MARINA INTERNATIONAL SCHOOL

BIOLOGY SCHEME OF WORK

FORM 6 - TERM 1

WEEK	TOPIC	TOPIC DETAILS
1.1	CELL BIOLOGY-The microscope in cell studies	☐ make temporary preparations of cellular material suitable for viewing with a light microscope ☐ draw cells from microscope slides and photomicrographs ☐ calculate magnifications of images and actual sizes of specimens from drawings, photomicrographs and electron micrographs (scanning and transmission) ☐ use an eyepiece graticule and stage micrometer scale to make measurements and use the appropriate units, millimetre (mm), micrometre (μm) and nanometre (nm) ☐ define resolution and magnification and explain the differences between these terms, with reference to light microscopy and electron microscopy
1.2	☐ Cells as the basic units of living organisms	☐ recognise organelles and other cell structures found in eukaryotic cells and outline their structures and functions, limited to: • cell surface membrane • nucleus, nuclear envelope and nucleolus • rough endoplasmic reticulum • smooth endoplasmic reticulum • Golgi body (Golgi apparatus or Golgi complex) • mitochondria (including the presence of small circular DNA) • ribosomes (80S in the cytoplasm and 70S in chloroplasts and mitochondria) • lysosomes • centrioles and microtubules • cilia • microvilli • chloroplasts (including the presence of small circular DNA) • cell wall • plasmodesmata • large permanent vacuole and tonoplast of plant cells

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2.1	Cells as the basic units of living organisms	☐ describe and interpret photomicrographs, electron micrographs and drawings of typical plant and animal cells ☐ compare the structure of typical plant and animal cells ☐ state that cells use ATP from respiration for energy-requiring processes ☐ outline key structural features of a prokaryotic cell as found in a typical bacterium, including: • unicellular • generally, 1–5 μm diameter • peptidoglycan cell walls • circular DNA • 70S ribosomes • absence of organelles surrounded by double membranes
2.2	Cells as the basic units of living organisms	☐ compare the structure of a prokaryotic cell as found in a typical bacterium with the structures of typical eukaryotic cells in plants and animals ☐ state that all viruses are non-cellular structures with a nucleic acid core (either DNA or RNA) and a capsid made of protein, some viruses have outer envelope made of phospholipid
3.1	Biological molecules- Testing for biological molecules	*Describe and carry out the Benedict's test for reducing sugars, the iodine test for starch, the emulsion test for lipids and the biuret test for proteins *describe and carry out a semi-quantitative Benedict's test on a reducing sugar solution by standardising the test and using the results (time to first colour change or comparison to colour standards) to estimate the concentration * describe and carry out a test to identify the presence of non-reducing sugars, using acid hydrolysis and Benedict's solution

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3.2	Carbohydrates and lipids	☐ describe and draw the ring forms of α-glucose and β-glucose ☐ define the terms monomer, polymer, macromolecule, monosaccharide, disaccharide and polysaccharide ☐ state the role of covalent bonds in joining smaller molecules together to form polymers ☐ state that glucose, fructose and maltose are reducing sugars and that sucrose is a non-reducing sugar ☐ describe the formation of a glycosidic bond by condensation, with reference to disaccharide including sucrose and polysaccharide ☐ Carbohydrates and lipids continued Learning outcomes Candidates should be able to: ☐ describe the breakage of a glycosidic bond in polysaccharides and disaccharides by hydrolysis, with reference to the non-reducing sugar test ☐ describe the molecular structure of the polysaccharides starch (amylose and amylopectin) and glycogen and relate their structures to their functions in living organisms ☐ describe the molecular structure of the polysaccharide cellulose and outline how the arrangement of cellulose molecules contributes to the function of plant cell walls ☐ state that triglycerides are non-polar hydrophobic molecules and describe the molecular structure of triglycerides with reference to fatty acids (saturated and unsaturated), glycerol and the formation of ester bonds ☐ relate the molecular structure of triglycerides to their functions in living organisms ☐ describe the molecular structure of phospholipids with reference to their hydrophilic (polar) phosphate heads and hydrophobic (non-polar) fatty acid tails
4.1	Proteins	☐ describe and draw the general structure of an amino acid and the formation and breakage of a peptide bond ☐ explain the meaning of the terms primary structure, secondary structure, tertiary structure and quaternary structure of proteins ☐ describe the types of interaction that hold protein molecules in shape: • hydrophobic interactions • hydrogen bonding • ionic bonding • covalent bonding, including disulfide bonds ☐ state that globular proteins are generally soluble and have physiological roles and fibrous proteins are generally insoluble and have structural roles ☐ describe the structure of a molecule of haemoglobin as an example of a globular protein, including the formation of its quaternary structure from two alpha (α) chains (α–globin), two beta (β) chains (β–globin) and a haem group ☐ relate the structure of haemoglobin to its function, including the importance of iron in the haem group ☐ describe the structure of a molecule of collagen as an example of a fibrous protein, and the arrangement of collagen molecules to form collagen fibres ☐ relate the structures of collagen molecules and collagen fibres to their functions explain how hydrogen bonding occurs between water molecules and relate the properties of water to its roles in living organisms, limited to solvent action, high specific heat capacity and latent heat of vaporisation

