

An anatomical illustration of the human shoulder and upper arm. The skeletal structure, including the ribs, scapula, humerus, and radius, is shown in a light tan color. The muscles are depicted in a vibrant red with white connective tissue. The illustration is set against a dark, almost black background, highlighting the anatomical details.

# HUMAN ANATOMY

SIXTH EDITION

## Chapter 18

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# The Nervous System — General and Special Senses

**PowerPoint® Lecture Slides  
prepared by Jason LaPres  
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# Introduction

- A sensory *receptor* is a specialized cell or cell process that monitors conditions in the body or the external environment.
- Stimulation of the receptor directly or indirectly alters the production of action potentials in a sensory neuron.
- The sensory information arriving at the CNS is called a *sensation*.
  - A *perception* is a conscious awareness of a sensation.

## ■ **General senses**

- Sensations of temperature, pain, touch, pressure, vibration, and proprioception (body position)
- Receptors throughout the body
- These sensations arrive at the primary sensory cortex, or somatosensory cortex

## ■ **Special senses**

- Sensations of smell (olfaction), taste (gustation), balance (equilibrium), hearing, and vision
- Specialized receptor cells that are structurally more complex than those of the general senses

# Receptors

- ***Receptor specificity*** — each receptor responds to one type of stimulus
- ***Receptive field*** — the area that a receptor monitors
- ***Tonic receptors*** — always send signals, thus information is based on the frequency of the action potentials
- ***Phasic receptors*** — send action potentials only if stimulated
- ***Peripheral adaptation*** — receptors may stop sending AP even if the stimulus is still present
- ***Central adaptation*** — CNS ignoring a AP from a receptor

# Receptors

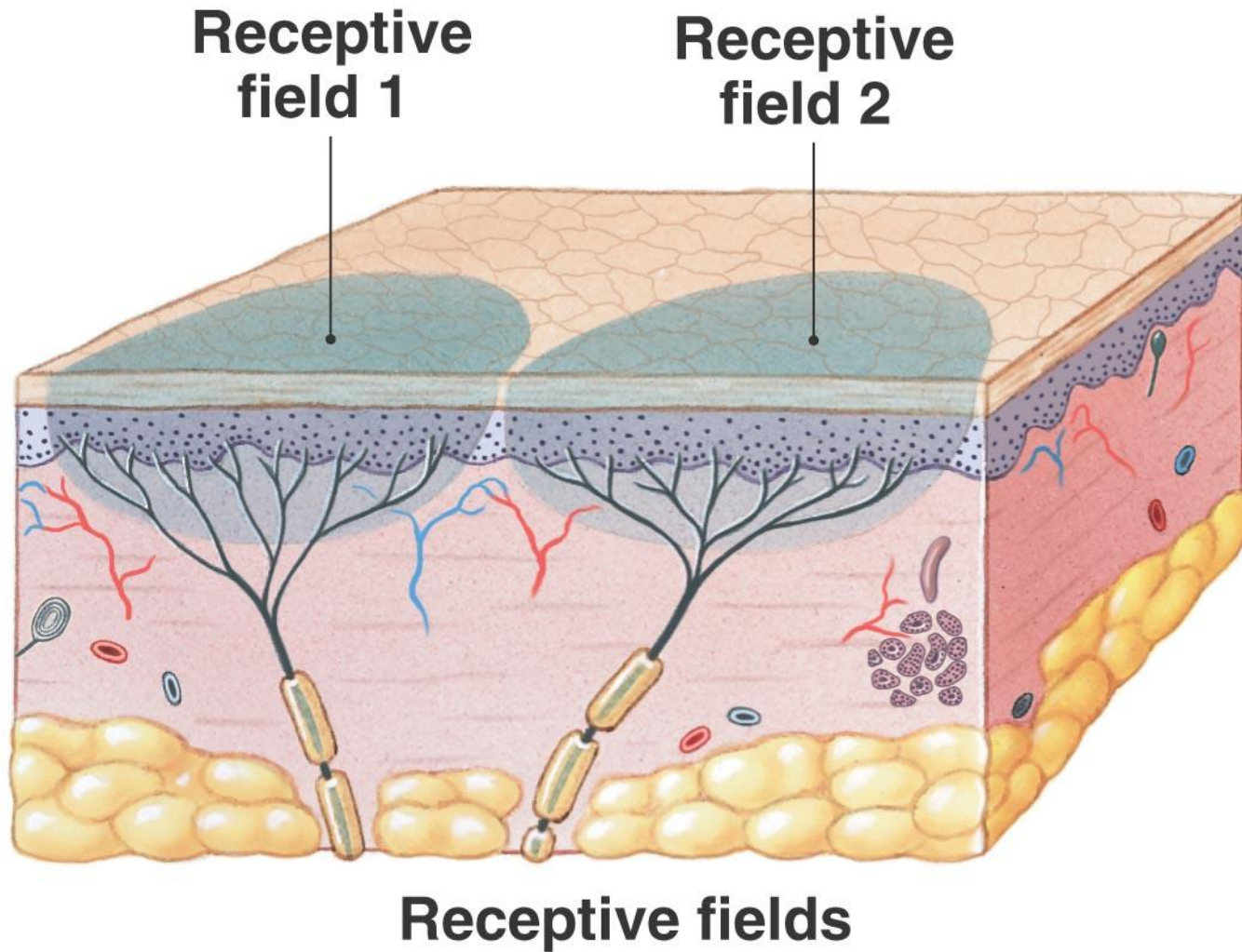


Figure 18.1 Receptors and Receptive Fields

## ■ Sensory Limitations

- Humans do not have receptors for every possible stimulus.
- Our receptors have characteristic ranges of sensitivity.
- A stimulus must be interpreted by the CNS. Our perception of a particular stimulus is an interpretation and not always a reality.

# The General Senses

- Receptors for general senses classified by location:
  - *Exteroceptors* provide information about the external environment.
  - *Proprioceptors* monitor body position.
  - *Interoceptors* monitor conditions inside the body.
- Receptors for general senses classified by type of stimulus:
  - *Nociceptors* = tissue damage
  - *Thermoreceptors* = change in temperature
  - *Mechanoreceptors* = physical distortion, contact, or pressure
  - *Chemoreceptors* = chemical composition of body fluids



