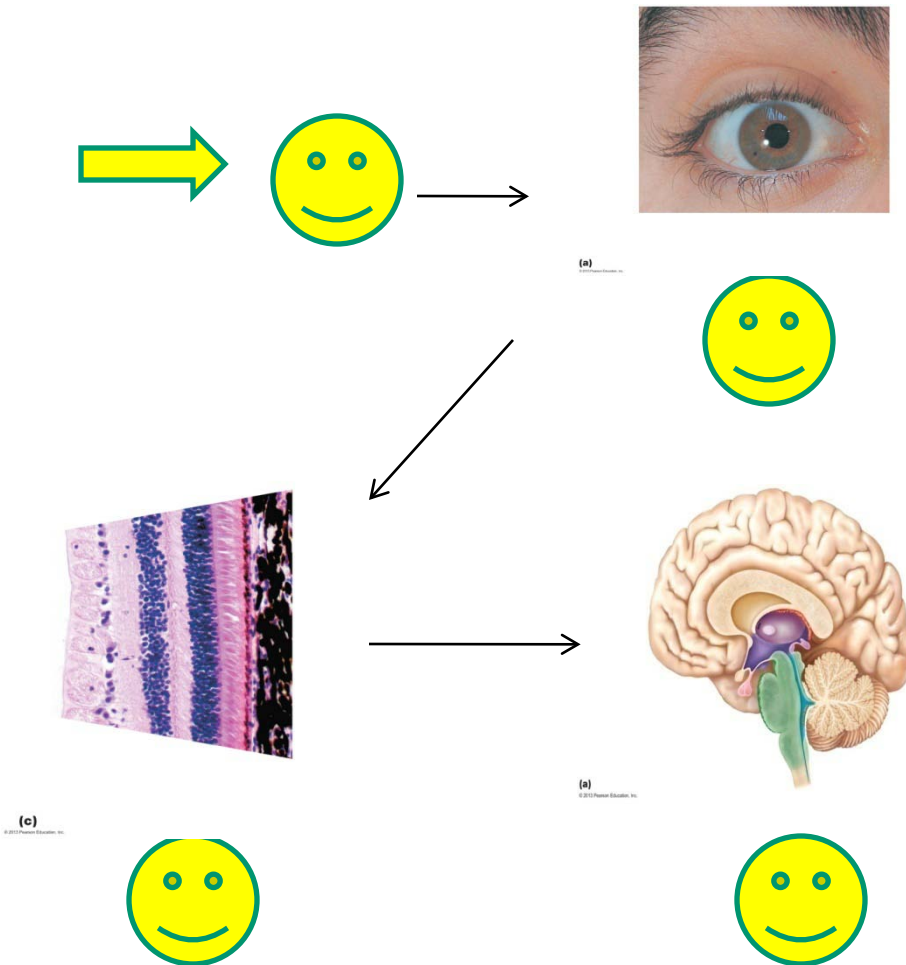


Sight

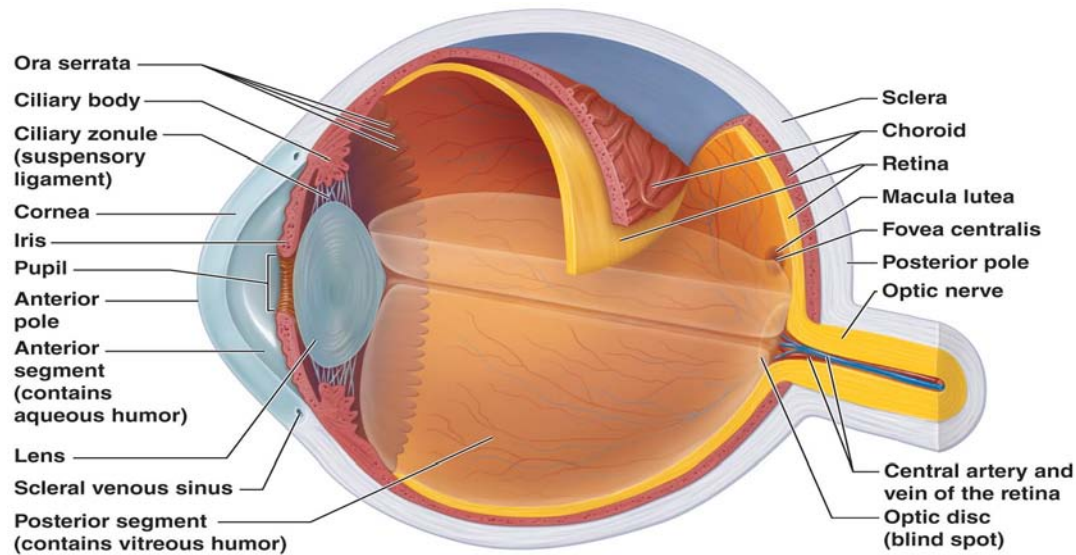


sun

- > object
- > image of object*
- > camera (eye)*
- > film (retina)*
- > connector
(optic nerve)*
- > computer (brain)*
- > interpret object

*image transmitted
"pixel by pixel"

Eyeball - 3 Tunics



(a) Diagrammatic view. The vitreous humor is illustrated only in the bottom part of the eyeball.



