OCR (B) Biology A-level

Topic 2.1 - Cells and Chemicals for Life

Definitions and Concepts

2.1.1 Cells and microscopy

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.

Adenosine triphosphate (ATP) - A nucleotide derivative that acts as the energy currency of cells. It consists of a molecule of ribose, a nitrogenous adenine base and three phosphate groups.

Blood smear technique - The process of spreading a drop of blood onto a slide using the slide cover.

Cell surface membrane - A semipermeable lipid bilayer studded with proteins that surrounds the cell and many organelles.

Cell wall - A permeable layer made of polysaccharides that surrounds plant, algal and fungal cells.

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.

Cholesterol - A steroid hormone which adds stability to the lipid bilayer.

Confocal scanning microscope - A type of microscope 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.

Diffusion - The passive spreading out of substances from a high concentration to a lower concentration (down their concentration gradient) without the use of energy.

Endocytosis - A method of bulk transport into a cell which relies on invagination of the cell membrane and requires energy in the form of ATP.

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

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

Exocytosis - A method of bulk transport out of a cell which occurs when vesicles fuse with the cell membrane and release their contents. It requires energy in the form of ATP.

Extrinsic proteins - Proteins located on either side of the membrane. In their resting state, they do not pass through the membrane.

Eyepiece graticule - A scale bar inside the eyepiece of a light microscope which can be calibrated against a ruler to measure structures.

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

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

Flow cytometry - A technique that can be used to analyse blood. A fluid sample is passed through the apparatus such that one cell at a time flows through a laser beam. Fluorescent markers are used to label cells.

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

Glycolipid - A lipid which is bound to a monosaccharide or oligosaccharide.

Glycoprotein - A protein which is bound to a carbohydrate chain.

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

Haemocytometer - A device used to count blood cells.

Histology - The study of microscopic anatomy.

Intrinsic proteins - Transmembrane proteins in the lipid bilayer.

Leishman's stain - A stain used to differentiate between blood cells in a smear. It binds strongly to the nuclei of leukocytes.

Leukocytes - Cells involved in the immune response (commonly referred to as white blood cells, and also known as leukocytes).

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

Lymphocytes - A type of leukocyte involved in the specific immune response. There are two broad subcategories: B-lymphocytes and T-lymphocytes.

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:

$$Image\ size = Actual\ size \times Magnification$$

Mesosome - An infolding of the cell membrane in bacteria which acts as the site of aerobic respiration.

Mitochondrion (pl. mitochondria) - An organelle found in eukaryotic cells that is the site of aerobic respiration.

Monocyte - A type of leukocyte that can become a tissue macrophage and perform phagocytosis.

Motor proteins - Proteins that move organelles along the cytoskeleton using energy from ATP.

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

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.

Organelle - A structural component of a cell which is designated to carry out a single overall function.

Pili - A hairlike structure on the cell wall of some bacterial cells that is involved in horizontal gene transfer.

Phospholipid - The type of lipid which forms the cell surface membrane bilayer. Individual phospholipids are formed by the condensation of one molecule of glycerol, two molecules of fatty acid and a phosphate group.

Plasmid - A ring of genetic material stored outside the nucleus.

Platelets - Cell fragments found in blood which are involved in clot formation.

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

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.

Specialised cell - A differentiated cell with features that allow it to carry out a specific set of functions.

Stage micrometer - A scale that may be mounted to the stage of a light microscope and can be used to calibrate an eyepiece graticule.

Tonoplast - The lipid bilayer that surrounds a permanent vacuole.

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

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

Vacuole (permanent) - A membrane-bound structure found in plant cells that contains cell sap.

Vesicles - Membrane-bound structures used for transport and storage.

2.1.2 Water and its importance in plants and animals

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.

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.

Biosensor - A biological molecule is paired with a device that generates a thermal, optical or electrical signal when a specific reaction takes place in order to detect the presence of a particular chemical.

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

Cell sap - The fluid stored in plant vacuoles contains organic and inorganic molecules dissolved in water, including pigments and enzymes.

Colorimetry - A quantitative technique which uses absorption of light to measure concentration.

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.

Disaccharide - Formed when two monosaccharides join in a condensation reaction.

Electrolyte - A charged particle in solution e.g. chloride ions (Cl^-), hydrogen ions (H^+), hydrogencarbonate ions (HCO_3^-), potassium ions (K^+), sodium ions (Na^+), magnesium ions (Mg^{2+}) in the body.

Glucose - A hexose monosaccharide which has alpha and beta enantiomers. The alpha form 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.

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

Hydrogen bonding - 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.

Iodine test - A biochemical test that produces a blue/black colour when it is added to a solution containing starch. It can be combined with colorimetry to give a value of starch concentration.

