CO-ORDINATION / IRRITABILITY IN ORGANISMS

This is the ability of an organism to detect and respond to changes in the environment / stimulus.

Definitions of important terms

1. **Stimulu**s; this is a change in the environment of an organism.
2. **Internal environment**; this is the immediate surrounding of cells in the body of an organism. In animals, it is the blood and tissue fluid.
3. **External environment**; this is the surrounding of the entire organism.
4. **Response**; this is a change shown by an organism in reaction to a stimulus.
5. **Receptors**; these are structures that detect stimuli.
6. **Effectors**; these are structures that carry out a response.
7. **Impulse**; this is an electric message that is carried from receptors to effectors to cause a response.

COORDINATION IN PLANTS

Coordination and control in plants is carried out by hormones especially ***auxins.***
Plant hormones usually cause responses involving growth, called ***TROPISMS***.

TROPISM

This is the growth movement of the plant part in response to a unidirectional stimulus.

Characteristics of tropisms

1. It involves growth
2. It is a slow response
3. It occurs at the shoots and root tips
4. It is related to the direction of stimulus
5. It is induced by a directional stimulus

Importance of tropisms to plants

1. It enables plants leaves to trap maximum sunlight by enabling plant shoots to grow upright towards light.
2. It enables plants to become firmly anchored in the soil by the roots growing towards the ground.
3. It enables plant roots to absorb water, which necessary for plant growth.
4. It enhances fertilization in plants since the pollen tubes grow towards the chemicals of the embryo sac.
5. It enables climbing plants to gain support by twinning around the support.
6. Tropisms allow plant parts to alter direction in response to changing conditions in the environment.
7. It enhances pollination by shoots growing upwards to expose flowers to agents of pollination.
8. It enhances fruit dispersal by shoots growing upwards to expose fruits to agents of dispersal.

TYPES OF TROPISMS

Tropisms are divided into different types depending on the nature of the stimulus ie

Name of tropism	Stimulus
1. Hydrotropism	Water

2. Thigmotropism / haptotropism	Touch
3. Chemotropism	Chemicals
4. Geotropism	Gravity
5. Phototropism	Light
6. Aerotropism	Air

The table below shows some of the tropic movements shown by plants

Type of tropism	Stimulus	Positive response	Negative response
Phototropism	Light	Shoot	Root
Geotropism	Gravity	Root	Shoot
Hydrotropism	Water	Roots	Shoots
Chemotropism	Chemicals	Pollen tube	-
Thigmotropism	Touch	Tendrils of passion fruits	Root tips when in contact with an obstacle

CHEMOTROPISM

It is a growth movement of a plant part in response to a source of chemicals in a single direction.

THIGMOTROPISM

It is a growth movement of a plant part in response to touch from a single direction.

PHOTOTROPISM

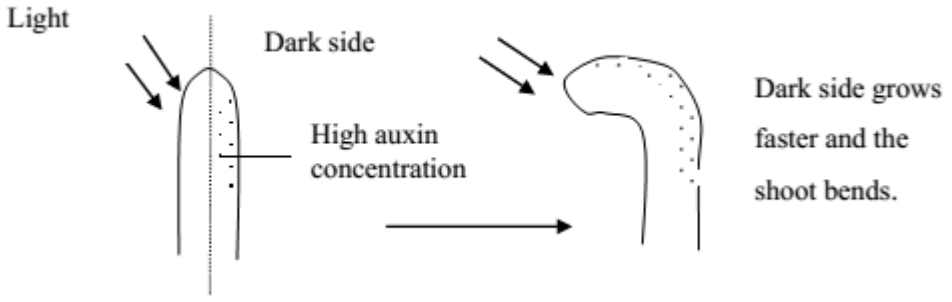
This is the growth movement of a plant part in response to unidirectional source of light.

AUXINS AND PHOTOTROPISM

Auxins concentrate on the dark side of a shoot.

A high concentration of auxins on the side with little or no light increases the rate of cell division and elongation on that side, hence that side grows faster than the one in light.

This causes the shoot to bend towards the direction of light (positive phototropism)



However, high auxins concentration limits growth in plant roots

EXPERIMENT TO DEMONSTRATE PHOTOTROPISM IN A PLANT SHOOT

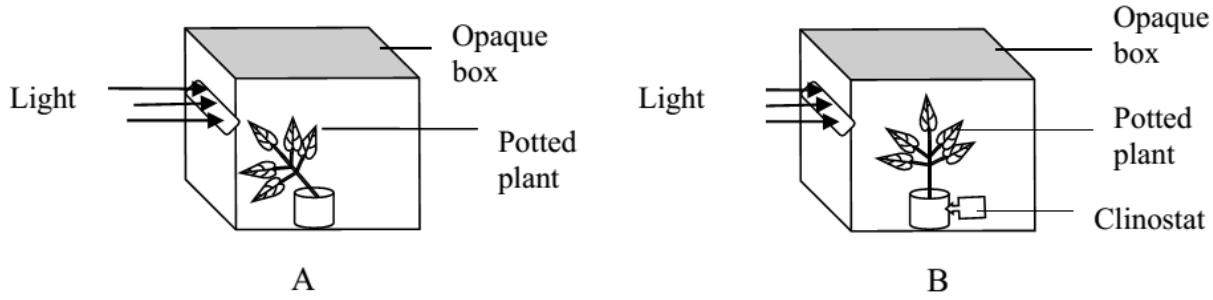
Materials

2 Potted plants, 2 opaque boxes, clinostat and Razor blade

Procedure

-Get two opaque boxes and using a razor blade cut a small hole on one side of each.
-Get two potted plants of equivalent size.
-Place one in box A and another in box B but fixed on a clinostat to serve as the control experiment.
-Place both boxes in light and start the clinostat to rotate the plant in box B.
-Leave the experiment for 4 days.

Setup



Observation:

The shoot in A bent towards the direction of light while that in B continued to grow straight.

Conclusion:

The shoot responds positively towards light.

PHOTOPERIODISM

This is the response of an organism mainly plants to the relative length of light and dark periods. It mainly affects the production of flowering hormone ***florigen***.

Some plants need a relatively longer period of light for flowering, and are called ***long day plants***.

Some plants need a short period of light of flowering e.g. tomatoes, and are called **short day plants**.

Duration of light has no effect on some plants to flower e.g. sun flower, and are called **day neutral plants**.

Due to the above facts, particular plants are grown in particular seasons.

GEOTROPISM

This is the growth movement of the plant part in response to the direction of the force of gravity. Roots grow towards the direction of force of gravity.

-When a seedling with a radicle and plumule is laid horizontally, auxins concentrate on the lower side of the plumule and radicle.

-The lower side of the plumule with a higher auxin concentration grows faster than the upper side, hence the shoot grows upwards, and thus shoots are negatively geotropic.

-The upper side of the radicle with a lower auxin concentration grows faster than the lower side, hence the root grows downwards, and thus roots are positively geotropic.

Experiment to demonstrate geotropism in plant roots (the effect of gravity on roots)

Apparatus

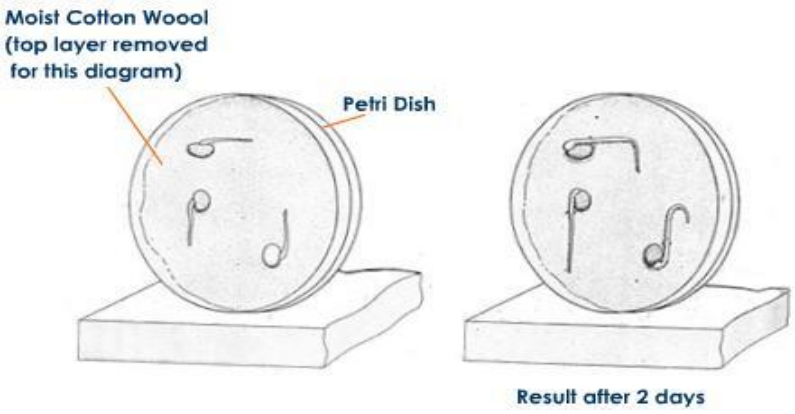
Seedlings	Plasticine
Petri dish	Cellotape

Moist Cotton wool
Cupboard

Procedure

-Three seedlings with straight radicles are selected.
-They are arranged on moist cotton wool on a petri dish so that the radicle of one is horizontal, the second radicle points vertically upwards and the third radicle points vertically downwards (A).
-Cover the petri dish with a lid and secure it with cellotape.
-Fix the petri dish in an upright position using plasticine.
-Leave the experiment to stand for 3 days in a dark cupboard, to prevent the effects of phototropism.

