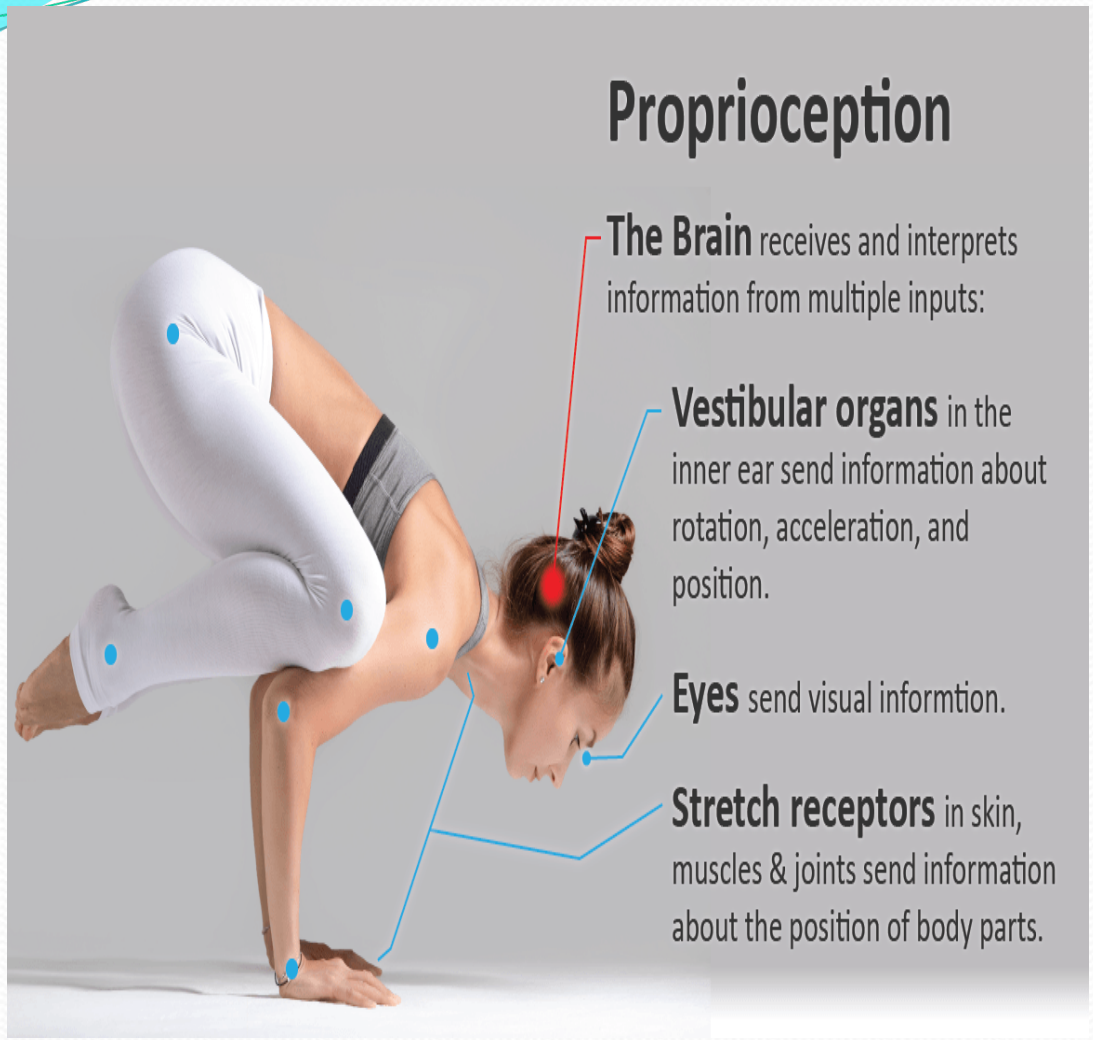
Inner ear in balance and equilibrium



Equilibrium:

Reflexes maintain body position at rest & movement

Through: Receptors of postural reflexes

- 1-Proprioceptors
- 2-Visual(retinal) receptors
- 3-Non auditory membranous labyrinth

- Labyrinth:-

1- Membranous labyrinth :-

a- Auditory (cochlea for hearing)

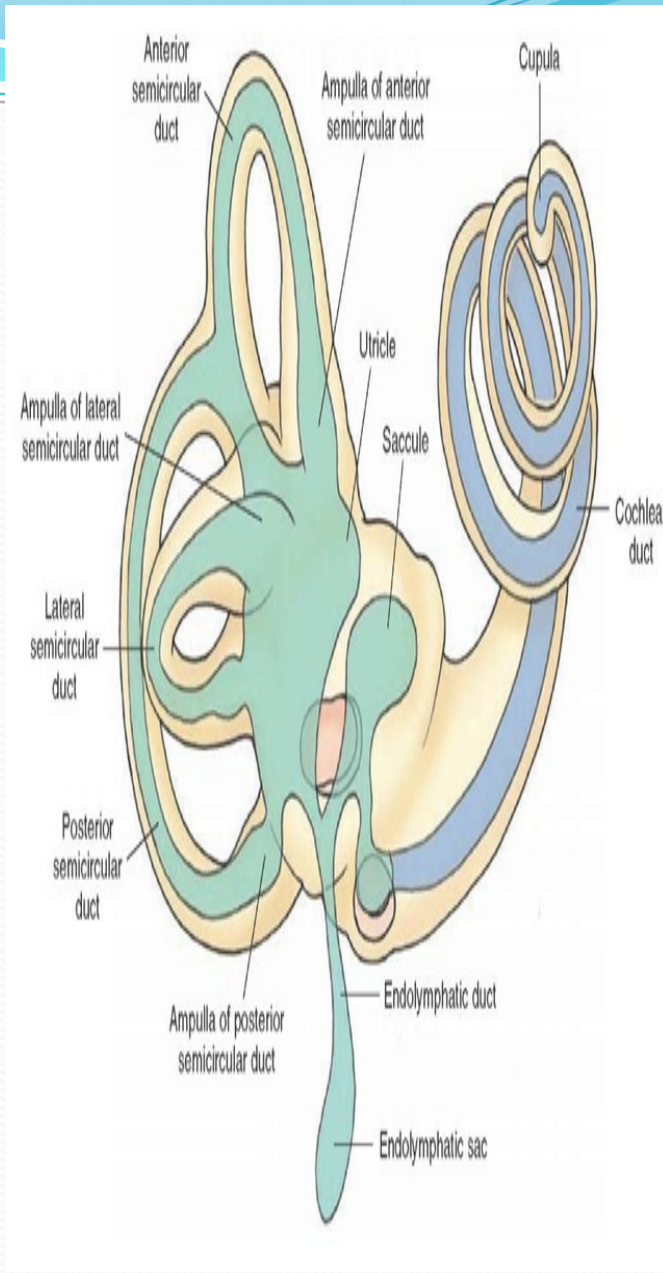
b- Non- auditory for equilibrium

(Vestibular apparatus)

