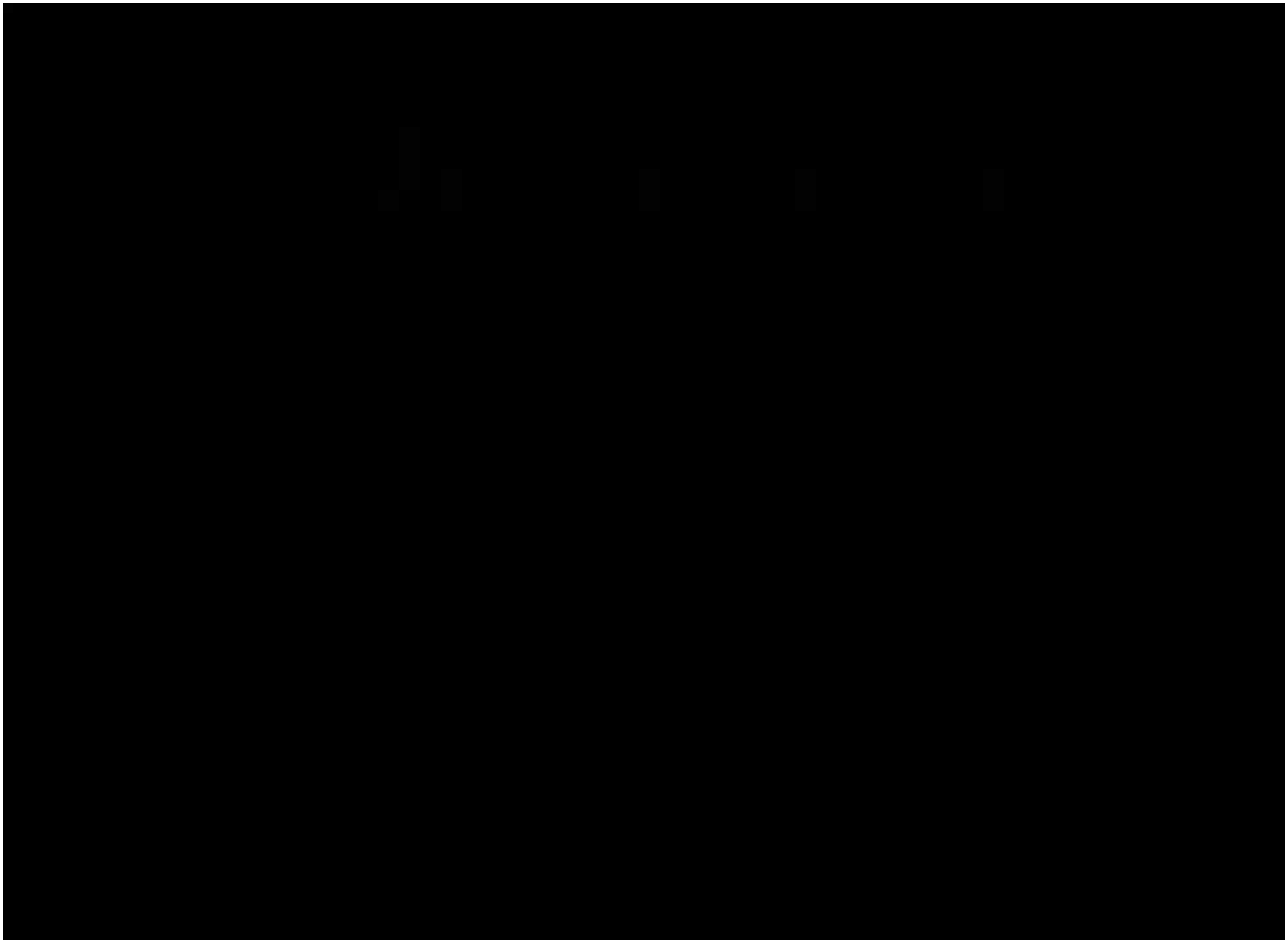
# Physiology of hearing

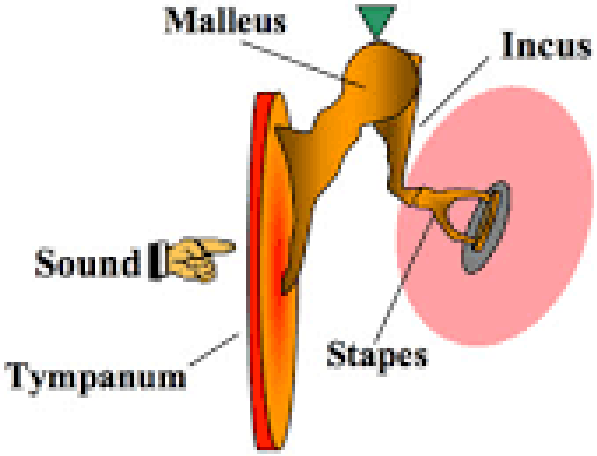
Prof. Dr. Haider Alsarhan

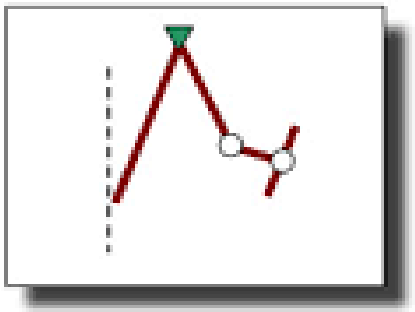
FIBMS- ENT



# The Lever mechanism

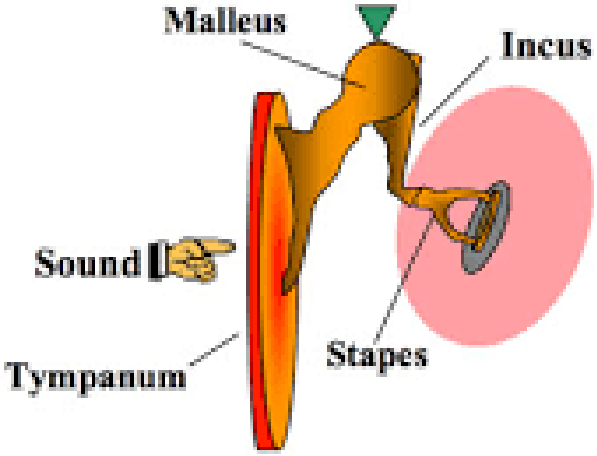
The lever action of the middle ear bones imparts a further mechanical advantage to the system—occurring because the anvil is shorter than the hammer—and further **increases pressure by roughly 35 percent**.

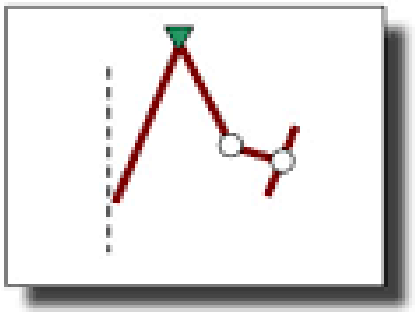


# The Lever mechanism

difference in length of the manubrium of the malleus and the long process of the incus. Because the manubrium is slightly longer than the long process of the incus, a small force applied to the long arm of the lever (manubrium) results in a larger force on the short arm of the lever (incus long process). In humans, the lever ratio is about 1.31 : 1 (2.3 dB)



