The inner ear

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The inner ear (site):

Petrous part of temporal Bone

The inner ear (parts):

1: cochlea

2: vestibular apparatus

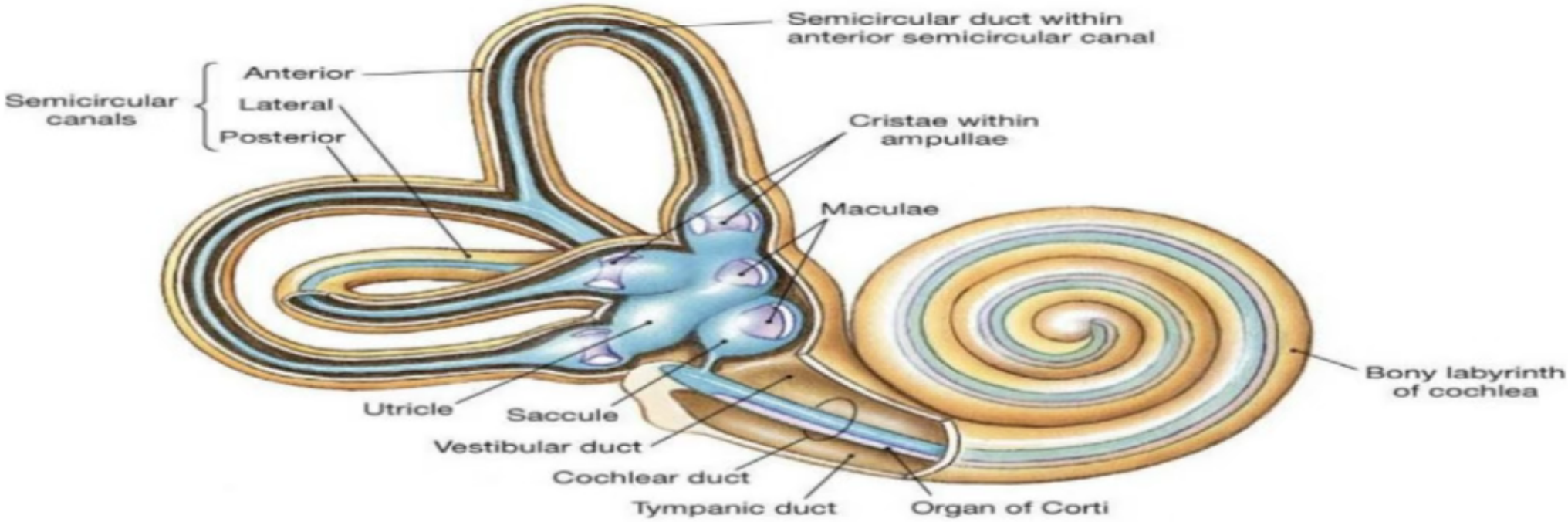


Fig: inner ear

1: Cochlea (Def):

- **3.5cm long** coiled bony tube
- Makes **2½ Turns around modiolus** (bony axis)

Cochlea (features):

1. **start** (broad base), **End** (narrow apex)

2. Cochlear cavity divided by **2 membranes**
Vestibular membrane/ Basilar membrane

3. Chochlear Cavity divided to **3 compartments or (scalae)**
Scala vestibuli/ Scala media/ Scala tympani

Scala media (endocochlear duct):