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5.1	Enzymes- Mode of action of enzymes	state that enzymes are globular proteins that catalyse reactions inside cells (intracellular enzymes) or are secreted to catalyse reactions outside cells (extracellular enzymes) ☐ explain the mode of action of enzymes in terms of an active site, enzyme–substrate complex, lowering of activation energy and enzyme specificity, including the lock-and-key hypothesis and the induced-fit hypothesis ☐ investigate the progress of enzyme-catalysed reactions by measuring rates of formation of products using catalase and rates of disappearance of substrate using amylase ☐ outline the use of a colorimeter for measuring the progress of enzyme-catalysed reactions that involve colour changes
5.2	Factors that affect enzyme action	☐ investigate and explain the effects of the following factors on the rate of enzyme-catalysed reactions: • temperature • pH (using buffer solutions) • enzyme concentration • substrate concentration • inhibitor concentration ☐ explain that the maximum rate of reaction (Vmax) is used to derive the Michaelis–Menten constant (Km), which is used to compare the affinity of different enzymes for their substrates explain the effects of reversible inhibitors, both competitive and non-competitive, on enzyme activity investigate the difference in activity between an enzyme immobilised in alginate and the same enzyme free in solution, and state the advantages of using immobilised enzymes
6.1	Transport in plants- Structure of transport	☐ draw plan diagrams of transverse sections of stems, roots and leaves of herbaceous dicotyledonous plants from microscope slides and photomicrographs ☐ describe the distribution of xylem and phloem in transverse sections of stems, roots and leaves of herbaceous dicotyledonous plants ☐ draw and label xylem vessel elements, phloem sieve tube elements and companion cells from microscope slides, photomicrographs and electron micrographs ☐ relate the structure of xylem vessel elements, phloem sieve tube elements and companion cells to their functions

