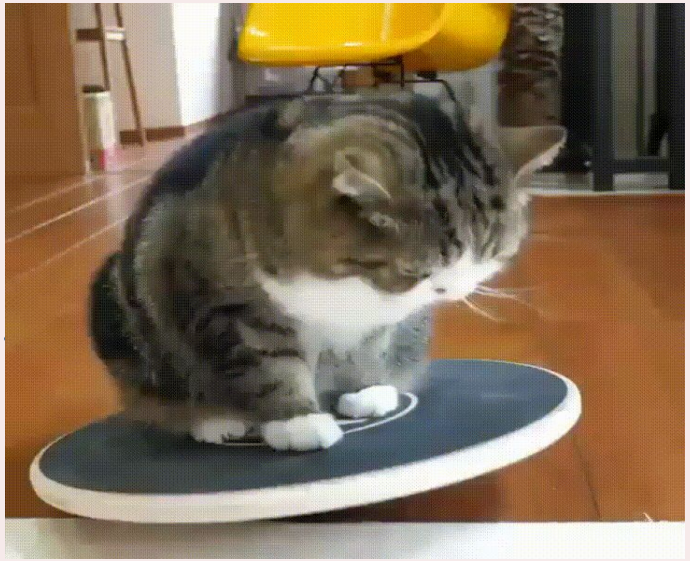
COGS 17

Week 7

Vestibular & Somatosensory System



Reminders!

Homework Problem Sets

- Homework #6 is due WED @ 11:59 PM!
- No late homeworks accepted

Midterm

- Midterm 2 is this Thursday 3:30-4:50
- Can be taken online or in class
- Will be proctored in class

Extra Credit

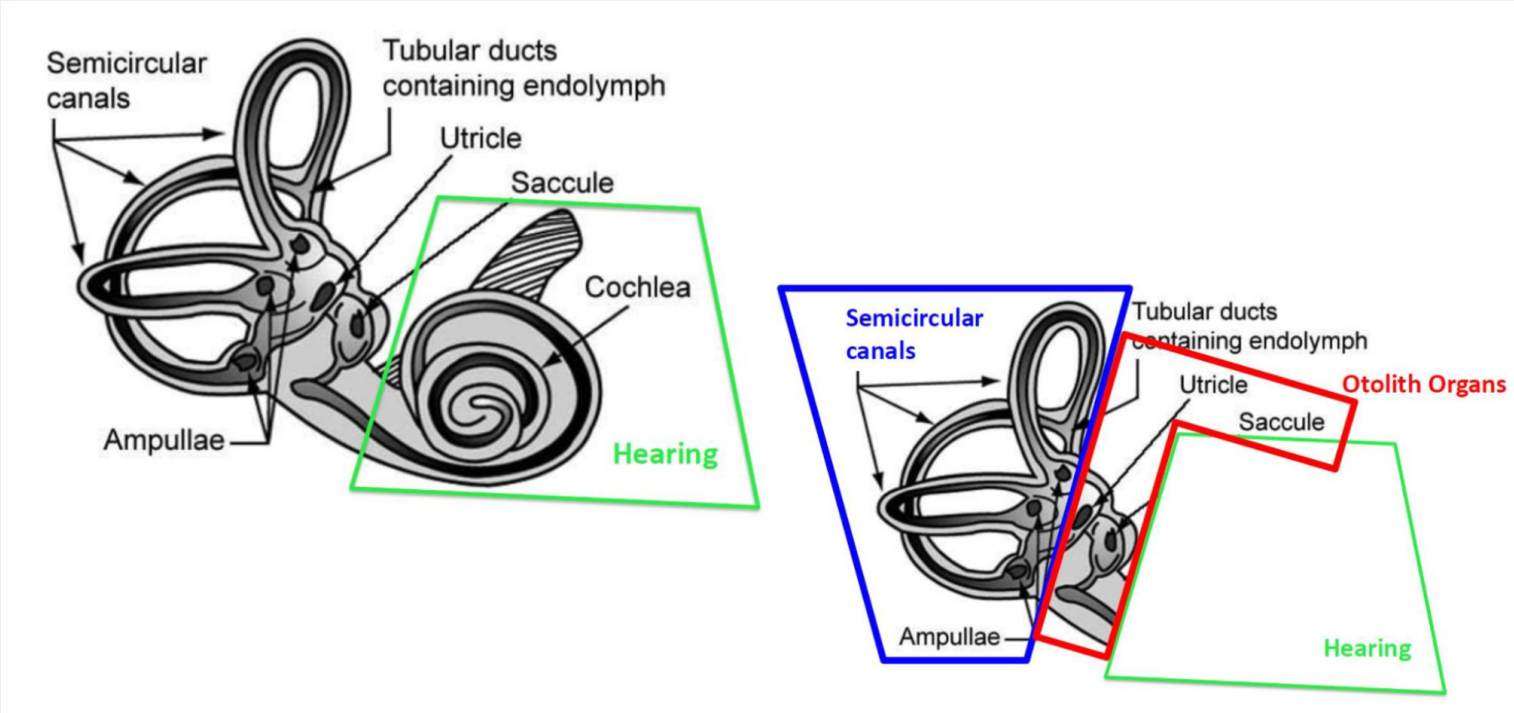
- SONA
- Mnemonics
- Do all HWs → 4 extra credit points

