

Biology definitions

Cells

- **movement:** an action by an organism or a part of an organism causing a change of position or place
- **Metabolism:** chemical reactions that take place in the body
- **Anabolism:** when a complex molecule is formed from simpler ones
- **Catabolism:** when a complex molecule is broken down into a simple molecule
- **Respiration:** the chemical reactions in the cell that break down nutrient molecules and release energy for metabolism
- **Sensitivity:** the ability to detect or sense stimuli in the internal or external environment and make appropriate responses
- **Growth:** a permanent increase in size and dry mass by an increase in cell number or cell size or both
- **reproduction:** the processes that make more of the same kind of organism
- **Excretion:** removal from organisms of the waste products of metabolism which include chemical reaction in cells including respiration taking materials and substances in excess of requirements
- **Nutrition:** taking in of materials for energy, growth and development. plants require light ,carbon dioxide ,water and ions whereas animals need organic compounds, ions and usually need water.
- **Cell :** the functional and structural basic unit of life
- **Light microscope :**a microscope that uses light which shines through the piece of animal or plant you're looking at and uses glass lenses to magnify and focus the image which can magnify up to 1500 times. It is used to make photo micrographs.
- **electron microscope:** a microscope which uses beams of electrons to magnify up to 500,000 times. It is used in making an electron micrograph.
- **Eyepiece:** lens present at the top and is used to see the objects under study which have magnification of 10 to 15 times
- **Tube:** also called the body tube which connects the eyepiece to the objective lenses

- **Resolving nosepiece** : it allows the rotation of lenses while viewing and has holders for the different objective lenses
- **Coarse adjustment knob**: use for focus on scanning
- **Fine adjustment knob**: use for focus on Oil. Moves the body tube for focusing the high power lens
- **Arm**: It supports the tube of microscope and connects to the base of the microscope
- **Stage**: the platform that is flat used for placing the slides under observation
Stage dip: holds the slides in proper place
- **Base**: provide basal and support
- **Power switch**: the main power station that turns the illumination on and off in a light microscope
- **Magnification of a diagram**: is how many times it is larger than the real object. The formula is $M = \frac{Image}{Actual}$
- **Cell membrane**: is the partially permeable membrane made up of proteins and fat. It controls what enters and leaves the cell.
- **Cell wall**: is made up of cellulose (polysaccharide) and is fully permeable. It protects and supports the cell.
- **Cytoplasm**: is 70% water and consists of proteins dissolved in it for metabolic reactions to take place.
- **Vacuoles**: a plant vacuole consists of sugar solution and cell sap. An animal vacuole is called a vesicle and consists of nutrients or water.
- **Chloroplast**: present only in plants and contains chlorophyll and starch grains. Animals store carbohydrates in the form of glycogen granules.
- **Nucleus**: consists of chromosomes which have DNA.

Movement in and out of cells

- **diffusion**: the net movement of molecules from a region of their higher concentration to a region of their lower concentration down a concentration gradient, as a result of their random movement.
- **osmosis**: is the diffusion of water molecules through a partially permeable membrane (semi-permeable membrane) from a region of high water potential to low water potential.
- **partially permeable membrane**: allows small molecules like water to pass through, but not large dissolved solutes.
- **Water potential** : is a property of a solution that describes how free the water molecules are and it's stored energy of the water molecules before it has to use it for dissolving the solute
- **Hypertonic**: More solute concentration (low water potential)
- **Isotonic**: Equal solute concentration
- **Hypotonic**: Less solute concentration (high water potential)
- **Concentration gradient**: it's where there is a different number of nutrients on both sides of the cell membrane
- **Passive transport**: movement of molecules from high concentration to lower concentration and energy is not required as molecules move towards the gradient
- **Active transport**: movement of molecules from low concentration to higher concentration and energy is required in the form of ATP and it doesn't work for maintenance of equilibrium
- **Hydrophobic**: they don't dissolve in water
- **Hydrophilic**: they dissolve in water
 - Animal cells burst in pure water as too much water enters the cell.
 - Animal cells shrink in low water potential as too much water leaves the cell.
 - Plant cells become swollen and full in pure water.
 - Plant cells become flaccid and plasmolysed in a conc. solution.
- **Turgor pressure**: is experienced by a plant cell placed in pure water as water enters the cell, thus exerting pressure outwards, making the cell turgid.

- **Flaccid:** when a plant cell is placed in a concentrated solution, too much water leaves the cell, making it floppy and shriveled up.
- **Plasmolysis:** is a process in which the cell membrane tears away from the cell wall when a cell is placed in a concentrated solution.

Biological molecules

- **Uses of water:**
 1. Metabolic reactions take place only if chemicals are dissolved in water
 2. Transport of glucose by dissolving it in water
 3. Digestion takes place only if enzymes and nutrients are dissolved in water
- **carbohydrates:** includes starches and sugars and are made of elements carbon, hydrogen and oxygen. Provides energy.
- Functions of carbohydrates:
 1. Release energy from respiration
 2. Glucose transport
 3. Sucrose transport in plants
 4. Stored as starch in plants and glycogen in humans
 5. Cellulose formation for cell wall
- **Sugars/monosaccharides:** the simplest kinds of carbohydrates. They taste sweet and are soluble in water. E.g.: glucose
- **Complex sugars/disaccharide:** a large molecule formed by joining of two simple sugar molecules. They taste sweet and dissolve in water. E.g.: sucrose, maltose
Polysaccharides: when many simple sugar molecules join together, a polysaccharide is formed. They are not sweet and are insoluble in water. E.g.: cellulose, starch and glycogen.
- **Benedict's solution:** used to test the presence of reducing sugars and changes colour from blue to green to yellow to orange and then brick red in presence. Or else remains blue.

