MARINA INTERNATIONAL SCHOOL

BIOLOGY SCHEME OF WORK

FORM 7 - TERM 1

WEEK	TOPIC	TOPIC DETAILS
1.1	Energy	☐ outline the need for energy in living organisms, as illustrated by active transport, movement and anabolic reactions, such as DNA replication and protein synthesis ☐ describe the features of ATP that make it suitable as the universal energy currency ☐ state that ATP is synthesised by: • transfer of phosphate in substrate-linked reactions ☐ chemiosmosis in membranes of mitochondria and chloroplasts ☐ explain the relative energy values of carbohydrates, lipids and proteins as respiratory substrates
1.2	Energy continue	☐ state that the respiratory quotient (RQ) is the ratio of the number of molecules of carbon dioxide produced to the number of molecules of oxygen taken in, as a result of respiration ☐ calculate RQ values of different respiratory substrates from equations for respiration ☐ describe and carry out investigations, using simple respirometers, to determine the RQ of germinating seeds or small invertebrates (e.g. blowfly larvae)
2.1	Respiration	☐ State where each of the four stages in aerobic respiration occurs in eukaryotic cells: • glycolysis in the cytoplasm • link reaction in the mitochondrial matrix • Krebs cycle in the mitochondrial matrix • oxidative phosphorylation on the inner membrane of mitochondria ☐ outline glycolysis as phosphorylation of glucose and the subsequent splitting of fructose 1,6-bisphosphate (6C) into two triose phosphate molecules (3C), which are then further oxidised to pyruvate (3C), with the production of ATP and reduced NAD
2.2	Respiration continue	explain that, when oxygen is available, pyruvate enters mitochondria to take part in the link reaction ☐ describe the link reaction, including the role of coenzyme A in the transfer of acetyl (2C) groups ☐ outline the Krebs cycle, explaining that oxaloacetate (4C) acts as an acceptor of the 2C fragment from acetyl coenzyme A to form citrate (6C), which is converted back to oxaloacetate in a series of small steps

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3.1	Respiration continue	☐ explain that reactions in the Krebs cycle involve decarboxylation and dehydrogenation and the reduction of the coenzymes NAD and FAD ☐ describe the role of NAD and FAD in transferring hydrogen to carriers in the inner mitochondrial membrane ☐ explain that during oxidative phosphorylation: • hydrogen atoms split into protons and energetic electrons • energetic electrons release energy as they pass through the electron transport chain (details of carriers are not expected) • the released energy is used to transfer protons across the inner mitochondrial membrane • protons return to the mitochondrial matrix by facilitated diffusion through ATP synthase, providing energy for ATP synthesis (details of ATP synthase are not expected) • oxygen acts as the final electron acceptor to form water
3.2	Respiration continue	☐ describe the relationship between the structure and function of mitochondria using diagrams and electron micrographs ☐ outline respiration in anaerobic conditions in mammals (lactate fermentation) and in yeast cells (ethanol fermentation) ☐ explain why the energy yield from respiration in aerobic conditions is much greater than the energy yield from respiration in anaerobic conditions (a detailed account of the total yield of ATP from the aerobic respiration of glucose is not expected) ☐ explain how rice is adapted to grow with its roots submerged in water, limited to the development of aerenchym main roots, ethanol fermentation in roots and faster growth of stems ☐ describe and carry out investigations using redox indicators, including DCPIP and methylene blue, to determine the effects of temperature and substrate concentration on the rate of respiration of yeast ☐ describe and carry out investigations using simple respirometers to determine the effect of temperature on the rate of respiration
4.1	Photosynthesis(Photosynthesis as an energy transfer process)	describe the relationship between the structure of chloroplasts, as shown in diagrams and electron micrographs, and their function ☐ explain that energy transferred as ATP and reduced NADP from the light-dependent stage is used during the light-independent stage (Calvin cycle) of photosynthesis to produce complex organic molecules ☐ state that within a chloroplast, the thylakoids (thylakoid membranes and thylakoid spaces), which occur in stacks called grana, are the site of the light-dependent stage and the stroma is the site of the light-independent stage ☐ describe the role of chloroplast pigments (chlorophyll a, chlorophyll b, carotene and xanthophyll) in light absorption in thylakoids 5 interpret absorption spectra of chloroplast pigments and action spectra for photosynthesis

