CONTROL OF RESPONSES IN MAMMALS

Coordination in mammals can be divided into two

1. THE ENDOCRINE SYSTEM

This is a system of ductless glands in which hormones are produced

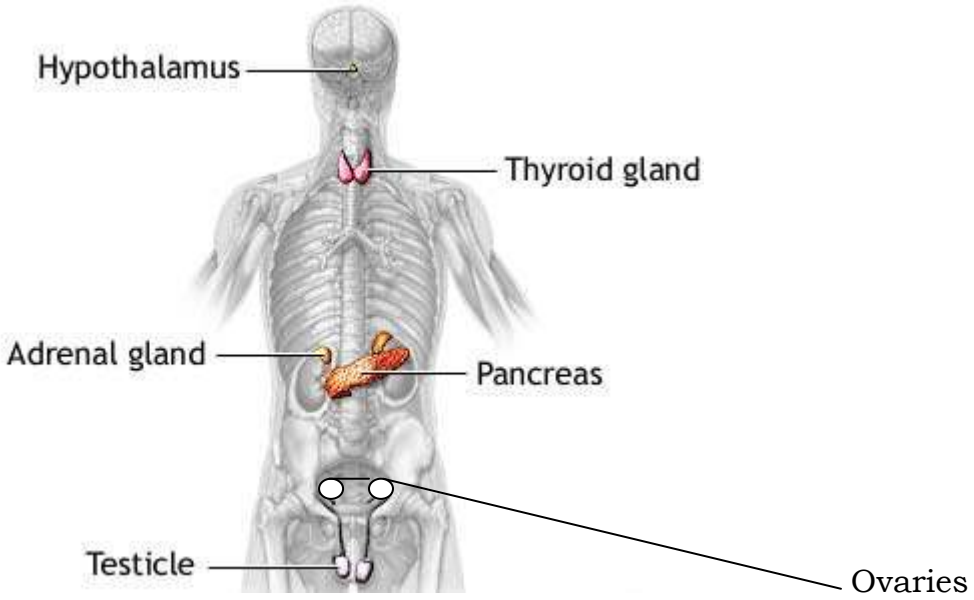
The release of their secretion is stimulated by either the central nervous system or a hormone from another gland

A hormone is an organic substance which is produced in small quantities and transported by blood to target organs where it exerts its effects.

2. EXOCRINE GLANDS

These are glands which have ducts through which their secretions are transported together with the nervous system, the endocrine system is very important for the integration of body functions and Coordination.

STRUCTURE OF HUMAN BODY SHOWINING LOCATION OF DIFFERENT GLANDS



GLAND	SECRETION
Salivary gland	Saliva containing enzymes
Tear gland	Tear
Mammary gland	Milk
Sweat gland	Sweat

Gastric gland	Gastric juice containing enzymes
Pituitary gland	Oxytocin, prolactin, ADH, TSH, ACTH, FSH, LH, growth hormone
Thyroid gland	Thyroxine
Parathyroid	Parathormone
Pancreas	Enzymes, insulin, glucagon
Gastric wall	Gastrin
Adrenal gland	Adrenaline, cortisol, sex corticoids
Testis	testosterone
Ovary	Oestrogen, progesterone
Duodenum wall	Secretin

DIFFERENCE BETWEEN ENDOCRINE AND EXOCRINE GLANDS

ENDOCRINE GLAND	**EXOCRINE GLAND**
1. It releases its secretion into the blood stream	It releases its secretion into a duct
2. It does not have a duct	It has a duct
3. The secretion is a hormone	The secretion is an enzyme, milk, sweat, but not a hormone
4. It is found far from the target	It is found near the target

HORMONES

This is a substance that is secreted by an endocrine gland.

Hormones regulate physiological processes like growth, metabolism, and blood sugar level regulation.

The hormone diffuses from the endocrine gland into the blood stream, which transports it to the target. Generally, the point of secretion and target of a hormone are in different parts of the body, e.g. vasopressin is secreted by the pituitary gland in the head region, but its target is the nephron in the abdominal region.

THE PROPERTIES OF A HORMONE

1. A hormone is steroid or protein in nature
2. A hormone regulates physiological processes by stimulating or inhibiting the activity of target organs.
3. It is effective in a small quantity.
4. Its effect is wide spread
5. It is altered or destroyed immediately after performing its role
6. It is secreted directly into the blood stream
7. It is synthesized by an endocrine gland
8. It is secreted in response to a stimulus
9. Its gland and target are in separate and distant parts of the body

THE DIFFERENCES BETWEEN A HORMONE AND AN ENZYME

HORMONE	ENZYME
1. It is secreted by an endocrine gland	It is secreted by an exocrine gland
2. It is discharged into the blood stream	It is discharged into the duct
3. It stimulates or inhibits target structures	It controls and speeds up chemical reactions
4. It is steroid or protein in nature	It is protein in nature
5. It is altered or destroyed after action	It is not altered or destroyed after action
6. Its gland and target are in distant parts of the body	Its gland and target are in close parts of the body

A TABLE SHOWING THE HORMONES PRODUCED BY THE ENDOCRINE SYSTEM AND THEIR EFFECTS

Glands	**Hormone produced**	**Effects/ functions**
Anterior pituitary gland	Thyroid stimulating hormone (TSH)	• It stimulates the thyroid gland to produce the thyroxine hormones
	Follicle stimulating hormone.(FSH)	• It stimulates egg development in the females and sperm development in the males. • Stimulates the ovaries to produce oestrogen • Stimulates release of progesterone by the ovary • Stimulates testosterone secretion in testes
	Luteinizing hormone (LH)	• It causes ovulation in the females, • It causes conversion of the graafian follicle into corpus luteum in ovaries. • It stimulates testosterone secretion in the testes
	Growth hormone (GH)	• It stimulates growth especially bones, excess in children results into gigantism and under secretion in children results into stunted growth (dwarfism)
	Andrenocoticotrophic hormone (ACTH)	• It causes the adrenal cortex to produce/secrete its hormones. • Stimulates lipid breakdown and release of fatty acids from fat cells
Posterior pituitary gland NB. Pituitary gland is the master gland.	Anti-diuretic hormone(A.D.H) vasopressin	• It causes reabsorption of water in the kidney nephrons. i.e. osmoregulation • Under secretion results in diabetes insipidus
	Oxytocin	• It brings about parturition (contraction of the uterus during birth)

		• Stimulates milk flow from the mammary glands
Thyroid gland (neck region)	Thyroxine	• Controls metabolic activity, raises body metabolic rate (BMR) • Excess results into an increased metabolic rate which leads to protrusion of eye balls. Under secretion leads to goiter.
Parathyroid glands.	Parathyroid hormone	• It increases iron calcium absorption
stomach	gastrin	• Stimulates secretion of gastric juice
Duodenum	Secretin	• Controls secretion of bile and pancreatic juices
Pancreas (Islets of Langerhans)	Insulin,	• It controls the balance of sugar in blood by converting glucose to glycogen in case there is an excess. • Under secretion results into diabetes mellitus.
	glucogon	• It converts glycogen in to glucose
Adrenal gland	adrenalin	• For flight and fight actions, by increasing heart rate and metabolic rate.
Ovary (lower abdomen)	Oestrogen hormone	• It brings about healing and repair of the uterus wall after menstruation. • It brings about development of female reproductive organs. • It brings about development of secondary sexual characteristics. • Deficiency causes delay in the development of secondary sexual characteristics.
	Progesterone	• It promotes proliferation of uterus wall • Controls the menstrual cycle

		• It maintains pregnancy.
Testis (produced on scrotum)	Testosterone (male sex hormone)	• Development of male sexual characters • Deficiency causes delay in the development of secondary characters.