# The General Senses

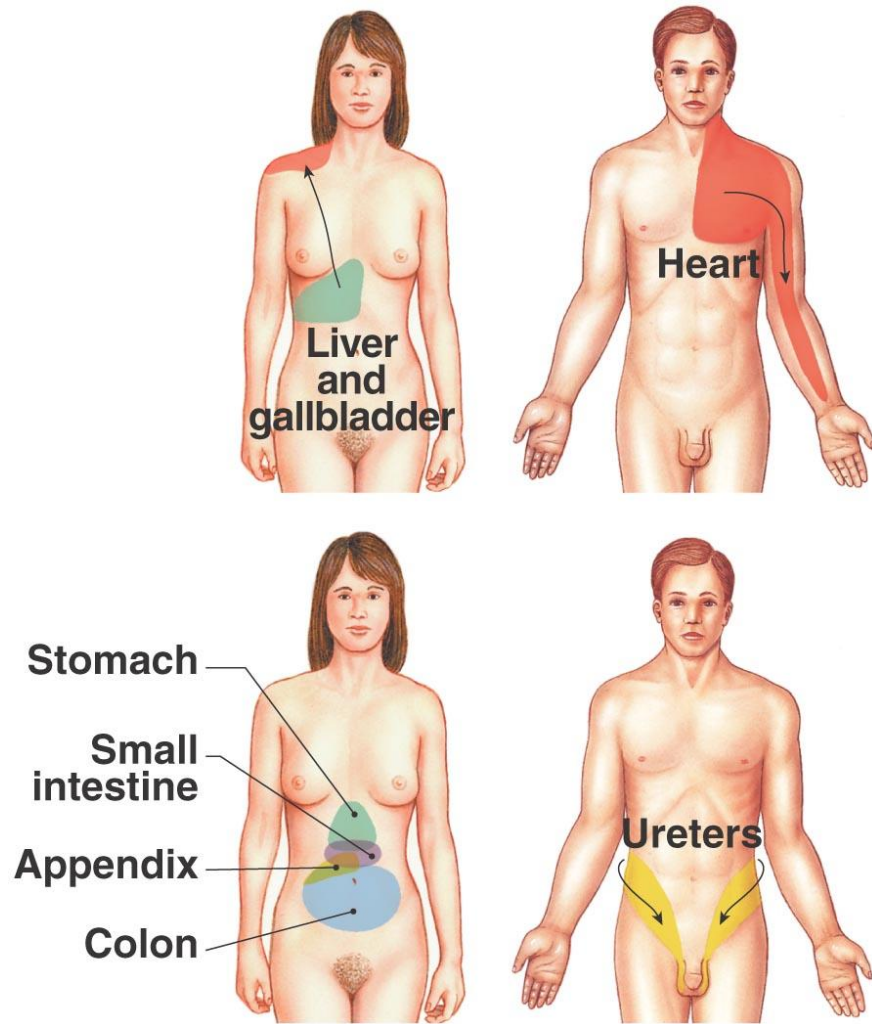


Figure 18.2 Referred Pain



# The General Senses

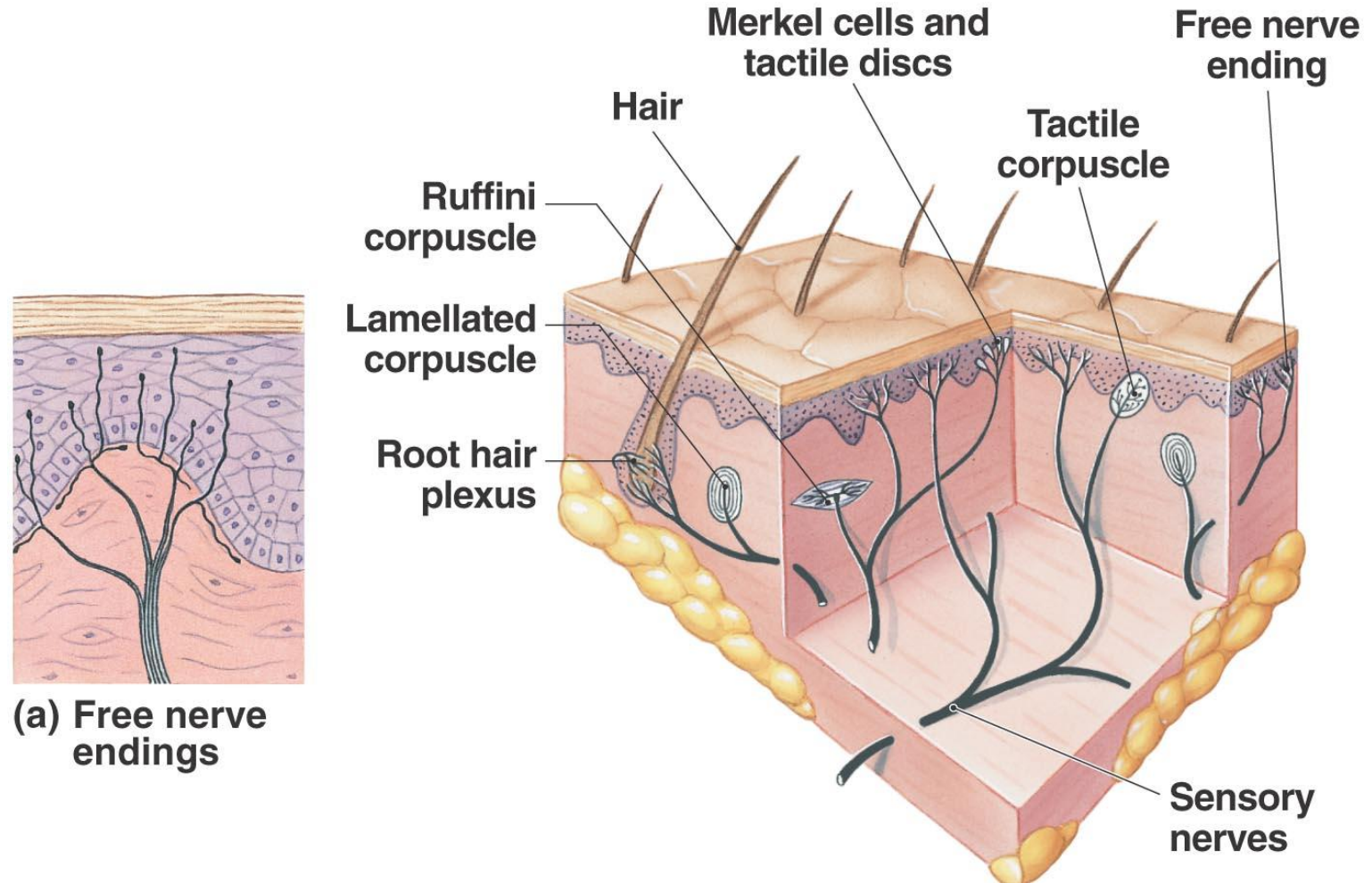


Figure 18.3 Tactile Receptors in the Skin

# The General Senses

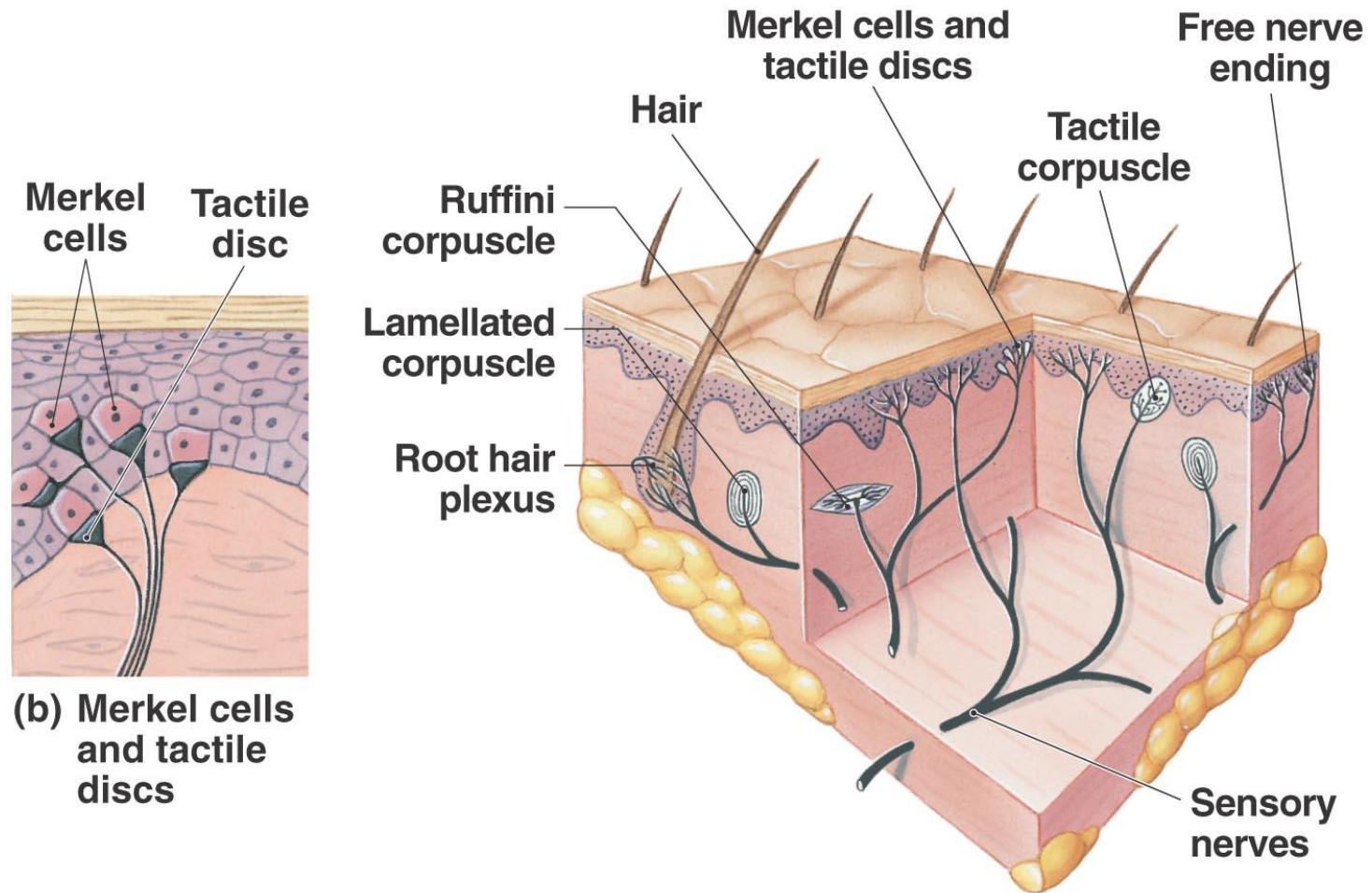


Figure 18.3 Tactile Receptors in the Skin

# The General Senses

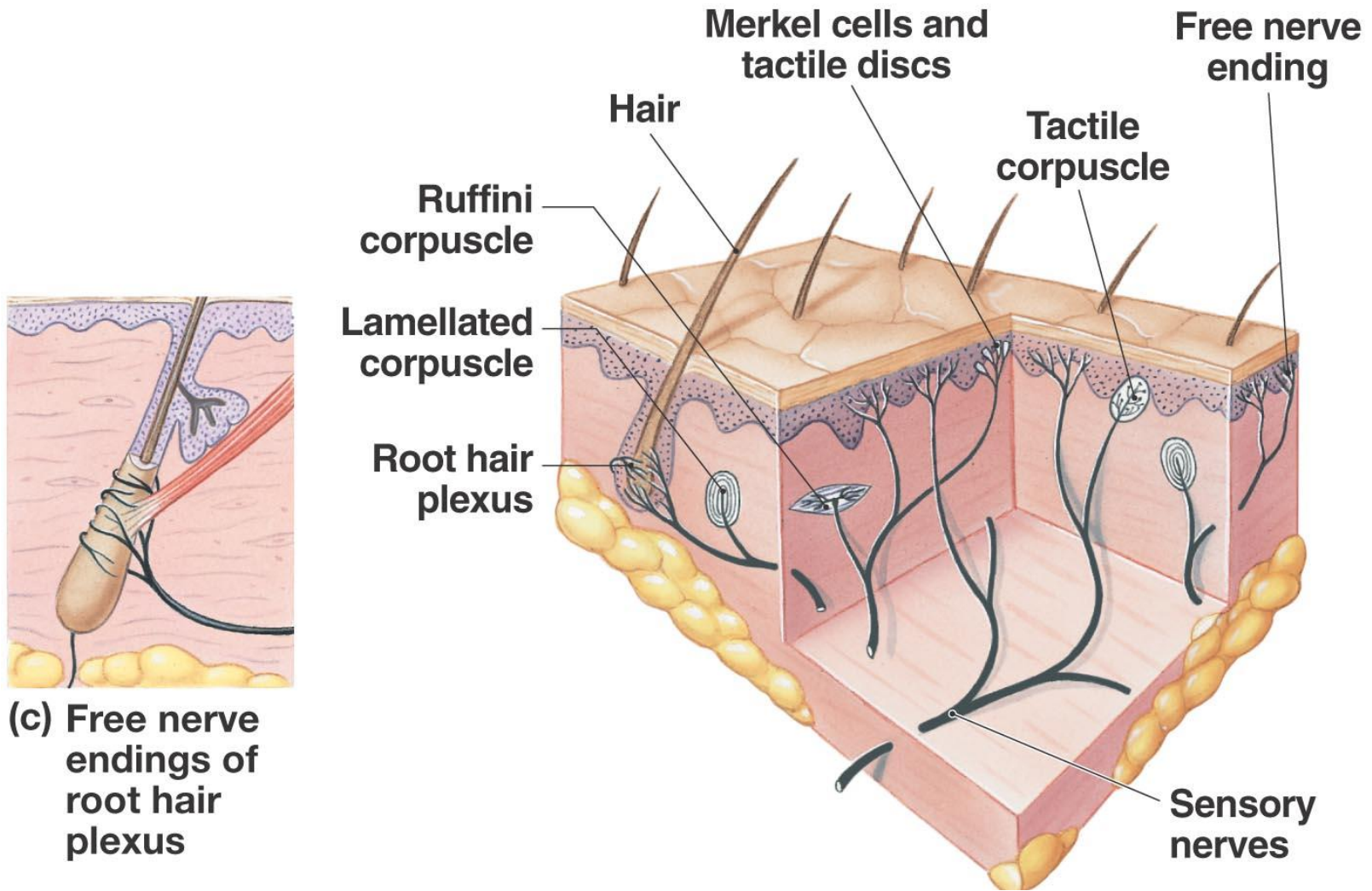


Figure 18.3 Tactile Receptors in the Skin



# The General Senses

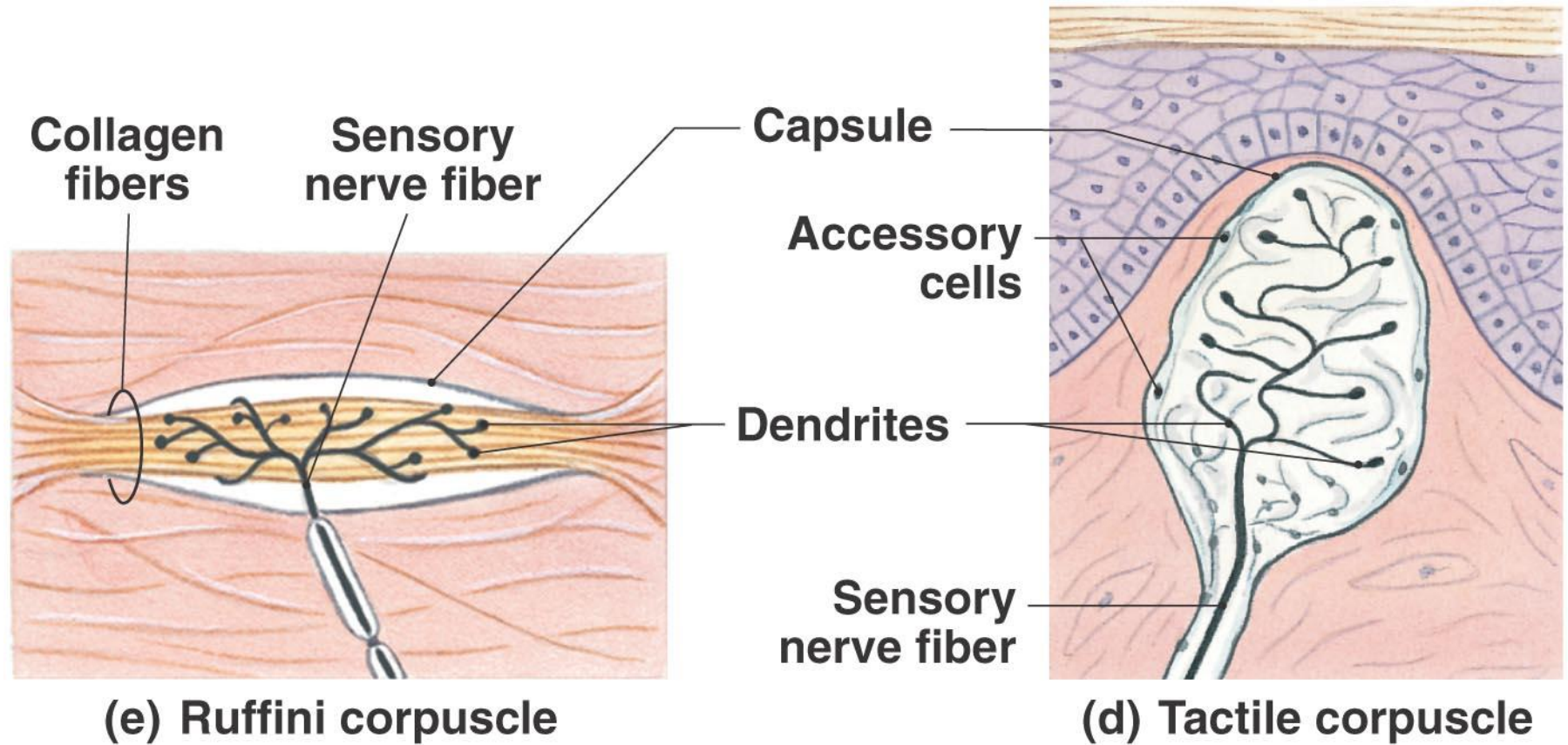
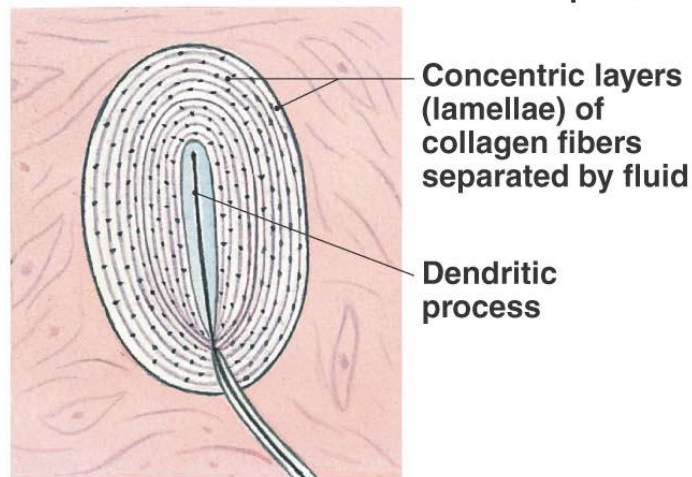
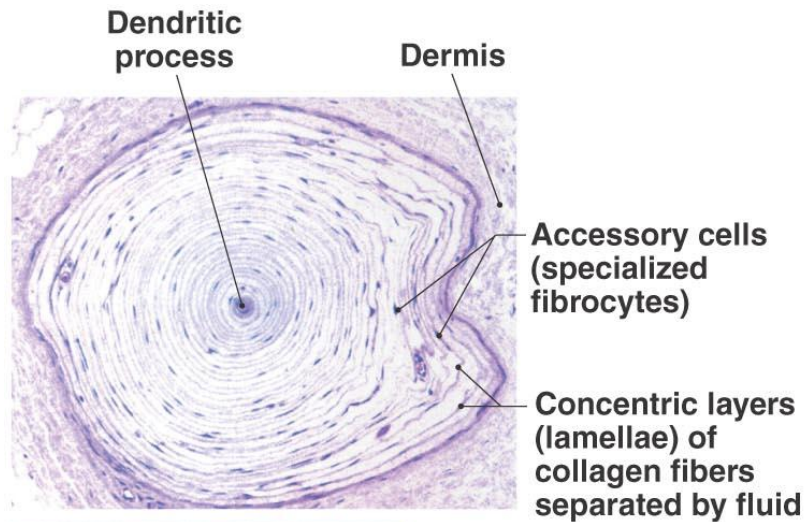


Figure 18.3 Tactile Receptors in the Skin

# The General Senses



(f) Lamellated corpuscle

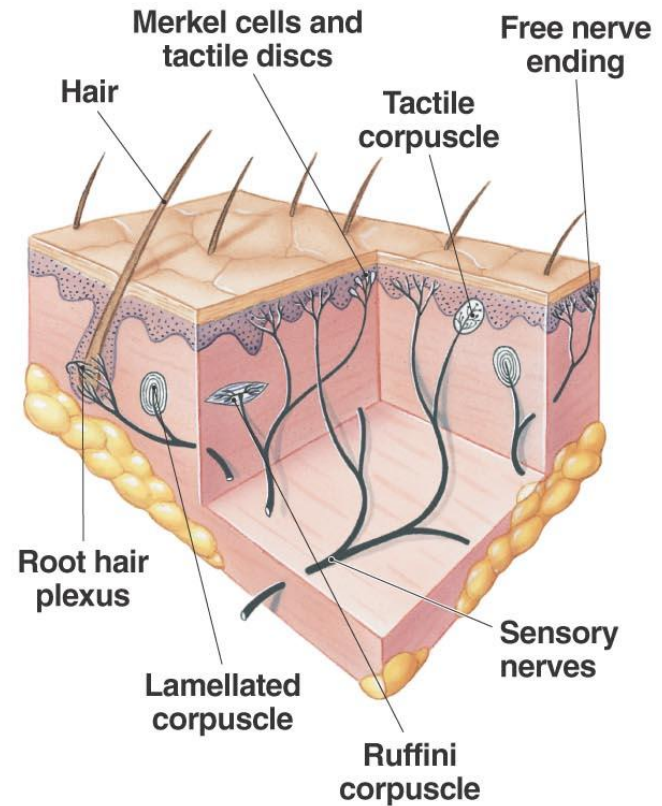


Figure 18.3 Tactile Receptors in the Skin

# The General Senses

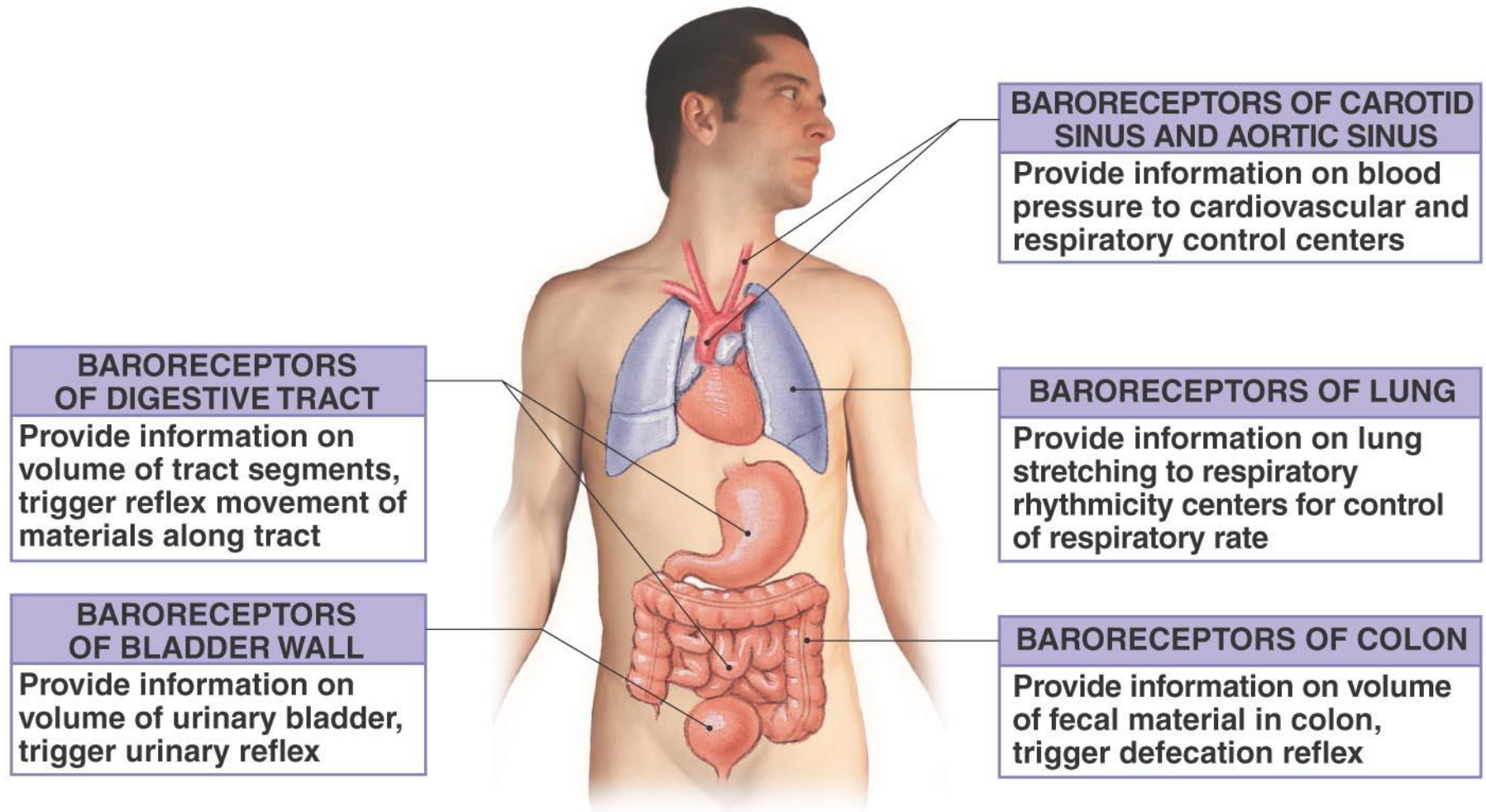


Figure 18.4 Baroreceptors and the Regulation of Autonomic Functions



# The General Senses

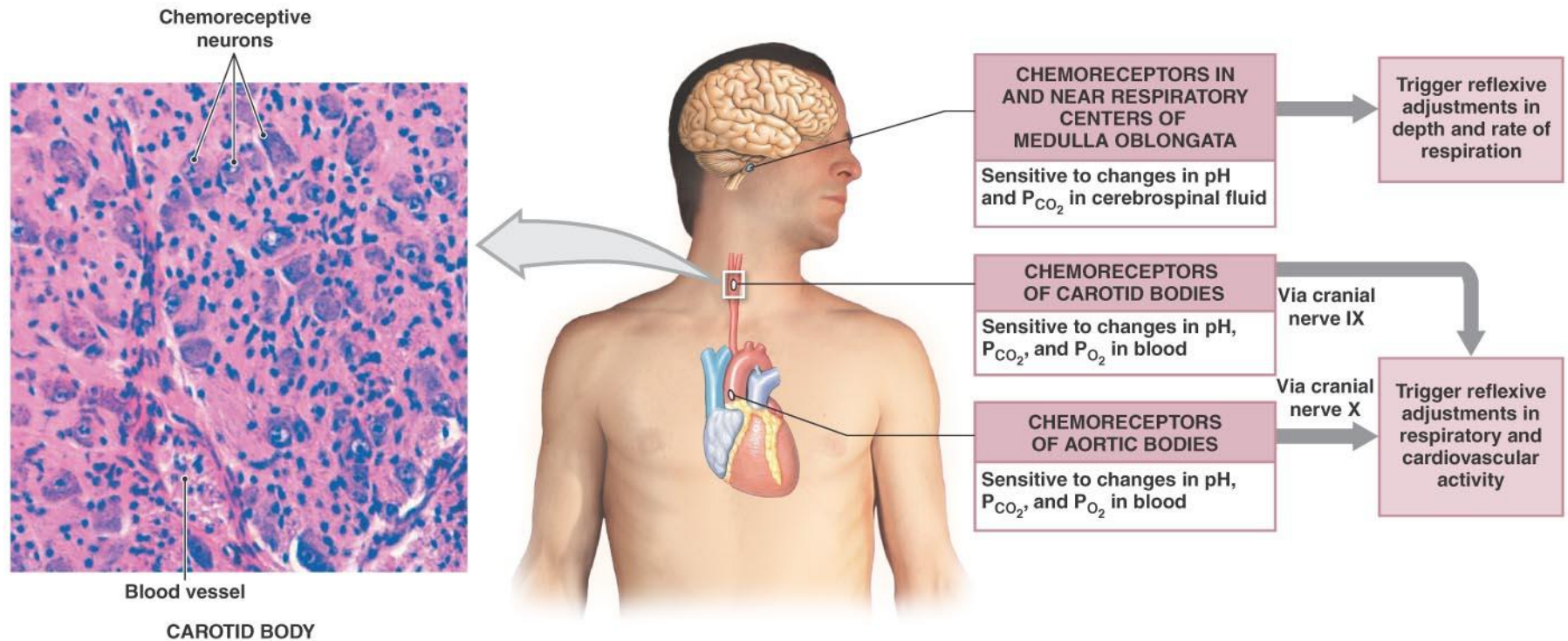


Figure 18.5 Chemoreceptors



# The General Senses

**TABLE 18.1 Touch and Pressure Receptors**

<b>Sensation</b>	<b>Receptor</b>	<b>Responds to</b>
Fine touch	Free nerve ending Tactile disc Root hair plexus	Light contact with skin As above Initial contact with hair shaft
Pressure and vibration	Tactile corpuscle Lamellated corpuscle	Initial contact and low-frequency vibrations Initial contact (deep) and high-frequency vibrations
Deep pressure	Ruffini corpuscle	Stretching and distortion of the dermis

**TABLE 18.1 Touch and Pressure Receptors**

# Olfaction (Smell)

- Olfaction
  - Olfactory organs
    - Nasal cavity
- Olfactory epithelium
  - Bipolar olfactory receptors (N I)
  - Supporting cells
  - Basal cells (stem cells)
- Lamina propria
  - Olfactory glands (Bowman's glands)
  - Blood vessels
  - Nerves (axons of N I)

# Olfaction (Smell)

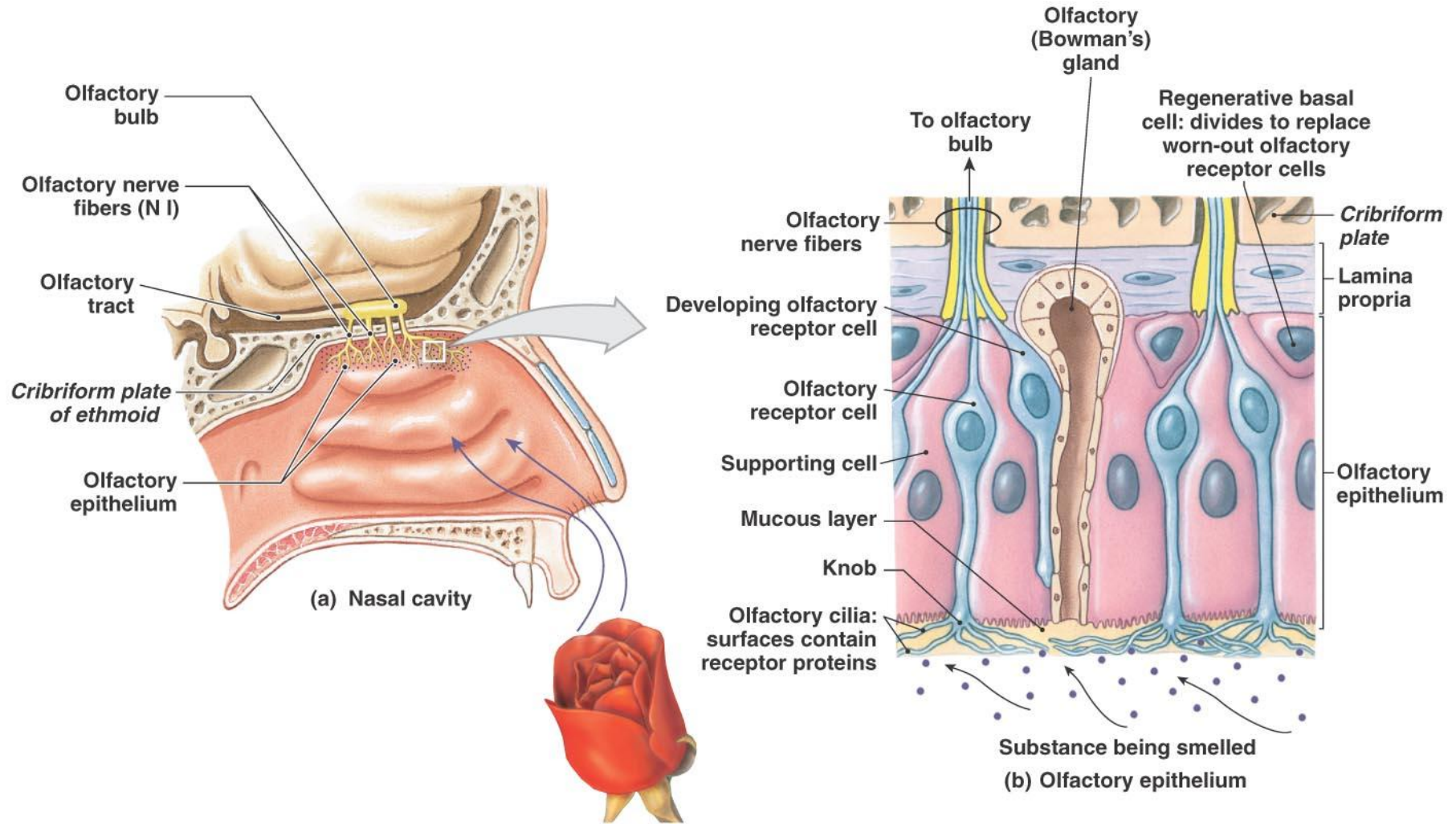


Figure 18.6 The Olfactory Organs

# Gustation (Taste)

- Gustatory receptors are clustered in taste buds, which contain gustatory cells that extend taste hairs through a taste pore.
- Three types of papillae (epithelial projections) on human tongue:
  - Filiform
  - Fungiform
  - Circumvallate
- Four primary tastes:
  - Salty
  - Bitter
  - Sweet
  - Sour
- Also water and umami (characteristic of broth)

