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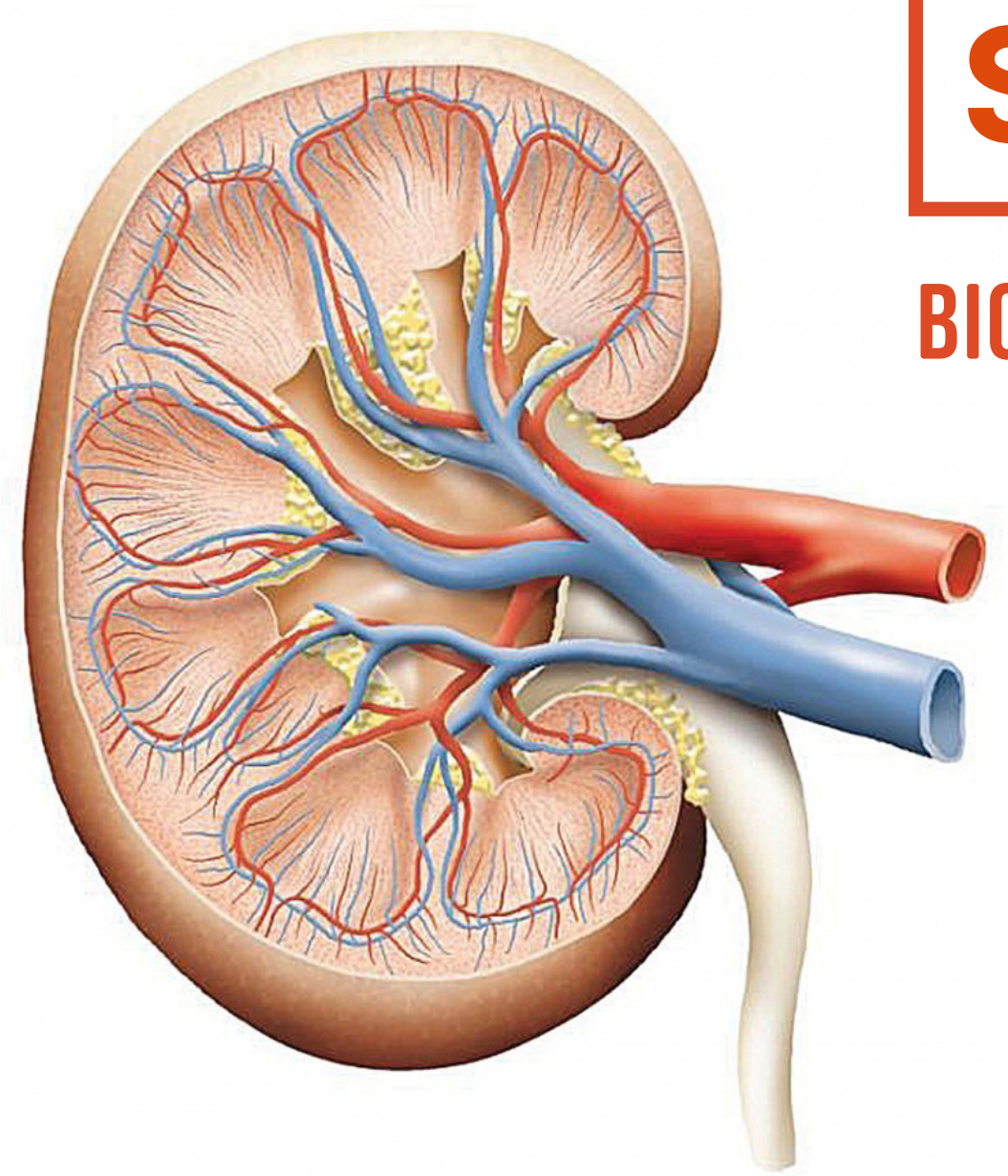
BIOLOGY



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Never Stop Learning

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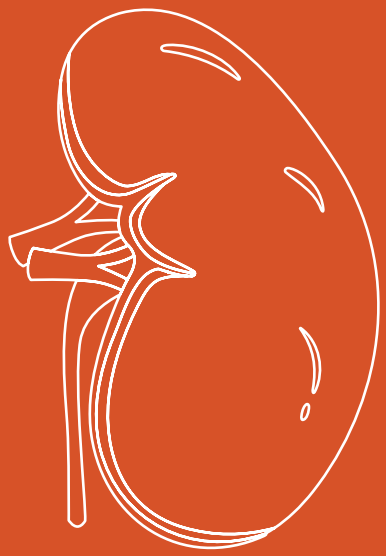


Organisms at Work

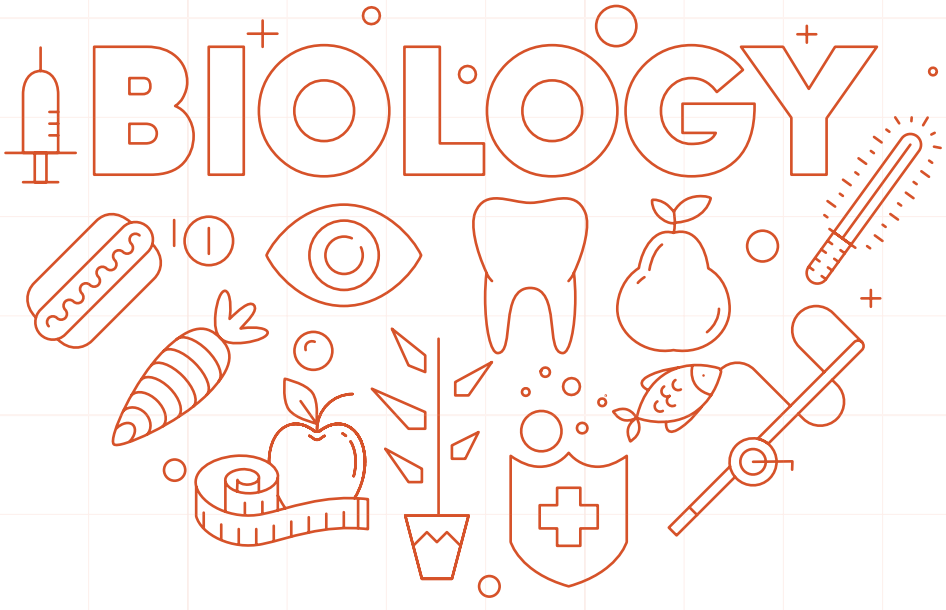
The Organism and Its Environment

Continuity of Life

REGULATION OF INTERNAL ENVIRONMENT

PERFORMANCE OBJECTIVES

1. List the main organs and substances involved in homeostasis (control mechanism).
2. Describe the structure and functions of these organs: kidney and liver.
3. Name some kidney diseases and explain their symptoms and effects.
4. Name some liver diseases and explain their symptoms and effects.
5. Discuss the remedy for unhealthy conditions of kidney and liver.
6. Explain what hormones are.
7. List some endocrine glands, their positions in the body and their functions.
8. State the effects of over-production or under-production of these hormones.
9. Identify the mammalian skin under the microscope.
10. Draw and label main structures of the skin.
11. State few ways to care for the skin.



MALEZI
EMPOWERING THOSE WHO CARE

Internal environment means the outside of the cells inside the body of an organism. Every cell of a multicellular organism must regulate its surroundings to help keep a relatively stable internal environment. The tendency to maintain a stable, relatively constant internal environment is called homeostasis. The body maintains homeostasis for many factors, for instance, the concentration of various ions in your blood must be kept steady, along with pH and the concentration of glucose. If these values get too high or low, you can end up getting very sick.

The word homeostasis is derived from Greek, with home meaning "similar," and stasis, meaning "stable." refers to any process that living things use to actively maintain fairly stable conditions necessary for survival.

Homeostasis is a property of cells, tissues, and organisms that allows the maintenance and regulation of the stability and constancy needed to function properly.

It is the ability to maintain a relatively stable internal state that persists despite changes in the world outside. All living organisms, from plants to puppies to people, must regulate their internal environment to process energy and ultimately survive.

HOMEOSTATIC ORGANS AND SUBSTANCES

Some of the more important variables that the body needs to control include temperature, levels of blood sugar, oxygen and carbon dioxide. A number of organs are involved in homeostasis, and these include the lungs, pancreas, kidneys and skin.

The lungs are involved in respiration, exchanging carbon dioxide in the bloodstream for oxygen from the air. The pancreas regulates blood-glucose levels with the release of insulin or glucagon. The hypothalamus detects how much water is present in the blood, and controls how much water the kidneys hold or excrete in urine. The skin controls body temperature in two ways. It releases sweat to cool the body when its temperature is too high, and it flattens or stands up body hairs to release heat or insulate the body, depending on what the body needs.

THE KIDNEYS

The kidneys are a pair of organs that are found on either side of the spine, just below the rib cage in the back. The paired kidneys are the excretory organs of humans which help to regulate the internal environment.

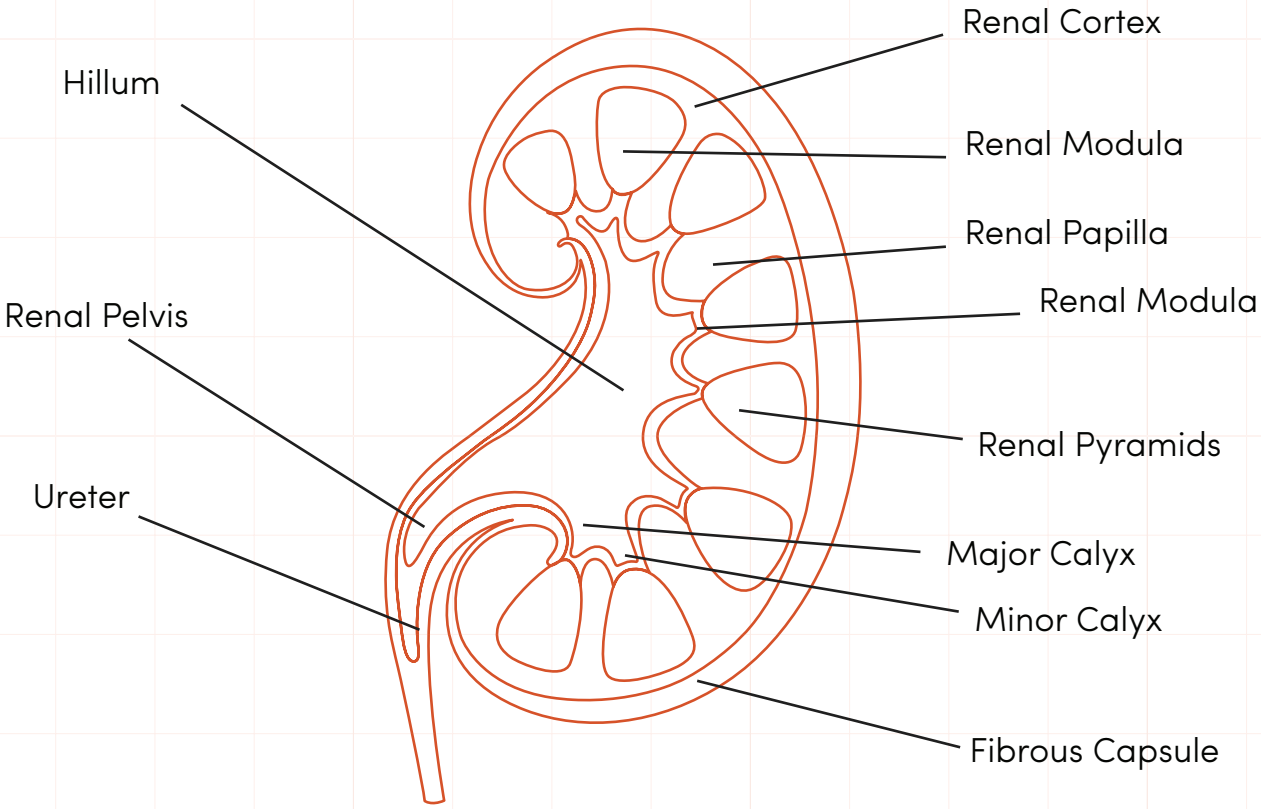


Fig. 1.1: Parts of a human kidney

FUNCTIONS OF THE KIDNEYS

1. The kidneys remove nitrogenous waste like urea and other ammonium compounds from the blood – the excretory function
2. The kidneys control the amount of water, salt (Sodium, Potassium and Chloride ions) and acids (Potassium and Hydrogen carbonate ions) – the Osmoregulatory function.

WATER BALANCE

On cold days or when much water is drunk, we excrete a large amount of dilute urine when sweat is less. On hot days, we lose water from the body through sweating and we excrete small amounts of concentrated urine. This is because the kidneys regulate the amount of water excreted in the urine in order to keep the osmotic pressure of blood constant. Increase in the osmotic pressure of blood is detected by osmoreceptors in the hypothalamus in the brain.

When there is an increase in the osmotic pressure of the blood, the osmoreceptors in the hypothalamus send nerve impulses to stimulate the release of anti-diuretic hormone (ADH) from the posterior pituitary gland. The ADH is carried by the blood to the kidneys where it causes an increase in the reabsorption of water by the tubules into the bloodstream. The urine becomes concentrated as its volume decreases, while the blood becomes diluted, and its osmotic pressure decreases. When the osmoregulators detect a normal osmotic pressure, they stop stimulating the release of ADH and less water is reabsorbed by the kidneys and the urine produced is dilute.

URINE FORMATION

1. Ultra filtration: It is the process of filtering materials from the glomerulus into the Bowman's capsule. As blood circulates through the glomerulus, ultrafiltration occurs. The blood is filtered blocking the passing of larger molecules like plasma proteins and the blood cells and allowing the small molecules such as water, urea, mineral salts, sugar to pass through the wall of capillaries and the Bowman`s capsule into the capsular space.
2. Selective reabsorption: It is the process of reabsorbing useful materials back into the blood. The filtered fluid known as glomerular filtrate passes through the Proximal convoluted tubule and the Henle`s loop and this process allows selective reabsorption to take place. Water and useful substances like sugar, amino acids and salts are reabsorbed into the surrounding blood capillaries.
3. Tubular secretion: The filtrate then moves into the distal convoluted tubule and tubular secretion occurs. Large waste molecules like creatinine and ions (hydrogen, potassium and hydrogen carbonate) if necessary are secreted into the tubules to keep the osmotic concentration of the blood constant. The fluid that eventually remains in the tubule is concentrated and is known as urine; this moves down through the ureter and collects it in the bladder. An average of 1.5 litres of urine is produced daily.

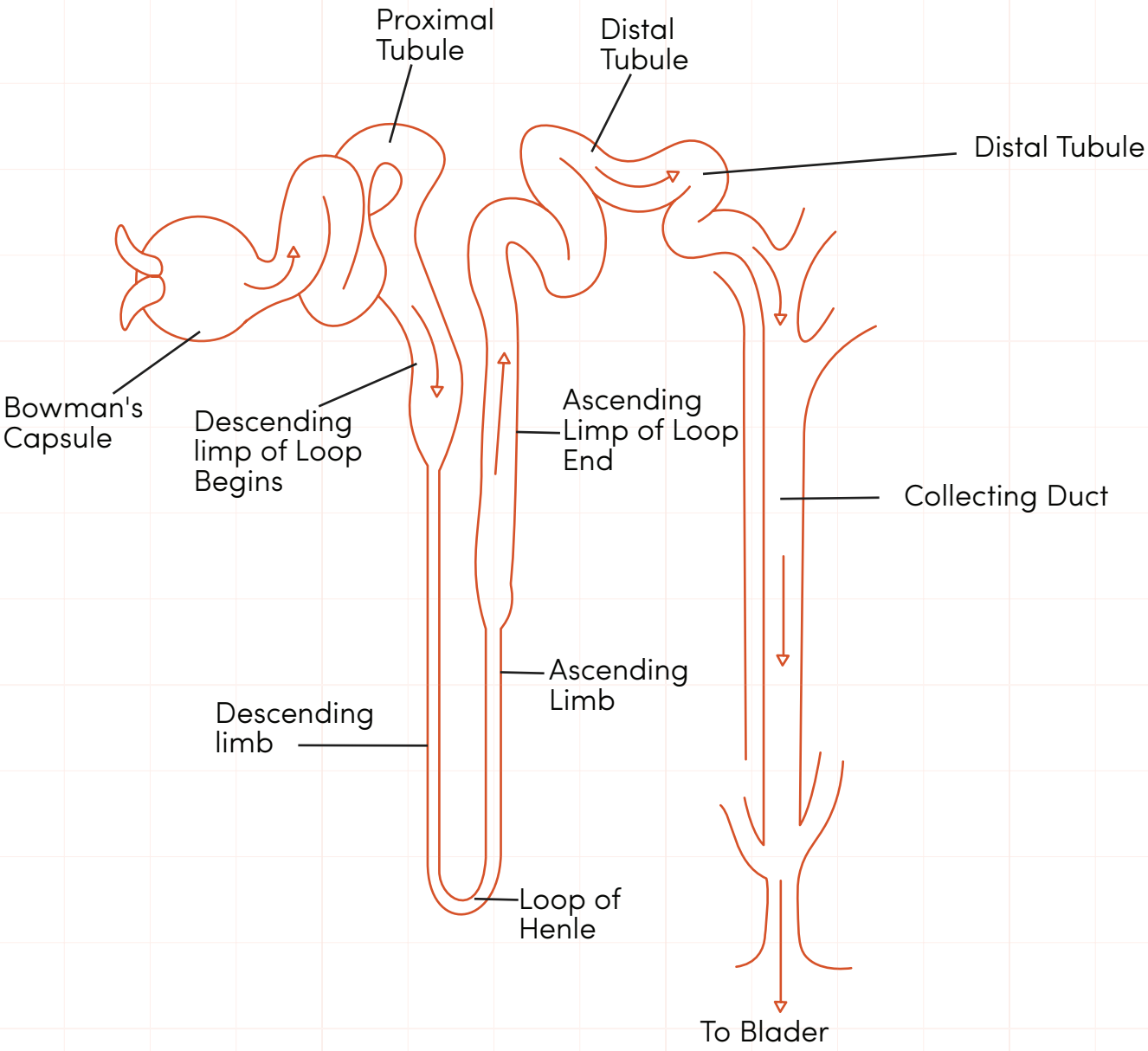


Fig. 1.2: Parts of a nephron

DISEASES OF THE KIDNEY

Diuresis: It is a condition in which the cells of the kidney tubules are not reabsorbing water from the glomerular filtrate and as a result, a large amount of water is passed out in urine

Effects of Diuresis

1. It leads to loss of weight
2. It leads to excretion of large amount of urine

Remedy

1. Drugs such as diuretics should be administered to get rid of excess water in the body.
2. Surgical operation should be performed on the patient.
3. Nephritis: It is the condition in which the blood vessel in Bowman's capsule becomes inflamed and porous as a result of which they cannot carry out the function of ultra-filtration completely.

Effects of Nephritis

1. Presence of amino acid in urine
2. Weakness of the body

Remedy

1. Use of dialysis
2. Kidney transplant
3. Use of antibiotics
4. Kidney stones: It is caused by some diseased growth within the tubules.

Effects of Kidney Stones

1. It obstructs the passage of urine.
2. Pain is experienced on passing out urine.

Remedy

1. Patients should avoid excessive intake of calcium.
2. Surgery called nephrectomy can be performed i.e. involves the opening up of the kidney over more stones.

THE LIVER

The liver is a large dark reddish-brown organ that weighs about 3 pounds, located in the upper right-hand portion of the abdominal cavity, beneath the diaphragm, and on top of the stomach, right kidney, and intestines.

There are two distinct sources that supply blood to the liver,

1. Oxygenated blood flows in from the hepatic artery
2. Nutrient-rich blood flows in from the hepatic portal vein

The liver holds about 13 percent of the body's blood supply at any given moment. The liver consists of two main lobes, both of which are made up of thousands of lobules. These lobules are connected to small ducts that connect with larger ducts to ultimately form the hepatic duct. The hepatic duct transports the bile produced by the liver cells to the gallbladder and duodenum (the first part of the small intestine). The liver can lose three-quarters of its cells before it stops functioning. In addition, the liver is the only organ in the body that can regenerate itself.

The peritoneum connects the liver in 4 locations: the coronary ligament, the left and right triangular ligaments, and the falciform ligament. These connections are not true ligaments in the anatomical sense; rather, they are condensed regions of the peritoneal membrane that support the liver.

1. The wide coronary ligament connects the central superior portion of the liver to the diaphragm.
2. Located on the lateral borders of the left and right lobes, respectively, the left and right triangular ligaments connect the superior ends of the liver to the diaphragm.
3. The falciform ligament runs inferiorly from the diaphragm across the anterior edge of the liver to its inferior border. At the inferior end of the liver, the falciform ligament forms the round ligament (ligamentum teres) of the liver and connects the liver to the umbilicus. The round ligament is a remnant of the umbilical vein that carries blood into the body during fetal development.

The liver consists of 4 distinct lobes – the left, right, caudate, and quadrate lobes.

1. The left and right lobes are the largest lobes and are separated by the falciform ligament. The right lobe is about 5 to 6 times larger than the tapered left lobe.
2. The small caudate lobe extends from the posterior side of the right lobe and wraps around the inferior vena cava.
3. The small quadrate lobe is inferior to the caudate lobe and extends from the posterior side of the right lobe and wraps around the gallbladder.

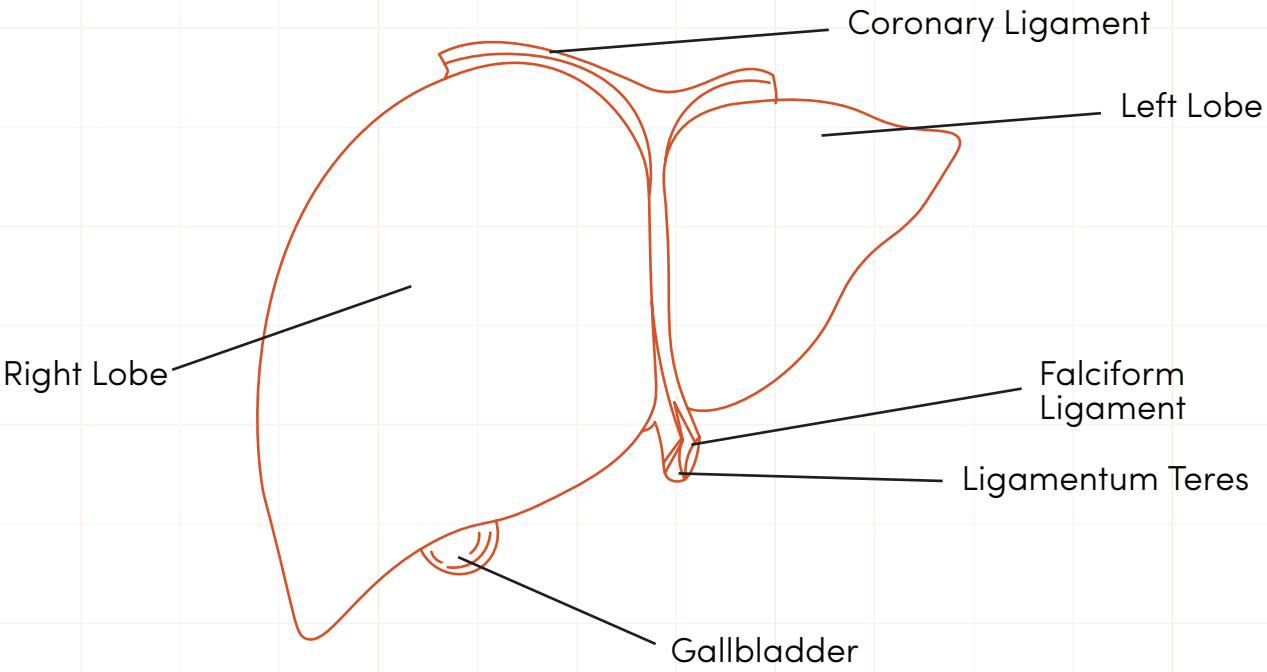


Fig. 1.3: Parts of a human liver

Functions of the Liver

The liver regulates most chemical levels in the blood and excretes a product called bile, which helps carry away waste products from the liver. All the blood leaving the stomach and intestines passes through the liver. The liver processes this blood and breaks down the nutrients and drugs into forms that are easier to use for the rest of the body. Some of the more well-known functions include the following:

1. Production of bile, which helps carry away waste and break down fats in the small intestine during digestion
2. Production of certain proteins for blood plasma
3. Production of cholesterol and special proteins to help carry fats through the body
4. Conversion of excess glucose into glycogen for storage (glycogen can later be converted back to glucose for energy)
5. Regulation of blood levels of amino acids, which form the building blocks of proteins
6. Processing of hemoglobin for use of its iron content (the liver stores iron)
7. Conversion of poisonous ammonia to urea (urea is an end product of protein metabolism and is excreted in the urine)
8. Clearing the blood of drugs and other poisonous substances
9. Regulating blood clotting

10. Resisting infections by producing immune factors and removing bacteria from the bloodstream

When the liver has broken down harmful substances, its by-products are excreted into the bile or blood. Bile by-products enter the intestine and ultimately leave the body in the form of feces. Blood by-products are filtered out by the kidneys, and leave the body in the form of urine.

Diseases of the Liver

Important diseases of the liver include the following;

- **Gall Stone:** These are stony masses that form in the gallbladder or bile duct as a result of the production of abnormal bile by the liver. Gallstone obstruct the flow of bile and causes inflammation of the gallbladder.
- **Viral Hepatitis:** There are two types of viral hepatitis. Hepatitis A and Hepatitis B. In both cases, the virus causes inflammation and destruction of the liver cells.
- **Cirrhosis:** This is a serious liver disease in which the damaged liver cells become replaced by useless fibrous tissue. Cirrhosis may be caused by excessive drinking of alcohol over a period.
- **Amoebic Liver Abscess:** The parasitic amoeba, Entamoeba histolytica, gets into the liver from the large intestine via the hepatic-portal vein, produces an enzyme that destroys liver tissues and causes an abscess to form.

Effects of Diseases of the Liver

The effects of liver diseases are due to failure of the liver cells to function properly. The most common signs and symptoms are:

i. Weakness and tiredness
ii. Jaundiced
iii. Slight fever
iv. Tendency to bleed and bruise easily
v. High blood pressure in the hepatic-portal vein in cirrhosis.
vi. Oedema
vii. Mental changes such as apathy in most liver disease.

Remedy/Treatment

The liver has a high capacity to replace damaged cells and function normally. In most cases of liver diseases, the basic treatment procedures include:

1. Rest, preferably in bed
2. A nutritious but controlled low fat diet
3. No taking of alcoholic drinks (for the rest of the patient's life in the of cirrhosis)
4. Removal of liver disorder where possible, in the case of bile duct obstruction
5. Liver transplantation.

THE SKIN

The skin is one of the hard working organs in the body. The skin is the outer covering of the body. In humans, it is the largest organ and sense organ. Skin is a thin layer of tissue forming the natural outer covering of the body of a person or an animal. It is the largest organ of the body. The skin protects us from microbes and the elements help regulate body temperature, and permits the sensations of touch, heat, and cold. The skin's color is created by special cells called melanocytes, which produce the pigment melanin. Melanocytes are located in the epidermis. The skin is made up of two main layers namely: **Dermis and Epidermis**

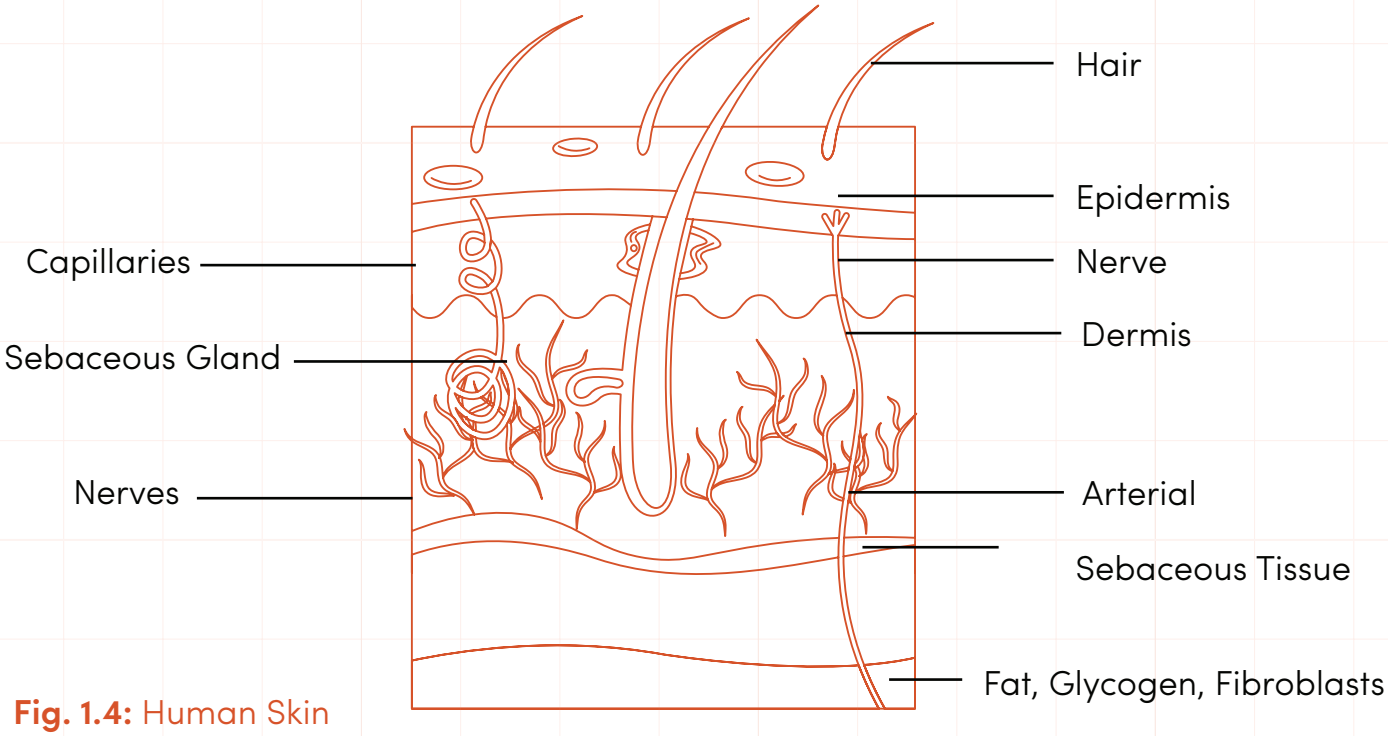


Fig. 1.4: Human Skin

1. **The Dermis:** This is the inner layer also known as the "true skin". It is directly under the outer layer. Inside the true skin, you will find other structures like the oil gland (sebaceous gland), sweat gland, sweat duct, fat deposit etc.

2. **The Epidermis:** This is the outer layer. It has no blood vessels or nerves. It is covered with hair and tiny holes called "seat pores"

Epidermis: is the outermost layer of the skin. It provides a waterproof barrier and creates our skin tone. The epidermis consists of three layers:

- **The innermost Malpighian layer**
- **The middle Granular layer, and**
- **The outermost (surface) Cornified layer.**

Malpighian layer: Also known as germinative layer. It consists of actively dividing cuboidal cells. They contain melanin, a pigment that gives the skin its colour and absorbs ultraviolet radiation. The cells of this layer get their nutrients and supply of oxygen by diffusion from the blood of the capillaries found in the dermis.

Granular Layer: This consists of living cells produced by the Malpighian (germinative) layer beneath. These cells are continuously converted to cornified cells. Keratin is deposited inside them, and they lose their nuclei and become flattened in shape.

Cornified Layer: This consists of scale-like dead cells impregnated with keratin. The keratin makes this layer tough, flexible and waterproof. They are constantly wearing away and are replaced from the granular layer beneath.

Dermis: This is beneath the epidermis. It is a layer of connective tissue containing blood capillaries, hair follicles, sweat glands, sebaceous gland, sensory nerve ending and fat cells.

Blood capillaries: This supplies food and oxygen to the dermal and epidermal cells and removes wastes. The capillary loops close to the body surface help to regulate the body temperature.

Hair Follicles: This is a deep pit formed by the in-folding of the Malpighian layer. Each hair is a cylinder composed of dead cells; they grow as new cells at the 'root'. A hair erector muscle is attached to each follicle. Its contraction pulls the hair to a more upright position, i.e. it makes the hair 'stand up'.

Sebaceous gland: Secretes sebum which repels water (waterproof) and also prevents microbes from multiplying.

Sweat gland: Absorbs fluid from the surrounding tissues and capillaries. This fluid is then passed out as sweat through the sweat duct. Sweat is 99% water, 0.3% salt, and minute amounts of urea and lactic acid.

Sensory nerve ending: The skin is also a sense organ. Various nerve endings, capable of responding to touch, heat, cold and pressure.

Subcutaneous fat: It is found beneath the dermis. It acts as a food reserve and an insulating layer, to prevent heat loss.

Functions of the skin

1. It keeps the body warm in cold weather
2. It helps the body to get rid of waste products through sweating
3. It protects the body against dehydration, invading microbes, mechanical damage and damage due to ultraviolet rays and poisonous chemicals.
4. It contains receptors sensitive to heat, cold, touch and pressure.
5. It plays a major role in temperature control (vasodilation and vasoconstriction).
6. It has a minor role as an excretory organ. Urea and lactic acid are lost.
7. The skin produces vitamin D in the fatty cells by using infra-red rays of the sun
8. It helps to keep the body temperature normal by producing sweat during hot weather
9. It protects the body from bacterial infections (germs) poor weather and injury
10. When the sun shines on the skin, vitamin D is produced by the skin
11. Sensation: contains a variety of nerve endings that react to heat and cold, touch, pressure, vibration, and tissue injury.
12. Heat regulation: the skin contains a blood supply far greater than its requirements which allows precise control of energy loss by radiation, convection and conduction. Dilated blood vessels increase perfusion and heat loss, while constricted vessels greatly reduce cutaneous blood flow and conserve heat.
13. Control of evaporation: The skin provides a relatively dry and semi-impermeable barrier to fluid loss. Loss of this function contributes to the massive fluid loss in burns.

14. Storage and synthesis: Acts as a storage center for lipids and water, as well as a means of synthesis of vitamin D.
15. Excretion: Sweat contains urea, however its concentration is 1/130th that of urine, hence excretion by sweating is at most a secondary function to temperature regulation.
16. Water resistance: The skin acts as a water resistant barrier so essential nutrients aren't washed out of the body.

Control of the body temperature

Under normal conditions, the heat the body gains is balanced by the heat it loses. The balance, however, can be upset by hot weather, vigorous exercise, high fever or exposure to solar radiation. The balance is restored by the actions of the hypothalamus and the skin.

- A rise in body temperature stimulates the following processes to get rid of excess body heat:

1. **Vasodilation:** The arteriole in the skin (swell) increases the flow of blood through the skin. This leads to increased loss of heat through the dermis by convection and radiation.
2. **Sweating:** The sweat glands become active and produce large amounts of sweat that flow out onto the surface of the skin. As this sweat evaporates, heat from the body is used up, thus cooling the body. A fall in body temperature stimulates the following processes to produce and conserve heat:
3. **Vasoconstriction:** The arterioles are narrowed, thereby reducing the flow of blood to the skin and so minimizing heat loss.
4. **Sweating:** The sweat glands become inactive and produce very little sweat that flows out to the skin surface, thereby conserving body heat.

Care of the skin

It is necessary to keep the skin clean by having regular baths. In order to care for the skin, it is important to:

1. Wash your whole body daily more than once during hot, dry and dusty season
2. Have a shower after serious exercise or games to avoid body odor
3. Keep your towel, under wears and other clothes clean
4. Use good toilet soap and sponge
5. Take abundant fresh air
6. Do not use bleaching cream
7. Eat a balanced diet that is rich in milk, proteins, fruits, cod-liver oil, vegetables etc.

HORMONES

Sensitivity is an important characteristic of all living things. It is the ability to respond to external and internal stimuli. To do this, the different organs, systems in a complex organism have to work together. In animals, the coordination work is done by two communication networks: the hormones and the nervous system.

Many glands in the mammalian body produce secretions. Some glands like salivary glands, deliver their secretions to wherever they are needed via ducts. These are known as exocrine glands. Other secretory glands do not have ducts, their secretions diffuse directly into the bloodstream and are transported to wherever they are needed. These glands are known as endocrine glands and their secretions are the hormones.

Endocrine glands are tissues or organs that secrete chemical substances (hormones) directly into the blood. Common endocrine glands are the hypothalamus, pineal, and adrenal glands. Hormones are chemical messengers that are secreted directly into the blood, which carries them to organs and tissues of the body to exert their functions. Hormones can have a wide range of effects on the body. They can cause mood swings, regulate the metabolism, control the reproductive cycle, induce hunger and cravings, stimulate or inhibit growth and prepare the body for changes such as puberty, childbirth or menopause.

ENDOCRINE GLAND, HORMONES AND THEIR FUNCTIONS

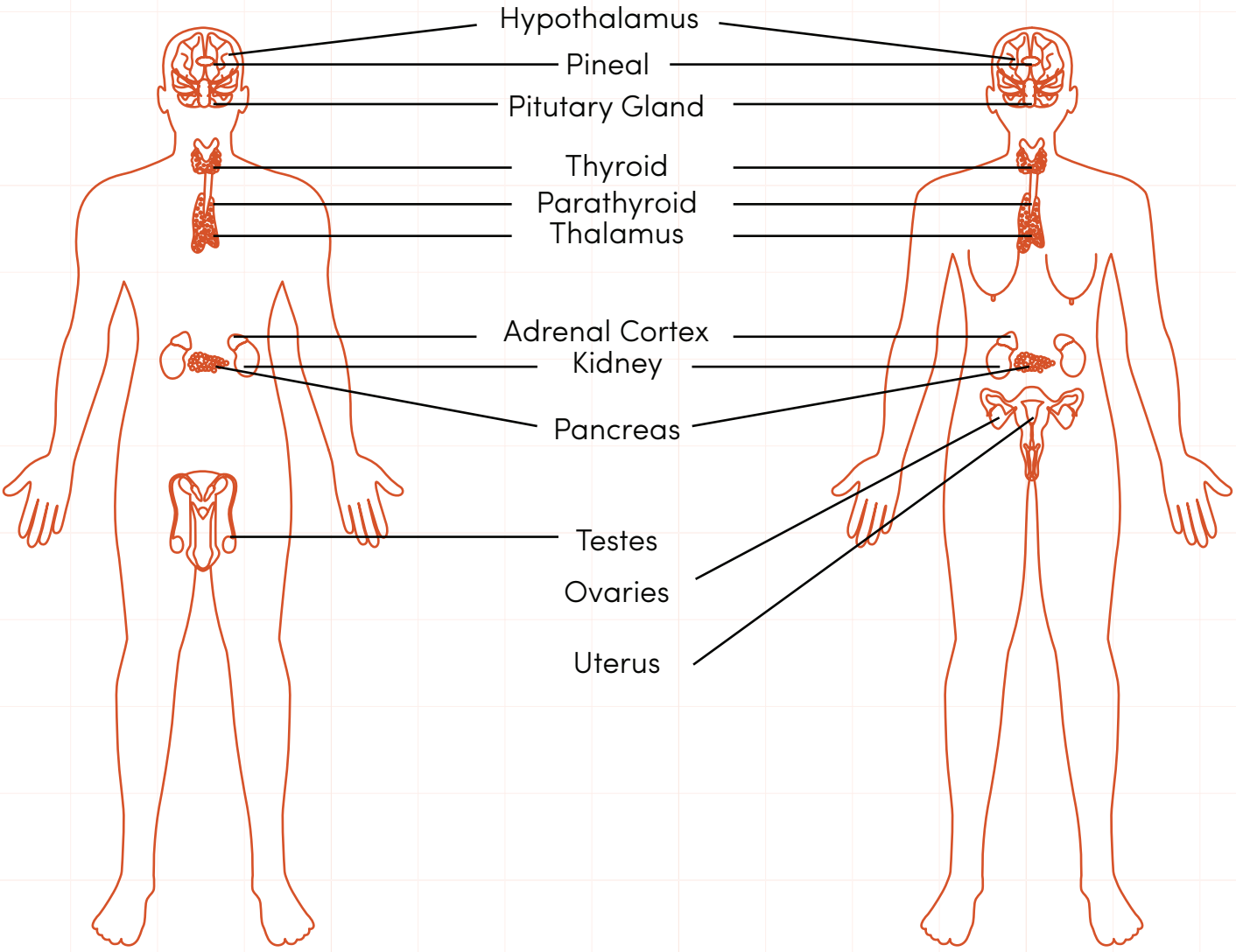


Fig. 1.5: Parts of an endocrine system

Hypothalamus

The hypothalamus is a part of the brain. It serves many different functions in the nervous system, and is also responsible for the direct control of the endocrine system through the pituitary gland.

Pituitary Gland

The pituitary gland, also known as the hypophysis, is a small pea-sized lump of tissue connected to the inferior portion of the hypothalamus of the brain. It is also called "master gland" because its secretion controls other glands. The pituitary gland is actually made of 2 completely separate structures: the posterior and anterior pituitary glands.

Posterior Pituitary: is a small extension of the hypothalamus. The hypothalamus produced 2 hormones that are stored and released by the posterior pituitary:

1. Oxytocin triggers uterine contractions during childbirth and the release of milk during breastfeeding.
2. Antidiuretic hormone (ADH) prevents water loss in the body by increasing the re-uptake of water in the kidneys and reducing blood flow to sweat glands.

Anterior Pituitary: The anterior pituitary gland is the true glandular part of the pituitary gland. The function of the anterior pituitary gland is controlled by the releasing and inhibiting hormones of the hypothalamus. The anterior pituitary produces 6 important hormones:

1. Thyroid stimulating hormone (TSH), as its name suggests, is a tropic hormone responsible for the stimulation of the thyroid gland.
2. Adrenocorticotropic hormone (ACTH) stimulates the adrenal cortex, the outer part of the adrenal gland, to produce its hormones.
3. Follicle stimulating hormone (FSH) stimulates the follicle cells of the gonads to produce gametes—ova in females and sperm in males.
4. Luteinizing hormone (LH) stimulates the gonads to produce the sex hormones—estrogens in females and testosterone in males.
5. Growth hormone (GH) also known as pituitrin affects many target cells throughout
6. Prolactin (PRL) has many effects on the body, chief of which is that it stimulates the mammary glands of the breast to produce milk.
7. Oxytocin stimulates both the release of milk from nipples and contraction of the uterus during birth.

