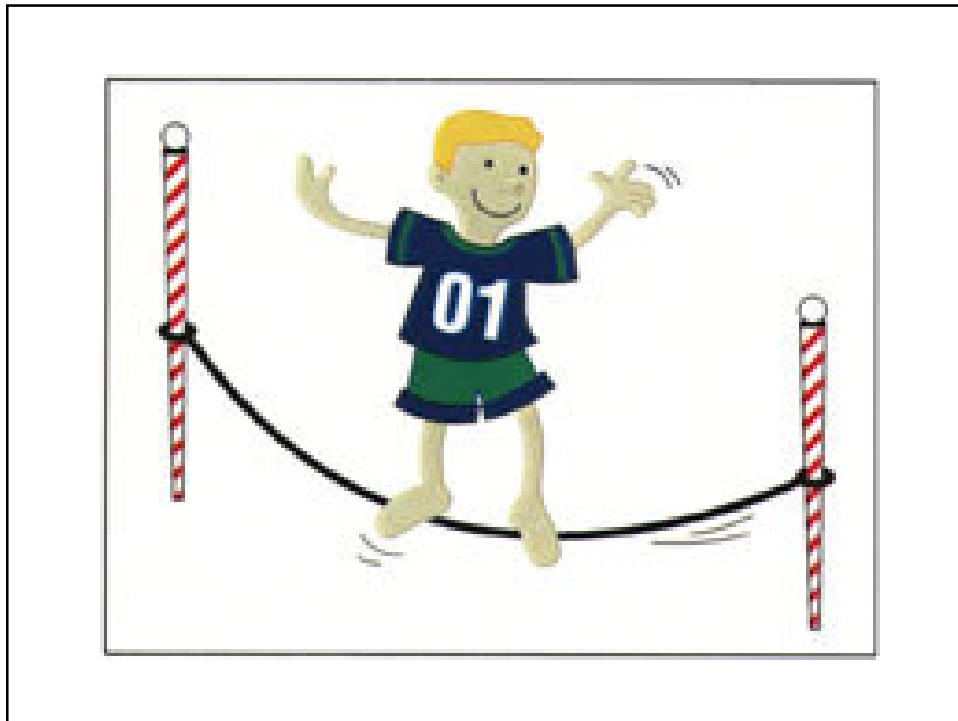


بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

VESTIBULAR FUNCTION

Professor A.M.A Abdel Gader
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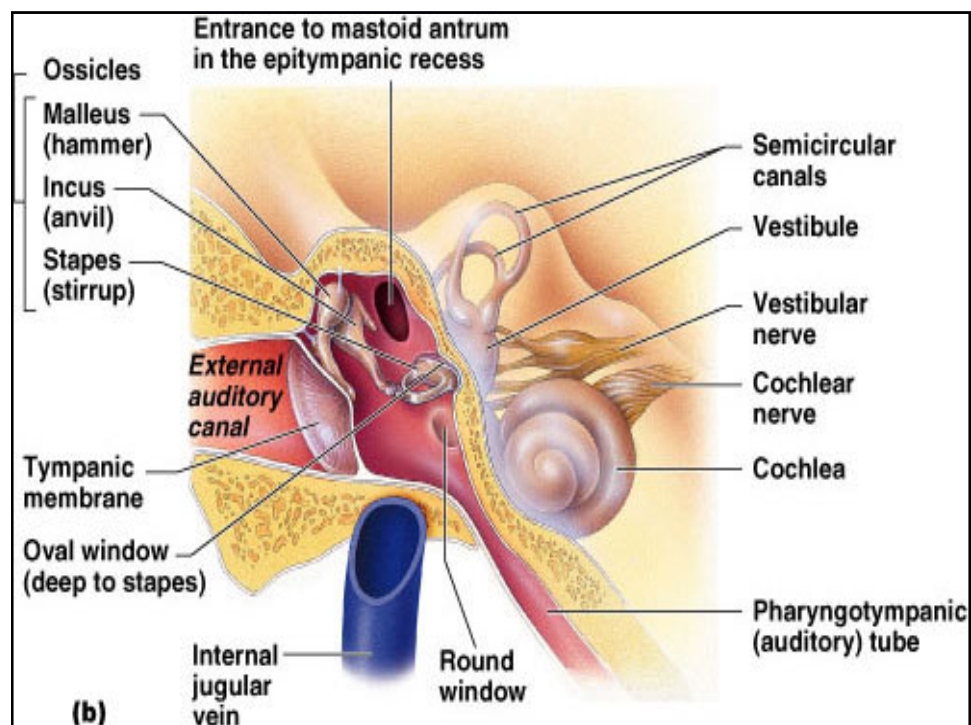
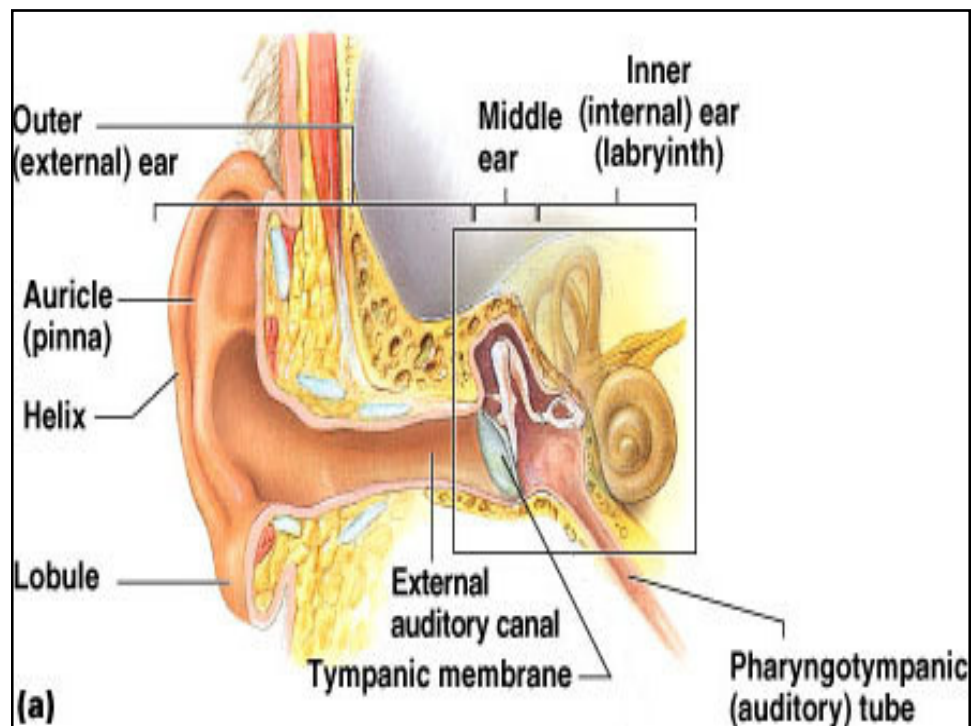


