## ✓ RECEPTION, RESPONSE, CORDINATION

- ✓ **Sensitivity / irritability** – it's the ability to detect and respond to changes in the environment.
- ✓ Stimuli (singular stimulus – it's a variation in condition which can produce a change in activity in part or the whole organism.
- ✓ **Response** - it's a change in activity by the organism
- ✓ **Receptors** – the part of the body which receives stimuli
- ✓ **Effectors –** those parts of the body that bring about response.
- ✓ In order for sensitivity and response to be effected there must be receptors to receive the stimuli, coordinators to integrate information received transmission system to conduct the stimuli &effectors to respond to the stimuli e.g.
- ✓ **Response to a variety of stimuli**
- ✓ Responses can be grouped according to the type of stimuli. This may involve the movement of the whole organism or a part of it in response to the stimuli. If the movement is towards the stimuli, then it is called a positive (-ve) response but if it's away from it its called negative responseE.g.
- ✓ **Taxis** - this is a locomotory response of a motile cell e.g. gamete or a whole organism in response to an external stimuli. The stimuli is unidirectional i.e. a stimuli from one direction. The responses are grouped according to the stimuli which cause them.
- ✓ **Phototaxis** – this is a response to variation in light intensity and direction e.g. when Euglena, spirogyra and fruit flies move towards light; wood lice, maggots and termites usually move away from the light.
- ✓ **Aerotaxis** – this is response to variation in oxygen concentration e.g. amoeba

moving from an area of low oxygen concentration to high oxygen concentration.

- ✓ **Osmotaxis** – response to variation in osmotic pressure as shown by marine crabs burrowing in the sand to avoid dilution of the body fluids.
- ✓ **Rheotaxis** – response to variation in direction of water or air currents.
- ✓ Fishes and planarians move against currents in water while butterflies and moths fly into wind currents in order to detect the scent of flowers.
- ✓ **Chemotaxis** – response to variation in chemical substance e.g. movement of male gametes towards the female gametes. Sperms (antherozoids) of mosses and ferns are attracted to move towards chemical produced by the ovum in the archegonia. Mosquitoes will fly away from insecticide repellants.
- ✓ **Thermotaxis** – it is the locomotory response o temperature ($15^0$c) to moderate warmth ($25^0$c)
- ✓ **Survival value of tactic responses**
- ✓ Enable organisms escape from harmful stimuli e.g. excessive heat, predators.
- ✓ Organisms are able to seek favorable habitats and acquire resources e.g. nutrients, mates e.t.c.
- ✓ Chemo taxis enables fertilization to take place
- ✓ **Reception, response coordination in plants**
- ✓ The sensitivity of plants is brought about by responses on part of the plant. This response is in form of growth movement or tropisms.
- ✓ **Tropisms**
- ✓ This is a growth movement of parts of plants in response to unidirectional external stimulus.
- ✓ The growth movements are often slow because growth rate is usually controlled by plant hormones(auxins)
- ✓ **Types of Tropisms**
- ✓ **Phototropism**
- ✓ This is a growth curvature in response to the direction of intensity of light. Shoots are positively phototropic while roots show negative phototropism.
- ✓ **Chemotropism**
- ✓ This is a growth curvature in

response to a gradient of chemical concentration e.g. pollen tubes grow towards chemicals secreted by the embryo sac.

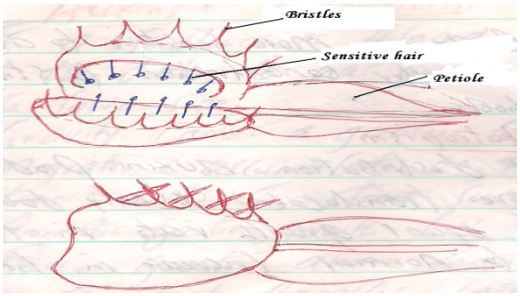
- ✓ **Geotropism**
- ✓ This refers to the growth curvature in response to gravity. Roots are positively geotropic while shoots are negatively geotropic.
- ✓ **Hydrotropism**
- ✓ It refers to the curvature in response to water or moisture. Plant roots are positively hydrotropic.
- ✓ **Haptotropism/ Thigmotropism**
- ✓ This is growth curvature in response to contact with a solid object. It is shown by tendrils or climbing stems which twine around objects e.g. branches or tree stems.
- ✓ Root tips show negative thigmotropism when they grow avoiding solid obstacles such as rocks.
- ✓ **Survival value of tropic responses**
- ✓ Phototropism exposes the leaves in position to maximize light absorption thereby enhancing photosynthesis.
- ✓ Hydrotropism enables the roots of the plant to seek water.
- ✓ Haptotropism enables the plant to obtain mechanical support especially in those plants lacking woody stems.
- ✓ Geotropism enables plants roots to grow deeper into the soil thus offering firm anchorage to the plant.
- ✓ Chemotropism enables the pollen tubes to grow towards the embryo sac thereby facilitating fertilization.
- ✓ **Comparison of tropic and tactic responses.**
- ✓ Tropism and taxes are both adaptive responses that enable the organism to survive better in their environments.
- ✓ Both responses are due to similar external stimuli such as light, water temperature.
- ✓ Both responses are due to unidirectional stimuli.

| Tropisms | Taxes. |
|---|---|
| i. Results in growth curvature responses which are more | Results in Locomotory responses which are temporary. |

| | |
|---|---|
| permanent | |
| ii. Responses are slow | Reponses are fast |
| iii. Are brought about by influence of growth hormones | Absence of hormonal influence. |

- ✓ **(b) Nastic responses**
- ✓ These are non-directional movements of parts of plants in response to diffuse stimuli. Such responses include folding of leaves in hot weather, opening and closing of flowers in response to intensity of light, closing of leaves of ***Mimosa pudica*** when touched.
- ✓ These movements are brought about by turgor pressure changes at the leaf and petal bases of certain plants. At these bases there are pressure sensitive swellings called pulvini which through loss or gain of turgidity bring about these movements.
  - o **Types of Nastisms**
- ✓ **Nyctinasty (Sleep movement)**
- ✓ These are movements in response to differences in light intensity and temperature changes of the day and night e.g. sunflower.
- ✓ If the response is specifically for light then it is called photonasty where it opens in the presence of light and close in its absence.
- ✓ If the response is specifically for temperature changes then it is called thermonasty.
- ✓ **Haptonasty**
- ✓ This is the response to touch e.g.:-
- ✓ ***(i)Mimosa pudica***:- The leaves of this plant will close rapidly if they or their stem are touched. A sudden change of temperature will initiate a response.
- ✓ (ii)Venus fly-trap (Dionaea)- This is an insectivorous plant that grows in soil deficient in Nitrogen so it gets its Nitrogen by trapping and digesting insects. When the sensitive (trigger) hairs on the leaves are touched by a

landing insect, the mid-rib cells lose water rapidly causing the trap to spring hence closing the leaf with the spines interlocking.

- 


- ✓ **Chemonasty**
- ✓ This is the response to the presence of specific chemical substances of nitrogenous compounds such as urea and ammonium compounds found in insectivorous plants e.g. sundew (Drosera)
- ✓ When an insect is trapped by the tentacles of Drosera, the insect provides the chemical stimulus for the release of digestive enzymes by the plant.
- ✓ **Hydronasty.**
- ✓ This is a response to changes in humidity. This type of response is seen in some flowers e.g. Dandelion genus which close when the air is moist.
- ✓ **Survival value of nastism**
- ✓ Protection of the inner delicate parts of the flowers.
- ✓ Reduction of transpiration
- ✓ Regulation of temperature
- ✓ A way of obtaining some limited mineral nutrients

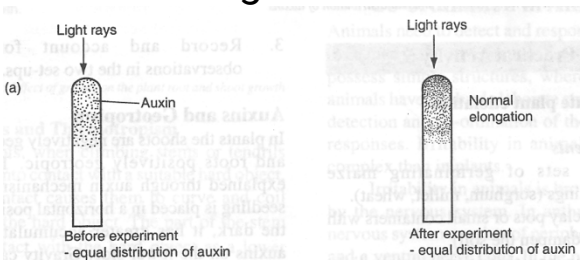
- **Coordination in plants**
- **Role of auxins in Tropisms**

- ✓ Auxins are a group of plant growth hormones and one of the commonest auxins is indole-acetic acid (IAA). Auxins are produced at the apical meristems of the shoots and roots.
- ✓ IAA stimulates growth in both shoots and roots at the region of elongation. Roots are more sensitive to auxins than shoot i.e. requires smaller concentration to stimulate growth compared to shoots.

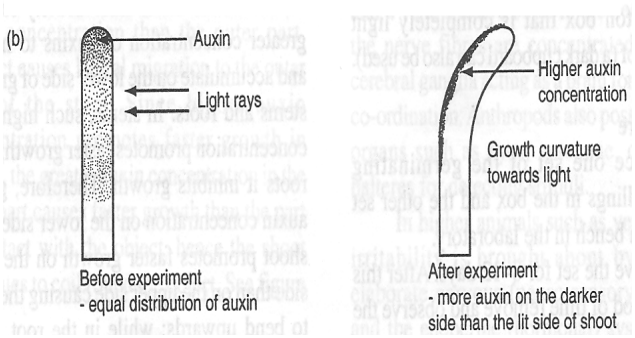
- **Auxins and phototropism**

- ✓ Under uniform light

distribution auxins produced from the shoot apex are translocated evenly down the shoot therefore there is equal growth rate in the height of the shoot. E.g.