# Gustation (Taste)

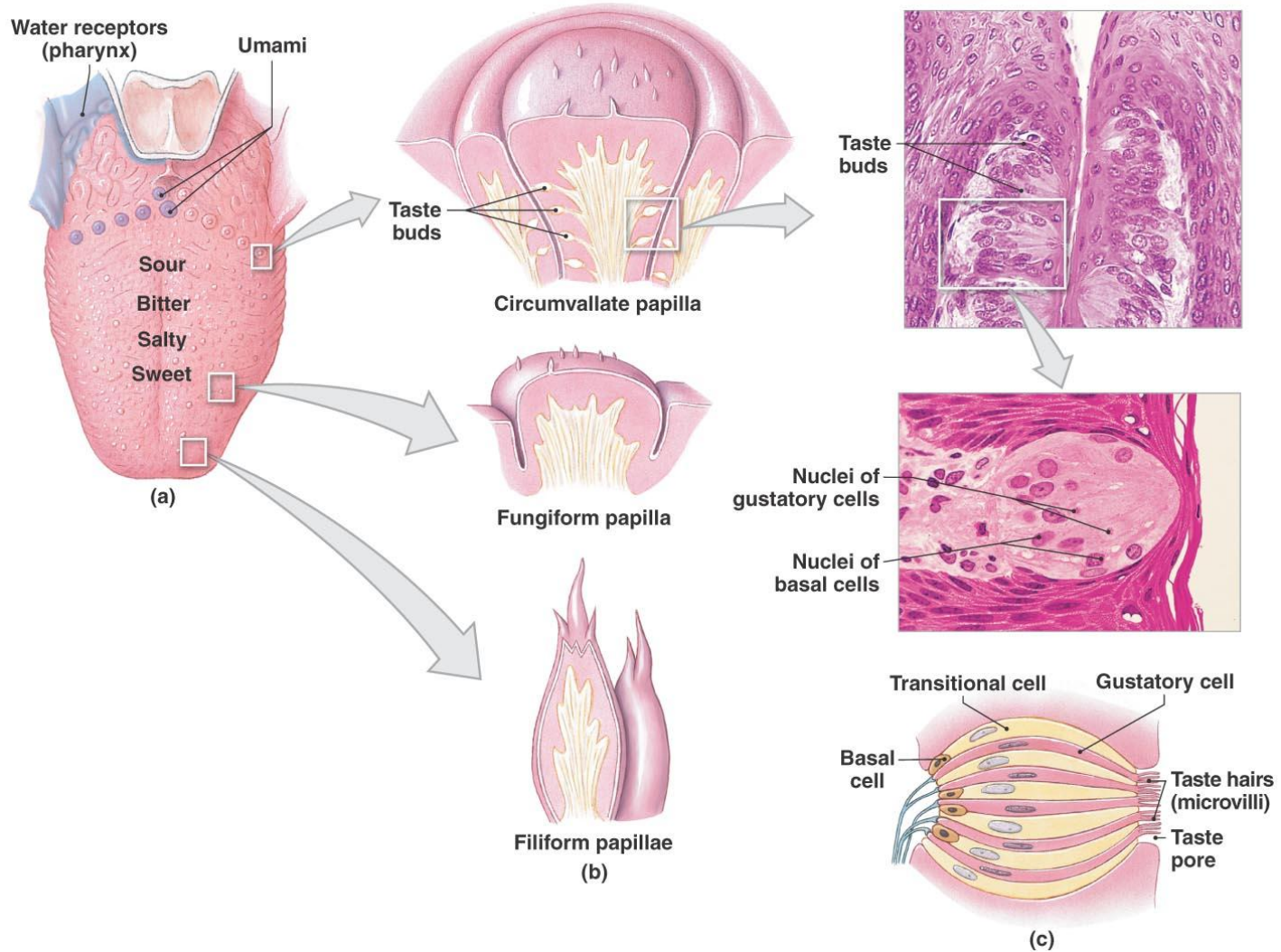


Figure 18.7 Gustatory Reception



# Gustation (Taste)

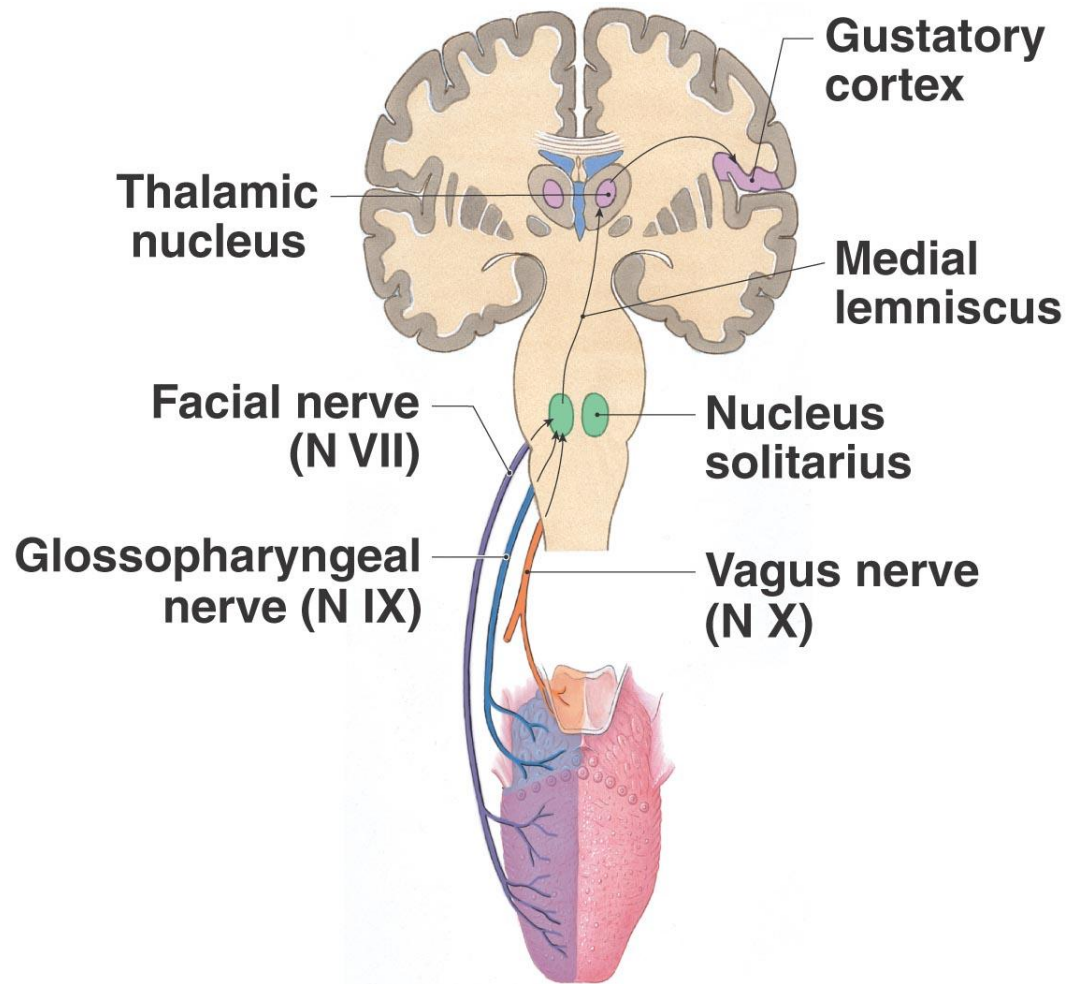


Figure 18.8 Gustatory Pathways

# Equilibrium and Hearing

- The Ear
  - External ear
  - Middle ear
    - Auditory ossicles
  - Inner ear
    - Vestible and semicircular canals
      - Equilibrium
    - Cochlea
      - Hearing



# Equilibrium and Hearing

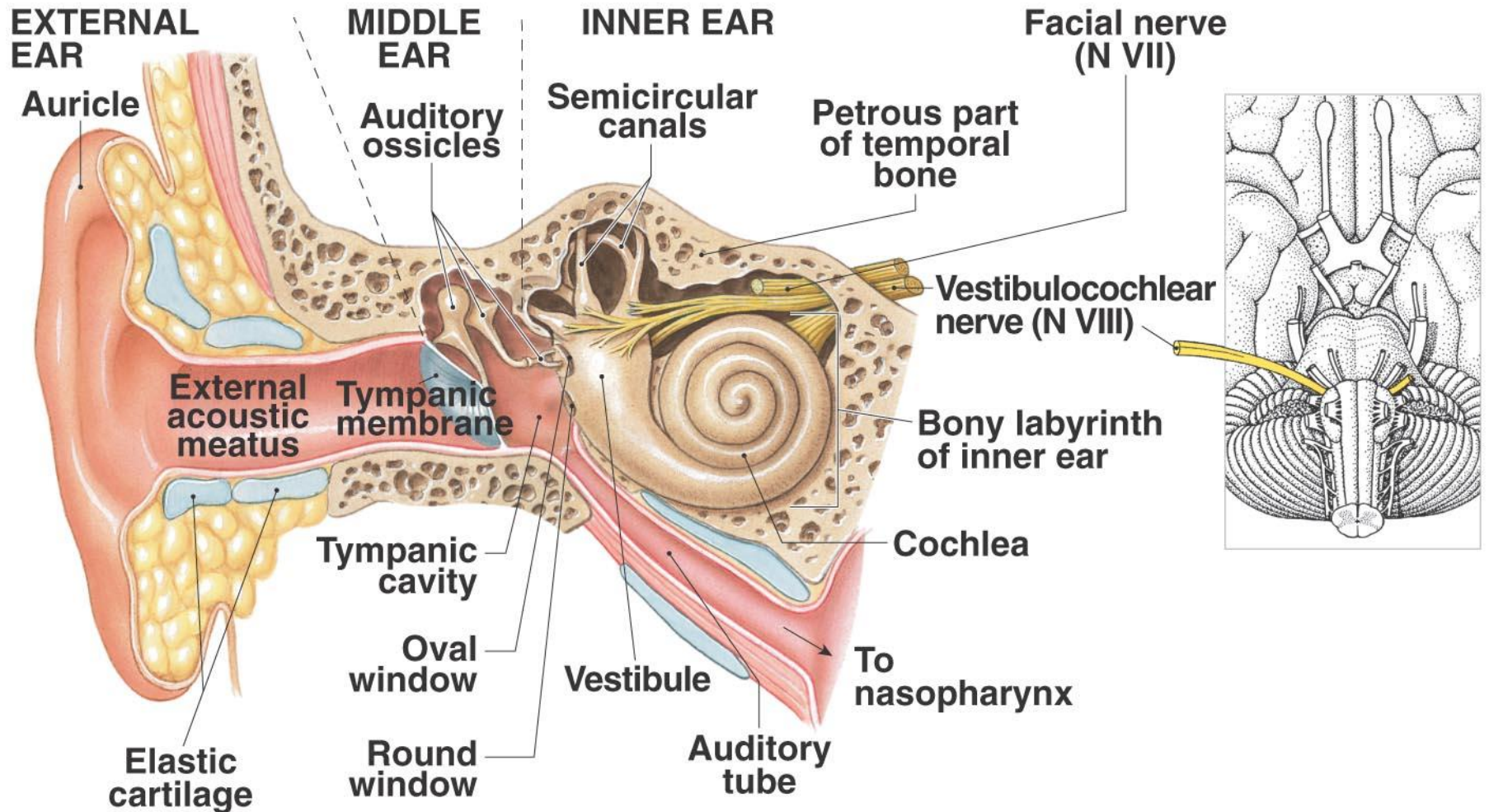
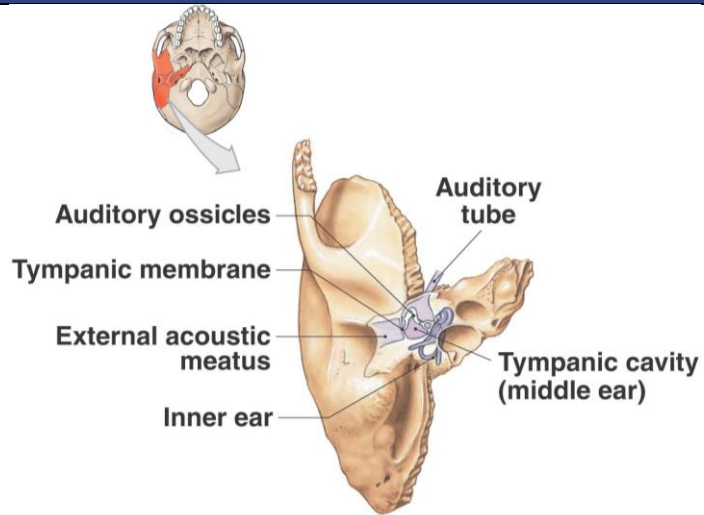
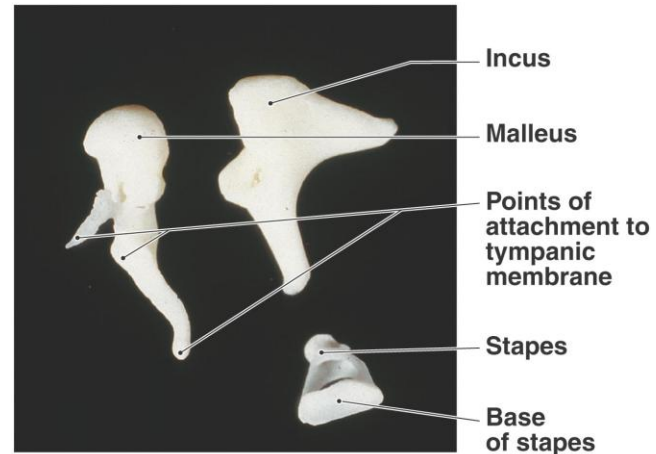


Figure 18.9 Anatomy of the Ear

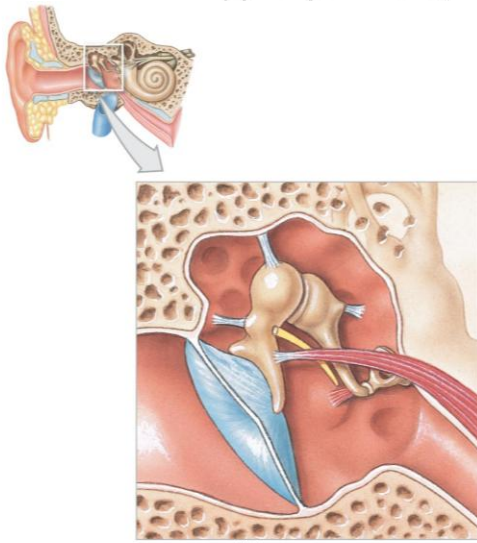
# Equilibrium and Hearing



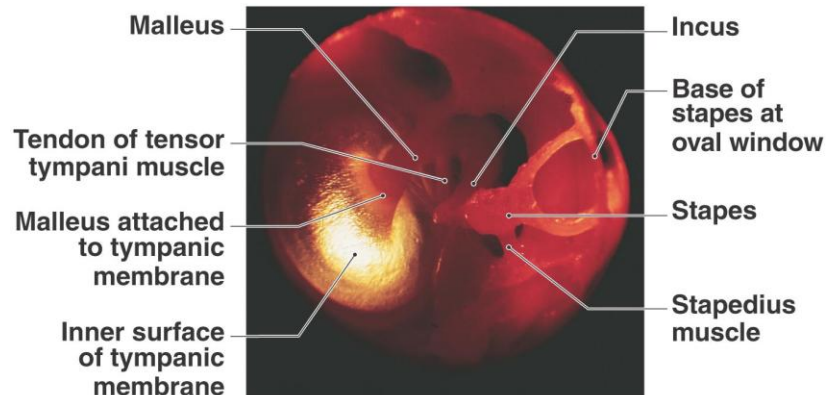
(a) Temporal bone, inferior view



(c) Auditory ossicles



(b)



