آغا خان یونیورسٹی ایگزامینیشن بورڈ

AGA KHAN UNIVERSITY EXAMINATION BOARD

Secondary School Certificate
Examination Syllabus

Biology

Grades IX - X

(Based on New National Curriculum 2022-2023)

Student Learning Outcomes of AKU-EB SSC Biology Syllabus

Part I (Grade IX)

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level[1]		
				R	U	A and beyond
1. Introduction to Biology		Students should be able to:				
1.1	Introduction	1.1.1	define 'biology';	*		
		1.1.2	differentiate among the major divisions of biology, i.e., botany, zoology and microbiology;		*	
1.2	Divisions and Branches of Biology	1.2.1	explain the significance of given branches of biology, i.e., morphology, anatomy, physiology, embryology, taxonomy, cell biology (cytology), histology, palaeontology, pathology, environmental biology (ecology), sociobiology, molecular biology, immunology, genetics, pharmacology, marine biology, freshwater biology;		*	
1.3	Relationship of Biology with Other Sciences	1.3.1	relate biology to other branches of science, i.e., biophysics, biochemistry, biostatistics, biomathematics (biometry), biogeography, bio-economics, computational biology and biotechnology;		*	
1.4	Careers in Biology	1.4.1	describe the roles and responsibilities of professionals working in medicine and surgery, fisheries, agriculture, animal husbandry, horticulture, farming and forestry;		FA[2]	

[1]R = Remember, U = Understand, A = Apply and beyond [Apply (A), Analyse (An), Evaluate (E), Create (C)]
[2]FA= Formative Assessment, not to be assessed under examination conditions

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level[1]		
				R	U	A and beyond
1.5	Study of Life from the Perspective of the Holy Quran	1.5.1	explain instructions about the origin and the characteristics of life given in the verses (*Sura-e-Ambia*, verse: 30, *Sura-e-Rehman*, verse 14, *Sura-e-Al-Mominoon*, verse 14, *Sura-e-Al-Nur*, verse 45) of the Holy Quran;		FA	
1.6	The Levels of Organisation	1.6.1	describe bioelements as the most basic level of biological organisation;		*	
		1.6.2	explain biomolecules and their types, i.e., micro molecules and macro molecules (based on molecular masses);		*	
		1.6.3	differentiate among the levels of organisation of life (sub-atomic particles, atom, molecules, organelles, cells, tissues, organs, organ systems, organism, population, community, ecosystem, biosphere);		*	
		1.6.4	identify the types of tissues that form different organs i.e., stomach/ lungs in human beings and leaf/ root/ stem in plants;		*	
		1.6.5	exemplify that different organ systems work together to form a functioning human body;		*	
1.7	Division of Labour in Unicellular and Multicellular Organisms	1.7.1	define 'division of labour' in living organisms;	*		
		1.7.2	compare division of labour in unicellular and multicellular organisms;		*	
		1.7.3	differentiate between colony-level and tissue-level organisation in volvox and frog respectively;		*	
		1.7.4	justify that the volvox colony does not meet the criteria for having the true tissue-level organisation;			E
		1.7.5	evaluate the role of different cell types within a specific tissue/ organ for its overall functioning.			E

Topics and Sub-topics		Student Learning Outcomes	Cognitive Level		
			R	U	A and beyond
2. Solving a Biological Problem		Students should be able to:			
2.1 Biological Method	2.1.1	explain steps involved in the biological method, i.e., recognition of a biological problem, observation (qualitative and quantitative), building up hypotheses via inductive and deductive reasoning, deducing, devising experiments, inferring and reporting results, proposing theory and putting forward law/ principle (malaria can be taken as an example);		*	
	2.1.2	differentiate between hypothesis, theory and law in the context of scientific research;		*	
	2.1.3	design a solution for a biological problem by following the scientific method: a. formulate a working hypothesis, b. write instructions for conducting investigations or following a procedure, c. design an appropriate experiment with a control group, dependent, independent and constant variables, d. organise data appropriately using techniques such as tables and graphs, e. plot a bar graph, line graph and pie chart from the given set of biological data, f. interpret bar graph, line graph, pie chart, scatter plot chart and histogram from the given set of biological data, g. analyse data to make predictions, decisions or make conclusions;			C
	2.1.4	justify that science is a collaborative field that requires interdisciplinary researchers working together to share knowledge and critique ideas.			E

