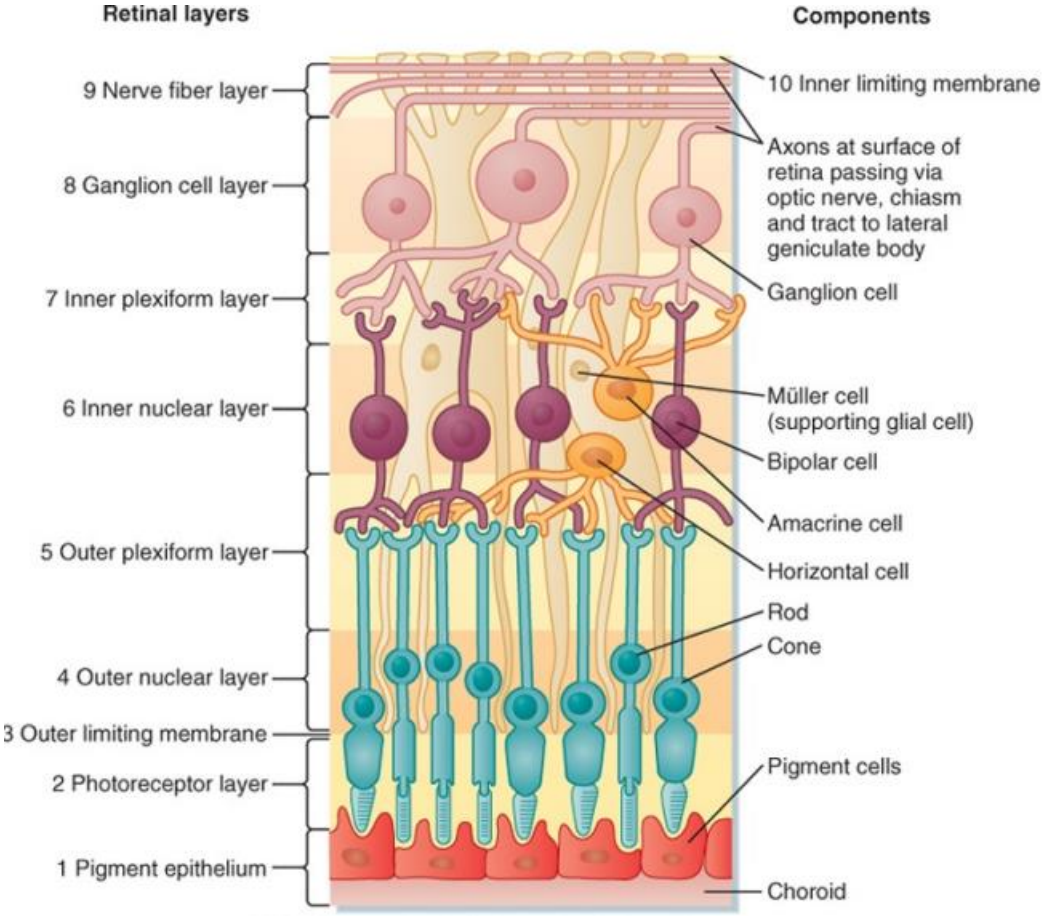
Retina. Phototransduction.

Match retinal layers and components with their functions.



a. Contains ganglion cells, which receive information from bipolar cells and transmit it to the brain.

b. Contains synapses between bipolar, amacrine, and ganglion cells, further processing visual signals.

c. The site of synapses between photoreceptors, bipolar cells, and horizontal cells, which help process visual signals.

d. This outermost layer absorbs excess light, prevents scattering, and provides nutrients to the photoreceptors.

e. Formed by axons of ganglion cells that converge to form the optic nerve, sending visual signals to the brain.

f. Contains the cell bodies of bipolar, horizontal, and amacrine cells, which refine and integrate visual information.

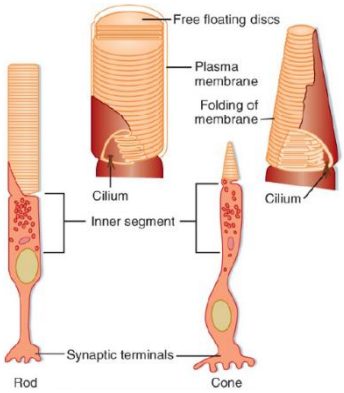
g. Contains rods (for dim light and black-and-white vision) and cones (for color and sharp vision in bright light).

h. Contains the cell bodies of photoreceptors.

1 - …… 2 - …… 4 - …… 5 - …… 6 - …… 7 - …… 8 - …… 9 - ……

Images adapted from : Berne and Levy Physiology, 6th Edition

Fill the gaps



……. are specialized cells in the retina that detect light and convert it into electrical signals, which are sent to the brain for visual processing. There are two main types of photoreceptors: …… and ……. .

…… – These photoreceptors are highly sensitive to low light and enable vision in dim conditions (…… vision). They do not detect color but are essential for night vision and peripheral vision. Rods contain the visual pigment rhodopsin, which helps them function in darkness.

