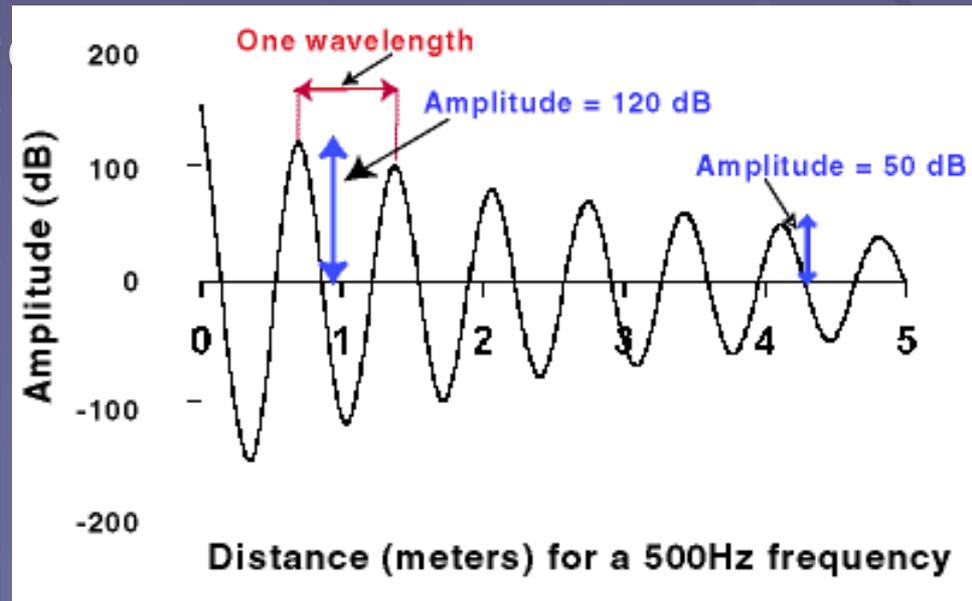


The Special Senses

3) Auditory

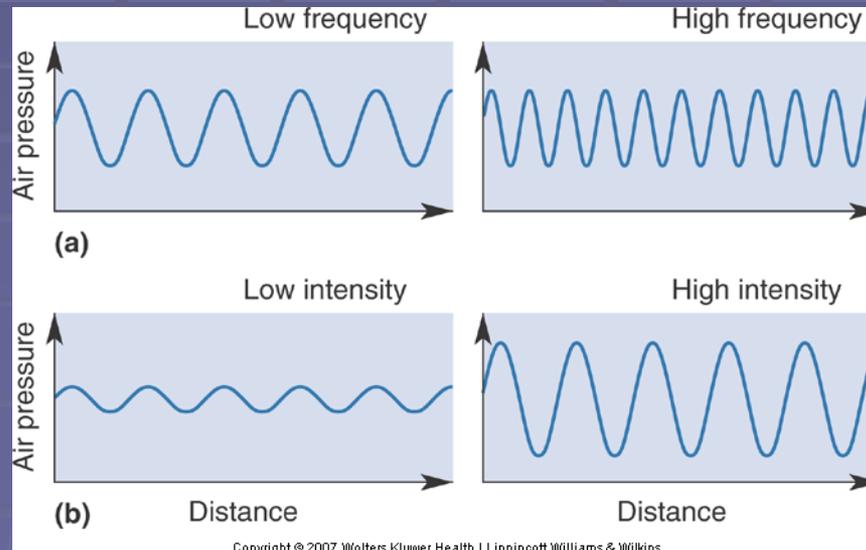
The Nature of Sound

- All waves have basic characteristics:
 - Amplitude
 - Frequency
 - Wavelength
- These properties have particular names with reference to sound
 - Amplitude = loudness
 - Frequency = pitch

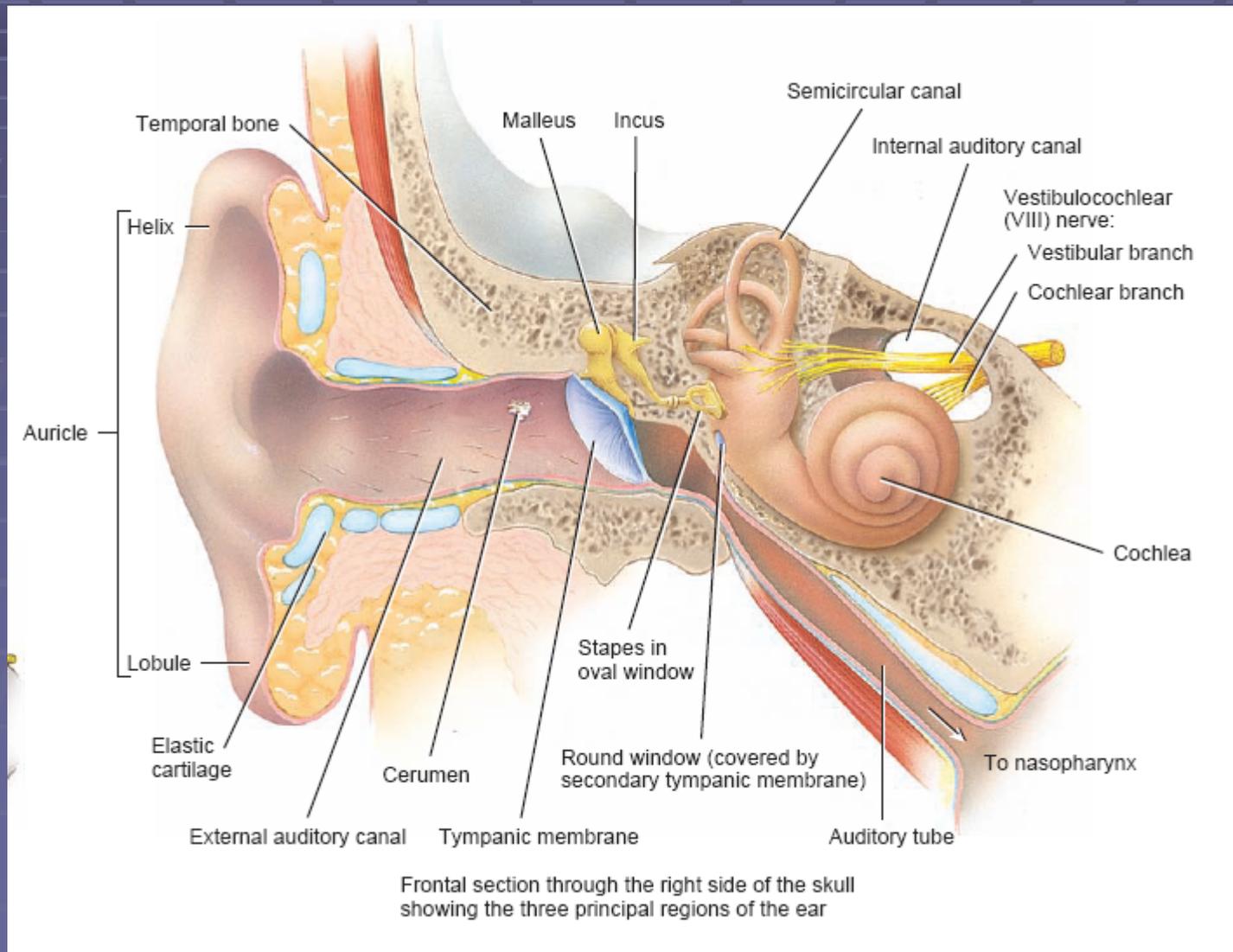


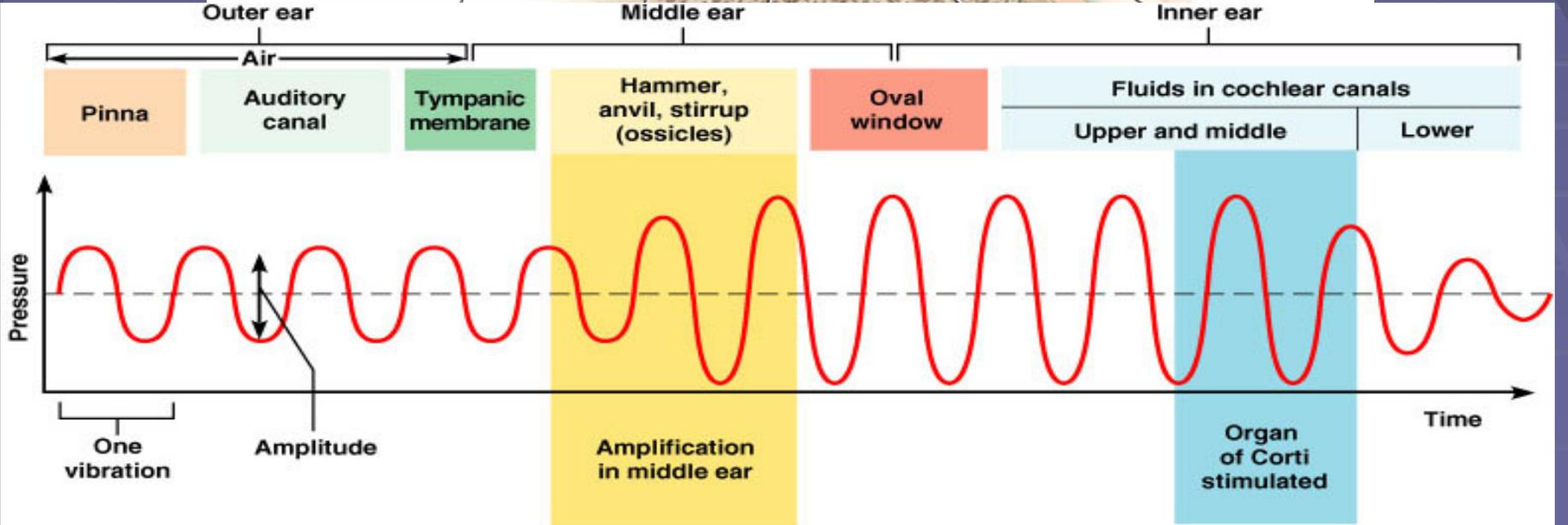
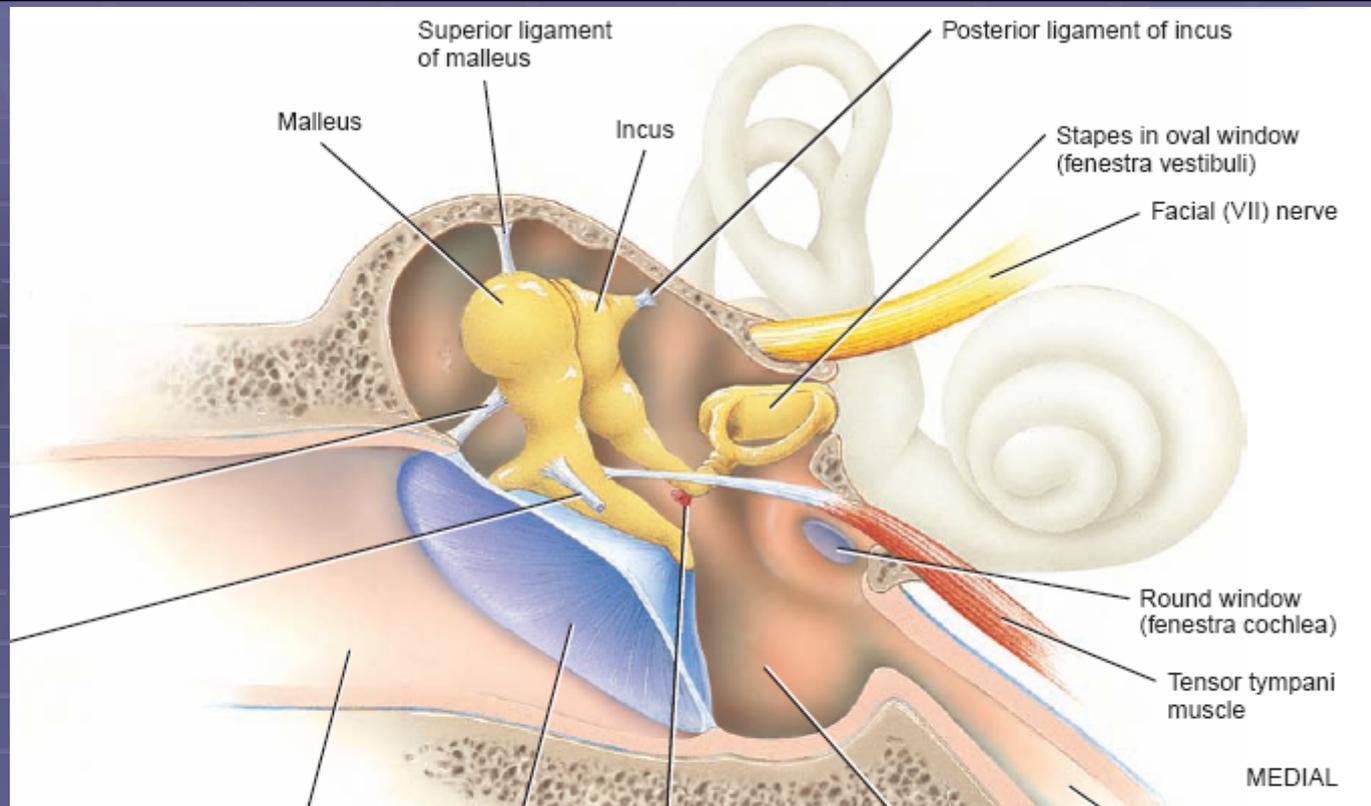
The Nature of Sound

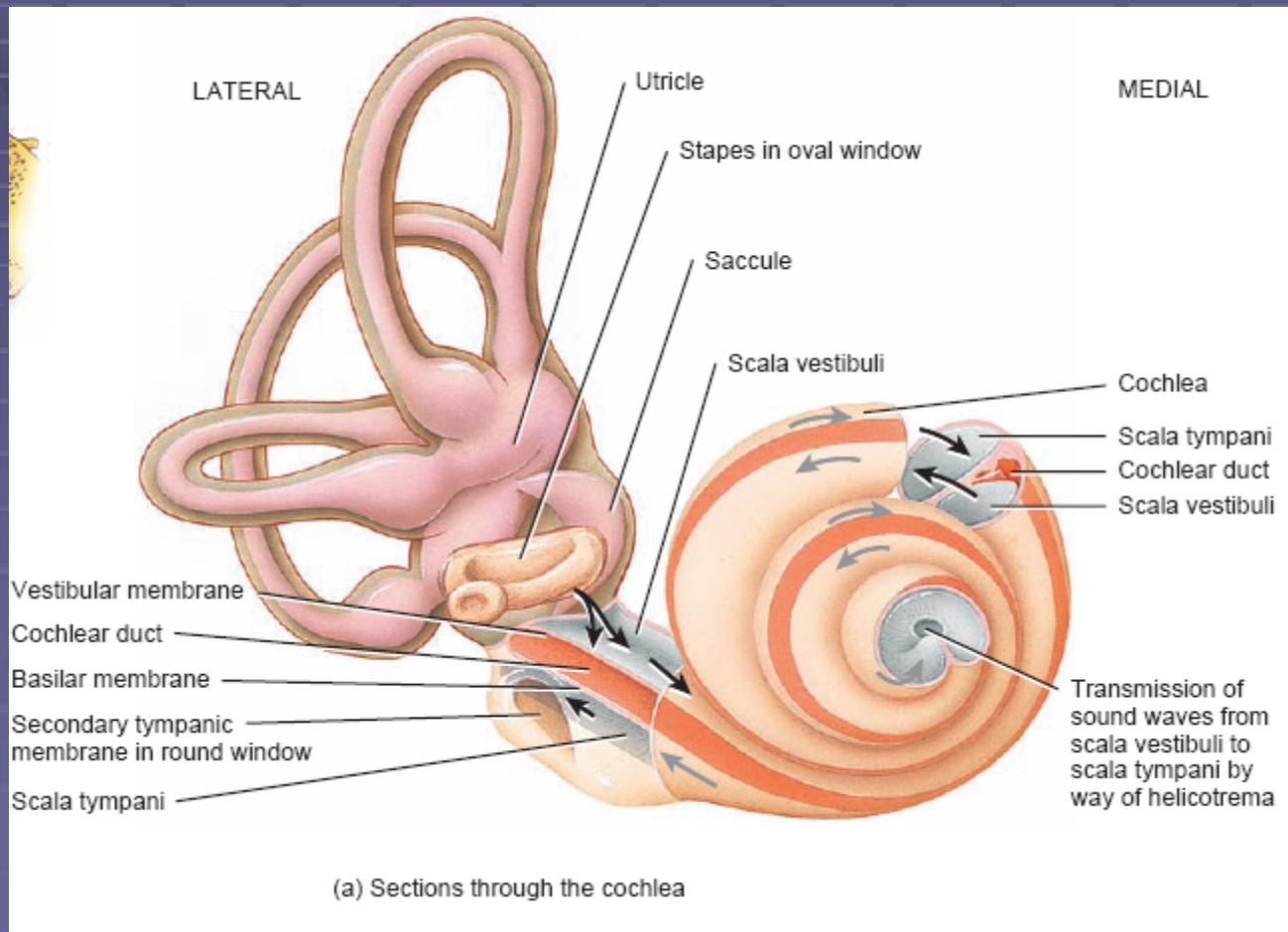
- Sound
 - Range: 20 Hz to 20,000 Hz
 - Pitch: High pitch = high frequency; low frequency = low pitch
 - Intensity: High intensity louder than low intensity

