



SWGS KS5 VOCABULARY LIST: BIOLOGY

This list consolidates key vocabulary in the subject, making it easier for you to know, understand and use it accurately. This may be provided as a pre-filled glossary or a word list to complete. Your teachers will use this vocabulary frequently, and you will encounter it in reading. You will be expected to learn meanings and spellings.

Module 2 from page 1
Module 3 from page 14
Module 4 from page 22
Module 5 from page 30
Module 6 from page 42

Module 2 – Foundations in Biology

Topic 2.1: Cell structure

Centrioles: Structures found in the cytoplasm made of microtubules that produce the spindle fibres during mitosis.

Chloroplasts: Organelles found in plants and algae that are the site of photosynthesis.

Cilia: Small hair-like structures that project from the surface of cells.

Confocal microscopy: A type of microscopy that uses lasers to scan a specimen point by point to produce an image.

Cytoskeleton: A mesh of protein fibres found in the cytoplasm of eukaryotic cells used for structural support and intracellular transport.

Differential staining: Using multiple different stains to distinguish different parts of a specimen.

Eukaryotic cell: A type of cell that contains a nucleus along with membrane bound organelles.

Flagella: A whip-like structure found on bacterial cells that is used for cell movement.

Golgi apparatus: An organelle found in eukaryotic cells that is involved in the modification and packaging of proteins.

Light microscope: A type of microscope that uses a series of lenses to magnify the visible light reflecting off a specimen.

Lysosomes: Membrane-bound vesicles found in the cytoplasm that contain a hydrolytic enzyme called lysozyme.

Magnification: How much bigger an image appears compared to the original object calculated using the following formula:

$$\text{Image size} = \text{Actual size} \times \text{Magnification}$$

Mitochondrion: An organelle found in eukaryotic cells that is the site of aerobic respiration.

Nuclear envelope: A double membrane that surrounds the nucleus.

Nucleolus: A structure found inside the nucleus that contains proteins and RNA and is involved in synthesizing new ribosomes.

Nucleus: An organelle found in eukaryotic cells that stores the genetic information of the cell as chromosomes and is surrounded by a membrane called the nuclear envelope.

Plasma membrane: A semipermeable lipid bilayer studded with proteins that surrounds the cell and many organelles.

Prokaryotic cell: A type of cell that does not contain any membrane bound organelles or a nucleus.

Resolution: The ability to distinguish two different points in a specimen.

Ribosomes: Organelles found either free in the cytoplasm or membrane bound that are involved in the synthesis of proteins.

Rough endoplasmic reticulum (RER): A membrane-bound organelle that is involved in the synthesis and packaging of proteins.

Scanning electron microscope (SEM): A type of microscope that passes a beam of electrons over the surface of a specimen to produce an image.

Smooth endoplasmic reticulum (SER): A membrane-bound organelle involved in lipid synthesis.

Transmission electron microscope (TEM): A type of microscope that passes a beam of electrons through a sample to produce an image.

Topic 2.2: Biological molecules

Adhesion: A property of water molecules that creates an attraction between them and surfaces that they are in contact with.

Amino acid: The monomers containing an amino group (NH_2), a carboxyl group (COOH) and a variable R group that make up proteins.

Amylopectin: A branched polysaccharide made up of alpha glucose monomers joined by α -1,6 glycosidic bonds that makes up starch along with amylose.

Amylose: An unbranched polysaccharide made up of alpha glucose monomers joined by α -1,4 glycosidic bonds that makes up starch along with amylopectin.

Anions: An ion with a negative charge.

Benedict's test: A biochemical test used to detect the presence of a reducing sugar in a solution and distinguish between solutions of different reducing sugar concentrations.

Biuret test: A biochemical test that produces a purple colour when it is added to a solution containing protein.

Cations: An ion with a positive charge.

Cellulose: A linear polysaccharide that is the main component of the cell wall in plants and is made up of many beta glucose molecules joined by β -1,4 glycosidic bonds.

Chromatography: A technique used to separate different molecules in a solution by their different properties.

Cohesion: A property of water molecules that creates an attraction between them which causes them to stick together.

Collagen: A type of fibrous protein that provides strength to many different cell types and makes up connective tissues.

Condensation reaction: A type of reaction that joins two molecules together with the formation of a chemical bond involving the elimination of a molecule of water.

Conjugated protein: A protein with a prosthetic group bound to it.

Elastin: A type of fibrous protein that allows tissues and structures like blood vessels to stretch and return to their original shape.

Fibrous protein: A class of long chain proteins that are generally insoluble in water and typically have structural roles.

Globular protein: A class of spherical shaped proteins that are generally water soluble and typically have metabolic roles.

Glucose: A hexose monosaccharide that is the main respiratory substrate in eukaryotes.

Glycogen: A highly branched polysaccharide that is used as the main energy storage molecule in animals and is made up of alpha glucose monomers joined by α -1,4 glycosidic bonds.

Haemoglobin: A type of conjugated globular protein used to transport oxygen that is made up of four polypeptide chains each containing a haem prosthetic group.

Hexose monosaccharide: A simple sugar that contains 6 carbon atoms.

Hydrogen bond: A type of weak bond formed between an electropositive hydrogen and an electronegative atom like oxygen or nitrogen.

Hydrolysis: Breaking a chemical bond between two molecules involving the use of a water molecule.

Insulin: A globular protein hormone that is made in the pancreas in response to detection of high glucose levels in the blood.

Iodine test: A biochemical test that produces a blue/black colour when it is added to a solution containing starch.

Keratin: A type of fibrous protein that provides strength to hair and nails.

Lactose: A disaccharide made of a molecule glucose and galactose joined by a glycosidic bond.

Lipid emulsion test: A biochemical test that produces a cloudy emulsion when performed on lipids.

Maltose: A disaccharide made of two molecules of glucose joined by a glycosidic bond.

Monomer: An individual unit that can be bonded to other identical monomers to make a polymer.

Monomers: The smaller units from which larger molecules are made.

Pentose monosaccharide: A simple sugar that contains 5 carbon atoms.

Phospholipid: A type of amphipathic lipid made from a molecule of glycerol bonded to two fatty acid molecules and a phosphate group.

Polymer: A molecule made from many repeating monomers joined together.

Polymers: Molecules made from a large number of monomers joined together.

Primary structure: The individual sequence of amino acids in a protein.

Quaternary structure: A structure only applicable to proteins with multiple polypeptide chains that describes the interactions of the different chains.

Ribose: A pentose monosaccharide which composes the backbone of RNA.

Saturated fatty acid: A type of fatty acid molecule containing only single bonds between the carbon atoms.

Secondary structure: The local interactions of the amino acids in the polypeptide chain.

Solvent: A liquid that solutes can dissolve in to form a solution.

Starch: A polysaccharide used for energy storage in plants that is made up of alpha glucose joined together in the forms of amylose and amylopectin.

Sucrose: A disaccharide made of a molecule glucose and fructose joined by a glycosidic bond.

Tertiary structure: The way that the whole protein folds to make a three dimensional structure.

Triglyceride: A type of lipid formed from a molecule of glycerol joined by ester bonds to three fatty acid molecules.

Unsaturated fatty acid: A type of fatty acid molecule containing at least one double bond in the carbon chain.

Topic 2.3: Nucleotides and nucleic acids

Adenosine triphosphate (ATP): A nucleotide consisting of a molecule of ribose joined to the nitrogenous base adenine and three phosphate groups.

Degenerate (genetic code): A term used to describe the fact that some amino acids can be coded for by multiple different codons.

Deoxyribonucleic acid (DNA): A double stranded polynucleotide that contains the genetic material of an organism and is made up of deoxyribonucleotide monomers joined together by phosphodiester bonds.

DNA nucleotide: The monomer that makes up DNA and consists of deoxyribose, a nitrogenous base and a phosphate group.

DNA polymerase: An enzyme that catalyses the formation of phosphodiester bonds between nucleotides during the synthesis of a new DNA strand.

RNA polymerase: An enzyme that catalyses the formation of phosphodiester bonds between nucleotides during the synthesis of a new RNA strand.

Helicase: An enzyme that catalyses the unwinding and unzipping of DNA in many processes like replication and transcription.

Messenger RNA (mRNA): A type of RNA that carries genetic information from the DNA in the nucleus to the ribosomes for translation.

Non-overlapping (genetic code): A term used to describe the fact that each base is only part of one codon and that each codon is read one at a time in order.

Nucleotide: The monomer from which nucleic acids are made that consists of a pentose sugar, nitrogenous base and phosphate group.

Phosphodiester bond: A type of bond that joins nucleotides together to create polynucleotides.

Purines: A class of nitrogenous bases which are made up of two rings that adenine and guanine are members of.

Pyrimidines: A class of nitrogenous bases which are made up of a single ring that cytosine, thymine and uracil are members of.

Ribosomal RNA (rRNA): A type of RNA that makes up ribosomes.

RNA nucleotide: The monomer that makes up RNA and consists of ribose, a nitrogenous base and a phosphate group.

Semi-conservative replication: The replication of DNA to produce two new DNA molecules which both contain one new strand and one old strand from the original DNA molecule.

Transcription: The process of synthesising a new mRNA strand from a molecule of DNA.

Transfer RNA (tRNA): A type of RNA that has three hairpin loops, an anticodon for attachment to the mRNA codon and an amino acid binding site and is used to carry amino acids to the ribosome.

Translation: The process of protein synthesis where complementary tRNAs carrying amino acids are brought to each codon in an mRNA molecule as it moves through a ribosome.

Triplet (genetic code): A term used to describe the fact that DNA is grouped into three base long codons that are read together and code for an amino acid.

Universal (genetic code): A term used to describe the fact that the same codons code for the same amino acids in all organisms.

Topic 2.4: Enzymes

Activation energy: The amount of energy needed for a reaction to happen.

Active site: A specific region on an enzyme where the substrate binds and the reaction takes place.

Amylase: An enzyme that catalyses the extracellular breakdown of starch.

Catalase: An enzyme that catalyses the intracellular breakdown of hydrogen peroxide into oxygen and water.

Coenzyme: A type of cofactor that is bound loosely to an enzyme with weak interactions.

Cofactors: A non-protein molecule that is needed for the effective functioning of an enzyme.

Competitive inhibitor: A molecule which binds to the active site of an enzyme and prevents the substrate from binding.

Cyanide (CN⁻): A metabolic poison which acts as an irreversible inhibitor of cytochrome oxidase and hence preventing respiration.

End-product inhibition: A method of enzyme inhibition where the product of an enzyme controlled reaction can bind to the enzyme and prevent it from working.

Enzyme: A biological catalyst used to speed up the rate of biochemical reactions without being used up or permanently altered.

Enzyme-product complex: The temporary complex formed after the enzyme has catalysed the reaction but before the products have left the active site of the enzyme.