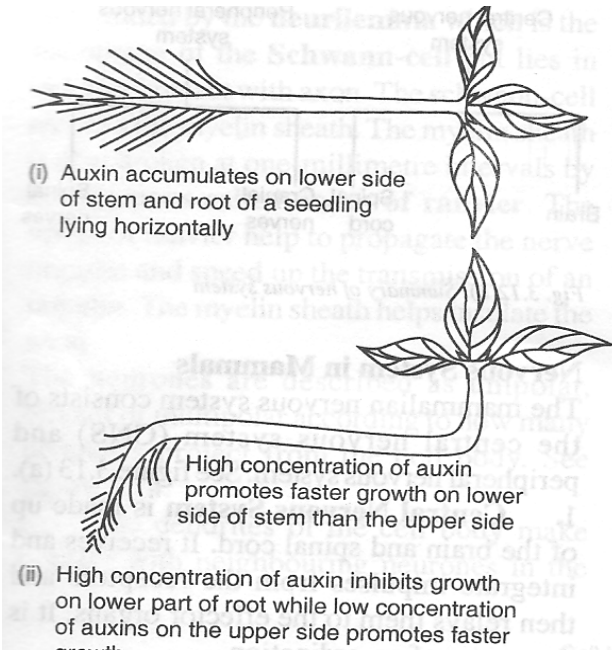

- ✓ When a shoot is exposed to unidirectional light, the shoot tip bends towards the light source. This is because light causes lateral migration of auxins from the lit side of the shoot to the darker side. This leads to higher concentration of the auxins on the darker side. This higher concentration of the auxins stimulates rapid cell elongation and hence faster growth rate than the lit side. Eventually the shoot curves towards the source of light hence the positive phototropic response to light in shoots e.g.




- ✓

## o Auxins and geotropism

- ✓ If the seedling is placed in a horizontal position in the dark, it has greater accumulation of auxins on the lower side.
- ✓ Gravity causes a greater concentration of auxins to migrate and accumulate on the lower side of growing stems and roots. In the stems such high auxins concentration promotes faster growth but in roots it inhibits growth. Therefore greater auxin concenntation on the lower side in the shoot promotes faster growth on the lower side than on the upper side causing the shoot to bend upwards; while in the root lower auxin concentration on the upper side promotes faster growth on the upper side than on the lower hence the root bends downwards. Eg

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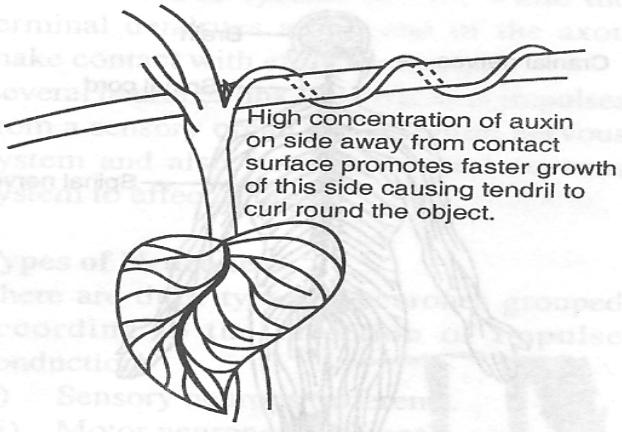
### o Auxins and thigmotropism

- ✓ In plants when climbing stems or tendrils come into contact with a suitable hard object, the contact causes them to curve and coil round the hard object. The part of he stem in contact with the hard object has a lower auxin concentratation than the outer part. Contact causes lateral migration to the outer side of the stem.
- ✓ Since the higher auxin concentration promotes faster growth in shoots, the greater auxin concentration in the outer part causes faster growth than the part in contact with the object hence the shoot continues to coil round the object.

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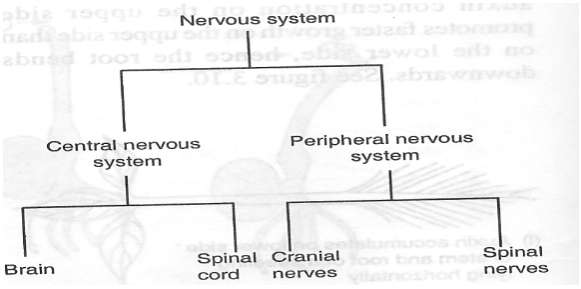
### Co-ordination in animals

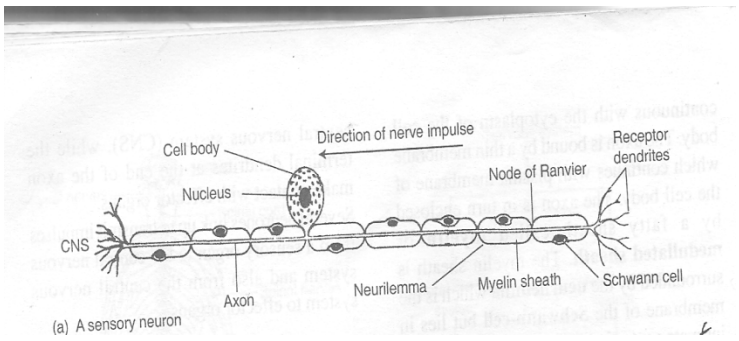
- ✓ Irritability in animals is caused by the nervous system.
- ✓ In arthropods the nervous system consists of peripheral nerves and a ventral nerve cord.
- ✓ In higher animals such as vertebrates, irritability is brought about by a more elaborate nervous (neuro-sensory) system and the endocrine (hormonal) system. The nervous (neuro-sensory) system provides the quickest means of communication in animals.




- ✓ Brain

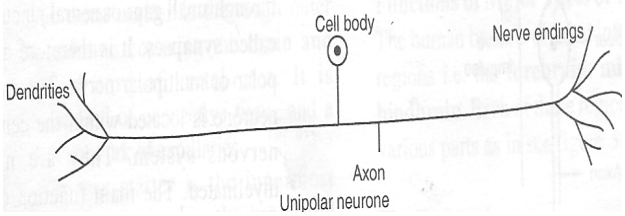
### o Nervous systems in mammals.

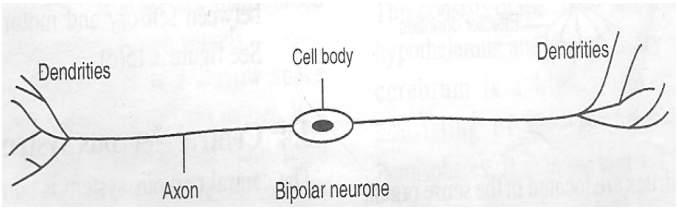
- ✓ It consists of:
- ✓ **Central Nervous System (CNS)**
- ✓ It is made up of the brain and the spinal cord It receives and integrates impulses from the receptors and then relays them to the effector organs. It is the centre of coordination
- ✓ **Peripheral Nervous System**
- ✓ It is made up of sensory nerves and transmits nerve impulses from the receptors in the sensory organs to the CNS and motor nerves that transmit impulses from the CNS to the effector organs.
- ✓ **Structure and function of Nerve Cell**
- ✓ The nerve cell (neurone) is the basic functional unit of a nervous system. It's a cell which is modified to transmit impulses
- ✓ A nerve impulse is an electric signal that is transmited along a nerve fibre.
- ✓ The neorone consists of :
- ✓ The cell body (Centron)
- ✓ Extensions called dendrites
- ✓ In some neurons one of the dendrites is elongated to form an axon.
- ✓ Each axon is filled with a specified cytoplasm called axoplasm, which is usually continous with the cytoplasm of the cell body.

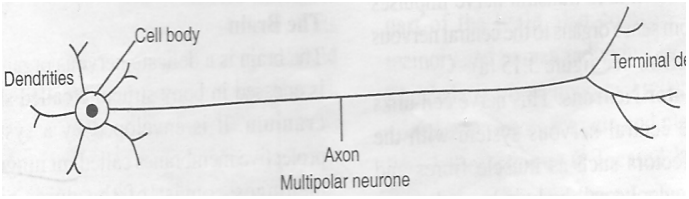



- ✓ The axon is enclosed by a fatty sheath called myelin or medullated sheath. The myelin sheath is surrounded by the neurilemma which is the membrane of the schwann cell.
- ✓ Myelin sheath is broken at one millimeter intervals by constrictions called nodes of ranvier.

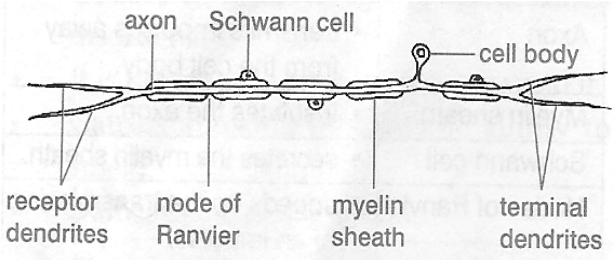
- ✓ Nodes of ranvier help to propagate the nerve impulse and speed up the transmission of an impulse.
- ✓ Myelin sheath helps to insulate the axon.
- ✓ Neurones are described as unipolar, bipolar or multipolar according to how many dendrites project from the cell body. Eg.