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
3. Biodiversity		Students should be able to:				
3.1	Introduction	3.1.1	define the terms 'biodiversity' and 'classification';	*		
		3.1.2	describe the importance of biodiversity for producing food, obtaining drugs, getting industrial products, maintaining ecosystems and recycling nutrients;		*	
3.2	Aims and Principles of Classification	3.2.1	describe aims and principles of classification;		*	
3.3	Phylogeny	3.3.1	define 'phylogeny';	*		
		3.3.2	explain that classification systems aims to reflect evolutionary relationships;		*	
		3.3.3	describe basis of classification of living organisms with reference to homology and analogy;		*	
3.4	History of Classification Systems	3.4.1	describe the contribution of different biologists (Aristotle, *Abu Usman Umer Aljahiz*, Ernest Hackel, Robert Whittaker, Margulis and Schwartz) in proposing the classification schemes;		FA	
		3.4.2	compare two-kingdom, three-kingdom, four-kingdom and five-kingdom classification systems;		*	
		3.4.3	describe that Robert Whittaker's five-kingdom classification system provides a more comprehensive understanding of the diversity of living organisms compared to other classification systems;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
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3.5	Units of Classification	3.5.1	explain the hierarchical structure of classification from species to kingdom (species, genus, family, order, class, division/ phyla, kingdom);		*	
		3.5.2	differentiate among the domains of biological classification system (bacteria, archaea and eukarya);		*	
3.6	Binomial Nomenclature	3.6.1	list the universal rules adopted for writing the scientific name of a species, including the use of binomial nomenclature;	*		
		3.6.2	explain the significance of using binomial nomenclature in ensuring clarity and consistency in scientific communication;		*	
		3.6.3	apply the rules of binomial nomenclature for writing the scientific names of given species;			A
		3.6.4	assess likely evolutionary relationships between organisms based on their binomial names;			E

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
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3.7	The Five Kingdoms	3.7.1	describe salient features of prokaryotes taking bacteria as an example;		*	
		3.7.2	describe salient features of the given protists: chlamydomonas and paramecium;		*	
		3.7.3	describe salient features of fungi taking rhizopus as an example;		*	
		3.7.4	classify kingdom plantae based on their major characteristics (seed producing and non-seed producing, flowering and non-flowering, number of cotyledons);		*	
		3.7.5	differentiate between monocot and dicot plants in terms of types of roots, arrangement of vascular bundles in stem, types of venations and number of floral leaves;		*	
		3.7.6	differentiate among invertebrates (sycon, jellyfish, tapeworm, roundworm, earthworm, snail, butterfly and sea star) based on their salient features;		*	
		3.7.7	differentiate among vertebrates (fish, frog, lizard, bird and cat) based on their salient features;		*	
3.8	Acellular structure	3.8.1	describe the general structure of virus;		*	
		3.8.2	justify the exclusion of viruses from the five-kingdom classification system;			E

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
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3.9	Viral Diseases	3.9.1	list common diseases caused by pathogens (viruses, bacteria, protozoan, fungi);	FA		
		3.9.2	describe the causes, symptoms and preventive measures of Covid 19;		FA	
		3.9.3	identify zoonotic diseases, i.e., anthrax, plaque and rabies with reference to their modes of transmission;		FA	
		3.9.4	describe vector borne diseases such as zika virus, malaria, dengue and chikungunya;		FA	
		3.9.5	state the causes of some common types of allergies (i.e., food allergy, insect sting's allergy, drug allergy and hay fever);	FA		
		3.9.6	describe viral diseases of plants commonly present in Pakistan, in terms of their effect on plant health, yield and methods used for their treatment (leaf curl virus, banana bunchy top virus, mosaic of sugarcane, potato leaf roll virus).		FA	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
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4. Cells and Tissues		Students should be able to:				
4.1	Microscopy and the Emergence of Cell Theory	4.1.1	define 'magnification' and 'resolution' of the microscope;	*		
		4.1.2	compare light microscopy and electron microscopy;		*	
		4.1.3	calculate the total magnification of a specimen observed under a compound light microscope by applying the formula: Total Magnification = Eyepiece Magnification × Objective Lens Magnification			A
		4.1.4	differentiate among scanning electron microscopy and transmission electron microscopy;		*	
		4.1.5	determine whether an image is from a light microscope, scanning electron microscope or transmission electron microscope based on image resolution, magnification and structural details observed;			A
		4.1.6	trace development of the cell theory from Aristotle to Robert Hooke, Antonie van Leeuwenhoek, Robert Brown and Schwann and Schleiden;		FA	
		4.1.7	state the postulates of cell theory;	*		
4.2	Cellular Organelles	4.2.1	explain structure, composition and functions of the sub-cellular components of a eukaryotic cell (cell wall, plasma membrane, nucleus, cytoplasm, cytoskeleton, Golgi bodies, mitochondria, vacuole, ribosomes, endoplasmic reticulum, lysosomes, peroxisomes, centrioles and plastids) with the help of diagrams/ photomicrographs;		*	
		4.2.2	compare: a. prokaryotic and eukaryotic cells, b. plant and animal cells;		*	
		4.2.3	evaluate the overall effect of a malfunctioned organelle on the cellular function;			E