- **Iodine solution:** used to test the presence of starch. If it is present, the colour changes to blue black or else remains orange brown.
- **Fats/lipids:** made up of carbon, hydrogen and oxygen. They are formed by joining one glycerol molecule to three fatty acid molecules (triglycerides) and are insoluble in water. Provide instant energy, found as large oil droplets under the skin, help in making new cell membranes and provide insulation.
- **Oils:** fats which are liquid at room temperature and don't dissolve in water.
- Functions of fats:
 1. Provide energy when carbohydrates are used up
 2. Insulation
 3. Energy for germinating seeds in the form of oil reserves in the seeds
- **Ethanol emulsion test:** used to test the presence of fats. When food is shaken in ethanol and added to water, if an emulsion forms, fat is present. But if the solution remains transparent, fats are not present.
- **Emulsion:** a mixture consisting of millions of tiny droplets which appears opaque like milk
- **Proteins:** made up of amino acids and contains elements like carbon, hydrogen, oxygen, nitrogen and sulfur in some cases. Used for making new cells, enzymes, haemoglobin, keratin and also provide energy.
- **Biuret test:** used to test the presence of proteins. First, the food is shaken with water and then dilute copper sulfate solution and then dilute potassium hydroxide solution is added and if protein is present colour changes to purple or else remains blue.
- **Catalyst:** alters the rate at which the reaction is taking place without being changed itself and is still present at the end of the reaction.
- **Enzymes:** proteins/biological catalysts which ensure metabolic reactions take place in the cells
- Properties of enzymes:
 1. All enzymes are proteins
 2. Enzymes are made inactive by high temperatures
 3. Enzymes work best at their optimum temperatures

4. Enzymes work best at particular pH
 5. Enzymes are biological catalysts
 6. They are substrate specific
- **Catalase:** works inside the cells of most living organisms which breaks down hydrogen peroxide to water and oxygen
 - **Non catalyst enzymes:** enzymes like starch phosphorylase which builds starch from glucose molecules in plant cells
 - **Substrate:** the substance which is present in the start of the reaction
 - **Product:** a substance made by the reaction
 - **Active site:** the dent in every enzyme molecule which is complementary to the shape of the substrate so that it can fit in it and form an enzyme-substrate complex
 - **Lock and key mechanism:** substrate is the key and the enzyme is a lock
 - **Denatured enzyme:** when a substrate no longer fits into the enzyme due to the active site losing its shape due to high temperatures
 - **Optimum temperature:** the temperature at which the enzymes work their best ●
 - **Hydrate:** anything that dissolves in water and has ratio 2:1

Plant nutrition

- **Feeding/nutrition:** taking in of useful substances
- **Photosynthesis:** the process by which plants manufacture carbohydrates from raw materials using energy from sunlight (carbon dioxide + water —sunlight and chlorophyll→ glucose + oxygen)
- **Chlorophyll:** present in plant cells which traps sunlight so that it can be used in the process of photosynthesis
- **Epidermis:** layer of cells with no chloroplast on the upper and lower sides of the leaf which protect the cells inside and allow easy penetration of sunlight
- **Cuticle:** waxy substance released by the epidermis which stops too much water transpiration and is thin to allow maximum light penetration
- **Stomata:** small openings present in the lower epidermis which help in gas exchange which have chloroplasts

- **Palisade mesophyll cells:** rod shaped cells that contain large number of chloroplasts for photosynthesis and they are close to the leaf surface, upright, elongated and tightly packed to maximise light absorption.
- **Spongy mesophyll:** smaller cells found in the lower part of the leaf. They have less number of chloroplasts and large air spaces for easy diffusion of gases.
- **Vascular bundle(vein):** contain xylem and phloem arranged as a group
- **Translocation:** movement of sugars and amino acids via the phloem
- **Autotrophs:** get their energy from sunlight and build organic food molecules from carbon dioxide and make energy and synthesizes sugars through photosynthesis
- **Heterotrophs:** get energy from feeding on other organisms
- **Tip:** pointed part of the leaf
- **Midrib:** middle sectioning of the leaf
- **Margin:** outer perimeter of the leaf
- **Vein:** bundle of xylem and phloem vessels
- **Lamina:** photosynthesis happens here and it is a broad surface
- **Petiole:** on the surface of the leaf, it extends as midrib and then veins
- **Uses of glucose:**
 1. Used for energy
 2. Stored as starch
 3. Used to make proteins and other organic substances
 4. Changed to sucrose for transport
- **Nitrate ions** are used by plants to make amino acids, which are used for making proteins, which leads to plant growth. Lack of it makes plants look stunted, gives them yellow leaves and weak growth.
- **Magnesium ions** are used to make chlorophyll and lack of it causes yellowing between the veins of leaves.

Animal nutrition

- **Diet:** the food an animal intakes everyday

- **Seven types of important nutrients:** carbohydrates (macro), proteins (macro), fats (macro), vitamins (micro), minerals (micro), water and roughage.
- **Balanced diet:** a diet which consists of all the 7 types of nutrients in the correct amounts and proportions.
- **Energy needs depend on** gender, work you do and your age.
- **Vitamin C:** obtained from citrus fruits and raw vegetables which helps in making the stretchy protein collagen and keeps skin in good repair. Lack of it causes scurvy which causes pain in joints and muscles and bleeding from the gums and other places.
- **Vitamin D:** obtained from butter, egg yolk and can be made by skin when sunlight falls on it. Helps in calcium absorption for making bones and teeth. Lack of it causes rickets, where the bones become soft and deformed.
- **Calcium:** obtained from milk, bread and dairy products. Needed for strong bones and teeth and blood clotting. Lack of it causes brittle bones and teeth and poor blood clotting.
- **Iron:** obtained from liver, red meat, egg yolk and dark green vegetables. Needed for making haemoglobin and lack of it causes anaemia, where the person gets tired easily due to lack of red blood cells which causes low supply of oxygen to the tissues.
- **Inorganic nutrients:** minerals, water
- **Organic nutrients:** carbohydrates, fats, proteins, vitamins
- **Fibre:** it helps to keep the alimentary canal working properly.
- **Peristalsis**, movement of muscles contracting and relaxing to squeeze the food along, is simulated by fibre as it is a hard food.
- **Bran** is the combination of the outer husk of cereal grains, such as oats, wheat and barley. It prevents bowel cancer, constipation and keeps the food moving down the alimentary canal.
- **Saturated fat:** fat obtained from animals, containing cholesterol.
- **Unsaturated fat:** obtained from vegetable oils and oils from fish, better for the health.
- **CHD (coronary heart disease):** occurs when fat deposits build up on the inside of the arteries, making them stiffer and narrower, which decreases the blood supply to the heart muscles due to which heart muscles run out of oxygen quickly and can't work properly. This can cause a blood clot, and thus a heart attack.

