Sensoric System

Astri Handayani

Capaian Pembelajaran Mata Kuliah (CPMK)	
CPMK 1	Mengidentifikasi dan menganalisis molekul, struktur, dan fungsi sel dan jaringan normal terkait system musculoskeletal dan neurosensoris berbasis bukti (evidence Based)
CPMK 2	Mengakses dan memanfaatkan informasi kesehatan dan medis secara akurat dan tepat.
Sub-Capaian Pembelajaran Mata Kuliah (Sub-CPMK)	
Bila dihadapkan pada skenario kasus dan data sekunder di bidang muskuloskeletal, mahasiswa semester 1 mampu:	
Sub-CPMK 1	Mengidentifikasi struktur sel dan jaringan yang relevan secara mikroskopik dan biomolekular
Sub-CPMK 2	Menjelaskan struktur dan fungsi organ yang membentuk sistem neurosensori-muskuloskeletal
Sub-CPMK 3	Menjelaskan neurotransmiter yang relevan (termasuk sintesis, sekresi, degradasi, reuptake dan fungsinya)
Sub-CPMK 4	Menjelaskan mekanisme kerja sinaps, prinsip kontraksi, relaksasi dan performa otot
Sub-CPMK 5	Menjelaskan integrasi sistem neurosensori dan muskuloskeletal
Sub CPMK 6	Menunjukkan karakter kepemimpinan dan pembelajar dewasa yang profesional, terbuka terhadap kritik dan saran berdasarkan nilai kemanusiaan, agama, moral dan etika

PRETEST

https://bit.ly/kuliah_AH

Contents of this chapter

- General properties of sensory system
- Somatic senses
- Pain
- Spesial senses
  - Chemoreseption : Smell and Taste
  - The Ear : Hearing and Equilibrium
  - The Eye : Vision

General Properties: Sensory Division

General properties of the sensory system

- Sensory receptors enable us to perceive different aspects of the world around us
- Sensory stimuli are divided into special senses and somatic senses

TABLE 10-1 Information Processing by the Sensory Division

STIMULUS PROCESSING IS USUALLY CONSCIOUS	
Special senses	**Somatic senses**
Vision	Touch
Hearing	Temperature
Taste	Pain
Smell	Itch
Equilibrium	Proprioception
PROCESSING IS USUALLY SUBCONSCIOUS	
Somatic stimuli	**Visceral stimuli**
Muscle length and tension	Blood pressure
Proprioception	Distension of gastrointestinal tract
	Blood glucose concentration
	Internal body temperature
	Osmolarity of body fluids
	Lung inflation
	pH of cerebrospinal fluid
	pH and oxygen content of blood

Sensory Receptors – 4 major groups

TABLE 10-2 Types of Sensory Receptors

TYPE OF RECEPTOR	EXAMPLES OF STIMULI
Chemoreceptors	Oxygen, pH, various organic molecules such as glucose
Mechanoreceptors	Pressure (baroreceptors), cell stretch (osmoreceptors), vibration, acceleration, sound
Photoreceptors	Photons of light
Thermoreceptors	Varying degrees of heat

Receptive Fields of Sensory Neurons

Receptive Field = The physical area to which a sensory neuron responds to stimuli, may be irregular in shape, can overlap
Smaller the receptive field the greater the localization

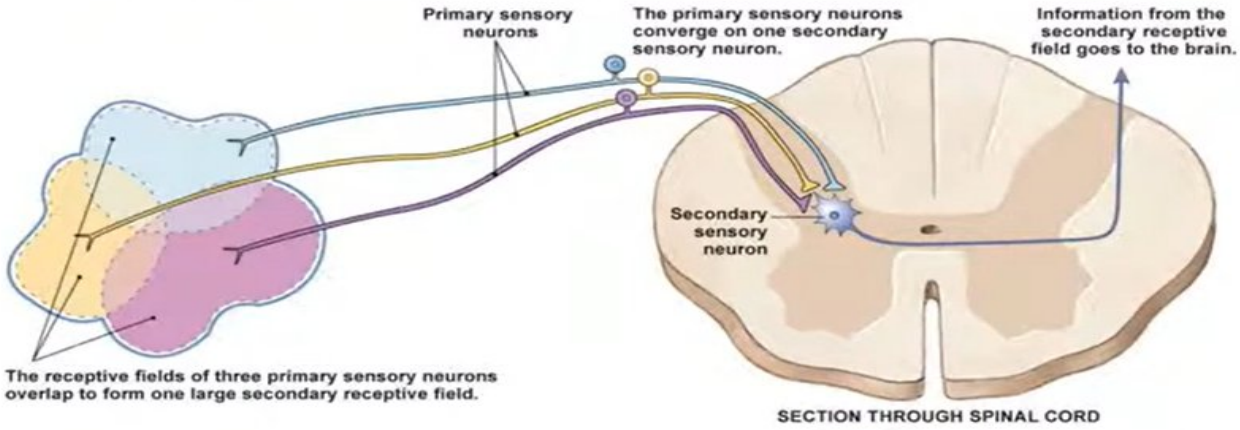

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Figure 10-2

Sensory Neurons: Two-Point Discrimination

- The size of secondary receptive fields determines how sensitive a given area is to a stimulus

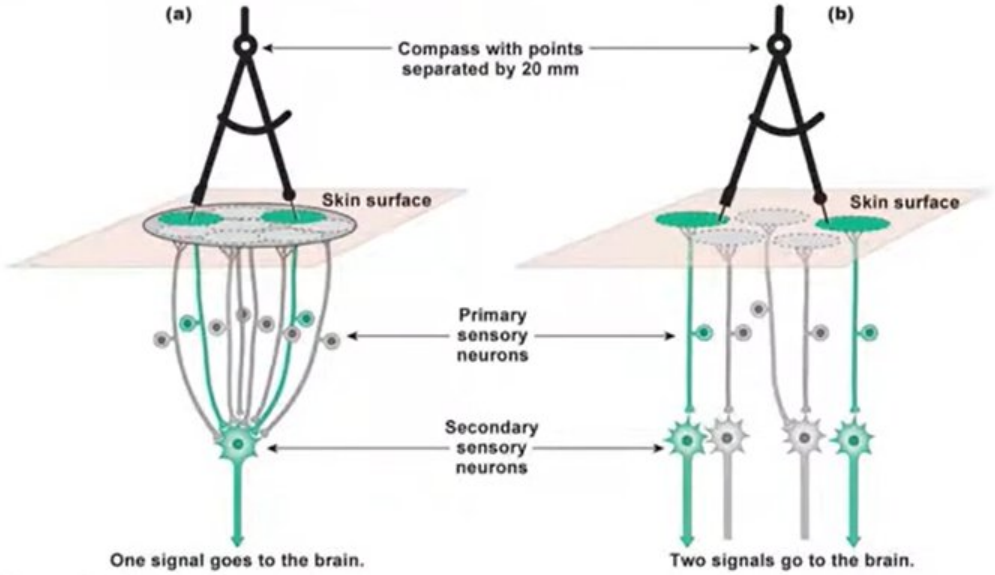

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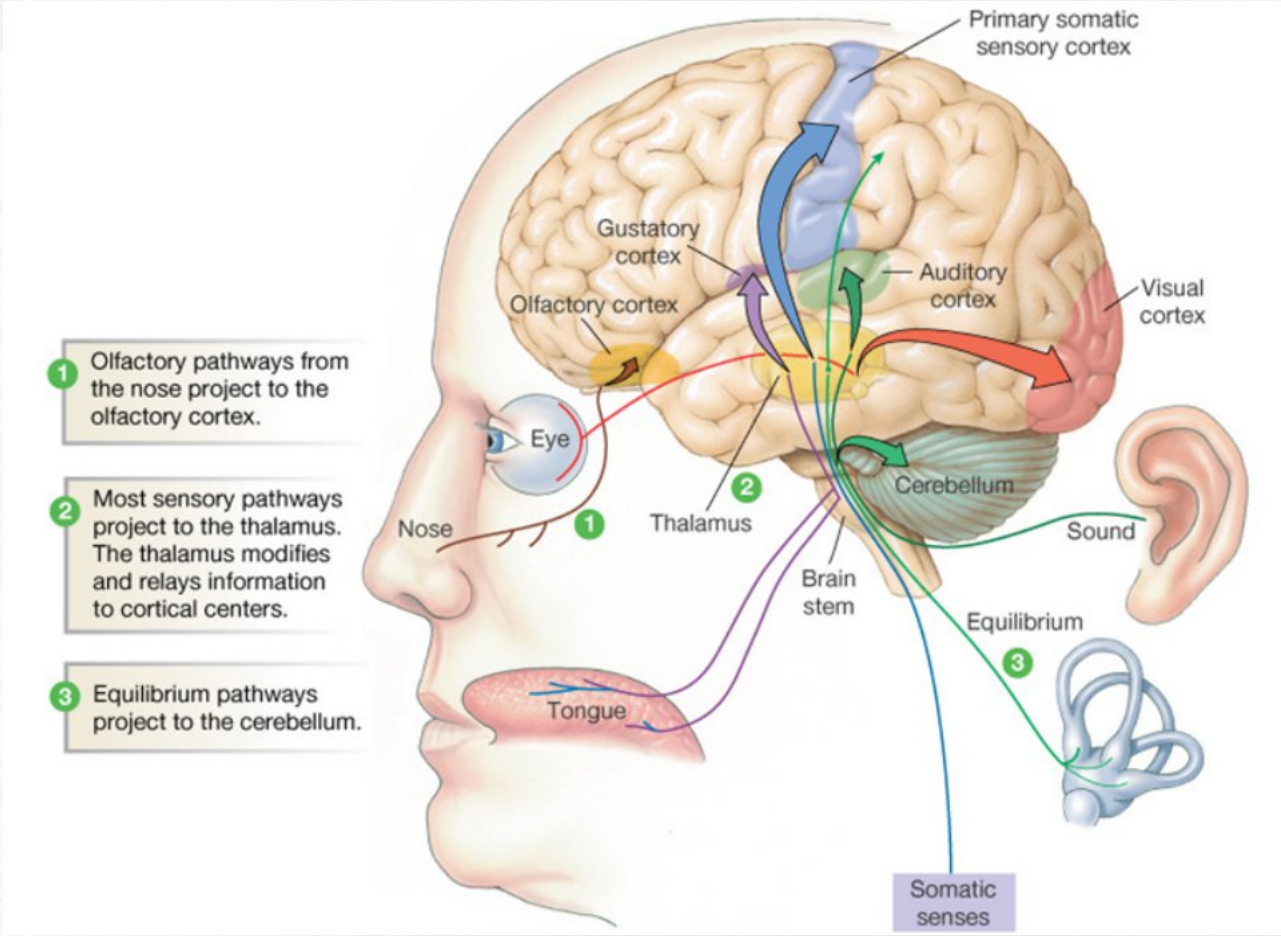
Figure 10-3