Diagram of setup



A **B**

Observation:

The horizontal radicle curves downwards towards the pull of gravity.
The radicle that was pointing vertically upwards also curves downwards.
The radicle that was pointing vertically downwards continues to grow downwards (B).

Conclusion:

Roots are **positively geotropic**.

HYDROTROPISM

This is the growth movement of a plant part in response to a unilateral source of water.

Experiment to show hydrotropism in roots

Materials:

Wire gauze Trough
Water
Seedlings
Anhydrous Calcium chloride

Method

-Place wire gauze horizontally above a trough containing water.
-Place moist cotton wool on the wire gauze leaving some spaces through which the radicle can pass
-Place the germinating seedlings on the cotton wool.

-Set up a control experiment with a trough containing anhydrous calcium chloride instead of water, which absorbs moisture from the trough.
-Leave the set up for 3 days.

Diagram of set up

Observation

In A, the radicles grow towards water while in B, they curve away from the dry air.

Conclusion

Roots respond positively to water.

Experiment to show hydrotropism in roots

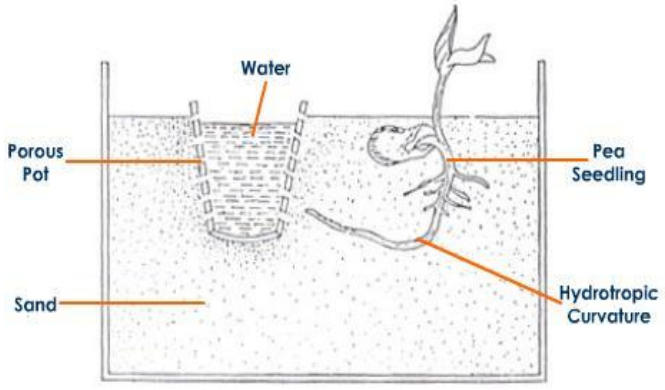
Materials:

Porous pot
Viable seeds
Water
Sow dust

Procedure:

-An empty porous pot is put in a dish containing moist sow dust, with viable seeds..
-After elongation of the radicles, watering of the sow dust stopped and instead, water is poured in the porous pot.
-A control is set up as above but without water in the porous pot.
-The experiment is left to stand for 3 days.

Set up:

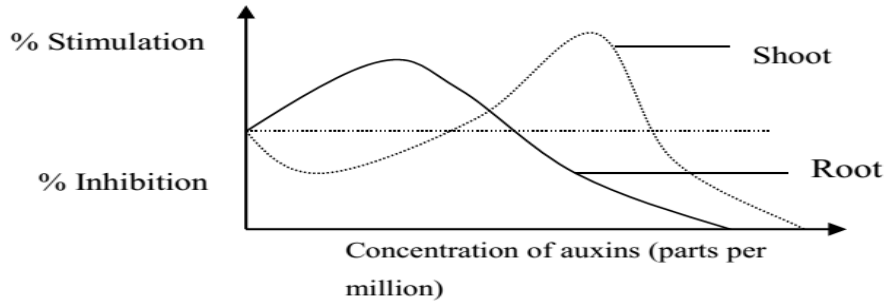


Observation: The radicles grow inwards towards the water in the porous pot, unlike in the control experiment.
Conclusion: Roots are **positively hydrotropic**.

CONTROL OF RESPONSES IN PLANTS

-Responses in plants are controlled by plant hormones especially auxins.
-Auxins are produced at the root and shoot tips and are transported in the phloem with manufactured food.
-Auxins control responses by controlling growth through stimulation of cell elongation.
-High auxins concentration stimulates faster growth in shoots and inhibits growth in roots.

Graph showing the effect of auxins concentration on the growth of roots and shoots.



When the concentration of auxins increases, growth in the shoot increases gradually to a maximum beyond Growth in the root decreases with increase in auxin concentration.

Importance of auxins

- ✓ Causes apical dominancy, hence side branches don't develop from axillary buds.
- ✓ Leads to parthenocarpy (formation of fruits without fertilisation)
- ✓ Causes tropism
- ✓ Causes rooting of stem cutting.

OTHER PLANT GROWTH SUBSTANCES

1. **Indole Ascetic Acid (IAA)**
   - **C**auses cell elongation.
   - Causes root initiation
   - Causes Parthenocarpy
   - Causes apical dormancy
2. **Gibberellins**
   - They are in varying amounts in seeds and young plants.
   - They increase the water absorbing capacity of seeds
   - They contribute to flowering and growth of fruits.
3. **Cytokinins**
   - They promote cell division but only in the presence of auxins.
   - Some are used in killing weeds.

EXPERIMENTS ABOUT AUXINS

1. Experiment to show that auxins are responsible for growth / tips exert an effect on growth

Materials

Plant seedlings and razor blade

Procedure

-Using a razor blade, some seedlings are decapitated (tips cut off) and others are not.

-Leave them to stand for 4 days.

Observations

-Seedlings whose tips were removed stopped growing while those whose tips were not removed, continued to grow.

Conclusion

Tips exert an effect on growth / auxins are responsible for growth

2. Experiment to show that auxins are diffusible substances

Materials.

- Maize seedlings with coleoptiles. -razorblade
- Agar block (gelatinous substance through which auxins diffuse).

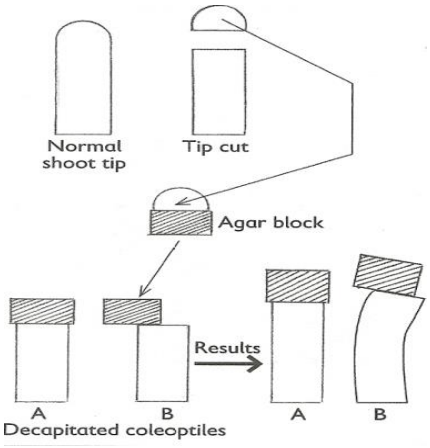
Procedure

-Tips of shoots are cut off using a razorblade, and placed on an agar block for one day.

-Tips are then thrown away and the agar block is placed on the decapitated shoot as shown below.

-The experiment is left for 3 days.

Diagram of set up



Observation

Shoot A grew straight upright while shoot B grew bending away from the side with agar block.

Conclusion

Auxins are diffusible substances.

Explanation

Auxins diffused from the coleoptile tips into the agar block.

In shoot A, Auxins diffuse from the agar block into the decapitated shoot. All sides receive same concentrations of auxins. Cell elongation occurred and growth took place evenly hence the shoot grew upwards.

In shoot B, Auxins diffused on one side of the shoot. i.e. the side covered with agar block. This side grew faster than the side without the agar block hence shoot curves towards the side without the agar block.

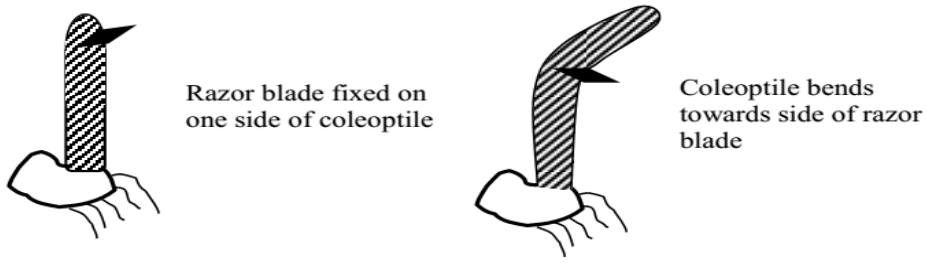
3. Experiment to investigate the effect of auxin distribution on plant growth

Materials:

Coleoptile and Razor blade

Procedure:

Insert a razor blade on one side of the coleoptile tip and leave it to grow for 3 days.



Observation:

The coleoptile continues to grow bending towards the side with the razor blade.

Conclusion:

High auxin concentration promotes growth and low auxin concentration slows down growth in shoots.

Explanation:

The razorblade prevents auxins from diffusing to the lower side, therefore the side without a razorblade has many auxins hence grows faster, causing bending towards the side with a razorblade.

TACTIC RESPONSE (TAXIS)

This is the movement of whole organism or cell from one place to another in response to a directional stimulus.

It is a positive tactic response when the whole organism moves towards the stimulus and negative taxis when the organism moves away from the stimulus.