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5.1	Photosynthesis as an energy transfer process	☐ describe and use chromatography to separate and identify chloroplast pigments (reference should be made to Rf values in identification of chloroplast pigments) ☐ state that cyclic photophosphorylation and non-cyclic photophosphorylation occur during the light-dependent stage of photosynthesis ☐ explain that in cyclic photophosphorylation: • only photosystem I (PSI) is involved ☐ • photoactivation of chlorophyll occurs ☐ • ATP is synthesized ☐ explain that in non-cyclic photophosphorylation: ☐ • photosystem I (PSI) and photosystem II (PSII) are both involved ☐ • photoactivation of chlorophyll occurs ☐ • the oxygen-evolving complex catalyses the photolysis of water ☐ • ATP and reduced NADP are synthesised
6.1	Photosynthesis as an energy transfer process continued	☐ explain that during photophosphorylation: • energetic electrons release energy as they pass through the electron transport chain (details of carriers are not expected) • the released energy is used to transfer protons across the thylakoid membrane • protons return to the thylakoid space by facilitated diffusion through ATP synthase, providing energy for ATP synthesis (details of ATP synthase are not expected)
6.2	Photosynthesis as an energy transfer process continued	outline the three main stages of the Calvin cycle: • rubisco catalyses the fixation of carbon dioxide by combination with a molecule of ribulose bisphosphate (RuBP), a 5C compound, to yield two molecules of glycerate 3-phosphate (GP), a 3C compound • GP is reduced to triose phosphate (TP) in a reaction involving reduced NADP and ATP • RuBP is regenerated from TP in reactions that use ATP ☐ state that Calvin cycle intermediates are used to produce other molecules, limited to GP to produce some amino acids and TP to produce carbohydrates, lipids and amino acid
7.1	Investigation of limiting factors	☐ state that light intensity, carbon dioxide concentration and temperature are examples of limiting factors of photosynthesis ☐ explain the effects of changes in light intensity, carbon dioxide concentration and temperature on the rate of photosynthesis ☐ describe and carry out investigations using redox indicators, including DCPIP and methylene blue, and a suspension of chloroplasts to determine the effects of light intensity and light wavelength on the rate of photosynthesis ☐ describe and carry out investigations using whole plants, including aquatic plants, to determine the effects of light intensity, carbon dioxide concentration and temperature on the rate of photosynthesis

WEEK	TOPIC	TOPIC DETAILS
8.1	Inheritance(Passage of information from parents to offspring)	☐ explain the meanings of the terms haploid (n) and diploid (2n) ☐ explain what is meant by homologous pairs of chromosomes ☐ explain the need for a reduction division during meiosis in the production of gametes ☐ describe the behaviour of chromosomes in plant and animal cells during meiosis and the associated behaviour of the nuclear envelope, the cell surface membrane and the spindle (names of the main stages of meiosis, but not the sub-divisions of prophase I, are expected: prophase I, metaphase I, anaphase I, telophase I, prophase II, metaphase II, anaphase II and telophase II) ☐ interpret photomicrographs and diagrams of cells in different stages of meiosis and identify the main stages of meiosis ☐ explain that crossing over and random orientation (independent assortment) of pairs of homologous chromosomes and sister chromatids during meiosis produces genetically different gametes ☐ explain that the random fusion of gametes at fertilisation produces genetically different individuals
9.1	☐ The roles of genes in determining the phenotype	☐ explain the terms gene, locus, allele, dominant, recessive, codominant, linkage, test cross, F1, F2, phenotype, genotype, homozygous and heterozygous ☐ interpret and construct genetic diagrams, including Punnett squares, to explain and predict the results of monohybrid crosses and dihybrid crosses that involve dominance, codominance, multiple alleles and sex linkage ☐ interpret and construct genetic diagrams, including Punnett squares, to explain and predict the results of dihybrid crosses that involve autosomal linkage and epistasis (knowledge of the expected ratios for different types of epistasis is not expected) ☐ interpret and construct genetic diagrams, including Punnett squares, to explain and predict the results of test crosses ☐ 5 use the chi-squared test to test the significance of differences between observed and expected results (the formula for the chi-squared test will be provided, as shown in the Mathematical requirement
10.1	Role of gene in heredity and gene control (The roles of genes in determining the phenotype continued)	☐ explain the relationship between genes, proteins and phenotype with respect to the: • TYR gene, tyrosinase and albinism • HBB gene, haemoglobin and sickle cell anaemia • F8 gene, factor VIII and haemophilia • HTT gene, huntingtin and Huntington’s disease ☐ explain the role of gibberellin in stem elongation including the role of the dominant allele, Le, that codes for a functional enzyme in the gibberellin synthesis pathway and the recessive allele, le, that codes for a non-functional enzyme