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
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4.3	Cell Specialisation	4.3.1	define 'stem cells' as unspecialised cells;	*		
		4.3.2	describe cell specialisation and its importance for the efficient functioning of complex organisms;		*	
		4.3.3	relate structure of the following specialised cells with their functions: a. root hair cells - for absorption of water and minerals, b. xylem vessels - for conduction and support, c. mesophyll cells - for photosynthesis and gaseous exchange, d. epidermal cells with cuticle - for protection and regulation of water loss, e. red blood cells - for transport of oxygen and f. nerve cells - for conduction of nerve impulse;		*	
		4.3.4	assess the potential impacts on the functioning of multicellular organisms if the cells (a – f) mentioned in SLO 4.3.3 were not specialised;			E
4.4	Surface Area to Volume Ratio	4.4.1	calculate the surface area to volume ratio of different-sized cells (cubes) using appropriate formulas and measurements;			A
		4.4.2	evaluate the relationship between surface area to volume ratio and cell size;			E
		4.4.3	assess the efficiency of cellular processes, such as nutrient/ gaseous exchange and excretion, based on the surface area-to-volume ratio of cells;			E
4.5	Active and Passive Transport of Matter	4.5.1	define 'tonicity' of the solution;	*		
		4.5.2	describe different types of solution based on the types of tonicities (hypertonic solution, hypotonic solution and isotonic solution);		*	
		4.5.3	analyse the effects on plant and animal cells when placed in hypotonic, hypertonic and isotonic solutions;			An

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
		4.5.4	differentiate between plasmolysis and deplasmolysis;		*	
		4.5.5	compare different types of membranes (permeable, partially permeable and impermeable);		*	
		4.5.6	predict the direction of movement of molecules through permeable, partially permeable and impermeable membranes based on their properties and concentration gradients;			E
		4.5.7	compare the phenomena of diffusion, facilitated diffusion, osmosis, active transport, endocytosis and exocytosis;		*	
		4.5.8	analyse the factors that affect rate of diffusion in cells, i.e., surface area, temperature, concentration gradient and distance;			An
		4.5.9	describe the significance of passive transport and active transport, i.e.: a. facilitated diffusion: transport of glucose, b. diffusion: gaseous exchange in plants and animals, c. osmosis: water absorption by root hair cell, d. active transport: sodium-potassium pump in nerve cells, uptake of glucose in the intestinal cells of humans and mineral ions into root hair cells of plants;		*	
		4.5.10	exemplify the importance of turgor pressure in plants;		*	
4.6	Tissues (Types of Plant and Animal Tissues)	4.6.1	describe tissue as a group of cells with similar size, shape and function;		*	
		4.6.2	differentiate between simple and compound plant tissues;		*	
		4.6.3	compare major plant tissues in terms of their cell specificities, locations and functions, i.e., simple tissues (meristematic tissues and permanent tissues including epidermal, parenchyma, collenchyma and sclerenchyma) and compound tissues (xylem and phloem);		*	
		4.6.4	compare major animal tissues in terms of their sub types, cell specificities, locations and functions (epithelial, connective, muscular and nervous tissues).		*	

Topics and Subtopics		Student Learning Outcomes		Cognitive Level		
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5. Gaseous Exchange		Students should be able to:				
5.1	Introduction	5.1.1	differentiate between breathing (ventilation) and respiration;		*	
5.2	Gaseous Exchange in Plants	5.2.1	compare photosynthesis and respiration in plants;		*	
		5.2.2	describe the process of gaseous exchange in plants, highlighting the roles of stomata in the leaves and lenticels in the stems;		*	
5.3	Gaseous Exchange in Human Beings	5.3.1	relate the structure of each part of human respiratory system with its function i.e., nasal passages, pharynx, larynx, glottis, trachea, bronchi, bronchioles, alveoli, lungs, pleural membranes, thoracic cavity, ribs, sternum, external and internal intercostal muscles and diaphragm;		*	
		5.3.2	describe the role of goblet cells, mucus and ciliated epithelial cells in protecting the breathing system from pathogens and particles;		*	
		5.3.3	assess the overall impact of a malfunctioned respiratory organ or structure on the overall function of respiratory system;			E
		5.3.4	explain the adaptations of alveoli for efficient gaseous exchange;		*	
		5.3.5	explain gaseous exchange in alveoli;		*	
		5.3.6	predict the overall impact on alveolar function if a specific alveolar adaptation is compromised;			E
		5.3.7	describe mechanism of breathing (inhalation and exhalation) with reference to the role of ribs, internal and external intercostal muscles and diaphragm in producing volume and pressure changes in the thorax leading to the ventilation of lungs;		*	
		5.3.8	analyse the effect of exercise on the rate and depth of breathing;			An

	5.3.9 5.3.10	differentiate between the composition of inspired and expired air; predict the physiological implications of changes in the composition of inspired and expired air under different conditions (e.g. during exercise, rest and exposure to polluted environments);		* 	 E
5.4 Respiratory Disorders	5.4.1 5.4.2	describe causes, symptoms, treatment and prevention of the following respiratory diseases: a. bronchitis, b. emphysema, c. pneumonia, d. asthma, e. lung cancer; analyse the effects of smoking on the lungs and circulatory system.		* 	 An