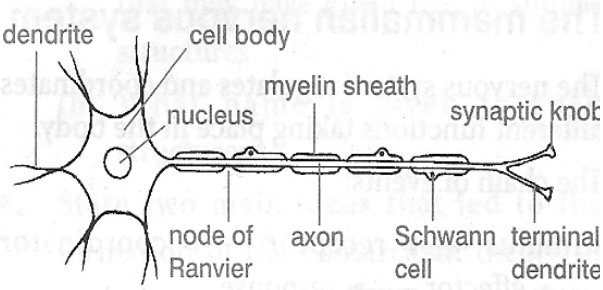




- ✓ The dendrites of the cell body make contact with neighbouring neurones in the CNS while the terminal dendrites at the end of axon make contact with effector organs.
- ✓ **Types of Neurones**
- ✓ There are three types of neurones grouped according to the direction of impulse conduction i.e.
- ✓ **Sensory Neurones (Afferent)**
- ✓ This nerve cell links the sense organs such as the ear, eye skin, nose and tongue with the CNS.
- ✓ Its cell body is situatsd off the axon and outside the C NS.
- ✓ Its receptor dendrites are located in the sense organ while the terminal dendrites are located in the CNS
- ✓ Its function is to transmit nerve impulse from sense organs to the CNS




### o Motor neurones

- ✓ This nerve cell links the CNS with the effectors such as muscle fibres and glands.
- ✓ Its cell body is located at one end of the axon with the CNS
- ✓ its motor end plates terminate in a muscle or gland.
- ✓ It transmits nerve impulses from the CNS to the effectors.

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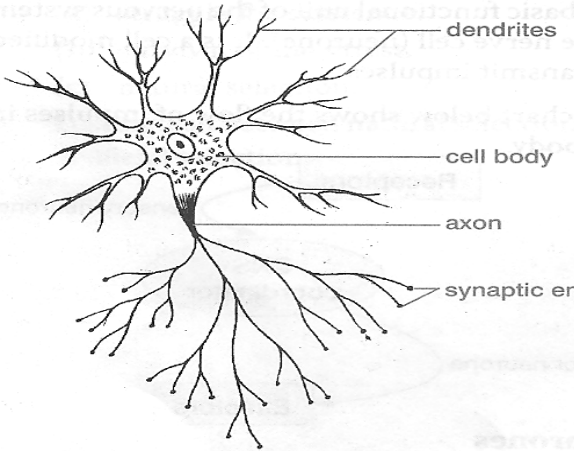
- **Relay neurone**

✓ This neurone links a sensory nerve with a motor neurone through small gaps or neural junctions called synapses. It's therefore a bipolar or multi-polar nerve.
✓ The entire neurone is located within the CNS.
✓ They are non-myelinated.
✓ The main function of a relay neurone is to relay nerve impulses between sensory and motor neurone.

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## Central Nervous System (CNS)

✓ Its composed of:

✓ **The brain**
✓ It's encased in a bony structure called the skull or cranium.
✓ It is enveloped by a system of protective membranes called meninges.
✓ The meninges consist of:
✓ **Dura matter.**
✓ It's the tough outer membrane covering the brain and the spinal cord of vertebrates.
✓ It's composed of connective tissues and rich network of capillaries.
✓ **Pia matter**
✓ It's the inner most membrane covering the brain and the spinal cord.
✓ It possesses many blood capillaries and lymph vessels.
✓ **Arachnoid layer**
✓ It is a narrow space between the dura and pia matter.
✓ It is filled with cerebrospinal fluid, from which oxygen and nutrients diffuse into the brain cells
✓ Within the brain there is a system of cavities called ventricles which are filled with cerebrospinal fluid. This fluid is continuous with the spinal fluid of the central

cord of the spinal cord. This fluid is similar to lymph.

- ✓ It provides nourishment to brain tissues
- ✓ Serves as a shock absorber from mechanical damage.

### o Functions of major parts of the brain

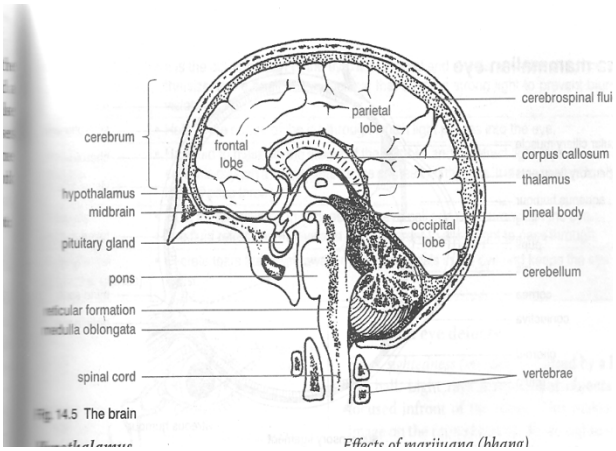
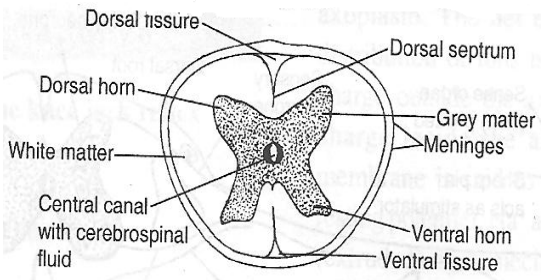
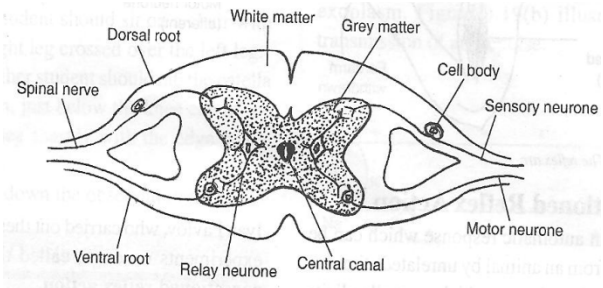


Fig. 14.5 The brain

- ✓ The brain is divided into three major regions i.e.
- ✓ **Fore brain**
- ✓ Largest part of the brain about .⅔ of the brain
- ✓ It consists of:
- ✓ Cerebrum
- ✓ Thalamus
- ✓ Hypothalamus
- ✓ Pituitary gland
- ✓ **Cerebrum**
- ✓ It is a highly developed part consisting of left and right cerebral hemispheres. It is important for;
- ✓ Integration of sensory impulses such as vision, hearing and taste- responsible for emotions i.e. joy and sorrow
- ✓ It controls voluntary body movements e.g. Limbs, lips and neck.
- ✓ It also controls learning, memory and human individuality, imagination and intelligence, thoughts and reasoning
- ✓ **NB Plasmodium may enter the brain causing cerebral malaria leading to mental disorder.**
- ✓ **Thalamus** – it contains receptors for pain and pleasure
- ✓ The center for integration of sensory information
- ✓ **Hypothalamus** – it is located below the thalamus.
- ✓ It has receptors for homeostatic functions such as thermoregulation and

osmoregulation.
- ✓ It controls appetite, thirst and sleep.
- ✓ **Pituitary gland** – it is attached to the hypothalamus and projects downwards from it.
- ✓ It is the master endocrine gland controlling the rest of the endocrine glands.
- ✓ **Mid Brain – (Corpora quadrigemia)**
- ✓ It is the connecting stalk between the fore brain and hind brain.
- ✓ It relays impulses between nerves from the spinal cord and the fore brain
- ✓ **Hind brain**
- ✓ The major parts of the hind brain are:
- ✓ **Cerebellum**
- ✓ The main function is maintenance of body posture and balance. This is achieved by controlling and coordinating muscular movement.
- ✓ Dexterity in fine movements.
- ✓ **Medulla oblongata.**
- ✓ Controls involuntary activities such as breathing, swallowing, salivation and vomiting.
- ✓ Controls dilation or constriction of blood vessels thereby influencing blood pressure
- ✓ **Spinal cord.**
- ✓ It is the posterior extension from the brain to the tail.
- ✓ It is enclosed in the meninges and protected by the vertebral column.
- ✓ It's made up of grey matter and white matter.
- ✓ The **grey matter** is **H**-shaped and surrounds a central canal which is filled with cerebrospinal fluid. This grey matter relays information between the sensory & motor neurones.
- ✓ It consists of cell bodies & dendrites of relay and motor neurones which give it its darker appearance hence the term "grey" matter.
- ✓ **White matter**- it surrounds the grey matter and consists of the sensory & motor neurones.
- ✓ The myelin sheath of these neurones gives this part its shiny white appearance.
- ✓ Arising from the spinal cord are dorsal and ventral roots of spinal nerve.
- ✓ **Transverse section of the spinal cord**