2- Bony labyrinyth

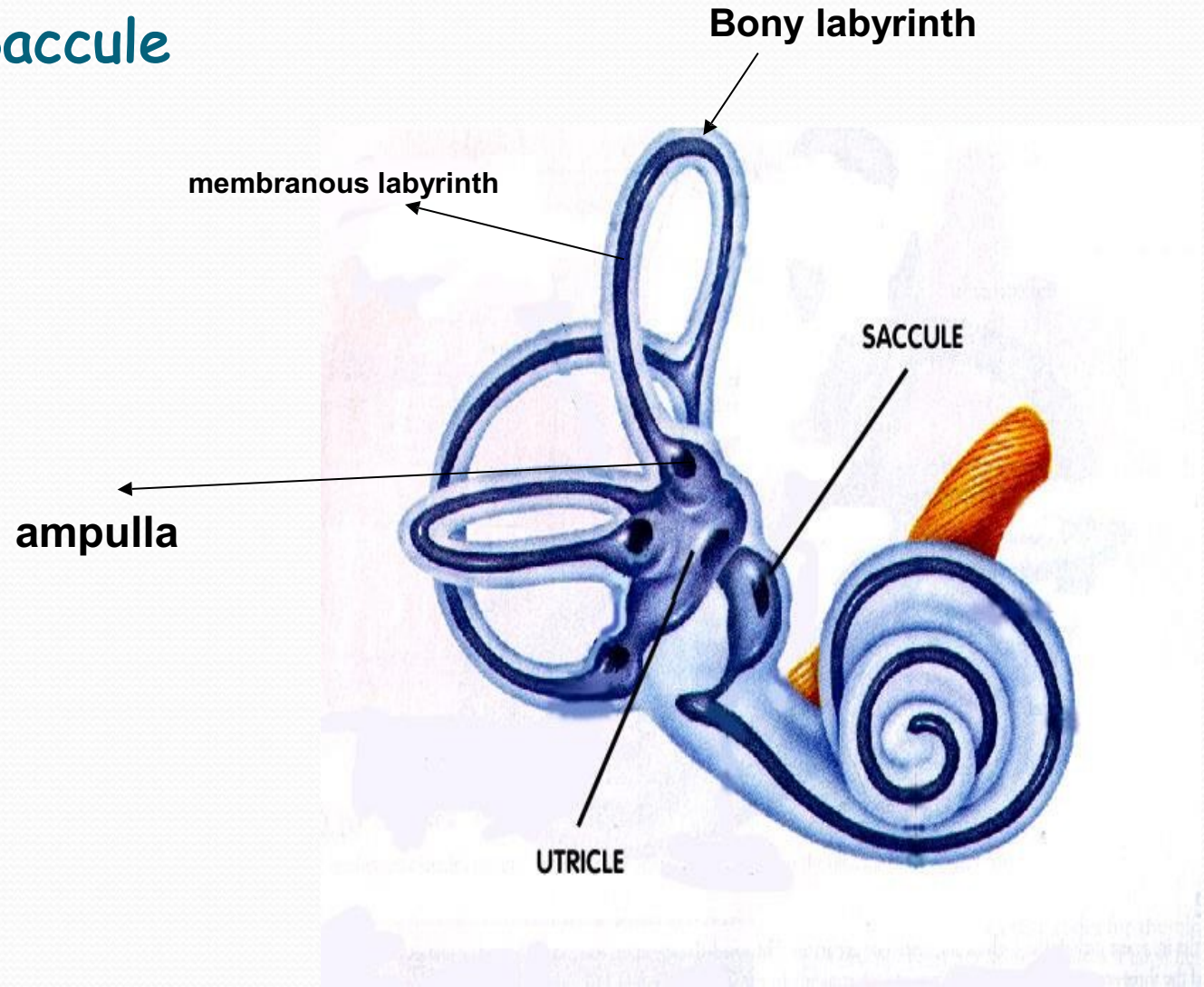
(bony cochlea & 3 bony semicircular canals)

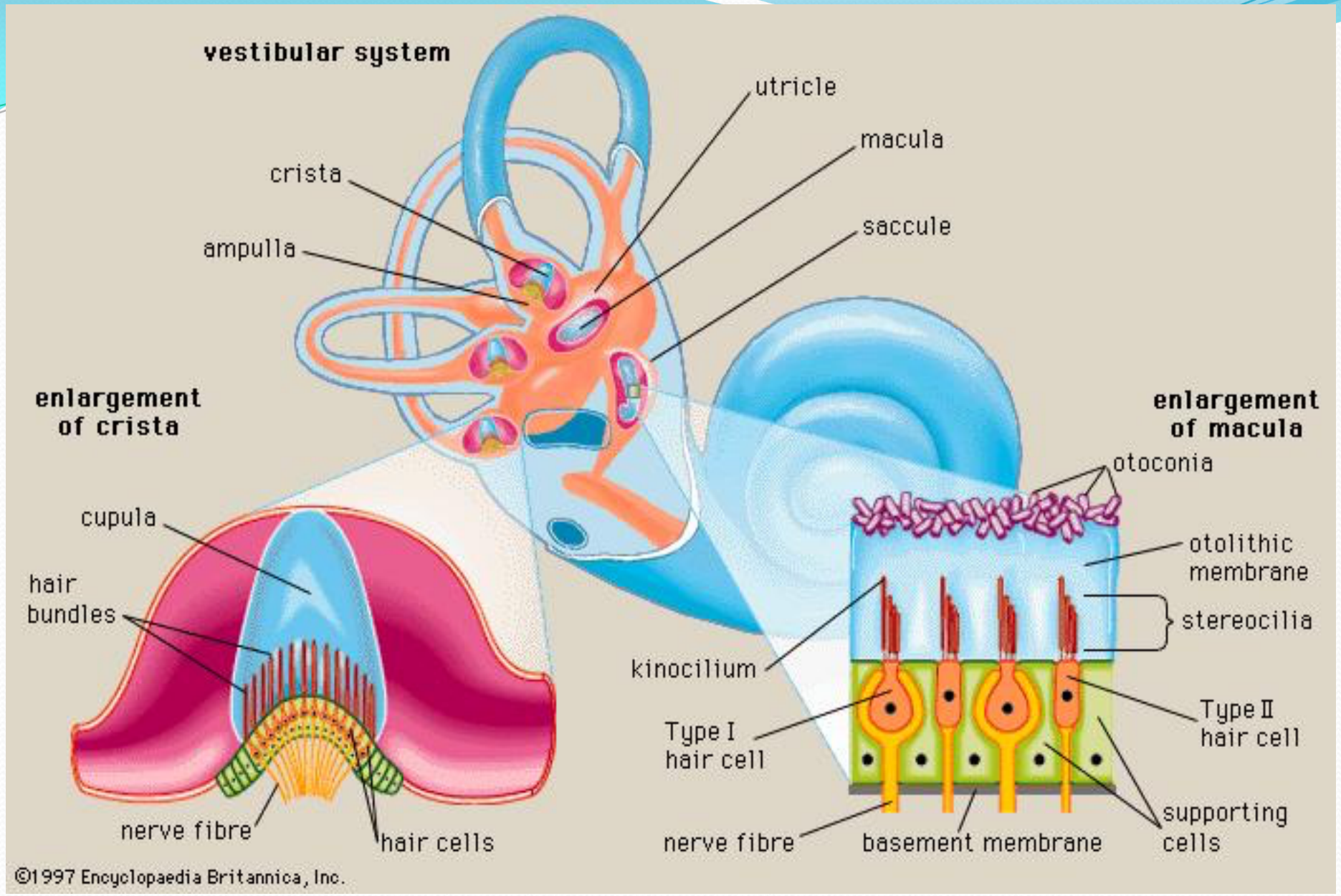
Enclose the membranous labyrinth.



