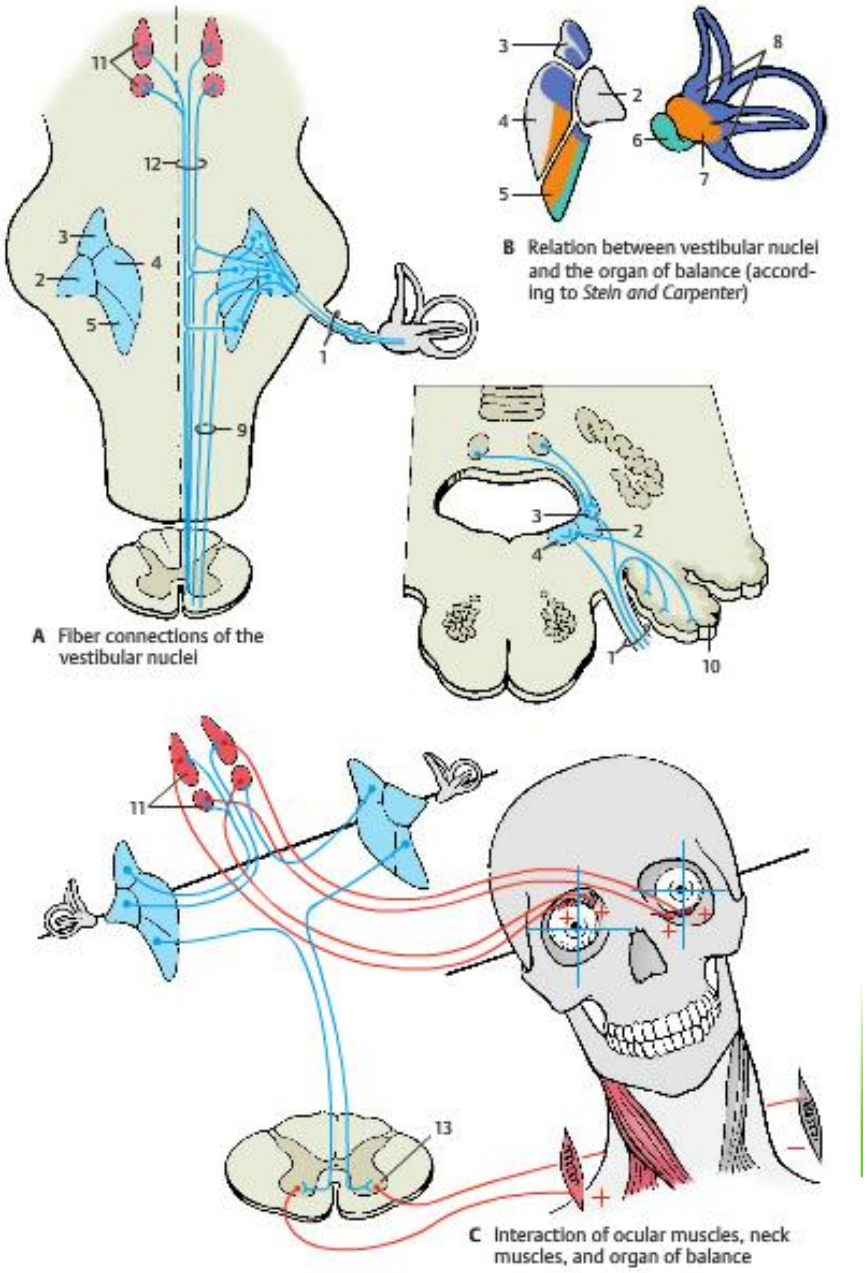


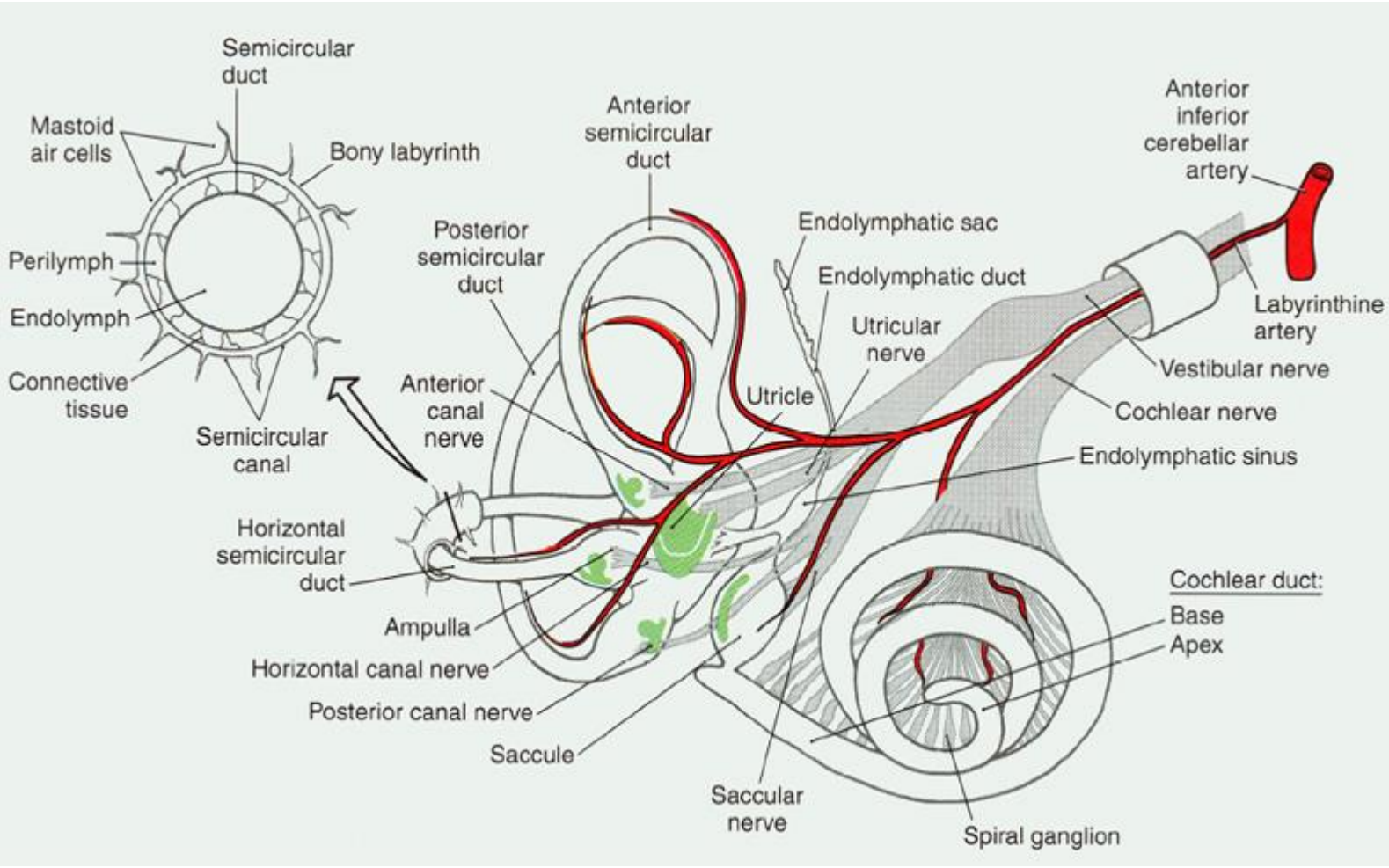




Vestibular ggl.
(anteroinferior and posterosuperior parts)

MLF – medial longitudinal fascicle




Semicircular duct
Mastoid air cells
Bony labyrinth
Perilymph
Endolymph
Connective tissue
Semicircular canal
Anterior semicircular duct
Posterior semicircular duct
Anterior canal nerve
Horizontal semicircular duct
Ampulla
Horizontal canal nerve
Posterior canal nerve
Saccule
Saccular nerve
Utricle
Endolymphatic sac
Endolymphatic duct
Utricular nerve
Anterior inferior cerebellar artery
Labyrinthine artery
Vestibular nerve
Cochlear nerve
Endolymphatic sinus
Cochlear duct:
Base
Apex
Spiral ganglion