- **Obesity:** occurs when people consume more energy than they use, which causes the fat to get stored. Obese people tend to have more risks of heart attack, heart disease, joint pains, diabetes and strokes.
 - **Malnutrition:** improper intake of nutrients/not eating a balanced diet
 - **Kwashiorkor:** caused by lack of protein in the diet. Children suffering from it are underweight, have a swollen abdomen,
 - **Marasmus:** caused by lack of protein and energy in the diet. The child has body weight much lower than normal and looks emaciated.
 - **Alimentary canal:** long tube inside a mammal's body running from one end to another
 - **Ingestion:** taking substances into the body through the mouth
 - **Digestion:** the breakdown of large, insoluble food molecules into small, water-soluble molecules using chemical and mechanical processes
 - **Mechanical digestion:** the breakdown of food into smaller pieces without chemical change to the food molecules
 - **Chemical digestion:** the breakdown of large insoluble molecules into small soluble molecules by the use of chemicals
 - **Absorption:** the movement of digested food molecules through the walls of the intestine into the blood
 - **Assimilation:** the movement of digested food molecules into the cells of the body where they are used, becoming part of the cells
- Egestion:** passing out of food that has not been digested, as faeces, through the anus
- **Teeth:** help with the ingestion and mechanical digestion of the food we eat. They chop, crush or grind the food into smaller pieces.
 - **Parts of the teeth are:**
 1. **Root:** the part of the tooth that is embedded into the gum
 2. **Crown:** part of the tooth which is not embedded into the root
 3. **Enamel:** is the hard covering over the crown of the tooth. It can't be broken or chipped, but can be dissolved by acids.
 4. **Dentine:** it is under the enamel and has channels containing living cytoplasm.
 5. **Pulp cavity:** it contains nerves and blood vessels which supply the cytoplasm in the dentine with food and oxygen.

6. **Cement:** the root of the tooth is covered with cement which attaches it to the jawbone but allows minimal movement.

- **The different types of teeth are:**

1. **Incisors:** are the sharp-edged, chisel-shaped teeth at the front of the mouth used for biting off pieces of food. (8)
2. **Canines:** are the more pointed teeth on either side of the incisors used for gripping food and tearing meat apart. (4)
3. **Premolars:** are the broad teeth at the back of the mouth. They are used for crushing and grinding food. (8)
4. **Molars:** are the broad teeth at the total end of the jawline and are used for crushing, grinding and breaking down the food. (8)

- **Plaque:** is a sticky film formed by the bacteria in the mouth, reacting with the saliva. It forms in between the teeth and between the teeth and gums. It is soft and easy to remove in the start but sooner it hardens and forms tartar which can't be removed by brushing.

- **Tooth decay:** If there is sugar in your mouth, the bacteria in the plaque will feed on it and use it in respiration, changing it into an acid. This acid starts dissolving the enamel and dentine and if it reaches the pulp cavity, the tooth will have to be removed.

- **Cavities and tooth problems can be avoided by:**

1. Not eating too much sugar
2. Using a fluoride toothpaste and mouthwash
3. Making regular visits to the dentist

- **Alimentary canal:** is a part of the digestive system and it is a long tube which runs from the mouth to the anus.

- **Digestive system:** consists of the alimentary canal and accessory organs (liver and pancreas) which helps in the digestion of food.

1. **Mouth:** the food is ingested via the mouth. Teeth break it down into smaller pieces and the tongue mixes the food with saliva, forming a bolus.

- The water in the saliva dissolves the food, helping taste it.
- The mucus in the saliva, lubricates the food, pushing it down the esophagus.
- The enzyme amylase in the saliva, start digesting any starch in the food.

2. **Oesophagus:** it takes food down to the stomach by a movement called peristalsis. The sphincter muscle which guards the entrance to the stomach, relaxes to let the food pass through.
3. **Stomach:** the muscular walls of the stomach relax and contract to churn and mix the food with enzymes and mucus, forming chyme. The goblet cells in the stomach make the mucus. Other glands make hydrochloric acid (which kills any harmful microorganisms and bacteria) and the protease pepsin which can work in acidic conditions.
 - Pepsin breaks down proteins into polypeptides.
4. **Small intestine:** it is divided into duodenum and ileum. It helps in the absorption of water, mineral salts and vitamins. The pancreatic duct is connected with the small intestine which releases pancreatic juices made in the pancreas which is a cream-coloured gland lying underneath the stomach. The pancreatic juices contain sodium hydrogen carbonate which neutralises the acidity of chyme, so that the following enzymes can work:
 - Amylase breaks down starch to maltose
 - Trypsin breaks down proteins into polypeptides
 - Lipase breaks down fats to fatty acids and glycerol
5. **Bile** is an yellowish-green alkaline, watery liquid, which helps neutralise chyme due to the presence of sodium hydrogen carbonate that is present. It is made in the liver and stored in the gallbladder after which it is secreted into the small intestine via the bile duct. The bile salts help in a process called emulsification, where fats are broken down into smaller drops of oil, increasing their surface area, so that they can be broken down chemically, by other enzymes.
6. **Villi:** cover the inner walls of the small intestine and cells covering the villi make enzymes which stay close to their production cell. These enzymes complete the digestion of food.
 - Maltase breaks down maltose into glucose
 - Proteases finish breaking down any polypeptides into amino acids
 - Lipase completes the breakdown of fats into fatty acids and glycerol

- Sucrase breaks down sucrose into glucose and fructose
 - Lactase breaks down lactose into glucose and galactose
7. **Large intestine/colon:** more amounts of water and salts are absorbed here. All the undigested food (fibre and roughage), bacteria and some dead cells pass on from here into the rectum and anus, to be excreted.

