RECEPTION, RESPONSE & CO-ORDINATION

There are several changes in environment, so for an organism to survive; it must detect them and respond accordingly. Ability of an organism to detect and respond to changes in their surroundings is called **sensitivity** or **irritability**.

Stimulus is the variation in conditions that brings about change in activity or part of organism. Change in activity is therefore called **response**. **Receptors** are parts that receive stimuli while those which bring about response are called **effectors**.

Types of stimulus:

a) Internal changes

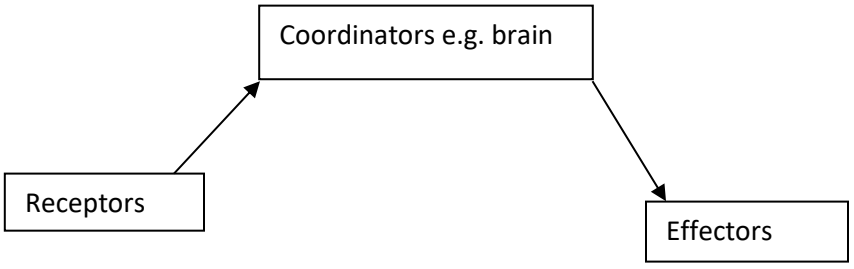
- Temperature
- Glucose level
- Hunger
- Disease infection
- Concentration of gases
- Accumulation of waste
- Presence of parasites

b) External changes

- Temperature
- Light intensity
- Population density
- Presence of predators
- Ph
- Humidity
- Mineral salts concentration
- Touch

Therefore irritability constitutes:

- Receptors
- Effectors
- Co-coordinators which integrate information received



Response can be positive i.e. movement towards stimuli or negative i.e. moving away from stimuli.

Types of response

- Taxis

It is unidirectional meaning; stimulus comes from one direction. It involves movement of whole organism (locomotory response) e.g. swimming of gamete as in sperm cells.

They are grouped according to stimulus that brings about it

Type of response	Explanation
Phototaxis	Is response to variation in light intensity and direction. It is shown when euglena move towards light (+ve response) and woodlice, maggots and termites move away from light (-ve response)
Aerotaxis	Is response to variation in oxygen concentration e.g. amoeba moving from an area of low oxygen concentration to an area of high oxygen concentration
Osmotaxis	Response to variation in osmotic pressure as shown in marine crabs burrowing in sand to avoid dilution of their body fluid.
Rheotaxis	Response to variation of water or air currents e.g. fish and planarians move against currents of water while moths and butterflies fly into wind currents in order to detect scent of flowers.
Chemotaxis	Response to variation in chemical substances e.g. male gametes move towards female gametes. Sperms of moss and fern are attracted to move towards chemicals produced by ovum in archegonia.
Thermotaxis	Response to temperature change e.g. Paramecium moves from temperatures lower than 15^{o}c to moderate warm waters of about 25^{o}c

Survival value of tactic responses:

- Enable organisms escape from harmful stimuli e.g. predators
- Enable organism seek favorable habitats and acquire resources e.g. nutrients, mates
- Brings about fertilization i.e. chemotaxis

IRRITABILTY IN PLANTS

Plants don't have well developed nervous system as in animals; thus they bring about response on parts of their bodies.

This response is called tropism i.e. involves growth movement or curvature.

- Tropism

It is growth movement of part of the plant in response to unidirectional external stimulus.

Type	Explanation
phototropism	Growth curvature in response to the direction and intensity of light. Shoots are +vely phoyotropic while roots are-ve phototropism.
Chemotropism	Growth curvature in response to a gradient of chemical concentration e.g. developing pollen tube which grows towards chemicals secreted by embryo sac.
Geotropism	Growth curvature in response to gravity; roots are +ve geotropic while shoots are –ve geotropic.
Hydrotropism	Growth curvature in response to water or moisture; plant roots are +ve hydrotropic.
Thigmotropism/ Haptotropism	Growth curvature in response to contact with objects as shown by tendrils or climbing stems which twine around objects e.g. tree trunks and branches.
Thermotropism	Growth curvature in response to variation in temperature as shown by movement of sunflower following the direction of sunlight or sunrays.

Survival value of tropic response

- Phototropism exposes the leaves in position to maximize light absorption enhancing photosynthesis.
- Haptotropism enables plans to obtain mechanical support especially non-woody plants.
- Geotropism makes plant roots grow deep into soil offering firm anchorage.
- Chemotropism enables pollen tube to grow towards embryo sac thereby facilitating fertilization.
- Hydrotropism enables the roots of the plant to seek water.

Comparison of tropic and tactic responses

- Both bring about adaptive responses that enable organisms to survive in their environment.
- They have similar stimuli e.g. light, water, and temperature.
- They are both due to unidirectional stimuli.

Differences between tropic and tactic responses

Tropism	Taxes
It is growth response hence permanent	Locomotory response and they are temporary
Response are slow	Response are faster

Brought about by growth hormones	Are not brought about by influence of growth hormones

C) Nastic responses

These are non-directional movements of parts of plant in response of various stimuli e.g.

- Folding of leaves in hot weather
- Opening and closing of flowers in response to light intensity
- The closing of leaves of ***Mimosa pudica*** when touched.

Types of nastism

1. Nyctinasty (sleep movement)

It is movement in response to difference in light intensity and temperature changes of the day and night as seen in sunflower.

In response to light is called photonasty; flower opens in presence of light and closes on its absence.

If the response is for temperature is called thermonasty, some plants open flowers with increase in temperature and closes on its decrease.

2. Haptonasty

It is response to touch e.g. in ***Mimosa pudica;*** its leaves closes rapidly when touched.

Also fly trap (***Dionaea spp***) an insectivorous plant which grows in soil deficient of nitrogen. When sensitive hairs on the leaves are touched by landing insect, midrib cells lose water rapidly causing the trap to spring hence closing the leaf with spikes interlocking. The insect traped is digested to supply nitrogen which is deficient in soil.

3. Chemonasty

Response in presence of specific chemical substances of nitrogenous compound e.g. urea and ammonium compound found in insectivorous plants e.g. sundew.

When an insect is trapped by sundew plant (***Drosera spp***) the insect provide chemical substance that will trigger release of digestive enzymes by plants.

4. Hydronasty

Response to changes in humidity e.g. in flowers such as Dandeloion which close when air is moist.

Survival value of nastism

- Protection of inner delicate parts of a flower
- Reduction of transpiration

- Regulation of temperature
- A way of obtaining limited mineral nutrients e.g. nitrogen by insectivorous plants.

Coordination in plants

The process of coordination in plants is brought about by growth hormones e.g. auxins, cytokinins, gibberillins. Mainly tropism in plants is influenced by auxins.

Role of auxins in tropism

One common auxin is called IAA (Indoles Acetic Acid). Its commonly produced at the apical meristems of shoot and root.

