SUBJECT

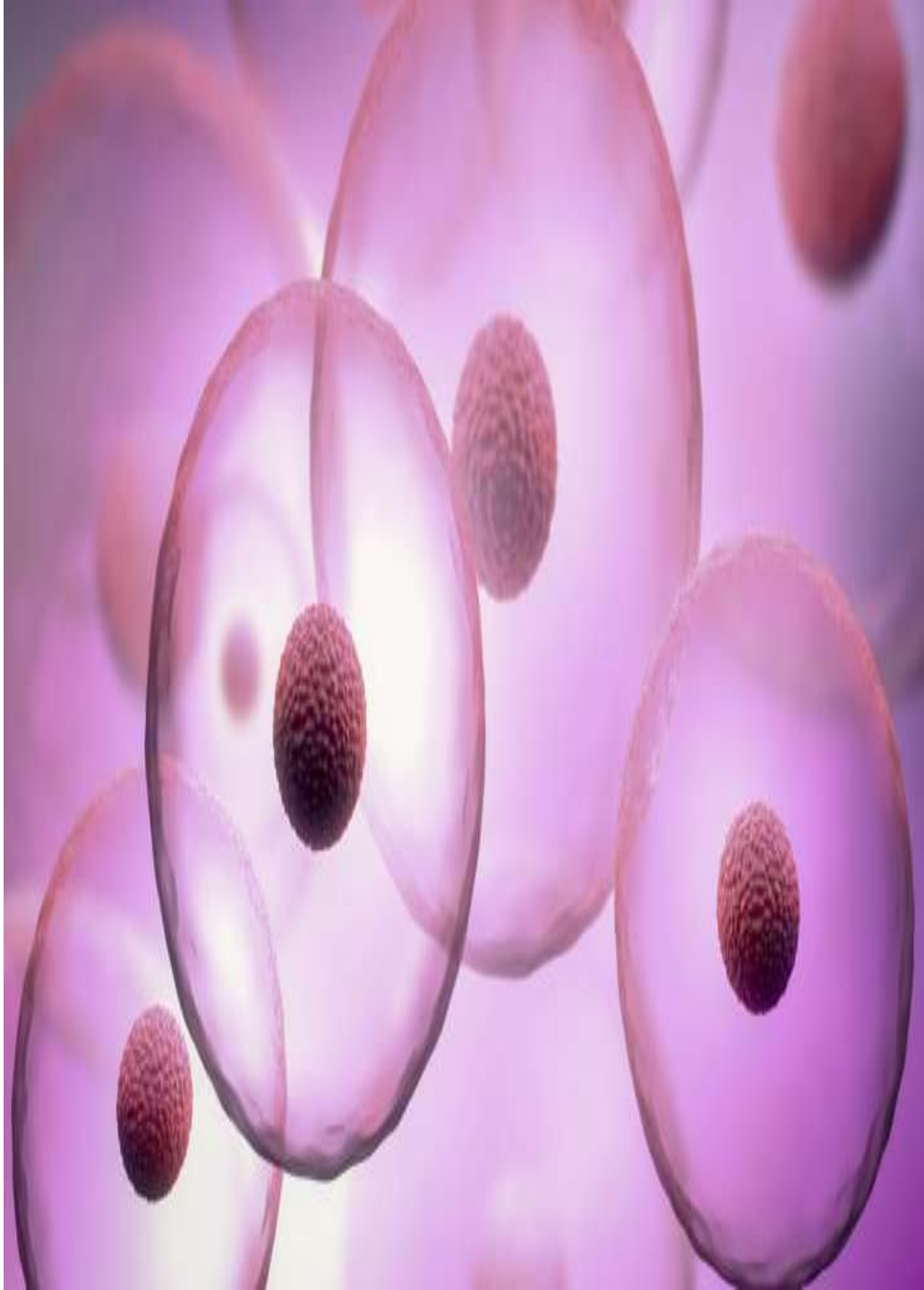
BIOLOGY

TOPIC

SENSE ORGAN

CLASS

S.S. 3



SENSE ORGANS

LEARNING OBJECTIVES

1. Describe the structure of the mammalian ear.
2. Explain the functions of the ear (hearing and balance).
3. Describe the mammalian eye and explain the functions of its various parts.
4. Explain the functions of the eye: - image formation - accommodation
5. Explain the terms myopia, hypermetropia, astigmatism, cataracts and night blindness
6. Name the kind of lens that can be used to correct myopic and hypermetropia defects.