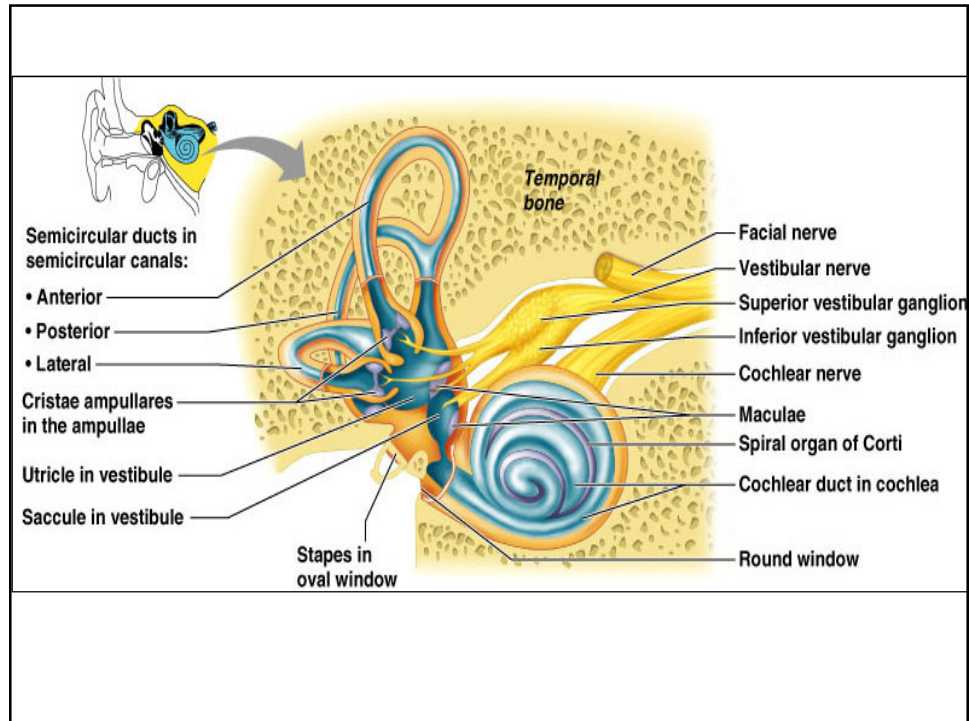
Control of Equilibrium

"Accurate control requires accurate information"

Sensory inputs:

1. Vestibular system
2. Visual system
3. Proprioceptive system
4. Cutaneous sensations

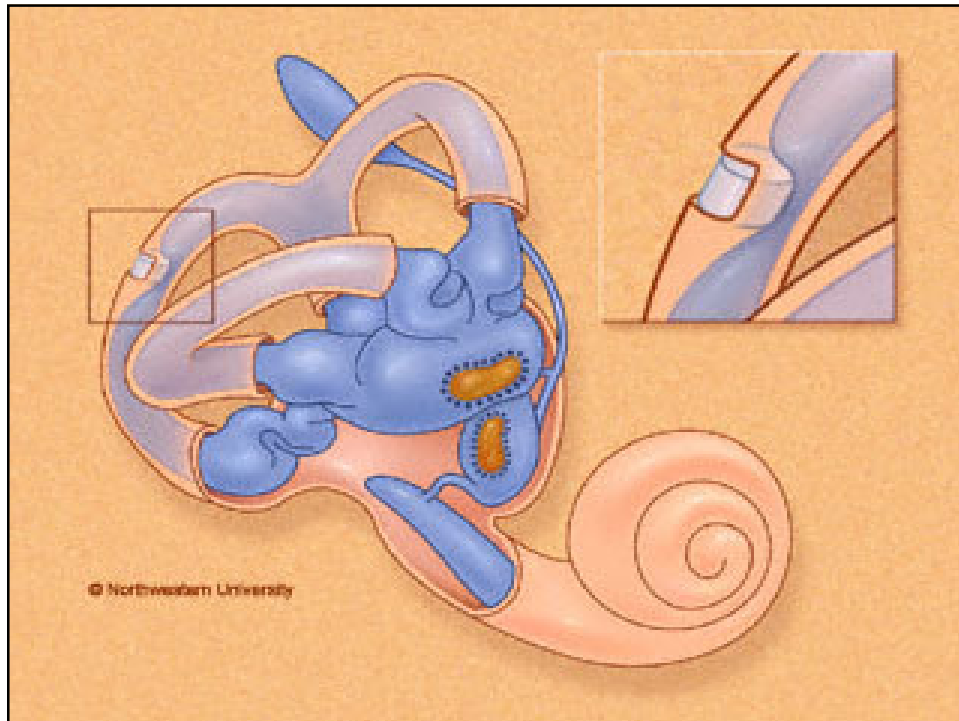




Vestibular system-cont.