Vestibular apparatus:-

1- Utricle & Saccule
2- SCC




vestibular system
utricle
macula
crista
saccule
ampulla
enlargement of crista
enlargement of macula
otoconia
cupula
otolithic membrane
hair bundles
stereocilia
kinocilium
Type I hair cell
Type II hair cell
nerve fibre
hair cells
nerve fibre
basement membrane
supporting cells
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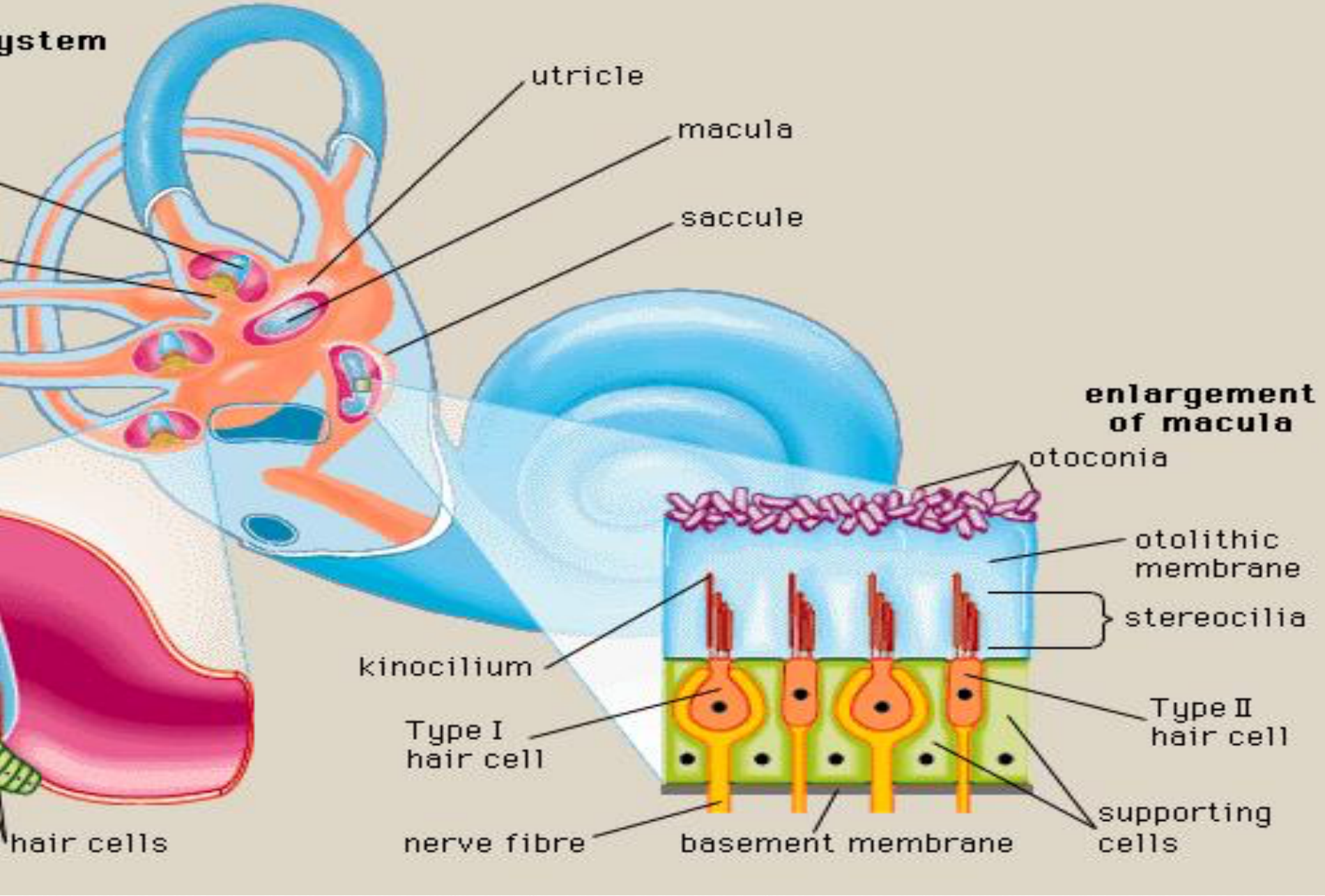
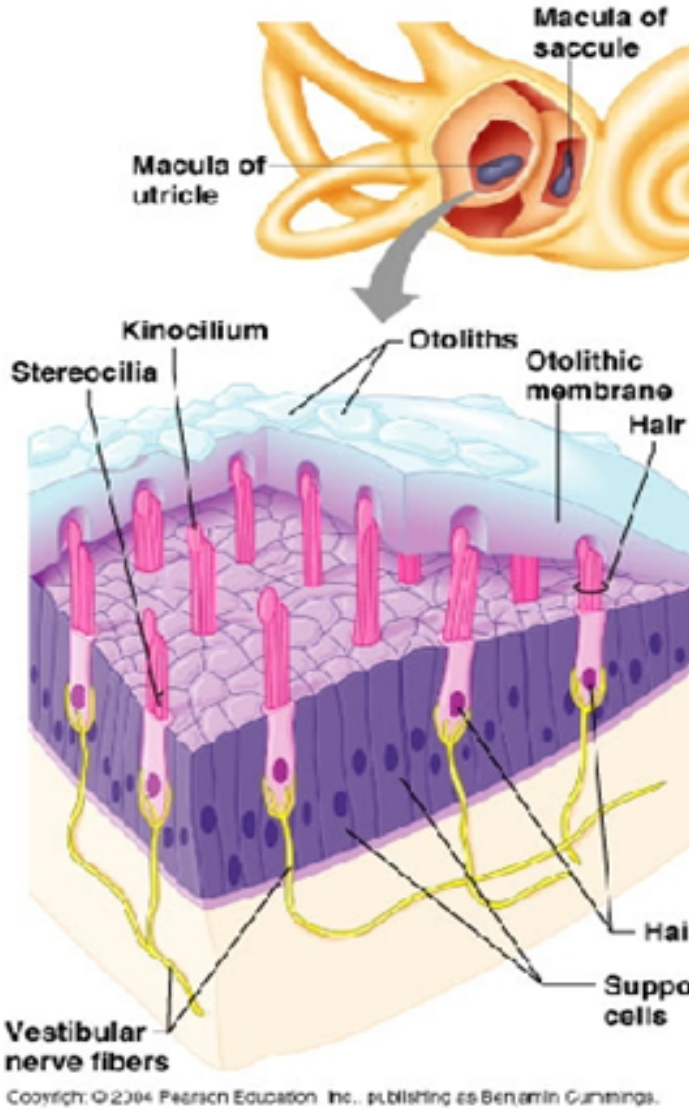

ystem
utricle
macula
saccule
enlargement
of macula
otoconia
otolithic
membrane
stereocilia
kinocilium
Type I
hair cell
Type II
hair cell
supporting
cells
hair cells
nerve fibre
basement membrane