THE EAR

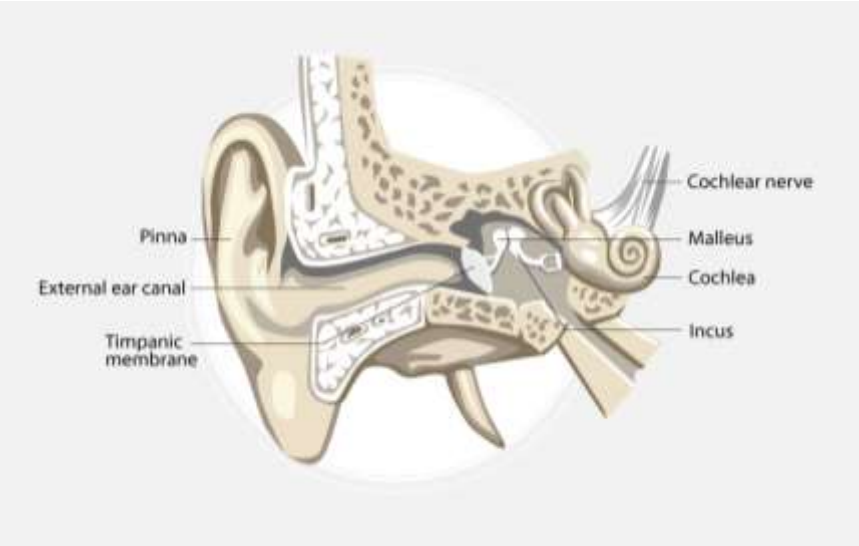
This is one of sensitive organ of the human body. It is mainly concerned with detecting, transmitting and transducing (converting) sound. This is known as hearing or audio caption.

Maintaining a sense of balance is another important function performed by the human ear. The hair cells present in the inner ear of mammals help in sensing the position of the body, in accordance with gravity and maintain the equilibrium.

STRUCTURE OF THE EAR

Structure of ear comprises three main sections:

1. The outer ear,
2. The middle ear
3. The inner ear



THE OUTER EAR

AURICLE (PINNA)

The auricle comprises a thin plate of elastic cartilage covered by a layer of skin. It consists of funnel-like curves that collect sound waves and transmits them to the middle ear. It also has very fine hairs and glands. The glands secrete wax. It protects foreign organisms and dust from entering.

EXTERNAL AUDITORY MEATUS/CANAL

It is a slightly curved canal supported by bone in its interior part and cartilage in the exterior part. The meatus or the canal is lined with stratified epithelium and wax glands.

TYMPANIC MEMBRANE OR EARDRUM

This is made up of connective tissue. Skin covers the outer portion and from inside, it is covered by mucous membrane. It separates the middle ear from the outer ear. It receives and amplifies the sound waves.

Pinna receives the sound in the form of vibration. The sound waves reach and vibrate the eardrum through the external auditory canal.

THE MIDDLE EAR

This part of the ear consists of the following:

Tympanic Cavity

This is a narrow air-filled cavity separated from the external ear by tympanic membrane and from inner ear by the bony wall. The tympanic cavity has an auditory tube known as the eustachian tube in its anterior wall.

THE EUSTACHIAN TUBE

This is the connection between the middle ear and the pharynx. It equalises pressure between the middle ear and the outer atmosphere.

EAR OSSICLES

These are responsible for transmitting sound waves from the eardrum to the middle ear. There are three ear ossicles in the human ear:

MALLEUS:

A hammer-shaped part that is attached to the tympanic membrane through the handle and incus through the head. It is the largest ear ossicle.

INCUS:

An anvil-shaped ear ossicle connected with the stapes.

STAPES:

It is the smallest ossicle and also the smallest bone in the human body. It is stirrup-shaped and attached to the oval window of the cochlea.

THE INNER EAR

This portion is also known as labyrinth. It is composed of a group of interconnected canals and sacs.

The membranous labyrinth is present inside the **bony labyrinth** and surrounded by a fluid known as **perilymph**.

The **endolymph** is filled within the membranous labyrinth.

Auditory receptors are located in the cochlea and vestibular apparatus maintains the body balance.