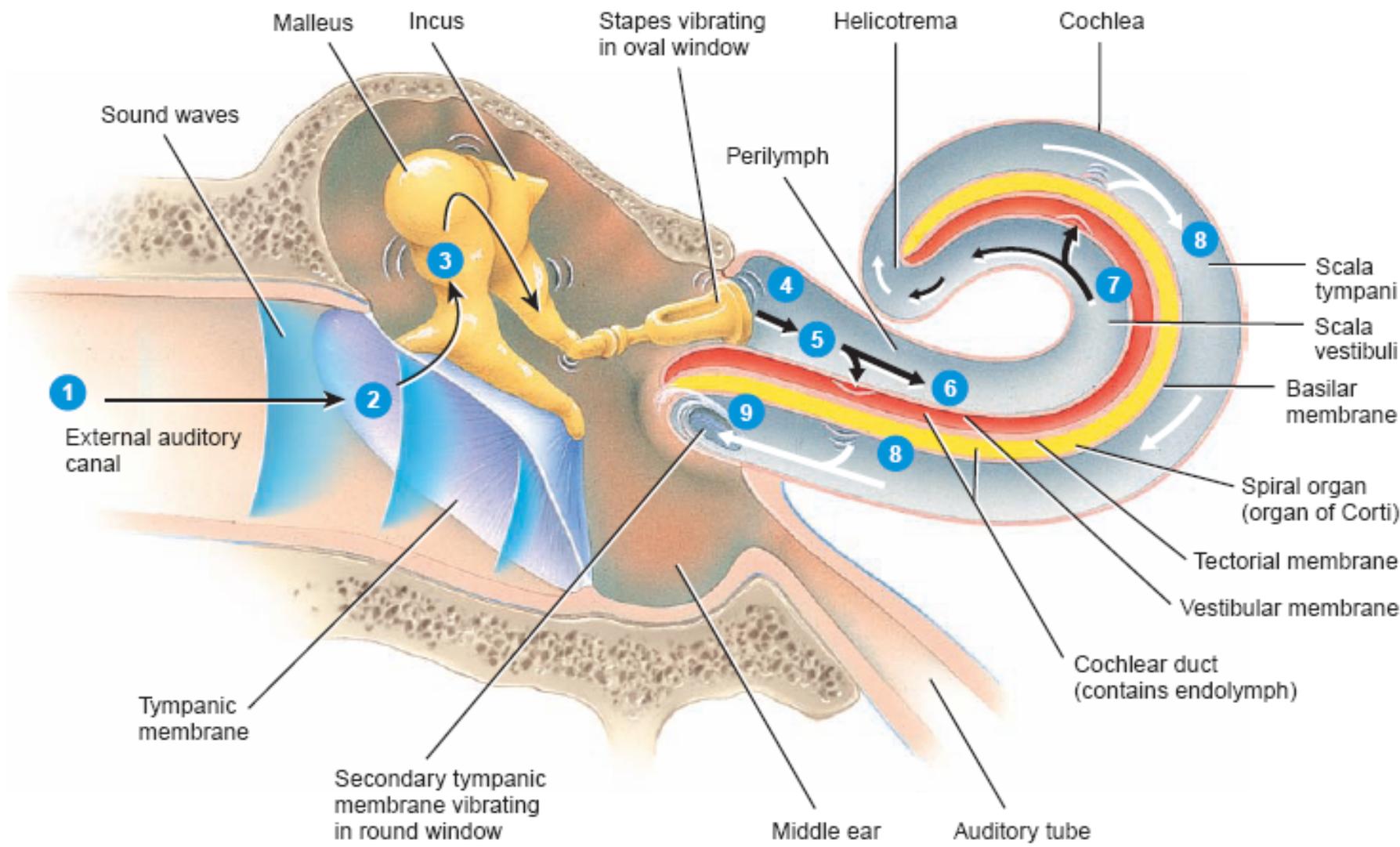


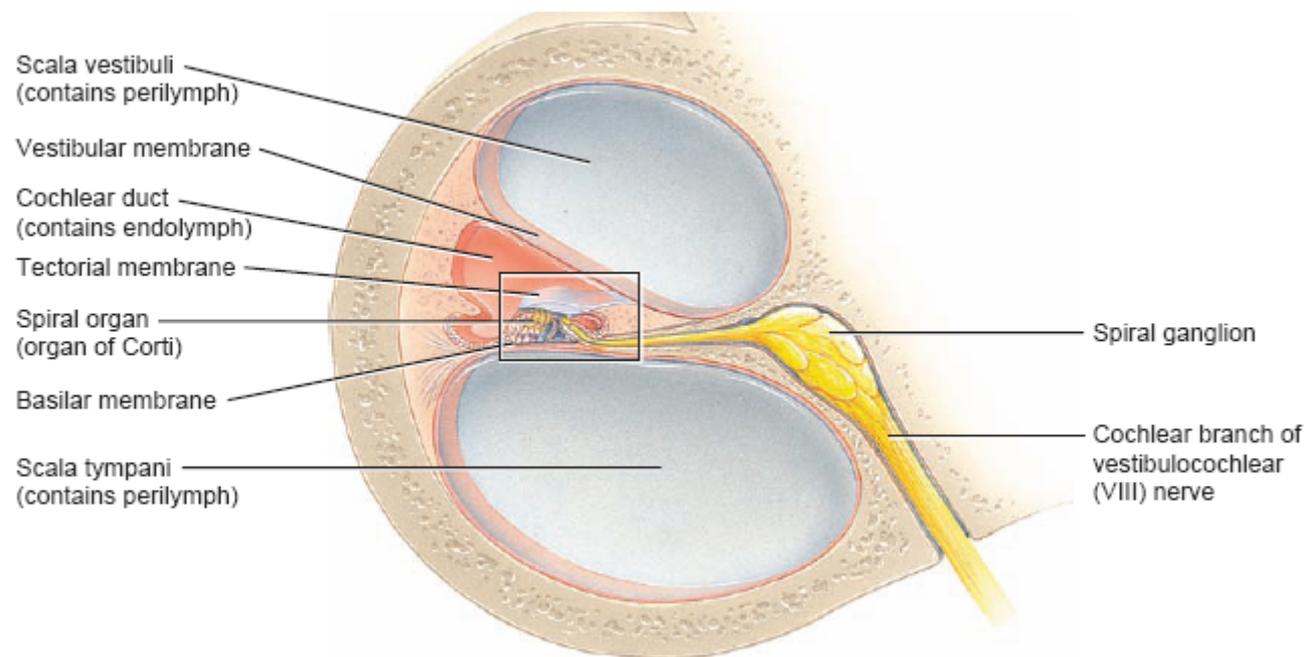
Anatomy of the ear





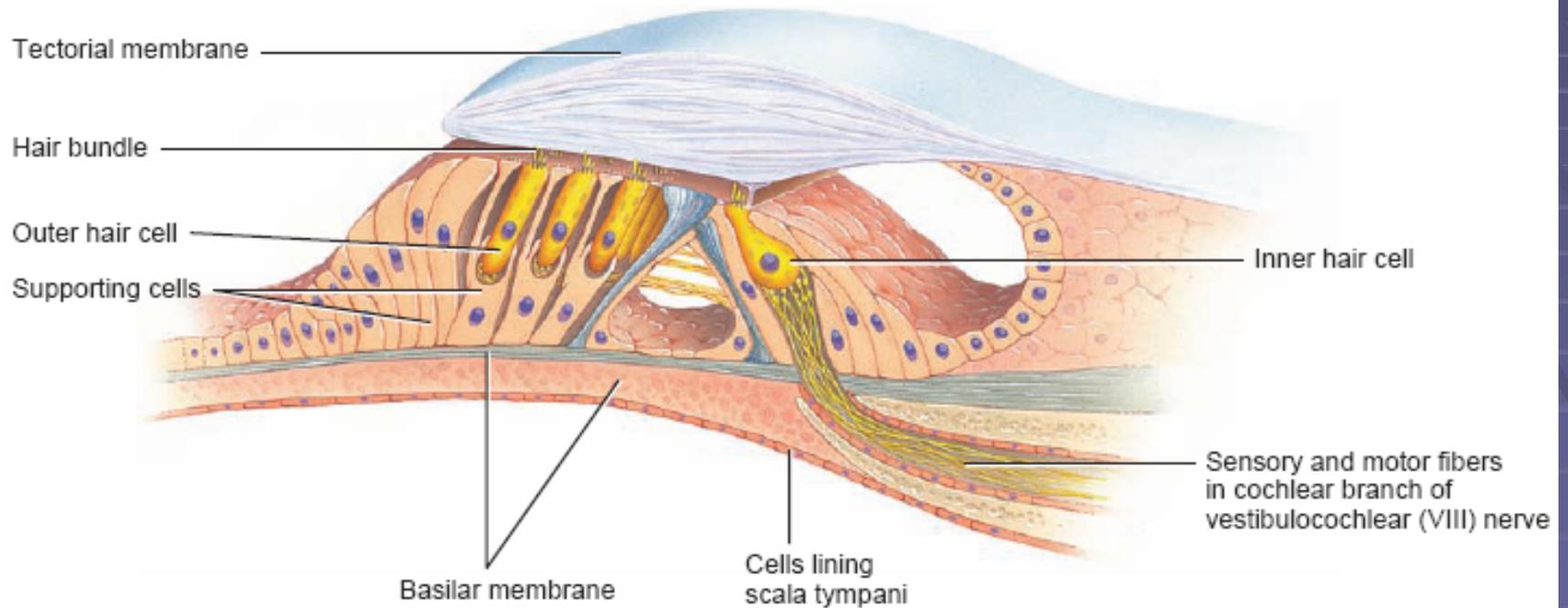




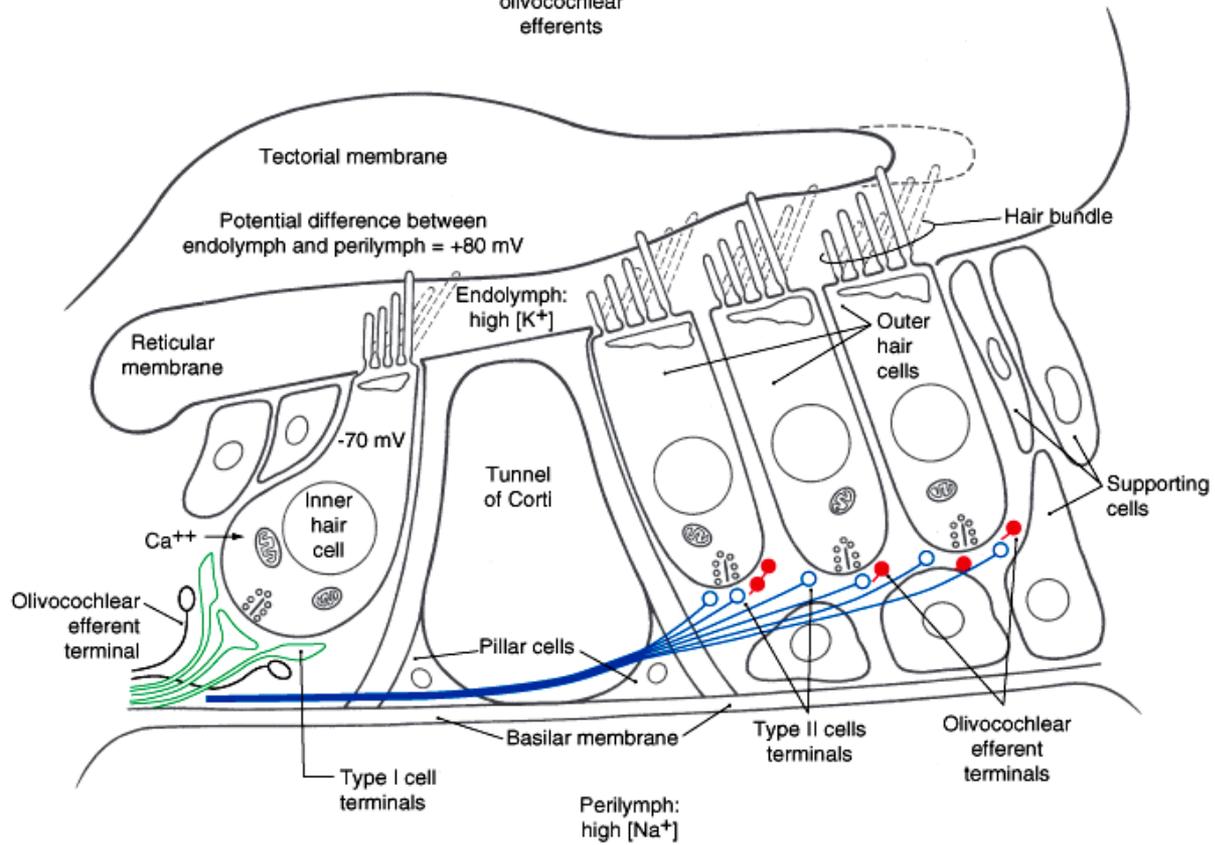
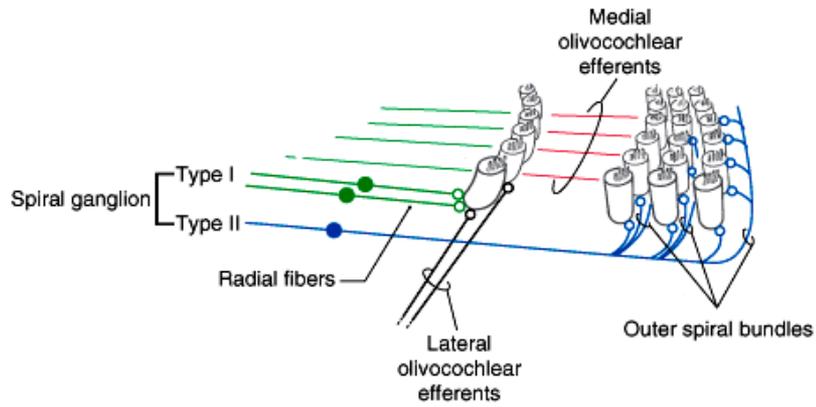


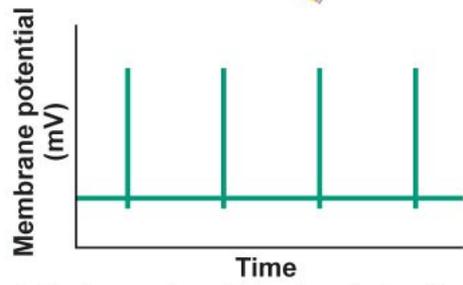
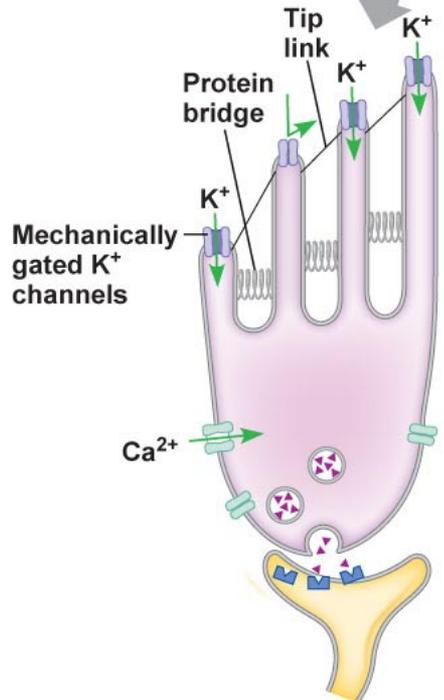
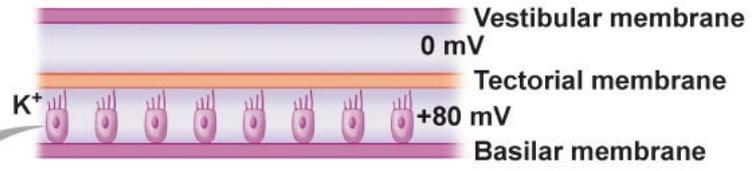
(c) Section through one turn of the cochlea

(c) Section through one turn of the cochlea

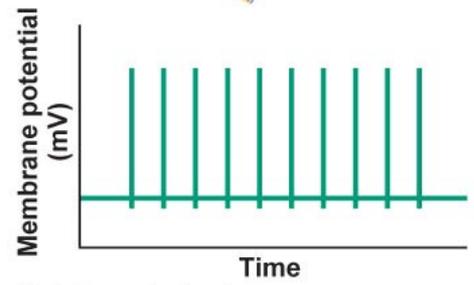
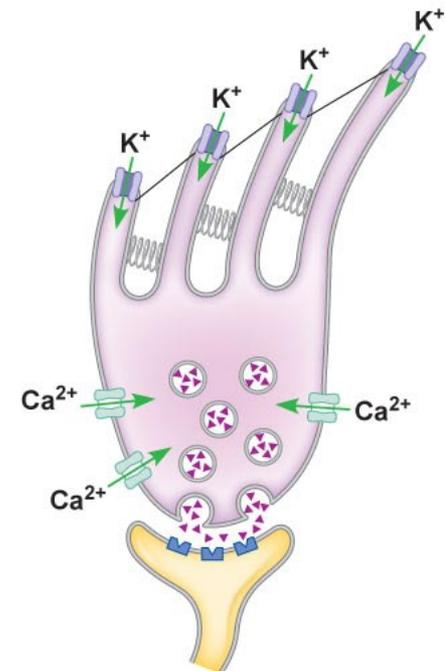


(d) Enlargement of spiral organ (organ of Corti)

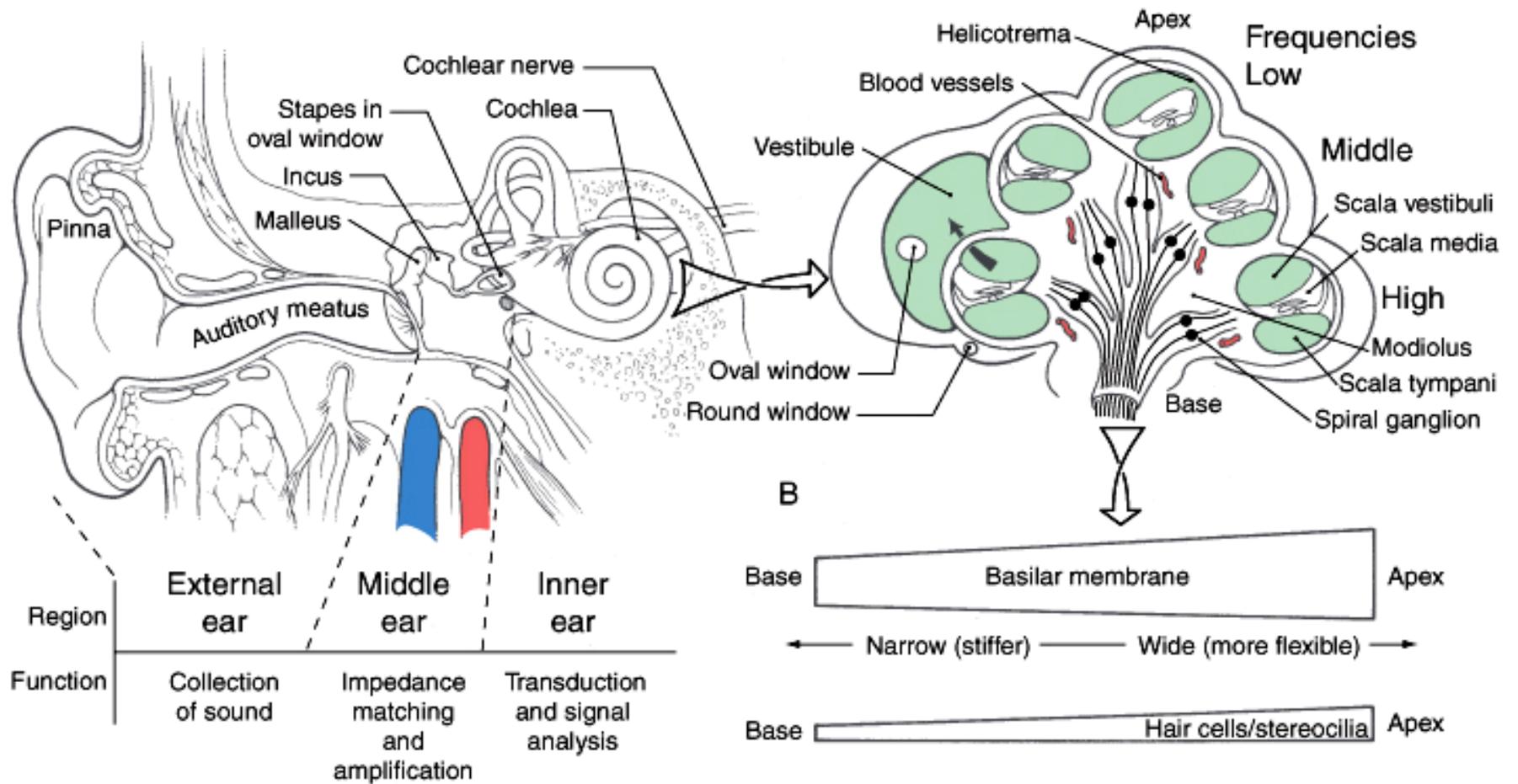




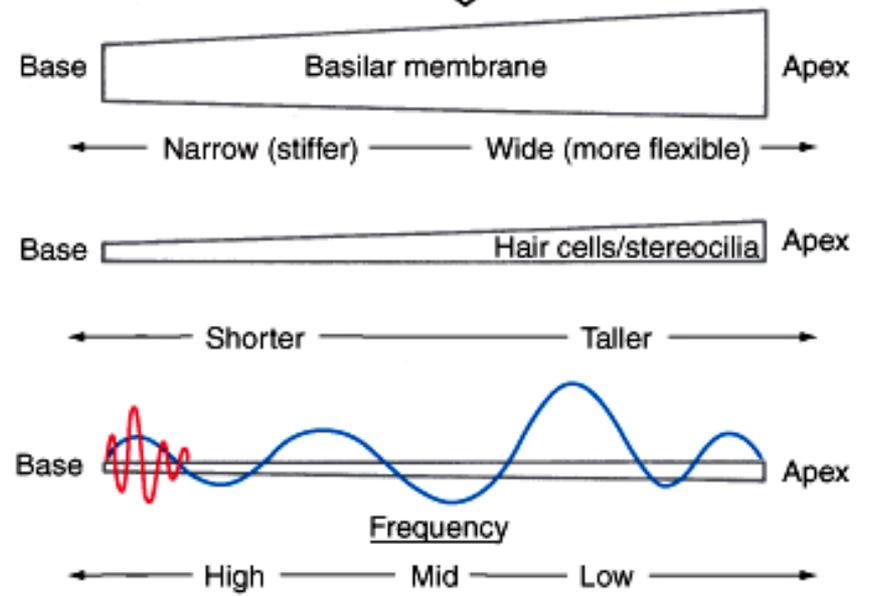
(a) At rest (partially depolarized)