Pineal Gland

The pineal gland is found posterior to the thalamus of the brain. The pineal gland produces the hormone melatonin that helps to regulate the human sleep-wake cycle known as the circadian rhythm.

Thyroid Gland

The thyroid gland is located at the base of the neck. The thyroid gland produces 3 major hormones: Calcitonin, Triiodothyronine (T3) and Thyroxine (T4).

Calcitonin is released when calcium ion levels in the blood rise above a certain set point. Calcitonin functions to reduce the concentration of calcium ions in the blood by aiding the absorption of calcium into the matrix of bones. The hormones T3 and T4 work together to regulate the body's metabolic rate. Lack of thyroxine in little children causes mental retardation and cretinism or dwarfism. But lack of thyroxine after maturity causes myxoedema (the person becomes physically and mentally sluggish and obese) and it can be treated effectively with thyroxine supplements.

Parathyroid Glands

The parathyroid glands are 4 small masses of glandular tissue found on the posterior side of the thyroid gland. The parathyroid glands produce the hormone parathyroid hormone (PTH), which is involved in the control of calcium content of the bone. PTH is released from the parathyroid glands when calcium ion levels in the blood drop below a set point. PTH stimulates the osteoclasts to break down the calcium containing bone matrix to release free calcium ions into the bloodstream. PTH also triggers the kidneys to return calcium ions filtered out of the blood back to the bloodstream so that it is conserved.

Adrenal Glands

The adrenal glands are a pair of roughly triangular glands found immediately superior to the kidneys. The adrenal glands are each made of 2 distinct layers, each with their own unique functions: the outer adrenal cortex and inner adrenal medulla.

Adrenal cortex: The adrenal cortex produces many cortical hormones in 2 classes: glucocorticoids and mineralocorticoids

1. Glucocorticoids have many diverse functions, including the breakdown of proteins and lipids to produce glucose. Glucocorticoids also function to reduce inflammation and immune response.
2. Mineralocorticoids, as their name suggests, are a group of hormones that help to regulate the concentration of mineral ions in the body. The most important of these hormones is aldosterone which increases the reabsorption of sodium ions by the kidney tubules.

Adrenal medulla: The adrenal medulla produces the hormones Adrenaline (epinephrine) and noradrenaline (norepinephrine) which are the emergency hormones. Both of these hormones help to increase the flow of blood to the brain and muscles to improve the "fight-or-flight" response to stress. These hormones also work to increase heart rate, breathing rate, and blood pressure while decreasing the flow of blood to organs that are not involved in responding to emergencies.

PANCREAS

Pancreas is a large gland located in the abdominal cavity just inferior and posterior to the stomach. Within these pancreas are 2 types of cells—alpha and beta cells.

The alpha cells produce the hormone glucagon, which is responsible for raising blood glucose levels. Glucagon triggers muscle and liver cells to break down the polysaccharide glycogen to release glucose into the bloodstream. The beta cells produce the hormone insulin, which is responsible for lowering blood glucose levels after a meal. Insulin triggers the absorption of glucose from the blood into cells, where it is added to glycogen molecules for storage.

Gonads

The gonads—ovaries in females and testes in males—are responsible for producing the sex hormones of the body. These sex hormones determine the secondary sex characteristics of adult females and adult males.

1. Testes: The testes are organs found in the scrotum of males that produce the testosterone in males after the start of puberty. During puberty, testosterone controls the growth and development of the sex organs and body hair of males, including

pubic, chest, and facial hair.

2. Ovaries: The ovaries are located in the pelvic body cavity in females. The ovaries produce the female sex hormones progesterone and estrogens. Progesterone is most active in females during ovulation and pregnancy where it maintains appropriate conditions in the human body to support a developing fetus. Estrogens are a group of related hormones that function as the primary female sex hormones. The release of estrogen during puberty triggers the development of female secondary sex characteristics such as uterine development, breast development, and the growth of pubic hair.

Thymus: produces hormones called thymosins that help to train and develop T-lymphocytes during fetal development and childhood. The T-lymphocytes produced in the thymus go on to protect the body from pathogens throughout a person's entire life.

The table below shows effects of under and over-production of some hormones.

Endocrine Disorders

Result from hormone excess or deficiency or decreased peripheral responsiveness

- Underproduction
  - Autoimmune destruction
  - Tumor
  - Infections
  - Hemorrhage
  - Dietary
- Defects in hormone system
- Increased hormone removal from the blood and execration

- Overproduction typically result from:
  - Tumor
  - Hyperplasia
  - Autoimmune simulation
- Reduced binding to plasma proteins
- Decreased removal from the blood

- Defects in sensitivity from resistance to hommone or with the occurence of hormanal therapy

PLANT HORMONES AND THEIR FUNCTIONS:

Auxin: It promotes cell elongation e.g. tropic responses of plants. It stimulates cell division, e.g. root and fruit development. It also causes apical dominance and inhibits abscission.

Gibberellins: It promotes cell elongation, e.g. stem growth. It induces dormant seeds to germinate.

Cytokinins: It promotes cell division, e.g. stem, root and axillary bud growth. It inhibits ageing in leaves.

Abscisic acid: are growth inhibitors and induces dormancy, ageing and abscission e.g. suppresses growth of buds. It also controls opening and closing of stomata.

Ethylene: is a gas produced by ripe fruits. Why does one bad apple spoil the whole bunch? Ethylene is used to ripen crops at the same time. Sprayed on a field it will cause all fruits to ripen at the same time so they can be harvested.

Uses of Auxins in Agriculture

1. **Apical Dominance:** The auxins greatly influence the development of plant form and structure. It has long been known that while the main shoot of a plant is growing, its lateral buds are inhibited. If, however, the bud at the apex is cut off, the lateral buds begin to develop. It has been postulated that an inhibiting substance diffuses from the growing bud to the tissue below it.
2. **Meristematic Activity:** Auxin produced in the apical bud stimulates and regulates the activity of the cambium in woody plants. It seems probable that the resumption of cambial growth in the spring is due to auxin produced by the buds in this season. Cambial growth may also be induced by the artificial application of auxin.
3. **Rooting:** Propagation of plants by vegetative means is quite commonly practiced in horticulture. Several experiments performed on a great variety of plants showed that auxin applications are generally beneficial in bringing about the rooting of cuttings.

   The most widely used of the synthetic auxins for this purpose is Indole butyric acid (IBA). It is used either alone or in combination with other auxins such as Naphthalene acetic acid (NAA).

4. **Parthenocarpic or Seedless Fruits:** Another property of auxins that has grown to economic importance is their ability, when applied to the flowers of certain species, to initiate development of fruit without pollination. Fruits so induced are usually seedless; so besides increasing yields, auxin treatments may make possible the development of new seedless varieties. Naphthalene acetic acid (NAA) and Naphthoxyacetic acid (NOXA) have been successfully used in many plants to induce parthenocarpy.
5. **Prevention of Premature Fall of Fruits:** Large amounts of auxins can be used for the prevention of premature fall of fruits.
6. **Prevention of Sprouting of Potatoes:** Still another commercial application of auxins takes advantage of their growth inhibiting ability. The methyl ester of Naphthaleneacetic acid prevents the sprouting of potatoes in storage; thus the tubers will keep longer, even at warm temperatures.
7. **Weed Killing:** 2, 4-D (2, 4-Dichlorophenoxyacetic acid) has received wide acclaim as a weed-killer, for when sprayed on plants it kills the broadleaved dicotyledons, while sparing the grasses.
8. **Control of Lodging:** In some plants when the crop is ripe and there is heavy rain accompanied by strong winds, the plants bend as a result of which the ear (inflorescence) gets submerged in water and decays. If a dilute solution of any auxin is sprayed upon young plants, the possibility of bending of plants is reduced as the stem becomes stronger by the application of auxins.
9. **Differentiation of Xylem and Phloem:** Experiments with intact plants and also of tissue culture have shown that differentiation of xylem and phloem is under the control of auxins.
10. **Sex Expression:** The spray of auxins increases the number of female flowers in cucurbits. In maize, application of NAA (Naphthalene Acetic Acid) during the period of inflorescence differentiation can induce formation of hermaphrodite or female flowers in a male inflorescence. Thus auxins induce femaleness in plants.
11. Auxins' accumulation in the base of the plant induces growth of adventitious roots, forming a new root system capable of replacing the damaged ones.

SUMMARY

So far, we have learnt how to

1. List the main organs and substances involved in homeostasis (control mechanism).
2. Describe the structure and functions of these organs: kidney and liver.
3. Name some kidney diseases and explain their symptoms and effects.
4. Name some liver diseases and explain their symptoms and effects.
5. Discuss the remedy for unhealthy conditions of kidney and liver.
6. Explain what hormones are.
7. List some endocrine glands, their positions in the body and their functions.
8. State the effects of over-production or under-production of these hormones.
9. Identify the mammalian skin under the microscope.
10. Draw and label main structures of the skin.
11. State few ways to care for the skin.

INTERACTIVE ASSESSMENT QUESTIONS

1. _____ are growth inhibitors and induces dormancy, ageing and abscission

A Auxin
B Gibberellin
C Cytokinin
D Abscisic Acid

2. _____ stimulates both the release of milk from nipples and contraction of uterus during birth

A Oxytocin
B Prolactin
C Lactate
D Luteinizing hormone

3. Antidiuretic hormone (ADH) prevents _____ loss in the body by increasing the re-uptake of water in the kidneys and reducing blood flow to sweat glands.

A Thyroid
B Adrenal
C Pituitary
D Hypothalamus

4. The three processes involved in the formation of urine are: Tubular secretion, Ultrafiltration and selective reabsorption. Arrange the processes accordingly.

A Tubular secretion, Ultrafiltration, selective reabsorption
B Selective reabsorption, Tubular secretion, Ultrafiltration
C Ultrafiltration, Tubular secretion, selective reabsorption
D Ultrafiltration, selective reabsorption, Tubular secretion

5. What does ADH stand for?

A Anti-diluted hormone
B Antidiuretic hormone
C Anti-diagnoses hormone
D Anti-disease human

6. Where is ADH produced?

A The kidneys
B The liver
C The hypothalamus
D The pituitary gland

7. These are kidney diseases except

A Cirrhosis
B Oedema
C Diuresis
D Nephritis

8. The bile is secreted by_____

A Lungs
B Pancreas
C Stomach
D Liver

9. The functions of the liver include

A Destroying old red blood cells
B Production of fibrinogen
C Deamination
D All of the above

10. The removal of amino groups from amino acids is called _____

A Assimilation
B Emulsification
C Ingestion
D Deamination

11. Jaundice affects the liver. True or False

A True
B False

12. Which hormone is released from the posterior lobe of the pituitary gland?

A ADH and GH
B ACTH and TSH
C ADH and Oxytocin
D TRH and CRH

13. _____ hormone controls the rate of metabolism in the body.

A Thyroxine
B Adrenaline
C Renin
D Estrogen

14. _____ is the master gland of the endocrine system

A Pineal
B Pituitary
C Thyroid
D Thymus

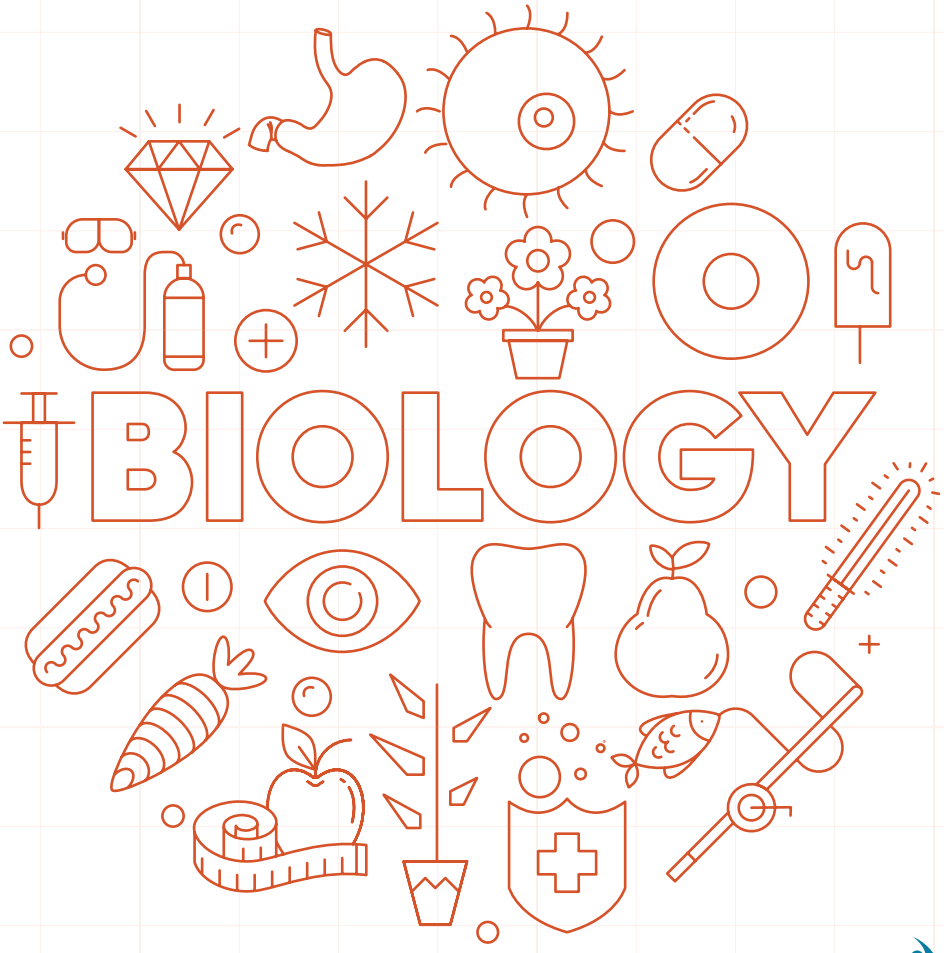
15. Which plant hormone ripens fruit?

A Ethylene
B Auxin
C Gibberelin
D Cytokinin

NERVOUS COORDINATION

PERFORMANCE OBJECTIVES

1. Locate the position of the CNS in a dissected vertebrate.
2. Describe the structure of the brain and explain the functions of its various organs.
3. Describe the spinal cord and explain its function.
4. State the structural difference between the brain and spinal cord.
5. Identify the PNS and describe its function.
6. Describe typical neurone.
7. Group neurones according to functions as found in vertebrates
8. Explain the process of impulse transmission.
9. Distinguish between a reflex action and a conditioned reflex action giving a few example of each.



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NERVOUS CO-ORDINATION

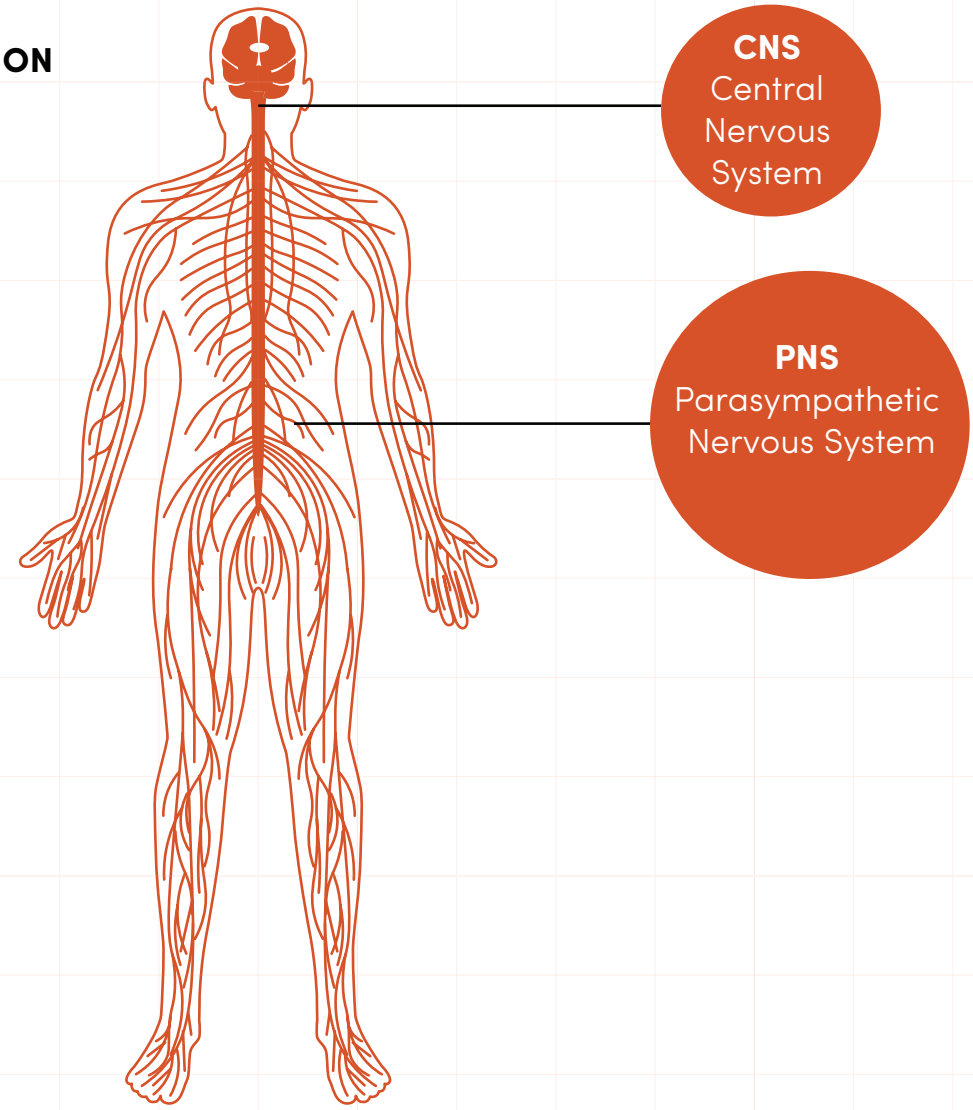


Fig. 1.6: The human nervous System coordination

The behavior of an animal in its environment to maintain itself depends on the coordination of its organ systems. Without co-ordination of various organ systems, various physiological processes would work in a haphazard way, without linking together activities. The linking together in time and space of various activities of an animal is called co-ordination. Co-ordination is brought about by the nervous system and sense organs, and by means of chemical substances (hormones) secreted by the endocrine glands.

The most fundamental functions of a nervous system are:

1. to receive a stimulus
2. transmission of a stimulus to a central "brain"
3. interpretation and analysis of the stimulus
4. proper response by an effector.

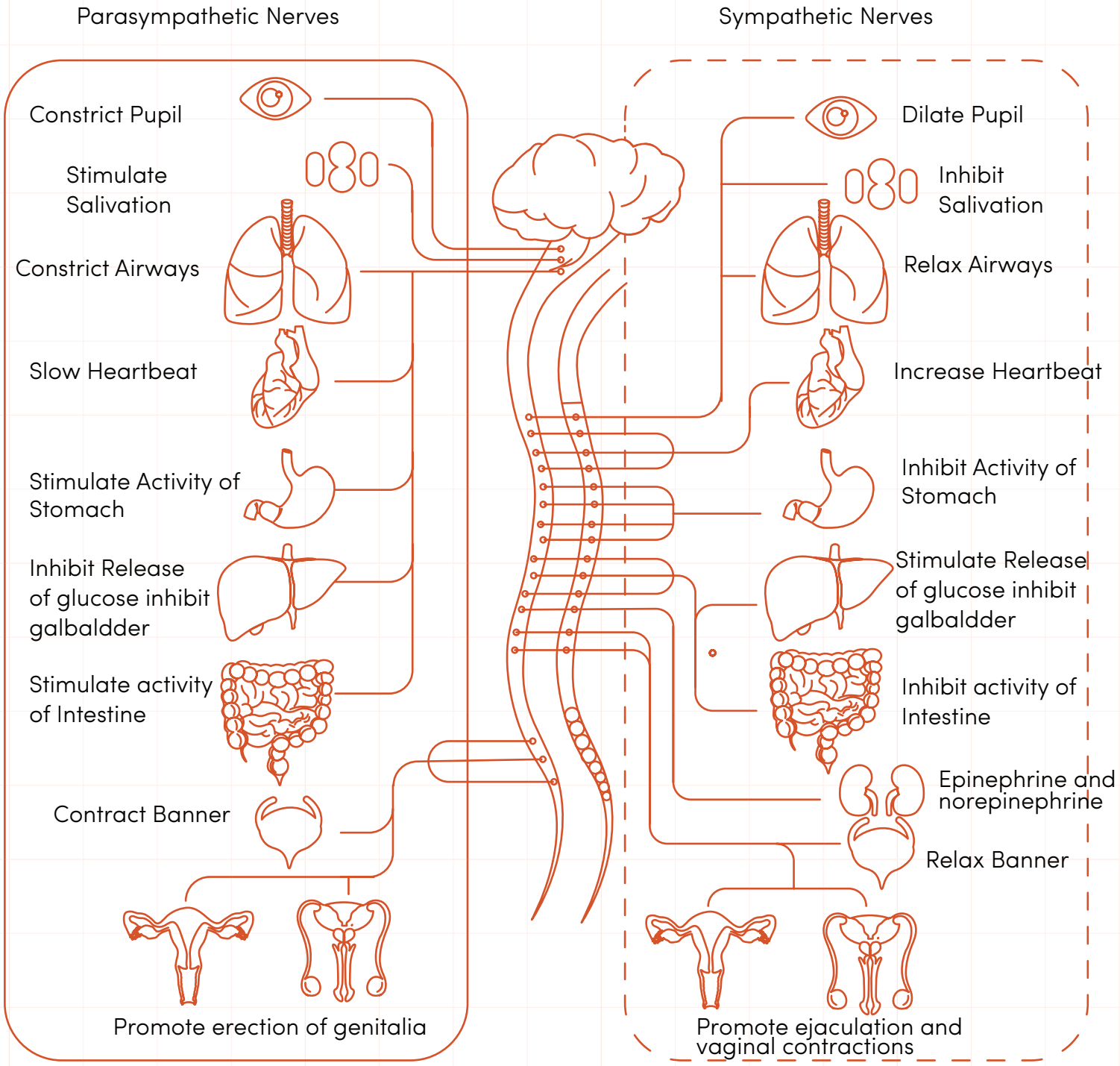


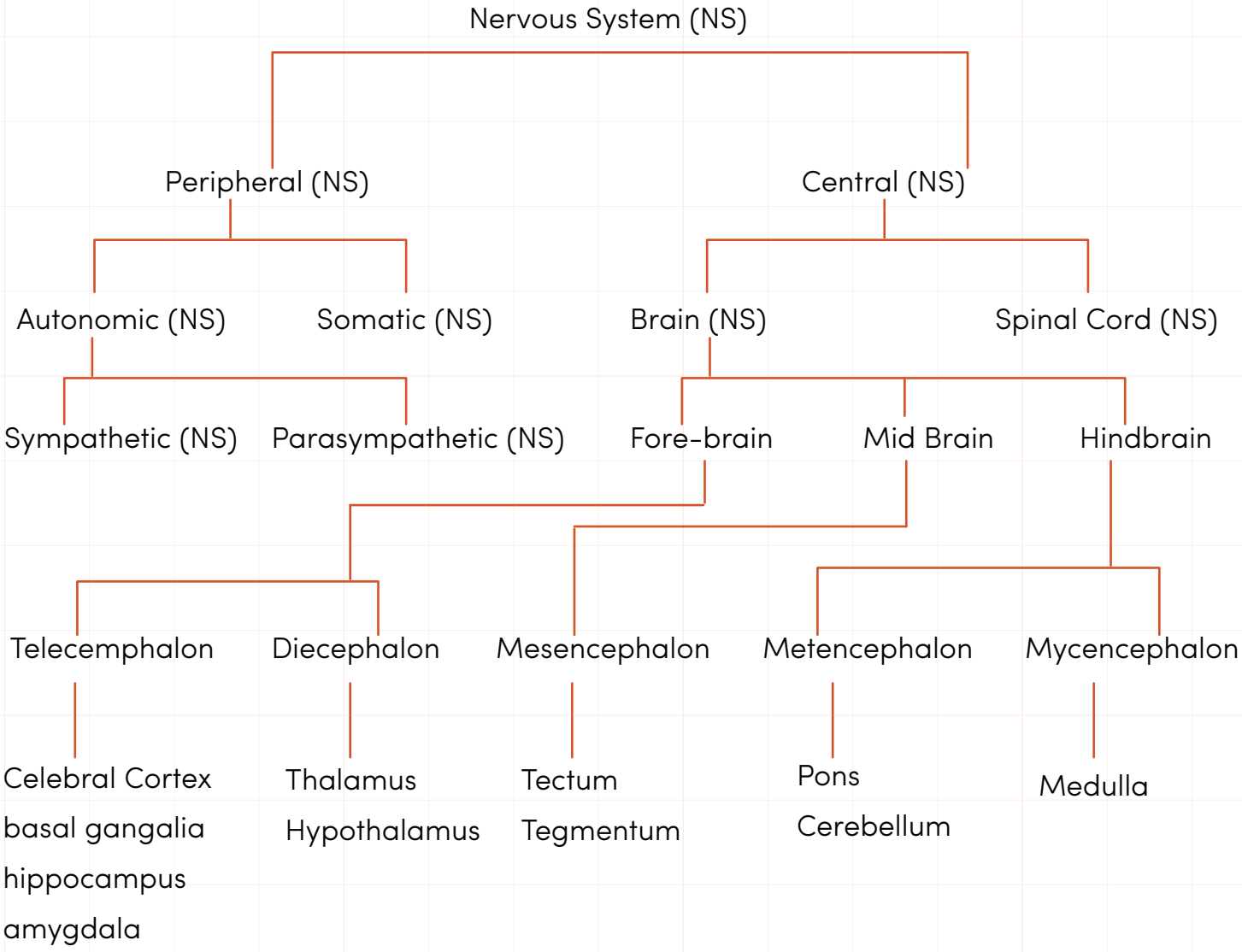
Fig. 1.7: Human Nervous System (HNS)

THE HUMAN NERVOUS SYSTEM

The human nervous system is divided into two interrelated parts:

i. The central nervous system (brain and spinal cord).

ii. The peripheral nervous system (nerves and ganglia).



CENTRAL NERVOUS SYSTEM

Brain: The human brain is the central information processing organ of our body, and acts as the 'command and control system'. It weighs about 1.5kg (average 1350 gms or 3 pounds) and is enclosed in the cranial (skull) cavity. It is covered by 3 membranes, called meninges. The outer membrane, called dura mater ("tough mother") is a tough, protective covering formed of white fibrous tissue the middle delicate membrane is called arachnoid (web like), and the inner most transparent membrane is called pia mater ("soft mother"), containing blood vessels (nutritive in function). Between the bony and membranous coverings, there is cerebrospinal fluid, which acts as a protective internal cushion. The bony skull, meninges and the cerebrospinal fluid protect the brain from external injury and shocks.

The brain can be divided into three major parts:

(i) Forebrain, (ii) Midbrain, and (iii) Hindbrain

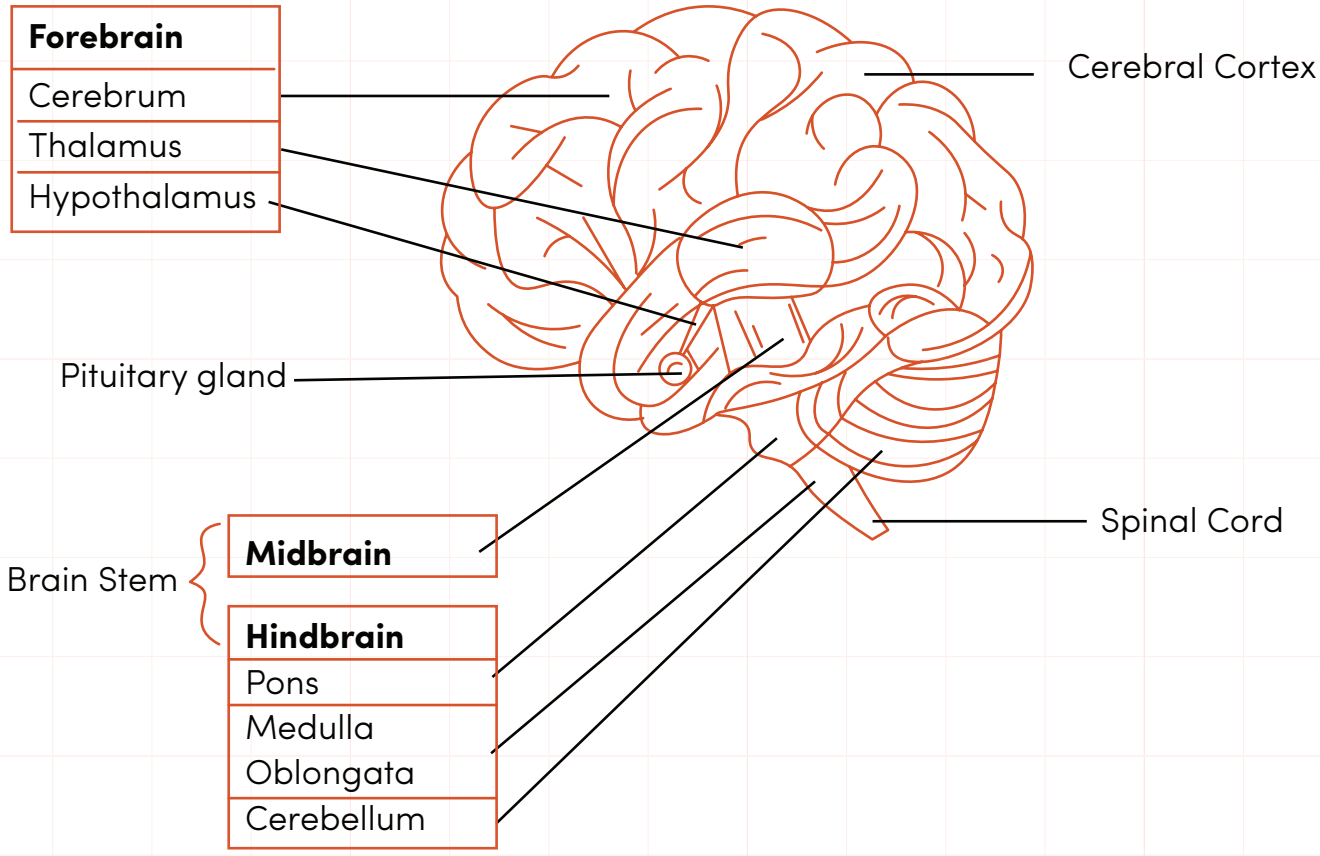


Fig. 1.8: The Central Nervous System (CNS)

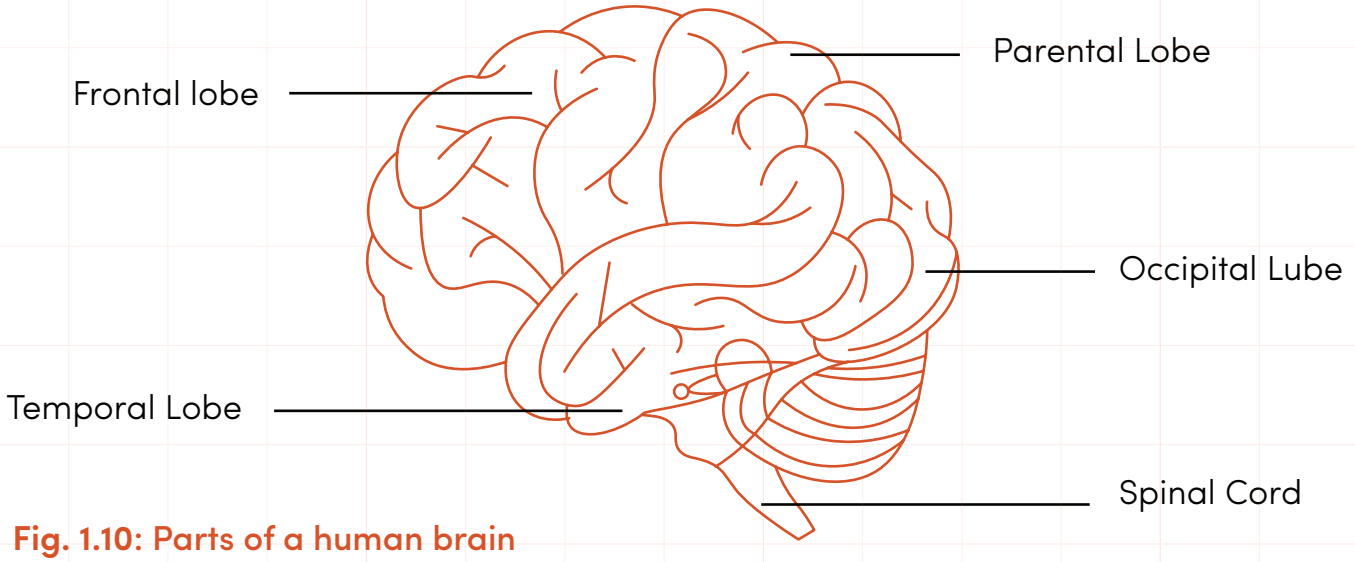


Fig. 1.10: Parts of a human brain

HUMAN BRAIN

Forebrain

The forebrain consists of cerebrum, thalamus and hypothalamus. Cerebrum forms the major part of the human brain. A deep cleft divides the cerebrum longitudinally into two halves, which are termed as the left and right cerebral hemispheres. The hemispheres are connected by a tract of nerve fibres called corpus callosum. Each hemisphere consists of a frontal lobe, partial lobe, occipital lobe and temporal lobe. The layer of cells which covers the cerebral hemisphere is called cerebral cortex and is referred to as the grey matter due to its greyish appearance.

It is involved in the regulation of sexual behaviour, expression of emotional reactions (e.g., excitement, pleasure, rage and fear), and motivation. The cerebrum wraps around a structure called thalamus, which is a major coordinating centre for sensory and motor signaling. Another very important part of the brain called hypothalamus lies at the base of the thalamus. The hypothalamus contains a number of centres which control body temperature, urge for eating and drinking. It also contains several groups of neurosecretory cells, which secrete hormones called hypothalamic hormones.

Midbrain

It is known to connect forebrain to other parts of brain and spinal cord.

Hindbrain

The hindbrain comprises pons, cerebellum and medulla (also called the medulla oblongata). Pons consists of fibre tracts that interconnect different regions of the brain. Cerebellum is for balance and muscular control and medulla oblongata controls heartbeat, breathing and digestion.

THE SPINAL CORD

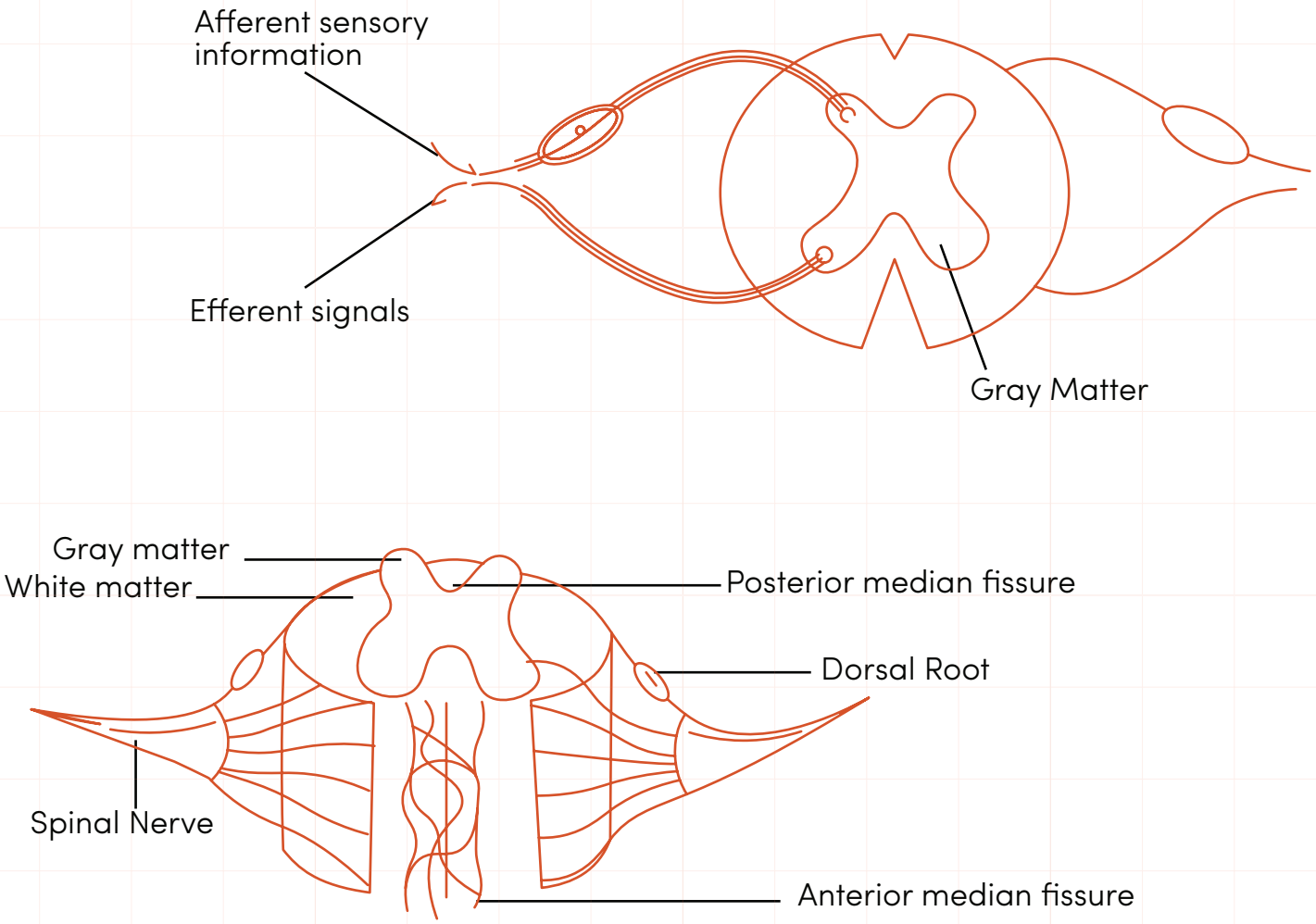


Fig. 1.11: The Spinal Cord

The Spinal cord is a cylindrical shaped bundle of nerve fibers that is connected to the brain. The spinal cord runs down the center of the protective spinal column (vertebra) extending from the neck to the lower back. The spinal cord contains grey matter in the centre surrounded by white matter. It nerves transmit information from body organs and external stimuli to the brain and send information from the brain to other areas of the body.

Functions of Spinal Cord

1. It carries impulse to the brain
2. It controls reflex action

Differences between brain and spinal cord:

	Brain	Spinal cord
1.	It serves as the centre for thinking, sensing, reasoning and remembering.	It performs reflexive actions.
2.	It sends executive commands to different parts of the body.	It carries commands of motion from brain to the different body parts.
3.	It processes sensory information that spinal cord brings from the body parts to the brain.	It returns sensory signals from body parts to the brain.
4.	It has white matter at the core and grey matter on the cortex.	It has grey matter at the core and white matter on the outside.

Peripheral Nervous System

The peripheral nervous system (PNS) is the division of the nervous system containing all the nerves that lay outside of the central nervous system (CNS), that is, the PNS consists of all other nerves and neurons that do not lie within the CNS. The peripheral nervous system is divided into two, the somatic nervous system and the autonomic nervous system.

There are two types of cells in the peripheral nervous system, these include:

i. **Sensory nervous cell:** sends information to the CNS from internal organs or from external stimuli.
ii. **Motor nervous cells:** carries information from the CNS to organs, muscles, and glands.

Peripheral Nervous System Divisions

The peripheral nervous system is divided into the following sections:

i. **Somatic Nervous System** – controls skeletal muscle as well as external sensory organs.
ii. **Autonomic Nervous System** – controls involuntary muscles, such as smooth and cardiac muscle. This is further divided into two;
iii. **Sympathetic** – controls activities that increase energy expenditures.
iv. **Parasympathetic** – controls activities that conserve energy expenditures.

The somatic nervous system: The somatic nervous system is responsible for coordinating the body's movements, and also for receiving external stimuli. It is the system that regulates activities that are under conscious control. This system is said to be voluntary because the responses can be controlled consciously. Reflex reactions of skeletal muscle however are an exception. These are involuntary reactions to external stimuli.

The autonomic nervous system: This controls involuntary muscles, such as smooth and cardiac muscle. This system is also called the involuntary nervous system. The autonomic nervous system can further be divided into the parasympathetic and sympathetic divisions.

The sympathetic nervous system: responds to impending danger or stress (the flight or fight response), and is responsible for the increase of one's heartbeat and blood pressure, dilate pupils, relax the bladder and the sense of excitement one feels due to the increase of adrenaline in the system.

The parasympathetic nervous system: on the other hand, is evident when a person is resting and feels relaxed, and is responsible for the construction of the pupil, the slowing of the heart, the dilation of the blood vessels, contracting the bladder and the stimulation of the digestive and genitourinary systems. The nerves of the sympathetic division often have an opposite effect when they are located within the same organs as parasympathetic nerves.

Differences between the Somatic and the Autonomic Nervous Systems

	Somatic Nervous System	Autonomic Nervous System
1.	Impulses speed along motor fibres that extend from CNS to effectors without synapses	Impulses speed along motor fibres that extend from CNS to where they synapse.
2.	It affects skeletal muscles.	It affects glands, cardiac muscles and smooth muscles.
3.	It always stimulates effectors.	It may stimulate or inhibit effectors.
4.	Body activities are mainly voluntary.	Activities are mainly involuntary.

Peripheral Nervous System Connections

Peripheral nervous system connections with various organs and structures of the body are established through cranial nerves and spinal nerves. There are 12 pairs of cranial nerves in the brain that establish connections in the head and upper body, while 31 pairs of spinal nerves do the same for the rest of the body. While some cranial nerves contain only sensory neurons, most cranial nerves and all spinal nerves contain both motor and sensory neurons

THE NEURONE OR NERVE CELL

The nerve cell or neurone is defined as the basic unit of nervous system which is responsible for the transmission of impulses within the body.

The brain is what it is because of the structural and functional properties of interconnected neurones. The mammalian brain contains between 100 million and 100 billion neurones, depending on the species. Each mammalian neurone consists of a cell body, dendrites, and an axon.