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Cochlea (Auditory Organ)

The Cochlea is a coiled portion of the membranous labyrinth, which looks like a snail. The cochlea is made up of three canals, namely;

- The scala vestibuli/Vestibular Canal is filled with the perilymph and terminates at the oval window.
- The scala tympani/Lower Tympanic Canal is also filled with the perilymph and ends at the opening in the middle ear, i.e. round window.
- The scala media/Middle Cochlea Duct is filled with endolymph and contains the auditory organ known as the organ of Corti.

Each **organ of Corti** contains ~18000 hair cells**.**

The Reissner's membrane separates scala media and scala vestibuli.

The Basilar membrane, which separates scala media from scala tympani.

Stereocilia project from the hair cells and extend till the cochlea duct.

Hair cells present in the cochlea detect pressure waves, there are sensory receptors (afferent nerves) present at the base of hair cells that send signals to the brain.

Vestibular apparatus (Equilibrium organ)

Vestibular apparatus maintains the equilibrium and is present above the cochlea. It is present in the membranous labyrinth. It has two sac-like chambers called saccule and utricle and three semicircular canals.

Saccule and **utricle** have macula, which is a projecting ridge.

Macula has hair cells, which are sensory.

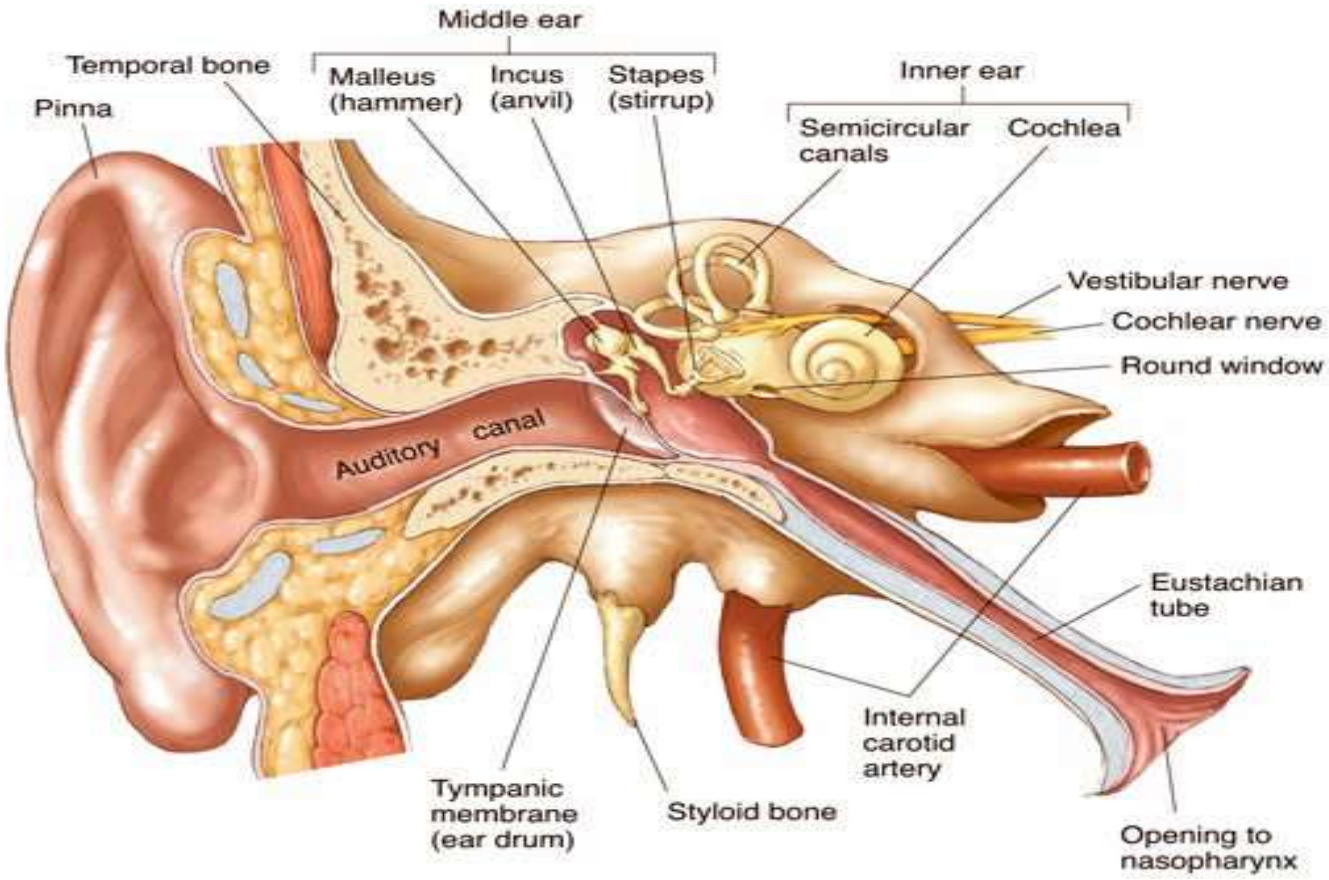
Stereocilia are covered by ampullary cupula, which is gelatinous and otoliths are embedded in it.