1 Olfactory pathways from the nose project to the olfactory cortex.
2 Most sensory pathways project to the thalamus. The thalamus modifies and relays information to cortical centers.
3 Equilibrium pathways project to the cerebellum.
Primary somatic sensory cortex
Gustatory cortex
Olfactory cortex
Auditory cortex
Visual cortex
Eye
Nose
Thalamus
Cerebellum
Sound
Brain stem
Equilibrium
Tongue
Somatic senses


PAIN

Definition of Pain

- Unpleasant sensory and emotional experience associated with actual or potential tissue damage.(IASP)
- Pain serves as important protective function, alerting us to injuries that required evasion or treatment
- Perception of pain is Subjective and influence by many factors.

Ganong, Review of Medical Physiology, 23rd ed,2010

Classification of Pain

- Based on Pathophysiology
  - ❖Nociceptive pain
    - Transient pain in response to noxious stimulus
    - Arises from a stimulus outside of the nervous system
    - Pain proportionate to the stimulation of nociceptors
    - Serves as a protective function
  - ❖Inflammatory pain
    - Initiated by tissue damage and/or inflammation
    - Arises from a stimulus that is outside of the nervous system
    - Spontaneous pain and hypersensitivity to noxious stimulus
    - Disproportionate to the stimulation of nociceptors
    - Serves no protective function
  - ❖Neuropathic pain
    - Initiated or caused by a primary lesion or dysfunction in the nervous system
    - No nociceptive stimulation
    - Disproportionate to the stimulation of receptors
    - Other evidence of nerve damage (eg, postherpetic neuralgia)

Woolf CJ. Ann Intern Med. 2004;140:441-451

Classification of Pain

Based on Pain duration

ACUTE PAIN

- Physiologic pain
- Sudden onset
- Recedes during the healing process
- "good Pain" as it serves an important protective mechanism
- pain of less than 3 to 6 months duration

CHRONIC PAIN

- Can result from nerve injuries (neuropathic pain)
- pain lasting for more than 3-6 months
- persisting beyond the course of an acute disease, or after tissue healing is complete

TABLE 6-2 Characteristics of Pain

Fast Pain	Slow Pain
Occurs on stimulation of mechanical and thermal nociceptors	Occurs on stimulation of polymodal nociceptors
Carried by small, myelinated A-delta fibers	Carried by small, unmyelinated C fibers
Produces sharp, prickling sensation	Produces dull, aching, burning sensation
Easily localized	Poorly localized
Occurs first	Occurs second; persists for longer time; more unpleasant

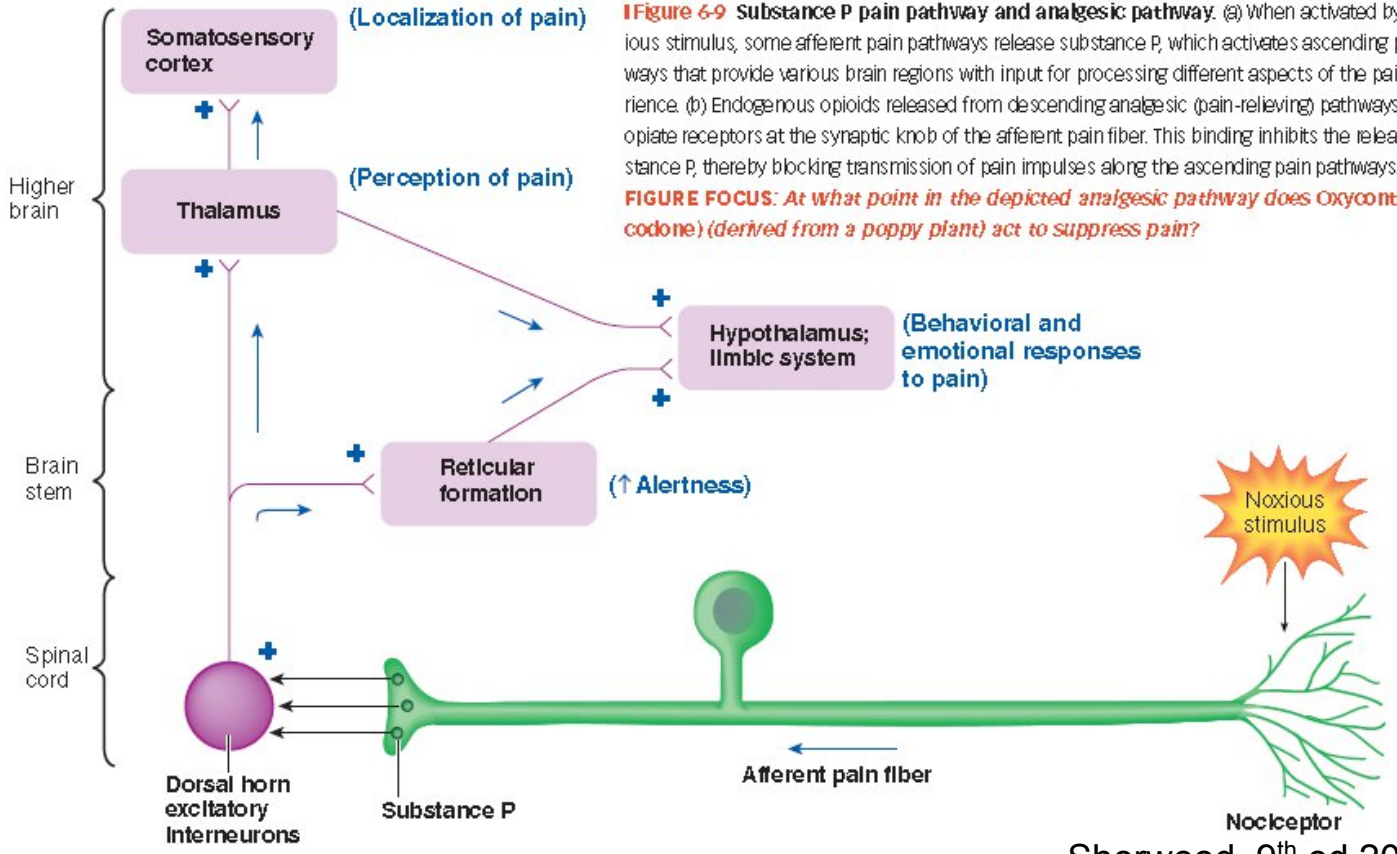
Sherwood, Principles of Human Physiology, 7th ed

Classes of Somatosensory Nerve Fibers

Table 10.3

Fiber Type	Fiber Characteristics	Speed of Conduction	Associated With
Aβ (beta)	Large, myelinated	30–70 m/sec	Mechanical stimuli
Aδ (delta)	Small, myelinated	12–30 m/sec	Cold, fast pain, mechanical stimuli
C	Small, unmyelinated	0.5–2 m/sec	Slow pain, heat, cold, mechanical stimuli

Silverthorne, Human Physiology Integrated Approach, 6th ed, 2013



(a) Substance P pain pathway

Figure 6-9 Substance P pain pathway and analgesic pathway. (a) When activated by a noxious stimulus, some afferent pain pathways release substance P, which activates ascending pain pathways that provide various brain regions with input for processing different aspects of the painful experience. (b) Endogenous opioids released from descending analgesic (pain-relieving) pathways bind with opiate receptors at the synaptic knob of the afferent pain fiber. This binding inhibits the release of substance P, thereby blocking transmission of pain impulses along the ascending pain pathways.

