THIRD TERM: BIOLOGY NOTES

SUBJECT: BIOLOGY

CLASS: SS 2

SCHEME OF WORK

WEEKS TOPICS

1. **Revision of last term's work**
2. **Regulation of internal environment (kidney):** (a)Homeostatic organs; substances involved in homeostasis (b)The kidney(i)structure, functions and diseases of the kidney
3. (ii)The effects of kidney diseases and remedy Regulation of internal environment (Liver and Skin): (c)(i) Structure, functions and diseases of the liver,bile products(ii)
4. The effects of liver diseases and remedy (d) Skin (i) structure of the skin (ii) care of the skin (iii) functions of the skin
5. **The endocrine system** Major ductless glands in the body: the pituitary gland, the thyroid glands, adrenal glands, and the glands of the gonads. Hormones such as thyroxine, pituitrin, adrenaline, testosterone, oestrogen and progesterone
6. **Major plant hormones**; Auxin, cytokinin, gibberellins, abscissic acid and ethelene
7. **The Nervous System:** (a) Organization of the nervous system (i) Central Nervous System (CNS) (ii) Peripheral Nervous System(PNS)
8. The Brain-position, structure and functions (c)The Spinal Cord-position, structure and functions
9. **The Nervous System** (d) PNS (i) Somatic nervous system (ii)Autonomic nervous system
10. Structure and functions of a neuron (motor, sensory and relay neuron)(f) Reflex and voluntary actions.
11. **Revision**
12. **Examination**

Rules for Biological Drawings

1. Draw what you see, not what you think should be there. 2. A lead pencil, preferably a 2H, is to be used for drawings, titles, and labels. 3. Drawings (or diagrams) should be as simple as possible with clean cut lines (do not sketch) showing what has been observed. All drawings should be done on unlined (blank) paper and should be also neatly labelled. 4. Drawings must be large enough to show all parts without crowding. The greater the number of parts to be included, the larger the drawing should be. Drawings must be about half a page in size. 5. Keep your drawing to the left of the centre of the page. (Save the right-hand side of the page for labels) 6. All labels should be in a column to the right of the drawing and printed. Lines to the labelled parts should be drawn with a ruler and parallel to each other (see diagram below). The lettering of the words should be horizontal. 7. Use a ruler for label lines. 8. Do not shade your drawing. If you wish to indicate a darker area use dots(stipple). 9. Indicate the thickness of a plant cell wall by using 2 lines. 10. Most plant and animal tissues are made up of individual cells. When one representative cell of such a tissue is to be drawn, make sure you include the cell boundaries of the other cells that border it. This will indicate the general appearance of the tissue without the necessity of drawing every cell. 11. All drawings are titled. The printed and underlined title appears immediately above the drawing, against the left-hand margin. The magnification of the object drawn follows the title and is in parentheses. Example: Blood Cell (300X). 12. Name and date are printed in the top right hand corn

TOPIC: REGULATION OF INTERNAL ENVIRONMENT (KIDNEY)

CONTENT:

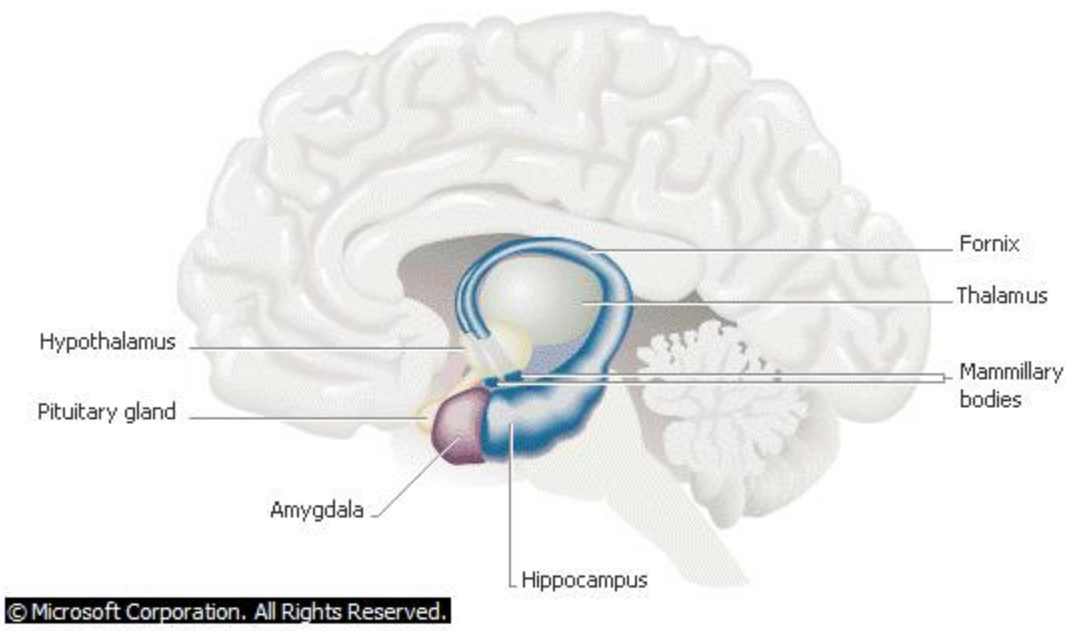
1. Homeostatic Organs: substances involved in Homeostatis
2. The kidney (i) structure, functions and diseases of kidney (ii)the effects kidney diseases and remedy

SUB-TOPIC 1: HOMEOSTATIC ORGANS: SUBSTANCE INVOLVED IN HOMEOSTASIS

Homeostasis is the maintenance of a steady internal environment in an organism. Internal conditions such as glucose level, salt concentration, osmotic pressure, body temperature, ionic concentration of substances like sodium ion (Na^+), potassium ion (K^+) and hydrogen ion (H^+) (and others like Ca^{2+}, Cl^-) are kept under control.

For example, when glucose level in the blood shoot up above the optimum, homeostasis ensures that some of it is withdrawn from the blood and converted to glycogen which is stored in the liver and muscle. Another example is when there is insufficient (Ca^{2+}) calcium ion in the diet of a pregnant woman, the homeostatic process can deplete from her bones as a last resort. That is why pregnant woman are advice to eat balance diet.

The process of homeostasis involves the detection of changes by sensory cells, signal is sent to the relevant body parts involved in the specific control mechanism. The central nervous systems interpret the signal and send message to the relevant effectors organs to restore normality in the internal environment. Thus, homeostasis involves monitoring changes in the external and internal environment by means of receptors and adjusting the composition the body fluids accordingly.



Limbic System

The limbic system is a group of brain structures that play a role in emotion, memory, and motivation. For example, electrical stimulation of the amygdala in laboratory animals can provoke fear, anger, and aggression. The hypothalamus regulates hunger, thirst, sleep, body temperature, sexual drive, and other functions.

Organs involved in Homeostasis

The organs involved in homeostasis control are mainly organs involved in some body functions such as excretion, respiration and glands. Excretion and osmo-regulation are important in the process; especially in the maintenance of acid-base balance and temperature of the body. The brain has the most overall influence on homeostasis.

Among the major organs involved in homeostasis are:

i. Kidney
ii. Liver
iii. Lungs
iv. Skin and
v. Endocrine glands

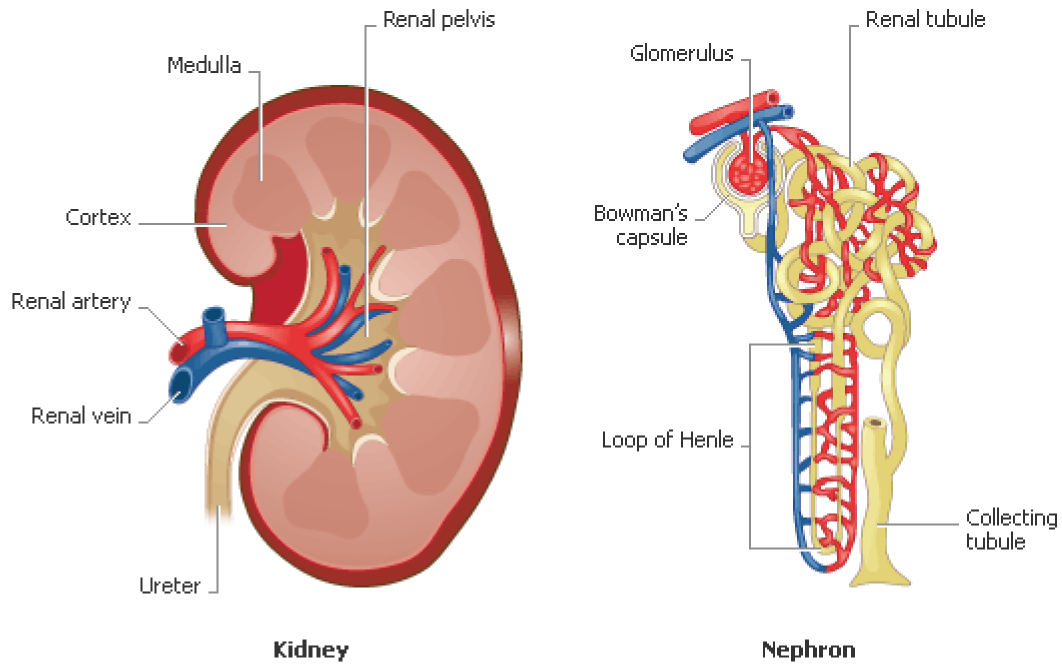
SUB-TOPIC 2: THE KIDNEY

The kidney is the major excretory and osmo-regulatory organ of mammals. All vertebrate have a pair of kidney. The kidney has a rich supply of blood and regulates the blood composition. It ensures the composition of the tissue fluid is maintained at an optimum level for the cells bathe by it and enables the cell to function efficiently at all times.

Structure of the kidney

The human kidney plays dual role of removal of waste (mainly nitrogenous waste) from the body and also osmo-regulation maintaining the body water level and ensuring adequate aqueous medium for the body metabolic processes.

Each kidney is a bean shaped brown organ attached to the dorsal wall of the abdominal cavity. The concave part of the kidney called the hilum is connected to the renal vein and renal artery which carry blood into and out of kidney respectively. The third tube, ureter leads downwards from each kidney to the bladder (the bladder is connected to the outside via urethra.

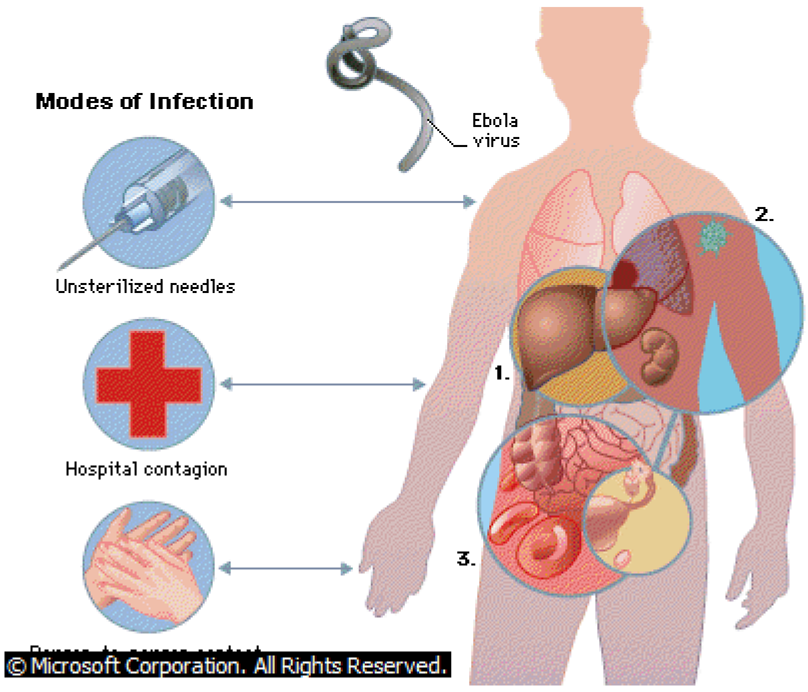


Kidney

A longitudinal section of kidney shows three distinct regions: the outer cortex, an inner medullar and the funnel shaped pelvis. The cortex and pyramid is the location of the urinary tubules which are the structures responsible for separating waste from the blood. There are millions of them and their function is enhanced by their connection with the rich network of capillaries in the kidney.

Each urinary tubule consists of a cup-like capsule known as the Bowman's capsule leads away a coiled section of the tubule called the proximal convoluted tubule.

Beyond the cortex in the medulla the tube forms a U-shaped loop called the loop of Henle. The far arm of the loop leads to another coiled section of the loop called the distal convoluted tubule which is also richly supplied with capillaries connected to the renal veins. After this point, the tubule leads back into the cortex to join other tubules which eventually leads out through the pyramid into the pelvis.



Functions of the kidney

The main function of kidney is osmo-regulation, excretion and secretion of hormones. The removal of waste products from the body by the kidney is known as excretion. The kidney also function as endocrine gland by producing two namely erythropoietin and calcitrol. Erythroprorethin acts on the bone marrow to increase the production of red blood cells, while calcitro promotes the absorption of calcium from food in the intestine and acts directly on bones to shift calcium to the blood stream.

Osmoregulation is controlled by variation of quantities of water returned to the blood from the kidneys during selective reabsorption as follows:

a. If the osmotic pressure in blood begins to rise, more water is reabsorbed from the kidney tubules, so that less urine passed to the urinary tract.

b. If the osmotic pressure of the blood begins to fall, less water is reabsorbed and more urine is produced and passed to the urinary bladder. This regulation is controlled by the anti-diuretic hormone (ADH) which is produced by the pituitary gland. ADH stimulates water reabsorption by the kidney tubules, thus reducing the loss of water in the urine. It makes the cells living the distal convoluted tubules and collecting duct more permeable to water, thus facilitating the osmotic withdrawal of water into the surrounding blood vessels. This is an example of a homeostatic feedback process.

Excretory function of the kidney

Excretion is the removal of metabolic water product in the body of an organism. The process varies from one organism another and from one environment to another.

