General & Special Senses

Chapter objectives:

1. Distinguish between general and specific senses
- Classify receptors according to stimulus detected, body location, and histological structure
- Describe the structures of the ear and eye
- Explain the pathways of sound in the ear and light in the eye
- Identify, describe, and discuss the receptors and neural pathways involved in each of the five special senses

Classification of Sensory System by structural Complexity

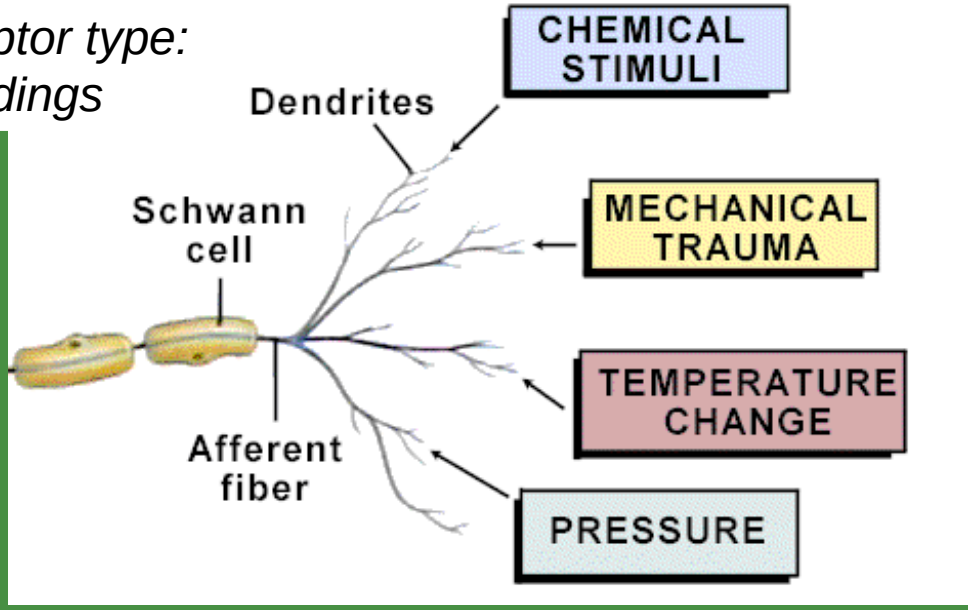
4 general senses

- Nociceptors
- Thermoceptors
- Mechanoceptors
- Chemoreceptors

5 special senses

- Olfaction
- Gustation
- Hearing
- Equilibrium
- Vision

simplest receptor type:
free nerve endings



Sensory Receptors

= specialized cells or cell processes monitoring conditions in/outside body (→ extero- and interoceptors)

Receptors are specific for a certain type of stimulus → "receptor specificity"

All sensory receptors are transducers, changing incoming stimulus of pressure, vibration, light, etc., into electro-chemical neuron impulses.

Area monitored by one receptor:

= Receptive field 2

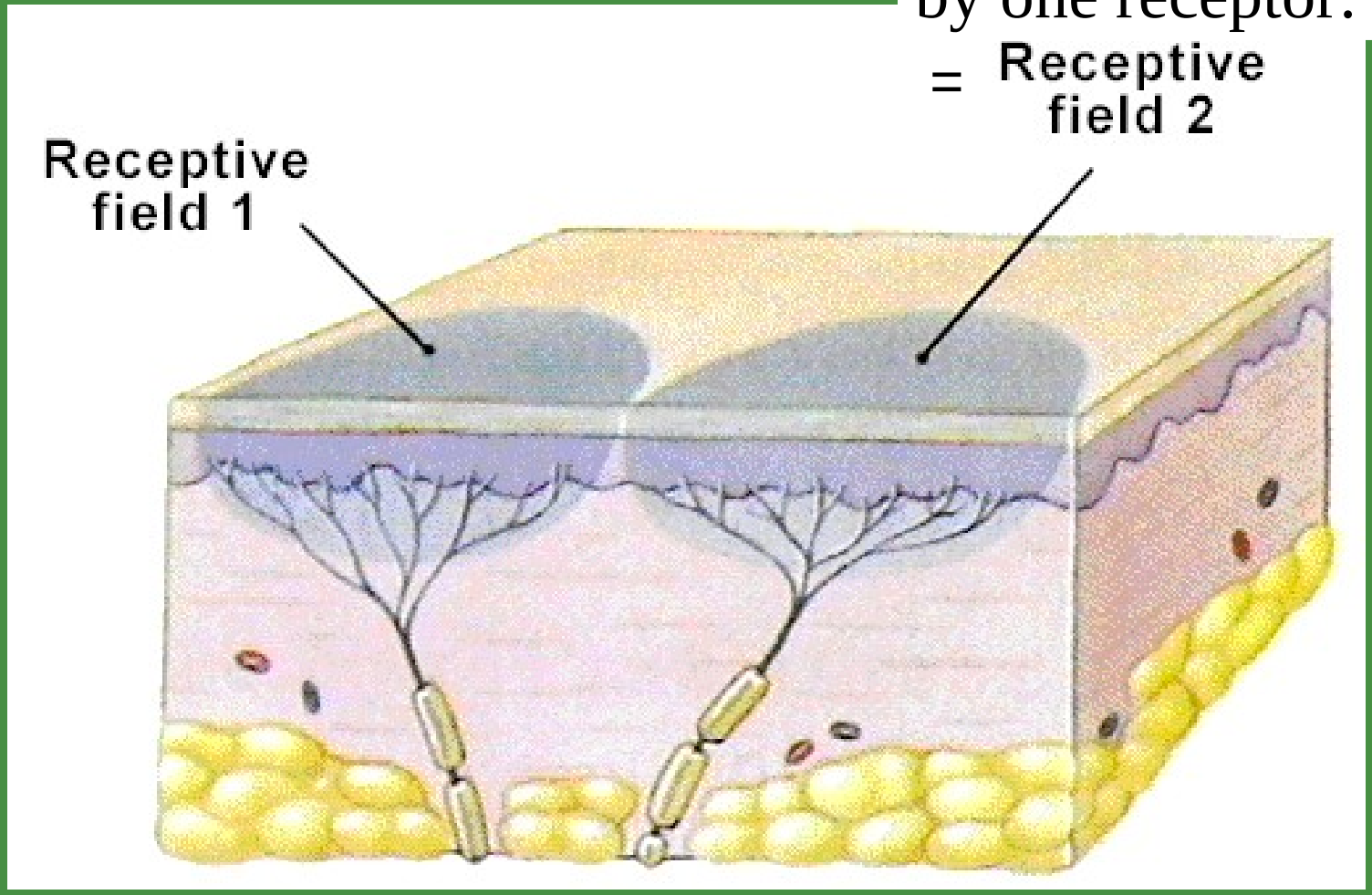
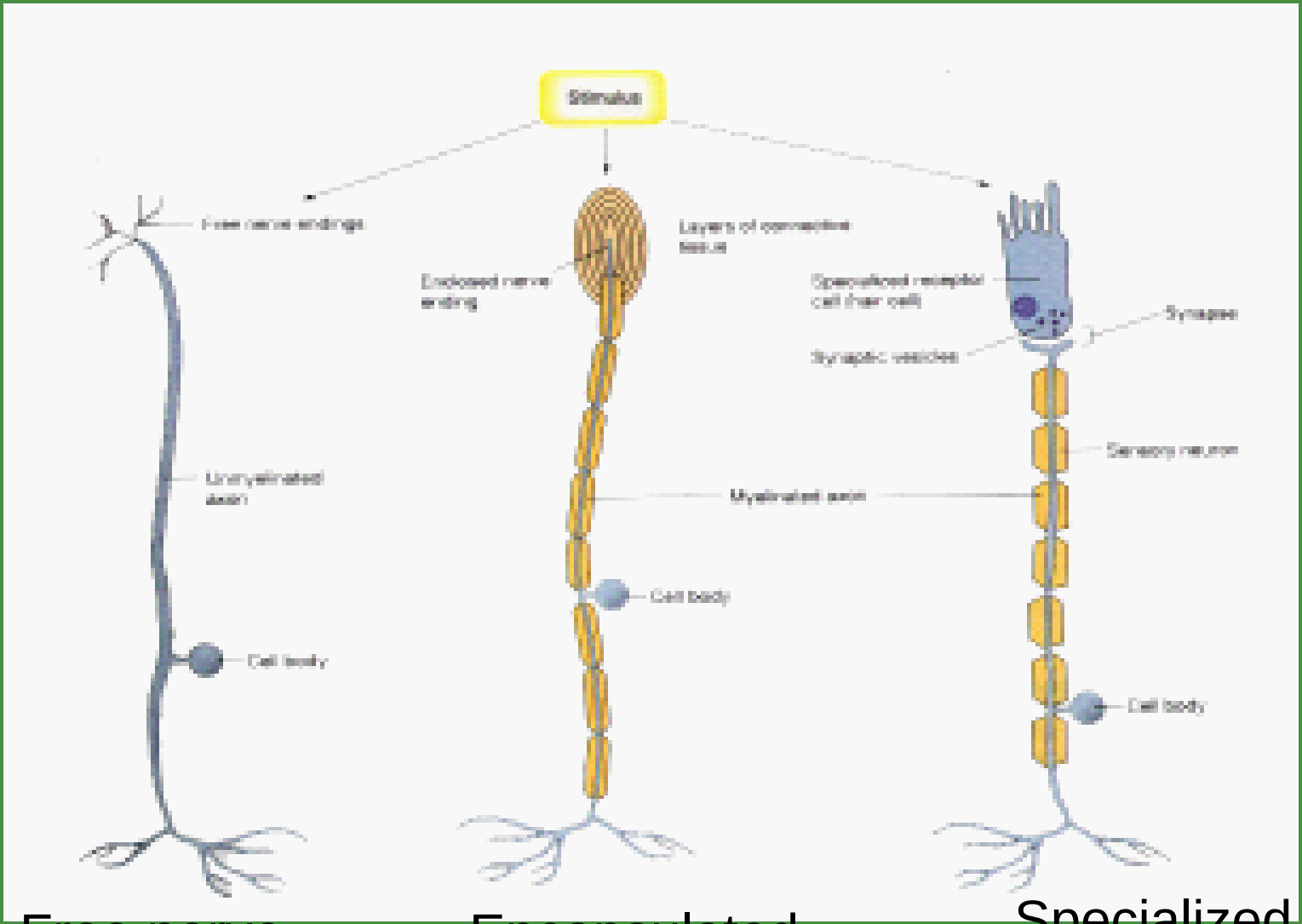


Fig 18-1

The larger the receptive field, the poorer ability to localize stimulus *(2 pt. discrimination test)*