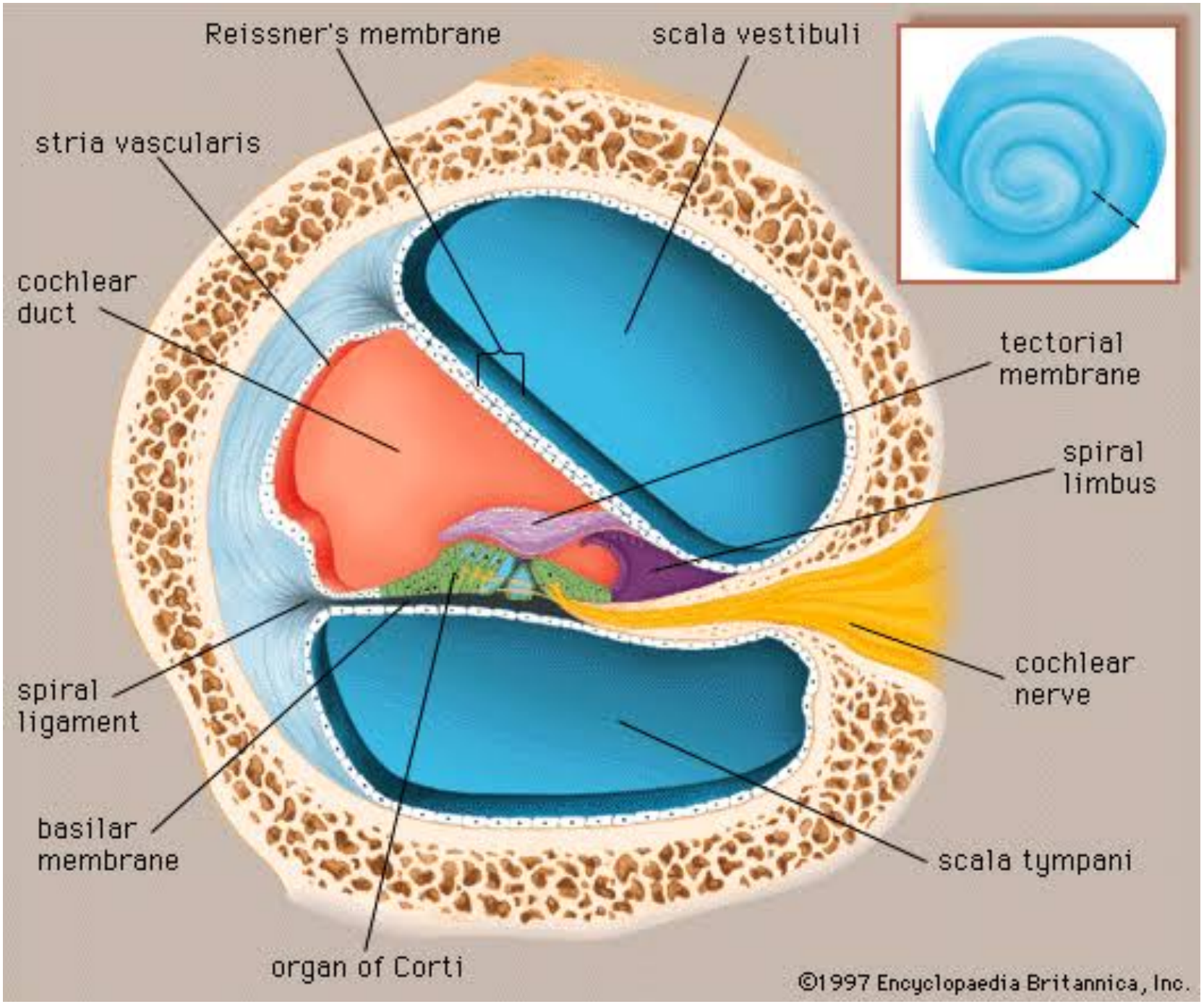
- Contains **endolymph** (similar to intercellular fluid)
- end at the cochlea apex as **blind sac**

Scala vestibuli & tympani

- contain **perilymph** (similar to Extracellular fluid)
- Both end at the cochlea base

S. Vestibuli: **ends at the oval window**

S. Tympani: **ends at the round window**


Reissner's membrane
scala vestibuli
stria vascularis
cochlear duct
tectorial membrane
spiral limbus
spiral ligament
cochlear nerve
basilar membrane
scala tympani
organ of Corti
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- **oval window:** sealed by footplate of stapes
- **round window:** sealed by flexible 2ry tympanic membrane

vestibular membrane (Def)

- Thin, easy moving membrane that **transmits vibrations** from s.Vestibuli to s.Media

Basilar membrane (Def)

- Fibrous, **carry organ of corti**
- Contain 25,000 **basilar fibers** that project from the modiolus to outer cochlear wall