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
6. Enzymes		Students should be able to:				
6.1	Characteristics of Enzymes	6.1.1	define ‘metabolism’;	*		
		6.1.2	compare catabolic and anabolic reactions in terms of energy requirement, molecular changes, significance and examples;		*	
		6.1.3	describe the role of enzymes as biological catalysts;		*	
		6.1.4	explain the key characteristics of enzymes, including specificity, reusability and sensitivity to environmental factors;		*	
		6.1.5	compare the functioning of enzymes with inorganic catalysts in terms of specificity and reaction conditions;		*	
		6.1.6	define ‘cofactors’;	*		
		6.1.7	differentiate between the main types of cofactors: prosthetic groups, coenzymes and metal ions (activators);		*	
		6.1.8	illustrate with examples that cofactors assist enzymes in facilitating biochemical reactions;			A
		6.1.9	compare intracellular and extracellular enzymes;		*	
6.2	Factors Affecting Activity of Enzymes	6.2.1	assess the impact of varying temperatures on the rate of enzyme-catalysed reactions;			E
		6.2.2	illustrate the effect of pH on enzyme activity;			A
		6.2.3	analyse examples of enzymes that work best at specific pH levels, i.e., pepsin and renin in the stomach, amylase in mouth and small intestine, trypsin and lipase in small intestine and catalase in cells;			An
		6.2.4	analyse the relationship between rate of enzyme-catalysed reactions and substrate/ enzyme concentrations;			An
		6.2.5	evaluate the progression of enzyme-catalysed reactions by measuring changes in the concentrations of reactants and products over time;			E
6.3	Mechanism of Enzyme Action	6.3.1	define ‘activation energy’ of chemical recation;	*		

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
		6.3.2 6.3.3	analyse graphs showing activation energy of biochemical reactions with and without enzymes; illustrate the mechanism of enzyme action with reference to the substrate, active site, enzyme-substrate complex and product(s) according to lock and key and induced-fit models;			An A
6.4	Industrial Uses of Enzymes	6.4.1	identify specific enzymes used in industrial processes (e.g. proteases in detergents, amylases in baking or lipases in biofuels).		FA	

Topics and Subtopics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
7. Bioenergetics		Students should be able to:				
7.1	Introduction	7.1.1	define 'bioenergetics';	*		
		7.1.2	describe the importance of oxidation-reduction reactions for the flow of energy through living systems;		*	
		7.1.3	describe adenosine triphosphate (ATP) as the chief energy currency of all cells;		*	
		7.1.4	describe synthesis and breaking of ATP through adenosine triphosphate-adenosine diphosphate (ATP-ADP) cycle;		*	
7.2	Photosynthesis	7.2.1	define 'photosynthesis';	*		
		7.2.2	state the equation (in words and symbols) for photosynthesis;	*		
		7.2.3	describe that chlorophyll traps light energy and converts it into chemical energy for the formation of carbohydrates and their subsequent storage;		*	
		7.2.4	describe the utilisation and storage of carbohydrates produced in photosynthesis, focusing on starch as an energy reservoir, cellulose for constructing cell walls, glucose utilised in respiration to generate energy and sucrose for transport throughout the plant;		*	
		7.2.5	describe the events of light dependent reaction of photosynthesis including its location in chloroplast, absorption of light energy by photosystem-II, photolysis of water, release of oxygen gas as a byproduct, electron transport chain, ATP synthesis, excitation in photosystem-I and formation of $NADPH_2$;		*	
		7.2.6	describe light independent reactions as a cyclic process including its location in chloroplast, the substances required, i.e., carbon dioxide, pentose sugar, ATP and $NADPH_2$ and the products, i.e., 3 carbon sugar which eventually converts into 6 carbon sugar;		*	

Topics and Subtopics		Student Learning Outcomes		Cognitive Level		
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		7.2.7	explain the adaptations of leaves, i.e., large surface area, thinness, distribution of chloroplasts, cuticle, guard cells, stomata, upper and lower epidermis, palisade and spongy mesophylls, air spaces, xylem, phloem and petiole for photosynthesis;		*	
		7.2.8	analyse the impact of the loss of specific leaf adaptations (as given in SLO 7.2.7) on the plant's physiological processes;			An
7.3	Factors Affecting Rate of Photosynthesis	7.3.1	define 'limiting factor';	*		
		7.3.2	explain the effect of temperature, light intensity and carbon dioxide concentration in limiting the rate of photosynthesis;		*	
		7.3.3	interpret graphs showing the relationship between photosynthetic rate and various limiting factors, i.e., temperature, light intensity and carbon dioxide concentration;			E