Enzyme-substrate complex: The temporary complex formed when the substrate binds to the active site of the enzyme.

Extracellular reaction: A reaction that occurs outside of cells.

Inactive precursor: An inactive form of an enzyme that cannot carry out its function until it is activated.

Induced fit hypothesis: A model of enzyme action that describes how once a specific substrate binds to the active site, the enzyme undergoes subtle conformational changes to fit the substrate better.

Intracellular reaction: A reaction that occurs within cells.

Lock and key hypothesis: A model of enzyme action that describes how the enzyme will only fit a substrate that has the correct complementary shape to the active site.

Metabolism: The sum of all the chemical reactions taking place in a cell.

Non-competitive inhibitor: An inhibitor which binds to a different part of an enzyme known as the allosteric site and prevents the enzyme from functioning.

Prosthetic group: A type of cofactor that is bound tightly to an enzyme with strong interactions.

Substrate specificity: The ability of an enzyme to catalyse only a specific reaction or set of reactions which have substrates complementary to the active site of the enzyme.

Temperature coefficient (Q_{10}): A method of calculating an increase in reaction rate after a 10°C temperature increase - calculated using the following equation:

$$Q_{10} = \frac{R_2}{R_1}$$

Trypsin: An enzyme that catalyses the extracellular breakdown of proteins.

Topic 2.5: Biological membranes

Active transport: The active movement of substances from a low concentration to a higher concentration (up their concentration gradient) with the use of energy in the form of ATP.

Amphipathic: A molecule with both hydrophobic and hydrophilic parts.

Cell lysis: The bursting of a cell, particularly after the uptake of too much water into an animal cell through osmosis.

Cholesterol: A mostly hydrophobic molecule that sits in the hydrophobic portion of the membrane and regulates membrane fluidity.

Crenation: The shrinking of a cell when placed in a hypertonic solution due to large amounts of water moving out of the cell through osmosis.

Endocytosis: The bulk uptake of substances into a cell by invagination of the membrane to form a vesicle trapping the substances inside the cell with the use of energy in the form of ATP.

Exocytosis: The bulk transport of substances out of a cell using a vesicle that fuses with the plasma membrane using energy in the form of ATP.

Facilitated diffusion: The net movement of substances from a high concentration to a lower concentration (down their concentration gradient) through transport proteins without the use of energy.

Fluid mosaic model: A model that describes membrane structure as a sea of mobile phospholipids studded with various proteins.

Hydrophilic: A molecule which is attracted to water.

Hydrophobic: A molecule which repels water.

Integral membrane protein: A type of protein bound to the membrane with strong interactions.

Osmosis: The net movement of water molecules across a partially permeable membrane from a region of high water potential to a region of lower water potential without the use of energy.

Peripheral membrane protein: A type of protein that is weakly bound to the surface of the membrane.

Phagocytosis: The ingestion of solid material (particularly pathogens and foreign material) by phagocytic cells.

Phospholipid: A type of lipid formed by the condensation of one molecule of glycerol, two molecules of fatty acid and a phosphate group.

Pinocytosis: The bulk uptake of liquids into the cell using energy in the form of ATP.

Plasmolysis: The effect produced by placing plant cells in a hypertonic solution causing the cell to shrivel from water loss, resulting in the membrane pulling away from the rigid cell wall.

Simple diffusion: The spreading out of substances from a high concentration to a lower concentration (down their concentration gradient) without the use of energy.

Turgid: A term used to describe a cell that is swollen due to large amounts of fluid uptake

Water potential: A measure of the tendency of water molecules to move from one area to another measured in kilopascals (kPa) and given the symbol Ψ .

Topic 2.6: Cell division, cell diversity and cellular organisation

Acrosome: An organelle found in the head of sperm cells which is specialised to digest the outer coating of an egg cell during fertilisation.

Anaphase: The third stage in mitosis where the chromosomes are pulled apart to the poles of the cell by the spindle fibres.

Anaphase 1: The third stage of meiosis where the chromosomes that make up the bivalent are pulled apart to the poles of the cell by the spindle fibres.

Anaphase 2: The seventh stage of meiosis where the chromatids are pulled apart to opposite poles of the cell.

Anucleate: A type of cell which does not have a nucleus.

Asexual reproduction: The production of genetically identical offspring from one parent through the process of mitosis.

Bivalent: A pair of homologous chromosomes.

Ciliated epithelium: A type of epithelium which has many fine protrusions known as cilia and is specialised for sweeping dirt and debris out of the body.

Crossing over: The exchange of genetic material between two chromosomes in a bivalent.

Cytokinesis: The division of the cytoplasm at the end of mitosis to produce two new daughter cells.

Differentiation: The process where a cell develops certain features so that it is specialised to carry out a certain function.

Diploid: Cells with two copies of each chromosome.

Erythrocyte: An anucleate cell specialised to carry oxygen from the lungs around the body (commonly referred to as a red blood cell).

G₁ (gap 1) checkpoint: The first checkpoint in the cell cycle which occurs just before the end of G₁ phase and commits the cell to division under favourable conditions.

G₁ (Gap 1) phase: The first growth phase in interphase where the cell synthesises proteins and RNA, duplicates its organelles and increases in size before DNA replication in S phase.

G₂ (gap 2) checkpoint: The second checkpoint in the cell cycle which occurs at the end of G₂ phase and checks that the DNA was correctly replicated during S phase before the cell enters mitosis.

G₂ (Gap 2) phase: The second growth phase of interphase where the cell continues to increase in size and synthesise biomolecules.

Gametes: Sex cells that have a haploid nucleus and are produced through meiosis.

Gene loci: The location of a gene on a chromosome.

Guard cells: A type of cell usually found in pairs that is specialised to control the opening and closing of stomata.

Haploid: Cells with only one copy of each chromosome.

Homologous chromosomes: Two chromosomes with similar gene loci but different alleles, one inherited from each parent.

Independent assortment: A source of variation in meiosis where the bivalent chromosomes can line up either way around on the metaphase plate.

Interphase: The largest part of the cell cycle where cells spend most of their time growing, synthesising biomolecules and preparing for mitosis.

M (Metaphase) checkpoint: The checkpoint occurring at the end of metaphase during mitosis which ensures all of the chromosomes have correctly attached to the spindle fibres and aligned at the metaphase plate.

Meiosis: A type of cell division used to produce gametes that produces four genetically different haploid daughter cells from one parent cell.

Meristematic tissue: A type of plant tissue which contains stem cells and is usually found in the growing regions of the plant.

Metaphase: The second stage in mitosis where the chromosomes attach to the spindle fibres and align in the centre of the cell along the metaphase plate.

Metaphase 1: The second stage of meiosis where the bivalent chromosomes align along the metaphase plate and independent assortment occurs.

Metaphase 2: The sixth stage of meiosis where the recombinant chromosomes align on the metaphase plate.

Mitosis: The division of a cell to produce two genetically identical daughter cells.

Multipotent: A type of stem cell which has the ability to differentiate into any cell type within a certain tissue in the body.

Neutrophil: A type of white blood cell with a multi-lobed nucleus which is specialised to engulf and destroy pathogens.

Organ: A group of specialised tissues working together to carry out a specific function.

Organ system: A group of specialised organs working together to carry out a specific function.

Palisade cell: A type of cell found in the leaves of plants which contains many chloroplasts and is specialised to carry out photosynthesis.

Phloem: A tissue found in plants which is specialised for the transport of assimilates from their site of production to different parts of the plant where they are needed.

Pluripotent stem cell: A type of stem cell which has the ability to differentiate into any cell type in the body.

Prophase: The first stage in mitosis where the nuclear envelope breaks down, the centrosomes move to opposite poles of the cell, the mitotic spindle begins to form and the chromosomes condense.

Prophase 1: The first stage of meiosis where the nuclear envelope breaks down, the spindle fibres form and the chromosomes condense and form bivalents. This is the stage of meiosis where crossing over occurs.

Prophase 2: The fifth stage of meiosis where the nuclear envelope breaks down, the spindle fibres form and the chromosomes condense.

Recombinant chromosomes: The chromosomes produced by the crossing over and exchange of genes during metaphase 1.

Root hair cell: A type of cell that is found in the roots of cells which has a large surface area and is specialised for the uptake of water and ions from the soil.

S (synthesis) phase: The second phase in the cell cycle where the DNA in the cell is replicated.

Somatic cells: Any cells that make up an organism excluding sex cells (sperm and egg cells).

Sperm cell: The male gamete which contains a long tail, an acrosome and lots of mitochondria and is specialised to fertilise an egg cell.

Squamous epithelium: A type of epithelium which is only one cell thick and is specialised for rapid diffusion.

Stem cell: A type of undifferentiated cell which has the ability to divide many times and differentiate into many different cell types.

Stomata: Small openings in the leaves or stem of a plant that can be opened or closed by guard cells in response to varying conditions.

Telophase: The final stage of mitosis where new nuclear envelopes begin to form around the separated sets of chromosomes.

Telophase 1: The fourth stage of meiosis where the nuclear envelopes reform around the separated chromosomes and they uncoil.

Telophase 2: The final stage in meiosis where the nuclear envelopes reform around the separated chromatids (now called chromosomes) and they uncoil.

Tissue: A group of specialised cells working together to carry out a specific function.

Totipotent stem cell: A type of stem cell which has the ability to differentiate into any type of cell in the body or in the placenta.

Xylem: A tissue found in plants which is specialised for the transport of water and dissolved minerals up the plant.

Topic 3.1: Exchange surfaces

Alveoli: Tiny air sacs that serve as the primary gaseous exchange surface. They consist of a thin epithelial cell layer, collagen and elastic fibres.

Breathing rate: The number of breaths per minute.

Bronchi: Divisions of the trachea that lead into the lungs. They are small tubes supported by incomplete rings of cartilage.

Bronchioles: Many small divisions of the bronchi. They contain smooth muscle to restrict airflow to the lungs but do not have cartilage. They are lined with a thin layer of ciliated epithelial cells.

Cartilage: Strong, flexible connective tissue that supports the walls of the trachea and bronchi, preventing collapse. It is found in an incomplete ring shape.

Ciliated epithelial cells: Specialised cells with tiny hair-like cilia found lining the trachea that waft bacteria-containing mucus up to the back of the throat, where it is swallowed.

Countercurrent flow: An adaptation for gaseous exchange in bony fish. Blood in the gill filaments and water moving over the gills flow in opposite directions, maintaining a steep oxygen concentration gradient.

Elastic fibres: Fibres of elastin that allow the alveoli to stretch as air is drawn in and recoil back to normal size, expelling air. They are also found in the trachea, bronchi and bronchioles.

Exchange surface: A surface over which materials are exchanged from one region to another. An effective exchange surface has a large surface area, thin layers, a good blood supply, and ventilation to maintain a steep diffusion gradient.