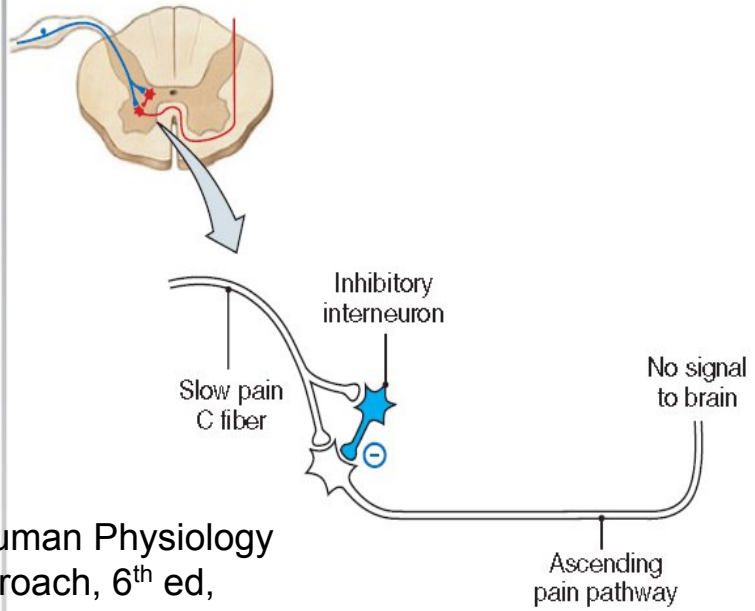
FIGURE FOCUS: *At what point in the depicted analgesic pathway does* Oxycontin (oxycodone) *(derived from a poppy plant) act to suppress pain?*

Sherwood, 9th ed,2016

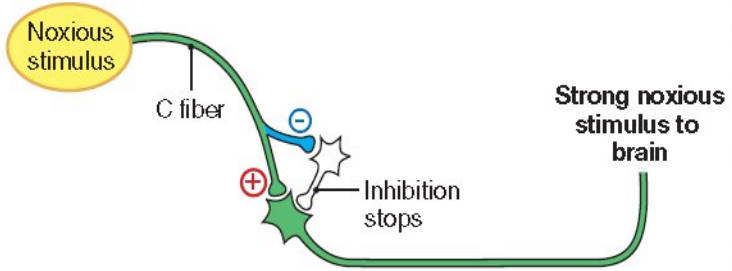
THE GATE CONTROL MODEL

In the gate control model of pain modulation, nonpainful stimuli can diminish the pain signal.

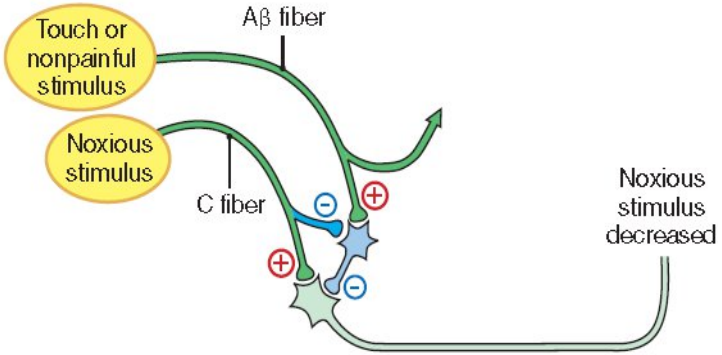
(a) In absence of input from C fibers, a tonically active inhibitory interneuron suppresses pain pathway.



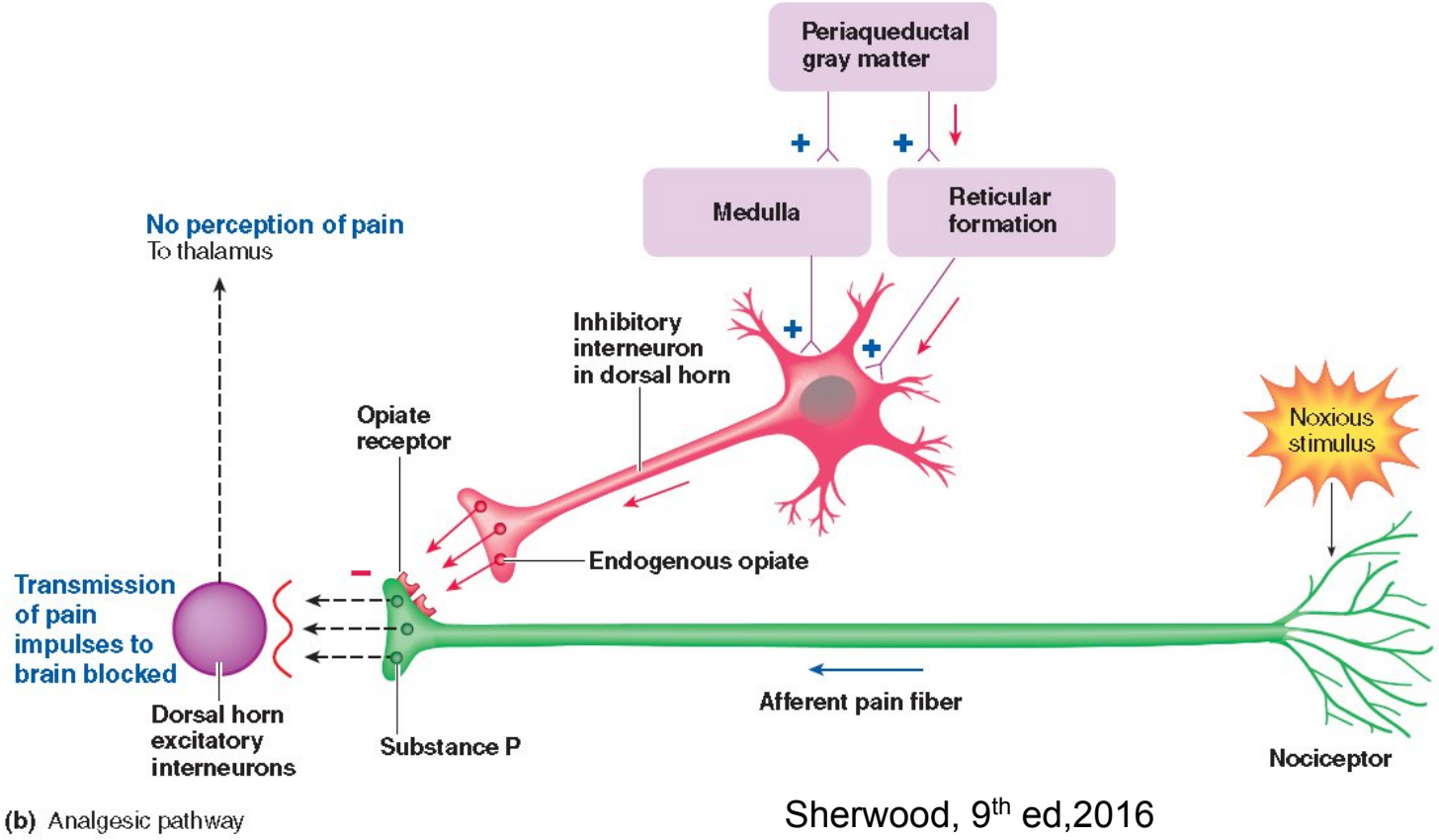
(b) With strong pain, C fiber stops inhibition of the pathway, allowing a strong signal to be sent to the brain.



(c) Pain can be modulated by simultaneous somatosensory input.



Silverthorne,Human Physiology Integrated Approach, 6th ed, 2013

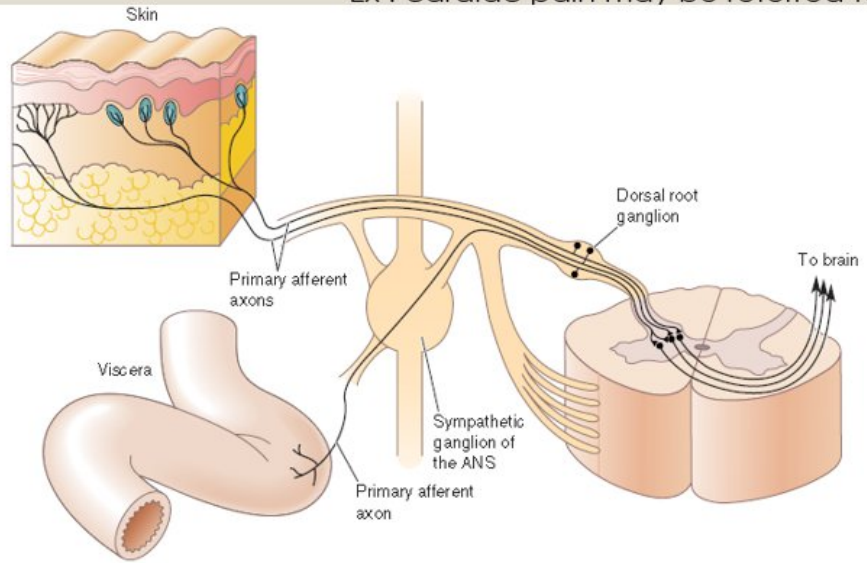


Sherwood, 9th ed,2016

REFERRED PAIN

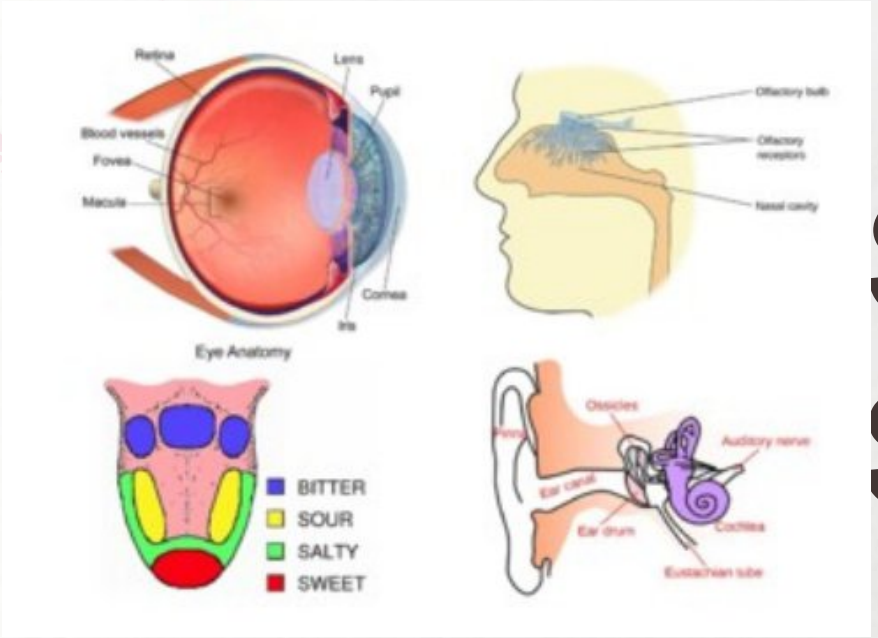
Irritation of visceral organ frequently produces pain that is feel not at that site but in some somatic structure that may be considerable distant away.