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6.2	Transport mechanisms	☐ state that some mineral ions and organic compounds can be transported within plants dissolved in water ☐ describe the transport of water from the soil to the xylem through the: • apoplast pathway, including reference to lignin and cellulose • symplast pathway, including reference to the endodermis, Casparian strip and suberin ☐ explain that transpiration involves the evaporation of water from the internal surfaces of leaves followed by diffusion of water vapour to the atmosphere ☐ explain how hydrogen bonding of water molecules is involved with movement of water in the xylem by cohesion-tension in transpiration pull and by adhesion to cellulose in cell walls ☐ make annotated drawings of transverse sections of leaves from xerophytic plants to explain how they are adapted to reduce water loss by transpiration ☐ state that assimilates dissolved in water, such as sucrose and amino acids, move from sources to sinks in phloem sieve tubes ☐ explain how companion cells transfer assimilates to phloem sieve tubes, with reference to proton pumps and cotransporter proteins ☐ explain mass flow in phloem sieve tubes down a hydrostatic pressure gradient from source to sink
7.1	Transport in mammals- The circulatory system	state that the mammalian circulatory system is a closed double circulation consisting of a heart, blood and blood vessels including arteries, arterioles, capillaries, venules and veins ☐ describe the functions of the main blood vessels of the pulmonary and systemic circulations, limited to pulmonary artery, pulmonary vein, aorta and vena cava ☐ recognise arteries, veins and capillaries from microscope slides, photomicrographs and electron micrographs and make plan diagrams showing the structure of arteries and veins in transverse section (TS) and longitudinal section (LS) ☐ explain how the structure of muscular arteries, elastic arteries, veins and capillaries are each related to their functions ☐ recognise and draw red blood cells, monocytes, neutrophils and lymphocytes from microscope slides,photomicrographs and electron micrographs
7.2	Transport in mammals- The circulatory system	photomicrographs and electron micrographs ☐ state that water is the main component of blood and tissue fluid and relate the properties of water to its role in transport in mammals, limited to solvent action and high specific heat capacity ☐ state the functions of tissue fluid and describe the formation of tissue fluid in a capillary network ☐ Transport of oxygen and carbon dioxide Learning outcomes Candidates should be able to: ☐ describe the role of red blood cells in transporting oxygen and carbon dioxide with reference to the roles of: • haemoglobin • carbonic anhydrase • the formation of haemoglobinic acid • the formation of carbaminohaemoglobin

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8.1	circulatory system continue	☐ 2 describe the chloride shift and explain the importance of the chloride shift ☐ 3 describe the role of plasma in the transport of carbon dioxide 4 describe and explain the oxygen dissociation curve of adult haemoglobin ☐ explain the importance of the oxygen dissociation curve at partial pressures of oxygen in the lungs and in respiring tissues ☐ describe the Bohr shift and explain the importance of the Bohr shift
8.2	The heart	describe the external and internal structure of the mammalian heart ☐ explain the differences in the thickness of the walls of the: • atria and ventricles • left ventricle and right ventricle ☐ describe the cardiac cycle, with reference to the relationship between blood pressure changes during systole and diastole and the opening and closing of valves ☐ explain the roles of the sinoatrial node, the atrioventricular node and the Purkyne tissue in the cardiac cycle (knowledge of nervous and hormonal control not expected)
9.1	Gas exchange-The gas exchange system	describe the structure of the human gas exchange system, limited to: • lungs • trachea • bronchi • bronchioles • alveoli • capillary network ☐ describe the distribution in the gas exchange system of cartilage, ciliated epithelium, goblet cells, squamous epithelium of alveoli, smooth muscle and capillaries ☐ recognise cartilage, ciliated epithelium, goblet cells, squamous epithelium of alveoli, smooth muscle and capillaries in microscope slides, photomicrographs and electron micrographs
9.2	The gas exchange system	☐ recognise trachea, bronchi, bronchioles and alveoli in microscope slides, photomicrographs and electron micrographs and make plan diagrams of transverse sections of the walls of the trachea and bronchus ☐ describe the functions of ciliated epithelial cells, goblet cells and mucous glands in maintaining the health of the gas exchange system ☐ describe the functions in the gas exchange system of cartilage, smooth muscle, elastic fibres and squamous epithelium ☐ describe gas exchange between air in the alveoli and the blood in the capillaries
10.1	Paper 3 Advanced Practical Skills	• manipulation, measurement and observation • presentation of data and observations • analysis, conclusions and evaluation. candidates for practical exams

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10.2	Paper 3 The paper:	• requires candidates to carry out an investigation or investigations. They may be asked to: • – make decisions on techniques • – collect quantitative or qualitative data • – present the data or observations as tables, charts, graphs and other appropriate means • – analyse the data appropriately, including calculations • – draw conclusions • – suggest improvements to the procedure or modifications for extending the investigation • requires candidates to carry out activities using a light microscope. They may be asked to: – prepare slides – make observations of specimens – present their observations appropriately – analyse data appropriately, including calculations – make deductions and conclusion from the observations
11.1	Paper 3 Advanced Practical Skills continue	• requires each center to provide microscopes for half of the candidates at a time (see Apparatus and materials section for microscope specifications), so half the candidates should start on the investigation while the others start with access to the light microscope ☐ • includes questions set in different areas of AS Level Biology and may include material from unfamiliar contexts.