Expiration: During expiration (exhalation) the diaphragm relaxes and reverts to a dome. The external intercostal muscles relax, moving the ribs down and in. The volume of the thorax decreases and thoracic pressure exceeds air pressure. Air moves out of the trachea.

Gill filaments: The main site of gaseous exchange in fish, over which water flows. They are found in large stacks, known as gill plates, and have gill lamellae which provide a large surface area for exchange.

Gill lamellae: The fine branches of the gill filaments. They are adapted for gaseous exchange by having a large surface area and good blood supply.

Gill plates: Large stacks of gill filaments.

Gills: The organs of gaseous exchange in fish. They are contained in a gill cavity and are made up of gill lamellae, gill filaments and gill plates.

Goblet cells: Specialised cells that secrete mucus onto the trachea lining. The mucus traps harmful substances and microorganisms, preventing their entry into the lungs.

Inspiration: During inspiration (inhalation) the diaphragm contracts and flattens and the external intercostal muscles contract, moving the ribs up and out. The volume of the thorax increases and thoracic pressure falls below air pressure. Air moves into the trachea.

Internal intercostal muscles: Muscles found between the ribs which are responsible for forced exhalation.

Mammalian gaseous exchange system: A complex system found in mammals in which oxygen and carbon dioxide gases are exchanged.

Operculum: A flap that covers the gills of bony fish. It protects the gills and helps to maintain a constant stream of water over them.

Smooth muscle: An involuntary muscle found in the walls of the trachea and bronchi. It constricts the lumen of the bronchi by contracting, reducing airflow to the lungs.

Spiracles: Small, external openings along the thorax and abdomen of most insects, through which air enters, and air and water leave the gaseous exchange system. Spiracle sphincters open and close the spiracles to control gas exchange.

Spirometer: A device used to examine patterns of breathing and determine different aspects of lung volume.

Surface area to volume ratio: The surface area of an object divided by its volume. The larger the surface area to volume ratio, the smaller the object.

Tidal volume: The volume of air that moves into and out of the lungs during a normal breath.

Trachea (mammals): The primary airway which carries air from the nasal cavity down into the chest. It is a tube supported by incomplete rings of cartilage.

Tracheae (insects): Large tubes that run from the spiracles, into and along an insect's body. They are supported by spirals of chitin. The tracheae divide further into smaller tracheoles.

Tracheal fluid: A fluid found at the ends of the tracheoles. The amount of fluid affects the surface area available for gaseous exchange and water loss.

Tracheoles: Divisions of the tracheae that run throughout the tissues of an insect, forming a complex network. They are the main site of gas exchange and are completely permeable to gases.

Ventilation: The movement of fresh air into the lungs and stale air out of the lungs via inspiration and expiration.

Vital capacity: The largest volume of air that can be breathed in following the strongest possible exhalation.

Topic 3.2: Transport in animals

Affinity: The tendency of one substance to bind with another substance.

Aorta: The artery that takes oxygenated blood away from the heart to the body.

Arteriole: A type of blood vessel that connects the arteries and capillaries. The walls of the arterioles contain large amounts of smooth muscle, some elastic fibres and some collagen.

Artery: A type of blood vessel that carries blood away from the heart to the tissues, under high pressure. The walls of the arteries contain collagen, smooth muscle and elastic fibres.

Atrial fibrillation: An arrhythmia that involves the rapid contraction of the atria, preventing complete ventricular filling.

Atrial systole: The stage of the cardiac cycle in which the atria contract, pushing blood into the ventricles. The AV valves are pushed open fully and the atria are emptied of blood.

Atrioventricular node (AVN): A group of cells located between the atria that slow down the wave of excitation and pass it between the ventricles, along the bundle of His.

Atrioventricular (AV) valves: The valves found between the atria and ventricles. They prevent the backflow of blood from the ventricles into the atria. There are two types of atrioventricular valves: bicuspid and tricuspid.

Bicuspid valves: The atrioventricular valves found between the left atrium and left ventricle.

Blood: The transport medium in the mammalian circulatory system. It consists of plasma, red blood cells, white blood cells and platelets.

Bohr effect: The loss of affinity of haemoglobin for oxygen as the partial pressure of carbon dioxide increases.

Bradycardia: A slow resting heart rate below 60 bpm.

Bundle of His: A collection of Purkyne fibres which run from the AVN down to the apex of the ventricles.

Capillaries: Microscopic blood vessels that form a large network through the tissues of the body and connect the arterioles to the venules. They are the site of exchange of substances between the blood and the tissues.

Carbonic anhydrase: An enzyme that catalyses the reversible reaction between water and carbon dioxide to produce carbonic acid.

Cardiac cycle: Describes the sequence of events involved in one complete contraction and relaxation of the heart. There are three stages: atrial systole, ventricular systole and diastole.

Cardiac output: The volume of blood pumped by the heart through the circulatory system in one minute. It is calculated using the equation:

$$\text{cardiac output} = \text{heart rate} \times \text{stroke volume}$$

Chloride shift: The process by which chloride ions move into the erythrocytes in exchange for hydrogen carbonate ions which diffuse out of the erythrocytes. This maintains the electrochemical equilibrium of the cell.

Circulatory system: The transport system in animals.

Closed circulatory system: A circulatory system in which the blood pumped by the heart is contained within blood vessels. The blood does not come into direct contact with the cells. Closed circulatory systems are found in animals, e.g. vertebrates.

Diastole: The stage of the cardiac cycle in which the heart muscle relaxes. The atria and ventricles fill with blood.

Double circulatory system: A circulatory system in which the blood flows through the heart twice in two circuits. Blood is pumped from the heart to the lungs before returning to the heart. It is then pumped around the body, after which it returns to the heart again. Double circulatory systems are found in mammals.

Ectopic heartbeat: Additional heartbeats outside of the normal heart rhythm.

Electrocardiogram (ECG): A technique used to indirectly measure the spread of electrical activity through the heart by measuring tiny changes in the skin's electrical conductivity. This produces a trace which is used to detect abnormalities in heart rhythm.

Haemoglobin: The red pigment found in erythrocytes that binds reversibly with four oxygen molecules to form oxyhaemoglobin. It is a globular protein that consists of four polypeptide chains, each with a prosthetic haem group.

Haemoglobinic acid: The product formed when haemoglobin accepts free hydrogen ions. This enables haemoglobin to act as a buffer, reducing changes in blood pH.

Heart rate: The number of times the heart beats in one minute.

Hydrostatic pressure: The pressure exerted on the sides of a vessel by a fluid.

Inferior vena cava: The vein that returns deoxygenated blood to the heart from the lower body.

Lymph: Modified tissue fluid that drains into the lymphatic system. It carries less oxygen and fewer nutrients than tissue fluid, but also contains fatty acids.

Myogenic: Describes cardiac muscle tissue that initiates its own contraction, without outside stimulation from nervous impulses.

Oncotic pressure: The movement of water into the blood by osmosis due to the tendency of plasma proteins to lower the water potential of the blood.

Open circulatory system: A circulatory system in which the transport medium pumped by the heart is not contained within vessels, but moves freely. The transport fluid comes into direct contact with the cells. Open circulatory systems are found in invertebrates, e.g. insects.

Oxygen dissociation curve: A graph that describes the relationship between the partial pressure of oxygen and the percentage saturation of haemoglobin in the blood.

Plasma: The main component of the blood that carries red blood cells. It is a yellow liquid that contains proteins, nutrients, mineral ions, hormones, dissolved gases and waste.

Pulmonary arteries: The arteries that carry deoxygenated blood away from the heart to the lungs.

Pulmonary veins: The veins that carry oxygenated blood from the lungs to the heart.

Purkyne tissue: Specialised cardiac muscle fibres which make up the bundle of His and conduct the wave of excitation through the septum, from the AVN down to the apex of the ventricles.

Semilunar valves: A pair of valves found between the ventricles and arteries. They prevent the backflow of blood from the arteries into the ventricles.

Septum: The wall of muscle which separates the left side of the heart from the right side of the heart, preventing oxygenated and deoxygenated blood from mixing.

Single circulatory system: A circulatory system in which the blood travels one circuit; blood flows through the heart and is pumped around the body before returning to the heart. Single circulatory systems are found in fish.

Sinoatrial node (SAN): A group of cells in the wall of the right atrium that generate electrical activity, causing the atria to contract. The SAN is often referred to as the heart's pacemaker.

Stroke volume: The volume of blood pumped by the left ventricle of the heart in a single contraction.

Superior vena cava: The vein that returns deoxygenated blood to the heart from the head and upper body.

Tachycardia: A rapid resting heart rate over 100 bpm.

Tissue fluid: The fluid that surrounds the cells of animals. It has the same composition of plasma but does not contain red blood cells or plasma proteins.

Tricuspid valves: The atrioventricular valves found between the right atrium and right ventricle.

Vein: A type of blood vessel that carries blood towards the heart under low pressure. They have a wide lumen, a smooth inner lining and valves. The walls of the veins contain large amounts of collagen, smooth muscle and little elastic fibre.

Ventricular systole: The stage of the cardiac cycle in which the ventricles contract, pushing blood into the arteries. The semi-lunar valves are pushed open fully.

Venule: A type of blood vessel that connects the capillaries and veins. The walls of the venules contain small amounts of collagen and smooth muscle.

Topic 3.3: Transport in plants

Active loading: The process by which hydrogen ions are actively pumped out of companion cells using ATP, before diffusing down a concentration gradient, back into the cells via co-transporter proteins, whilst carrying sucrose.

Adhesion (water movement): The formation of hydrogen bonds between carbohydrates in the xylem vessel walls and water molecules. This contributes to the capillarity of water and transpiration pull.

Apoplast route: One of two pathways by which water and minerals move across the root. Water moves through intercellular spaces between cellulose molecules in the cell wall.

Casparian strip: A waterproof strip surrounding the endodermal cells of the root that blocks the apoplast pathway, forcing water through the symplast route.

Cohesion (water movement): The formation of hydrogen bonds between water molecules. This contributes to the capillarity of water and transpiration pull.

Cohesion-tension theory: The model that explains the movement of water from the soil to the leaves, in a continuous stream.

Companion cells: The active cells of the phloem located adjacent to the sieve tube elements. They retain their nucleus and organelles, producing ATP for metabolic processes in both themselves and the sieve tube elements.

Dicotyledonous plants: Plants that produce seeds that contain two cotyledons. They have two primary leaves.

Hydrophytes: Plant that are adapted to live and reproduce in very wet habitats, e.g. water lilies.

Hydrophytes: Plant that are adapted to live and reproduce in very wet habitats, e.g. water lilies.

Phloem: A living plant transport vessel responsible for the transfer of assimilates to all parts of the plant. The phloem consists of sieve tube elements and companion cells.