Ex : cardiac pain may be referred to the right arm.



▲ FIGURE 12.29
The convergence of nociceptor input from the viscera and the skin.

Bear, Neuroscience Exploring The Brain, 4th ed, 2016



Special Senses

Olfactorius Tract

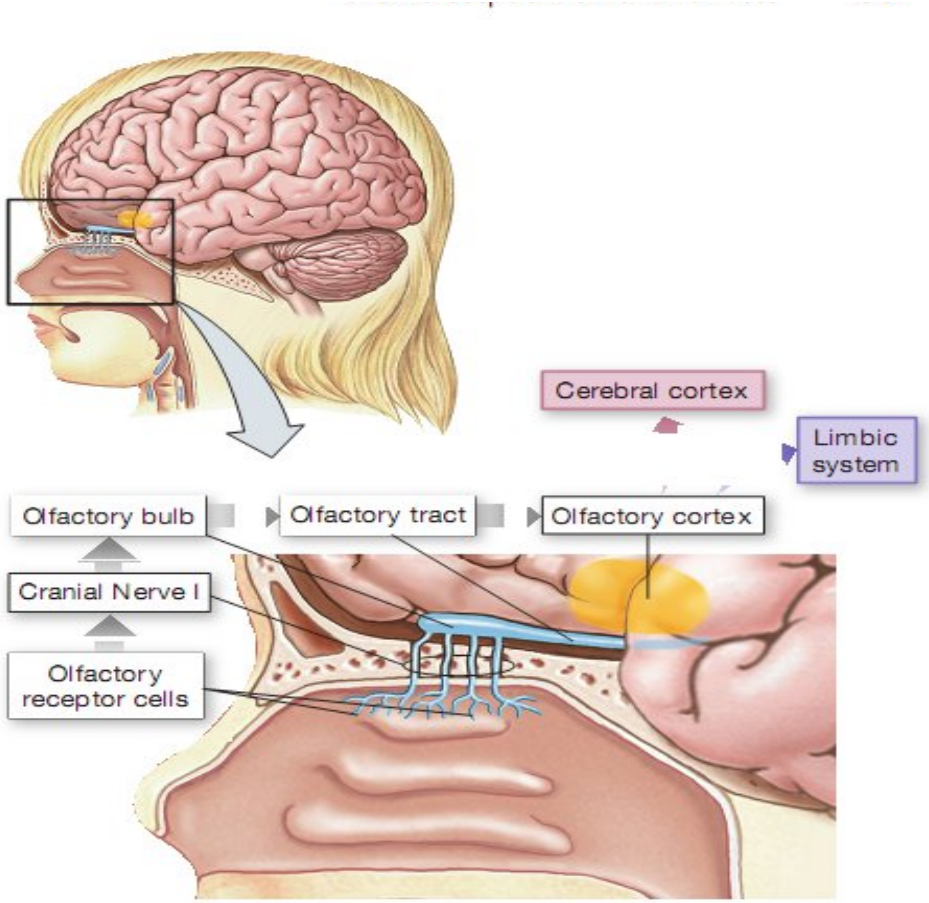


FIGURE 10-15 *Olfactory pathways*

Summary of Taste Transduction

Although smell is sensed by hundreds of types of receptors, taste is a combination of only 5 sensations:

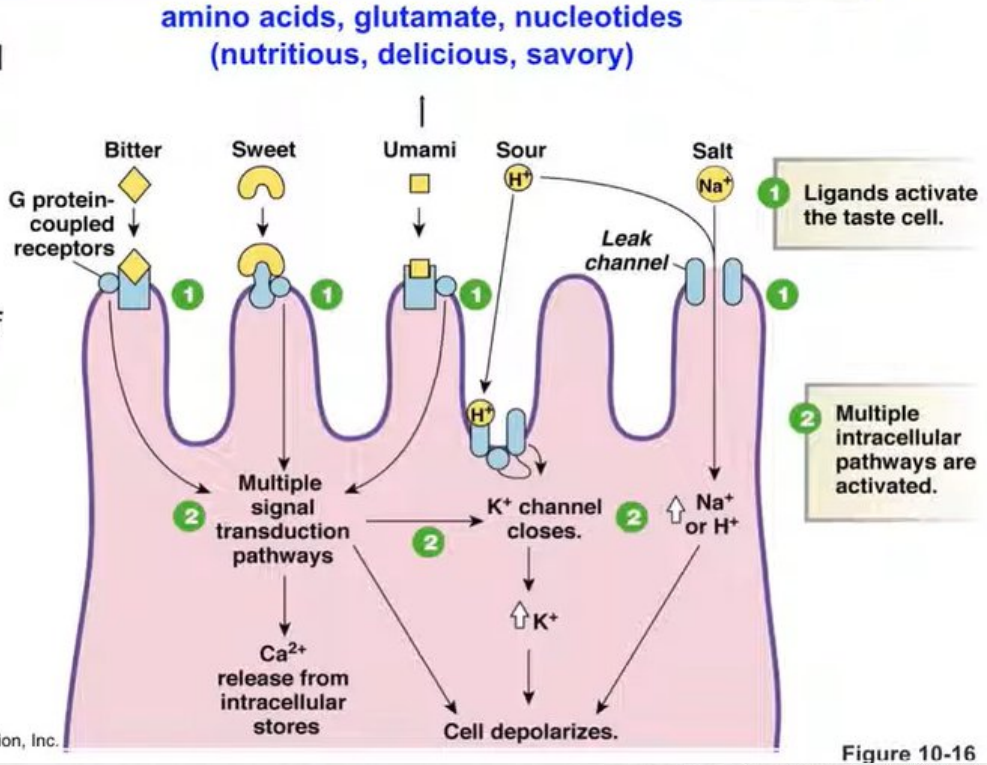


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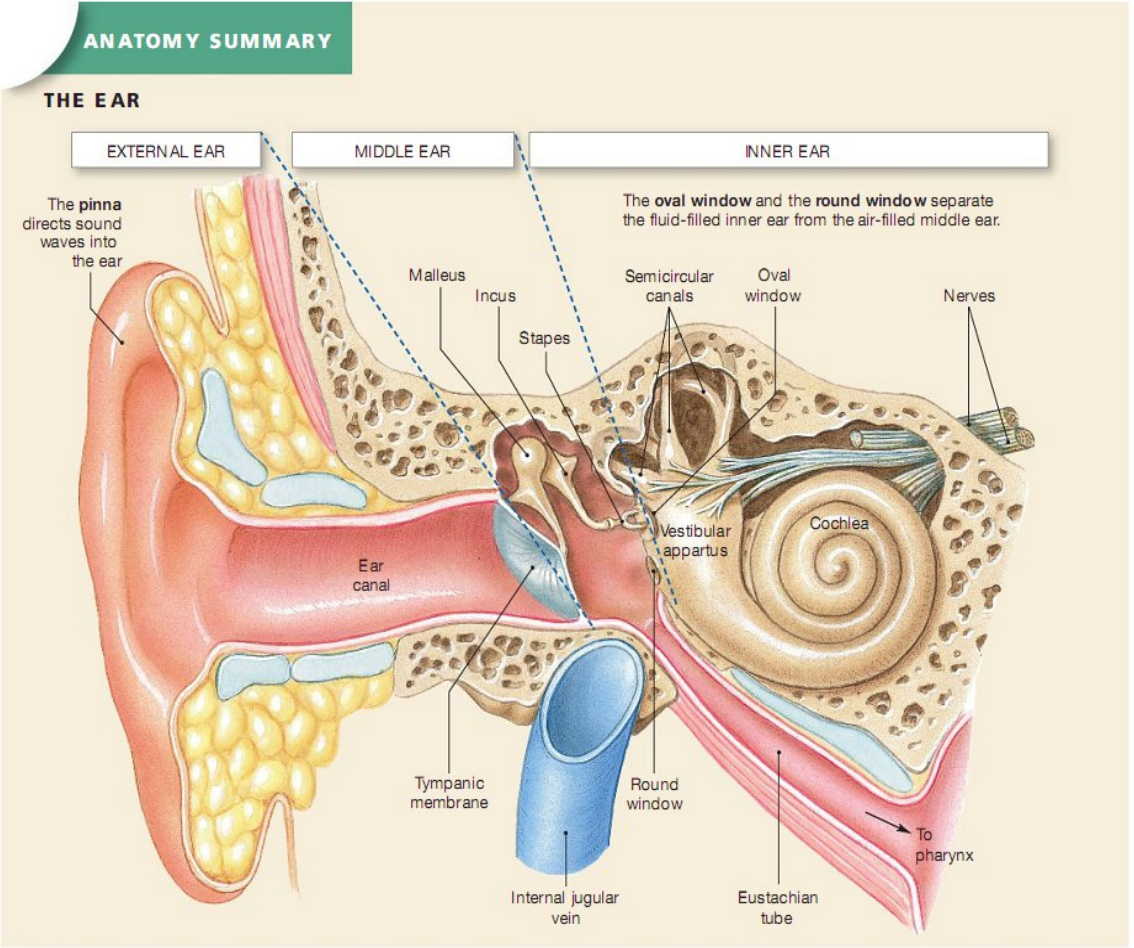
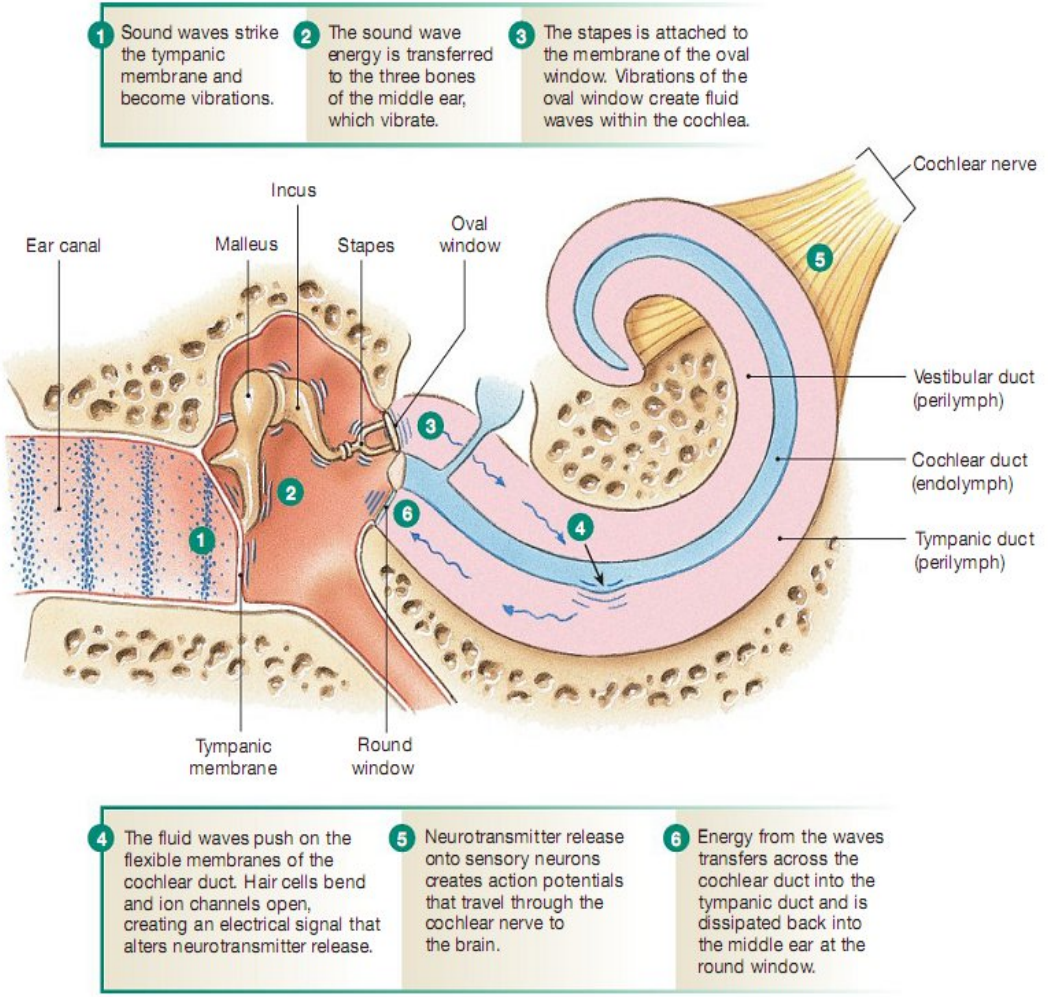
Figure 10-16

Anatomy of the ear



Sound waves Transmission



Signal transduction in hair cells

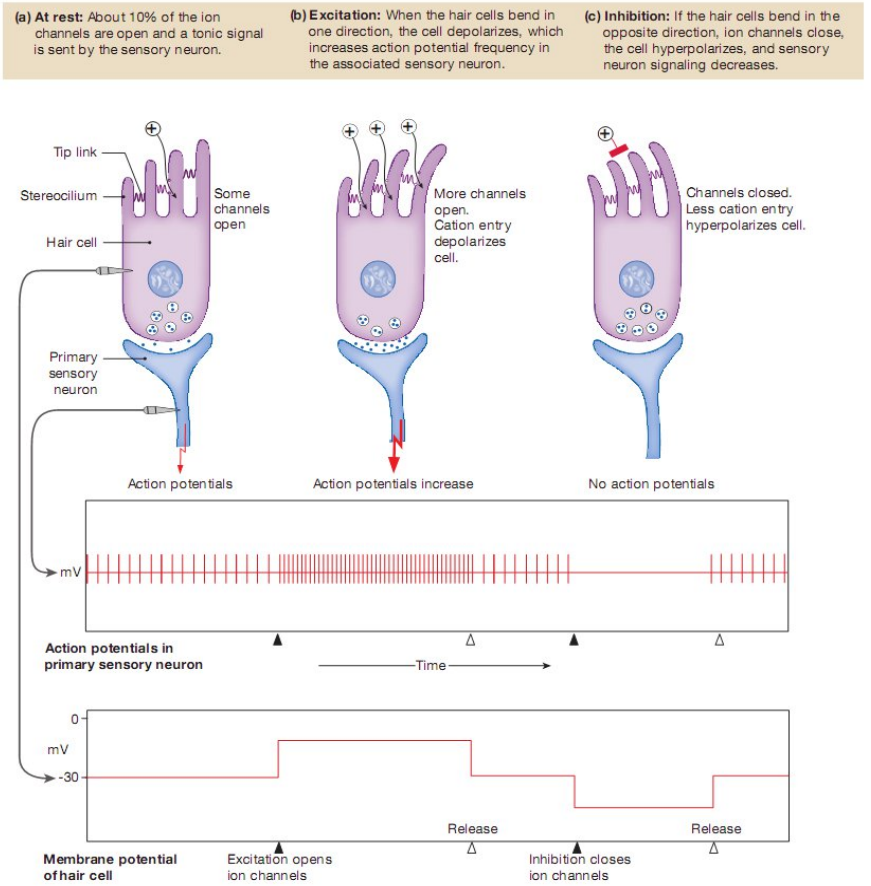
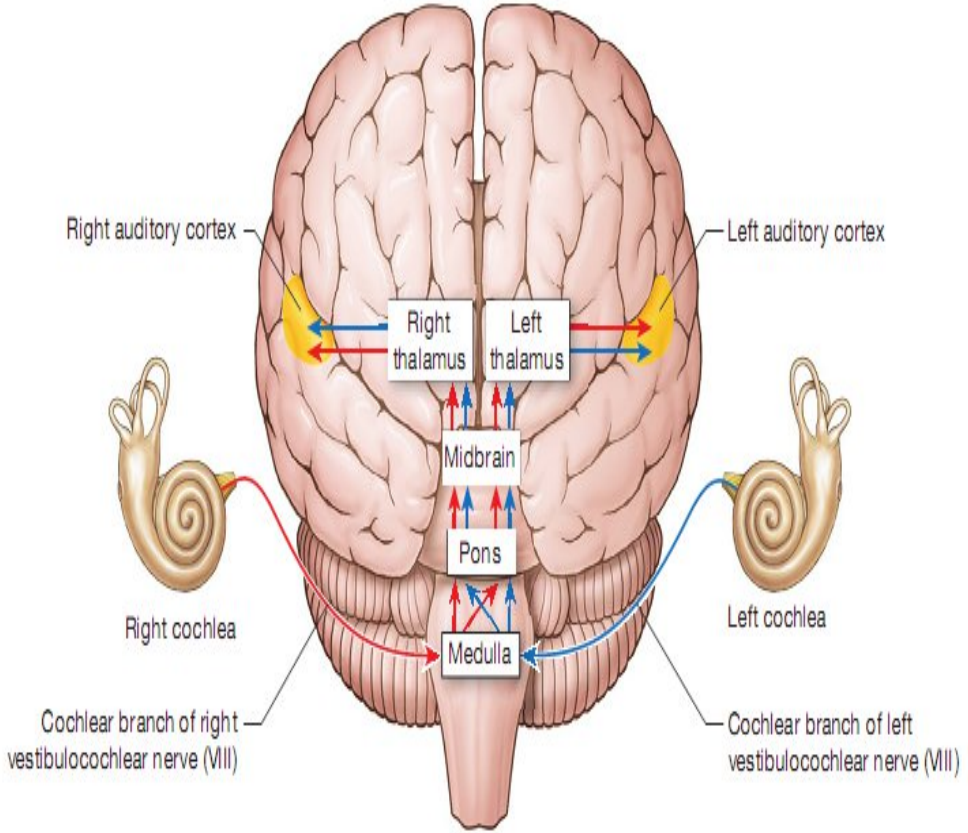


FIGURE 10-22 *Signal transduction in hair cells.* The stereocilia of hair cells have "trap doors" that close off ion channels. These openings are controlled by protein-bridge tiplinks connecting adjacent cilia.