Complexity Range of Receptors



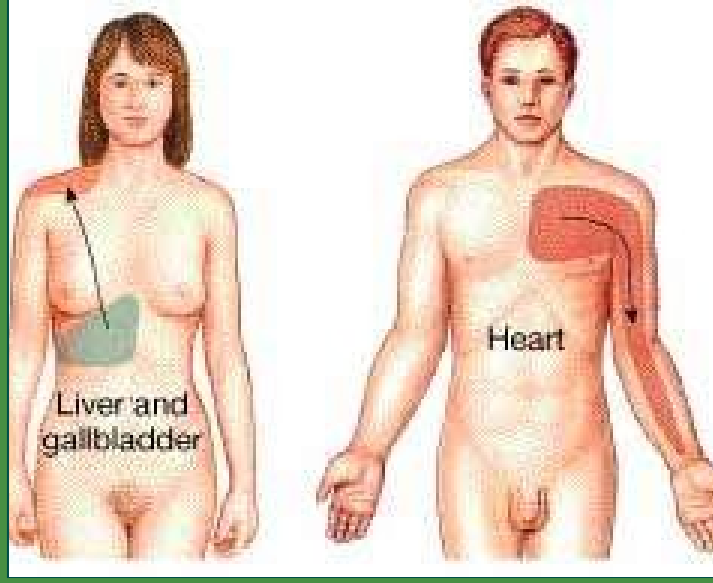
Free nerve ending

Encapsulated nerve ending

Specialized receptor cells

Four General Senses

1. Nociceptors



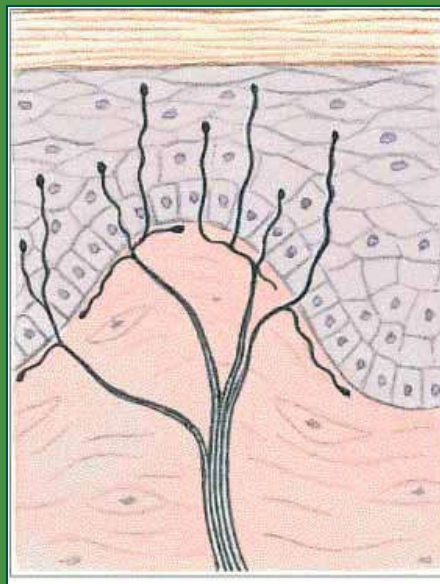
Respond to heat, mechanical stress and chemicals – associated with tissue damage

Most concentrated in skin

Fast pain (to cortex, usually triggers reflex)

Slow pain (later, persistent, indistinct source)

Referred pain (visceral, "incorrect" source perceived)



(a) Free nerve endings

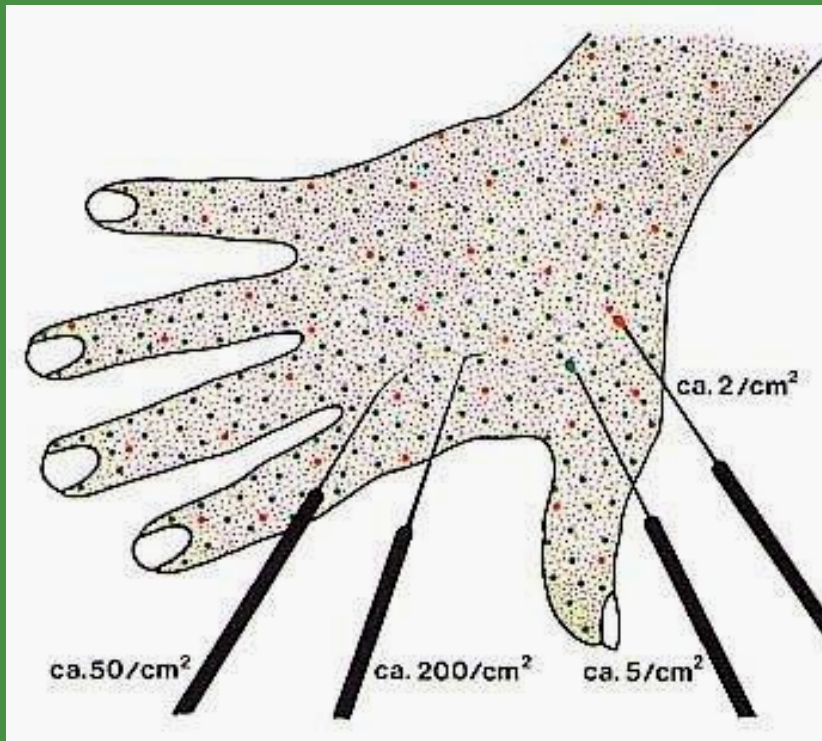
2) Thermoreceptors

Respond to changes in temperature

In dermis, skeletal muscles, liver and hypothalamus

Free nerve endings

Cold receptors > **warm** receptors



3) Mechanoreceptors

Respond to physical distortion of cell membrane (e.g.: stretching, twisting, compression)

Subdivided into

- **Baroreceptors** Sensitive to internal pressures: blood pressure, lung stretch, digestive tract tension
- **Proprioceptors** monitors of muscle stretch
- **Tactile receptors** - touch, pressure, vibration
  - Unencapsulated: free nerve endings, Merkels dics - fine touch
  - Encapsulated: Meissners corpuscles - fine touch; Pacinian corpuscles - deep pressure

4) Chemoreceptors

- Respond to small concentration changes of specific molecules (chemicals)
- Internal chemoreceptors monitor blood composition (e.g. Na^+, pH, pCO_2)
- Found within aortic and carotid bodies
- Very important for homeostasis

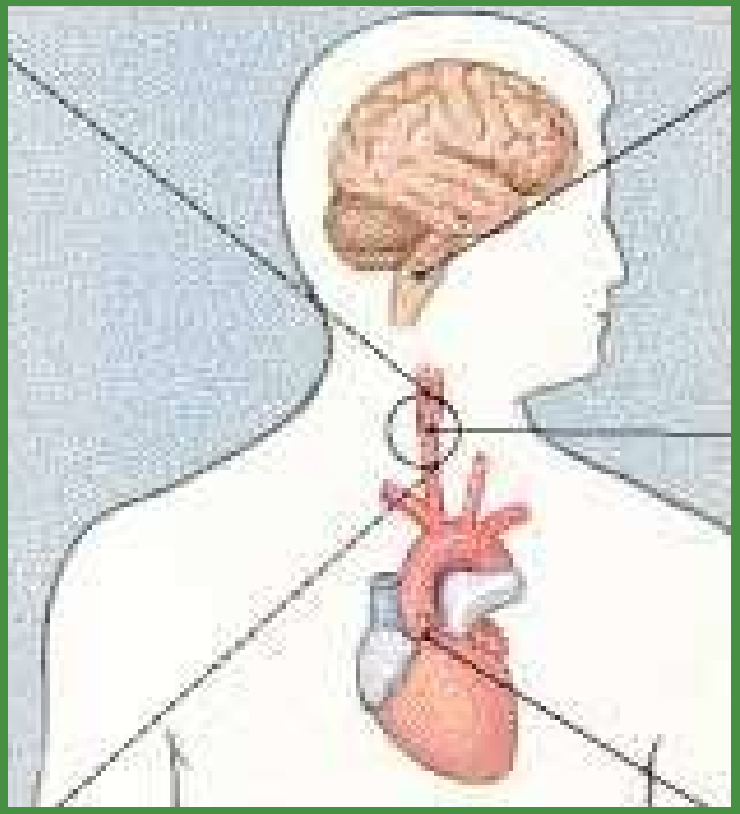


Fig 18-5

Special Senses

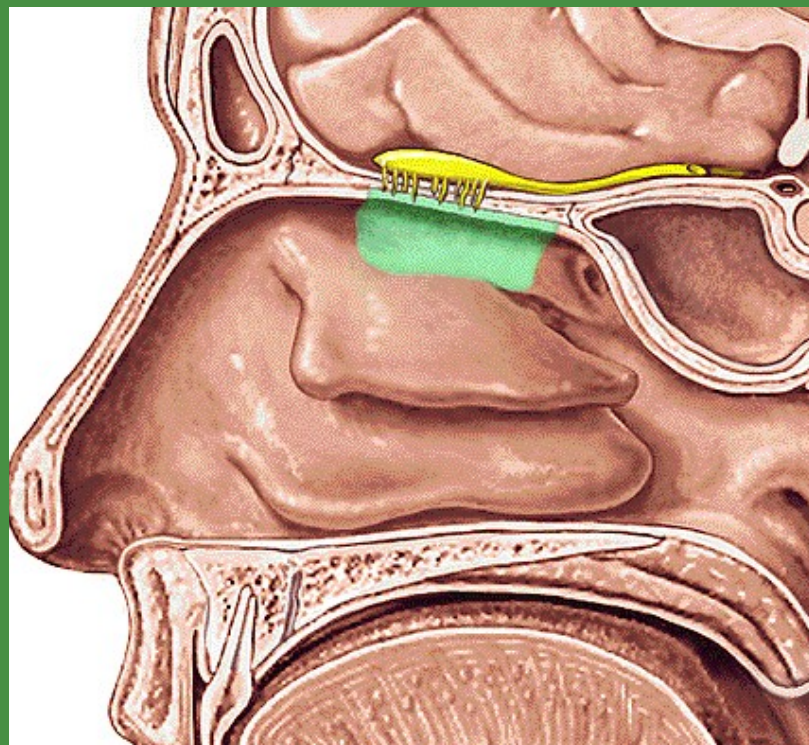
- Olfaction
- Taste
- Vision
- Hearing
- Equilibrium

Organ responsible ??

Olfaction: Paired Olfactory Organs

- Olfactory epithelium (10-20 Mio receptors / 5 $cm^{2)}$
- Responds to molecules dissolved in mucus or lipids
- Easy to recognize – hard to categorize
- (Only) neuron that can be replaced in adult
- Through cribriform plate of ethmoid to olfactory bulb

Type of receptor??



Olfactory Pathways

Receptor neurons pass into cranium through cribiform plate and synapse in olfactory bulbs.

Olfactory neurons are the only neurons known

1. to routinely replace themselves
2. to reach the cerebrum without synapsing in the thalamus

Olfactory discrimination - Although difficult to describe, the number of different odors recognizable is immense.