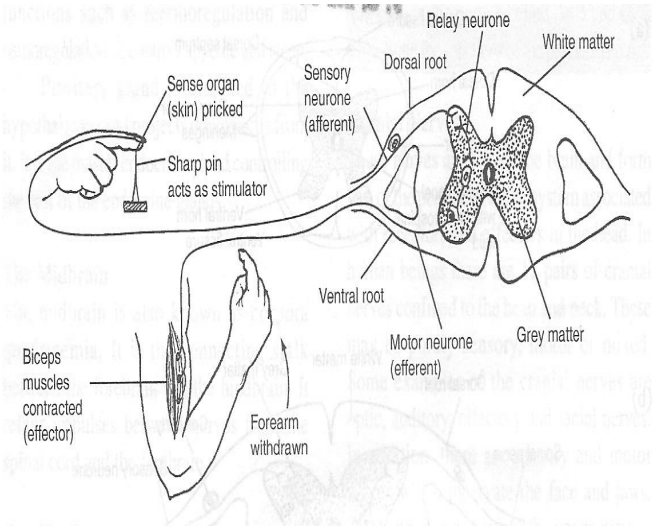




- PERIPHERAL NERVOUS SYSTEM

- ✓ It's made of
- ✓ **Cranial nerves**
- ✓ They arise from the brain and form part of peripheral nervous system associated with receptors & effectors in the head.
- ✓ In human beings there are 12 pairs of cranial nerves confined to the head and neck. Examples of cranial nerves are optic, auditory, facial and olfactory nerves.
- ✓ There are also sensory & motor nerves which innervate the jaws and face.
- ✓ The 10th cranial nerves, vagus nerve, innervate the heart, lungs, diaphragm and the gut.
- ✓ **Spinal nerves**
- ✓ They innervate the skeletal muscles of the limbs and trunk.
- ✓ In association with cranial nerves they control all the organs of the body below the head e.g. urinary bladder, the gut, liver, kidney and lungs.
- ✓ **Reflex action**
- ✓ It's a rapid automatic response to a certain stimulus. There are two types of reflex action
  - **Simple reflex action**
- ✓ In a simple reflex action there is a specific single automatic response to a particular stimulus. It is the simplest form of reflex and does not depend on learning
- ✓ **Examples**
- ✓ Withdrawal of a finger from the hot or sharp object.
- ✓ Blinking of the eye when an object passes close to it.
- ✓ Coughing
- ✓ Sneezing
- ✓ Knee jerk reflex when the knee is tapped
- ✓ Salivation
- ✓ Secretion of tears when an onion is cut.
- ✓ The structural basis of a reflex action is called the

reflex arc, which is the pathway followed by the nerve impulse. The simplest reflex arc is made up of the 3 neurones; the receptors (sensory), relay and motor. They link the receptors with the effectors through the spinal cord.

- ✓ When somebody accidentally touches a hot object the pain receptor in the skin are stimulated. This generates an impulse which is conducted by a sensory neurone to the spinal cord. Here the impulse is passed to the motor neurones via the relay neurones.
- ✓ The impulse travels along the motor neurones to the biceps which contract resulting in the withdrawal of the hand from the painful stimulus.
- ✓ The sensory neurone is also connected to an ascending neurone (longitudinal inter-neurones) which transmits impulse to the brain. This makes one to become aware of the pain a fraction of a second after withdrawal of the hand.




## o CONDITIONED REFLEX

- ✓ This is as automatic response which can be evoked from an animal by unrelated stimulus substituted for one which normally elicits the response.
- ✓ The 1st experiments on conditioned reflex were carried out by Russian scientist Ivan Pavlov in 1902 using dogs.
- ✓ Ordinarily the sight or smell of food initiates salivation in dogs. This is a normal reflex action called the salivation reflex.
- ✓ In this experiments Pavlov rang a bell whenever he was feeding his dogs. He continued doing this for several weeks and the dogs learnt to associate bell

ringing with food.

- ✓ Later on he rang the bell in the absence of food. He found out that this stimulated salivation in dogs, thus the original stimulus (sight or smell of food) was replaced by a different and unrelated stimulus (Ringing the bell) through learning.
- ✓ A conditioned reflex usually weakens with time therefore it must be reinforced by repeated stimulus. This forms the basis of learned behaviour.
- ✓ Examples of conditioned reflex
- ✓ Walking
- ✓ Playing
- ✓ Cycling
- ✓ Writing
- ✓ Swimming
- ✓ Driving
- ✓ Everyday practical applications of conditioned reflex action include. Training of dogs, learning processes.

**Differences between conditioned and simple reflex**

| **Simple reflex action** | **conditioned reflex action** |
|---|---|
| i) single stimulus to bring about response | Repeated stimulus to bring about response |
| ii) Simplest form of behavior and is independent of experience. | Involves modification of behaviors depending on experience. |
| iii) sensory and motor components are the same at all times | Primary and sensory components are replaced by a secondary component but the motor component remains unchanged. |

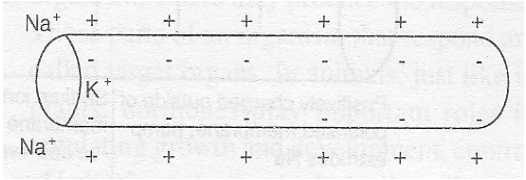
- **o Transmissions of nerve impulse**

- ✓ A nerve impulse is an electrical charge or wave of electrical disturbance arising from changes in ionic concentrations across the surface membrane of a nerve fibre (axon or dendrite).
- ✓ The ions involved in impulse transmission are sodium ions (Na+) and potassium ions

(K+)

- **Resting Potential**

- ✓ A non- conducting nerve fibre is described to be in a resting potential. In this state there is more Na+ outside the axon membrane than inside in relation to the concentration of K+ which is higher within the axoplasm.
- ✓ There are also relatively more anions (negatively charged ions) within the axoplasm. The net effect of this unequal distribution of ions is that there is positive charge outside the axoplasm and negative charge inside the axoplasm so that the membrane is said to be polarised.
- ✓ During resting potential, Na+ are actively pumped out by a mechanism called sodium pump e.g.

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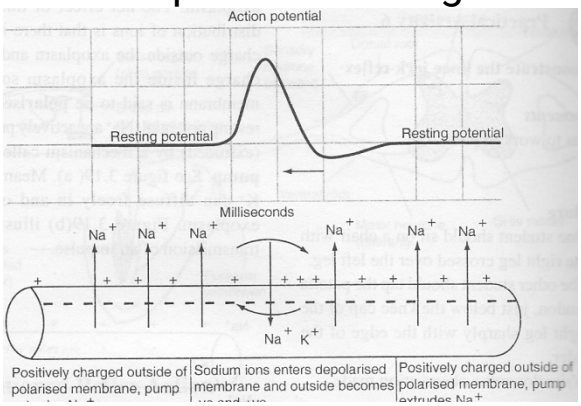
- **Action potential**

- ✓ It's a localised change in electrical potential between the inside and the outside of the nerve fibre when stimulated. The inside becomes positively charged while the outside becomes negatively charged. This is called depolarisation e.g.



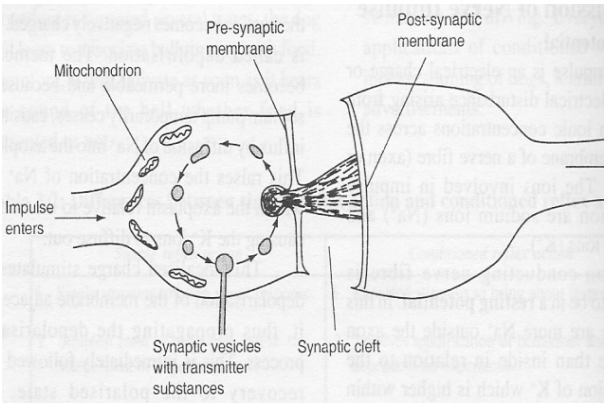

- ✓

- ✓ The membrane becomes more permeable. The sodium pump ceases causing an influx by diffusion of Na+ into axoplasm. This raises the concentration of Na+ ions within the axoplasm relative to the outside, causing the k+ ions to diffuse out.
- ✓ This localised charge stimulates the depolarisation of the membrane adjacent to it, thus propagating the depolarisation process. This is immediately followed by the recovery to the polarised state. The movement of this action potential along a nerve fibre constitutes an impulse.

- **Synapse/ Neuro-**

## junction

- ✓ A synapse is a point at which two nerve cells come into contact. At this point, a dendrite from one of the nerve cell forms an enlargement called a synaptic knob.
- ✓ The function of the synapse is to allow the transmission of nerve impulses from neurone to neurone.
- ✓ The transmission of impulses across a synapse is a chemical process that is mediated by chemical substances called neuro-transmitter substances.
- ✓ The synaptic knob contains numerous sac-like structures called synaptic vesicles and mitochondria. The vesicles contain neuro-transmitter substances.
- ✓ Mitochondria supply the energy necessary for continuous synthesis of neuro-transmitter substances.
- ✓ The terminal part of the synaptic knob is called pre-synaptic membrane.
- ✓ The membrane of the adjoining nerve cell is called the post-synaptic membrane.
- ✓ Between the two membranes is a gap called the synaptic cleft.