BIOLOGY SCHEME OF WORK

FORM 6 - TERM 2

WEEK	TOPIC	TOPIC DETAILS
1.1	The mitotic cell cycle- Replication and division of nuclei and cells	☐ describe the structure of a chromosome, limited to: • DNA • histone proteins • sister chromatids • centromere • telomeres ☐ explain the importance of mitosis in the production of genetically identical daughter cells during ☐ • growth of multicellular organisms • replacement of damaged or dead cells • repair of tissues by cell replacement • asexual reproduction ☐ outline the mitotic cell cycle, including: • interphase (growth in G1 and G2 phases and DNA replication in S phase) • mitosis • cytokinesis ☐ outline the role of telomeres in preventing the loss of genes from the ends of chromosomes during DNA replication ☐ 5 outline the role of stem cells in cell replacement and tissue repair by mitosis 6 explain how uncontrolled cell division can result in the formation of a tumour
2.1	Chromosome behaviour in mitosis	☐ describe the behaviour of chromosomes in plant and animal cells during the mitotic cell cycle and the associated behaviour of the nuclear envelope, the cell surface membrane and the spindle (names of the main stages of mitosis are expected: prophase, metaphase, anaphase and telophase) ☐ interpret photomicrographs, diagrams and microscope slides of cells in different stages of the mitotic cell cycle and identify the main stage of mitosis

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3.1	Nucleic acids and protein synthesis	☐ Structure of nucleic acids and replication of DNA ☐ describe the structure of nucleotides, including the phosphorylated nucleotide ATP (structural formulae are not expected) ☐ state that the bases adenine and guanine are purines with a double ring structure, and that the bases cytosine, thymine and uracil are pyrimidines with a single ring structure (structural formulae for bases are not expected) ☐ describe the structure of a DNA molecule as a double helix, including: • the importance of complementary base pairing between the 5' to 3' strand and the 3' to 5' strand (antiparallel strands) • differences in hydrogen bonding between C–G and A–T base pairs • linking of nucleotides by phosphodiester bonds
3.2	Structure of nucleic acids and replication of DNA	☐ describe the semi-conservative replication of DNA during the S phase of the cell cycle, including: • the roles of DNA polymerase and DNA ligase (knowledge of other enzymes in DNA replication in cells and different types of DNA polymerase is not expected) • the differences between leading strand and lagging strand replication as a consequence of DNA polymerase adding nucleotides only in a 5' to 3' direction ☐ describe the structure of an RNA molecule, using the example of messenger RNA (mRNA)
4.1	Protein synthesis	☐ state that a polypeptide is coded for by a gene and that a gene is a sequence of nucleotides that forms part of a DNA molecule 2 describe the principle of the universal genetic code in which different triplets of DNA bases either code for specific amino acids or for start and stop signals
4.2	Protein synthesis	describe how the information in DNA is used during transcription and translation to construct polypeptides, including the roles of: • RNA polymerase • messenger RNA (mRNA) ☐ • codons • transfer RNA (tRNA) • anticodons • ribosomes ☐ state that the strand of a DNA molecule that is used in transcription is called the transcribed or template strand and that the other strand is called the non-transcribed strand ☐ explain that, in eukaryotes, the RNA molecule formed following transcription (primary transcript) is modified by the removal of non-coding sequences (introns) and the joining together of coding sequences (exons) to form mRNA ☐ state that a gene mutation is a change in the sequence of base pairs in a DNA molecule that may result in an altered polypeptide ☐ explain that a gene mutation is a result of substitution or deletion or insertion of nucleotides in DNA and outline how each of these types of mutation may affect the polypeptide produced