Components of the Vestibular system

1. Utricle and saccule
2. Semicircular canals

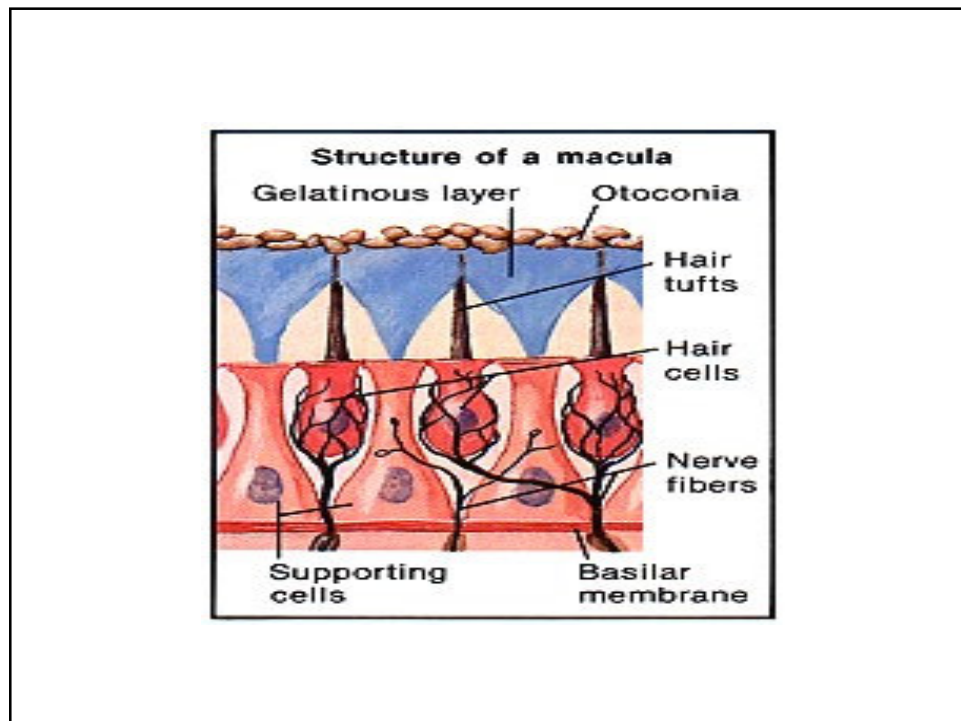
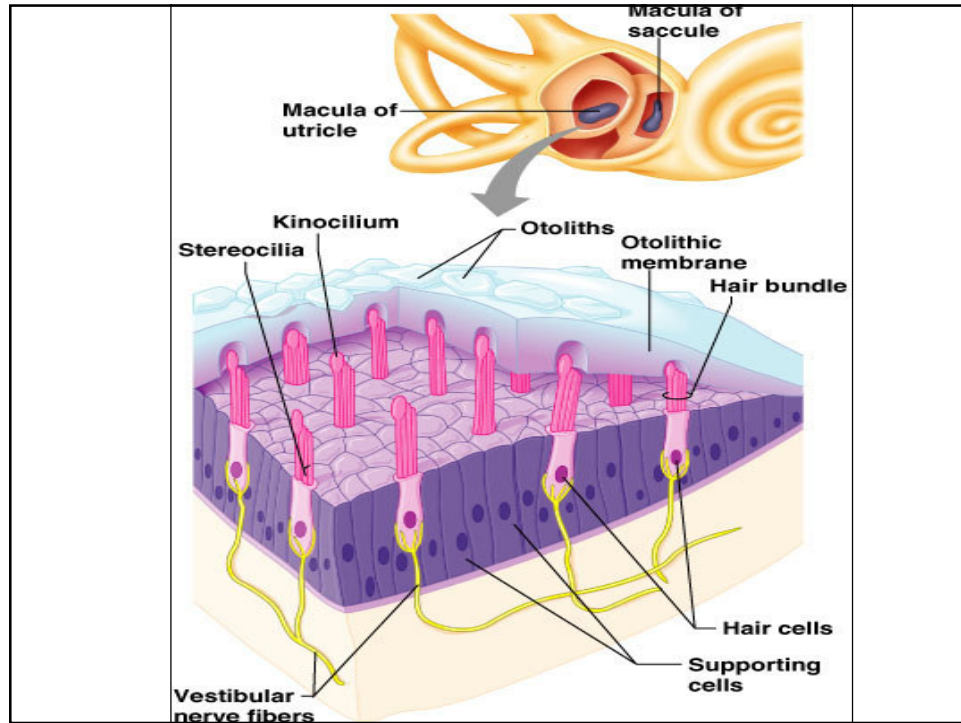