### o Transmission of an impulse

- ✓ When an impulse reaches the synaptic knob, it stimulates the vesicles to move towards the pre-synaptic membrane releasing neuro-transmitter substances (acetylcholine). Acetylcholine makes the membrane permeable.
- ✓ Acetylcholine diffuses across the synaptic cleft to the post-synaptic membrane which then becomes depolarized.
- ✓ Na+ ions from the cleft then flow through the post-synaptic knob causing an action potential here.

- ✓ The action potential is then transmitted as a nerve impulse along the neurone.
- ✓ Immediately afterwards acetylcholine liberated in the synaptic cleft is destroyed by an enzyme called cholinesterase into inactive end products (choline and acetic acid (ethanoic acid).
- ✓ These are then reabsorbed by the axon terminals and reconstituted into acetylcholine using energy in the form of ATP provided by mitochondria.
- ✓ The rapid breakdown of acetylcholine is necessary to repolarise the pre-synaptic membrane for the next nerve impulse propagation so that there is no merging of successive nerve impulses from neurone to neurone.

### o Accommodation of synapses

- ✓ If a synapse is stimulated continuously for a long time, a point comes when no impulses are transmitted in the post-synaptic neurone.
- ✓ The synapse is then said to accommodate or adapt to the stimulus e.g.
- ✓ When one wears a rough shirt, an unpleasant sensation is initially felt. After sometime the sensation is not felt any more.
- ✓ Accommodation is thought to result from exhaustion of the neuro-transmitter substance which cannot be synthesized as fast as it is required.

### o Synaptic inhibitors

- ✓ These are the substances that interfere with transmission of nerve impulses across the synapse e.g.
- ✓ Atropine and curare block the post-synaptic membrane preventing it from being stimulated by neuro-transmitter substances
- ✓ Organophosphates e.g. malathion inhibit enzyme cholinesterase. This prevents the destruction of acetylcholine leading to overstimulation of the post-

synaptic membrane

- ✓ **Endocrine system**
- ✓ The system comprises of endocrine glands that are ductless and secrete hormones.
- ✓ Hormones are organic compounds which are either protein or steroids in nature. They are produced in minute quantities in cells in one part of the body and transported by blood stream to the other parts of the same organism where they produce the response.
- ✓ Those parts of an organism that respond are called target organs.
- ✓ **Hormonal feedback mechanism**
- ✓ e.g. if thyroid gland is producing too much thyroxine hormone, the signal level will be sent to the pituitary gland to secrete less thyroid stimulating hormone (TSH) also called thyrotrophin. The amount of thyroxine therefore falls.
- ✓ This coordination is called negative feedback mechanism.
- ✓ The hormones produced by the human body are:
- ✓ ***Thyroxine***
- ✓ It is produced by the thyroid gland found at the neck region. It is a compound of iodine.
- ✓ **Functions**
- ✓ Controls basal metabolic activities by increasing glucose oxidation
- ✓ Enhances the effect of growth hormone (Somatotrophin). This ensures normal growth and mental development.
- ✓ It also works in conjunction with adrenaline to enhance involuntary activities such as increased circulatory rates.
- ✓ **Effects of under – secretion (Hypothyroidism)**
- ✓ It leads to insufficient iodine in the diet or defective enzymatic reaction concerned with its formation.
- ✓ It leads to:

- ✓ *Cretinism in children*
- ✓ -The children have deformed legs
- ✓ -Dry leathery skin
- ✓ -Large tongue
- ✓ -General body sluggishness
- ✓ -Poor mental development resulting in low intelligence
- ✓ **Myxoedema in adults**
- ✓ -*S*welling of the thyroid gland called goitre. This is due to overworking of the thyroid gland in an attempt to synthesize enough thyroxine
- ✓ -Due to the low thyroxine concentration, individuals have low metabolic rate as shown by reduced heart beat, breathing rate and body temperature.
- ✓ -They are mentally and physically sluggish
- ✓ -The low physical activity results into weight gain (obesity), retention of excess fluid (oedema) hence swollen feet and puffy face.
- ✓ **NB.** Hypothyroidism can be controlled by use of balanced diet supplemented by iodized table salt and administration of iodine tablets.
- ✓ **Effects of overproduction of thyroxine(hyperthyroidism)**
- ✓ Hyperthyroidism is due to the presence of plasma proteins that stimulate the thyroid activity i.e. defective enzymatic reactions.
- ✓ Leads to increased metabolic rate resulting in increased heart beat, breathing rate and high temperatures.
- ✓ Individual show nervousness, restlessness and are easily irritable
- ✓ Extreme hyperthyroidism can lead to heart failure, a condition known as thyrotoxicosis.
- ✓ Can be controlled by treatment with radioactive iodine.
- ✓ Surgical removal of parts of the thyroid gland can also be done.
- ✓ *Adrenaline*
- ✓ Produced by medulla part of the adrenal glands located above the kidney.
- ✓ It prepares the body for emergency – fight or flight

e.g.

- ✓ -The heart beat increases hence increasing rate of circulation.
- ✓ -Increases metabolic rate.
- ✓ -Arterioles of the skin and digestive system constrict.
- ✓ -In the liver, glycogen is converted into glucose.
- ✓ -Skeletal muscles contract and relax which can allow movement.
- ✓ -Breathing rate becomes faster and deeper.
- ✓ -Fats are converted to fatty acids which are available in the blood for muscle contraction
- ✓ ***NB*** over secretion can be brought about by growth of tumour in the medulla of adrenal glands. Symptoms are:
- ✓ High blood pressure
- ✓ Severe headache
- ✓ Racing heart
- ✓ Sweating
- ✓ Faintness
- ✓ The resultant effect is aging of major body organs such as kidney, heart and liver.
- ✓ **Comparison between endocrine and nervous system**
- ✓ Both provide a means of communication within the body of an organism.
- ✓ Both involve transmission of a message triggered by a stimulus and a response
- ✓ The target organs of hormones are like effector organs
- ✓ Both involve chemical transmission.
- ✓ Both bring about survival response.
- ✓ **Differences between endocrine and nervous system**

| **Endocrine system** | **Nervous system** |
|---|---|
| Chemical substance to evoke reaction | Nerve impulse to evoke response |
| chemical transmitted through blood | impulse only through nerve fibre |
| response slow but affect several parts of the body | responses quick, specific and localized |
| effects are long lasting | effects are rapid and short – lived |
| responses take place involuntarily | takes place voluntarily and |

| | involuntarily |
|---|---|

- **Effects of Drug abuse on human Health.**

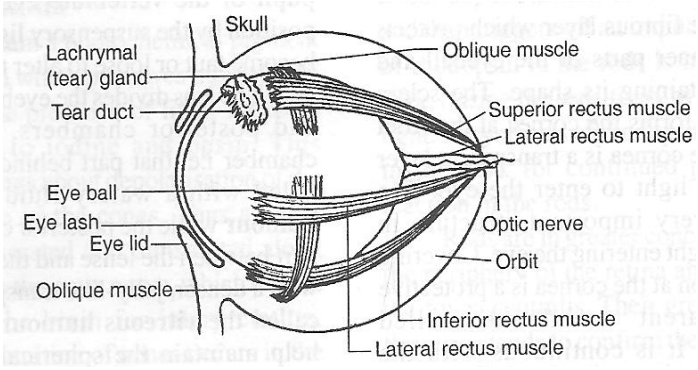
- ✓ **Drug-**Its any chemical substance which when taken into the body has psychological and physiological effects.
- ✓ **Drug abuse**- It's the indiscriminate use of drug with no regard to their side effects
- ✓ Commonly abused drugs include:
- ✓ Khat (miraa)
- ✓ Nicotine
- ✓ Cannabis Sativa
- ✓ Alcohol
- ✓ Prolonged abuse of drugs can cause addiction (drug dependence)

- **Effects of Drug abuse**

- ✓ Depressed appetite and poor feeding habits leading to emaciation
- ✓ Interference with absorption of vital vitamins such as vitamin K, E which may lead to sterility and blindness.
- ✓ Lowers nervous coordination leading to loss of posture and balance. This decrease performance in sports and manual activity.
- ✓ Irritation of the lungs and the respiratory tract leading to frequent coughing and infections.
- ✓ May lead to cancer of the lungs, throat and that of urinary bladder.
- ✓ May also cause stomach ulcers.
- ✓ Damage too many tissues of the heart and liver leading to heart attack and liver cirrhosis respectively.
- ✓ Interference of temperature regulation leading to excessive heat loss.
- ✓ Damage caused to brain may lead to sleeplessness(insomnia) , loss of memory (amnesia), deliriums, hallucination and mental illness (madness)
- ✓ In women, drug abuse may lead to poor foetal development and pregnancy complication.
- ✓ Irreversible damage to vital body tissues and organs and may eventually lead to death.
- ✓ Addicted persons have an impaired judgment which may predispose them to accidents and infections

such as HIV\AIDS.