Lower animals such as amoeba get rid of waste product by diffusion through their body surface. Higher animals such as worms excrete through structures called nephridia; insects make use of malpighian tubules, while amphibians, reptiles, birds, and mammals have kidneys as their excretory organs. These kidneys differ in structure and their products as they are adapted to different environments where these vertebrates live.

Maintenance of acid-base balance

The body fluid becomes acidic when the concentration of acid exceeds that of the bases. The kidney regulates it by excreting more acid in the urine and at the same time and at the same time prevents excessive loss of base. On the other hand when the concentration of base becomes higher, more are excreted in the urine.

DISEASES OF THE KIDNEY

Diseases of the kidney include nephritis, kidney stone, dieresis, kidney failure, dropy and kidney cysts.

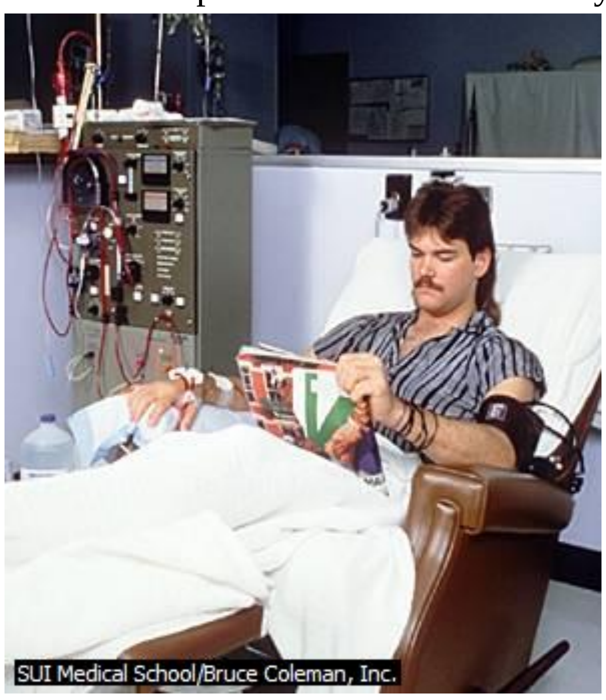
i. **Nephritis (Bright's disease).** This is a disease condition in which the kidney is inflamed as a result of bacterial infection. The blood vessels of the kidney, especially the glomenilus is affected, leading to incomplete ultrafiltration, as a result of which some useful substances are passed out in the urine. This disease may be acute or chronic. Symptoms of the disease include fever, headache, pain in the back vomiting, oedema (swelling of some parts of the body), loss of weight and hypertension.

ii. **Kidney stone (renal caulculi)**. Kidney stones may be produced when the water intake is low, salt intake is high or when the urine is either abnormally acidic or alkaline. Kidney stones are stony masses of minerals or organic matter which crystallize in the kidney and narrow down the funnel of the tubules, thus obstructing the normal passage urine. This results in the infected person having difficult in passing urine and may also experience pain when passing urine. The urine may also contain albumin and blood. The kidney stones vary in size from very small sand-like particles to large masses which can block the renal pelvis. Kidney stones may be removed by surgery.

iii. **Diuresis:** it is a condition of the kidney that leads to the production of large volumes of urine not long after water has been taken (usually less than an hour of taken water). The condition is complicated in diabetic patient. The cells of the lubules fail to reabsorb water from the glomerular filtrate. As a result, large quantities of dilute urine in diabetic patients are the result of reduction in the production of ADH.

iv. **Dropsy (Oedema):** this condition is caused by an accumulation of large quanity of intercellular fluid in the tissues, thereby making the affected part to swell up. Most often, this results from the inability of the cells of the kidney tubules to absorb water within the blood.

v. **Kidney failure:** this is a condition whereby the kidney stop working and can no longer remove wasters and concentrated urine. It could be caused by injury to the kidney, high blood pressure, poisoning and dehydration. Sudden interruption of blood to the kidney also leads to kidney failure.



Kidney Dialysis

THE EFFECTS OF THE KIDNEY DISEASE AND REMEDIES

Most of the disease condition of the kidney gave rise to the following:

i. Alteration of the normal concentration of substances in the urine.
ii. Inefficiency of the kidney in removing waste products from the body.
iii. Retention of waste products in the body.
iv. Poisoning of the cells of the kidneys.
v. Death in some cases.

Remedies to kidney diseases

i. Immediate medical attention should be sought by people with diagnosed or suspected cases of kidney diseases.
ii. Drugs could be used

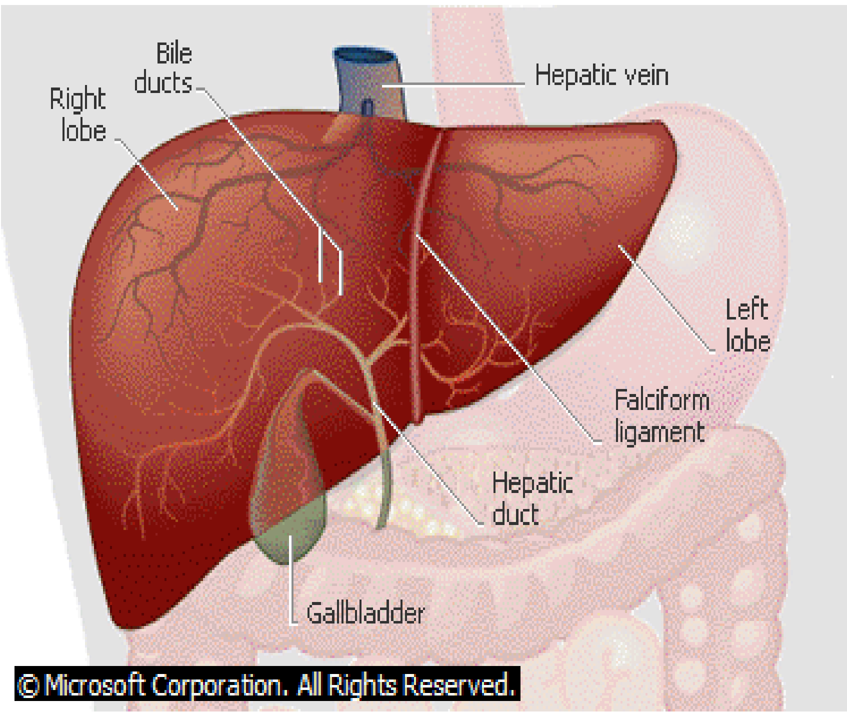
TOPIC: REGULATION OF INTERNAL ENVIRONMENT (LIVER AND

Structure of the liver

The liver is the largest gland in the body. It is located on the right side of the upper end of the abdomen, just below the diaphragm.

The liver is a reddish brown soft and well vascularised organ which consists of four lobes, two of which are very prominent. These are the right lobe which is the largest, the left lobe, the quadrate lobe and the candate lobe. The quadrate and candate lobes are small in size and lie behind the right lobe. Each lobe of the liver is made up of smaller units called lobules.

The liver is spongy in texture. Blood enters the liver through the portal vein. The gall bladder is found on the side of the right lobe.



Liver

FUNCTIONS OF THE LIVER

Theliver performs a number of functions and it is one of the most important organs concerned with metabolism, storage and detoxification.

Functions of the liver include the following:

1. **Control of glucose level:** the liver controls the amount of glucose in the blood stream. The optimum blood sugar level in man's about 90mg/cm^2/blood. Any amount in excess of this, the kidney first would attempt excreting it in urine and the liver follows by converting it to glycogen for storage. Any shortage from the optimum blood sugar level causes brain damage and the liver would again convert the store glycogen for release into the blood to prevent damage to brain cells. In the liver glucose is converted to glycogen is reconverted by glucagon (a hormone) to glucose when the body requires more glucose.
2. **Protein metabolism (Deamination):** deamination is the process by which the liver breaks down excess protein in the form of amino acids in the liver into ammonia to be excreted by the kidney. The liver is responsible for amino acids levels in homeostasis. When protein is in excess, the liver breaks down the excess nitrogen containing amino acids and then converts it to urea which is also excreted by the kidneys. Liver also converts keto acids to glucose, glycogen and fats.
3. **Manufacturing of plasma and protein, globulins, fibrinogen and bile.**
4. **Liver is a storage organ** for soluble vitamins such as A, D, E, K and water soluble vitamins such as B and C. Mineral ions of Zink, copper and potassium are stored in the liver.

5. **Formation of red blood cells** in foetus and lysis of red blood cells in adults. Haemoglobin released from worn-out red corpuscles destroyed in the bone marrow and the spleen is broken down by the formation of bile.
6. **It is involved in the de-toxication of toxin**, drugs and medicines, food preservations and additives as well as pollutants in air and water.
7. **Production of heat:** the liver produces heat which is distributed in the body through the circulatory system. The heat keeps the body warm.
8. **Production of prothrombin:** The enzyme ptothrombin, which takes part in blood clotting, is produced in the liver.
9. **Removal of lactic acid:** lactic acid, formed as a waste product by muscles during vigorous exercise is removed by the liver and converted into glycogen.
10. **Action on fats:** the liver acts on saturated fats and removes hydrogen, forming unsaturated fats. This is called desideration. The cell in tissues can use these unsaturated fats for their respiration.

Bile products

The liver metabolises and excretes many substances and toxins into the bile, thus eliminating them. One of the most important wastes thus eliminated is bilirubin. Bilirubin is a useless and toxic breakdown product of haemoglobin. The iron component is recycled. If in excess, bilirubib accumulates in extracellular fluid, a yellow discolouration of the skin, sclera and mucous membrane is observed. This condition is called jaundice.

Gall stone

It is a crystalline growth formed within the gallbladder by accumulation of bile components. Presence of gall stones in the gall bladder may leads to inflammatory condition in which bile is retained in the gall bladder. It may cause obstructive jaundice. The condition could be treated using appropriate drug, ultrasonic shock waves or by surge**ry.**

THE EFFECTS OF LIVER DISEASES AND REMEDY

Some of the common liver diseases are

i. Jaundice,
ii. Cirrhosis
iii. Viral hepatitis,
iv. Gallstone,
v. Amoeba liver abscess

i. Jaundice:it is a disease characterised by yellowing of the eyes and skin. It results from the breakdown the red blood cells leading to increased production of bilirubin. Inherited red blood cell defects such as sickle cell may also cause it in newborn. Excessive destruction of the red blood cells in the case of infections like malaria could also lead to jaundice. Some poisons cause lysis of the red blood cells and release of bilirubin. When the bile duct is obstructed by gall stone or some other object, a back flow of bile and accumulation may lead to increase concentration of bilirubin in the blood. Additionally, this disease is also characterised by the passing of pale stool and yellow to dark brown urine. When the liver is diseased and its cells are damaged that they areno longer able to absorb bilirubin**.**


Dr. P. Marazzi/Science Source/Photo Researchers, Inc.

ii. **Cirrhosis:** it is a condition in which the liver tissue gradually turns from the soft highly vascularised texture to fibrous hard and irregular form. It is known to have a variety of causes, including hepatitis infection and excessive drinking. In many cases however, it is difficult to trace it to any particular cause.

iii. **Viral hepatitis:** the disease is characterised by inflammation and destruction of liver cells. There are two major types based on the type of virus.

iv. **Hepatitis A** virus cause infection hepatitis and it is usually transmitted via the oral faeces route when an individual takes contaminated water, milk or food. Jaundice is one of the symptoms.

v. **Hepatitis B** causes what is called the serum hepatitis and this is usually transmitted via blood transfusion or exchange of body fluid or infected blood products. When hepatitis is unchecked, it may lead to complete damage of the entire liv

MANIFESTATION OF LIVER DISEASE

The common symptoms and signs of liver diseases include the following:

i. Weakness and tiredness
ii. Slight fever
iii. Jaundice
iv. Oedema (especially in the abdomen)
v. Enlarge and tender liver (in the case of hepatitis and liver abscesses)
vi. Biliary colic (in the case of gall stones lodged in the bile duct)

SUB TOPIC 6: THE SKIN

The skin is the outer covering of the body. It covers the entire body surface and it is thickly covered with hair in most mammals but in man, it is sparsely covered except the head where the hair is thick and long

Structure of the skin

The skin is made up of two main layers:

1. The external epidermis
2. The dermis

1. THE EPIDERMIS

The epidermis is made up of three layers, namely

i. The cornified layer
ii. The granular layer and
iii. The malpighian layer

i. **The Cornified layer** is the outermost layer of the skin. It is composed of dead cells. It is scaly and the dead constantly peel off it. The dead cells are impregnated with keratin, a fibrous protein. The cornified layer is well developed and very thick in the sole of the feet and palms of the hands. As the cells of the cornified layer are sloughed, they are constantly replaced by new cells from the granular layer
ii. **The Granular layer** is the middle layer of the epidermis containinjg living cells rich in keratin. The cells are constantly pushed up and flattened out to replace the cells of the cornified layer as dead cells.
iii. **The Malpighian layer** is made up of cells that are actively dividing. They are unboidal cells that are constantly being pushed up to replace cells in the granular layer. They are rich in melanin (the pigment which impact colour to the skin). The layer has many folding into the dermal layer where sebaceous glands and hair follicles are located. Because they are also actively growing, they are well supplied with nutrient and oxygen by the capillaries in the dermal layer.

2. THE DERMIS

The dermis is thicker than the epidermis. It is made up of connective tissues. Most of the special structures of the skin including blood capillaries, hair follicles, sweat gland sensory nerve ending, sebaceous glands and fat cells are located here.
Blood capillaries supply the dermis and lower epidermis with nutrient and oxygen. They also remove wastes. They form a network around the root of the hair follicles and sweat glands.

Hair follicles contained the hairs of the skin. The hair follicle is an invargination into the dermal layer which is the lining with malpighian layer. The hair is a shaff made up of keratin with a bulbous base which is richly supplied with blood capillaries and nerve endings. The nerve endings are what makes the hair very sensitive to touch. Also attached to the base of the hair is the erector muscle.

The rector muscle contracts when the weather is clod causing the hair to become erect. This also happens when the animal is in fear. This is what gives rise to the so called goose pimples.

Sebaceous gland is a bulbous gland lined with malpighian cell layer on the side of the hair follicle. It secretes oil called sebum which helps to keep the hair and epidermal layer oily and water proof. It also wards off micro-organisms.