(d) Tympanic membrane and ossicles

Figure 18.10 The Middle Ear

# Equilibrium and Hearing

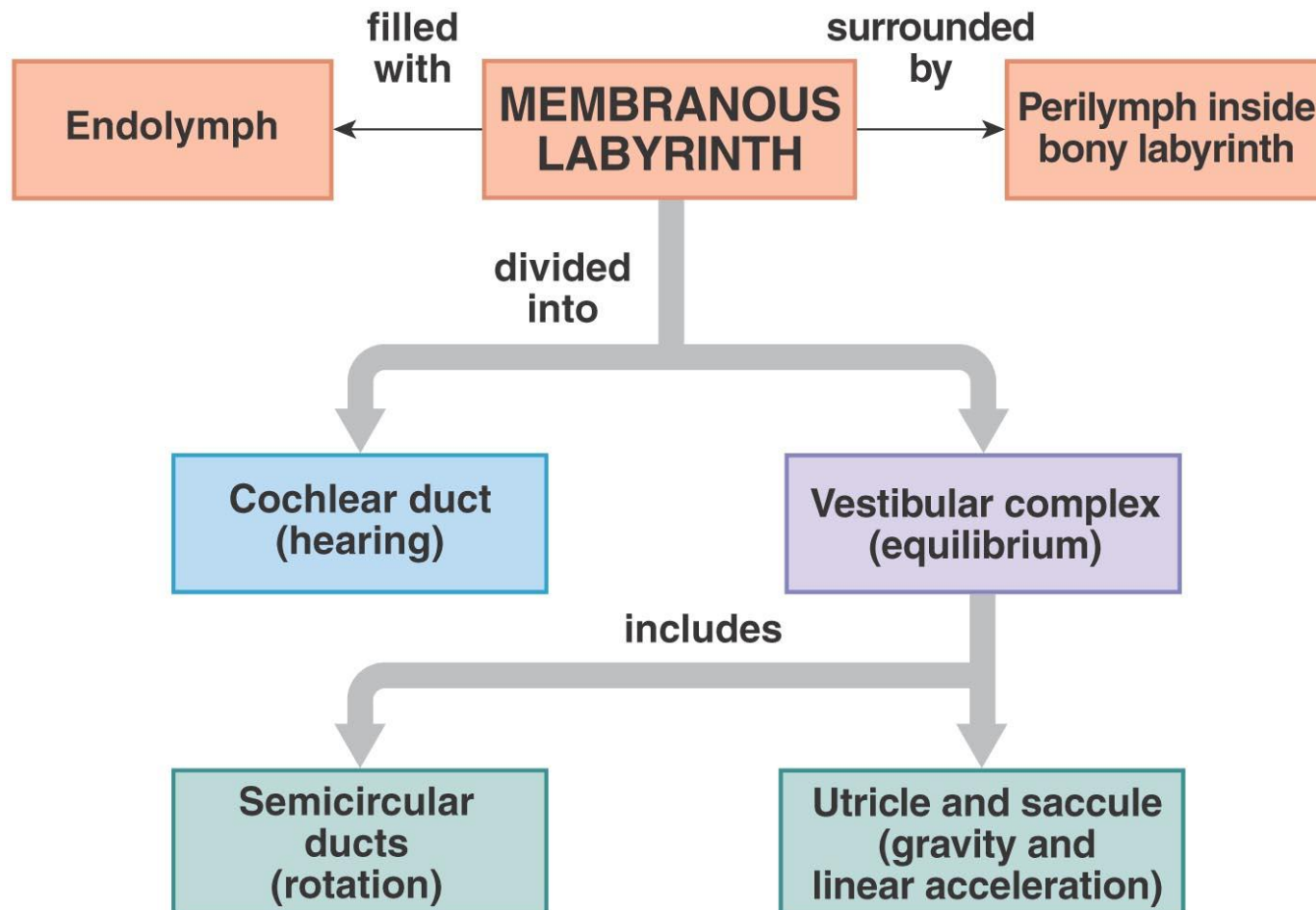


Figure 18.11 Structural Relationships of the Inner Ear



# Equilibrium and Hearing

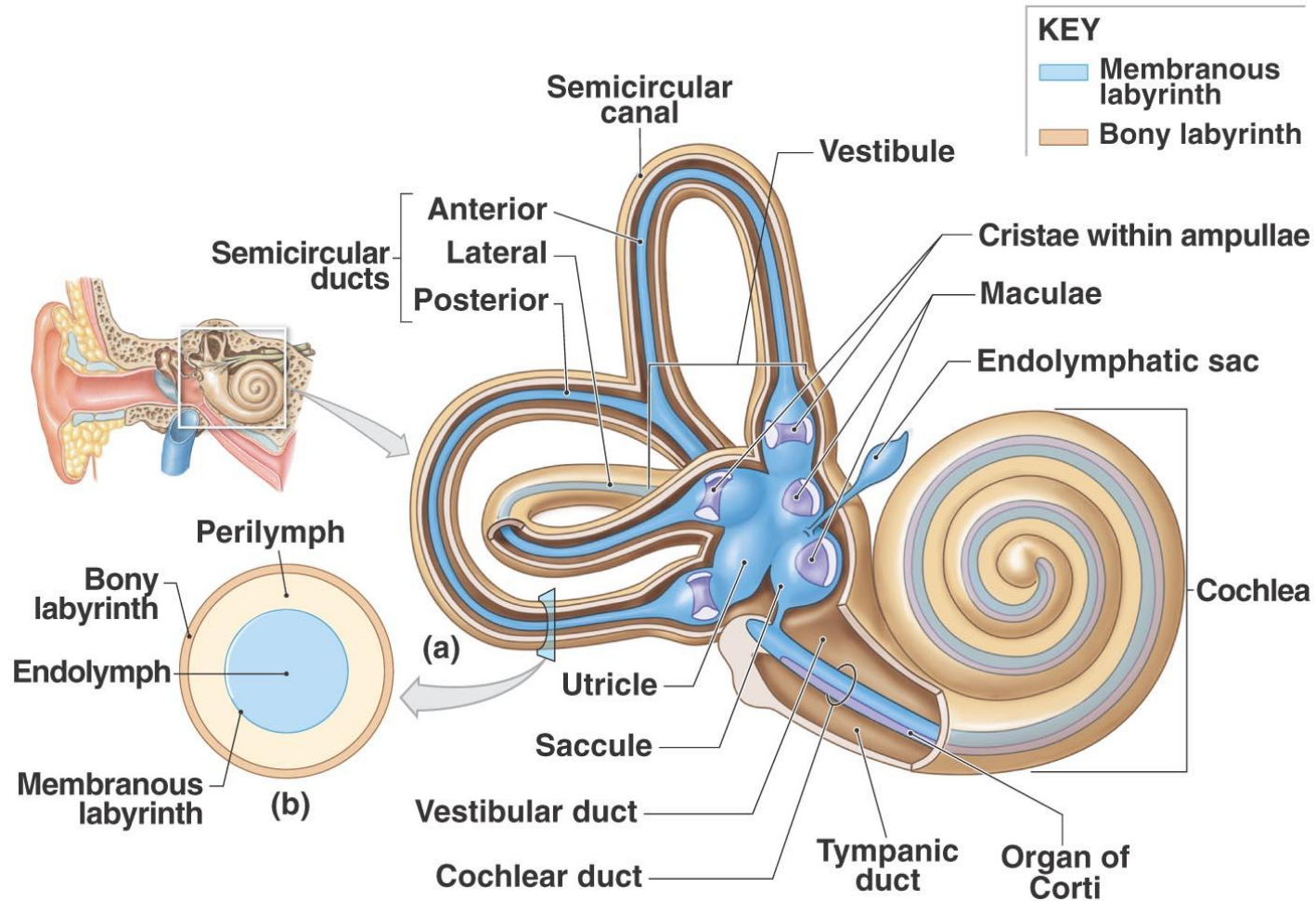


Figure 18.12 Semicircular Canals and Ducts

# Equilibrium and Hearing

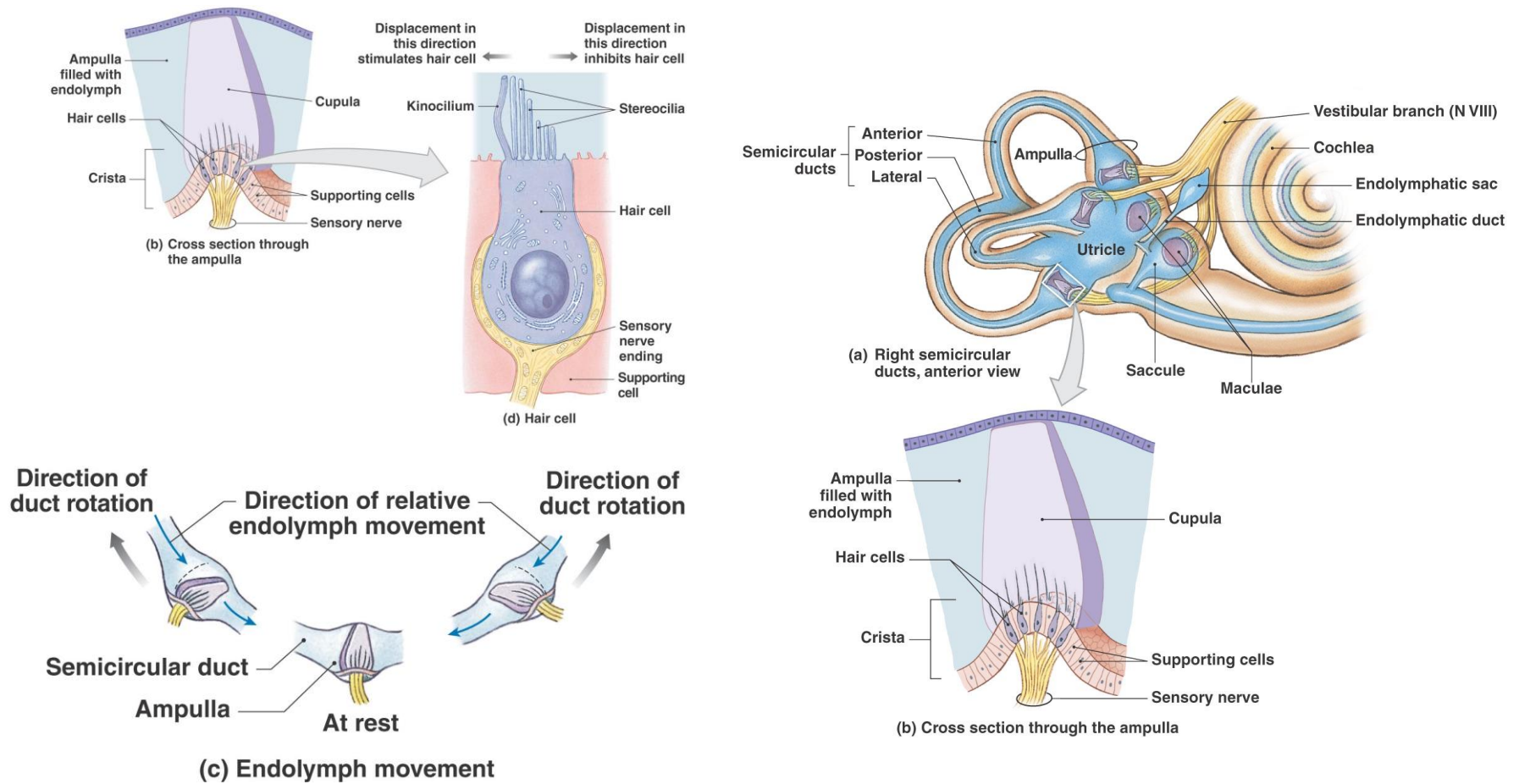


Figure 18.13 The Function of the Semicircular Ducts, Part I

# Equilibrium and Hearing

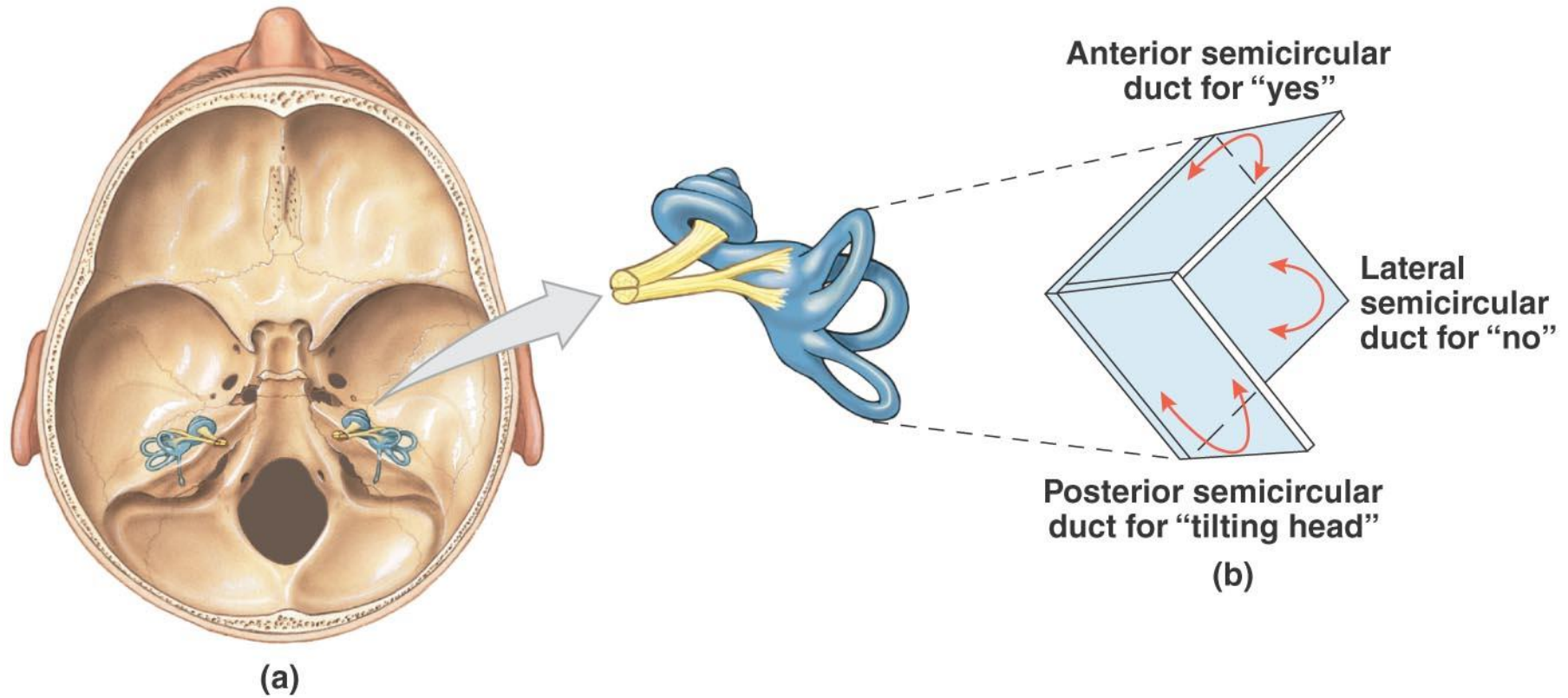


Figure 18.14 The Function of the Semicircular Ducts, Part II



# Equilibrium and Hearing

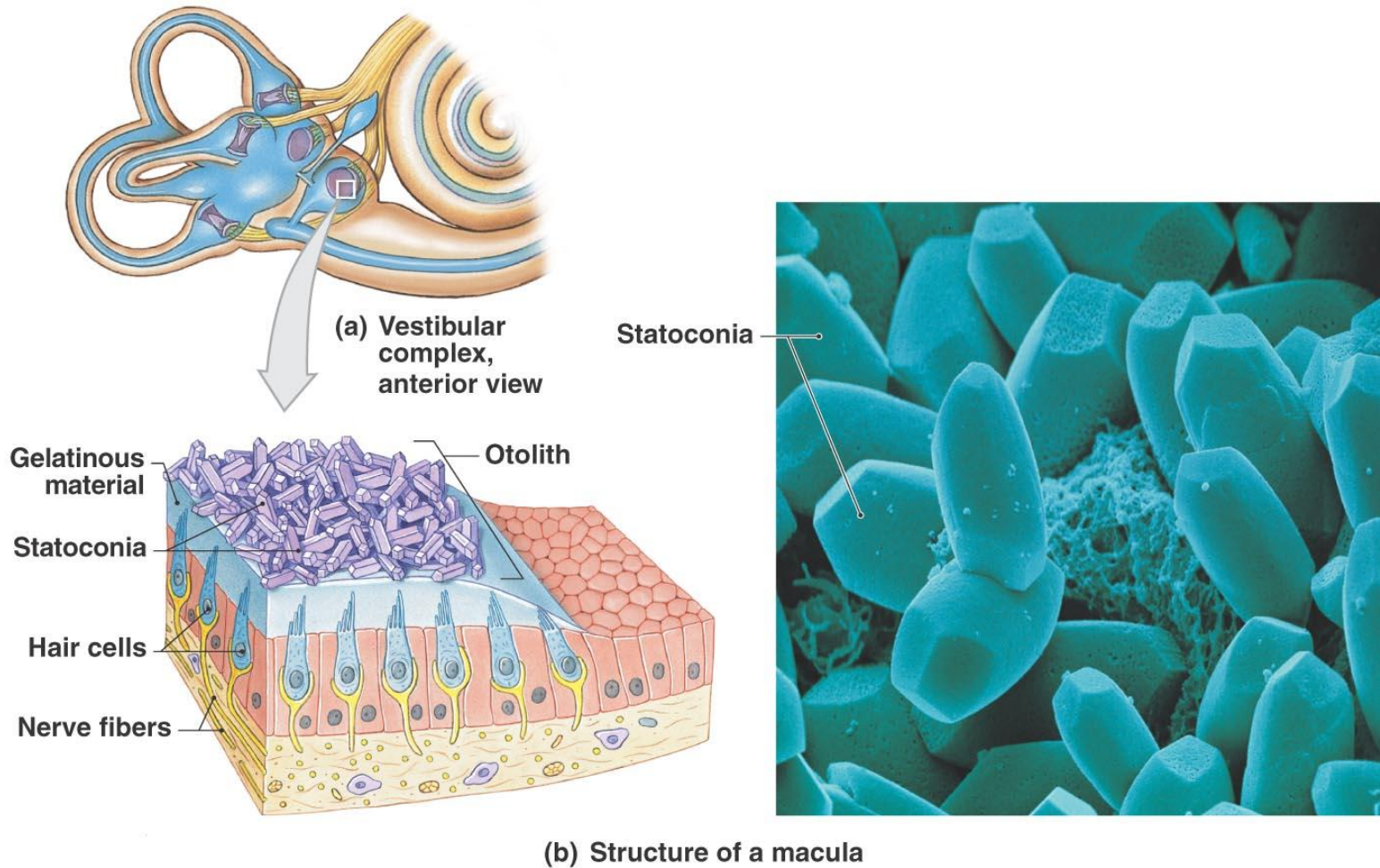
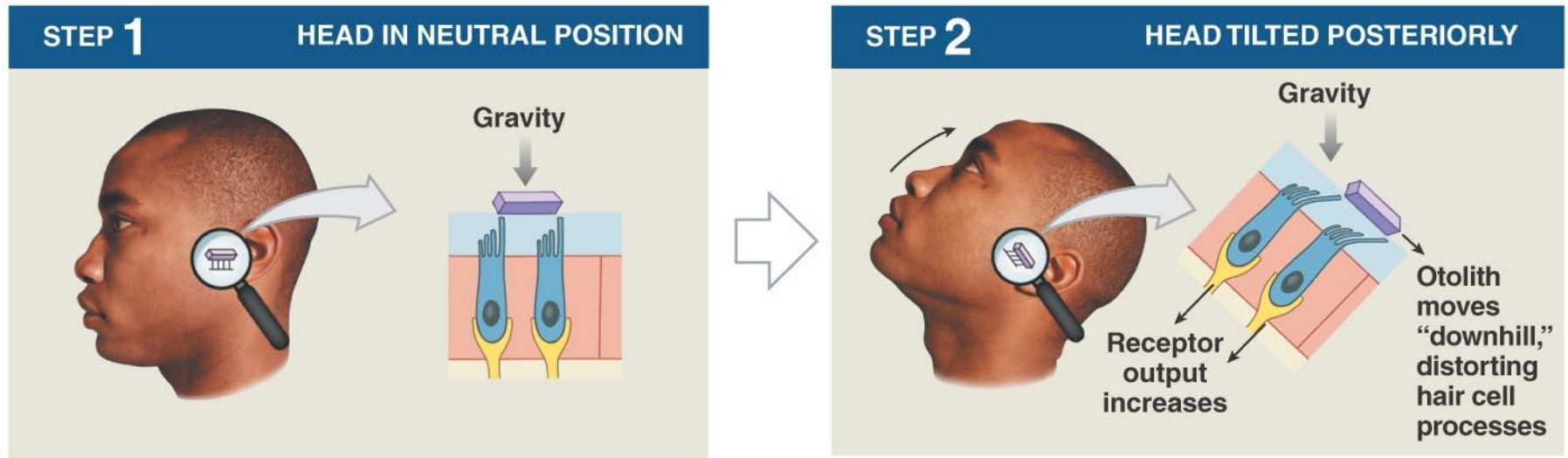


Figure 18.15a,b The Maculae of the Vestibule: (a) Vestibular Complex, Anterior View: (b) Structure of the Macula