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- 1) fibrous tunic - cornea, sclera**
- 2) vascular tunic - choroid, ciliary body, iris, pupil, lens, anterior chamber, aqueous humour, suspensory ligament, posterior chamber, vitreous humour**
- 3) neural / sensory tunic - retina w/ macula lutea, fovea centralis, optic disc, optic nerve**

4 Regions of Brain



cerebrum, diencephalon, brain stem, cerebellum

TABLE 12.1 Functions of Major Brain Regions

REGION	FUNCTION
Cerebral Hemispheres (pp. 433–441)	
	<p>Cortical gray matter: Localizes and interprets sensory inputs, controls voluntary and skilled skeletal muscle activity, and functions in intellectual and emotional processing.</p> <p>Basal nuclei (ganglia): Subcortical motor centers important in initiation of skeletal muscle movements.</p>
Diencephalon (pp. 441–445)	
	<p>Thalamic nuclei: Relay stations in conduction of (1) sensory impulses to cerebral cortex for interpretation, and (2) impulses to and from cerebral motor cortex and lower (subcortical) motor centers, including cerebellum. The thalamus is also involved in memory processing.</p> <p>Hypothalamus: Chief integration center of autonomic (involuntary) nervous system; it functions in regulation of body temperature, food intake, water balance, thirst, and biological rhythms and drives. It regulates hormonal output of anterior pituitary gland and is an endocrine organ in its own right (produces ADH and oxytocin). Part of limbic system.</p> <p>Limbic system (pp. 451–452) A functional system involving cerebral and diencephalon structures that mediates emotional response; also involved in memory processing.</p>

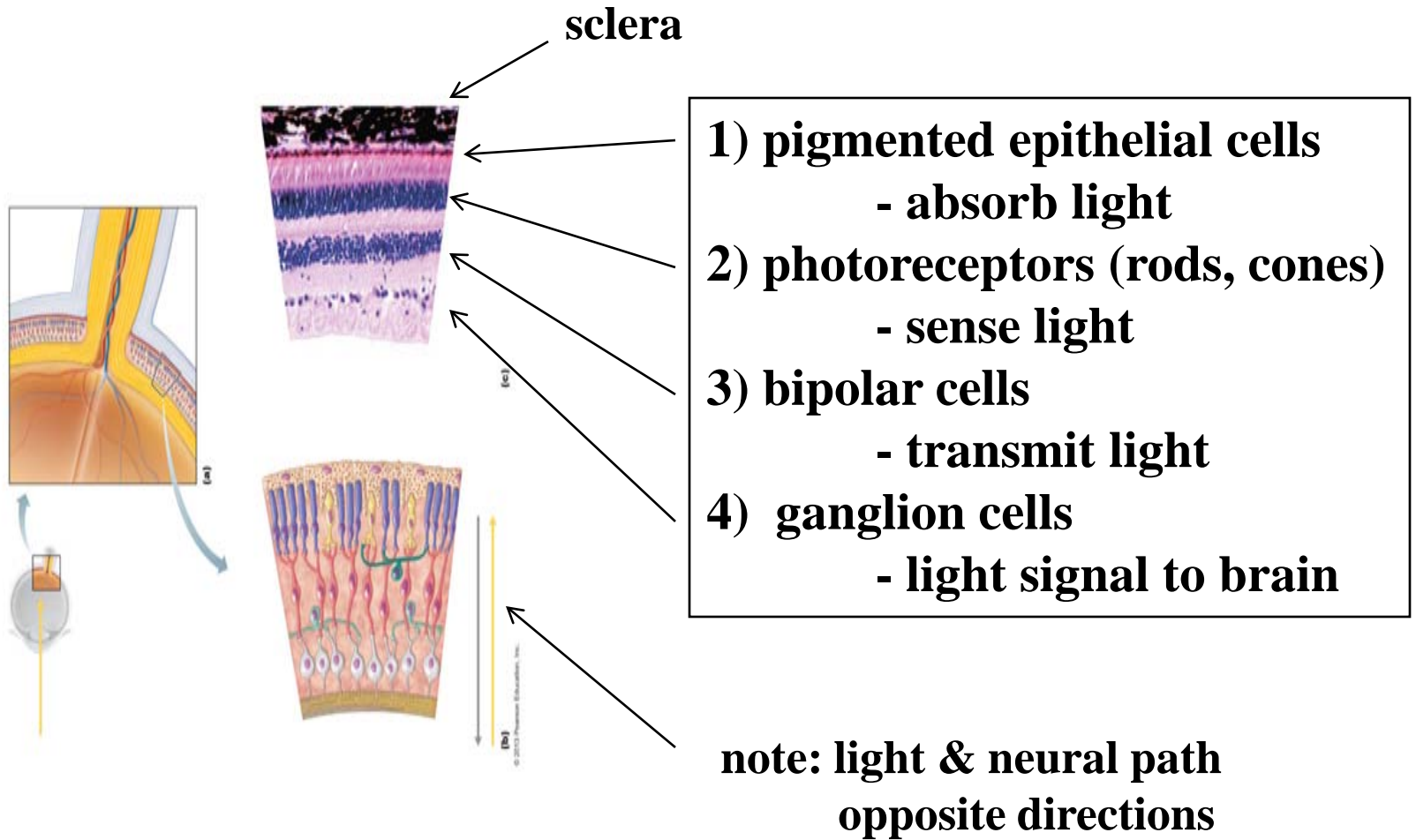
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TABLE 12.1 Functions of Major Brain Regions (continued)