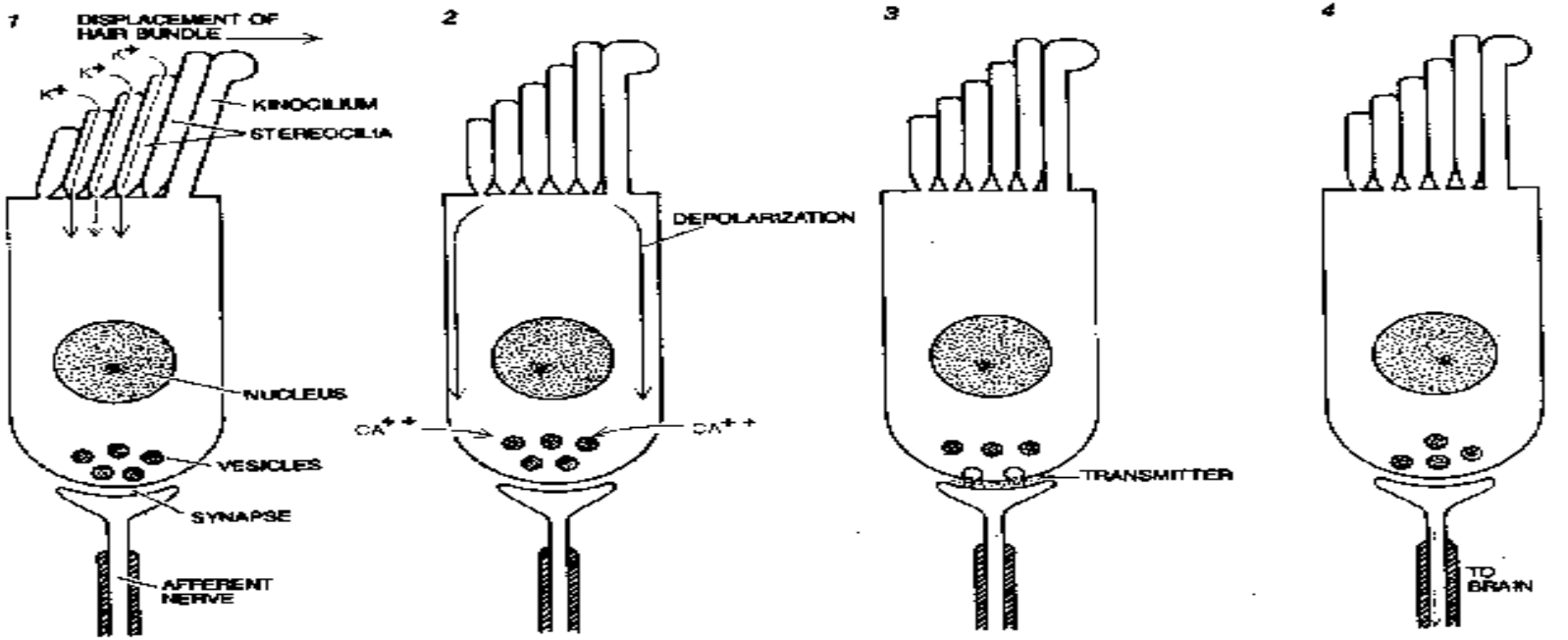
Macula (otolith organs) of utricle and saccule:-

- -hair cell synapse with endings of the vestibular nerve
- -Hair cell has 30-150 (stereocilia)

  &
- one large cilium called (kinocilium)
- Both connectdd with thin filamnetous attachments
- -All cilium membrane has positive potassium channels
- -Otolithes (statoconia) of calcium carbonate suspended in gelatinous material.
- - macula of utricle is IN horizontal plane if the head is vertical , so cilia point upwards
- - stimulated when the head bends forward & backward & laterally



- Macula of:
- Utricles detect balance in horizontal direction
- Saccule detect balance in horizontal and vertical direction



- Mechanism of action:-
- 1- bending of stereocilia towards kinocilium>>>>> depolarization & Ca entry & neurotransmitter release >>>>>>- increase rate of impulses to 8th nerve fibers

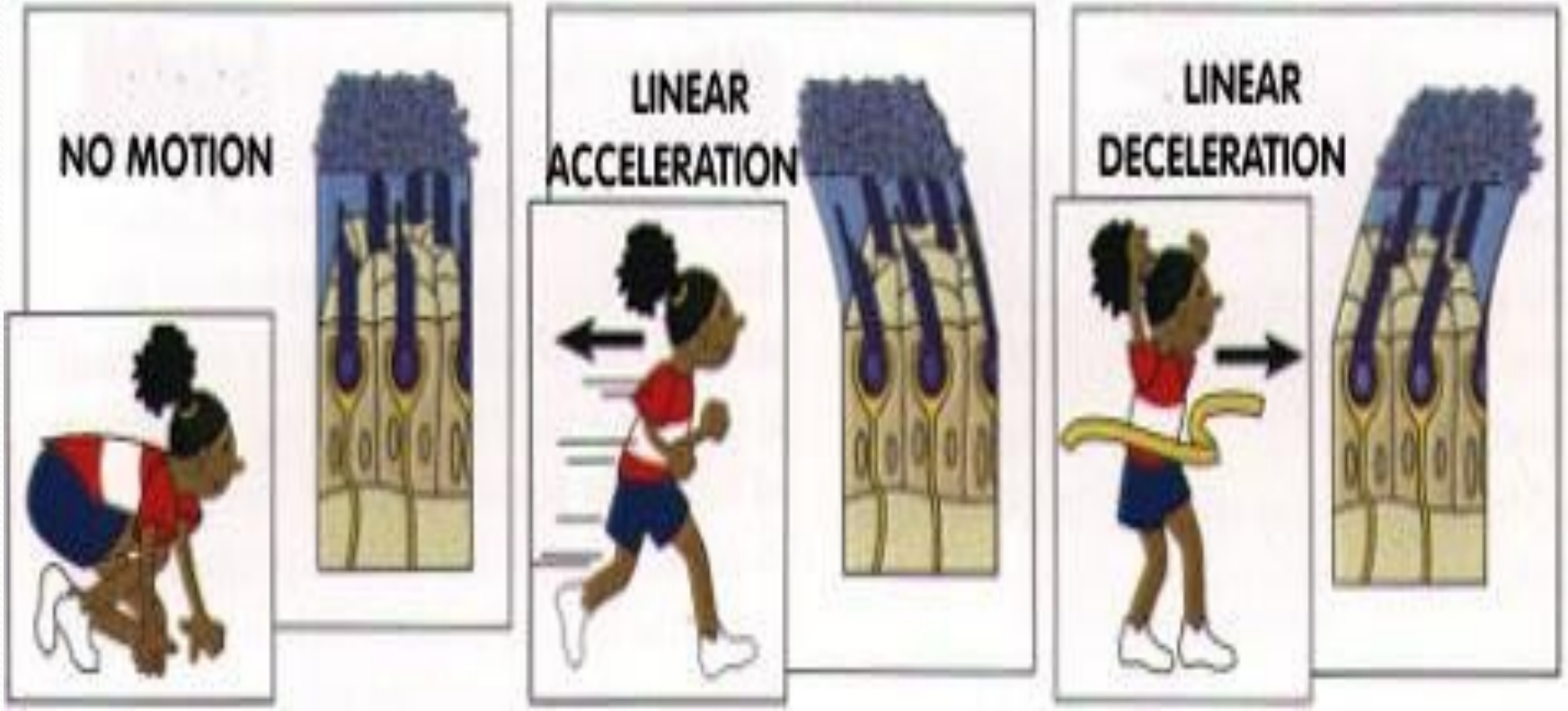
- 2- bending of stereocilia away from kinocilium
- >>>>-- hyperpolarization>>>>decrease rate of impulses to 8th nerve fibers

- 2- Detection of linear acceleration :-

- - linear acceleration:- as at running & standing in a bus .