For Slides + Problem Sets

Link:

https://drive.google.com/drive/folders/1DlvXFvEKxhF3ykEaK2_jBsNUgGOb8fS3?usp=drive_link

Vestibular System



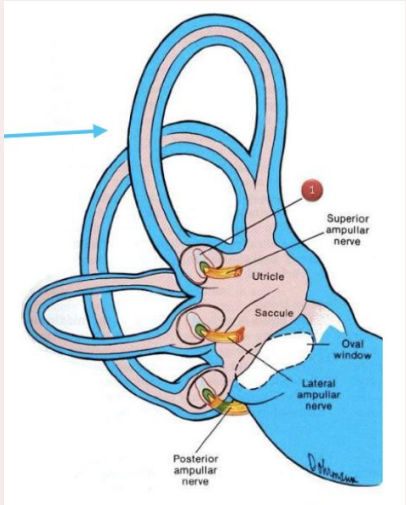
Vestibular System

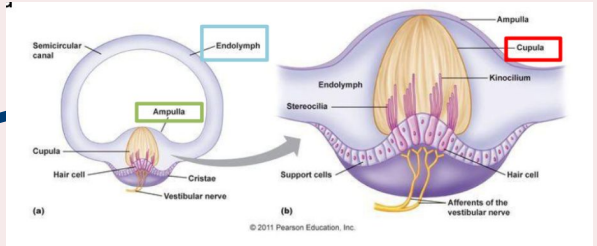
2 structures: **semi-circular canals (for ROTATION) and Otolith Organs (HEAD TILT)** → provide movement and balance info

Semicircular canals

- 3 looped tubes orientated to different orthogonal planes (XYZ) filled with K+ rich **Endolymph** fluid
- **Hair cell (vestibular receptor cells):** in a chamber (Ampulla) at the base of the semi-circular canals, embedded in a gelatinous cap (Cupula), its cilia are bent by flow of endolymph in Ampulla

- When the head rotates (start of rotation), fluid in ampulla lags behind movement
- When head movement stops (end of rotation), the fluid overshoots movement
- This motion deforms the cilia of the hair cells and alters NT release



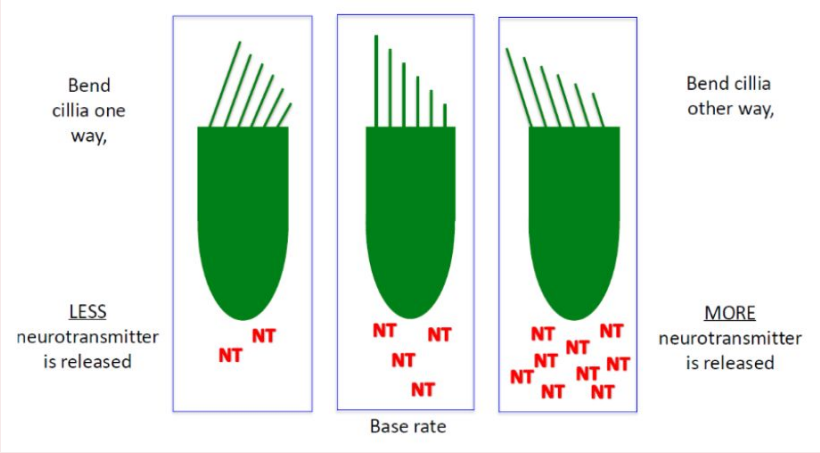


Vestibular Hair Cells

Similar with Hair Cells in Auditory system, except…
Vestibular HC has spontaneous firing, absence of input
= When no rotation, hair cells release a base rate of NTs

Rotation of Endolymph fluid causes the cilia of hair cells to bend

- K+ in the Endolymph fluid enters the HCs to open Ca++ gates which facilitates NT release
- If the cilia bends towards the **tallest, more NT** is released and vice versa
- Graded potentials based on the magnitude of rotation/bend