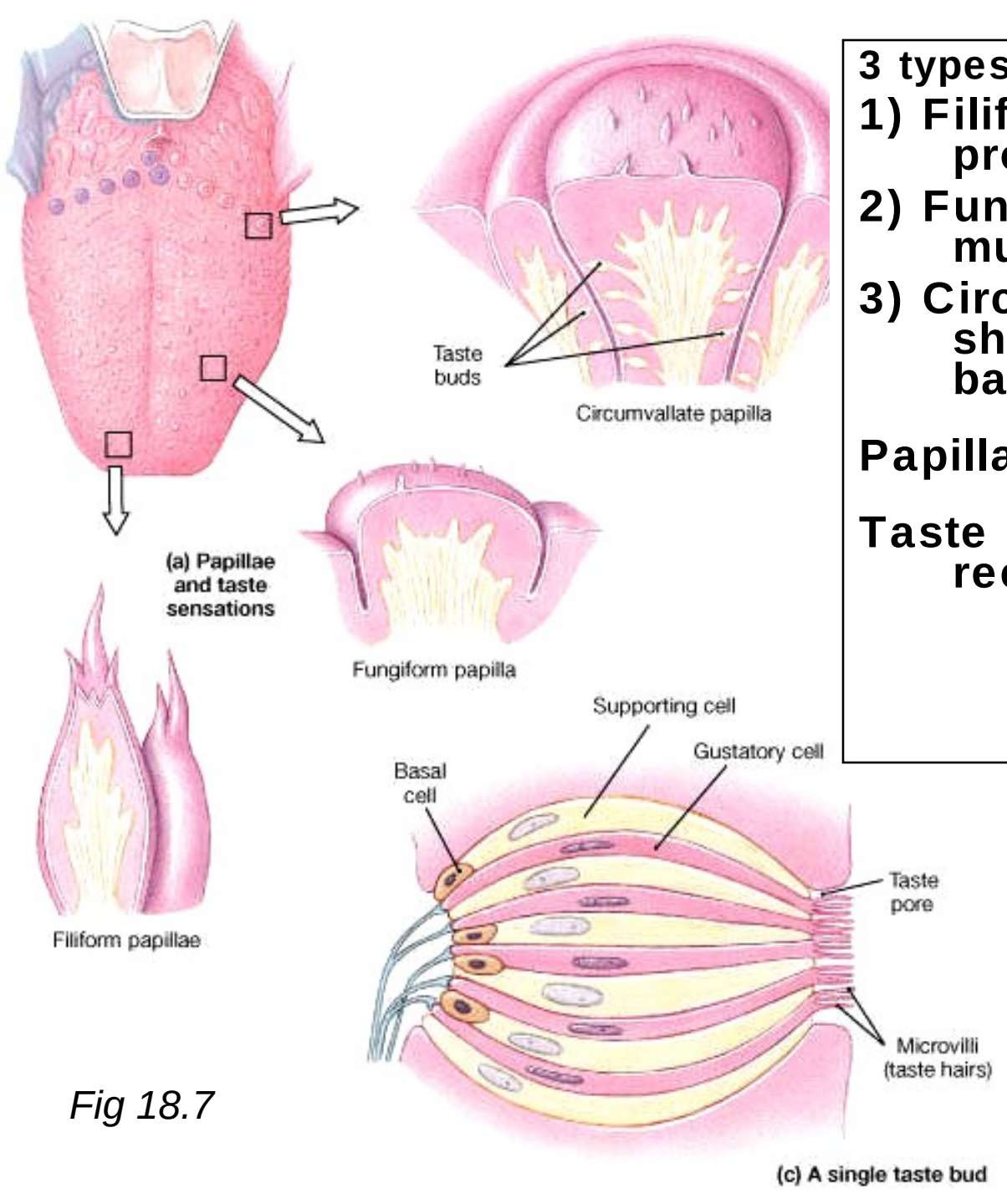


Fig 18.7

3 types of papillae

1) **Filiform - thin, thread like projections**
2) **Fungiform - shaped like mushrooms.**
3) **Circumvallate - large target-shaped bumps near the back of the tongue**

Papillae contain taste buds

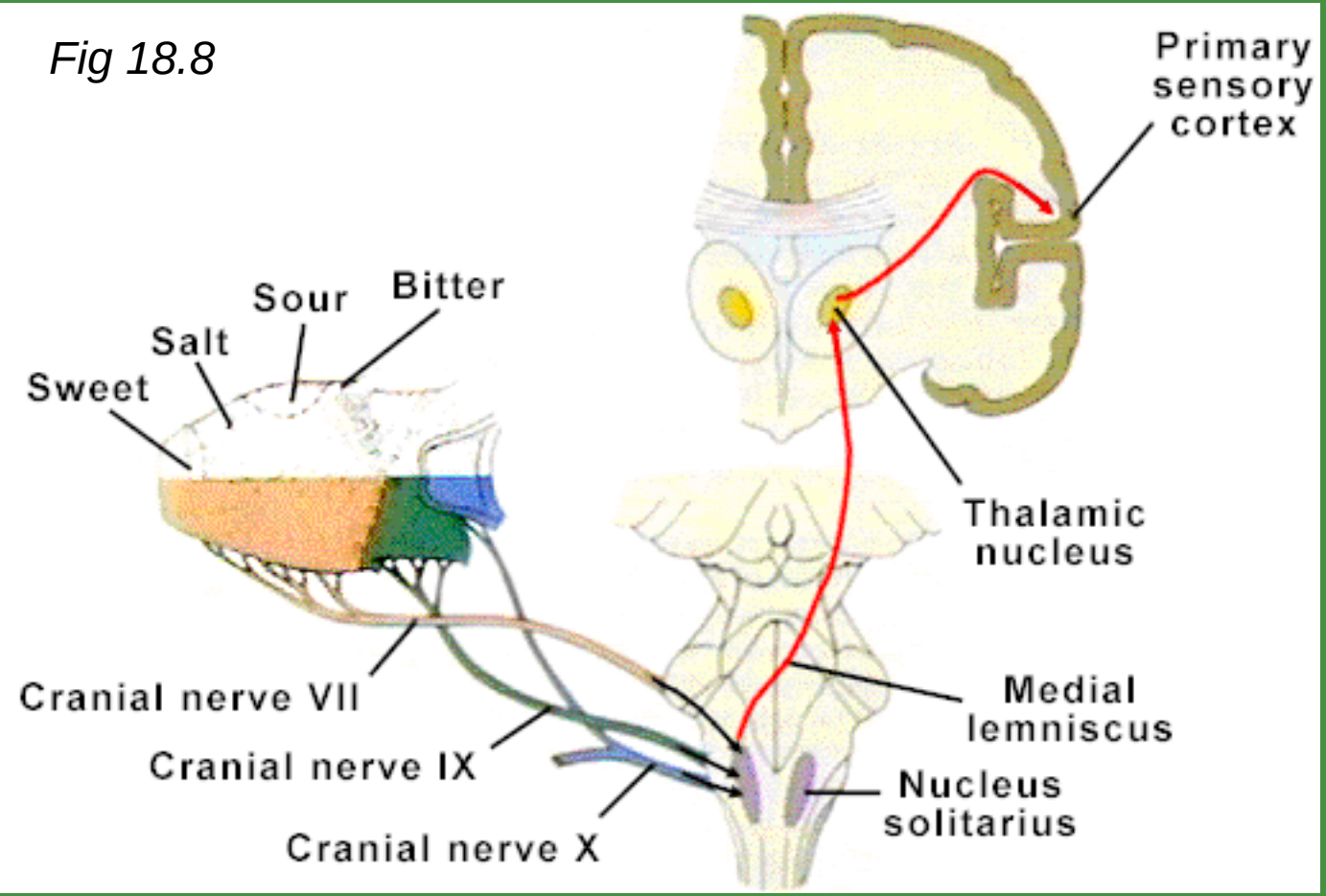
Taste buds contain group of receptor & support cells

Gustation

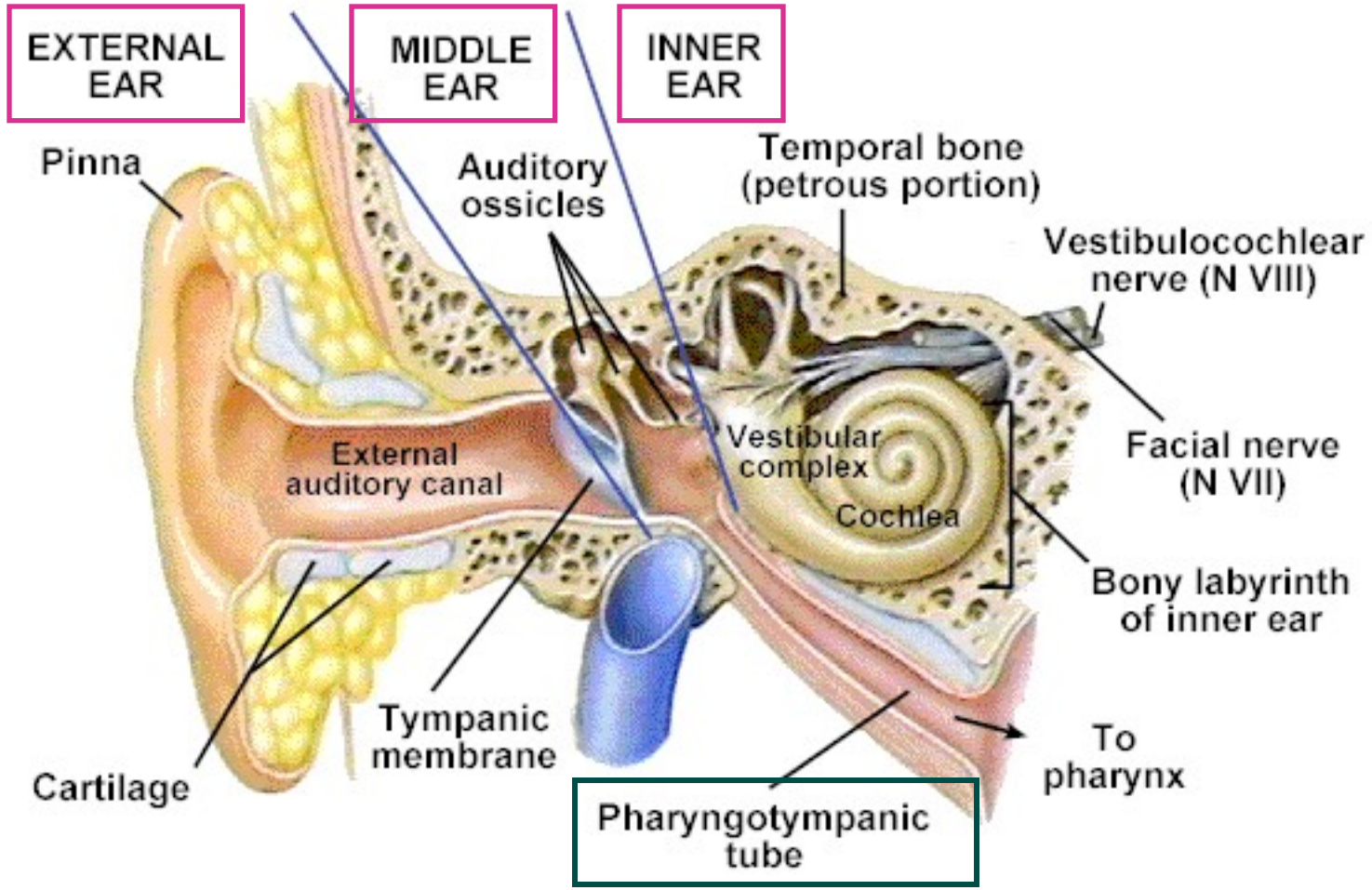
How many 1° taste sensations?