Plasmodesmata (phloem): Small pores between adjacent sieve tube elements and companion cells that allow communication and the exchange of materials.

Potometer: An apparatus used to measure water uptake from a cut shoot.

Root hair cells: Specialised cells responsible for the uptake of water and minerals from the soil. They have long hair-like extensions known as root hairs, which are adapted as exchange surfaces.

Sieve plates: The perforated end walls of sieve tube elements that allow plant assimilates to flow between cells unimpeded.

Sieve tube elements: The main cells of the phloem. They are elongated cells laid end-to-end with sieve plates between. They contain few organelles.

Sinks (plants): The regions of a plant that remove assimilates e.g. roots, meristem, fruits.

Sources (plants): The regions of a plant that produce assimilates e.g. leaves, storage organs.

Symplast route: One of two pathways by which water and minerals move across the root. Water enters the cytoplasm through the plasma membrane and moves between adjacent cells via plasmodesmata. Water diffuses down its water potential gradient by osmosis.

Translocation: The movement of organic compounds in the phloem, from sources to sinks.

Transpiration: Water loss from plant leaves and stems via diffusion and evaporation. The rate of transpiration is affected by light, temperature, humidity, air movement and soil-water availability.

Transpiration stream: The flow of water from the roots to the leaves in plants, where it is lost by evaporation to the environment.

Vascular bundle: The vascular system in herbaceous dicotyledonous plants. It consists of two transport vessels, the xylem and the phloem.

Vascular system: A network of transport vessels in animals and plants.

Xerophytes: Plant that are adapted to live and reproduce in dry habitats where water availability is low, e.g. cacti and marram grass.

Xylem: A non-living plant transport vessel responsible for the transfer of water and minerals from the roots to the shoots and leaves.

Topic 4.1: Communicable disease, disease prevention and the immune system

Active immunity: Resistance in an organism that has developed through the production of specific antibodies in response to a pathogen. It provides long-lasting immunity as memory cells are produced.

Agglutinins: Chemicals that cause pathogens to aggregate together, aiding phagocytosis. Antibodies can act as agglutinins.

Antibiotic: A chemical or compound produced by a living organism that kills or prevents the growth of bacteria.

Antibiotic-resistant bacteria: Bacteria that mutate to become resistant to an antibiotic, survive and reproduce very rapidly, passing on their antibiotic resistance.

Antibodies: Immunoglobulins produced by B-lymphocytes in response to a specific antigen, triggering an immune response.

Antigen: A chemical present on the surface of a cell that induces an immune response.

Antigen-presenting cell: A macrophage that displays foreign antigens.

Anti-toxins: Chemicals produced by white blood cells that neutralise toxins released by pathogens.

Anti-toxins: Chemicals produced by white blood cells that neutralise toxins released by pathogens.

Artificial active immunity: The production of antibodies by the immune system following the exposure to a weakened, attenuated or dead pathogen, e.g: by vaccination.

Artificial passive immunity: The immunity acquired from the administration of specific antibodies from another organism, e.g: by vaccination.

Athlete's foot: A form of ringworm in humans that affects the feet, resulting in cracking and scaling of the skin.

Autoimmune disease: A condition in which the immune system attacks and destroys healthy body tissue, e.g: arthritis, lupus.

Bacteria: Prokaryotic cells that have cell walls but lack organelles. Some bacteria are pathogenic, producing toxins that damage host cells.

B effector cells: A type of B lymphocyte that divides to form plasma cells.

Black sigatoka: A fungal disease in tomatoes caused by *Mycosphaerella fijiensis*, the hyphae of which penetrate and digest host leaf cells, turning them black.

B lymphocytes: Lymphocytes that mature in the bone marrow. There are three main types; plasma cells, B effector cells and B memory cells.

B memory cells: B lymphocytes that provide immunological memory.

Callose: A plant polysaccharide that contains β -1,3 and β -1,6 linkages between glucose molecules. It is deposited between the cell walls and cell membrane in cells adjacent to infected cells, serving as a defence against pathogens. It is also found in the cell walls of infected cells and the plasmodesmata between infected cells.

Chitinases: Enzymes that degrade chitin in fungal cell walls.

Clonal expansion: The mass proliferation of specific antibody-producing cells.

Clonal selection: The identification of an antibody-producing cell with complementary receptors to the shape of a specific antigen.

***Clostridium difficile*:** A type of bacteria found in the gut of some individuals which is resistant to most antibiotics.

Communicable disease: A disease that is caused by a pathogen and transmitted directly between organisms.

Cytokines: Cell-signalling molecules produced by mast cells in damaged tissue. They attract white blood cells to the site of damage.

Direct transmission: The transfer of a pathogen directly from one organism to another. This can occur via direct contact, ingestion or the sharing of contaminated needles.

Epidemic: A rapid rise in the incidence of a communicable disease at a local or national level.

Expulsive reflexes: Coughs or sneezes initiated upon irritation of the respiratory tract. They remove microorganism-containing mucus from the gaseous exchange system.

Fungi: Eukaryotic, often multicellular organisms that may cause disease. They digest and destroy cells, and produce spores that can spread rapidly between organisms.

Histamine: A chemical produced by mast cells in damaged tissue. It makes blood vessels dilate and causes their walls to become leakier.

Human Immunodeficiency Virus (HIV): An infectious virus that destroys T helper cells, weakening the immune system of the body. HIV makes an individual more susceptible to opportunistic infections and can lead to AIDS (Acquired Immunodeficiency Syndrome).

Indirect transmission: The transfer of a pathogen indirectly between organisms via fomites, vectors, droplet infection or soil contamination.

Inflammation: A localised response of vascular tissue to pathogens, damage or irritants. It is characterised by pain, redness, heat and swelling.

Influenza: A common viral infection caused by the family of viruses, *Orthomyxoviridae*, that destroys ciliated epithelial cells in the gaseous exchange system, exposing the airways to secondary infection.

Interleukins: Cytokines produced by T helper cells that stimulate B cells.

Lymphocytes: White blood cells that contribute to the specific immune response.

Lysosome: A membrane-bound organelle that contains hydrolytic enzymes.

Malaria: A disease caused by the protoctista *Plasmodium* that lives within two hosts, mosquitoes and humans. It causes recurrent episodes of fever and can be fatal.

Mast cells: Specialised cells in connective tissue that are important in the inflammatory response, releasing histamines and cytokines.

MRSA: A type of bacteria that is resistant to the antibiotic methicillin.

Mucous membranes: The membranes lining body cavities that secrete a sticky mucus.

Natural active immunity: The production of antibodies by the immune system following infection.

Natural passive immunity: The immunity acquired by an infant mammal when antibodies are transferred through the placenta and the colostrum from the mother.

Non-specific defences: Defenses that are always present and are the same for all organisms, e.g: skin, blood clotting, inflammation, mucous membranes and expulsive reflexes.

Opsonins: Chemicals that bind to and tag foreign cells, making them easily recognisable to phagocytes.

Passive immunity: Resistance in an organism acquired via the transfer of antibodies. It provides short-term immunity as no memory cells are produced.

Pathogen: A disease-causing microorganism. Includes bacteria, viruses, fungi and protoctista.

Penicillin: The first conventional, effective and safe antibiotic derived from the mould *Penicillium chrysogenum*. It was discovered by Alexander Flemming.

Personalised medicine: A form of medical care that enables doctors to provide healthcare that is customised to an individual's genotype.

Phagocytes: Specialised white blood cells that engulf and destroy pathogens. There are two types: neutrophils and macrophages.

Phagocytosis: The process by which phagocytes engulf and destroy pathogens.

Phagolysosome: A vesicle within a phagocyte formed by the fusion of a phagosome and lysosome.

Phagosome: The vacuole inside a phagocyte in which a foreign particle is engulfed.

Plasma cells: B lymphocytes that produce antibodies specific to a particular antigen.

Potato blight: A disease caused by the fungi-like protoctist *Phytophthora infestans* whose hyphae penetrate host cells, causing the collapse and decay of the leaves, fruit and tubers. Also known as tomato blight or late blight.

Primary immune response: The response of the immune system to a pathogen when it is first encountered. A small number of antibodies are produced slowly.

Protoctista: A group of eukaryotic, single-celled microorganisms that may cause disease. They digest cells and use the cell contents to reproduce.

Ring rot: A bacterial disease in tomatoes, potatoes and aubergines that results in damage to the leaves, fruit and tubers. It is caused by the *Clavibacter michiganensis* bacterium.

Ringworm: A fungal disease that affects mammals, causing grey-white, circular, crusty lesions on the skin.

Secondary immune response: The response of the immune system to a pathogen when it is encountered for a second (third, fourth...etc.) time. Immunological memory gives a rapid production of a large number of antibodies.

T helper cells: T lymphocytes with CD4 receptors on the cell surface membrane. These bind to antigens on antigen-presenting cells and secrete interleukins.

T killer cells: T lymphocytes that produce perforin, destroying pathogens with a specific antigen.

T lymphocytes: Lymphocytes that mature in the thymus gland. There are four main types: T helper cells, T killer cells, T memory cells and T regulatory cells.

T memory cells: T lymphocytes that provide immunological memory.

Tobacco mosaic virus (TMV): A virus that infects many species of plants, in particular tobacco plants. It damages the leaves, flowers and fruit, and stunts plant growth.

T regulator cells: T lymphocytes that regulate the immune response by suppressing other T cells and maintaining tolerance to self-antigens.

Tuberculosis (TB): A bacterial disease, caused by *Mycobacterium tuberculosis* and *M. bovis*, that damages lung tissue and weakens the immune system.

Vaccination: The deliberate exposure of an individual to antigens from a pathogen to provide artificial active immunity.

Vector: A living or non-living agent that transmits a pathogen between organisms.

Viruses: Non-living infectious agents that invade host cells and take over cell metabolism, replicating within them.

Topic 4.2: Biodiversity

Adaptation: A feature of an organism that increases its chance of survival in its environment. An adaptation may be anatomical, physiological or behavioural.

Belt transect: A line along a sampled area upon which quadrats are placed at intervals to determine the abundance and distribution of organisms in an ecosystem.

Binomial system: The universal system of naming organisms. It is made up of two parts; the first gives the genus and the second, the species e.g. *Homo sapiens*.

Biodiversity: The variety of living organisms in an ecosystem.

Charles Darwin: The scientist who developed the theory of evolution by natural selection.

Classification: The organisation of organisms into groups.

Community: All of the populations of different species living together in a habitat.

Conservation: The maintenance of ecosystems and biodiversity by humans in order to preserve the Earth's resources.

Continuous variation: When a characteristic can have any value within a given range e.g. height, mass, heart rate.

Convention on Biological Diversity (CBD): A treaty that promotes the sustainable use of and maintenance of biodiversity. One of three Rio Conventions.