Transport in plants

- **Xylem tissue:** transports water from roots to leaves.
- **Xylem vessels:** are dead at maturity. They are joined end to end and the endwalls of cells are perforated. Their walls are made up of cellulose and lignin and they are unidirectional and transport water and mineral ions via passive transport (energy is not used)
- **Phloem tissue:** transports sap (water and sugar) from “source” to “sink.”
- **Phloem vessels:** are alive at maturity, but need companion cells and they are bidirectional and use active transport (energy is required)
- **Source:** where the sugar starts its journey (either where it is produced or stored)/ where substances are produced
- **Sink:** where sugar ends up (either where it is needed or will be stored)/ where the substance can be stored
- **Companion cells:** narrow, thin wall with an abundance of cytoplasm and a nucleus. They keep the sieve tube alive by providing nutrients and contains many mitochondria to provide energy for translocation.
- **Vascular bundle:** A strand of conducting vessels in the stem or leaves of a plant, typically with phloem on the outside and xylem on the inside.
- **Cambium cells:** they can divide to give rise to new xylem and phloem tissue, hence thickening of the stem
- **Pith:** the central region, serving as a storage tissue, that is formed due to xylem and phloem vessels arranging themselves in a ring
- **Cortex:** region between xylem and phloem vessels which also serves as a storage tissue for food

- **Cuticle:** waxy layer covering the epidermal cells which avoids excess transpiration
- **Pericycle cells:** present around the xylem and phloem vessels in the stem which helps keep the stem upright and the plant grow
- **Root cap:** layer of cells at the tip of the root which protects the root as it grows through the soil
- **Transpiration:** is the loss of water vapour from plant leaves by evaporation of water at the surfaces of the mesophyll cells followed by diffusion of water vapour through the stomata
- **Adaptations that help transpiration:**
 1. Root hair cells provide large surface area
 2. Hollow, narrow xylem vessels, providing an easy pathway
 3. Many air spaces inside the leaf, providing a large surface area
 4. Open stomata, encouraging more water to evaporate
- **Cohesion:** water molecules stick together to each other - So they will stay together in the xylem tissue
- **Adhesion:** water molecules stick to other molecules. So the water molecules will stick to the walls of the xylem as they move up.
- **Transpiration pull/stream:** This is because when the water evaporates at the top of the plant, it removes water from the xylem vessel, creating a negative pressure at the top. This negative pressure causes water to “suck” up the xylem vessel.
- **Translocation:** Movement of sucrose and amino acids in phloem- from regions of production to regions of storage or to regions of utilisation (in respiration or growth) via the phloem (source to sink)
- **potometer:** can be used to measure the volume of water absorbed.

Transport in humans

- **Circulatory system:** consists of the heart, blood and blood vessels (arteries, veins and capillaries). It is a system of a pump and valves to ensure one-way flow of blood.
- **Open circulatory system:** heart pumps into open cavities, blood vessels carry blood to all parts of the body

- **Closed circulatory system:** blood remains in a network of closed blood vessels
- **Fish circulatory system:** it is a single loop system. Atrium collects blood from the body and sends it to the ventricle which sends this blood to the gills where it will get oxygenated and goes to body cells where it gives off oxygen and picks up carbon dioxide
- **Double circulation:** consists of pulmonary and systemic circulation. In pulmonary circulation, the veins and arteries carrying blood to and from the lungs are considered. In systemic circulation, the flow of blood around the body and the blood vessels which do that are considered. In double circulation, the blood travels through the heart twice, in one complete circuit of the body.
- **Single circulation:** the blood passes through the heart only once in one complete circuit around the body. In fish, the blood to the body is pumped by the gills.
- **Pulmonary artery:** carries deoxygenated blood away from the heart to the lungs
- **Pulmonary vein:** carries oxygenated blood towards the heart
- **Oxygenated blood:** is the blood rich in oxygen because it has just travelled through the lungs and then picked up oxygen there by diffusion and has come to the left side of the heart to get pumped around the body.
- **Deoxygenated blood:** is the blood which has passed through the body and the oxygen from it has been used by the cells, so it is sent to the right hand side of the heart and then to the lungs to get rich with oxygen.
- **The heart is made up of cardiac muscle.**
- **Blood flow:** the blood from the head and body travel through superior and inferior vena cava and enter the right atrium. The AV valves open, sending the blood into the right ventricle. From here, the deoxygenated blood goes to the lungs via pulmonary artery. From the lungs, oxygenated blood comes into the left atrium via the pulmonary vein. The AV valves open again, pushing the blood into the left ventricle. The left ventricle pumps the blood around the body, via the aorta.
- **CHD (coronary heart disease):** is the blockage of the coronary arteries which supply the heart muscles with oxygen and nutrients. If the heart runs short of oxygen, it stops beating, thus an heart attack/cardiac arrest has occurred. **The following increase the chances of getting CHD:**

1. Smoking cigarettes
 2. Diet: high in salt and saturated fats or cholesterol, increase the chances.
 3. Obesity
 4. Stress
 5. Genes: most likely to pass on
- **Pulse:** is caused by the expansion and relaxation of an artery, caused by the heart pumping blood into it. Thus, pulse rate and the heart rate are the same.
 - **Pacemaker:** is a patch of muscle in the right atrium which controls the pace at which the heart beats.
 - **How the heart pumps blood:** (AV- atrioventricular valves, SL- semilunar valves)
 1. **Diastole / relaxation:** all muscles are relaxed. Blood flows into the heart. AV valves are open but SL valves are closed. The valves in the veins (vena cava and pulmonary vein) are open.
 2. **Atrial systole / atrial contraction:** the muscles of the atria contract but the muscles of the ventricles remain relaxed, which causes the blood to be squeezed into the ventricles. The AV valves open, but the SL valves remain closed. The valves in the veins remain shut.
 3. **Ventricular systole / ventricular contraction:** the muscles of the atria relax. The muscles of the ventricles contract. Blood is pumped out of the ventricles into the arteries. The SL valves and valves in the veins are open but the AV valves remain shut.
 - **Arteries:** take blood away from the heart (oxygenated blood). They have very strong walls to withstand the pressure with which the blood is being pumped out. They have elastic walls to stretch and recoil as the blood surges through them unevenly.
 - **Capillaries:** take nutrients, oxygen and other materials to all cells of the body and take away waste materials. Their walls are only one cell thick for easy diffusion to take place. Arterioles are arteries extending into capillaries and venules are veins extending into capillaries.
 - **Veins:** carry deoxygenated blood towards the heart. Since the blood travels with a low pressure, veins don't need thick, strong and elastic valves. Instead they have wider

lumens to provide an easy passage for blood flow. They have valves which avoid backward flow of blood.