Gustatory Pathway

Cranial nerves VII, IX and X to nucleus solitarius in medulla oblongata to gustatory cortex

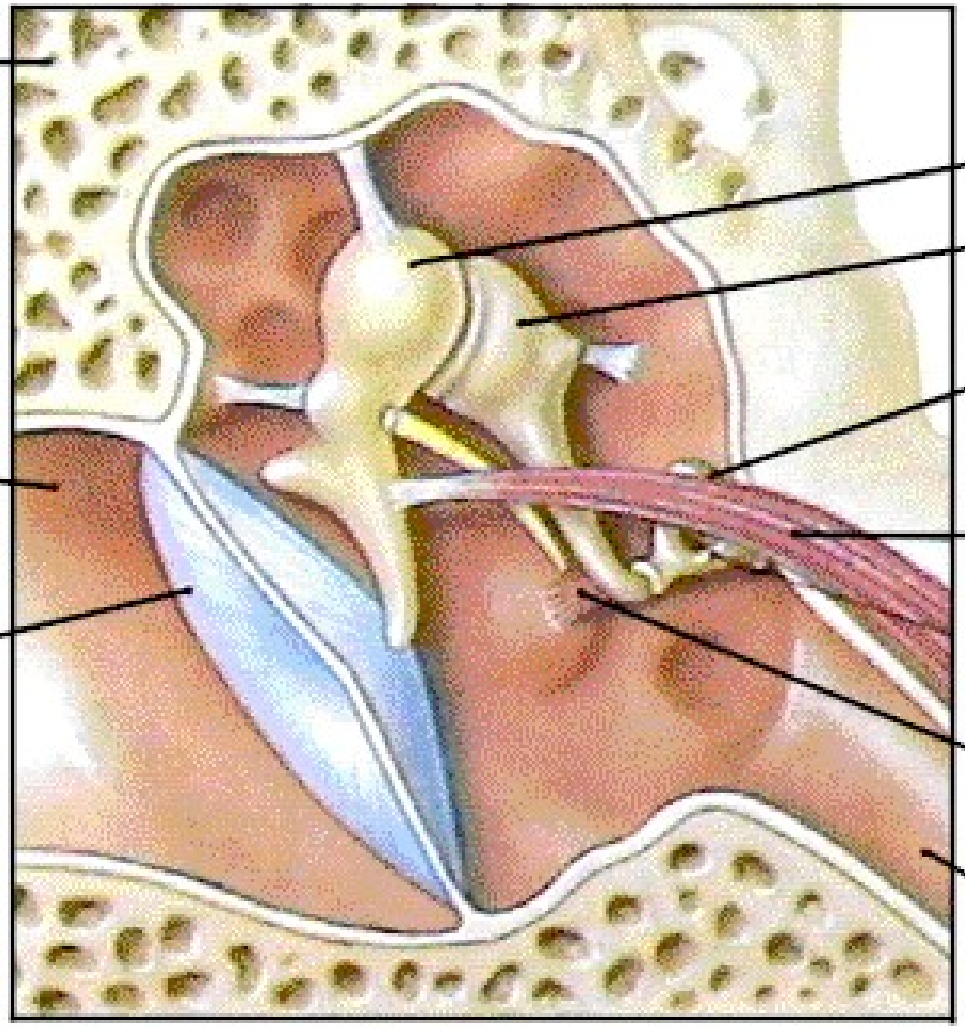


Hearing & Equilibrium



2 other names??

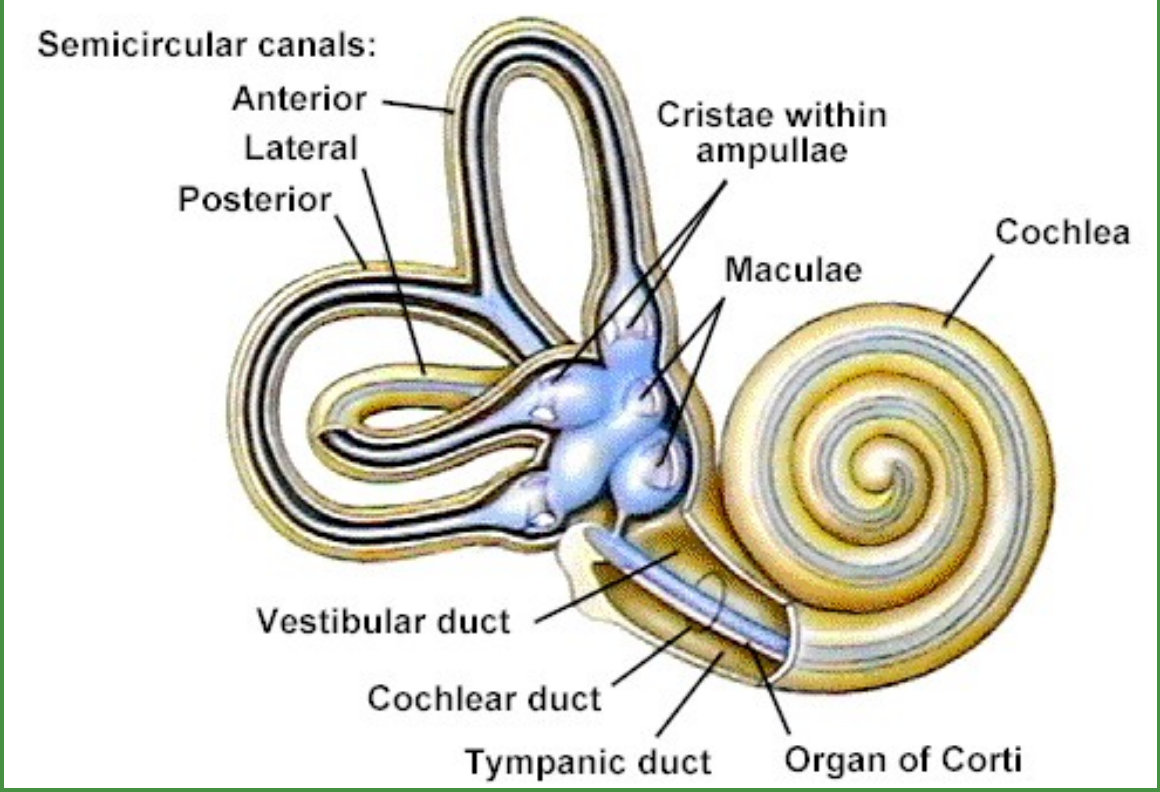
Middle Ear



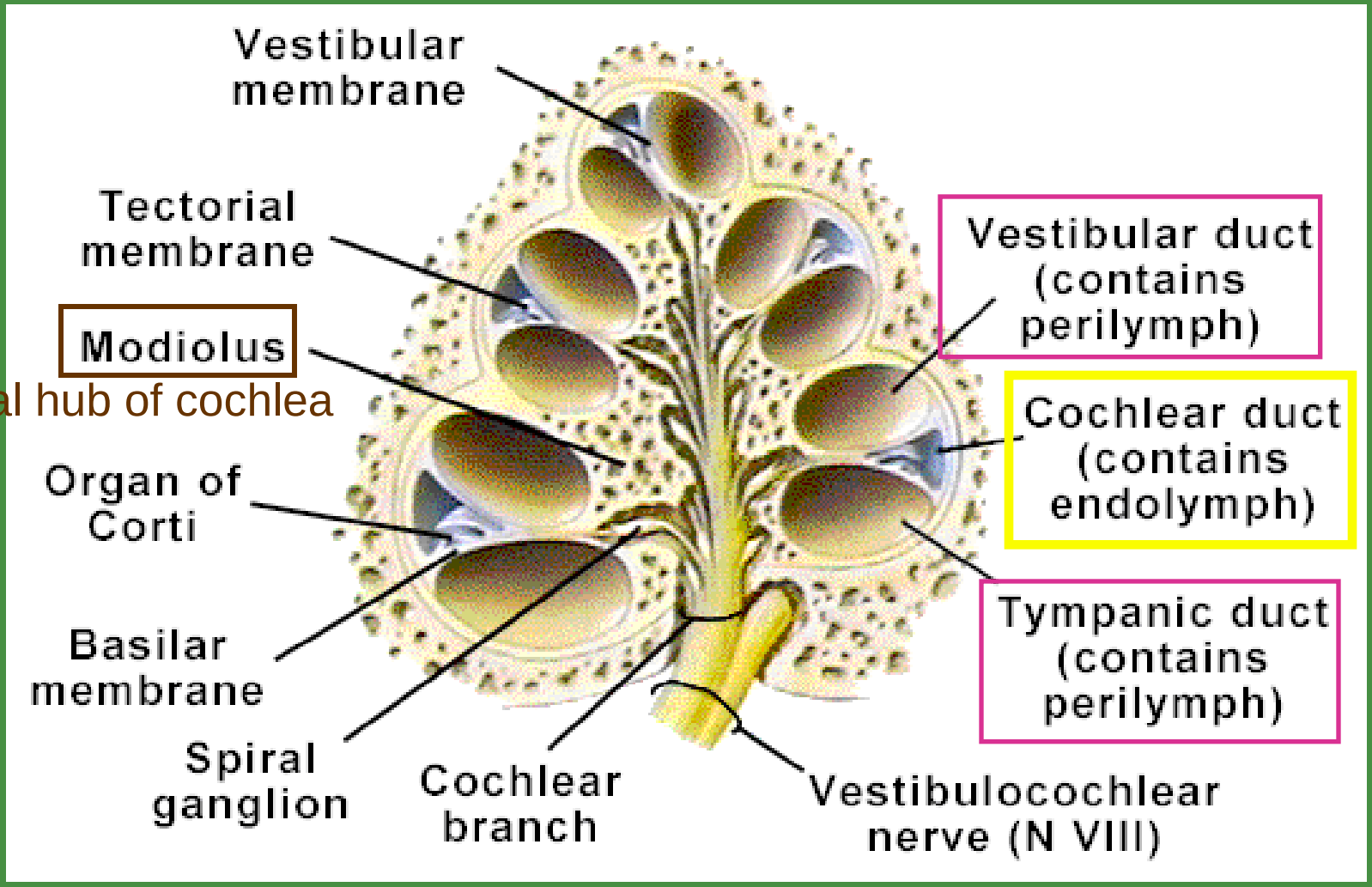
Function of the 2 muscles?