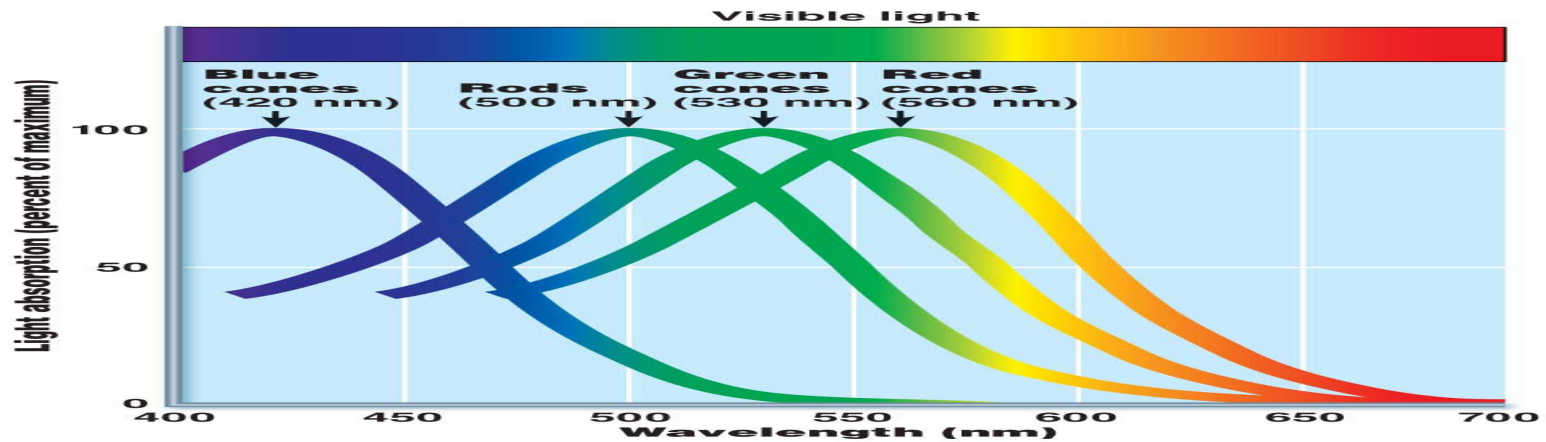
REGION	FUNCTION
Brain Stem (pp. 445–449)	
	<p>Midbrain: Conduction pathway between higher and lower brain centers (e.g., cerebral peduncles contain the fibers of the pyramidal tracts). Its superior and inferior colliculi are visual and auditory reflex centers; substantia nigra and red nuclei are subcortical motor centers; contains nuclei for cranial nerves III and IV.</p> <p>Pons: Conduction pathway between higher and lower brain centers; pontine nuclei relay information from the cerebrum to the cerebellum. Its respiratory nuclei cooperate with the medullary respiratory centers to control respiratory rate and depth. Houses nuclei of cranial nerves V–VII.</p> <p>Medulla oblongata: Conduction pathway between higher brain centers and spinal cord, and site of decussation of the pyramidal tracts. Houses nuclei of cranial nerves VIII–XII. Contains nuclei cuneatus and gracilis (synapse points of ascending sensory pathways transmitting sensory impulses from skin and proprioceptors), and visceral nuclei controlling heart rate, blood vessel diameter, respiratory rate, vomiting, coughing, etc. Its inferior olivary nuclei provide the sensory relay to the cerebellum.</p>
Reticular formation (pp. 452–453)	A functional brain stem system that maintains cerebral cortical alertness (reticular activating system) and filters out repetitive stimuli. Its motor nuclei help regulate skeletal and visceral muscle activity.
Cerebellum (pp. 449–451)	
	Processes information from cerebral motor cortex and from proprioceptors and visual and equilibrium pathways, and provides "instructions" to cerebral motor cortex and subcortical motor centers that result in proper balance and posture and smooth, coordinated skeletal muscle movements.