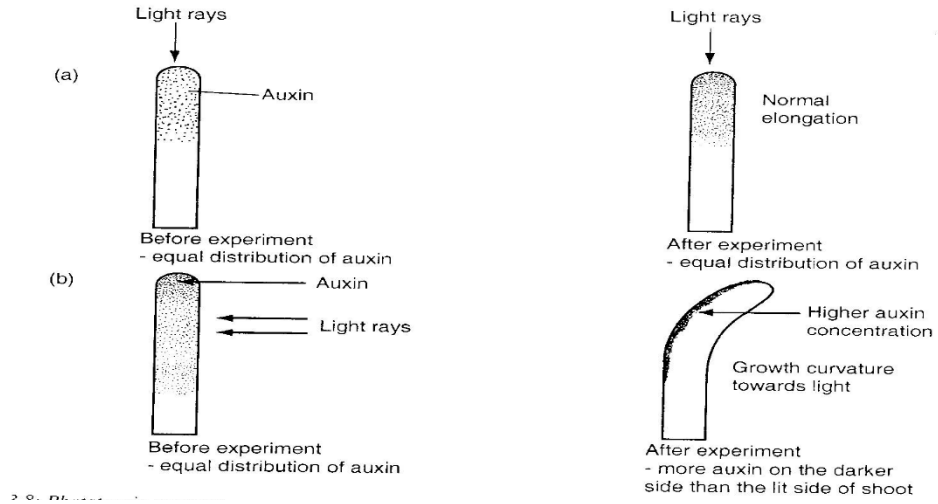
When auxins are produced they move by diffusion to the zone of elongation where they exert their effect.

Also large amount of it is translocated by phloem from shoot towards roots. IAA stimulates growth in both shoot and root at region of elongation. Small amount is required; roots are very sensitive to auxins than stem, thus require small concentration.

NB concentration that causes maximum growth in shoots inhibit growth in roots

Auxins and phototropism

Uniform light distribution causes auxins produced at the shoot to be evenly translocated leading to equal growth rate in zone of elongation.



When unidirectional light is exposed or directed to the shoot, shoot bends towards light source. This is because auxins are sensitive to light; so they migrate away from source.

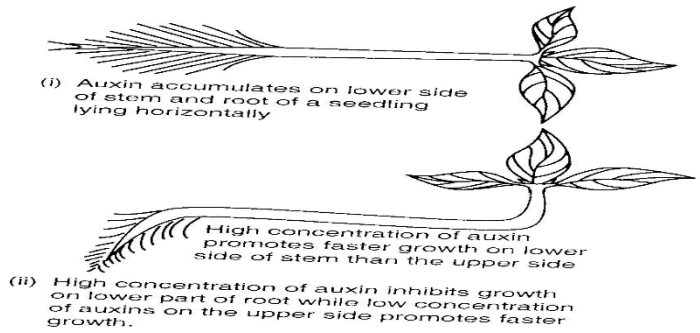
Darker side of shoot will have high concentration of auxins which leads to rapid elongation hence faster growth rate than lighted side. Eventually shoot curves towards the light.

Auxins and geotropism

Shoots are negatively geatropic while roots are positively geotropic. This can be clearly determined if a seedling is placed horizontally. Due to gravity auxins migrate to lower side of the growing stem and root.

High auxin concentration on lower side of the shoot promotes faster growth on lower side causing the shoot to bend upwards.

In the root high concentration of auxins inhibit growth but lower concentration promotes faster growth therefore the root bends downwards.



Auxins and thigmotropism

When climbing stems or tendrils comes into contact with hard objects, they curve and coil on hard objects.

Contact causes lateral migration of auxins to outer side of the stem where due to their high concentration promotes faster growth than part in contact with object; hence the shoot continues to coil round hard objects.

IRRITABILTY IN ANIMALS

Animals have complex irritability than plants. Lower animals have simple structures whereas higher animals have evolved elaborate structures for detecting, coordinating and effecting responses.

Nervous system in mammals

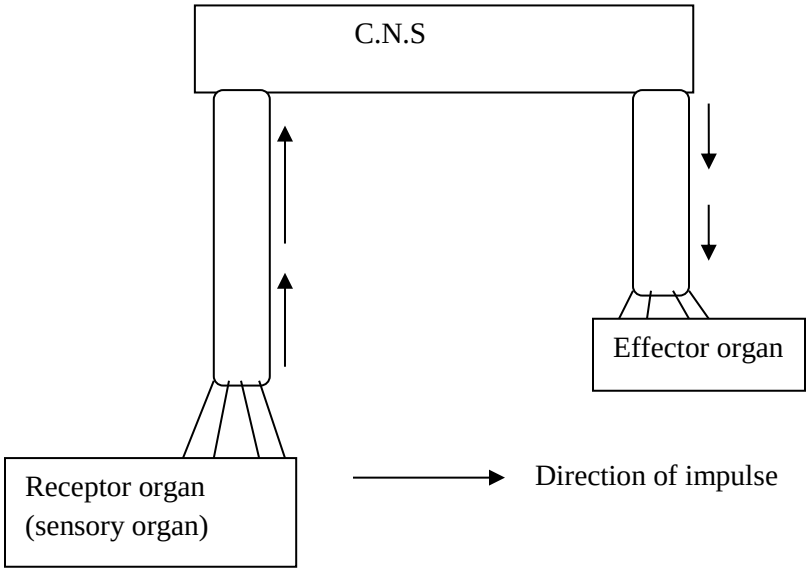
It consists of:

a) Central nervous system (CNS)

Brain and spinal cord form this. Receives impulses from receptors integrates it then relay it to effectors.

b) Peripheral nervous system

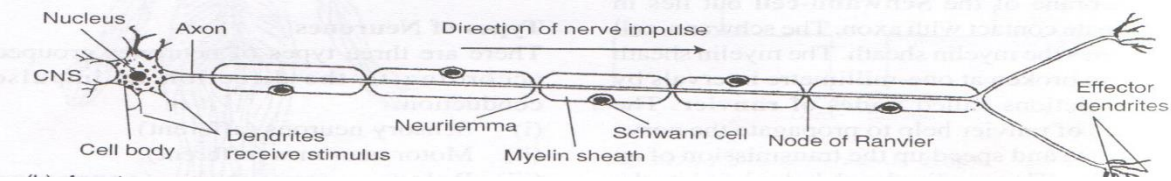
It consists of sensory neurons that transmit impulse from receptors to CNS and motor neurons that transmit impulse from CNS to effectors.



Structure and function of nerve cell

Nerve cell is a functional unit of nervous system whose main function is to transmit impulse. Nerve impulse is electrical signal that is transmitted along nerve fibre.