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
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7.4	Cellular Respiration	7.4.1	define 'cellular respiration';	*		
		7.4.2	state aerobic respiration by means of word and symbolic equation;	*		
		7.4.3	differentiate between photosynthesis and respiration;		*	
		7.4.4	differentiate between alcoholic fermentation and lactic acid fermentation in terms of their pathways, end products, organisms involved and conditions under which each occurs;		*	
		7.4.5	identify the three main stages of cellular respiration: glycolysis, the Krebs cycle and the electron transport chain;		*	
		7.4.6	describe the process of glycolysis, including its location, specific reactants and products;		*	
		7.4.7	describe decarboxylation and dehydrogenation of pyruvate in link reaction (conversion of pyruvate to acetyl CoA);		*	
		7.4.8	describe the Krebs cycle (Citric acid or TCA cycle), including its location, specific reactants and products;		*	
		7.4.9	describe the process of the electron transport chain (ETC), including its location, specific reactants, products and its role in ATP production during cellular respiration;		*	
		7.4.10	describe that lactic acid builds up in the muscles and blood during vigorous exercise causing an oxygen debt;		*	
		7.4.11	explain the removal of oxygen debt after exercise, with respect to: a. continuation of fast heart rate to transport lactic acid in the blood from the muscles to the liver, b. continuation of deeper and faster breathing to supply oxygen for aerobic respiration of lactic acid, c. aerobic respiration of lactic acid in the liver;		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
	7.4.12	compare aerobic and anaerobic respiration in terms of location, energy yield, reactants and products, efficiency and conditions under which each occurs;		*	
	7.4.13	describe the various functions of respiratory energy (ATP) in the body, including muscle contraction, active transport, biochemical reactions, i.e., synthesis of macromolecules like proteins, nucleic acids and maintaining homeostasis.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
8. Nutrition and Digestion		Students should be able to:				
8.1	Mineral Nutrition in Plants	8.1.1	describe the concept of mineral nutrition in plants;		*	
		8.1.2	classify minerals into macronutrients (carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium and sulphur) and micro-nutrients (boron, chlorine, manganese, iron, zinc, copper and molybdenum);		*	
		8.1.3	describe that nitrogen is important in protein synthesis and magnesium for chlorophyll formation;		*	
		8.1.4	analyse visual symptoms and growth patterns to diagnose nitrate deficiency and magnesium deficiency in plants (e.g. stunted growth, yellowing of leaves due to nitrate deficiency and slower growth, reduced yield, poor root development, interveinal chlorosis due to magnesium deficiency);			An
8.2	Components of Human Food	8.2.1	classify carbohydrates as monosaccharides, disaccharides and polysaccharides with examples;		*	
		8.2.2	state the composition and general formula of carbohydrate;	*		
		8.2.3	identify the food sources and metabolic functions of carbohydrates;		*	
		8.2.4	illustrate the general structure of amino acid;			A
		8.2.5	describe the linking of amino acids through peptide bonds to form a polypeptide chain (polymer);		*	
		8.2.6	identify the food sources and functions of protein;		*	
		8.2.7	illustrate the general structure of lipid (triglyceride) molecule (head with glycerol and tail with three chains of fatty acids);			A
		8.2.8	describe the food sources and functions of lipids/ fats;		*	
		8.2.9	calculate the energy content of carbohydrates, proteins and fats in a food;			A
		8.2.10	identify food sources and metabolic functions of vitamin A, B, C, D and K;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
		8.2.11	identify food sources and metabolic functions of calcium and iron;		*	
		8.2.12	describe the deficiency diseases of vitamins A, B, C, D and K and minerals (calcium and iron);		*	
		8.2.13	identify sources and functions of water and dietary fibre in the body;		*	
		8.2.14	analyse different scenarios to identify the specific nutrient deficiencies based on symptoms and lifestyle factors;			An
		8.2.15	suggest appropriate solutions, such as dietary adjustments, supplementation to correct the deficiencies;			E
8.3	Balanced Diet	8.3.1	define 'balanced diet';	*		
		8.3.2	describe the significance of balanced diet;		*	
		8.3.3	analyse the importance of a balanced diet and variations in energy requirements based on factors such as age, gender, physical activity and body condition (e.g. pregnancy, lactation, or illness);			An
		8.3.4	create a weekly balanced diet meal plan for your family;			FA
8.4	Ingestion, Digestion and Absorption of Food in Human Beings	8.4.1	explain the significance of ingestion, digestion, absorption, assimilation or egestion;		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
	8.4.2	relate the following structures of alimentary canal with their functions: a. mouth, b. oesophagus, c. stomach, d. small intestine, e. large intestine or colon, f. rectum, g. anus;		*	
	8.4.3	explain the structure and digestive functions of organs and glands associated with the alimentary canal (gut/ gastrointestinal tract), i.e., salivary glands, liver, gall bladder and pancreas;		*	
	8.4.4	explain the mechanism of swallowing, emphasising the roles of the tongue, larynx, pharynx and epiglottis;		*	
	8.4.5	describe the coordination of circular and longitudinal muscles during peristalsis in the oesophagus, stomach and intestines to propel the food forward through the digestive tract;		*	
	8.4.6	describe the functions of hydrochloric acid in the stomach;		*	
	8.4.7	describe digestion of food in mouth, oesophagus, stomach and small intestine;		*	
	8.4.8	describe the action of enzymes in specific regions of the alimentary canal with respect to their substrates and products;		*	
	8.4.9	describe the structural adaptations of small intestine and villi for absorbing digested nutrients;		*	
	8.4.10	describe the absorption of nutrients, i.e., sugars, amino acids, mineral salts, vitamins, glycerol and fatty acids through intestinal villi;		*	
	8.4.11	describe the transportation of absorbed nutrients to the liver via the hepatic portal vein;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
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		8.4.12	describe the functions of liver associated with assimilation of sugars and amino acids, i.e., regulation of blood glucose concentration and deamination of amino acids;		*	
		8.4.13	describe the role of large intestine in water and electrolyte absorption, formation and storage of faeces, productions of vitamins (e.g. Vitamin K and some B vitamins) and waste processing;		*	
8.5	Disorders of Gut	8.5.1	describe the symptoms, causes, treatment and preventions of the disorders of the gut, i.e., [Irritable Bowel Syndrome (IBS) or diarrhoea and constipation], dyspepsia or [(Gastroesophageal Reflux Disease (GERD)], gastroenteritis, ulcer and food poisoning;		*	
		8.5.2	analyse the impact of malfunctions in specific features or structures of the gastrointestinal tract on digestion and absorption of food.			An