Structure of a Neurone

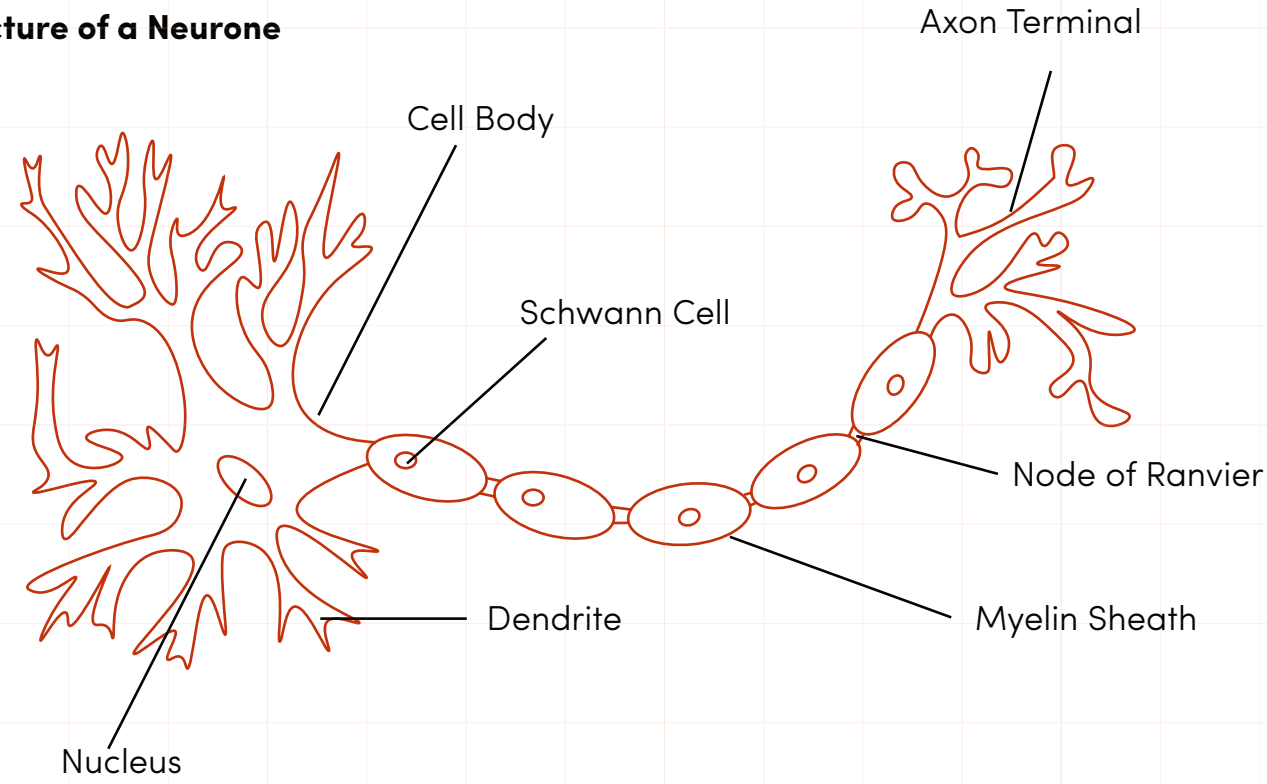


Fig. 1.12: Neuron structure

The neurone has a cell body (Soma) which contains the nucleus and cytoplasm. The axon extends from the cell body and often gives rise to many smaller branches before ending at nerve terminals.

Dendrites extend from the neurone cell body and receive messages from other neurons. Synapses are the contact points where one neuron communicates with another. The dendrites are covered with synapses formed by the ends of axons from other neurones. When neurones receive or send messages, they transmit electrical impulses along their axons. Many axons are covered with a layered myelin sheath, which accelerates the transmission of electrical signals along the axon. This sheath is made by specialized cells called glia. In the brain, the glia that make the sheath are called oligodendrocytes, and in the peripheral nervous system, they are known as Schwann cells.

The brain contains at least ten times more glia than neurones. The glia (Neuroglia) performs many jobs. Researchers have known for a while that glia transport nutrients to neurones, clean up brain debris, digest parts of dead neurons, and help hold neurons in place.

There are several differences between axons and dendrites:

	Axon	Dendrites
1.	Take information away from the cell body.	Bring information to the cell body.
2.	Smooth surface.	Rough surface (dendritic spines)
3.	Generally only 1 axon per cell.	Usually many dendrites per cell.
4.	No ribosomes.	Have ribosomes.
5.	Can have myelin.	No myelin insulation.

Different Types Of Neurones

There are different types of neurones. They all carry electro-chemical nerve signals, but differ in structure (the number of processes, or axons, emanating from the cell body) and are found in different parts of the body.

i. *Sensory neurones or bipolar neurones carry messages from the body's sense receptors (eyes, ears, etc.) to the CNS. These neurones have two processes. Sensory neurone account for 0.9% of all neurones. (Examples are retinal cells, olfactory epithelium cells.)*

ii. *Motor neurones or multipolar neurones carry signals from the CNS to the muscles and glands. These neurones have many processes originating from the cell body. Motor neurones account for 9% of all neurones. (Examples are spinal motor neurones, pyramidal neurones.)*

iii. *Intermediate neurones or Pseudo polar (Spelling) cells form all the neural wiring within the CNS. These have two axons (instead of an axon and a dendrite). One axon communicates with the spinal cord; one with either the skin or muscle. These neurones have two processes. (Examples are dorsal root ganglia cells.)*

The Transmission of Nerve Impulses

Nerve impulses have a domino effect. Each neuron receives an impulse and must pass it on to the next neurone and make sure the correct impulse continues on its path.

Through a chain of chemical events, the dendrites (part of a neurone) pick up an impulse that's shuttled through the axon and transmitted to the next neurone. The entire impulse passes through a neurone in about seven milliseconds — faster than a lightning strike. Here's what happens in just four easy steps:

i. **Polarization of the neurone's membrane:** Sodium is on the outside, and potassium is on the inside. Cell membranes surround neurones just as any other cell in the body has a membrane. When a neurone is not stimulated — it's just sitting with no impulse to carry or transmit — its membrane is polarized, not paralyzed. A polarized membrane means that the electrical charge on the outside of the membrane is positive while the electrical charge on the inside of the membrane is negative. The outside of the cell contains excess sodium ions (Na^+); the inside of the cell contains excess potassium ions (K^+). (Ions are atoms of an element with a positive or negative charge.)

ii. **Resting potential gives the neuron a break:** When the neuron is inactive and polarized, it's said to be at its resting potential. It remains this way until a stimulus comes along.

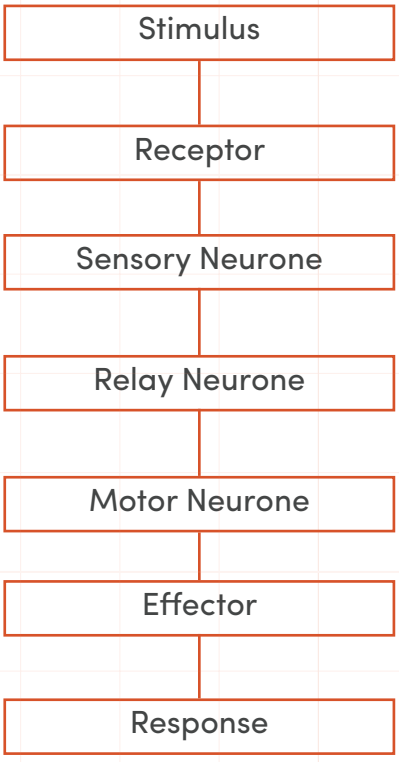
iii. **Action potential:** Sodium ions move inside the membrane. When a stimulus reaches a resting neurone, the gated ion channels on the resting neurone's membrane open suddenly and allow the Na+ that was on the outside of the membrane to go rushing into the cell. As this happens, the neurone goes from being polarized to being depolarized. When the neurone was polarized, the outside of the membrane was positive, and the inside of the membrane was negative. Well, after more positive ions go charging inside the membrane, the inside becomes positive, as well; polarization is removed and the threshold is reached. Each neurone has a threshold level — the point at which there's no holding back. After the stimulus goes above the threshold level, more gated ion channels open and allow more Na+ inside the cell. This causes complete depolarization of the neurone and an action potential is created. In this state, the neurone continues to open Na+ channels all along the membrane. When this occurs, it's an all-or-none phenomenon. "All-or-none" means that if a stimulus doesn't exceed the threshold level and cause all the gates to open, no action potential results. However, after the threshold is crossed, there's no turning back. Complete

depolarization occurs and the stimulus will be transmitted. When an impulse travels down an axon covered by a myelin sheath, the impulse must move between the uninsulated gaps called nodes of Ranvier that exist between each Schwann cell.

iv. **Repolarization:** Potassium ions move outside, and sodium ions stay inside the membrane. After the inside of the cell becomes flooded with Na+, the gated ion channels on the inside of the membrane open to allow the K+ to move to the outside of the membrane. With K+ moving to the outside, the membrane's repolarization restores electrical balance, although it's opposite of the initial polarized membrane that had Na+ on the outside and K+ on the inside. Just after the K+ gates open, the Na+ gates close; otherwise, the membrane couldn't repolarize.

REFLEX ACTION

A reflex action is an automatic (involuntary) and rapid response to a stimulus, which minimizes any damage to the body from potentially harmful conditions, such as touching something hot. Reflex actions are therefore essential to the survival of many organisms. A reflex action follows this general sequence and does not involve the conscious part of the brain. This is why the response is so fast.



The nerve pathway followed by a reflex action is called a reflex arc. For example, a simple reflex arc happens if we accidentally touch something hot.

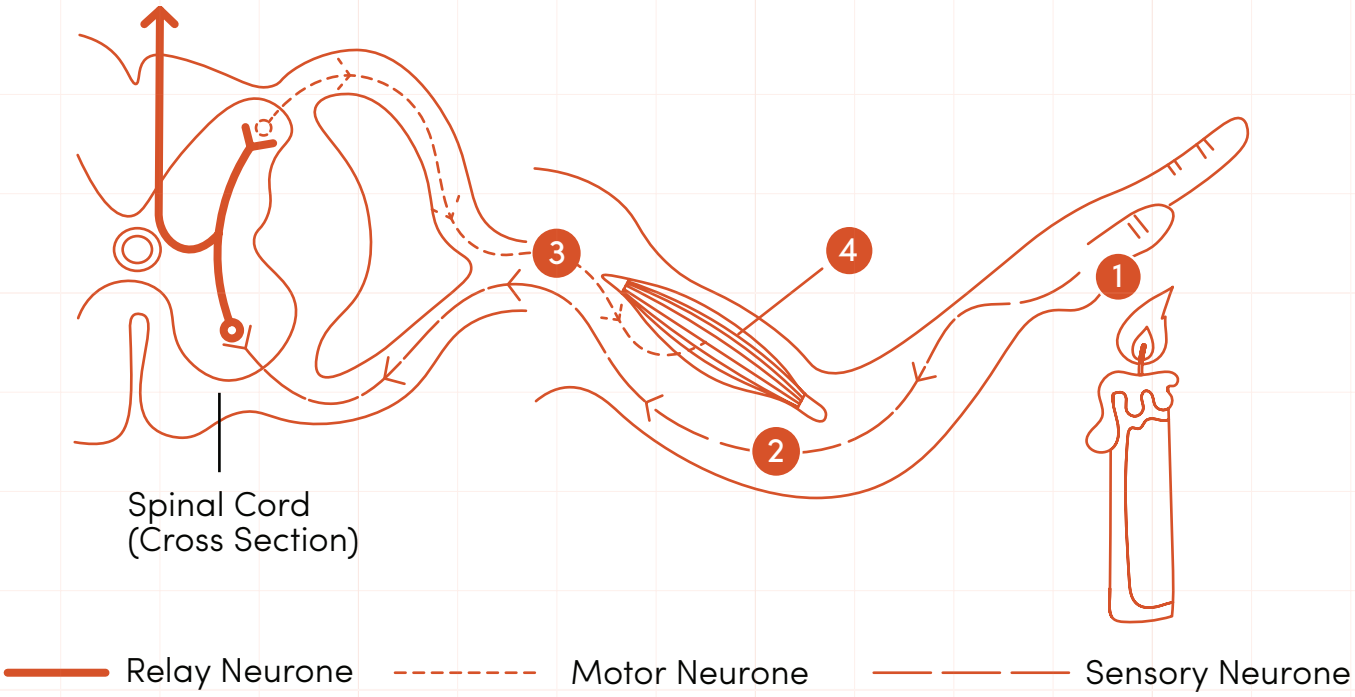


Fig. 1.13: The neural relay from a reflex action

1. Receptor in the skin detects a stimulus (the change in temperature)
2. Sensory neuron sends electrical impulses to a relay neuron, which is located in the spinal cord of the CNS. Relay neurons connect sensory neurons to motor neurons
3. Motor neuron sends electrical impulses to an effector.
4. Effector produces a response (muscle contracts to move hand away).

Organisms are able to modify a reflex action and overcome it, but this uses the brain and has to be learnt. For example, keeping hold of a hot object requires a nerve impulse to be sent to the motor neuron of the reflex arc to interfere with the normal reflex action to drop the object. Eyes closing, moving the hand away and food digestion are the forms of unconditioned reflexes

Conditioned reflex actions

These are some actions or feeling that you learn to do in response to a specific situation or stimulus. An example of a conditioned reflex is if you learn to run to the door to get presents every time your mom gets back from a business trip.

Differences between reflex and conditioned reflex actions

Simple reflex :

- Automatic response that is not learnt
- same stimulus always evoke same response
- Response coordinated by the spinal cord.
- Involuntary action

Conditioned reflex:

- Automatic response that is learnt
- Different stimuli can evoke same response over time
- Response coordinated by the brain.
- Voluntary action

The Conditioned Response in Classical Conditioning

Russian physiologist Ivan Pavlov first discovered the classical conditioning process during his research on the salivary systems of dogs. Pavlov noted that the dogs would salivate to the taste of meat, but that after a while they also began to salivate whenever they saw the white coat of the lab assistant who delivered the meat.

To look closer at this phenomenon, Pavlov introduced the sound of a tone whenever the animals were fed. Eventually, an association was formed, and the animals would salivate whenever they heard the sound, even if no food was present.

In Pavlov's classic experiment, the food represents what is known as the unconditioned stimulus (UCS). This stimulus naturally and automatically triggers an unconditioned response (UCR), which in this case was salivation. After pairing the unconditioned stimulus with a previously neutral stimulus, the sound of the tone, an association is formed between the UCS and the neutral stimulus.

Eventually, the previously neutral stimulus begins to evoke the same response, at which point the tone becomes known as the conditioned stimulus. Salivating in response to this conditioned stimulus is an example of a conditioned response.

In classical conditioning, the conditioned response is the learned response to the previously neutral stimulus. For example, the smell of food is an unconditioned stimulus, a feeling of hunger in response to the smell is an unconditioned response, and the

sound of a whistle when you smell the food is the conditioned stimulus. The conditioned response would be feeling hungry when you heard the sound of the whistle.

SUMMARY

So far, we have learnt how to

1. Locate the position of the CNS in a dissected vertebrate.
2. Describe the structure of the brain and explain the functions of its various organs.
3. Describe the spinal cord and explain its function.
4. State the structural difference between the brain and spinal cord.
5. Identify the PNS and describe its function.
6. Describe typical neurone.
7. Group neurones according to functions as found in vertebrates and explain their functions
8. Explain the process of impulse transmission.

INTERACTIVE ASSESSMENT QUESTIONS

1. Which of the following statements are true?

A Roots anchor the plant to the ground, absorb water and nutrients, and store sugars and carbohydrates.

B The stem carries water and nutrients to the leaves, moves food to other parts of the plant, and provides support for the plant.

C Leaves can be compound, made of a single leaf blade connected by a petiole the stem, or simple, divided into separate leaflets attached to the stem.

D Flowers have stigma, a sticky knob at the top of the pistil and the style, a long, tube-like structure, connected to the ovary, which contains ovules.

E Fruits are ripened ovaries that, after fertilization, swell and become either soft and fleshy, or hard and dry to protect the developing seeds.

2. Which type of neuron transmits a signal from a sense organ to the CNS?

A Sensory
B Relay
C Motor
D Association

3. Which type of neurone transmits a signal from the CNS to an effector such as a muscle?

A Sensory
B Relay
C Motor
D Association

4. What is a synapse?

A A type of reflex action
B A gap between two neurones
C A long fibre in a nerve cell.
D An involuntary action

5. Which of these is not a reflex response?

A Moving a hand off something hot.
B Sneezing
C Blinking
D Picking up a pencil

6. Which part of the nervous system is not involved in producing reflex action?

A Brain
B Spinal cord
C Receptors
D Neuron

7. The Nervous system is broadly divided into _____ and _____

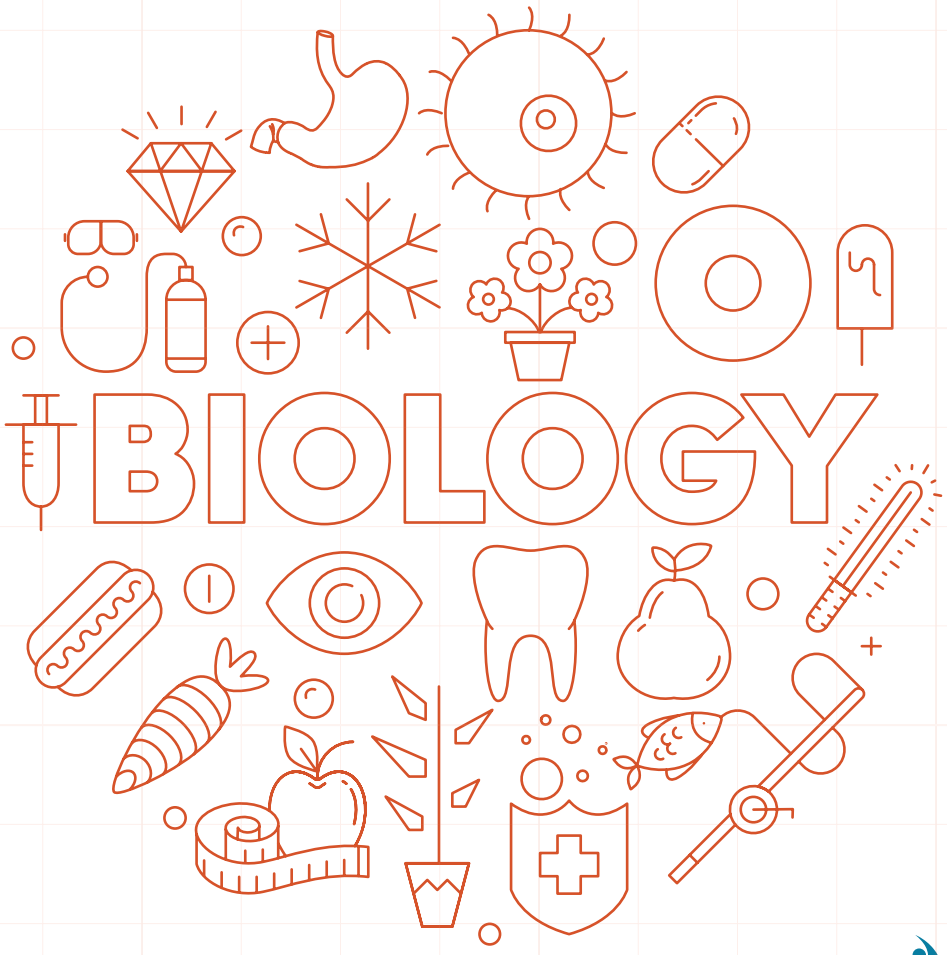
8. Which of these is not a part of neurone?

A Brain
B Spinal cord
C Receptors
D Neuron

SENSE ORGANS

PERFORMANCE OBJECTIVES

1. List the major sense organs and infer their locations.
2. Describe the organs of smell and taste.
3. Identify the different parts of the tongue associated with sweetness, bitterness, salty taste and sour taste.
4. Draw the skin showing the different receptors present.
5. Describe the structure and functions of the mammalian ear.
6. Describe the mammalian eye and explain the functions of its various parts.
7. Explain the functions of the eye: image formation and accommodation.
8. Explain the terms myopia, hyper metropia, astigmatism, cataracts, and night blindness.



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SENSE ORGANS

Sense organs are the organs that respond to external stimuli by conveying impulses to the sensory nervous system.

They are organs by which humans can see, smell, hear, taste, and touch or feel. The five sense organs are the eyes (for seeing), nose (for smelling), ears (for hearing), tongue (for tasting), and skin (for touching or feeling).

These five sense organs contain receptors that relay information through the sensory neurons to the appropriate places within the nervous system. The receptors could be classified into two parts viz. the general and special receptors. The former is present throughout the body while the latter includes chemoreceptors, photoreceptors, and mechanoreceptors.

THE NOSE

The nose is the prominent structure between the eyes that serves as the entrance to the respiratory tract and contains the olfactory organ. It provides air for respiration, serves the sense of smell, conditions the air by filtering, warming, and moistening it, and cleans itself of foreign debris extracted from inhalations.

The Nasal Cavity

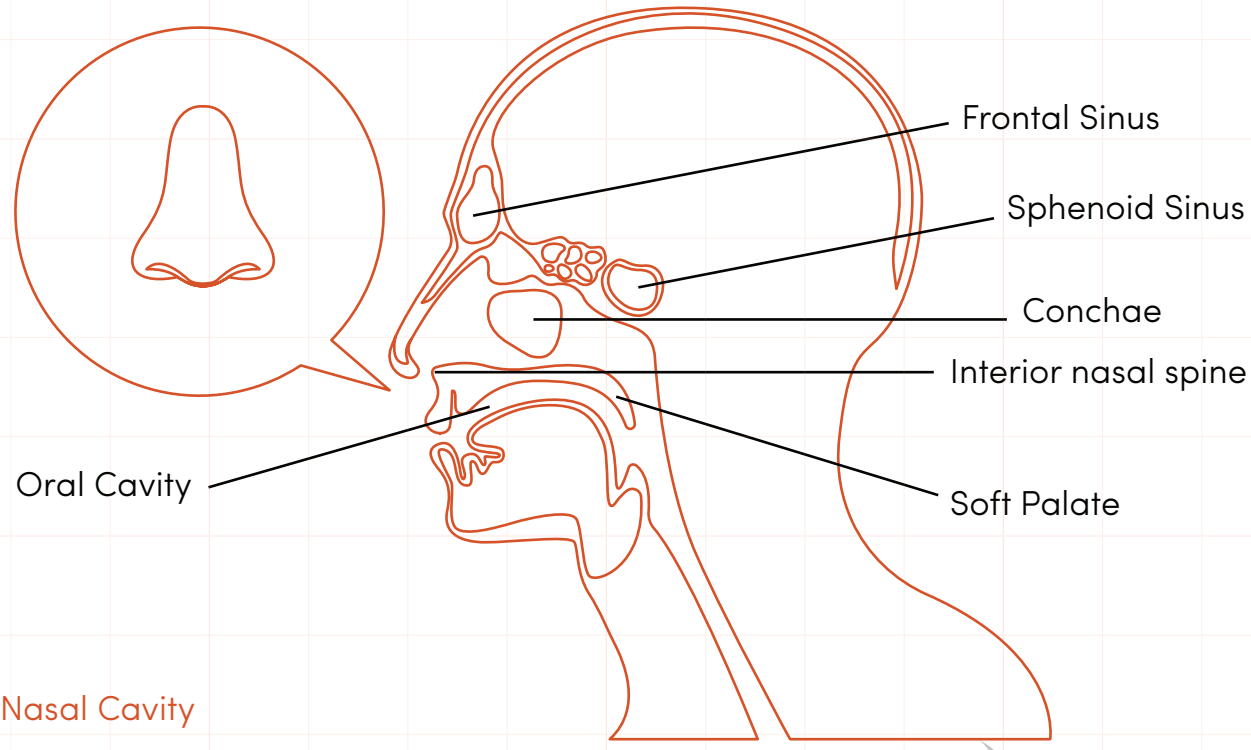


Fig. 1.14: Nasal Cavity

Smelling Things

Your sense of smell, like your sense of taste, is part of your chemosensory system, or the chemical senses.

The ability to smell comes from specialized sensory cells, called olfactory sensory neurons, which are found in a small patch of tissue high inside the nose. These cells connect directly to the brain. Each olfactory neuron has one odour receptor. Microscopic molecules released by substances around us (whether it's coffee brewing or pine trees in a forest) stimulate these receptors. Once the neurons detect the molecules, they send messages to the brain, which identifies the smell.

Smells reach the olfactory sensory neurons through two pathways.

The first pathway is through our nostrils.

The second pathway is through a channel that connects the roof of the throat to the nose. Chewing food releases aromas that access the olfactory sensory neurons through the second channel. If the channel is blocked, such as when your nose is stuffed up by cold or flu, odours can't reach the sensory cells that are stimulated by smells. As a result, you lose much of your ability to enjoy a food's flavour. In this way, your senses of smell and taste work closely together.

THE TONGUE

The tongue is a muscular organ in the mouth. The tongue is covered with moist, pink tissue called mucosa. Tiny bumps called papillae to give the tongue its rough texture. Thousands of taste buds cover the surfaces of the papillae. Taste buds are collections of nerve-like cells that connect to nerves running into the brain.

The tongue is anchored to the mouth by webs of tough tissue and mucosa. The tether holding down the front of the tongue is called the frenum. In the back of the mouth, the tongue is anchored into the hyoid bone. The tongue is vital for chewing and swallowing food, as well as for speech.

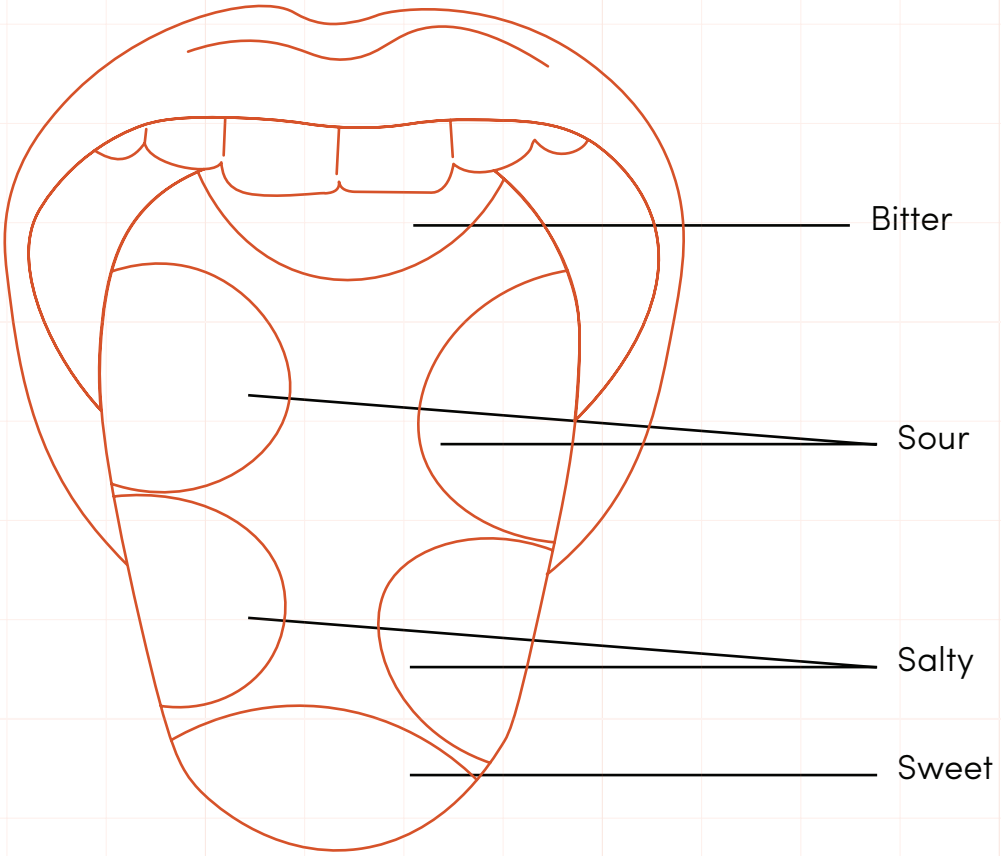


Fig. 1.15: The four common tastes are sweet, sour, bitter, and salty.

The tongue has many nerves that help detect and transmit taste signals to the brain. Because of this, all parts of the tongue can detect these four common tastes

THE SKIN

The skin is one of the most active organs in the body. The skin is the outer covering of the body. In humans, it is the largest organ and sense organ. Skin is a thin layer of tissue forming the natural outer covering of the body of a person or an animal. It is the largest organ of the body. The skin protects us from microbes and the elements help regulate body temperature and permit the sensations of touch, heat, and cold. The skin's colour is created by special cells called melanocytes, which produce the pigment melanin. Melanocytes are located in the epidermis. The skin is made up of two main layers namely: Dermis and Epidermis

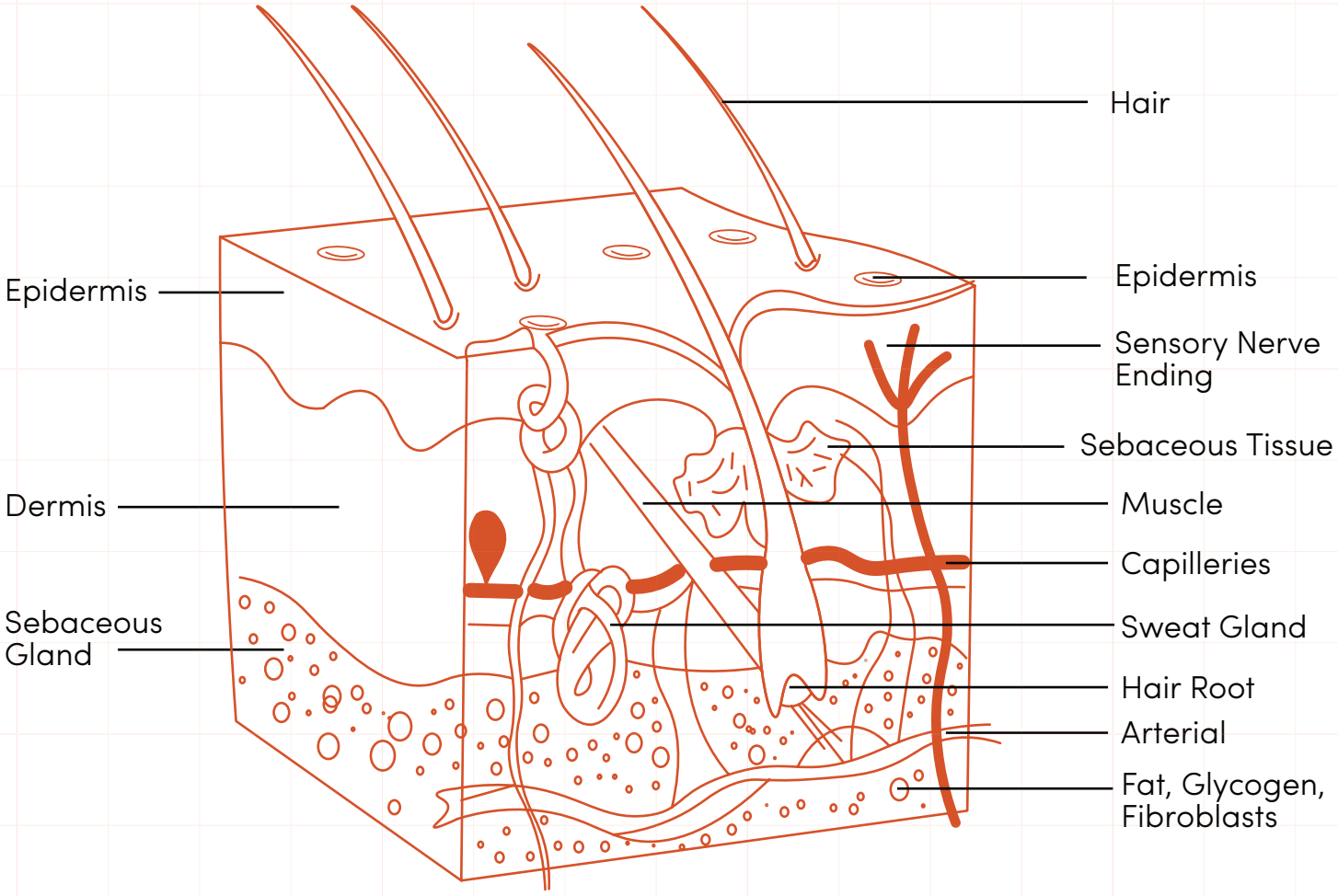


Fig. 1.16: Layers of a human skin

i. **The Dermis:** This is the inner layer also known as the "true skin". It is directly under the outer layer. Inside the true skin, you will find other structures like the oil gland (sebaceous gland), sweat gland, sweat duct, fat deposit etc.

ii. **The Epidermis:** This is the outer layer. It has no blood vessels or nerves. It is covered with hair and tiny holes called "seat pores"

The epidermis is the outermost layer of the skin. It provides a waterproof barrier and creates our skin tone. The epidermis consists of three layers:

- The innermost - Malpighian layer
- The middle - Granular layer, and
- The outermost (surface) - Cornified layer.

Malpighian layer: Also known as the germinative layer. It consists of actively dividing cuboidal cells. They contain melanin, a pigment that gives the skin its colour and absorbs ultra violet radiation. The cells of this layer get their nutrients and supply of oxygen by diffusion from the blood of the capillaries found in the dermis.

Granular Layer: This consists of living cells produced by the Malpighian (germinative) layer beneath. These cells are continuously converted to cornified cells. Keratin is deposited inside them, and they lose their nuclei and become flattened in shape.

Cornified Layer: This consists of scale-like dead cells impregnated with keratin. The keratin makes this layer tough, flexible, and waterproof. They are constantly wearing away and are replaced by the granular layer beneath.

Dermis: This is beneath the epidermis. It is a layer of connective tissue containing blood capillaries, hair follicles, sweat glands, sebaceous gland, sensory nerve ending and fat cells.

Blood capillaries: This supplies food and oxygen to the dermal and epidermal cells and removes wastes. The capillary loops close to the body surface help to regulate the body temperature.

Hair Follicles: This is a deep pit formed by the in-folding of the Malpighian layer. Each hair is a cylinder composed of dead cells; grow as new cells at the 'root'. A hair erector muscle is attached to each follicle. Its contraction pulls the hair to a more upright position, i.e. it makes the hair 'stand up'.

Sebaceous gland: Secretes sebum which repels water (waterproof) and also prevents microbes from multiplying.

Sweat gland: Absorbs fluid from the surrounding tissues and capillaries. This fluid is then passed out as sweat through the sweat duct. Sweat is 99% water, 0.3% salt, and minute amounts of urea and lactic acid.

Sensory nerve ending: The skin is also a sense organ. Various nerve endings, capable of responding to touch, heat, cold and pressure.

Subcutaneous fat: It is found beneath the dermis. It acts as a food reserve and an insulating layer, to prevent heat loss.

Functions of the skin

1. It keeps the body warm in cold weather
2. It helps the body to get rid of waste products through sweating
3. It protects the body against dehydration, invading microbes, mechanical damage, and damage due to ultraviolet rays and poisonous chemicals.
4. It contains receptors sensitive to heat, cold, touch, and pressure.
5. It plays a major role in temperature control (vasodilation and vasoconstriction).
6. It has a minor role as an excretory organ. Urea and lactic acid are lost.
7. The skin produces vitamin D in the fatty cells by using infra-red rays of the sun
8. It helps to keep the body temperature normal by producing sweat during hot weather
9. It protects the body from bacterial infections (germs) poor weather and injury
10. When the sun shines on the skin, vitamin D is produced by the skin
11. **Sensation:** contains a variety of nerve endings that react to heat and cold, touch, pressure, vibration, and tissue injury.
12. **Heat regulation:** the skin contains a blood supply far greater than its requirements which allows precise control of energy loss by radiation, convection, and conduction. Dilated blood vessels increase perfusion and heat loss, while constricted vessels greatly reduce cutaneous blood flow and conserve heat.
13. **Control of evaporation:** The skin provides a relatively dry and semi-impermeable barrier to fluid loss. Loss of this function contributes to the massive fluid loss in burns.
14. Storage and synthesis act as a storage center for lipids and water, as well as a means of synthesis of vitamin D.
15. **Excretion:** sweat contains urea, however, its concentration is 1/130th that of urine, hence excretion by sweating is at most a secondary function to temperature regulation.
16. **Water resistance:** The skin acts as a water-resistant barrier so essential nutrients aren't washed out of the body.

Control of Body Temperature

Under normal conditions, the heat the body gain is balanced by the heat it loses. The balance, however, can be upset by hot weather, vigorous exercise, high fever, or exposure to solar radiation. The balance is restored by the actions of the hypothalamus and the skin.

A rise in body temperature stimulates the following processes to get rid of excess body heat:

i. **Vasodilation:** The arteriole in the skin (swell) increases the flow of blood through the skin. This leads to increased loss of heat through the dermis by convection and radiation.
ii. **Sweating:** The sweat glands become active and produce large amounts of sweat that flow out onto the surface of the skin. As this sweat evaporates, heat from the body is used up, thus cooling the body. A fall in body temperature stimulates the following processes to produce and conserve heat:
iii. **Vasoconstriction:** The arterioles are narrowed, thereby reducing the flow of blood to the skin and so minimizing heat loss.
iv. **Sweating:** The sweat glands become inactive and produce very little sweat that flows out to the skin surface, thereby conserving body heat.

Care of the skin

It is necessary to keep the skin clean by having a regular bath. To care for the skin, it is important to:

1. Wash your whole body daily more than once during hot, dry, and dusty season
2. Have a shower after serious exercise or games to avoid body odor
3. Keep your towel, underwear, and other clothes clean
4. Use good toilet soap and sponge
5. Take abundant fresh air
6. Do not use bleaching cream
7. Eat a balanced diet that is rich in milk, proteins, fruits, cold-liver oil, vegetable etc.

THE EAR

Hearing is the ability to sense sound waves, and the ear is the organ that senses sound. Sound waves enter the ear through the ear canal and travel to the eardrum. The sound waves strike the eardrum and make it vibrate. The vibrations then travel through the three tiny bones (hammer, anvil, and stirrup) of the middle ear, which amplifies the vibrations. From the middle ear, the vibrations pass to the cochlea in the inner ear. The cochlea is a coiled tube filled with liquid. The liquid moves in response to the vibrations, causing tiny hair cells (which are mechanoreceptors) lining the cochlea to bend. In response, the hair cells send nerve impulses to the auditory nerve, which carries the impulses to the brain. The brain interprets the impulses and "tells" us what we are hearing.

Balance

The ears are also responsible for the sense of balance.

Balance is the ability to sense and maintain an appropriate body position. The semicircular canals inside the ear contain fluid that moves when the head changes position. Tiny hairs lining the semicircular canals sense movement of the fluid. In response, they send nerve impulses to the vestibular nerve, which carries the impulses to the brain. The brain interprets the impulses and sends messages to the peripheral nervous system which triggers the contractions of skeletal muscles as needed to maintain balance.

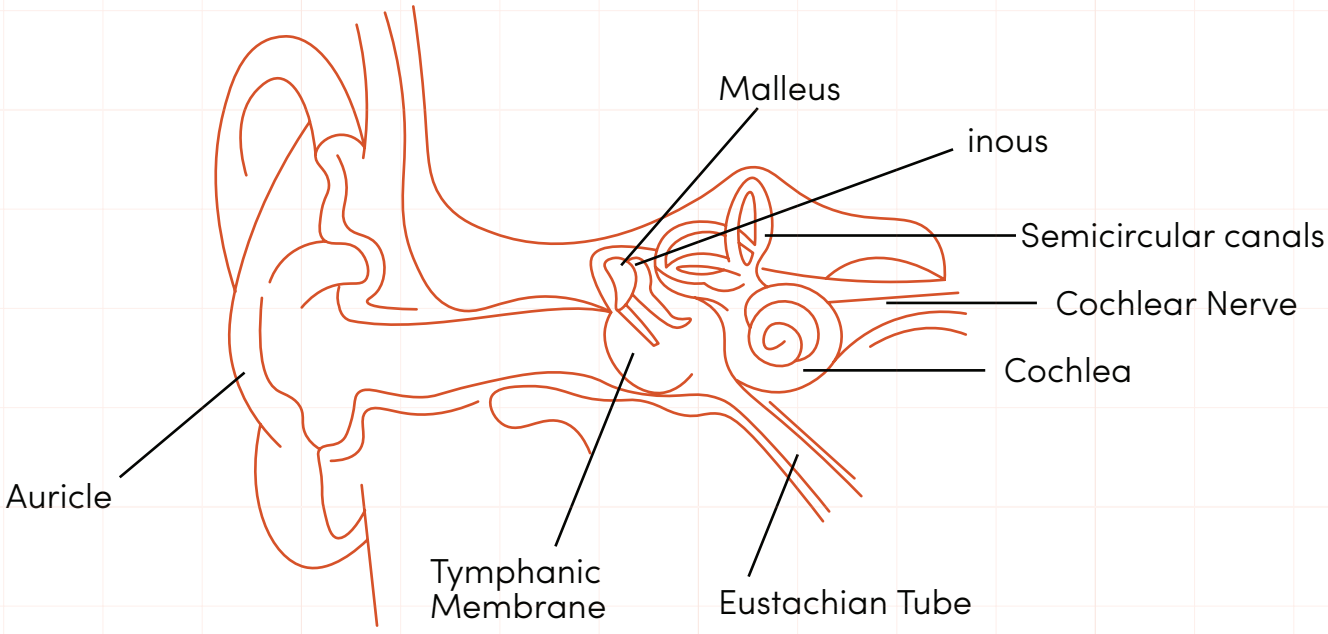


Fig. 1.17: A human ear

THE EYE

The organ of sight. The eye has a number of components. These components include but are not limited to the cornea, iris, pupil, lens, retina, and macula, optic nerve, choroid and vitreous.