# Area difference mechanism

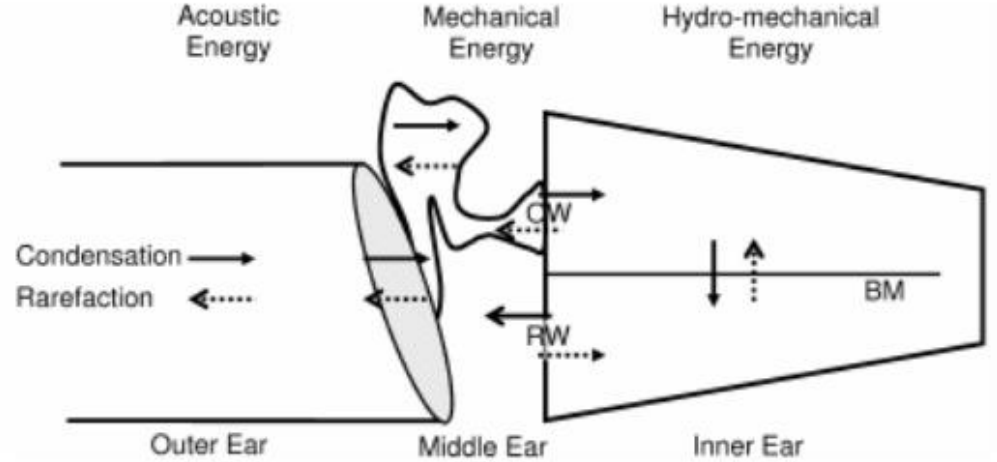
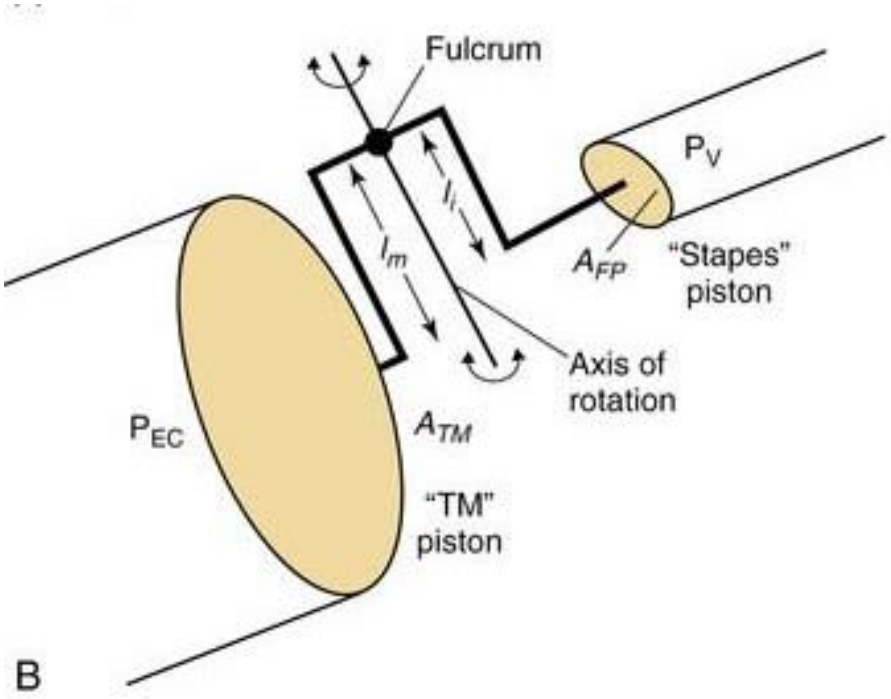



**FIGURE 5–1.** Overview of the transduction process from acoustic to hydromechanical, whereby the acoustic energy that enters the ear canal is converted into mechanical energy in the middle ear and then to hydromechanical energy in the fluid-filled inner ear. The *arrows* represent the vibration phase (rarefaction or condensation). Notice that there is a reciprocal relationship in the movement of the oval window (OW) and the round window (RW) that is necessary for the vibrational energy to occur in the incompressible fluid-filled cochlea. BM, basilar membrane; RW, round window; OW, oval window.

# Area difference mechanism




The human tympanic membrane has a surface area approximately 20 times larger than the stapes footplate (69 vs. 3.4 $mm^2$).If all the force applied to the tympanic membrane were to be transferred to the stapes footplate, the force per unit area would be 20 times larger (26 dB) on the footplate than on the tympanic membrane.