- Bony labyrinth vs. membranous labyrinth
- Perilymph vs. endolymph
- Cochlea & vestibular complex

Inner Ear



Structure of cochlea: 2.5 turns of ducts

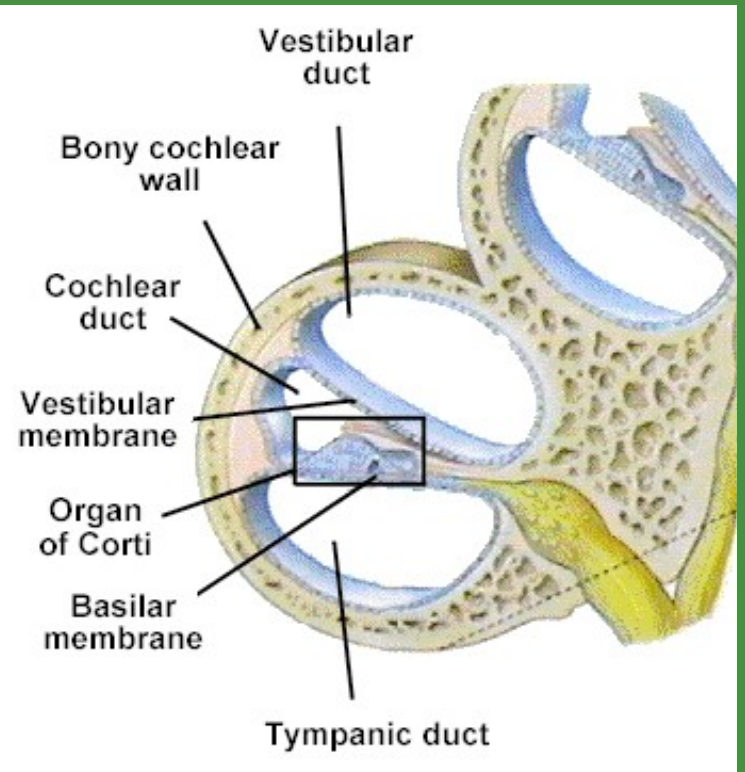


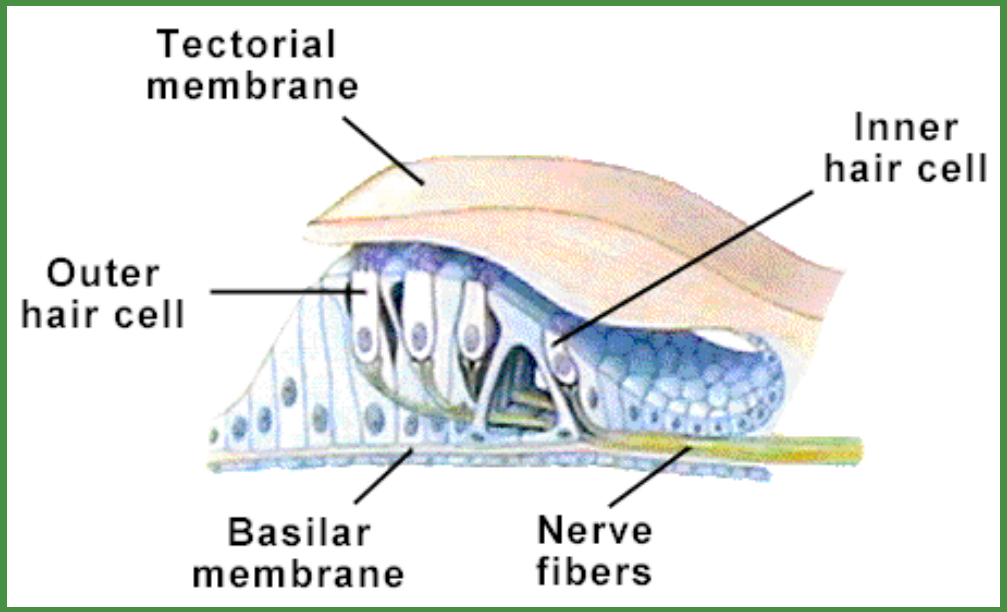
Organ of Corti

Basilar membrane on which sit hair cells with stereocilia

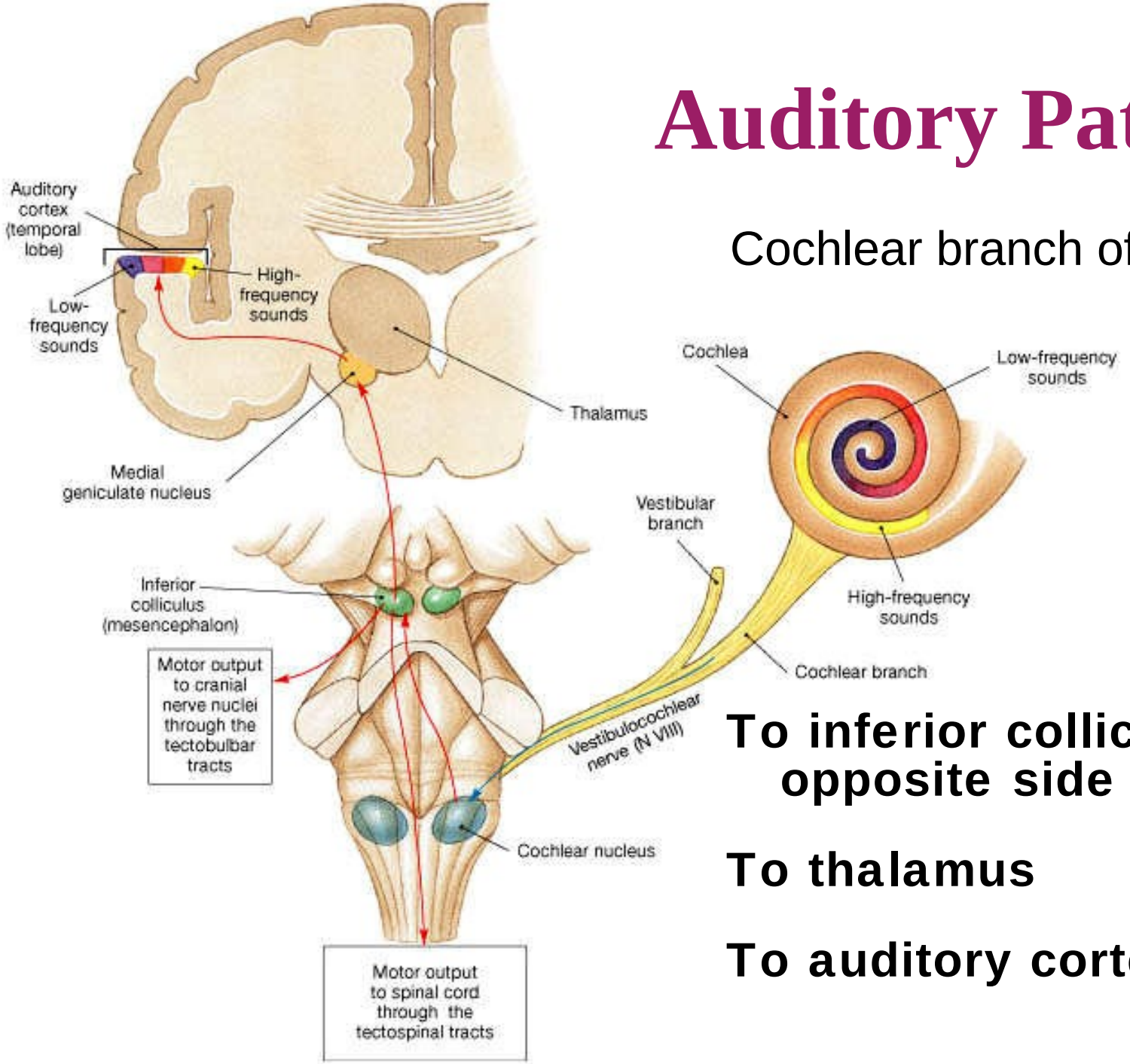
Tectorial membrane above the hair cells

Sound causes hair cells to bounce and touch tectorial membrane causing transduction





Auditory Pathway



Cochlear branch of CN VIII

To cochlear nucleus of medulla

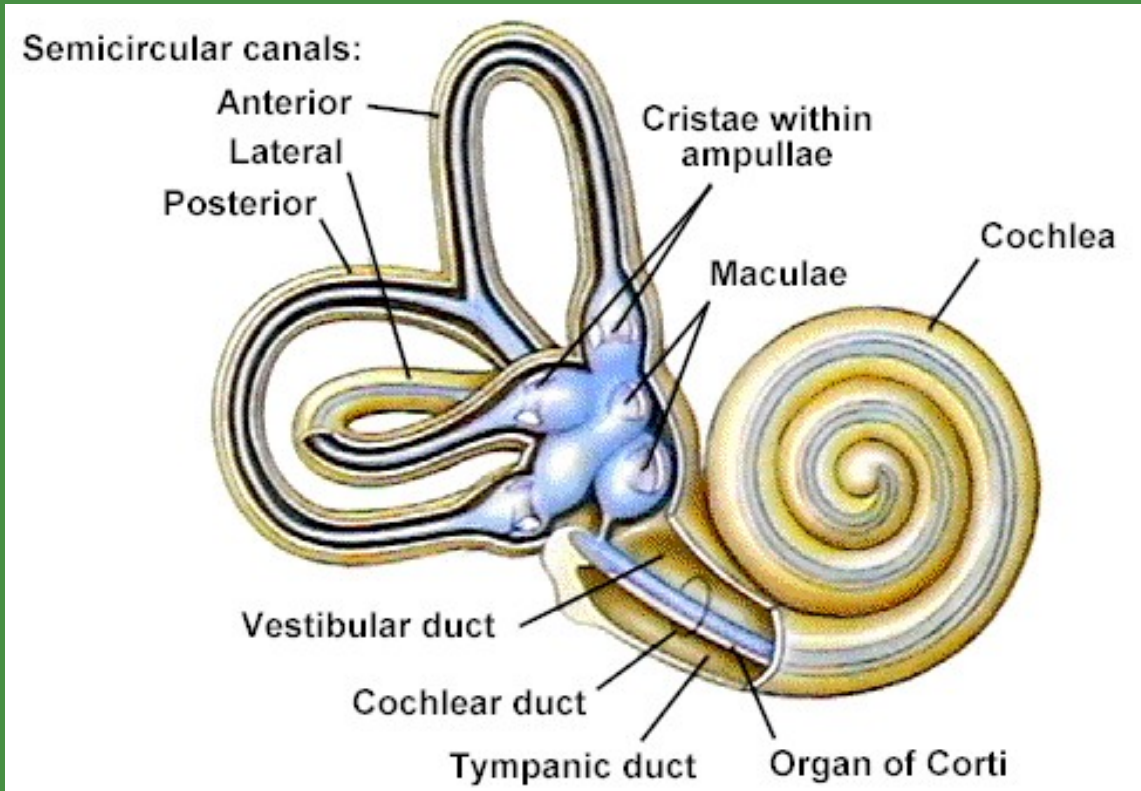
To inferior colliculus of opposite side of midbrain