The neuron



i) Dendrites

These are projections from cell body. Some are elongated to form axon. Dendrites help to make contact with other neighbouring neurons in CNS while terminal or effector dendrites make contact with effector organs.

ii) Axon

It is filled with axoplasm which is continuous with cytoplasm of the cell body. Its function is to transmit impulse.

iii) Myelin sheath

Its enclosed by neurilemma, its function is insulate the axon.

iv) Schwann cell

It secretes myelin sheath (fatty sheath)

v) Nodes of ranvier

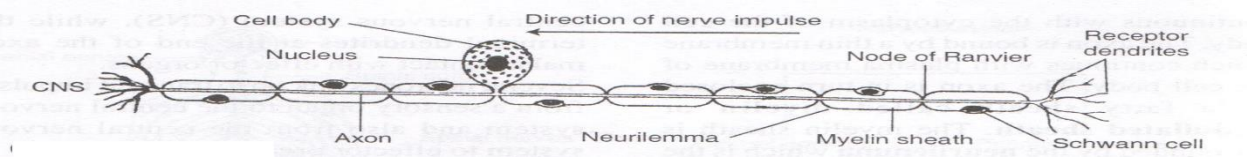
These are millimeter intervals. It helps to propagate the nerve impulse and speed up the transmission of impulse.

Types of neurons

They are of three types:

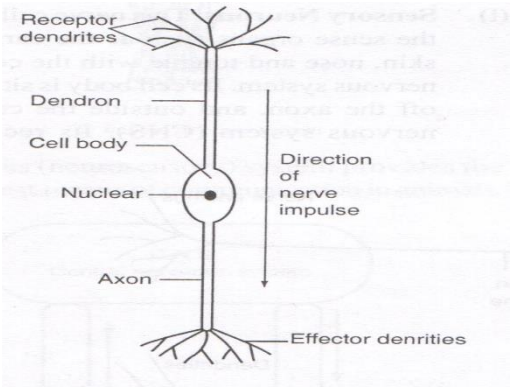
a) Sensory neurons

Transmit impulse from receptor organs e.g. ear, eye, skin, tongue, nose to central nervous system. Its cell body is situated off the axon. Its unipolar



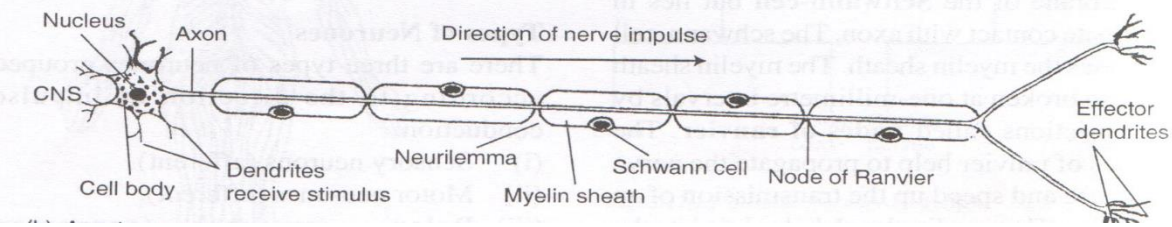
b) Relay neurons

It links the sensory neuron and motor neuron. Located entirely within the CNS. Its cell body is located in the middle of axon thus bipolar. It is also not myelinated.



c) Motor neurone

Links the effector organs and CNS. Its cell body located at one end of the axon. It is multipolar as many dendrites project from its cell body.



Central nervous system (CNS)

Composed of brain and spinal cord.

The brain

Brain is delicate so enclosed by bony structure called skull or cranium.

The brain is cushioned by meninges to between it and cranium. Meninges consist of:

i) Dura matter – its tough outer membrane made of connective tissue and rich in network of capillaries.

ii) Pia matter – innermost membrane; possesses many blood capillaries and lymph vessels

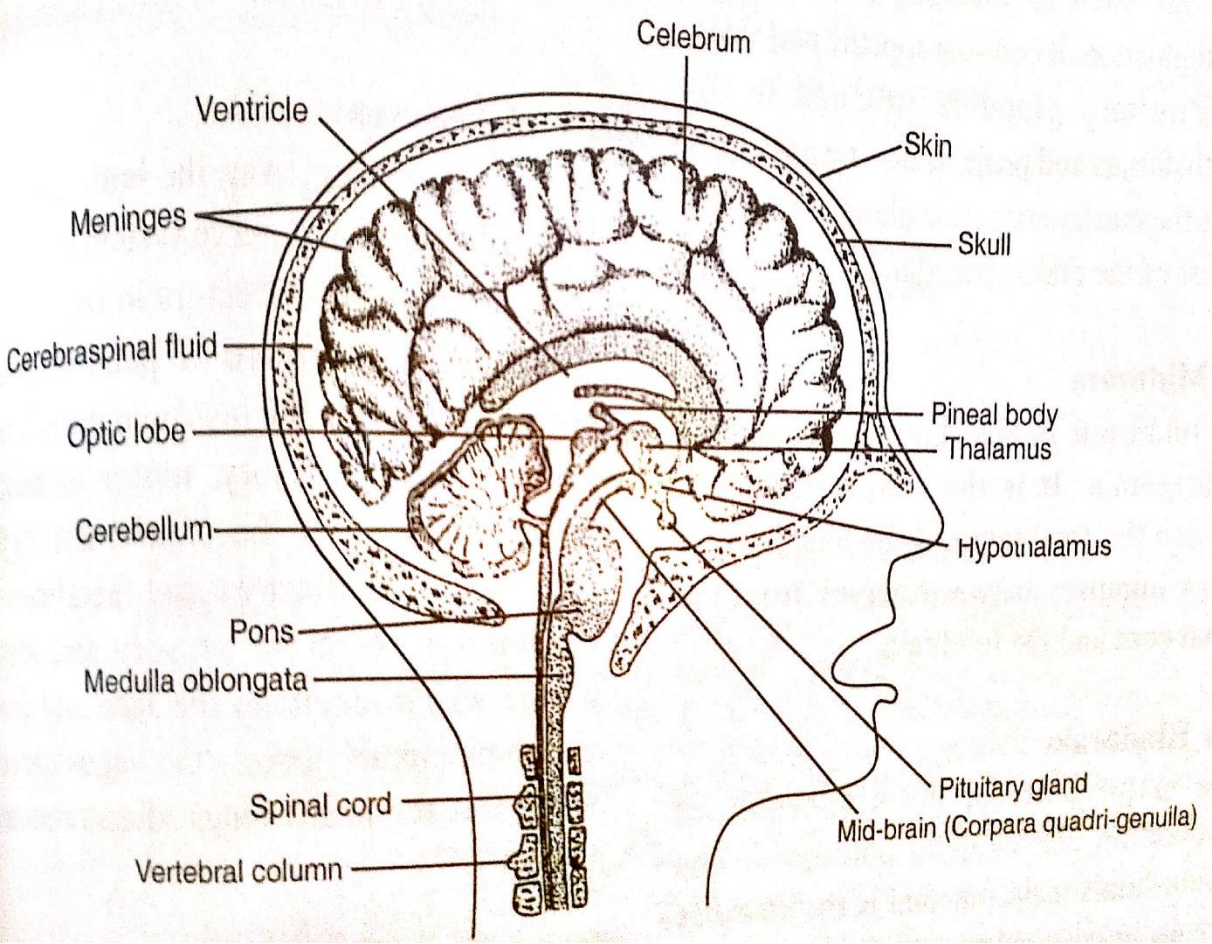
iii) Arachnoid layer – is a space between dura and pia filled with cerebrospinal fluid from which oxygen and nutrients diffuse to brain cells.