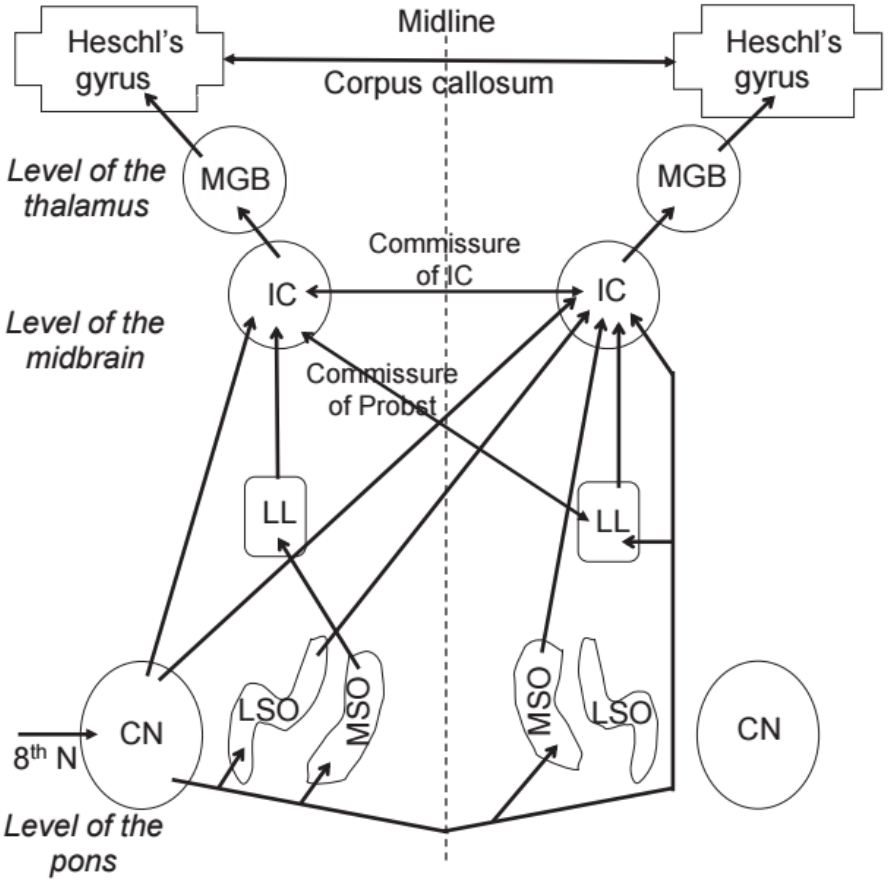



**FIGURE 4–26.** Central auditory neural pathways from one ear through the brainstem to the auditory cortex. The *dotted line* represents the midline of the brainstem. There are multiple pathways coursing along an ipsilateral route and a more dominant contralateral route. 8th N, 8th cranial nerve; CN, cochlear nucleus; LSO, lateral superior olivary complex; MSO, medial superior olivary complex; LL, lateral lemniscus; IC, inferior colliculus; MGB, medial geniculate body.