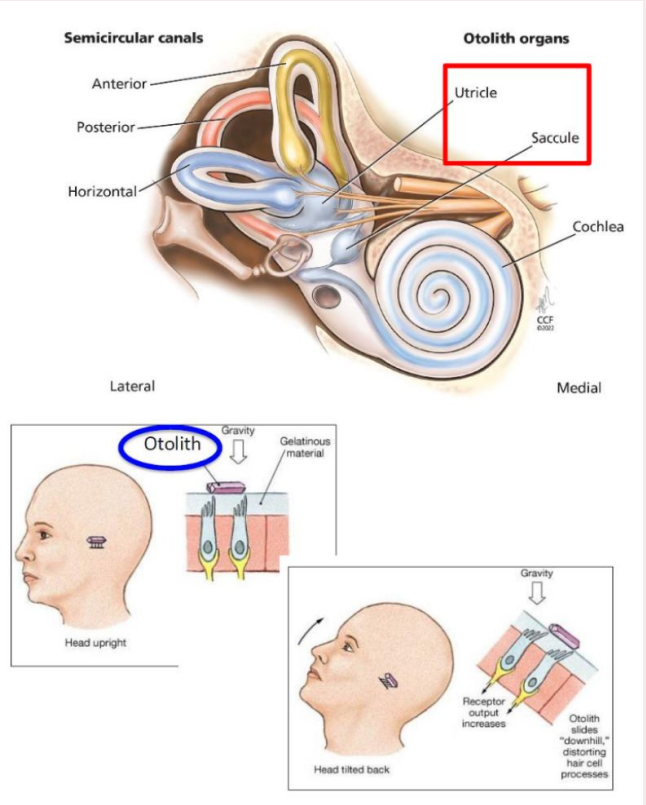


Otolith Organs

Detects **changes** in head tilt relative to the body

Consists of the 2 chambers (together form the Macula): HCs line the walls of these Endolymph-filled chambers

Ear Stones (Otoliths): Calcium-Chloride crystals sit in gelatinous material in which HCs are embedded



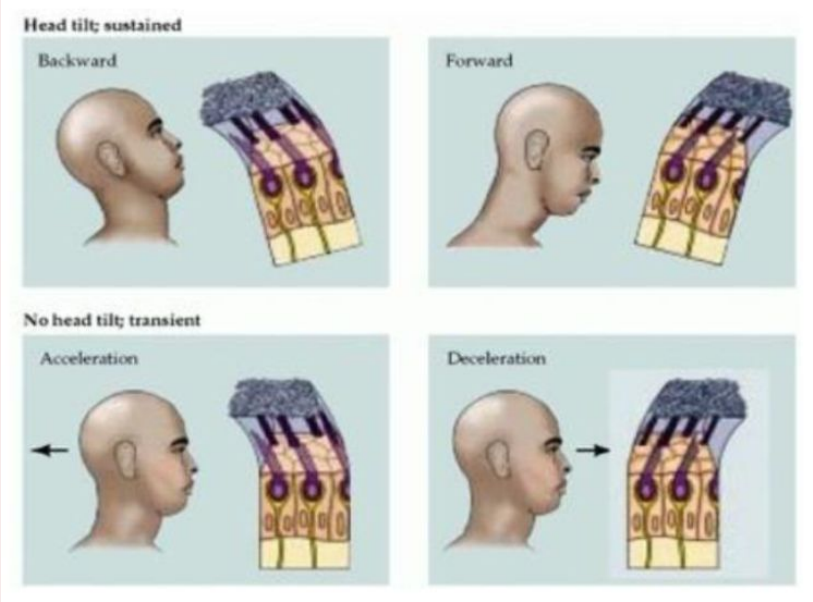
Otolith Organs

When head is upright: Base firing rate

- Whichever angle you tilt your head, some Otoliths weigh down the cilia of some HCs (bend one way, fire more; bend other way, fire less)

Note that Acceleration and Deceleration has the same effect as tilt backward and tilt forward, respectively

Otolith organs detect the start/stop of locomotion as well as head tilt



Vestibular Pathway

HCs cause NT release which synapses onto vestibular ganglions >

Vestibular ganglions project to 8th cranial nerve >

From the 8th cranial nerve splits >

- Cerebellum: Direct connection for maintaining balance
- Vestibular nuclei: Multiple overlapping functions, plays an essential role in maintaining equilibrium, posture, head position, etc. Disruption leads to Nausea