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Retina - 4 Layers



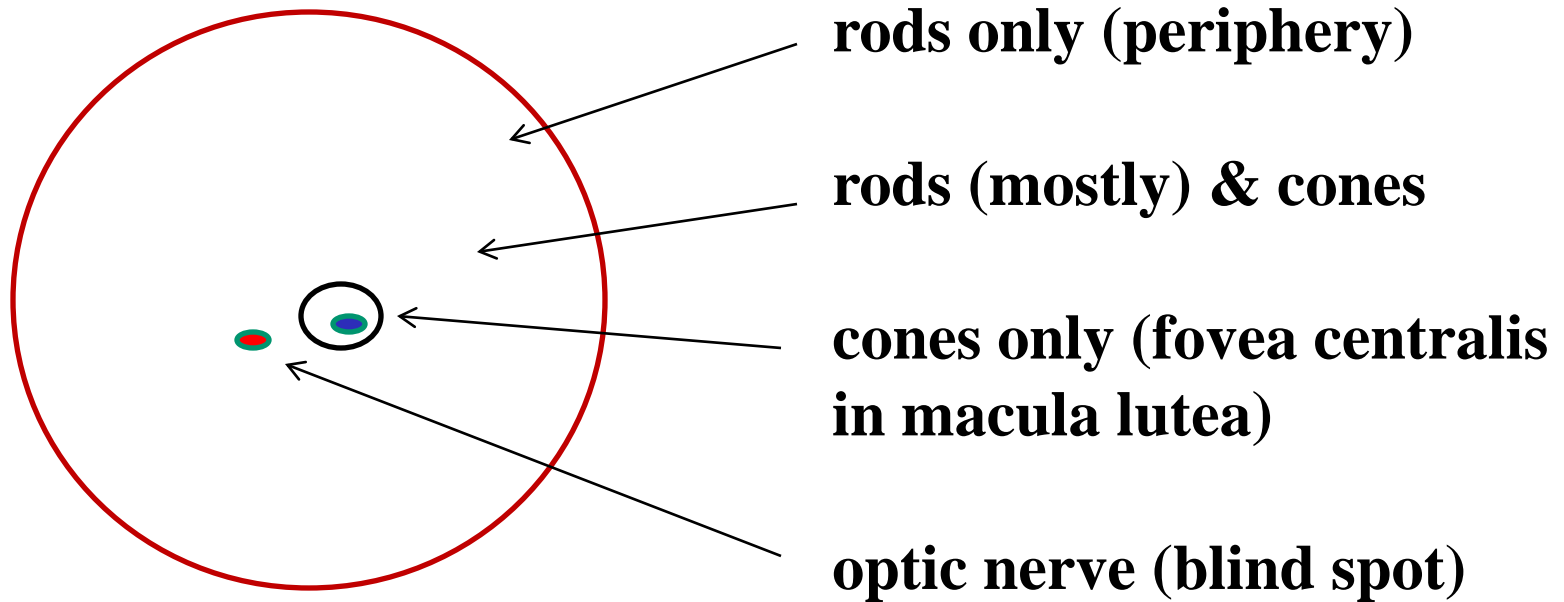
Photoreceptors



(b)
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feature	rods	cones (RGB)
time	night	day
# (mil)	90-120	4-8
retinal site	periphery	center
neural	many to one	one to one
adapt	slow (min)	fast (sec)
usage	peripheral, motion	details, colors

Retinal Layout



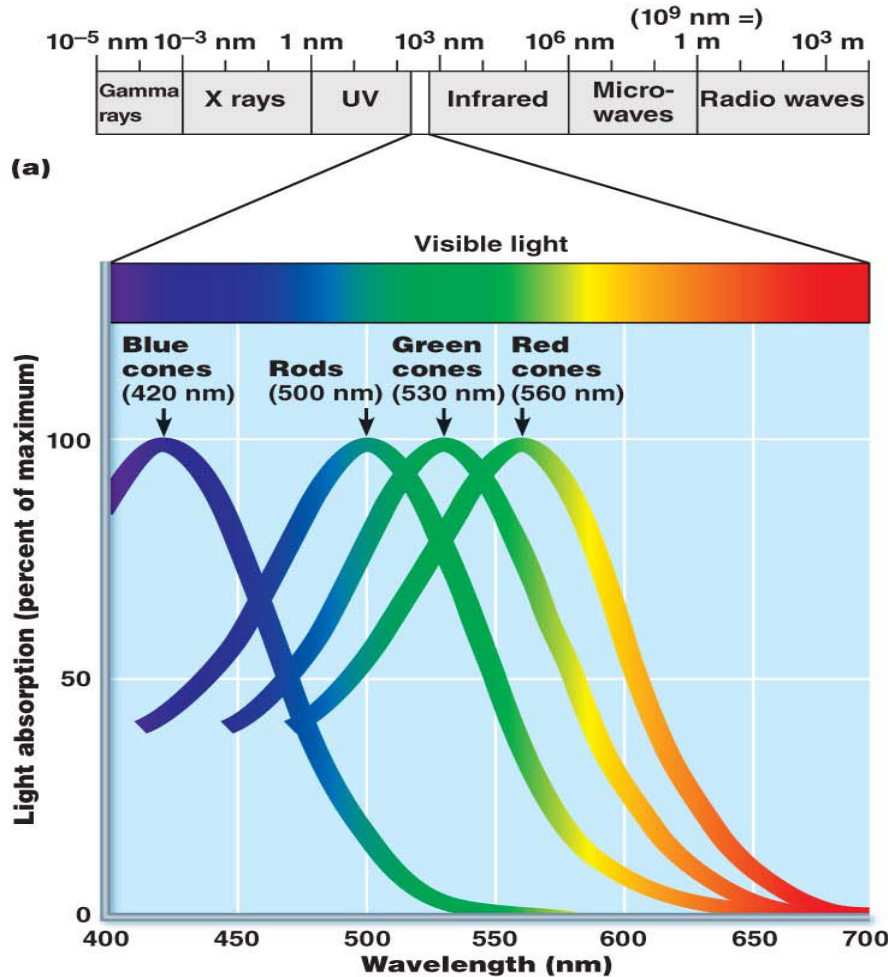
cones: daytime, see well-lit details, colors