To thalamus

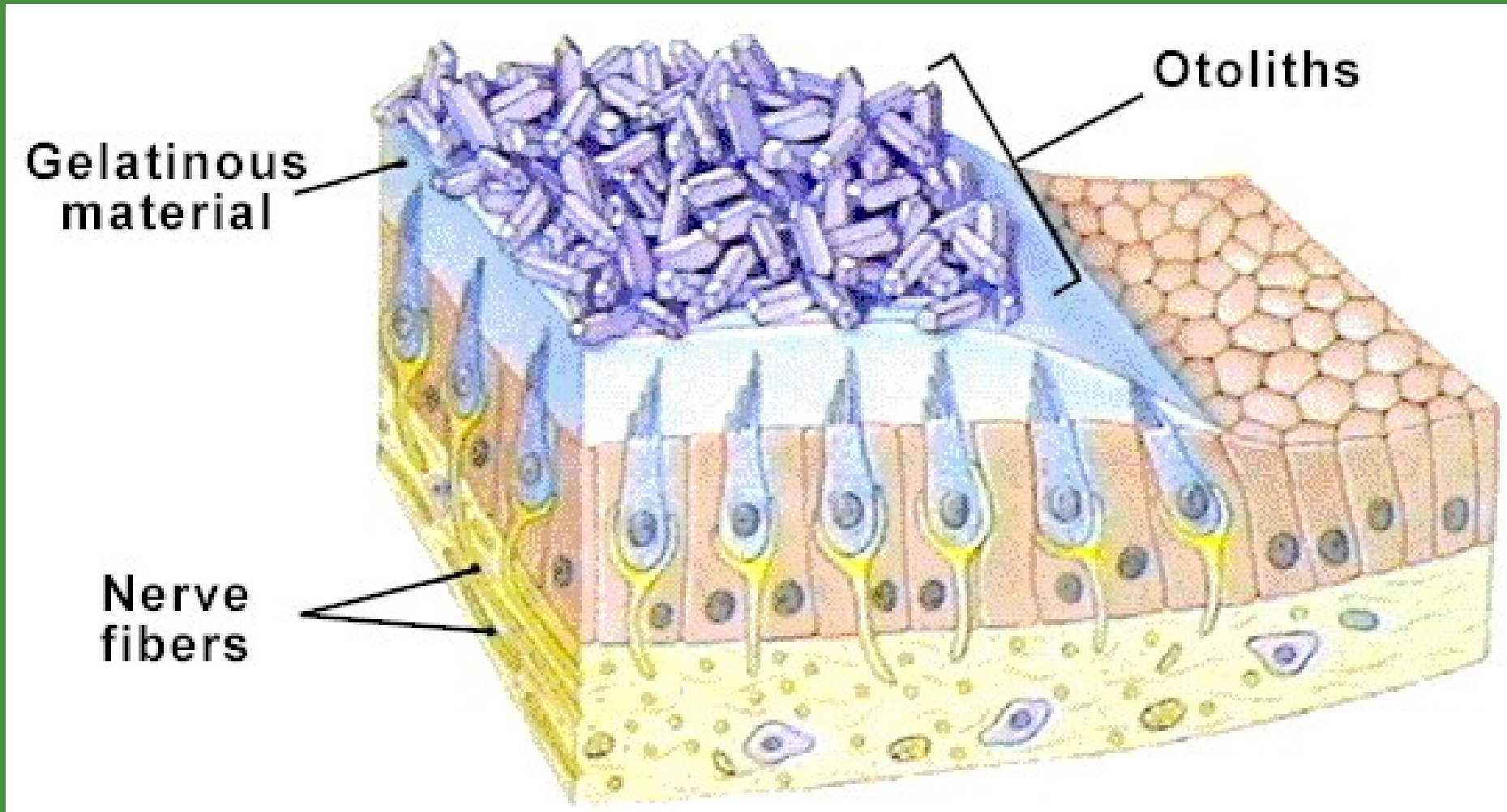
To auditory cortex

Vestibular Complex:

- Semicircular canals with ampullae (mutually perpendicular)
- Saccule and utricle (= fill up vestibule)

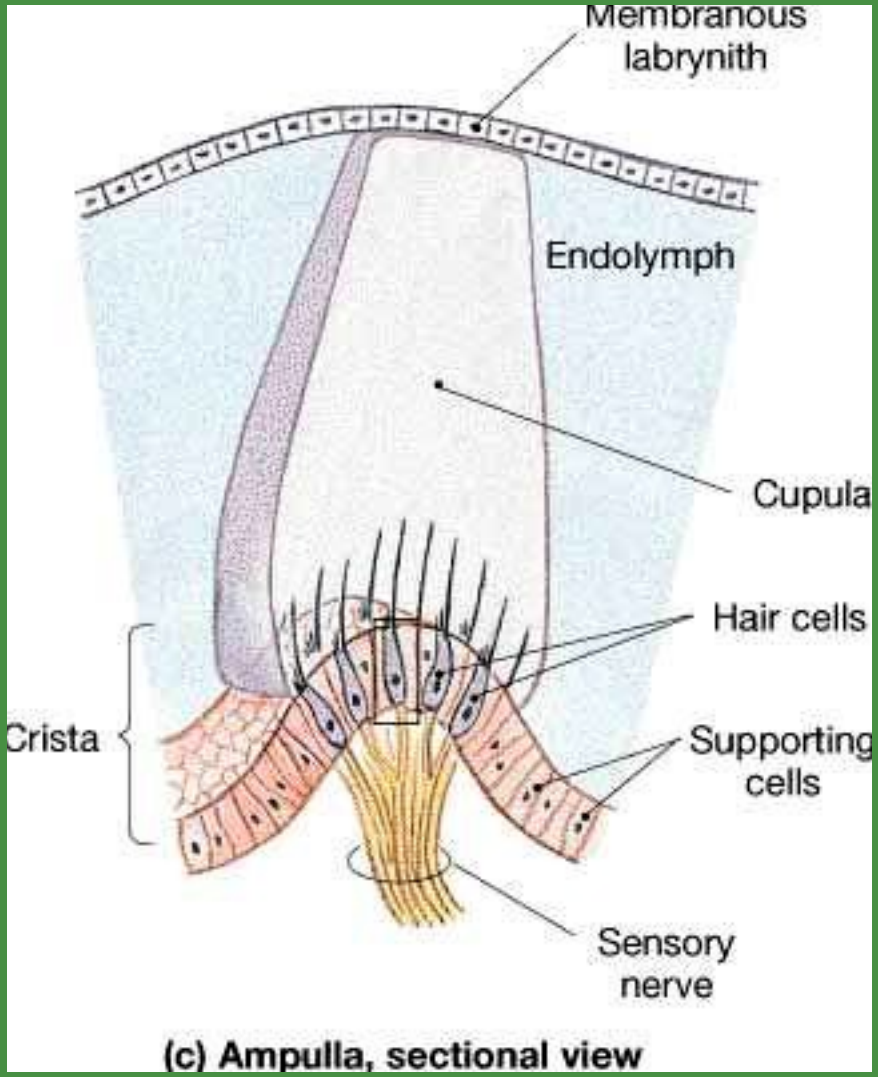


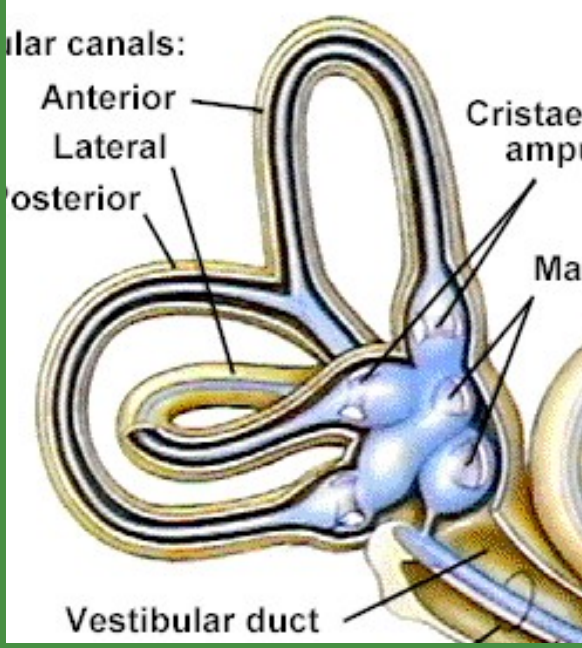
Two Receptor Organs: Maculae of Vestibule (or: macula of saccule plus macula of utricle)

