UNIT-IV
SPECIAL SENSES
Human Eye: Anatomy, parts and structure

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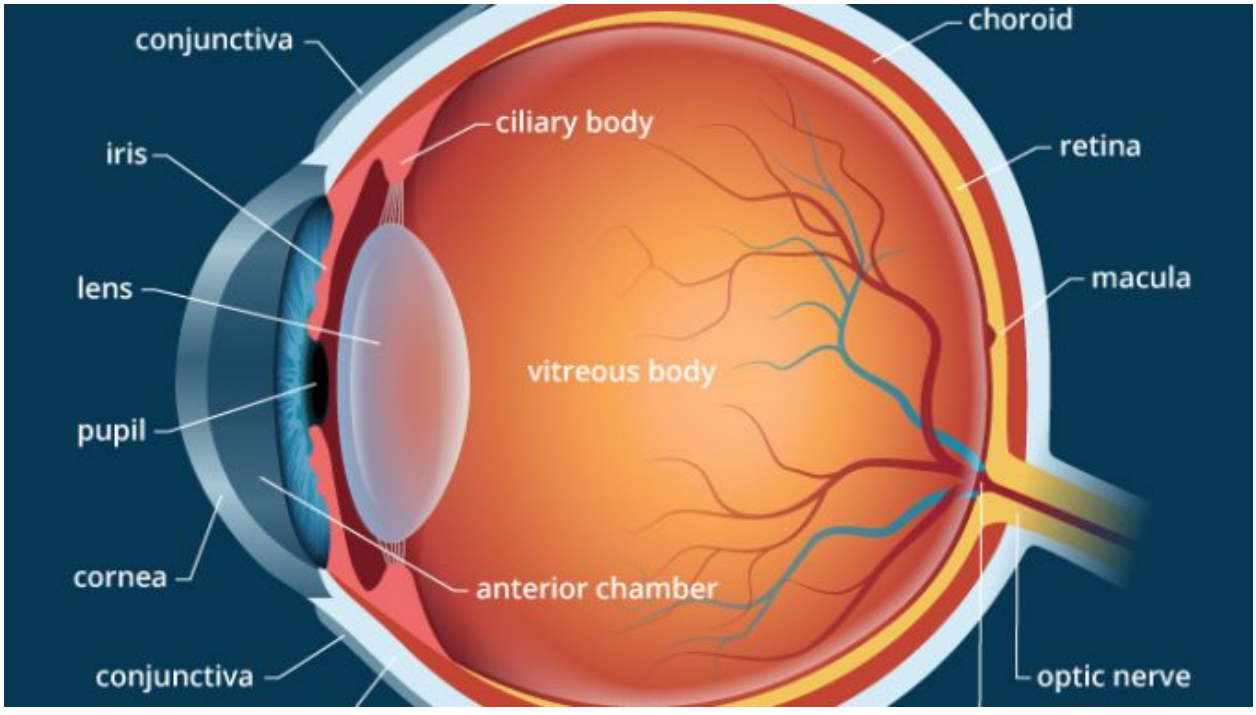
a) Eye is the photo-receptor organ.
b) **Size and shape:** Human eye is spherical about 2.5 cm in diameter.
c) **Location:** it is situated on an orbit of skull and is supplied by optic nerve.
d) There are 6 sets of muscles attached to outer surface of eye ball which helps to rotate it in different direction.
e) Four sets of these muscles are straight muscles; superior, inferior, medial and lateral rectal muscle and two sets are oblique muscles; superior and inferior oblique muscles.
f) Structurally two eyes are separated but some of their activities are coordinated so that they functions as a pair.

Anatomical structure of Eye

Eye ball consists of three layers

1. **Outer fibrous layer**: Sclera, cornea and conjunctiva
2. **Middle vascular layer:** ciliary body, choroid and iris
3. **Inner layer:** retina



I. Outer fibrous layer

It consists of following parts.

1. Sclera

a) It is outermost supporting layer consists of thick membrane of tough fibrous connective tissue.
b) It covers 5/6 parts of eye ball.
c) It maintains the shape of eye and provide attachment to the extrinsic muscle of eye.

2. Cornea

a) It is a thin transparent front part of sclera.
b) It forms a slight bulge at the front and covers an anterior 1/6 part of sclera.
c) Cornea is avascular and absorbs oxygen from air.
d) It refracts light to focus on retina.

3. Conjunctiva

a) Cornea further extends with a membranous structure called conjunctiva
b) It is a thin transparent layer that covers the cornea.
c) It is formed of single layer of stratified squamous epithelium.
d) It protects the cornea.

II. Middle vascular layer:

It consists of following parts

1. Choroid

a) It is thick vascular and pigmented layer situated below sclera.
b) The pigmented cells absorbs light and prevent it from being reflected.
c) The function of choroid is to provide nutrition and to prevent reflection of light.