……. – Responsible for color vision and sharp detail (…… vision), cones work best in bright light. They contain different types of opsin pigments that determine their sensitivity to specific wavelengths:

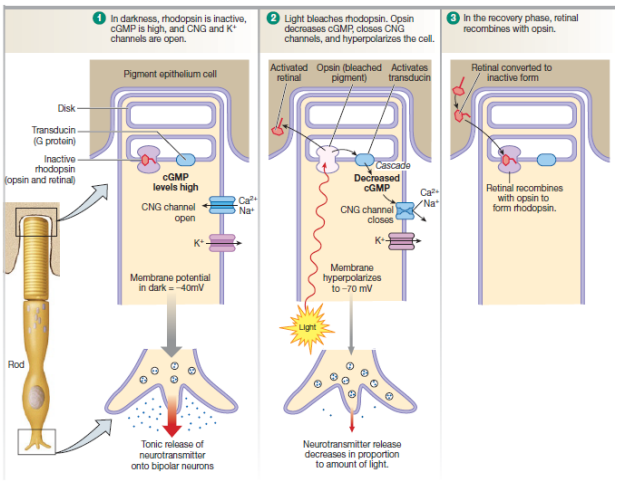
S-cones (short wavelength) – Detect …… light, contain cyanolabe.

M-cones (medium wavelength) – Detect ……. light, contain chlorolabe.

L-cones (long wavelength) – Detect ……. light, contain erythrolabe.

Together, rods and cones allow us to perceive the world in both light and dark conditions, with a full range of colors and details.

Phototransduction.



1. In darkness, photoreceptors are slightly depolarized because cGMP-gated Na+/Ca2+ and K+ channels in their outer segments are open, thereby increasing gNa and driving the membrane potential toward the Na+ equilibrium potential. This net influx of Na+ results in a continuous current, called the dark current.

2. When light is absorbed, the photoisomerization of rhodopsin activates a transducing. This G protein decreases the cGMP concentration in the rod cytoplasm. The reduction in cGMP leads to closing of the cGMP-gated ion channels, hyperpolarization of the photoreceptor membrane, and a reduction in the release of transmitter (glutamate).

3. Bipolar Cells. Glutamate release from photoreceptors onto bipolar neurons begins signal processing. There are two types of bipolar cells, light-on (ON bipolar cells) and light-off (OFF bipolar cells). ON bipolar cells are activated in the light when glutamate secretion by photoreceptors decreases. In the dark, ON bipolar cells are inhibited by glutamate release. OFF bipolar cells are excited by glutamate release in the dark. In the light, with less glutamate, OFF bipolar cells are inhibited. By using different glutamate receptors, one stimulus (light) creates two different responses with a single neurotransmitter. Whether glutamate is excitatory or inhibitory depends on the type of glutamate receptor on the bipolar neuron. ON bipolar cells

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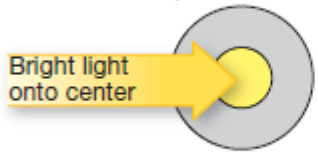
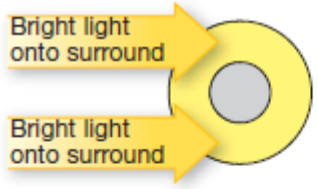
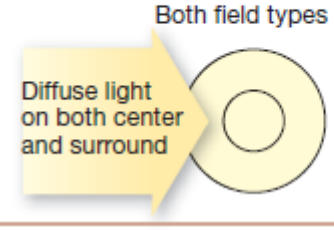
have a metabotropic glutamate receptor that hyperpolarizes the cell when the receptor binds glutamate in the dark. When the receptor is not activated, the ON bipolar cell depolarizes. OFF bipolar cells have an ionotropic glutamate receptor that opens ion channels and depolarizes the OFF bipolar cell in the dark. Bipolar cell signal processing is also modified by input from the horizontal and amacrine cells.

4. Ganglion Cells. Bipolar cells synapse with ganglion cells, the next neurons in the pathway. Each ganglion cell receives information from a particular area of the retina. These areas, known as receptive fields. The receptive field of a ganglion cell near the fovea is quite small. Only a few photoreceptors are associated with each ganglion cell, and so visual acuity is greatest in these areas. At the edge of the retina, multiple photoreceptors converging onto a single ganglion cell results in vision that is not as sharp.

There are two types of ganglion cell visual fields. In an on-center/off-surround field, the associated ganglion cell responds most strongly when light is brightest in the center of the field. If light is brightest in the off-surround region of the field, the on-center/off-surround field ganglion cell is inhibited and stops firing action potentials. The reverse happens with off-center/on-surround fields. These On-Off receptive fields help the brain to detect contrast, edges, and transitions between light and dark areas, which are essential for forming a clear image. These functions are especially important in tasks like edge detection and visual contrast sensitivity.

Visual field type	Field is on-center/off-surround	Field is off-center/on-surround
On-center, off-surround 	Ganglion cell is excited by light in the center of the visual field.	Ganglion cell is inhibited by light in the center of the visual field.
Off-center, on-surround 	Ganglion cell is inhibited by light on the surround of the visual field.	Ganglion cell is excited by light on the surround of the visual field.
Both field types 	Ganglion cell responds weakly.	Ganglion cell responds weakly.

There are multiple types of ganglion cells in the retina. The two predominant types, which account for 80% of retinal ganglion cells, are M cells and P cells. Large magnocellular ganglion cells, or M cells, are more sensitive to information about movement. Smaller parvocellular ganglion cells, or P cells, are more sensitive to signals that pertain to form and fine detail, such as the texture of objects in the visual field.

Images adapted from : Berne and Levy Physiology, 6th Edition