

BIOLOGY
Intermediate 2

Unit 1: Living Cells

a) Cell structure and function

- i Similarities and differences between animal and plant cells.
- ii Function of cell structures. Functions of nucleus, cytoplasm, cell membrane, cell wall, chloroplasts and vacuole.
- iii Commercial and industrial uses of cells.

Bread making. Anaerobic respiration in yeast produces carbon dioxide gas which causes dough to rise.

Alcohol production. Fermentation in yeast results in the production of alcohol (beer and wine).

Antibiotic production. Fungi used to produce wide range of antibiotics that can destroy bacteria; resistant bacteria are unaffected by antibiotics and are on the increase due to overuse of antibiotics.

Yoghurt production. Bacteria convert sugar in milk (lactose) into lactic acid, causing curdling.

Alternative fuel production.

Biogas is produced when bacteria respire anaerobically to produce methane from waste products.

Gasohol is produced when alcohol produced by the fermentation of sugar cane is mixed with petrol.

b) Diffusion and osmosis in plant and animal cells

- i Diffusion as the movement of substances from a high concentration to a low concentration down a concentration gradient. Examples of substances which enter and leave the cell by diffusion, e.g. glucose and amino acids (i.e. dissolved food), oxygen, carbon dioxide and waste products (e.g. urea).
- ii The importance of diffusion to cells. To gain raw materials for respiration and photosynthesis. To remove waste products.
- iii Osmosis as a 'special case' of diffusion of water. Osmosis defined as the movement of water across a selectively permeable membrane as a result of a water concentration gradient.
- iv Osmotic effects in plant and animal cells. The effects of placing plant and animal cells in hypertonic, hypotonic and isotonic solutions should be studied. The terms plasmolysed, turgid and flaccid should be known.

c) Enzyme action

- i Properties of catalysts and enzymes. The properties and functions of catalysts: lower the energy input required for chemical reactions, speed up chemical reactions, take part in reactions but remain unchanged. Enzymes are biological catalysts made by all living cells. Enzymes are proteins required for the functioning of all living cells.
- ii Specificity of enzymes for their substrates. The characteristic shape of enzyme molecules complementary to their substrate. Presence of specific active site.
- iii Enzymes involved in degradation and in synthesis. Degradation: the chemical breakdown of a substance as illustrated by amylase and catalase. Synthesis: the building of a complex molecule from simpler molecules as illustrated by phosphorylase.
- iv The influence of temperature and pH on enzyme activity giving rise to optimum operating conditions and denaturing (protein structure alters resulting in change in shape of active site and inactivation of enzyme).

d) Aerobic and anaerobic respiration

- i Glucose as a source of energy in the cell. The chemical energy stored in glucose is released by a series of enzyme-controlled reactions called respiration. Some energy is released as heat from cells during respiration but most is used for cellular activities such as muscle contraction, cell division, synthesis of proteins and transmission of nerve impulses.
- ii Role of ATP. Energy released from the breakdown of glucose is used to synthesise ATP from ADP and Pi. The ATP can then be used as an energy source.
- iii Comparison of energy yield in aerobic and anaerobic respiration.
Aerobic respiration yields 38 molecules of ATP per glucose molecule.
Anaerobic respiration yields 2 molecules of ATP per glucose molecule.
- iv Aerobic Pathway. Breakdown of glucose to pyruvic acid by glycolysis. Further breakdown of pyruvic acid to carbon dioxide and water in presence of oxygen.
- v Anaerobic Pathway. Breakdown of glucose to pyruvic acid by glycolysis. Reversible anaerobic conversion of pyruvic acid to lactic acid in animals. Effect of lactic acid on muscle cells (i.e. muscle fatigue) and subsequent repayment of oxygen debt. Irreversible anaerobic conversion of pyruvic acid to ethanol and carbon dioxide in plants and yeast.

e) Photosynthesis

i Sunlight as the source of energy. The light energy from the sun is trapped by chlorophyll in the chloroplasts and is converted into chemical energy in the form of ATP which is used in the production of glucose.

ii Summary equation for photosynthesis. Carbon dioxide and water as raw materials for the production of glucose and oxygen as a by-product. Occurs in the presence of chlorophyll and light.

iii Photosynthesis as a set of two summary reactions: photolysis followed by carbon fixation. Photolysis as the breakdown of water to provide hydrogen, ATP and oxygen. The oxygen is released as a by-product and the hydrogen is picked up by a hydrogen carrier molecule. Carbon fixation as the combining of the hydrogen produced by photolysis with carbon dioxide to form glucose using the ATP produced during photolysis.

iv Conversion of glucose to other carbohydrates. Starch as a storage carbohydrate and cellulose as a structural component of the cell wall.

v Limiting factors. Light intensity, carbon dioxide concentration and temperature as limiting factors.

vi Production of early crops in horticulture. The use of supplementary lighting, carbon dioxide enrichment and heating to produce early crops in horticulture.