The meninges covers brain and spinal cord.

Within the brain is a system of cavities called ventricles filled with cerebrospinal fluid whose functions are:

- Provide nourishment to brain cells
- Acts as shock absorber thus protect against mechanical damage

Parts of the brain and their functions



Part	Function
Fore brain	
Cerebrum	Large portion of brain divided into right and left cerebral hemispheres. Integrate sensory impulses such as vision, hearing & taste. Also control voluntary body movements such as limps, lips & neck. It controls learning, memory and individuality.
Thalamus	Controls receptors for pain and pleasure
Hypothalamus	Located below thalamus it controls homeostatic activities e.g. thermoregulation, osmoregulation, also appetite and sleep.
Pituitary gland	Attached to hypothalamus, called master endocrine controlling the rest endocrine glands
Mid brain Also known as corpra quadrigemia. Connects fore and hind brain as it relays impulses between nerves from spinal cord and fore brain	
Hind brain	
Cerebellum	Maintains body balance and posture by controlling and coordinating muscular movements

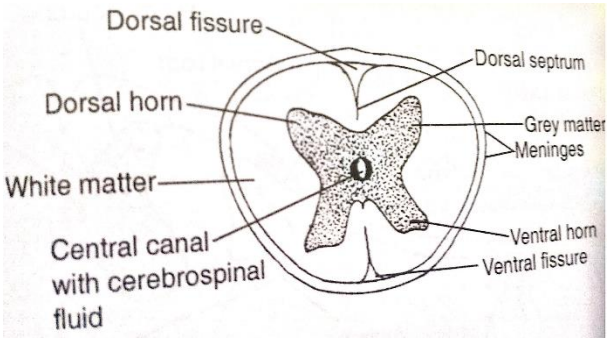
Medulla oblongata	Controls involuntary activities such as breathing, swallowing, salivation, vomiting. Also influence blood pressure by controlling dilation and constriction of blood vessels.

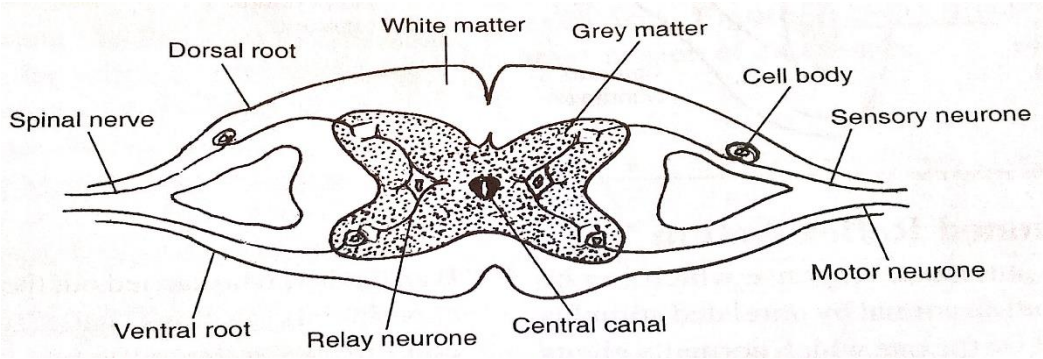
The spinal cord

It is extension of the brain posteriorly. It is enclosed by meninges and protected within the vertebral column (back bone). It's made of grey and white matter.

a) Grey matter is H- shaped and surrounds the central canal filled with cerebrospinal fluid. It relays impulse between the sensory neuron and motor neuron. Due to presence of cell bodies of relay and motor neuron that gives it darker appearance hence the term "grey" matter.

b) White matter surrounds the grey matter; it consists of axons of sensory and motor neuron. Myelin sheath of these neurons makes this part shiny white.





Reflex action

It is rapid automatic response to a certain stimulus while reflex arc is the path followed by nerve impulse. They are of two types:

- Simple reflex
- Conditioned reflex

Simple Reflex Action

It is automatic response to specific single stimulus. It does not depend on learning e.g.

- blinking when something is brought near the eyes

- sneezing

- withdrawing finger from sharp of hot object

- Knee jerk when tapped below the knee cap

- coughing

- Salivation on seeing or smelling food

- Secretion of tears when onion is cut

- swallowing

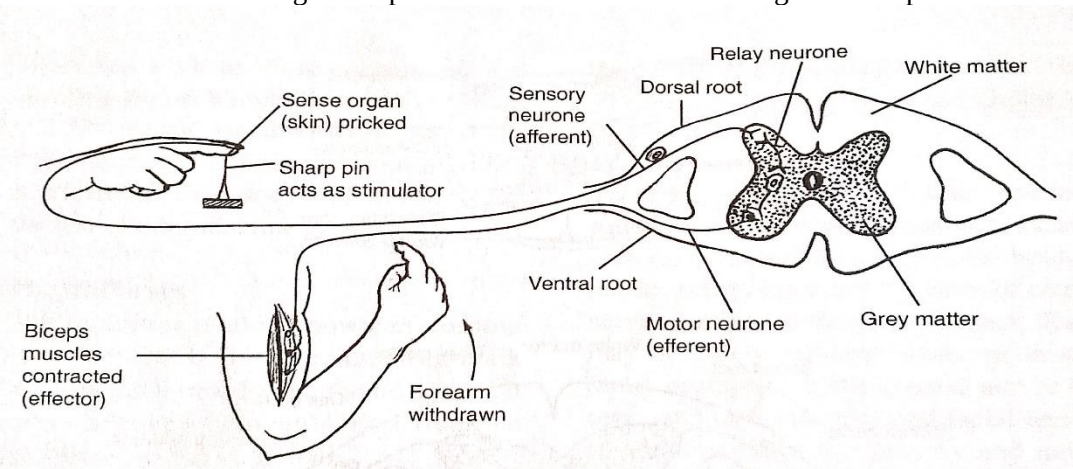
- Pupil enlargement at varying light intensities

Reflex arc involves three neurons: sensory, relay & motor neurons which link receptors and effectors through the CNS.

EXAMPLE

When a finger touches a hot object the hand is withdrawn automatically. Why?

- On touching hot object receptors on the finger skin are stimulated
- An impulse is generated and transmitted along sensory neuron to grey matter of spinal cord through dorsal root. The impulse pass on to relay neuron via synapse
- From relay neuron the impulse is passed to motor neuron through another synapse.
- Impulse is transmitted by motor neuron out of spinal cord through ventral root to bicep muscles (effector) which on receiving the impulse contracts raising the hand hence withdrawing it.
- At same time original impulse is sent to brain where its registered as pain.



Conditioned reflex action

This is an automatic response to unrelated stimulus which replaces the normal one.

For example:

In normal cases a dog salivate when it sees or smells food; but if a bell is rung first then food is presented to the dog, it's found that after repeating this procedure many times the dog starts to relate bell ringing with presentation of food. Therefore it salivates when bell is rung even without seeing food.

Ivan Pavlov a Russian did these experiments and called it conditioned reflex. It depends on learning e.g. walking, playing, cycling, writing, swimming, driving.