Sweat gland is a coiled tube embedded in the dermis that leads to an opening on the skin surface called sweat pore via the sweat duct. The capillaries associated with sweat gland release water and mineral salts; the mineral salts and water form what is called sweat which moves to the skin surface as droplets of water. This has both excretory and regulatory functions.

Sensory nerve endings: The skin is a veritable sense organ with many different types of sensory receptors and nerve endings. Some of these receptors include touch receptor (meissners corpuscle), pressure receptors (pacinian corpuscles) pain receptors (free nerve endings) and thermo receptors wider so that more blood flows to the surface and heat is lost by radiation and convention.

The sweat glands absorb fluid from the blood capillaries, which passes out sweat through the sweat pores

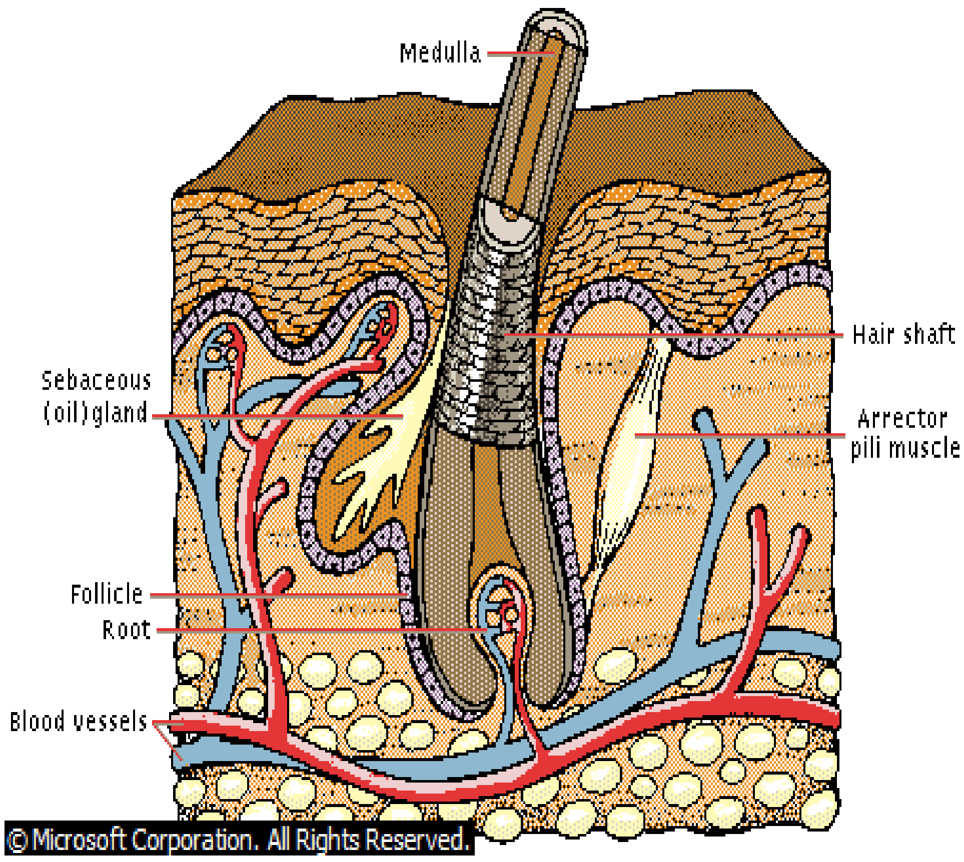
On evaporation of the sweat, a cooling effect is produced in the body and the body temperature is reduced.

CARE OF THE SKIN

The skin is constantly in contact with the external environment and liable to be dirty and its function negatively affected. Although the outer layer is made up of dead cells, the pores and hair follicles and bruises when these occur are portals of entry of germs if not kept clean. Hence the need to take appropriate hygiene steps.

Some of these include:

i. Regular cleaning of the skin and keeping of moist, particularly avoiding oily body cream in hot weather
ii. The use of cosmetics which are likely to remove the melanin pigment should be avoided
iii. Regular intake of vitamins A and B2 (riboflavin) helps to maintain a healthy skin
iv. A regular exercise helps to keep the sweat pores and ducts clean and functional



FUNCTIONS OF THE SKIN

The skin performs a number of functions such as protection against entry of pathogens and excessive water loss, insulation, temperature regulation, sensation (sensitivity) and synthesis of vitamin

i. **Protection:** protection from cuts and scratches is provided by the horny (cornified) layer and also with the help of hair in some parts, such as the head. Also, the dead cells that form the cornified layer together with oily secretions from the sebaceous glands protect the body from excessive evaporation of water from dying and from penetration of germs
ii. **Sensitivity:** sensitivity is provided by the various types of nerve endings, each being sensitive to one particular type of stimulus. Each nerve ending, when stimulated initiates an impulse, which passes along a nerve to the brain, where it is interpreted as pain, heat or pressure. With the nerve endings, we can also distinguish grades of roughness and smoothness, which we call a sense of texture
iii. **Excretion:** the sweat gland of the skin secretes sweat which contains water, salts and urea
iv. **Production of vitamin:** The skin produces vitamin D on exposure to early morning sunlight
v. **Regulation of body temperature:** Animals whose body temperature varies according to changes in their external surroundings are said to be poikilothermic e.g fish, amphibians and reptiles). Birds and mammals whose body temperature remains constant regardless of the changes in the temperature of their external environments are said to be homeothermic. The mammalian skin helps to regulate the body temperature in specific ways. In a hot surrounding or weather a mammal keeps its body temperature constant in the following ways. The blood vessels close to the skin surface dialate

THE ENDOCRINE SYSTEM

Endocrine system is a network of several glands that create or secrete hormones. A gland is an organ that produces one or more substances such as hormones, digestive juices, sweats or tears. Endocrine glands secrete hormones directly into the bloodstream.

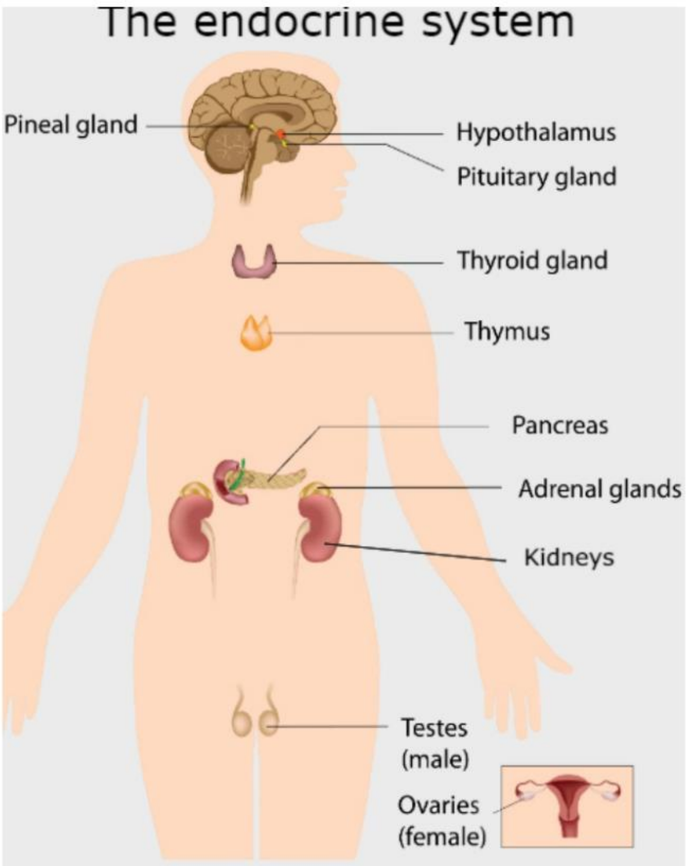


Diagram showing the positions of endocrine glands in the human body.

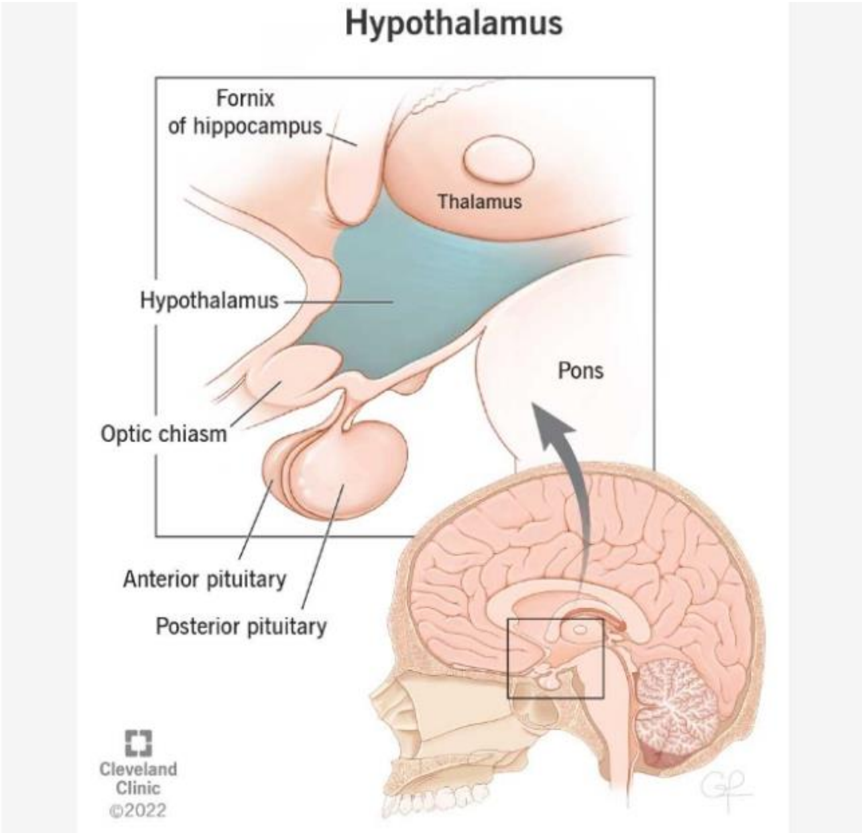
The endocrine system is a messenger system comprising feedback loops of the hormones released by internal glands of an organism directly into the circulatory system, regulating distant target organs. In vertebrates, the hypothalamus is the neural control center for all endocrine systems. In humans, the major endocrine glands are the thyroid gland, parathyroid gland, pituitary gland, pineal gland, the testes (male), ovaries (female), and the adrenal glands. The hypothalamus, pancreas, and thymus also function as endocrine glands, among other functions. Other organs, such as the kidneys, also

Major endocrine glands are the thyroid gland, parathyroid gland, pituitary gland, pineal gland, the testes (male), ovaries (female), and the adrenal glands. The hypothalamus, pancreas, and thymus also function as endocrine glands, among other functions. Other organs, such as the kidneys, also have roles within the endocrine system by secreting certain hormones. The study of the endocrine system and its disorders is known as endocrinology. It is one of the most important systems of the human body including bone, kidneys, liver, heart and gonads.

The endocrine system can be contrasted to both exocrine glands, which secrete hormones to the outside of the body, and paracrine signalling between cells over a relatively short distance. Endocrine glands have no ducts, are vascular, and commonly have intracellular vacuoles or granules that store their hormones. In contrast, exocrine glands, such as salivary glands, sweat glands, and glands within the gastrointestinal tract, tend to be much less vascular and have ducts or a hollow lumen. Endocrinology is a branch of internal medicine

Endocrine glands are glands of the endocrine system that secrete their products, hormones, directly into interstitial spaces where they are absorbed into blood rather than through a duct. The major glands of the endocrine system include the pineal gland, pituitary gland, pancreas, ovaries, testes, thyroid gland, parathyroid gland, hypothalamus and adrenal glands. **The hypothalamus and pituitary gland are neuroendocrine organs.**

Hypothalamus:



The hypothalamus is a key part of the brain and hormonal system. It acts as the body's smart control coordinating centre. Its main function is homeostasis. It does its job by directing autonomic nervous system or by managing hormones

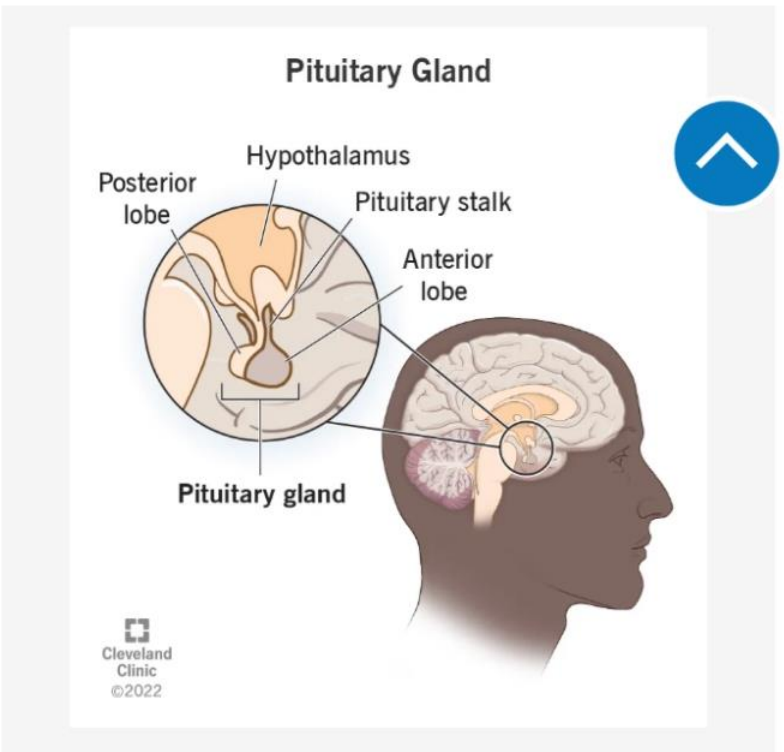
The hypothalamus receives chemical messages from nerve cells in the brain. The hypothalamus helps to manage the;

I. Body temperature
II. Blood pressure
III. Hunger and thirst
IV. Sense of fullness when eating
V. Managing sexual behaviour (sex drive)
VI. Sleep
VII. Releasing hormones
VIII. Regulating emotional responses(mood)
IX. Maintaining daily physiological cycles

The hypothalamus makes some hormones itself and stores them in the posterior pituitary gland. They include;

I. Oxytoxin
II. Antiduretic hormone
III. Dopamine
IV. Serotonin
V. gonadotropins

The pituitary gland: the pituitary gland also known as the hypophysis is a small pea-sized gland located at the base of the brain beneath the hypothalamus.