- - at beginning of movement statoconia lag behind movement by its inertia >>>>> fall backwards
- >>>>cilia moves backward >>>>> person feels he is falling backwards
- >>>> try to correct this by leaning forwards to shift statoconia & cillia anteriorly

- - at deceleration (runner try to stop) >>>>>
- statoconia move forwards by its momentum
- >>>> person feels falling anteriorly


NO MOTION
LINEAR ACCELERATION
LINEAR DECELERATION

Semicelrcular canals

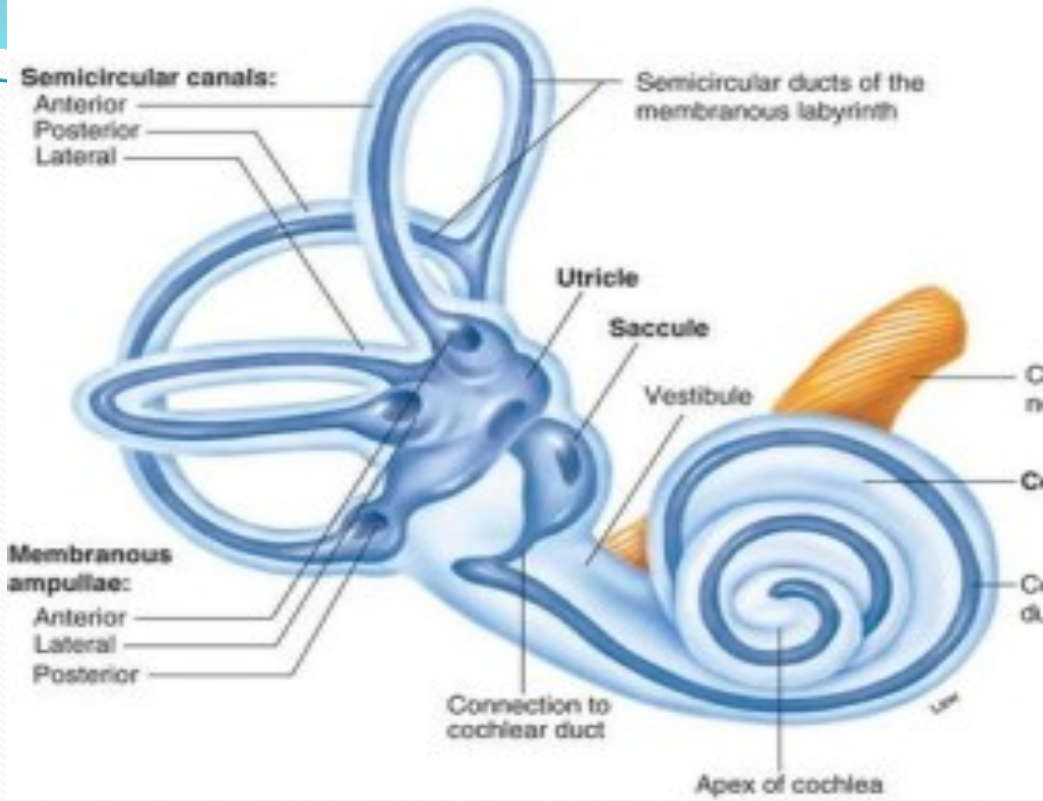
Horizontal

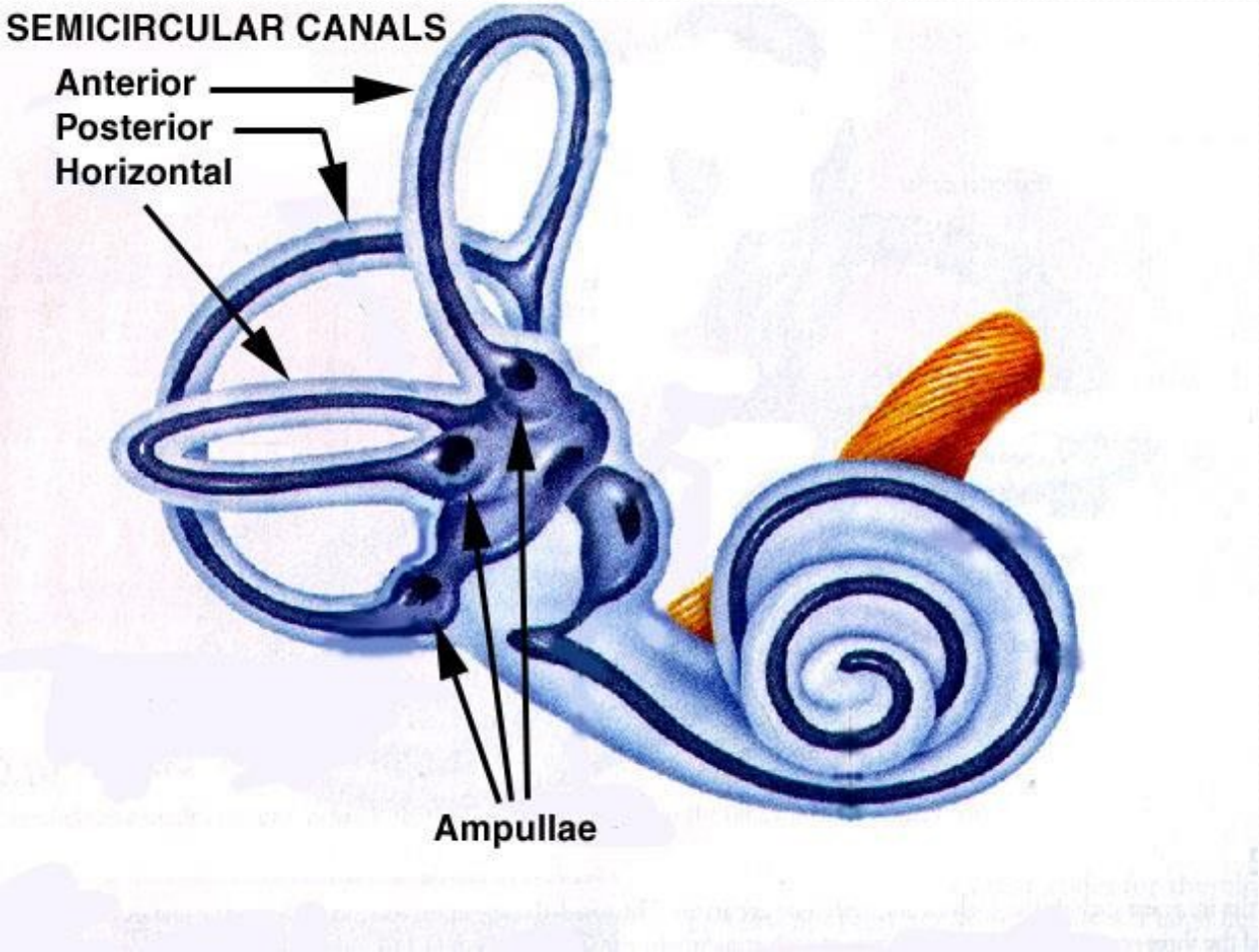
Anterior

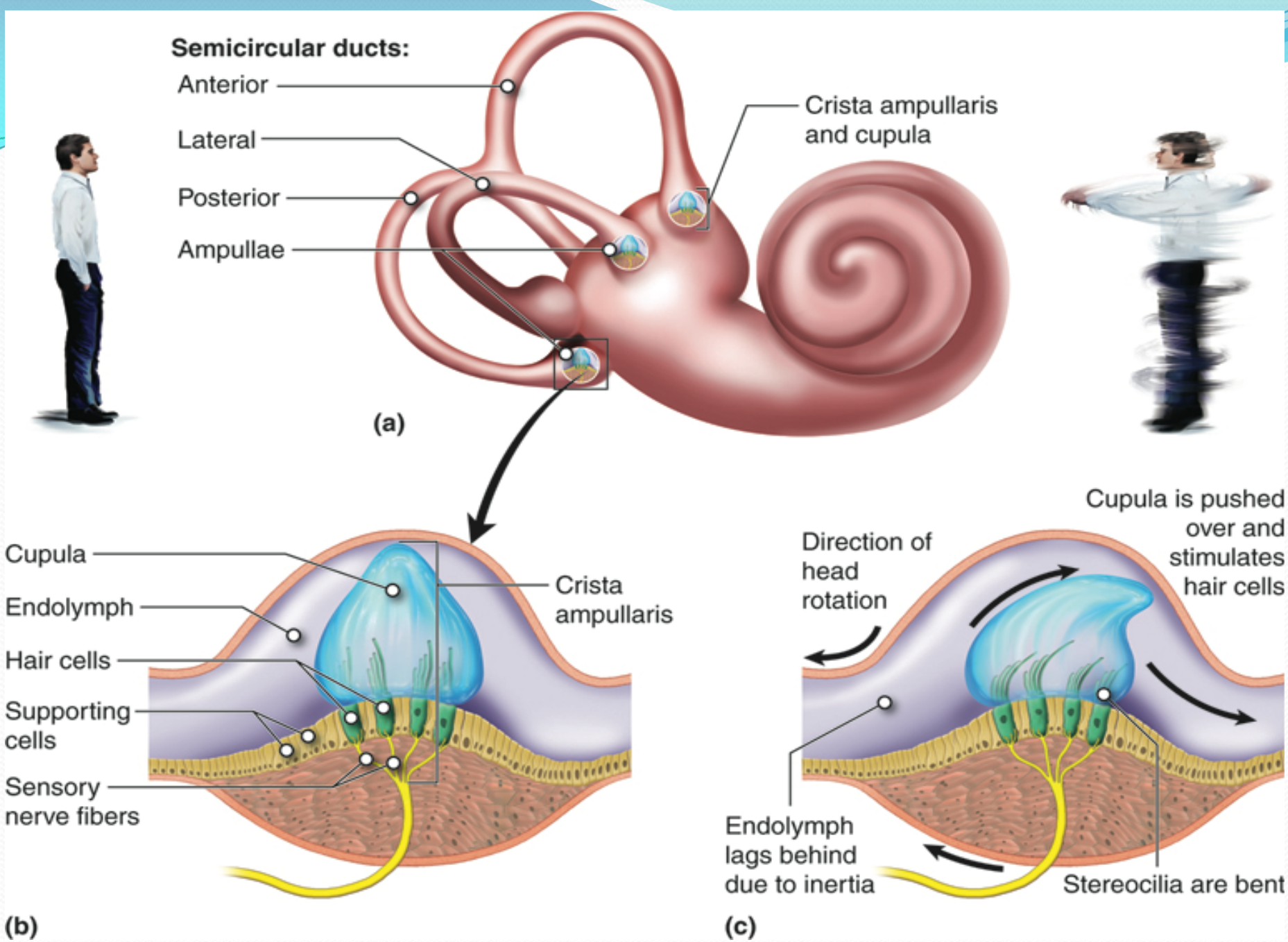