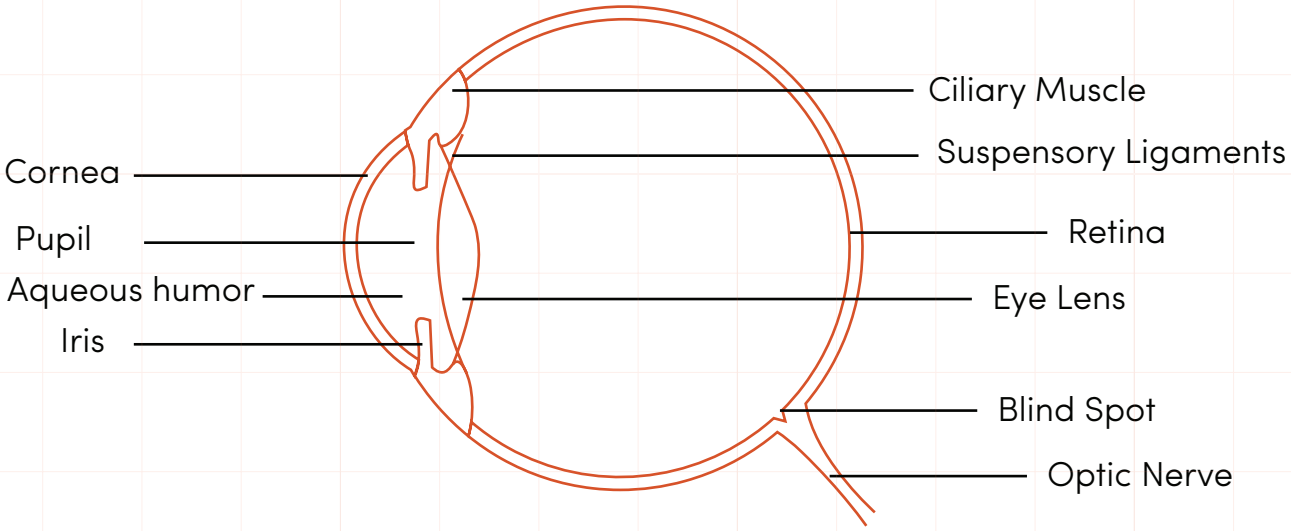


Fig. 1.18: Parts of a human eye

The structures and functions of the eyes are complex. Each eye constantly adjusts the amount of light it lets in, focuses on objects near and far, and produces continuous images that are instantly transmitted to the brain.

The orbit is the bony cavity that contains the eyeball, muscles, nerves, and blood vessels, as well as the structures that produce and drain tears. Each orbit is a pear-shaped structure that is formed by several bones.

The outer covering of the eyeball consists of a relatively tough, white layer called the sclera (or white of the eye).

Near the front of the eye, in the area protected by the eyelids, the sclera is covered by a thin, transparent membrane (conjunctiva), which runs to the edge of the cornea. The conjunctiva also covers the moist back surface of the eyelids and eyeballs.

Light enters the eye through the cornea, the clear, curved layer in front of the iris and pupil. The cornea serves as a protective covering for the front of the eye and also helps focus light on the retina at the back of the eye.

After passing through the cornea, light travels through the pupil (the black dot in the middle of the eye).

The **iris**—the circular, colored area of the eye that surrounds the **pupil**—controls the amount of light that enters the eye. The **iris** allows more light into the eye (enlarging or dilating the **pupil**) when the environment is dark and allows less light into the eye (shrinking or constricting the **pupil**) when the environment is bright. Thus, the **pupil** dilates and constricts like the aperture of a camera **lens** as the amount of light in the immediate surroundings changes. The size of the **pupil** is controlled by the action of the **pupillary sphincter** muscle and **dilator** muscle.

Behind the **iris** sits the **lens.** By changing its shape, the lens focuses light onto the retina. Through the action of small muscles (called the **ciliary muscles)**, the lens becomes thicker to focus on nearby objects and thinner to focus on distant objects.

The **retina** contains the cells that sense light (photoreceptors) and the blood vessels that nourish them. The most sensitive part of the **retina** is a small area called the **macula**, which has millions of tightly packed photoreceptors (the type called **cones)**. The high density of cones in the **macula** makes the visual image detailed, just as a high-resolution digital camera has more megapixels.

Each photoreceptor is linked to a **nerve fiber**. The nerve fibers from the photoreceptors are bundled together to form the **optic nerve.** The **optic disk**, the first part of the **optic nerve**, is at the back of the eye.

The photoreceptors in the **retina** convert the image into electrical signals, which are carried to the brain by the **optic nerve**. There are two main types of photoreceptors: **cones and rods**.

Cones are responsible for sharp, detailed central vision and color vision and are clustered mainly in the **macula.**

Rods are responsible for night and peripheral (side) vision. **Rods** are more numerous than cones and much more sensitive to light, but they do not register color or contribute to detailed central vision as the cones do. **Rods** are grouped mainly in the peripheral areas of the retina.

How do we see colours?

The light-sensitive cells in the retina of our eye are of two shapes; rod shape and cone shape. The function of rod-shaped cells is to respond to the brightness of the light. And the function of cone-shaped cells is to make us see colours and distinguish between them.

Seeing distant and nearby objects

i. **Distant objects:** When the rays of light are coming from the distant objects they are diverging at the beginning but become parallel when they reach our eye. Therefore to see a distant object, we need to have convex eye-lens of low converging power to focus them to form an image on the retina of the eye. The convex eye-lens of low converging power have a large focal length and are quite thin.
ii. **Nearby objects:** When the rays of light are coming from the nearby objects they diverge when they reach our eyes. Therefore, to see a nearby object we need to have convex eye-lens of high converging power to focus and form an image on the retina. Convex eye-lens with high converging power have a short focal length and is thick.

Power of accommodation of the eye

The ability of the eye to focus distant as well as nearby objects clearly on the retina of the eye is called accommodation.

When our eyes see distant objects then the ciliary muscles relax and the focal length is maximum in this position. The eye-lens then converge the parallel rays of light to form an image of the distant object on the retina. When the eye sees the distant object they

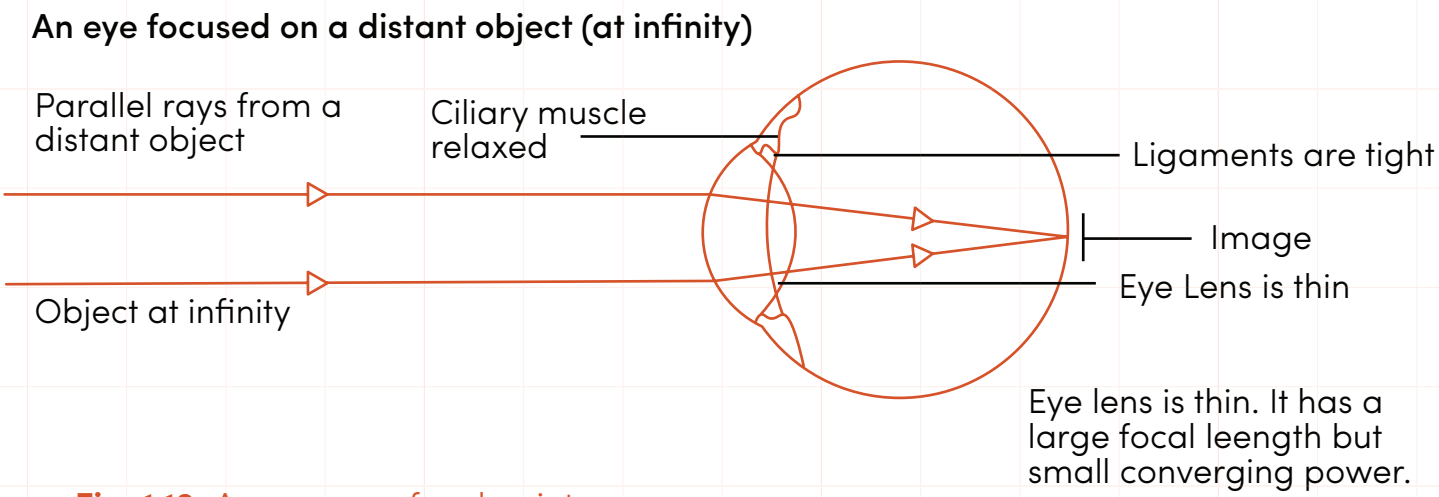


Fig. 1.19: An eye on a focal point

Defects of vision and their corrections

There are three common defects of vision. They are:

i. Myopia (Short-sightedness or Near-sightedness)
ii. Hypermetropia (Long-sightedness or Far-sightedness)
iii. Presbyopia

MYOPIA

The defect of an eye in which it cannot see distant objects clearly is called myopia. A person with myopia can see nearby objects. Myopia is caused due to:

i. **High converging power of the lens**
ii. **Eye-ball being too long**

Due to the high converging of the eye-lens, the image is formed in front of the retina and a person cannot see clearly the distant objects. In another case, if the eyeball is too long then the retina is at a larger distance from the eye-lens. In this case, also the image is formed in front of the retina even though the eye-lens has correct converging power. Myopia or short-sightedness can be corrected by wearing spectacles containing a concave lens. This is because when a concave lens of suitable power is used for the myopic eye then the concave lens first diverges the parallel rays of light coming from a distant object. Therefore, first, a virtual image is formed at the far point of the myopic eye. Now since the rays of light appear to be coming from the eye's far point, they are easily focused by the eye-lens, and the image is formed on the retina. A concave lens is used for a myopic eye to decrease the converging power of the eye-lens.

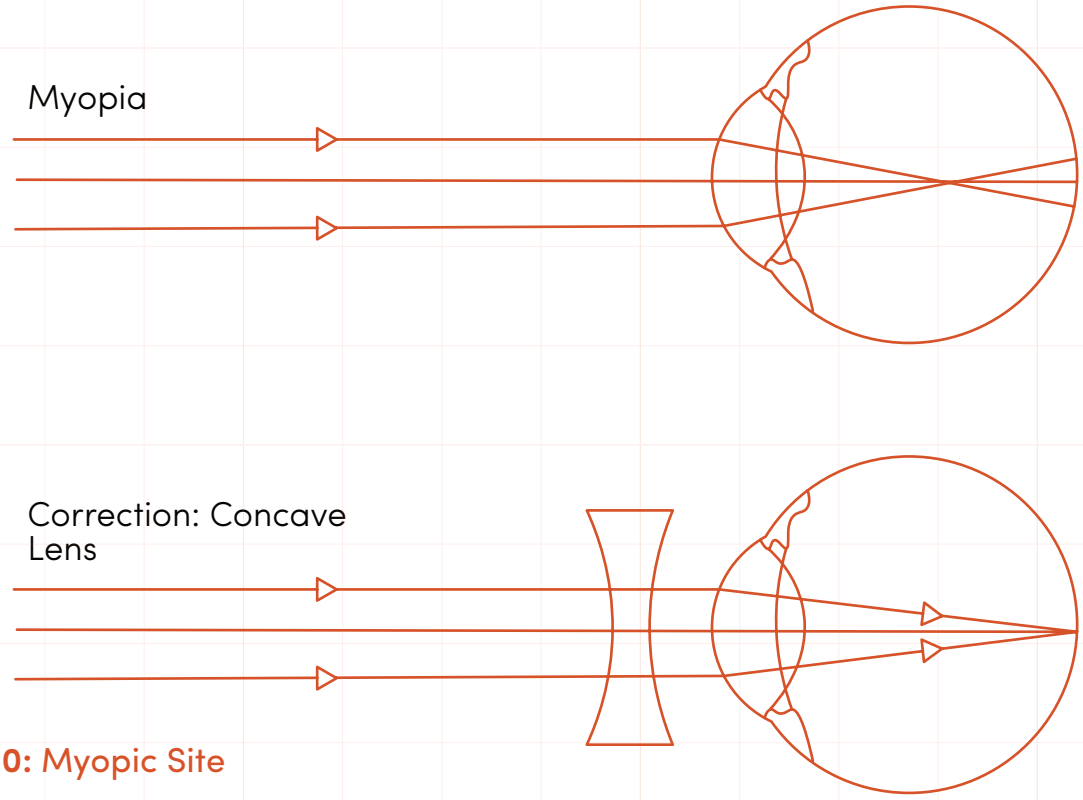


Fig. 1.20: Myopic Site

HYPERMETROPIA

Hypermetropia or long-sightedness is a defect of an eye where a person cannot see nearby objects clearly. The near-point of the hypermetropic eye is more than 25 km away. This defect of the eye is caused due to:

1. Low converging power of eye-lens
2. Eye-ball being too short

In the case of hypermetropia, the image of an object is formed behind the retina and therefore, a person cannot see clearly nearby objects.

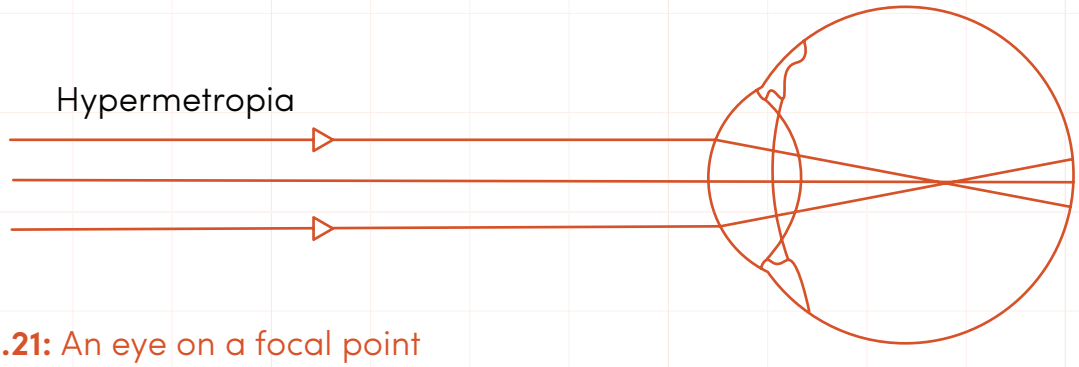


Fig. 1.21: An eye on a focal point

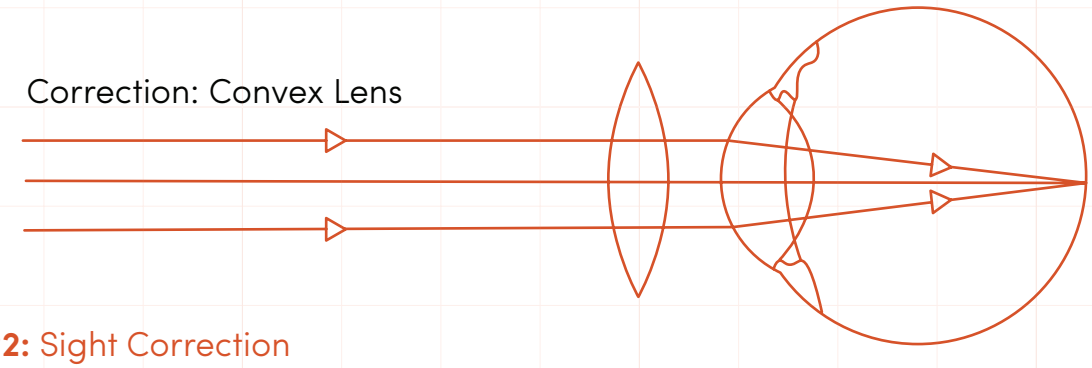


Fig. 1.22: Sight Correction

The near-point of an eye having hypermetropia is more than 25 cm. The condition of hypermetropia can be corrected by putting a convex lens in front of the eye. This is because when a convex lens of suitable power is placed in front of the hypermetropic eyes, then the convex lens first converges the diverging rays of light coming from a nearby object at the near point of the eye at which the virtual image of the nearby object is formed. Since the light rays now appear to be coming from the eye's near point, the eye-lens can easily focus and form the image on the retina. A convex lens is used for hypermetropia to increase the converging power of the eye-lens.

PRESBYOPIA

This defect of vision usually happens in old age when ciliary muscles become weak and can no longer adjust the eye-lens. The muscles become inflexible in this condition and cannot see nearby objects clearly.

The near-point of an old person having presbyopia is much more than 25 cm. Presbyopia can be corrected by wearing spectacles having a convex lens.

Another point to be noted is that a person can have both myopia and hypermetropia. In such a condition, spectacles having a bifocal lens are worn. The upper part of the bifocal lens is concave and the lower part consists of a convex lens.

CATARACT

A yet another defect of the eye which usually comes in old age is the cataract. The medical condition in which the lens of the eye of a person becomes progressively cloudy resulting in blurred vision. It develops when the eye-lens of a person becomes cloudy due to the formation of a membrane over it. It decreases the vision of the eye gradually and can lead to a total loss of vision of the eye. It can be restored after getting surgery. The opaque lens is removed and an artificial lens is inserted in its place via operation. This defect cannot be corrected by any type of spectacle lenses.

SUMMARY

So far, we have learnt how to

1. List the major sense organs and infer their locations.
2. Describe the organs of smell and taste.
3. Identify the different parts of the tongue associated with sweetness, bitterness, salty taste and sour taste.
4. Draw the skin showing the different receptors present.
5. Describe the structure of the mammalian ear.
6. Explain the functions of the ear-hearing, balance.
7. Describe the mammalian eye and explain the functions of its various parts.
8. Explain the functions of the eye: image formation and accommodation.
9. Explain the terms myopia, hyper metropia, astigmatism, cataracts, and night blindness.
10. Name the kind of lens that can be used to correct myopic and hypermetropia defects.

INTERACTIVE ASSESSMENT QUESTIONS

1. Which of the following statements are true?

   A Roots anchor the plant to the ground, absorb water and nutrients, and store
   B sugars and carbohydrates.
   C The stem carries water and nutrients to the leaves, moves food to other parts
   D of the plant, and provides support for the plant.
   E Leaves can be compound, made of a single leaf blade connected by a petiole the stem, or simple, divided into separate leaflets attached to the stem.
   Flowers have a stigma, a sticky knob at the top of the pistil, and the style, a long, tube-like structure, connected to the ovary, which contains ovules.
   Fruits are ripened ovaries that, after fertilization, swell and become either soft and fleshy, or hard and dry to protect the developing seeds.

2. Organs involve in the sensation of the body is known as _____

A Organ system
B Muscular system
C Nervous system
D Sense organs

3. _____ is the part of the eye which is involved in focusing light on the retina.

A Sclera
B Iris
C Cornea
D Ciliary muscles

4. The innermost layer of the human eye is _____

A Sclera
B Choroid
C Cornea
D Retina

5. Colour blindness is due to defect in _____

A Rods
B Cones
C Rods and cons
D Rhodopsin

6. Sense of smell is perceived by _____

A Pituitary
B Hypothalamus
C Olfactory lobe
D Cerebrum

7. Which of these is not one of the sense of taste_____

A Sandy
B Sweet
C Salty
D Sour

8. The two main layers of the mammalian skin are _____ and _____

9. The sense of smell and _____ are linked.

A taste
B sight
C feel
D sound

10. _____ is the pigment that gives the skin it colour.

A Melanin
B Chlorophyll
C Carotene
D Haemoglobin

11. The colourful part of the eye is known as _____

A Iris
B Cornea
C Pupil
D Eye ball

12. Find the incorrect match

A Middle ear – amplifies sound waves
B Hair cells – present on basilar membrane
C Saccule and utricle – maintain static equilibrium
D Cristae – performs hearing function

THEME 02

Organisms at Work

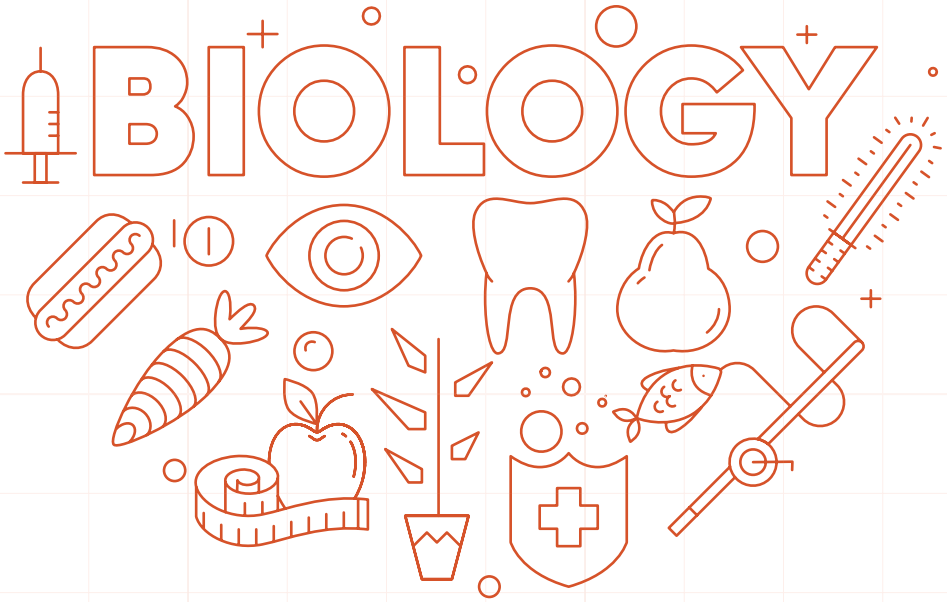
The Organism and Its Environment

Continuity of Life

ECOLOGY OF POPULATION

PERFORMANCE OBJECTIVES

1. Define the term succession.
2. Distinguish between primary and secondary succession.
3. Describe the series of changes which often culminate in a stable ecosystem.
4. Discover a definite sequence of plants colonization.
5. Describe the characteristics of a stable community and recognize the climax of succession.
6. Define the term overcrowding.
7. State factors that may cause overcrowding.
8. State the effects of overcrowding.
9. State measures adopted in nature to avoid overcrowding.
10. State the causes of food shortage.
11. List the effects of food shortage.
12. Infer that food has direct influence on mortality and animal population.



ECOLOGICAL SUCCESSION

This is a series of progressive changes in the composition of an ecological community over time.

It can also be defined as the process by which communities colonise an ecosystem and are then replaced over time by other communities. The process of succession may take millions of years.

Scientists refer to individual stages of an ecosystem's growth as "seral stages," and they refer to the entire process of succession as a "sere."

Succession may be initiated either by formation of new habitat (landslide or lava flow) or disturbance of already existing habitat (fires, land clearance).

STAGES OF SPECIES IN SUCCESSION

Pioneers/Colonisers: These are the species that thrive the new habitat at the beginning of ecological succession. They are the first species to occupy a new habitat, starting new communities. They have rapid reproductive strategies, enabling them to quickly occupy an uninhabited area. Many have an asexual stage to their reproduction. They are hardy species. Some lichens grow on rocks without soil, so may be among the first of life forms, and break down the rocks into soil for plants. Planktons, fungi, bacteria, lichens etc., are the pioneer species of ecological succession.

Intermediate: These are species which appear immediately after the pioneer and are later replaced by a climax community. Due to changes in the environment brought on by the growth of the grasses and other species, over many years, shrubs will emerge along with small pine, oak, and hickory trees. These organisms are called intermediate species.

Climax community: This is a community that has reached the stable stage. When extensive and well defined, the climax community is called a biome. They are the stable community that is reached, beyond which, no further succession occurs. The last seral stage in a process of biological succession is called a "climax community." Climax communities are much more stable environments than pioneer communities, and they support a much wider array of plant and animal life. A fully grown forest, for instance,

has many more habitats for animals than a field does. Many types of birds can nest in the trees, as can animals such as squirrels and chipmunks. Forests provide more shelter from the elements, and they provide habitats for larger animal species as well.
Examples are tundra, grassland, desert, and the deciduous, coniferous, and tropical rain forests.

Characteristics of a Stable Community

The characteristics that make a community stable include but not limited to the following.

1. Less variation in productivity from year to year.
2. Resistance or resilience to occasional disturbances (natural or man-made).
3. Resistance to invasions by alien species.
4. It should be able to restore itself in a short period of time.

Types of succession

1. Primary succession
2. Secondary succession

Primary succession

Biologists use the term "primary succession" to refer to the first time an area develops from bare rock into a fully developed ecosystem. The first step in an instance of primary succession involves lichens and physical weathering processes that break stone into soil. Only when soil is present can vegetation begin to grow in any quantity. Because the breaking down of rock into soil occurs so slowly, primary succession can take thousands of years.
This occurs when the starting point is a bare ecosystem, (e.g. following a volcanic eruption or a landslide). The pioneer species are usually lichen, moss or algae. They are able to penetrate the bare surface, trap organic material and begin to form humus. Over several generations soil begins to form. The soil can be used by a more diverse range of plants with deeper root systems. Gradually larger and larger plants occupy the ecosystem along with a diversity of animals.
Finally a climax community is reached and the species present do not change unless

the environment changes in some way.

An example of primary succession forming an oak woodland:

1. Bare rock is colonised by mosses and lichen.
2. Small plants, ferns and grasses take over.
3. Larger plants with deeper roots appear.
4. Bushes and shrubs replace non-woody plants.
5. Fast growing trees form a dense, low wood.
6. Larger, slow growing oak trees create the oak woodland.

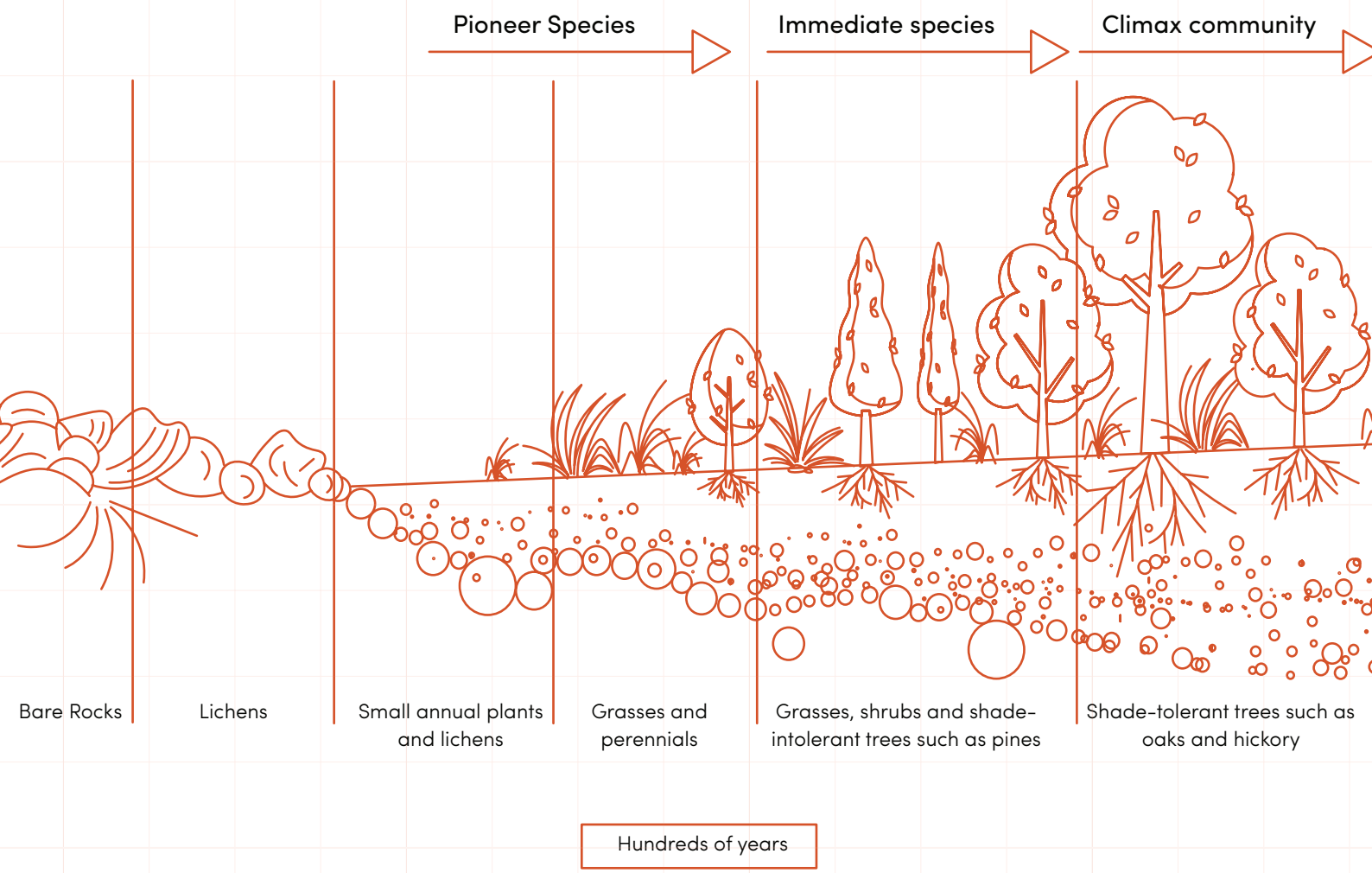
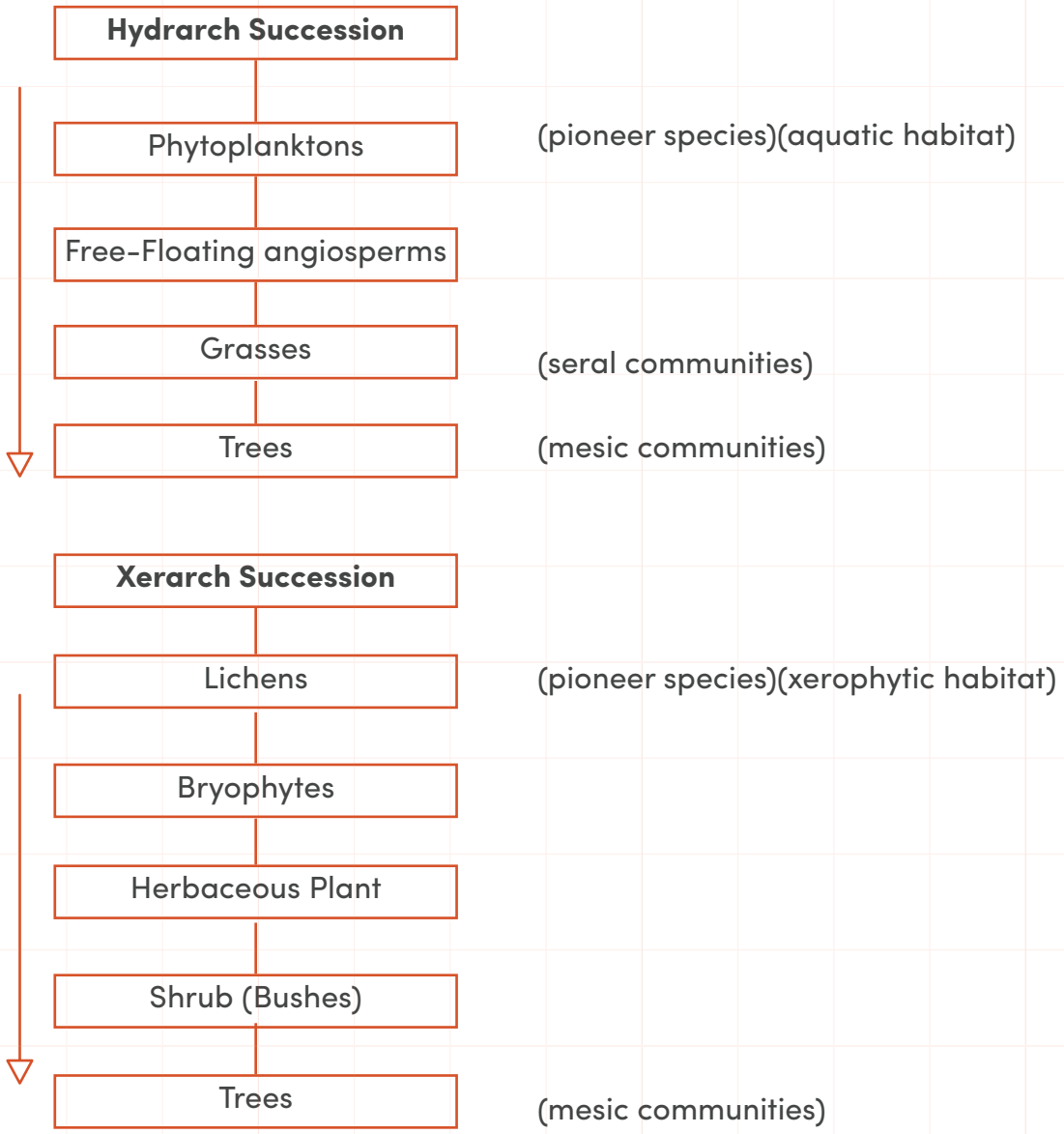


Fig. 2.1: A primary Succession in terrestrial habitat

This is an example of primary succession in a wet area



Secondary succession

Secondary succession refers to an instance of biological succession that occurs in an area where primary succession has already taken place and soil is already established. Normally, secondary succession happens when an ecosystem has suffered some catastrophe, such as a forest fire or a volcanic eruption.

Secondary succession also occurs when an area has been ruined by human activities, such as clear-cutting and slash-and-burn agriculture. Because soil is already

established, the process of secondary succession can be completed much more quickly than primary succession.

This occurs when the starting point is bare, existing soil, (e.g. following a fire, flood or human intervention). This type of succession proceeds in the same way as primary succession except that the pioneer species tend to be grasses and fast growing plants.

An example of secondary succession forming an oak woodland:

1. Bare soil is colonised by grasses and pioneer plants.
2. Grasses begin to predominate with time.
3. Shrubs replace the grasses.
4. Fast growing trees appear.
5. Slow growing oaks create the climax community.

In secondary succession, a previously occupied area is re-colonized following a disturbance that kills much or all of its community.

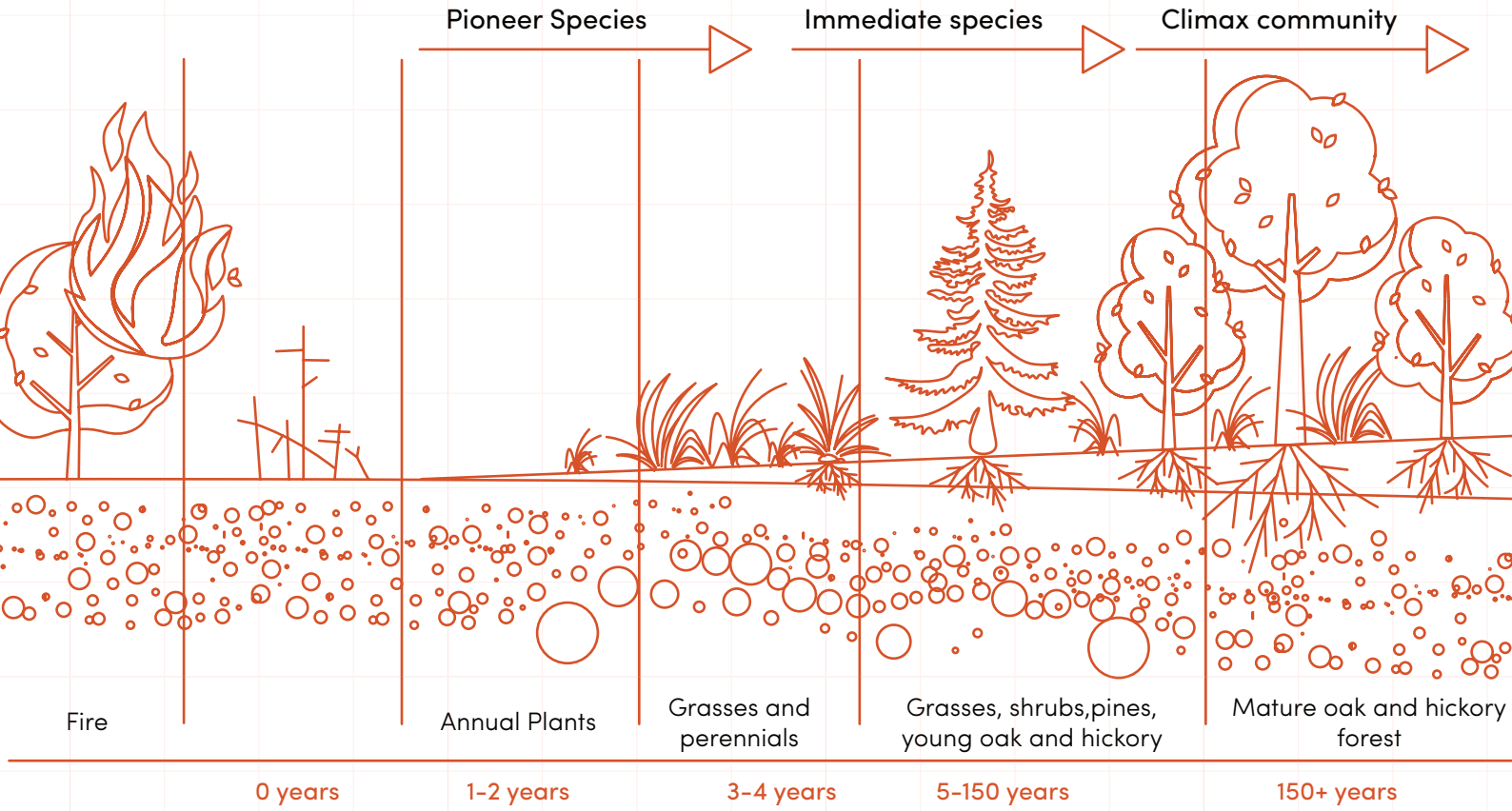


Fig. 2.2: An eye on a focal point

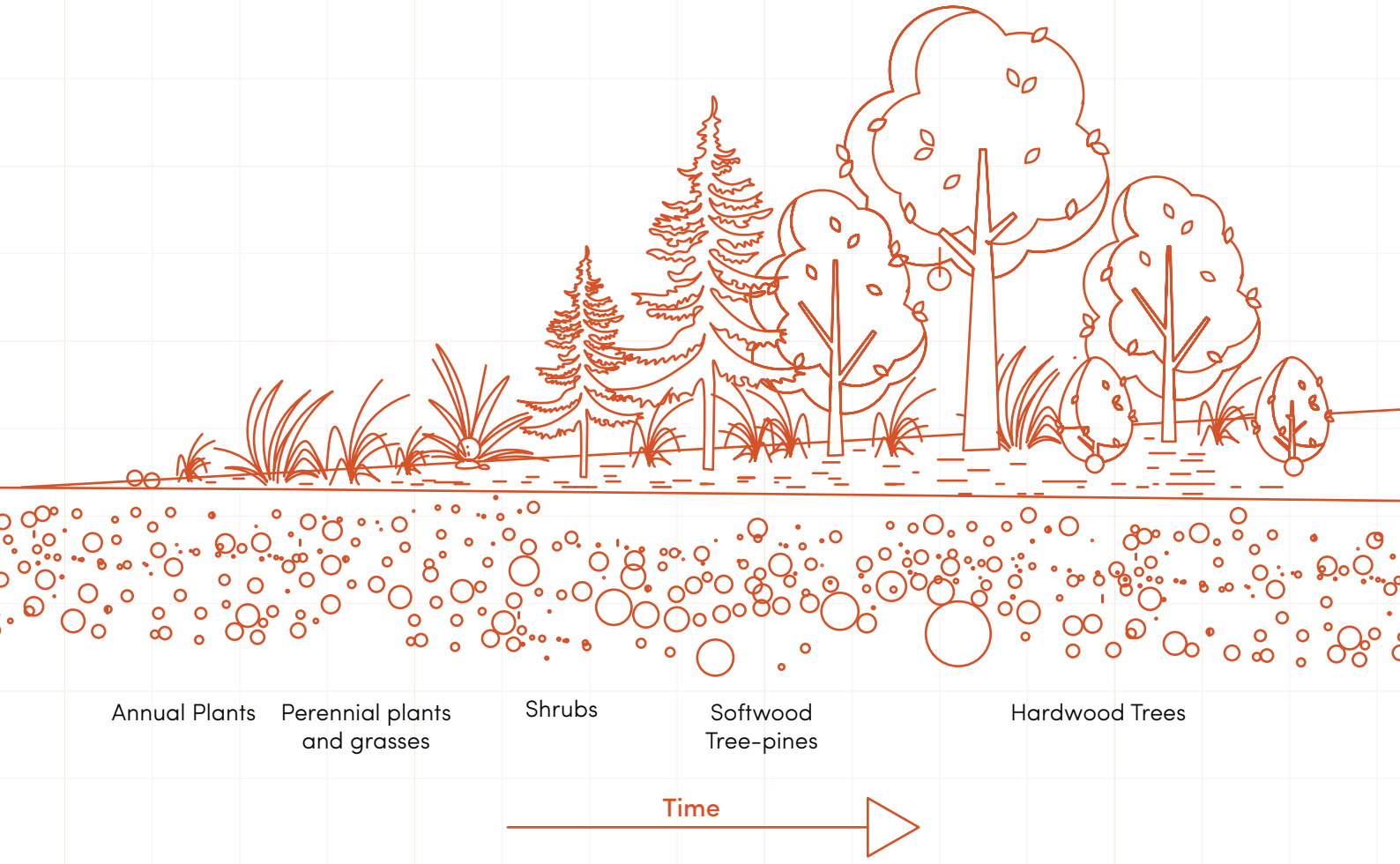


Fig. 2.3: A secondary succession forming an oak woodland

RELATIONSHIP BETWEEN COMPETITION AND SUCCESSION

Succession is the progressive natural development of vegetation towards climax, during which one community is gradually replaced by others. This replacement might be some form of competition. It stands to reason then that succession can only occur after there has been competition. The weaker organism is succeeded by the stronger one after competing.

Differences Between Competition and Succession

Competition	Succession
It occurs in all places inhabited by organisms	It occurs only in a particular area;
It is triggered off when resources are in short/ limited supply in an existing habitat	It usually starts within new habitats;
The replacement of an old population by a population is due to interspecific competition	Old population is gradually being replaced with new dominant population;
It has no end/ it continues	It ends when a stable or a climax community has been attained;
It speeds up succession	It provides basis for competition;
The replacement of one population by another in a given environment in a competition is due to 'survival of the fittest'	The replacement of one population by another in a particular area (is transitory and) leads to a climax or stable community.

OVERCROWDING

Overcrowding occurs when a population in a given habitat increases beyond a point where the resources in the habitat are not enough to support all the individuals in the habitat.

Population: This is a group of individuals of the same species that inhabit a shared environment.

In an ecosystem, the community is made up of many populations of different species

Population Density

Population density is defined as the number of individual organisms per unit area of the habitat. Mathematically, population density is expressed as:

Total population or population size/ Area of habitat

Population density can be used to estimate the total number of individual species of a population or population size.

Mathematically:

Population size = population density x area of habitat

Factors that may cause overcrowding

Natality and immigration are two important factors that add individuals to a population and so lead to overcrowding. The following factors may be responsible for overcrowding:

- **Increase in birth rate (Natality):** When there is an increase in the rate at which a particular specie gives birth in a restricted area, overcrowding will definitely take place.
- **Increase in food supply:** With increase in the supply of food to a particular habitat, there will be a corresponding increase in the population which will later result in overcrowding.
- **Decrease in death rate (Mortality):** If the rate at which organisms die in a habitat is very low compared to the rate at which they are being given birth to, the population will not reduce, hence overcrowding will take place.
- **Immigration:** The movement of animals into another habitat may result in overcrowding. Animals migrate for different reasons such as feeding, seasonal changes etc.
- **Lack of dispersal:** If the fruits or seeds of certain plants fall just under the tree and germinate there. This lack of dispersal causes overcrowding
- **Social habits:** Most social animals such as termites, ants and bees which continues to live and multiply in a colony increase the population until the area is overcrowded
- **Absence of predators:** When predators are absent, the population of some species (prey) can grow to such a level that overcrowding occurs.