Types of taxis

i) Phototaxis in response to light
ii) Chemotaxis in response to chemicals
iii) Thigmotaxis in response to touch
iv) Geotaxis in response to gravity
v) Hydrotaxis in response to water
vi) Thermotaxis in response to heat

Examples of taxis

i) Unicellular organisms e.g. Euglena swim towards light hence positively phototactic
ii) Earth worms, wood lice and cockroaches move away from light hence negatively phototactic.
iii) Sperms swim towards the chemical produced by the ovum hence positively chemotactic.

iv) White blood cells move towards harmful bacteria in the body hence positively chemotactic.
v) Crabs move away from water hence negatively hydrotactic.

NASTIC RESPONSE

This is the movement of a plant part in response to a non-directional stimulus.
The response is not related to the direction of stimulus but to its intensity.

Types of Nastic responses

i) Photonasty in response to light
ii) Chemonasty in response to chemicals
iii) Thigmonasty in response to touch
iv) Hydronasty in response to water
v)

Characteristics of nastic responses

1) It involves movement of a plant part.
2) It involves changes of turgidity of plant cells.
3) It is a rapid response.
4) It occurs in any part of a plant
5) It is induced by non-directional stimulus.
6) It depends on the intensity of the stimulus.
7) It does not involve auxins hence no growth

Examples of nastic response

1) Opening and closing of flowers in response to light e.g. morning glory.
2) Sudden closure of leaflets of *Mimosa pudica* in response to touch.
3) Closures of leaves of insectivorous plants e.g. butter Walt and pitcher plant where the insect lands on the leaf. Such plants are found in nitrogen deficient soils.

Similarities between nastic and tropic movement

- ✓ Both are brought about by external stimulus.
- ✓ Both occur in plants
- ✓ Both involve movement of plant parts.

Differences between tropisms and nastic responses

Nastic response	Tropism
i) Does not depend on the direction of the stimulus.	It depends on the direction of the stimulus
ii) It occurs in any part of the plant.	It occurs in growing tips of plants
iii) It does not involve auxins	It involves auxins
iv) Are usually faster	Are usually slower
v) It involves no growth but turgor changes	It involves growth only.

CO-ORDINATION IN ANIMALS

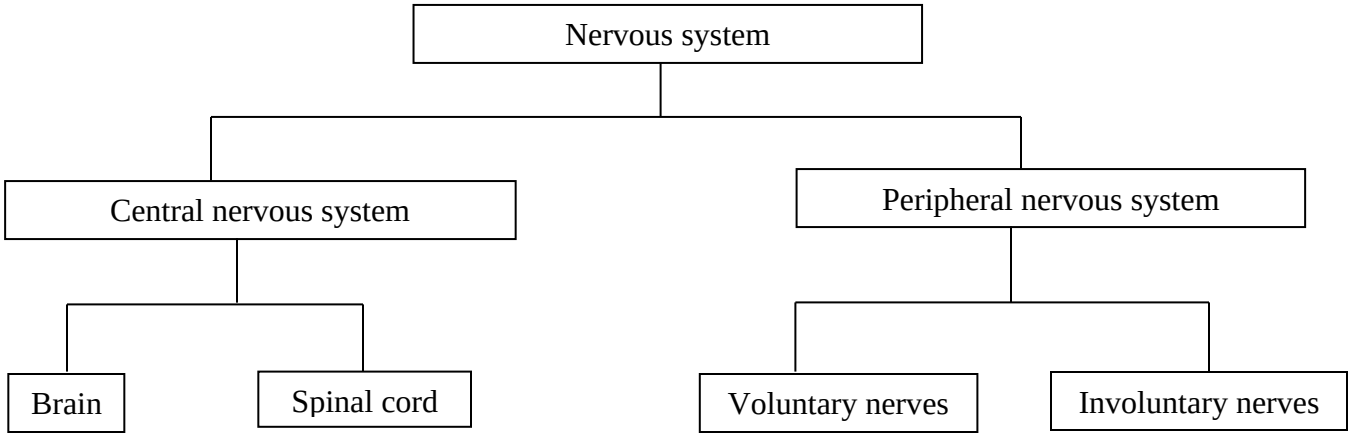
It is brought about by two systems ie

1. The nervous system
2. The endocrine system

THE NERVOUS SYSTEM

This is a system of nerve cells and sensory organs that carry out co-ordination by transfer of impulses.

COMPONENTS OF THE NERVOUS SYSTEM



The nervous system consists of;

i) Receptors:

These detect the stimuli e.g. sensory endings in the skin, eye and ear.

ii) The central nervous system (CNS)

This interprets and determines the nature of the response. The CNS consists of the brain and spinal cord.

iii) Peripheral nervous system

This consists of voluntary and involuntary nerves.

iv) Effectors

These are organs that carry out the response.

Functions of the nervous system

1. It receives impulses from all sensory organs of the body.
2. It stores information
3. It correlates various stimuli from different sensory organs
4. It sends messages to all parts of the body making them function accordingly.
5. It's involved in temperature regulation.

The nervous system is made up of cells called neurons. A neuron is a cell that transmits impulses.

Types of neurons.

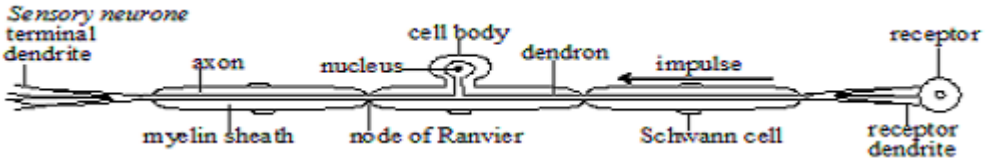
1. Sensory neuron
2. Motor neuron
3. Intermediate /relay / Associate neuron

Sensory neuron

It transmits impulses from receptors to the central nervous system.

Structure / characteristics.

- It has a cell body as a branch of the axon
- It has a short axon
- It has one long dendrone
- The axon and dendrone may be covered with myelin sheath
- The myelin sheath is broken at points called nodes of Ranvier
- The terminal brushes are embedded in the receptor

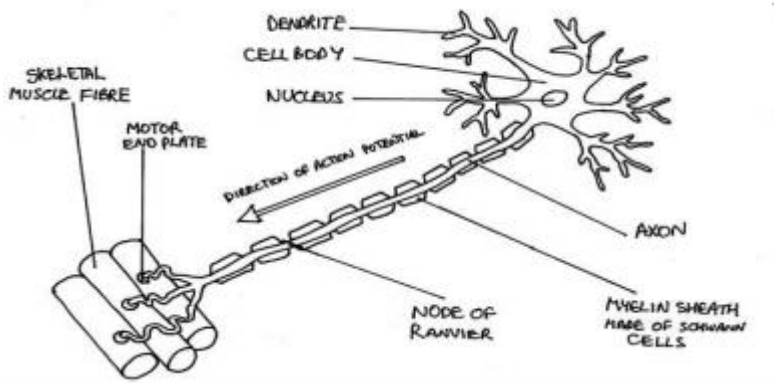


Motor neuron

It transmits impulses from the central nervous system to the effectors.

Structure / characteristics

- The cell body is at one end, containing a nucleus and cytoplasm
- The cell body has dendrones which branch in to dendrites
- From the cell body is a long axon
- The axon may be covered with myelin sheath
- Myelin sheath is broken at points nodes of Ranvier
- Has many dendrones
- Terminal brushes are connected to the effector



Intermedate / relay neuron

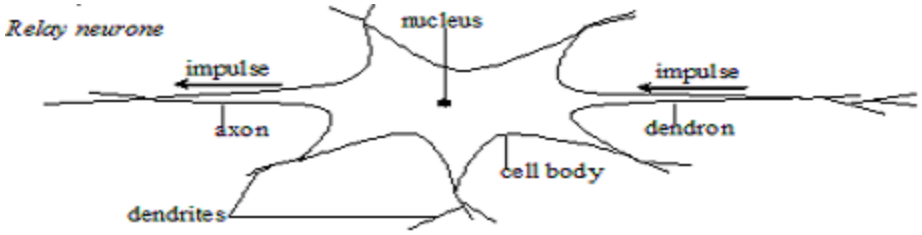
It receives impulses from the sensory neuron and transmits them to the motor neuron, within the central nervous system.

Structure / characteristics.