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10.2	Gene control	☐ describe the differences between structural genes and regulatory genes and the differences between repressible enzymes and inducible enzymes ☐ explain genetic control of protein production in a prokaryote using the lac operon (knowledge of the role of cAMP is not expected) ☐ state that transcription factors are proteins that bind to DNA and are involved in the control of gene expression in eukaryotes by decreasing ☐ explain how gibberellin activates genes by causing the breakdown of DELLA protein repressors, which normally inhibit factors that promote transcription
11.1	Selection and evolution (Variation)	explain, with examples, that phenotypic variation is due to genetic factors or environmental factors or a combination of genetic and environmental factors ☐ explain what is meant by discontinuous variation and continuous variation ☐ explain the genetic basis of discontinuous variation and continuous variation ☐ use the t-test to compare the means of two different samples (the formula for the t-test will be provided, as shown in the Mathematical requirements)
11.2	Natural and artificial selection	☐ explain that natural selection occurs because populations have the capacity to produce many offspring that compete for resources; in the 'struggle for existence', individuals that are best adapted are most likely to survive to reproduce and pass on their alleles to the next generation ☐ explain how environmental factors can act as stabilising, disruptive and directional forces of natural selection ☐ explain how selection, the founder effect and genetic drift, including the bottleneck effect, may affect allele frequencies in populations ☐ outline how bacteria become resistant to antibiotics as an example of natural selection
11.3	Natural and artificial selection continue	☐ use the Hardy–Weinberg principle to calculate allele and genotype frequencies in populations and state the conditions when this principle can be applied (the two equations for the Hardy–Weinberg principle will be provided, as shown in the Mathematical requirements) ☐ describe the principles of selective breeding (artificial selection) ☐ outline the following examples of selective breeding: • the introduction of disease resistance to varieties of wheat and rice • inbreeding and hybridisation to produce vigorous, uniform varieties of maize • improving the milk yield of dairy cattle ☐ outline the theory of evolution as a process leading to the formation of new species from pre-existing species over time, as a result of changes to gene pools from generation to generation ☐ discuss how DNA sequence data can show evolutionary relationships between species ☐ explain how speciation may occur as a result of genetic isolation by: • geographical separation (allopatric speciation

BIOLOGY SCHEME OF WORK

FORM 7 - TERM 2

WEEK	TOPIC	TOPIC DETAILS
1.1	Homeostasis in mammals	☐ explain what is meant by homeostasis and the importance of homeostasis in mammals ☐ explain the principles of homeostasis in terms of internal and external stimuli, receptors, coordination systems (nervous system and endocrine system), effectors (muscles and glands) and negative feedback ☐ state that urea is produced in the liver from the deamination of excess amino acids ☐ describe the structure of the human kidney, limited to: • fibrous capsule • cortex • medulla • renal pelvis • ureter • branches of the renal artery and renal vein ☐ Identify, in diagrams, photomicrographs and electron micrographs, the parts of a nephron and its associated blood vessels and structures, limited to: • glomerulus • Bowman's capsule • proximal convoluted tubule • loop of Henle • distal convoluted tubule • collecting
1.2	Homeostasis in mammals continue	☐ describe and explain the formation of urine in the nephron, limited to: • the formation of glomerular filtrate by ultrafiltration in the Bowman's capsule • selective reabsorption in the proximal convoluted tubule ☐ relate the detailed structure of the Bowman's capsule and proximal convoluted tubule to their functions in the formation of urine ☐ describe the roles of the hypothalamus, posterior pituitary gland, antidiuretic hormone (ADH), aquaporins and collecting ducts in osmoregulation continued