Otoliths are calcium ear stones, which press stereocilia against gravity and play an important role in spatial orientation.

Each **semicircular canal** is filled with endolymph and present at the right angle to each other and connects to the utricle. The base of canals is swollen and known as the ampulla.

Crista ampullaris is present in each of the ampulla and responsible for sensing angular rotation. It has hair cells.

There are no otoliths present in cristae like maculae of saccule and utricle and stereocilia of hair cells are stimulated by the movement of endolymph in the canals.


Middle ear
Temporal bone
Pinna
Malleus (hammer)
Incus (anvil)
Stapes (stirrup)
Inner ear
Semicircular canals
Cochlea
Vestibular nerve
Cochlear nerve
Round window
Auditory canal
Eustachian tube
Internal carotid artery
Tympanic membrane (ear drum)
Styloid bone
Opening to nasopharynx

THE PROCESS OF HEARING

Sound waves enter the outer ear and travel through the ear canal to the middle ear.

The ear canal channels the waves to the eardrum which vibrates. The vibration then continues on to the three ear ossicles (malleus, incus, stapes).

The stirrup touches a liquid filled sack and the vibrations travel into the cochlea. Inside the cochlea, a vestibular system formed by three semi-circular canals are responsible for the sense of balance and spatial orientation of the vibration. The movement of these particles over small hair cells in the inner ear sends signals to the brain that are interpreted as motion and acceleration.

MAINTAINING EQUILIBRIUM

Equilibrium is a response to movements of the head - Example: a cat landing on its feet if dropped from upside down.

Vestibular Apparatus is the equilibrium receptors of the inner ear.

Equilibrium is divided into static and dynamic equilibrium.

STATIC EQUILIBRIUM

maintained by macula of saccule and utricle. Otoliths press against stereocilia due to gravitational pull and stimulate the initiation of a nerve impulse. When the head is tilted or moves in a straight line with increasing speed, otoliths press on stereocilia of different cells. The brain interprets the nerve impulses resulting in the awareness of body position with respect to ground, irrespective of the head position.

Utricle responds to the vertical movement and Saccule responds to the sideways movement of the head.

DYNAMIC EQUILIBRIUM

This is detected by cristae of semi-circular canals. When the head moves in an angular direction, the endomlymph lags behind as the cupula drags against the stationary endolymph, the cupula bends.

This stimulates hair cells to transmit signals to the vestibular nerve.

THE EYES

The eyes are the visual sensory organs in the body. These are sensitive to light images. The eyes vary in colour depending upon the amount of melanin present in our body. It helps in the sense of sight by detecting and focussing on the light images.

STRUCTURE AND FUNCTIONS OF THE EYES

The eyes is the most complicated sense organs of the animal body and every muscles, tissues, nerves and blood vessels of the eyes is responsible for certain action.

From an anatomical perspective, the human eye can be broadly classified into 3 layers

1. Outer Layer
2. Middle Layer
3. Inner Layer

THE OUTER LAYER

SCLERA OR SCLEROID LAYER (WHITE OF EYE)

This is the outermost layer that forms the eyeball- a tough protective layer of connective tissue that helps maintain the shape of the eye and provides an attachment for the muscles that move the eye

CONJUNCTIVA

Membrane inside the eyelid attached to the sclera

CORNEA

This is the transparent surface covering the iris and pupil- a clear, dome-shaped part of the sclera covering the front of the eye through which light enters the eye

ANTERIOR CHAMBER

This is a small chamber between the cornea and the pupil

AQUEOUS HUMOUR

This is the fluid behind the cornea. It is the clear fluid that fills that anterior chamber of the eye and helps to maintain the shape of the cornea providing most of the nutrients for the lens and the cornea and involved in waste management in the front of the eye.