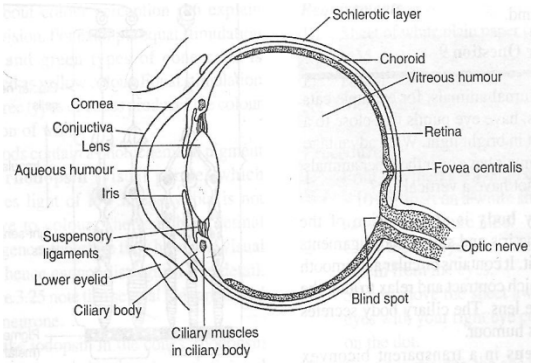
- ✓ **SENSE ORGANS**
- ✓ In mammals, the main organs of special sense are:
- ✓ Eye for sight
- ✓ Ear for hearing
- ✓ Tongue for taste
- ✓ Nose for smell
- ✓ Skin for pressure, pain and temperature.
- ✓ **The Eye**
- ✓ The function is to receive light by which an animal perceives and distinguishes objects in its immediate environment.
- ✓ The eye is located in a socket in the skull called orbit, which offers protection against physical damage.
- ✓ Within the orbit there is a fatty layer lining which provides further protection as a shock absorber against mechanical damage.
- ✓ In the socket the eye is suspended by sets of muscles which move the eye i.e.




- ✓ Lateral rectus muscles- They move the eye left and right.
- ✓ Superior and inferior rectos muscles –Move the eye up and down.
- ✓ Oblique muscles – Steady the eye in it's up and down movement.
- ✓ In the front of the eyeball, there are two thin folds of skin, the eyelids which protect the eye.
- ✓ From the edge of the eyelids, there are many hairs called eyelashes which protect the eye from entry of small particles.
- ✓ Eye brows – they are raised portions of the skin above the eye, thickly covered with hair whose function is to prevent sweat and dust from entering the eye.
- ✓ In land vertebrates there is a lachrymal (tear) gland that

continuously secretes watery, saline & antiseptic fluid called tears.

- ✓ The tears moisten the cornea and wash foreign particles out of the eye. The fluid drains through the lachrymal duct into the nose.
- ✓ In mammals, the lachrymal gland is beneath the upper eyelid, while in other animals it is located beneath the lower eyelid.
- ✓ In amphibians, birds, reptiles, some fish and some mammals, e.g. cat, there is a transparent membrane called nictitating membrane which is drawn across the eye to clean it.
- ✓ The mammalian eye is spherical, fluid filled structure whose walls consist of three layers i.e.
- ✓ Sclerotic (outer layer) / sclera
- ✓ Choroid (middle layer
- ✓ Retina (inner layer)




- ✓ ***Sclera / sclerotic / outer layer***
- ✓ This is a white fibrous layer which protects the delicate inner part of the eyeball and helps in maintaining its shape.
- ✓ The sclera forms cornea at the front of the eye.
    - o **Cornea** – it's a transparent layer
- ✓ It allows the light to enter the eye
- ✓ It aids in reflecting the light entering the eye.
- ✓ **Conjunctiva**:- It's a protective thin transparent membrane covering the front portion at the cornea.
- ✓ ***Choroid/ middle layer***
- ✓ It's a dark-pigment, membranous layer. It has numerous blood vessels.-
- ✓ Absorbs stray light hence

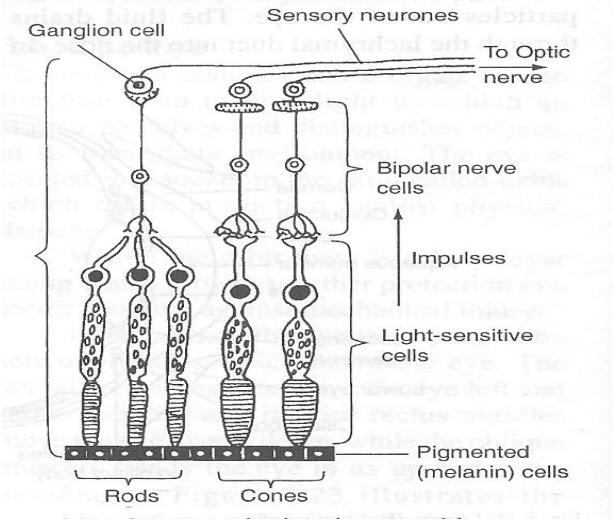
prevents internal reflection within the eye.

- ✓ Provides nourishment to the eye due to presence of numerous blood vessels.
- ✓ At the front of the eye, the choroid extends and forms ciliary body and iris
- ✓ Iris – it is a thin round sheet of muscular muscles (circular and radial) which controls the diameter of the pupil.
- ✓ Its pigmented giving the eye its colour i.e. black, brown or blue
- ✓ Pupil – it's the opening in the iris which allows the light to enter the eye. In some vertebrates e.g. cats the pupil is narrow and slit – like while in most vertebrates it appears round.
- ✓ Ciliary body – it's an extension of choroid, iris and suspensory ligaments attached to it.
- ✓ It contains circular and smooth muscles which contract and relax to alter the shape of the lens.
- ✓ Ciliary body secretes the aqueous humour.
- ✓ Lens – it is a transparent biconvex structure located immediately behind the pupil of the vertebrate eye
- ✓ It's held in position by suspensory ligaments which become tight or loose to alter the shape of the lens.
- ✓ The lens divides the eyeball into anterior & posterior chambers
- ✓ The anterior chamber i.e. the part behind the cornea is filled with a watery fluid called aqueous humour.
- ✓ The posterior chamber i.e. the part between the lens & retina is filled with a denser, jelly – like transparent material called vitreous humour.
- ✓ This fluid helps to maintain the spherical shape of the eyeball and refracts incoming light towards the retina.

✓ ***Retina***

- ✓ It is the light sensitive layer composed of 3 regions i.e.
- ✓ an outer pigmented region in contact with the choroid

- ✓ a middle region of photoreceptors consisting of cones & rods.
- ✓ An innermost region of neurones. These neurones run over the surface of the retina and join to form the optic nerve which transmits nerve impulses from the retina to the brain for interpretation.




- ✓

- ✓ **Cones**
- ✓ Cones – they are densely packed together in a certain region of the retina called fovea or yellow spot. They contain the light sensitive pigment called iodopsin.
- ✓ Iodopsin is adapted for:-
- ✓ Bright light vision
- ✓ Perception of fine details
- ✓ For colour vision
- ✓ When one looks at an object directly, light rays from it falls on the fovea. This enables the object to be observed in detail.
- ✓ In the presence of light, iodopsin breaks down to iodine & opsin. Each cone has its own bipolar neurone which in turn links it with an optic nerve i.e. it lacks retinal convergence.
- ✓ This property of the cones enables them to have high visual acuity (ability of the eye to distinguish objects clearly)
- ✓ In higher vertebrates there are 3 types of cones cells which enable them to differentiate the different colours they perceive i.e. blue, green & red.
- ✓ The trichromatic theory which suggests that the simultaneous stimulation of the 3 types of cones at different degrees brings about colour perception e.g.
    - o -Equal stimulation of red and green types of cones cells is perceived

as yellow colour.

- -Equal stimulation of all 3 types of cones produces the colour sensation of white.

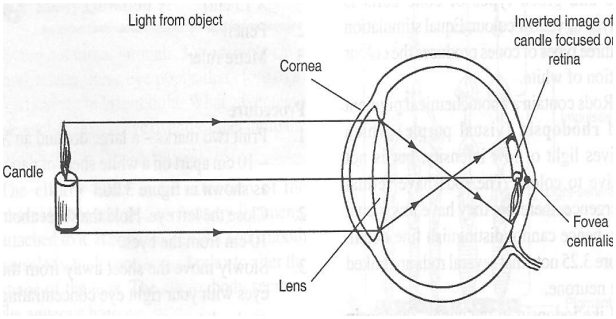
✓ ***Rods***

- ✓ Rods contain a photochemical pigment called rhodopsin (visual purple) which perceives light of low intensity but is not sensitive to colour.
- ✓ The rods have retinal convergence, therefore they have low visual acuity hence cannot distinguish fine details
- ✓ Rhodopsin degenerates to opsin and retinal ( derivative of vitamin A) to bring about depolarization of the cell membrane, and then triggers off an impulse i.e. Rhodopsin
  light opsin + Retinal
- ✓ The amount of rhodopsin in the eye is increased in the dark, raising the sensitivity of the rods to dim light.
- ✓ Resynthesis of rhodopsin occurs slowly in the dark for continued photochemical reaction in the rods.
- ✓ Rods are in greater concentration round the periphery of the retina and are absent in fovea centralis. Because of this, one can see an object better in dim light if he looks at it from the corner of the eye. This way, the image falls on the rods.
- ✓ Diurnal animals (that operate during the day) like man have large number of cones in their retina.
- ✓ Nocturnal animals (those that operate during the night like bats have large numbers of rods in their retina.
- ✓ In the retina there is an area where the optic nerves enter the eyeball. This is called blind spot. This area has neither rods nor cones, so images from objects falling on the blind spot cannot be perceived.

✓ **Image formation and interpretation**

- ✓ Light from the object is reflected by cornea, aqueous humour and lens through the vitreous humour and focused on to the fovea centralis on the retina.