- Liver has connections with **hepatic** vein and artery. Kidneys have connections with **renal** artery and vein.
- **Plasma**: is the liquid part of the blood. It consists of water, plasma proteins (fibrinogen and antibodies), lipids (cholesterol and fatty acids), carbohydrates, mineral ions, hormones and dissolved gases. Its **functions** are to:
 1. Transport carbon dioxide in solution
 2. Transport nutrients in solution
 3. Transport hormones in solution
 4. Transport heat
 5. Transport antibodies
 6. Acts as a liquid medium in which cells and platelets can float
- **Red blood cells**: They are made in the bone marrow of some bones. They don't have a nucleus, instead they have a red pigment called haemoglobin which is a protein and contains iron. The iron readily combines with oxygen which increases the oxygen carrying capacity of the RBC. They are biconcave discs which gives them a lot of surface area which increases the rate at which oxygen diffuses into and out of the cells.
- **White blood cells**: they have a large and lobed nucleus. Their function is to fight pathogens and to clear up dead body cells.
 1. **Phagocytes** fight bacteria and viruses by taking in bacteria and digesting them in a process called phagocytosis. They have a lobed nucleus.
 2. **Lymphocytes** fight pathogens by releasing antibodies on them.
- **Platelets**: are made in the red bone marrow and they are involved in blood clotting. They are small fragments of cells with no nucleus.

Respiration and gas exchange

- **Cells need energy for:**
 1. Contracting muscles
 2. Making protein molecules

3. Making new cells
 4. Cell division
 5. Producing heat inside the body
- **Respiration:** is the process that takes place in living cells when energy is released from food molecules which takes place in the mitochondria
 - **Aerobic respiration:** the chemical reaction in cells that uses oxygen to break down nutrient molecules to release energy
 1. Glucose + oxygen → carbon dioxide + energy + water
 2. $C_6H_{12}O_6 + 6O_2 \rightarrow 6 CO_2 + H_2O + ATP_{energy}$
 - **Anaerobic respiration:** the chemical reactions in cells that break down nutrient molecules to release little energy without using oxygenate
 - **Alcohol fermentation:** anaerobic respiration in fungus
 1. glucose → ethanol (C_2H_6O) + carbon dioxide + 2ATP
 - **Lactic acid fermentation:** glucose → lactic acid ($C_3H_5O_3$) + 2ATP
 - **Oxidative respiration:** the respiration that takes place in the presence of oxygen.
Reaction: glucose + oxygen → carbon dioxide + water + 38ATP
 - **Fermentation:** anaerobic respiration where oxygen is not present. It's of two types; alcohol and lactic acid fermentation
 - **Oxygen debt:** After anaerobic activity, oxygen is needed to neutralize the lactic acid. This is called an oxygen debt. It is repaid after exercise by heavy breathing. The oxygen reacts with the lactic acid to form CO_2 and water. Rapid and deep breathing is needed for a short period after high intensity exercise in order to repay the debt.
 - **Ventilation:** is the movement of air into and out of the lungs in two stages; inspiration and expiration. Movement of diaphragm and rib cage controls this
 - **Gas exchange:** the exchange (diffusion) of oxygen and carbon dioxide to and from the blood at the alveoli and respiring tissues
 - **Special characteristics of gas exchange sites:**
 1. Thin to allow easy diffusion of gases across them
 2. Close to an efficient transport system
 3. Large surface area

4. Good supply of oxygen

- **Cell respiration:** production of ATP in the cellular level (mitochondria)
- **Larynx** - the voice box. Infection here causes laryngitis
- **Trachea** - also called the **windpipe**, trachea is the main respiratory tube. The flexible tube is kept open by the rings of C-shaped cartilages so it prevents collapsing (like a straw). Mucus present here traps bacteria and dust helping to keep the air going to the lungs clean.
- **Bronchus** - subdivides the trachea into smaller tubes, one large bronchus into each of the lungs. Infection here causes bronchitis
- **Bronchiole** - even smaller subdivisions of the tubes, the bronchioles branches off in the lungs, leading into the ● alveoli.
- **Alveolus**- is the air sac which is the site of gas exchange. Each of them is surrounded with blood capillaries which takes the blood away with the oxygen in it.
- **Lung** - the spongy tissue found in the chest containing the organs for breathing.
- **vital capacity:** the maximum volume of air that can be stored in the lungs
- **Diaphragm** - the sheet of muscle forming the floor of the chest, controls the expansion of the lungs.
- **Ribs**- the bones which protect the organs in the chest.
- **Intercostal Muscles** - the set of muscles in the ribs which move the ribs up and down to allow more room for expansion during breathing.
- **Pleural fluid:** allows the lungs to move freely
- **Pleural membranes:** consists of fluids which cushions the lungs
- **Nose:** air here is moistened by mucus, warmed by blood vessels and cleaned by cilia hairs.
- **Epiglottis:** a small piece of cartilage above the larynx which automatically closes the opening to the trachea so that food doesn't enter it
- **Goblet cells and mucus glands:** produce and release mucus onto the surface so that any pathogens can be stopped from entering further into the body and then the mucus is removed by the cilia.

- **Ciliated cells:** these cells have cilia that can move and wave in coordination so that the mucus can easily be swept along the surface of the respiratory tubes so that it can be swallowed and safely digested.
- **Breathing:** alteration of inhalation (active) and exhalation (passive)
- **Inspiration:** external intercostal muscles are used to inhale air. Inhaled air has a lower concentration of carbon dioxide, higher concentration of oxygen, lower water content and temperature. Here rib cage moves up and out and the diaphragm contracts and moves down and thus pressure decreases and air enters the lungs
- **Forced expiration:** internal intercostal muscles are used to exhale air. Exhaled air has a higher concentration of carbon dioxide, lower concentration of oxygen, more temperature and more water content. Here the rib cage moves in and down and the diaphragm relaxes and moves upwards, which increases the pressure in the lungs and thus the air is pushed out
- **Smoke:** consists of tar, benzene, nicotine, carbon monoxide and smoke particles.
- **Passive smoking:** when non-smokers are in a smokers environment and end up inhaling the harmful smoke from the cigarette **Carcinogen:** cancer causing chemicals
- **Asthma:** a severe allergic reaction in which contraction of the bronchioles makes breathing difficult
- **Bronchitis:** an inflammation of the lining of the bronchial tubes. The passageways to the alveoli become swollen and clogged with mucus
- **Emphysema:** lungs lose their elasticity, deterioration of the lung structure
- **Pneumonia:** alveoli become filled with fluid. Caused by a bacterial or viral infection
- **Lung Cancer:** a disease in which tumors form in the lungs as a result of irregular and uncontrolled cell growth
- **COPD:** chronic obstructive pulmonary disease caused by the chemicals released by WBC which damage the lungs itself
- **Leukemia:** cancer of WBC caused by benzene found in cigarette smoke