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
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9. Transport		Students should be able to:				
9.1	Introduction	9.1.1	describe the importance of transport system in living organisms;		*	
9.2	Transport of Water and Ions in Plants and Transpiration	9.2.1	explain the structural adaptations of xylem and phloem in vascular plants;		*	
		9.2.2	illustrate the positions of tissues (xylem, phloem and cortex) as seen in transverse sections (diagrams or photomicrographs) of non-woody dicotyledonous roots and stems;			A
		9.2.3	define: a. root pressure b. capillary action c. transpiration and transpiration pull;	*		
		9.2.4	explain the pathways and processes, i.e., osmosis, capillary action, cohesion and adhesion, transpiration pull to transport water through the root, stem and leaf;		*	
		9.2.5	describe that water evaporates from the surfaces of the mesophyll cells into air spaces and then diffuses out of the leaves through the stomata as water vapour;		*	
		9.2.6	describe temperature, light, wind, surface area and humidity as the factors affecting the rate of transpiration;		*	
		9.2.7	relate wilting with excessive transpiration;		*	
		9.2.8	describe the significance of transpiration;		*	
9.3	Phloem Translocation	9.3.1	define ‘phloem translocation’;	*		
		9.3.2	describe the terms ‘source’ and ‘sink’ with reference to translocation in plants;		*	
		9.3.3	explain pressure flow mechanism of translocation in plants;		*	
9.4	Types and Efficiency of Circulatory Systems	9.4.1	describe the circulatory system as a system of blood vessels with a pump and valves to ensure one-way flow of blood;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
		9.4.2	relate the circulatory system to other transport systems (e.g. postal systems, plumbing systems) in terms of the delivery of materials (oxygen, nutrients) to and removal of waste products from the body;		*	
		9.4.3	compare different types of circulatory systems, i.e., open and close circulatory systems, single circuit and double circuit circulations;		*	
		9.4.4	describe the advantages of a double circulation system over single circulation system;		*	
9.5	Components of Blood and Blood Group Systems	9.5.1	describe the components and functions of blood;		*	
		9.5.2	describe the composition of blood plasma;		*	
		9.5.3	relate the structure of red blood cells, white blood cells (neutrophils, eosinophils, basophils, monocytes and lymphocytes) and platelets with their functions;		*	
		9.5.4	explain the blood group systems, i.e., ABO and Rh;		*	
		9.5.5	determine the risk of incompatibility in blood transfusion due to antigen-antibody reactions;			A
		9.5.6	describe symptoms, causes and treatments of anaemia, leukaemia, thalassemia and haemophilia;		*	
9.6	Blood Vessels and Tissue Fluid	9.6.1	relate the structure of arteries, veins and capillaries with their respective functions in transporting blood throughout the body;		*	
		9.6.2	define ‘tissue fluid (interstitial fluid)’;	*		
		9.6.3	differentiate between tissue fluid and lymph;		*	
		9.6.4	illustrate the transfer of materials between capillaries and tissue fluid;			A
		9.6.5	identify origin, location and target areas of main arteries, i.e., pulmonary arteries, aorta with hepatic artery, renal arteries and femoral arteries;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
		9.6.6	identify origin, location and target areas of main veins, i.e., pulmonary veins, superior vena cava, inferior vena cava with femoral veins, renal veins and hepatic vein;		*	
9.7	Human Heart	9.7.1	identify the components of the mammalian heart, including the pericardium, muscular wall, septum, left and right ventricles, atria, atrioventricular and semilunar valves and associated blood vessels;		*	
		9.7.2	explain the functional demands on the heart chambers that lead to differences in their muscle wall thickness, i.e., left and right ventricles, atria and ventricles;		*	
		9.7.3	explain the functioning of heart in terms of the contraction of atria and ventricles and the action of the valves in a heartbeat;		*	
		9.7.4	describe the reason for low-pressure circulation to the lungs and a high-pressure circulation to the body tissues;		*	
		9.7.5	define the terms ‘heartbeat’ and ‘heart/ pulse rate’;	*		
		9.7.6	evaluate the role of cardiovascular health in determining heart rate response and recovery time after exercise;			E