Medulla projects to spinal cord/brain stem (posture), superior colliculus (coordinate w/ visual motion) and cranial nerves 3, 4, and 6 (eye movements)

Higher pathways are still areas of research

Motion sickness: when vestibular and visual systems are not coordinated or improperly integrated

Free Nerve Endings

Respond to change in **Temperature (Thermoreceptors: Warm-best & Cool-best)** and **Path and Itch (Nociceptors)**

Encapsulated Nerve Endings

Respond to

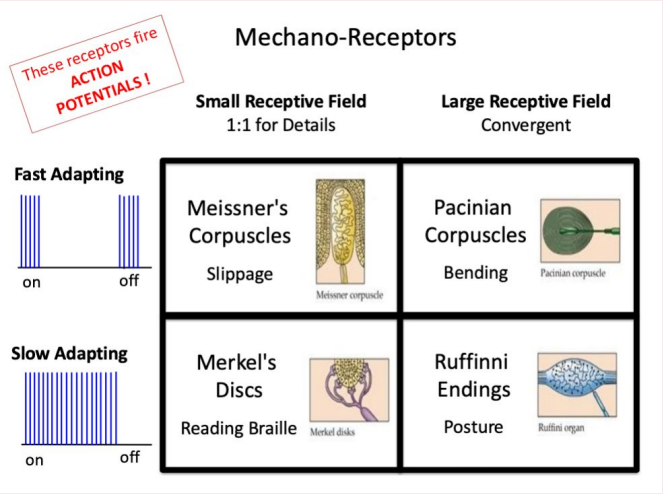
1) Various types of **Touch**
2) **Proprioception** = internal muscle and organ movement

Meissner's Corpuscles (Mechanoreceptors) have small RFs and are fast adapting - respond to rapid change (ex. slippage)

Merkel's Discs have small RFs and are slow adapting - for detail discrimination (ex. reading Braille)

Pacinian Corpuscles have large RFs and are fast adapting - respond to large scale changes (ex. bending)

Ruffinni Endings have large RFs and are slow adapting - respond to sustained, large-scale events (ex. posture)



Across Fiber Coding

Normal response to 89 degrees (WB=CB)

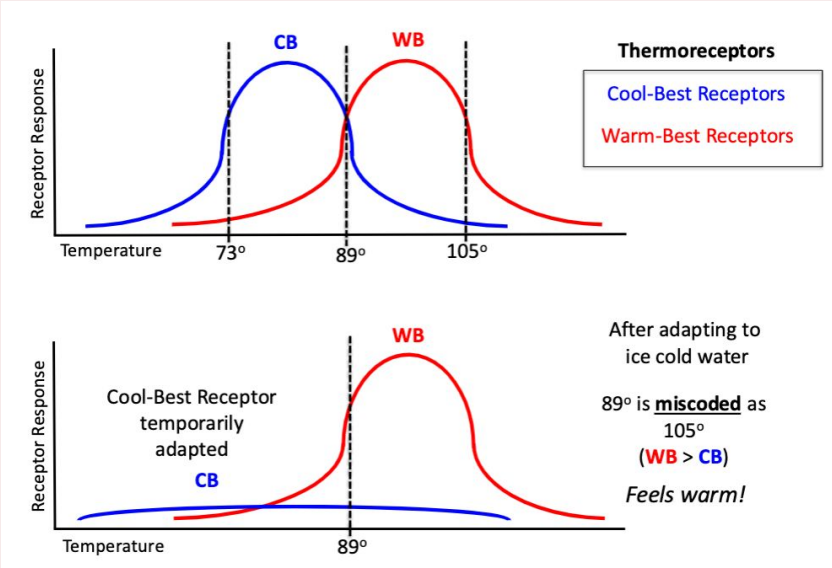
Normal response to 105 degrees (CB<WB)

Normal response to 75 degrees (CB>WB)

Response to 89 degrees after selective adaptation to hot water (CB>WB)

Response to 89 degrees after selective adaptation to cold water (CB<WB)

At 89 degrees, there is a “Physiological Zero”



Somatosensory Pathways

Medial Lemniscal Pathway

- "Second-order" cells cross over in Brain Stem (tract called "Medial Lemniscus") to synapse in contralateral VPN

Spinothalamic Pathway

- "Second-order" neurons cross over in Spinal Cord, ascend on contralateral side to synapse in contralateral VPN

Brown-Sequard Syndrome → damage to only one side of the spinal cord >>

- Loss of Touch on IPSI-lateral side
- Loss of Temp/Pain on CONTRA-lateral side