Coordination and homeostasis

- **Sensitivity:** ability to detect and respond to changes in an organism's environment (internal and external)
- **Stimuli:** changes in an organism's environment
- **Coordination:** the way in which receptors pick up stimuli and pass it on to effectors
- **Receptors:** nerve cells which detect stimulus and produce electrical signals in response
- **Effectors:** muscles and glands which produce a response based on the electrical impulses sent to them from the receptors
- **Neuron:** specialised cell that carries electrical impulses around the body
- **Sensory neuron:** conducts impulses to cord and has a long dendrite, short axon and cell body/ dendrite outside spinal cord and cell body is a dorsal root
- **Relay/interneuron:** it interconnects sensory neurons with motor neurones and has a short dendrite and axon, and cell body is entirely within CNS
- **Motor neurone:** conducts impulses to effectors and has short dendrites and long axon and cell body/dendrites in spinal cord and axon outside spinal cord
- **Impulse:** is an electrical message that is carried along a neuron
- **Autonomic:** controls self-regulated action of internal organs and glands
- **Somatic:** controls voluntary movement of skeletal muscles
- **CNS:** the central nervous system which consists of the brain and spinal cord which coordinates the information traveling through the nervous system
- **PNS:** the peripheral nervous system consists of the nerves and receptors
- **Reflex action:** A means of automatically and rapidly integrating and coordinating stimuli with the responses of effectors (muscles and glands) to minimise any further damage to the body
- **Reflex arc:** The nerve pathway followed by a reflex action
- **Voluntary action:** slow response which is under conscious control and response is with the benefit of experience. Same stimulus may result in various actions
- **Involuntary action:** fast response which is not done consciously and response is to avoid/minimise danger. Same stimulus results in one action

- **Sense organs:** An organ of the body which responds to external stimuli by conveying impulses to the sensory nervous system. It contains different specialized receptors
- **Conjunctiva** - a clear, thin layer that protects the cornea and front of the eye
- **Cornea** - the tough transparent part of the outer surface of the eye to allow light through/clear window of the sclerotic layer.
- **Iris** - Aperture like ring that controls the amount of light that is let into the lens by changing size to control the size of pupil and give eye its colour
- **Pupil** - the hole in the middle of the iris that changes size according to intensity of the light
- **Aqueous humour** - the watery liquid in between the cornea and lens which helps maintain shape of the eye
- **Lens** - focuses the incoming light, can change thickness according to the distance of focus of vision and helps focus the image at the back of the eye
- **Ciliary body** - muscles that pull the lens to make it thinner or thicker.
- **Suspensory ligament** - Ligaments that connect the ciliary body to the lens and holds the lens in place
- **Vitreous humour** - the major liquid that forms the volume of the eye and help maintain its shape
- **Retina** - The inner surface of the eye where there are many light receptors (sensory neurons) and they send messages to the brain from here
- **Choroid** - the black layer between the retina and the sclera which prevents light from reflecting all around the eye and nourishes the eye with blood and oxygen
- **Fovea** - most of the light is focused onto this point in the retina (most densely arranged receptor)
- **Optic nerve** joins the eye to the brain and passes on information about the object so that the image is seen the right way up
- **Blind spot** - at this point, there are no light receptors, because the optic nerve and blood vessels join the eyeball
- **Sclera** - the tough outside protection layer of the eye
- **The pupil reflex:** an involuntary action which causes the pupil to dilate or contract based on the amount of light entering the eye

- **Dilation of pupil:** occurs when low amount of light is entering the eye which causes the pupil to become big and the iris to become smaller. The radial muscles contract and the circular muscles relax
- **Contraction of pupil:** occurs when large amounts of light enters the eye which causes the pupil to become smaller as the radial muscles relax and the circular muscles contract.
- **Accommodation:** the ability of the lens of the eye to change its shape depending on the distance of the object from the eye to focus on the object
- **Distant object:** the light rays bend while entering the eye, the lens are thin, suspensory ligaments are tense and ciliary muscles are relaxed
- **Near object:** the light rays don't bend as much while entering the eye, the lens are fat, suspensory ligaments are loose and ciliary muscles contract.
- **Hormones:** substances produced by endocrine glands, carried by the blood, which alters the activity of one or more specific target organs and then destroyed by the liver
- **Endocrine glands:** ductless glands that transport their secretions via the bloodstream
- **Exocrine glands:** glands with ducts that transport their secretions to the target organs via the ducts
- **Tropism** - growth of all or part of an organism in a particular direction in response to an external stimulus
- **Positive tropisms** – the plant grows towards the stimulus
- **Negative tropisms** – the plant grows away from the stimulus
- **Gravitropism:** a response in which a plant grows towards or away from gravity
- **Phototropism:** a response in which a plant grows towards or away from the direction from which light is coming
- **Auxins:** are a family of plant hormones (phytohormone). They are mostly made in the tips of the growing stems and roots, which are known as apical meristems, and can diffuse to other parts of the stems or roots and they control the growth of plants by promoting cell division and causing elongation in plant cells
- **Weed killers/herbicides:** similar to auxins and if sprayed on the plants they cause rapid, uncontrolled growth and respiration leading to death of the plants