Convention on International Trade in Endangered Species (CITES): A treaty that regulates the trade of plants and wild animals across international borders.

Convergent evolution: The process by which unrelated species evolve similar traits due to exposure to similar environments or selection pressures.

Countryside Stewardship Scheme (CSS): A scheme in England (1991-2014) that aimed to provide financial incentives to farmers to enhance and conserve the environment. Replaced by the Environmental Stewardship Scheme (ESS).

Discontinuous variation: When a characteristic can only take certain values e.g. sex, eye colour, blood group.

Domain: The highest taxonomic rank. There are three domains; Archaea, Bacteria and Eukaryota.

Evolution: The gradual change in the allele frequencies within a population over time. Occurs due to natural selection.

Ex situ conservation: A type of conservation that takes place outside of an organism's natural habitat e.g. zoos, botanic gardens, seed banks.

Fossil: The remains of dead organisms found in rocks which are millions of years old.

Fungi: A biological kingdom consisting of mushrooms, yeasts and moulds.

Genetic biodiversity: A measure of the variety of genes that make up a species.

Habitat biodiversity: A measure of the number of different habitats found within an area.

In situ conservation: A type of conservation that takes place within an organism's natural habitat e.g. wildlife reserves, marine conservation zones.

Interspecific variation: Differences between members of different species.

Intraspecific variation: Differences between members of the same species.

Keystone species: A species which has an unexpectedly large effect on the environment and is crucial for the maintenance of biodiversity.

Kick-sampling: A method used to sample organisms living on the bed of a river. It involves disturbing an area of river bed before placing a net downstream to capture released organisms.

Kingdom: The second highest taxonomic rank. There are five kingdoms: Prokaryotae, Protoctista, Fungi, Plantae and Animalia.

Line transect: A line along a sampled area. The species touching the transect at regular intervals are recorded to determine the abundance and distribution of organisms in an ecosystem.

Monoculture: The growth of one crop in a given area.

Natural selection: The process by which the frequency of 'advantageous' alleles gradually increases in a population's gene pool over time.

Non-random sampling: A sampling method in which a sample is not chosen randomly. Three types; opportunistic, stratified and systematic.

Opportunistic sampling: A type of non-random sampling that involves drawing a sample from part of the population that is conveniently available.

Phylogenetic tree: A diagram used to show the evolutionary relationships between organisms.

Phylogeny: The evolutionary relationships between individuals or groups of organisms.

Pitfall trap: A device used to catch small ground surface invertebrates. It consists of a container buried beneath the ground and a roof structure.

Pooters: A device used in the collection of small insects. It consists of two tubes, one connecting the holding chamber to a mouthpiece (with a filter) and the other to an inlet tube.

Prokaryotae: A biological kingdom consisting of unicellular prokaryotes (bacteria).

Proportion of polymorphic gene loci: A measure of genetic biodiversity. Calculated using:

$$\text{proportion of polymorphic gene loci} = \frac{\text{number of polymorphic gene loci}}{\text{total number of loci}}$$

Protoctista: A biological kingdom consisting of unicellular eukaryotes.

Quadrat: A square grid of known area used in sampling to determine the abundance of organisms in a habitat. There are two types; point quadrats and frame quadrats.

Random sampling: A sampling technique used to avoid bias e.g. creating a square grid and generating random coordinates.

Seed bank: A storage of seeds to preserve genetic material.

Selection pressures: Environmental factors that drive evolution by natural selection and limit population sizes e.g. competition, predation and disease.

Simpson's Index of Diversity (D): A measurement of diversity that considers both species richness and evenness. Calculated using the formula:

$$D = 1 - \sum \left(\frac{n}{N} \right)^2$$

Spearman's rank correlation coefficient: A statistical test used to determine the relationship between two variables.

Species biodiversity: A measure of species richness and species evenness.

Species evenness: The number of individuals of each species living together in a community.

Species richness: The number of different species found within an area.

Stratified sampling: A type of non-random sampling in which populations are divided into strata and a random sample is taken from each, proportional to its size.

Student's t-test: A statistical test used to analyse whether there is a significant difference between the means of data values of two populations.

Sweep nets: A funnel-shaped net used to catch insects and other small animals.

Systematic sampling: A type of non-random sampling in which samples are taken from different regions of a habitat.

Taxon: Each group within a phylogenetic classification system.

Taxonomic hierarchy: The arrangement of organisms into successive levels of classification known as taxonomic groups.

Three-domain system: A method of classification in which organisms are categorised into three domains and six kingdoms. Developed by Carl Woese.

Tullgren funnel: A device used to extract living organisms from a soil sample.

Variation: The differences between individuals due to genes, the environment or a combination of both.

Topic 5.1: Communication and homeostasis

Abscissic acid (ABA): A plant hormone that stimulates stomatal closing, maintains seed dormancy and triggers cold protective responses.

Abscission: The shedding of leaves in plants.

Acetylcholine: A type of neurotransmitter that is used for communication between neurones.

Actin: A type of protein filament found in myofibrils. It forms thin filaments consisting of two long twisted chains.

Actin-myosin binding site: A site on actin that is normally blocked by tropomyosin. During muscle contraction, it becomes exposed, allowing a myosin head to attach.

Actin-myosin cross-bridge: The cross-bridge formed when a myosin head attaches to the myosin binding site on an actin filament.

Adenylyl cyclase: An enzyme that catalyses the conversion of ATP to cAMP.

Adrenal glands: Glands which are located on the top of the kidneys and produce adrenaline and steroid hormones.

Adrenaline: A hormone that is secreted by the adrenal glands under stressful conditions. It serves as a 'primary messenger', activating adenylyl cyclase.

Afferent arteriole: The larger diameter arteriole which carries blood to the glomerulus for ultrafiltration.

Alkaloids: A group of nitrogenous compounds found in plants. They are bitter-tasting and affect the metabolism of animals or insects that take them in.

All-or-nothing principle: The principle that describes how any generator potential which reaches or exceeds the threshold potential will produce an action potential of equal magnitude.

Alpha cells (α cells): Cells found in the pancreas which secrete glucagon into the blood to raise glucose concentration.

Anisotropic (A) bands: The darker bands in a myofibril, which consist of overlapping actin and myosin filaments.

Anabolic steroids: A class of performance enhancing drugs that are structurally similar to testosterone and used illegally by athletes to promote muscle growth.

Anterior pituitary gland: The region of the pituitary gland that produces and secretes hormones.

Antidiuretic hormone (ADH): A hormone released from the posterior pituitary gland that increases the reabsorption of water in the kidney tubules.

Aquaporin: A membrane channel used for the selective transport of water in and out of the cell.

Autonomic nervous system: A branch of the nervous system that carries nerve impulses to muscles and glands. It controls involuntary activities and has two divisions: the sympathetic nervous system and the parasympathetic nervous system.

Auxins: A class of plant hormones that control cell elongation, produce tropisms, prevent abscission, maintain apical dominance and stimulate the production of ethene.

Axon: An extension from a nerve cell that carries impulses away from the cell body.

Beta cells (β cells): Cells found in the pancreas which secrete insulin into the blood to lower glucose concentration.

Bile canaliculi: Vessels which collect the bile produced by hepatocytes.

Blinking reflex: The involuntary blinking of the eyelid when an object is held close to the eye. It is the last reflex to be lost.

Cardiac muscle: A myogenic muscle found in the walls of the heart.

Central nervous system (CNS): The brain and spinal cord.

Cerebellum: The region of the brain that controls muscle coordination and non-voluntary movement (e.g. balance, posture).

Cerebrum: The largest region of the brain, consisting of two hemispheres, that receives sensory information from receptors and sends information via the motor neurones to effectors. It is responsible for all voluntary and some involuntary responses.

Cholinergic synapse: A synapse which uses the neurotransmitter acetylcholine.

Creatine phosphate: A compound stored in muscles that serves as a phosphate reserve, enabling ATP regeneration.

Cutting: A small section of the root or stem of an adult plant.

Cyclic AMP (cAMP): A 'second messenger' involved in the action of adrenaline that activates protein kinase.

Dendron: An extension from a nerve cell that carries impulses towards the cell body.

Depolarisation: The rapid influx of sodium ions into the cell which cause it to lose its negative charge and the membrane potential to increase.

Ectotherm: A type of organism which is dependent on its environment to maintain its body temperature.

Effector: An organ, tissue, or cell that produces a response to a stimulus.

Efferent arteriole: The smaller diameter arteriole which carries the blood away from the glomerulus after ultrafiltration.

Endocrine signalling: A type of signalling that uses hormones secreted by endocrine cells into the blood which produce an effect on receptors.

Endotherm: A type of organism which can regulate its own body temperature without relying on external heat sources.

Ethene: A plant hormone that stimulates the ripening of fruit and promotes abscission in deciduous trees.

Excitatory postsynaptic potential (EPSP): An impulse which stimulates an action potential in the postsynaptic neurone.

Excretion: The process of removing metabolic waste from an organism.

Fight or flight response: The physiological reaction of the body in response to a potentially dangerous situation.

Geotropism: A plant's growth response to gravity.

Gibberellins: Plant hormones that control stem elongation, trigger the growth of the pollen tube during fertilisation and stimulate the mobilisation of food storage reserves during seed germination.

Glomerular filtration rate (GFR): A method of measuring kidney function which assesses the amount of blood plasma filtered per unit of time and produces a value which should be above 90mL/min in healthy adults.

Glomerulus: The bundle of blood vessels at the beginning of a kidney nephron where ultrafiltration takes place.

Haemodialysis: A type of dialysis used where a patient's blood is fed into a dialysis machine and passed across an artificial membrane to remove waste.

Hepatic artery: The main artery which supplies the liver tissue with oxygenated blood from the heart.

Hepatic portal vein: The main vein which carries blood rich in nutrients from the small intestine and pancreas to the liver.

Hepatic vein: The main vein which takes deoxygenated blood away from the liver back to the heart.

Homeostasis: Maintaining a constant internal environment around an optimum despite external change.

Hormonal weedkillers: Hormones such as synthetic dicot auxins that alter plant metabolism, promoting rapid growth that is unsustainable.

Hormones: Cell signalling molecules produced by endocrine glands and released into the blood. They travel to target cells and bind to specific receptors, initiating a response. The effects of hormones are usually long-lasting.

Hyperpolarisation: The drop in membrane potential below the resting potential after repolarization due to open potassium ion channels.

Hypothalamus: The region of the brain that serves as the control centre for the autonomic nervous system. It is responsible for production of hormones, the regulation of the water potential of body fluids and the control of behavioural patterns.

H-zone: The lighter region in the centre of each A band.

Inhibitory postsynaptic potential (IPSP): An impulse which inhibits the next neurone from generating an action potential.

Islet of Langerhans: Regions of the pancreas which contain α and β cells.