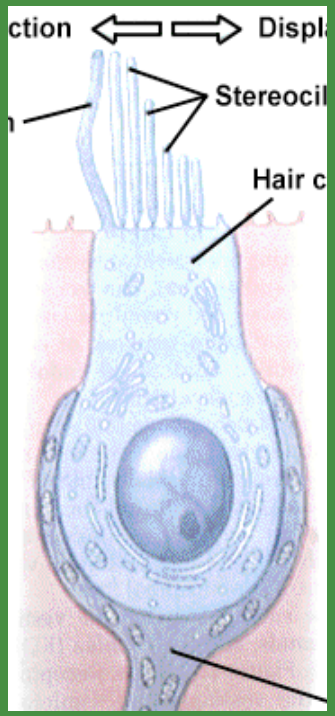


Cristae ampullaris

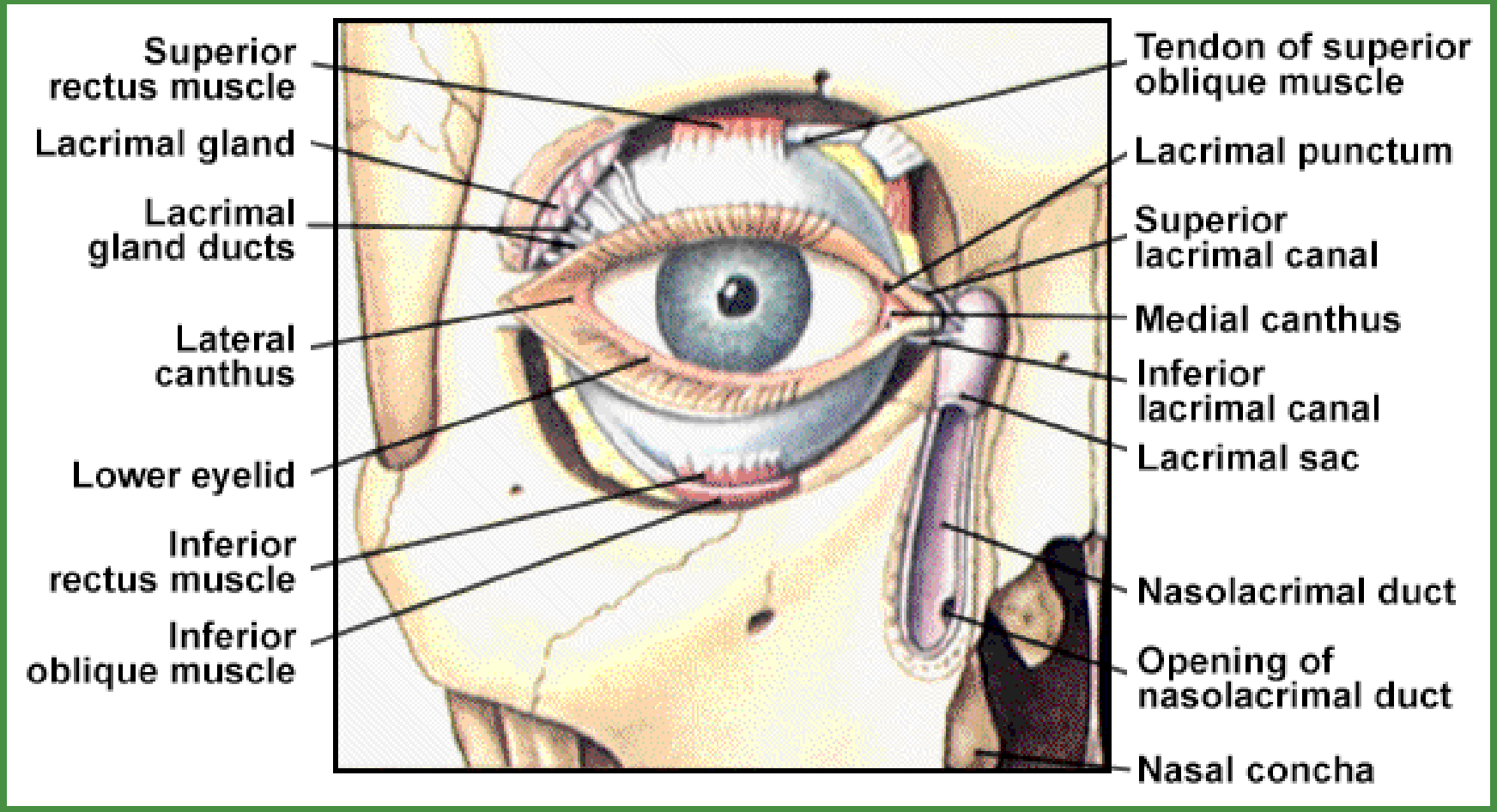
(how many?)







Vision: Eyeball + Accessory Structures



Palpebrae = Eyelid

- Continuation of skin
- Eyelashes
- Meibomian glands (on inner margin of lid)
  - lipid rich product, fu?
  - bacterial infection → chalazion
- Conjunctiva (= mucous membrane)
  - over cornea very thin (5-7 cells thick)

Lacrimal Apparatus

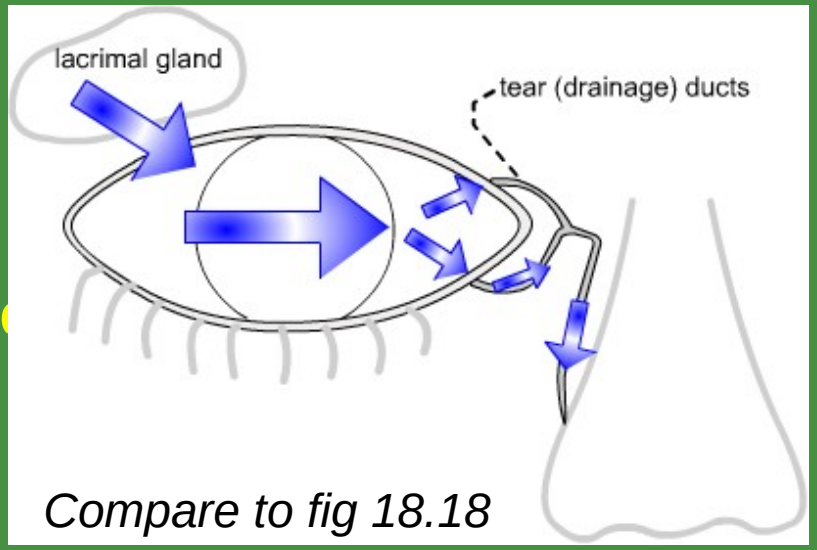
Lacrimal gland with several ducts - superior and lateral to eye

Lacrimal puncta (superior and inferior) - holes near nose to drain tears

Lacrimal canaliculi - drain tears to

Nasolacrimal duct - empties to nasal cavity

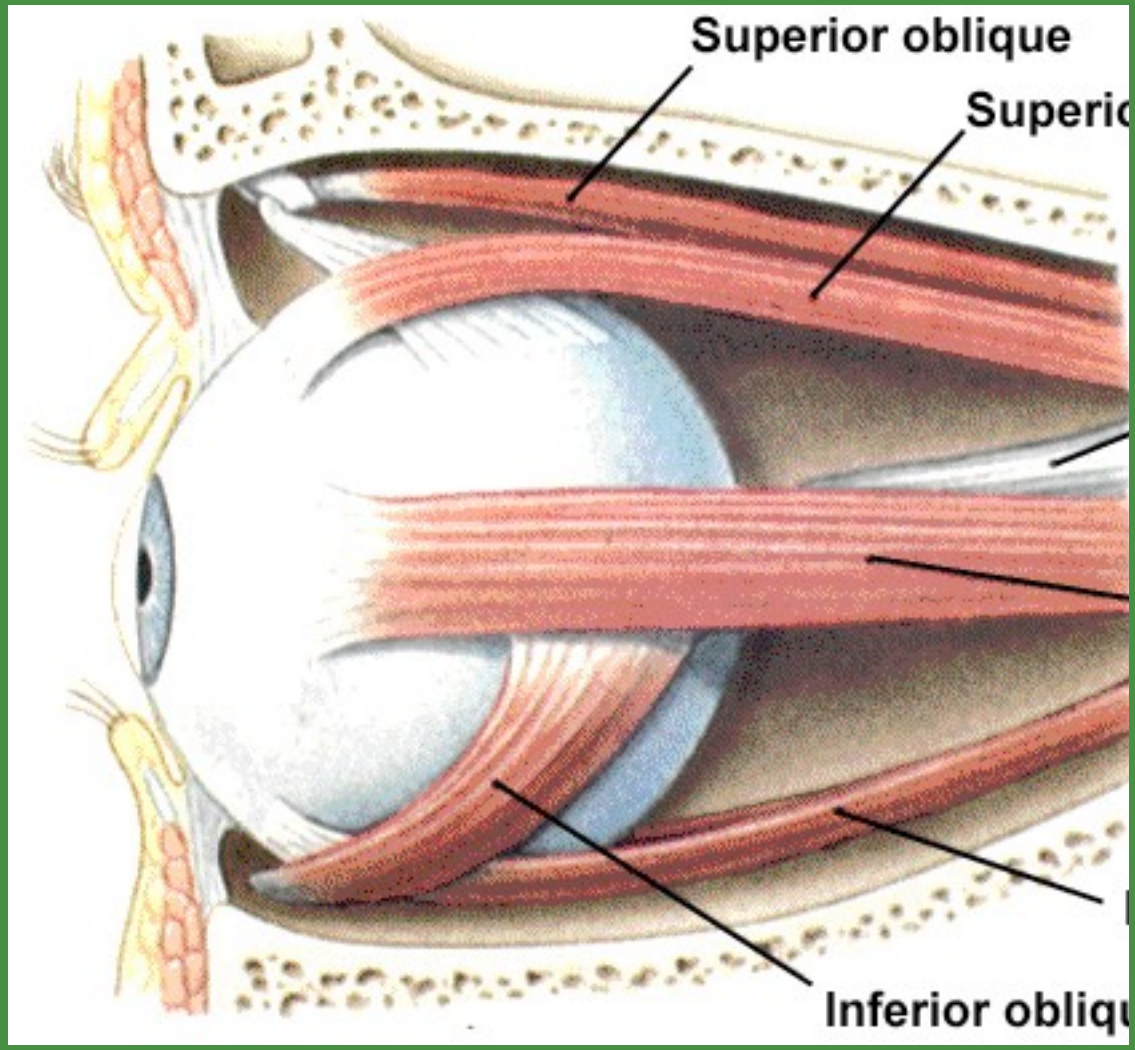
Secretion contains lysozym



Compare to fig 18.18

Extrinsic Eyemuscles *(see p.272)*

- 4 recti
- 2 oblique
- Innervation?



The Three Tunics:

1) Fibrous Tunic (tough outer layer)

sclera - white part of fibrous tunic

cornea - transparent avascular anterior part

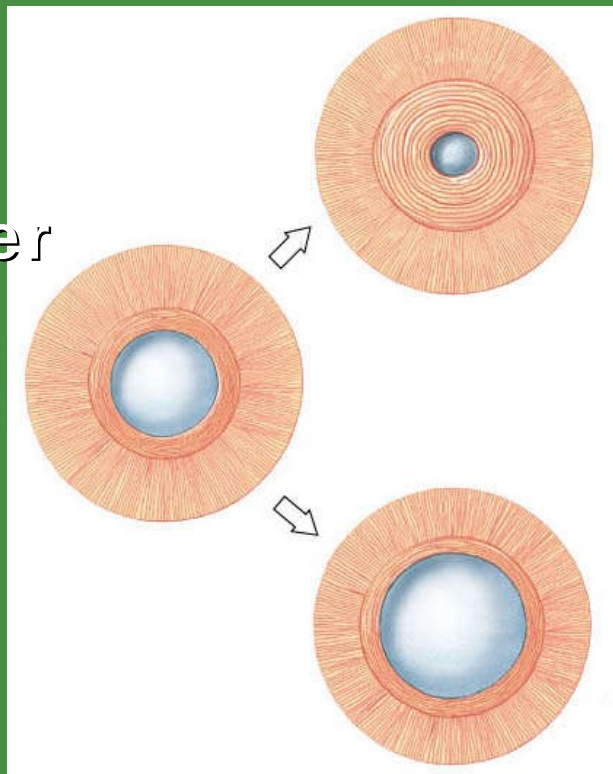
limbus - boundary between the above

2) Vascular Tunic (= Uvea)