The effect of adrenaline

It prepares the body for emergency, danger and stress conditions such as fear, anxiety, shock in the following ways;

1. It increases the rate of metabolism. This generates more energy.
2. The rate of heart beat increases. This ensures fast distribution of glucose and oxygen to the respiring cells.
3. The breathing rate increases. This allows inhalation of more oxygen and exhalation of carbon dioxide
4. The bronchioles relax. This ensures that more oxygen inflates the alveoli
5. It changes glycogen to glucose. The glucose is broken down to produce energy.
6. The rate of respiration increases to produce more energy
7. Blood is diverted to the vital organs to distribute oxygen and glucose
8. The pupil dilates so that more light enters
9. It inhibits peristalsis and digestion. This reduces appetite and causes gastric upsets
10. It prevents contraction of the bladder
11. The hair rises to an upright position
12. It can cause shivering and development of goose flesh
13. It causes an increase in body temperature and sweating
14. It increases mental awareness and reduces the sensory threshold.

THE NERVOUS SYSTEM

The nervous system acts as a system of coordination within the the body of an organism.

There are three **specific** components of the nervous system namely;

1. **Receptors** [sensory cells]; these are cells or organs that receive stimuli like smell; touch; taste, sight, etc.
   Examples of sense organs include eye, nose, skin, ear, tongue.

The Receptors must produce a message called an impulse on receiving the stimulus.

2. **Neurons [nerve cells].** These are the functional units of the nervous system. Their function is to transmit information to and away the central Nervous system.
3. **Effectors**; these are cells or structures which perform a particular function in response to impulse reaching them. The effectors are either muscles which contract or glands which secrete useful substances.

ORGANISATION OF THE NERVOUS SYSTEM

The nervous system is divided into the **central nervous system** (brain and spinal cord) and the **peripheral nervous system**.
The function of the central nervous system is to coordinate and regulate various activities of the different body parts.

The peripheral nervous system is divided into

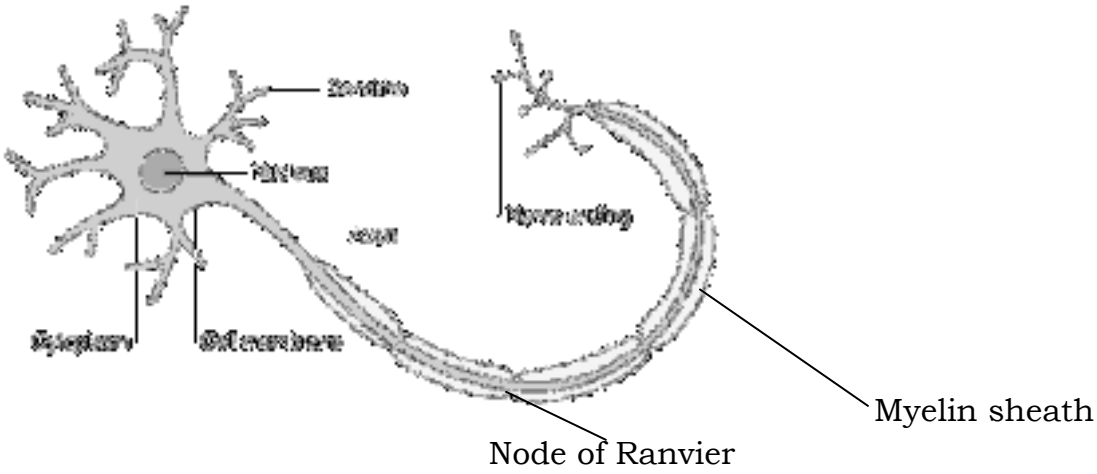
1. Voluntary which is responsible for the movement of the skeletal muscles
2. Autonomic (involuntary) nervous system. This is responsible for the involuntary movements in the body like breathing; heart beat; movement of food along the gut.

Types of neurons

There are three types of neurons

NEURONE	STIMULATED BY	TRANSMITS IMPULSES TO	STRUCTURE
1. Sensory/ Afferent	Receptor	Relay neurone	Cell body in root cell ganglion
2. Relay/ intermediate/ Associate	Sensory neurone	Motor neurone	No axon
3. Motor/effector	Relay neurone	Gland, muscle (effector organ)	Schwann cells

PARTS OF A NEVRONE



The tree types of neurons vary in structure however they share a number of structural features and this include;

1. **Cell body**;

This consists of dense cytoplasm surrounding a prominent nucleus. It is where energy required to transmit the impulse is produced and the nucleus controls all the other activities within the neurone

In motor neurons, the cell body is found at end of the axon and it branches into dendrones which also branch into dendrites.

2. **Myelin** sheath

This is a fatty material that surrounds the axon. It is produced by Schwann cells. The myelin sheath insulates and protects the axon and also aids the transmission of impulses.

It is broken at various points called Nodes of Ranvier and this increases the rate at which the impulse is transmitted.

3. **Dendrites**

These provide connection inform of a synapse with other nevrones to effect communication. They are delicate hair like out growths which are in close contact with other neurons or with stimulus receptor cells.

4. **The axon**.

This is along cytoplasmic extension running from the cell body. Inside the axon is exoplasm which contains ions that facilitate transmission of impulses. In motor and sensory nerves, it is usually covered with myelin sheath.