Unit 2: Environmental Biology and Genetics

a) Ecosystems

- i Components of an ecosystem. Habitats, populations and communities as components of an ecosystem.
- ii Food chains and food webs. Producers, primary and secondary consumers, herbivores, carnivores, omnivores, predators, prey and decomposers in ecosystems.
- iii Pyramids of energy, numbers and biomass in ecosystems.
- iv The importance of biodiversity at species level. Biodiversity defined as the range of species in an ecosystem. A species defined as a group of organisms which can interbreed to produce fertile offspring. A stable ecosystem has a wide range of species and food webs.
- v Factors affecting biodiversity. Adaptations to habitat and niche. As illustrated by Darwin's finches (adaptations of beak shape and size) and desert plants (adaptations of roots, reduced leaf surface area and presence of thick waxy cuticle on leaves). Effects of grazing. High intensity of grazing will maintain species diversity. Very high or low intensity of grazing will decrease diversity. Effects of human activity. Pollution and habitat destruction lead to decrease in species diversity. Competition in plants and animals. Plants compete mainly for water, light and soil nutrients. Animals compete for food (e.g. predator-prey interactions), water and shelter.
- iv Behavioural adaptations in animals and their adaptive significance. As illustrated by responses to light and relative humidity in woodlice.

b) Factors affecting variation in a species

- i Gamete (sex cell) production. Site of production of male and female gametes in mammals. Mammals: sperm are produced in the testes and eggs are produced in the ovaries. Site of production of male and female gametes in flowering plants. Flowering plants: anther produces pollen which contains the male gamete, ovary produces ovules which contain the female gamete.
- ii Fusion of nuclei. Fusion of nuclei forms a zygote producing variation by random combination of parental gametes.
- iii The importance of chromosome structure to an organism's characteristics. Chromosomes contain genetic information that gives rise to an organism's characteristics. Chromosomes are a chain of DNA bases. The relationship between DNA sequence and protein synthesised. The order of DNA bases encodes information for the sequences of amino acids in proteins. These in turn dictate the structures and therefore functions of these proteins.

iv Division of the nucleus in gamete production (meiosis). Gametes have one set of chromosomes. Body cells have two matching sets of chromosomes. The reduction in number of chromosomes to a single set occurs during gamete formation. The two sets of chromosomes are restored at fertilisation. The random assortment of chromosomes during meiosis leads to variation in offspring.

v Sex determination. In humans, each male gamete has an X or a Y chromosome, while each female gamete has an X chromosome.

vi Characteristics controlled by forms of a gene called alleles. Genes are parts of chromosomes. Different forms of a gene are called alleles. Each gamete carries one allele of the gene. Use of the terms homozygous, heterozygous, dominant and recessive.

vii Genotype and phenotype. Relationship of genotype to phenotype. Examples of the same phenotype with different genotypes.

vii Monohybrid crosses. Use of terms true breeding, P, F1 and F2.

viii Proportions and ratios of phenotypes of the F1 and F2 offspring. Reasons for differences between observed and predicted figures in monohybrid crosses (i.e. fertilization is a random process).

ix Co-dominance. Two alleles of a gene can be co-dominant when neither is dominant nor recessive.

x Polygenic inheritance. A range of phenotypes is produced e.g. skin colour in humans, and seed mass in plants. The characteristics arise due to the interaction of the alleles of several genes.

xi Environmental impact on phenotype. The final appearance of an organism (phenotype) is the result of its genotype and the effects of the environment.

xii Natural selection. The process by which organisms that are better adapted to their environment survive and breed, while those less well adapted fail to do so. The better adapted organisms are more likely to pass their characteristics to succeeding generations.

xiii Selective Breeding. The selective breeding of plants and animals showing desirable characteristics. Over several generations improved offspring may result. Takes a relatively long period of time and the results are not always guaranteed.

xiii Genetic Engineering. Stages in the production of desired product by genetic engineering. To include the following stages: identification and removal of required gene from source chromosome; insertion of required gene into bacterial plasmid; insertion of plasmid into bacterial cell; synthesis of required product by bacteria. Applications of the products of genetic engineering. Production of medicines for human use e.g. insulin and growth hormone. Advantages and disadvantages of

genetic engineering. Advantages to include increased range of products and increased rate of production. Disadvantages to include the possible release of genetically engineered bacteria into the environment and cost of development.

Unit 3: Animal Physiology

a) Mammalian nutrition

- i Requirement for food. The main food groups: carbohydrates, proteins, fats, vitamins and minerals and their roles in the body. Simple structure of carbohydrates, proteins and fats in terms of chemical elements present, simple sugars, amino acids, fatty acids and glycerol.
- ii Food tests for starch, glucose, protein and fat.
- iii Energy content of food. Different food groups have different energy contents e.g. fat contains more energy than protein and carbohydrate.
- iv The need for digestion. Digestion involves the breakdown of large, insoluble food molecules into smaller, soluble food molecules to allow absorption into the blood stream through the lining of the small intestine.
- v The mouth, salivary glands and oesophagus. The mechanical breakdown of food in the mouth. Saliva contains amylase which digests starch into maltose. Mucus in saliva from salivary glands helps lubricate mouth and food to aid swallowing. Oesophagus and the mechanism of peristalsis.
- vi The role of the stomach. Food is churned in the stomach by the action of longitudinal and circular muscles to mix food with gastric juices. Chemical breakdown of protein by pepsin. Functions of mucus-secreting cells, enzyme secreting cells, and acid-secreting cells.
- vii The role of the small intestine in the absorption and secretion of food. To include further digestion of fat by lipase and protein by trypsin. The absorption of food by diffusion. The structure of a villus, including the lacteal and blood capillaries and the food molecules each absorbs. The fate of absorbed materials to include storage, energy source, raw materials for synthesis and deamination.
- viii The role of the pancreas, liver and gall bladder Pancreas produces lipase, Liver stores excess glucose as glycogen and is the site of deamination. Gall bladder stores bile which emulsifies fats to aid digestion.
- v The role of the large intestine, rectum and anus. Water absorption and elimination of undigested material.