- **Homeostasis:** is the maintenance of constant internal environment, which is vital for an organism to stay healthy.
 - **Negative feedback:** Homeostatic control is achieved using negative feedback mechanisms which are, if the level of something rises, control systems reduce it again and if the level of something falls, control systems raise it again.
- Thermoregulation:** is a homeostatic function which helps the body maintain a constant temperature despite the external environment. The body has mechanisms to lose heat if we get too hot or retain heat if we get too cold.
- **Temperature receptors** -Detect change in temperature (too hot or cold) and sends a message to adjust the body accordingly.
 - **Sweat glands** -Produces and secretes sweat through the pores to cool down the body if it gets too hot
 - **Blood Capillaries** - By vasoconstriction and vasodilation, it can control the loss of heat through the blood capillaries
 - **vasoconstriction:** when it's cold, the vessels are pulled closer in the body and hair stands up, minimising heat loss
 - **vasodilation:** allows the vessels to be closer to the surface and hair lays flat down, to lose heat when its hot
 - **Hair muscles:** allow the hair to stand up and this allows the hair to trap air
 - **shivering:** muscles contract and relax spontaneously which produces heat and warms blood
 - **Hypothalamus:** a part of the brain which coordinates temperature control by measuring the temperature of blood flowing through it and sending signals across the body accordingly

Reproduction in plants and animals

- **Reproduction:** is the biological process by which new individual organisms – "offspring" – are produced from their "parents".
- **Asexual reproduction:** needs only one parent and all the offspring are genetically identical to each other/ clones

- **Sexual reproduction:** needs two parents and offspring are genetically different from each other and the parents
- **Fertilisation:** The process involving the fusion of haploid nuclei to form a diploid zygote and the production of genetically dissimilar offspring (OR) formation of a new organism by the fusion of gametes
- **gamete:** a haploid cell that fuses with another haploid cell during fertilization in organisms that sexually reproduce. They contain half the number of chromosomes (haploid)and are formed by meiosis division
- **Petal :** have attractive colours and scents so that pollinators are attracted to the flower
- **Sepal :** protective leaf that protects the flower when it is in the bud
- **Petiole :** joins the flower to the stem
- **Nectary :** produces and contains nectar, a sweet liquid, to attract insects.
- **Stamen :** the male sex organ of a flower, divided into the anther and filament
- **Anther :** contains pollen sacs that open to release pollen
- **Filament :** stalk that holds the anther
- **Carpel :** the female sex organ of a flower, divided into the stigma, style, and ovary
- **Stigma :** collects and receive pollen
- **Style :** tube that connects the ovary and the stigma
- **Ovary :** contains ovules (egg cells), after fertilisation, the ovary becomes the fruit
- **Testa -** the hard protective cover on the outside of the seed
- **Cotyledon -** food store until the plant grows leaves for photosynthesis
- **Micropyle -** this is where the pollen tube connected with the ovule.
- **Plumule -** grows upwards into a shoot (upper part) of the plant
- **Radicle -** grows downwards into a root (lower part) of the plant
- **Pollination:** the transfer of pollen grains from the male part of the plant (anther of stamen) to the female part of the plant (stigma)
- **Self-pollination:** pollen from the same flower land on the same flower's stigma
- **Cross pollination:** pollen of the flower gets transferred to another flower's stigma
- **Ovary :** ova (egg cells) are stored in and released by the ovaries. Female hormone oestrogen is made here.

- **Oviduct : (Fallopian tube)** -The tube through which the ova travel through to reach the uterus. The oviduct is lined with ciliated cells which move the ova across.
 - **Uterus** : Commonly called the **womb**, is where the baby develops until birth
 - **Uterus Lining** : The soft inner wall of the uterus which hold the ova, and break down during menstruation.
 - **Uterus Wall** :The muscular wall of the womb which contract to push the baby out during birth.
 - **Cervix** : Separation between the vagina and the uterus. The cervix dilates when a baby is due to be delivered.
 - **Vagina** : Passage leading to the cervix which the penis can enter during sexual intercourse
 - **Testes**: produces sperms, releases male sex hormones, androgen and testosterone, which causes physical and psychological changes in males
 - **Scrotum**: a sac which covers and protects the testes and holds them outside the body
 - **Seminal vesicles**: stores sperms and secretes fluid into the sperm ducts which provide nutrients for the sperms to swim in and avoid them from sticking to each other
 - **Prostate gland**: secretes fluid into the semen which activated the sperms
 - **Sperm duct**: carries sperm from the testes to the urethra
 - **Urethra** : a duct which carries urine and sperm outside the body
- Implantation**: The uterus has a thin, spongy lining, and the embryo sinks into it **Morula** : a ball of cells formed after some mitosis divisions
- **Blastocyst**: the unequally formed fluid-filled cavity in the middle when a ball of cells divides which happens before implantation. It consists of inner mass of cells (develops into embryo), outer layer (develops into the placenta) and a fluid filled cavity
 - **Placenta**: is the life support system of the baby. It releases progesterone (maintains endometrium and prevents contraction) , HCG (initially maintains the corpus luteum) and oestrogen (maintains lining of uterus). Exchange of materials between maternal and fetal blood takes place as well.
 - **Umbilical cord**: connects foetus to placenta. 2 arteries have blood from fetus to placenta and 1 vein returns blood to fetus.

- **Process of birth:** first the oxytocin hormone triggers labour. Muscular walls of the uterus start to contract and the pressure breaks the amniotic sac. Contractions become more frequent pushing the baby out through the cervix. Cervix dilates and the vagina stretches to push the baby out. Placenta breaks away from the uterus wall and the umbilical cord is cut and tied.
- **Menstruation:** the thickened uterine lining falls away in the form of blood, so the body can start making a new one.
- **Follicular:** hormones prompt the creation of follicles on the ovaries and usually just one follicle will mature into one egg.
- **Ovulation:** the mature egg is released from the follicle and is ready for fertilisation.
- **Luteal:** if there is no fertilised egg, your body will prepare to shed its thickened lining and the cycle will begin again.
- **AIDS** (acquired immunodeficiency syndrome): a disease caused by the HIV virus
- **HIV** (human immunodeficiency virus): a fragile virus which is transported via the human fluids and can't survive outside the human body.