Practical application is:

- Training dogs
- Learning process
- Advertisement

Difference between simple reflex and conditioned reflex action

Simple reflex	Conditioned reflex
Single stimulus brings about response	Repeated stimulus applied to bring about response
It's in depended on experience	Depend on experience
Sensory neuron and motor neuron remain the same	Primary sensory neuron is replaced by secondary sensory neuron but motor neuron remain same

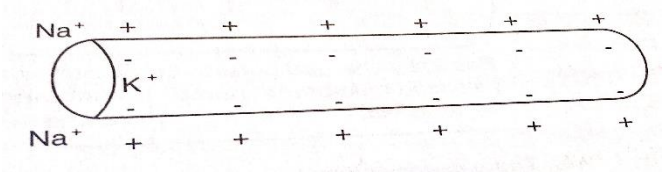
Transmission of Nerve Impulse

Nerve impulse is an electrical charge transmitted along the nerve fibre.

Ions involved are:

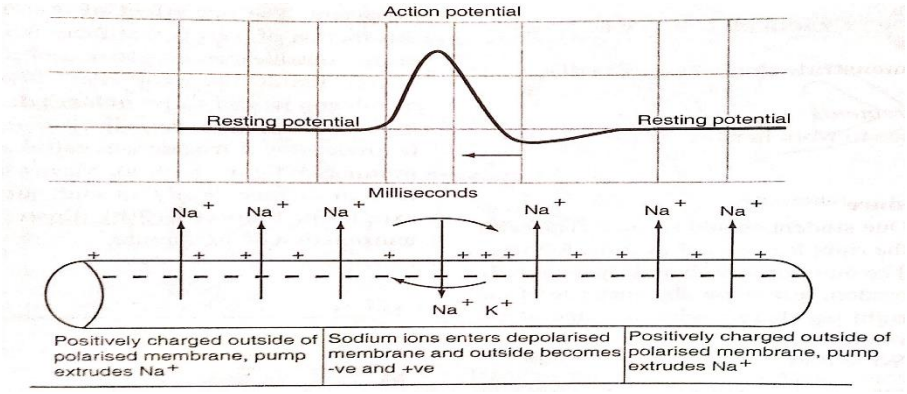
- Sodium ions
- Potassium ions

When the nerve is not transmitting impulse; outside is positively charged with a lot of sodium ions which are actively pumped out by sodium pump mechanism; while inside the membrane is negatively charged with a lot of potassium ions. It's said the nerve is **polarized** and it is at **resting potential**.



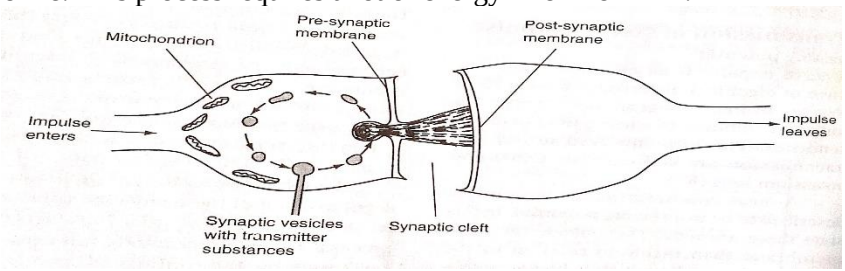
When impulse is being transmitted sodium ions diffuses since sodium pump ceases for a while and membrane becomes permeable in while potassium moves out. Then inside becomes positively charged while outside becomes negatively charged; a process called **depolarization**. The nerve is said to be at **action potential**.

Once impulse has been transmitted the membrane is immediately re-polarized.



Transmission across the synapse/ neurojunction

Synapse is the junction between two neurons. It allows transmission of impulse from one neuron to another. Also distribute impulse from one neuron to many others.
In synapse transmission involves chemical called transmitter substance e.g. **acetylcholine** or **noradrenaline**.
Presynaptic knob has vesicles which contain transmitter substance, so when impulse reaches the synaptic knob; it stimulates vesicles to move towards presynaptic knob membrane releasing acetylcholine. Acetylcholine then diffuses across the synaptic cleft to the postsynaptic knob where they cause depolarization. They make sodium ions diffuse from cleft to diffuse into post synaptic knob where they initiate action potential. Action potential is then propagated along the neuron.
Immediately acetylcholine in cleft is broken down by and enzyme called cholinesterase into acetic acid and choline. Which are reabsorbed back to presynaptic knob where they are reconstituted back to acetylcholine. This process requires a lot of energy inform of ATP.



The endocrine system

This is hormonal system. Hormones are organic compounds which are either proteins or steroids. There are various glands in the body that produce various hormones e.g.

Hormone	Gland	Topic	Form
Gastrin	Gastric	Nutrition	I
Aldosterone	Adrenal	Excretion & homeostasis	II
Antidiuretic	Pituitary	,,	II
Insulin	Pancreas	,,	II
Glucagon	Pancreas	,,	II
Androgen	Testis	Reproduction	III
Oestrogen	Ovaries	,,	III
FSH	Pituitary	,,	III
LH	,,	,,	III

Progesterone	Ovaries	,,	III
Prolactin	Pituitary	,,	III
Oxytocin	Pituitary	,,	III
Adrenaline	Adrenal	Irritability	IV
Thyroxin	Thyroid	,,	IV

In this topic we are going to deal with adrenaline and thyroxin hormones. Hormones work in feedback mechanism. Remember types of feed backs form 2 work.

Thyroxin hormone

It is produced by thyroid gland located on the neck. It's a compound of iodine and amino acids.

Function:

It control

- rate of metabolism
- effects of growth hormone called somatotrophin

Hypothyroidism

This is under secretion of thyroxin hormone. It causes cretinism in children and myxoedema in adults.

i) Cretinism

- Deformed legs
- Dry leathery skin
- Large tongue
- General body weakness
- Poor mental development

ii) Myxoedema (goitre)

This is swelling of thyroid gland due to overworking

Effects are:

- Low metabolism
- Reduced heart beat and breathing rate
- Low body temperature
- Mental and physical weakness
- Low physical activity leads to obesity and oedema

It is controlled by use balanced diet supplemented by iodized salts and administration of iodine tablets.

Hyperthyroidism

This is over secretion of thyroxin hormone

It causes:

- Increased rate of metabolism
- Increased heart beat and breathing rate
- High body temperatures
- Individuals show nervousness, restlessness and easily irritable
- Extreme hyperthyroidism can cause heart failure a condition called thyrotoxicosis.

It is contained by treatment using radioactive iodine or surgical removal of thyroid gland

Adrenaline

It is produced by medulla of adrenal gland. Its function is to prepare the organism for emergencies i.e. flight or fight when faced with situations such as fear, shock, stress and anxiety.

Effects:

- Increased heart beat increasing circulation of blood.
- Vessels that supply blood to skin and gut constrict to allow more supply of blood to muscles
- Breathing rate increase and becomes deep to ensure proper supply of oxygen to muscles as they respire to provide energy.
- Glycogen is converted to glucose and fats are also converted to fatty acids which are made .available for muscle contraction.