2. Ciliary body

a) These are attached to choroid and present at the junction of sclera and cornea.
b) It consists of two sets of ciliary muscle and suspensory ligament.
c) Ciliary body is attached to lens and holds it in position.
d) Its function is to change the shape of lens by contraction or relaxation of muscle.

3. Iris

a) It is muscular, pigmented and opaque diaphragm which hangs in the eye ball in front of lens.
b) It has small circular opening called pupil.
c) It has two types of muscles; circular and radial muscle. The movement of these muscles control the size of pupil.

d) Pigment in iris gives color to eye.
e) Iris control the amount of light entering into eye by controlling the size of pupil.

III. Inner layer

It consists of photoreceptor cells and photo sensitive elements.

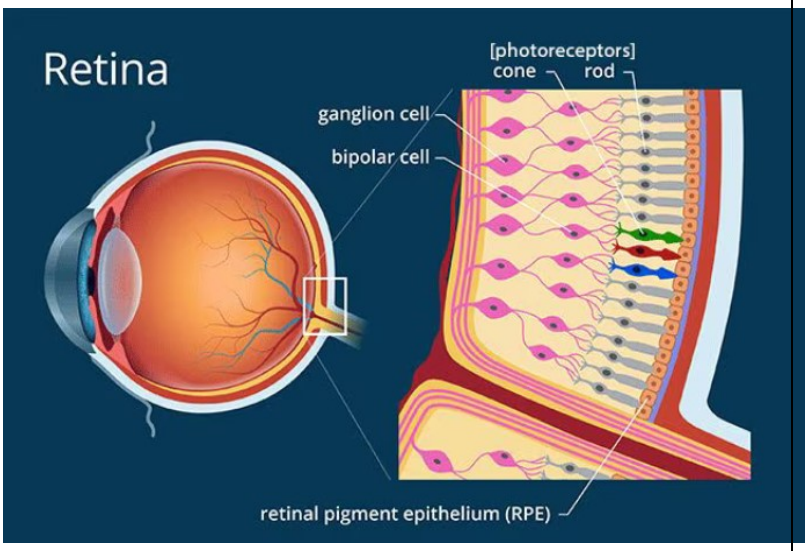
1. Retina

- Retina is innermost layer.
- Neuroretina contains highly specialized photoreceptor nerve cells; rods and cones
- Each eye ball has 125 millions of rod cells and 7 millions of cone cells.
- Small depression in retinal wall is called **Fovea centralis,** contains only cone cells . this structure is present in centre of a yellow part called **yellow spot**.
- Fovea centralis is highly sensitive to light and forms magnified image and give sharp and acute vision.
- Retina have **photoreceptor** cell as **Rods and Cones**.
- The optic nerve enter retina at a point called **blind spot**. It does not contains any rods or cone cells. It is least sensitive to light and forms no image when light falls on blind spot

Types of Photoreceptors

Rod cell

a) **Rods** are sensors for perception of black to white shades
b) Night vision is almost rod vision.
c) It function in dim light
d) Contains a photosensitive pigment **Rhodopsin** formed from vitamin A.



Cone cell

a) Cones are sensors for perception of colors.
b) It functions in bright light and differentiate colors.
c) Contains a photosensitive pigment **Iodopsin**.

Eye lens and chambers

1. Eye Lens

- It is a large, flexible, transparent biconvex and fibrous crystalline body situated behind iris.

- Lens is enclosed in a transparent elastic capsule.
- Ciliary muscles control the thickness of lens and its power of accommodation.
- It forms the image of the object on retina.
- Lens separates the eye ball into two chamber

i. Aqueous chamber

ii. Vitreous chamber

Aqueous chamber

- It is a smaller fluid filled chamber between cornea and lens.
- It is filled with aqueous humour containing aminoacids, glucose, ascorbic acid, hyaluronic acid and respiratory gases.
- The aqueous humour nourishes the lens and cornea and refracts light rays to focus on retina.

Vitreous chamber

- It is a larger fluid filled chamber between lens and retina.
- It is filled with gelatinous vitreous humour containing salts and muco proteins
- It supports retina and refracts light to focus on retina.

Eye Muscles

The muscles of the eye are responsible for both the movement of the eyeball within its socket and the adjustment of internal structures for focusing and light regulation. They are divided into two main categories: Extrinsic (outer) and Intrinsic (inner) muscles.

1. Extrinsic Eye Muscles

These are six voluntary muscles located on the outside of the eyeball. They are responsible for controlling the movement of the eye in different directions.

The Rectus Muscles (Four)

These muscles pull the eye directly in the direction of their name:

- **Superior Rectus:** Moves the eye upward.
- **Inferior Rectus:** Moves the eye downward.
- **Medial Rectus:** Moves the eye toward the nose (adduction).
- **Lateral Rectus:** Moves the eye away from the nose (abduction).