- fovea in center, look directly, eg read

rods: night time, see background, little color

- whole eye, look indirectly -> landscape, motion

EM Spectrum

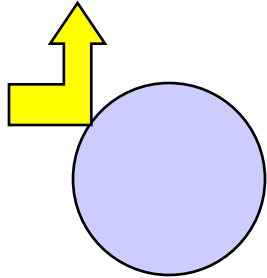


1) visible light
- only part our eyes (photoreceptors) can pick up

2) larger waves
(infr., micro., radio)
- less dangerous

3) smaller waves
(UV, X-ray, gamma)
- dangerous, medical images

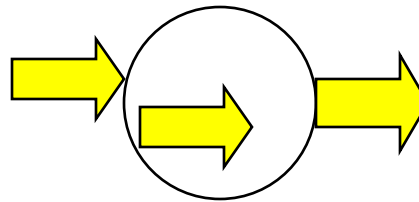
Light Behavior



opaque object

REFLECTION

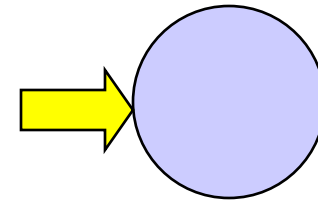
**light cannot pass
light redirected**



clear object

REFRACTION

**light passes thru
light bent**

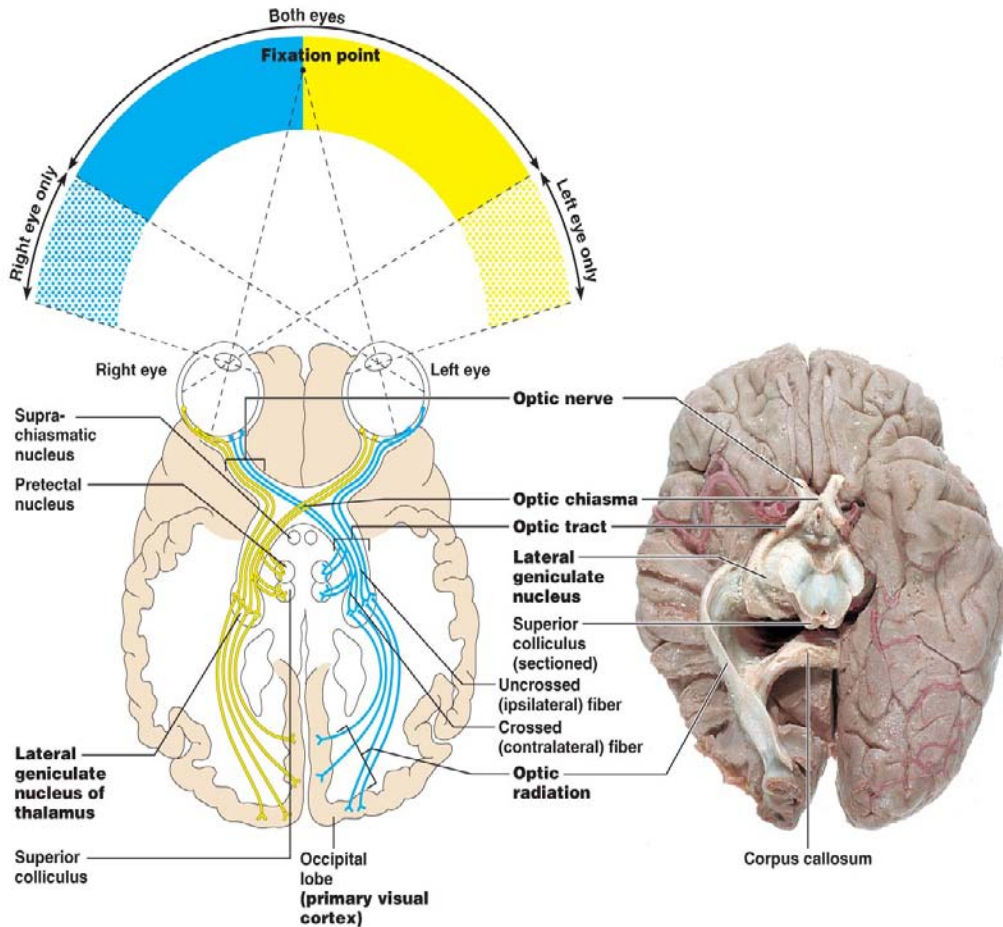


opaque object

ABSORPTION

**light cannot pass
light absorbed**

Visual Path



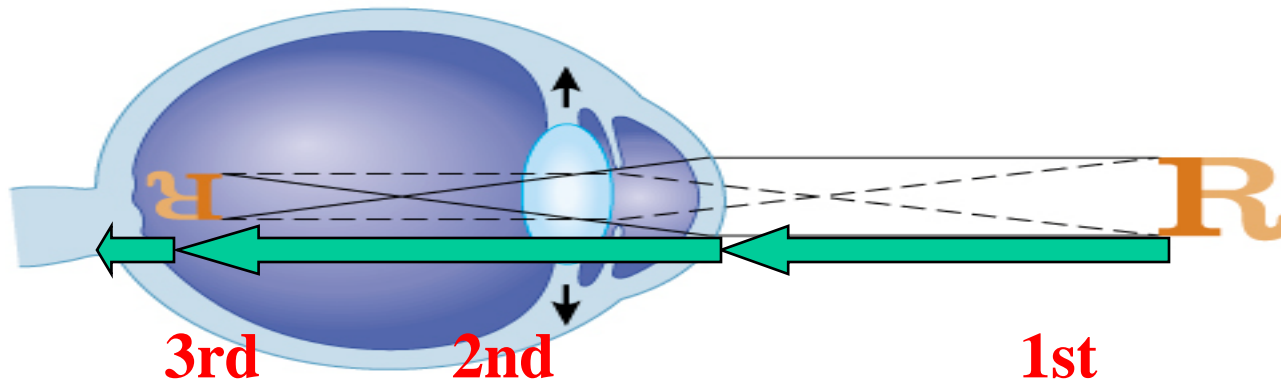
(a) The visual fields of the two eyes overlap considerably. Note that fibers from the lateral portion of each retinal field do not cross at the optic chiasma.

(b) Photograph of human brain, with the right side dissected to reveal internal structures.