THE MIDDLE LAYER

CHOROID LAYER

This is the middle layer of the eye containing may blood vessels.

CILIARY BODY

This is a circular band of muscle that is connected and sits immediately behind the iris. It produces aqueous humour, changes shape of lens for focusing.

IRIS

It is the pigmented, coloured portion of the eye, visible externally. The main function of the iris is to control the diameter of the pupil according to the light source.

PUPIL

A small opening in the iris is known as a pupil. Its size is controlled by the help of iris. It controls the amount of light that enters the eye.

LENS

This is the transparent structure behind the pupil. By the action of ciliary muscles, it changes its shape to focus light on the retina. It becomes thinner to focus distant objects and becomes thicker to focus nearby objects.

VITREOUS HUMOUR

it is a transparent, jelly-like substance present between the lens and the retina. It contains water (99%), collage, proteins, etc. The main function of vitreous humour is to protect the eyes and maintain its spherical shape.

THE INNER LAYER

RETINA

It is a light-sensitive layer that consists of numerous nerve cells. It converts images formed by the lens into electrical impulses. These electrical impulses are then transmitted to the brain through optic nerves.

OPTIC NERVES

These are the nerves that transmit electrical impulses to the brain from the brain. There are of two types. These include cones and rods.

- **Cones**: Cones are the nerve cells that are more sensitive to bright light. They help in detailed central and colour vision.
- **Rods**: Rods are the optic nerve cells that are more sensitive to dim lights. They help in peripheral vision.

At the junction of the optic nerve and retina, there are no sensory nerve cells. So no vision is possible at that point and is known as a **blind spot**.

Macula is the central area of the retina surrounding the Fovea and it is responsible for central vision

Fovea is the central pit in the macula that produces the sharpest vision. Most cones are located here

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EXTRAOCULAR MUSCLES

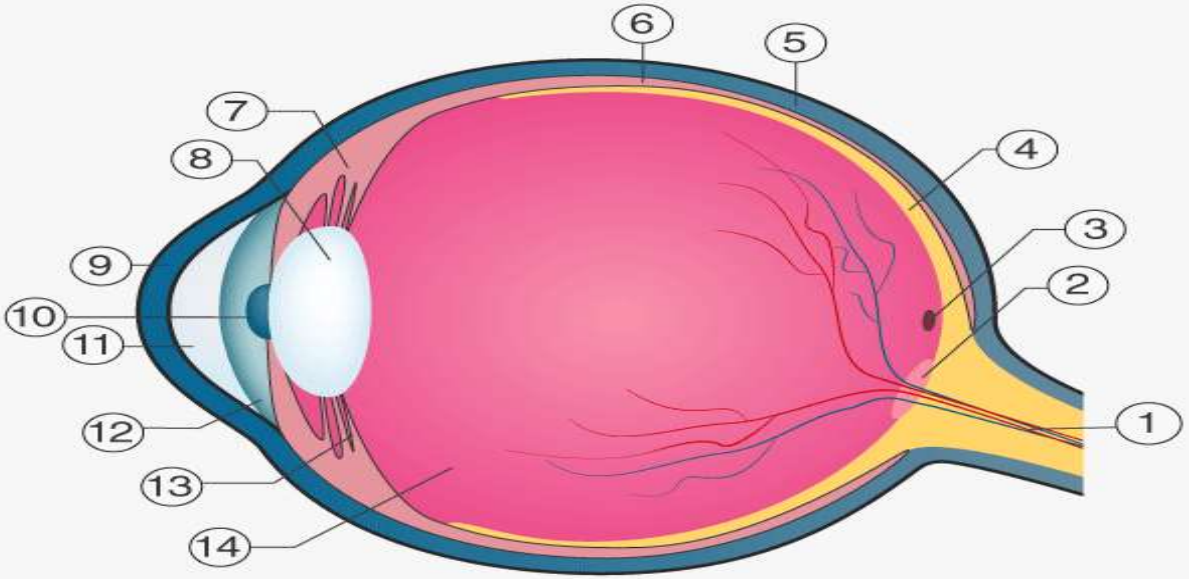
There are six (6) extra ocular muscles in each eye and they are largely divided into 2

- Rectus Muscles
- Oblique Muscles

- **Rectus Muscles**. There are four Rectus muscles that are responsible for **straight movements**: Superior (upward), Inferior (lower), Lateral (toward the outside, or away from the nose), and Medial (toward the inside, or toward the nose).