5. Node of Ranvier: It speeds up the transmission of impulses

DIFFERENCES BETWEEN A MOTOR NEURONE AND A **SENSORY NEURONE**

MOTOR NEURONE	SENSORY NEURONE
1. Relays impulses from the central nervous system to effectors	Relays impulses from a receptor to the central nervous system.
2. Has long axon	has a short axon
3. has a short dendrons	has only one Dendron which is long
4. Cell body is in the terminal end of the axon	Cell body is between the axon and the much elongated dendrone.
5. Terminal dendrites connect with muscles and effectors	Terminal dendrites connect with the intermediate nevrone

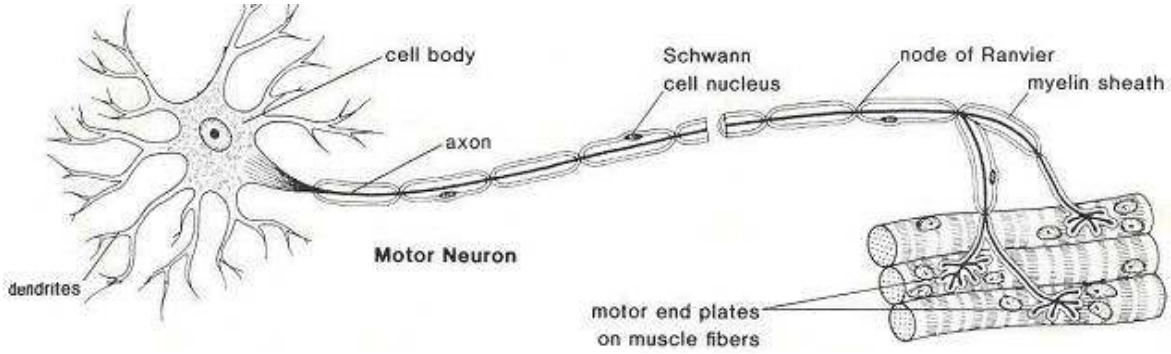
The differences between the structure of the sensory and motor neurone

SENSORY NEURONE	MOTOR NEURONE
1. It has one Dendron	1. It has more than one dendrons
2. The Dendron is long	2. Each Dendron is short
3. The Dendron may be myelinated	3. The Dendron is not myelinated
4. The axon is short	4. The axon is long
5. The cell body is on an axon branch between the axon and Dendron	5. The cell body is at the extreme end of the axon
6. The cell body is outside the central nervous system	6. The cell body is in the central nervous system
7. There are no projections on the cell body	7. There are projections on the cell body

The similarity between the structure of the sensory and motor neurone

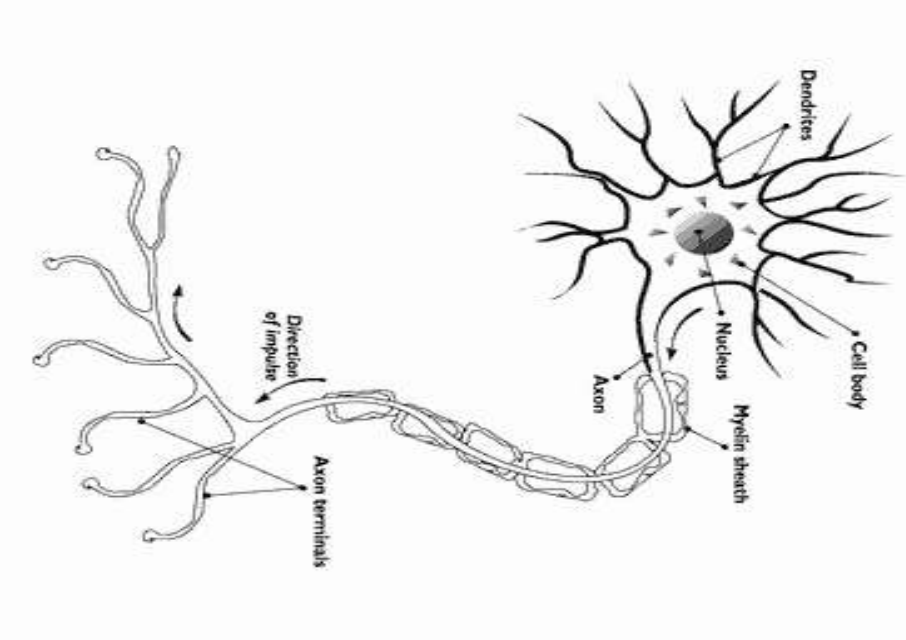
1. The nerve fibre has a fluid called axoplasm
2. They have one axon
3. The axon may be myelinated
4. The axon has branches called terminal dendrites
5. The terminal dendrites have synaptic knobs
6. They have one cell body
7. Each Dendron has branches called receptive dendrites

Motor neurone



Intermediate neurone

This is the neurone that transmits an impulse from the sensory to the motor neurone. It is found in the central nervous system. It is the area where information is interpreted.

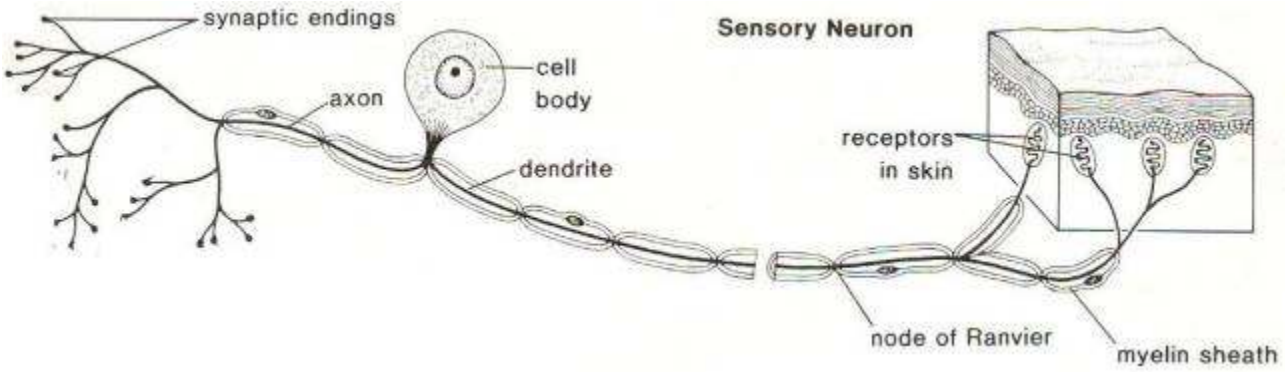


Sensory neurone

This is a nerve cell that transmits impulses from the receptor to the central nervous system. The axon is short. The Dendron is long. The cell body is between the axon and Dendron, i.e. the cell body is on a branch from the axon. The axon ends in small branches called terminal dendrites, which have synaptic knobs. The Dendron has branches called receptive dendrites, i.e. nerve endings. In some cases, the Dendron and axon are myelinated, i.e. they

have a white fatty material called myelin. The nerve fibre contains a fluid called axoplasm.