# Central auditory pathway

**Cochlear nerve**

**Cochlear nucleus**

**Superior olive**

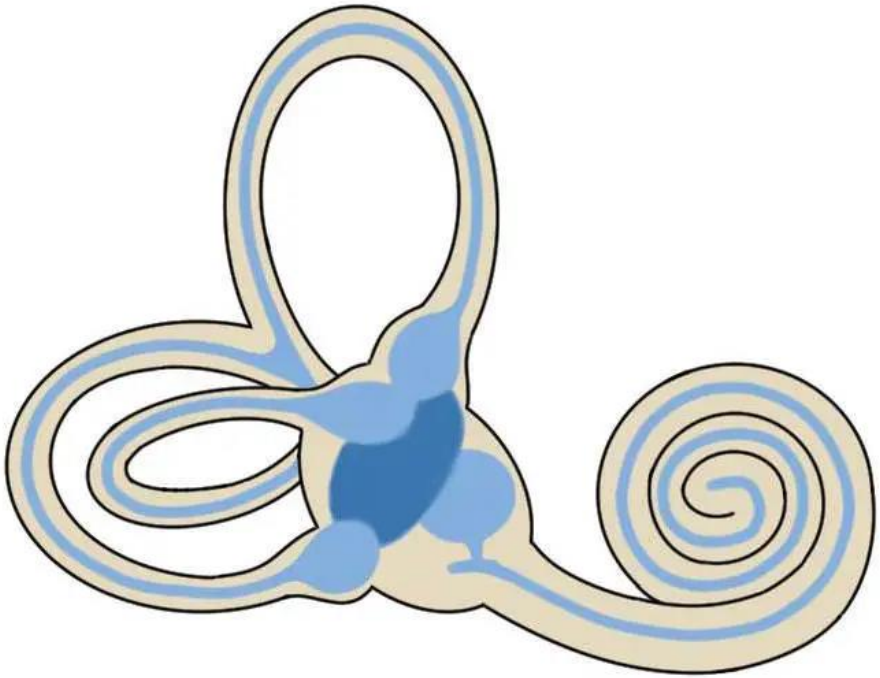
**Lateral meniscus**

**Inferior colliculus**

# Balance – the vestibule

- 5 sensory organs in each vestibule

the utricle , the saccule and the 3 SCCs

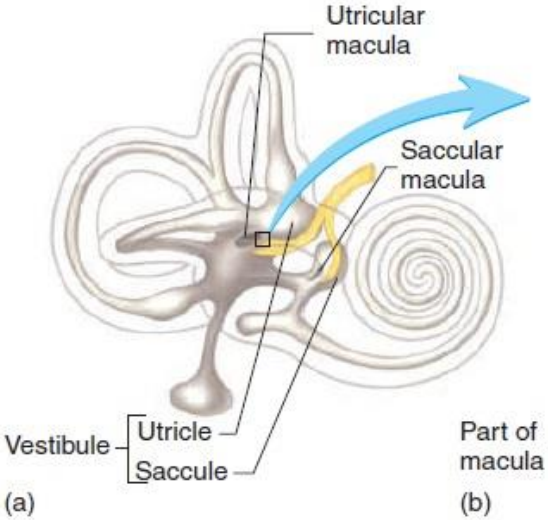


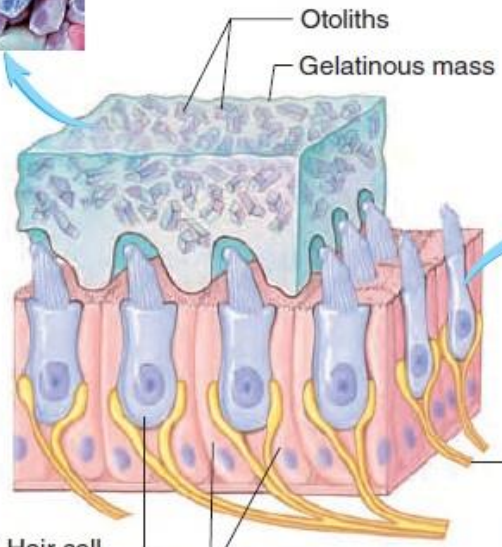
# Balance – the vestibule

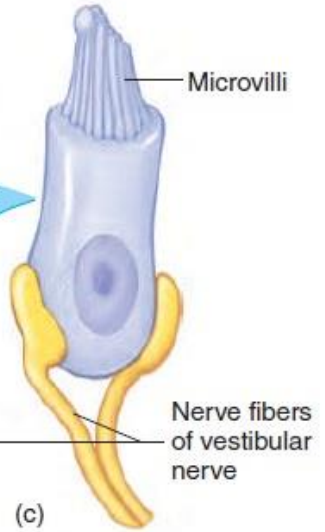
- The hair cells in the utricle and the saccule are located in the region called **the macula**
- **The utricle is horizontally located** and is responsible for detection of the **horizontal acceleration / deceleration**
- **The saccule is vertically located** and is responsible for detection of the **vertical acceleration / deceleration**

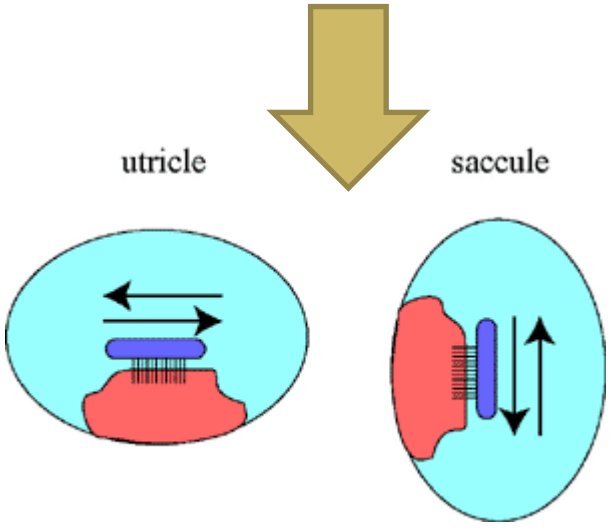
# Balance – the vestibule

(d)