- **Oblique Muscles**. There are two Oblique muscles that are responsible for **angled movements**. The superioroblique muscles control angled movements upward toward the right or left. Inferior oblique muscles control angled movements downward toward the right or left.

STRUCTURE OF HUMAN EYE



1. Optic nerve
2. Optic disc
3. Fovea centralis
4. Retina
5. Sclera
6. Choroid
7. Ciliary body
8. Lens
9. Cornea
10. Pupil
11. Aqueous body
12. Iris
13. Suspensory ligament
14. Vitreous body

IMAGE FORMATION

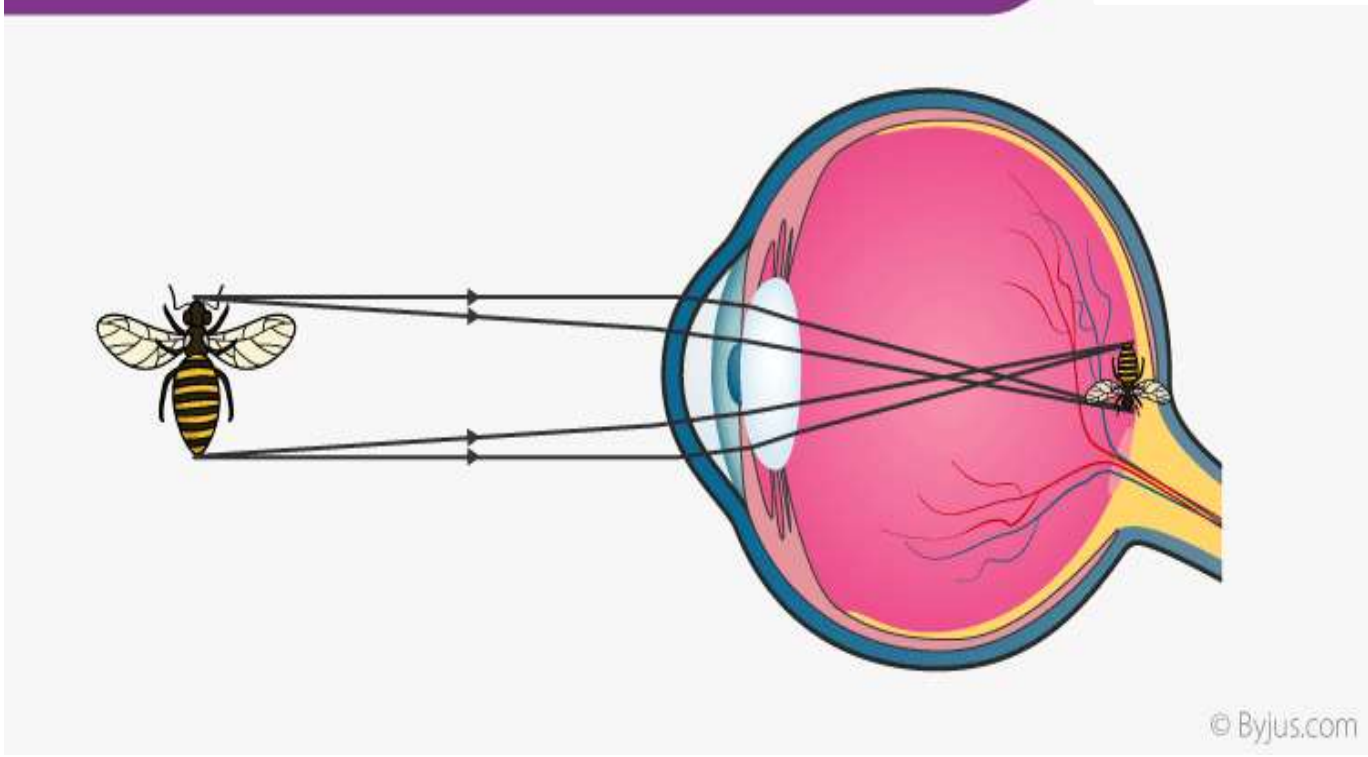
The eye is like a camera that focuses and lets in light to produce images.

Basically, light rays that are deflected from or by distant objects land on the retina after they pass through various mediums like the cornea, crystalline lens, aqueous humour, the lens, and vitreous humour.