(b) Depolarized

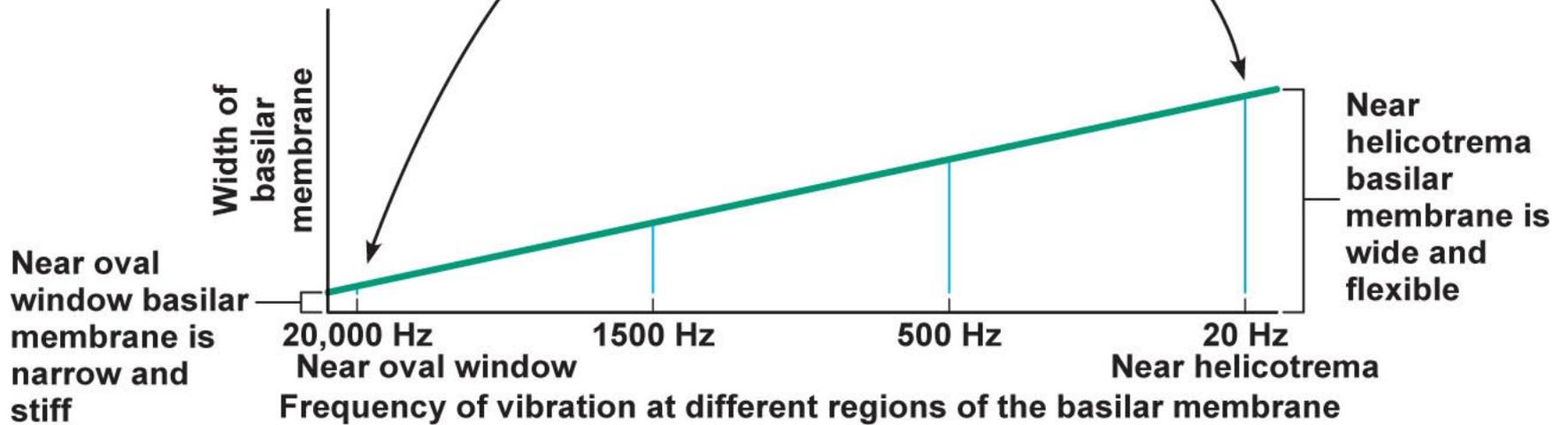
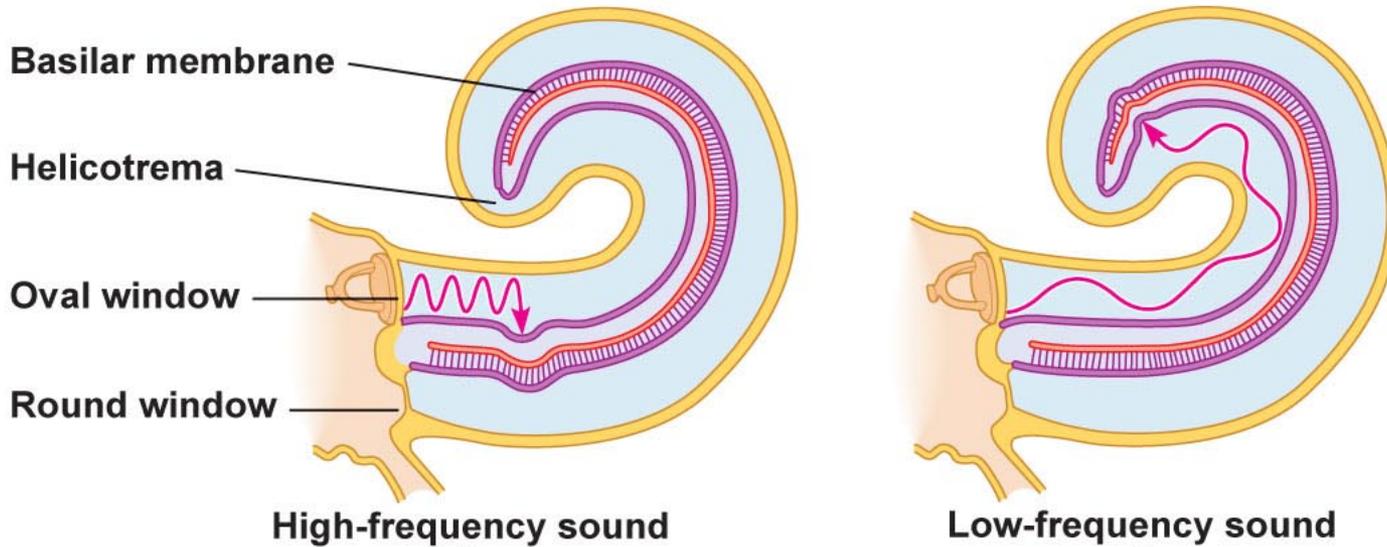


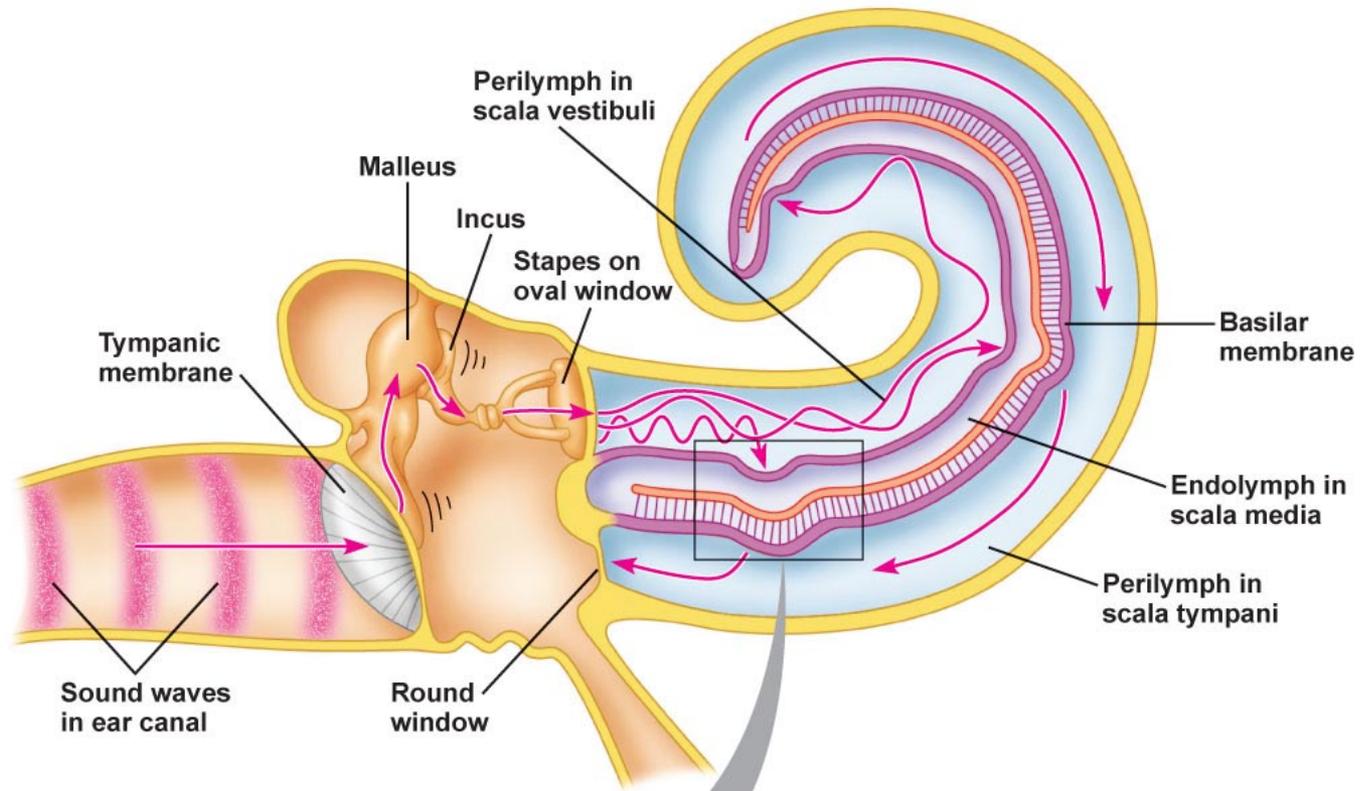
B



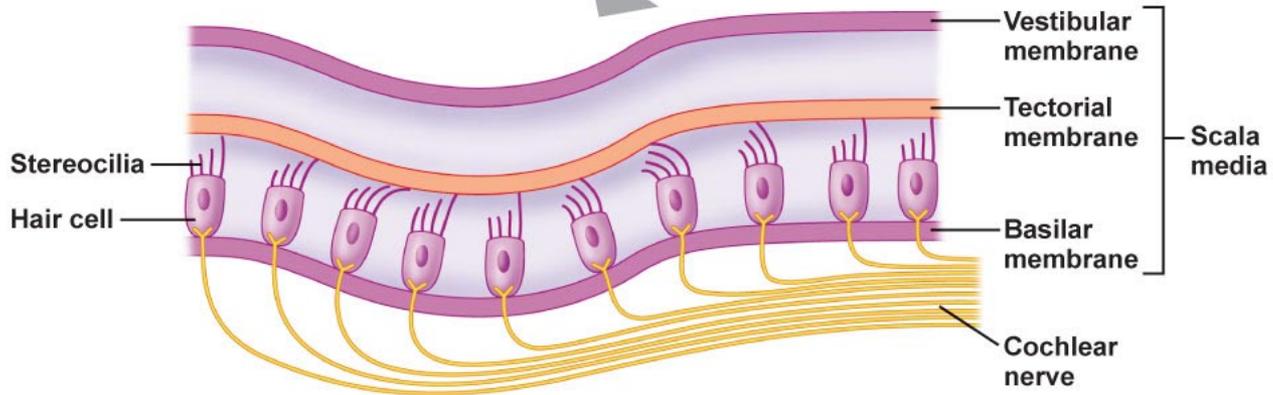
C

A

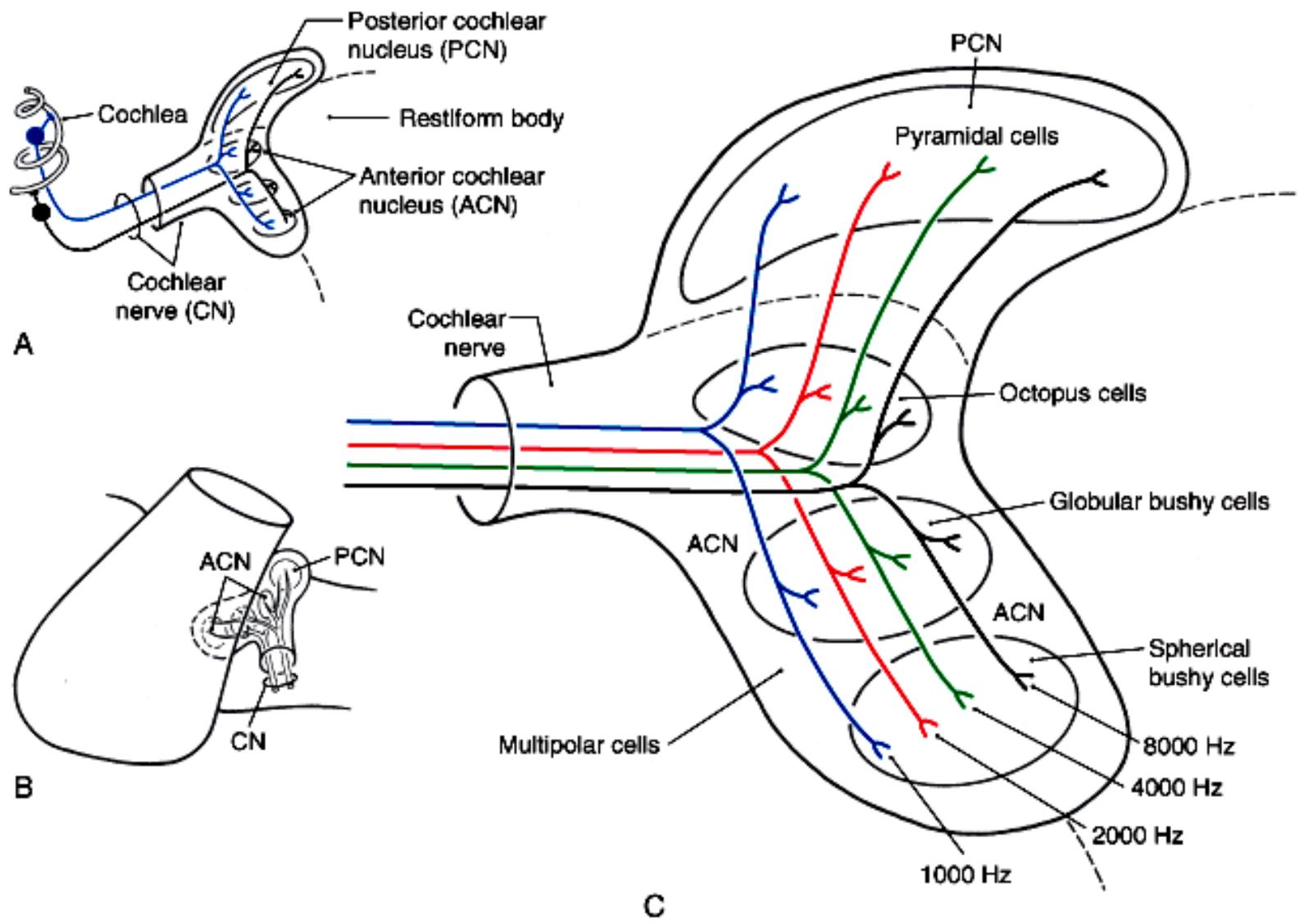




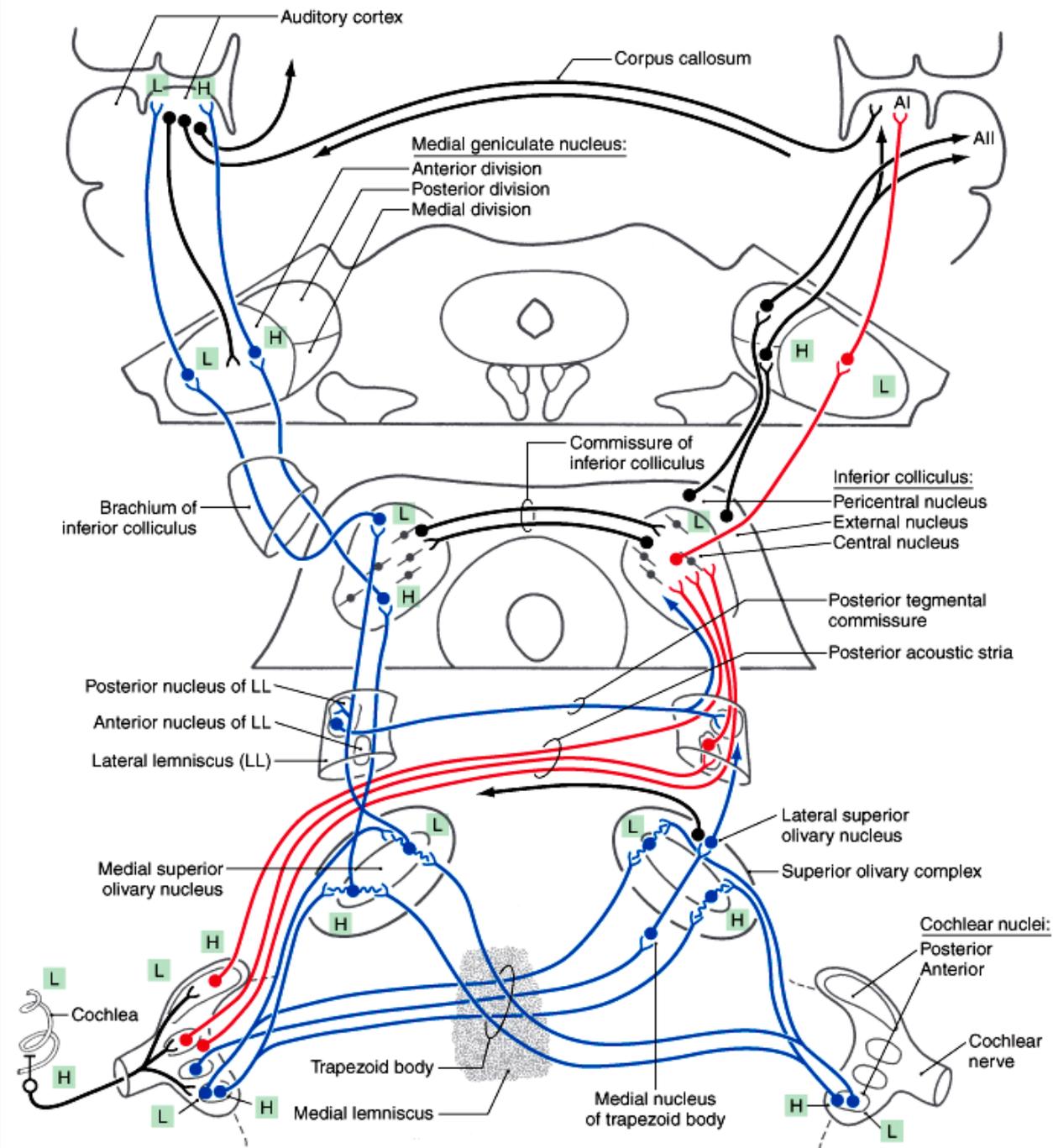
(a)