It releases several important hormones and controls the function of many other endocrine system glands.

It is called the master endocrine gland because it controls several other glands. The pituitary gland is divided into two, the anterior pituitary (frontal lobe) and the posterior pituitary(back lobe). It is connected to the hypothalamus through a stalk of blood vessels and nerves called the pituitary stalk.

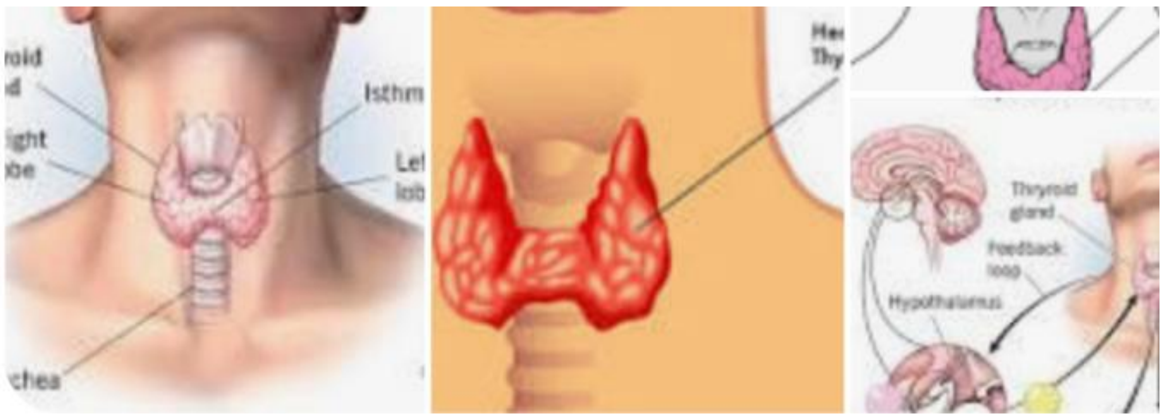
The main role of the anterior pituitary gland is to produce and secrete tropic hormones. the pituitary gland produces the following hormones;

I. **Adenocorticothropic hormone**(ACTH or corticotrophin) responsible for producing cortisol (the stress hormone) by stimulating the adrenal glands
II. **Follicle-stimulating hormone (FSH)** stimulates sperm production in males. Stimulates the production of estrogen and plays a role in egg development (ovary)
III. **Growth hormone (GH)** stimulates thyroxin production by the thyroid glands
IV. **Luteinizing hormone** ; stimulates ovulation in females and testosterone production in males
V. **Prolactin**; stimulates lactation in females. It also affects fertility and sexual functions in adults

The posterior pituitary gland produces the following;

I. **Antiduiretic hormone**(ADH or vasopressin) this hormone regulates the water balance and sodium levels of the body
II. **Oxytoxin**; it plays complementary roles in during child birth, lactation and ejaculation The posterior pituitary gland does not produce any hormone but stores and secretes hormones such as antidiuretic hormone (ADH) which is synthesized by the anterior pituary gland
III. **supraoptic** nucleus of hypothalamus and oxytocin which is synthesized by paraventricular nucleus of hypothalamus. ADH functions to help the body to retain water; this is important in maintaining a homeostatic balance between blood solutions and water. Oxytocin functions to induce uterine contractions, stimulate lactation, and allows for ejaculation.

Thyroid gland



Position of the thyroid gland

A thyroid is a small butterfly shaped gland located at the front of the neck under the skin. It controls many of the bodys important functions by releasing certain hormones.

It controls the rate of metabolism (the rate at which the body transforms food into energy) anterior pituitary gland, which further regulates the metabolic activity and rate of all cells, including cell growth and tissue differentiation. The thyroid gland produces thyroxin which influences body growth and development.

Thyroid hormones affect the following:

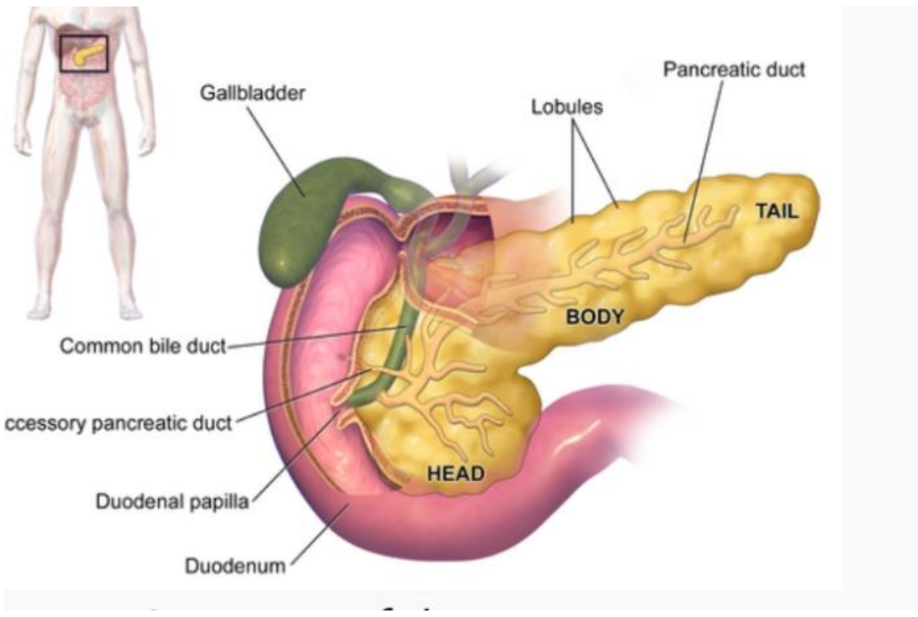
I. Heart rate
II. Breathing
III. Digestion
IV. Body temperature
V. Brain development
VI. Mental activity
VII. Skin and bone maintainance
VIII. fertility

Parathyroid gland

Epithelial cells of the parathyroid glands are richly supplied with blood from the inferior and superior thyroid arteries and secrete parathyroid hormone

The parathyroid gland is located behind the thyroid at the bottom of the neck and are about the size of a grain of rice. The parathyroid hormone produced by the thyroid glands helps maintain the right balance of calcium int the bloodstream and in tissues that depend on calcium for proper functioning. This is especially important for nerve and muscle function as well as bone health.

Pancreas gland:



The pancreas is both endocrine and exocrine in functions. The exocrine functions includes production of digestive enzymes while the endocrine function is the the release of enzymes that helps control the amount of sugar in the bloodstream. The pancreas produces insulin which reduces high blood sugar levels and glucagon which includes low blood sugar levels.

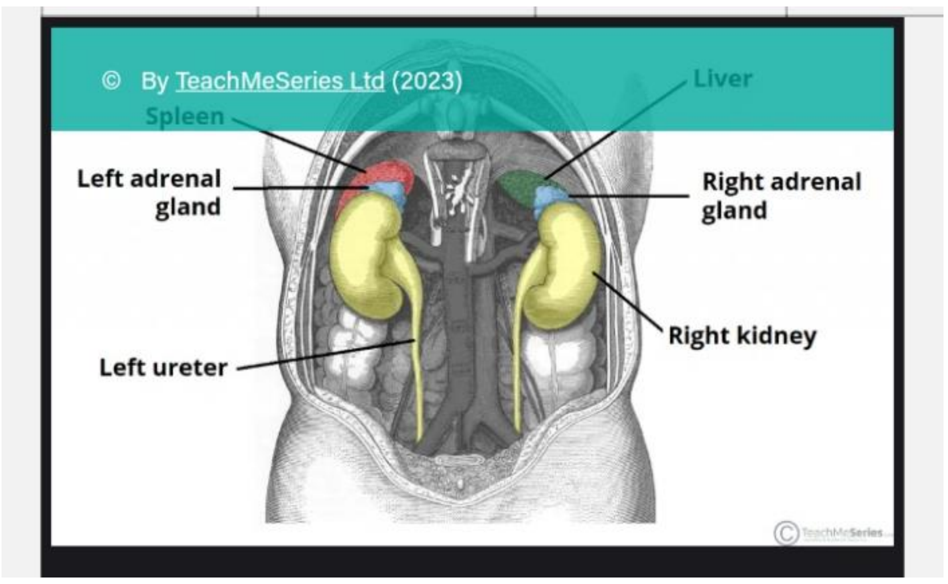
Your body needs balanced blood suger levels to better serve the kidneys, liver, and the brain. The circulatory system and nervous system also need balanced levels of insulin and glucagon to function.

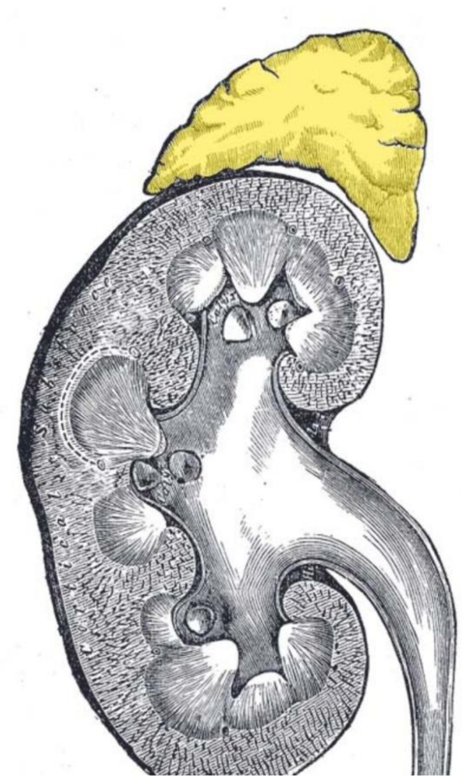
The following disorders can affect the pancrease

I. type 1 and 2 diabetes
II. hyperglycemia(high blood sugar levels)
III. hypoglycaemia(low blood sugar levels)
IV. pancreatitis
V. pancreatic cancer

Adrenal glands

Also called the suprarenal glands are small triangular shaped glands located on the top of both kidneys. Adrenal glands produce hormones that help regulate your metabolism, immune system, blood pressure, response to stress and other essential functions





The adrenal glands are composed of two parts- the cortex and medulla which are responsible for producing different hormones. When adrenal glands do not produce enough hormones, this can lead to adrenal insufficiency. The adrenal glands produce cortisol, adrenaline and aldosterone all of which perform different essential functions

Glands of the Gonads; aside from the gametes, the gonads are responsible for producing hormones and are considered to be endocrine glands. The testes produce hormones collectively called the androgens, the chief androgen is testosterone secreted by the testes, a small amount of it is produced by the adrenal cortex. This steroid is responsible for;

I. the growth and development of male reproductive structures
II. increased skeletal and muscular growth
III. enlargement of the larynx accompanied by voice changes
IV. growth and distribution of body hair
V. increased male sexual drive

Hormones produced in the ovaries are estrogens and progesterone. These steroid hormones contribute to the growth, development and function of the female reproductive organs. Esrogens facilitates;

I. The development of the breasts
II. Distribution of fats evidenced in the hips, legs and breast
III. Maturation of reproductive organs such as uterus and vagina
IV. Progesterone causes the linning of the uterine wall thicken in preparation for pregnancy
V. Progesterone inhibits ovulation during pregnancy

PLANT HORMONES

Plant hormones (also known as phytohormones) are signal molecules that exist at extremely low concentrations and are formed within plants. From embryogenesis, organ size regulation, pathogen protection, stress tolerance, and reproductive development, plant hormones regulate all aspects of plant growth and development. There are some intrinsic variables that control plant growth and

development.Some examples of plant hormones are Indole (auxins), terpenes (Gibberellins), adenine (Cytokinins), carotenoids (Abscisic acid), and gases (Ethylene) .In nearly all parts of the plant, these hormones are produced and are transferred to different parts of the plant.Plant hormones may act individually or synergistically. It may be complementary or antagonistic to the functions of various hormones. Hormones, along with extrinsic influences, play an important role in processes such as vernalization, seed germination, phototropism, dormancy, etc. In regulated crop production, synthetic plant hormones are exogenously added. Phototropism in the canary grass coleoptiles was first observed by Charles Darwin and auxin was first isolated from the coleoptiles of oat seedlings by F.W Went.

Plant Hormones help in regulating the growth of plants. Plant hormones are chemical compounds found in a plant's body in a very low concentration. Hormones play a very important role in a plant’s body and facilitate processes like vernalisation, phototropism, seed germination, dormancy etc. with the help

of external factors like sunlight, water and oxygen.Crop production is controlled by the application of synthetic hormones.Main Functions of Plant HormonesAll the growth and development activities such as cell division, enlargement, flowering, seed formation, dormancy, and abscission are regulated by plant hormones and are the main functions of plant hormones.Plant hormones are categorised into two groups based on their action:Plant Growth Promoters.Plant Growth Inhibitors.Types of Plant Hormones and their Functions

Auxins: Auxin means to be able to grow. In agricultural and horticultural practises, they are widely used. They are found in roots and stems in rising apices of plants. Functions of Plant Hormone Auxin:

I. Elongation of cells of stems and roots.
II. IAA in apical buds suppresses the development of lateral buds with apical dominance.
III. Induces parthenocarpy, i.e. fruit growth without fertilisation, for example, in tomatoes. Prevent leaves, flowers, and fruits from dropping prematurely.
IV. Useful in stem cuts and grafting where rooting is initiated.
V. Promotes flowering in plants
VI. Division and xylem differentiation.

Gibberellin: There exist more than a hundred (100) known Gibberellins In nature, they are found to be acidic. These kinds of hormones are majorly observed in higher plants and fungi. Functions of Plant Hormone Gibberellin:

I. Promotes bolting, i.e. sudden internode elongation just before flowering, as seen in cabbage, beet, and others.
II. Delays in senescence.
III. Stimulates parthenocarpy.
IV. elongation and reversing dwarfism in plants

Promotes the synthesis of hydrolytic enzymes such as amylase, lipase, in the endosperm of germinating barley seeds and cereal grains.3

Abscisic Acid:It is a hormone that has a role in inhibiting the growth of plants.