Over secretion of adrenaline may occur, which have the following signs:

- High blood pressure
- Severe headache
- Sweating & faintness

Consequently these leads to aging of main organs.

Functional similarities and differences between nervous and hormonal systems

Similarities:

- ❖ Both provide means of communication within the body of an organism
- ❖ Both involve transmission of message triggered by stimulus and a response
- ❖ The target organs of hormones are like effector organs
- ❖ Both involve chemical transmission
- ❖ Both bring about survival response

Differences

Endocrine system	Nervous system
Chemical substance evoke response	Nerve impulse evoke a response
Chemical transmitted through blood	Impulse transmitted through nerve fibre
Response slow but affect several parts of the body	Response quick, specific and localized
Effects are long lasting	Effects rapid are short lived
Response takes place involuntarily	Takes place voluntarily and involuntarily

Assignment

Discuss drugs under the following sub headings.

i) Define drug, drug abuse, prescription, dosage

ii) Commonly abused drugs and classify them either as prohibited or non-prohibited in your country

iii) General effects of drug abuse to human health

Sense organs

These include eye, ears, tongue, nose and skin

The eye

This is sense organ with photoreceptors that perceive light from objects.

It's contained in cavities sockets in the skull called orbits where they are lined with fats that cushion them against mechanical damage due to shock.

In the socket the eyes are suspended by rectus muscles i.e.

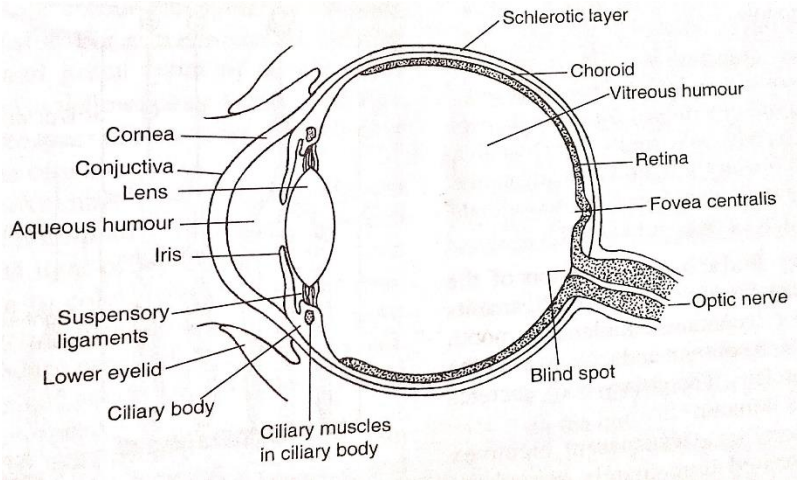
- Lateral rectus muscle moves the eye side ways
- Superior and inferior rectus muscles moves the eye up and down
- Oblique rectus muscle steady the eye as it moves up and down.

In front of eyeball are lose skin called **eyelids** that protect the eyeballs and on their edges are many hairs called **eyelashes** that prevent entry of small foreign particles. Above the eye are raised portions of skin called **eyebrows** covered by thick hair that prevent sweat and dust from entering the eye.

Under the lids are lachrymal glands that secrete saline and antiseptic fluid called tears; which moisten cornea and wash away foreign particles from the eye.

The eye is made of three layers

- Sclera (outer layer)
- Choroids (middle layer)
- Retina (inner layer)



Sclera

- It external tough layer covering the eye thus protect and maintains its shape.
- To the front it forms **cornea** which is transparent to allow light pass through, also being curved it refract light rays as they get into the eye.
- Covering the cornea is **conjunctiva** which protects it. Also being transparent allows light rays pass through.

Choroid

It's a middle layer which is pigment whose function is to absorb stray light rays. Also has many blood vessels that provide nourishment to the eye parts.

To the front it extents to ciliary body and iris.

Iris is thin round sheet of muscular tissue. It has two muscles, circular and radial which control diameter of **pupil** thus regulating amount of light entering the eye. It gives the eye color e.g. black, brown, pink.

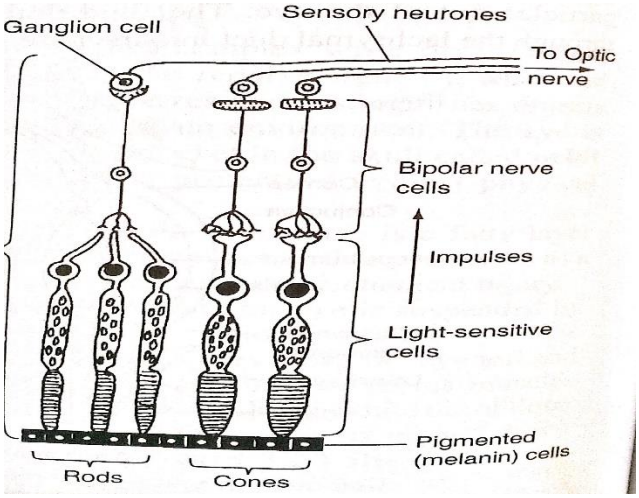
Ciliary body its main function is to secrete aqueous humour. To it is iris and suspensory ligaments attached. **Suspensory ligaments** hold lens on place; being flexible it alters the shape of lens bringing image to sharp focus.

Lens is transparent to allow light rays to pass through and refract it. It divides the eye into anterior and posterior chambers.

Anterior part is watery fluid the aqueous **humour** while posterior part is jelly like substance called **vitreous humour**. Both are transparent to allow light pass and refract them. These fluids maintain the shape of the eye ball.

Retina

It is the innermost layer containing light sensitive photoreceptors cells i.e. cones and rods. On its surface are many neurons that run and join up together forming optic nerve which transmits impulse to the brain for interpretation.



Cones contain photochemical pigment called **iodopsin** which is sensitive to high light intensity. In high light intensity iodopsin is broken down to iodine and opsin binging about depolarization, thus create impulse that is being transmitted to brain via optic nerve.

Numerous cones appear at localized point on retina called **fovea centralis** (yellow spot). Each cone as its own bipolar nerve so no retinal convergence and therefore enable high visual acuity i.e. ability to distinguish objects clearly.

In higher vertebrates are three types of cones which enable them differentiate colours e.g. green, red and blue. Find out about Trichromatic theory ……..

Rods contain chemical called rhodopsin which perceives low light intensity so not sensitive to colour. They have retinal convergence i.e. several rods are linked to one neurone thus lack visual acuity. In low light intensity rhodopsin break to opsin and retinine (derivative of vitamin A) which bring about depolarization leading to impulse.

Resynthesize of rhodopsin takes place slowly in dark. In nocturnal animals are more rods on their eyes than cones because they operate in low light intensity.