# Equilibrium and Hearing



(c) Macular function

Figure 18.15c The Maculae of the Vestibule: (c) Macular Function

# Equilibrium and Hearing

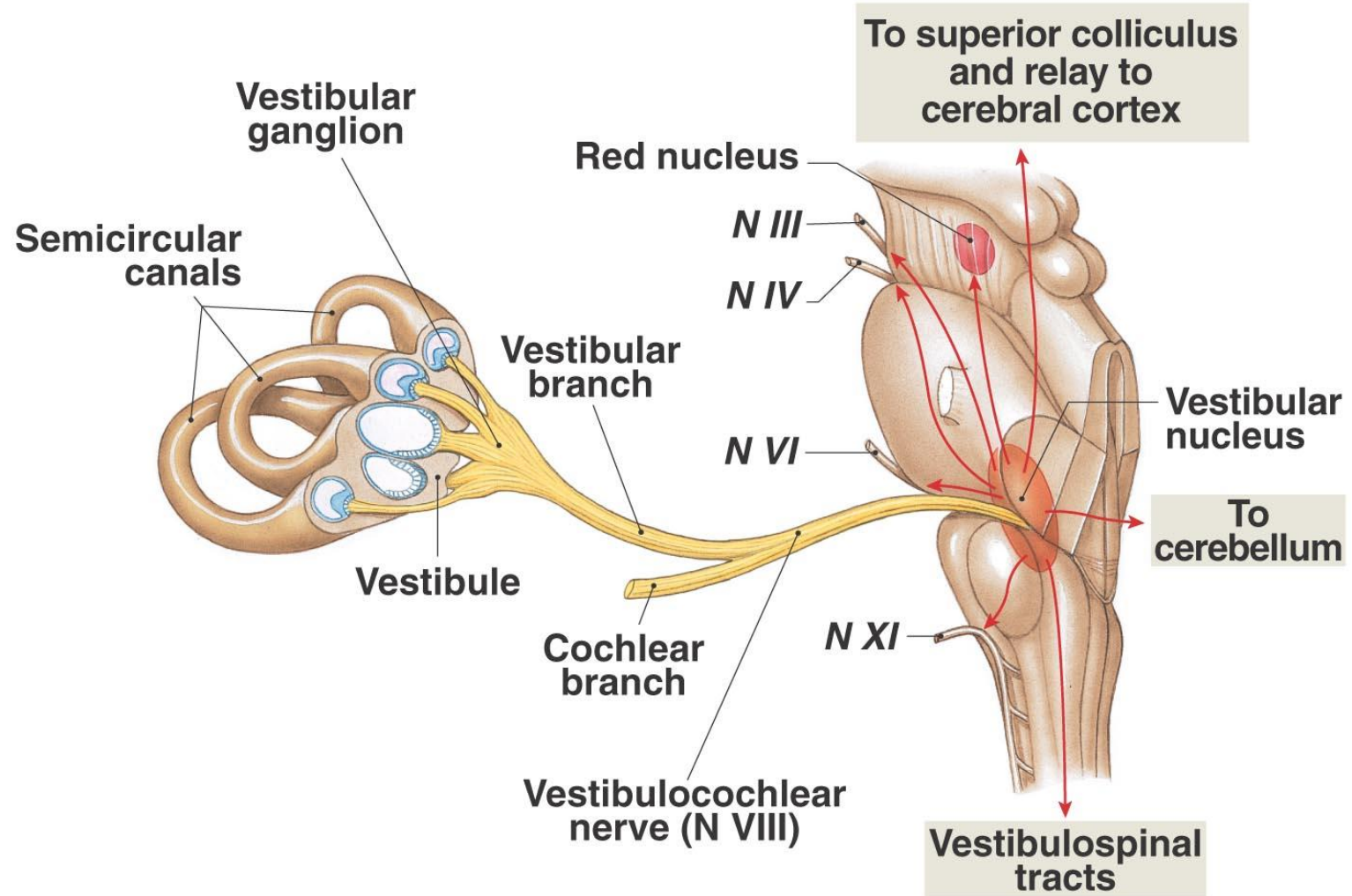
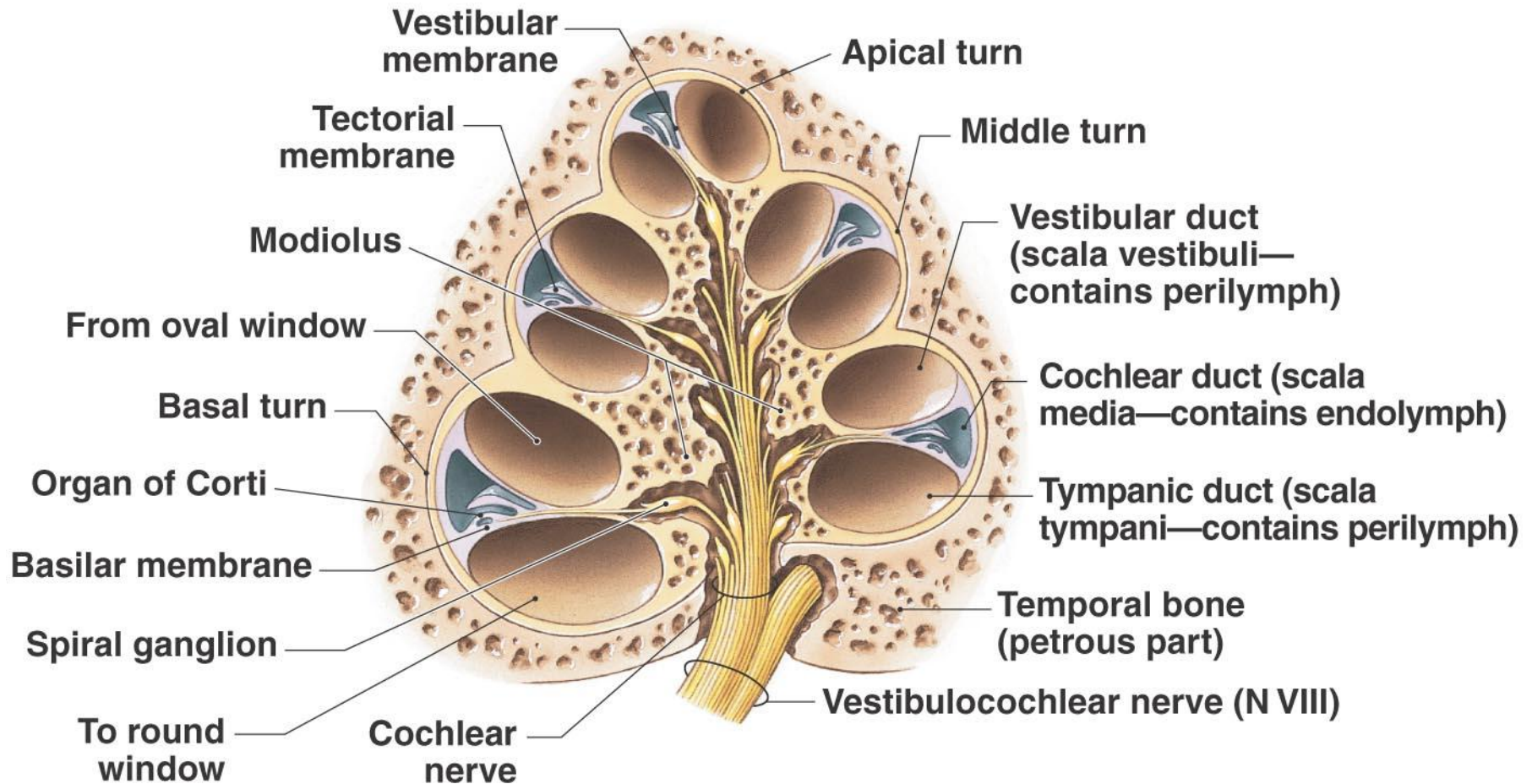


Figure 18.16 Neural Pathways for Equilibrium Sensations



# Equilibrium and Hearing



(b) Cochlear section, diagrammatic

Figure 18.17b The Cochlea and Organ of Corti: (b) Cochlear Section, Diagrammatic



# Equilibrium and Hearing

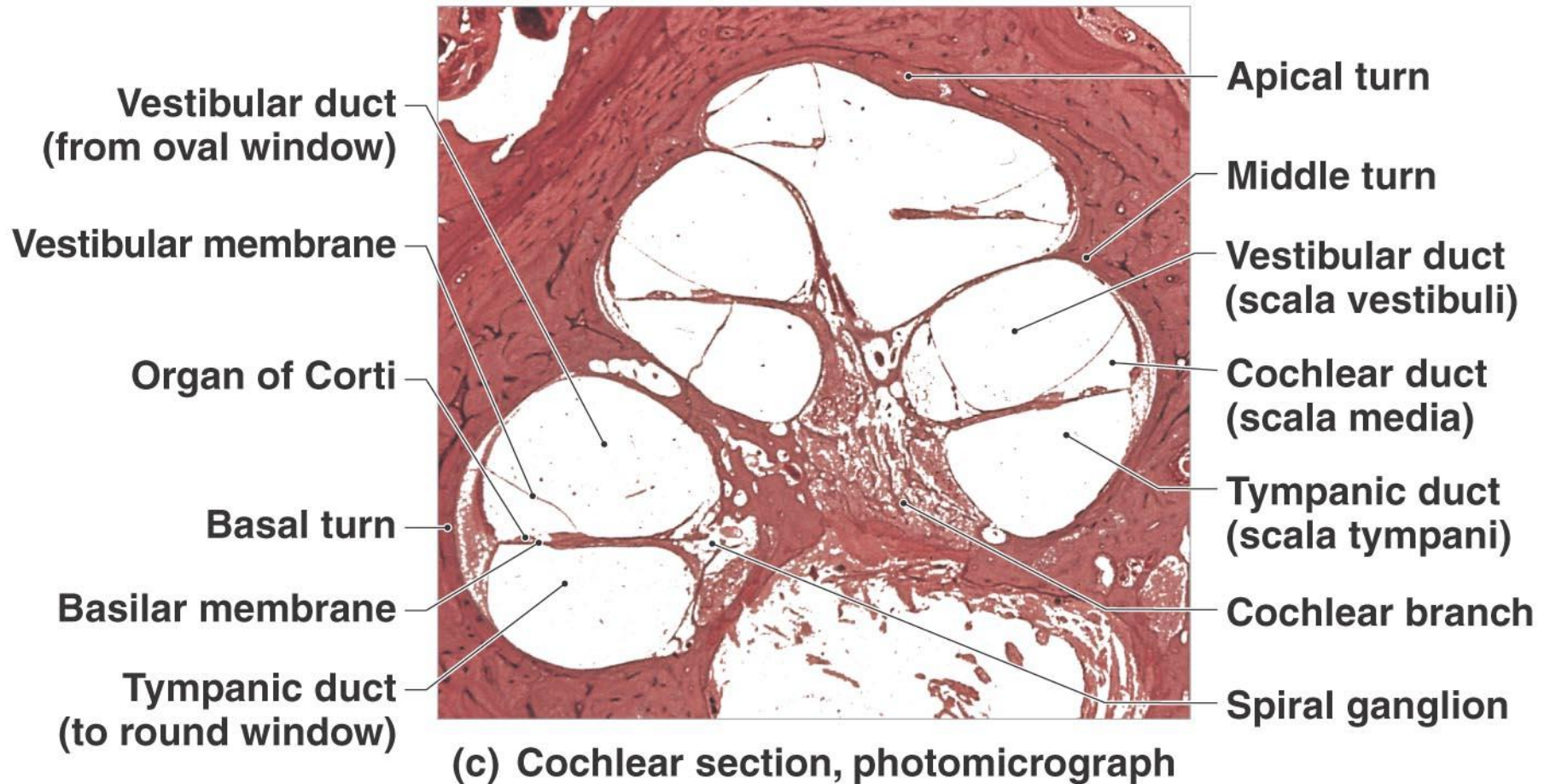


Figure 18.17c The Cochlea and Organ of Corti: (c) Cochlear Section, Photomicrograph



# Equilibrium and Hearing

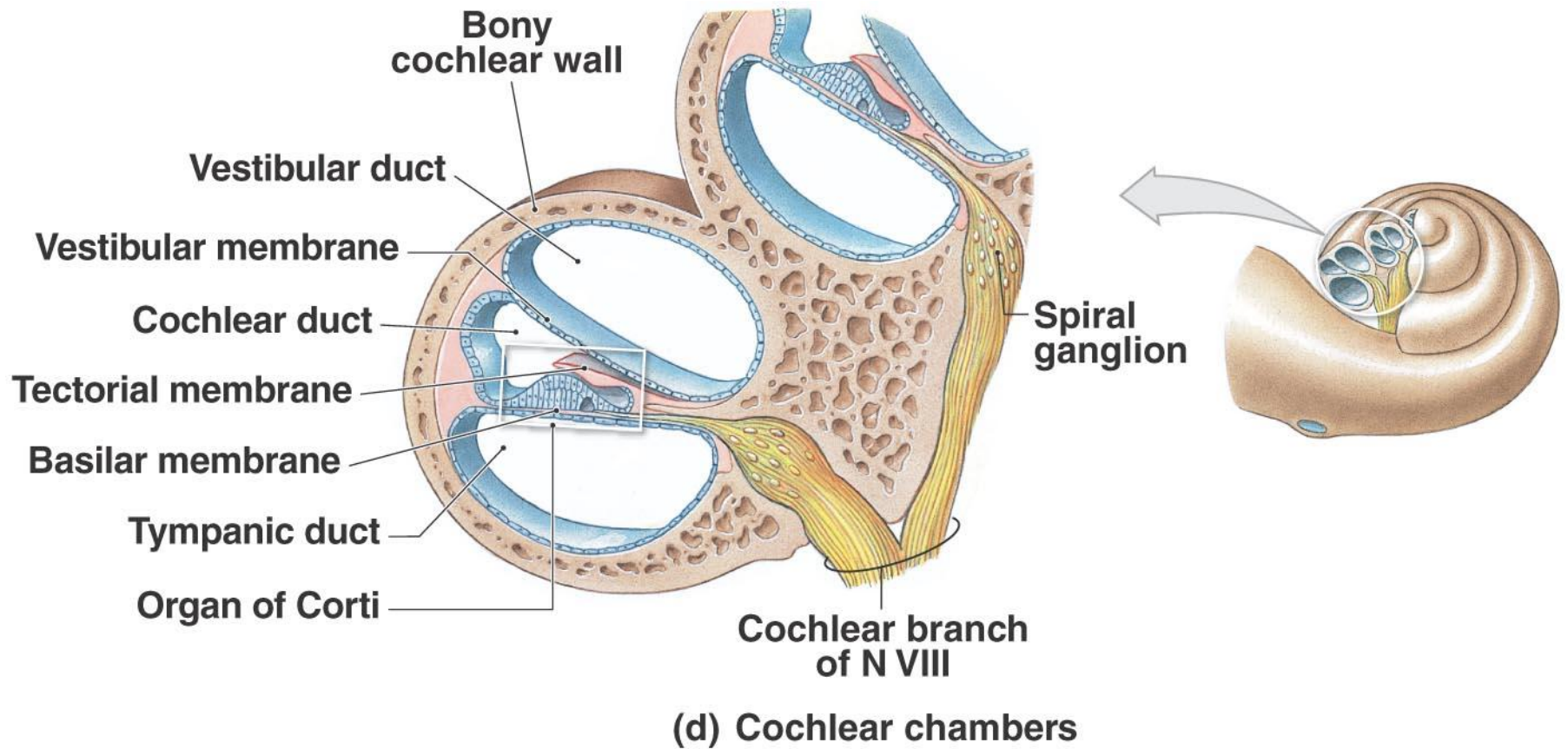
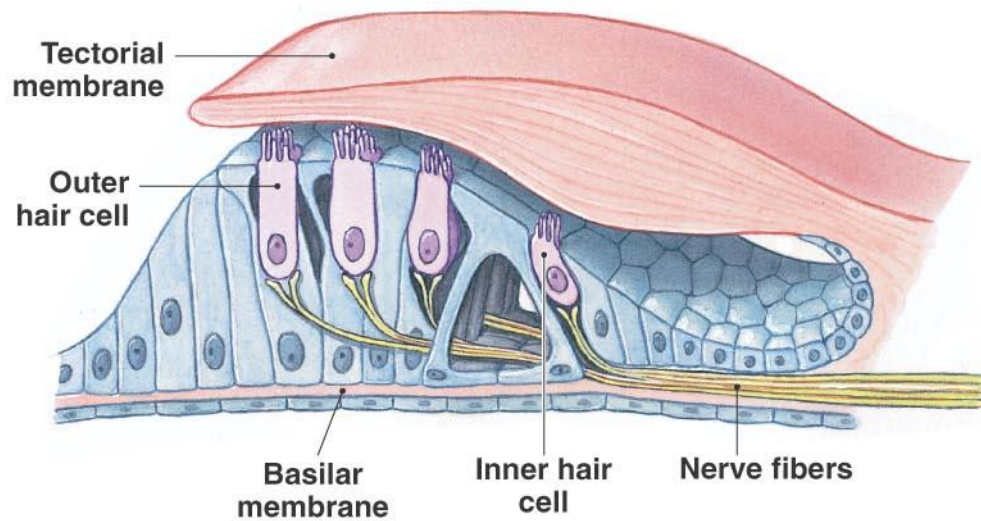


Figure 18.17d The Cochlea and Organ of Corti: (d) Cochlear Chambers

# Equilibrium and Hearing



(e) Organ of Corti

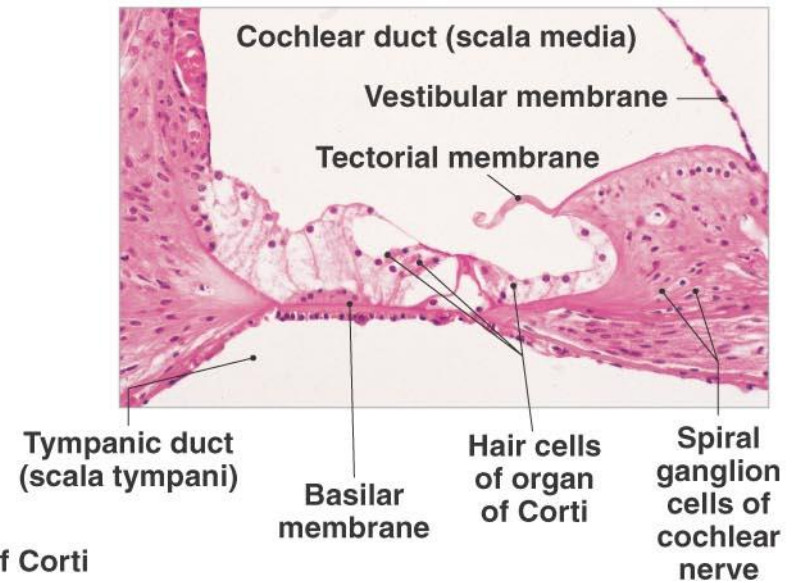


Figure 18.17e The Cochlea and Organ of Corti: (e) Organ of Corti

# Equilibrium and Hearing

**Stereocilia of inner hair cells**



**Stereocilia of  
outer hair cells**

**(f) The receptor surface of the  
organ of Corti**

SEM × 1320

Figure 18.17f The Cochlea and Organ of Corti: (f) The Receptor Surface of the Organ of Corti