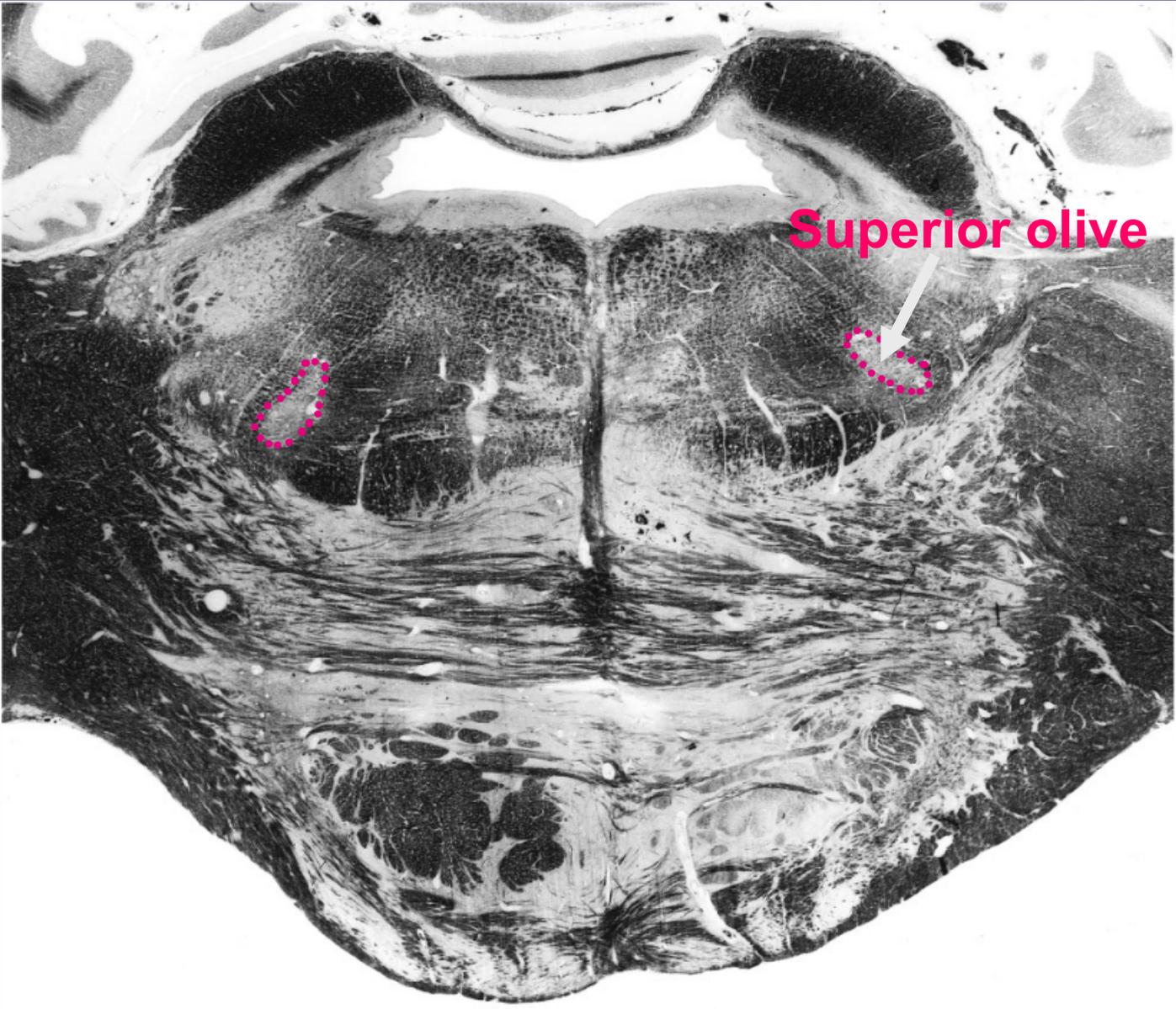


(b)

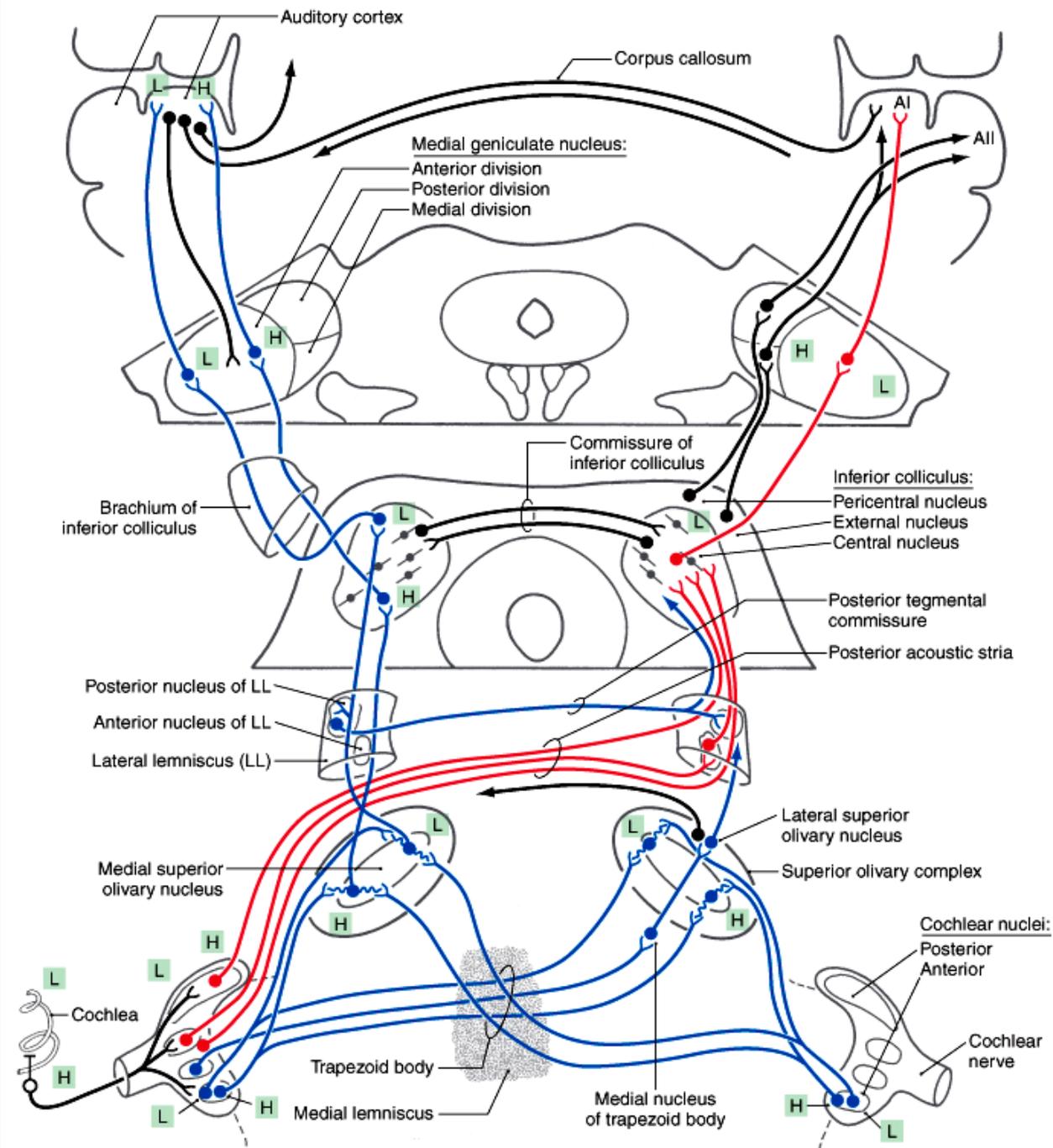


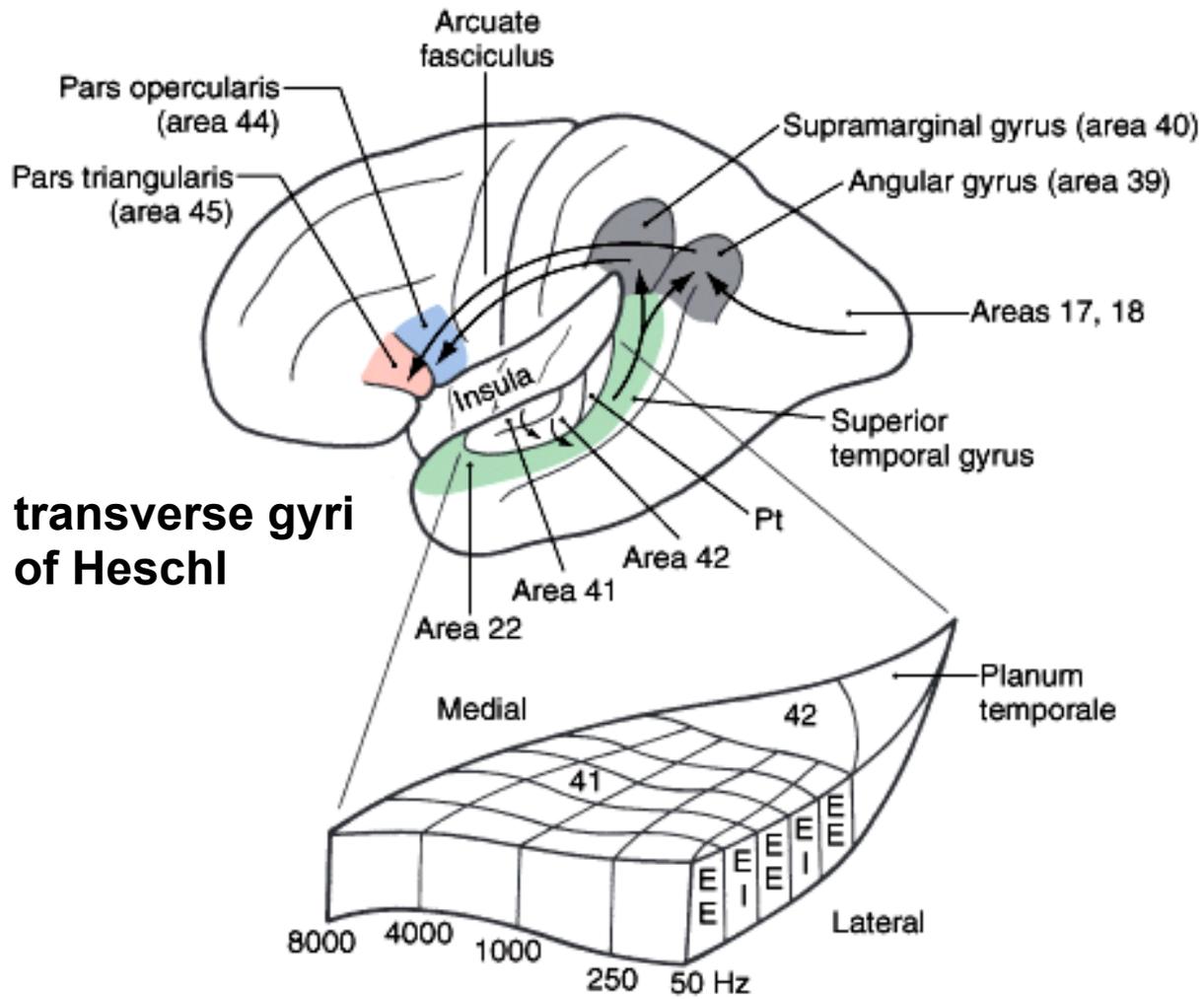






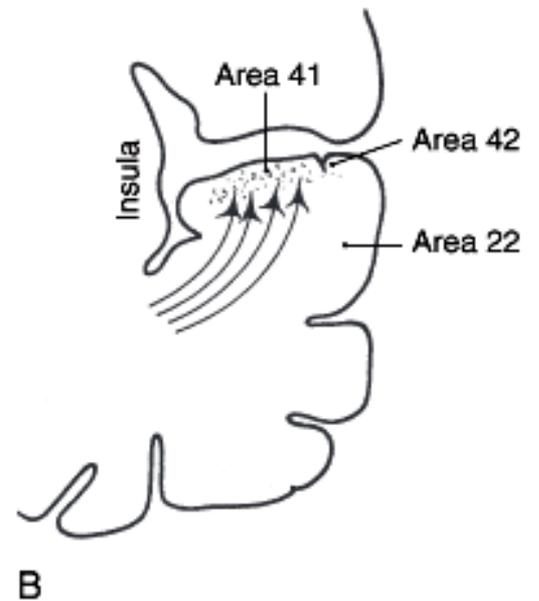
Superior olive



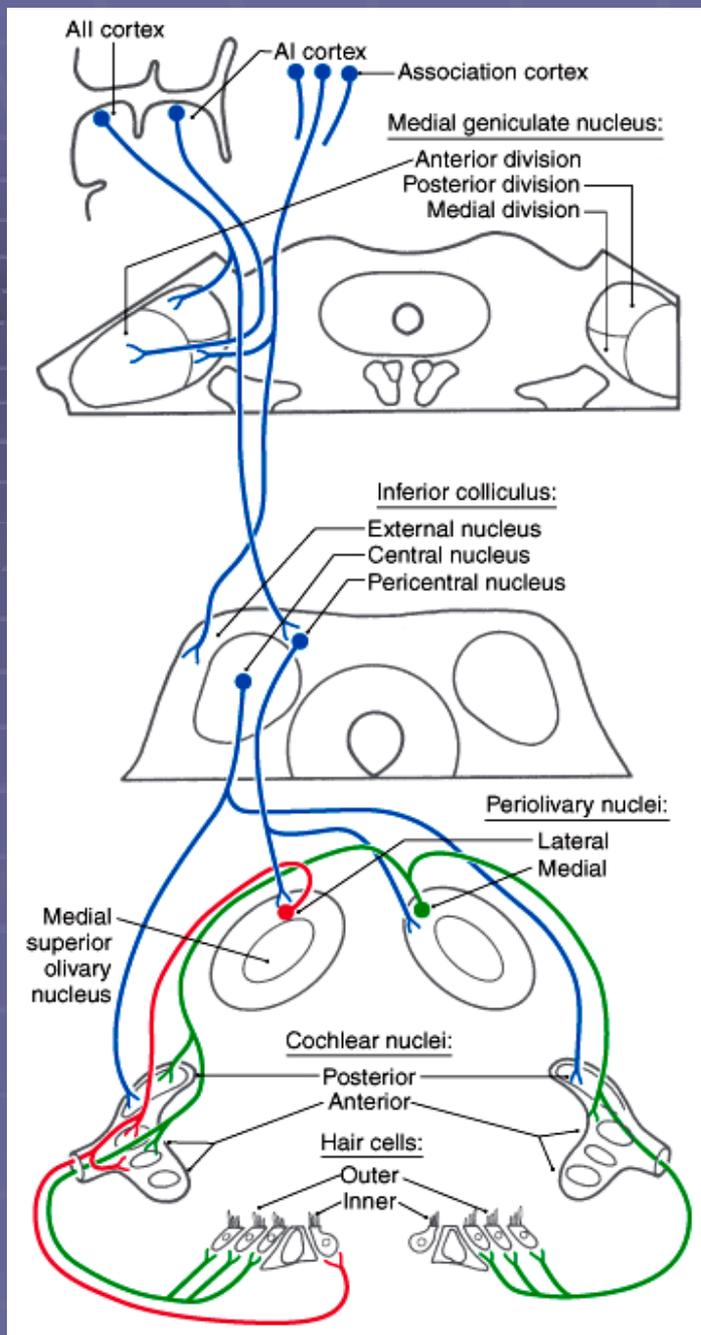


**transverse gyri
of Heschl**

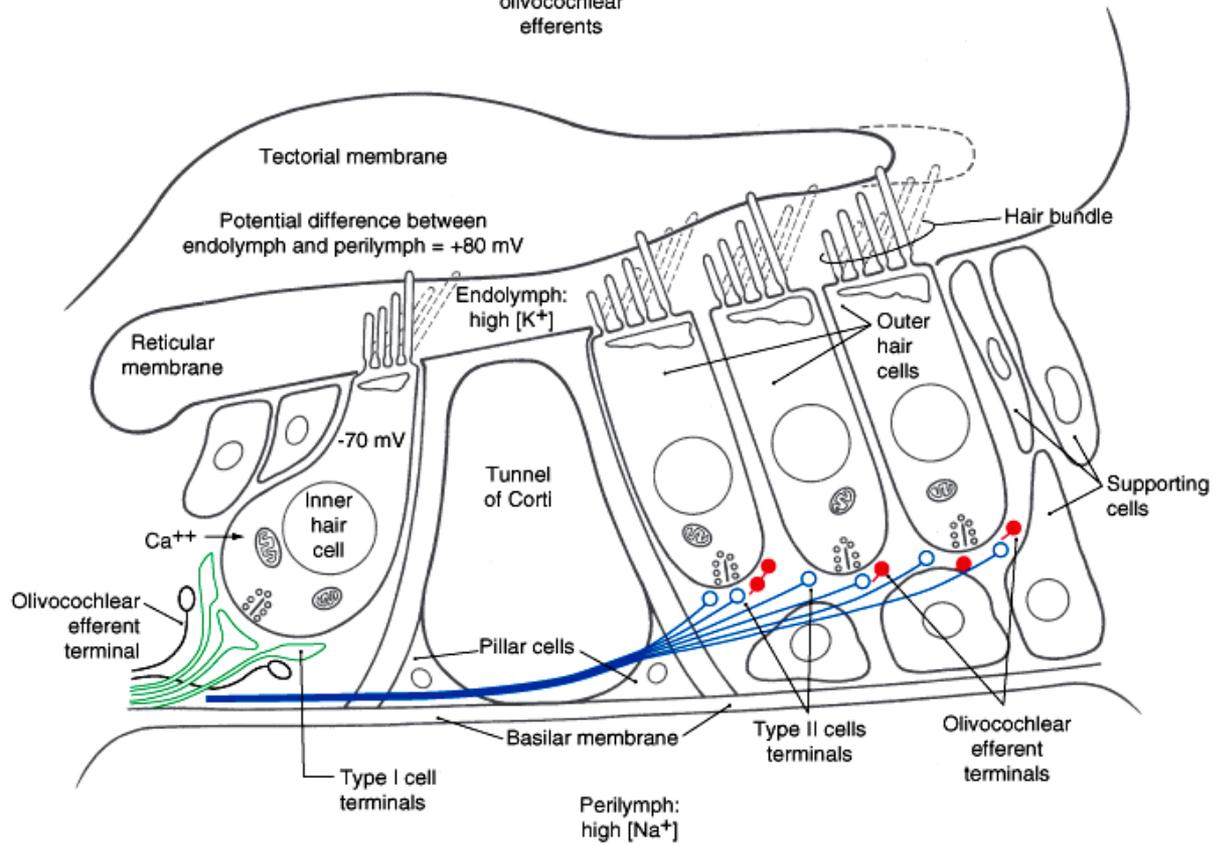
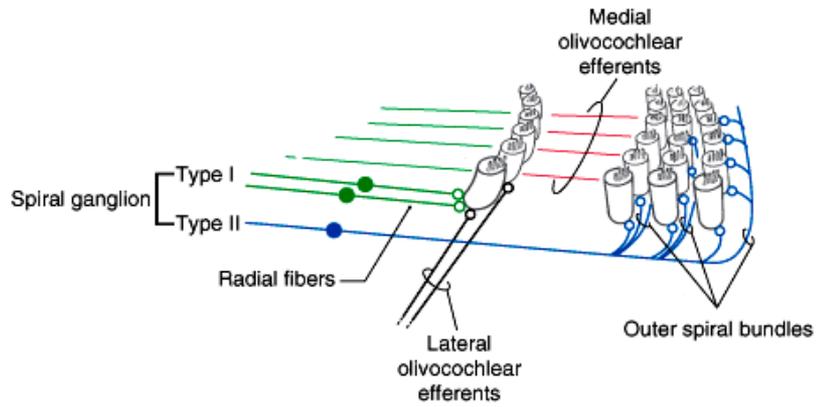
A