-It has no myelin sheath

-cell body is in the middle of the fibre

-has one dendrone



General functions of the parts of a neuron

1. **Cell body**; this consists of a nucleus surrounded by cytoplasm. The nucleus controls all activities of the neuron.
2. **Axon**; It is filled with cytoplasm called **axoplasm**.
   It transmits impulses within the neuron
3. **Myelin sheath**; it insulates the axon and speeds up transmission of impulses.
4. **Schwann cells,** they form the myelin sheath
5. **Schwann cell**; this is a cell which secretes the myelin sheath.
6. **Node of Ranvier**; It speeds up transmission of impulses .
7. **Cytoplasm**; this is a site for chemical reactions in the neuron.
8. **Dendrone**; it is a branch through which impulses are transmitted to the cell body.
9. **Dendrites**; they form a linkage between adjacent neurons.

Comparison between motor and sensory neurons

Similarities:

1. They both transmit impulses.
2. They both have a nucleus.
3. They both have an axon, dendrone dendrites and cytoplasm.
4. In both impulses move in one direction.

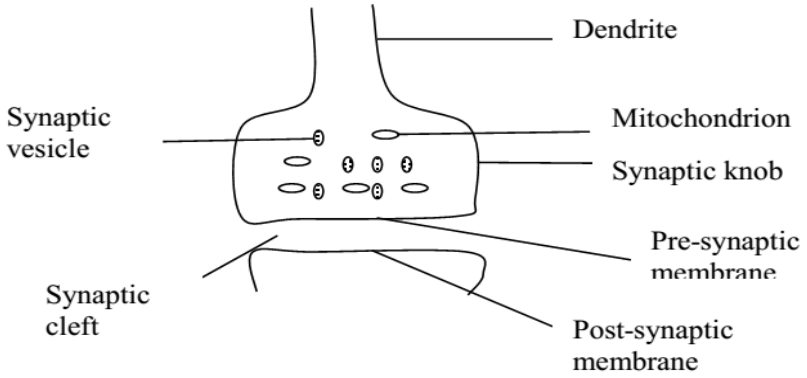
Differences:

Motor neuron	Sensory neuron
i) Has a long axon	Has a short axon
ii) It has a cell body at the terminal end of the axon	Has a cell body located on the axon as a branch.
iii) It has a short Dendron	It has a long Dendron
iv) It carries impulses from the central nervous system to the effectors	It carries impulses from the receptors to the central nervous system.
v) It has several dendrones	It has one Dendron
vi) Terminal dendrites connect with effectors	Terminal dendrites connect to relay neurons

THE SYNAPSE

A synapse is a junction or space between the terminals of two adjacent neurons. Movement of impulses across the synapse occurs by secretion of a transmitter chemical in the space known as the synaptic cleft.

Structure of a synapse



Functions of the synapse

1) It enables movement of an impulse from one neuron to another.
2) It ensures that an impulse moves in one direction by having vesicles on one side of the synapse.
3) The synapse acts as a junction in the nervous system that can diverge, or converge information.
4) It prevents continuous stimulation of body organs.

THE NERVE IMPULSE

An impulse is an electric message transmitted along the nerve fibres.

The nerve impulse is initiated by stimulation of receptors by a given stimulus e.g. light, sound etc. the stimulus causes enough stimulation to a point that triggers off an impulse called the threshold level. If the stimulation does not reach the threshold, no impulse is formed and that stimulus is not detected.

Transmission of an impulse

When a receptor cell is stimulated, it generates an impulse which is passed to the cell body of a neuron. The impulse is then transmitted from one neuron to the dendrites of another neuron via a gap called the ***synapse***.

The arrival of an impulse at the end of an axon triggers the release of the transmitter substance into the synapse. This diffuses across the gap and stimulates the dendrites of an adjacent neuron to form an impulse hence the impulse being passed on.

After the passage of an impulse across the synapse, the transmitter substance is destroyed and a new one is made within the axon.

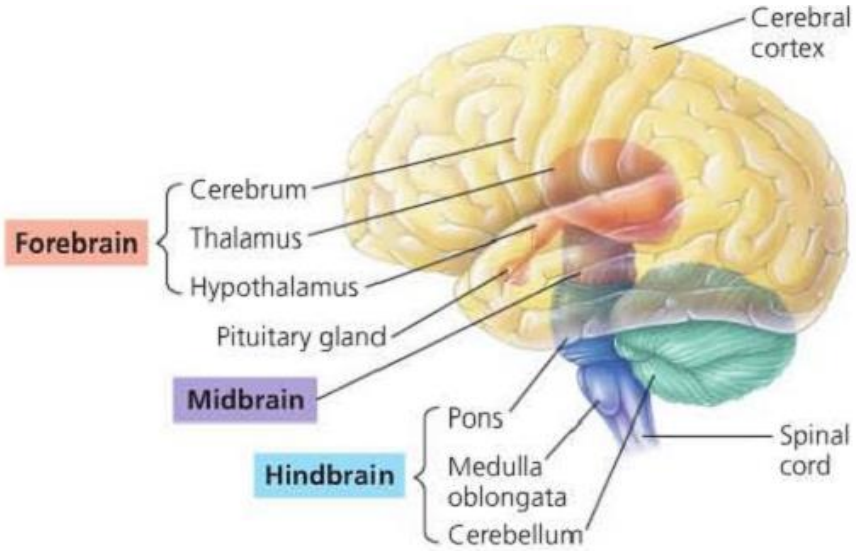
The mechanism ensures that an impulse travels only in one direction across a synapse.

THE CENTRAL NERVOUS SYSTEM

This is made up of the brain and spinal cord.

THE BRAIN

(get drawing from introduction to Biology pg 143)



The brain is covered and protected externally by the skull (cranium) and internally by membranes called meninges.

Functions of the brain

1. It receives impulses from all receptors
2. It interpretes impulses from receptors
3. It sends impulses to the effectors.
4. It controls involuntary activities of the body
5. It stores information.
6. It makes right judgement

The brain is divided into three major regions, that is;

1. Fore brain
2. Mid brain
3. Hind brain
4.

1. **The fore brain**

It consists of:

i) The cerebrum (cerebral hemisphere)

This is the largest part of the brain.

It is made up of 2 hemispheres i.e. the left and the right cerebral hemispheres. The right hemisphere controls the activities of the left side of the body while the left hemisphere controls the activities of the right side of the body.

-It controls all voluntary activities

-It is a center of memory,judgement, imagination and reasoning.

-It controls general awareness of one's self

-It receives impulses from the sense organ of smell, touch, sight, taste and sound.

-It is concerned with speech

ii) The olfactory lobes:

-They receive impulses from the olfactory nerves bringing about the sense of smell.

2. The mid brain

It consists of:

i) Thalamus

-It integrates sensory impulses from the eyes, skin and ear and sends them to the cerebrum.

-It also directs impulses from all parts of the body to particular areas of the brain.

ii) Hypothalamus

-It controls involuntary activities e.g. water and salt balance (osmoregulation)

-Controls body temperature,

-Controls CO_2 levels in blood

-Controls appetite

-controls sleep

-Controls hunger

-Controls wakefulness

-Controls sex drive

iii) Pituitary gland

-It secretes a number of hormones like the thyroid stimulating hormone, FSH, LH, ADH, etc. which control various activities.

-It also controls other endocrine glands in the body thus called the ***master gland.***

iv) Optic lobes

-They interprete sight.

3. Hind brain

It is made up of:

i) Cerebellum

This is concerned with

-maintenance of balance, locomotion and posture.

-It receives impulses from the skeletal muscles.

ii) Medulla oblongata

This controls involuntary actions like yawning, vomiting, blinking of the eye, etc. Any injury to this region leads to instant death.

THE SPINAL CORD

This is part of the central nervous system that runs from the brain through the vertebral column.

Functions of the spinal cord

1. Receives impulses from receptors
2. Interprets messages especially in reflex arc
3. Sends impulses to the effect

VOLUNTARY AND INVOLUNTARY ACTIONS

The nervous system controls several actions in the body. Such actions may be voluntary or involuntary.

A voluntary action *is one initiated consciously under the direct control of the brain i.e. they are actions one does at will e.g. dancing, laughing, walking, running, etc.*

Involuntary actions *are the ones that occur without conscious thoughts e.g. breathing, sneezing, heart beat*

THE REFLEX ACTION

This is a rapid automatic response of an organism, to a stimulus. It does not involve the brain for its initiation.