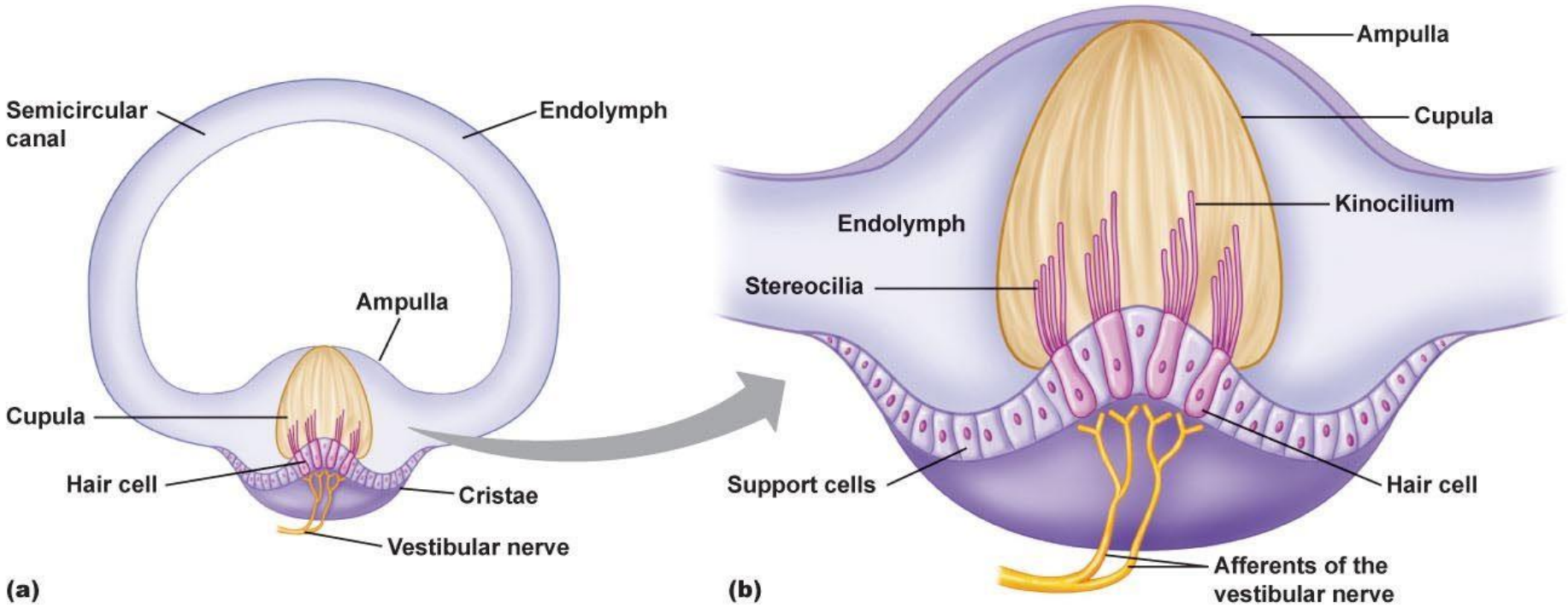
# Balance – the vestibule

- The hair cells in the semi-circular canals are located in the region called **the ampula**

- **The SCCs are** responsible for detection of the **angular acceleration/deceleration**

- **The ampula consist of**
- **1. the cupula -** the gelanenous material
- **2. the cristae –**contain **the hair cells**

# Balance – the vestibule



# Balance – the vestibular reflexes

- 1. the vestubulo-occular reflex
- 2. the vestibulo-spinal reflex
- 3. the vestibulo-collic reflex
- 4. the vestibulo-autonomic reflex