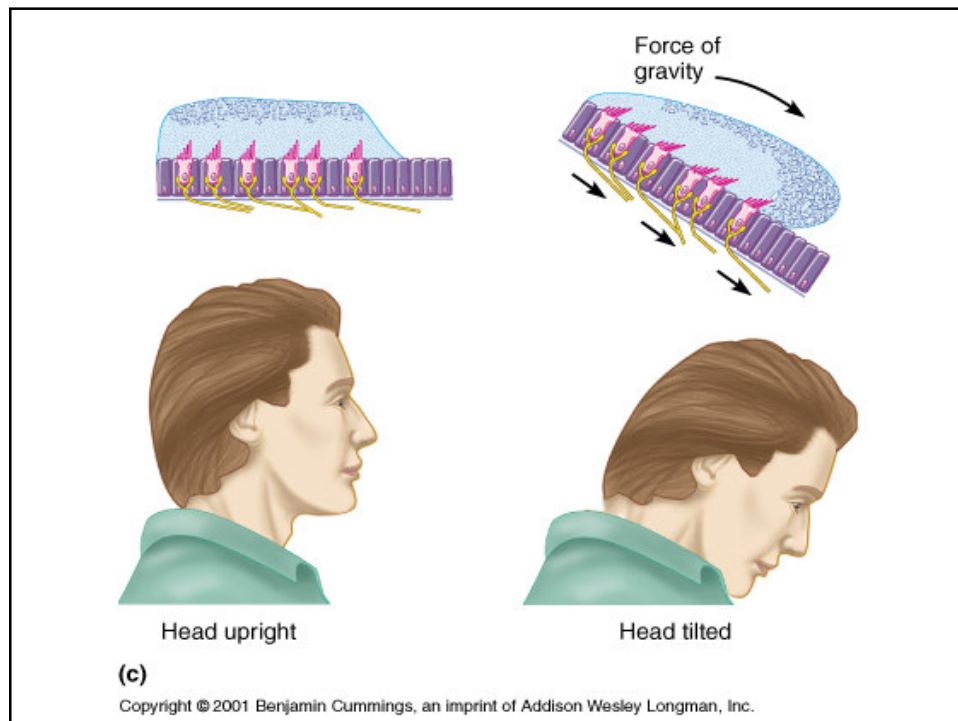
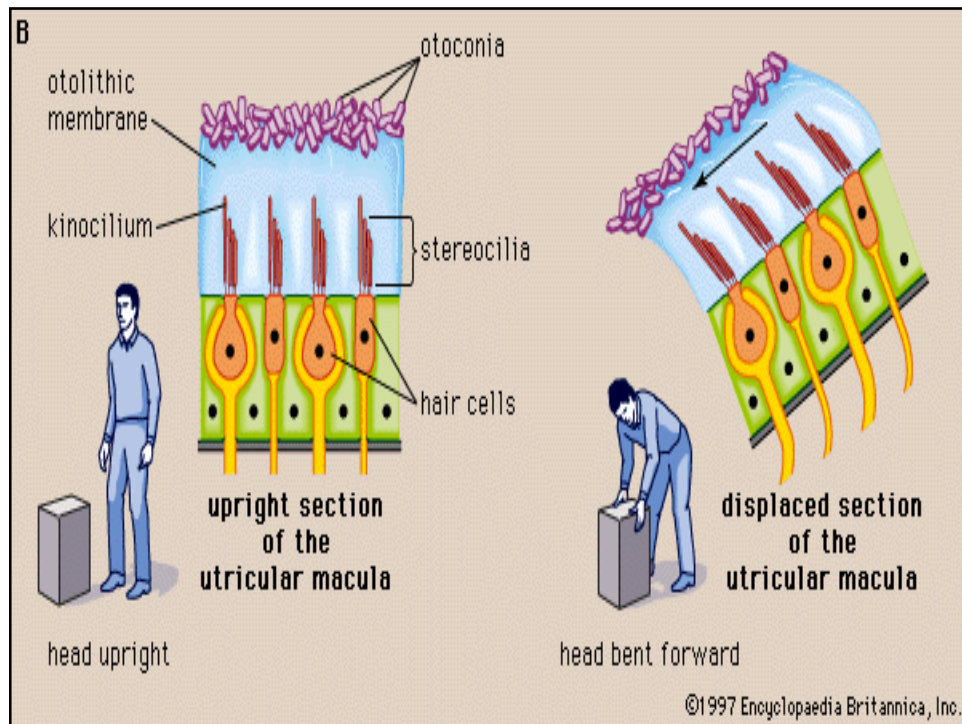
Vestibular system-cont.

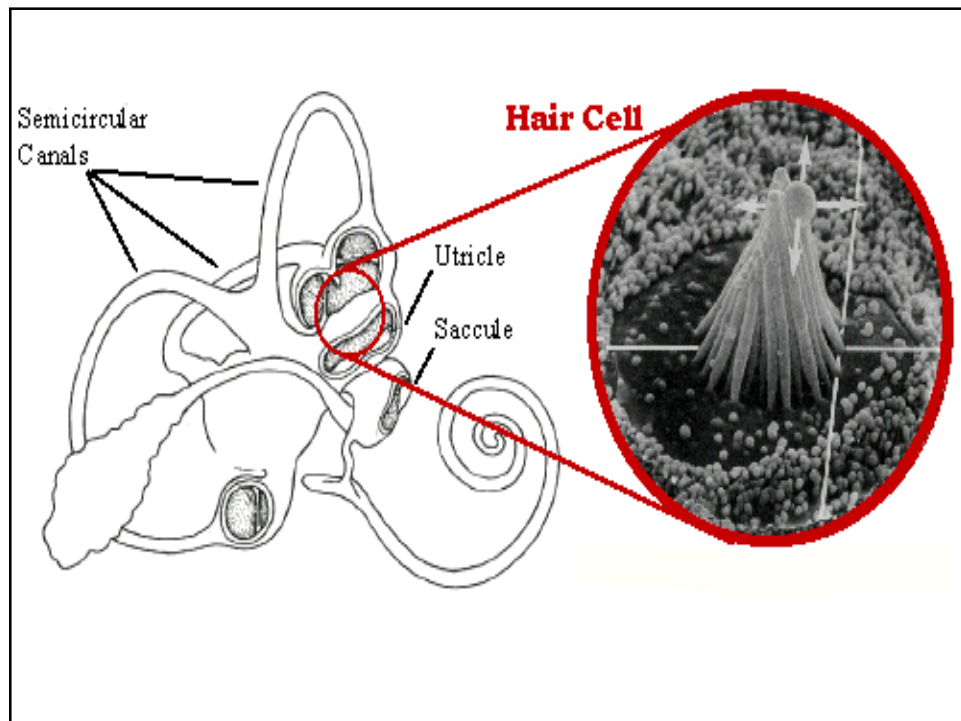
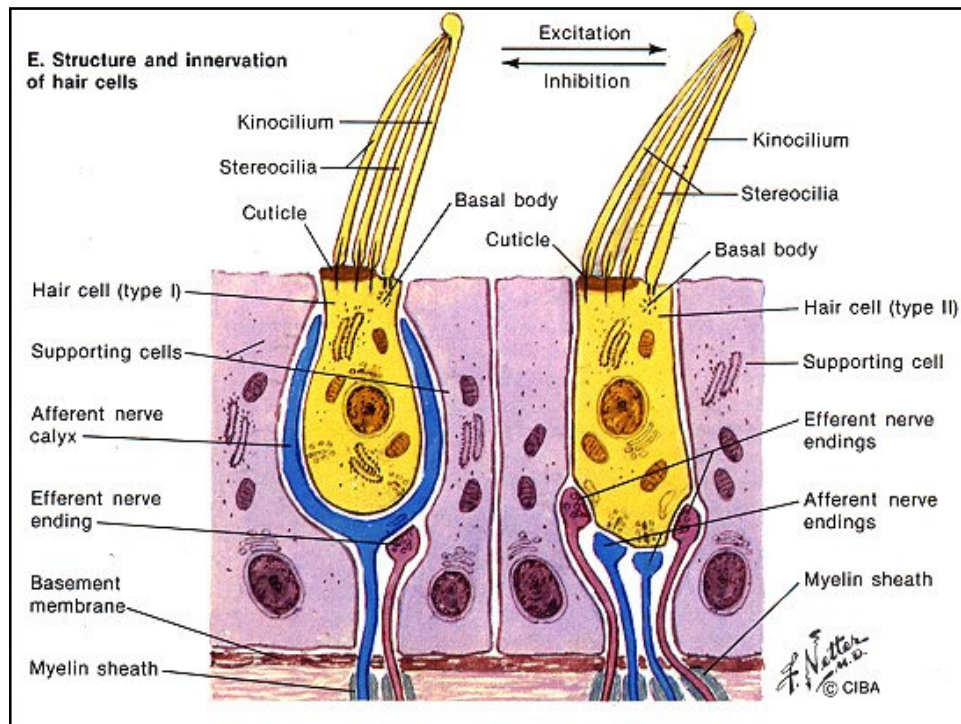
Utricle and saccule