MEASURES ADOPTED IN NATURE TO AVOID OVERCROWDING

(Adaptations to Avoid Overcrowding)

In nature, many organisms have adaptations to avoid overcrowding.

These are:

1. **Dispersal of seeds and fruits:** Dispersal is the movement, spread or transport of seeds or fruits away from the parent plant. Plants cannot move away if their habitat is crowded. Some plants naturally avoid overcrowding by dispersing their seeds/ fruits far and wide through agents like animals, water and wind. These various adaptations of seeds and fruits for dispersal prevent overcrowding.
2. **Migration:** Several factors necessitated the movement of animals from one habitat to another. For example many animals avoid overcrowding by moving out of the habitat with short supply of food to another habitat where there is abundance of food .This migration results in preventing overcrowding.
3. **Territorial Behaviour:** This is the method by which an animal, or group of animals protects its territory from invasion by others of its species. By marking out territories, individuals of a population are spaced out in their habitat, so that there is no overcrowding.

Effects of Overcrowding

Overcrowding do have effects on the organisms occupying the habitats. The effects of overcrowding include:

- **Shortage of space:** As a result of increase in the population of species, there would be lack of space for the organism.
- **Shortage of food:** The available food in the habitat is rapidly eaten up due to overcrowding and this eventually results in overcrowding and this eventually results in the shortage of food.
- **Competition:** Due to increase in the population with limited resources such as food and space, individuals have to compete among themselves to get these scarce resources. The stronger ones get these resources while the weaker ones are deprived of them.
- **Anti-social behaviour:** Most animals due to stress as a result of overcrowding resort to fighting or cannibalism.
- **Spread of diseases:** Diseases can easily spread in an overcrowded environment. For instance, tuberculosis in human which is an air-borne disease can easily be spread.

- **Preying on each other:** Animals in overcrowded environment have the tendency to prey or feed on each other especially when food is in short supply.
- **Death of organisms:** Death of some weaker organisms may occur in an overcrowded area as a result of non-availability of food and space. The stronger ones survive while the weaker ones die off.

FOOD SHORTAGE

In any habitat, the producers provide the food that supports all consumer species either directly or indirectly. Some factors bring about the decrease in the food supplies in the habitat resulting in food shortage.

Causes of food shortage

The following factors are responsible for food shortage:

1. Diseases
2. Pests
3. Drought
4. Flood
5. Bush burning
6. Poor storage facilities
7. Poor processing facilities
8. Overpopulation
9. War
10. Soil infertility.

Effectsof food shortage

Food shortage causes decrease in population sizes, this decrease is brought about by several factors such as:

1. **Mortality (Death rate):** This is the rate at which an individual of a specie dies within a given period of time. Food shortage increases the rate of mortality.
2. **Competition:** This is a relationship between organisms in which one is harmed

when both are trying to use the same resource related to growth, reproduction, or survivability. Competition stems from the fact that resources are limited. During food shorage, members of a population will compete with one another for the limited food available.

3. **Emigration:** This is the movement of members of a population away from its habitat to various other areas. During food shortage, organisms move away into another habitat.
4. **Low reproductive rate:** Food shortage lowers the rate of reproduction and delays sexual maturity.

NOTE: Food has a direct influence on mortality and population because the availability of food in a community will reduce the rate of mortality and increase the population of that community, all things being equal.

SUMMARY

So far, we have learnt how to

1. Define the term succession.
2. Distinguish between primary and secondary succession.
3. Describe the series of changes which often culminate in a stable ecosystem.
4. Discover a definite sequence of plants colonization.
5. Describe the characteristics of a stable community and recognize the climax of succession.
6. Define the term overcrowding.
7. State factors that may cause overcrowding.
8. State the effects of overcrowding.
9. State measures adopted in nature to avoid overcrowding.
10. State the causes of food shortage.

11. List the effects of food shortage.
12. Infer that food has direct influence on mortality and animal population.

INTERACTIVE ASSESSMENT QUESTIONS

1. Which of the following statements are true?

   A Roots anchor the plant to the ground, absorb water and nutrients, and store sugars and carbohydrates.

   B The stem carries water and nutrients to the leaves, moves food to other parts of the plant, and provides support for the plant.

   C Leaves can be compound, made of a single leaf blade connected by a petiole the stem, or simple, divided into separate leaflets attached to the stem.

   D Flowers have stigma, a sticky knob at the top of the pistil and the style, a long, tube-like structure, connected to the ovary, which contains ovules.

   E Fruits are ripened ovaries that, after fertilization, swell and become either soft and fleshy, or hard and dry to protect the developing seeds.

2. The two types of ecological succession are _____ and _____

3. The total number of organisms of the same species living together in a given area at a particular time is _____

   A Population
   B Populace
   C Population Density
   D Community

4. _____ is defined as the number of individual organisms per unit area of the habitat.

   A Population
   B Populace
   C Population Density
   D Community

5. During ecological succession, when are pioneer species found?

   A During early stages
   B During late stages
   C At the very end
   D Never

6. _____ involves the movement of individuals or animals out of their locality to another place for settlement in a new habitat

   A Immigration
   B Migration
   C Emmigration
   D Movement

7. _____ is defined as a situation which occurs when a population in a given habitat increase beyond a point where the resources in the habitat such as space and food are not enough to support all the individuals in the population.

   A Population
   B Overcrowding
   C Succession
   D Community

8. Which of these is not an anti-social behaviour in animals?

   A Fighting
   B Cannibalism
   C Predation
   D Reproduction

9. What type of succession occurs when a previously occupied area is re-colonized following a disturbance that kills much or all of its community?

   A Primary
   B Secondary
   C Pioneers
   D Intermediate

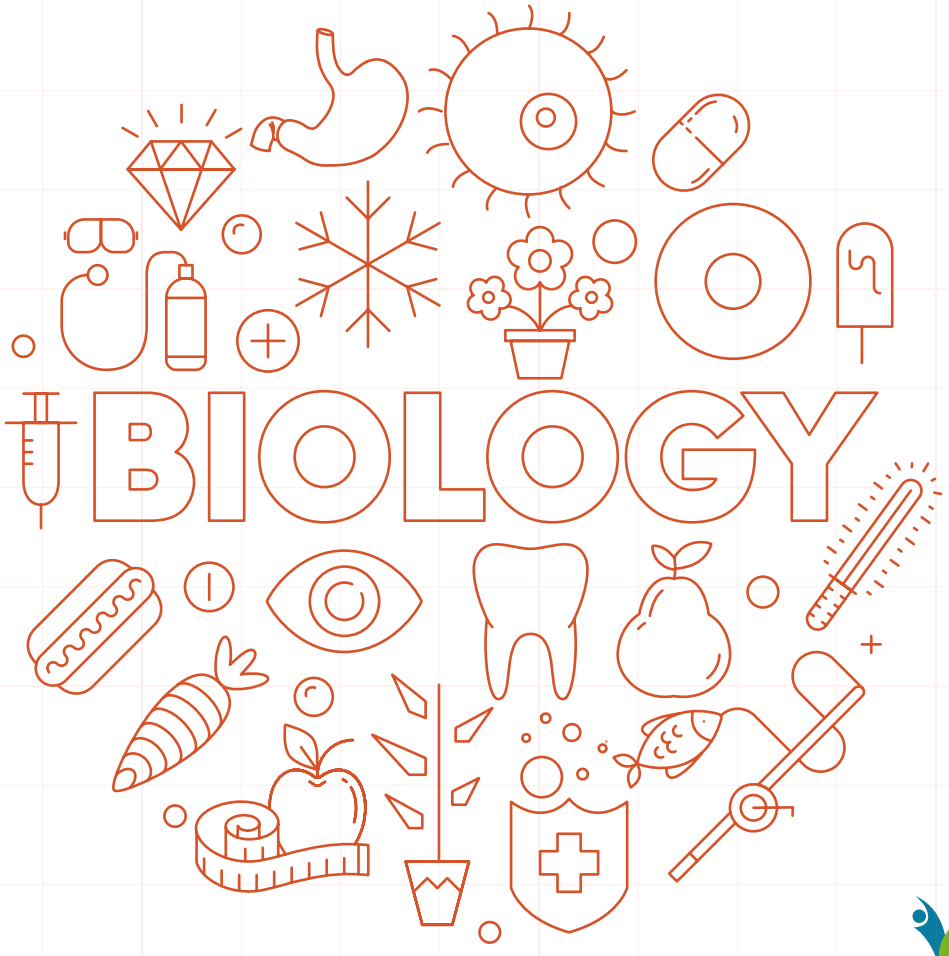
10. Which of these is not a pioneer specie?

   A Shrubs
   B Fungi
   C Bacteria
   D Lichens

BALANCE IN NATURE

PERFORMANCE OBJECTIVES

1. Recognise population as an integral part of the community.
2. List factors that may effect changes in population.
3. Explain the term dynamic equilibrium as related to different population in a climax community.
4. Recognise the approximately constant numbers of individuals in a population despite fluctuation.
5. List some family planning methods in human community.



MALEZI
EMPOWERING THOSE WHO CARE

Population is a group of individuals of the same species that inhabit a shared environment. A community is a group or association of populations of two or more different species occupying the same geographical area at the same time.
Communities include multiple co-existing, interacting populations of different species. Population is an integral part of the community.

Factors affecting population

In ecology, the interaction between plant and animals in an environment produces a stable and a balance system. A population is referred to as stable if the population size remains relatively constant.
There are many factors that contribute to the balance in nature; these factors are either abiotic or biotic

1. Abiotic factors these factors are:
    - Availability of space
    - Light
    - Heat
    - Oxygen (air)
    - Water
    - Food
2. Biotic factors: these factors are
    - Predators
    - Parasites
    - Diseases
    - Natality
    - Mortality
    - Territorial behaviour
    - Dispersal
    - Food
    - Competition (Inter specific or Intra-specific)

Intraspecific competition is an interaction in population ecology, whereby members of the same species compete for limited resources. Resources such as food, water, space, light, mates or any other resource which is required for survival or reproduction.

Interspecific competition occurs when members of different species compete for a shared resource. Members of the same species have rather similar requirements for resources, whereas different species have a smaller contested resource overlap, resulting in intraspecific competition generally being a stronger force than interspecific competition.

Dynamic Equilibrium in Nature and Factors that Maintain it

The biotic community in each ecosystem is composed of population of many species. In an ecosystem with a stable climax community, the population sizes of the various species are constant. For each species the population size fluctuates around the carrying capacity of the habitat for that particular species. The various populations in a climax community are said to be in balance or in dynamic equilibrium. The equilibrium is said to be dynamic because though the population remains constant, new individuals are being added while the existing ones are removed at the time. Rate of addition is equal to the rate of removal.

A factor which limits population growth is called limiting factor and the sum of all limiting factors is known as environmental resistance.

The net effect of these abiotic and biotic factors is that at a point, the population size of living organisms tends towards a dynamic equilibrium known as balance in nature. When the population increases, the environmental resistance increases too. This means that when population is on the increase, the available food tends to decrease. This calls for competition which will later lead to death of the weaker organisms, thereby keeping the population relatively constant.

Human beings are able to control the population by family planning and birth control whereas in nature, biological equilibrium is maintained by predator – prey relationship.

FACTORS THAT MAINTAIN DYNAMIC EQUILIBRIUM IN NATURE

Dynamic equilibrium in nature is maintained by two major factors that relate to density:

1. **Density –independent factors:** also called limiting factor, refers to any force that affects the size of a population of living things regardless of the density of the population (the number of individuals per unit area). Density-independent factors often arise from physical and chemical (rather than biological) phenomena. Some factors affecting growth of a population irrespective of its population density. Such factors stemming from weather and climate—as well as flooding, wildfires, landslides, and other disasters—affect a population of living things whether individuals are clustered close together or spaced far apart
2. **Density dependent factors:** these are factors that affect the growth of a population and are dependent on the number of individual in a population.

Examples Of density dependent factors are

a. Diseases
b. Predation
c. Competition
d. Parasitism

These factors have a greater effect on densely populated areas than sparsely populated area

For instance, as population increases food availability decreases and disease outbreak occur more frequently. These may lead to low birth rate and high mortality rate thereby reducing the population.

Therefore as population size increases, density dependent factors cause population growth to slow down and help check definite population growth.

FAMILY PLANNING.

In nature, population of living things grows exponentially until they meet with environmental resistance. Each population stabilizes at a certain size which can be supported by its habitats. The human population is however an exception to this usual situation. Through the effort of humans, the human population can be controlled through

birth control and family planning. A couple can plan when to have children and when not to have children even if they have sexual intercourse.

Family planning is therefore the use of birth control methods to determine the number and timing of children born in the family.

FAMILY PLANNING METHODS

There are two main methods of Birth control :

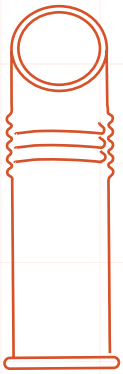
i. Natural Method
ii. Artificial Method

i. Natural methods:

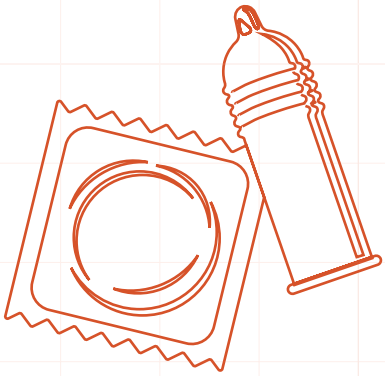
a. **Rhythm method:** This is also known as safe-period/calendar method. It based on the fact that in every menstrual cycle, there is a fertile period when ovulation is most likely to occur. For pregnancy to be prevented, sexual intercourse is to be avoided during the period. The fertile period may be from the 12th to the 16th day from the beginning of menstruation. This method however is most unreliable as many other factors such as emotional stress and illness may alter the length of the menstrual cycle.
b. **Withdrawal method:** this is also known as coitus interruptus. It involves the withdrawal of the penis from the vaginal just before ejaculation. This method is unreliable as some viable semen may enter the vagina before ejaculation.

ii. Artificial methods:

a. **Condom:** this is also known as a sheath. It is a thin rubber tube that is used to cover the erect penis before intercourse. A small teat at the end of the sheath collects the semen. If used properly, this method is quite reliable. It also helps to protect the user against diseases. The condom is impermeable and prevents germs from semen to get in contact with the vaginal wall and likewise germs from the vaginal wall of an infected female from entering the urethra of the male.



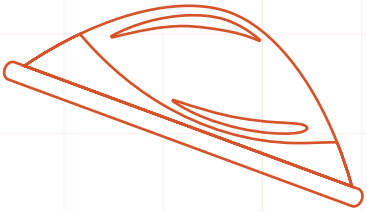
Female condom



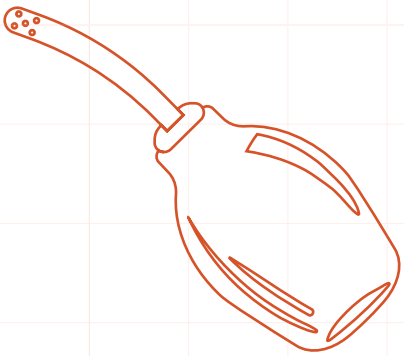
Male condom

Fig. 2.4: Female and Male Condoms

b. Diaphragm: this is dome –shaped rubber cap with an elastic rim. It is inserted into the top of the vaginal and placed over the cervix, thus preventing sperms from getting into the uterus. A spermicidal cream may be used together with the cap to kill the sperms.



Diaphragm



Contraceptive jell

Fig. 2.5: Diaphragm

c. Intra-uterine device (IUD): this is a coil or loop of plastic inserted into the uterus to prevent the implantation of the fertilised egg into the uterine wall.

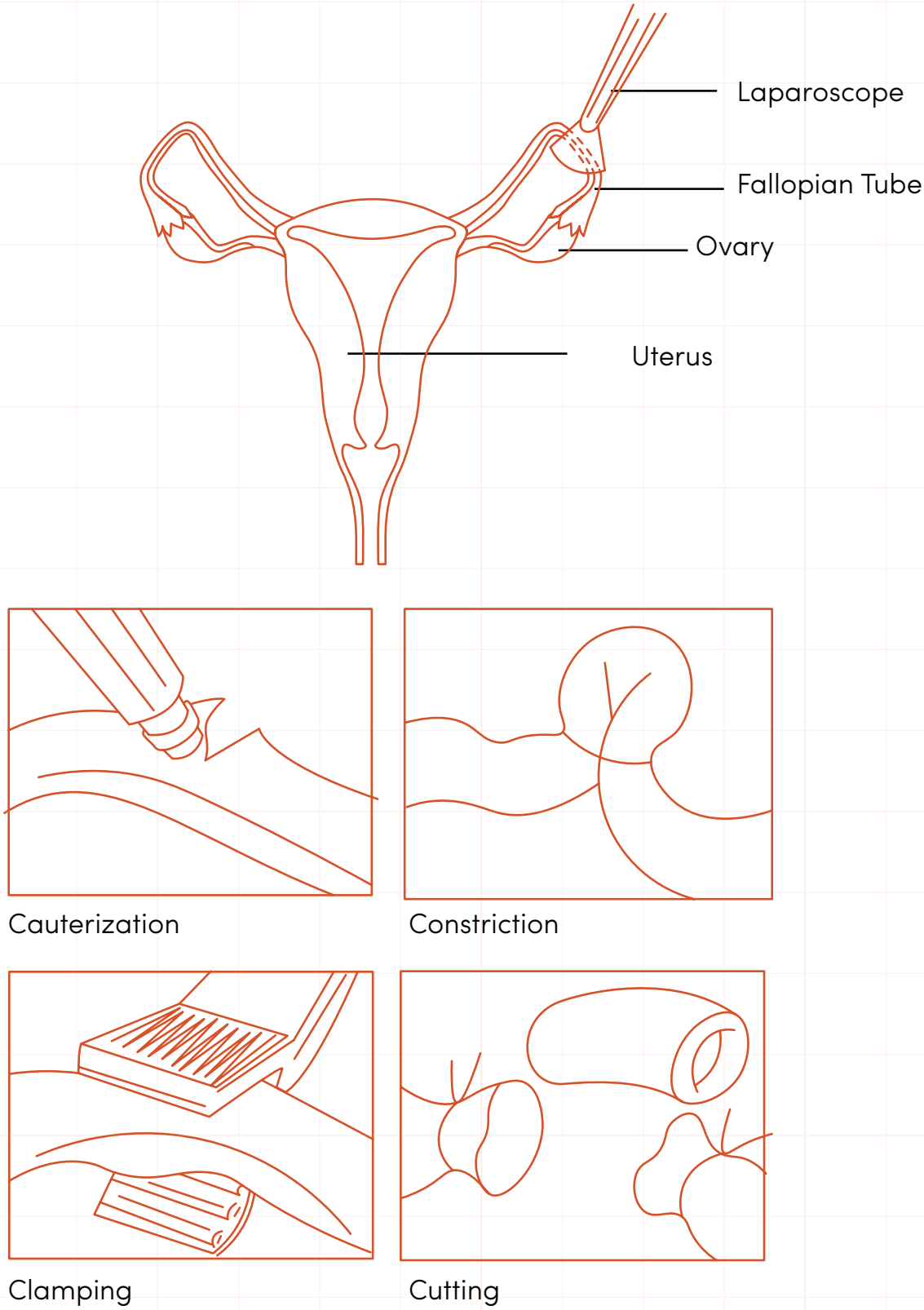


Fig. 2.6: Intra-uterine device (IUD)

d. Sterilization: This can be tubal ligation or vasectomy:

Tubal sterilization (tubal ligation) or female sterilization, is an operation to prevent pregnancy in which the fallopian tubes in the female reproductive system are closed off so that the eggs produced by the ovaries cannot be fertilized by sperm after

sexual intercourse. Surgeons typically use a laparoscope, a thin, hollow tube inserted via a tiny incision in the abdominal wall, in this procedure. The tubes may be closed off by a variety of methods including cauterization, searing the tubes closed with burning heat; clamping using plastic clips that remain in the body; constriction using a plastic band; or cutting away a section of the tube and tying off the severed ends.

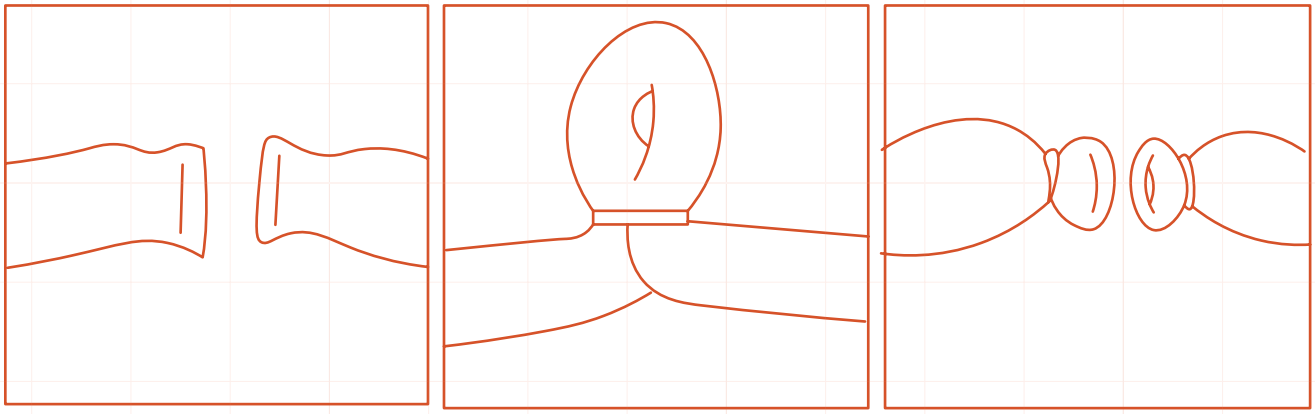


Fig. 2.7: Sterilization

e. **Vasectomy:** This is a surgical procedure for male sterilization or permanent contraception. During the procedure, the male vasa differentia are cut and tied or sealed so as to prevent sperm from entering into the urethra and thereby prevent fertilization of a female through sexual intercourse.

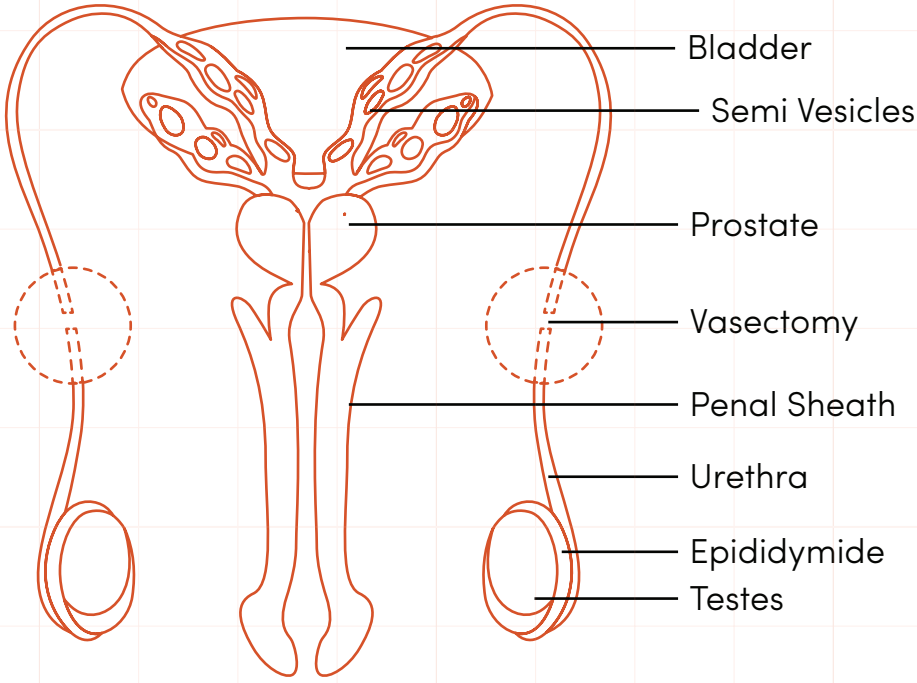


Fig. 2.8: Vasectomy

f. **Use of Spermicides:** These are chemical agents which are used to kill sperms. They may be in the form of a cream, jelly, foam or tablet. The spermicides are placed high into the vagina before intercourse. When used in conjunction with the diaphragm or condom, it offer greater protection

g. **Contraceptive pills:** These pills contain female sex hormones (oestrogen and progesterone like hormone) that prevent ovulation. One pill must be taken every 24 hours from the 5th to the 25th day from onset of menstruation. She then stops taking the pill for menstruation to occur. She repeats the cycle again from the 5th day. This methods is very reliable if instruction are duly followed

h. **Depo-Provera:** This is a well-known brand name for medroxyprogesterone acetate, a contraceptive injection that contains the hormone progestin. Depo-Provera is given as an injection every three months. It typically suppresses ovulation, keeping ovaries from releasing an egg.

SUMMARY

So far, we have learnt how to

1. Recognise population as an integral part of the community.
2. List factors that may effect changes in population.
3. Explain the term dynamic equilibrium as related to different population in a climax community.
4. Recognise the approximately constant numbers of individuals in a population despite fluctuation.
5. List some family planning methods in human community.

INTERACTIVE ASSESSMENT QUESTIONS

1. Which of the following statements are true?

   A Roots anchor the plant to the ground, absorb water and nutrients, and store sugars and carbohydrates.
   B The stem carries water and nutrients to the leaves, moves food to other parts of the plant, and provides support for the plant.
   C Leaves can be compound, made of a single leaf blade connected by a petiole the stem, or simple, divided into separate leaflets attached to the stem.
   D Flowers have stigma, a sticky knob at the top of the pistil and the style, a long, tube-like structure, connected to the ovary, which contains ovules.
   E Fruits are ripened ovaries that, after fertilization, swell and become either soft and fleshy, or hard and dry to protect the developing seeds.

2. Which of the following contribute to an increase in population size?

   A Decreased mortality rate
   B Increased emigration
   C Increased competition
   D Decreased reproductive capacity

3. _____ is the process by which the sperm duct of a man is cut off or tied up to prevent fertilization.

   A Preventive
   B Tubal ligation
   C Depo-Provera
   D Vasectomy

4. Family planning methods can be broadly divided into _____ and _____

State the answer

5. _____ is the process by which the fallopian tube of a woman is cut off or tied up to prevent fertilization.

A Preventive
B Tubal ligation
C Depo-Provera
D Vasectomy

6. Density-independent factors include the following except _____

A Availability of food
B Flood
C Drought
D Storm

7. The abiotic factors which affect population size include all of the following except _____

A Competition
B Temperature
C Water
D Space

8. The following are examples of artificial methods of family planning except _____

A Condom
B Rhythm method
C Ligation
D Contraceptive pills

9. Human beings are able to control the population by all of the following ways except _____

A Family planning
B Birth control
C Use of contraceptives
D Predator-prey relationship

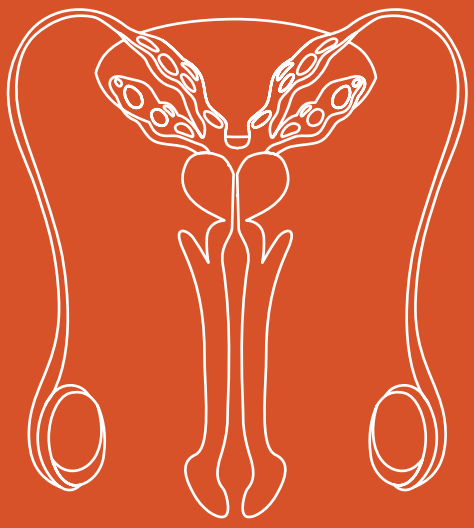
10. A factor which limits population growth is called _____

A Unlimiting factor
B Limiting factor
C Coordinating factor
D Biotic factor

11. What is the full meaning of I.U.D in family planning?

State the answer

THEME 03



Organisms at Work

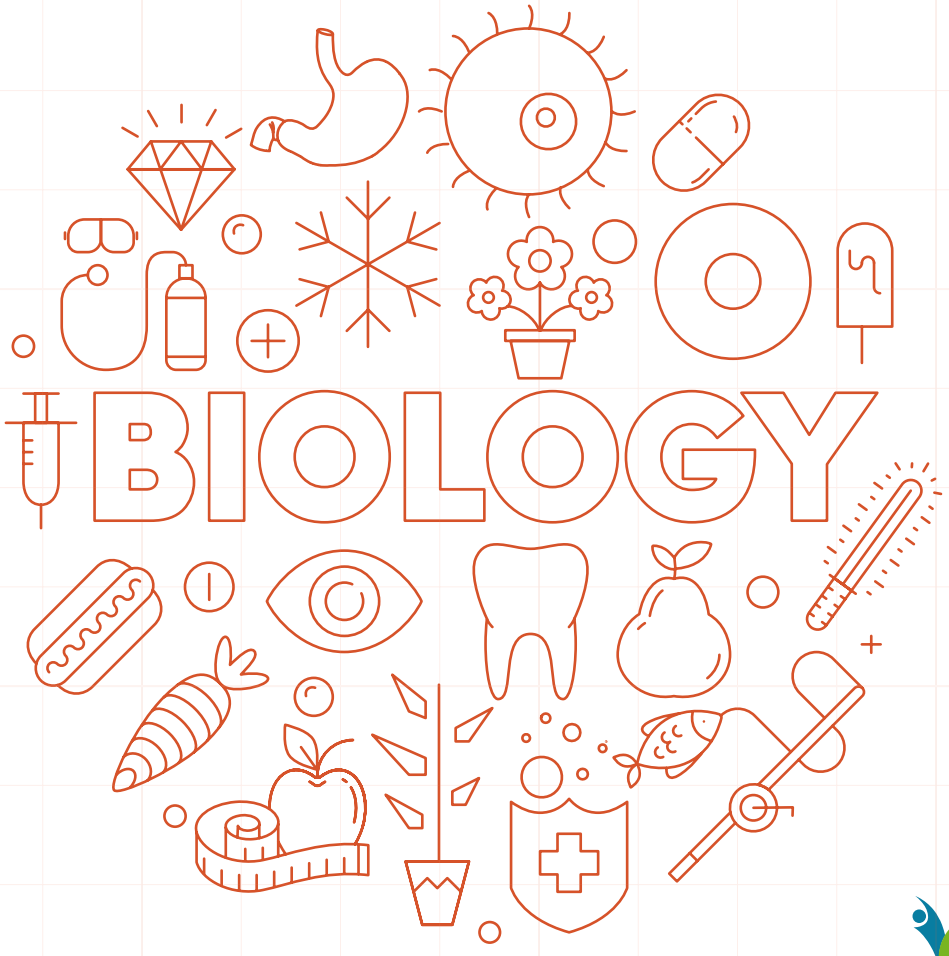
The Organism and Its Environment

Continuity of Life

REPRODUCTIVE SYSTEM AND REPRODUCTION IN HUMANS

PERFORMANCE OBJECTIVES

1. Identify the various parts of the male and female reproductive system in man.
2. Draw, label and describe the male and female reproductive organ in man.
3. State the function of the various parts of the male and female reproductive systems in man. Compare the structures
4. Draw, label and describe the structure of the male and female gametes(sperm and ovum)
5. Explain the process of fertilization in man and also, list the conditions necessary for survival



MALEZI
EMPOWERING THOSE WHO CARE

One of the characteristics of living things is their ability to produce young ones of their kinds. Every living thing reproduces its kind. Human beings also give birth to their young ones, etc. They do this by the process of reproduction.

Reproduction is the process by which living things produce their kinds. Mammals such as human beings reproduce their young ones and take care of them until they become independent.

The reproductive system in human are the most highly developed among the animals. Basically, the male and the female reproductive system consist of the gonads where the sex cell or gametes are produced, as well as glands that are involved in secretion of hormones and fluids essential for development and sexual process. It also consists of the internal genitalia which are contained within the abdominal cavity and the external genitalia which is found outside the body in the groin region

THE REPRODUCTIVE SYSTEM IN A MALE HUMAN

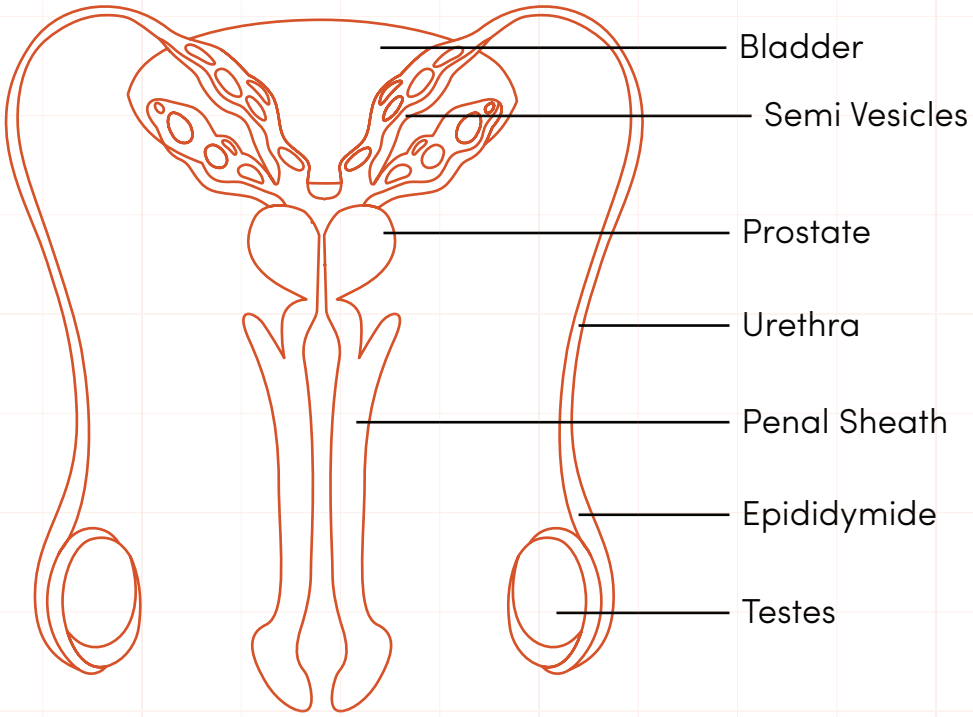


Fig. 3.1: A male reproductive system

The organs of the male reproductive system enable a man to have sexual intercourse and to fertilize female sex cells (eggs) with sperm. The gonads, called testicles, produce sperm. Sperm pass through a long duct called the vas deferens to the seminal vesicles, a pair of sacs that lies behind the bladder. These sacs produce seminal fluid, which mixes with sperm to produce semen. Semen leaves the seminal vesicles and travels through the prostate gland, which produces additional secretions that are added to semen. During male orgasm, the penis ejaculates semen.

The male reproductive system consists of the following organs

i. Testes
ii. Penis
iii. Vas deferens
iv. Urethra
v. Epidydimus
vi. Prostate gland, Cowper's gland and seminal vesicles

1. **The testes:** These are two oval structure situated in the scrotal sac. They are external and suspended in the posterior end of the abdominal cavity. They have descended into the scrotum at birth. They require temperature range of below 350C to function effectively. The testes contain coiled tubules called seminiferous tubes. This contains actively dividing cells that produce sperm cells. The seminiferous tubes continue and emerge into a spongy structure called epididymis atop the testes. This structure stores sperms produced in the testes. The cells of these tubules divide repeatedly to form sperm cells in a process called spermatogenesis. The testes produce the sperm- the male gametes. It also secretes the hormones testosterone, which is responsible for producing secondary sex characteristics in males as well as stimulating sperm production.
2. **Penis:** The penis is the male sex organ, reaching its full size during puberty. In addition to its sexual function, the penis acts as a conduit for urine to leave the body. An erection results from changes in blood flow in the penis. When a man becomes sexually aroused, nerves cause penis blood vessels to expand. More blood flows in

and less flows out of the penis, hardening the tissue in the corpus cavernosum. The urethra is a common duct for sperms and urine in the male, thus the penis is described as a urinogenital organ. The penis is covered with a sensitive skin called glans penis and retractable foreskin called the prepuce. This can be surgically removed during circumcision,

3. **Vas deferens:** this is called the sperm duct. This is a tube that connects the epidermis with the urethra. Sperm is stored here.
4. Male urethra : This is a narrow fibromuscular tube that conducts urine and semen from the bladder and ejaculatory ducts, respectively, to the exterior of the body
5. **Epididymis:** A set of profusely coiled tubule known as epididymis connects each testis to the vas deferens, which conveys the sperm cells to the seminal vesicle for storage until there is the need for ejaculation.
6. **Prostate glands:** Prostate gland whose main function is to secrete an alkaline fluid that comprises approximately 70% of the seminal volume. The secretions produce lubrication and nutrition for the sperm. This secretions also help to normalise acidic matters along the wall of the urethra. . Seminal fluid secreted by the prostate gland provides a medium for sperm cells to swim and be nourished. On ejaculation, the sperms are discharged to the outside through the urethra.
7. **Cowper's glands:** are pea sized glands present inferior to the prostate gland in the male reproductive system. They produce thick clear mucus prior to ejaculation that drains into the spongy urethra.
8. **Seminal vesicles:** are two small glands that store and produce the majority of the fluid that makes up semen. During ejaculation, the fluid from the seminal vesicles is expelled into the ejaculatory duct where it can then move on to mix with sperm and other reproductive fluids.

The human male gamete (spermatozoa)

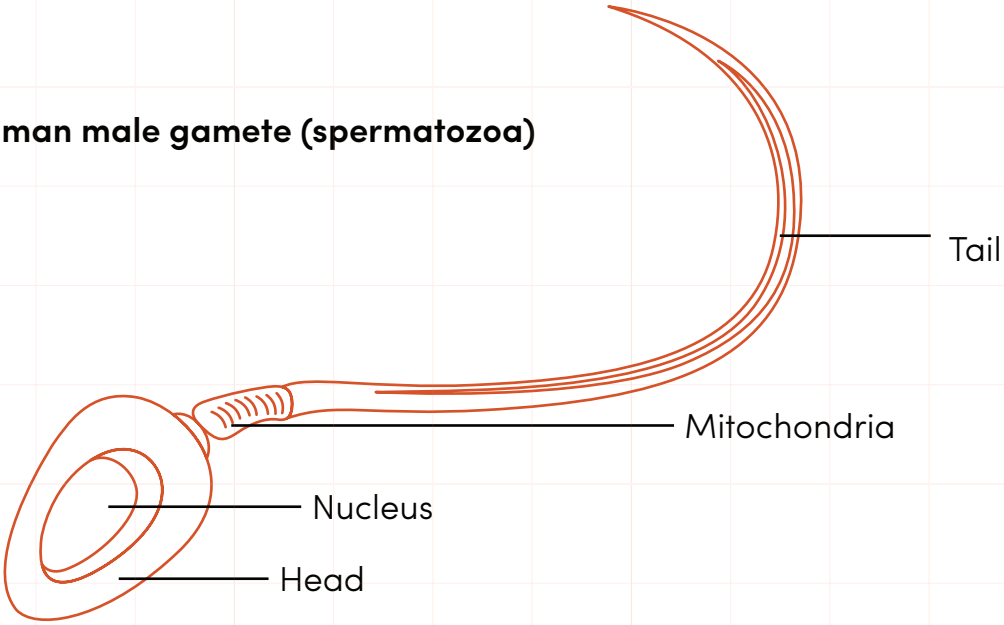


Fig. 3.2: A swimming spermatozoa

The male gametes, the spermatozoon is shaped like tadpole. It consists of a head with a nucleus having an apical acrosome, a middle piece containing mitochondria and a tail or flagellum. The whole sperm including the tail with which it moves inside the seminal –fluid is about 60µm long. A sperm cell is microscopic and is usually smaller than an egg (Ovum).

FEMALE REPRODUCTIVE SYSTEM

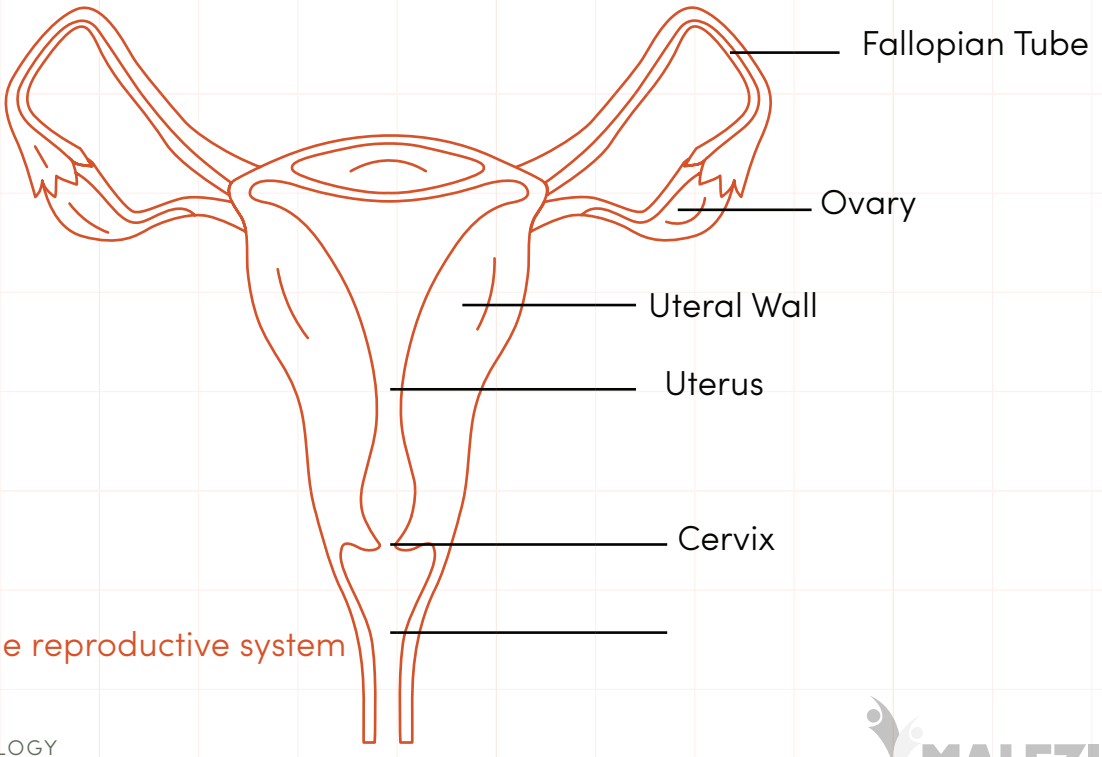


Fig. 3.3: A female reproductive system

The female reproductive system consists of the internal and external sex organs that take part in the production of new offspring. In humans, the female reproductive system is immature at birth and develops to maturity at puberty to be able to produce gametes, and to carry a foetus to full term. The female reproductive system consists of the following: Ovary, Oviduct, Uterus, Cervix, Vagina and Clitorris.

a. **Ovary:** The ovaries produce and release eggs (oocytes) into the female reproductive tract at the mid-point of each menstrual cycle. They also produce the female hormones oestrogen and progesterone. The shedding of mature ovum is called ovulation.
b. **Oviduct:** The passageway from the ovaries to the outside of the body is known as the oviduct. In female mammals this passageway is also known as the uterine tube or fallopian tube. The egg released by the ovary is received by the fallopian funnel. Fertilization occurs in the oviduct which opens to the uterus iii. Uterus (womb): The uterus is a hollow muscular organ located in the female pelvis between the bladder and rectum. It is the site for implantation. It opens to the vaginal through muscular ring called cervix. It has a glandular lining membrane for nourishing the embryo in the early stage of development. It also has smooth muscles in it concentration ultimately expels the foetus and its placenta.
c. **Cervix:** The cervix is the lower portion of the uterus, It connects the vagina with the main body of the uterus, acting as a gateway between them. It closes after fertilisation to avoid further entrance of sperm and foreign bodies.
d. **Vagina:** The vagina is an elastic, muscular canal with a soft, flexible lining that provides lubrication and sensation. The vagina connects the uterus to the outside world. The vulva and labia form the entrance, and the cervix of the uterus protrudes into the vagina, forming the interior end. It serves as the receptor of sperm cells ejaculated by male and an escape path for baby during delivery. It opens posteriorly to the vulva. There is a film of connective tissue called hymen that cover the vagina opening. This tissue can be easily removed by sexual activities or physical exercises.
e. **Clitoris:** this is a rod-like rudimentary structure analogous to the penis in the male. It is sensitive and erectile. It does not play any serious role in reproduction other than arousal. The clitoris is the pleasure center of the vulva.