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2.1	Homeostasis in mammals:	describe the principles of cell signalling using the example of the control of blood glucose concentration by glucagon, limited to o binding of hormone to cell surface receptor causing conformational change o activation of G-protein leading to stimulation of adenylyl cyclase o formation of the second messenger, cyclic AMP (cAMP) o activation of protein kinase A by cAMP leading to initiation of an enzyme cascade o amplification of the signal through the enzyme cascade as a result of activation of more and more enzymes by phosphorylation o cellular response in which the final enzyme in the pathway is activated, catalysing the breakdown of glycogen explain how negative feedback control mechanisms regulate blood glucose concentration, with reference to the effects of insulin on muscle cells and liver cells and the effect of glucagon on liver cells ☐ explain the principles of operation of test strips and biosensors for measuring the concentration of glucose in blood and urine,
3.1	Homeostasis in plants	☐ explain that stomata respond to changes in environmental conditions by opening and closing and that regulation of stomatal aperture balances the need for carbon dioxide uptake by diffusion with the need to minimise water loss by transpiration ☐ explain that stomata have daily rhythms of opening and closing ☐ describe the structure and function of guard cells and explain the mechanism by which they open and close stomata ☐ describe the role of abscisic acid in the closure of stomata during times of water stress, including the role of calcium ions as a second messenger
4.1	Control and coordination in mammals	☐ describe the features of the endocrine system with reference to the hormones ADH, glucagon and insulin compare the features of the nervous system and the endocrine system ☐ describe the structure and function of a sensory neurone and a motor neurone and state that intermediate neurones connect sensory neurones and motor neurons ☐ outline the role of sensory receptor cells in detecting stimuli and stimulating the transmission of impulses in sensory neurons ☐ describe the sequence of events that results in an action potential in a sensory neurone, using a chemoreceptor cell in a human taste bud as an example ☐ describe and explain changes to the membrane potential of neurones, including: o how the resting potential is maintained o the events that occur during an action potential o how the resting potential is restored during the refractory period ☐ describe and explain the rapid transmission of an impulse in a myelinated neurone with reference to saltatory conduction ☐ explain the importance of the refractory period in determining the frequency of impulses

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4.2	Control and coordination in mammals-continue	describe the structure of a cholinergic synapse and explain how it functions, including the role of calcium ions □ describe the roles of neuromuscular junctions, transverse system tubules and sarcoplasmic and reticulum in stimulating contraction in striated muscle □ describe the ultrastructure of striated muscle with reference to sarcomere structure using electron micrographs and diagrams □ explain the sliding filament model of muscular contraction including the roles of troponin, tropomyosin, calcium ions and ATP
5.1	Control and coordination in plants	□ describe the rapid response of the Venus fly trap to stimulation of hairs on the lobes of modified leaves and explain how the closure of the trap is achieved □ explain the role of auxin in elongation growth by stimulating proton pumping to acidify cell walls □ describe the role of gibberellin in the germination of baley
6.1	Classification, biodiversity and conservation	discuss the meaning of the term species, limited to the biological species concept, morphological species concept and ecological species concept □ describe the classification of organisms into three domains: Archaea, Bacteria and Eukarya □ state that Archaea and Bacteria are prokaryotes and that there are differences between them, limited to differences in membrane lipids, ribosomal RNA and composition of cell walls □ describe the classification of organisms in the Eukarya domain into the taxonomic hierarchy of kingdom, phylum, class, order, family, genus and species □ outline the characteristic features of the kingdoms Protoctista, Fungi, Plantae and Animalia □ outlines how viruses are classified, limited to the type of nucleic acid (RNA or DNA) and whether this is single stranded or double stranded
7.1	Biodiversity	□ define the terms ecosystem and niche □ explain that biodiversity can be assessed at different levels, including: o the number and range of different ecosystems and habitats o the number of species and their relative abundance o the genetic variation within each species □ explain the importance of random sampling in determining the biodiversity of and describe and use suitable methods to assess the distribution and abundance of organisms in an area, limited to frame quadrats, line transects, belt transects and mark-release-recapture using the Lincoln index (the formula for the Lincoln index will be provided, as shown in the Mathematical requirements)