Auditoric pathway



The Ear: Equilibrium

Vestibular apparatus provides information about **equilibrium, movement and position in space**

Equilibrium pathways project primarily to the cerebellum and collateral pathways project to the medulla or up to the cerebral cortex

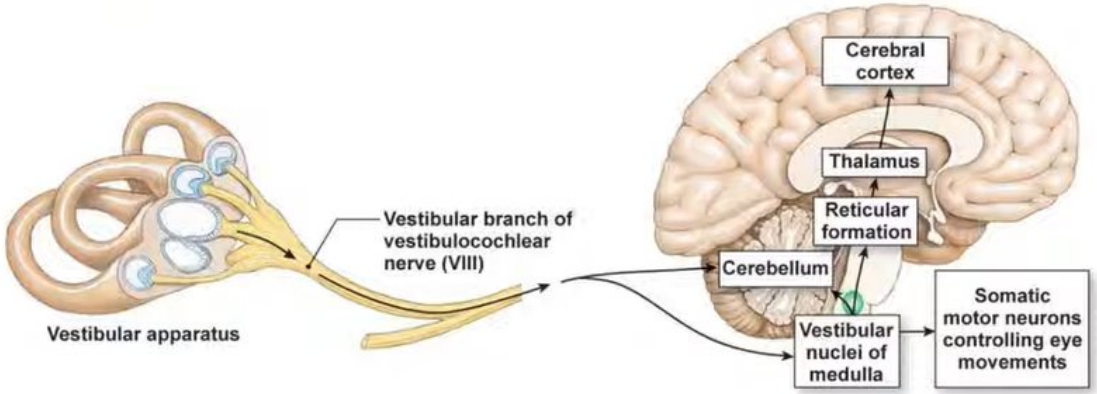


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Figure 10-28

THE EYE

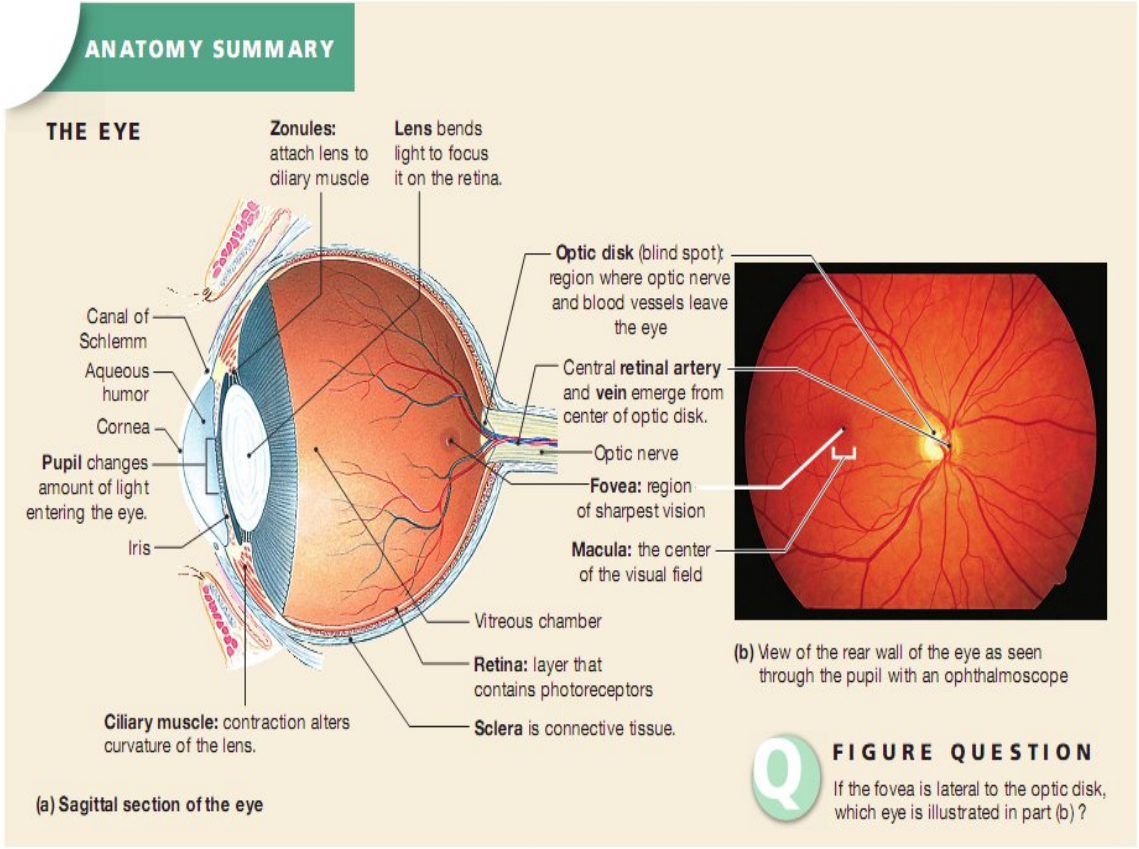
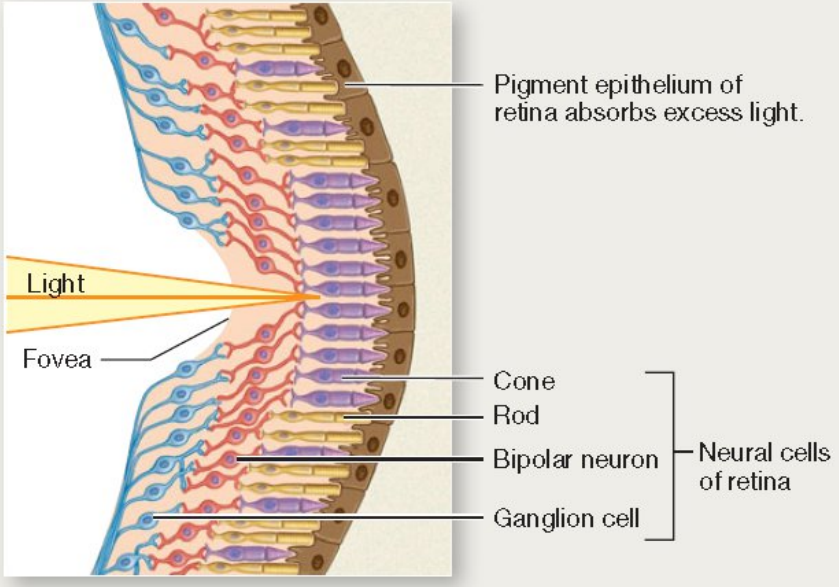


FIGURE 10-30



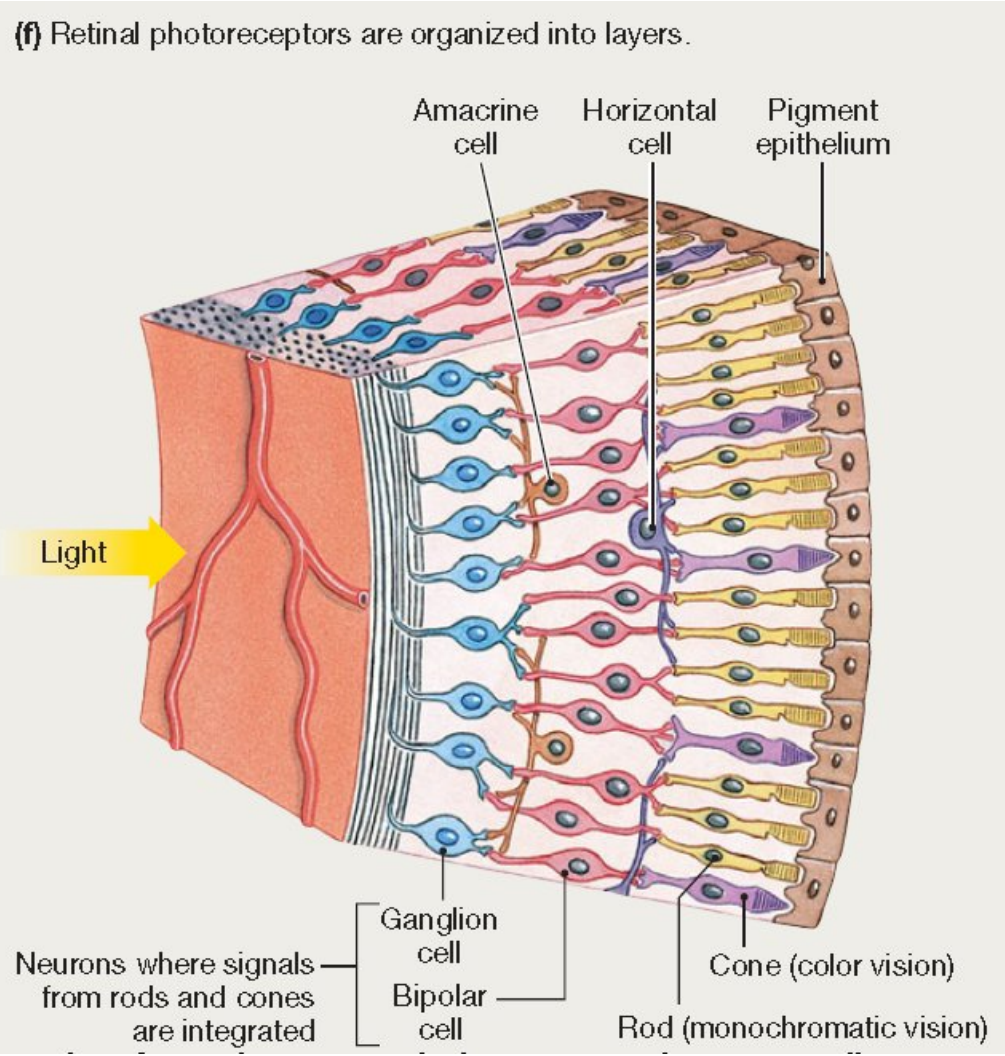
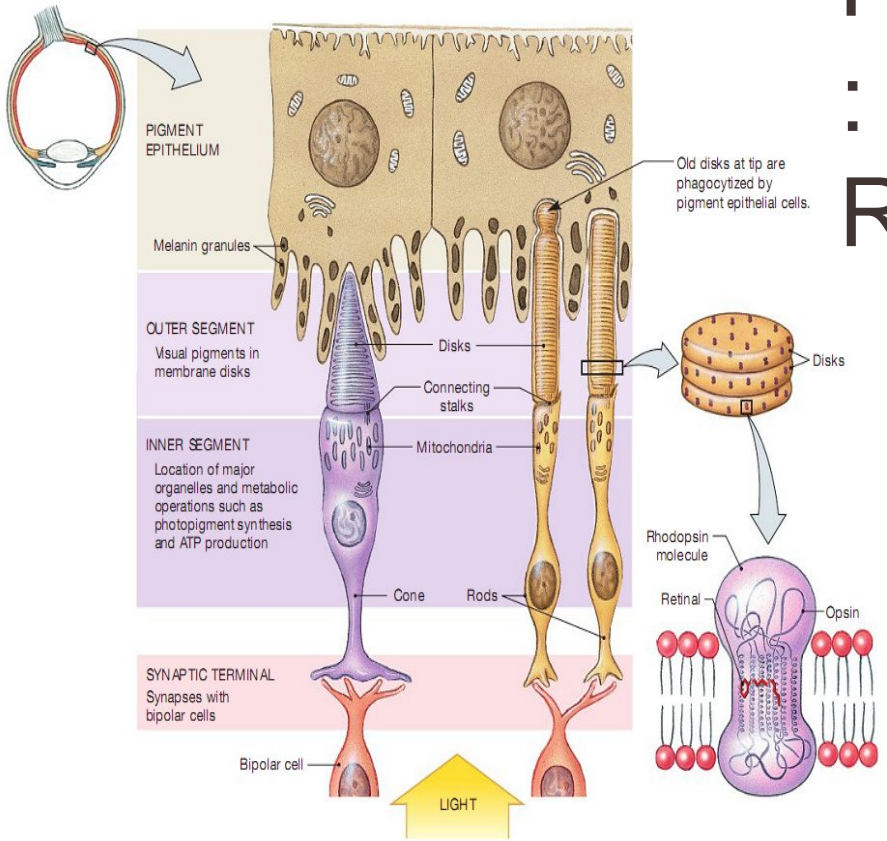
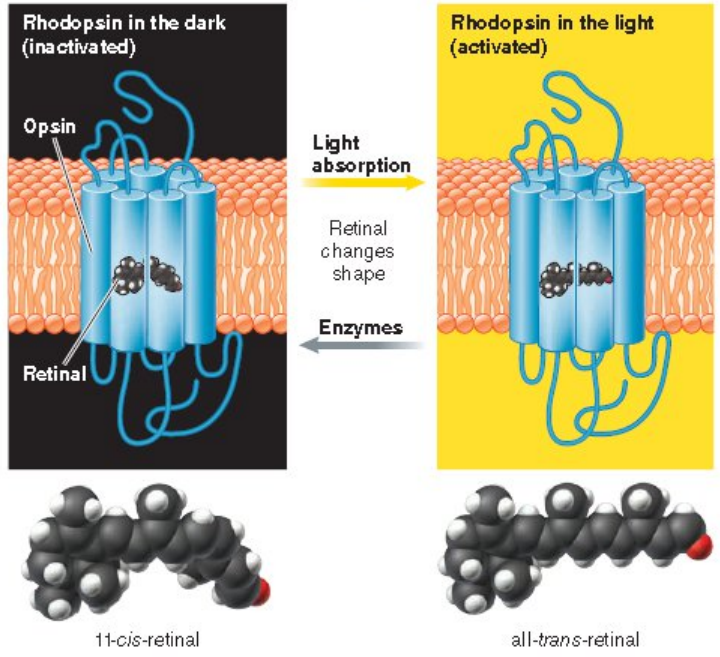