- 1) light path
 - form visual image
 - site: eyeball

- 2) neural path
 - proc. visual info.
 - site: a) retina
 - b) ANS
 - c) dien. & b/s
 - d) cerebrum

Light Path



(a) Lens is flattened for distant vision

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1) light reflects (air)

- light bounces off opaque object (R)

2) light refracts (eyeball - clear areas)

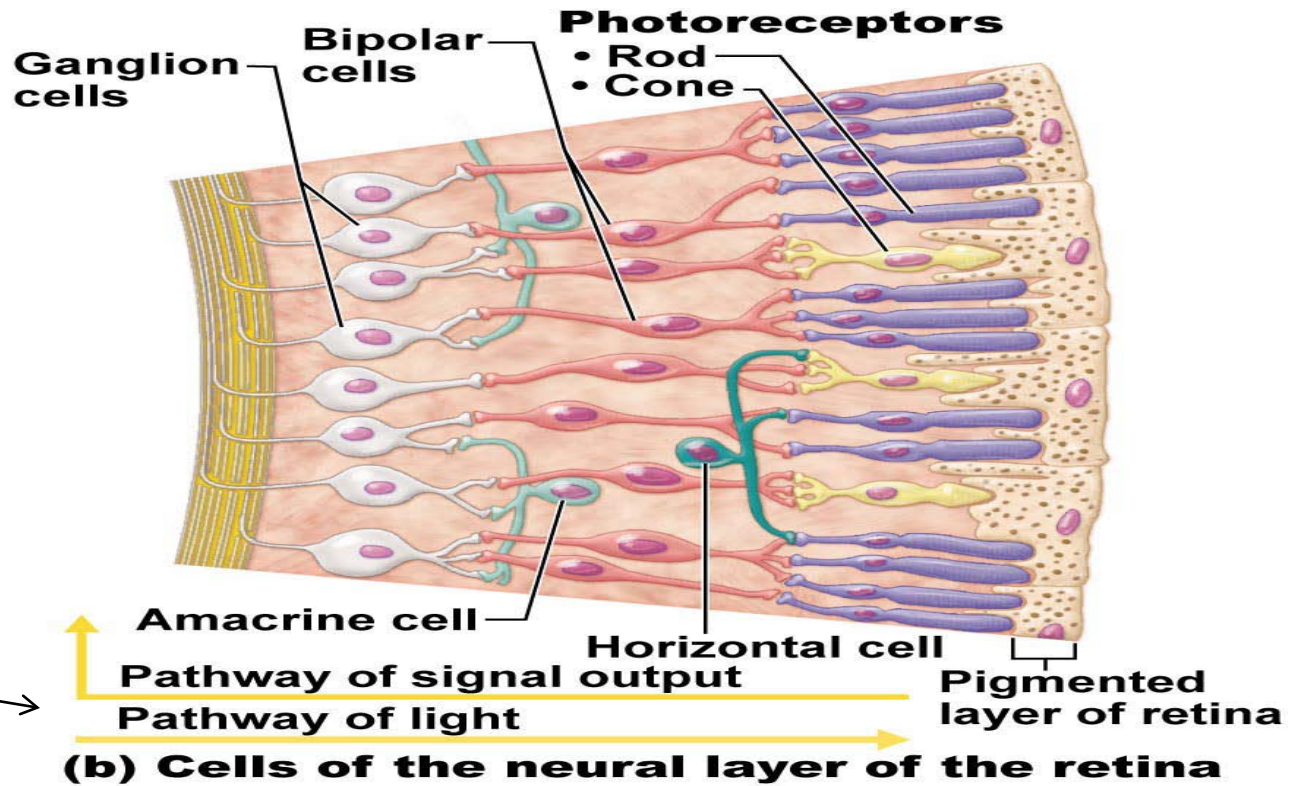
- light passes clear objects and is bent
- cornea -> aqueous h. -> lens -> vitreous h.

3) light absorbed (retina)

- light does not pass thru opaque object
- pigmented layer

Retina - 2 Paths

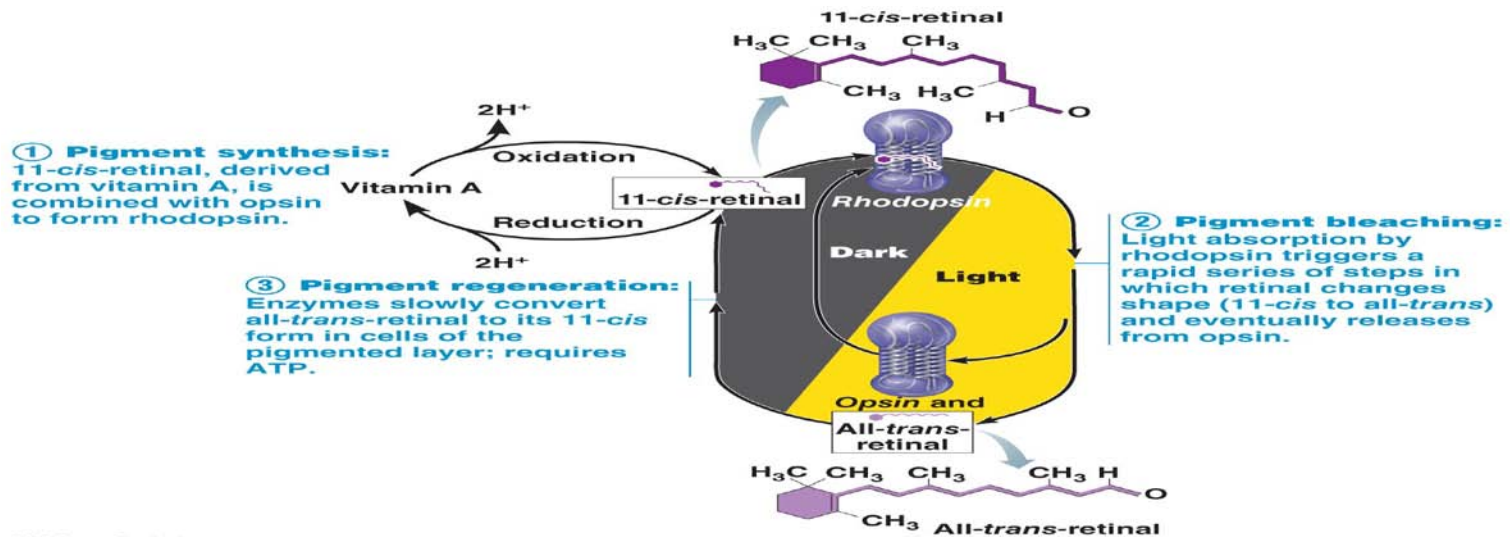
Light Path:	1st	2nd	3rd	4th
Neural Path:	4th	3rd	2nd	1st