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.

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

Monosaccharide - The individual sugar monomers from which larger carbohydrates are made.

Organic molecule - A molecule that contains carbon as well as other elements.

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.

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.

Polar - When the distribution of electrons in a covalent bond is not even, one group has a slight net positive charge and the other has a slight net negative charge.

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

Polysaccharide - Molecules formed by the condensation of many monosaccharides.

Reagent test strip - A biochemical test. The colour of the test strip changes when a particular substance is added.

Serum - The blood components which do not contribute to clot formation.

Solvent - A liquid that solutes can dissolve into 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.

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

Transpiration stream - Water loss from plant leaves and stems via diffusion and evaporation. As one water molecule evaporates, another is pulled up behind it due to cohesion between molecules.

Urine - A waste liquid containing urea. It flows through the kidneys, which regulate its water content, and is stored in the bladder before excretion.

Water - A polar molecule consisting of an oxygen atom bonded to two hydrogen atoms.

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.

2.1.3 Proteins and 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.

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

Amylase - An enzyme that catalyses the extracellular breakdown of starch. High blood amylase levels can indicate pancreatic disease.

Anticoagulant - A substance that reduces blood clotting.

Aspirin - A drug that acts as a permanent competitive inhibitor of COX-1 and COX-2 enzymes to prevent prostaglandin production and relieve pain. It also acts as an anticoagulant by preventing platelets from sticking together to form a plug.

Blood group - Classification based on surface antigens present on red blood cells and the presence of certain antibodies in the plasma.

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

Clotting - Blood changes from a liquid to a gel.

Clotting factors - Inert plasma proteins which contribute to the formation of blood clots when activated. Stored clotting factors are administered to patients with haemophilia.

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

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

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

Fibrin - An insoluble fibrous protein which forms a 'mesh' that traps blood cells.

Fibrinogen - A soluble protein which is hydrolysed by thrombin to form fibrin.

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

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.

Lactate dehydrogenase (LDH) - An enzyme that catalyses the conversion of lactate to pyruvate following anaerobic respiration. High levels of LDH can indicate tissue damage.

Leuco-depleted blood - A stored blood product containing few white blood cells which is used for immunodeficient patients.

Non-competitive inhibitor - An inhibitor which binds to a part of an enzyme which is not the active site (an allosteric site) and prevents the enzyme from functioning.

Packed blood - A stored blood product containing high levels of haemoglobin and little plasma which is administered to anaemic patients.

Peptide bond - The bond between amino acids formed by a condensation reaction between the -H of the amine group on one molecule and the -OH of the carboxylic acid group on the other molecule.

Platelets - Cell fragments found in plasma which stick together to form a 'plug' during clotting.

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.

Plasmin - A protease which hydrolyses fibrin.

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

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

Prothrombin - The inert precursor to thrombin.

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

Retention value (R*f* value) - Indicates the solubility of a substance in a particular solvent. A high R_f value represents high solubility. Calculated using the equation:

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

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

Streptokinase - A bacterial enzyme that can be used as an anticoagulant. It converts plasminogen into its active form, the protease plasmin.

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

Thrombin - A protein formed from prothrombin. It hydrolyses soluble fibrinogen into fibrin with the help of Ca^{2+} ions.

Thromboplastin - An enzyme secreted by tissue below the endothelium. It changes prothrombin into its active form, thrombin.

Warfarin - A synthetic inhibitor of epoxide reductase and glutamyl carboxylase that can be used as an anticoagulant.

Whole blood - A stored blood product which is transfused in cases of severe bleeding.

2.1.4 Nucleic acids

Adenosine di-phosphate (ADP) - A nucleotide derivative consisting of a molecule of ribose joined to the nitrogenous base adenine and two phosphate groups.

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

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

Chargaff's rules - Sets out which bases pair with each other.

Complementary base pairing - Hydrogen bonds form between complementary purine and pyrimidine bases. There are two hydrogen bonds between adenine (A) and thymine (T) in DNA or uracil (U) in RNA. There are three hydrogen bonds between guanine (G) and cytosine (C).

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 mutation - A change to at least one nucleotide base in DNA or the arrangement of bases. Gene mutations can occur spontaneously during DNA replication.

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.

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.

Nucleic acids - Polymers of nucleotides.

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

Pentose sugar - A monosaccharide containing five carbon atoms.

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

Precipitation - Nucleic acids precipitate out of an aqueous solution when ethanol and a salt are added.

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.

Ribonucleic acid (RNA) - A relatively short molecule made up of ribonucleotide monomers joined by phosphodiester bonds.

Ribosomes - Organelles found either free in the cytoplasm or bound to the ER that are involved in the synthesis of proteins.

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

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

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.