Characteristics of a Reflex Action

-It occurs rapidly
-It is inborn / innate but not learnt
-It is controlled by either the brain or spinal cord, but initiated by the spinal cord.
-it occurs without one's will

Examples of Reflex actions

1. Withdraw of a hand from a hot object.
2. Withdraw of the hand or food from a sharp object.
3. Sneezing
4. Knee jerk ie a relaxed leg gives a forward kick when tapped slightly below the patella
5. Blinking when a foreign body moves towards the eye

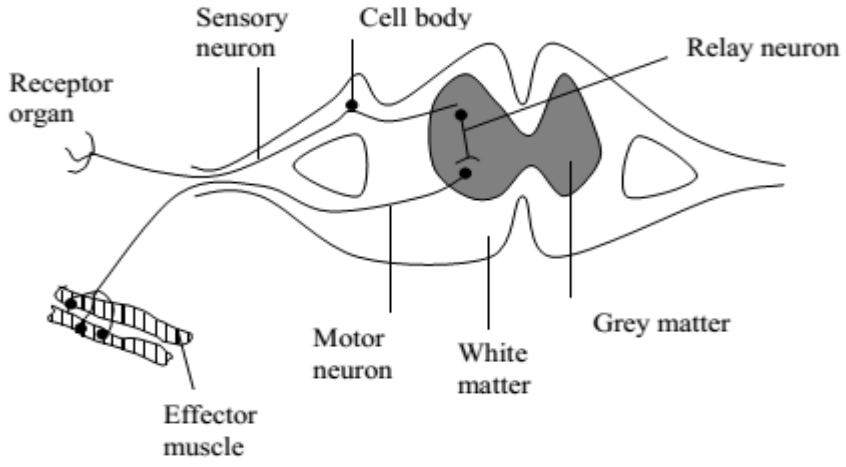
Advantages of reflex actions to animals

1. They help animals to avoid danger.
2. They control activities in the body, which we do not have conscious control over.
3. They form a basis of some animals' behaviour, e.g. amoeba.

THE REFLEX ARC

This is a route or path taken by impulses in a reflex action ie from receptors through the sensory neuron, to the relay neuron, motor neuron and to effectors.

Diagram illustrating a reflex action



Example of a simple reflex action (what happens when one touches a hot object)

- When one accidentally touches a hot object, the skin receptor cells are stimulated.

- They generate impulses that move along the sensory neuron to the spinal cord and then cross the synapse, to the relay neuron.
- Interpretation occurs and the impulses cross another synapse to the motor neuron.
- The motor neuron then carries the impulses to the biceps muscles (effector) of the hand, causing them to contract and the hand is quickly withdrawn.
- At the same time, the original message is sent to the brain which then interprets it as pain or heat.

Types of reflex actions

1) Spinal reflexes

These are reflex actions that pass through the spinal cord and are interpreted there e.g. withdrawing a hand from a hot object.

2) Brain/cranial reflexes

These pass through the brain and are interpreted there e.g. closing of the eye when an object is approaching, coming of tears when one is cutting onions, etc.

3) Instinctive/simple reflex actions

These are reflexes that do not require learning but are inborn e.g. suckling in human infants, making of a web by a spider, withdrawing a hand from a hot object.

Characteristics of simple reflexes

- ✓ They are rapid responses
- ✓ A given stimulus brings about the same response
- ✓ They are not learnt but instinct inborn

4) Conditioned reflex action

This is the type of reflex which involves organisms learning to respond to strange (meaningless stimulus) by associating it with another meaningful stimulus, e.g. ***the Ivan Pavlov's experiment on a dog.***

Ivan Pavlov performed an experiment to demonstrate a conditioned reflex in a dog. In the experiment, he used to give the dog food at a particular time. The dog would salivate either after the smell of food or taste of food (normal response). He then started ringing a bell before giving the dog food. After several times, the dog salivated when a bell was rang even without food being presented (conditioned response).
The dog learnt to associate the sound of the bell with food.
Later, when Pavlov rang the bell without food for a long time, the dog later stopped salivating implying that the conditioned reflexes are temporary.

Characteristics of conditioned reflex action

- ✓ It is a temporary reflex
- ✓ It involves learning
- ✓ It takes a longer time to learn
- ✓ It is coordinated in the brain
- ✓ It involves more than one stimulus
- ✓ It involves association of stimulus
- ✓ It is reinforced by repetition
- ✓ Responses are involuntary

Similarities between simple and conditioned reflexes

- ✓ They both involve the central nervous system particularly the brain.
- ✓ Both are autonomic responses
- ✓ Both are associated with a stimulus.
- ✓ Both involve neurons for the transmission of impulses

Differences between simple and conditioned reflexes

Conditioned	Simple
Stimulus and responses are not directly related	Stimulus and response are related
More than one stimulus is required to cause a	Only one stimulus is needed to cause a response

response	
It involves learning	No learning but in born
Takes a longtime	Takes a very short time
It is coordinated in the brain only	Co-ordinated in either the brain or spinal cord
Responses occur as a result of repetition and practice.	Responses occur instantly after a stimulus.

Similarities between involuntary /reflex and voluntary actions

- ✓ Both are coordinated by central nervous system.
- ✓ Both occur as a result of impulse transmission.

Differences between reflex actions and voluntary actions

Voluntary actions	Involuntary / Reflex actions
Are not spontaneous	Occur spontaneously
Are relatively slow	Occur very fast
Are initiated by the brain	The brain does not initiate them.
They involve many neurons	They involve three neurons

THE ENDOCRINE SYSTEM (HORMONAL SYSTEM)

This is the system of ductless glands that secrete chemical substances called hormones.
A hormone is a specific chemical substance that regulates the body's metabolic activities.
Their site of action is called the target organ
They are secreted by endocrine glands

Characteristics of hormones

- ✓ They are protein in nature
- ✓ They are secreted and work best in small quantities
- ✓ They are secreted directly into blood stream
- ✓ Their site of action is far from where they are produced
- ✓ Their effect on the target organ is either by stimulation or inhibition i.e. they regulate the activities of the target organs.

GLANDS

These are tissues or organs that secrete chemical substances.

TYPES OF GLANDS

1. **EXOCRINE GLANDS**

These are glands that secrete their substances to their target organs through ducts. eg

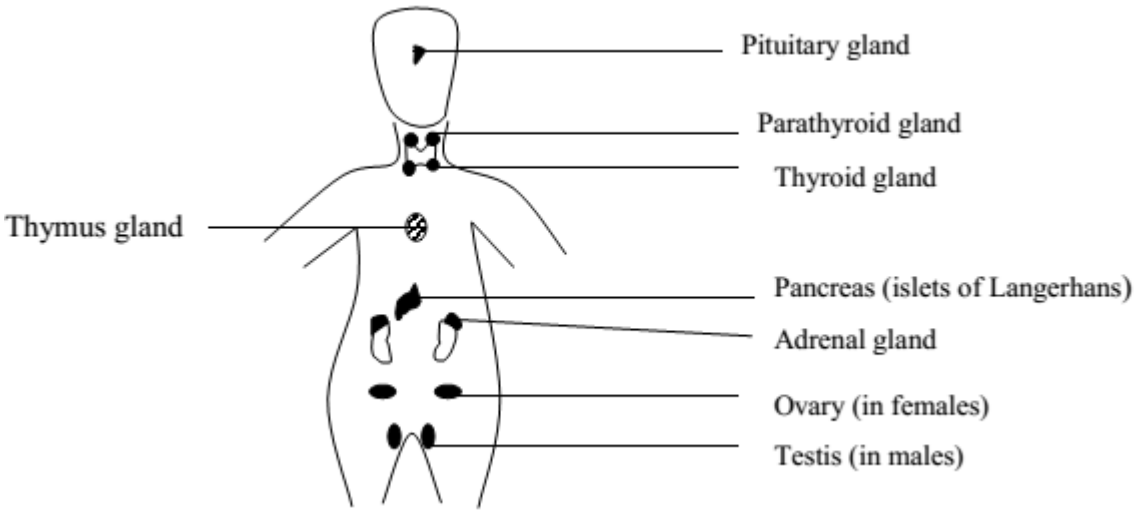
1) Pancreas releases pancreatic juice through pancreatic ducts
2) Salivary gland has salivary duct that carries saliva into the mouth cavity.
3) Sweat glands with sweat ducts
4) Tear glands with tear ducts

2. **ENDOCRINE GLANDS**

These are ductless glands that secrete their hormones directly into the blood stream. The blood carries the hormones from the glands to their target organs.