I. It prevents the metabolism of plants and controls abscission
II. Controls dormancy.
III. It is often referred to as a 'stress hormone' as it improves plant tolerance.

Cytokinins:

Cytokinins play a major role in the mechanism of cytokinesis. rIn plants where rapid cell division occurs, cytokinins are naturally synthesised, such as root apices, shoot buds, young fruits, etc. Functions of Plant Hormone Cytokinins:

I. This promotes lateral and adventitious shoot growth and is used in culture to initiate shoot production.
II. Assists in resolving auxin-induced apical dominance.
III. Stimulate the production of chloroplast in the leaves
IV. .Promoting the mobilisation of nutrients
V. And slowing leaf senescence. :.

Ethylene; Ethylene acts as both inhibitor as well as a growth promoter. It occurs in gaseous form. The synthesis of ethylene occurs in the maturing fruit and tissues which are undergoing senescence. Many physiological procedures are regulated by this hormone and are one of the most commonly used hormones in agriculture. Functions of Plant Hormone Ethylene:

It speeds up the fruit ripening
Controls leaf epinastine

Breaks the bud and seed dormancy

Facilitates rapid elongation of internodes and petioles

Senescence and abscission of leaves and flowers are encouraged.

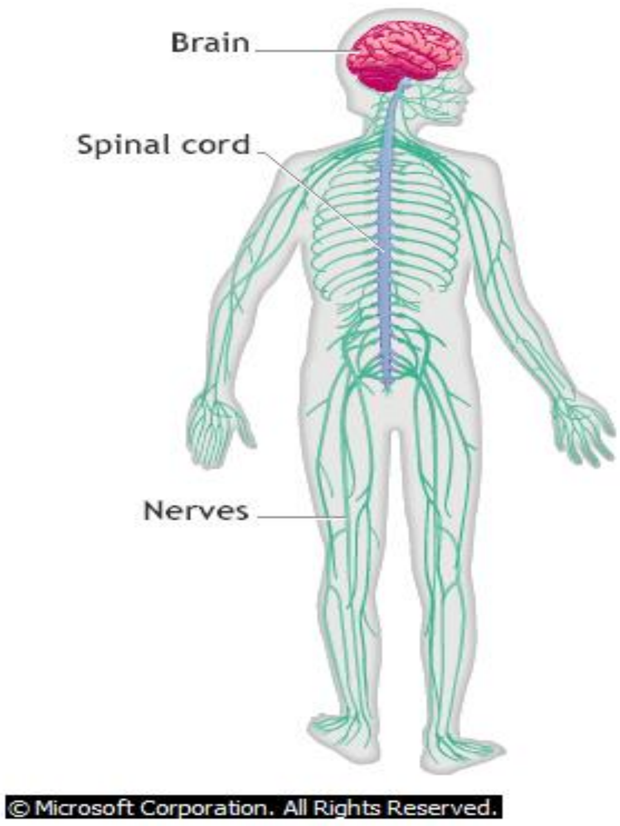
This raises the absorption surface by inducing root growth and root hair formation

Stimulates femininity in plants that are single

TOPIC: THE NERVOUS SYSTEM I

CONTENT:
(1) Organization of the nervous system
(i) Central Nervous System (CNS)
(ii) Peripheral Nervous System(PNS)
(2)The Brain-position, structure and functions
(3)The Spinal Cord-position, structure and functions

SUB-TOPIC 1: ORGANIZATION OF THE NERVOUS SYSTEM
In a complex multicellular organism many activities go on almost simultaneously. These activities are coordinated by the endocrine and nervous system. The two systems are linked by the hypothalamus.
The basic structural unit of the nervous system is the nerve cell (neurons). The nervous system is made up of millions of neurons.
The main parts of the nervous system are the central nervous system and the peripheral nervous system.



THE CENTRAL NERVOUS SYSTEM (CNS)

This consists of the **brain** and the **spinal cord**. The CNS coordinates the activities of the nervous system. It receives impulses from the organism's internal and external environment, processes and integrates the information and sends out impulses to appropriate effector organs to take action.

The CNS has millions of interconnected nerves which are of two types;

i. the **cranial nerves** come out of the brain and enter mainly structures in the head (e.g. the eyes and ears).

ii. The **spinal nerves** come out of the spinal cord and go into the arms, legs and various structures in the trunk.

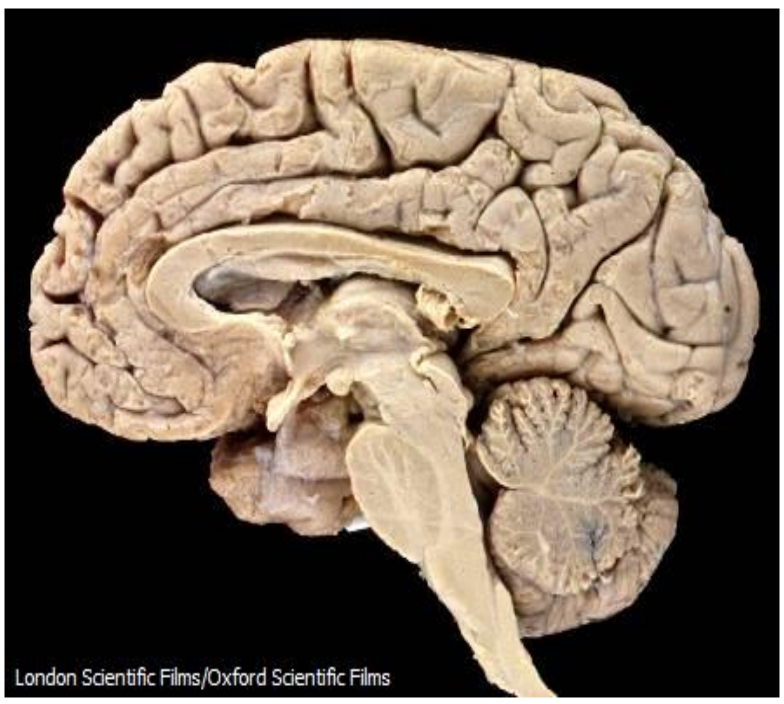
SUB-TOPIC2: THE BRAIN.

The human brain is made up of billions of neurones which form the grey matter (nerve fibres). The grey matter occupies the peripheral region, while the white matter is situated in the central portion of the brain.

Within the white matter lie hollow chambers called ventricles. The ventricles contain cerebrospinal fluid and are continuous with the spinal cord.

The cerebrospinal fluid is formed from the blood and returns to the blood stream after bathing the neurons, supplying them with oxygen and nutrients as well as removing wastes. The fluid also acts as a shock absorber, so the brain is cushioned from damage when a person jumps around or bangs the head against an object.

The adult human brain weighs about 1.2 to 1.4 kilograms and forms about 2% of the body's mass. The brain is protected by the cranium or brain case.



Human Brain

The human brain has three major structural components: the large dome-shaped cerebrum (top), the smaller somewhat spherical cerebellum (lower right), and the brainstem (center). Prominent in the brainstem are the medulla oblongata (the egg-shaped enlargement at center) and the thalamus (between the medulla and the cerebrum). The cerebrum is responsible for intelligence and reasoning. The cerebellum helps to maintain balance and posture. The medulla is involved in maintaining involuntary functions such as respiration, and the thalamus acts as a relay center for electrical impulses traveling to and from the cerebral cortex.

The vertebrate brain is made up of three regions;

1. The Fore brain,
2. The Mid brain
3. The Hind brain.

1. THE FORE BRAIN,

This is associated with higher brain functions like intelligence and speech.
It is made up of three main parts, namely,

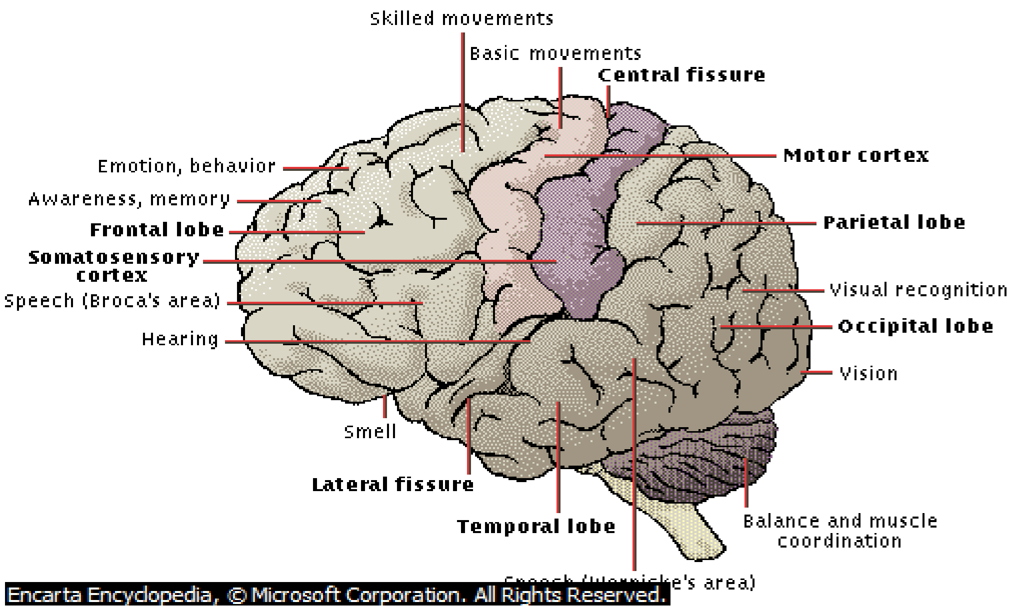
i. The Cerebrum,
ii. The Thalamus and
iii. The Hypothalamus.

i. **Cerebrum:**

This is made up of two halves, the right and left cerebral hemispheres. The two halves are bound by fibres called the corpus callosum, which keeps each hemisphere informed about the other. Each hemisphere has four distinct lobes namely;

a. Frontal lobe (in front)
b. Parietal lobe (at the top)
c. Temporal lobe (at the side)
d. Occipital lobe (at the back)

The most active part of the cerebrum is its outer layer, the cerebral cortex, which is composed of grey matter. It is highly convoluted to increase its surface area and consequently the number of neurones thus increasing the capabilities of the cerebrum.
The cerebral cortex is the seat of intelligence, speech, memory, learning, imagination and creativity. The left hemisphere controls the right side of the body while the right hemisphere controls the left part of the body.



ii. The Thalamus

There are two thalami, each one is an oval body attached to the back end of the cerebrum. They act as the relay centres for receiving and transmitting sensory information to relevant parts of the cerebral cortex. They also transmit outgoing motor impulses from the cerebral cortex.

iii. The Hypothalamus

This is an ovoid body projecting below the thalami. It is a controlling centre for the autonomic nervous system. It plays a homeostatic role by regulating temperature and endocrine secretions. Signals from it also trigger feelings of hunger and thirst. It also influences emotions like anger, pain and pleasure.

1. THE MIDBRAIN

This is the portion between the fore-brain and hind-brain. Specific portions control the reflexes of sight and hearing. Associated with these are the movements of the head when focusing on an object and the detection of sound.

2. THE HINDBRAIN

It is composed of three parts;

i. The Cerebellum,
ii. The Pons varolli and
iii. The Medulla oblongata.

i. The Cerebellum

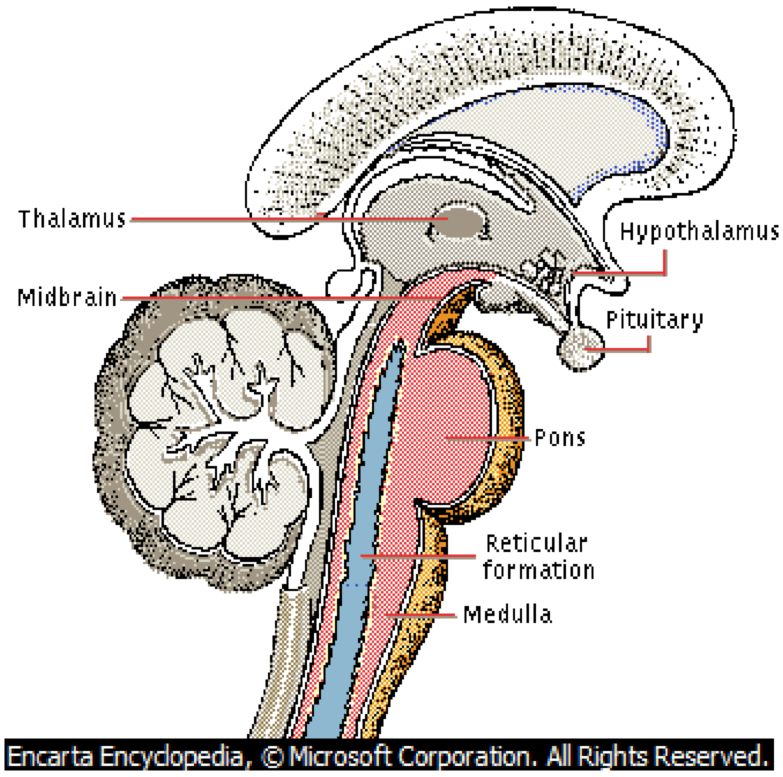
The Cerebellum is tri-lobed. There is one median lobe and two lateral cerebellar hemispheres. It controls and coordinates body posture and muscular movements, especially those that maintain the body's balance.

ii. The Pons varolli

The Pons varolli is a wide band of fibres that connect the lateral cerebellar hemispheres.

iii. The Medulla oblongata

The medulla oblongata is the posterior portion of the brain and continues into the spinal cord. It has an outer region of white matter and an inner region of grey matter. It controls involuntary movements like those involving respiration, digestion, heartbeat, constriction and dilation of blood vessels. PIC



The Stem of the brain

SUB-TOPIC 3: THE SPINAL CORD

The spinal cord is composed of a soft white tissue running from the medulla oblongata to the tail region. It is protected by the bones of the vertebral column and passes through the neural canal. It is enveloped by three membranes called the menninges which further protect it. A narrow spinal canal filled with cerebrospinal fluid runs through the centre of the spinal cord. The spinal cord has an inner area of grey matter and an outer region of white matter. The grey matter is composed of the cell bodies of the neurones in the spinal cord while the white matter is made up of the nerve fibres which emanate from the cell bodies. Many of the nerve fibres leave the spinal cord at intervals as spinal nerves and run to all parts of the body. Some others run longitudinally along the spinal cord to the brain. The nervefibres may be concerned with spinal reflexes or may carry sensory impulses to the brain or motor impulses from the brain to the muscles and other organs of the body.