Isotropic (I) bands: The lighter bands in a myofibril, which consist of non-overlapping actin and myosin filaments.

Knee-jerk reflex: A type of spinal reflex commonly tested by doctors. It involves the sudden involuntary movement of the lower leg when the patella is tapped.

Kupffer cell: A specialised type of macrophage which is located within the sinusoids of the liver and removes pathogens and dead cells.

Loop of Henle: A large hairpin shaped loop found in the kidney tubule used to regulate the water and salt concentration of the blood.

Negative tropism: The growth of a plant away from a stimulus.

Neurotransmitters: Chemicals that are used for communication between neurones and their target cells. Neurotransmitters are stored in synaptic vesicles in the presynaptic neurone and released into the synaptic cleft.

Medulla oblongata: The region of the brain that regulates autonomic activities such as ventilation, heart rate and peristalsis. It is made up of regulatory centres of the autonomic nervous system.

Metabolic waste: Products produced in metabolic reactions which have no benefit to the organism.

***Mimosa pudica*:** A plant that exhibits rapid leaf-folding and collapse in response to touch. This serves as a protective mechanism against larger herbivores and small insects.

Monoclonal antibodies: Antibodies which have been produced by plasma cells that are identical clones of the same parent cell.

Motor neurone: A neurone that carries nerve impulses from the CNS to the effectors.

Myelination: The formation of a myelin sheath around nerve cells by Schwann Cells.

Myofibrils: Tiny contractile muscle fibres which group together. Numerous myofibril bundles constitute muscles. Myofibrils consist of two protein filaments: actin and myosin.

Myogenic: Describes cardiac muscle tissue that initiates its own contraction without outside stimulation from nervous impulses.

Myosin: A type of protein filament found in myofibrils. It forms thick filaments, consisting of long tails with bulbous heads, positioned to the side.

Negative feedback: The product of a process that counteracts change to maintain an equilibrium around a normal level.

Neuromuscular junction: An excitatory synapse formed between a motor neurone and a muscle fibre that uses the neurotransmitter, acetylcholine.

Nodes of Ranvier: Unmyelinated sections of nerve cells which allow for the propagation of an action potential due to their many ion channels.

Osmoreceptor: A type of receptor found in the hypothalamus which can detect the water concentration of blood plasma to maintain an appropriate water balance in the body.

Pacinian Corpuscle: A type of sensory receptor which detects changes in pressure on the skin.

Pancreas: An organ which has both exocrine and endocrine functions and is involved in both digestion and the homeostatic control of blood glucose levels.

Paracrine signalling: A type of signalling which occurs between adjacent cells.

Parasympathetic nervous system: A branch of the autonomic nervous system that is active under normal, resting conditions. It inhibits effectors, slowing down activity.

Peripheral nervous system (PNS): Pairs of nerves that originate from the CNS and carry nerve impulses into and out of the CNS. It is divided into the sensory nervous system and motor nervous system.

Peritoneal dialysis: A type of dialysis where dialysis fluid is placed inside the abdomen and waste substances are passed across the peritoneal membrane from the blood.

Pheromones: A cell-signalling molecule produced by an organism that affects the social behaviour of other members of the same species.

Photoperiodism: A plant's growth response to seasonal changes in the length of daylight.

Phototropism: A plant's growth response to light.

Pituitary gland: A small, hormone-producing gland located at the base of the brain. It is divided into two regions, the anterior pituitary and the posterior pituitary.

Positive feedback: A process which causes an increase in change away from the normal

Positive tropism: The growth of a plant towards a stimulus.

Posterior pituitary gland: The region of the pituitary gland that stores and secretes hormones produced by the hypothalamus.

Postsynaptic neurone: The neurone after the synapse which contains specific receptor proteins on its membrane, complementary to the neurotransmitter.

Presynaptic neurone: The neurone before the synapse which releases neurotransmitters from synaptic vesicles into the synaptic cleft.

Receptor: Specialised structure that detects a specific type of stimulus.

Reflex: A rapid, automatic response to a sensory stimulus by the body. It serves as a protective mechanism.

Reflex arc: The pathway of neurones involved in a reflex action:

stimulus → receptor → sensory neurone → relay neurone → motor neurone → effector → response

Relay neurone: A neurone located in the spinal cord that links the sensory neurone to the motor neurone.

Resting potential: The potential difference across the cell membrane of a neurone at rest which is typically between -60 and -70 millivolts (mV).

Rooting powder: A hormone powder applied to cuttings that increases root formation and the chance of successful propagation.

Saltatory conduction: The setting up of localised circuits between nodes of Ranvier which allows for the rapid propagation of an action potential.

Sarcomere: Each repeating unit of striations between adjacent Z-lines.

Sarcoplasm: The cytoplasm shared by muscle fibres. It consists of a high concentration of mitochondria and endoplasmic reticulum.

Schwann cells: Cells that form the myelin sheath around nerve cells in the peripheral nervous system.

Second messenger model: The mechanism by which a hormone (e.g. adrenaline or glucagon) has an effect inside a cell by triggering the production of a second messenger such as cAMP.

Selective reabsorption: The selective reuptake of useful substances along the kidney nephron using membrane transport proteins.

Sensory neurone: A neurone that carries nerve impulses from the receptors to the CNS.

Sinusoid: A type of vessel found in the liver which is formed from the convergence of the hepatic artery and the hepatic portal vein.

Skeletal muscle: A voluntary muscle responsible for movement. It makes up the majority of body muscle and is attached to the skeleton by tendons.

Sliding filament theory: The mechanism by which a muscle contracts. During contraction, myosin filaments pull actin filaments to the centre of the sarcomere. The actin filaments slide along the myosin filaments. The sarcomere is shortened and the muscle length is reduced.

Smooth muscle: An involuntary muscle under the control of the autonomic nervous system. It is found in the walls of the blood vessels, digestive tract and organs.

Somatic nervous system: A branch of the nervous system that carries impulses to the skeletal muscles. It controls voluntary activities.

Summation: The combination of many impulses that can cumulatively stimulate the generation of an action potential in a postsynaptic neurone.

Sympathetic nervous system: A branch of the autonomic nervous system that is active under stressful conditions. It stimulates effectors, speeding up activity.

Synapse: The junction between two nerve cells or a nerve cell and an effector.

Synaptic vesicles: Secretory vesicles located in the presynaptic neurone that store neurotransmitters. Upon fusion with the presynaptic membrane, their contents are released into the synaptic cleft.

Tannins: Phenols produced by many plants. They serve as a chemical defence against herbivory; their bitter taste deters animals from eating them and they are toxic to insects.

The Ornithine Cycle: The cycle of reactions responsible for producing urea from ammonia for detoxification and excretion.

Tropism: The growth response of a plant to a directional stimulus.

Type 1 diabetes: An autoimmune disorder in which the beta cells are destroyed and the pancreas fails to produce sufficient insulin which is characterised by uncontrolled high blood glucose levels.

Type 2 diabetes: A type of diabetes where the body fails to produce enough insulin or when the pancreas no longer reacts to insulin which can be caused by a poor diet and a lack of exercise.

Ultrafiltration: The removal of small substances from the blood through the pressure created by the structure of the kidney nephron.

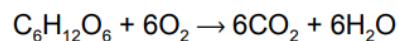
Z-line: The line in the centre of each I band.

Topic 5.2: Energy for biological processes

Acetyl coenzyme A: A two-carbon molecule formed in oxidative decarboxylation when an acetyl group is bound by coenzyme A. It is oxidised in the Krebs cycle.

Adenosine triphosphate (ATP): The universal energy carrier found in all living cells.

Aerobic respiration: A form of cellular respiration that takes place in the presence of oxygen and produces carbon dioxide, water and ATP. Overall:



Alcoholic fermentation: A type of fermentation that takes place in plant root cells and yeast cells, and produces ethanol and carbon dioxide.

Anaerobic respiration: A form of cellular respiration that takes place in the absence of oxygen. It produces less ATP than in aerobic respiration.

ATP synthase: An enzyme found embedded in cellular membranes that phosphorylates ADP to form ATP as protons flow through it.

Calvin cycle: See 'Light-independent reaction'.

Chemiosmotic theory: The synthesis of ATP through the movement of protons down their concentration gradient across a semipermeable membrane, catalysed by ATP synthase.

Chlorophyll: A photosynthetic pigment located in the thylakoids of chloroplasts that absorbs light energy. There are two main types, chlorophyll a and chlorophyll b.

Chloroplast: An organelle found in plants and algae that is the site of photosynthesis.

Citrate: A six-carbon molecule formed in the first stage of the Krebs cycle from the reaction of acetyl coenzyme A and oxaloacetate.

Coenzyme A: A coenzyme that binds an acetyl group to form acetyl coenzyme A during oxidative decarboxylation of aerobic respiration.

Coenzymes: Molecules that help enzymes carry out their function e.g. NAD, FAD, coenzyme A and NADP.

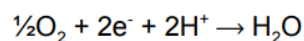
Cristae: Folds of the inner mitochondrial membrane that provide a large surface area for oxidative phosphorylation.

Cyclic photophosphorylation: The formation of ATP involving photosystem I only.

Decarboxylation: The removal of a carbon dioxide molecule.

Dehydrogenation: The removal of a hydrogen atom.

Electron acceptor: Oxygen acts as the final electron acceptor in the electron transfer chain:



Electron carriers: Protein molecules that accept and release electrons e.g. NAD, NADP.

Electron transport chain: A series of electron carrier proteins that transfer electrons in a chain of oxidation-reduction reactions.

FAD: A coenzyme that becomes reduced when it takes up hydrogen atoms during the Krebs cycle, forming reduced FAD.

Fermentation: A type of anaerobic respiration that does not involve an electron transport chain.

Glycerate 3-phosphate (GP): A three-carbon molecule that is reduced by reduced NADP in the light-independent stage of photosynthesis to form two molecules of TP. This requires ATP.

Glycolysis: An anaerobic process that takes place in the cytosol of the cell and breaks down glucose into two molecules of pyruvate. Two molecules of ATP and two molecules of reduced NAD are also formed.

Grana: Stacks of thylakoids connected by intergranal lamellae.

Hexose biphosphate: The compound formed from the phosphorylation of glucose in glycolysis. It splits into two molecules of triose phosphate.

Inner mitochondrial membrane: The mitochondrial membrane that segregates the matrix from the intermembrane space. It is the site of the electron transport chain.

Intermembrane space: The small space between the inner and outer mitochondrial membranes. The electron transport chain results in a high proton concentration here.

Krebs cycle: A series of oxidation-reduction reactions in the matrix of the mitochondria in which acetyl coenzyme A is oxidised, generating reduced NAD, reduced FAD, ATP and carbon dioxide.

Lactate dehydrogenase: An enzyme that catalyses the conversion of pyruvate to lactate.