- Sensory organ
 - macula (otolithic organs):
 - Columnar epithelium + Hair cells
 - Gelatinous layer
 - Otoliths (calcium carbonate crystals)**

** GRAVITY



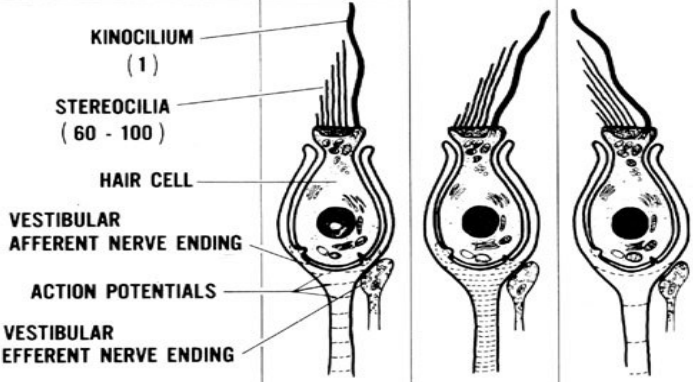







Hair cells

Features:

- One (large) kinocilium
- 30 to 150 (small) stereocilia progressively shorter away from kinocilium
- Cilia connected by fine filaments (tip links)

POSITION OF CILIA	NEUTRAL	TOWARD KINOCILIUM	AWAY FROM KINOCILIUM
			
POLARIZATION OF HAIR CELL	NORMAL	DEPOLARIZED	HYPERPOLARIZED
FREQUENCY OF ACTION POTENTIALS	RESTING	HIGHER	LOWER

Hair cells - cont.

- Resting condition: constant rate of firing of **action potentials**
- Stereocilia **bent** towards kinocilium
opening of ion channels >>> Depoln.

↑↑ **discharge rate**

- Stereocilia **bent** away from kinocilium
>>> Hyperpolarization

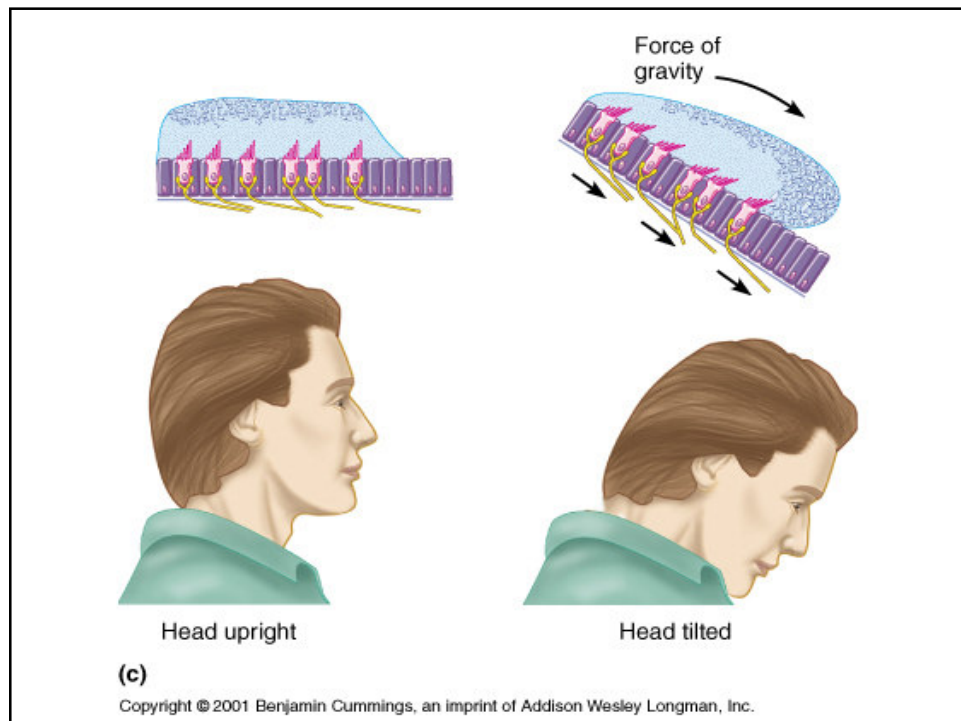
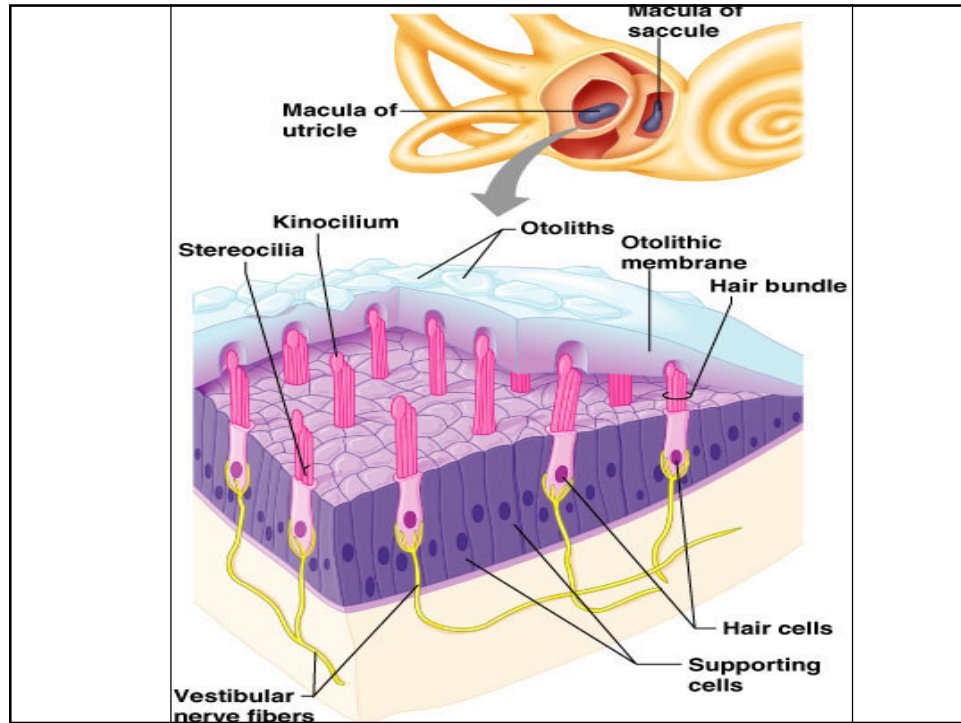
↓↓ **discharge rate**