B

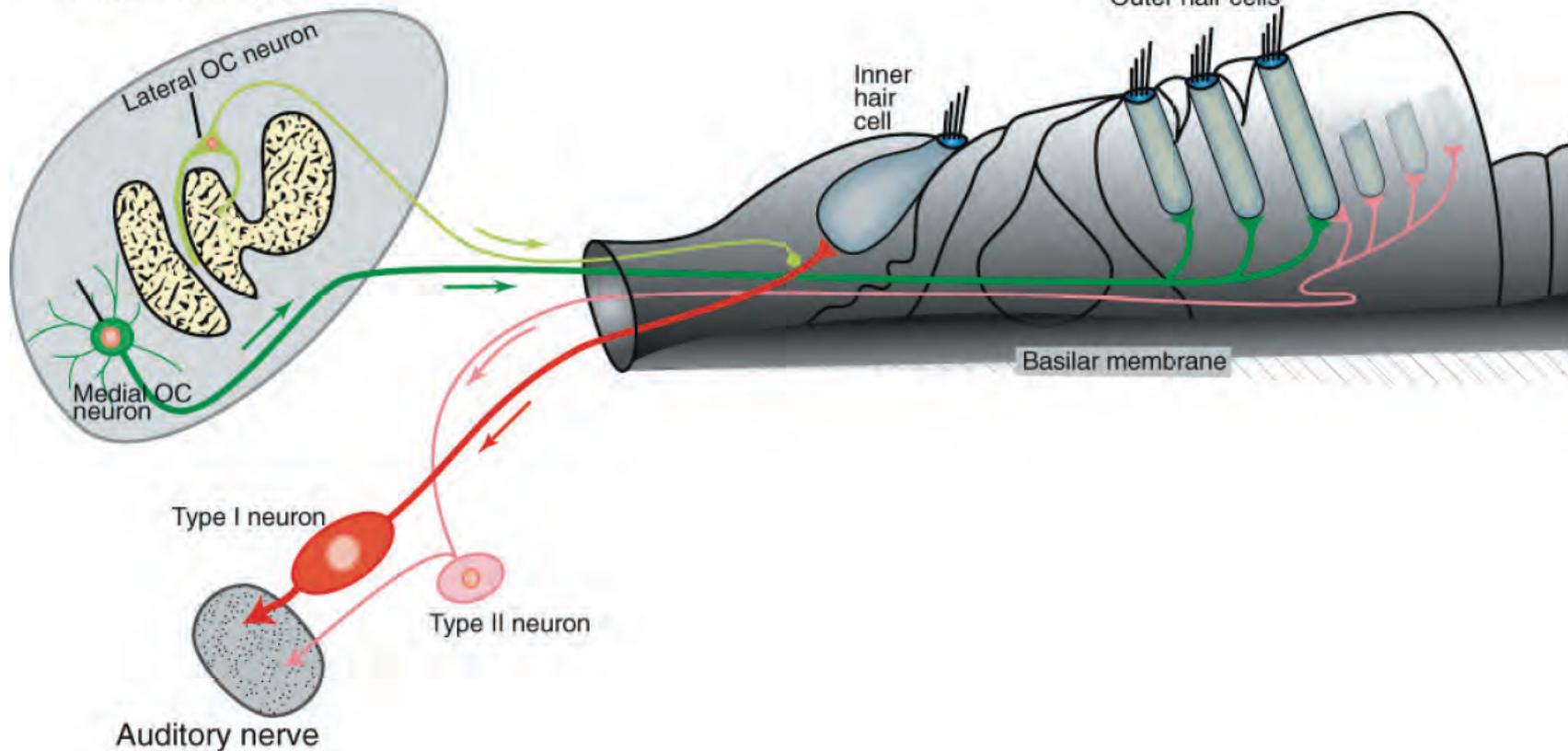


Olivocochlear descending feedback loop



Organ of Corti

Superior olivary complex



Outer hair cells

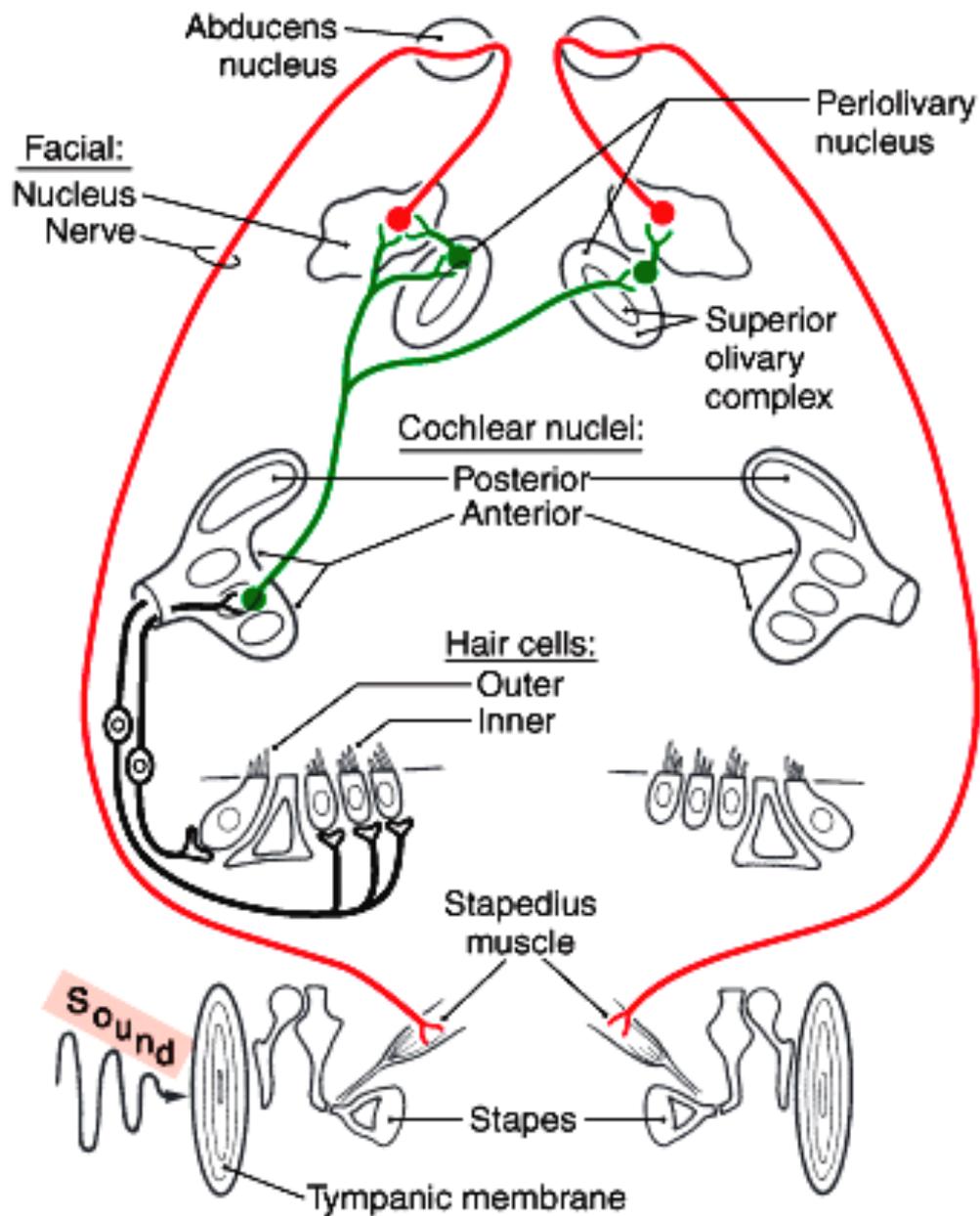
Inner hair cell

Basilar membrane

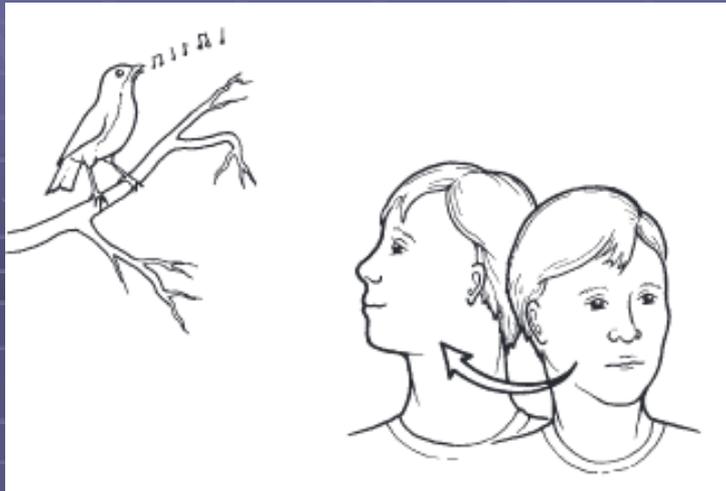
Type I neuron

Type II neuron

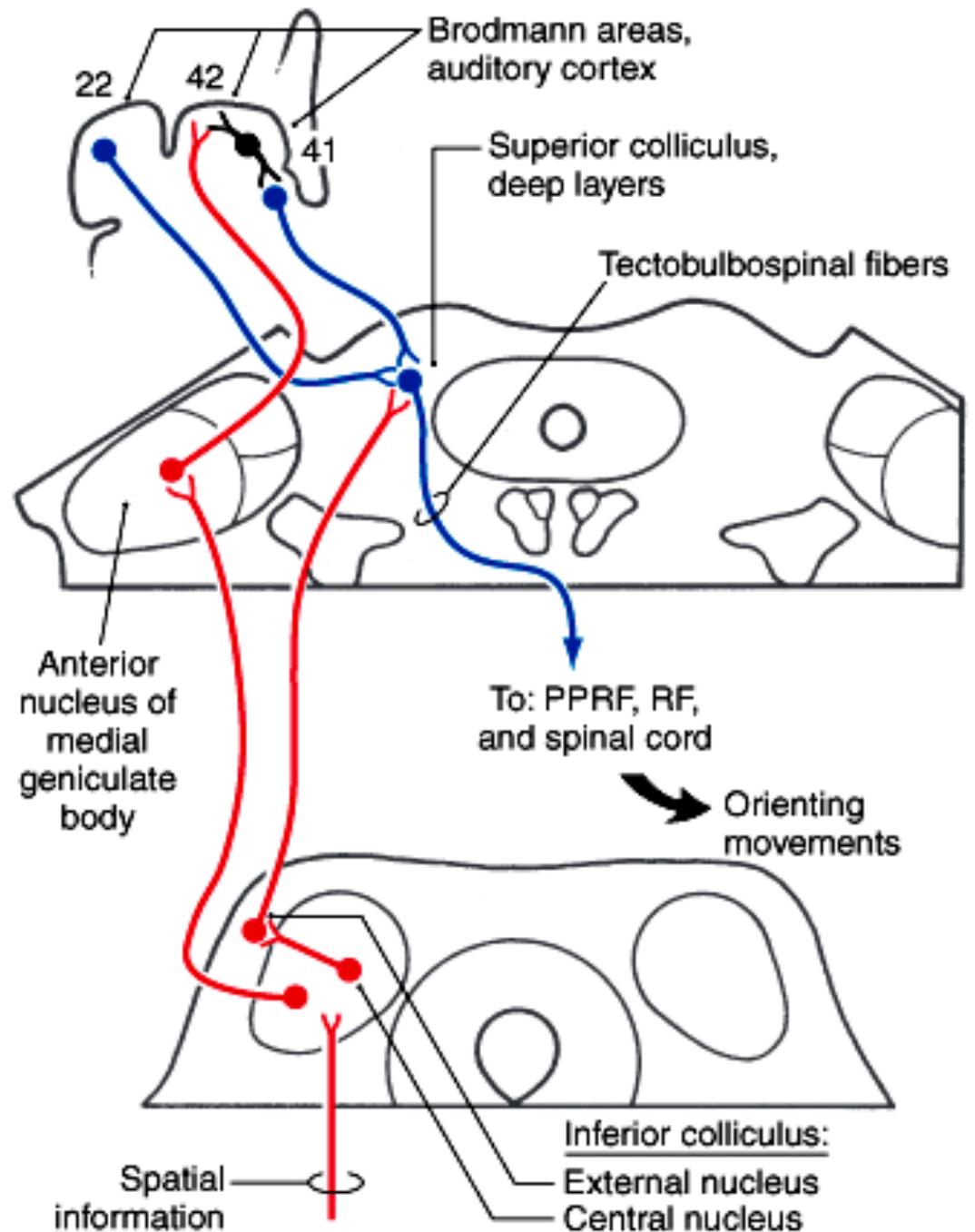
Auditory nerve



Middle ear reflex arc



Acoustic startle reflex



Tinnitus

Some of these causes include high blood pressure, diabetes, listening to loud music, a tumor, thyroid conditions, and medications / antidepressants, sedatives, antibiotics, anti-inflammatories, and aspirin.

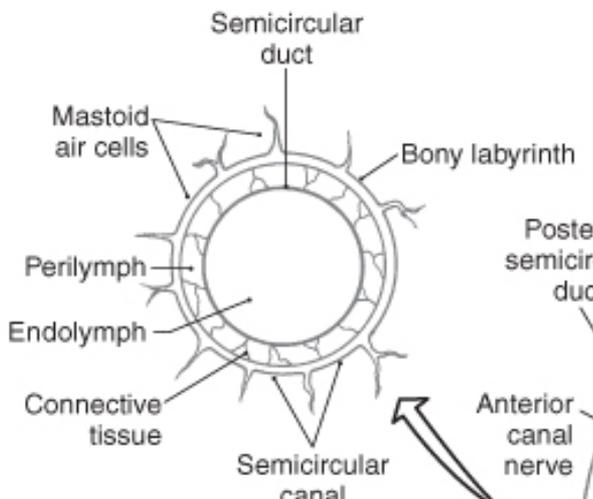
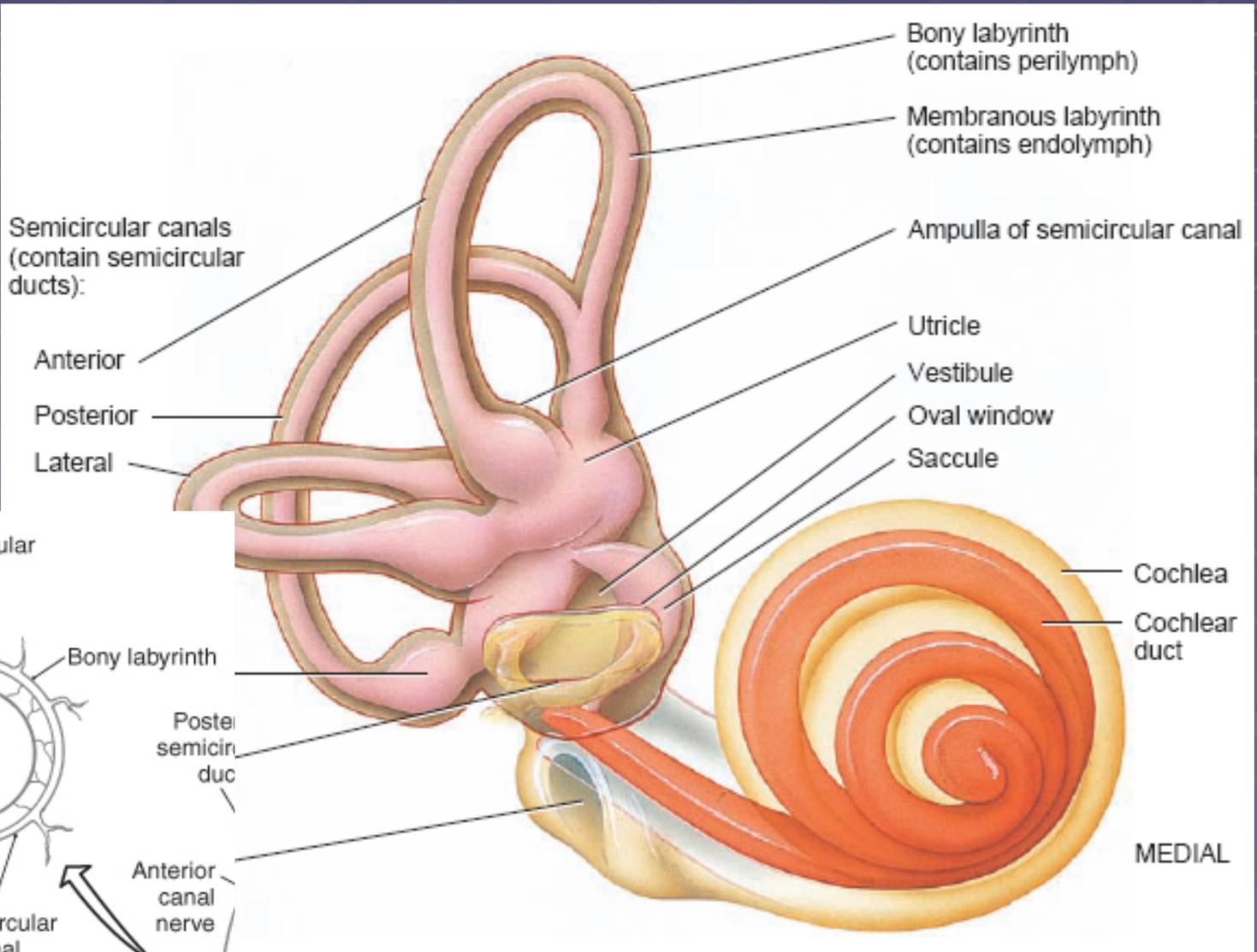
Pontine auditory hallucinosis