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
9.8	Cardiovascular Disorders	9.8.1	differentiate between arteriosclerosis and atherosclerosis;		*	
		9.8.2	describe that plaque buildup narrows the coronary arteries and restricts blood flow to the heart;		*	
		9.8.3	describe the causes and symptoms of angina pectoris (chest pain) and myocardial infarction (heart attack);		*	
		9.8.4	describe the preventive measures (such as dietary changes and regular exercise) and treatment options (like medications, e.g. aspirin and surgical procedures, e.g. angioplasty, coronary artery bypass grafting) for coronary heart diseases;		*	
		9.8.5	analyse lifestyle factors such as diet, physical activity and smoking that contribute to coronary heart diseases (CHDs);			An
9.9	Immune system	9.9.1	define the terms: 'pathogen', 'antigen' and 'antibody';	*		
		9.9.2	list the main components of the immune system, i.e., white blood cells, antibodies, and lymph nodes;	*		
		9.9.3	describe the function of each component (mentioned in SLO 9.9.2) in defending the body against pathogens;		*	
		9.9.4	list the components of the: first line of defence, i.e., physical barriers (e.g. nasal hair, ear wax, tears and cilia skin, mucous membranes and stomach acid), second line of defence (e.g. phagocytic cells, inflammation and fever) and third line of defence (e.g. B cells, T cells and antibodies);	*		
		9.9.5	differentiate between innate/ non-specific immunity (first and second lines of defence) and adaptive/ specific immunity (third line of defence) in terms of their: cell types, role in the body, response time, memory and specificity);		*	
		9.9.6	describe that phagocytic cell (e.g. macrophages, neutrophils, dendritic cells and natural killer cells) ingest and destroy pathogens as part of the second line of defence;		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
	9.9.7	describe the production of antibodies by B-cells to neutralise pathogens, the role of phagocytosis in eliminating pathogens and the importance of memory cells in providing long-term immunity;		*	
	9.9.8	describe that vaccines work to stimulate the immune system and provide protection against specific diseases;		*	
	9.9.9	differentiate between active (natural and artificial) and passive (natural and artificial) immunity;		FA	
	9.9.10	explain the steps involved in the process of blood clotting, i.e., vascular spasm (vasoconstriction), platelet plug formation, the coagulation cascade (clot formation) and clot retraction and repair.		*	

Topic-Wise Practical Activities

Part I (Grade IX)

S. No.	Topic-Wise Practical Activities	Apparatus/ Slide/ Specimen	Chemical/ Material
	Topic 1: Introduction to Biology		
1.	Demonstrate microscope focusing techniques to identify the key cellular features of amoeba	Prepared slide of amoeba, microscope	
2.	Observe the specimen/ model/ diagram of frog to identify the key structural features of frog	Specimen/ model of frog, forceps, pointer/ needle	
	Topic 3: Biodiversity		
3.	Demonstrate microscope focusing techniques to observe different types of bacteria (cocci, bacilli)	Prepared slides of cocci and bacilli, microscope (You may use charts or diagrams of cocci and bacilli if prepared slides are not available.)	
4.	Classify living organisms into their respective kingdoms and phyla by observing their morphological features using magnifying glass or microscope	Magnifying glasses, microscopes, prepared slides of chlamydomonas, rhizopus, paramecium. Specimens of funaria, pinus, monocot and dicot plants, sycon/ sponge, jellyfish/ hydra, tape worm/ liver fluke, round worm, earthworm/ leech, butterfly/ centipede/ prawn, snail/ unio, sea star/ sea urchin, fish, frog, lizard, bird, cat	

S. No.	Topic-Wise Practical Activities	Apparatus/ Slide/ Specimen	Chemical/ Material
	Topic 4: Cells and Tissues		
5.	Prepare temporary slide of animal cells (squamous epithelial of frog) and plant cells (onion epidermal peel) by using an appropriate temporary staining technique	Glass slide, cover slips, pointer, forceps, microscope	Dye for staining, i.e., methylene blue/ safranin/ iodine solution and glycerin
7.	Calculate surface area to volume ratio of cubes of different sizes	Petri dish, forceps, meter scale, razor (for cutting potato cubes)	Potato, dye
8.	Demonstrate the process of osmosis using a semi-permeable membrane	Beaker, iron stand, cellophane paper, thistle funnel	Sugar/ salt solution, distilled water
9.	Observe prepared slides/ charts/ photomicrographs to recognise structural differences among the different types of plant tissues (epidermal, collenchyma, sclerenchyma, parenchyma, xylem and phloem)	Prepared slides/ charts/ photomicrographs of plant tissues (epidermal, collenchyma, sclerenchyma, parenchyma, xylem and phloem), microscope	
10.	Observe prepared slides/ charts/ photomicrographs to recognise structural differences among the different types of animal tissues (epithelial, connective, muscular and nervous)	Prepared slides/ charts/ photomicrographs of animal tissues (epithelial, connective, muscular and nervous), microscope	