Functions of the Spinal Cord

1. It coordinates simple reflex actions such as knee jerk and automatic reflexes such as sweating.
2. It connects all peripheral pathways to the brain.

TOPIC: THE NERVOUS SYSTEM II

SUB-TOPIC1. THE PERIPHERAL NERVOUS SYSTEM (PNS)

The peripheral nervous system links the CNS with the body's receptors and effectors in mammals. When receptors pick up impulses of change in the environment, messages are sent to the CNS which integrates the information and sends appropriate messages to the effectors accordingly.

The peripheral nerves are of two types;

i. the spinal nerves connected to the spinal cord and
ii. the cranial nerves, connected to the brain.

The spinal nerves serve the receptors and effectors in the other body parts.
The cranial nerves are associated chiefly with the receptors and effectors in the head, while

The PNS consists of

i. The Somatic nervous system (SNS) and
ii. The Autonomic nervous system (ANS).

i. **Somatic Nervous System**

The nerves of the SNS principally serve the parts of the body which take part in responses to external stimuli (e.g. sense organs, limb muscles and glands) and voluntary activities. Nerve fibres without synapses extend from the brain through the spinal cord to the skeletal muscles. The motor neurones stimulate the effectors. The SNS also controls the emptying of the bladder and the opening of the anal sphincters.

ii. **Autonomic Nervous System**

The ANS is concerned with control of the bodies involuntary activities e.g. heartbeat, movements of the gut and secretion of sweat.

The ANS consists of two parts;

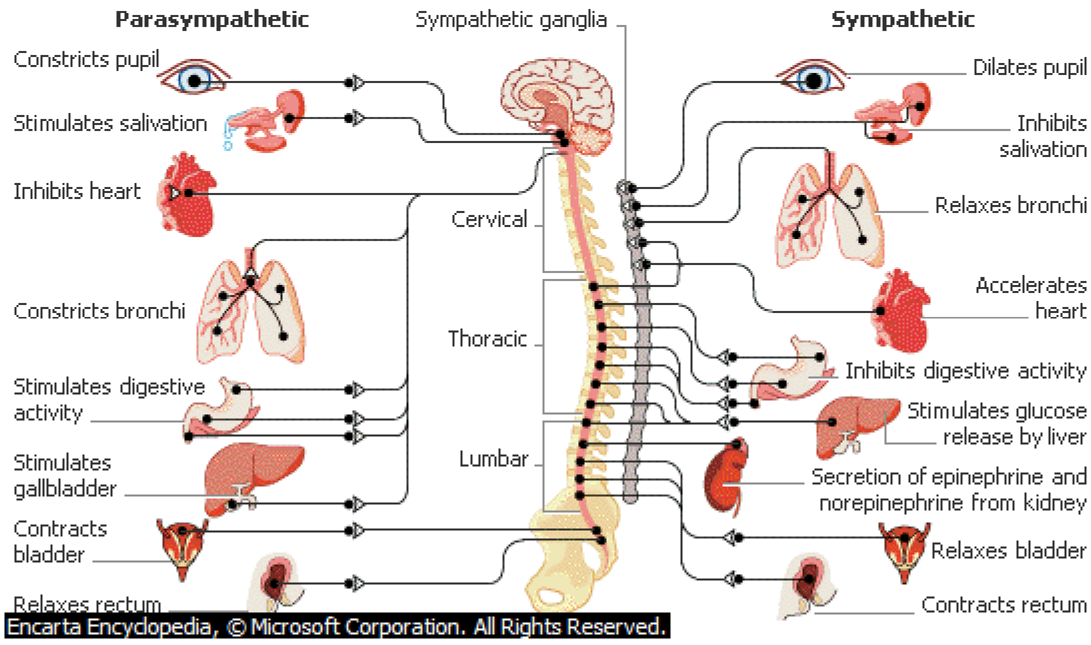
a. The Sympathetic and
b. The Parasympathetic systems.

Both contain nerve fibres serving structures over which the body has little or no voluntary control. In both cases nerve fibres from the brain or spinal cord pass into the organs concerned. Along the course of each pathway there is a complex set of synapses forming a **ganglion**.

a. **In the sympathetic system,** the ganglia lie alongside the vertebrae close to the spinal cord.
b. **In the parasympathetic system**, the ganglia are embedded in the wall of the effector itself. The effects produced by the two systems generally oppose one another (antagonistic).

Thus, if the sympathetic system causes a certain muscle to contract, the parasympathetic system relaxes it.

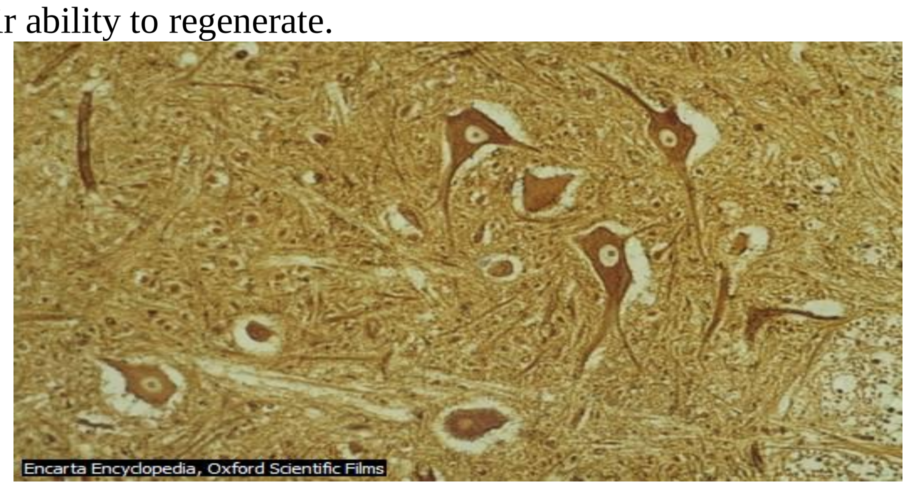
The following is a diagrammatic representation of the autonomic nervous system showing its connections with the central nervous system and its effects on some internal organs.



The Autonomic nervous system

The Neurone

The neurone is the basic structural unit of the nervous system**. It consists of a cell body and protoplasmic processes called nerve fibres** which are tied up in bundles called nerves. **It is specialized for transmitting electric impulses**. Mature neurones have lost their ability to regenerate.



Nerve cells

Structure of a Neurone

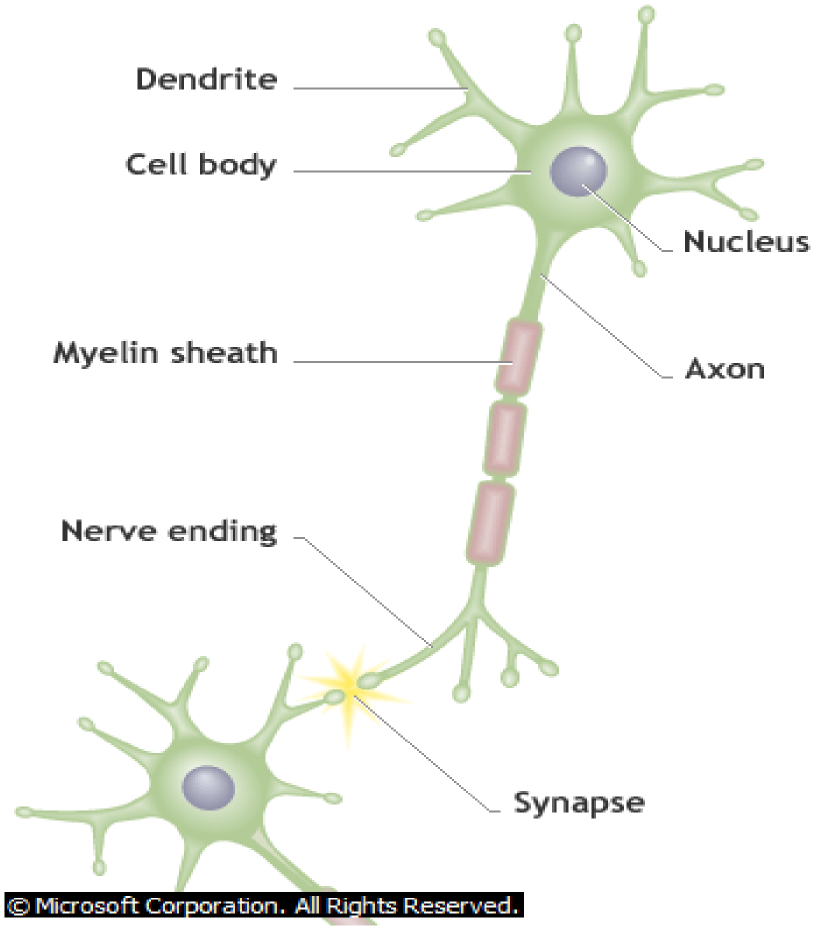
A Neuronehas three basic parts;

i. A cell body
ii. Dendron
iii. The axon

i. A cell body: this may be star-shaped, oval or angular. It has a large nucleus and dense granulated cytoplasm which gives it a greyish colour. The golgi apparatus manufactures vesicles containing chemicals needed for the transfer of electric impulses. The cell body relays impulses to the axon

ii. Dendron with branches called dendrites:dendrons carry nerve impulses that their dendrites receive to the cell body.

iii The axon ending in synaptic knob(s): this carries electric impulses away from the cell body to their destination. The synaptic knobs release chemicals that bring about transfer of electrical impulses from an axon to the target cells.



Neuron

The nervous system is made of bundles of cells called neurons. Neurons are found throughout your body. They send electrical signals that direct all of your body's activities, including thinking, breathing, and moving. These signals travel along the length of one neuron and jump to another neuron over a gap called a synapse.

There are different types of neurons

i. **Based on their functions**
ii. **Based on number of axons they possess**

i. <u>Based on their functions</u>

a. Sensory (afferent) neurone: this receives impulses from receptors and passes them towards the CNS.
b. Motor (efferent) neurone: this receives impulses from the CNS and passes them to the effector.
c. Relay/ association neurone: this transfers impulses from the sensory neurones to the motor neurones.

ii. <u>Based on number of axons they possess</u>

Neurones may also be grouped according to the number of axons they possess, thus, there are

i. Unipolar (one axon)
ii. Bipolar and (two axons)
iii. Multipolar neurons (more than two)

NERVE IMPULSES

A nerve impulse is a wave of electrical activity travelling along a neurone.

Nerve impulses are transmitted along a neurone in two main ways;

i. Electrical and
ii. Ionic (chemical) means.

i. <u>Electrical Transmission</u>

When an axon is in the resting state, its inside is negatively charged and its outside is positively charged. Thus the membrane surrounding the axon is polarized. This is called its resting potential.
When an impulse passes through the axon, its inside becomes positively charged and its outside becomes negatively charged. This is the action potential and the nerve membrane becomes depolarized for a short time after which the original resting potential is restored.
Once an action potential is set up, it moves rapidly along the neurone until it reaches the end of the axon.

ii. <u>Ionic (chemical) Transmission</u>

When an axon is at rest, the membrane is polarized i.e. its outside is positively charged and the inside is negatively charged. A resting neuron actively pumps out sodium ions (Na^+) out through the cell membrane and retains chloride ions (Cl^-). As each sodium ion is pumped out a potassium ion (k^+) is pumped into the cell. The potassium ions leak out again but the sodium ions cannot move in because the sodium gates are closed. This results in the polarization of the neurone. An electric potential difference thus exists across the membrane of the neurone.

When an impulse passes along the axon, the membrane suddenly becomes depolarized and permeable to sodium ions. This reverses the resting potential i.e., the inside of the axon becomes positively chargedand the outside negatively charged, thus an action potential is set up. Small local currents on both sides of the membrane (at the leading end of the region of polarization) excite the next part of the axon, so that an action potential is propagated along the whole length of the axon.

Impulses are set up in nerve cells as a result of excitation of the receptors. Nerves are stimulated by mechanical, osmotic, chemical, thermal and electrical stimuli. If the strength of a stimulus is below certain threshold intensity no action potential is evoked. Further increase in intensity of the stimulus however does not give a larger potential. A stimulated neurone therefore acts in an all-or-none manner.

Transmission of the impulse across the synapse occurs by chemical means. When an impulse arrives at a synapse a chemical substance, acetylcholine, is released. This diffuses across the gap and causes excitation of the adjacent nerve cell.

The synapse prevents impulses from going in the wrong direction i.e. an impulse can only go in one direction across a synapse but it can go in either direction along an axon.

REFLEX AND VOLUNTARY ACTIONS
Actions are responses to stimuli. They involve the nervous and endocrine system. There are two main action patterns;
i. The Reflex action
ii. The Voluntary action.

i. <u>Reflex Action</u>

Responses to a stimulus that are not controlled by will i.e. involuntary responses are called reflex actions. We are often not aware of our reflex actions though sometimes we may become aware of them shortly after doing them. Reflex actions help to protect us against danger and also to maintain equilibrium in both our internal and external environment.
Other examples of reflex actions are;

i. blinking of the eyes.
ii. Withdrawing the hand from a hot object.
iii. The knee jerk e.t.c.

The Reflex Arc
The reflex arc is the simplest pathway taken by a nerve impulse in mediating a simple response. In the simplest form it involves only two neurones; a sensory neurone and a motor neurone. For example in the knee jerk a sensory neurone synapse directly with a motor neurone.

The structures which take part in a reflex arc are;

i. The sensory receptor that detects the stimulus.
ii. The afferent neurone along which the sensory impulse is transmitted.
iii. The relay neurone in the central nervous system which passes the impulse from the afferent neurone to the motor neurone.
iv. The motor neurone which receives the impulse from the relay neurone
v. The effector muscle or gland which responds to the motor impulse with an appropriate action.