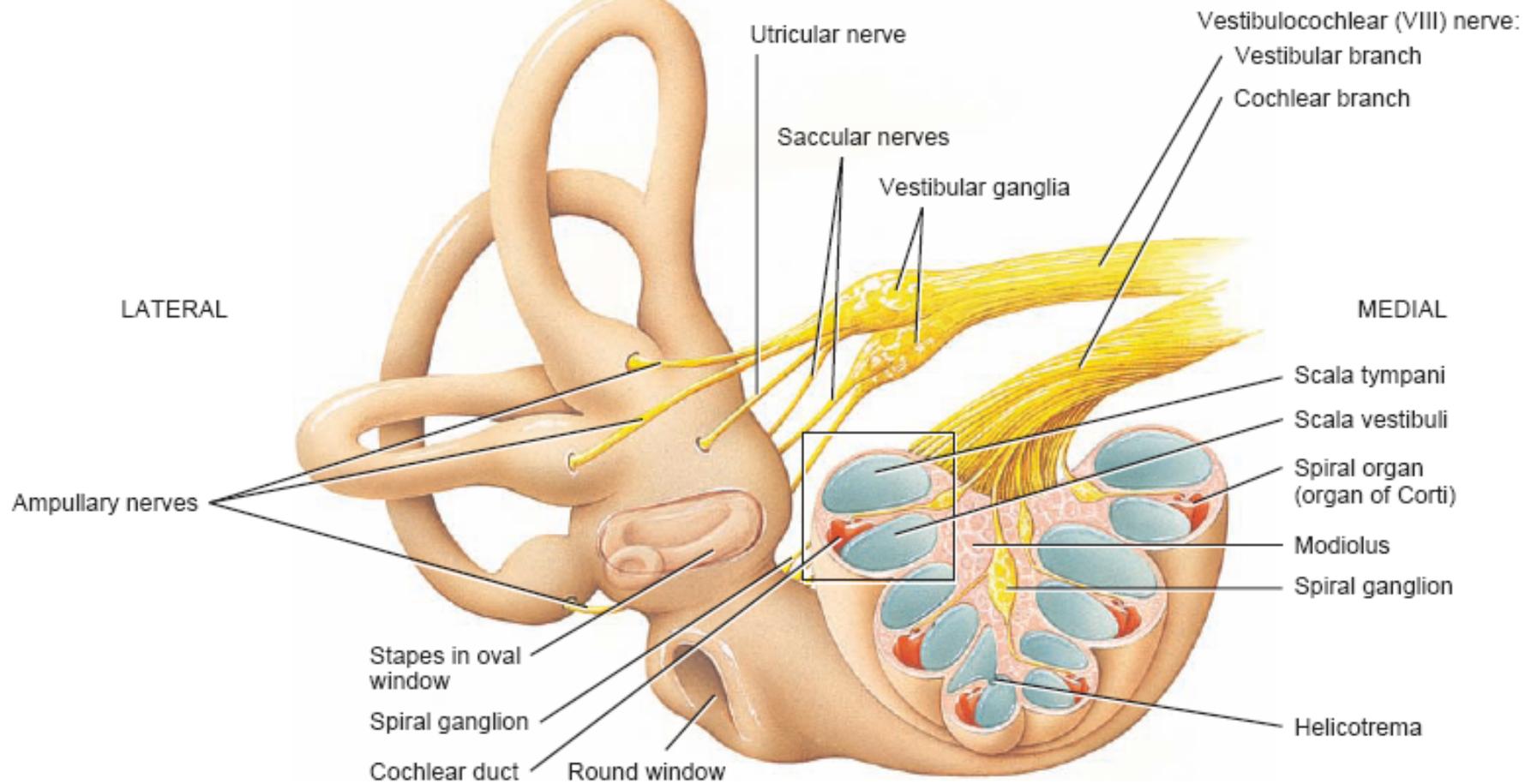
- perceived auditory events that sounds like and an orchestra out of tune, buzzing insects, or strands of music, which are accompanied by more typical symptoms of pontine lesions of auditory , such as cranial nerve deficits and long tract signs. A perception of noise or sounds may also be experienced by patients with temporal lobe seizures or a temporal lobe lesion that damages auditory cortices

The Vestibular System

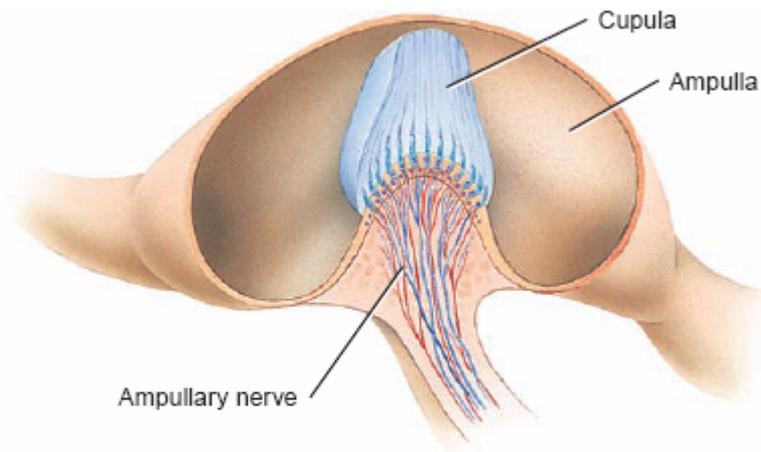
Anatomy of the ear

Internal ear

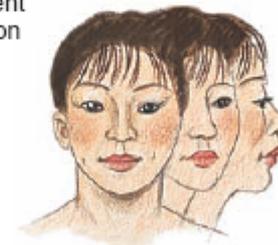
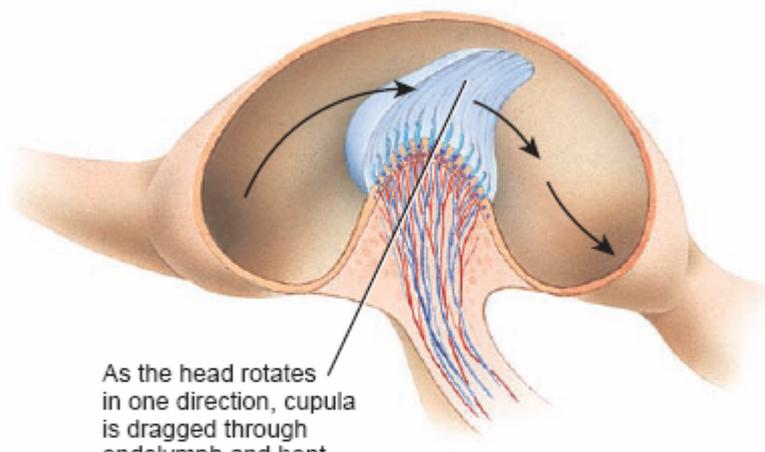




Ampulla of Semicircular canal



Head in still position



Head rotating

(b) Position of a cupula with the head in the still position (left) and when the head rotates (right)

Hair Cell Activation

Rotational head movements



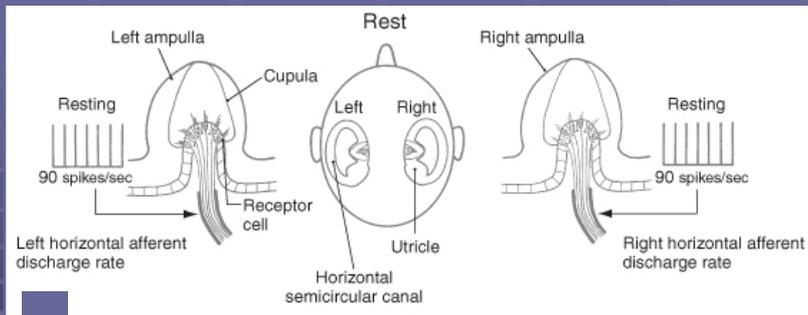
Angular accelerations



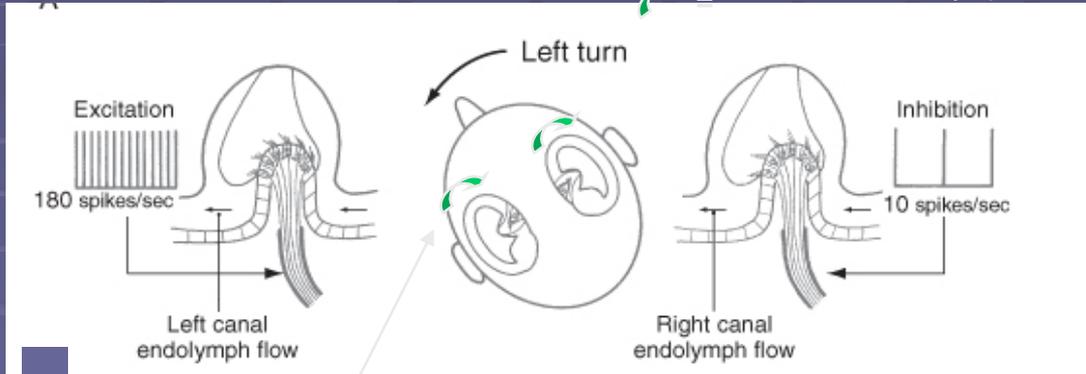
Displace endolymph in membranous ducts

Push cupula to one side or other

Displace stereocilia/kinocilium of
hair cells in same direction

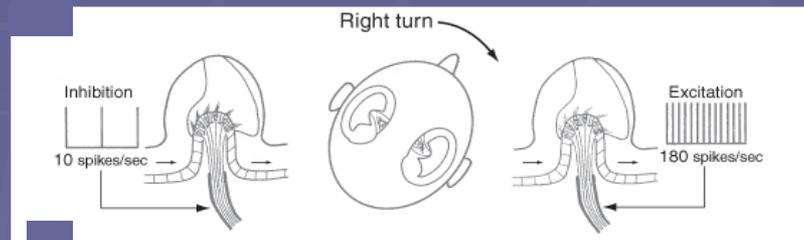


↻ = Movement of endolymph



Movement of endolymph toward ampulla

Movement of endolymph away from ampulla



Macula and otolith organ

(C)

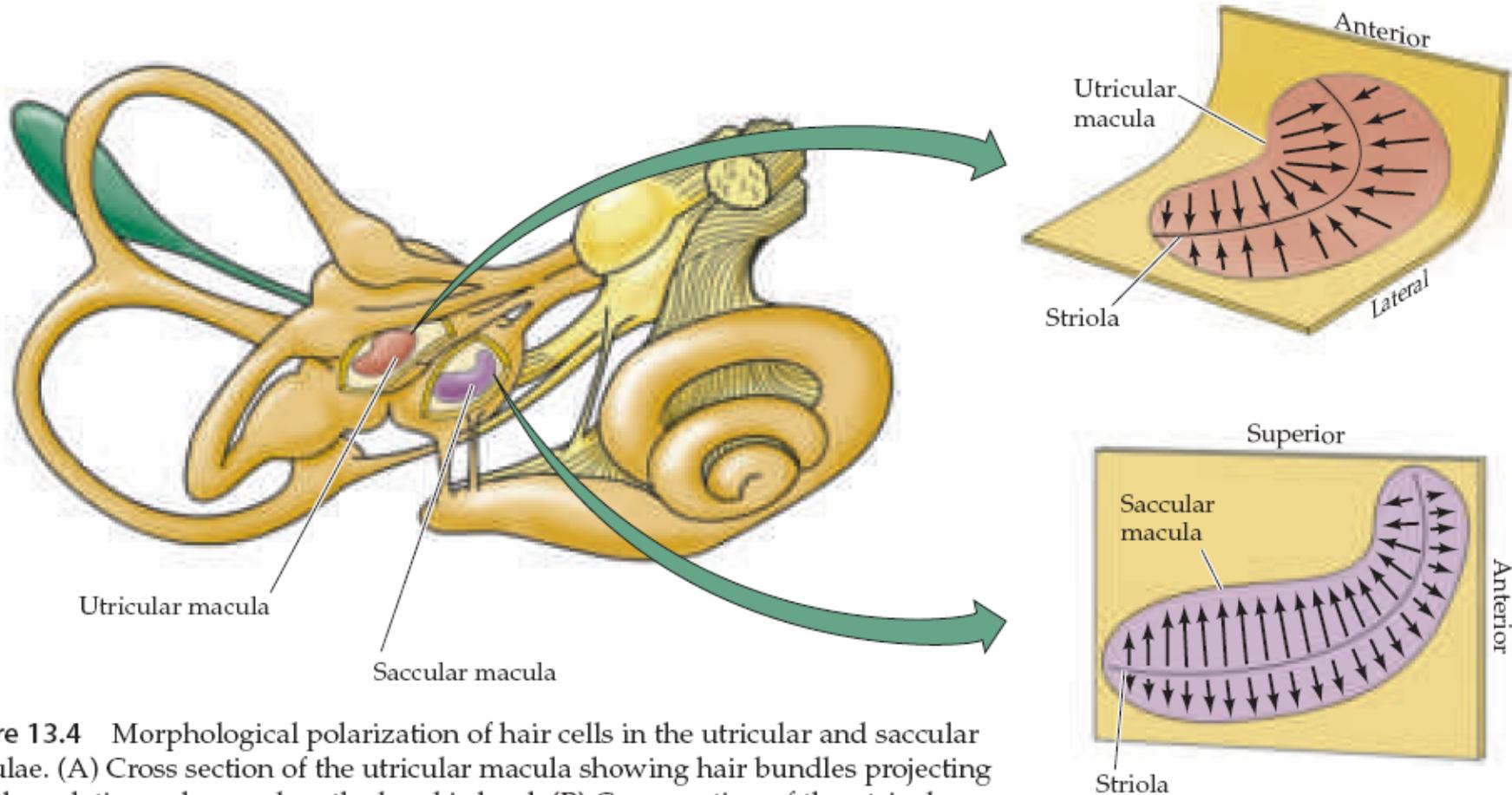
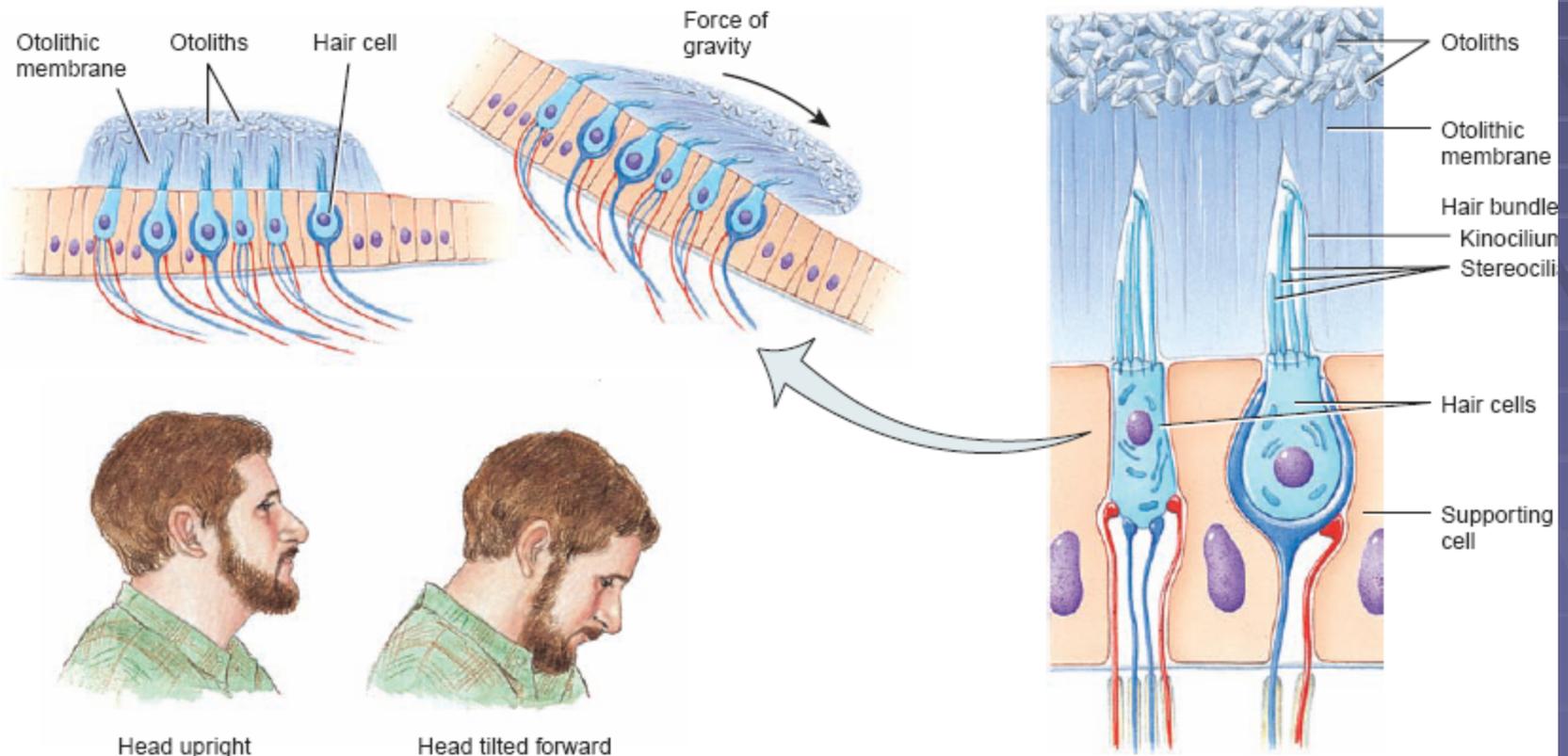


Figure 13.4 Morphological polarization of hair cells in the utricular and saccular maculae. (A) Cross section of the utricular macula showing hair bundles projecting into the gelatinous layer when the head is level. (B) Cross section of the utricular macula showing hair bundles projecting into the gelatinous layer when the head is tilted. (C) Diagram of the inner ear showing the location of the utricular and saccular maculae.