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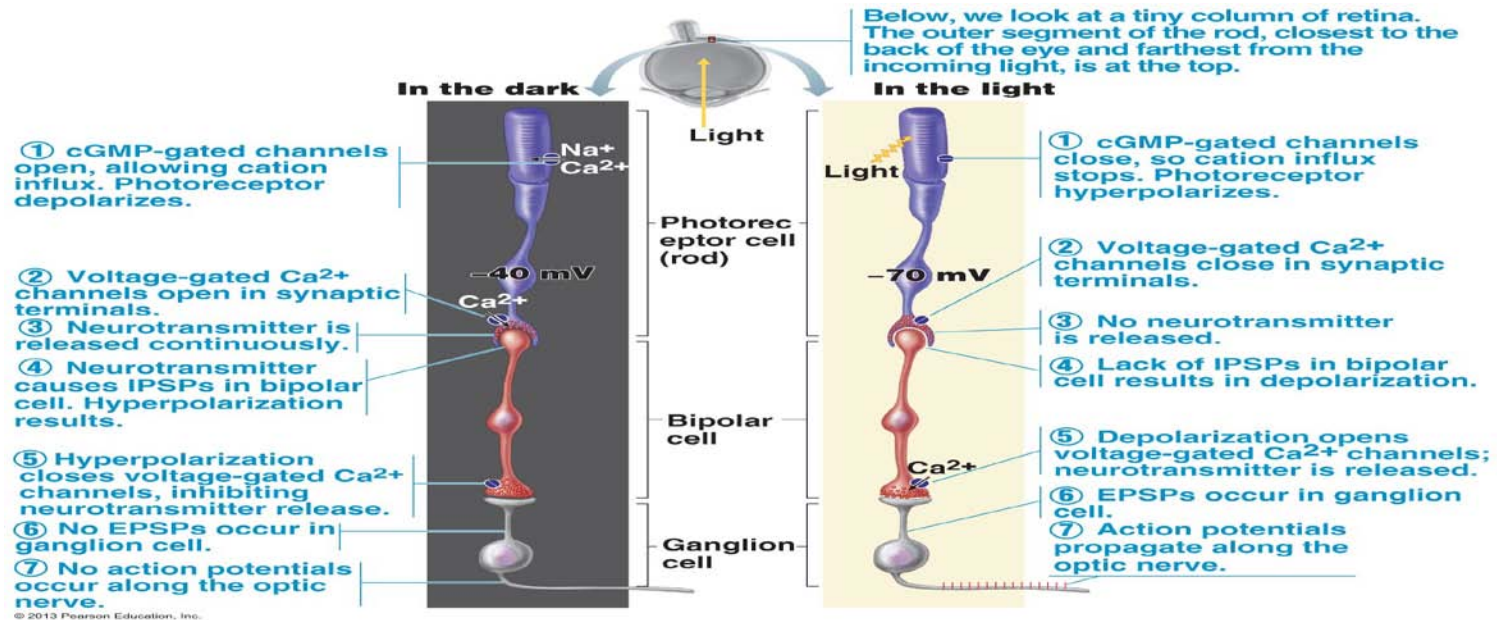
2 paths
- opposite
directions

Light Chemistry (Pigment)



- 1) make pigment: 11-cis-retinal + opsin → rhodopsin
- 2) bleach pigment:
rhodopsin + light: 11-cis-retinal → all-trans-retinal
- 3) remake pigment:
all-trans-retinal → 11-cis-retinal + opsin → rhodopsin

Image Transmits



**light -> photoreceptor hyperpolarize -> bipolar depolarize
-> ganglion EPSP -> ganglion AP propagates optic nerve**

Retinal Functions

A) light path: form image of object on retina

- 1) light reflects off object into eye**
- 2) light refracts object's image thru eye**
- 3) light signal moves thru retinal layers**
- 4) light is absorbed in pigmented layer**

B) neural path: transmit retinal image

- 5) light changes retinal pigment**
- 6) photoreceptor, bipolar, ganglion fires**
- 7) retinal image transmits to brain**

Retinal Image - Features

1) Image formation:

- point by point, with light, the image of an external object is formed on the retina
- no light, no retinal image, no “sight”

