INNER EAR IN BALANCE

Objectives:

أهداف المحاضرة ماكانت موجودة بالمحاضرة و لا بدليل الطالب.

Done by:

- **Team leaders:** Shahad AlEnezi - Malak AlHamdi
- **Team members:** Razan Alsabti - Hissah almuzini

Edited &Revised by: Shahad AlEnezi

Color index: Important - Further explanation - Doctors Notes - Numbers.

---

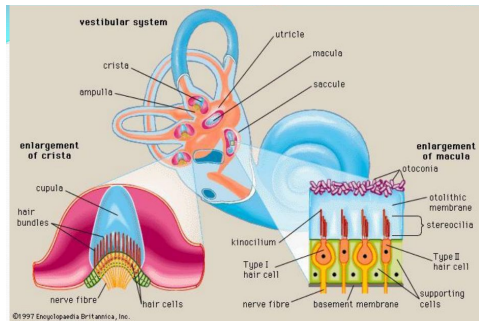
*Please check out this link before viewing the file to know if there are any additions or changes.

Control of Equilibrium:

- **Equilibrium:** Reflexes maintain body position at rest and movement through receptors of postural reflexes:
  a. **Proprioceptors.** We have a whole lecture about it.
  b. **Visual (retinal) receptors.** عشان كذا الي مايشوف ممكن يختل توازنه ويطيح
  c. **Non auditory membranous labyrinth.**

Labyrinth:

Definition



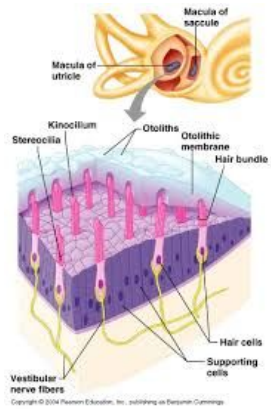
The labyrinth is present in the inner ear. Has two types: bony and membranous.The bony labyrinth is the network of passages with bony walls lined with periosteum. The membranous labyrinth runs inside of the bony labyrinth. There is a layer of perilymph fluid between them.

Types:

1. Bony labyrinth:

- Encloses the membranous labyrinth.
- Composed of: Bony cochlea and the 3 bony semicircular canals. "يعني كأنه هيكل السيارة الخارجي الصلب"

2. Membranous labyrinth:

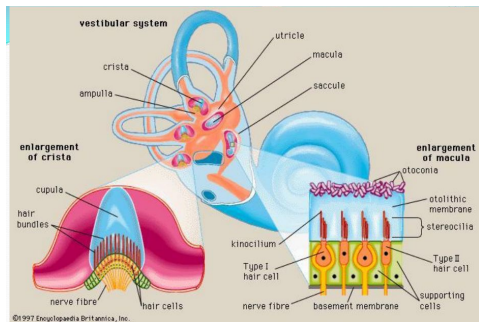


- You can think of it as the interior of the car.
  1. **Auditory** → for hearing → (Cochlea).
  2. **Non- auditory** → for equilibrium →**(Vestibular apparatus)**: composed of two parts:
     - Vestibule: (Utricle and Saccule) for linear acceleration.
     - Semicircular canals "SCC." for rotations of head.

Vestibular system:(6:45)

Macula (otolith organs) of utricle and saccule:

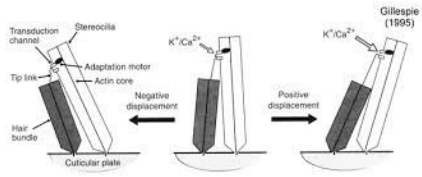
cochlea → organ of corti \ utricle and saccule → macula (otolith organ).



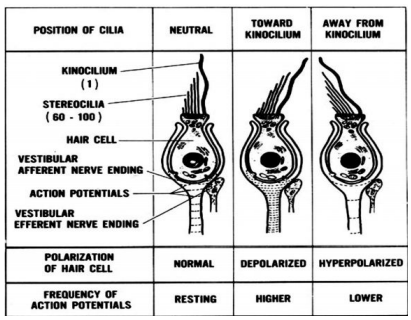
- Hair cell synapses with the endings of the **vestibular** nerve.
- Hair cell has 30-150 (**stereocilia**) and one **large** cilium called (**kinocilium**) both connected with thin **filamentous** attachments.
- All cilium membrane has positive **potassium (K+)** channels.

- 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.
  Vestibular system(1:55)

❖ Mechanism of action:



1. Bending of stereocilia **towards** kinocilium → depolarization + Ca entry + neurotransmitter release → **increase** rate of impulses to 8th nerve fibers.
   the hair cells surrounded by fluid. any movement of the body will cause movement of the **fluid** inside the semicircular canals or saccule and utricle → cause movement of the **gelatinous materials** and → move the **stereocilia**.
2. Bending of stereocilia **away from** kinocilium → hyperpolarization → **decrease** rate of impulses to 8th nerve fibers. اذا ابعدت الستيروسيلا عن الكنوكليوم تنشكر قنوات الصوديوم ويصير عند هايبربولارسيبشن



❖ Functions of macula (mainly utricle):

1. orientation of head in space & maintenance of static equilibrium

A. In erect upright position (vertical position):

- RT & LT utricle impulses balance each other.
- No sensation of male-equilibrium.

اذا كنا موقفين في وضع راسنا مستقيم تكون الماكيولا في كل الجهتين ترسل نفس الإشارات لعصب التوازن توصل له ان حنا في حالة اتزان

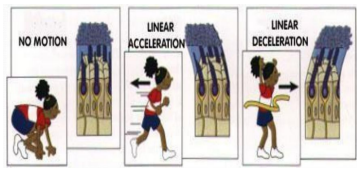
B. Bending the head to one side:

- statoconia crystals of hair cells fall to that side by their weight → pull stereocilia to move towards kinocilium → **depolarization** (stimulation).
- stereocilia of the other side moves away from kinocilium → **hyperpolarization** (inhibition).