Diagram showing the position of endocrine glands in man.

(Get drawing from introduction to biology pg 144)



HORMONES OF THE ENDOCRINE GLANDS AND THEIR FUNCTIONS

ENDOCRINE GLAND	HORMONE SECRETED	FUNCTIONS OF THE HORMONE
1. Pituitary gland	1-**Growth hormone**	• Stimulates growth • over secretion of G.H causes gigantism • Under secretion of GH causes dwarfism
	2. **AntiDiuretic hormone (Vasopressin)**	• Causes reabsorption of water in the kidney nephrons.
	3.**Thyroid stimulating hormone**	• It stimulates the thyroid gland to secrete thyroxine hormone.
	4.**Follicle stimulating hormone (FSH)**	• It stimulates growth of Graafian follicle in the ovary. • Iniciates formation of sperms.
	5.**Prolactin**	• Stimulates milk production in pregnant females.
	6.**Oxytocin**	• Stimulates milk flow from the mammary glands. • It causes contraction of the uterus leading to birth.
	Luteinizing hormone	• It causes ovulation.
2. Thyroid gland	**Thyroxine**	• Controls metabolic rate • Controls mental and physical development • Under secretion causes mental instability, restlessness (cretinism) and goitre. • Overproduction in adults increases rate of metabolism causing loss of weight.
3. Parathyroid	**Parathormone**	• Controls the distribution of calcium and phosphorous in the body.
4. Pancreas	**Insulin**	Causes conversion of excess glycogen to glucose
	Glucagon	Causes conversion of glycogen to glucose.

5. Adrenal gland	**Adrenaline**	• It prepares the body for action in an emergence by increasing the heart beat rate, blood pressure, breathing rate and sweating. It is hence called the fight or flight hormone.
6. Ovary (females)	**Oestrogen**	• It causes development of secondary sexual characteristics in females e.g. enlargement of breasts, menstruation, widening of hips, enlargement of the vagina, etc • It controls the menstrual cycle and pregnancy
	Progesterone	• It prepares the body for pregnancy by thickening of uterine walls. • It maintains pregnancy • It inhibits ovulation therefore widely used in contraceptive pills.
7. **Testis**	**Testosterone**	• It causes development of secondary sexual characteristics in males e.g. deepening of the voice, growth of beards, growth of hair under the armpits, production of sperms, enlargement of the penis, on set of wet dreams, widening of the chest, increase in muscularity etc.

Similarities between the nervous and endocrine system

- ✓ Both are affected by stimulus
- ✓ Both cause a response
- ✓ They provide a means of co-ordination in the body
- ✓ Both systems transmit messages.

Nervous system	Endocrine system
Information carried is electrical (impulses)	Information carried is chemical (hormones)
Responses are fast.	Responses are slow
Impulses move along neurons	Hormones are carried in blood
Effect is specific to a body part	Effect is wide spread in the whole body
Stimulus arises from any part of the body where sensory receptors are located.	Stimulus arises from specific places only e.g. endocrine glands.

Diseases of the neuro-endocrine system

1. Poliomyelitis
2. Tetanus
3. Meningitis
4. Leprosy
5. Cerebral malaria
6. Epilepsy

SENSE OR RECEPTOR ORGANS IN MAMMALS

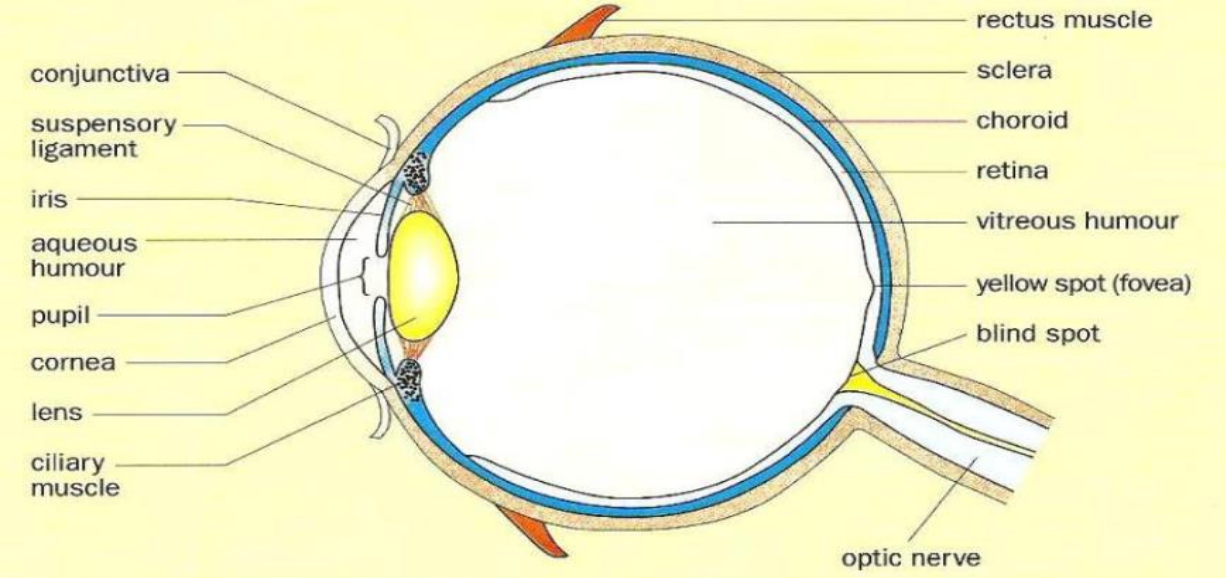
These are organs that perceive the stimulus and change it into nervous impulse (transduction).
They contain receptor cells that detect stimuli.

THE MAMMALIAN EYE

Functions.

1. Enables organism s to see different colours.
2. Determines the shape of objects.
3. Determines the distance between it and the object.
4. Provides a wide field of view.

Structure of the mammalian eye
(Get drawing from Introduction to Biology pg 130)



Parts of the eye

1. The conjunctiva:
This is a thin transparent layer lining the inside of the eyelid and in front of the eyeball.
It protects the eye and holds it in position.[
It enables the eye ball to move easily by secreting mucus.

2. The sclera:
This is a tough inelastic layer that gives shape to the eye.
It protects the inner most delicate parts.
It provides attachment for the muscles of the eye.

3. The cornea:
This is a transparent layer in front of the eye.
It allows light to enter the eye.

4. The choroid layer:
It contains black pigments which prevent internal reflection of light.
It contains a network of blood vessels supplying oxygen and food to the eye.

5. Aqueous humour:
It is a solution of sugar, salts and proteins.
It is a watery fluid which maintains the shape of the eye.
It also refracts light into the pupil and the lens.

6. The vitreous humour:
It is a jelly-like substance that fills the inner cavity of the eye.
It is transparent and maintains the shape of the eye.

It refracts light to the retina.

7. The ciliary body:

This contains ciliary muscles, which control the size of the lens during viewing nearby or distant objects.

8. The lens.

It is transparent and held by suspensory ligaments.
It refracts light rays to form an image on the retina.

9. The iris

It determines the size of the pupil hence controlling the amount of light entering the eye.

10. The retina

It is where the image is formed in the eye.
It contains photoreceptor cells (light sensitive cells) ie rods and cones.
The cones *contain* a pigment called IODOPSIN, sensitive to coloured light and are responsible for colour vision. They are also sensitive to light of high intensity and are used during daytime.
Most cones on the retina are concentrated on the fovea or yellow spot.
The rods contain a pigment called RHODOPSIN, incapable of perceiving coloured light and are sensitive to light of low intensity (dim light). They are used during night vision.
Nerve fibers from the photoreceptor cells run to the brain via the optic nerve.
The retinas of nocturnal animals have mainly rods, hence nocturnals can't perceive different colours.

11. Suspensory ligaments.

These are inelastic fibers that hold the lens in position.

12. The blind spot:

This is a region where the nerve fibers leave the eye to enter the optic nerve. It has no light sensitive cells. When an image falls on this point, it is not taken to the brain thus blind spot.

13. The fovea

This is a small depression in the center of the retina. It has only cones in a high concentration. Due to this, it produces the most accurate and clear images in the eye.