Lactate fermentation: A type of fermentation that takes place in animal cells and produces lactate.

Lamellae: Membranous channels that connect adjacent grana in a chloroplast.

Light-dependent reaction: The first stage of photosynthesis that uses light energy to produce ATP, reduced NADP and oxygen. It takes place in the thylakoids of the chloroplast.

Light-harvesting system: A collection of protein and chlorophyll molecules found in the thylakoid membranes of chloroplasts that absorbs light energy of varying wavelengths and transfers it to the reaction centre. It is also known as an antennae complex.

Light-independent reaction: The second stage of photosynthesis, also known as the Calvin cycle, in which the products of the light-dependent stage and carbon dioxide are used to build organic molecules. It does not require light energy and takes place in the stroma.

Limiting factor: A variable that limits the rate of a particular reaction.

Link reaction: See 'oxidative decarboxylation'.

Matrix: The fluid-filled space within the inner membrane of the mitochondria which contains mitochondrial DNA and enzymes required for aerobic respiration.

Mitochondrion: An organelle found in eukaryotic cells that is the site of aerobic respiration.

NAD: A coenzyme that becomes reduced when it takes up hydrogen atoms during aerobic respiration, forming reduced NAD.

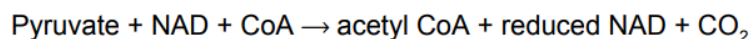
NADP: A coenzyme that becomes reduced when it takes up hydrogen atoms during the light-dependent stage of photosynthesis, forming reduced NADP.

Non-cyclic photophosphorylation: The formation of ATP and reduced NADP involving both photosystems I and II.

Outer mitochondrial membrane: The membrane segregating the contents of the mitochondrion from the rest of the cell. It creates optimal conditions for aerobic respiration.

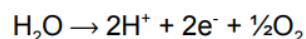
Oxaloacetate: A four-carbon molecule that combines with acetyl coenzyme A to produce six-carbon citrate in the first stage of the Krebs cycle. It is eventually regenerated, allowing the cycle to continue.

Oxidative decarboxylation: The first stage of aerobic respiration (also known as the 'link reaction') that takes place in the mitochondrial matrix and converts pyruvate into acetyl coenzyme A and carbon dioxide. Reduced NAD is also formed. Overall:



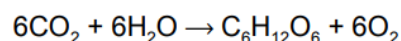
Oxidative phosphorylation: The synthesis of ATP from reduced coenzymes and oxygen in the electron transport chain of aerobic respiration.

Photolysis: The splitting of a molecule of water in the presence of light that occurs during the light-dependent stage of photosynthesis. This produces protons, electrons and oxygen:



Photophosphorylation: The harnessing of light energy in photosynthesis to phosphorylate ADP, forming ATP.

Photosynthesis: A complex metabolic pathway that synthesises organic molecules in the presence of light. It consists of three main stages: capturing of light energy, light-dependent reaction, light-independent reaction. Overall:



Photosynthetic pigments: Molecules present in chloroplasts that absorb certain wavelengths of light e.g. chlorophyll a, chlorophyll b, xanthophylls and carotenoids.

Photosystem: A protein complex consisting of a light-harvesting system and reaction centre, that is involved in the absorption of light and transfer of electrons in photosynthesis.

Pyruvate: A three-carbon molecule produced in glycolysis. In the link reaction of aerobic respiration, it is oxidised to acetate. During fermentation, it is converted to lactate (animals) or ethanol and carbon dioxide (plants and microorganisms).

Reaction centre: The region of a photosystem where energy is funneled and photosynthetic reactions take place. It contains two chlorophyll a molecules.

Respiration: A set of metabolic reactions that take place in organisms and break down respiratory substances, such as glucose, into smaller inorganic molecules, like water and carbon dioxide. This is linked to the synthesis of ATP.

Respiratory quotient (RQ): The ratio of carbon dioxide produced to oxygen consumed during respiration. Calculated using:

$$RQ = \frac{\text{CO}_2 \text{ produced}}{\text{O}_2 \text{ consumed}}$$

Respiratory substrate: An organic molecule that can be broken down via the respiratory pathways to produce ATP.

Respirometer: A device used to determine respiration rate in living organisms by measuring the change in volume of oxygen or carbon dioxide.

Retention value (R_f): Calculated using the equation:

$$R_f = \frac{\text{Distance travelled by component}}{\text{Distance travelled by solvent}}$$

Ribulose biphosphate (RuBP): A five-carbon compound that reacts with carbon dioxide in the light-independent stage of photosynthesis, forming two molecules of GP.

Ribulose biphosphate carboxylase (RuBisCO): An enzyme that catalyses the reaction of RuBP and carbon dioxide in the light-independent stage of photosynthesis.

Stroma: The fluid interior of chloroplasts that contains the enzymes required for the light-independent reaction.

Substrate-level phosphorylation: The synthesis of ATP by the transfer of a phosphate group from a phosphorylated intermediate to ADP.

Thin-layer chromatography (TLC): A technique used to separate photosynthetic pigments by their rate of movement when carried by a solvent, across an inert surface. Differences in rate arise due to varying solubilities in the mobile phase and interactions with the stationary phase.

Thylakoids: A series of flattened membrane-bound compartments in chloroplasts. They are stacked to form grana and contain the chlorophyll and other molecules needed for the light-dependent reaction.

Triose phosphate (TP): A three-carbon compound formed in glycolysis and the light-independent stage of photosynthesis. It may serve as a starting material for the formation of organic molecules or be used to regenerate RuBP.

Module 6 – Genetics, Evolution and Ecosystems

Topic 6.1: Genetics and evolution

Allele: A version of a gene.

Allopatric speciation: A form of speciation that occurs when two populations become geographically isolated due to a physical barrier.

Apoptosis: Programmed cell death. This is important for pruning surplus cells and tissues in development.

Artificial selection: See 'selective breeding'.

Autosomal linkage: When two or more genes are positioned on the same autosome. They are unlikely to be separated by crossing over during meiosis so are often inherited together.

Autosome: A chromosome that is not an X or Y chromosome.

Bioinformatics: The development of the computer tools and software required to organise and analyse unprocessed biological data.

Chi-squared (X^2) test: A statistical test used to determine whether a pattern of inheritance is statistically significant.

Chlorosis: A condition in which plant leaf cells produce insufficient chlorophyll, resulting in pale or yellow coloured leaves. This may be due to mineral deficiencies, lack of light, or viral infections.

Codominance: When both alleles for a gene in a heterozygous organism equally contribute to the phenotype.

Computational biology: The use of computational techniques to analyse large amounts of biodata and build theoretical models of biological systems.

Continuous variation: A type of variation that cannot be categorised e.g. skin colour, height. It produces a continuous range in which a characteristic can take any value. Multiple genes influence continuous variation.

Degrees of freedom (X^2 test): The number of categories minus one.

Deletion: A form of gene mutation in which one or more nucleotide bases are removed from a DNA sequence. This may lead to a frameshift mutation, changing every successive codon.

Dihybrid inheritance: The determination of a trait by the inheritance of two genes.

Directional selection: A type of selection that favours one extreme phenotype and selects against all other phenotypes.

Discontinuous variation: A type of variation that can be categorised e.g. blood group. A characteristic can only appear in discrete values. One or two genes influence discontinuous variation.

Disruptive selection: A type of selection that favours individuals with extreme phenotypes and selects against those with phenotypes close to the mean.

DNA barcode: A short sequence of DNA that is used to identify a species. DNA barcodes are common to all species but vary between species.

DNA ligase: An enzyme that joins the sugar-phosphate backbone of two DNA segments.

DNA profiling: A technique used to determine the patterns in the non-coding DNA of an individual. It involves five main stages: DNA extraction; digestion; separation of DNA fragments; hybridisation; and observation.

DNA sequencing: Determining the entire DNA nucleotide base sequence of an organism.

Dominant: Describes an allele that is always expressed. Represented by a capital letter.

Electrophoresis: A type of chromatography that separates nucleic acid fragments or proteins by size using electric current.

Electroporation: A method of transformation in which a small electric current is used to transfer recombinant plasmids into bacterial cells or fragments of DNA into eukaryotic cells.

Epistasis: Describes a relationship between genes at different loci, where the allele of one gene affects the expression of a different gene.

Etiolation: A condition in plants characterised by weak stems and small, pale leaves, due to insufficient exposure to light.

Evolution: The gradual change in the allele frequencies within a population over time. Occurs due to natural selection.

Exon: A sequence of DNA that codes for an amino acid sequence.

Founder effect: A type of genetic drift in which a few individuals of a species break off from the population and form a new colony. This results in smaller gene pools and an increased frequency of rare alleles.

Gene mutation: A change to at least one nucleotide base in DNA or the arrangement of bases. Gene mutations can occur spontaneously during DNA replication and may be beneficial, damaging, or neutral.

Gene therapy: A therapeutic technique in which a faulty allele is replaced with a functional allele in order to treat or prevent disease.

Genetically modified organism (GMO): An organism that has had its genome altered.

Genetic bottleneck: A drastic reduction in population size leading to reduced genetic diversity within a population.

Genetic drift: Random variations in allele frequencies in small populations, due to mutations.

Genetic engineering: The modification of the genome of an organism by the insertion of a desired gene from another organism. This enables the formation of organisms with beneficial characteristics.

Genome: The complete genetic material of an organism.

Genotype: An organism's genetic composition. Describes all alleles.

Germ line cell gene therapy: A type of gene therapy in which a faulty allele is replaced with a functional allele in germ cells or a very early embryo. The effects of this are permanent and can be inherited.

Hardy-Weinberg principle: A model that predicts that the ratio of dominant and recessive alleles in a population will remain constant between generations if the following five conditions are met: no new mutations; no natural selection; no migration; large population; and random mating. It provides a formula for calculating the frequencies of alleles:

$$p^2 + 2pq + q^2 = 1.0$$

where p is the frequency of the dominant allele, and q is the frequency of the recessive allele.

Heterozygous: When someone has two different alleles of a gene e.g. Ff.

High-throughput sequencing: More recent, large-scale approaches to DNA sequencing that use a flow cell. They enable many clusters of DNA fragments to be sequenced simultaneously, giving efficient and rapid sequencing. This has allowed whole-genome sequencing.

Homeobox genes: A group of regulatory genes that contain a homeobox, a DNA sequence that is highly conserved in animals, plants and fungi. Homeobox genes are responsible for the development of body plans in different organisms.

Homozygous: When someone has two identical alleles of a gene e.g. ff.

Hox gene: A type of homeobox gene that is present in animals only. The terms “Hox gene” and “homeobox gene” can be used interchangeably.

Inbreeding: The formation of offspring from the breeding of closely related individuals.

Insertion: A form of gene mutation in which one or more nucleotide bases are added to a DNA sequence. This may lead to a frameshift mutation, changing every successive codon.