Macula and otolith organ

(a) Overall structure of a section of the macula

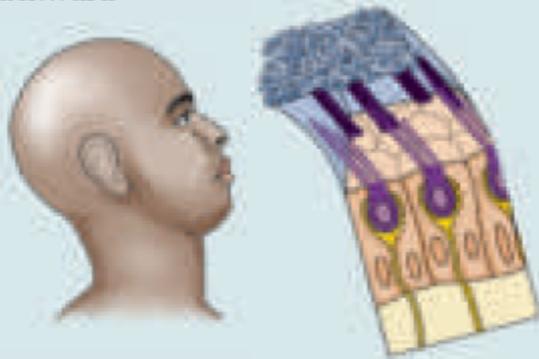


(c) Position of macula with head upright (left) and tilted forward (right)

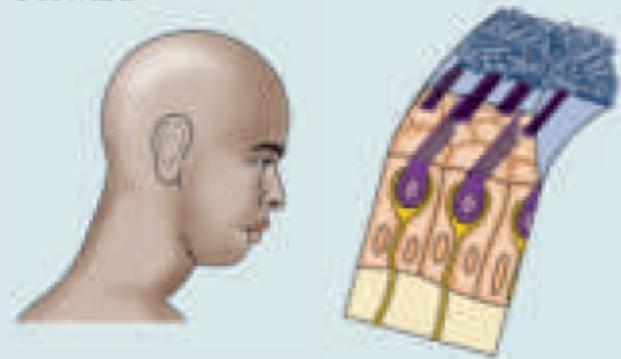
(b) Details of two hair cells

Head tilt; sustained

Backward

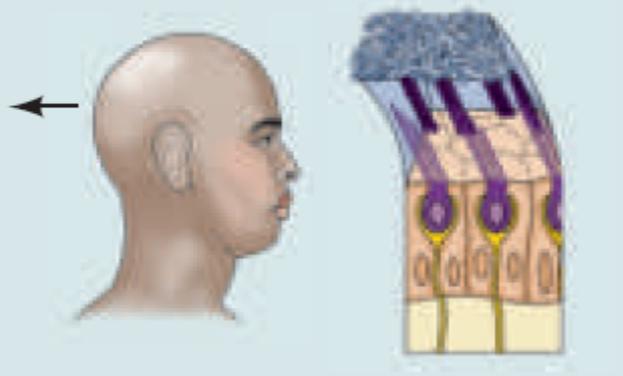


Forward

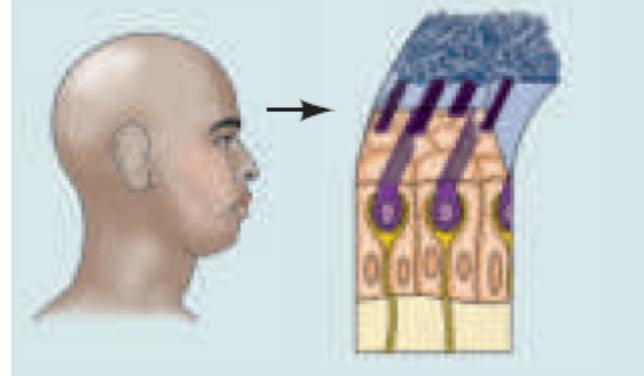


No head tilt; transient

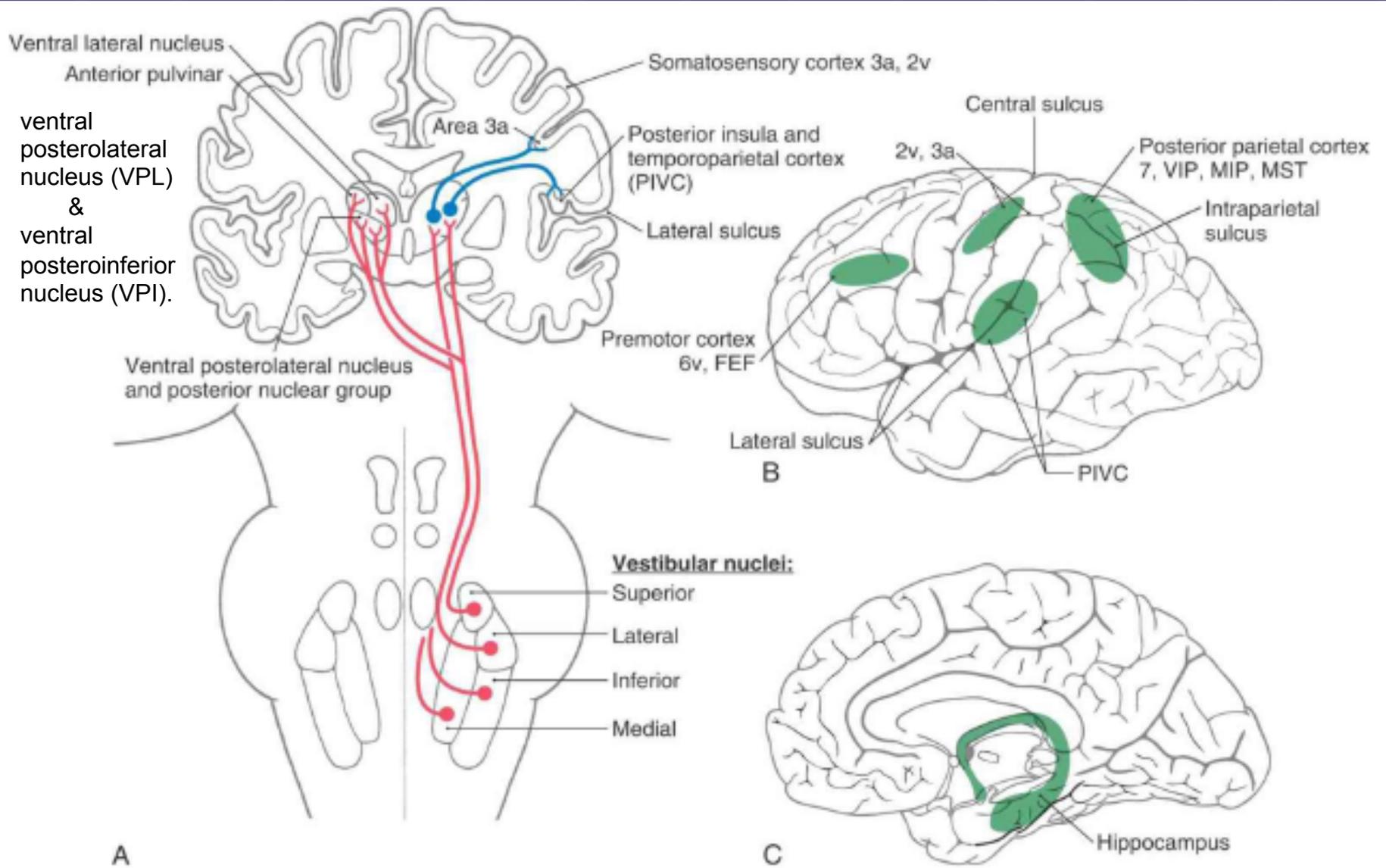
Forward acceleration



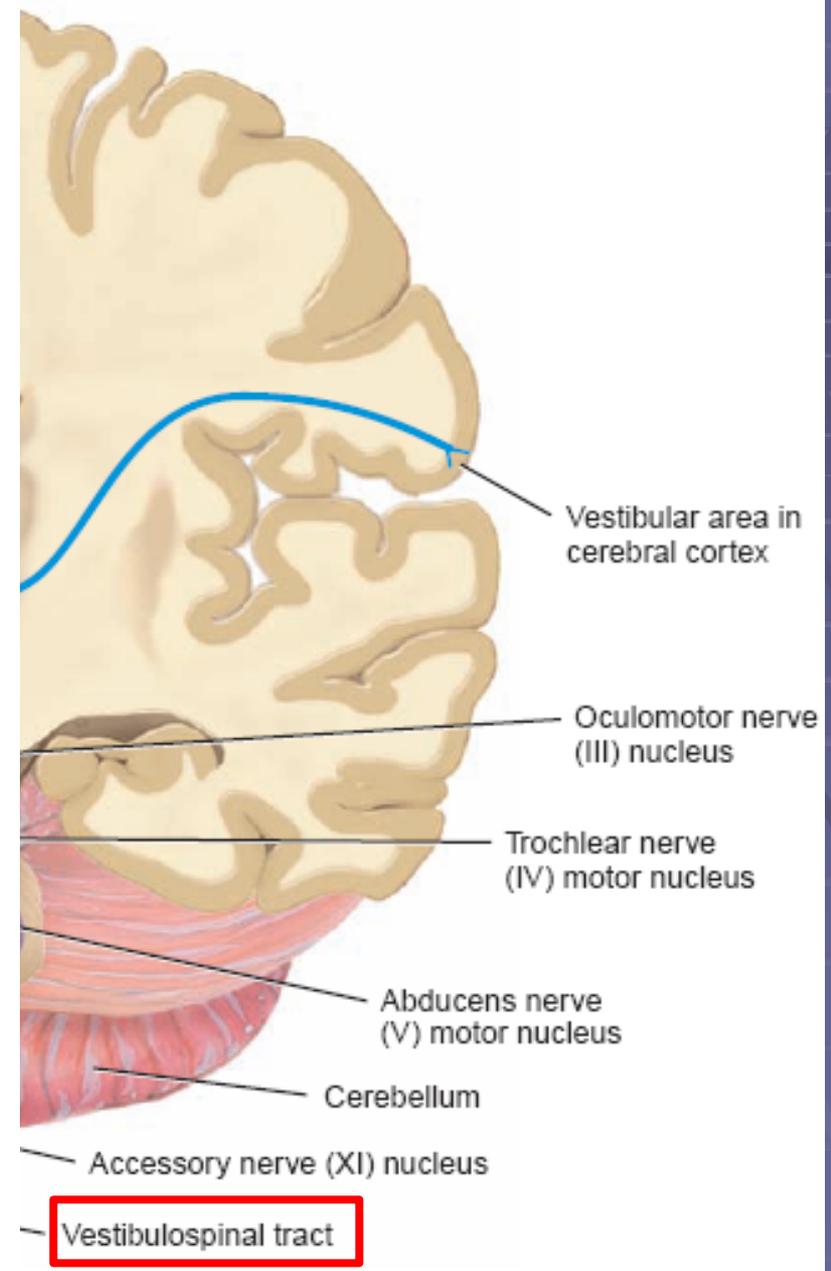
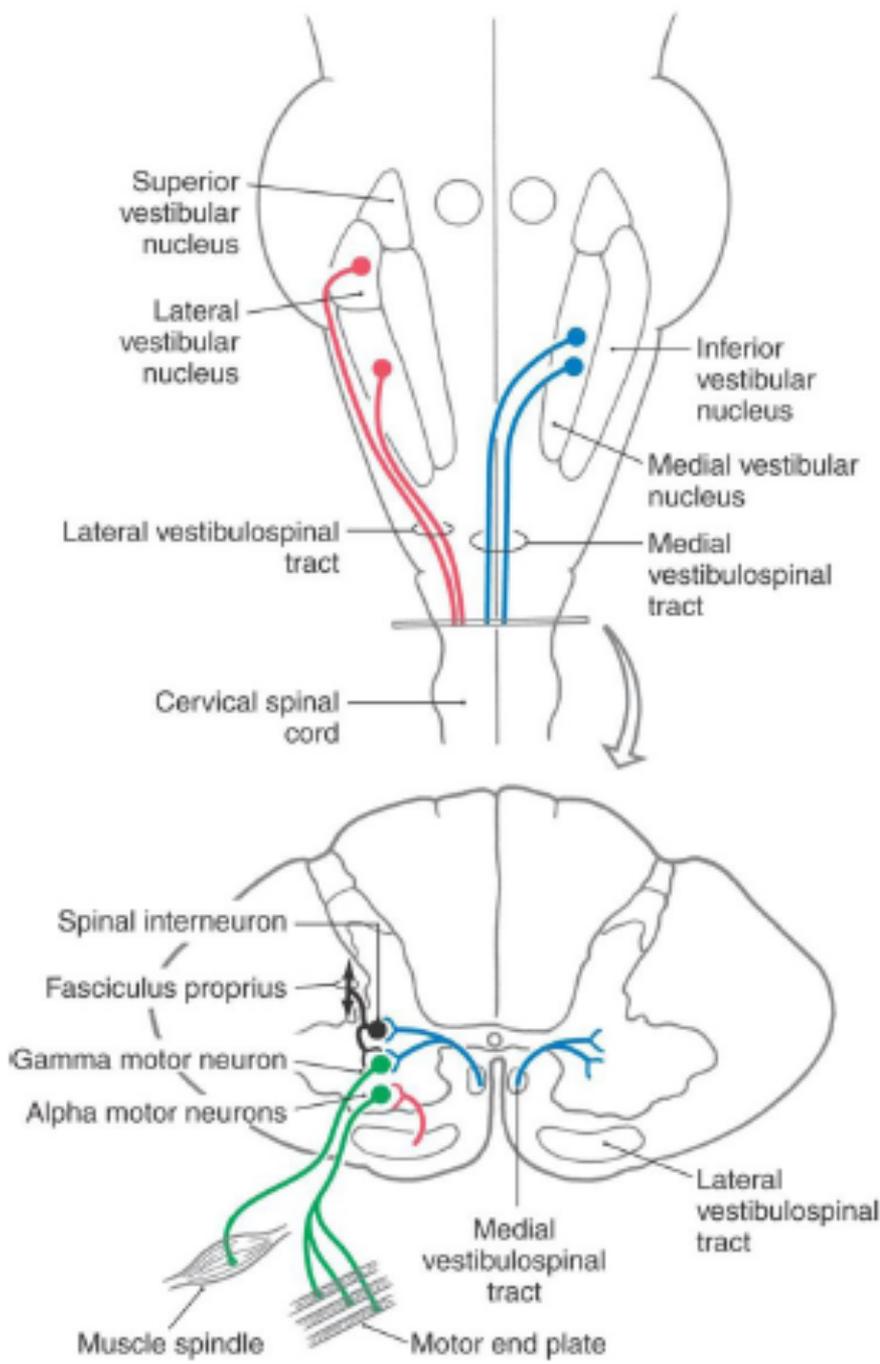
Deceleration



VESTIBULAR PATHWAY



Vi
Ni
Vi
ve
(\nVi
g:



Vestibulospinal Network:

Influences muscle tone & produces reflexive postural adjustments of the head and body

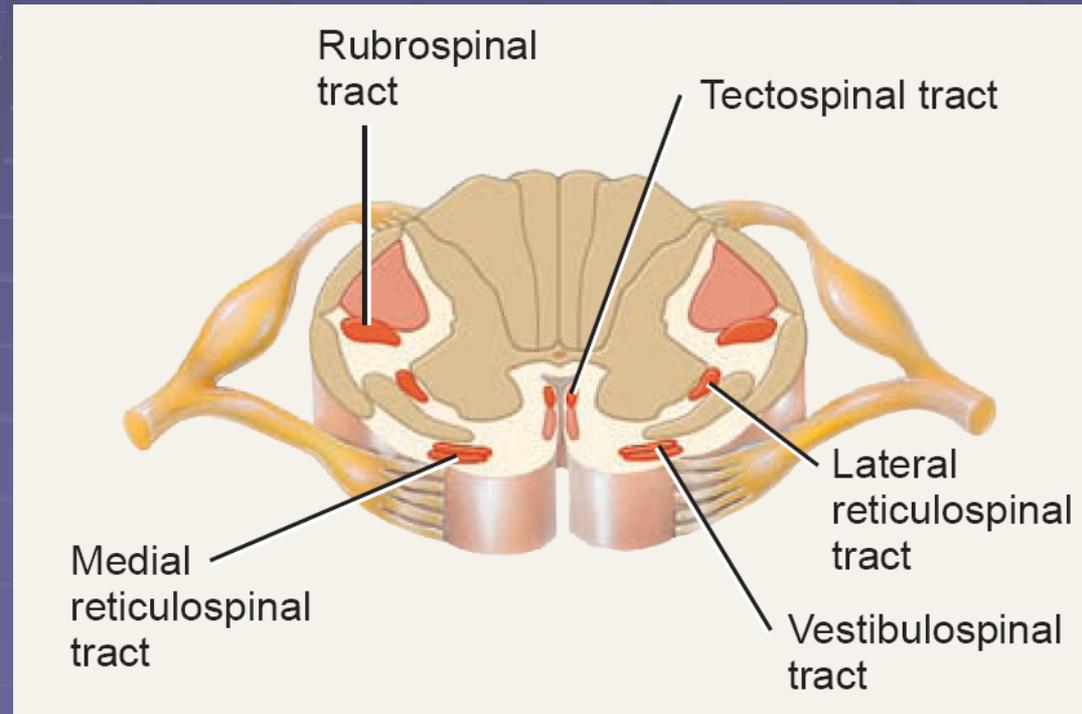
vestibular nucleus

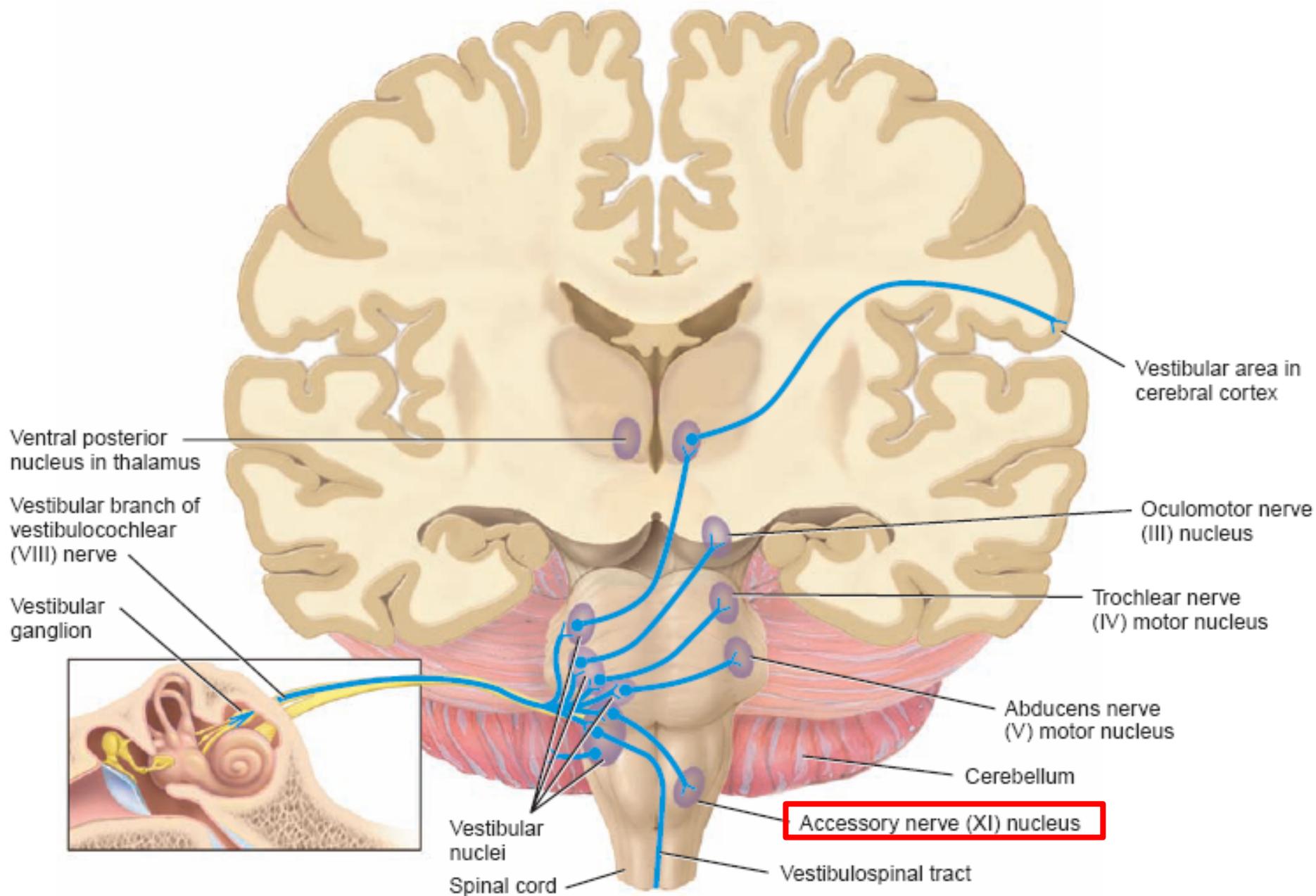
Projects to all levels of the spinal cord