choroid - heavily vascular

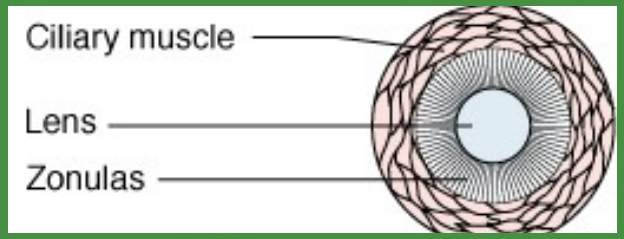
iris with pupil hole - inner sphincter and outer radial muscles

ciliary body - muscle attached to suspensory ligaments, regulates focus of lens

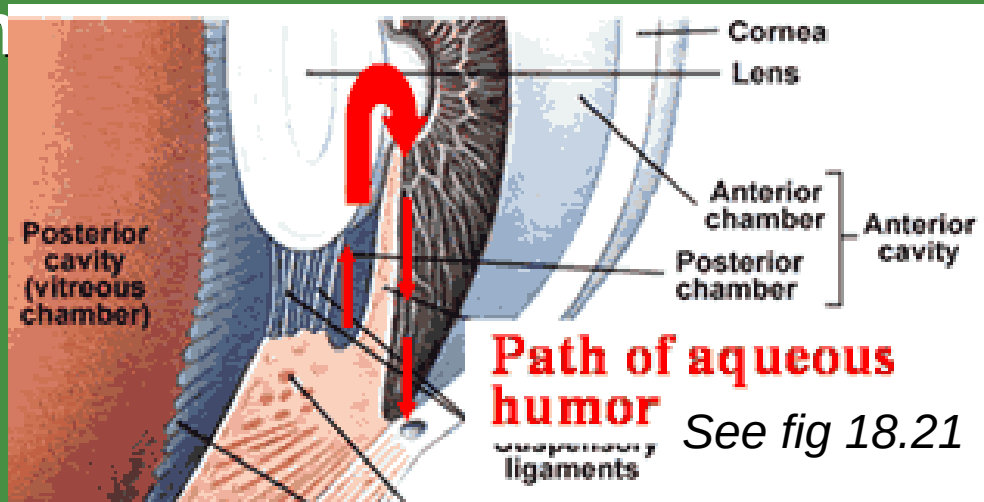


Lens and Chambers of the Eye

- Ciliary body
- Suspensory ligaments
- Anterior and posterior chambers (= anterior cavity) with aqueous humor
- Posterior cavity with vitreous humor
- Cataract



Glaucoma=?



See fig 18.21

3) Nervous Tunic: Retina

Outer layer pigmented - inner layer photoreceptors
- a) rods - black/white vision, dim light
- b) cones - color vision, intense light

Bipolar cells - synapse with rods and cones

Ganglion cells - synapse with bipolar cells

Ora serrata - anterior edge of retina

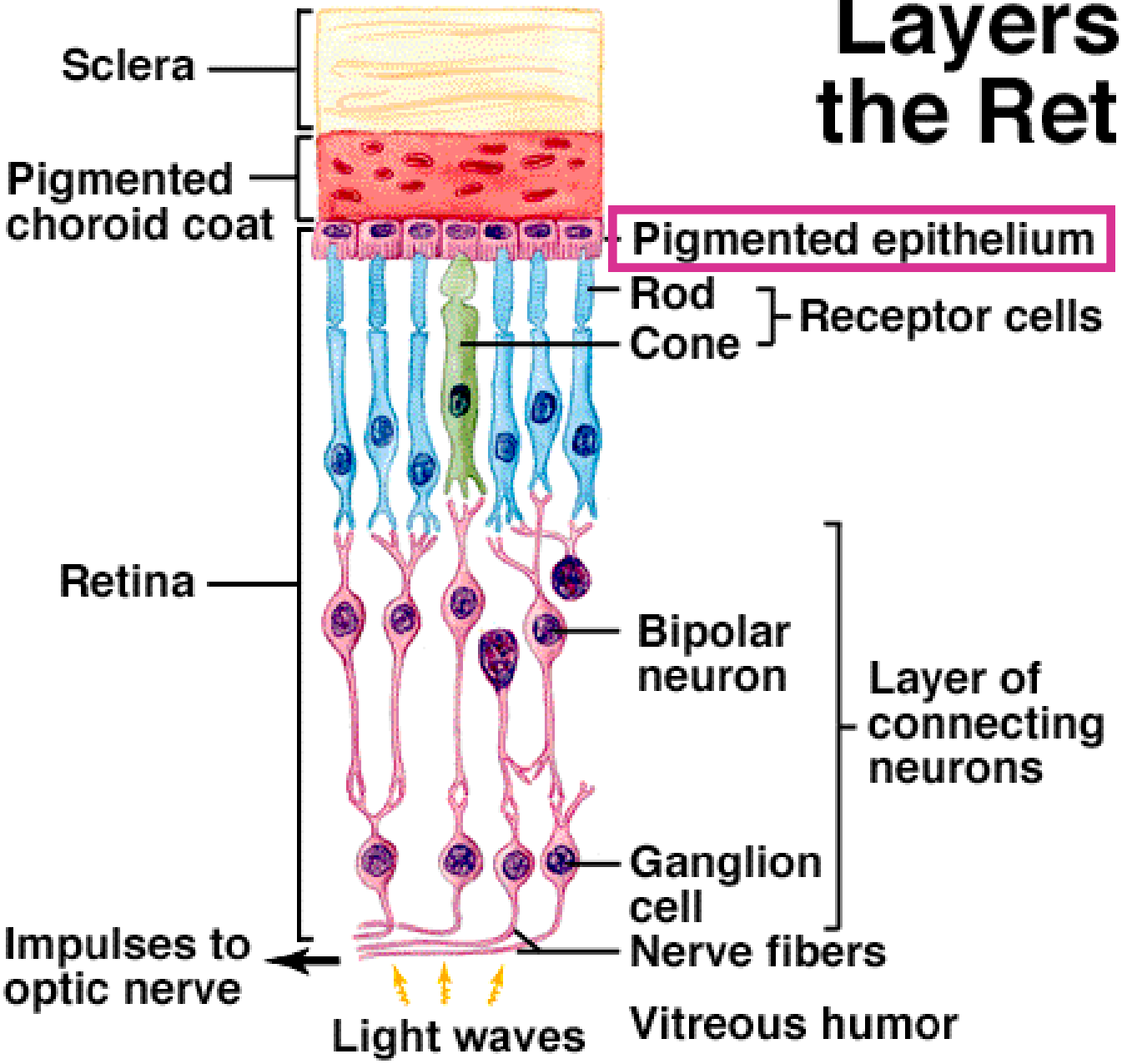
Macula lutea – fovea centralis - all cones, best vision

Optic disc – blind spot, where optic nerve exits eye

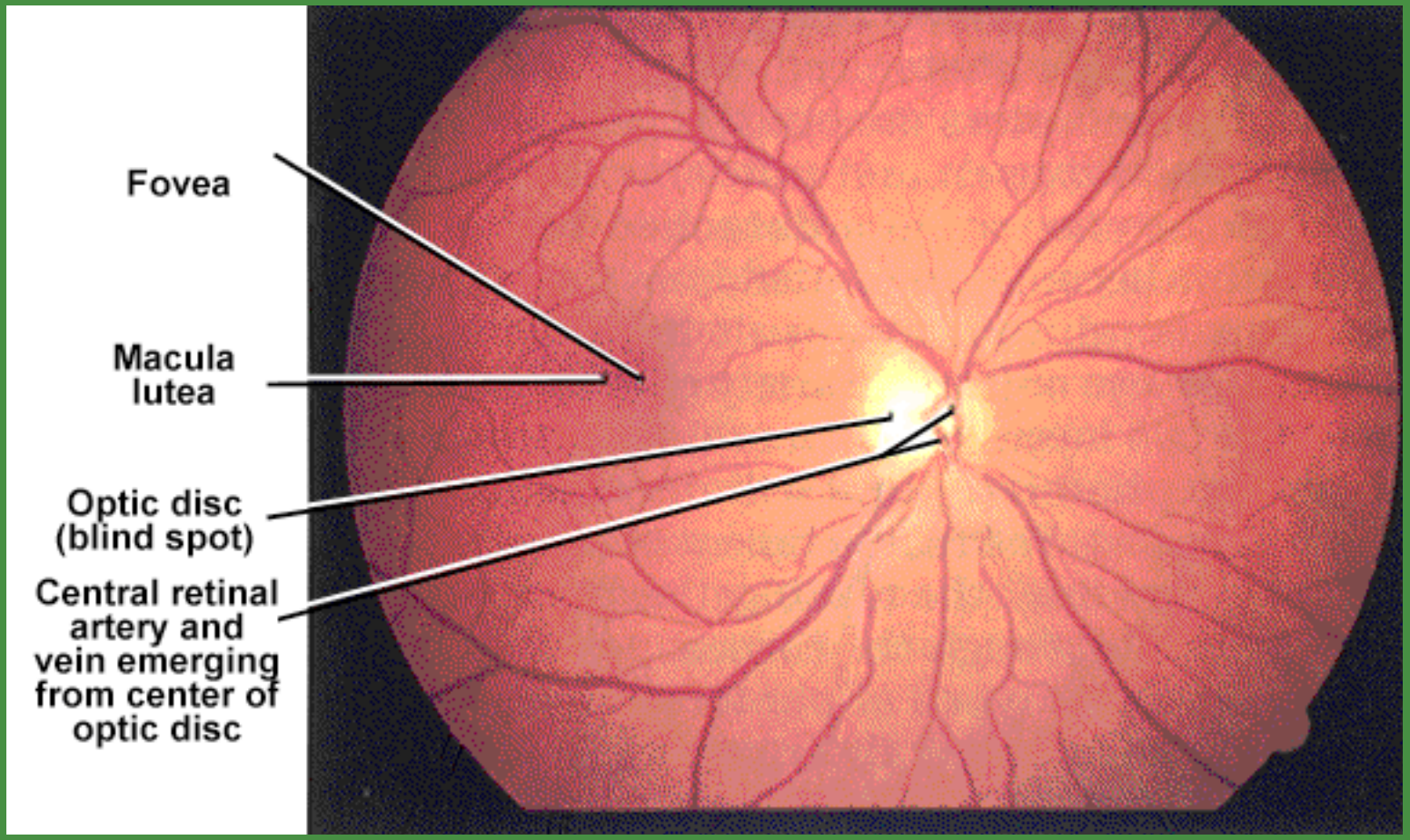
Optic nerve

See Fig 18.22

Layers of the Retina



Eye Fundus: clinical significance ?



Visual Pathway

Optic chiasma - optic nerves partially cross (right side of the field of each eye combining and going to the lateral geniculate on the right, those from the left to the left)

To superior colliculus and thalamus

To visual cortex in _____ lobe