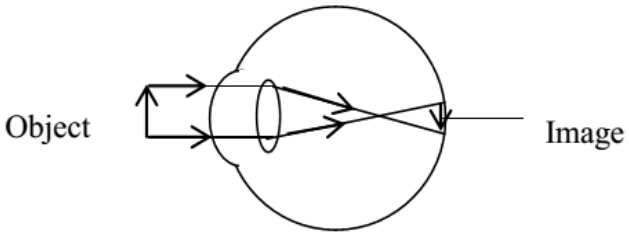
14. Eye lids and Eye lashes

These protect the eye by preventing foreign particles from entering it.

IMAGE FORMATION AND VISION

Light rays from an external object enter the eye through the cornea.
They are refracted by the cornea into the aqueous humour.
The aqueous humour then refracts them to the lens.
The lens refracts them to the vitreous humour.
The vitreous humour finally refracts light and focuses it to the retina forming an image on the retina.
The photoreceptors in the retina change the light stimulus into a nervous impulse.
The impulse travels along the optic nerve to the brain where interpretation of the image is made.
The image formed on the retina is smaller to the real object and it is ***upside down.***

Illustration



CONTROL OF LIGHT AMOUNT ENTERING THE EYE

The iris determines the size of the pupil hence controls the amount of light entering the eye.

In dim light:

- Radial muscles contract,
- Circular muscles relax,
- Pupil widens
- more light is enters the eye.

Leave 6 lines for a drawing

In bright light:

- Circular muscles contract,
- Radial muscles relax,
- Pupil becomes smaller and narrower,
- Less light enters the eye.

Leave 6 lines for a drawing

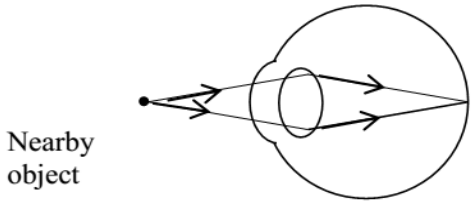
ACCOMMODATION OF THE EYE

This is the ability of the eye to change the focal length of the lens when viewing distant or nearby objects.

When viewing a nearby object,

-The ciliary muscles in the ciliary body contract
-Ciliary body becomes dome shaped
-Suspensory ligaments slacken.
-This makes the lens short and thick.
-Focal length of the lens decreases forming a clear image on the retina.

Illustration



When viewing a distant object,
-Ciliary muscles in the ciliary body relax.
-Ciliary body becomes taut
-Suspensory ligaments pull the lens apart making the lens thin and long.
-Focal length of the lens increases, forming a sharp image on the retina.
Illustration leave 6 lines for a drawing

Eye defects

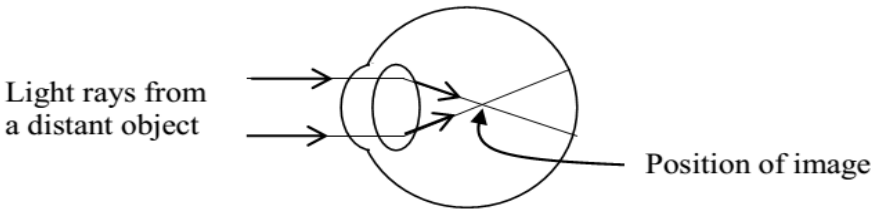
An eye defect is a condition where the eye fails to focus an object well unless aided by external lenses. The common eye defects include:

1. Short sightedness (myopia):

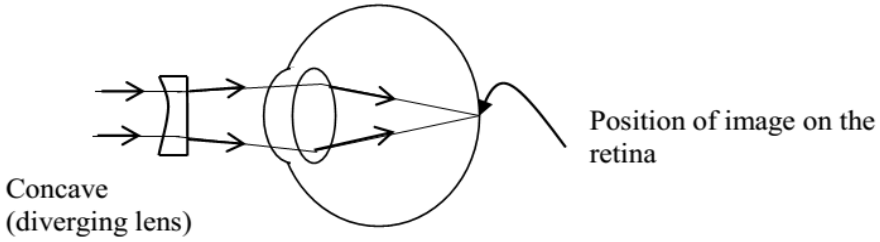
This is a condition in which a person can see near objects clearly but cannot see distant objects.
Light from a distant object is focused in front of the retina.

Causes
-The eye ball is too long
-The lens is too thick

Illustration



Correction
By putting on spectacles with diverging (concave) lenses.

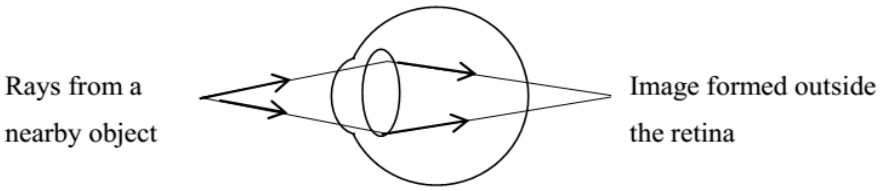


2. Long sightedness (hypermetropia):

This is a condition in which a person can see distant objects clearly but cannot see nearby objects.
Light from a nearby object is focused behind the retina.

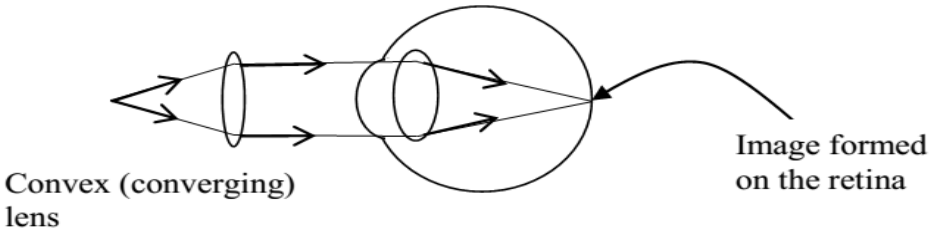
Causes
-The eye ball is too short
-The lens is too thin

Illustration



Correction

By wearing spectacles with converging (convex) lenses.



3. Astigmatism

This is caused by the surface of the cornea and lens not being perfectly smooth or spherical, hence a sharp image can not be formed on the retina.

-It is corrected by wearing spectacles with cylindrical lenses.

4. Presbyopia

This condition occurs when the lens hardens due to old age and does not focus.

It can be corrected by wearing spectacles with convex lenses.

5. Cataract

It is a condition which occurs when an individual is aging. It is caused by the eye lens becoming opaque due to a thin covering formed on it. It is corrected by surgical removal of the thin opaque layer of the lens.

6. Colour blindness

It is the failure of an individual to see particular colours, mainly red and green. It is caused by lack of cones of a particular colour on the retina.

THE EAR

The ear performs two main functions i.e.

1. Hearing
2. Body balance

Structure of the ear

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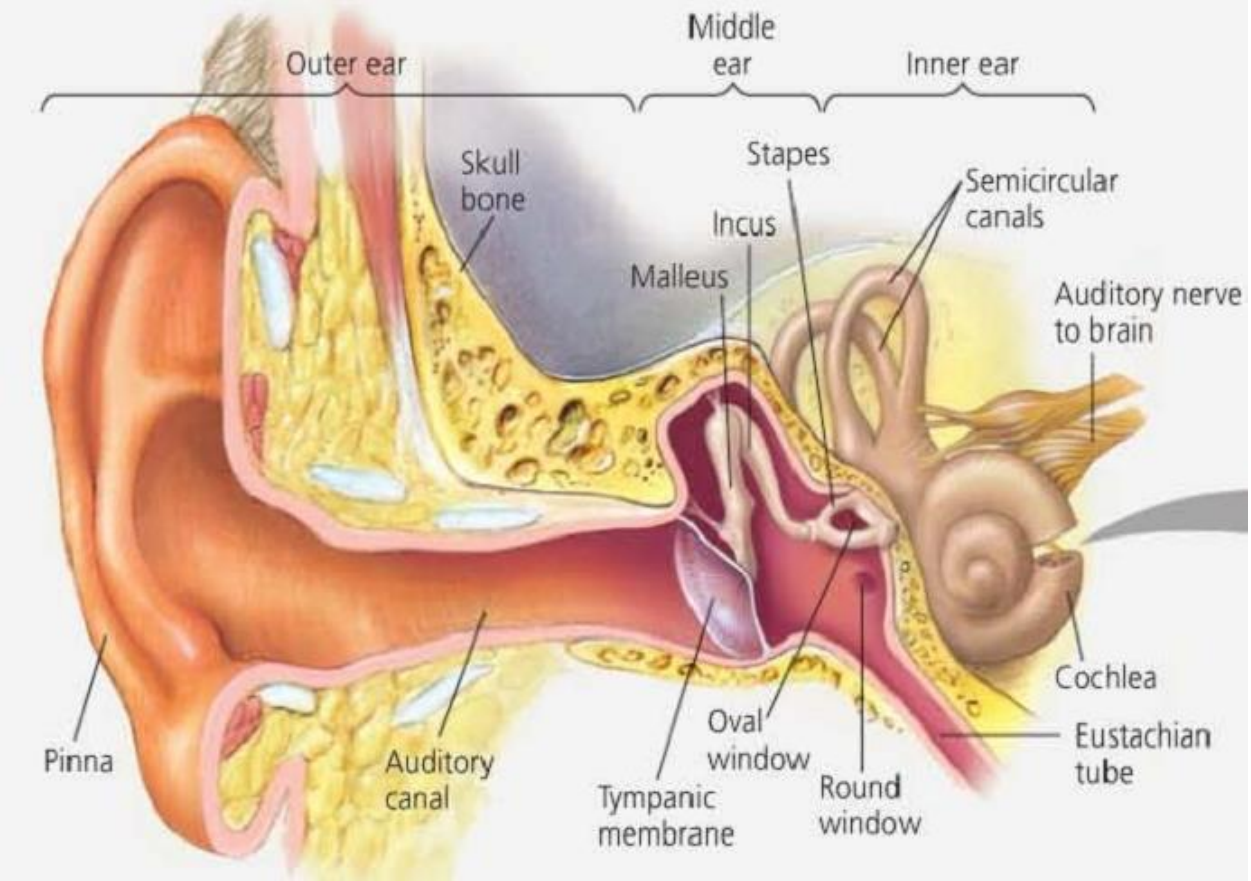