# Equilibrium and Hearing

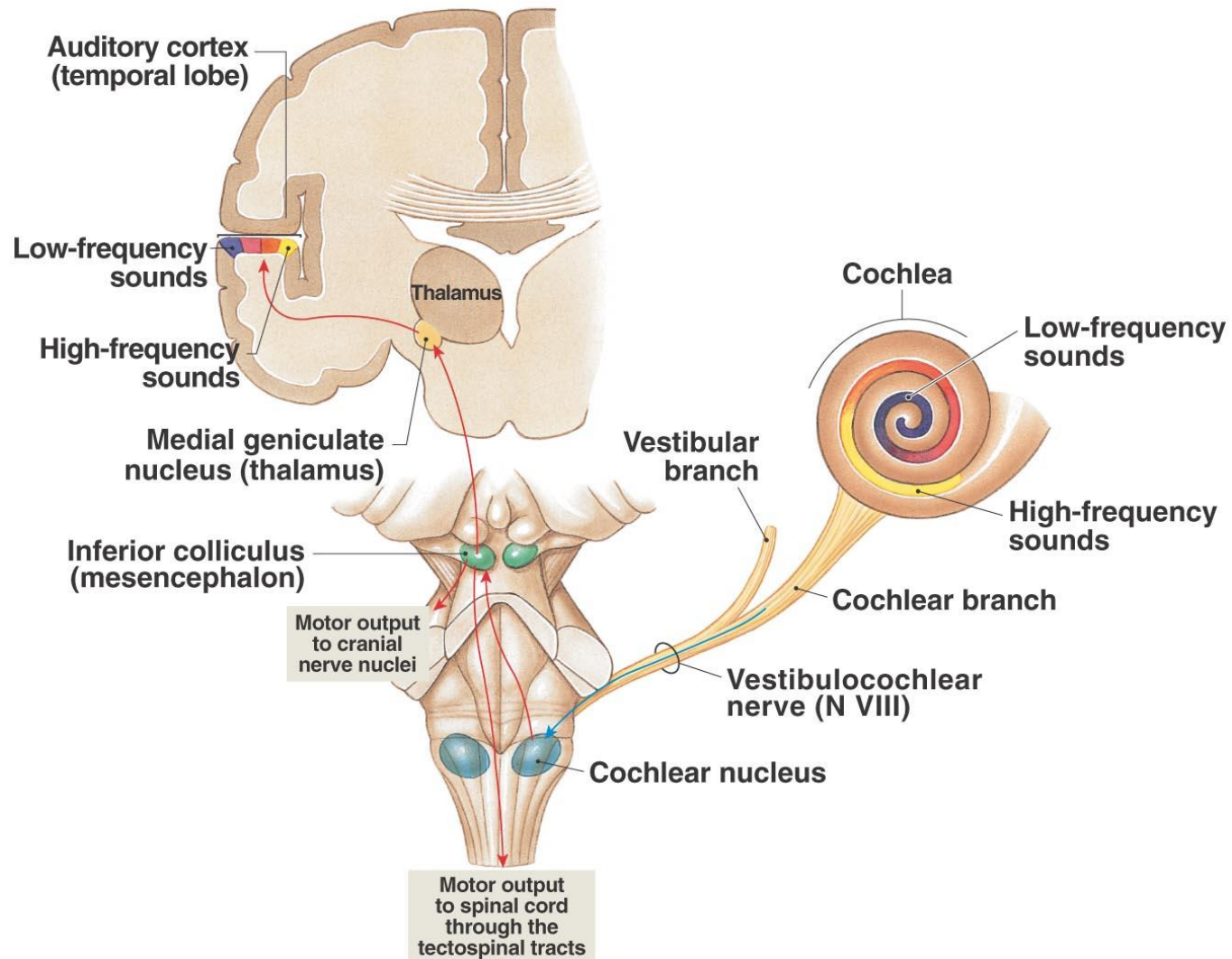


Figure 18.18 Pathways for Auditory Sensations



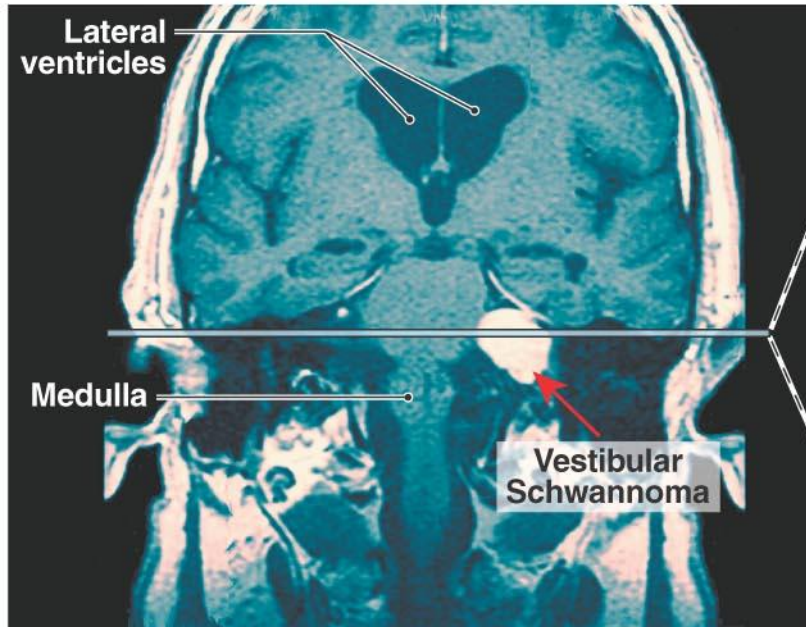
# Equilibrium and Hearing

**TABLE 18.2 Steps in the Production of an Auditory Sensation**

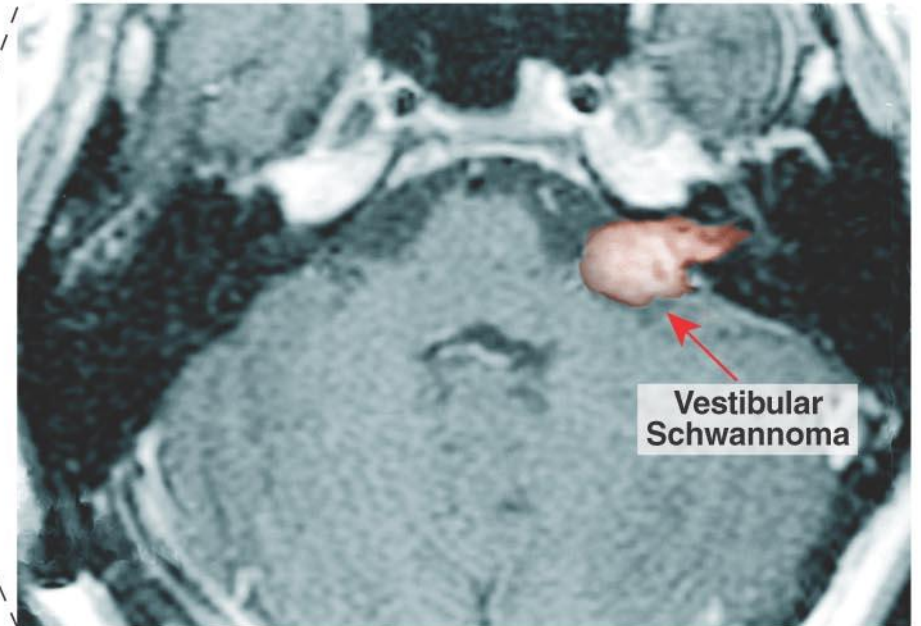
1. Sound waves arrive at the tympanic membrane.
2. Movement of the tympanic membrane causes displacement of the auditory ossicles.
3. Movement of the stapes at the oval window establishes pressure waves in the perilymph of the vestibular duct.
4. The pressure waves distort the basilar membrane on their way to the round window of the tympanic duct.
5. Vibration of the basilar membrane causes vibration of hair cells against the tectorial membrane, resulting in hair cell stimulation and neurotransmitter release.
6. Information concerning the region and intensity of stimulation is relayed to the CNS over the cochlear branch of N VIII.

TABLE 18.2 Steps in the Production of an Auditory Sensation

# Equilibrium and Balance



(a) MRI, frontal plane

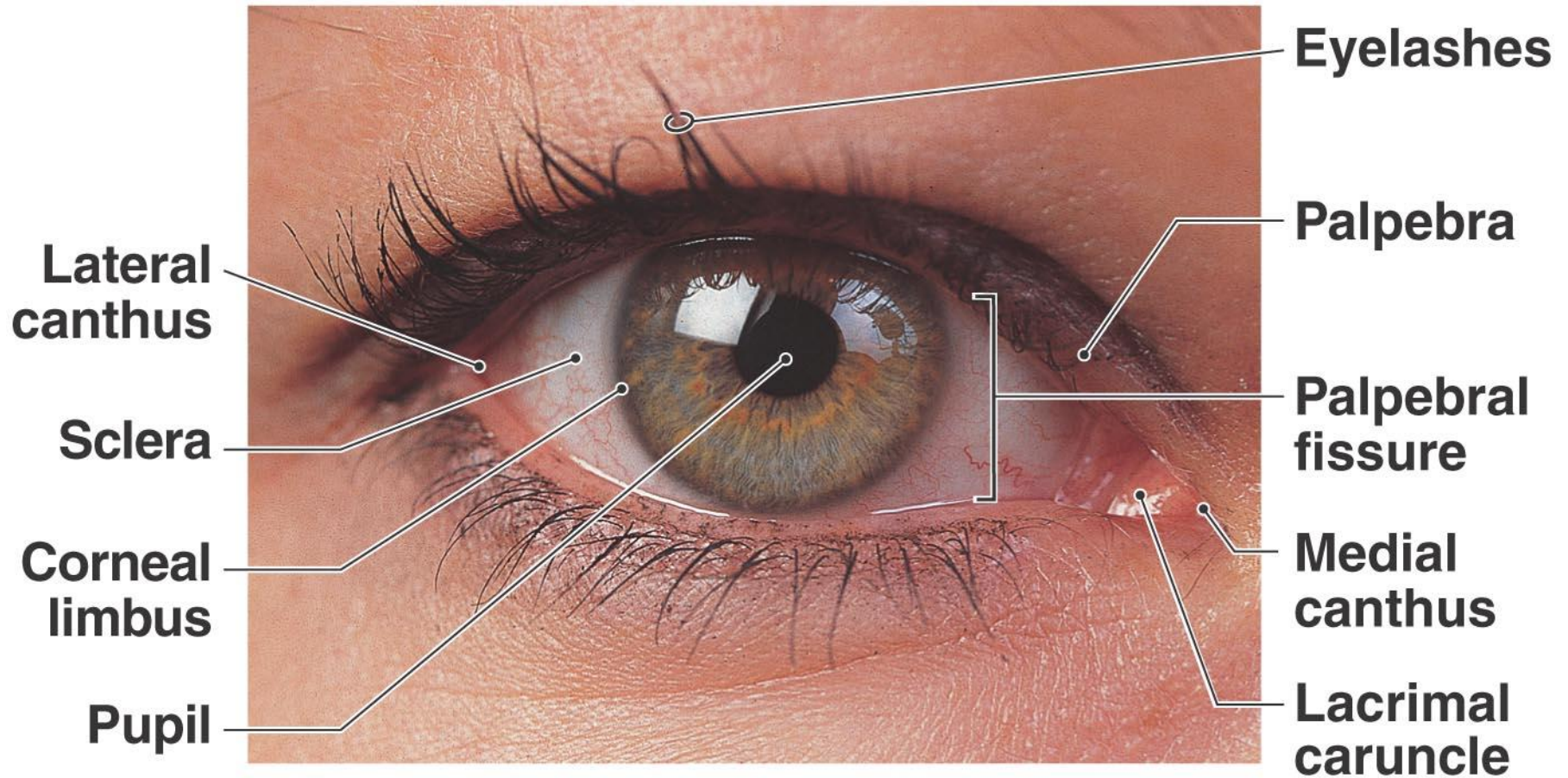


(b) MRI, horizontal plane

Figure 18.27 Vestibular Schwannoma

- Accessory Structures
  - Eyelids
  - Lacrimal apparatus
- Eye
  - Fibrous tunic
  - Vascular tunic
  - Neural tunic
  - Chambers of the eye
- Visual pathways

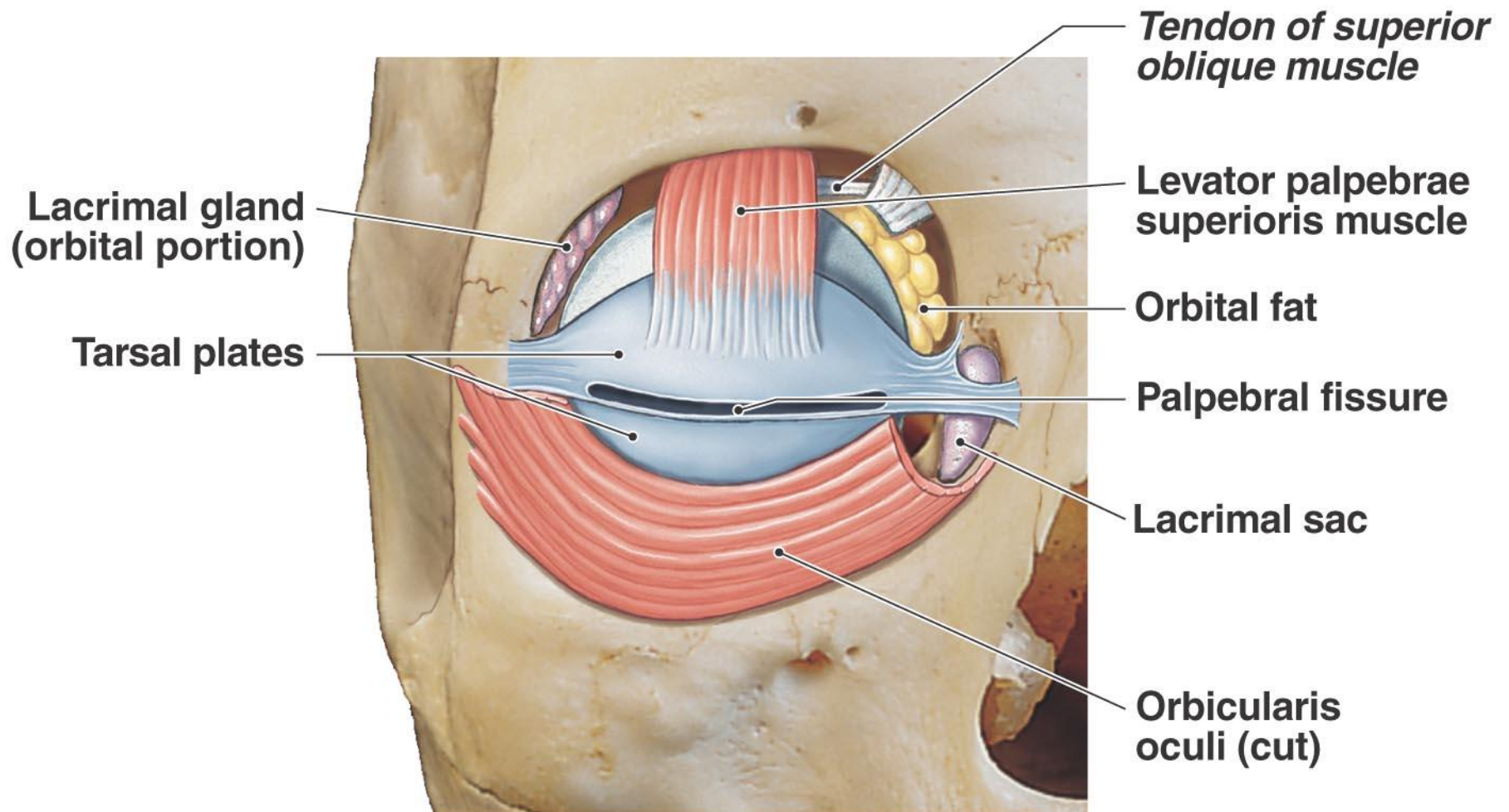




**(a) Right eye, accessory structures**

Figure 18.19a Accessory Structures of the Eye, Part I: (a) Right Eye, Accessory Structures





**(b) Superficial dissection of right orbit**

Figure 18.19b Accessory Structures of the Eye, Part I: (b) Superficial Dissection of Right Orbit

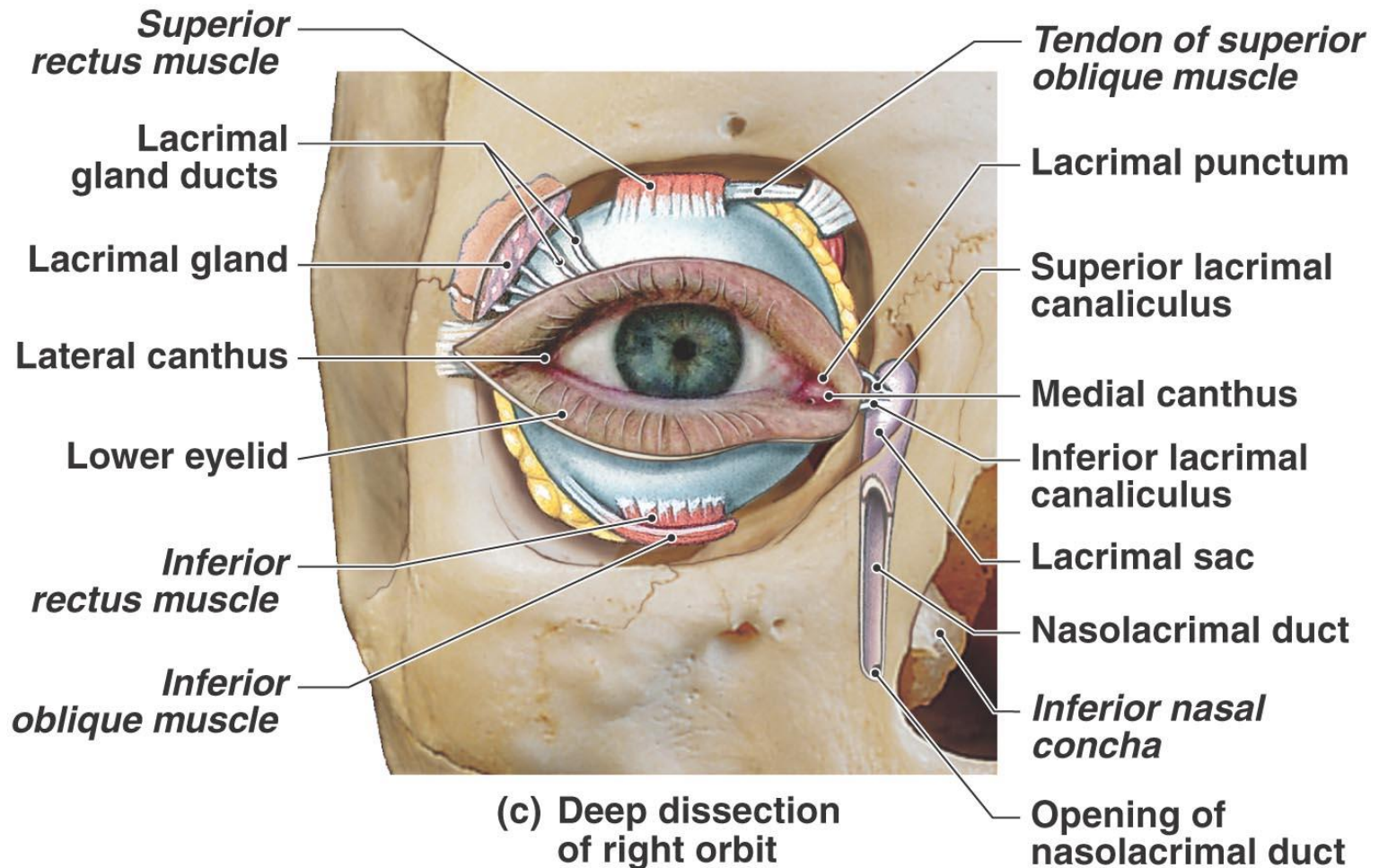


Figure 18.19c Accessory Structures of the Eye, Part I: (c) Deep Dissection of Right Orbit