The basilar fibers gradually change in diameter, length & stifness as they move from base to apex (Short, thick, stiff at base) & the opposite at apex

With gradual change in between

The organ of corti (Def)

- It's the sense **organ of hearing**

Site: Basilar membrane

(spirally from base to apex of cochlea)

The organ of corti (structure)

- **Receptor** (hair) **cells (2 types)** {next slide}
- **supporting** (phalangeal) **cells**
- **Tectorial membrane:** gelatinous elastic tissue on hair cells' cilia
- **Nerve Fibers**: peripheral cochlear nv branches **synapse** with hair cells & nv fibers **cross** tunnel of corti to **reach** spiral ganglion in cochlear modiolus

Receptor (hair) **cells** (2 types)

1: Outer hair cells (20,000 cells in 3~4 rows)
controlling sensitivity of inner ear to different pitches of sound

2: inner hair cells (3,500 in a single row)
detecting sounds

☆**Both (outer & inner) are:**

- **Separated by rods of corti** (arches of corti tunnel)
- Hair bearing ends are **packed by reticular lamina** which is supported on the rods of corti
- Bases & sides of hair **surrounded** by cochlear nv ends

Auditory Hair cells (def):

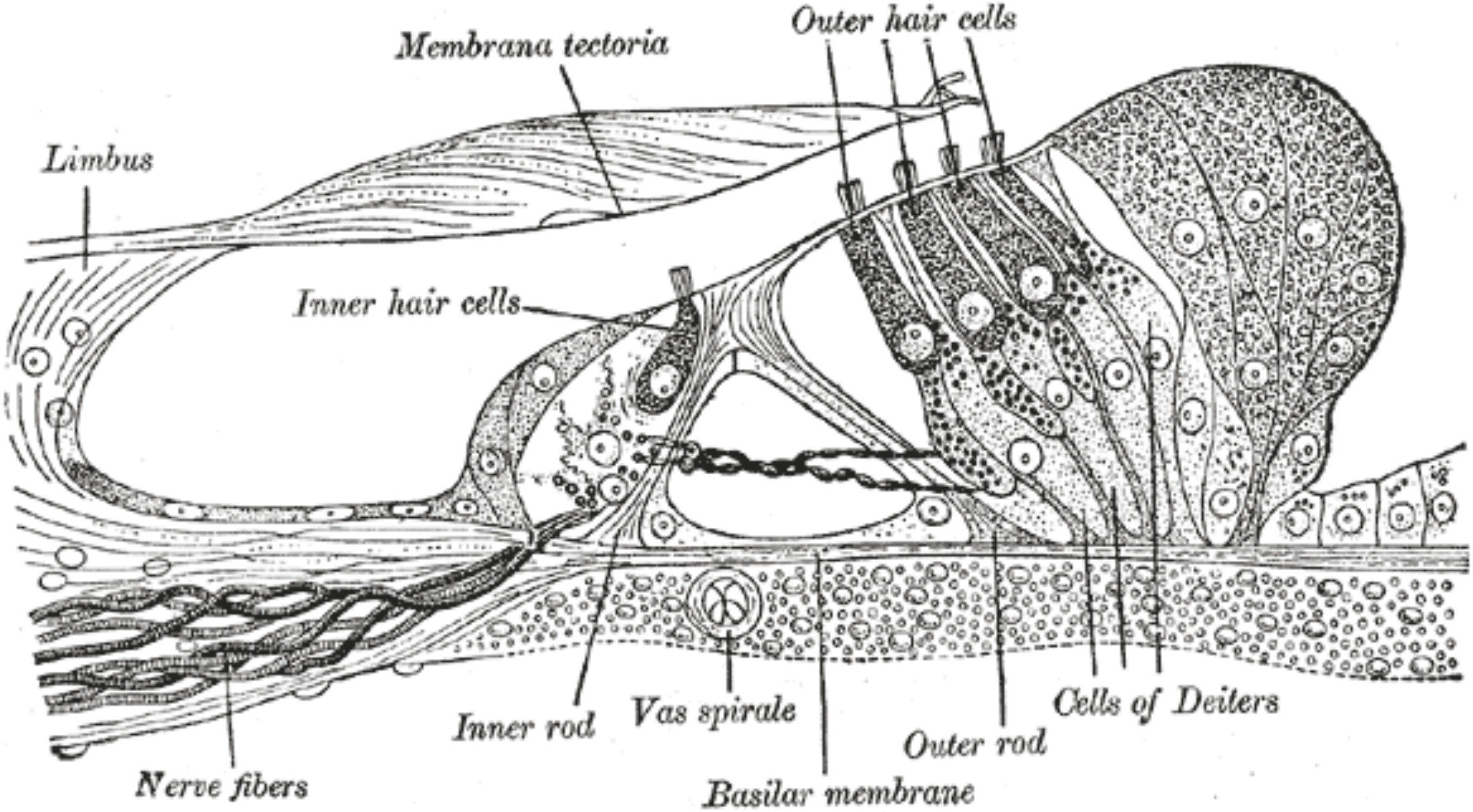
Mechanoceptors Detect movement

Auditory Hair cells (structure):

- **Hair bundle** (apical end)
- **Synaptic contact** (with cochlear nv fibers at basilar end)

Hair bundles (types):

- **Kinocilium** (Lare one on one side of the bundle)
- **Stereocilia** (many less in height, connected by elastic protein filaments called **tiplinks**, but still slide respectively to each other
- When the bundle deflects on side.


Membrana tectoria
Outer hair cells
Limbus
Inner hair cells
Inner rod
Vas spirale
Cells of Deiters
Outer rod
Nerve fibers
Basilar membrane

Mechanism of hearing (steps):

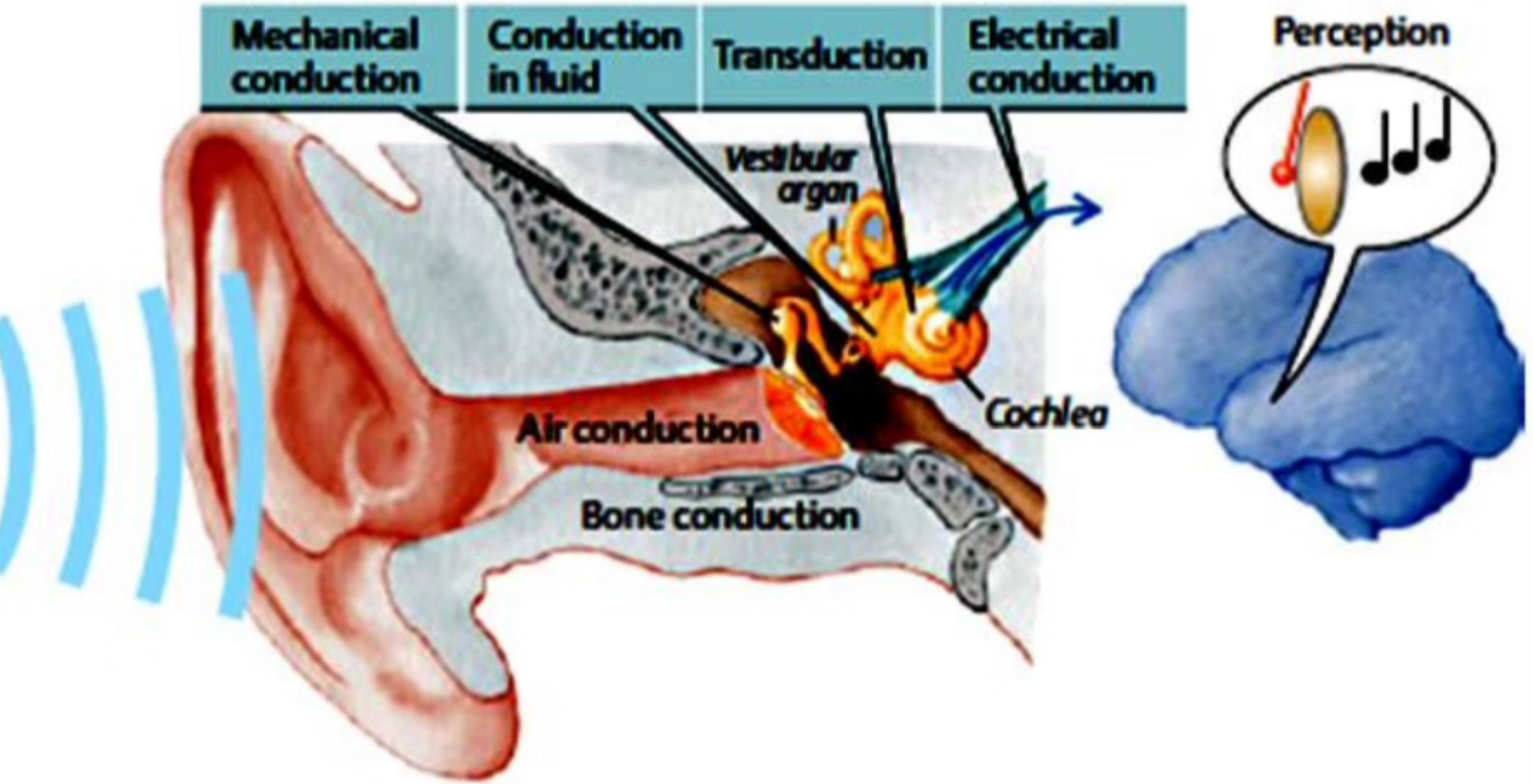
1) transmission of sound in (**OUTER AND MIDDLE ears**)
2) Transmission of sound in **cochlea** (traveling wave)
3) Receptor potential & cochlear nv impulse