The concept is that as the light rays move through the various mediums, they experience refraction of light (the change in direction of the rays of light as they pass between different mediums). The different refractive indices of the various parts of the eye is what bends the ray to form images on the retina. The optic nerve (rods and cones) then detect the intensity and the frequency of the light and transmit the impulses to the brain.

The image formed is usually inverted but the brain corrects this phenomenon.

FUNCTIONING OF THE HUMAN EYE



DEFECTS OF THE EYES

Myopia(shortsightedness): This is a defect of vision in which far objects appear blurred but near objects are seen clearly. The image is focused in front of the retina rather than on it usually because the eyeball is too long or the refractive power of the eye's lens too strong. Myopia can be corrected by putting on glasses/contacts with concave lenses which will help to focus the image on the retina.

Hypermetropia(longsightedness): This is a defect of vision in which there is difficulty with near vision but far objects can be seen easily. The image is focused behind the retina rather than upon it. This occurs when the eyeball is too short or the refractive power of the lens is too weak. Hyperopia can be corrected by wearing glasses/contacts that contain convex lenses.

Astigmatism: This defect is when the light rays do not all come to a single focal point on the retina, instead some focus on the retina and some focus in front of or behind it. This is usually caused by a non-uniform curvature of the cornea. This can be corrected by using a special spherical cylindrical lens; this is placed in the out-of-focus axis.

Cataracts: This is a clouding of the lens, which prevents a clear, sharp image being produced. A cataract forms because the lens is sealed in a capsule and as old cells die they get trapped in the capsule, with time this causes a clouding over of the lens. This clouding results in blurred images.

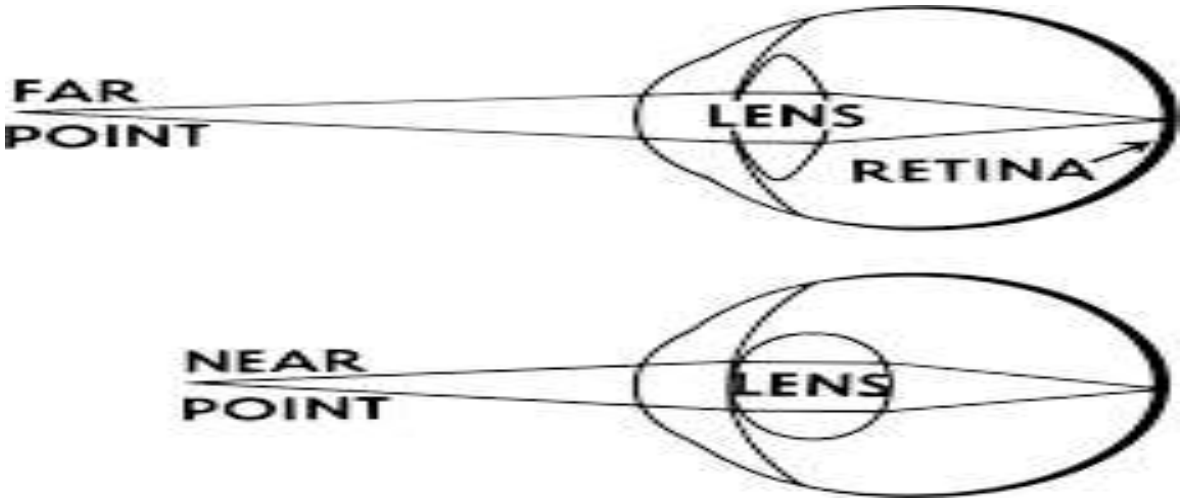
Night blindness (nyctalopia) failure of the eye to adapt promptly from light to darkness that is characterized by a reduced ability to see in dim light or at night. It occurs as a symptom of numerous congenital and inherited retinal diseases or as a result of vitamin A deficiency.

Accommodation of the Eye

The process by which the ciliary muscles function to change the focal length of the eyes so that the image is clearly formed on the retina. This will vary for near and distant objects and also for objects moving away or towards the eye.

By adjusting the focal length, the eye is actually changing its lens power as well. This is called the **accommodating power of the eye**.

Keep your finger in front of you and try to focus only on the finger. You will notice that objects in the background tend to get blurry. Now do the opposite. Keep your finger in front of your face but focus on something in the background.


FAR
POINT
LENS
RETINA
NEAR
POINT
LENS

EVALUATION

1. Name the three parts of the ear.
2. Name five parts of the eye and describe their functions.
3. Name the kind of lens used to correct short-sightedness.

THANK YOU FOR WATCHING