Hair cells

In macula:

hair cells are oriented in
different direction >>>>>>

Tilt Of Head In Any
Direction Is Signaled



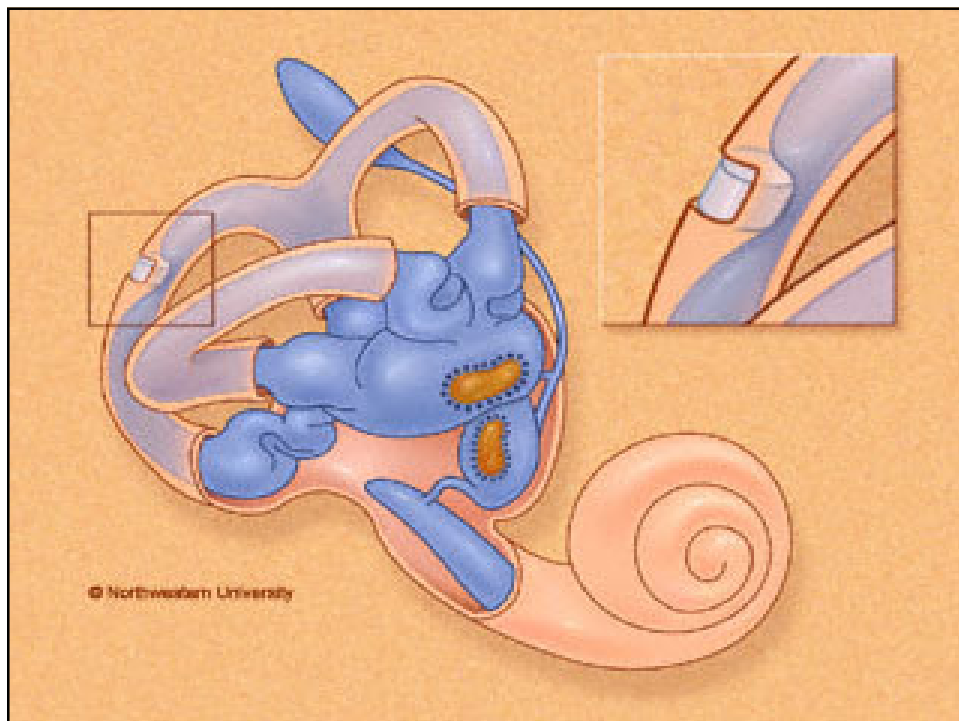
Hair cells

In upright position: (Head vertical)

- In utricle:

- Macula in horizontal plane
- Hairs pointing upwards
- Hair cells signal head movements in any direction >> >>

inform the brain of
orientation of head in space



Hair cells_{-cont}

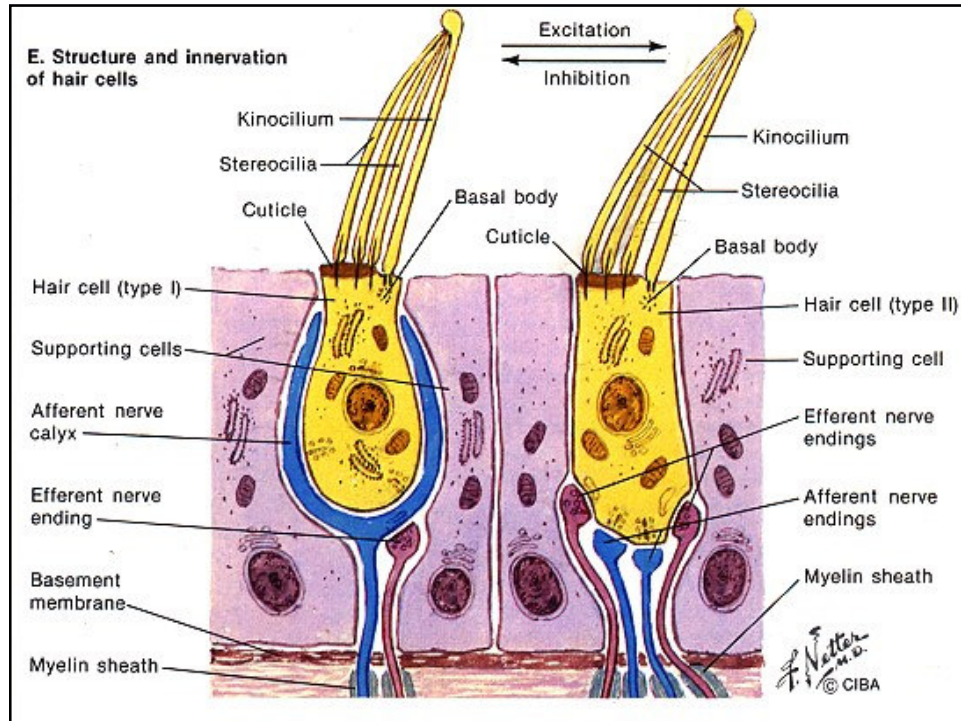
In upright position: (Head vertical)