DIAGRAM



QN. Compare the function of the sensory and motor neurone

The difference between the function of the sensory and motor neurone

SENSORY NEURONE	**MOTOR NEURONE**
1. It transmits the impulse from the receptor to the central nervous system	1. It transmits the impulse from the central nervous system to the effector
2. The impulse is transmitted to the cell body by one long Dendron	2. The impulse is transmitted to the cell body by many short dendrons
3. The terminal dendrites transmit the impulse to the intermediate or motor neurone	3. Terminal dendrites transmit the impulse to the effector
4. The receptive dendrites receive the impulse from a receptor	4. The receptive dendrites receive the impulse from a relay or sensory neurone
5. The impulse is transmitted from the cell body by a short axon	5. The impulse is transmitted from the cell body by a long axon
6. The transmission of the impulse is by myelinated or un myelinated Dendron	6. The transmission of the impulse is by un myelinated dendrons

The similarity between the function of the sensory and motor neurone

1. They transmit an impulse
2. The impulse is transmitted to the cell body by a Dendron
3. The impulse is transmitted from the cell body by an axon

The transmission of the impulse is through a myelinated or un myelinated axon

FACTORS AFFECTING THE SPEED OF IMPULSE TRANSMISSION ALONG THE NEVRONES

1. Presence of myelin sheath impulse transmission is faster in myelinated axon /neurons than in non –myelinated neurons.
2. Diameter of the axon.
   Larger neurones transmit impulses faster than narrow axons.

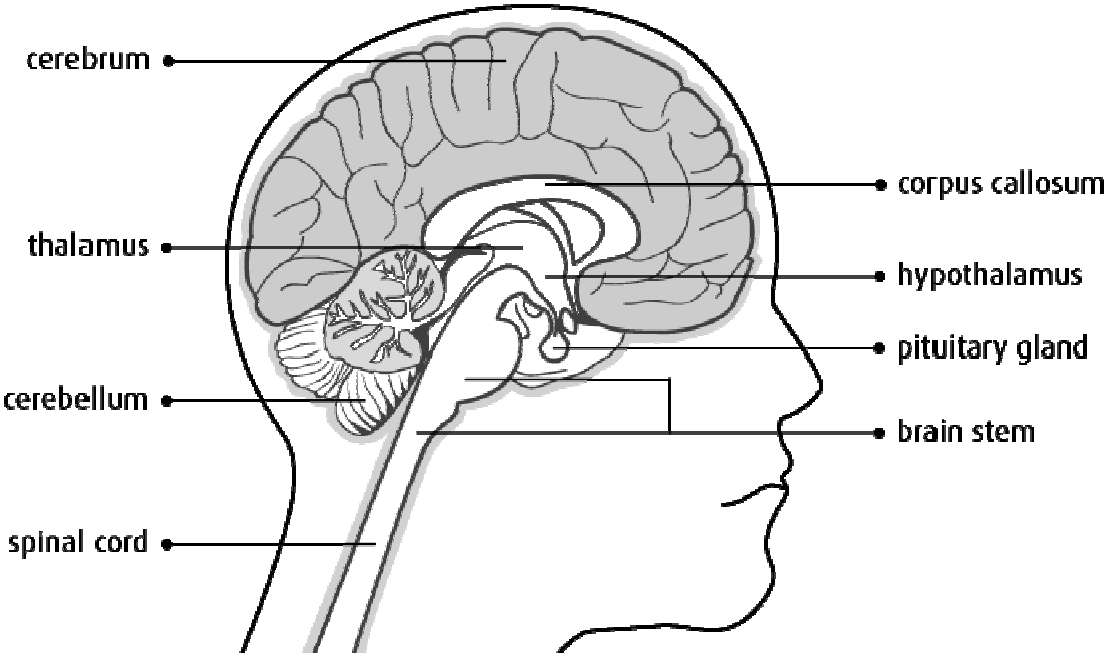
SYNAPSES

A synapse is a specific functional point that links one neurone to another or it is a means by which a nervous impulse is passed from one nevrone to another.

IMPULSE TRANSMISSION ACROSS A SYNAPSE

When a stimulus reaches the receptors it generates an impulse which passes to the cell body of the sensory neurone.
The impulse then goes through the axon to the dendrite and then to the dendrite of another nevrone across the synapse.
An impulse in one axon triguors release of a transmitter substance (acetylcholine) into the synaptic gap.
The transmitter substance stimulates the adjacent neurone to form an impulse and so the stimulus is passed on.
The transmitter substance is then destroyed and is resythesised to carry more impulses. This ensures that an impulse travel only in one direction.

THE STRUCTURE OF THE BRAIN



THE CENTRAL NERVOUS SYSTEM

THE BRAIN;

It is protected by three main structures.

1. The skull (cranium) - which protects it externally.
2. The meninges – these are membranes which protect it internally.
3. Cerebral –spinal fluid, this is a shock absorber and it also provides nourishment to the brain.

The brain is composed of three regions namely

1. The fore brain
2. The mid brain
3. The hind brain.

GENERAL FUNCTIONS OF THE BRAIN

I. It receives impulses from sensory organs and sends them to the respective organs for proper functioning of the body (relay centre).

II. It makes decisions based on inherited characteristics or past experiences so as to modify behaviour.
III. It helps the muscular body balance.
IV. It co-ordinates the vital body processes like regulation of body temperature, breathing, heartbeat etc.

PARTS OF THE BRAIN

FORE BRAIN (has the following parts, Cerebrum and Olfactory lobes)

1. **Cerebrum** (**cerebral hemisphere**).

This is a well developed in mammals and is the largest part of the brain.
The surface of the cerebral hemispheres is called the cerebral cortex and it gathers information from the receptors. Its surface area is increased by its part being highly folded. The functions of the cerebral hemispheres include;

- Controlling the voluntary activities of the brain.
- It is responsible for reasoning, memory, learning ability, imagination and personality of an individual.

2. **Olfactory lobes**.

These are paired lobes found at the base of the cerebrum. They interpret impulses from olfactory nerves bringing about the sense of the smell

MID- BRAIN.

Relays information from the fore brain to the hind brain

3. **Optic lobes**.

Their main function is the interpretation of sight.
They control the muscles of the eyeballs in relation to the stimulus received from the retina.

4. **Thalamus**

This intergrets sensory impulse from the eyes, ears, skin e.t.c. and sends them to the cerebral cortex.

5. **Hypothalamus**

This is the centre of many functions of the brain and these includes;

- It monitors and controls homoeostatic processes e.g. Omoregulation, water control, carbondioxide in blood.
- It is a centre of feelings such as thirst, sleep, hunger, sex drive e.t.c.
- It secretes a number of hormones which may regulate the activity of the pituitary gland.

6. **Pituitary gland**.

This is an endocrine gland responsible for the production of many hormones.