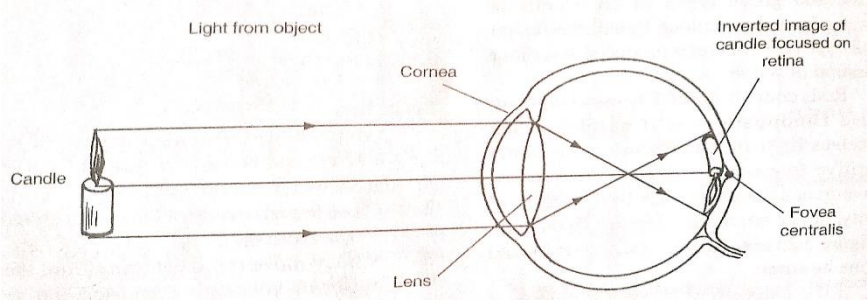
Combination of cones and rods enable s the eye work at different qualities of light.

Blind spot is point on retina where optic nerve enters the eyeball. Any image falling here cannot be perceived as there are no either cones or rods.

Formation of Image

- Light from the image is reflected into the eye.
- Rays are the refracted by the curved surface of cornea, lens, aqueous and vitreous homour
- The images is the focused of the retina which is upside down, real and smaller than object
- When image falls on the retina photoreceptors are stimulated and impulse triggered. Impulse is conducted by optic nerve to the brain for interpretation.

- In the brain all details of object are perceived e.g. size, colour, distance and image is upright in brain.

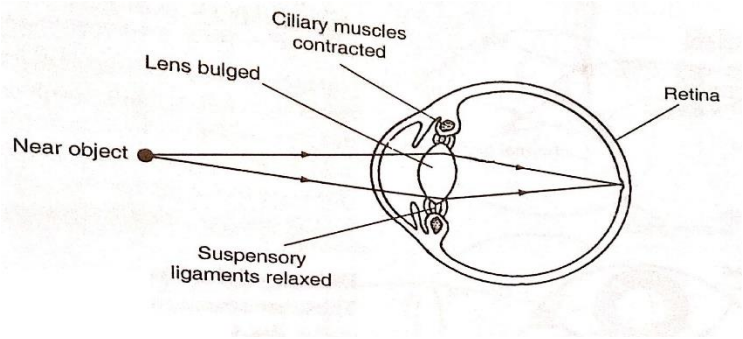


Accommodation of the eye

This is adjustment of eye structures to bring an image from a near or far object into sharp focus on the retina.

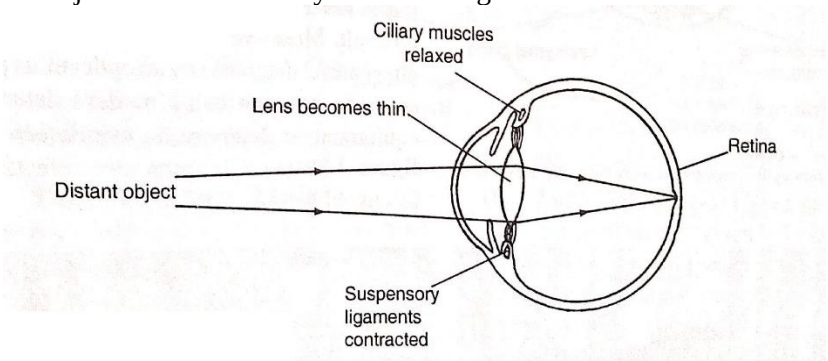
i) Accommodation of near objects

- Ciliary muscles contracts relaxing tension on suspensory ligaments
- Curvature of the lens then increases
- Making close objects to be highly refracted by lens focusing it on retina



ii) Accommodation of far objects

- Ciliary muscles relax increasing tension on suspensory ligaments
- Curvature of lens decreases
- Making far objects less refracted by lens focusing on retina.

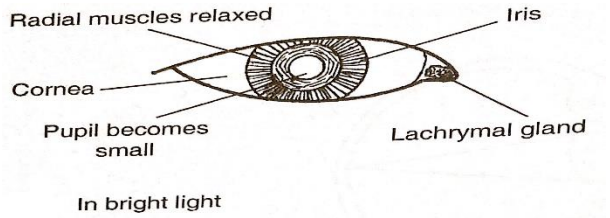


Regulation of light

Iris regulate amount of light entering the eye:

In bright light:

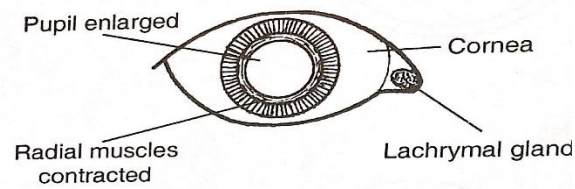
- Circular muscles of iris contract while radial muscle relaxes and pupil become smaller.
- This prevent excess light entering the eye that may damage retina



In bright light

In dim light:

- Circular muscles of iris relax while radial muscle contract and pupil become large.
- More light enters the eye stimulating the photoreceptors



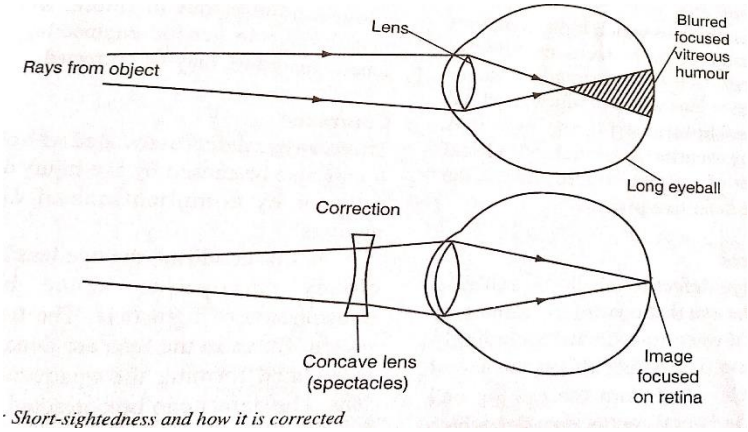
In dim light

Defects of the eye

These are structural changes that alter proper vision. Well diagnosis by optician these defects can be corrected.

a) Short sightedness (myopia)

This is condition where light from distant object are focused in front of retina. It is caused by large eyeballs.
It is corrected by using concave lens to diverge light before entering the eye.

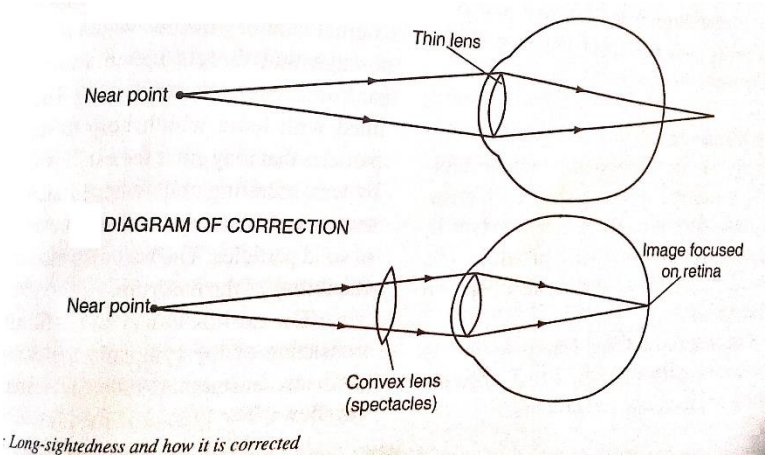


· *Short-sightedness and how it is corrected*

b) Long sightedness (hypermetropia)

This is where light from near objects are focused behind the retina. It's caused by short eye ball.