- In saccule:
 - Macula in vertical plane
 - Hairs pointing laterally
 - Hair cells operate when one is lying down

Hair cells_{-cont}

Transducers Characteristics:

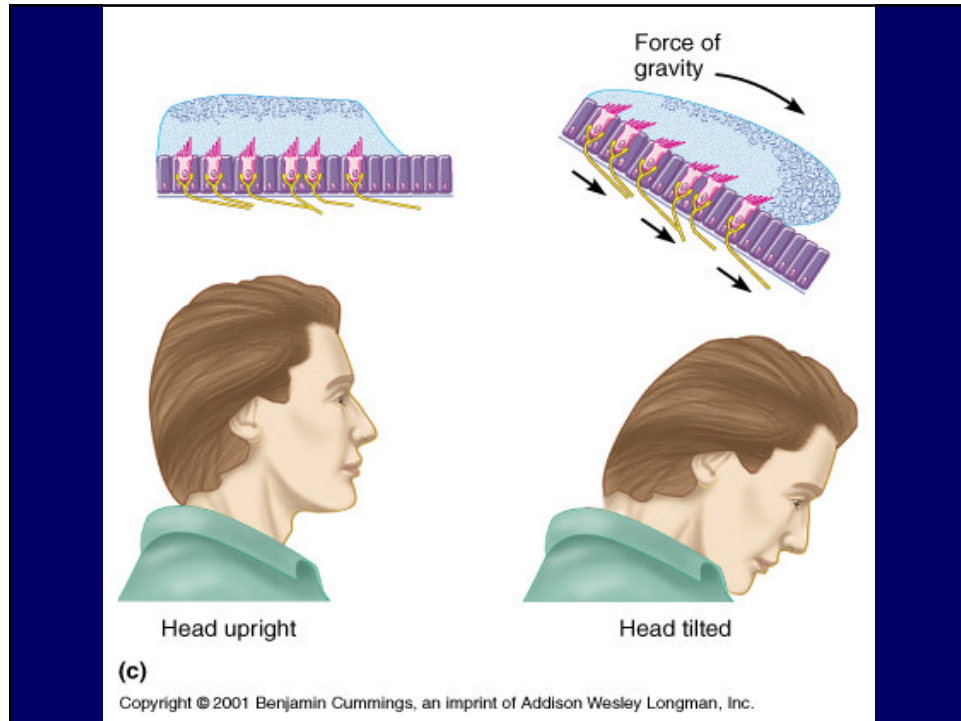
1. Directional sensitivity ++++
2. Slow adaptation
3. Highly sensitive to mechanical stimulation



Functions of the utricle and saccule

1. Detection of static tilt

- Upright vertical position:
Impulses from both utricle maculae
balance each other
- Body tilts to one side:
Two maculae send signals informing brain of
- new position of head in space
- Sensation of imbalance
(Response???)



Functions of the utricle and saccule

2. Detection of linear acceleration:

Sudden acceleration >>>

Falling backwards >>>

Otoliths falls back on hairs >>>

sensation of malequilibrium >>

Correction by leaning forward

*Saccular maculae detect vertical acceleration

*Both utricle and saccule horizontal acceleration

Vestibular system-cont.

Components of the Vestibular system

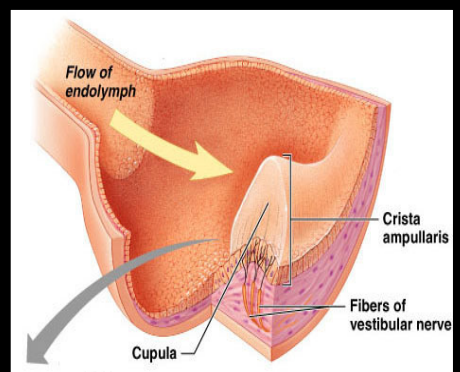
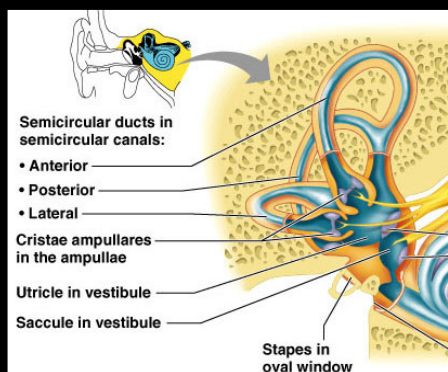
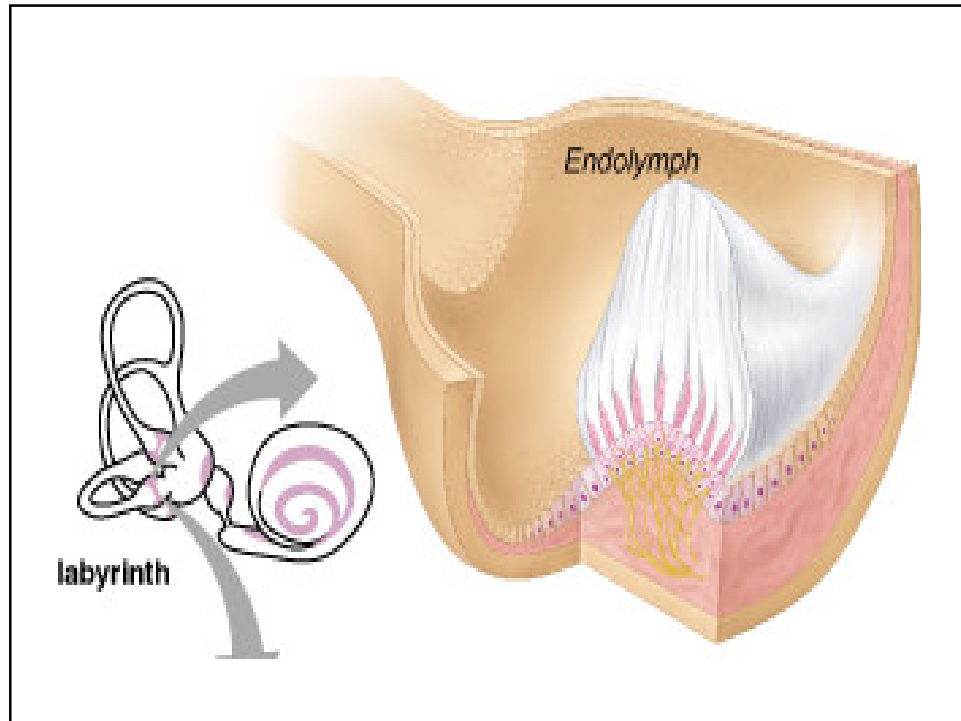
1. Utricle and saccule