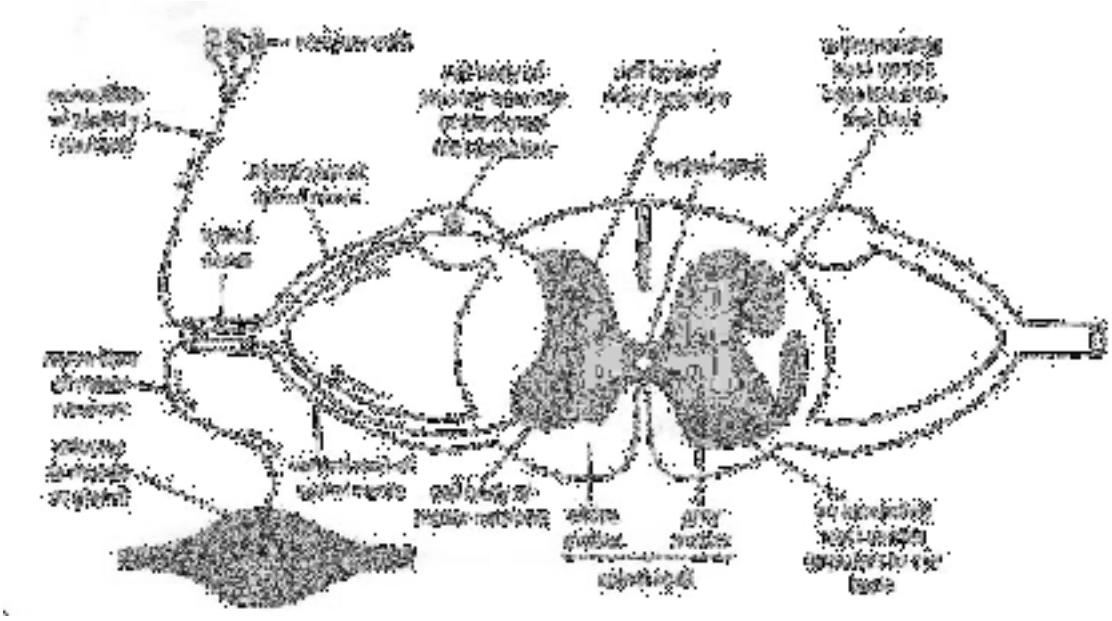
- **HIND BRAIN**.

Its main function is to relay impulses from and to the;

7. **Cerebellum**
   - This is responsible for balance and muscular control.
   - It mainly controls posture during locomotion.
8. **Medulla oblongata;**

- This is found at the base of the brain and connects to the spinal cord directly.
- It controls all the involuntary activities in the body e.g. yawning, blinking, heartbeat, sneezing, digestion, constriction and dilation of blood vessels.
- Most of the activities controlled here are automatic therefore any injury to this part of the brain results into instantaneous death.

9. **The spinal cord**.



This is the posterior extension on the brain. It is protected by the vertebra column. It has two major regions i.e;

1. The grey matter and
2. The white matter.

The grey matter is centrally located and it consists of large numbers of cell bodies and their dendrites. The grey matter surrounds a small canal which contains the cerebral spinal fluid that supplies food to the cells.

The white matter surrounds the grey matter and consists of myelinated axons that conduct impulses to and from the brain.
Spinal nerves; these are groups of axons that enter or leave the spinal cord at intervals. each has a separate dorsal and ventral root

Functions of the spinal cord

- It coordinates spinal reflexes.
- It connects the peripheral nervous system to the brain.
- Transports nerve impulses to and from the brain

REFLEX ACTIONS (INVOLUNTRARY)

This is a sudden, automatic and uncontrolled response of parts of the body to a stimulus e.g. knee jerk, withdrawal of a hand from a hot object, blinking due to an approaching object, sneezing, Constriction and dilation of the pupil due to changes in light intensity

REFLEX ARC;

This is described as the path taken by a nerve impulse in a reflex action. The route that is followed by impulses during a reflex action is called **reflex arc**. A reflex action moves in the following direction;

1. A receptor is stimulated and an impulse travel along a sensory nerve fibre to the spinal cord
2. The impulse is picked up by an intermediate neurone within the CNS
3. The intermediate nerve fibre transmits the impulse to a motor nerve fibre which is connected to an effector.
4. The effectors which could be muscles or glands respond to the stimuli appropriately

Spinal reflex, this is a reflex action which involves the spinal cord. It usually occurs in actions which occur below the head i.e. Knee jerk, peristalsis,
Cranial reflex; this is a reflex action which occurs in the region of a head and it involves the brain e.g. Salivation, blinking.

Characteristics of reflex actions

I. They occur rapidly.
II. They occur spontaneously and take a short time.
III. They are coordinated either by brain or spinal cord
IV. They are not learned but inborn.

CONDITIONED REFLEX ACTIONS

This is a reflex action triggered by a certain stimulus which the animals learn to associate with a different stimulus.

Conditioned reflex is a learned response an organism develops after practice when an ineffective stimulus is introduced.

It was observed by Pavlov that the sight, smell, taste of meat caused hungry dog to salivate. He later introduced another stimulus which was the ringing of the bell before introducing the meat. After many presentations, he found out on ringing the bell alone, the dog could be induced to salivate. The dogs were therefore conditioned to the sound of the bell.

When he rang the bell without food for sometime, the dogs later stopped salivating.

Most cases of simple learning are forms of conditioned reflexes e.g. learning ride a bicycle, a child learning to walk, learning to cook food etc.

VOLUNTARY ACTIONS;

These are actions done consciously by an animal i.e. one is aware of them. They are initiated by the celebral cortex of the brain e.g. singing, slapping, walking, and eating.

DIFFERENCES BETWEEN VOLUNTARY ACTIONS AND INVOLUNTARY ACTIONS

VOLUNTARY ACTIONS	**REFLEX ACTIONS**
1. They don't occur spontaneously	occurs spontaneously after receiving a stimulus
2. They do not occur very rapidly	Occur very rapidly
3. Many neurons are involved	Only three types of neurons are involved.
4. They are mediated by pathways In the cerebral cortex of the brain	Are mediated by pathways either in the brain or spinal cord.
5. Responses to stimulus are always Varying according to conditions	Responses to stimulus are normally the same.

AUTONOMIC NERVOUS SYSTEM

This is part of the nervous system that controls involuntary activities such as blinking. It is made up of two parts i.e.

1. parasympathetic system and
2. Sympathetic.

The sympathetic system is important especially during emergency situations. it brings about responses associated with fight or flight.
The parasympathetic nervous system controls internal responses associated with a relaxed state. These often cause antagonistic effects in the organs e.g. the heartbeat may be accelerated by the sympathetic system while the parasympathetic system slows it down.