2. Detection of linear acceleration:

مثل لما يكون الشخص واقف في الباص اول مايتحرك الباص لقدام يحس انه بيطيح على ورا ويتمسك الشخص هنا يمثل الهيرسيلز

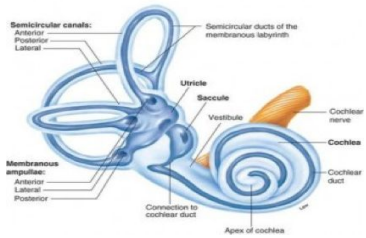
- **Linear acceleration:** as at running & standing in a bus.
  - At beginning of movement statoconia lag behind movement by its inertia → fall backwards → cilia moves backward → person feels he is falling backwards → try to correct this by leaning forwards to shift statoconia & cilia anteriorly.



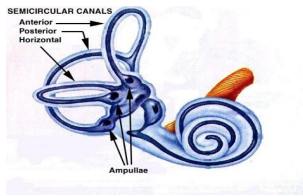
And will stimulate the brain to send signals to muscle to contract (feedback mechanism).

- **At deceleration** (runner try to stop) → statoconia move forwards by its **momentum** → person feels falling anteriorly.

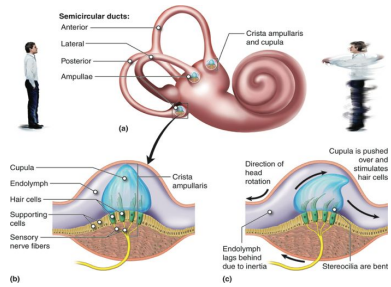
Semicircular canals



- Three canals (**Horizontal, anterior and posterior** semicircular canals) **perpendicular** to each other.
- Filled with **endolymph**. الفلويد يتحرك عكس اتجاه الحركة
- Dilated end called **ampulla**. للتذكر :نفس شكل القنبلة ونفس نطقها
- **Ampulla**: has crista ampularis (as macula).
- cilia embedded in a **gelatinous** mass called **cupula**.



❖ Mode of action & functions



1- during rest : equal discharge from SCC on both

2- Detect & maintain posture during head rotation in any direction (**angular acceleration**) rotation

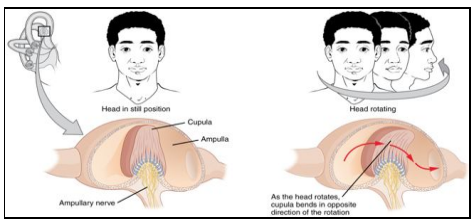
According to the movement:

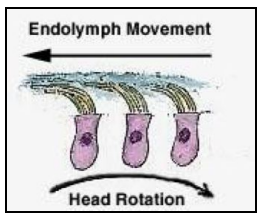
- if we move to the right, will stimulate right semicircular canal , stimulate right vestibular nuclei , inhibition of the opposite side .
- if we move to the left, will stimulate left semicircular canal, stimulate left vestibular nuclei , inhibition of vestibular nucleus on the right (opposite side).

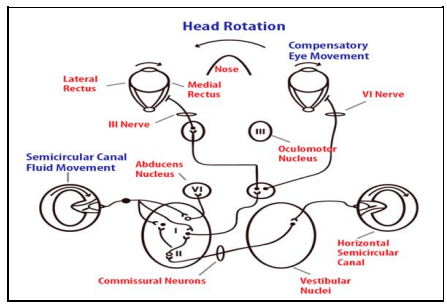
- **Rotation from left to right in horizontal plane:-**

Endolymph → opposite direction by inertia **from right to left.** → the cilia of right side bent by **endolymph towards the kinocilium → towards the utricle → Depolarization → impulses** from right side **increase**.

→ In the other hand left side cilia bent **away from kinocilium → Impulses decrease** from left side → sensation of rotation to right.







مثال : لما الف يسار واشوف يمين lateral rectus of the right eye stimulation , medial rectus of the left eye stimulated
lateral rectus of the left eye inhibited , medial rectus of the right eye inhibited

Neuronal connection:

The **vestibular nuclei**[1] on either sides of the brainstem **send signal to**:

- **Cerebellum.**

[1] Vestibular nuclei ; maintain eye movement and balance.

- Nuclei of cranial nerves III, IV, and VI.
- Reticular formation. Take information from visual , auditory to maintain conscious and it's IMPORTANT for balance.
- Spinal cord (**vestibulospinal tracts**).
- Thalamus.

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

1- Vertigo مثل: إذا درنا كثير ووقفنا نحس ان الدنيا تدور وتدور الأشياء اللي حولنا

- This false sensation of counter- rotation at end of rotation

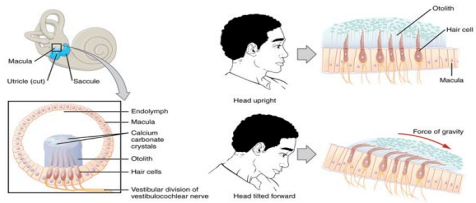
2- Nystagmus

- jerky eye movements at the beginning & end of rotation to fix objects in the eye field.

3- Bradycardia

4- Hypotension إذا درنا كثير ندوخ لان الضغط انخفض عندنا

5- Increased muscle tone on same side of rotation to support the body & decreased muscle tone on the opposite side.



★ **References:**

- 435 girls slides and notes.