1) transmission in outer & middle ear:

Ear pinna **collects & directs** sound to **external auditory canal**

-> sound vibrates **tympanic membrane** at same frequency

-> movements of tympanic membrane are transmitted & amplified by 3 bony ossicles of **middle ear** to oval window via Stapes footplate


Mechanical conduction
Conduction in fluid
Transduction
Electrical conduction
Perception
Vestibular organ
Cochlea
Air conduction
Bone conduction

2) transmission in cochlea (traveling wave):

(Traveling wave in the **basilar membrane**)

Inward movement of the footplate of stapes -> ↑ **S.vestibuli perssure**

-> **Displacement of the cochlear membrane** (V & B) to S.Tempani
-> ↑ S. Tempani pressure -> round window **bulge in middle ear**

-> basilar membrane moves rapidly in response to sound waves & these (traveling waves) move in basilar membrane from base to apex

1) Receptor potential & cochlear nv impulse

Basilar membrane Vertical movements -> **shearing force in the tectorial membrane** (depolarization & hyperpolarization) of receptor cells

Endolymph around apex of hair cells has more K^+ than inside hair cells. Opening K^+ channels at the apex causes depolarization, while closing them causes hyperpolarization

- Bending toward the kinocilium **opens K^+ channels** → K^+ influx → depolarization → Ca^{2+} channels open → Ca^{2+} influx → excitatory transmitter (likely glutamate) release → sensory neuron stimulation.
- Bending away **closes K^+ channels** → hyperpolarization → Ca^{2+} channel inhibition → reduced transmitter release.

The Auditory Cortex

	A) Primary auditory area (areas 41 & 42):	B) Secondary (associated) auditory area (area 22):
Site:	The upper part of temporal lobe.	Surrounds the primary area.
Receive impulses from:	-Both ears through fibers from the ipsilateral MGB. - **Anterolateral part** receives impulses from **apex** of cochlea (**low pitched** sounds) and **posteromedial part** receives impulses from **base** of the cochlea (**high pitched** sounds).	the primary auditory area

Functions:	-Perception of pitch, amplitude, and sound pattern without understanding its meaning. -Perception of the source of the sound.	-Interpreting& understanding the meaning of sounds.
Lesion:	- Bilateral damage ➔ greatly reduces the capacity for hearing -Unilateral damage ➔ slightly reduces hearing of the opposite ear	-The person will be unable to interpret the meaning of the heard sound **(auditory aphasia or word deafness).**

-End-