DIFFERENCES BETWEEN THE NERVOUS CORDINATION AND HORMONAL CORDINATION

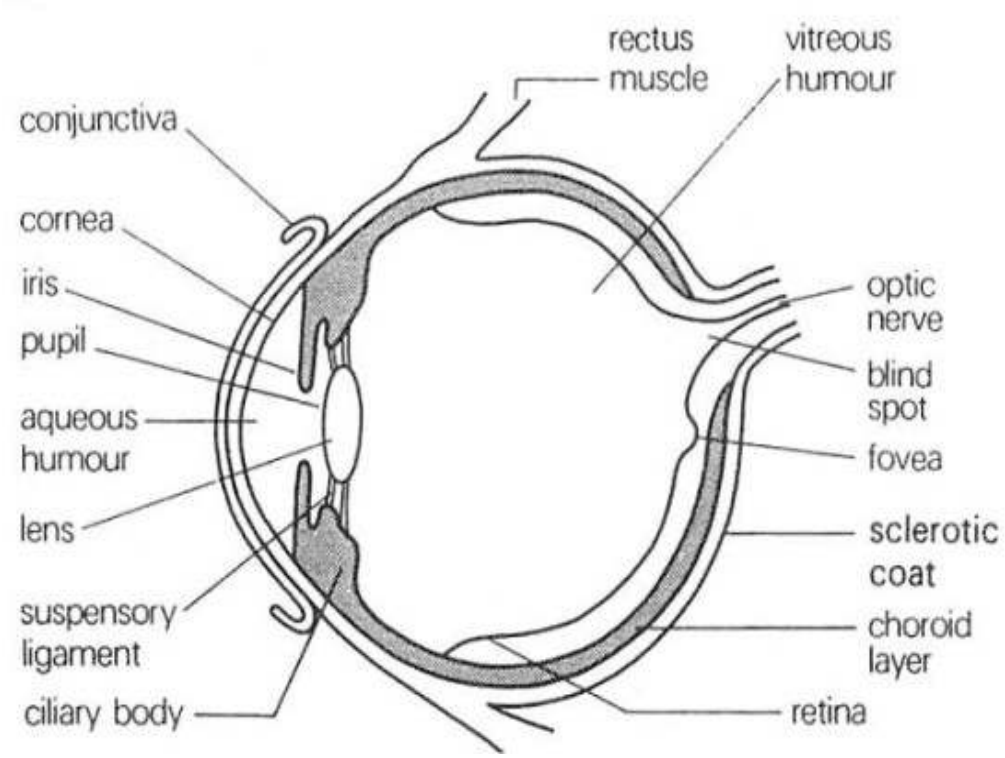
THE NERVOUS CORDINATION	**HORMONAL CORDINATION**
1. Massage is electrical	Message is chemical
2. The message travels in nerve cells and Neurones.	the massage travels in blood
3. There is quick transmission	slow transmission
4. Response lasts for a short time	Response lasts for a long time.
5. controlled by the brain and the spinal cord	Most are controlled by pituitary gland in the brain
6. Response is usually in one part of the body	response usually in many parts of the body

DIFFERENCES BETWEEN TROPISMS AND REFLEX ACTIONS

TROPISMS	**REFLEX ACTION**
1. Involve growth movements that occur In plants	• involve muscular movements that occur in animals
2. there is un equal growth and this results Into bending	• involve contraction of muscles which can be reversed
3. occur only in growing regions	• continues throughout life in all parts of the body
4. they are usually slow	• they are usually fast

SENSE ORGANS

THE MAMMALIAN EYE



THE SCLERA (**WHITE OF EYE**); It is a tough, non-elastic protective outermost coat /layer around the eye. It continues as a cornea.

THE CORNEA; being a denser medium than air, light entering is refracted inwards towards the pupil and the lens (rays begin to converge).

THE CHOROID; It's a layer of tissue lining the interior of the sclera.

It contains a network of blood capillaries providing food and oxygen to the eye.

It deeply pigmented (black) reducing the reflection of light with the eye.

THE AQUEOUS AND VITREOUS HUNOUR; these are solutions of salts, sugars and proteins in water. Aqueous humor is quite fluid and vitreous jelly like;

- They help to refract light and produce an image on the retina.
- Their pressure outwards on the sclera maintains the shape of the eye.
- The crystalline Len, the cornea and conjunctiva absorb their food and oxygen from the aqueous humors.

THE LENS; the cornea and crystalline lens refract light so producing an image on the retina.

SUSPENSORY LIGANENTS; they hold the lens in position and attach it to the hairy body.

CILIARY BODY; it contains ciliary muscles which help in focusing or accommodation. (curvature of lens is altered which alters the focal length so enabling clear images of objects at varying distances to be formed on retina).
IRIS; in its centre is a pupil. The contraction or relaxation of opposing muscles fibres in the iris increases or decreases the size of the pupil, so controlling the intensity of light entering the iris contains blood vessels and pigment layers that determine the eye color.
THE RETINA; this is a layer that contains light sensitive cells. It is on the retina that images are formed.
There are two light-sensitive cells in the retina

1. Rods. These are sensitive to different shades of light but not color. The rods are more responsive to light of low intensity.
2. Cones. Are sensitive to colour but do not respond in dim light. This why at dusk we can no longer distinguish between colours but see objects as shades of grey

THE BLIND SPOT; region where the nerve fibres leave the eye to enter the optic nerve, there are no light-sensitive cells.
THE FOVEA OR YELLOW SPOT; it gives most accurate interpretation of an image (for colour). It contains only cones and has greatest concentration of sensory cells**.**
THE RECTUS MUSCLE; it attaches the eyeball to the orbit (depression in the skull) and all allows it to move within the orbit.
THE CONJUNTIVA; it covers the exposed part of the eyeball.
It also forms a continuous layer with the skin of eyelids which protect the eyeball and control the amount of light entering the eye. It is kept moist by a solution from the tear gland.

IMAGE FORMATION IN THE BRAIN
Light rays from the object are refracted into the retina by the cornea, lens; aqueous and vitreous humor until they are focused in the retina. Impulses are then sent to the brain through the optic nerve for interpretation.
The image formed on the retina is diminished, inverted and real, however the brain interprets the image to give an impression of an upright image of the right size and colour but then also judges the distance of the object from the eye.
ACCOMODATION
This refers to the change in the shape of the lens in order to focus images onto the retina. Rays from a distant object would be focused at a point behind the

retina if the lens were not adjusted appropriately. This is made possible by adjusting the size and shape of the lens by the ciliary muscles and also the suspensory ligament.

Far objects

Parallel light rays are refracted by the cornea. The ciliary muscles in the ciliary body relax. The suspensory ligaments straighten/tighten; the lens becomes thin and less convex. Light rays are then focused onto the retina.