NOTE: The urinary and the reproductive passage of human female are separate and they open separately to the exterior through external genitalia called vulva. Hence urino-genital organ are present in all mammals except in human female.

Human Female Gamete

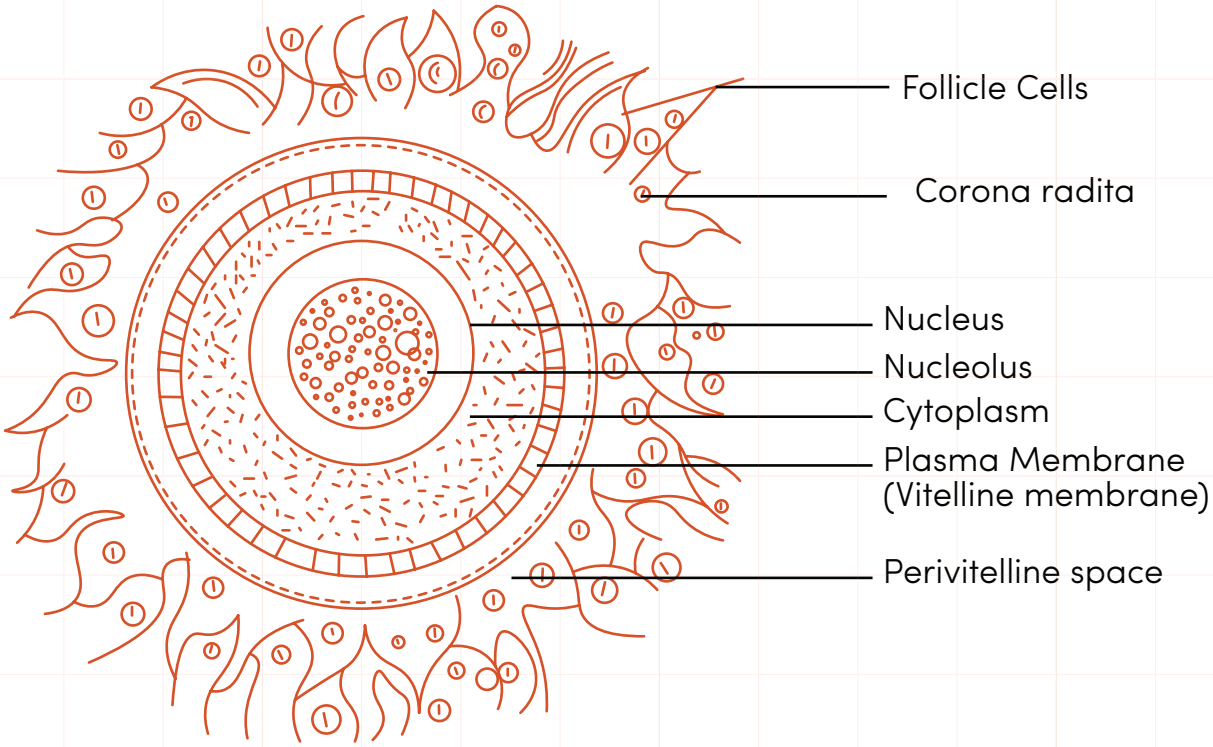


Fig. 3.4: Female gamete

Ovum, plural ova, is a single cell released from the female reproductive organs, the ovaries, which is capable of developing into a new organism when fertilized (united) with a sperm cell. The human female gametes (egg) are also microscopic but are larger than the sperm cell. Each ovum is about 0.1mm. in diameter. It consist of a cytoplasm, a nucleus l the centre, granules and yolk droplets. The yolk provide sources of nourishment for the embryo at least in its early stage of development.

The ovum's cytoplasm is surrounded by two membranes. The inner one is the plasma membrane, while the out one is the vitelline membrane. The ovum is bounded on the outside by a jelly coat of variable thickness made up of glycoprotein.

The nuclei of the sperm cell and the ovum contain chromosome which are treated like the material that carry genes. The genes are responsible for passing on the parents'

characteristics to the offspring. Each of the two gametes (sperm and ovum) is haploid. An individual ovum is visible to the naked eye and one of the largest single cells in the body. Across most animal species, eggs are bigger than sperm.

FERTILISATION

Fertilization is the fusion of the spermatozoa and an ovum. It takes place in the oviduct/ fallopian tube. In human, fertilisation is preceded by the process of sexual intercourse or coition, where a man discharges semen into the vagina. The semen of about 2cm3 which contains about 100million sperm cells is deposited in the vagina near the cervix of the uterus.

FUSION OF GAMETES

Spermatozoa discharged into the vagina during copulation swim up to the cervix into the uterus and up the fallopian tube where fertilization takes place.

When the sperm encounters the ovum, it usually digests the jelly covering of the egg by means of the enzyme contained in the acrosome. The sperm attaches itself to the layer of follicle cells outside the secondary oocyte known as corona radiate. There is a fusion of egg plasma and sperm plasma membrane. The yolk at the point where the sperm penetrate the egg bulges out to form a cone. Once the sperm penetrates the egg, the yoke change to a membrane known as vitelline membrane. One other very important event is that the tail of the sperm is lost and the middle piece disintegrates. The egg now travels down the fallopian tubes and the second meiotic division takes place consequently upon fusion of sperm with egg. It is noteworthy that once a sperm has entered the ovum, another sperm cannot enter it because of the development of a protective cortical layer.

IMPLANTATION

The zygote resulting from the fusion of the sperm cell and the egg contains the characteristic features of both the man and the woman involved in the sexual intercourse. The zygote under a number of cell division divides into two cells, four cells, eight cells,

etc. until a ball of cell known as blastocyst is obtained as it passed further down the fallopian tube on it way to the uterus. On reaching the uterus, it becomes embedded in the uterus wall which is thick and highly vascularized. This process is known as implantation and as a result the woman is pregnant

Implantation is the time when the fertilized egg successfully attaches and implants itself into the lining of the uterine wall such that it cannot be flushed out. Implantation usually occurs between 6–10 days after the egg is fertilized. It is the first stage of development of placenta. It involves the adhesion of the embryonic trophoblast (mitotically divided mass of cell at the early stage of embryonic development) and microvilli of the mother and embryonic cells.

DEVELOPMENT OF EMBRYO

The cells of the embryo grow and divide constantly. At first, they appear similar but later develop differing structures and functions. They eventually form various specialize tissue of a new individual. These tissues grow and extend in relation to each other, thus giving rise to the body organs which becomes easily recognizable in pregnancy. For example, the blood vessel and the heart develop within a month in the developing embryo.

Conditions necessary for the development of embryo include

i. The Placenta,
ii. The Amniotic fluid and
iii. The Umbilical cord.

Selective exchange of the materials between the mother and the child takes place in the placenta. In the course of the development of the embryo in pregnancy, an organ called placenta in formed. This a disc of tissue with projections adhering to the living of the uterus. It is formed between the embryo and the uterine wall. Through the placenta, nourishment and oxygen are obtained by the embryo from the mother and waste products such as carbon (IV) oxide and urea are removed.

Gestation

The period between fertilization and birth is called gestation or pregnancy. Compared to other mammals, primates have unusually long gestation periods and primate babies are born in a more mature state than other mammals. For example, nearly all primates are born with their eyes open, while most mammals do not open their eyes for days, or even weeks, after birth.

Human gestation, which lasts about nine months, is divided into **three trimesters**.

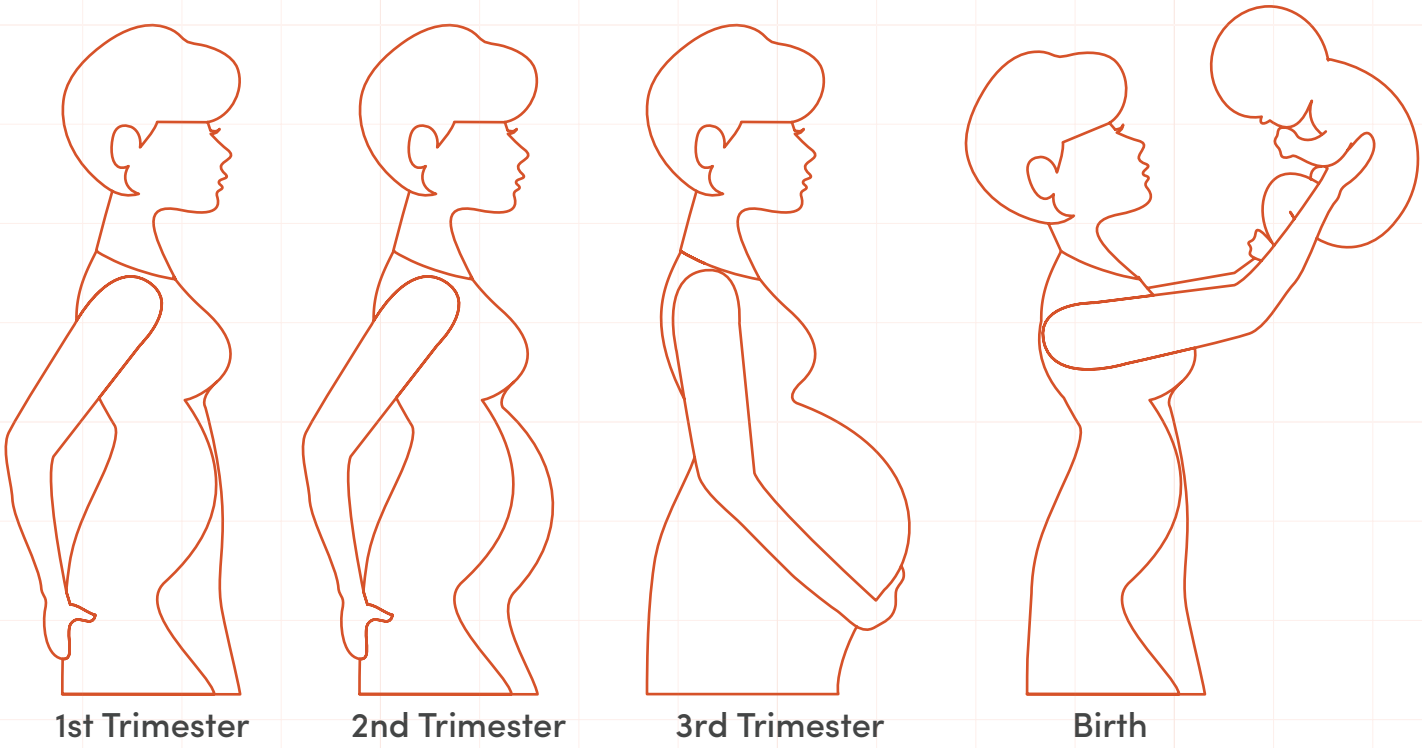


Fig. 3.5: Gestation

The developing baby is called an embryo for the first eight weeks, after which it is called a foetus. All of its major organs develop in the first trimester.

In the second trimester foetus shows obvious human features and grows quickly.

In the third trimester, the foetal organs mature.

All the exchanges between the embryo and the blood circulation of the mother take place by diffusion through the placenta

Functions of the placenta include the following:

a. **Fetal Protection:** It anchors the embryo in the uterus

b. **Gas Exchange:** Excretory product such as urea, salt and carbon (IV) oxide from the

embryo's blood diffuse into the mother's blood through it.

c. **Metabolic Transfer:** It serves as the conveyor of water, dissolved oxygen, nutrient, hormone and salt from the blood of the mother to that of the embryo.
d. **Hormone Secretion:** It also produces hormones which help the mother to adapt to pregnancy.

Although there is exchange of materials between the embryo and the maternal blood streams, the blood of the mother and that of the embryo never mix, otherwise the blood pressure of the mother would kill the embryo. Also the blood group of the embryo may not be the same as the mother and agglutination of the embryo blood could occur.

The embryo is attached to the placenta by a tube known as umbilical cord which contains the blood vessel of the embryo. It contains two umbilical arteries that carry deoxygenated blood from the foetus to the placenta. it also contains the umbilical vein that transport oxygenated blood and food substances from the placenta to the foetus.

The foetus has a system of membrane and fluids which help to protect and cushion it against shock.

These membrane system include

a. **The amnion:** It is the innermost membrane that is filled with amniotic fluid which serves the following functions.
    - Protects the embryo from rocking, shock and desiccation
    - It helps to maintain the internal temperature
b. **The chorion:** It is the outermost membrane. It absorbs oxygen through it porous walls.
c. **The allantois:** It is involved in respiration, nutrition and excretion through the placenta.

The foetus continues to grow in the uterus. At the end of the nine month of pregnancy, the baby is fully formed and is ready to be born. At the end of the gestation (nine months) the foetus comes to lie with its head downward just above the cervix of the uterus.

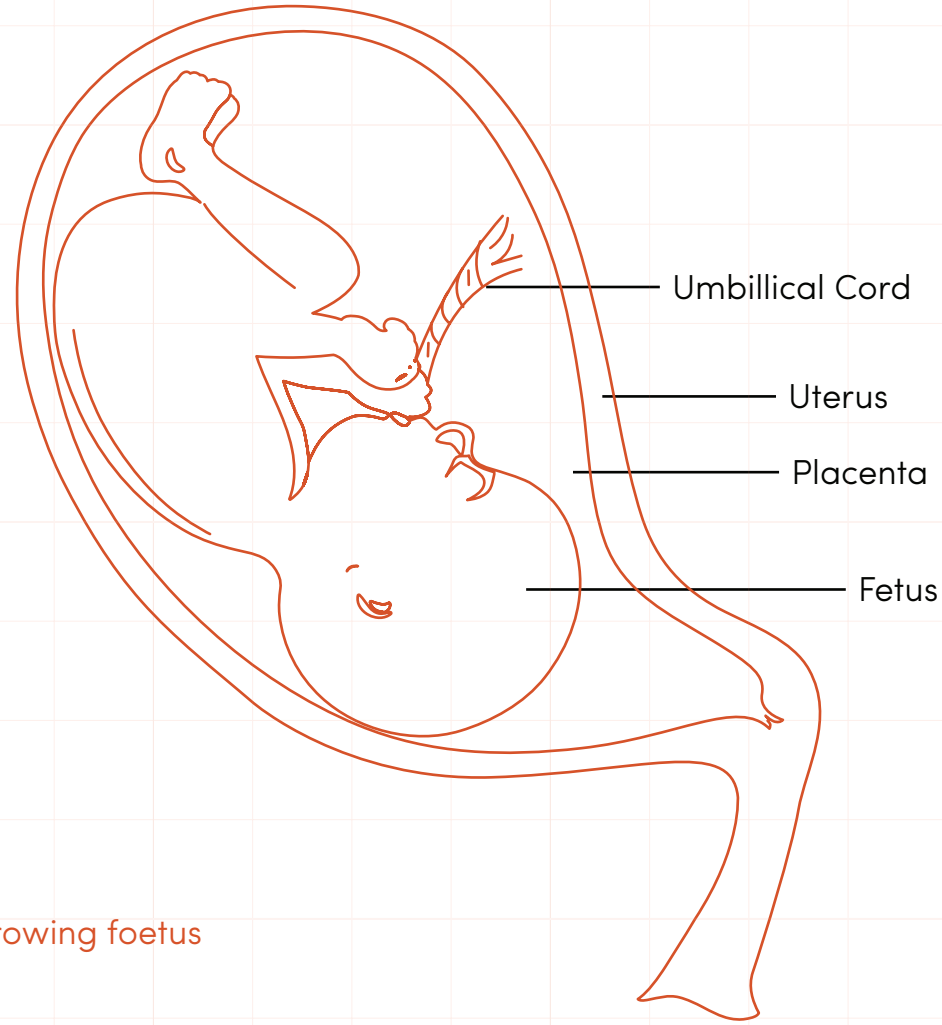


Fig. 3.6: A growing foetus

SUMMARY

So far, we have learnt how to

1. Identify the various parts of the male and female reproductive system in man.
2. Draw, label and describe the structures of the male and female reproductive organ in man.
3. State the function of the various parts of the male and female reproductive systems in man. Compare the structures
4. Draw, label and describe the structure of the male and female gametes(sperm and ovum)
5. Explain the process of fertilization in man.
6. List the conditions necessary for survival
7. Removal of excretory products from foetus

INTERACTIVE ASSESSMENT QUESTIONS

1. Which of the following statements are true?

   A The stem carries water and nutrients to the leaves, moves food to other parts of the plant, and provides support for the plant.
   B Leaves can be compound, made of a single leaf blade connected by a petiole the stem, or simple, divided into separate leaflets attached to the stem.
   C Flowers have stigma, a sticky knob at the top of the pistil and the style, a long, tube-like structure, connected to the ovary, which contains ovules.
   D Fruits are ripened ovaries that, after fertilization, swell and become either soft and fleshy, or hard and dry to protect the developing seeds.

2. After fertilization, the zygote increases in size and travels down the fallopian tube to become embedded in the walls of the womb. This process is known as_____

   A Ovulation
   B Implantation
   C Conception
   D Menstruation

3. Eggs/ Ova are produced in the _____

   A Kidneys
   B Gametes
   C Testes
   D Ovaries

4. This carries the ovum to the uterus_____

   A Vagina
   B Ovary
   C Cervix
   D Fallopian tube

5. Which of the following is not part of the female reproductive system?

A Vagina
B Urethra
C Prostate gland
D Ovary

6. Where in the female reproductive system is fertilization most likely to occur?

A Vagina
B Fallopian tube
C Uterus
D Cervix

7. _____ is the site for sperm maturation.

A Epididymis
B Ductus deferens
C Spermatic cord
D Urethra

8. The fluid from which of the following accessory gland neutralizes the acidity in a vagina of the female?

A Seminal vesicle
B Prostate gland
C Cowper's gland
D Urethra

9. _____ is an organelle that helps the sperm to penetrate the ovum.

A Acrosome
B Zona pellucida
C Megalis
D None of the above

10. The _____ is a temporary organ that connects a mammalian mother to its foetus

A Placenta
B Chorion
C Endometrium
D None of the above

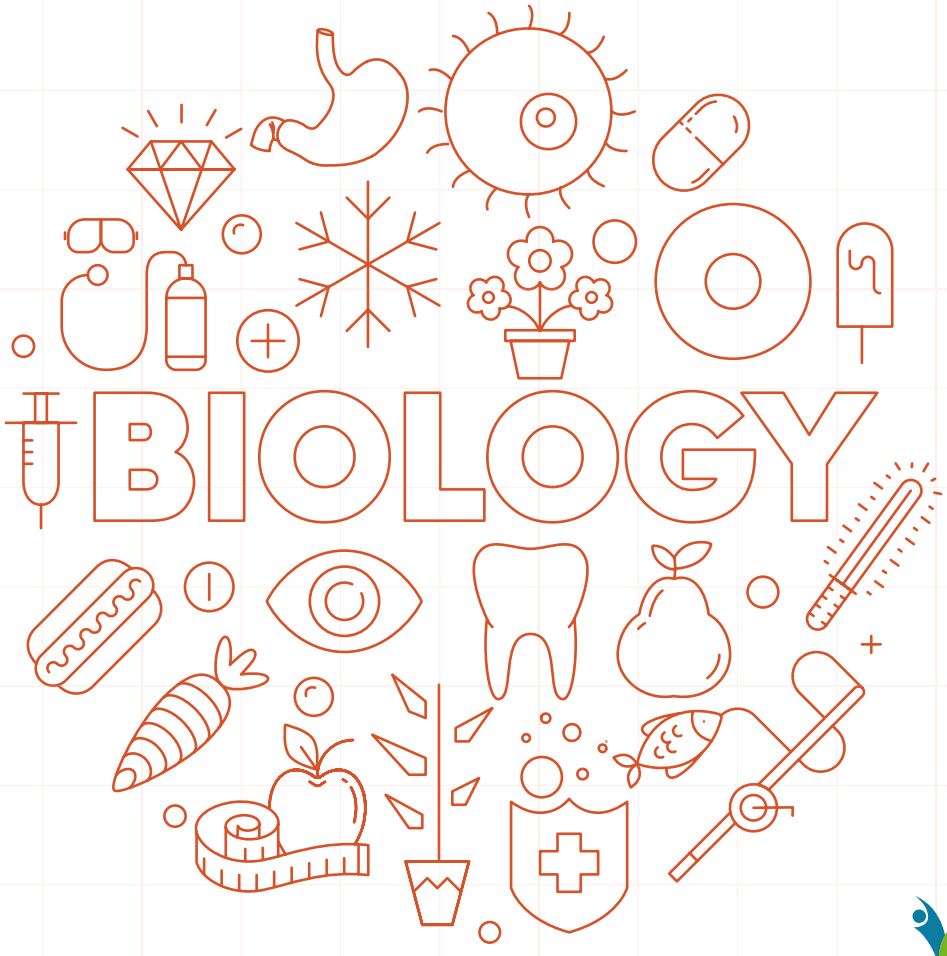
11. _____ is the innermost membrane that is filled with fluid which protects the embryo from rocking, shock and desiccation.

A Chorion
B Amnion
C Alantois
D Stomach

DEVELOPMENT OF NEW SEEDS

PERFORMANCE OBJECTIVES

1. Define fertilization
2. Draw and label the male and female reproductive parts involved in fertilization.
3. Describe the process of pollen development.
4. Process of development of zygote in the flowering plants.
5. Locate the position of embryo within the seed



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Seeds are plant parts containing embryo and this embryo give rise to new individual. Flower is the reproductive structure in flowering plants.There are two modes of plant reproduction: asexual reproduction and sexual reproduction. In asexual reproduction, offsprings are produced without meiosis or fusion of gametes and the plant multiplies through tubers, bulbs, corms and other vegetative parts while in sexual reproduction haploid egg and sperm fuse to form diploid zygotes, from which new seeds develop. Fertilization inside the flower often leads to the production of seeds which are capable of germinating into new plants.

PROCESS OF SEED DEVELOPMENT

Pollination is the first step in the process of sexual reproduction in flowering plants. It is followed by fertilization and development of zygote. These steps change the flower into a fruit enclosing seeds, the potential next plant

Pollination

This is the process whereby mature pollen grains are transferred from the anthers to the mature stigmas.

There are two types of pollination, They are:

1. Self pollination
2. Cross pollination

Self- Pollination

Self-pollination occurs when the pollen grains from a flower are transferred to the mature stigma of the same plant of the same species.

- Features of Self Pollinated Flowers
- Flowers are generally small.
- Flowers are less attractive.
- Flowers have no nectar.
- Fewer number of pollen grains are needed.

Cross Pollination

Cross pollination occurs when the pollen grains from one flower are transferred to the mature stigma of another plant of the same species.

Features of Cross Pollinated Flowers

i. Male and female reproductive parts occur in different flowers i.e. the flowers are unisexual
ii. If the plant is dioecious, then the male and the female flower occur on different plants of the same species.
iii. The flowers are brightly coloured.
iv. Pollen grains are light and smooth to float easily in the wind.
v. Anthers are often large and hinged on flexible filament. This arrangement makes it easy for pollen grain to be easily shaken off.
vi. Styles and stamen are long extending beyond the flower.
vii. Stigmas are often feathery for easy trapping of pollen in the air.

AGENTS OF POLLINATION

These include:

- Insects, birds, bats, and other animals
- Wind
- Water

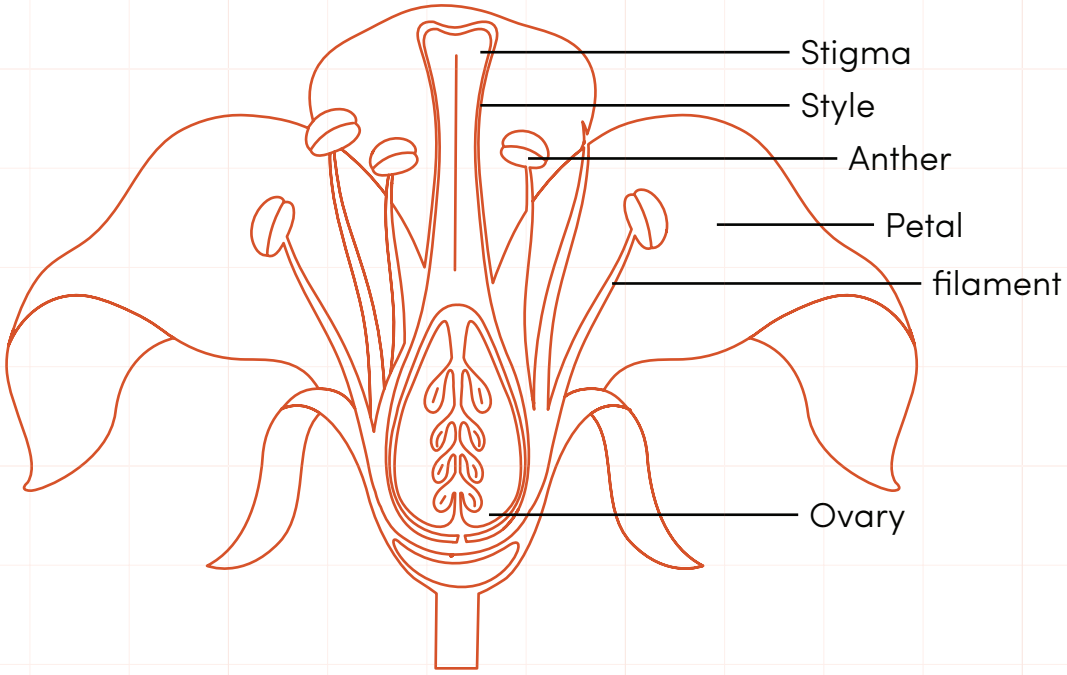


Fig. 3.7: Parts of a flower

PARTS OF A FLOWER

(From the image above)

a. **Petals:** This is a bright-coloured part that attracts pollinators (bees, insects, and birds.) Petals have different colours in different plants.

b. **Sepals:** Sepal is the green-coloured part beneath the petals. It protects rising buds.

c. **Stamen:** This is the male reproductive organ of the flower and is also known as Androecium. It is the pollen producing part of a flower. It consists of two parts namely: anther and filaments.

d. **The anther:** This is a yellowish, sac-like structure, where pollen is produced.

e. **The filament:** This is a slender stalk, threadlike object, which supports the anther.

f. **Pistil:** This is also known as carpels (group of carpels is known as gynoecium). The pistil is centrally located and usually consists of a swollen base (the ovary), which contains the potential seeds, or ovules .It consists of three parts -stigma, style and ovary.

g. **Stigma:** This is a stalk that supports the stigma and connects it to the ovary. It is the path through which pollen tubes travel to deliver sperm cells to the egg. It is the part of the pistil where pollen germinates.

h. **Style:** It is the stalk that supports and connects stigma to the ovary.

i. **Ovary:** This is the enlarged basal portion of the pistil, It is the organ that houses the ovules, which develop into seeds. It is the part of the plant where the seed formation takes place. The ovary itself develops into a fruit.

PROCESS OF POLLEN DEVELOPMENT

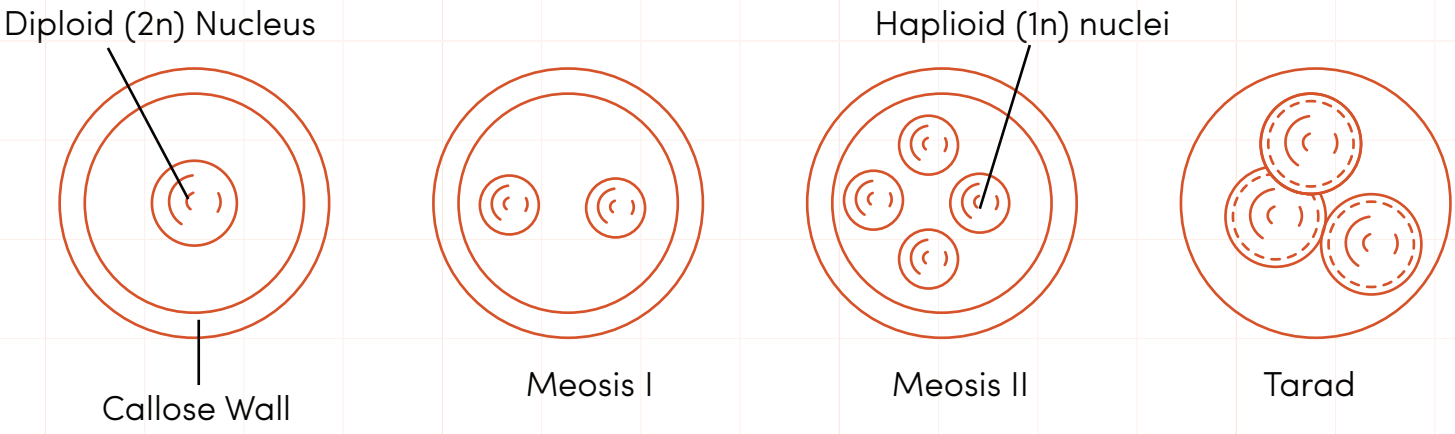


Fig. 3.8: Process of pollen development

Pollen grains are produced in the anther within a region known as pollen sacs.
In flowering plants the microspores develop into pollen grains, each containing a reduced, multicellular male gametophyte, each of this undergoes meiosis to produce four haploid micropores.The microspore divides by mitosis producing two cells: the generative cell and the tube cell. The members of each part of the microspores separate from each other and a double layered wall develops around each microspore. These steps occur in sequence and when complete, the microspores have become pollen grains, each consisting of four cells.

FERTILIZATION AND ZYGOTE DEVELOPMENT PROCESS IN FLOWERING PLANT

Fertilization is the fusion of male and female gametes. After pollination, a pollen grain sends out a pollen tube which can grow to where the egg cell is.

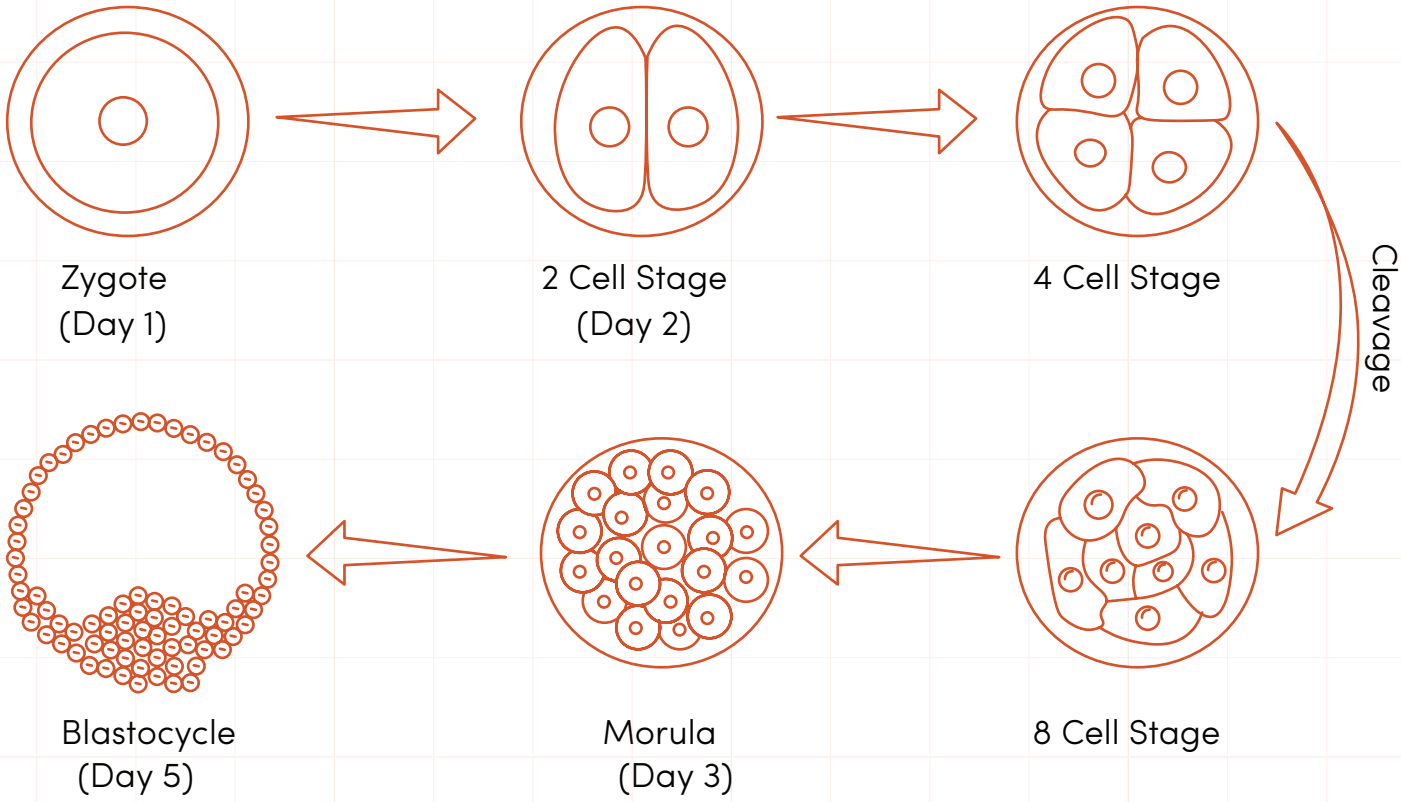


Fig. 3.9: Zygote development

Before germination, a pollen grain absorbs the sugary fluid secreted by the stigma and increases in size.

The intine grows out as a pollen tube through a pore in the exine.

Note: Energy needed for this process comes from the stored food in the pollen grain.

The pollen tube contains the tube nucleus at its tip followed by two male nuclei (gametes), formed by the mitotic division of the generative nucleus. The tube nucleus controls the growth of the pollen tube and as the tube grows, it secretes enzymes which digest the cells around it to provide the necessary nutrients and energy needed for its growth.

Eventually, the pollen tube enters the embryo sac, usually through the micropyle of the ovule. The tube nucleus then disintegrates and the two male nuclei(gametes) are released into the embryo sac. One of the male nuclei immediately fuses with the egg cell to form a diploid (2n) zygote and the other moves to the centre of the embryo sac and fuses with the two fused polar nuclei to form a triploid (3n) primary endosperm cell.

This process of double fertilization is unique to flowering plants.

NOTE: Usually more than one pollen tube grows down the style at the same time. However, only one tube enters an ovule. When the ovary has many ovules, a separate pollen tube enters each ovule.

After fertilization ,the other parts of the flower wither and fall off leaving behind the ovary which grows and develops as follows:

- Primary endosperm cell gives rise to the endosperm tissue. (nutritive endosperm) which is food source for developing embryo.
- Ovule becomes a seed.
- Ovary becomes a fruit.
- Zygote develops into an embryo. The zygote divides repeatedly by mitosis and the cells differentiate to form an embryo connected to the endosperm tissue.

Within the pollen tube are two nuclei and a pollen tube nucleus which is responsible for the development of the pollen tube. The moment the pollen tube reaches the ovule through the micropyle, the pollen tube nucleus disappears.

GERMINATION OF SEEDS

Germination is the stage when embryo develops into a seedling .It is also the sequence of events that begin with the hydration of the seed and result in the emergence of a new plant (seedling) .

A seed is a fertilized ovule of a flowering plant containing an embryo and capable of germination to produce a new plant

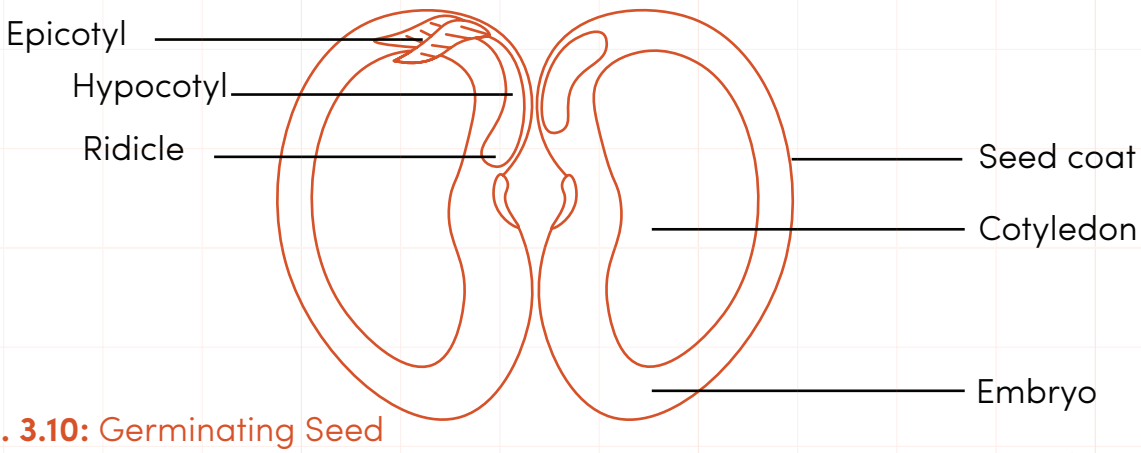


Fig. 3.10: Germinating Seed

A seed consists of:

a. **Seed coat:** This consists of one or more protective layers that encase the seed
b. **Embryo:** This is the young multicellular organism before it emerges from the seed
c. **Plumule:** This is the part of a seed embryo that develops into the shoot bearing the first true leaves of a plant.
d. **Hypocotyl:** The hypocotyl (short for "hypocotyledonous stem"), meaning "below seed leaf" is the stem of a germinating seedling, found below the cotyledons and above the radicle which will grow into the stem.
e. **Epicotyl:** This means above the cotyledon(s), It is a part of a seedling, the point along the embryonic shoot (the stem from which everything grows.
f. **Radicle:** This is the first part of a seedling to emerge from the seed during the process of germination. It is the embryonic root of the plant, and grows downward in the soil which will grow into primary root.
g. **Endosperm:** This is a source of stored food, for the growing seed, consisting primarily of starches.

TYPES OF GERMINATION

There are two types of germination:

1. Epigeal germination: This is when the hypocotyl grows rapidly and elongates carrying the cotyledon above the soil where they carry out photosynthesis before the first foliage leaves develop.

   Epigeal germination is also referred to as a type of germination in which the cotyledon is carried above the soil. Examples of plants with epigeal germination are in dicots
2. Hypogeal Germination: Hypogeal germination is the type of germination in which the cotyledons remain in the soil. Examples of plants with hypogeal germination are in monocots.

Differences between Epigeal And Hypogeal Germination

Epigeal germination	Hypogeal germination
Hypocotyl elongates	Epicotyl elongates
Cotyledon emerges out of the soil	Cotyledon remains in the soil
Cotyledon(s) turns green/ photosynthesis	Cotyledons do not photosynthesis
Plumule does not emerge simultaneously with the radical	Plumule emerges simultaneously with the radical
Food/energy derived from cotyledon	Food/energy derived from endosperm

Conditions Necessary for Germination

External conditions	Internal conditions
i. Availability of water,	i. Enzymes
ii. Temperature/warmth and	ii. Energy/food and
iii. Availability of oxygen	iii. Viability of seed

SEED DORMANCY

This is an inactive period of a seed during which growth slows/completely ceases due to certain internal or external factors.

SUMMARY

So far, we have learnt how to

1. Define fertilization
2. Draw and label the male and female reproductive parts involved in fertilization.
3. Describe the process of pollen development.
4. Process of development of zygote in the flowering plants.
5. Locate the position of embryo within the seed

INTERACTIVE ASSESSMENT QUESTIONS

1. Which of the following statements are true?

   A Roots anchor the plant to the ground, absorb water and nutrients, and store sugars and carbohydrates.
   B The stem carries water and nutrients to the leaves, moves food to other parts of the plant, and provides support for the plant.
   C Leaves can be compound, made of a single leaf blade connected by a petiole the stem, or simple, divided into separate leaflets attached to the stem.
   D Flowers have stigma, a sticky knob at the top of the pistil and the style, a long, tube-like structure, connected to the ovary, which contains ovules.
   E Fruits are ripened ovaries that, after fertilization, swell and become either soft and fleshy, or hard and dry to protect the developing seeds.