b) Control of the internal environment

- i The structure of the human urinary system. To include kidney, renal artery, renal vein, ureter, bladder and urethra.
- ii The role of the mammalian kidney. Osmoregulation. Osmoregulation is the regulation of water content in organisms. The kidneys as main organs for osmoregulation in mammals. Water gain through drinking, food and metabolic

water; water loss through sweat, breath, faeces and urine. The role of the urine in the excretion of nitrogenous waste. Urea as the waste product from breakdown of excess amino acids in the liver. The structure and function of the kidney. To include filtration, reabsorption and urine production in the kidney as related to the structure of the nephron, including the Bowman's capsule, glomerulus, blood capillaries and collecting duct.

iii Negative feedback control by ADH. Osmoreceptors in the hypothalamus are stimulated by a change in water concentration in the blood. A decrease in water concentration triggers an increase in the release of antidiuretic hormone (ADH) from the pituitary. ADH increases the permeability of the kidney tubules and collecting duct, resulting in more water being reabsorbed into the blood stream. As the water concentration of the blood rises, less ADH is released resulting in less water being reabsorbed.

iv Osmoregulation in marine and freshwater bony fish. Marine bony fish: hypotonic tissues, dehydration problem, overcome by drinking water and excreting excess salt and small volume of concentrated urine. Freshwater bony fish: hypertonic tissues, problem of influx of water, overcome by excreting copious and very dilute urine.

c) Circulation and gas exchange

i The structure of the heart related to its function as a muscular pump. The structure of the heart including the names of the four chambers of the heart; the position and function of valves; the reason for the differences in thickness of walls of the ventricles; the heart obtains its blood supply from the coronary arteries.

ii Blood vessels. The path of blood flow through the heart and its associated vessels; blood leaves heart in arteries, flows through capillaries and returns to heart in veins; the pulse indicates that blood is pumped through arteries; structural adaptations of arteries, veins and capillaries related to function. Names and positions of pulmonary artery and vein, aorta and vena cava, hepatic artery, hepatic vein, mesenteric artery, hepatic portal vein, renal arteries and renal veins.

iii Internal structure of lungs and features which make them efficient gas exchange structures. Structure to include trachea, bronchi, bronchioles and alveoli (air sacs). Features of alveoli which allow efficient gas exchange: large surface area, thin walls, moist surfaces and good blood supply. The role of diffusion in exchange of oxygen and carbon dioxide.

vi Features of capillary network which allow efficient gas exchange in tissues. To include large surface area, in close contact with tissue cells, thin walled.

v Function of red blood cells and plasma in the transport of respiratory gases and food. Oxygen carried in red blood cells, carbon dioxide carried in red blood cells and dissolved in plasma. Concentration of carbon dioxide carried dissolved in plasma is limited by the increase in acidity carbon dioxide causes in the blood. Soluble foods carried dissolved in the plasma. Examine prepared blood smears.

vi Function of haemoglobin in the transport of oxygen. Ability of haemoglobin to combine with oxygen to form oxyhaemoglobin at high oxygen levels in the lungs and to release oxygen at low oxygen levels in the tissues.

v Functions of macrophages and lymphocytes in defence. Phagocytosis by macrophages. Stages of phagocytosis (engulfing, then digestion). No requirement to name pseudopodia and lysosomes.

d) Sensory mechanisms and processing of information

i Functions, in simple terms, of cerebrum, cerebellum, medulla and hypothalamus. Structures to include cerebrum, cerebellum, medulla and hypothalamus.

ii Discrete areas of cerebrum related to sensory/motor function. Cerebrum as the site of conscious responses and higher centres, cerebellum as the centre of balance and co-ordination of movement, medulla as the site of the vital centres such as breathing and heart rate, hypothalamus as the centre for regulation of water balance and temperature. Location of sensory and motor strip as discrete areas of the cerebrum.

ii The brain, spinal cord and nerves. Nerves carry impulses from the senses to the central nervous system and impulses from the central nervous system to the muscles.

iii Reflex action and the reflex arc. Reflex arc as receptor, sensory neurone, relay fibre, motor neurone and effector. Detailed structure need not be known. Rapidity and protection as function of reflex response.

iv The role of the central nervous system (CNS).

iv Temperature regulation as a negative feedback mechanism. To include changes of temperature, constriction and dilation of blood vessels, alterations in blood flow to the skin, shivering, sweating and consequent changes in body temperature.