Near objects

The diverging light rays are refracted by the cornea. The ciliary muscles in the ciliary body contract. The suspensory ligaments relax and hence sluken. The lens thus becomes thicker and more convex. Light rays are focused into the retina.

Dark and light vision

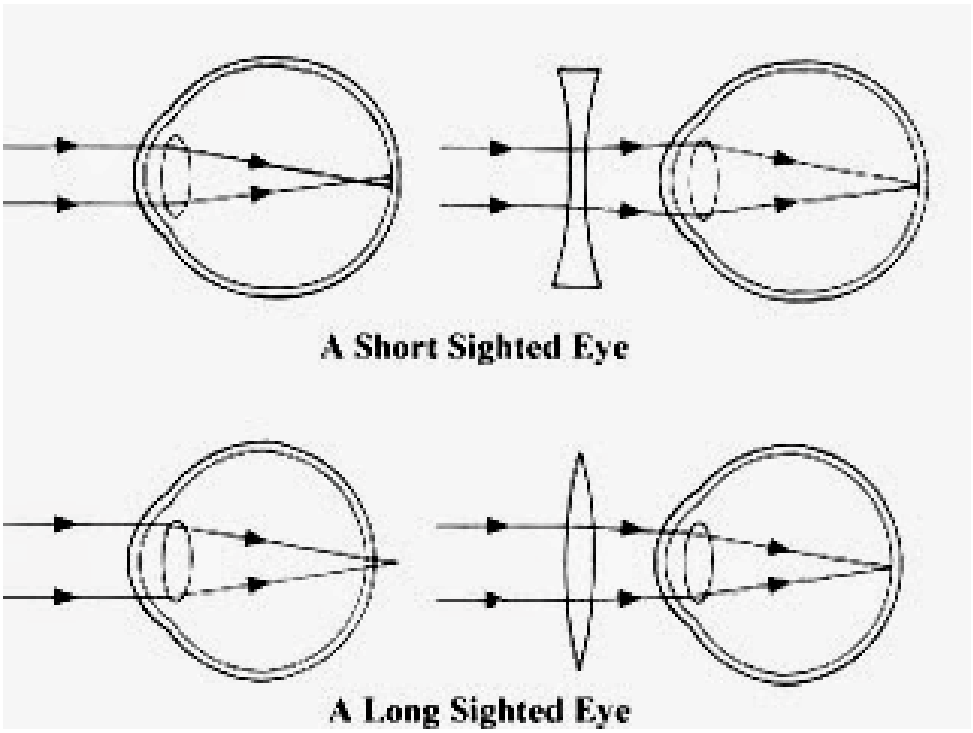
The eye is also adapted to see both in dim light by varying the amount of light entering it. This is done by varying the size of the pupil so that it is wide to allow in more light when it is dim and is narrow to allow in little light in bright light. These adjustments are done by a set of antagonistic muscles in the iris.

DEFECTS OF THE EYE

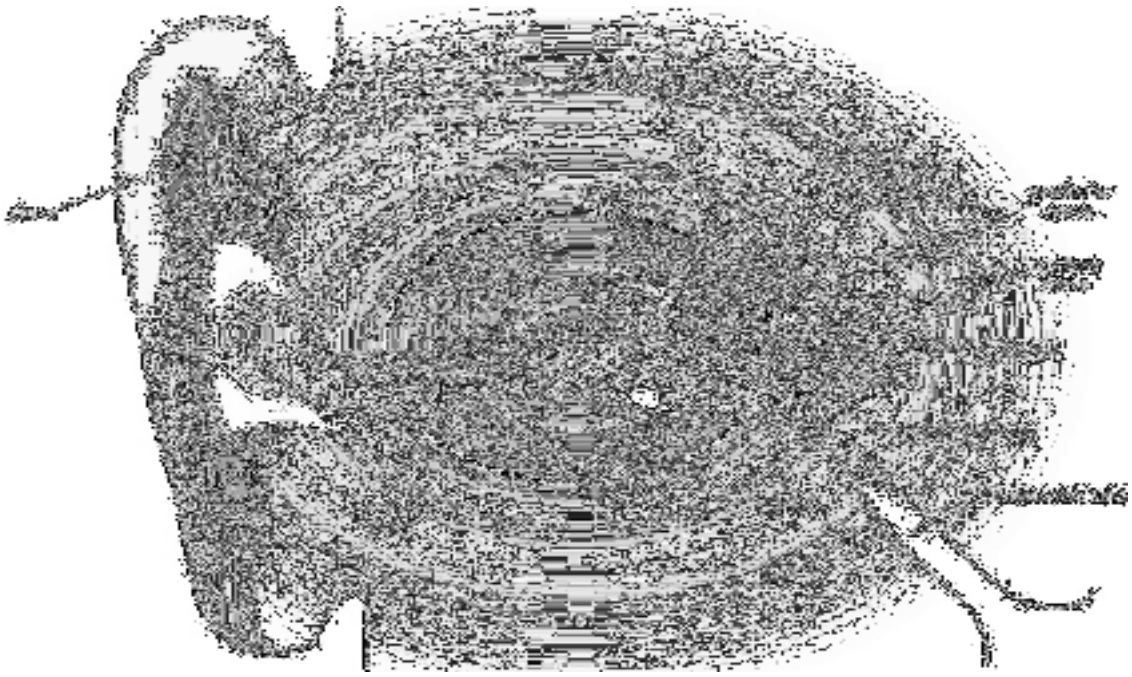
These occur when the eye can no longer focus light on the retina unless assisted by some external lenses.

1. **Short sightedness (myopia)**
   A short sighted person cannot focus distant objects properly. Light rays from a distant object fall at a point in front of a retina forming a blurred image. This may be due to the eyeball being too long.
   The defect can be corrected by using spectacles with concave
2. **Long sightedness (hypermetropia**)
   A long-sighted person cannot focus near objects properly. Light rays from the object fall at a point behind the retina. This occurs when the eyeball is too short.
   This defect can be corrected by using spectacles with convex lenses which make the light rays converge before they reach the eye
3. **Astigmatism (presbyopia)**
   This refers to a condition in which the cornea or the lens is unevenly curved, so that light rays passing through them are bent at different angles. This leads to poor formation of images in the retina. It is a characteristic of old age. It can be corrected by wearing spectacles with special cylindrical lenses.