S. No.	Topic-Wise Practical Activities	Apparatus/ Slide/ Specimen	Chemical/ Material
	Topic 6: Enzymes		
11.	Investigate of the action of amylase on starch at room temperature	Beaker, test tubes, dropper	Starch solution, amylase, iodine solution, distilled water
12.	Investigate of the action of pepsin on proteins at room temperature	Beaker, test tubes, dropper	Food item containing proteins, pepsin, iodine solution
13.	Investigate of the effect of pH on action of amylase and pepsin	Beaker, test tubes, dropper	0.1 M sodium hydroxide, 0.1 M hydrochloric acid, distilled water, food items containing carbohydrates and proteins (separately), amylase, pepsin, distilled water, iodine solution
14.	Investigate the effect of temperature on enzyme action	Beaker, test tubes, dropper, thermometer, ice bath	Starch solution, amylase, iodine solution, distilled water
	Topic 7: Bioenergetics		
15.	Perform an experiment to show the release of oxygen during photosynthesis	Beaker, short stem funnel, test tube, match box	Hydrilla plant (or any aquatic plant), sodium bicarbonate
16.	Conduct investigations on the necessity of light, chlorophyll and carbon dioxide for photosynthesis with destarched plants	For light: Black card paper, cellophane tape/ clips	Potted destarched plant, iodine solution
		For chlorophyll: Water bath, dropper, petri dish	Potted destarched plant with variegated leaves, iodine solution
		For carbon dioxide: Wide-mouthed bottle, split cork, retort stand, beaker	Potted plant, potassium hydroxide, iodine solution, Vaseline
17.	Set up an experiment to investigate the release of heat during aerobic respiration in germinating seeds	Thermos flask, cotton wool, thermometer	Germinating seeds, boiled/ dead seeds

	Topic 8: Nutrition and Digestion		
18.	Perform the following food tests: • Iodine test for starch • Benedict's test for reducing sugar • Biuret test for proteins • Emulsion test for lipids	For starch: Petri dish, dropper	Iodine solution, potato
		For reducing sugar: Test-tube, test-tube holder, test tube stand, beaker or water bath, Bunsen burner, match box	Benedict's solution, water, orange juice/ breakfast cereal/ bread
		For proteins: Test-tube, test-tube holder, test tube stands, dropper	Egg albumin, water, sodium or potassium hydroxide solution, dilute copper sulphate solution
		For lipids: Test tube, thermometer	Butter/ peanuts, Ethanol or 95% ethyl alcohol, distilled water
19.	Observe the key features of villi in the prepared slides/ charts/ photomicrographs	Prepared slides/ charts/ photomicrographs of transverse section of villi, microscope	
	Topic 9: Transport		
20.	Conduct an experiment to investigate the rate of water loss at the two surfaces of leaves by using cobalt chloride paper	Potted plant, paper clips/ cellophane tape	Cobalt chloride paper

Scheme of Assessment

Grade IX

Table 1: Exam Specifications

Topic No.	Topics	Marks Distribution			Total Marks
		MCQs	CRQs	ERQs	
1.	Introduction to Biology	2	Total 2 Marks (1 CRQ)		4
2.	Solving a Biological Problem	2	Total 2 Marks (1 CRQ)		4
3.	Biodiversity	5	Total 2 Marks (1 CRQ)		7
4.	Cells and Tissues	8		6 Marks Choose any ONE from TWO	18
5	Gaseous Exchange	4			
6.	Enzymes	2	Total 2 Marks (1 CRQ)		4
7.	Bioenergetics	2	Total 3 marks (1 CRQ)		5
8.	Nutrition and Digestion	5		6 Marks Choose any ONE from TWO	23
9.	Transport	10	Total 2 marks (1 CRQ)		
	Total	**40**	**13**	**12**	**65**
	Practical*				**10**
	Total				**75**

Examination Structure and Practical Requirements for Grades IX and X

Theory:

- Multiple Choice Question (MCQ) requires candidates to choose one best/ correct answer from four options for each question. Each MCQ carries ONE mark.
- Constructed Response Question (CRQ) requires students to respond with a short text (few phrases/ sentences), calculations or diagrams.
- Extended Response Question (ERQ) requires students to answer in a more descriptive form. The answer should be in paragraph form, with diagrams where needed, and address all parts of the question.
- Table 1 and 2 contains the mark distribution for each topic.
- There will be two examinations, one at the end of grade IX and one at the end of grade X.
- In each grade, the theory paper will be of 3 hours and will consist of two parts: paper I and paper II.
- Paper I theory will consist of 40 compulsory, multiple choice items. These questions will involve four responses options. The OMR (Optical Mark Recognition) sheet for paper I will be provided separately.
- Paper II theory will carry 25 marks and consist of Constructed Response Questions (CRQs) and Extended Response Questions (ERQs). Each extended response question will be presented in an either/ or form.
- The booklet for paper II will serve as an answer script.

Practical:

- In each grade, practical examination (Paper III) will be conducted separate from the theory paper and will consist of 10 marks.
- Practical examination (Paper III) will be based on the list of practical activities given in the examination syllabus. Schools may design their own practical manuals based on these activities for teaching and learning purpose.
- Practical journal/ portfolio should be developed by students and endorsed by a figure of authority, such as a teacher or principal, and submitted at the time of the practical examination (Paper III).
- It is essential for each school to equip its laboratories with chemicals, instruments, apparatus, specimens etc. according to the requirements of the practical activities. Each school will be responsible to make sure that each student is provided the opportunity to do the practical activities.