Photo transductio

PHOTORECEPTORS
:
RODS AND CONES



● **FIGURE 10-39** ***Photoreceptors: rods and cones.*** The dark pigment epithelium absorbs extra light and prevents that light from reflecting back and distorting vision. Light transduction takes place in the outer segment of the photoreceptor. Changes in photoreceptor membrane potential alter neurotransmitter release onto bipolar cells.



(b) Photopigment rhodopsin in the dark and light

PHOTOTRANSDUCTION IN RODS

Rods contain the visual pigment rhodopsin. When activated by light, rhodopsin separates into opsin and retinal.

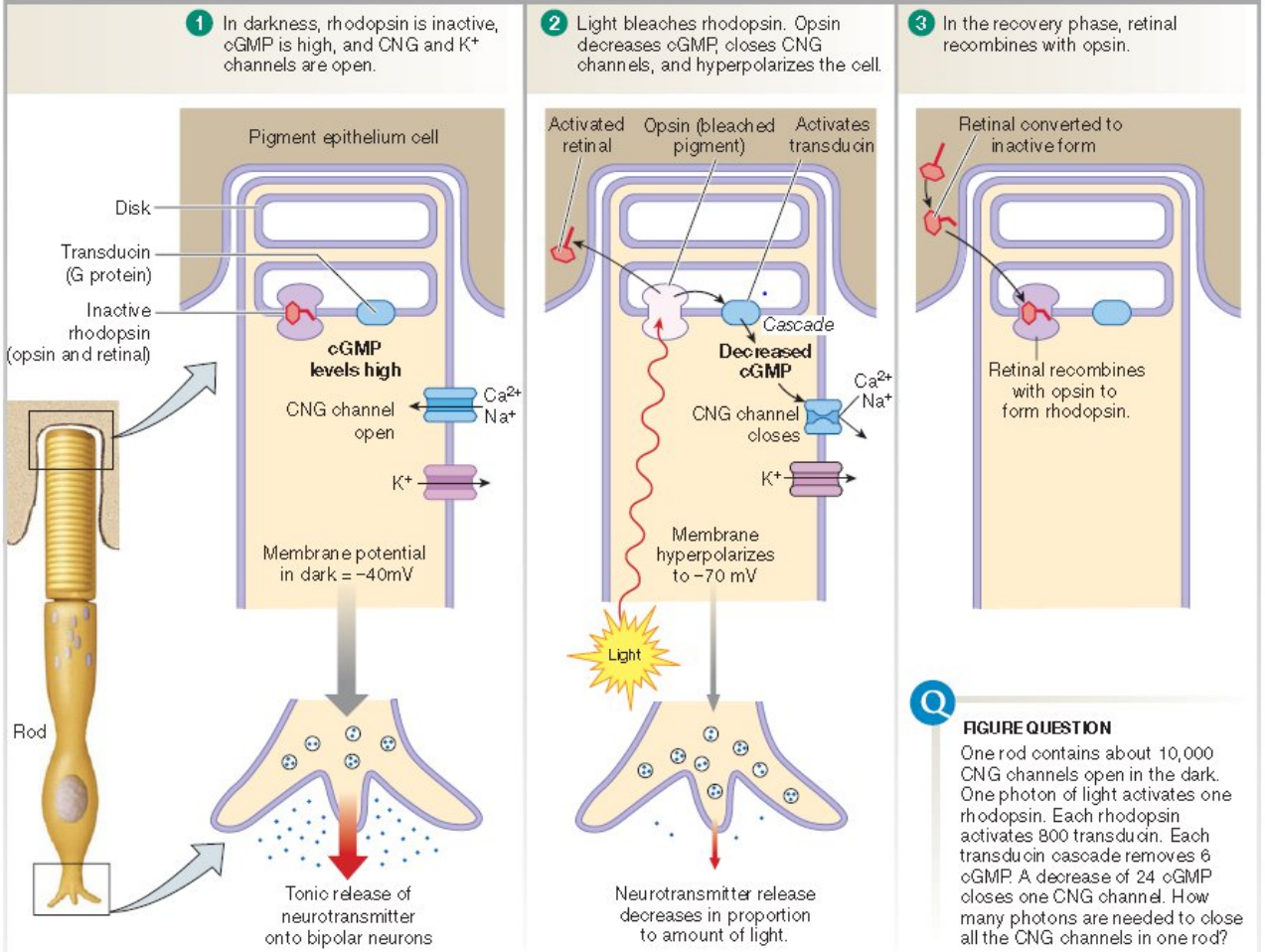


FIGURE QUESTION

One rod contains about 10,000 CNG channels open in the dark. One photon of light activates one rhodopsin. Each rhodopsin activates 800 transducin. Each transducin cascade removes 6 cGMP. A decrease of 24 cGMP closes one CNG channel. How many photons are needed to close all the CNG channels in one rod?