2. Semicircular canals

Semicircular canals

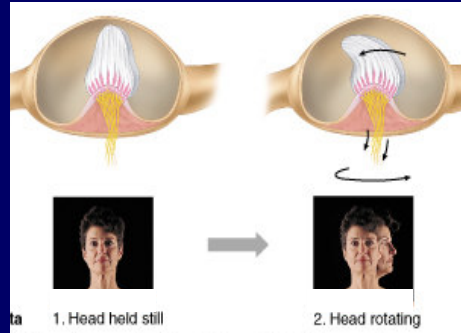
Three:

- **Horizontal (lateral)**
- **Vertical:**
 - **Anterior**
 - **Posterior**
- **Sensory organ: crista ampullaris**



Crista ampullaris

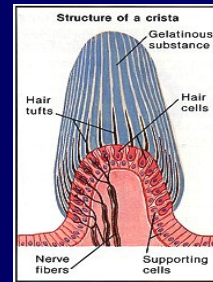
- Rotation of head
- Bending of cupula
- **Stereocilia bend**
- **Receptor cell fires**
- **Synapse activated**
- Stimulation of nerve endings
- Dynamic equilibrium sense



Crista ampullaris

Components:

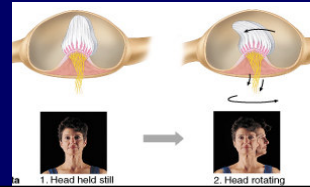
- Hair cells and supporting cells
- **Gelatinous mass (cupula) sealing the ampulla**
- **Stereocilia and kinocilia embedded in cupula**
- Hair cells in each crista are oriented in the **same direction** (unlike macula)



Semicircular canals-cont.

Plane of rotation determines which canal will be stimulated:

1. Rotation of head in vertical axis >>> Horizontal
2. Lateral movement of head (approximate head to shoulder) >>> posterior
3. Anterolateral or posterolateral head movement >>> Superior



Functions of Semicircular canals

Detection of angular acceleration
(head rotation) in any direction

- Resting rate of discharge: 200/sec
- Rotation of canal from L to R >>>
Endolymph moves in opposite direction R to L >>>
cupula (and hair cells) bent by endolymph >>
increase discharge from R canal
decrease discharge from L canal

Functions of Semicircular canals

Stimulated by: **angular (rotational) acceleration**

 Movement of endolymph in SCC


 Bending of hairs:

- towards ampulla on one side
- Away from ampulla on the other side

 Unbalanced discharge from two sides
(Sensation of rotation in CNS)

Semicircular canals - cont.

Unbalanced discharge from two sides

 As rotation continues endolymph will soon
rotate in the same direction (& speed)
as the SCC

 Cupula being elastic returns to resting position

 Discharge from both sides returns to resting level
(no sensation of rotation so long eyes are closed)

Semicircular canals – cont.

SCCs detect ONLY

- The beginning of rotation
- End of rotation
- Changes in rate of rotation

i.e. ANGULAR ACCELERATION

Joy Riding

VESTIBULAR FUNCTION

Predictive function of SCC in the maintenance of equilibrium

i.e. Predict ahead of time that mal-equilibrium is going to occur



Send impulses to CNS for corrective measures before the start of the fall

VESTIBULAR PATHWAY

Neural connections:

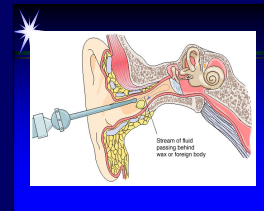
1. Cerebellum
2. Motor nuclei of CNS 3,4 & 6
3. Reticular formation (Spinal cord)**
4. Spinal cord (Vestibulo-spinal tract)**

** Impulses maintain equilibrium
i.e. facilitate or inhibit
the stretch reflex
(regulate muscle tone)

Semicircular canals-Clinical

Stimulation in the laboratory:

1. Rotation at high speed
2. Calorie test



Clinical signs:

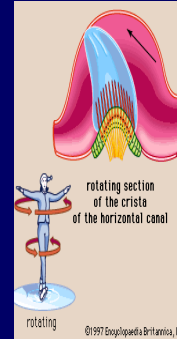
1. Vertigo: feeling of rotation when body is not
2. Nystagmus

Abnormal Stimulation Semicircular canals

Clinical signs:

- Nausea
- Vomiting
- Bradycardia
- Hypotension
- Sweating

Mechanism: autonomic stimulation



Control of Posture & Equilibrium

Depends on Reflexes maintain body position at rest & movement

"Accurate control requires accurate information"

Sensory input:

1. Vestibular system
2. Visual system
3. Proprioceptive system
4. Cutaneous sensations

VESTIBULAR FUNCTION

Control of equilibrium

"Accurate control requires accurate information"

Sensory input:

1. Vestibular system
2. Visual system
3. Proprioceptive system
4. Cutaneous sensations