It is corrected by using convex lens that increase the refraction of light rays from near objects.



· *Long-sightedness and how it is corrected*

Others are:

- Astigmatism – where light from an object is brought to retina in different planes, due to unequal curvature of lens. It is corrected by wearing special cylindrical lens.

- Squintedness – this is poor coordination of lateral rectus muscles thus eyeballs face different directions. It's difficult to correct.

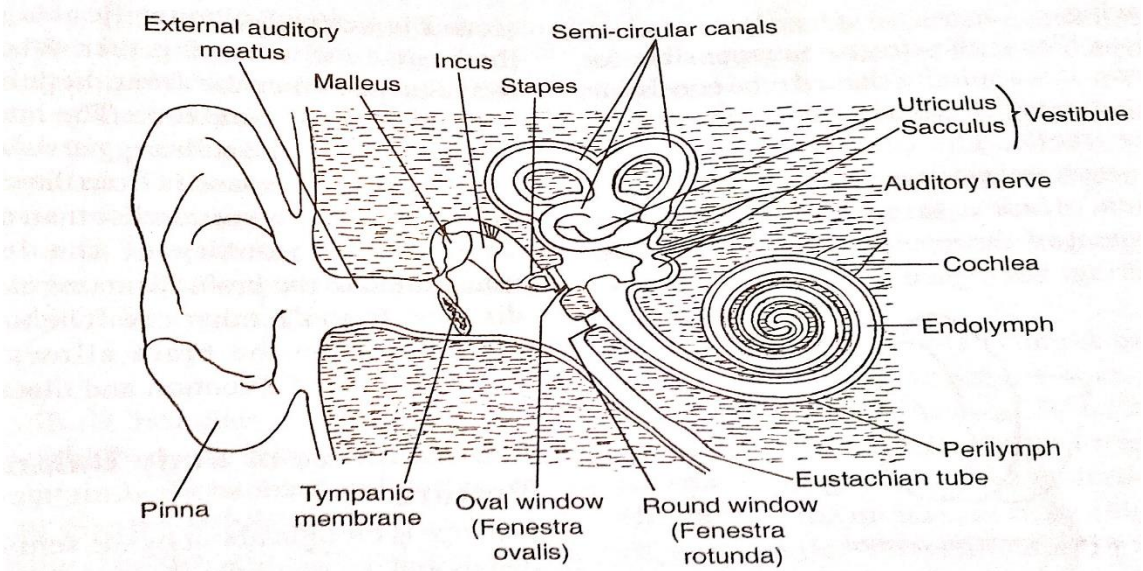
- Old sight (presbyopia) – caused by near objects focused behind retina while distant ones are sharply focused. Caused by lose of elasticity of lens and weakening of ciliary muscles. It can be corrected by wearing a convex or converging lens or one pair with different lenses called bifocal.

- Colour blindness- this is genetic defect where individual cannot distinguish red and green colour

- Cataract – associated with old age where lens becomes cloudy blocking transmission of light rays. It can be corrected surgically by replacing the defective lens.

Human ear

This is a sense organ which perceives sound and maintains body balance. It consists three parts; outer, middle and outer ear.



Longitudinal section of human ear

Structure	Function and adaptation
Outer ear	
Ear pinna	-it is funnel-shaped and has large surface area to collect and direct sound waves into auditory canal
Auditory canal	- It is a tube directing sound to ear drum - It is lined with cells secreting wax and hair; they trap small particles from reaching delicate ear drum. - Wax also makes the eardrum flexible
Ear drum	- It is thin and flexible membrane - Receives sound waves, vibrates and transmit it to ear ossicles in the middle ear.
Middle ear	
Eustachian tube	- It is a tube that connect middle ear and pharynx - It balances pressure between middle ear and outer ear protecting ear drum (tympanic membrane) from damage.
Ear ossicles	- They are three tiny bones (MIS) malleus, incus and stapes arranged in lever system from ear drum to oval window. - They amplify and transmitted vibrations to inner ear through oval window.

Inner ear	
Cochlea	- It is coiled to increase surface are for attachment of sensory hairs and fluid filled tube. Impulses are generated here.
Semi-circular canals	- These are three fluid filled canals that lie in right angle to each other, each has a swelling called ampulla containing a lot of sensory cells. - It maintains balance in relation to body movements
Utriculus and succulus	- They have sensory nerves that respond to gravity - They control body balance in relation to gravity
Auditory nerve	- This is sensory nerve that transmit impulses from inner ear to the brain for interpretation

Hearing process

Hearing process takes place in cochlea. Being coiled it offers large surface area for attachment of sensory hairs for hearing.

- Pinna collects and concentrates sound into auditory canal. The sound waves strikes ear drum and causes it to vibrate.
- Vibrations are then transmitted to ossicles where it's transmitted from malleus to incus and eventually to stapes. Ossicles are dense and due to their lever arrangement they highly amplify the vibrations as they transmit them to oval window.
- Stapes then pass the vibration to perilymph of cochlea through oval window
- In the cochlea vibrations disturbs the perilymph simulating sensory hairs to generate nerve impulse.
- Nerve impulse is transmitted to brain by auditory nerve where it interpreted as sound of specific pitch and loudness.
- Vibration in fluid is returned to middle ear through round window. The ear can detect different frequencies and direction of sound. If sound is from front both ears receives it at same time and sensory hairs are stimulated equally. But if it is from one direction one ear will pick the sound and its impulse intensity will be higher than the other.
- Time lapse of impulse to the brain allows for discrimination of direction and distance,

Balance and posture

a) Semi- circular apparatus

They are three canals arranged in right angle to each other. They are filled with endolymph and each has a swelling called ampulla containing sensory cells.

They maintain body balance and posture in relation to movement

During movement fluid in canals are disturbed stimulating the sensory cells in ampulla which result to impulse. Impulse is transmitted to brain through auditory nerve for interpretation.

Information is the relayed to muscles by motor neuron to restore balance.

b) Vestibule

It consist sacculus and utriculus which has sensory cells. Maintains body balance in relation to the gravity.

When body balance is shifted the fluid disturbs sensory hairs creating impulse transmitted to brain via auditory nerve where it is interpreted and information relayed to muscles by motor neuron to correct and restore posture.

Defects of the ear

i) Partial deafness

Caused by:

- Infection of middle ear
- Damage of ear drums i.e. accumulation of wax, infection or due to physical blow.

Correction is use of antibiotics for infections and for damaged ear drum hearing aids can be used and learn sign language.

ii) Permanent deafness

Total inability to perceive sound.

Caused by:

- Damage of cochlea or auditory nerve

Correction is learning sign language to communicate.