The ear is made up of three regions i.e. the outer ear, middle ear and inner ear.

The outer ear:

1.Pinna

-It is made of cartilage covered with a skin.

-It traps sound waves from the air

2. **Auditory canal**

-It is a hollow tube connecting the pinna to the eardrum

-It conducts sound waves from the pinna to the eardrum.

-it has glands that secrete wax that traps dust.

The middle ear:

1. Ear drum

-It is a thin flexible membrane which vibrates when sound waves strike it.

-It transforms sound waves in to sound vibrations.

2. **Ear ossicles**

-They include the Hammer (Malleus), Anvil (Incus) and Stapes (Stirrup)

-They transmit sound vibrations across the middle ear from the ear drum to the oval window.

-They also amplify sound of low tones.

3. **Eustachian tube**

-It connects the middle ear to the pharynx of the mouth.

-It equalizes the air pressure on the two sides of the eardrum so that it vibrates equally.

4. **oval window** (**fenestra ovalis**)

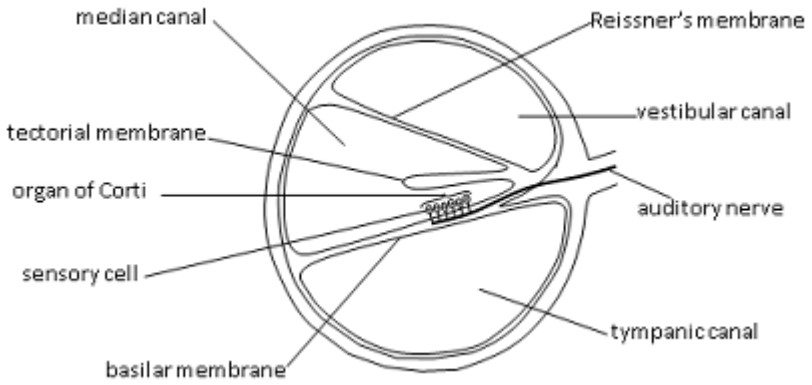
-It is a flexible membrane which vibrates and causes the fluid in the cochlea to vibrate.
-It transmits sound vibrations from the ossicles to the cochlea.

5. **Round window**
-It controls the displacement of the fluid in the cochlea

The Inner ear

1.**Cochlea**
-It is a three chambered fluid filled cavity, ie vestibular canal containing perilymph, median canal containing endolymph and tympanic canal containing perilymph.
-It contains sensory cells that form the ORGAN OF CORTI, which transforms sound vibrations in to impulses.

Transverse section of the cochlea



2.Semi-circular canals:
-They bring about body balance
-They are three at right angles to each other
-They contain a fluid called endolymph
-At one end is a swelling called AMPULLA which contains sensory cells

Section through the Ampulla
Leave 8 lines for the drawing

3.The **auditory nerve** transmits impulses to the brain.

The process of Hearing

- The pinna traps sound waves and concetrates them to the auditory canal .
- They are transmitted to the eardrum, which vibrates, changing sound waves in to sound vibrations..
- The vibrations are transmitted to the ossicles that also vibrate and amplify sound vibrations.
- They then transmit them to the oval window.
- The oval window vibrates and sets up vibration pressure waves in the perilymph of the cochlea.
- This causes vibration of the **Reissner's membrane,** and then the endolymph in the median canal.
- This in turn causes the **basilar membrane** to vibrate, stimulating sensory cells, of the **organ of Corti**.
- This then generates impulses which are transmitted by the auditory nerve to the brain, which interpretes them as so

The process of body balance

-Balance is the ability of the body to remain stable when subjected to different forces of destabilisation.
-It is done by the semi circular canals.
-When the head is displaced to one side, the endolymph in the AMPULLA is displaced to the opposite side.
-This displaces the CUPULLA, hence stimulates the sensory cells to generate impulses that are carried by the auditory nerves to the brain, where interpretation occurs, hence bringing about body balance.

NB.- If a person spins around in one direction and then suddenly stops, the endolymph continues to flow, giving a sensation of the ground spinning in the opposite direction.

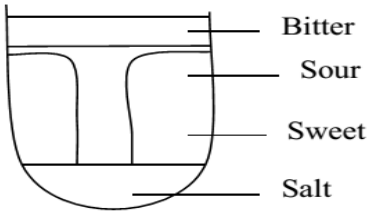
Common ear disorders

1. **Ear ache and ear discharge:**
2. **Deafness:**

This is caused by accumulation and hardening of wax in the outer auditory canal that presses against the eardrum. It is also caused by blockage of the Eustachian tube and exposure to loud noise over a long period of time.

THE TONGUE

The tongue is the receptor / sense organ for taste. It contains chemo-receptors on the taste buds.
The tongue distinguishes between four different kinds of tastes, i.e. ***sweet, sour, salt and bitter***.
The taste buds for the different tastes are located in different parts of the tongue as shown in the diagram below.



When a chemical is placed in the mouth, it dissolves in the moisture (saliva) in the buccal cavity. The dissolved chemicals then stimulate the taste buds in the different parts of the tongue depending on the type of taste to generate impulses that are carried by a sensory neuron to the brain and the brain interprets the type of taste.

THE NOSE

The nose is the receptor organ for smell. It is also made up of chemo-receptor cells and it is stimulated by chemicals in air.

THE SKIN

The skin is a sense organ responsible for the senses of pain, touch, pressure and temperature.

CARE FOR THE SENSE ORGANS

Eyes

- Eat yellow and orange fruits and vegetables. Good eyesight requires vitamin A found in these kinds of food.
- Protect your eyes from too much sunlight.
- Avoid reading inside a moving vehicle.
- Avoid playing with sharp and pointed objects.
- Do not rub your eyes if dirt gets into them.
- Be sure there is sufficient lighting when you read.
- Read with the light coming from over your shoulder and not from the front.
- Sit upright when you read.
- Rest your eyes by looking out of the window and focusing your sight on distant objects.

Ears

- Use soft cloth to clean your ears after taking a bath.
- Never poke any sharp object into your ear.

- Avoid listening to loud music in a closed room or through a headphone.
- If you have an earache, tell your parents about it so they can take you to a doctor.
- If an insect is inside your ear, pour lukewarm water (*Lukewarm water* is water that has a temperature a little warmer than room temperature) into the affected ear.
- If a foreign object inside an ear cannot be removed, call a doctor.

Nose and Tongue

- Use soft cloth or cotton balls to clean your nose after washing your face or taking a bath.
- Avoid blowing your nose too hard.
- Apply first aid in case of bleeding.
- Gently brush your tongue to remove tiny bits of food trapped between its folds.
- Eat fruits and vegetables.
- Take a bath daily.
- Avoid too much sunlight.
- In case of skin infection that takes a long time to heal, see a doctor for treatment.