WEEK	TOPIC	TOPIC DETAILS
8.1	Biodiversity-continue	☐ use Spearman’s rank correlation and Pearson’s linear correlation to analyse the relationships between two variables, including how biotic and abiotic factors affect the distribution and abundance of species (the formulae for these correlations will be provided, as shown in the Mathematical requirements) ☐ use Simpson’s index of diversity (D) to calculate the biodiversity of an area, and state the significance of different values of D (the formula for Simpson’s index of diversity will be provided, as shown in the Mathematical requirements)
9.1	Conservation	explain why populations and species can become extinct as a result of: o climate change o competition o hunting by humans o degradation and loss of habitats ☐ outline reasons for the need to maintain biodiversity ☐ outline the roles of zoos, botanic gardens, conserved areas (including national parks and marine parks), ‘frozen zoos’ and seed banks, in the conservation of endangered species ☐ describe methods of assisted reproduction used in the conservation of endangered mammals, limited to IVF, embryo transfer and surrogacy ☐ explain reasons for controlling invasive alien species ☐ outline the role in conservation of the International Union for the Conservation of Nature (IUCN) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

WEEK	TOPIC	TOPIC DETAILS
10.1	Genetic technology	☐ define the term recombinant DNA ☐ explain that genetic engineering is the deliberate manipulation of genetic material to modify specific characteristics of an organism and that this may involve transferring a gene into an organism so that the gene is expressed ☐ explain that genes to be transferred into an organism may be: ☐ • extracted from the DNA of a donor organism ☐ • synthesised from the mRNA of a donor organism ☐ • synthesised chemically from nucleotides ☐ explain the roles of restriction endonucleases, DNA ligase, plasmids, DNA polymerase and reverse transcriptase in the transfer of a gene into an organism ☐ explain why a promoter may have to be transferred into an organism as well as the desired gene ☐ explain how gene expression may be confirmed by the use of marker genes coding for fluorescent products ☐ explain that gene editing is a form of genetic engineering involving the insertion, deletion or replacement of DNA at specific sites in the genome ☐ describe and explain the steps involved in the polymerase chain reaction (PCR) to clone and amplify DNA, including the role of Taq polymerase ☐ describe and explain how gel electrophoresis is used to separate DNA fragments of different lengths ☐ outline how microarrays are used in the analysis of genomes and in detecting mRNA in studies of gene expression ☐ outline the benefits of using databases that provide information about nucleotide sequences of genes and genomes, and amino acid sequences of proteins and protein structures
11.1	Genetic technology applied to medicine And Agriculture	☐ explain the advantages of using recombinant human proteins to treat disease, using the examples insulin, factor VIII and adenosine deaminase ☐ outline the advantages of genetic screening, using the examples of breast cancer (BRCA1 and BRCA2), Huntington's disease and cystic fibrosis ☐ outline how genetic diseases can be treated with gene therapy, using the examples severe combined immunodeficiency (SCID) and inherited eye diseases ☐ discuss the social and ethical considerations of using genetic screening and gene therapy in medicine
11.2	Genetically modified organisms in agriculture	☐ explain that genetic engineering may help to solve the global demand for food by improving the quality and productivity of farmed animals and crop plants, using the examples of GM salmon, herbicide resistance in soybean and insect resistance in cotton ☐ discuss the ethical and social implications of using genetically modified organisms (GMOs) in food production

WEEK	TOPIC	TOPIC DETAILS
12.1	☐ Planning, Analysis and Evaluation	o use extended structured writing o use appropriate diagrams and tables to illustrate answers o design an experimental method for a given problem, for which they may be asked to use given information or a specific piece of apparatus o express a prediction linking independent and dependent variables, either as a written hypothesis or as a graph showing the expected result o analyse and evaluate given experimental data, presented as tables, graphs or written statements, and draw appropriate conclusions ☐ • identify appropriate mathematical or statistical methods to process experimental data