- ✓ The image is recorded as real, inverted and small e.g.




- ✓
- ✓ The photoreceptor cell becomes stimulated and nerve impulse is generated and transmitted by the optic nerve to the cerebrum part of the brain for interpretation. In the brain the impulses are interpreted and the object appears real, upright and normal.
- ✓ The images from the left eye are interpreted by the right cerebral hemisphere and those from the right eye by the left cerebral hemisphere.
- ✓ **Binocular vision / stereoscopic vision**
- ✓ Binocular vision refers to the ability of the right eye to provide a three dimensional view and a depth perception of an object under observation.
- ✓ It's seen in man and other primates all of whom have two eyes placed in front of the head. This way, both eyes can be focused on the same object. Each eye forms its own image of the object under the observation.
- ✓ Both images are sent to the brain which combines them to give a single impression of the object, since each eye "sees" a slightly different aspect of the same object, a combination of the two images provides a 3 dimensional view and depth perception.
- ✓ Binocular vision helps to accurately judge the distance as when monkeys leap on trees or when a man is driving.
- ✓ If the two eyes are not well aligned or if the visual cortex is intoxicated e.g. by alcohol the object under observation appears double & blurred.
    - o **NB** Improper alignment of the eye can be demonstrated by looking at an object & pressing the eye to the

side with a finger.

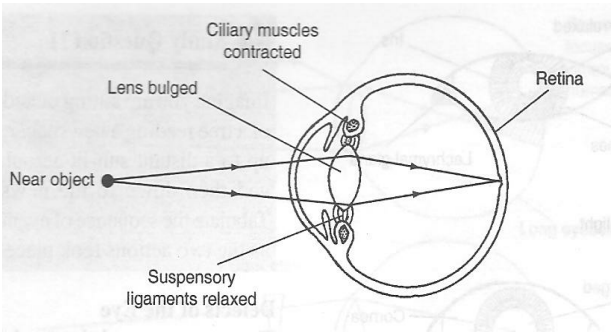
- **Accommodation of the eye**

✓ This refers to the ability of the eye to focus for both far and near objects. It is accomplished through a change in the shape of the lens.

- **Accommodation of a close object**

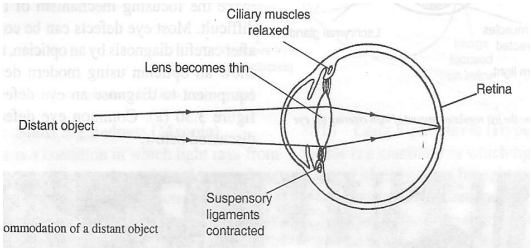
✓ The ciliary muscles contract thereby relaxing the tension on suspensory ligaments.

✓ The curvature of the lens increases i.e. the close object are gently refracted by the lens focusing them onto the retina e.g.



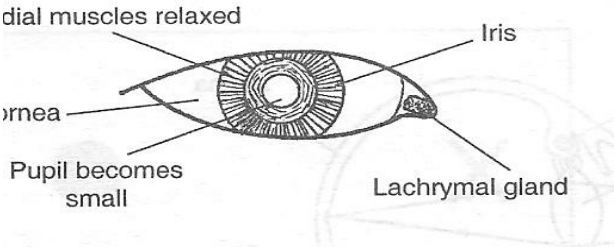

- **Accommodation of a distant object**

✓ The ciliary muscles relax thereby increasing the tension of the suspensory ligaments. This stretches the lens decreasing its curvature i.e. the lens become thinner. Light rays from a far object are less refracted and hence focused onto the retina e.g.




✓ During the accommodation, the iris regulates the amount of light entering the eye.

✓ In bright light, the circular muscles of the iris contract while the radial muscles relax and the pupil becomes smaller. This prevents damage of the retina by excessive light.

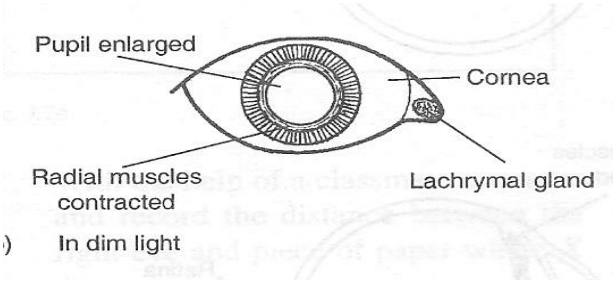



✓

✓ In dim light the radial muscles of the iris contract and the circular muscles relax, the pupil enlarges.

✓ This allows in enough light to stimulate photoreceptors on

the retina.

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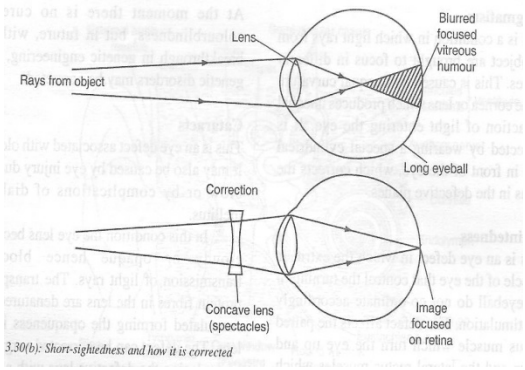


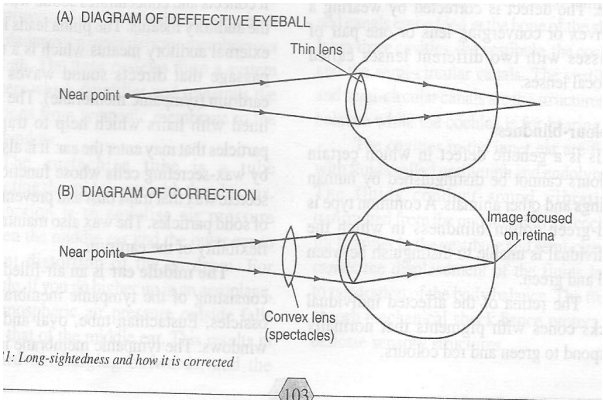
3.30(b): Short-sightedness and how it is corrected

- ✓ ***Defects of the eye.***
  - ***Short sightedness (Myopia)***

- ✓ *It is* also called near sighted and individuals with this defect have a longer than normal eye ball. Light rays from distant objects are focused at point in front of the retina.
- ✓ As a result distant objects appear blurred.
- ✓ This defect can be corrected by wearing glasses with concave (diverging) lenses. These bend light rays outwards before they reach the eyes enabling them to be focused on the retina.

  - **Long-sightedness (Hypermetropia)**

- ✓ Long sighted or far sighted individuals have a shorter than normal eyeball or weak lenses. Light rays from a near object are focused at a point behind the retina. As a result near objects appear blurred
- ✓ Light rays from distant objects are focused normally on the retina e.g.



1: Long-sightedness and how it is corrected



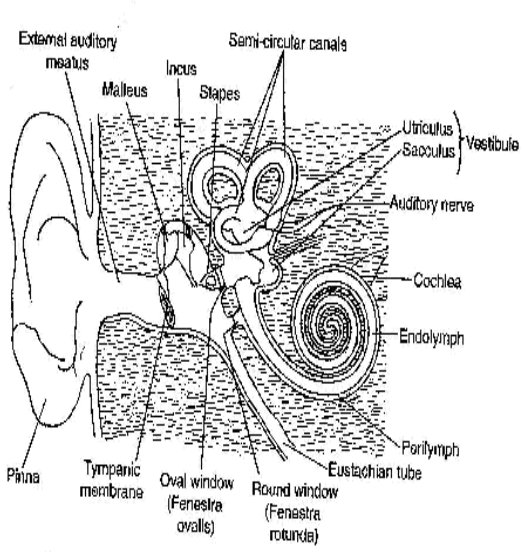
- ✓ This defect can be corrected by wearing glasses with convex (converging) lenses. The lenses bend the light rays inwards before they

reach the eyes enabling them to be focused on the retina

- ✓ **Astigmatism**
- ✓ This is a condition in which light rays from an object are brought to focus in different planes. This is caused by unequal curvature of the cornea or lens which produces unequal refraction of light entering the eye.
- ✓ It's corrected by wearing a special cylindrical lens in front of the eye which corrects the focus in the defective planes.
- ✓ **Squintedness**
- ✓ This is where the extrinsic muscle of the eye that control the turning of the eye ball do not co-ordinate above on stimulation.
- ✓ The defect affects the paired rectus muscle which turn the eye up and down and lateral rectus which move the eye left and right.
- ✓ In this condition, the eye ball face different direction hence focusing and accommodation are achieved with difficulty
- ✓ NB.Its difficult to correct this defect
- ✓ **Old sight (Presbyopia)**
- ✓ This is a condition in which the light rays from an object are brought to focus behind the retina, while rays from a distant object is sharply focused. This is by hardening (loss of elasticity)of the lens and weakening of the ciliary muscles due to old age
- ✓ The defect is corrected by wearing a concave or convent lens or one pair of glasses with two different lenses called bifocal lenses.
- ✓ **Colorblindness**
- ✓ This is a genetic defect in which certain colours can not be distinguished by human beings and other animals.e.g Red-green colour blindness in which an individual is unable to distinguish between red and green.
- ✓ The retina of the affected individual lacks cones with pigments that normally respond to red – green colors.
- ✓ NB. Currently there's no cure for colorblindness.