Some reflex actions involve only the spinal cord and are known as spinal reflexes e.g. the knee jerk while others involve the brain and are called cranial reflexes e.g. contraction of the pupils when a light source approaches them.

Complex Reflex Actions
A reflex action could be complex when the actions involve neurones at different levels of the spinal cord or the brain. Complex reflexes are also fast and automatic and produce stereotyped activities like simple reflexes, but they involve ascending and descending nerve fibres within and between the spinal cord and the brain.

ii. <u>Voluntary Actions</u>

These are actions which we think about first before doing them. These actions involve the brain and are usually the acts of will. They are consciously carried out e.g. a sudden withdrawal of the foot from a sharp object is a reflex action but going back to examine the foot and extract the object is a conscious or voluntary action.

Voluntary actions therefore;

i. Involve higher centres of the brain.
ii. Involve numerous neurones.
iii. Bring about comparatively sloe responses.
iv. Bring about responses that vary with circumstances.

The brain may also initiate a voluntary action without any sensory stimulation.

THE SENSE ORGANS

A sensory system consists of sensory neurons (including the sensory receptor cells), neural pathways, and parts of the brain involved in sensory perception and intereception. Commonly recognized sensory systems are those for vision, hearing, touch, taste, smell, balance and visceral sensation. Sense organs are transducers that convert data from the outer physical world to the realm of the mind where people interpret the information, creating their perception of the world around them.

The sense organs are connected to the brain with specialised neuron cells called sensory nerve cells that help transmit the signals to the brain and help an organism perceive the senses

The sensory nervous system is a part of the nervous system responsible for processing sensory information Gautama Buddha and Aristotle classified five 'traditional' human senses which have become universally accepted: **touch, taste, smell, sight, and hearing**. Other senses that have been well-accepted in most mammals, including humans, include **nociception, equilibrioception, kinaesthesia, and thermoception**. Furthermore, some nonhuman animals have been shown to possess alternate senses, including **magnetoreception and electroreception**.

The initialization of sensation stems from the response of a specific receptor to a physical stimulus. The receptors which react to the stimulus and initiate the process of sensation are commonly characterized in four distinct categories: **chemoreceptors, photoreceptors, mechanoreceptors, and thermoreceptors.** All receptors receive distinct physical stimuli and transduce the signal into an electrical action potential. This action potential then travels along afferent neurons to specific brain regions where it is processed and interpreted.

Chemoreceptors, or chemosensors, detect certain chemical stimuli and transduce that signal into an electrical action potential. The two primary types of chemoreceptors are:

Distance chemoreceptors are integral to receiving stimuli in gases in the olfactory system through both olfactory receptor neurons and neurons in the vomeronasal organ.

Direct chemoreceptors that detect stimuli in liquids include the taste buds in the gustatory system as well as receptors in the aortic bodies which detect changes in oxygen concentration.

Photoreceptors are capable of phototransduction, a process which converts light (electromagnetic radiation) into, among other types of energy, a membrane potential. The three primary types of photoreceptors are: Cones are photoreceptors which respond significantly to color. Rods are photoreceptors which are very sensitive to the intensity of light, allowing for vision in dim lighting. The concentrations and ratio of rods to cones is strongly correlated with whether an animal is diurnal or nocturnal. In humans rods outnumber cones by approximately 20:1

Mechanoreceptors are sensory receptors which respond to mechanical forces, such as pressure or distortion.While mechanoreceptors are present in hair cells and play an integral role in the vestibular and auditory systems, the majority of mechanoreceptors are cutaneous and are grouped into four categories:

Slowly adapting type 1 receptors have small receptive fields and respond to static stimulation.Slowly adapting type 2 receptors have large receptive fields and respond to stretch. Rapidly adapting receptors have small receptive fields **Pacinian receptors** have large receptive fields and are the predominant receptors for high-frequency vibration.

Thermoreceptors are sensory receptors which respond to varying temperatures. While the mechanisms through which these receptors operate is unclear, recent discoveries have shown that mammals have at least two distinct types of thermoreceptors, the end-bulb of Krause, or bulboid corpuscle, detects temperatures above body temperature. Ruffini's end organ detects temperatures below body temperature.

Nociceptors respond to potentially damaging stimuli by sending signals to the spinal cord and brain. This process, called nociception, usually causes the perception of pain.They are found in internal organs, as well as on the surface of the body.

In cellular organisms, the sensory organs are made up of sensory cells that respond to a specific type of stimuli. These sensory receptor cells transduce the physical stimuli to nerve signals that are interpreted by the brain cells.

The Five Sense Organs and their Functions

The human sensory system has five sensory organs that help sense five elements of the physical stimulus, namely:

Sense of sight through the eyes,

Sense of taste through the tongue,

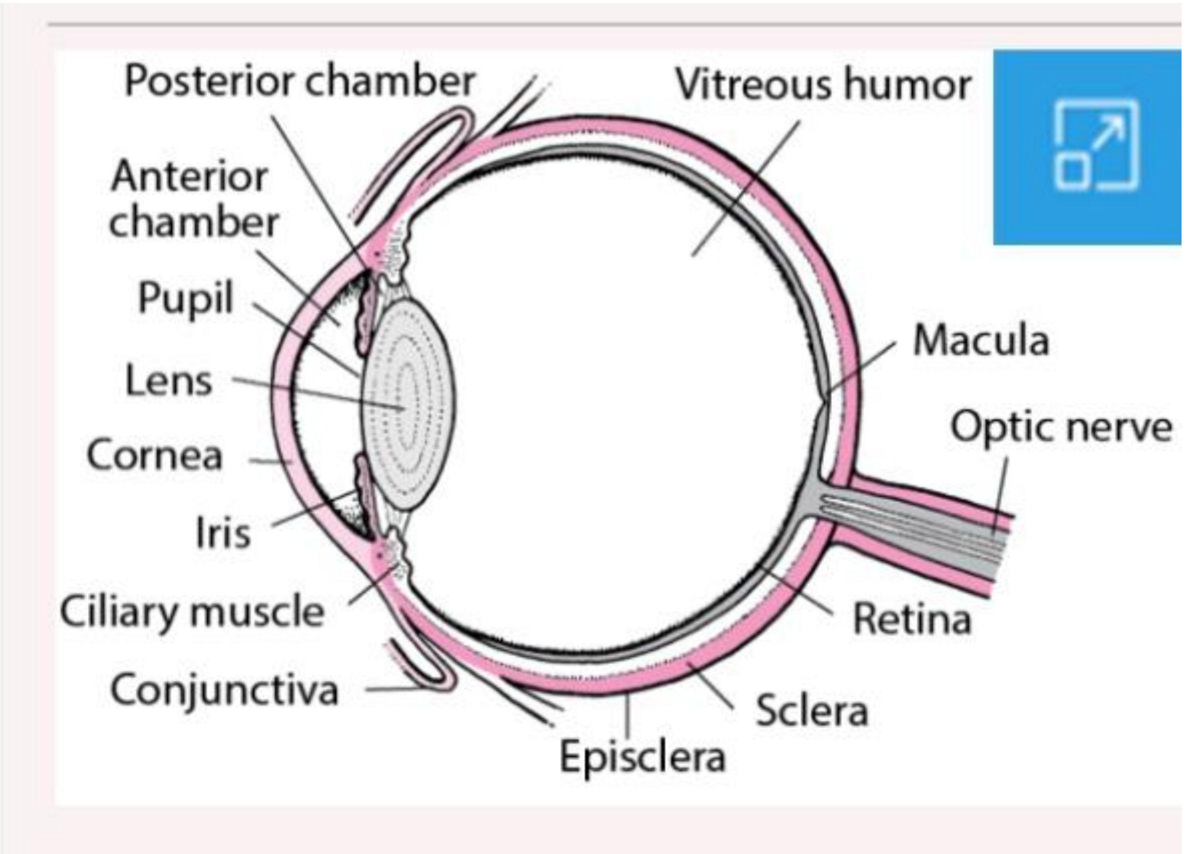
Sense of smell through the nose,

Sense of touch through the skin,

Sense of hearing through the ears.

Every sense organ receives external stimuli and sends messages to the brain via the sensory nerve. The brain responds to messages, helps sense organs reciprocate to the stimuli, and connects humans to the external environment. Let us get into the details of each sense organ and its functions.

EYES: Sense of Sight



THE DIAGRAM OF A HUMAN EYE

The sense of sight or eyes perceives things that a normal being can visualise or see. The eye can be a complex sensory organ, having 256 unique characteristics but accounting for 80% of our learning. It can capture nearly 50+ images in one millisecond.

The eye has a transparent outer layer called the cornea that bends the light. It also has a protective layer that works like a camera shutter called the iris. The light that passes through the iris goes through the small hole of the Pupil to reach the cornea. The cornea helps focus the light and allows them to pass through the lens.

The eye lenses then focus the light on the retina. The retina is the innermost layer drained by nerve cells.

They have a rod and cone-shaped cells that help translate the light into a colourful central vision. Rod-shaped cells even function in limited light zones or at night. The retina transmits the information as electrical impulses to the brain via the optic nerve.

Impairment of vision or eye functioning can cause eye conditions, including cataracts, age-associated macular degeneration, retinitis pigmentosa, glaucoma (tumours), eye infections, and diabetic retinopathy.

Care of the eye

Partial or complete loss of eyesight can be devastating, impacting everyday activities and your life. Here is what you can do to optimise your sense of sight.

Eat a healthy, nutritious diet: Eyes need a good amount of Omega-3 fatty acids, vitamin C, and vitamin E. Eat plenty of green leafy vegetables, berries, citrus fruits, nuts, seeds, and fish.

Monitor your blood pressure and blood sugar levels: Check your blood pressure and diabetes, as elevated blood pressure or sugar can affect eyesight.

Avoid straining your eyes: Do not overstrain your eyes. Have enough lighting while reading. Practice eye exercises that relax the eye muscles and strengthen them. Avoid more screen time and take more breaks while working on the computer.

Wear sunglasses for light sensitivity: The harmful UV radiations of the sun can damage the eyes. Sunglasses help protect the eyes when out in the sun.

Have an annual ophthalmological visit: Make sure to update your eye prescriptions and regularly get an eye check.

TONGUE: Sense of Taste

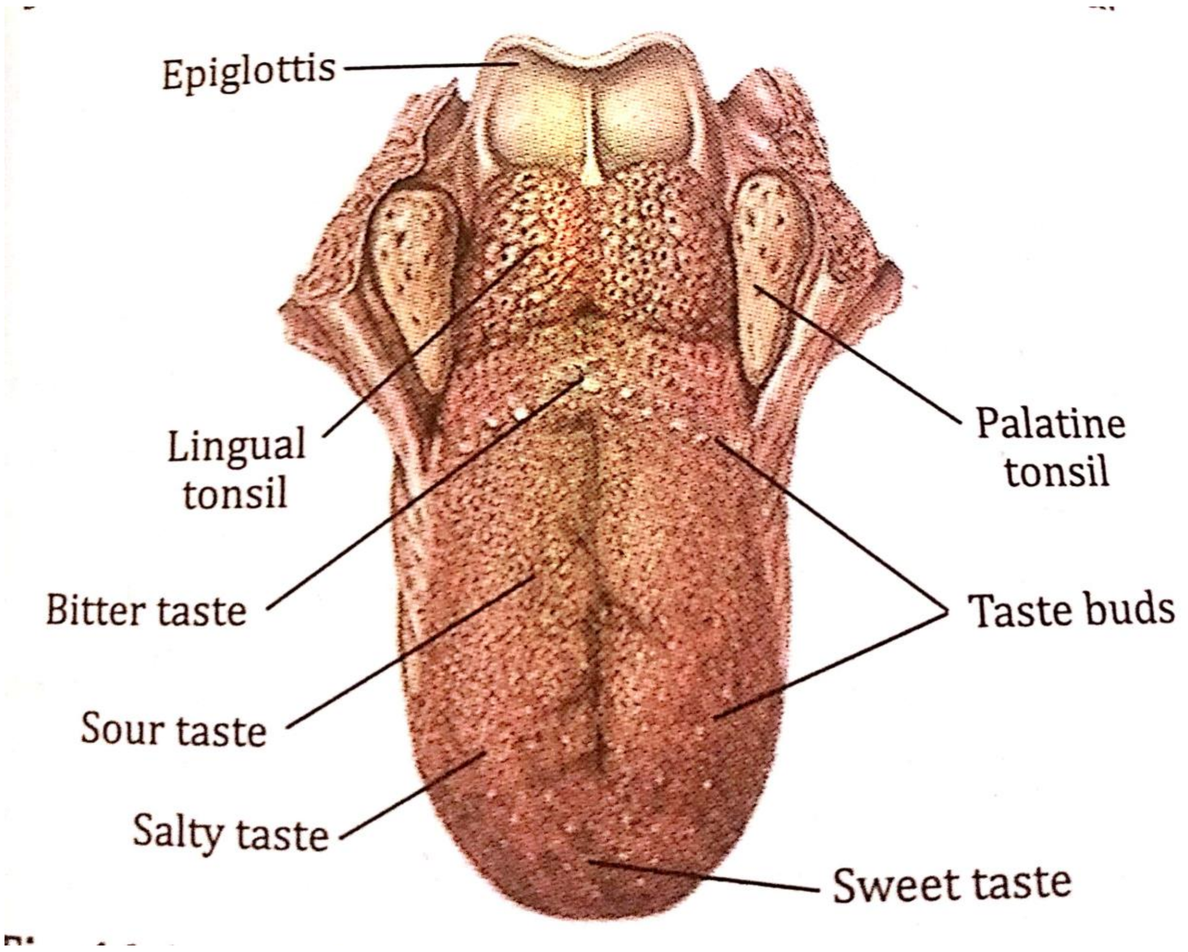


DIAGRAM OF A HUMAN TONGUE

The tongue helps taste different foods. The sense perceived by the tongue can be subdivided into five distinct tastes:

Sweet,

Bitter,

Salty,

Sour,

And Umami or savoury.