WEEK	TOPIC	TOPIC DETAILS
5.1	Infectious diseases	☐ state that infectious diseases are caused by pathogens and are transmissible 2 state the name and type of pathogen that causes each of the following diseases: • cholera – caused by the bacterium Vibrio cholerae ☐ • malaria – caused by the protoctists Plasmodium falciparum, Plasmodium malariae, Plasmodium ovale and Plasmodium vivax ☐ • tuberculosis (TB) – caused by the bacteria Mycobacterium tuberculosis and Mycobacterium bovis ☐ • HIV/AIDS – caused by the human immunodeficiency virus (HIV) ☐ 3 explain how cholera, malaria, TB and HIV are transmitted
6.1	Infectious diseases	☐ 4 discuss the biological, social and economic factors that need to be considered in the prevention and control of cholera, malaria, TB and HIV (details of life cycle of malarial parasite are not expected) ☐ 1 outline how penicillin acts on bacteria and why antibiotics do not affect viruses ☐ 2 discuss the consequences of antibiotic resistance and the steps that can be taken to reduce its impact
7.1	The immune system	☐ describe the mode of action of phagocytes (macrophages and neutrophils) ☐ explain what is meant by an antigen and state the difference between self-antigens and non-self-antigens describe the sequence of events that occurs during a primary immune response with reference to the roles of ☐ : • macrophages ☐ • B-lymphocytes, including plasma cells ☐ • T-lymphocytes, limited to T-helper cells and T-killer cells 4 explain the role of memory cells in the secondary immune response and in long-term immunity
8.1	☐ Antibodies and vaccination	relate the molecular structure of antibodies to their functions 2 outline the hybridoma method for the production of monoclonal antibodies 3 outline the principles of using monoclonal antibodies in the diagnosis of disease and in the treatment of disease 4 describe the differences between active immunity and passive immunity and between natural immunity and artificial immunity 5 explain that vaccines contain antigens that stimulate immune responses to provide long-term immunity 6 explain how vaccination programmes can help to control the spread of infectious disease

WEEK	TOPIC	TOPIC DETAILS
9.1	Manipulation, measurement and observation (Advance Practical Skills)	☐ Decisions relating to measurements and observations ☐ Within an investigation, candidates should be able to: • identify the independent variable and dependent variable • decide a suitable range of values to use for the independent variable at which measurements of the dependent variable are recorded • decide the number of different values of the independent variable (a minimum of five) and the intervals between them • decide how to change the value of the independent variable • decide how the dependent variable should be measured • decide the number of replicates at each value • decide on appropriate controls for the experiment or investigation • decide which variables need to be standardised and how to standardise them. (Variables expected to have a minimal effect, such as variation between test-tubes of the same type, do not need to be standardised.)
9.2	Manipulation, measurement and observation (Advance Practical Skills)	☐ When using the light microscope and photomicrographs, candidates should be able to: • set up a light microscope to view and observe specimens • follow instructions to find and draw particular tissues in plant and animal specimens and label the drawings appropriately • follow instructions to find and draw particular cells and structures within the cells • make a temporary slide of stained cells or tissues • calculate actual sizes of tissues or cells from measurements of photomicrographs, using magnifications, scale bars or representations of eyepiece graticules and stage micrometers • estimate the number of cells or cell organelles in a given area using a sampling method, such as grids or fields of view
10.1	Collection of data and observations	follow instructions to collect results • consider the hazards of the procedure, including the use of any solutions and reagents, and assess the risk as low, medium or high • take readings to obtain accurate data (quantitative results) or observations (qualitative results). ☐ When using the light microscope and photomicrographs, candidates should be able to: • draw plan diagrams to show the distribution of tissues in a specimen, with no cells drawn and the correct proportions of layers of tissues • draw the observable features of cells in a specimen showing: – the correct shapes – the thicknesses of cell walls where applicable (drawn with two lines or drawn with three lines where two cells touch) – the relative sizes and proportions – observable cell contents only