# Vision

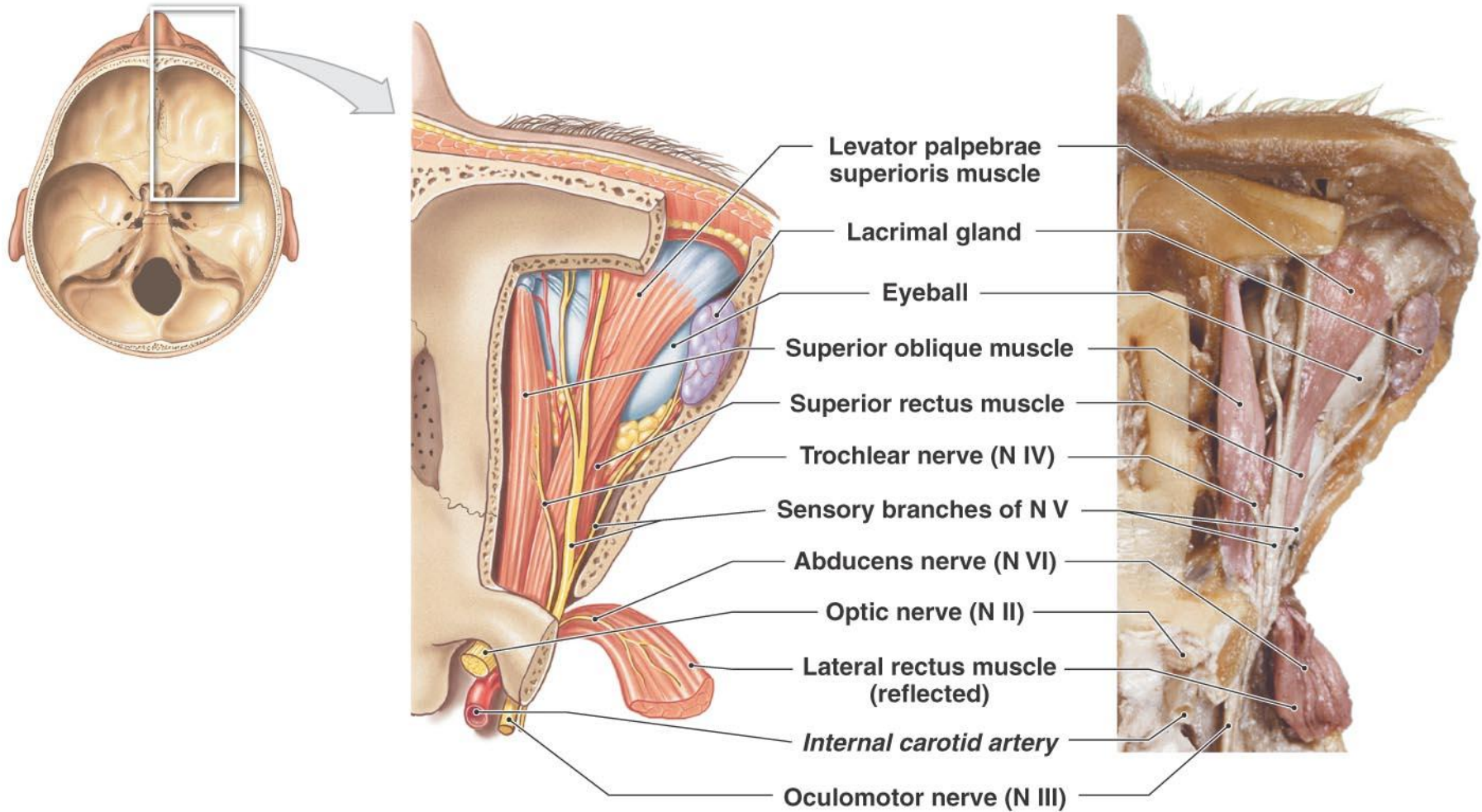


Figure 18.20 Accessory Structures of the Eye, Part II



# Vision

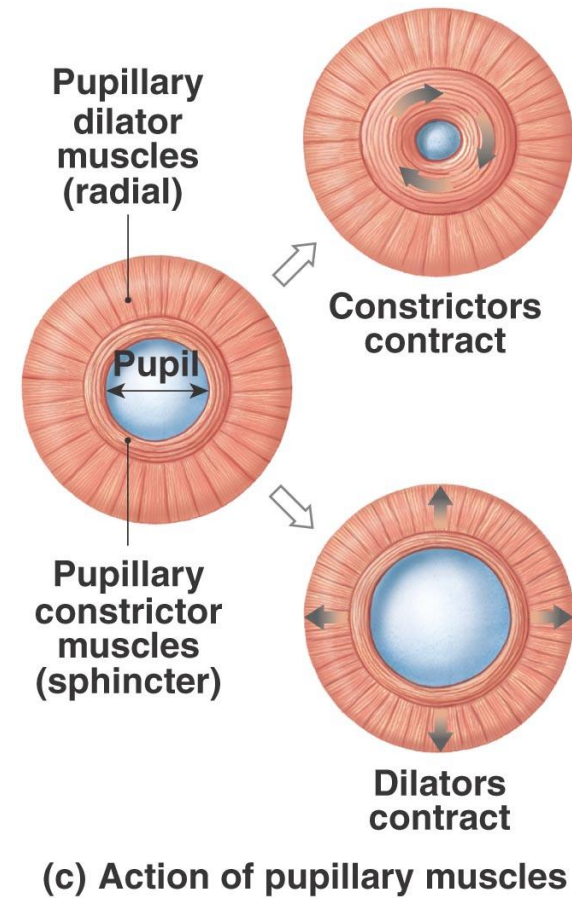
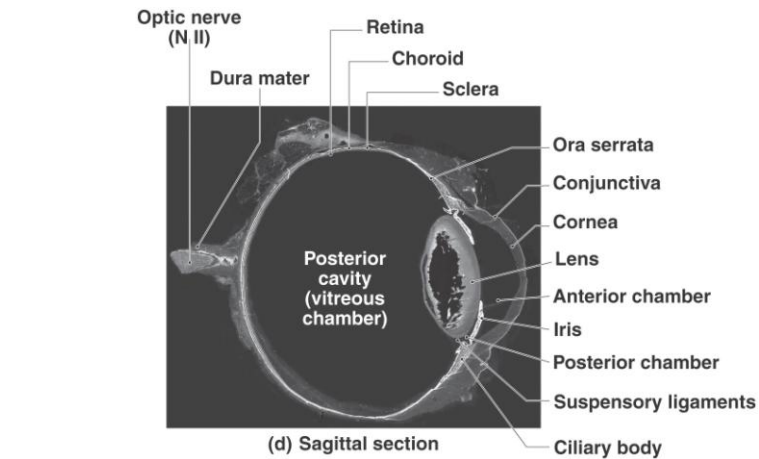
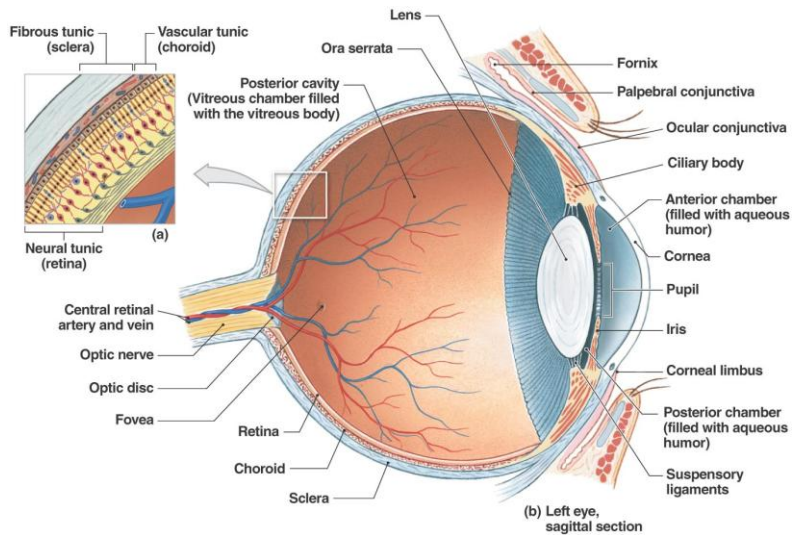


Figure 18.21a, b, c Sectional Anatomy of the Eye



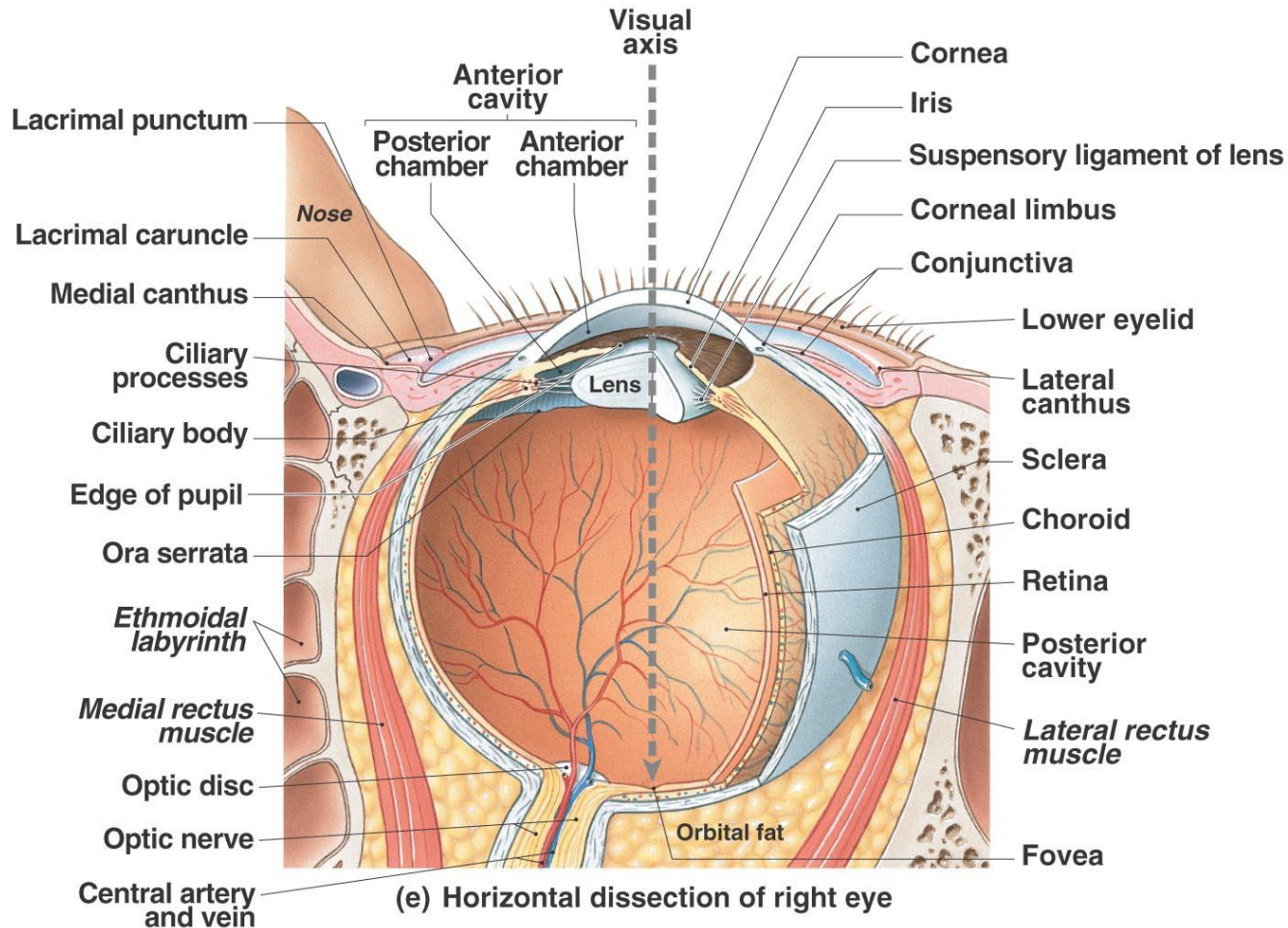


Figure 18.21e Sectional Anatomy of the Eye: (e) Horizontal Dissection of Right Eye

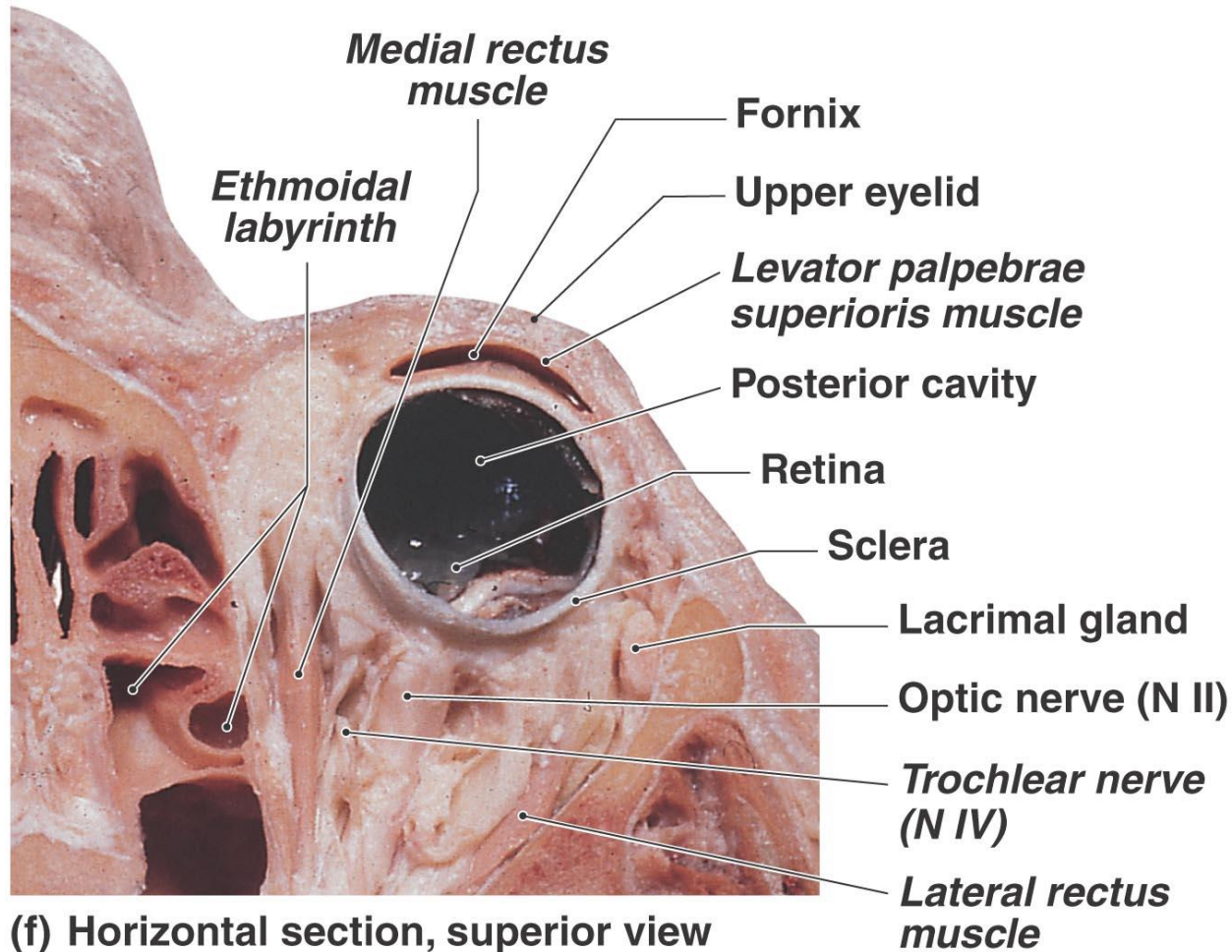
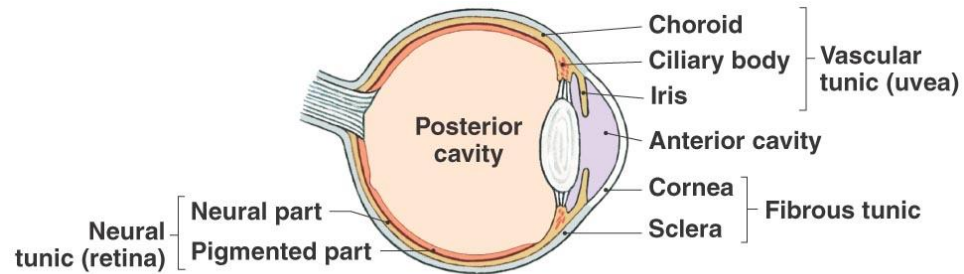
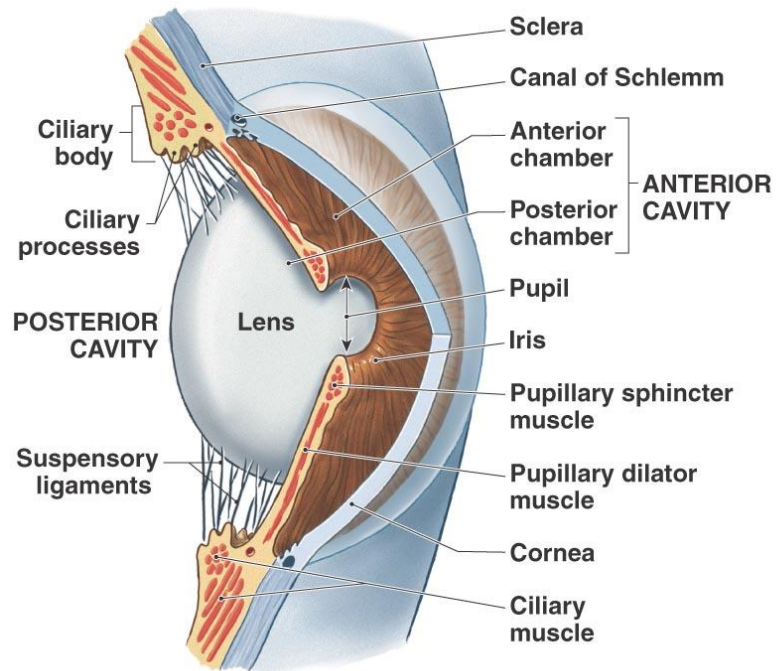


Figure 18.21f Sectional Anatomy of the Eye: (f) Horizontal Section, Superior View

# Vision



(a) Horizontal section of right eye



(b) Cavities of the eye

Figure 18.22 The Lens and Chambers of the Eye



# Vision

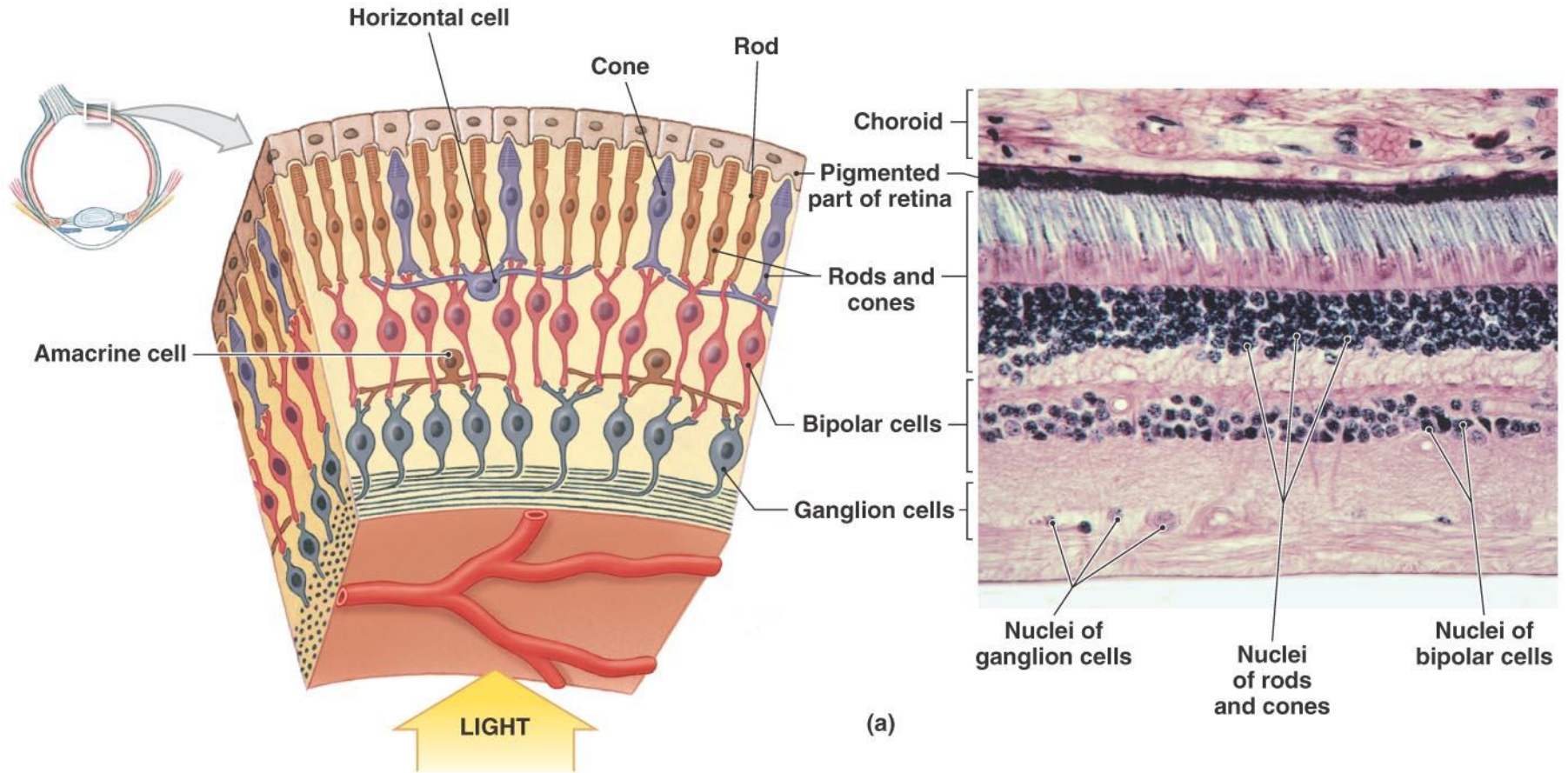


Figure 18.23a Retinal Organization (Histological)