Posterior

Perpendicular to each other
Filled with endolymph
Dilated end called ampulla
crista ampularis (as macula)
cilia embedded in a gelatinous mass called cupula)

Detect angular changes

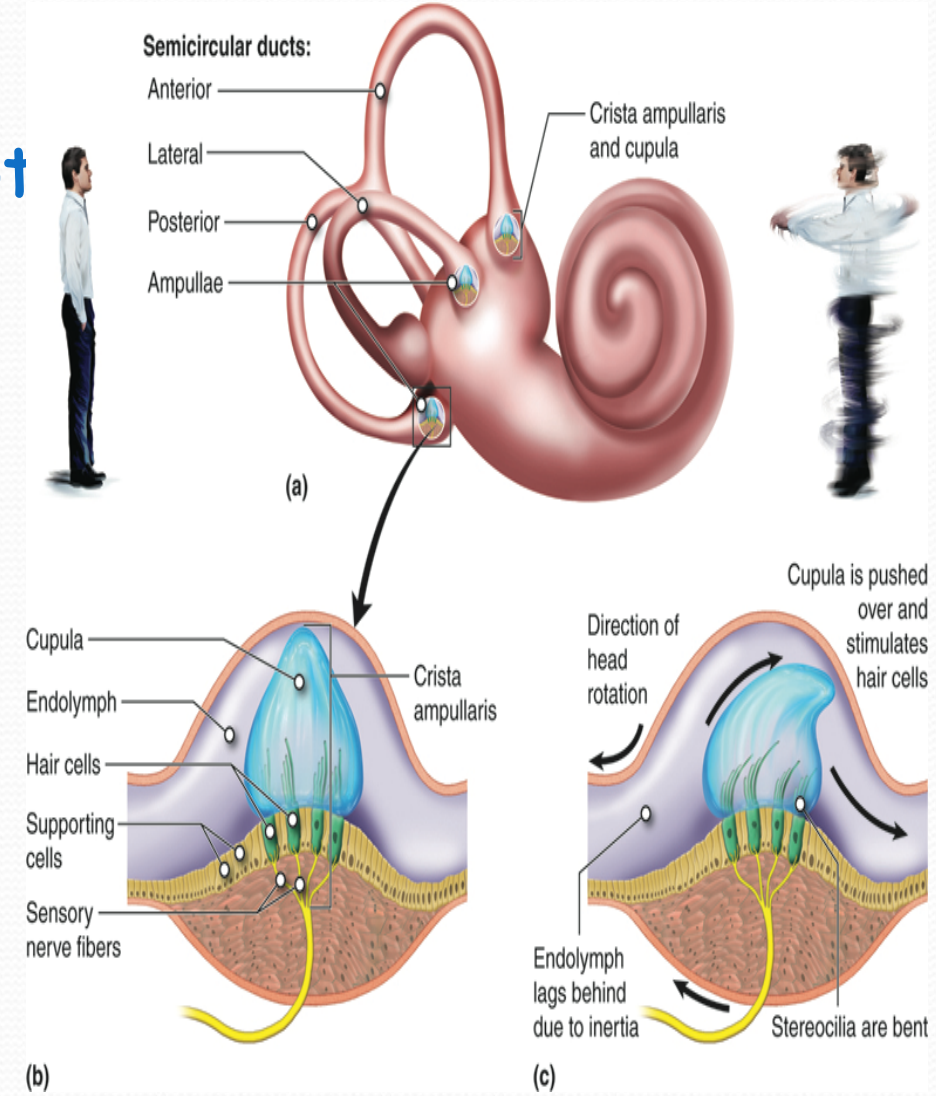



SEMICIRCULAR CANALS
Anterior
Posterior
Horizontal
Ampullae


Semicircular ducts:
Anterior
Lateral
Posterior
Ampullae
Crista ampullaris and cupula
(a)
Cupula
Endolymph
Hair cells
Supporting cells
Sensory nerve fibers
Crista ampullaris
(b)
Direction of head rotation
Cupula is pushed over and stimulates hair cells
Endolymph lags behind due to inertia
Stereocilia are bent
(c)