The Oblique Muscles (Two)

These muscles are responsible for rotation and more complex angled movements:

- **Superior Oblique:** Rotates the eye downward and outward.
- **Inferior Oblique:** Rotates the eye upward and outward.

2. Intrinsic Eye Muscles

These are involuntary (smooth) muscles located inside the eye. They adjust the eye's internal structures to allow for proper vision.

- **Ciliary Muscle:** Changes the shape of the **lens** to focus on near or far objects, a process called accommodation.
- **Iris Muscles:**
  - **Sphincter Pupillae:** Constricts the pupil in bright light (Parasympathetic).
  - **Dilator Pupillae:** Widens the pupil in dim light or during "fight or flight" responses (Sympathetic).

Eye Muscles	Muscle tested	Movement
SR: superior Rectus	SR	 Looks laterally and upwards
IR: Inferior Rectus	IR	 Looks laterally and downwards
LR: Lateral Rectus	LR	 Looks laterally
MR: Medial Rectus	MR	 Looks medially
IO: Inferior Oblique	IO	 Looks medially and upwards
SO: Superior Oblique	SO	 Looks medially and downwards

PHYSIOLOGY OF VISION

The physiology of vision is a complex process that converts light waves from the environment into electrical signals that the brain can interpret as images. This process can be broken down into four main stages.

1. Refraction and Focusing of Light

Light rays enter the eye and must be bent (refracted) so they converge exactly on the **retina** at the back of the eye.

- **The Cornea:** Performs the majority of the light refraction.
- **The Lens:** Undergoes **accommodation** (changing shape) to fine-tune the focus for near or distant objects.
- **The Pupil:** Constricts or dilates to regulate the amount of light entering the eye, preventing "overexposure" of the retinal cells.

2. Phototransduction (The Chemical Spark)

This occurs in the retina, where specialized cells called **photoreceptors** convert light energy into electrical changes.

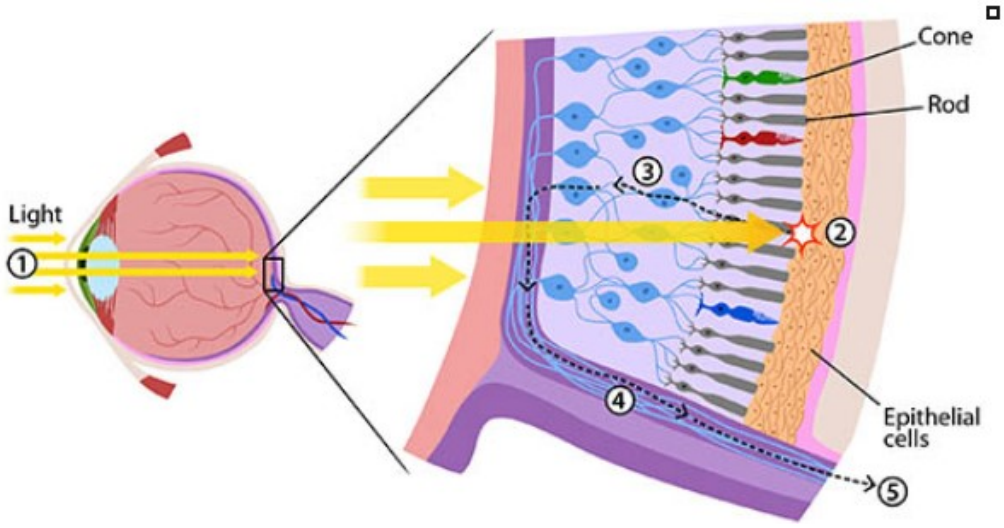
- **Rods:** Responsible for vision in dim light (scotopic vision); they are highly sensitive but do not perceive color.
- **Cones:** Responsible for color vision and high visual acuity (photopic vision); they function best in bright light.
- **The Pigment Cycle:** When light hits the photopigment **rhodopsin** (in rods), it splits into **opsin** and **retinal**. This chemical change triggers a hyperpolarization of the cell, which starts the electrical signal.

3. Processing in the Retina

Before the signal even leaves the eye, the retina performs "pre-processing."

- The signal travels from the **photoreceptors** to **bipolar cells**, and then to **ganglion cells**.

- Horizontal and amacrine cells help provide contrast enhancement, allowing us to see edges and movements more clearly.



4. The Visual Pathway to the Brain

The final electrical impulses are carried via the optic nerve to the brain's "processing center."

- **Optic Nerve:** Carries axons from the ganglion cells out of the eye.
- **Optic Chiasm:** Where some nerve fibers cross to the opposite side of the brain, allowing for **binocular vision** (depth perception).
- **Lateral Geniculate Nucleus (LGN):** A relay station in the thalamus.
- **Primary Visual Cortex (V1):** Located in the occipital lobe, where the brain finally interprets the signals as shape, color, and motion.