- ✓ *Cataracts*
- ✓ This is an eye defect associated with old age. It may also be caused by eye injury due to a blow or by complications of diabetes mellitus.
- ✓ The eye lens become cloudy or opaque hence blocking the transmission of light rays. The transparent protein fibres in the lens are denatured and coagulated forming the opaqueness in the lens.
- ✓ The defect can be corrected surgically by replacing the diffective lens with a good one from a donor or an artificial lens.

- ✓ **THE HUMAN EAR**
- ✓ The mammalian ear performs two main functions i.e.
- ✓ -Hearing
- ✓ -Maintenance of balance
- ✓ The ear can be divided into 3 main parts i.e.

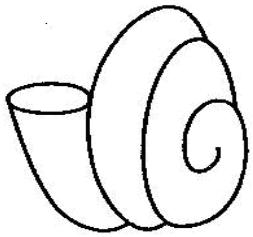



- ✓ **The outer ear**
- ✓ It consists of;
- ✓ -pinna
- ✓ -External auditory meatus
- ✓ **The pinna**
- ✓ It's a flap of skin and cartilage which partially covers the opening to external auditory meatus.Some animals e.g. cattle are able to rotate their pinna in order to locate the direction of sound.
- ✓ It collects and concentrates sound waves into the external auditory meatus. It leads into external auditory meatus.
- ✓ **External auditory meatus**

- ✓ It's a tube or passage that directs sound waves to the ear drum.
- ✓ The tube is lined with hairs which help to trap solid particles that may enter the ear.
- ✓ It's also lined by wax secreting cells whose function is to secrete wax that traps dust and prevents entry of solid particles. Wax also maintains the flexibility of the ear drum.
- ✓ **The middle ear**
- ✓ It's an air –filled cavity consisting of;
- ✓ -Eardrum (Tympanic membrane)
- ✓ -Ear ossicles
- ✓ -Eustachian tube
- ✓ -Oval window
- ✓ -Round window
- ✓ **Eardrum (Tympanic membrane)**
- ✓ It's taut but pliable like the skin of a drum which enables it to vibrate.
- ✓ When it is hit by sound waves from outside, it vibrates and transforms sound waves into vibrations. It then transmits the vibrations to the Ear ossicles.
- ✓ **(ii) Ear ossicles**
- ✓ These are 3 bones namely;
- ✓ -Malleus (hammer)
- ✓ -Incus (anvil)
- ✓ -Stapes (stirrup)
- ✓ They are suspended by muscles i.e. tensor tympani and stapedius.These muscles also prevent excessive vibrations which could damage the inner delicate membraneous labyrinth.
- ✓ The 3 Ear ossicles form a system of levers which amplifies and transmits the vibrations from Eardrum (Tympanic membrane) to the Oval window.
- ✓ **Eustachian tube**
- ✓ It's a tube connecting the middle ear with the pharynx.
- ✓ Its function is to equalize the air pressure between the middle ear and the outer ear

to prevent the distortion of the Eardrum (Tympanic membrane).e.g. if you go higher up in an aeroplane, the atmospheric air pressure outside falls below that of the middle ear. This results in the Eardrum (Tympanic membrane) bulging outwards and the condition can be rectified by yawning or swallowing which opens the Eustachian tube to equalize the pressure on both sides of the Eardrum.

- ✓ **NB** Eustachian tube can provide a passage for entry of pathogenic microbes from the pharynx to the middle ear causing ear infection.
- ✓ **Oval window**
- ✓ It's a membrane that covers a small hole leading to the semi-circular canals
- ✓ **Round window**
- ✓ It's a membrane that covers a small hole leading to the cochlea.
- ✓ **The Inner Ear**
- ✓ It's a fluid-filled cavity. It consists of;
- ✓ -Cochlea-Involved with hearing
- ✓ -Vestibular apparatus – Composed of vestibule and semi-circular canals which are involved in balance.
- ✓ The cavities in the inner ear are filled with fluids called perilymph and endolymph. The fluids conduct sound vibrations transmitted from the middle ear to the cochlea for hearing.
- ✓ In the vestibule and semi-circular canals the displacement of the fluids leads to the restoration of the body balance. The fluids absorb mechanical shock hence protect the delicate sensory structures.
- ✓ **Mechanism of hearing**
- ✓ Cochlea is spirally shaped tube consisting of a system of canals, membranes and sensory cells. The canals are filled with endolymph.and perilymph.The coiling of the cochlea offers a large surface area for attachment of the sensory cells responsible for hearing.

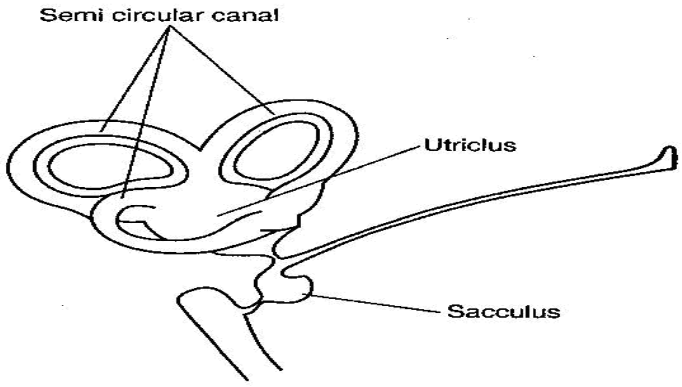


*External view of the cochlea*

- ✓ The pinna concentrates sound waves into the External auditory meatus.The sound waves strike the Eardrum and cause it to vibrate. The vibrations are transmitted to the ear ossicles in the middle ear.
- ✓ The first ossicle, Malleus picks the vibrations, and then transmits to Incus then to stapes. The stapes passes the vibrations to the Oval window from where the vibrations are transmitted to the perilymph of the cochlea.
- ✓ The 3 Ear ossicles are specially arranged to amplify the vibrations as they transmit the to the Oval window (amplifies 22 times)
- ✓ In the cochlea the vibrations stimulate the sensory cells hairs to generate nerve impulses which are transmitted to the brain via the auditory nerve for interpretation. The intensity of stimulus transmitted to the brain enables the brain to interprete the impulses as sound of specific pitch and loudness.
- ✓ Meanwhile the vibrations in the fluid of the inner ear are dissipated back into the middle ear through the Round window.
- ✓ The direction of sound is detected accurately as a result of both ears functioning together. When sound waves come from the front, both ears pick the waves at the same time.
- ✓ If the sound is from the sides, one ear will pick the waves earlier than the other. The time lapse of impulses to the brain allows for the determination of direction and distance.
- ✓ **Maintenance of body balance and posture**
- ✓ Balance is brought about by the semi-circular canals and the vestibule
- ✓ **Semi-circular canals**
- ✓ These are 3 tubular cavities containing endolymph.These canals lie mutually at right angles to each other and occupy the 3 planes of space.

They contain receptors that respond to rotation of head in any of the 3 planes.

- ✓ Each semi-circular canal has a swelling called ampulla at one end containing sensory cells.
- ✓ The semi-circular canals maintain body posture in relation to movement of the head e.g. when one spins and then stops suddenly, one feels dizzy. This is because the fluid is still in motion and stimulating sensory cells in the ampulla. The movement of the fluid stimulates the sensory cells which trigger off nerve impulses which are transmitted via the auditory nerve to the brain for interpretation.
- ✓ In the brain the information is relayed to the motor neourone to the muscles of the body to restore the correct posture.



*Vestibular apparatus*

### o Vestibule

- ✓ It consists of utriculus and succulus which contain sensory cells. They maintain posture and balance in relation to gravity.
- ✓ When the body balance is shifted the fluid disturbs sensory cells. This triggers a nerve impulse to the brain via the auditory nerve. The brain interprets the impulse according to the position of the body in relation to gravity. The brain relays a nerve impulse through the motor neourone to the muscles of the body to restore the correct posture..
- ✓ **Defects of the Ear**
- ✓ **Deafness-**This is a hearing defect which makes an individual unable to perceive sound. There are two categories i.e.

- ✓ **Permanent deafness-**This is due to damage of the cochlea or auditory nerve. It is caused by;
- ✓ **-**Prolonged exposure to loud sounds.
- ✓ **-**When the cochlea is sensitive to certain drugs e.g. some antibiotics
- ✓ **NB It's difficult to correct**
- ✓ **(ii) Partial deafness-**It's brought about by impairment of the structures that conduct vibrations to the cochlea e.g. ear drum and ear ossicles.
- ✓ **Ear ossicles**. - Can be impaired due to abnormal growth of the connective tissue(fibrosis) in the middle ear or by calcification of ear canals.
- ✓ **Ear drum**- Can be damaged by;
- ✓ -Infection
- ✓ -Physical blow
- ✓ -Production of too much wax which hardens hence blocking the external auditory meatus.
- ✓ -Partial deafness can be corrected by surgery or by using a hearing aid.