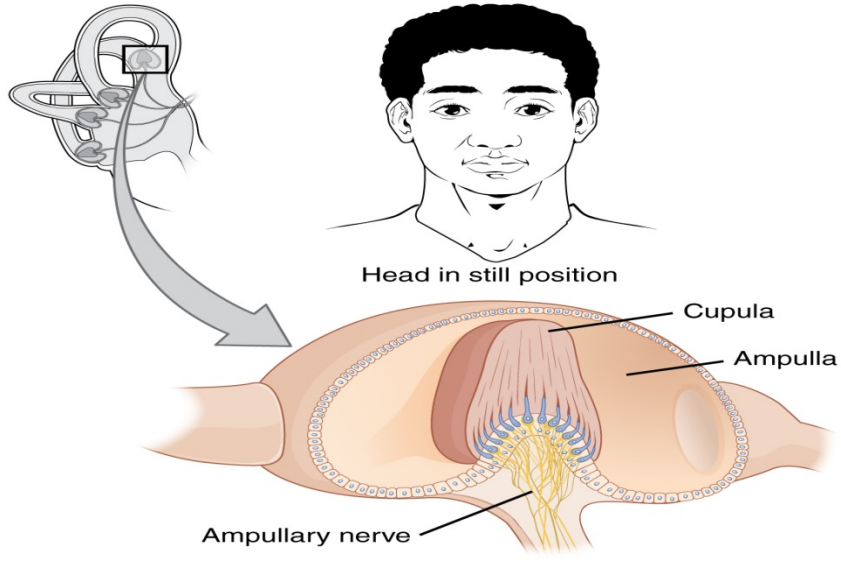
Mode of action & functions

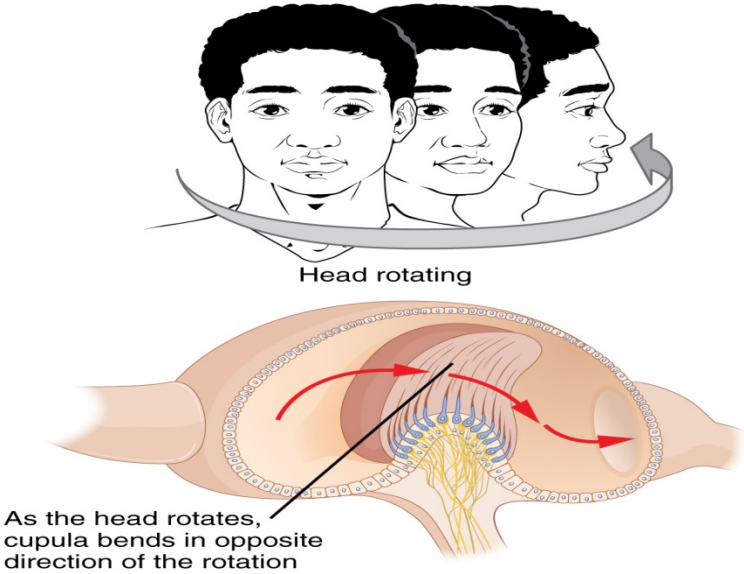
- 1- during rest : equal discharge from SCC on bot
- 2- Detect & maintain posture during head rotation in any direction
- (angular acceleration) rotation