2. Seeds develop from _____

   A Ovary
   B Embryo
   C Ovule
   D Embryo Sac

3. During seed germination, seed coat ruptures due to _____

A Differentiation of cotyledons
B Massive glycolysis in endosperm and cotyledons.
C Sudden increase in cell division.
D Massive imbibition of water

4. Seed dormancy allows the plants to_____

A Overcome unfavourable climate conditions.
B Develop healthy seeds
C Reduce viability
D Prevent deterioration of seeds

5. Fruits are mature _____ while seeds are mature _____

State the correct answer

6. The transfer of mature pollen grains from the anther to the stigma is called _____

A Fertilization
B Pollination
C Adoption
D Diffusion

7. The fusion of female reproductive nucleus with the male reproductive nucleus is known as _____

A Regeneration
B Excretion
C Fertilization
D Pollination

8. The two nuclei at the end of the pollen tube are called_____ and _____

A Tube and generative
B Sperm and ovum
C Generative and stigma
D Tube and sperm

9. The male reproductive parts of a flower, the stamens are collectively known as _____

A Androecium
B Filament
C Anther
D Gynoecium

10. Another name for gynoecium is _____

A Pistil
B Stigma
C Androecium
D Style

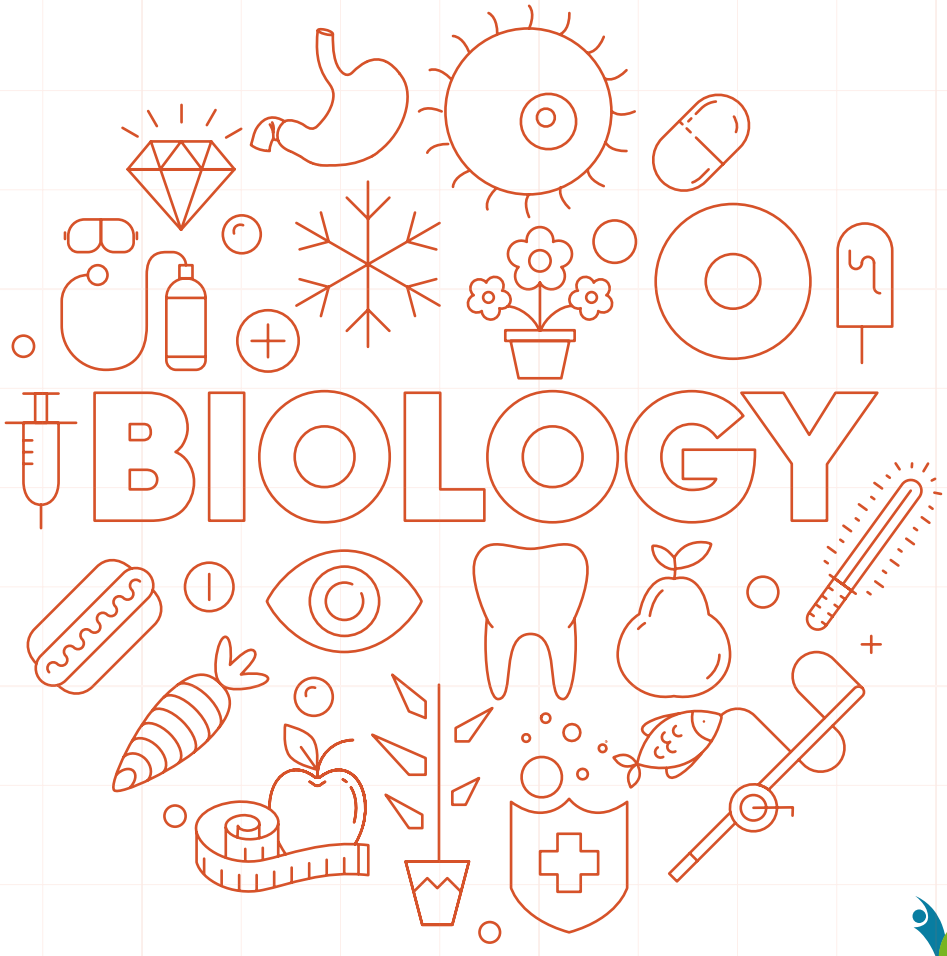
11. _____ is a source of stored food for the growing seed.

A Plumule
B Radicle
C Embryo
D Endosperm

FRUITS

PERFORMANCE OBJECTIVES

1. Distinguish between fruits and seeds
2. State various types of fruits
3. Classify fruits
4. State the ways fruits are
5. Dispersed
6. Describe the features that adapts fruits to their modes of dispersal



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FRUITS

A fruit is a matured fertilized ovary of a flower containing one or more seeds.

It is worthy of note that some plants do not undergo fertilization before the formation of their fruits. Such fruits are called parthenocarpic fruits e.g. banana and pineapple.

PARTS OF A FRUIT

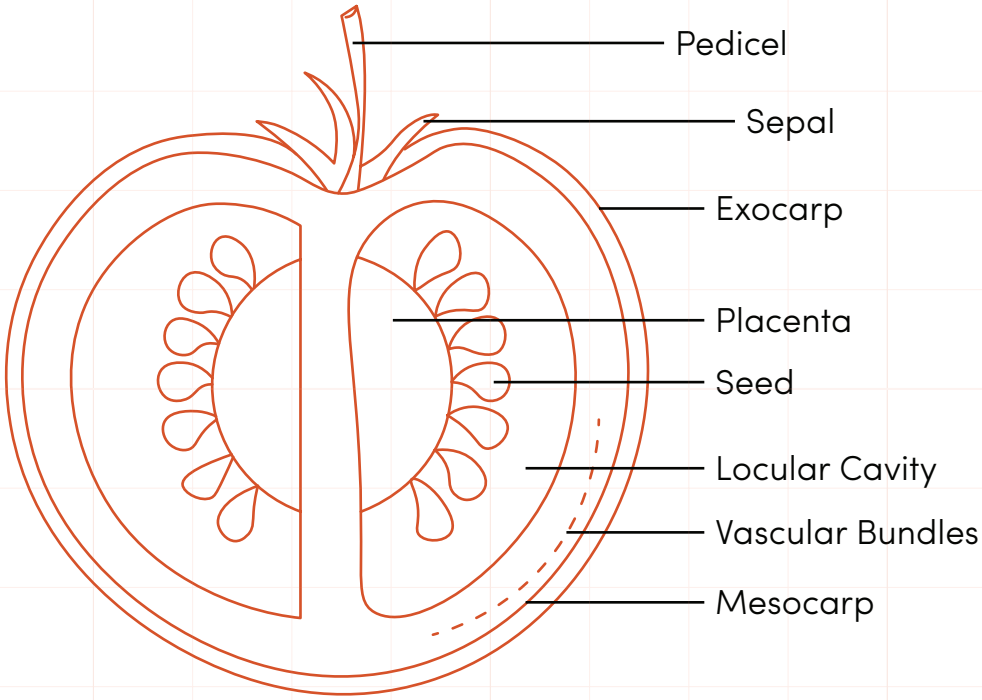


Fig. 3.11: Case Study: Tomato

A typical fruit has two main parts: Pericarp and Seed(s).

1. **Pericarp:** This is the fruit wall which is formed from the wall of the ripened ovary. In most fruits, It is made up of three layers: Epicarp, Mesocarp and Endocarp.
2. **Epicarp (Exocarp):** This is the outermost layer of the pericarp.
3. **Mesocarp:** This is the middle layer of the pericarp of a fruit, between the endocarp and the epicarp.
4. **Endocarp:** This is the innermost layer of the pericarp which surrounds a seed in a fruit. It may be membranous (as in apples) or woody (as in the stone of a peach or cherry).

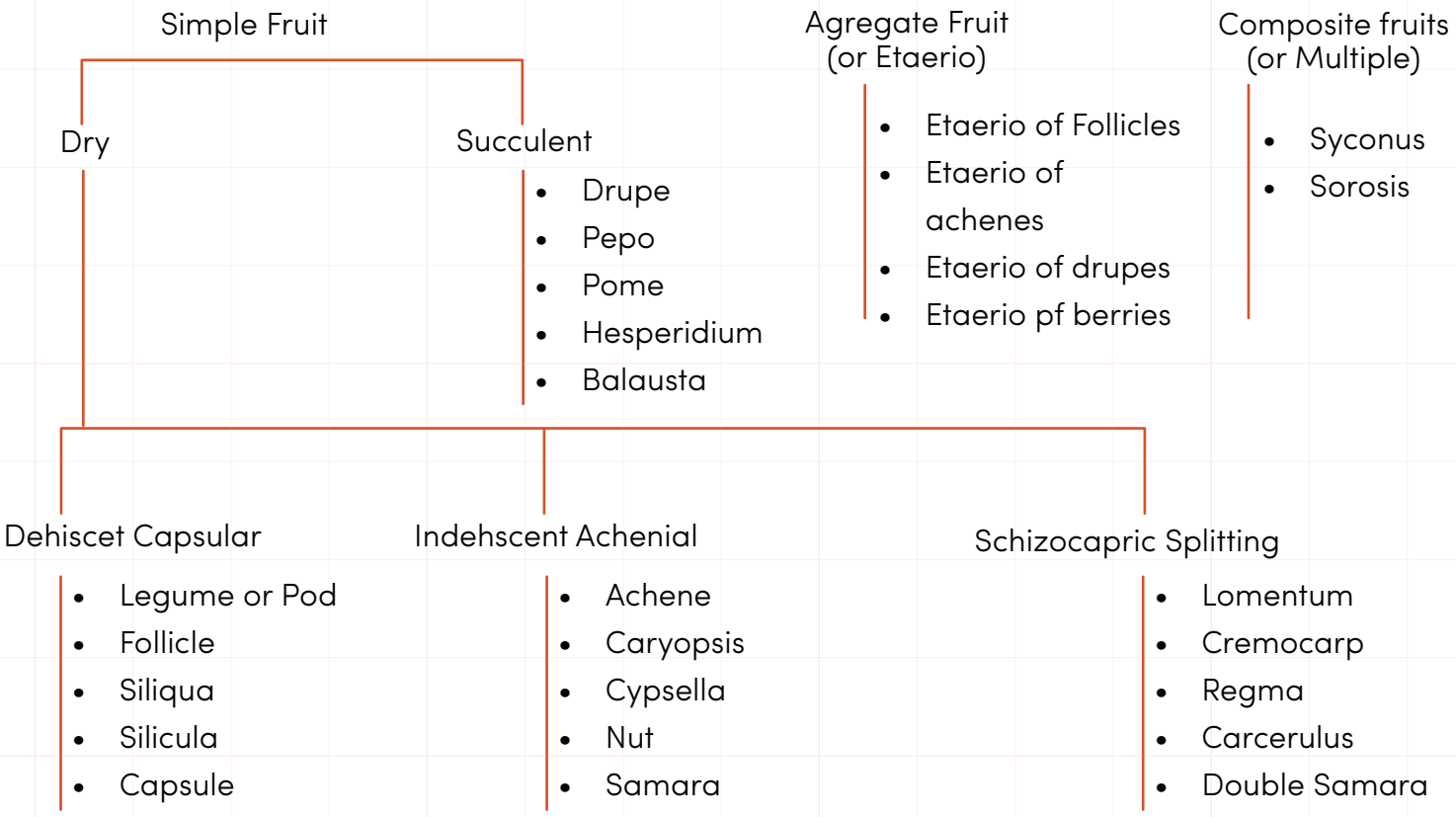
5. **Seed (seeds):** This is the matured ovule of a flower, usually found inside a fruit.
6. **Stalk:** The fruit is attached to the plant by the fruit stalk that develops from the flower stalk.

TYPES OF FRUITS

There are several types of fruits. These fruits are classified in different ways, based on their origin or structure. Common ways of classifying fruits are

- True and false fruits.
- Simple, aggregate and composite (multiple) fruits.
- Fleshy and dry fruits.
- Dehiscent and indehiscent fruits.

General classification of fruits



TRUE AND FALSE FRUITS

A true fruit develops from a fertilized ovary only, and it contains a pericarp and seed(s) e. g. mango, cowpea

A false fruit develops from the ovary and other floral parts. They have additional structures other than pericarp and seed(s) e. g. apple, pineapple, breadfruit and cashew.

SIMPLE, AGGREGATE AND COMPOSITE FRUITS

A simple fruit develops from a flower with a single ovary. e. g. cowpea, maize, okra, pawpaw and tomato.

An aggregate fruit develops from a single flower with several ovaries .e. g. custard-apple, strawberry, raspberry, kola and rose

A composite (multiple) fruit develops from an inflorescence (several flowers) or flowers positioned close to one another e. g. fig, breadfruit.

FLESHY AND DRY FRUITS

Fruits are classified as fleshy or dry based on the nature of their pericarps.

FLESHY FRUIT

This is a fruit that has the whole pericarp or at least one of its layers is thick, soft and (fleshy) succulent especially when ripe.in a few fruits, however, the fleshy part may develop from other floral parts that may or may not include pericarp.

There are six types of fleshy fruits:

1. **Drupe:** This is a true, simple fruit with a thin epicarp, fleshy or fibrous mesocarp and a hard and woody endocarp which encloses the seed(s) e. g. mango, coconut, oil palm fruits.
2. **Berry:** This is a true, simple fruit with a thin epicarp and succulent, edible mesocarp and endocarp e. g. tomatoes, guava etc.
3. **Hesperidium:** A special type of berry in which the epicarp and mesocarp are fused together and the endocarp form distinct chambers filled with succulent hairs e. g. oranges, lemon, grapes etc.

4. **Pome:** This is a fruit consisting of a fleshy enlarged receptacle and a tough central core containing the seeds, e.g. an apple, pear, or quince.
5. **Sorosis:** This is a fleshy multiple fruit, e.g. a breadfruit. Pineapple or mulberry, derived from the ovaries of several flowers.
6. **Syconium:** A composite false fruit that develop from a cup-like inflorescence enclosing numerous tiny male and female flowers e. g. fig

DRY FRUIT

This is a type of fruit in which the pericarp becomes dry, hard, woody or fibrous when the fruit ripens. Dry fruits can be grouped into dehiscent or indehiscent fruits depending on whether their pericarps split when ripe or not.

DEHISCENT FRUIT

This fruit splits open to release the seeds when ripe. Four main types are:

1. Legumes: - The pericarp split open longitudinally along both side to release the seeds e. g. cowpea. Flamboyant etc.
2. Follicle: - The pericarp split open longitudinally on one side only to release the seeds e. g. silk cotton, kola
3. Capsule: - The pericarp slit along many sides to release the seeds e. g. okra, cotton etc.
4. Siliqua: This is a type of fruit having two fused carpels separated by a false septum. It dehisces by both sutures. E.g. Tecoma, African tulip.

INDEHISCENT FRUIT

This fruit does not split open when mature but usually fall to the ground where the pericarp eventually decay to release the seeds .

Five main types are

1. **Achene:** This is a simple, true fruit which develop from an apocarpous pistil. It is a one-seeded fruit attached by a funiculus, but the seed coat is free from the inner wall of the pericarp. E.g. Clematis and rose.

2. **Cypsela:** This is a single-seeded dry indehiscent fruit that develops from a one part inferior ovary (on the stalk side of the flower). E.g. Tridax, sunflower and marigold.
3. **Caryopsis:** This is formed from a single carpel and indehiscent (not opening at maturity) and resembles an achene, except that in a caryopsis the pericarp is fused with the thin seed coat. E.g. fruits of grasses and cereals.
4. **Nut:** This is a simple, true fruit with a hard woody pericarp .It develops from superior bi or poly-carpous ovary and contains one seed. E.g. Cashew nut.
5. **Samara:** This is a fruit in which the pericarp is extended to form one or more wing-like structures. E.g. African rosewood and Combretum.
6. **Schizocarp:** This is a many-seeded fruit that develop from a syncarpous ovary and breaks up into units enclosing one seed each E.g. disodium, cassia and castor.

Differences between fruit and seed

Fruit	Seed
1. Formed from ovary	1. Formed from ovule
2. has two scars or points: • the remains of style or stigma • where it was attached to the floral receptacle	2. Has one scar or point • where it was attached to the placenta
3. Consist of a seed or seeds	3. Consist of an embryo
4. Has pericarp	4. Has testa

DISPERSAL OF SEEDS AND FRUITS

This is the transfer of the seed or fruit from the parent plant to other places where such seed may germinate. The essence of dispersal includes the following:

Agents of dispersal

These are the means by which seeds and fruits are removed from parents to other places. These agents include:

1. wind
2. water
3. animals and man
4. explosive mechanism

Features that aids methods of dispersal

WIND

1. Fruits or seeds are light.
2. Fruits or seeds may have floss, tuff or pappus e g. tridax, cotton, combretum etc.

WATER

1. Light fruits or seeds that can float in water.
2. Waterproof epicarp.
3. Fibrous mesocarp that can trap air to keep it afloat e. g. coconut

ANIMALS AND MAN

1. The fruits or seeds may have hooks or hairs to attach to the animal skin
2. The fruits are edible and the seeds indigestible e. g. pepper, desmodium

EXPLOSIVE MECHANISM

1. Presence of one or more lines of fission or weakness e. g. cowpea, flamboyant, okra etc.

SUMMARY

So far, we have learnt how to

1. Distinguish between fruits and seeds
2. State various types of fruits
3. Classify fruits
4. State the ways fruits are
5. Dispersed
6. Describe the features that adapts fruits to their modes of dispersal

INTERACTIVE ASSESSMENT QUESTIONS

1. Which of the following statements are true?

   A Roots anchor the plant to the ground, absorb water and nutrients, and store sugars and carbohydrates.
   B The stem carries water and nutrients to the leaves, moves food to other parts of the plant, and provides support for the plant.
   C Leaves can be compound, made of a single leaf blade connected by a petiole the stem, or simple, divided into separate leaflets attached to the stem.
   D Flowers have stigma, a sticky knob at the top of the pistil and the style, a long, tube-like structure, connected to the ovary, which contains ovules.
   E Fruits are ripened ovaries that, after fertilization, swell and become either soft and fleshy, or hard and dry to protect the developing seeds.

2. A true fruit develops from _____

   A The ovary only
   B Ovary and ovule only
   C The ovule only
   D The embryo sac only.

3. Tomato fruit is a _____

A Drupe
B Berry
C Pome
D Pepo

4. Which of the following is not a dry indehiscent fruit?

A Legume
B Cypsela
C Samara
D Caryopsis

5. Which of the following is a simple dry dehiscent fruit?

A Berry
B Drupe
C Caryopsis
D Siliqua

6. A fruit that develops from the ovary and other floral parts is called a ---------- fruit.

A True
B Aggregate
C False
D Simple

7. A fruit that develops from an inflorescence is known as a ---------- fruit.

A Aggregate
B Simple
C Composite
D True

8. The following except one belong to the same class of fleshy fruits A. coconut B. apple C. oil palm fruit D. mango

A Coconut
B Apple
C Beans
D Mango

9. The following are dispersed by explosive mechanism except _____

A Tridax
B Cowpea
C Flamboyant
D Okra

10. A fruit which develops without fertilization is described as _____ fruit.

A Simple
B Aggregate
C Multiple
D Parthenocarpic

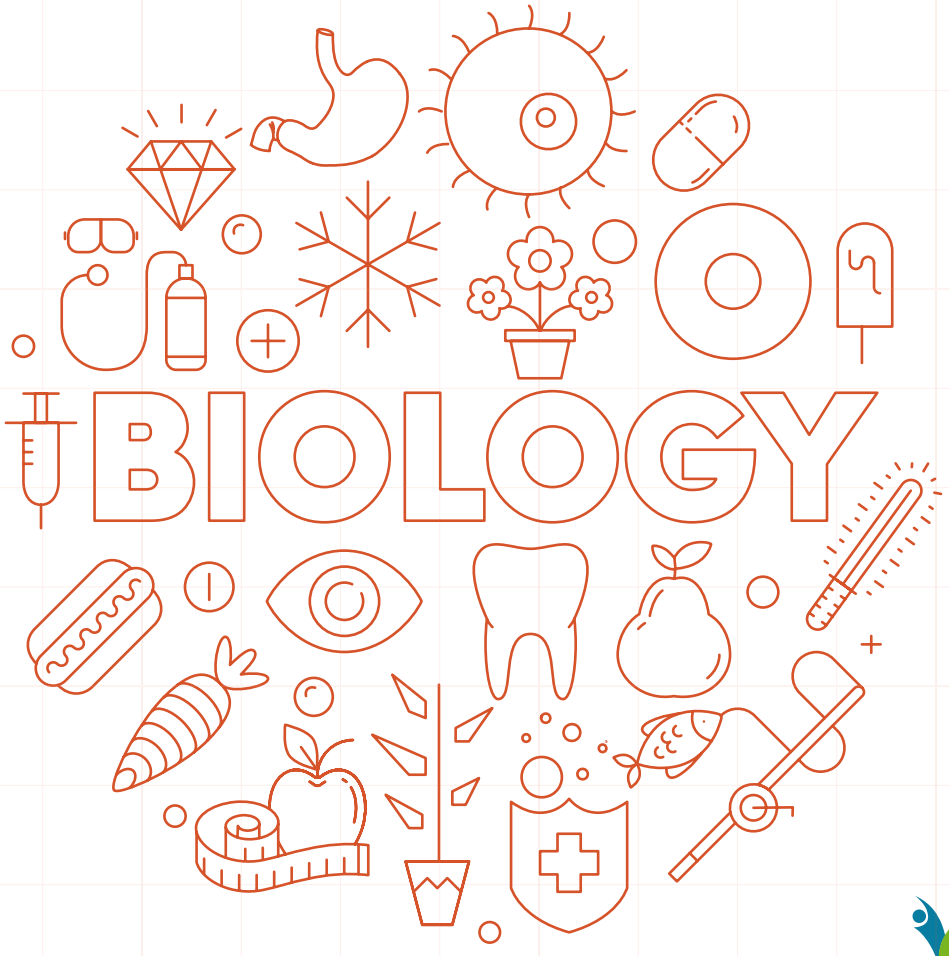
11. Air spaces are characteristics of seeds or fruits dispersed by _____

A Birds
B Water
C Wind
D Explosive mechanism

REPRODUCTIVE BEHAVIORS

PERFORMANCE OBJECTIVES

1. State the different types of courtship behaviours in different animals
2. Explain the terms; courtship and territorialism in animals



MALEZI
EMPOWERING THOSE WHO CARE

Reproduction is one of the characteristics of living things. It ensures the continuity of life. For sexual reproduction to be successful it involves the coming together of two matured opposite sexes.

Courtship is a collection of ritualized behaviours unique to each species that lead up to and enable animals to have successful sex union. It helps to bring close the two individuals that will take part in sexual reproduction.

Courtship behaviour consists of instinctive behaviour in response to certain external stimuli in animals. It is a pattern of behaviour that precede mating and reproduction in animals.

Importance of Courtship Behaviour in Reproduction

Courtship behaviour normally aids reproduction in animals in the following ways:

1. Courtship brings the male and female animals together
2. Courtship stimulates egg laying and sperm release in the partners
3. It prepares male and female for possible mating

Types of Courtship Behaviour

Different species of animals show different methods and signs unique to them. Some courtship behaviours found among animals are discussed below:

1. **Pairing:** This involves two animals, usually a male and a female, which separate themselves from others in a group to form a mating pair. This pairing may be very brief, just for the mating act only, or last for a lifetime.
   Many animal species exhibit pairing. These include toads, termites, fishes, human and some mammals.
2. **Pairing in fish:** During the breeding season, the male fish picks a female as a partner. They swim together to a quiet portion of the river. The male stimulates the female to lay eggs. As the eggs are laid, the male releases sperms on the eggs for external fertilization.
3. **Pairing in toad:** During the breeding season, the male goes to a pond. It croaks, the croaking attracts and possibly excites the female. When the female comes close, the male mounts on the back of the female. The female carries the male on its back for

2-3 days. During this period, the female lays her eggs in shallow water, and the male pours sperm over the eggs for external fertilization to take place.

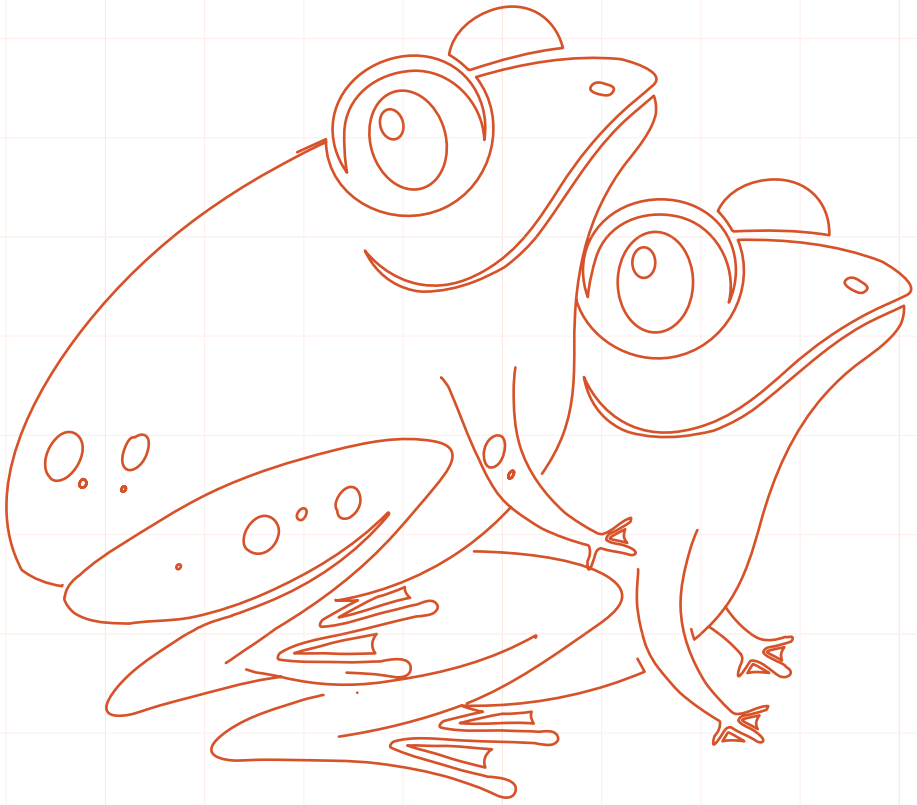


Fig. 3.12: Toads mounting each other

4. **Territoriality:** This is the behavior by which animal lay claim and defends an area against others of its species and sometimes members of other species. The territory defended could be hundreds of square miles in size or only slightly larger than the animal itself. A single animal, a pair, a family or entire herd may occupy the territory. Some animals use the territory as a source food and shelter and thus hold and defend it year round. Other animals establish a territory only at a certain time of the year, when it is needed for attracting a mate, breeding or raising a family. This behaviour pattern is exhibited by most vertebrates except the amphibians. In most cases, the males establish territories prior to mating. They may mark out their areas by scent markers such as urine or by patrolling along the boundaries. Intruding males are chased or scared away by their threat display. If a fight takes place, the

male hardly hurt each other and the loser is allowed to run away. Females however, may be allowed to enter the territory. Male fishes, reptiles, e.g. Agama lizards, birds and mammals show great deal of territorial behaviour.

5. **Territorial Behaviour in Agama Lizard:** The male Agama lizard exhibits territoriality. Usually there is only one adult male Agama lizard in a territory which could be an exclusive portion of a lawn, part of a roof or garden. Several female lizards and young males are usually the other members of this territory. The adult male lizard leads others back to its territory where they would stay overnight for protection against danger or predators. To gain dominance, the male becomes aggressive as soon as an intruding or rival adult male lizard enters its territory. It may make loud noise, launch forward to an opponent and even attempt to bite the rival male. It can threaten a rival by bobbing its head and expanding its gular fold. If the rival does not leave, a fight may ensue.
6. **Display of colour and body parts:** This is an elaborate process involving a series of fixed patterns of movements or attractive exhibitions between mating partners. The partners must respond correctly to each other's display if the performance is to end in mating. Animals that exhibit display include birds (fowls, hens, turkey and peacock) cricket, winged termite, lizard and he-goats. Display takes various forms in humans. They include the use of perfume, voice (intonation), beauty, seductive walking, facial expression, dressing and decoration. They use them to attract members of the opposite sex.

Forms of Display

Display is exhibited in the following ways in some animals;

i. **Goat:** The he goat chases the she goats around and makes a peculiar noise.
ii. **Lizards:** In their natural habitat, the female curves its back and rises up tail. The male in turn wags its tail, nods its head and shows off its brightly coloured (red) head and body to the female. The female could be attracted by this display.
iii. **Cricket:** The male cricket attracts the female by making shrill noise with its outer wings.

iv. **Birds:** Different birds exhibit diverse types of display. These include singing, dancing, feeding, building nests, preening and showing off their beautiful feathers and body
v. **Fireflies:** The male fireflies use flashes of light when flying around to seek mate. Female fireflies will use the same flashes to communicate their readiness for the male if interested. Some species even use different colours and intensities of light to signify their intentions.

Seasonal Migration;

This is a seasonal movement of animals in response to unfavorable climatic conditions, food availability or to ensure reproduction. Animals migrate in order to bear their young in places relatively safe from predators and rich in resources.

Examples of Organisms which Exhibit Seasonal Migration:

- **Fish:** Many fresh water fish, e.g. the mud fish migrate from deep to shallow water before laying their eggs. In shallow water, the young fish are more likely to survive as the water is too shallow for large animals which are likely to feed on the fish. The migration may be over short distances such as from the middle of a river to its side or a long distance. At the beginning of the rainy season, the mud fish migrate upstream to areas where they spawn. At the beginning of the dry season, they return downstream.
- **Birds:** Some birds, e.g. the cattle egret, during the dry season migrate from the northern part of Nigeria to the southern states as a result of lack of water, food and to escape the unfavourable weather of the north. During the rainy season, they migrate back from the south to the northern parts of the country where conditions for feeding and breeding have again become favourable.

SUMMARY

So far, we have learnt how to

1. State the different types of courtship behaviours in different animals
2. Explain the terms; courtship and territorialism in animals

INTERACTIVE ASSESSMENT QUESTIONS

1. Reproductive behaviours in animals include the following except

   A Pairing
   B Territoriality
   C Pollination
   D Display
   E Seasonal Migration

2. Which of these animals exhibit seasonal migration?

   A Cattle egret
   B Peacock
   C Lizard
   D Turkey
   E Dog

3. When two mature animals, of opposite sex go away from the rest in twos, this is referred to as ----------

   A Seasonal migration.
   B Display
   C Territoriality
   D Pairing
   E Display

4. Which of these uses flashes of light when flying around to seek mate?

A Birds
B Cricket
C Fireflies
D Fish
E Housefly

5. Which of these animals preen?

A Birds
B Cricket
C Fireflies
D Fish
E Housefly

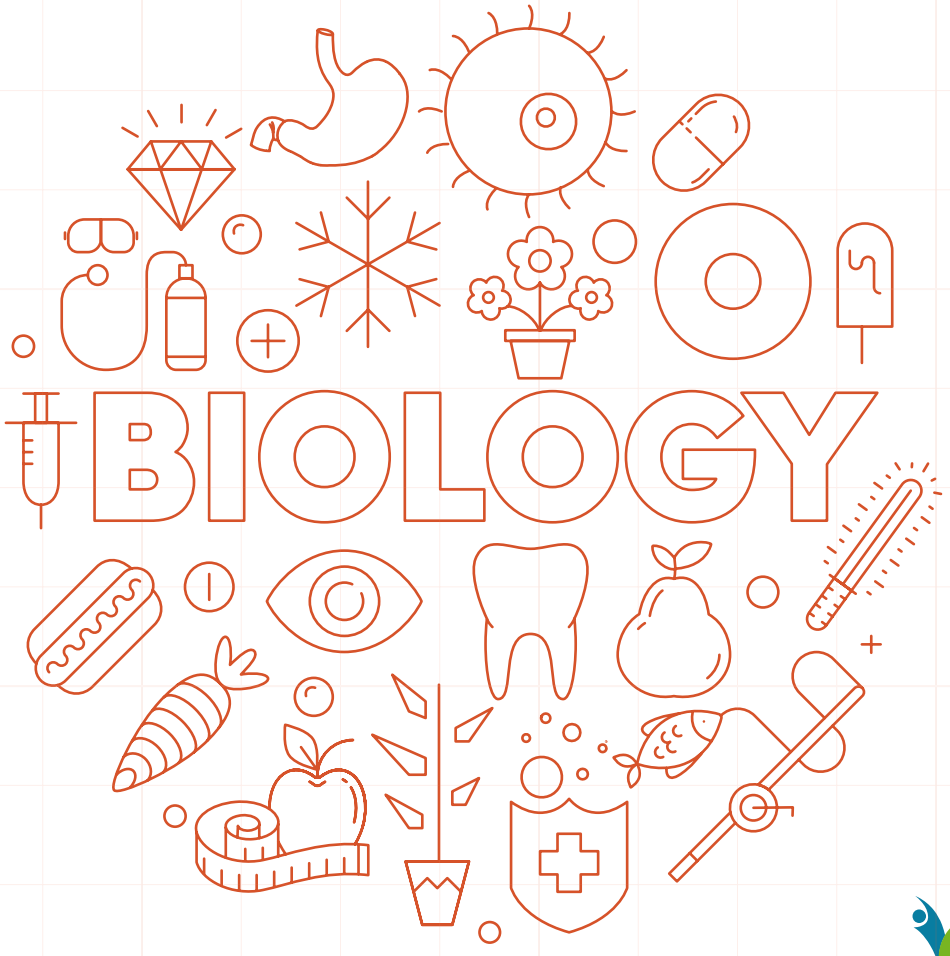
6. _____is the behavior by which animal lay claim and defends an area against others of its species and sometimes members of other species

A Pairing
B Seasonal Migration
C Display
D Territoriality

BIOLOGY OF HEREDITY (GENETICS)

PERFORMANCE OBJECTIVES

1. Identify the dominant/recessive characteristics.
2. Infer that dominant characters mask the contribution of the recessive characters for the F_1 generation.
3. Recognise that the dominant characters become manifest in more individual members of a population than the recessive characters.
4. Identify chromosomes in permanently prepared slides of cells.
5. Note that chromosomes carry genes which are responsible for inherited characters.
6. Explain the advantages and disadvantages of : Self and cross fertilization, Sexual and asexual reproduction, In and out-breeding etc



MALEZI
EMPOWERING THOSE WHO CARE

Genetics is a branch of biology which studies heredity and variation.

In other words, Genetics is the study of how genes bring about characteristics, or traits, in living things and how those characteristics are inherited.

Heredity/Inheritance is the transfer of characters (traits) from parents to offspring (progeny). It accounts for the usual resemblance between a parent and its offspring.

Variation is the difference among the parents and offspring of these parents.

Scientists who study genetics are known as Geneticists.

The laws of genetics were laid down by Gregor Mendel, an Austrian monk, in 1866 although the work was not credited to him until 1900. Johannsen, a Danish botanist, called the 'factors' that transmitted Mendel's characters, genes in 1909. Thomas Morgan, an American geneticist showed that genes were on chromosomes, in 1912.

TERMINOLOGIES IN GENETICS

1. Genes are hereditary or basic units of inheritance located in chromosomes and responsible for the transmission of characters from parents to offspring.
2. Chromosomes are rod or thread like bodies found in the nucleus of a cell which house the genes.
3. Characters are inheritable features possessed by an organism e.g. height, complexion, colour etc.
4. Gamete is a mature sex cell which takes part in sexual reproduction. E.g. pollen grains and ovules in plants, sperms and ova in man. Gamete is usually haploid.
5. Zygote is a single cell formed as a result of the union of male and female gamete. It is diploid.
6. Haploid is a cell that contains a single set of chromosomes (23 in number) e.g. sperm and ovum. It is represented by small letter n.
7. Diploid is a cell that contains two sets of chromosomes (46 in number), one from each parent. E.g. Zygote. It is represented by 2n.
8. Allelomorphs (alleles) are pairs of genes on a particular position of chromosomes. They control contrasting characters.
9. Locus is the site or location of a gene in the chromosome.

10. Genotype is the sum total of the genes or the genetic make-up of an individual inherited from both parents. It includes both dominant and recessive traits.
11. Phenotype is the sum total of all observable features of an organism. It includes the physical, physiological and behavioural traits e.g. height, skin colour etc.
12. Dominant trait is expressed in an offspring when two individuals with contrasting characters are crossed. Dominant trait is controlled by dominant gene e.g. Tt or Bb
13. Recessive trait is masked, with no effect in the presence of a dominant character. This trait is controlled by a recessive gene e.g. tt or bb
14. Homozygous is when an individual has two similar genes for the same character i.e. the individual has two identical alleles at a locus as a pair of chromosomes e.g. TT, tt.
15. Heterozygous is when an individual has different or contrasting alleles located on the locus as a pair of chromosomes e.g. Tt or Bb.
16. Filial generation is made up of offspring of parents. The generations are represented as F1, F2, F3, etc. one giving rise to the other.
17. Hybrid is an offspring from a cross between parents that are genetically different but of the same species.
18. Hybridization is the crossing of plants with contrasting characters. This can be monohybridization (i.e. two pure traits crossed) or dihybridization (two pairs of contrasting characters crossed).
19. Mutation is the change in the genetic makeup of an organism resulting in a new inheritable characteristic.

- Backcross: The cross of an F1 hybrid to one of the homozygous parents; for pea plant height the cross would be Dd x DD or Dd x dd.
- Testcross: The cross of any individual to a homozygous recessive parent; used to determine if the individual is homozygous dominant or heterozygous

Dominant and Recessive Characters

Hybrid offspring will only inherit the dominant trait in the phenotype. The alleles that are suppressed are referred to as the recessive traits.

MENDEL'S WORK IN GENETICS

Gregor Mendel (1822-1884) was an Austrian monk, known as the father of genetics. He made first systematic approach for the investigation of the mechanism of inheritance. He did a number of experiments on inheritance in pea plants ((Pisumsativum).

Mendel described the basic patterns of inheritance before genes was discovered. He called "factors" to what we now call genes. Presented the results of his experiments under name "Experiments on Plant Hybridization" before the Natural History Society of Brunn 1865 and published paper in 1866. No one realized the importance of his work until 1900. Mendel's brilliant and systematic work laid the foundation of a new branch of biology known as "genetics". Mendel's work was rediscovered by Hugo de Vries in Holland and Carl Correns in Germany. They independently obtained the same results as those obtained by Mendel.

Why Mendel selected pea as experimental material?

1. Mendel observed that pea plant((Pisumsativum) has various contrasting characters among its different varieties. He selected seven traits that are easily recognized and apparently only occur in one of two forms.
    - Seed form is round or wrinkled
    - Cotyledon color is yellow or green
    - Seed coat color is grey or white
    - Pod from is inflated or constricted
    - Pod color is green or yellow
    - Flower position is axial or terminal
    - Stem length is tall or dwarf
2. Pea plant has perfect flowers.
3. Ordinarily self-fertilized, but when cross pollination required can be easily crossed.
4. Pea plant is annual i.e. has short life cycle.
5. Can be grown and maintained in small space, with little expenditure.

The Mendel's methods of studying genetics are two:

a. Monohybrid inheritance

b. Dihybrid inheritance

Monohybrid inheritance

Mendel crossed two different plants which differ in one pair of contrasting characters e.g. tall and short plants. The procedures he followed are as follows:

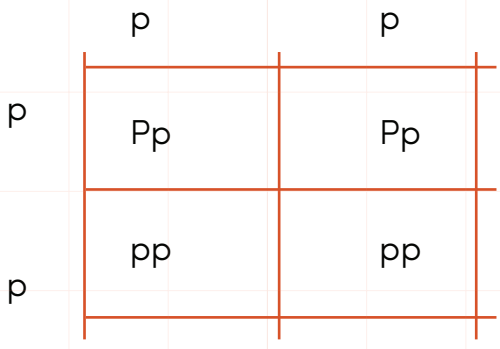
a. He planted tall plants for several generations and got all tall plant offspring. Likewise, the short plants he planted yielded all short plant offspring.

b. He then planted tall and short plants. When the flowers were produced, he cross pollinated the pollen grains (male gamete) of the tall plant with the stigma (female gamete) of the short plant.

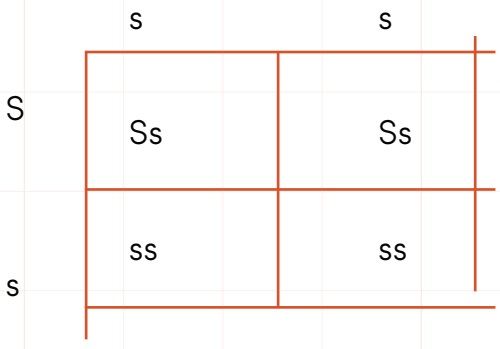
c. He then planted the seeds of the cross in the procedure (b) above and obtained all tall plants. This he called the first filial generation(F_1 ,)

d. He then crossed the F_1 plants, collected their seeds and sowed them. He got tall and short plant in ratio 3: 1. This he called second filial generation (F_2)

The crosses of F_1 and F_2



1/2 Pp (Purple)
1/2 pp (Yellow)



1/2 Ss (Smooth)
1/2 ss (Wrinkled)

Mendel's first law of inheritance otherwise known as the law of segregation of genes states that paired alleles segregate from each other when the homologous chromosomes on which they reside separate during meiosis. Each gamete receives one of the two alleles. The actual segregation occurs in F_2 generation.

DIHYBRID INHERITANCE

Gregor Mendel crossed plants which differ in two pairs of contrasting characteristics e.g. seed shape (round or wrinkled seeds) and seed colour (yellow or green seeds). He crossed plants having round and yellow seeds with these having wrinkled and green seeds. The F_1 seeds were having round and yellow seeds. Self-pollinating F_1 plants produced the F_2 plants of four (4) types

i. Round and yellow seeds : 9

ii. Wrinkled and yellow seeds: 3

iii. Round and green seeds : 3

iv. Wrinkled and green seeds : 1

This experiment resulted into Mendel's second law of inheritance

Mendel's second law of inheritance otherwise known as law of independent assortment of genes state that alleles of gen

Female Gametes

Male Gametes	YR	Yr	yR	yr
YR	YYRR (Yellow Round)	YYRr (Yellow Round)	YyRR (Yellow Round)	YyRr (Yellow Round)
Yr	YYRr (Yellow Round)	YYrr (Yellow Wrinkled)	yyRr (Yellow Round)	Yyrr (Yellow Wrinkled)
yR	YyRR (Yellow Round)	YyRr (Yellow Round)	yyRR (Yellow Round)	yyRr (Yellow Round)
yr	YyRr (Yellow Round)	Yyrr (Yellow Wrinkled)	yyRr (Yellow Round)	yyrr (Yellow Wrinkled)

DETERMINATION OF THE GENOTYPE OF A DOMINANT PHENOTYPE

A dominant phenotype has the genotypic patterns RR, Rr. The genotype is determined using test cross or back cross

PRINCIPLE OF INCOMPLETE DOMINANCE

This deal with the ability of two contrasting alleles to interact and produce a heterozygous phenotype that is different from the two homologous phenotypes: Examples of organisms exhibiting incomplete dominance include: 4 o'clock plant, Audlausian fowl. This principle opposes Mendel's principle of complete dominance.