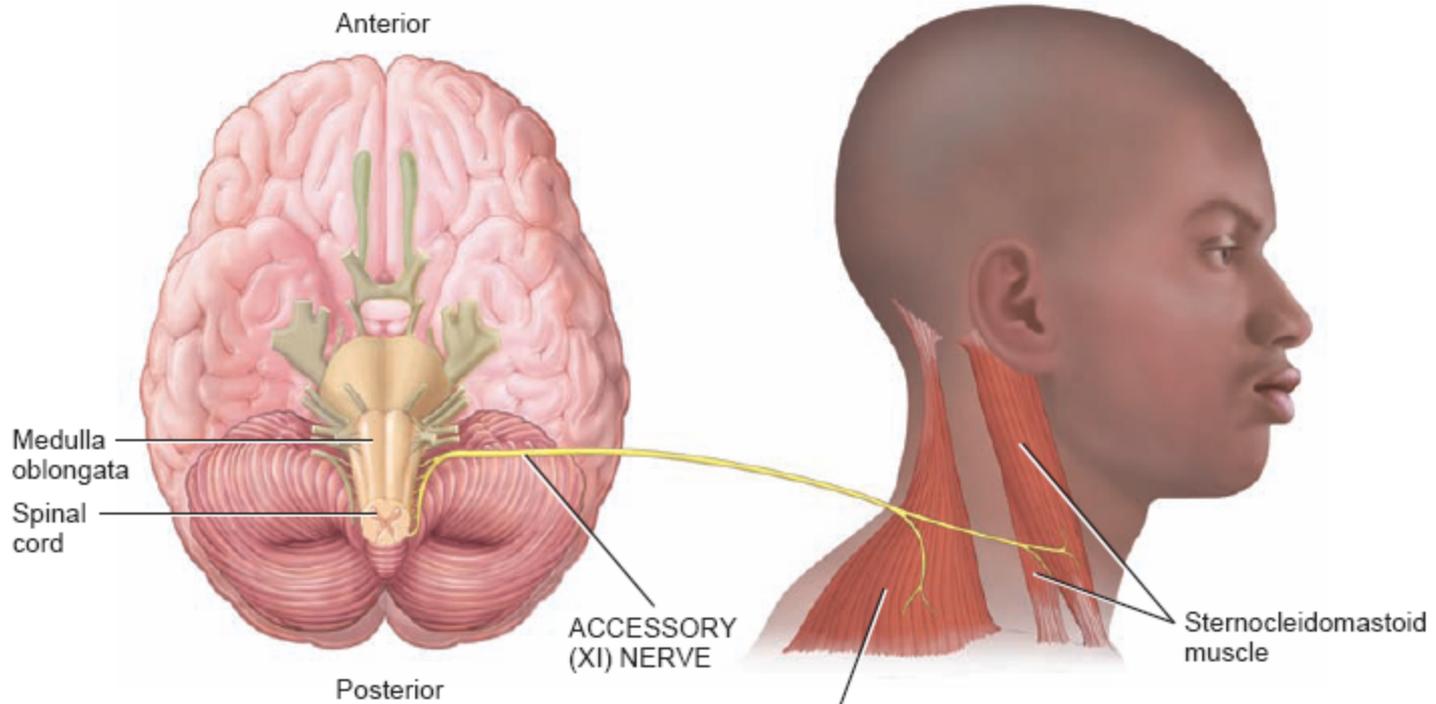
Terminate on alpha & gamma motor neurons

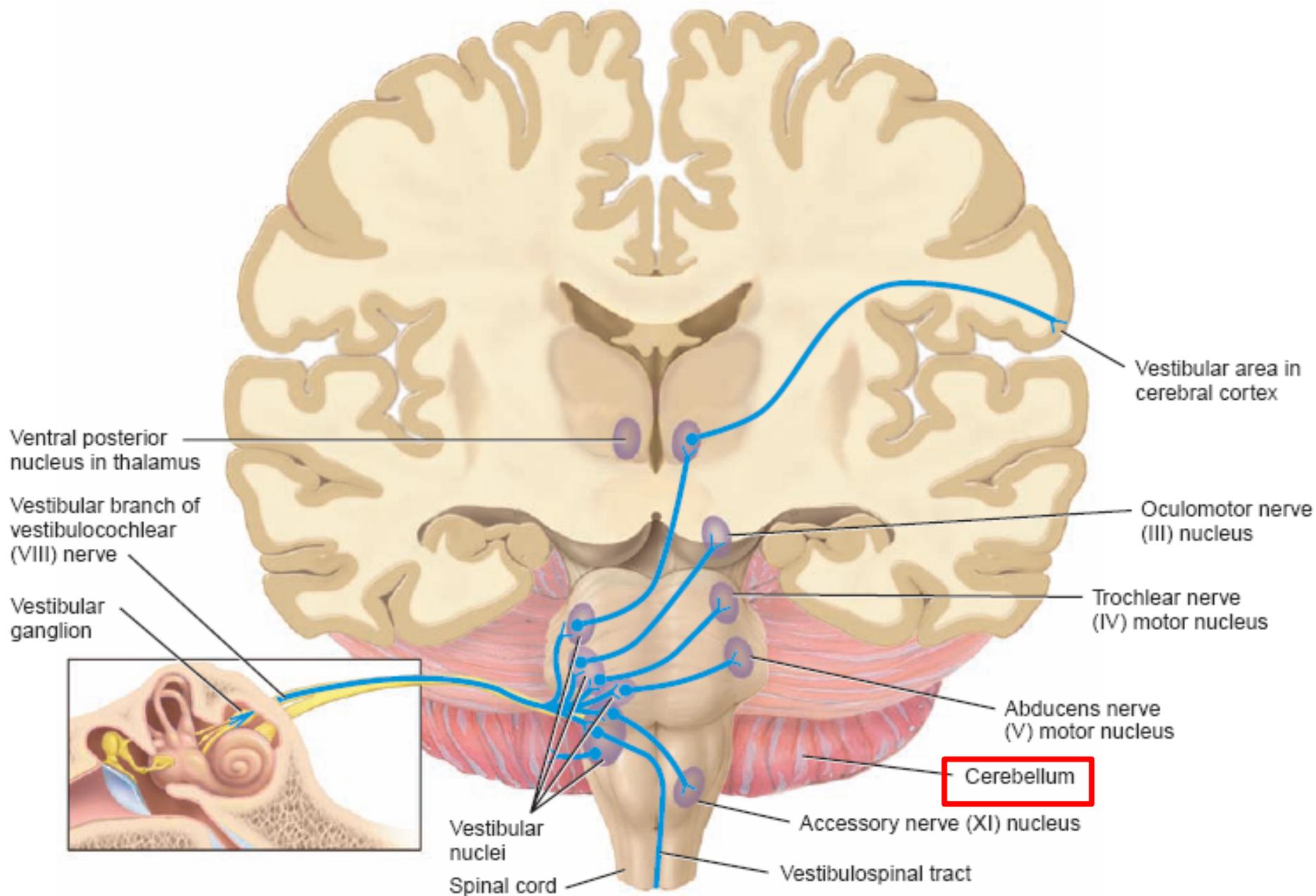
Excite extensor muscle motor neurons

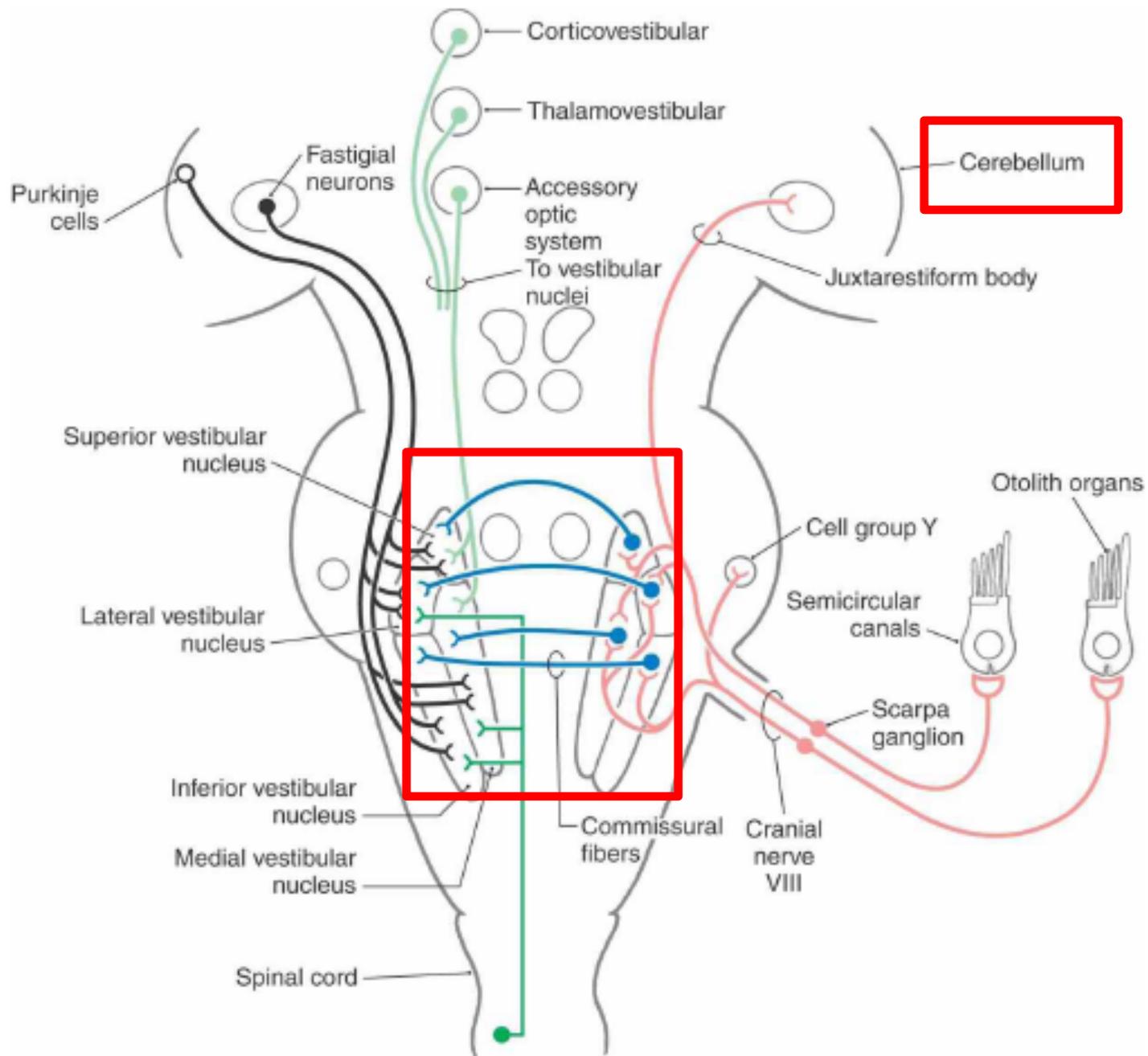
Stabilize body's center of gravity & preserves upright posture

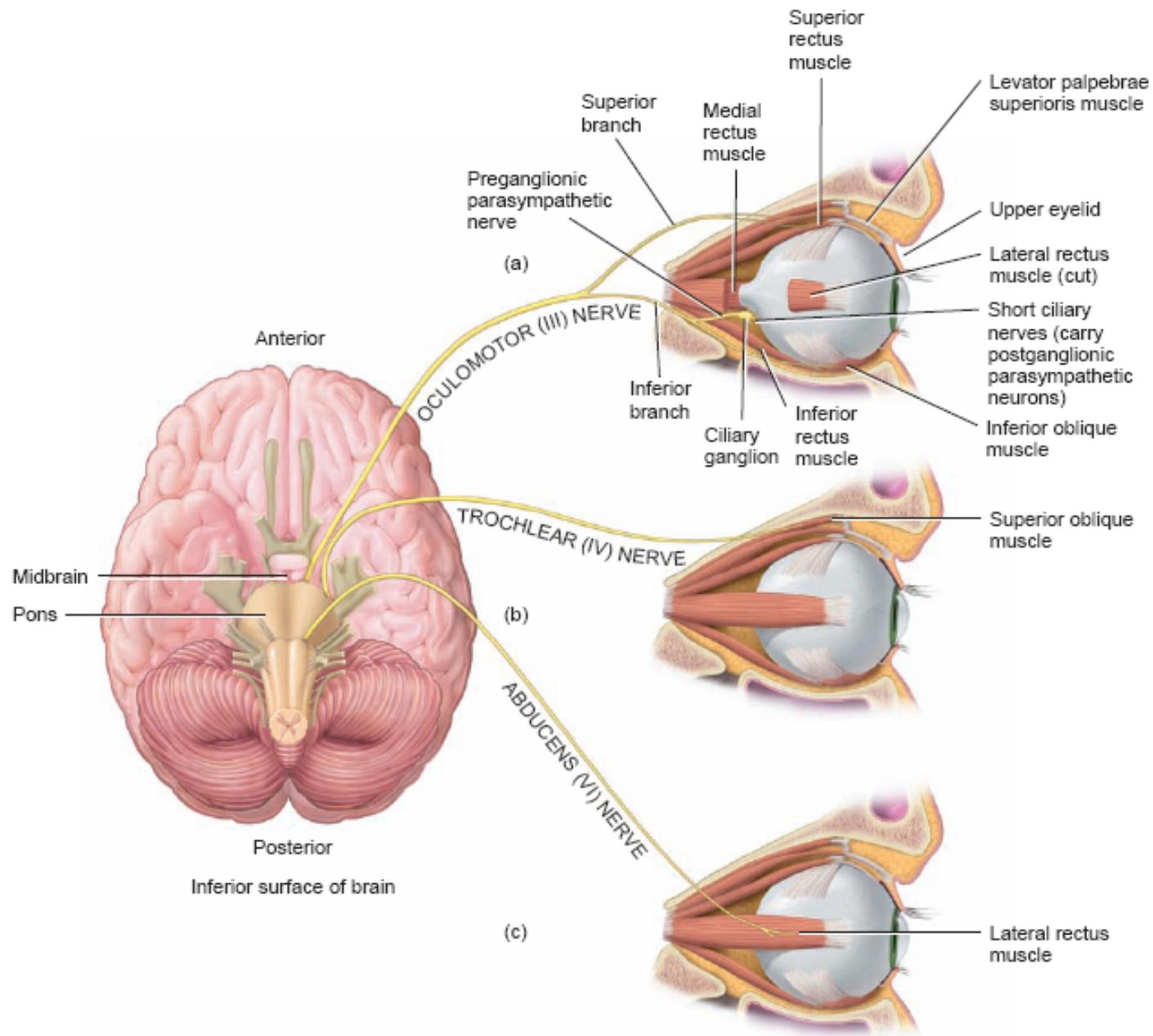






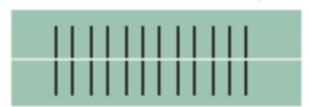
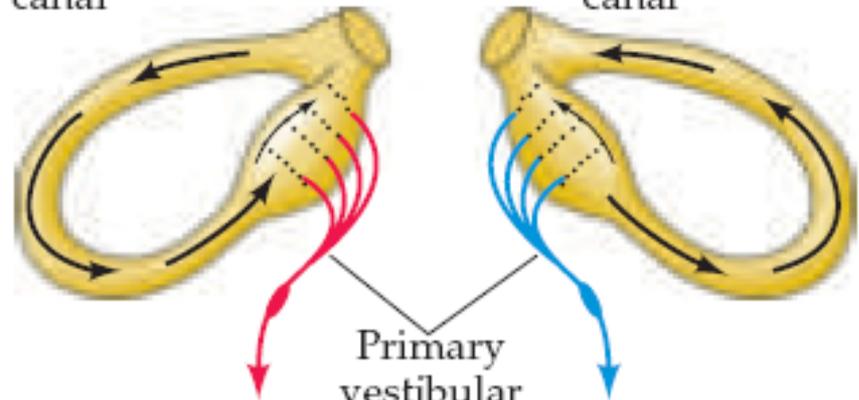






Right horizontal canal

Left horizontal canal

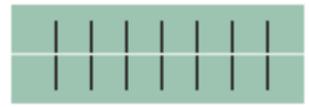


Increased firing

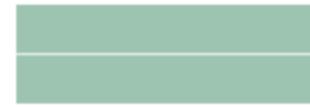


Decreased firing

(2) Spontaneous nystagmus



Baseline firing



No firing

DIZZINESS AND VERTIGO

Dizziness is a **nonspecific** term that generally means a spatial disorientation that may or may not involve feelings of movement. Dizziness may be accompanied by nausea or postural instability. A large number of factors may produce a dizzy sensation, and many are not exclusively vestibular in origin.

Vertigo is a specific perception of body motion, often spinning or turning, experienced when no real motion is taking place. Vertigo may be perceived as **subjective** vertigo or as **objective** vertigo. In subjective vertigo, the patient experiences the sensation of spinning while things in the environment are not moving; in objective vertigo, the sensation is one of objects spinning while the patient is not moving. As children, we all learn to produce vertigo by whirling in place as fast as possible and then abruptly stopping. For a few moments, the world seems to be spinning in the opposite direction. Examination of the eyes during this phase will reveal a nystagmus that beats in the direction opposite to the original direction of rotation. **Vertigo can also be elicited optokinetically if the visual surroundings are revolved while the body remains stationary.** Many modern amusement games take advantage of this phenomenon to produce the sensation of motion.