Intron: A non-coding sequence of DNA.

Lac operon: A group of three structural genes, lacZ, lacY and lacA, that are required for the metabolism of lactose.

Mature mRNA: The final mRNA product that has had introns removed, as well as having undergone other post-transcriptional changes.

Mitosis: A form of cell division that produces two genetically identical diploid daughter cells. Mitosis is important for growth, increasing the number of cells.

Monogenic inheritance: The determination of a trait by the inheritance of a single gene.

Multiple alleles: When a gene has more than two potential alleles.

Mutagen: A chemical, biological or physical agent that increases the rate of gene mutations above normal level.

Operon: A group of genes that are expressed together and controlled by the same regulatory mechanism.

Phenotype: An organism's observable characteristics. Due to interactions of the genotype and the environment.

Polymerase Chain Reaction (PCR): An *in vitro* technique used to rapidly amplify fragments of DNA.

Post-transcriptional control: The level of gene regulation in which primary mRNA can be modified, controlling translation.

Pre-mRNA: The product of transcription before any post-transcriptional regulation.

Recessive: Describes an allele that is only expressed in the absence of a dominant allele. Represented by a small letter.

Recombinant DNA: A combination of DNA from two different organisms.

Regulatory gene: A gene that codes for the production of proteins involved in DNA regulation. The expression of regulatory genes is influenced by internal and external stimuli.

Repressor protein: A protein that binds to the operator, altering the transcription rate.

Restriction endonucleases: Enzymes that cut DNA molecules at recognition sequences, creating sticky ends.

Sanger sequencing: The first method of DNA sequencing that involved the formation of DNA fragments of varying lengths. Fluorescent 'terminator' bases marked the final base of each fragment, allowing the overall DNA sequence to be determined.

Selection pressures: Factors that affect an organism's ability to survive in an environment e.g: disease, prey, competitors, water availability.

Selective breeding: The process by which humans artificially select organisms with desirable characteristics and breed them to produce offspring with desirable phenotypes. Selective breeding may also be referred to as 'artificial selection'.

Sex-linkage: The presence of a gene on an X or Y chromosome.

Sexual reproduction: A form of reproduction involving the random fusion of male and female gametes. This creates genetic variation.

Somatic cell gene therapy: A type of gene therapy in which a faulty allele is replaced with a functional allele in affected somatic cells. The effects of this are temporary and cannot be inherited.

Speciation: The formation of new species due to the evolution of two reproductively separated populations. Two forms: allopatric and sympatric speciation.

Stabilising selection: A type of selection that favours individuals with phenotypes close to the mean (average) and selects against extreme phenotypes.

Sticky ends: The staggered cut formed by restriction endonucleases in double-stranded DNA.

Structural gene: A gene that codes for the production of proteins or enzymes that are not involved in DNA regulation.

Substitution: A form of gene mutation in which one nucleotide base is exchanged for another. This may change an amino acid or produce the same amino acid (due to the degeneracy of the genetic code).

Sympatric speciation: A form of speciation that occurs when two populations within the same area become reproductively isolated.

Synthetic biology: The design and construction of new biological entities, as well as the reconstruction of pre-existing natural biological systems.

Thermocycler: A machine controlled by a computer that varies temperatures at predetermined time intervals.

Transcriptional control: The level of gene regulation in which genes are switched 'on' or 'off'.

Transcription factors: Proteins that help to switch genes 'on' or 'off' by controlling the binding of RNA polymerase to DNA.

Transgenic organism: An organism that contains recombinant DNA.

Translational control: The level of gene regulation in which translation can be initiated or stopped.

Vector: A carrier used to transfer a gene from one organism to another e.g. plasmid.

Topic 6.2: Cloning and biotechnology

Artificial twinning: The artificial production of monozygotic twins from the manual splitting of the early embryo.

Aseptic techniques: A range of techniques used to culture microorganisms under sterile conditions in order to minimise contamination.

Batch fermentation: An industrial method of fermentation that runs for a set period of time. The culture broth is not removed until the fermentation is complete.

Bioremediation: The use of microorganisms to remove soil and water pollution.

Biotechnology: The field of biology involving the use of living systems to produce or transform materials. Applications include agriculture, medicine and food science.

Clones: The genetically identical offspring produced as a result of cloning.

Cloning: A method of producing genetically identical offspring by asexual reproduction.

Continuous fermentation: An industrial method of fermentation in which culture broth is continuously removed and extra nutrient medium is added. The fermentation conditions remain relatively constant.

Culture: The growth of living matter *in vitro* in suitable conditions.

Cutting: A small section of the root or stem of an adult plant that is used in horticulture to produce natural clones.

Enucleation: The removal of the nucleus.

Fermentation: A type of anaerobic respiration that does not involve an electron transport chain.

Immobilised aminoacylase: An immobilised enzyme that is used to produce pure samples of L-amino acids.

Immobilised enzymes: Enzymes which are attached to an inert, insoluble material over which the substrate passes and the reaction takes place.

Immobilised glucoamylase: An immobilised enzyme that can be used to breakdown dextrins into glucose.

Immobilised glucose isomerase: An immobilised enzyme that is used to convert glucose to fructose.

Immobilised lactase: An immobilised enzyme that hydrolyses lactose to glucose and galactose in the production of lactose-free milk.

Immobilised penicillin acylase: An immobilised enzyme that is used to produce semi-synthetic penicillins from natural penicillins.

Micropropagation: The production of large numbers of clones from one parent plant using tissue culture.

Monozygotic twins: Identical twins formed from one fertilised egg that splits to form two embryos.

Natural cloning: A form of asexual reproduction that takes place in plants in which a new genetically identical plant grows from a structure (stem, leaf, bud or root) of the parent plant. Also known as vegetative propagation.

Penicillin: The first conventional, effective and safe antibiotic derived from the mould *Penicillium chrysogenum*.

Somatic cell nuclear transfer (SCNT): The production of an embryo (clone) from the transfer of the nucleus of an adult animal cell to an enucleated egg cell in the laboratory. The nucleus and egg are fused and stimulated to divide.

Tissue culture: The growth of cells or tissues outside of an organism in an artificial culture medium.

Topic 6.3: Ecosystems

Abiotic factors: The non-living aspects of an ecosystem e.g. light, temperature, water availability, oxygen availability and soil pH.

Abundance: The number of individuals per species in a specific area at any given time.

Ammonification: The production of ammonium compounds when decomposers feed on organic nitrogen-containing molecules.

Azotobacter: A type of nitrogen-fixing bacteria that lives freely in the soil.

Belt transect: A line along a sampled area upon which quadrats are placed at intervals to determine the abundance and distribution of organisms in an ecosystem.

Biomass: The total mass of organic material, measured in a specific area over a set time period. This can be calculated in terms of dry mass.

Biotic factors: The living components of an ecosystem e.g. food availability, pathogens, predators and other species.

Carbon cycle: The cycle through which carbon (in the form of carbon dioxide) moves between living organisms and the environment, involving respiration, photosynthesis and combustion.

Carrying capacity: The maximum population size that can be indefinitely supported by an environment.

Climax community: The stable community of organisms that exists at the final stage of ecological succession.

Conservation: The maintenance of ecosystems and biodiversity by humans in order to preserve the Earth's resources.

Consumers: Organisms that feed on other organisms to obtain energy.

Decomposers: Organisms that release enzymes which catalyse the breakdown of dead plant and animal material into simpler organic matter.

Deflected succession: Changes to the natural flow of succession due to human activity that result in a stable community known as a plagioclimax.

Denitrification: The conversion of nitrate ions to nitrogen gas by denitrifying bacteria.

Denitrifying bacteria: Anaerobic microorganisms, found in waterlogged soils, responsible for the reduction of nitrate ions to nitrogen gas.

Distribution: The spread of living organisms in an ecosystem.

Ecological efficiency: The efficiency of energy or biomass transfer between trophic levels is calculated using:

$$\text{ecological efficiency} = \frac{\text{energy or biomass available after transfer}}{\text{energy or biomass available before transfer}} \times 100$$

Ecosystem: The community of organisms (biotic) and non-living (abiotic) components of an area and their interactions.

Food chain: Describes the feeding relationships between organisms and the resulting stages of biomass transfer. It takes the form:

producer → primary consumer → secondary consumer → tertiary consumer

Interspecific competition: A type of competition that takes place between members of different species.

Intraspecific competition: A type of competition that takes place between members of the same species.

Limiting factor: A variable that limits the rate of a particular process.

Line transect: A line along a sampled area. The species touching the transect at regular intervals are recorded to determine the abundance and distribution of organisms in an ecosystem.

Nitrification: The conversion of ammonium ions to nitrate ions by nitrifying bacteria. This takes place in two stages: ammonium ions are oxidised to nitrite ions; nitrite ions are oxidised to nitrate ions.

Nitrifying bacteria: Aerobic microorganisms found in the soil responsible for the oxidation of ammonium ions to nitrate ions.

Nitrobacter: A genus of nitrifying bacteria that oxidises nitrites into nitrates.

Nitrogen cycle: The cycle through which nitrogen moves between living organisms and the environment, involving ammonification, nitrification, nitrogen fixation and denitrification.

Nitrogen fixation: The conversion of atmospheric nitrogen gas into ammonia by nitrogen-fixing bacteria in the soil or root nodules of legumes.

Nitrogen-fixing bacteria: Microorganisms responsible for the conversion of atmospheric nitrogen gas into nitrogen-containing compounds. They can be free-living or mutualistic.

Nitrosomonas: A genus of nitrifying bacteria that oxidises ammonium compounds into nitrites.

Peat bogs: Areas of peat soil in wetland habitats formed by the accumulation of partially decayed organic matter. They store carbon and are commonly referred to as 'carbon sinks'.

Pioneer species: Species that can survive in hostile environments and colonise bare rock or sand e.g. lichens.

Plagioclimax: A stage in succession in which artificial factors prevent the formation of a natural climax community.

Population: All organisms of the same species living with one another in a habitat at the same time.

Predator: An organism that eats other organisms.

Preservation: The restriction of human interference in an area in order to protect and maintain the ecosystem.

Prey: An organism that is eaten by predators.

Primary succession: A type of succession in which pioneer species colonise a newly formed or exposed area of land.

Producers: Photosynthetic organisms at the start of the food chain that manufacture biomass for all living things.

Quadrat: A square grid of known area used in sampling to determine the abundance of organisms in a habitat.

***Rhizobium*:** A type of nitrogen-fixing bacteria that lives inside the root nodules of leguminous plants.

Succession: Describes changes in the community of organisms occupying a certain area over time.

Sustainable: The ability to maintain something for future generations.

Sustainable resource: A resource that can be continuously renewed; it will not diminish or run out.

Trophic level: The position of an organism in a food chain.