CO – DOMINANCE

In co-dominance both alleles in the heterozygous individuals are fully expressed. The effect of one is not modified by the presence of the other. Therefore, three distinct phenotypes are produced e.g. Inheritance of human "ABO" blood group

Inheritance of Human Phenotype Pattern

Genotype	Phenotype (Blood group)
1A1A or	Group A
1A 1O	Group B
1B1Bor	
1B 1O	Group AB
1A 1B	Group O
1O1O	

Allele 1A implies the addition of antigen A to the cell surfaces of red blood cells resulting in a person with group A blood. Likewise Allele 1B implies the addition of antigen B to the cell surfaces of red blood cells resulting in a person with Group B.

In a heterozygous individual, (1_A 1_B) both antigens A and B are added to the cell surfaces of red blood cells. So the individual has blood group AB.

NOTE: 1_A and 1_B are co-dominants while 1Ois recessive.

SEXUAL AND ASEXUAL REPRODUCTION

Sexual reproduction is the creation of a new organism by combining the genetic material of two organisms.

Asexual reproduction is any form of reproduction that involves neither meiosis nor fusion of gametes

Advantages of Sexual Reproduction

1. It produces genetic variation in the offspring
2. Species can adapt to new environments due to variation, which gives them a survival advantage
3. The new formed individual has characteristics of both the parents.

Disadvantages of Sexual Reproduction

1. It requires time and energy to find a mate.
2. It is not possible for an isolated individual to reproduce.

Advantages of Asexual Reproduction

1. Only one parent is needed
2. The population can increase rapidly when the conditions are favourable
3. It is more time and energy efficient as you don't need a mate
4. It is faster than sexual reproduction

Disadvantages of Asexual Reproduction

1. It does not lead to genetic variation in a population.
2. The species may only be suited to one habitat.
3. Disease may affect all the individuals in a population.

Self-fertilization refers to the fusion of male and female gametes (sex cells) produced by the same individual. It occurs in bisexual organisms such as the protozoan.

Cross fertilization refers to the fusion of male and female gametes (sex cells) from different individuals of the same species.

Inbreeding refers to mating of related individuals.

Advantage: It increases homozygosity and so is used for developing pure lines.

Disadvantage: It causes inbreeding depression.

Outbreeding

It refers to matings between individuals from different populations, subspecies, or species.

Advantage: It produces hybrids with desirable characters.

Disadvantage: It causes outbreeding depression.

Genetics is useful in many fields of human endeavour. Among its applications are:

Application of Genetics in Agriculture

The knowledge of the principles of heredity (genetics) is used in animal and crop husbandry to produce desirable breeds of animals and varieties of crops. The application is as follows:

To increase yield: The varieties of crops and breeds of animals so developed by breeders are capable of giving high yield in crops and in animal products, e.g. meat, eggs or milk.

1. To improve quality of product
2. Development of early maturing varieties
3. Development of diseases resistant varieties
4. To obtain uniformity of plants
5. To produce crops and animals that can adapt to climatic conditions

Application of Genetics Medicine

Genetics has contributed immensely in various field of medicine. These include:

1. Determination of the paternity of a child
2. Blood transfusion
3. Marriage counseling
4. Diagnosis of diseases
5. Crime detection
6. Development of test tube babies
7. Choosing the sex of a baby
8. Knowing the sex of a baby

SUMMARY

So far, we have learnt how to

1. Identify the dominant/recessive characteristics.
2. Infer that dominant characters mask the contribution of the recessive characters for the F1 generation.
3. Recognise that the dominant characters become manifest in more individual members of a population than the recessive characters.
4. Identify chromosomes in permanently prepared slides of cells.
5. Note that chromosomes carry genes which are responsible for inherited characters.
6. Explain the advantages and disadvantages of :
7. Self and cross fertilization.
8. Sexual and asexual reproduction.
9. In and out-breeding
10. Relate the application of the above to practices in agriculture and medicine.

INTERACTIVE ASSESSMENT QUESTIONS

1. The basic hereditary unit is the ----------

   A Cell
   B Nerve
   C Gene
   D Nucleus
   E Chromosome

2. _____ is the transmission and expression of characters or traits from parents to offspring.

   A Variation
   B Heredity
   C Chromosome
   D Inheritance
   E Back cross

3. _____ is when an organism has one set of chromosomes in the cell.

   A Haploid
   B Heredity
   C Monohybrid
   D Diploid
   E Dihybrid

4. _____ trait is expressed in an offspring when two individuals with contrasting characters are crossed.

A Good
B Bad
C Recessive
D Dominant
E Mono

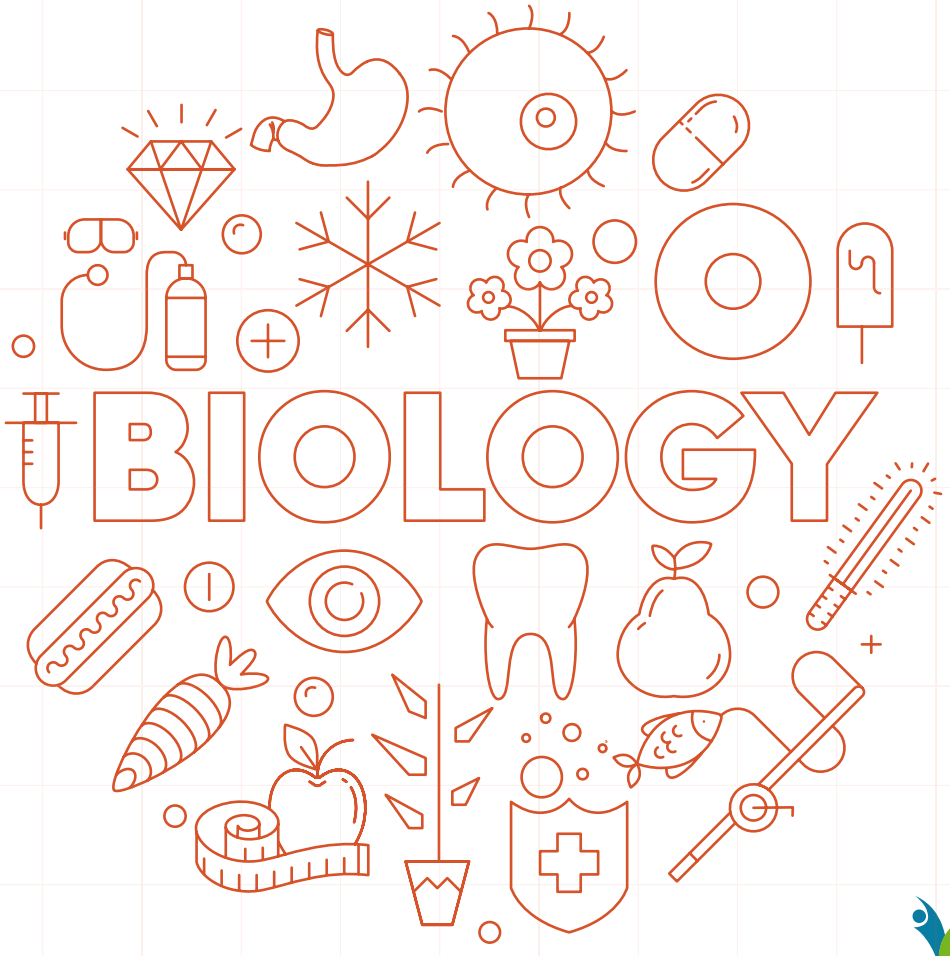
5. _____ is the site or location of a gene in the chromosome

A Gene
B Hybrid
C Loci
D Homozygous
E Diploid

VARIATION AND EVOLUTION

PERFORMANCE OBJECTIVES

1. Define the term evolution and variation in relation to living organisms.
2. Identify the relationship between the two terms: variation and evolution.
3. Describe the types of variation with examples.
4. List different ways that individuals vary in their behaviours and functions.
5. Explain the application of variation to crime detection.
6. State the blood group types that can be transfused for individual with known blood group.
7. Deduce the possibility of children with particular blood group belonging to a man (father).



MALEZI
EMPOWERING THOSE WHO CARE

Evolution is the sum total of adaptive changes that have taken place over a very long period of time. It leads to the development of new species from earlier ones.
Variations are differences in traits or characteristics between individuals of the same species.

CAUSES OF VARIATION

Genetic differences: A sudden change in a gene called mutation can be inherited when sex linked. This then brings about variation e.g. a gene responsible for green fruits in may be altered to produce a yellow fruit in the same plant.
Environmental differences: Environment include housing, food, healthcare, educational facilities, parental care etc. e.g. an intelligent person exposed to an unfavourable environment becomes dull.

Types of Variation

1. Morphological variation.
2. Physiological variation

Variation can also be

- Continuous or Discontinuous.

Continuous variations: These are features that vary gradually from one extreme form to the other. For example we show gradation in height from short to tall.

Examples includes:

i. The colour of skin
ii. Height etc.

Man is not just dark or fair, nor is he either tall or short. There are many intermediate skin colours and heights. Such characteristics show a continuous variation from one extreme to the other. A continuous variation is brought about by the combined (or additive) effects of many genes.

There may be genes for dark skin and gene for fair skin. The more dark-skin genes a person has, the darker will his skin colour be. Continuous variations are also affected by the environmental conditions for example; a greater exposure to sunlight may cause a person to have a darker skin colour. This is also known as acquired variation. Other examples of continuous variation in man are intelligence and weight.

Discontinuous variations: These are features that show no intermediate form. For example you either have ear lobes or not. They distinguishable and often arise as a result of mutation.

Examples of such traits include

i. The ability to roll the tongue
ii. Taste phenylthiocarbamide (PTB),
iii. ABO blood groups in man and
iv. Normal and vestigial wings in Drosophila.

Such discontinuous variation is brought about by one or a few genes.

Morphological Variation: This refers to the noticeable physical appearance of individuals of the same species. Some morphological features that show variations are size, weight, fingerprints, colour etc.

In human beings, morphological variations include:

- Height of the body
- Shape of various parts of the body such as head, mouth, nose, jaw, ears, eyes, legs and hands,
- Size of various parts of the body such as head, eyes, hands, necks
- Colour of parts of the body such as skin, eyes and hair
- Weight of individuals
- Hairiness of the body
- Finger print, etc.

Physiological Variation: This is defined as different ways individuals vary in behaviour and function. In other words, physiological variation relates to the differences in the ways individuals of the same species behave or react to conditions in their environment.

Differences of variations in behaviour by which organisms can be grouped into two or more classes within a population, without any graduation among them are called discontinuous variation.

Examples of physiological or discontinuous variation in human beings are:

Behaviour: This may be grouped as being:

1. Aggressive and non-aggressive
2. Excitable or calm
3. Timid or brave
4. Caring or uncaring
5. Intelligent or stupid
6. Ability to roll the tongue
7. Ability to close one eye and keep the other open
8. Ability to move the ears without moving the head
9. Ability to taste a chemical substance called phenyl thiocarbamide (PTC)
10. Differences in blood group

Examples of Discontinuous Variation in Plant

1. Colour of leaves
2. Colour of flowers
3. Colour of fruits
4. Colour of seeds
5. Shape of seeds and fruits

APPLICATIONS OF VARIATION

1. Blood transfusion: The blood group of the donor must be compatible with that of the recipient. If not, the donor's RBC will clump in the recipient's blood vessels causing serious harm to the recipient. Each blood group is characterized by specific proteins in the blood which are antigens in the RBC and antibodies in the blood plasma. The table below shows antigen-antibody reactions between donor and recipient's bloods.

DONOR / RECIPIENT	A (Antigen a)	B (Antigen b)	AB (Antigen a + b)	O (None)
A (Antibody b)	+	-	-	+
B (Antibody a	-	+	-	+
AB (None)	+	+	+	+
O (Antibody a + b)	-	-	-	+

\+ means positive reaction (no clumping)

\- means negative reaction (clumping)

Note: O is a universal donor while AB is a universal recipien

Crime Detection: Fingerprints are made of an arrangement of ridges, called friction ridges. Each ridge contains pores, which are attached to sweat glands under the skin. You leave fingerprints on everything you touch because of this sweat.

All of the ridges of fingerprints form patterns called loops, whorls or arches. Fingerprints are commonly used to solve crimes. Criminals usually tend to live their fingerprints at the scene of their crimes. These fingerprints are collected and compared with those of potential suspects and past criminals.

Fig. 3.13: Different types of Fingerprint

Detection of paternity: In cases where the paternity of a child is in dispute, knowledge of blood groups is usually applied to resolve the dispute. In a hypothetical case of disputed paternity in which the blood groups of the child, mother and contesting fathers are found to be as follows:

Child ⟶ Group AB

Mother ⟶ Group A

Contesting father X ⟶ B

Contesting father Y ⟶ O

The baby's genotype will be IA and IB and the mother will be IA or IAIA
Certainly IB gene of the baby must have been inherited from the father X. the baby does not belong therefore to the contesting father Y in blood group O. The father of blood group O and the mother of blood group A can bear children of blood group A only with genotype IA

The possible blood group of offspring from parents

Father's Blood Type

Mother's Blood Type	A	B	AB	O
A	A or O	A, B, AB or O	A, B, AB or O	A or O
B	A, B, AB or O	B or O	A, B or AB	B or O
AB	A, B or AB	A, B or AB	A, B, or AB	A or B
O	A or O	B or O	A or B	O

* Child's Blood Type

In medicine: The knowledge of variation is used widely in various field of medicine. As a result of differences in skin colour, human races are classified based on skin colour, shape of nose, texture of the hair into Caucasoid (European), Negroid (Black African) Mongoloid (Chinese and Japanese), Australoid (Australian).

In agriculture: Animal and plant breeders make use of variations in animals and crops to develop better breeds of animals and varieties of crops that have high yield, taste, disease resistance, adaptation to local environment etc. Example is the development of yellow maize from white maize.

SUMMARY

So far, we have learnt how to

1. Define the term evolution and variation in relation to living organisms.
2. Identify the relationship between the two terms: variation and evolution.
3. Describe the types of variation with examples.
4. List different ways that individuals vary in their behaviours and functions.
5. Explain the application of variation to crime detection.
6. State the blood group types that can be transfused for individual with known blood group.
7. Deduce the possibility of children with particular blood group belonging to a man (father).

INTERACTIVE ASSESSMENT QUESTIONS

1. Which of the following is not a continuous variation?

   A Height
   B Weight
   C Skin colour
   D Ability to smell
   E Hair colour

2. Variation factor used in determining of paternity is _____

   A Fingerprint
   B Skin colour
   C Blood group
   D Behaviour
   E Height

3. _____ variation is defined as different ways individuals vary in behaviour and function of its parts.

   A Discontinuous
   B Morphological
   C Physiological
   D Continuous
   E Attitude

4. Which of the following is not one of the applications of the knowledge of variation?

   A Determination of paternity
   B Crime detection
   C Blood transfusion
   D Determination of genotype
   E Classification of human race

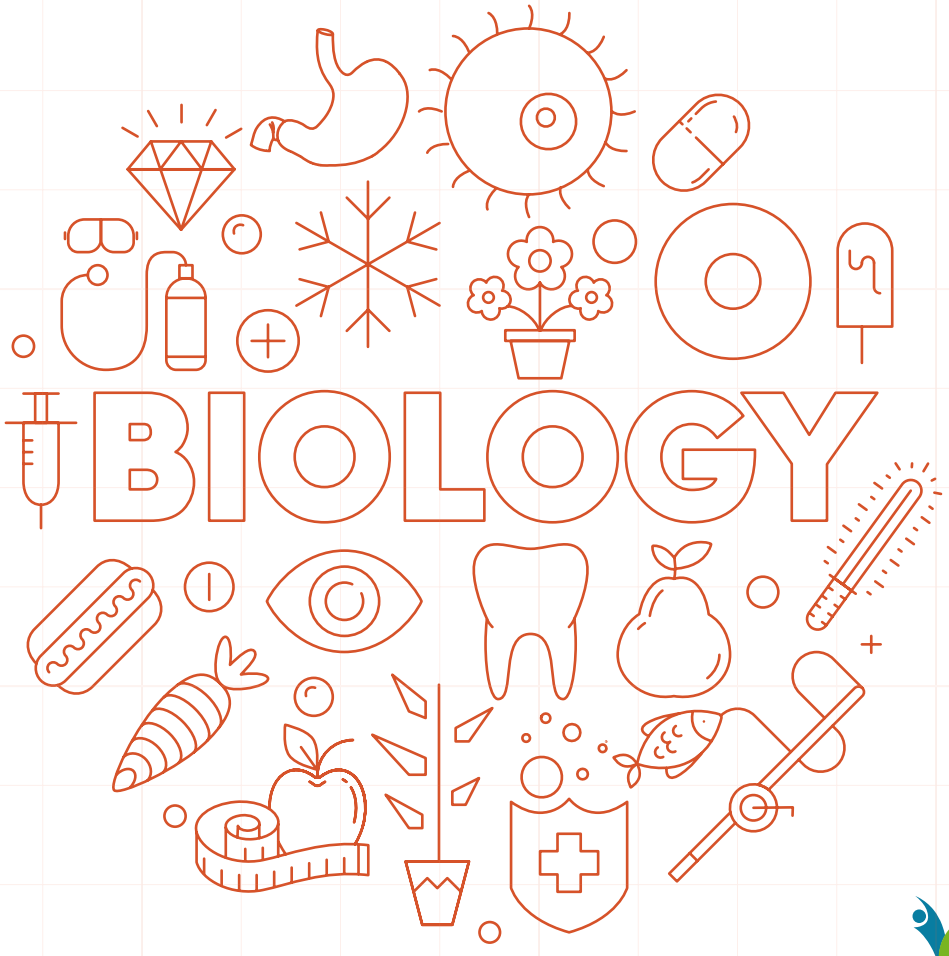
5. The blood group that is referred to as “universal donor” is _____

A A
B B
C AB
D O
E C

EVOLUTION

PERFORMANCE OBJECTIVES

1. Discuss the progressive change in anatomy of organisms from water to land.
2. Explain the term Adaptive colouration and their functions.
3. State examples of structural adaptations in the following organisms that aid their survival: Mosquitoes feeding and securing of mates in Agama lizard.
4. Explain the term behavioural adaptation as regards the castes in termites.
5. State the law of use and disuse according to Jean Baptiste de Lamar.
6. State two important features that support the evidence of evolution.
7. State other occurrences apart from natural selection that may bring about evolution.



MALEZI
EMPOWERING THOSE WHO CARE

Organic evolution refers to the slow and gradual process by which living organisms have changed from the simplest unicellular form to the most complex multicellular forms that are existing today.

Organic evolution suggests that all living things have arisen from pre-existing ones by a gradual process of change over a long period of time. Organic evolution primarily involves modifications in the existing organisms and the inheritance of these modifications.

Biological evolution is genetic change in a population from one generation to another. Continuous evolution over many generations can result in the development of new varieties and species. Likewise, failure to evolve in response to environmental changes can, and often does, lead to extinction.

Evolution proposes that life started in water; from marine water to fresh water to land and then to air. Progressive changes in the structure and anatomy of organisms have been going on as they inhabited these habitats at one time or the other. These changes enabled the organisms to be well adapted to the various habitats.

Organisms that live in water environments have streamlined body shape, soft and moist skin, water dependent reproductive system, efficient osmoregulation and other structural and anatomical adaptations.

The forelimbs of aquatic animals are also modified for swimming and orientation in water. These forelimbs in the course of progressive evolution changes are modified into crawling and hopping as in amphibians; running in reptiles; flight for birds and bat; climbing and swinging as in monkeys and walking and grasping as in humans and chimpanzees respectively.

All these animals have the same anatomical pattern of forelimbs but diversified structures for various adaptations in their respective habitats. Homologous Structures are similar structures that perform similar functions. The arm of a human, the wing of a bird or a bat, the leg of a dog and the flipper of a dolphin or whale are examples of homologous structures. They are different and have a different purpose, but they are similar and share common traits.

Analogous Structures are dissimilar structures that perform similar functions. Examples of analogous structures range from wings in flying animals like bats, birds, and insects, to fins in animals like penguins and fish.

STRUCTURAL ADAPTATIONS

To survive in their environments, organisms show different adaptations in their form and function. The following are some of the special adaptations shown by organisms for survival:

Adaptive Colouration: Many organisms possess bright, attractive colour with special markings on their bodies to help them obtain food, escape or hide from enemies and to secure mates. Some flowering plants have brightly coloured flowers which attract animal pollinators.

Warning Colouration: Many vulnerable preys develop bright colours and are bitter and unpalatable to their vertebrate predators. Distasteful insects are brightly coloured and conspicuous with contrasting pattern of different colour bands. Examples are lady bird beetles, wasps and butterflies. Even insects with nice taste but with colours like that of the unpalatable ones also survive.

Mimicry: This is the close resemblance of an animal called a mimic to another different object referred to as a model in order to increase its chances of survival. A harmless organism is usually protected from its predator by mimicking a dangerous species. A mimic and a model are naturally unrelated. For example, monarch and viceroy butterflies often resemble each other.

Camouflage: Many animals are protected from their predators by the close matching of their body appearance with their surrounding background. Many grasshoppers and praying mantis have green pigments in their cuticles making them look like green vegetation. The rattlesnakes easily fit into the colour of the green environment. Another example is the chameleon.

Colouration: Some animals possess bright body colouration which helps during mating. The bright colouration usually attracts the opposite sex for mating. Birds like peacock, turkey and cock exhibit colouration.

Counter Shading: In some animals, the upper part of the body has a different colour from the lower part of the body. Such animals are said to be counter shaded. Most fishes have dark dorsal colour which tend to blend with the dark coloured water while their ventral sides are light in colour which blend with the sky above.

Structural Adaptation for obtaining Food

Some animals have special structural adaptations that enable them obtain food. For instance the beaks of birds are adapted to their individual diets.

The mouth parts of some insects are also adapted to their feeding habits.

Flies and mosquitoes have proboscis as feeding organs with these they can freely feed on fluids by sucking (e.g. housefly) or piercing and sucking (e.g. Tse-tse fly and mosquitoes).

Grasshoppers, termites and caterpillars of butterflies and moths have sharp mouth parts (mandible and Maxillae) for biting and chewing.

Structural Adaptation To Attract Mates

Some animals have special structural adaptations that enable them attract mates. For instance adult male agama lizard displays its bright colour to attract its mates, flowering plants attract insects for pollination, bright coloured feathers of male domestic fowls and peacock etc.

Structural Adaptation To Regulate Body Temperature

Mammals have fat layer, sweat gland, feathers and subcutaneous fat in birds etc. All serve to regulate heat loss.

Structural Adaptation For Escape and Defence.

Escape adaptation can be grouped into camouflage (concealing ccolouration), individual and group responses e.g. caterpillars taking the colour of leaves. Defence adaptation may be inform of physical structure e.g. spines and shell, scales etc., chemical defence e. g. snakes attack their enemies by spitting venom, bees and scorpion have stings and mimicry (looking like an uninteresting objects) e. g. stone plant.

Structural Adaptation For Water Conservation: Some plants have small needle like leaves (conifers), thick bark (acacia), waxy cuticles etc. to reduce the rate of transpiration. Likewise some animals possess scales, exoskeleton, feathers etc. to reduce water loss.

BEHAVIOURAL ADAPTATIONS

Behavioural adaptations are the way an organism behaves which helps it to survive in its environment. Behavioural adaptations can be learned or instinctive (a behaviour an animal is born with). Migration, hibernation and hunting behaviours are all behavioural adaptations that help an animal to survive in its habitat. For example, lizard hides under rocks to avoid gaining too much heat from the sun and survive in deserts.

Some Behavioural Adaptations in Organisms:

1. **Aestivation:** is a state of animal dormancy (inactivity), similar to hibernation, although taking place in the summer rather than the winter. Some organisms remain dormant during dry season (e.g. mud fish) ,during a prolonged drought or during shortage of food
2. **Hibernation:** This is when animals undergo dormancy especially in winter, during which metabolic rate is much reduced and the body temperature of homoeothermic species drops to that of the surrounding. Example is one found in bears, amphibians, reptiles and mammals.
3. **Dormancy:** Some seeds of plants and spores of microorganism might remain inactive due to unfavourable environment for years, until when the weather improves e.g. cyst formation in protozoa like amoeba
4. **Migration:** is the behavioral adaptation that involves an animal or group of animals moving from one region to another and then back again.
5. **Behaviour for protection:** An animal's behavior sometimes helps to protect the animal. For instance the opossum plays dead. A rabbit freezes when it thinks it has been seen.
6. **Social behaviour:** Some animals live by themselves, while other live in groups. Those that live in group are so organized that there is division of labour among them, i.e. workers, soldiers, kings and queens as seen in termites. They live in colonies or communities. Examples of social animals include termites, bees, wasps, foxes, wolves, elephants, baboons and humans.

DIFFERENT CASTES OF TERMITES AND THEIR FUNCTIONS

Termites are social animals. They live in highly organized groups. They usually live in underground tunnels. Termites feed on cellulose thereby damaging wooden materials, crops and young trees. They help in maintaining soil fertility by breaking down dead materials into humus. Termites undergo incomplete metamorphosis.

A colony of termites is made up of the following castes :.

Castes of a colony of termites

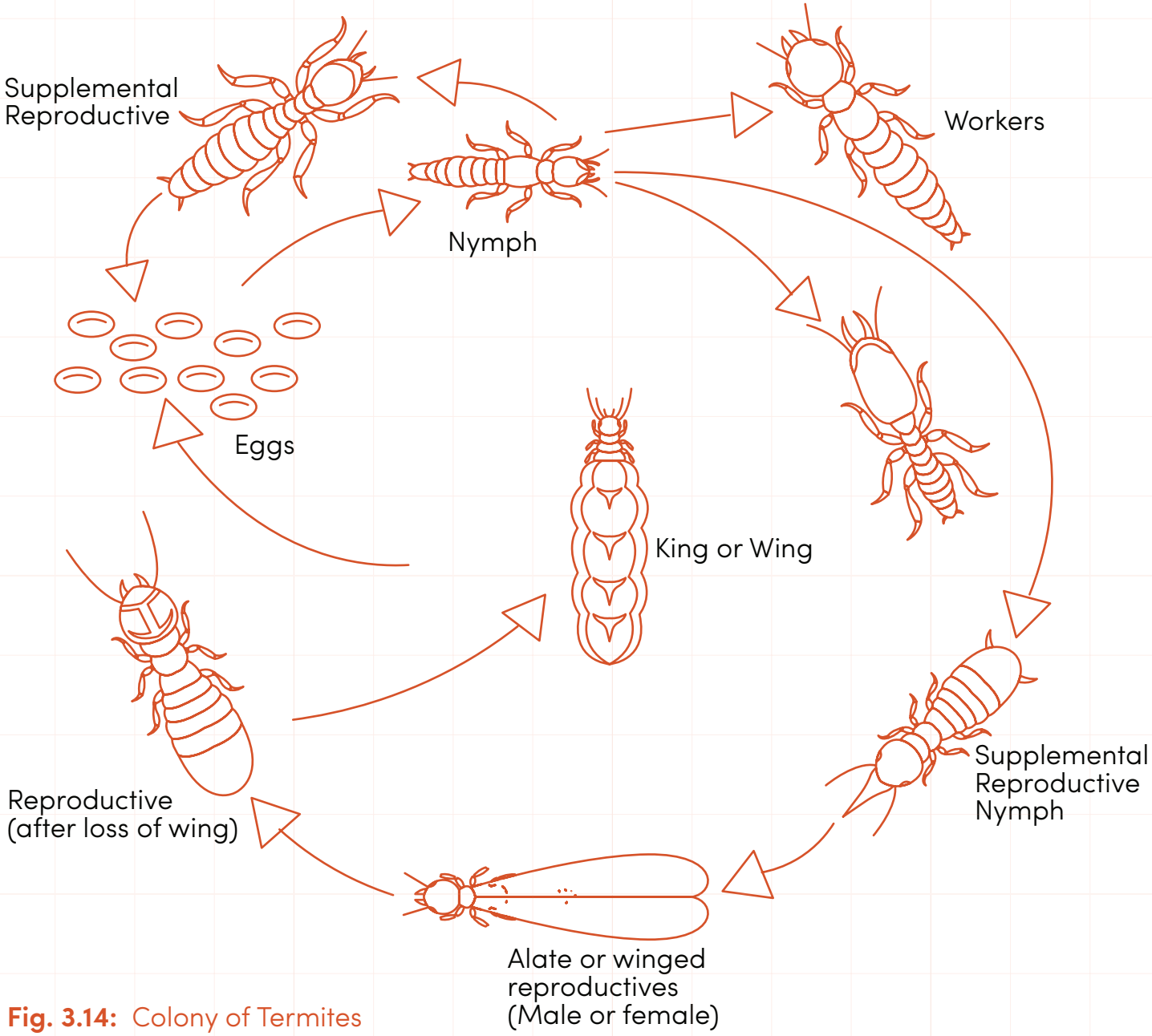


Fig. 3.14: Colony of Termites

1. **Queen and King:** These are the reproductive members of the castes with the responsibility of mating and laying eggs. There is always only one king and one queen at any point in time though there could be other fertile potential kings and queens. A fully grown queen is about 9cm long.
2. **Workers:** There are sterile females with no eyes, soft and pale exoskeleton and well developed mouthparts. Workers are responsible for building the termitarium, searching for and bringing in food for other members in colony. They also tend fungal gardens, collect eggs and care for the nymphs structural adaptations for regulating body temperature.

   After eating they regurgitate the partially digested food to feed the other members of the colony.
3. **Soldiers:** These are sterile, blind and wingless males with large heads, thick exoskeletons and huge mandibles. They are responsible for protecting the colony from invaders and also protect the workers as they gather food for the colony.

DIFFERENT CASTES OF BEES AND THEIR FUNCTIONS

A honey bee colony lives in a hive. Bees undergo complete metamorphosis.

The caste is composed of:

i. a single queen,

ii. a few hundred drones and

iii. several thousand workers.

Drones hatch from unfertilized eggs. The drones are responsible for fertilizing eggs.

The queen and workers hatch from fertilized eggs. Larvae feeding on pollen grains and honey become workers. If fed on royal jelly which contains vitamins, a larva develops into a queen.

The queen then secretes a queen substance that suppresses the development of ovaries in the workers.

The queen does the service of reproduction to replenish the castes. The workers labour for the colony

THEORIES OF EVOLUTION

This is an attempt to explain how this diversity has taken place. Many scholars made some discoveries on evolution, some of them are;

i. George Louis Buffon (1707-1777)
ii. Carl Linnaeues (1707-1778)
iii. Jean Lamarck (1744-1829)
iv. Thomas Malthus (1766-1834)
v. Charles Darwin (1809-1882)
vi. Alfred R. Wallace (19th century)

LAMARCK'S THEORY (1744-1829)

In the early 19th century, French biologist Jean Baptist de Lamarck embraced the idea of progressive change in living world based in part on his study of marine invertebrate fossils.

He was the first biologist to suggest that organisms undergo evolution. He propounded his systematically organized theory of evolution in 1801. This theory is based on the following ideas.

i. The use and disuse of organs
ii. The inheritance of acquired characteristics.

Lamarck believed that species do change over time through use and disuse of the body parts, and that animals evolve because of unfavourable conditions that the animals try to adapt to.

In his explanation, Lamarck cited example of giraffe and said their ancestors had short neck but kept stretching their necks to reach leaves in high trees during the period of food scarcity. Lamarck asserted that this voluntary, constant stretch of their neck slightly changed the hereditary characteristics controlling neck growth and that giraffe transmitted these acquired characteristics to its offspring. Lamarck was right when he asserted that we could acquire traits through voluntary use of body parts but was wrong when he concluded that these acquired characteristics are inheritable.

The following are the main points of the theory;

i. The environment forces an organism to have some needs.
ii. To satisfy these needs, the organism may use an organ.
iii. The organ that is frequently used develops.
iv. Characteristics developed by an organism while satisfying the environmental needs are transferred to the offspring.
v. The organ that is not used degenerates.(vestigial organs)

Although the inheritance of acquired characteristics seems to be logical, no evidence has been found to support this view. Genetic materials are contained in the chromosomes. Except for rare mutations, genetical information is passed on unchanged from generation to generation. If acquired characteristics could be inherited, then children of a great sport person would be born with the knowledge of sports. Acquired skills are usually developed anew in each generation. They are certainly not inherited.

DARWIN'S THEORY OF NATURAL SELECTION(SURVIVAL OF THE FITTEST)

About 50 years after Lamarck proposed his theory of evolution, the British naturalist Charles Darwin, revolutionized the thinking of most Biologists. In 1859, Darwin published a book called origin of species by means of natural selection. Like Lamarck, Darwin stated that living organisms gradually evolved adaptations to the environment. However, Darwin recognized the variations among members of a species. It is these variations rather than the acquired characteristics that aid natural selection.

The following are the main points of the theory:

1. Species have the ability to produce a large number of offspring.
2. The resources of the natural world are limited. Therefore, there must be competition for survival among the offspring in each generation.
3. There is great variability within the population of organism.
4. No two individuals are the same.
5. Much of these varieties are inherited.
6. The organisms that survive and produce offsprings are those that have inherited the

most beneficial traits for surviving in a particular environment.

7. As this process continues through many generations, the population gradually becomes better adapted to the environment.

Modern genetic research supports Darwin's theory. Both Lamarck and Darwin recognized the importance of the environment in evolution. Many biologists generally accept that it is by natural selection of the better adapted organisms by chance and the elimination of the much less adapted ones that evolution or chance occurs.

However, while Darwin recognized that organisms vary, he had no idea of why they vary. This became better understood through the works of Gregor Mendel, and modern discovery in genetics resulting in the modern theories of evolution.

Modern View of Evolution (Neo Darwinism)

The current theory of the process of evolution makes use of present day knowledge of genes and chromosomes to explain the source of genetic variation upon which natural selection works. It also postulates that although natural selection is the only force that regularly produces adaptive evolutionary change .Other forces responsible for evolution are mutation, gene flow and genetic drift.

I. MUTATION

In 1901, Hugo de Vries, a Dutch botanist, presented his mutation theory of evolution. He based his theory on many years of work with primrose plants. Of the 50,000 plants, about 800 showed spectacular new trait not present in the parent plant. Yet, these new trait were passed on to the offspring of the plants in which mutation had occurred. De Vries concluded that, mutation must occur often in other organisms too, and that the change by mutation was the basis of evolution. It has also been confirmed that chromosomal mutations though occurring less often than gene mutation, result in larger and better adapted plants. Today, many biologists believe that mutations contribute significantly to evolution.

Evolution is believed to occur when new species of organisms are formed. Other ways

besides mutations, in which evolution is believed to occur in modern times include isolation and the migration of a population to different environments.

II. GENE FLOW

A phenomenon whereby individuals move from one population to another introducing a new gene to the populations is referred to as gene flow. Gene flow moves alleles among populations through the process of interbreeding and migration of breeding individuals.

Gene flows increases variation within a population by introducing new alleles produced in another population. For example, chance dispersal can occur between two populations of related wildflowers, one red and the other white wildflower population. Due to the chance dispersal by strong wind, the gene for the red flowers may be introduced to the white population gene pool.

Persistent gene flow tend to decrease diversity among populations, causing gene pools to become similar. Restriction of gene flow between populations is important for the development of new species.

III. GENETIC DRIFT

Genetic drift is changes in allele frequencies of a gene pool due to chance or random events. It can cause the loss of an allele in a population even if the allele results in greater evolutionary fitness. It can also cause a situation where the allele can be found in every member of the population i.e. fixed even if the allele decreases fitness. Genetic drift is believed to be more widespread in small population where a chance or random event can wipe out the carriers of the allele completely from the population or drastically reduce their numbers.

EVIDENCES OF EVOLUTION

Since evolution is an extremely slow process, occurring over a long period of time, it is very difficult to observe evolution visibly or to obtain direct evidence of evolution in action. However, scientists from many fields have gathered at great deal of indirect evidence that supports the theory of evolution.

The following are the sources of such evidences.

1. Evidence from Fossil Records
2. Evidence from Embryology
3. Evidence from comparative Anatomy
4. Evidence from vestigial organs
5. Evidence from Biochemisty and Genetics

Evidence from Fossil Records.

Fossils are remains of organisms preserved mainly in sedimentary rocks. It is believed that the history of life on earth is recorded in fossils. The age of rocks in which fossils are found are determined by using radioisotope or carbon dating. The history of a particular evolutionary change can be traced through a series of fossils when carefully arranged according to their age from the oldest fossils to the most recent ones. An example is the evolution of the most modern horse (Equus) from the dawn horse; Eohippus, 60 million years ago.

Evidence from Embryology

When comparing the development of closely related organisms, it is often difficult to tell the early stages of one species from the early stages of another. The similarity of organisms often used as evidence of evolution. If two organisms descended from a common ancestor, they may still have developmental stages that are very similar.

Evidence from comparative Anatomy

All vertebrates show a basic plan which points to a common ancestry. These are features showing progressive complexity in the structure of vertebrates from fishes to mammals. For instance, there are progressive evolutionary changes in the anatomy of the heart among the classes of vertebrates.

Fishes have a simple heart with one auricle and one ventricle; reptiles have two auricles and a partially divided ventricle. In the course of these changes, the circulation of blood also changed from a single to a double circulation.

Evidence from vestigial organs

Vestigial organs are small or incomplete organs that have no apparent function. They have become reduced and useless. The presence of vestigial organs helps to explain evolution. According to the evolutionary theory, vestigial organs are the remaining parts of previous functioning organs. For examples, the muscles of the ear in man is a vestigial organ while in horse it plays important role in twisting back the ear to catch sound. The appendix in man is vestigial while it functions as caecum in herbivores.

Evidence from Biochemisty and Genetics.

Modern genetics also provides evidence of evolution. All organisms use the same genetic code to synthesis proteins. A universal genetic code is consistence with the idea that all organisms evolved from a single organism that used the code.

Biochemists have compared the amino acid sequence of proteins found in different organisms. Organisms that are closely related often have proteins with similar amino acid. In dissimilar organisms, the amino acid sequences of protein show many more differences.

SUMMARY

So far, we have learnt how to

1. Discuss the progressive change in anatomy of organisms from water to land.
2. Explain the term Adaptive colouration and their functions.
3. State examples of structural adaptations in the following organisms that aid their survival: Mosquitoes feeding and securing of mates in Agama lizard.
4. Explain the term behavioural adaptation as regards the castes in termites.
5. State the law of use and disuse according to Jean Baptiste de Lamar.
6. State two important features that support the evidence of evolution.
7. State other occurrences apart from natural selection that may bring about evolution.

INTERACTIVE ASSESSMENT QUESTIONS

1. The main force that regularly produces evolutionary change is _____

   A gene flow
   B genetic variation
   C mutation
   D natural selection
   E mimicry

2. Organic evolution proposes that life started from _____

   A Air
   B Fresh water
   C Land
   D Marine water
   E Forest

3. Which of the following biologists proposed the theory of inheritance of acquired characteristics?

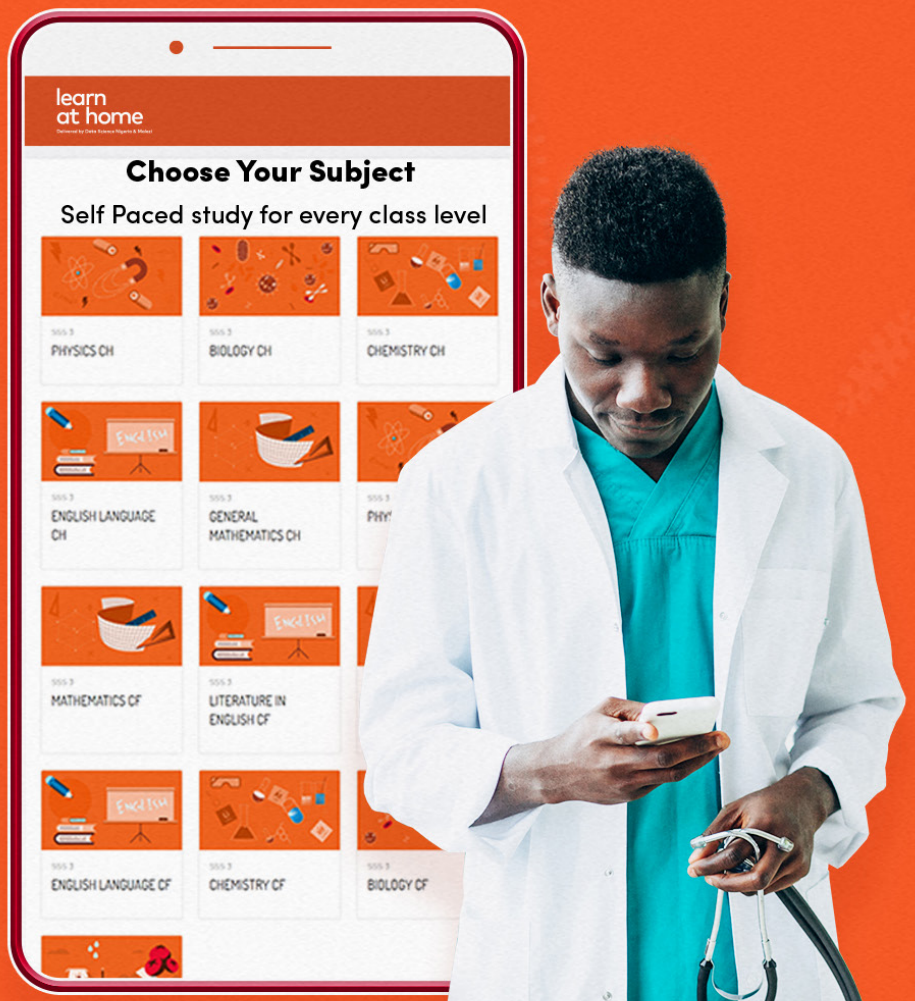
   A Lamarck
   B Darwin
   C Wallace
   D De Vries
   E John

4. Which of the following evidences is not used to support the theory of evolution?

   A Analysis of fossil records
   B Embryology
   C Mutation
   D Vestigial organs
   E Biochemical similarities

5. _____ are remains of organisms preserved in rocks.

A Fossils
B Evolution
C Embryology
D Analogous
E Homologous



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