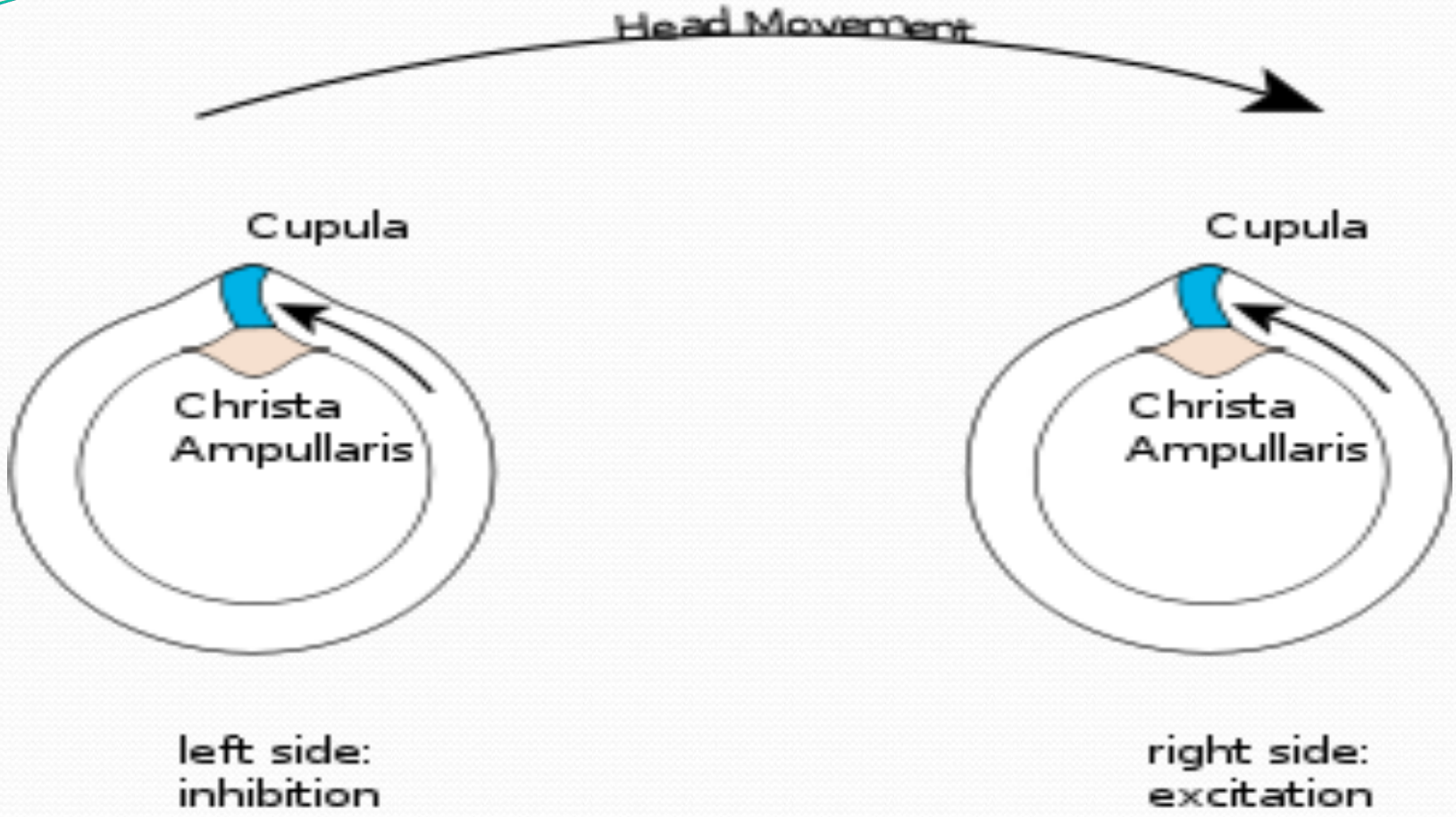


Rotation from left to right in horizontal plane:-

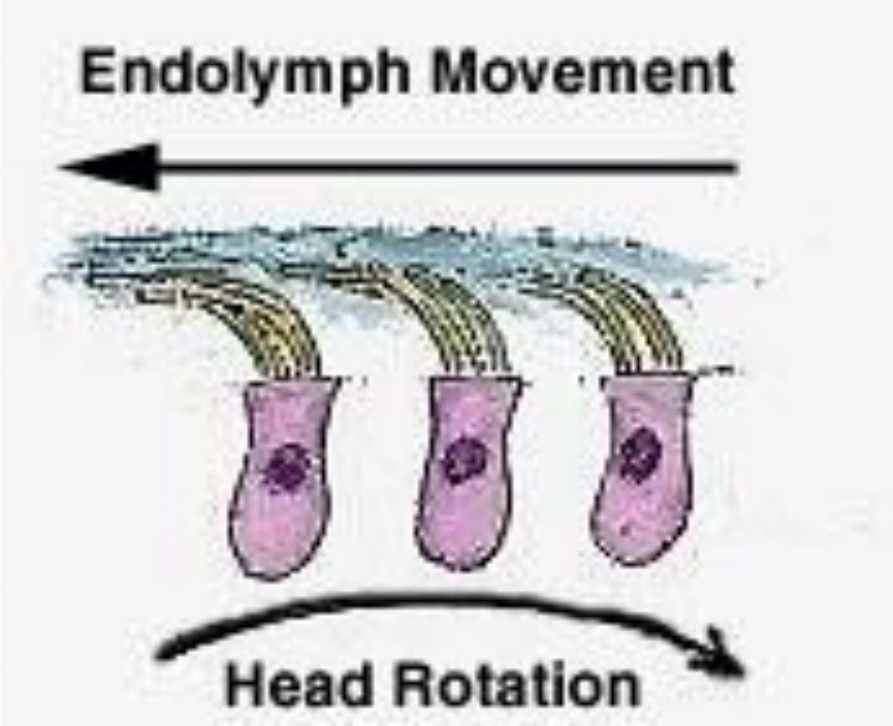
- Endolymph -->>>opposite direction by
- inertia --from right to left,
- -> the cilia of right side bent by endolymph towards the kinocilium >towards the utricle--
- depolarizationà--impulses from right side increase.
- --impulses fom left side decrease as cilia bent away from kinocilium.>>>>>
- - sensation of rotation to right.






Head Movement
Cupula
Christa Ampullaris
Cupula
Christa Ampullaris
left side: inhibition
right side: excitation

Copula in head rotation



Nervous connections of vestibular apparatus:-

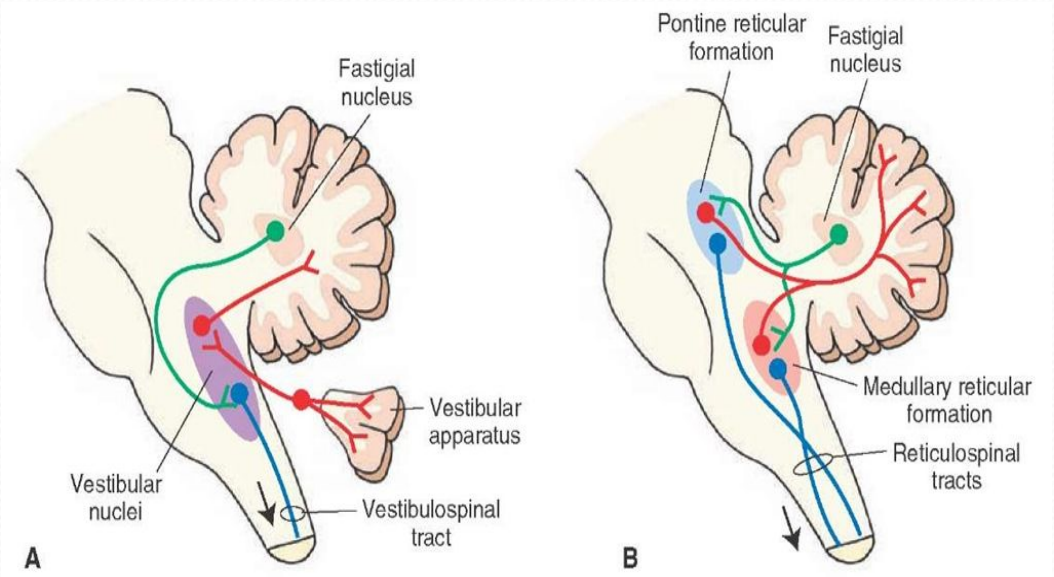
Nerve fibers from maculae & cristae ampularis

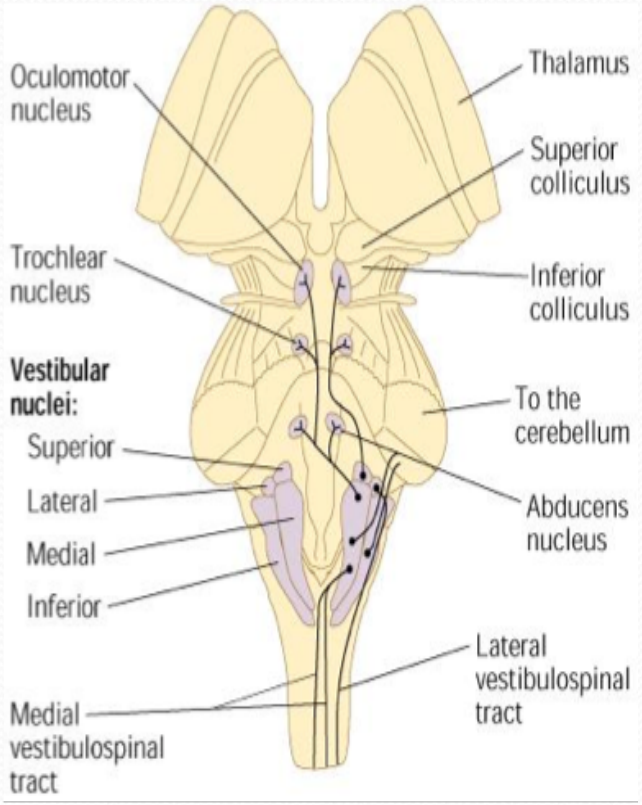
- >>Vestibular nerve>>epsilateral vestibular nucleus to :-

1- Cerebellum: floculonodular lobe

2- Spinal cord (vestibulospinal tracts)

3- Reticular formation





Effects of stimulation of S.C.C (rotation)

- Vertigo: this false sensation of counter- rotation at end of rotation
- Nystagmus
- Bradycardia & hypotension
- Increased muscle tone on same side of rotation to support the body & decreased muscle tone on the opposite side

- Thank You