# Vision

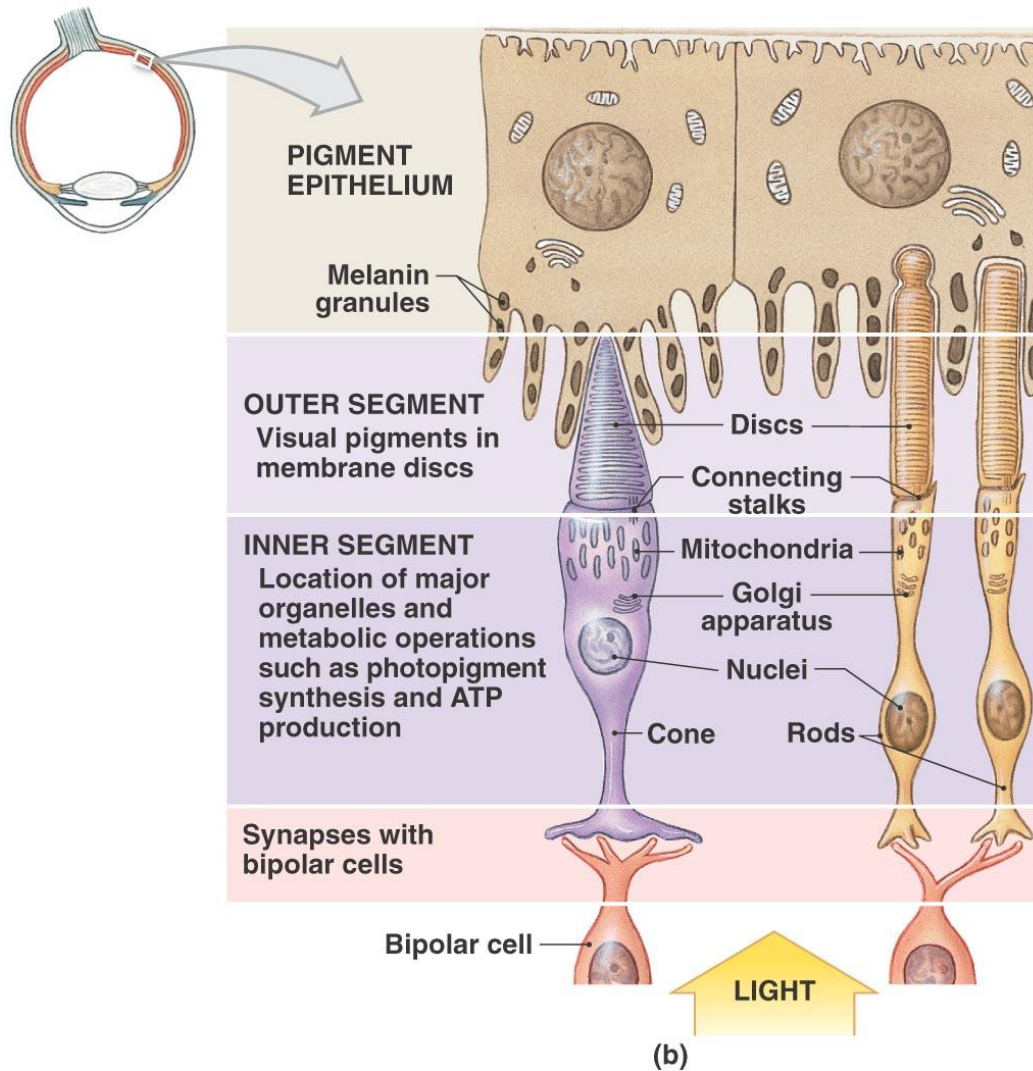


Figure 18.23b Retinal Organization (Diagrammatic View)

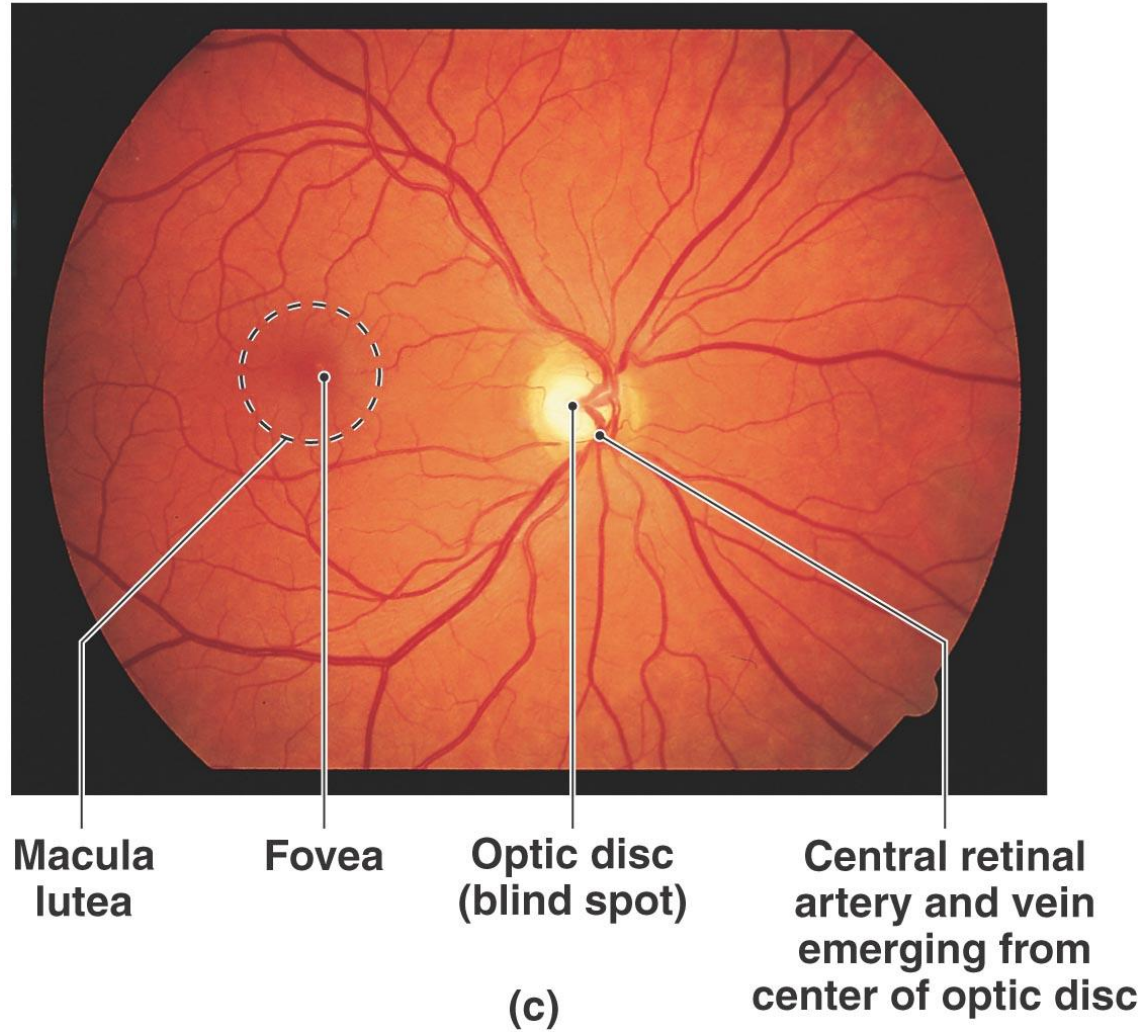


Figure 18.23c Retinal Organization

# Vision

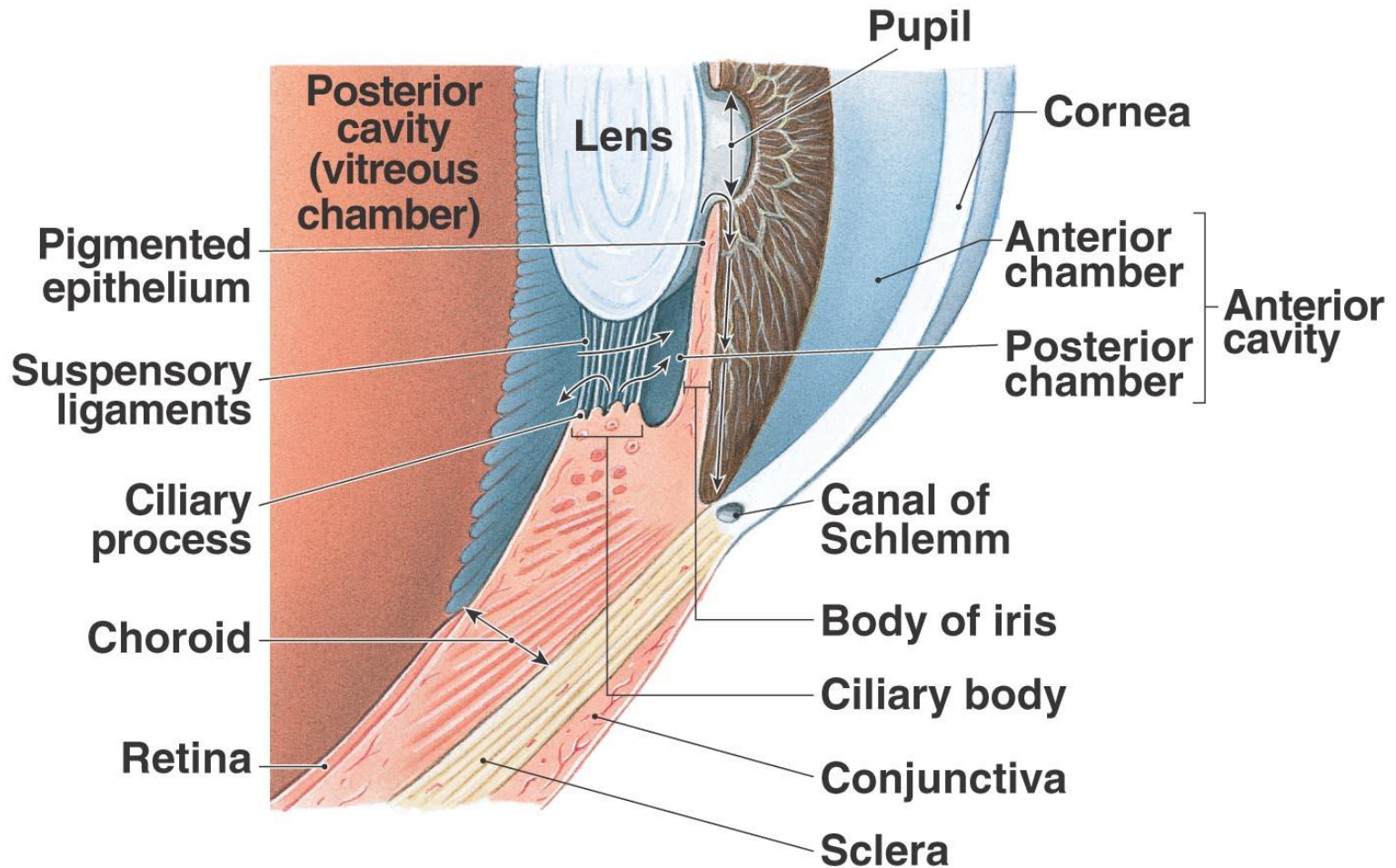


Figure 18.24 The Circulation of Aqueous Humor



# Vision

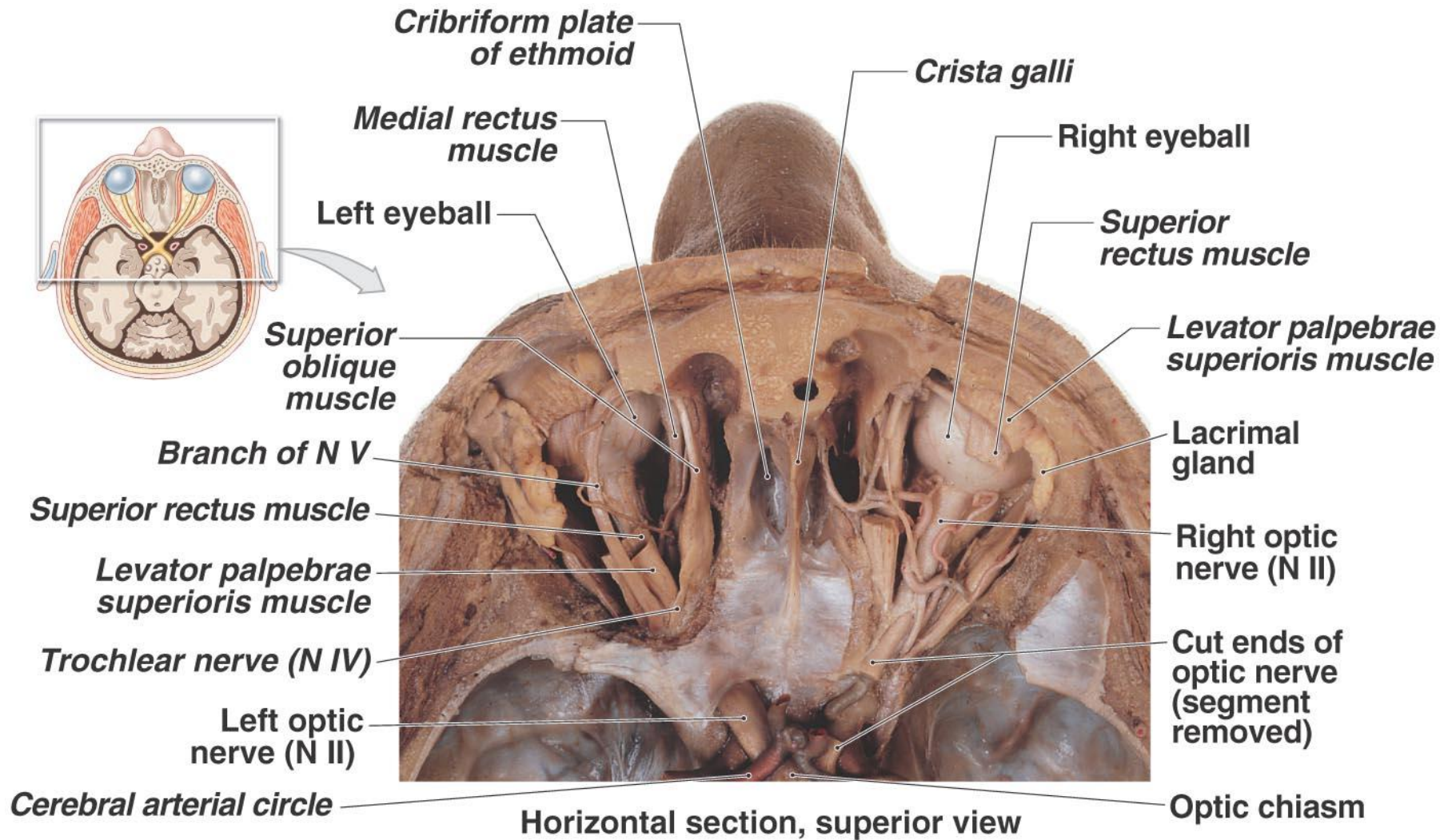


Figure 18.25 Anatomy of the Visual Pathways, Part I



# Vision

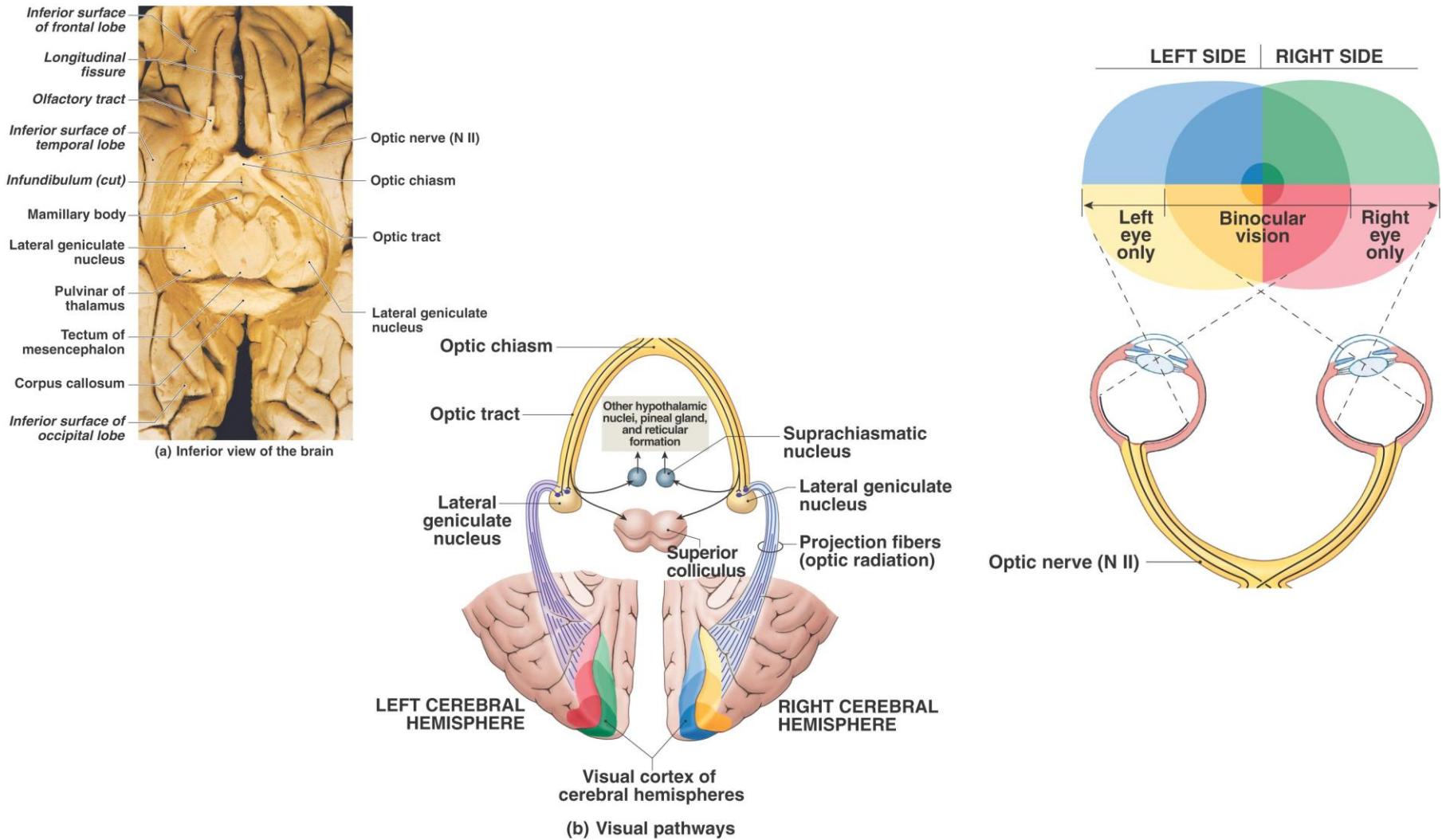


Figure 18.26 Anatomy of the Visual Pathways, Part II