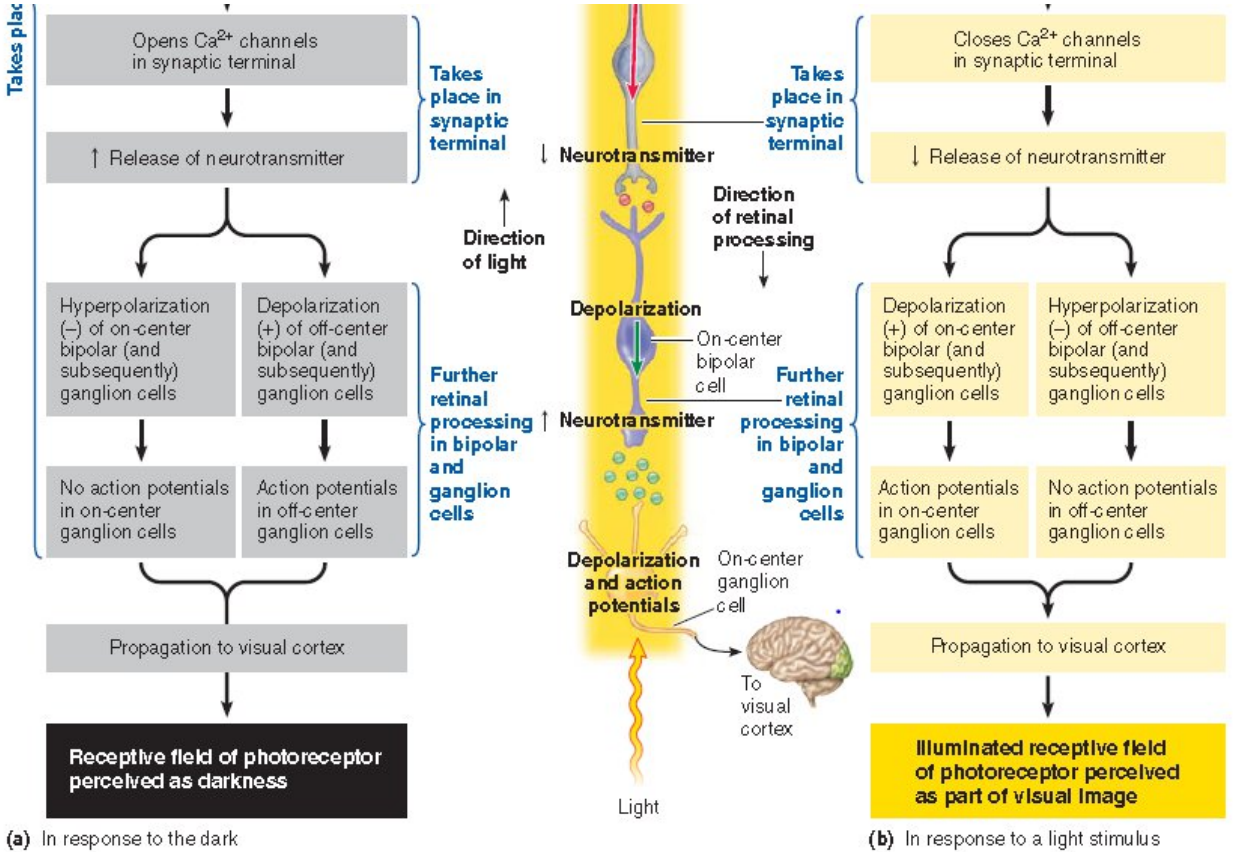
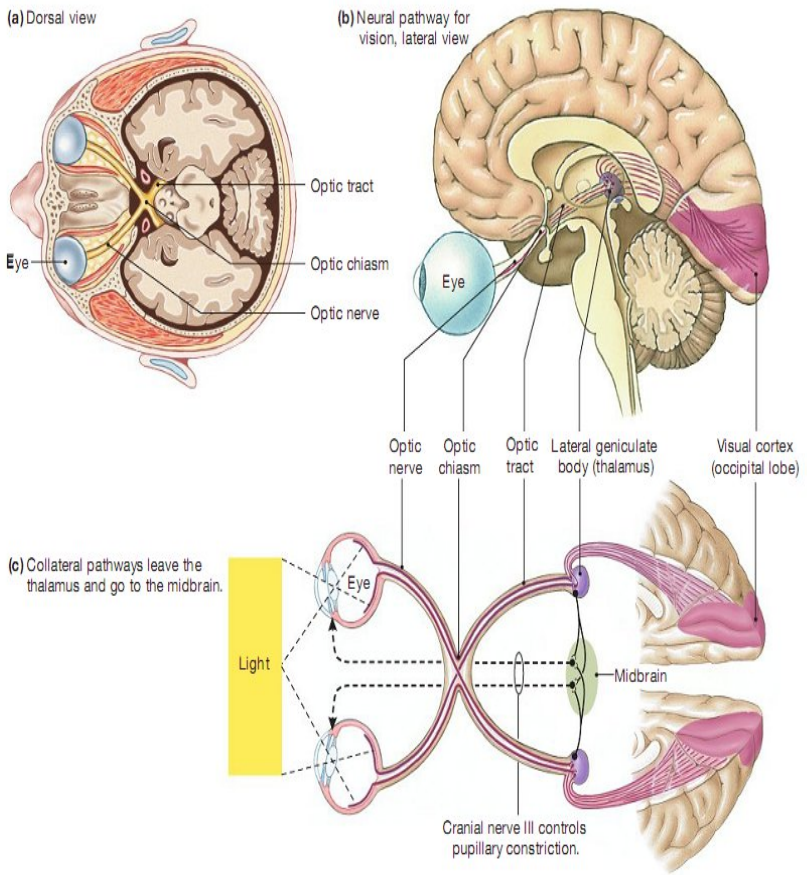
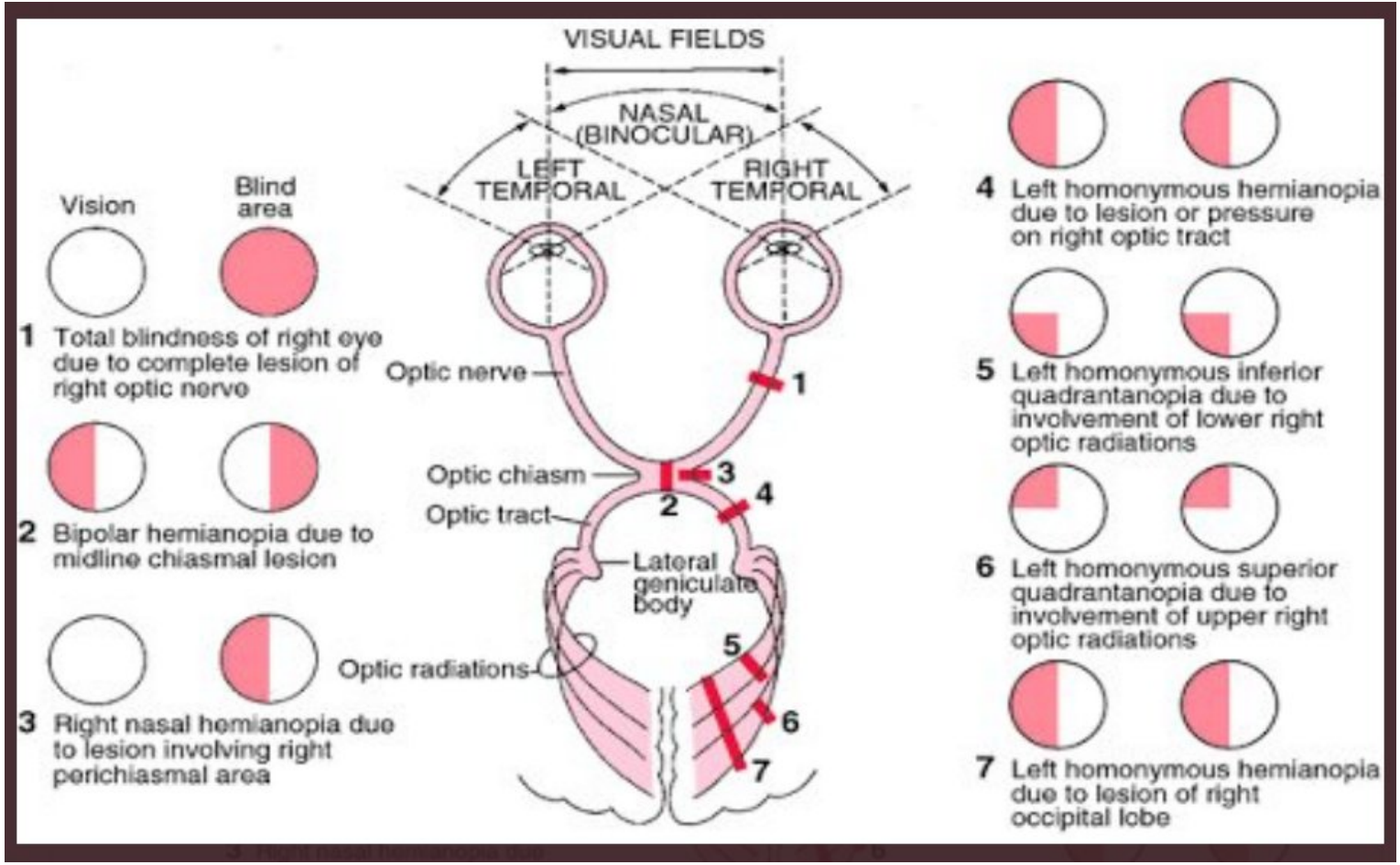


Figure 6-25 Phototransduction, further retinal processing, and initiation of action potentials in the visual pathway. (a) Events occurring in the retina and visual pathway in response to the dark. (b) Events occurring in the retina and visual pathway in response to a light stimulus.

FIGURE FOCUS: *How are photoreceptors depolarized in the absence of a stimulus and hyperpolarized in response to their adequate stimulus? How does a hyperpolarizing receptor potential lead to propagation of action potentials in on-center ganglion cells?*



● **FIGURE 10-31** *Neural pathways for vision and the pupillary reflex.*
Collateral pathways synapsing in the midbrain control constriction of the pupils.


VISUAL FIELDS
NASAL (BINOCULAR)
LEFT TEMPORAL
RIGHT TEMPORAL
Vision
Blind area
1 Total blindness of right eye due to complete lesion of right optic nerve
2 Bipolar hemianopia due to midline chiasmal lesion
3 Right nasal hemianopia due to lesion involving right perichiasmal area
Optic nerve
Optic chiasm
Optic tract
Lateral geniculate body
Optic radiations
1
2
3
4
5
6
7
4 Left homonymous hemianopia due to lesion or pressure on right optic tract
5 Left homonymous inferior quadrantanopia due to involvement of lower right optic radiations
6 Left homonymous superior quadrantanopia due to involvement of upper right optic radiations
7 Left homonymous hemianopia due to lesion of right occipital lobe

POST TEST


THANK
YOU!