Correction of short and long sightedness



THE EAR



Parts of the ear

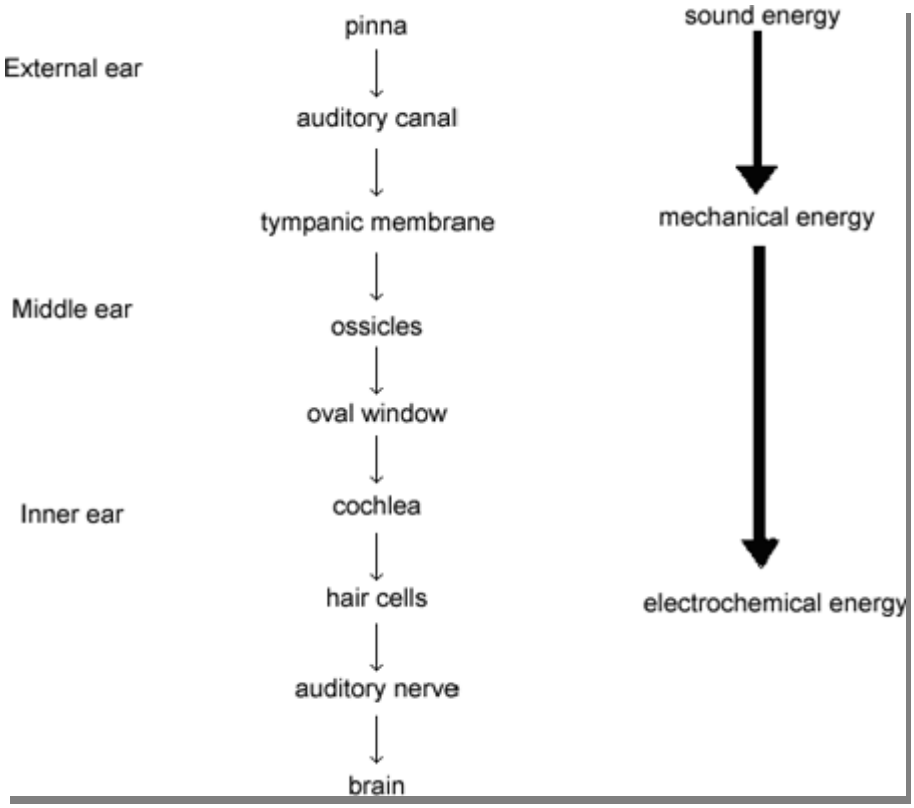
Structure	Description of Anatomy	Function
pinna	large fleshy external part of the ear	• collects sound and channels it into the ear • detects the direction of sound
Auditory canal	Narrow canal, air filled and has hairs	• passage of sound waves • prevents easy entry of foreign bodies and dust
Tympanic membrane	the eardrum - a membrane that stretches across the ear canal	• Vibrates when sound waves reaches it and transfers mechanical energy into the middle ear
Ear ossicles	Three tiny bones, the hammer (malleus), anvil (incus) and stirrup (stapes)	• amplify the vibrations from the tympanic membrane
Oval window	region that links the ossicles of the middle ear with the cochlea in the inner ear	• picks up the vibrations from the ossicles and passes them onto the fluid in the cochlea
Round window	membrane between cochlea and middle ear	• bulges outward to allow pressure differences in the cochlea
cochlea	circular fluid filled chamber	• changes mechanical energy into electrochemical
organ of Corti	a structure within the cochlea	• location of the hair cells that transfer vibrations into electrochemical signals

auditory nerve	the nerve that travels from the ear to the brain	• Transmits electrochemical signals to the brain
Eustachian tube	Narrow open and air filled	• Connects the mid ear to the roof of the mouth/buccal cavity • Equalizes pressure on either side of the ear drum

Process of hearing

The pinna collects the sound waves which are concentrated along the auditory canal to the ear drum. The ear drum then vibrates and the vibrations are picked by the ear ossicles which transmit the waves to the oval window. The oval window amplifies the vibrations and passes them to the fluid in the cochlea. The cochlea vibrates stimulating the hair cells which then move up and down. At this stage impulse are produced electrochemical signals and sent to auditory nerves which transmit the impulses to the brain where they are interpreted as sound.

Summary of the path taken by the sound waves



Balancing

Body balancing refers to the ability of the body to remain stable when subjected to certain forces of decentralisation. The senses of balance is carried out by the semi circular canals. The sensitivity results from many different stimuli perceived by by different receptors e.g

- Eyes supply information about the position and body movement.
- Mechanoreceptors detect changes in pressure and strecthing in muscles

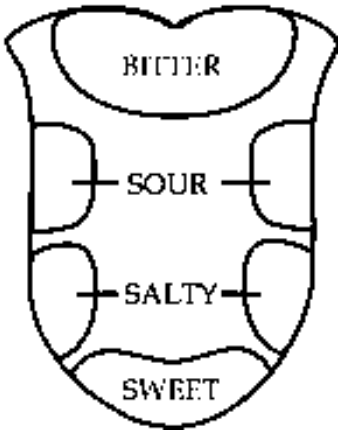
The semicircular canals contain a fluid called endolymph that flows when the head is moved, and sensory cells are embedded in a gelatinous mass containing calcium carbonate called otoliths. These form the capula.

Tonque

The tonque contains sensory cells grouped together in taste buds. Each taste bud consists of elongated cells embeded on the sides of the papillae. The sensory cells, also called gustatory cells have hair like processes projecting above the surface of the papillae.

Sensory nerve fibres connecting the cells to the brain are found at the base of the cells.

There are four basic taste stimuli that human tonque is capable of detecting.



The nose

This is the sense organ for smell or olfactory. Smell occurs as a result of chemicals in air dissolving in the moist linings of the nasal cavity. The dissolved substance stimulates the chemo receptors in the nose to generate

impulses which are carried to the brain by olfactory nerves for interpretation as odour.

The skin

This is an important sense organ because it enables the body to feel

- Touch
- Pressure
- Temperature changes
- Pain

Reflective questions

1. A child heard a dog barking; got frightened and ran. Describe how the events occurred
2. State the similarities and differences between the following
   (a) Voluntary and reflex actions
   (b) Conditioned reflexes and reflex actions
   (c) Hormones and enzymes
   (d) Sensory and motor neurons
   (e) Tropisms and reflex actions
   (f) Nervous and endocrine system
   (g) Exocrine and endocrine glands
3. Describe what happens to the nervous system during (i) a pupil reflex (ii) the knee jerk
4. (a) state the causes of long sightedness and short sightedness
   (b) Draw a diagram to show the structure involved in a spinal reflex
   (c) Draw a diagram to show how the eye defects in 4 (b) above can be corrected.
5. (a) draw a diagram to show the structure involved in a spinal reflex
   (b) What happens to your body when you sit on a sharp pin?
6. (a) describe the adaptation of the human eye
   (b) How is an image formed on the retina?
   (c) Describe the various causes of deafness
7. State the functions of the major parts of the brain
8. A boy moved out of the classroom to see a distant aeroplane. Describe the adjustments in his eye
9. Describe an experiment to show that plant shoots are positively phototrophic