Inheritance

- **Chromosome:** a thread like structure of DNA, carrying genetic information in the form of genes, present in the nucleus of every cell. The cell is in chromosome form when dividing.
- **Chromatin:** the form in which the cell is present when it is not dividing
- **Autosome/somatic chromosome:** they make up the 22 pairs of the chromosome and they make proteins, enzymes, hormones.
- **Sex chromosome:** they make up the 23rd pair in the chromosome and they determine the gender
- **1 pair of chromosome:** has 2 chromosomes with each having 4 DNA strands
- **DNA:** deoxyribonucleic acid, a bio molecule which has genetic information
- **Gene:** it is the functional unit of DNA and it is the length of DNA that codes for a protein
- **Allele:** different forms of genes; recessive and dominant alleles

- **Dominant:** an allele that is expressed if it is present
- **Recessive:** an allele that is expressed only when there is no dominant allele of the gene present
- **Homozygous:** both alleles are the same; either recessive or dominant / having two identical alleles of a particular gene
- **Heterozygous:** alleles are not same; either R and D or D or R / having two different alleles of a particular gene
- **Haploid nucleus:** a nucleus contains a single set of unpaired chromosomes (23)
- **Diploid nucleus:** a nucleus containing two sets of chromosomes (46)
- **Homologous Chromosomes:** the two chromosomes of a pair where one is from the mother and the other is from the father
- **Mitosis:** cell division giving reuse to the genetically identical cells in which the chromosome number is maintained by the exact duplication of chromosome. (1 cell divides into 2)
- **Meiosis:** reduction division in which the chromosome number is halved from diploid to haploid. 1 cell divides into 4 different haploid cells.
- **Genotype:** the genetic makeup of an organism in terms of the alleles present
- **Phenotype:** the observable features of an organism / physical features
- **Monohybrid inheritance:** the inheritance of one pair only of contrasting characteristics / study of one gene's inheritance
 - 2 allele make up one gene, 2 chromosomes make up one homologous pair of chromosomes, 23 pairs make up a DNA strand
- **Pure breeding:** happens when both the parents are homozygous
- **Pure breed:** when the alleles are in homozygous condition (exact copy of the parent cell)
- **Gene of Y chromosome:** controls male characteristics and produces sperm cells
- **Gene of X chromosome:** controls female characteristics
- XX female(homogametic) , XY male (heterogametic)
- **Pedigree analysis:** it is the transfer / inheritance of one gene through many generations and it is in a tree form (circle represents female, square represents male, circle and square joint by a line is married)

- **Carriers** : half shaded, carry the defective genes but don't show symptoms and fully shaded are affected individuals

Variation and selection

- **phenotypic variation**: differences between the features of different individuals
- **Genetic variation**: caused due to differences in genotypic variation
- **Variation**: differences between the individuals of the same species
- **Normal distribution**: when most people come into the middle range, with fewer on the lower or upper ends when comparing phenotypes/features
- **Mutation**: an unpredictable change in the gene or chromosome number causing formation of new alleles
- **Gene mutation**: defect in DNA base sequence
- **Chromosomal mutation**: defect in chromosome number
- **Natural selection/ survival of the fittest**: is a theory proposed by Charles Darwin which states “ the different survival and reproduction of individuals due to their different phenotypes “
- **Evolution**: the change in inheritable traits of a population over time
- **Speciation**: occurs when two individuals of the species can't interbreed to produce fertile offspring due to different adaptations and thus changes in the genes of the individuals
- **Artificial selection**: is a method used by humans to produce varieties of plants and animals which yield more economic benefit
- **continuous variation**: is influenced by genes and environment, resulting in a range of phenotypes between two extremes
- **natural selection**: the greater chance of passing on of genes by the best-adapted organisms.
- **discontinuous variations**: caused by genes alone and results in a limited number of distinct phenotypes with no intermediates
- **process of adaptation**: the process resulting from natural selection by which populations become more suited to their environment over many generations

Organisms and their environment

- **Sun:** is the principal source of energy input to biological systems.
- **Food chain:** a chart showing a flow of energy (food) from one organism to the next, beginning with a producer.
- **Food web:** a network of interconnected food chains showing the energy flow through a part of an ecosystem
 - Causes for energy loss:
 1. Lost as heat energy due to respiration
 2. All parts of the organism aren't completely consumed
 3. Undigested molecules are lost as faeces
- **Producer:** an organism that makes organic nutrients by usually using sunlight through photosynthesis
- **Herbivore:** an organism that gets its energy by feeding on plants
- **Carnivore:** an organism that gets its energy by feeding on other animals
- **Omnivores:** an organism that gets its energy by feeding on plants and/or animals
- **Consumer:** an organism that gets its energy by feeding on other organisms
- **Decomposer:** an organism that gets its energy from dead or waste organic matter
- **Trophic level:** the position of an organism in a food chain or food web or pyramid of biomass or numbers
- **Combustion:** when fossil fuels are burnt, the carbon in them combines with oxygen in the air, forming carbon dioxide
- **Enhanced greenhouse effect:** as the concentration of greenhouse gases increases in the atmosphere, more heat is trapped, making the atmosphere warmer
- **Ecology:** the study of the interaction between living organisms and their environment
- **Habitat:** the area where an organism lives
- **Population:** a group of organisms of the same species, living in the same area at the same time
- **Community:** all the organisms, of all the different species, living in the same habitat

- **Ecosystem:** a unit containing all the organisms and their environment , interacting together, in a given area (community and its environment)

- **Carbon cycle: how CO₂ is released in the atmosphere:**

1. Combustion of fuels
2. Respiration
3. Decomposers decomposing urine, faeces, etc.
4. Death of organisms

How CO₂ is taken from the atmosphere: photosynthesis

- **Problems rising due to deforestation:**

1. Soil erosion
2. Silting of water bodies
3. Flooding
4. Extinction of plants and animals
5. Increased concentration of CO₂
6. Decreased concentration of O₂
7. Disturbances in water cycle
8. Uneven / no rainfall

- **Causes of eutrophication:**

1. Fertilisers
2. Pollutants
3. Slurry (cattle and pigs)
4. Silage (pits where grass is left to rot)
5. Untreated sewage water

- **Eutrophication:** is a process in which substances causing water pollution fill up water bodies. Due to this algal bloom takes place so enough sunlight can't penetrate into the water body, so underwater plants tend to die. The death causes rise of bacteria which feed on these dead matter. These respiring bacteria reduce the oxygen concentration in the water, so even the fish and other organisms die.

- **Leaching:** the washing off of fertiliser nutrients from the soil into water bodies due to rain
- **Causes of water pollution:**
 1. Fertilisers
 2. Untreated sewage
 3. Discharge of chemical waste
 4. Discarded rubbish