The tongue is embedded with taste buds. It is estimated that a normal adult has nearly 2,000 to 4,000 taste buds lined up on the tongue, at the back of the throat, on the epiglottis, oesophagus, and nasal cavity.

And if you are wondering, spicy is one of the tastes. Spicy is a pain signal. The sensory cells on the taste buds have pores that function like funnels. The pores have tiny taste hairs. The hair protein binds with the cells through chemicals and helps with taste.

Note that the tongue has specific zones for each flavour. All five distinct flavours can be felt or sensed by any part of the tongue. However, they differ in their level of sensitivity to taste.

The sensation of taste and smell are correlated, and the sensation of smell is also perceived by the mouth- called olfactory referral. And so, often, people with stuffy noses have problems tasting food.

Also, the food texture felt through the skin and experienced through the eyes also contributes to its overall taste.

The basal cells of the tongue detect flavour and are regenerative cells that regenerate 10% of their cells every day. And so, the tongue burnt due to hot piping foods heals quickly and does not completely die

The receptors of basal cells receive these taste stimuli and send electrical signals to the brain. The taste receptors express and function through their chemosensory properties and help perceive the sense of taste.

Though the tongue is a small sensory organ, it can develop conditions like oral thrush, ageusia (loss of taste), or hypogeusia (limited sense of taste).

NOSE: Sense of Smell

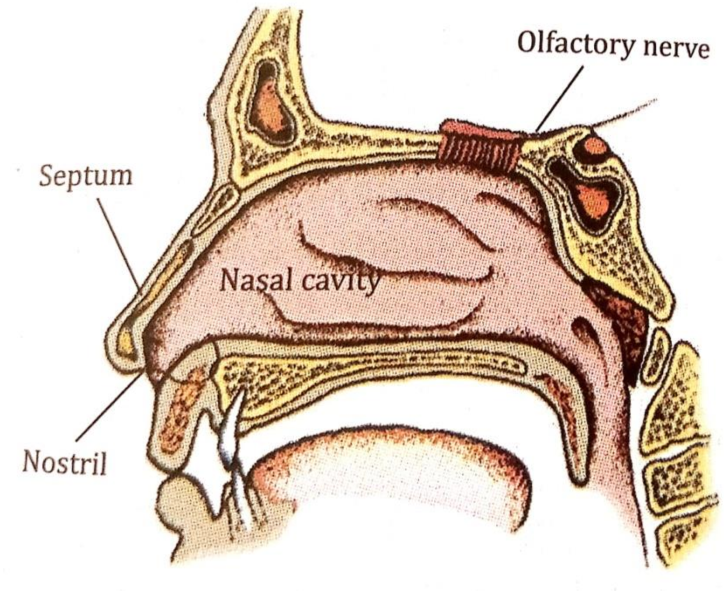


DIAGRAM ILLUSTRATING THE SENSE OF SMELL

According to Neuroscientists, humans have more than 400 smelling receptors on the floor of their nasal cavity that can help differentiate different odours just as effectively as dogs.

Decreased ability to smell or hypersomnia is a common age-related complaint, which can also be due to certain medical conditions, such as common flu, and sinusitis. Chronic conditions like schizophrenia, multiple sclerosis, brain injury, or Parkinson's can also cause loss of ability to smell or Anosmia. Did you know that humans can smell more than 1 trillion odours? The National Institutes of Health research shows how the olfactory cleft on the roof of the nasal cavity helps smell with the olfactory bulb and fossa. The olfactory cleft has nerve endings that aid in transmitting the signals to the brain.

HOW TO CATER FOR SENSES OF TASTE AND SMELL

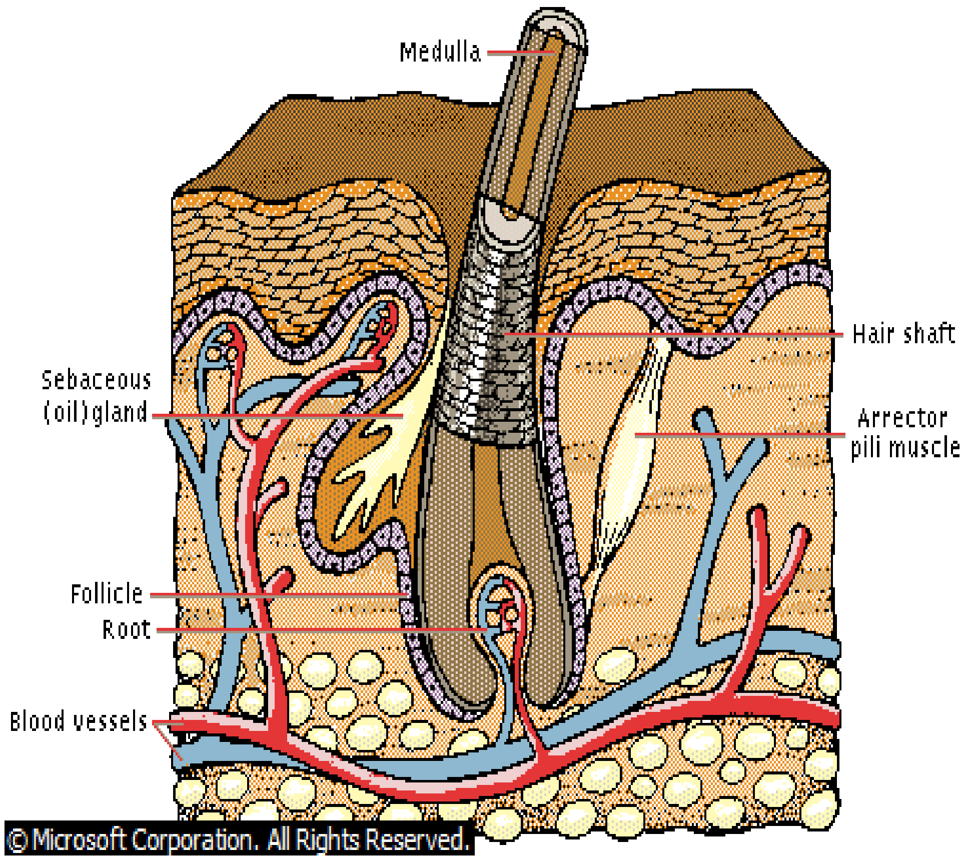
Taste and smell are interlinked. When there is a loss of smell, you tend to lose the sense of taste and vice-versa. Here are steps to protect the senses of taste and smell.

Maintain proper oral hygiene: Poor dental or oral health can often lead to issues with taste and smell. Disease or infections of the gums and teeth can affect the taste buds and the nasal cavity. And so, maintaining good oral hygiene is a must.

Limit your salt intake: Excess salt intake can destroy your taste buds. Reducing salt intake can improve your sense of taste and maintain sodium levels while improving overall health and improving blood pressure levels.

Nutrition is Vital: Avoid foods that can cause allergies, sinusitis, or tonsillitis that can affect both the sense of taste and smell. Have a healthy diet and experiment with different cuisines once in a while to enhance your taste bud activity.

SKIN: Sense of Touch



A crossection of the Human Skin

Skin is the largest sensory organ. It is the most sensitive and natural defence against many external predators. According to an article by Stanford Encyclopaedia of Philosophy, the sensation of touch through the skin is one of the first senses a human develops.

The specialised neurons of the skin transmit distinct sensations of touch- pressure, vibration, light touch, pain, tingle, texture, and temperature change to the brain.

The sensation of touch is tied to abstract concepts of compassion, pain, laughter, mood change, and even decision-making.

Ageing can affect your skin while impacting the sensation of touch, causing hypoesthesia (reduced sensitivity or loss of touch)

Care of the skin

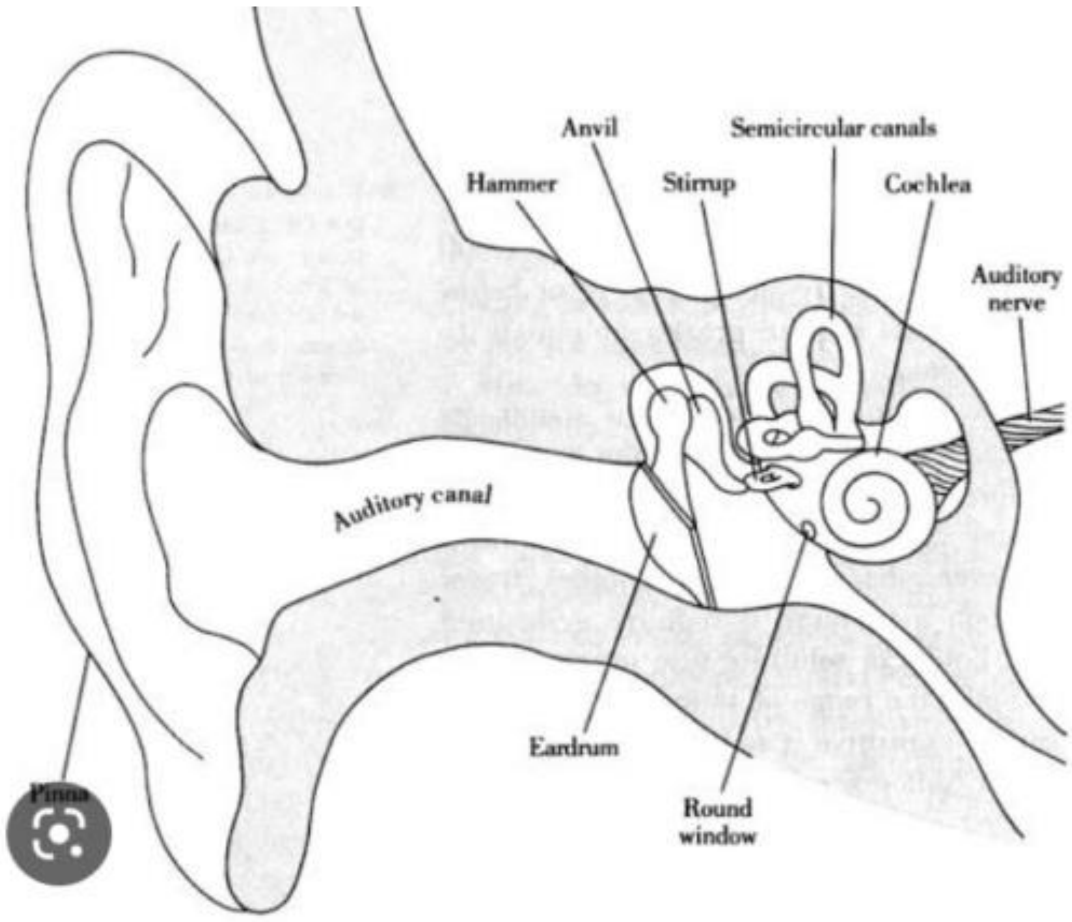
Here are some ways to take care of the skin.

Keep yourself physically active: Issues with blood circulation can cause loss of touch. Physical activities like running, walking, swimming, and exercising, can aid blood circulation.

Maintain healthy skin hygiene: Take care of your skin and skin problems by having a bath every day and using good-quality creams and lotions. Hydrate your skin with plenty of water intake. And use sunblock when venturing out in the sun.

Have a healthy diet: A well-balanced diet can fuel your nerves and brain and keep your skin healthy

EAR: Sense of hearing



A diagram of the Human ear

The ear is a spiral organ that helps us to hear. This receptor organ for hearing has three parts.

The external ear

The middle ear

The inner ear

The sound travels through the external ear and auditory canal and reaches the eardrum or tympanic membrane of the middle ear. The eardrum is a thin connective tissue sheet that vibrates as the sound waves strike it.

The sound further moves into the three bones of the middle ear, namely, the malleus (hammer), incus (anvil), and stapes (stirrup). The sound creates vibrations as they strike these tiny bones and send the vibrations to the organ of the Corti. The hair cells in the organ of Corti translate the vibrations into electrical impulses that travel to the brain via the auditory sensory nerves.

Ears also modulate the sense of balance. The middle ear equalises the air pressure to that of the external atmosphere.

Hearing loss can be due to ageing or due to any medical condition. However, statistics show that hearing loss is becoming a common concern in India, affecting around 63 million Indians, especially the elderly.

Care of the ears Here are ways to keep your ears away from hearing loss problems.

Avoid the use of any object, hard, soft or fluid on your ear.

Protect the ears from loud noises: Hearing loss damages can be irreparable. Protect your ears from loud sounds with ear plugs. Also, keep the volumes low while watching TV or listening to music.

Lessen the background sounds: Minimise the unnecessary background sounds, like switching off the television when not watching them, avoiding noisy and crowded places, etc.

Visit a specialist for any hearing problem: If . Hearing devices for specific or partial hearing loss can minimise ear strain and help in effective hearing

ANIMAL BEHAVIOUR

An animal's response to the changes in its environment is referred to as its behavior.
There are two main patterns of behavior;
i. Instinctive behavior.
ii. learned behavior.

i. **Instinctive Behaviour**

Reflexes which originate from birth are described as instinctive or innate. Examples are the sucking reflex of an infant and the pecking action of a newly-hatched chick.

ii. **Learned Behaviour**

Behaviours which are not innate/ instinctive develop through use. These are learned from experience. When a reflex action is modified by experience, it becomes a conditioned reflex.

The conditioned reflex was first demonstrated by a Russian scientist, Pavlov (1910) who noticed that a dog will salivate when food was presented to it. Pavlov changed the experience by ringing a bell just before food was presented to the dog. This was repeated several times, and then he decided to ring the bell without presenting food. He noticed that the dog salivated on hearing the bell. Thus in a conditioned reflex the stimulus and response do not have to be related, just like the bell was in no way related to the food.

Many simple reflex actions are consciously modified by manipulating conditions; the results are learned (conditioned) behaviours. With time these become almost automatic.

The learned behaviours of walking, speaking, typing, swimming, playing on an instrument and driving a car are almost automatic.

EVALUATION

1. Define the following terms (a) neuron (b) reflex action (c) behaviour (d) conditioned reflex (e) voluntary action

2. Discuss two of the terms you have defined

WEEKEND ASSIGNMENT

In a tabular form, differentiate between the reflex action and conditioned reflex.

Week 11:Revision

Week 12: Examination