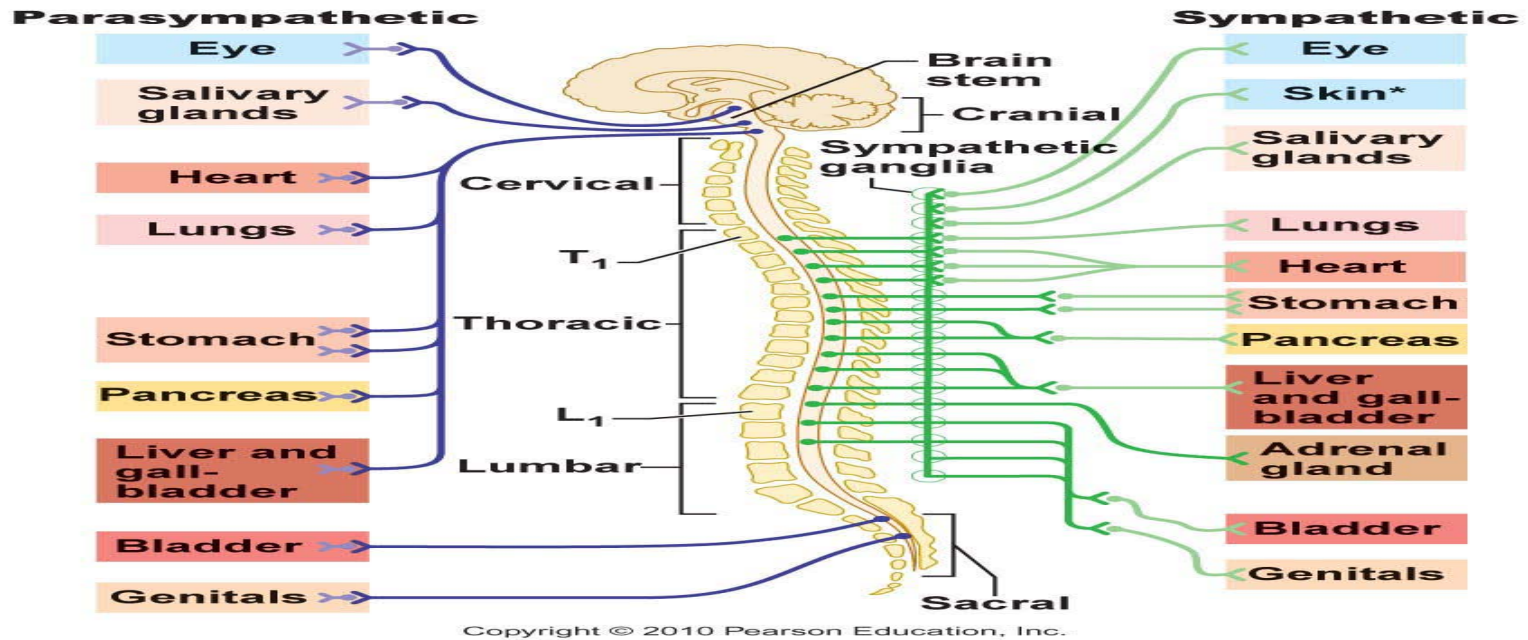
2) Light quality &/or image changes

- > retinal image changes
- motion seen as “blur”, as insuff. time for proper image formation on retina

3) Orientation changes:

- object vs retinal image (ref R image)
top -> bottom, right -> left

ANS - Reflexes



Parasympathetic

close vision (lens bulge)
pupils constrict

Sympathetic

distant vision (lens flatten)
pupils dilate

Dienceph. & Brain Stem

a) diencephalon

1) **hypothalamus: set internal clock**
- eg daily biorhythms, bio. clocks

2) **thalamus: quick response to danger**
- char: crude, fast, focus on center
of image (“face your enemy”)

b) brain stem:

- **midbrain: prepare for action**
- **visual reflexes, eg blink, pupil size changes**

Cerebrum

function:

interpret, understand, respond to visual signal

image slow to form:

- **complete image formation**
 - **incl. form, color, motion, background**
- **comprehensive**
 - **incl. memory & sensory info.**
- **evaluative**
 - **incl. past & future**
- **action oriented**
 - **links to motor responses**

Visual Path Table

path	ipsi-lateral	contra-lateral
photoreceptors	1. same side	1. same side
bipolar cells	2. "	2. "
ganglion soma	3. "	3. "
optic nerve	4. "	4. "
optic chiasma	-	5. cross pt.
optic tract	5. "	6. opp. side
midbrain	-	7. "
hypothalamus	-	8. "
thalamus	6. "	9. "
optic radiation	7. "	10. "
visual cortex	8. "	11. "

Refraction Prob.

2) refraction problems:

a) lens:

- 1) myopia (near-sighted)
- 2) hyperopia (far-sighted)
- 3) cataracts - cloudy lens

b) lens & cornea:

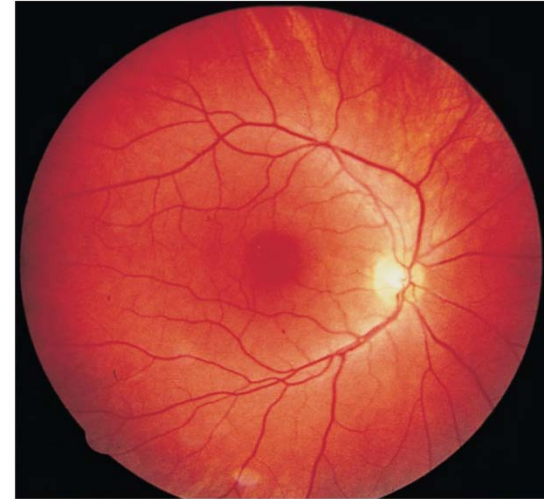
- astigmatism - scratches

c) aq. humour:

- glaucoma - blocked humour ->
↑ eye pressure -> compressed nerves

d) vitr. humour:

- diabetes
- leaky BV -> cloudy humour



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Lubric. & Receptor Prob.

3) eyeball lubrication

- a) sty - infected oil glands
- b) conjunctivitis (pink eye)
 - infected conjunctiva, contagious
- c) watery eyes - blocked tear ducts

4) photoreceptors

- a) color-blindness - impaired cones
(genetic)
- b) night blindness - impaired rods
(age)