



آغا خان یونیورسٹی ایگزامینیشن بورڈ  
AGA KHAN UNIVERSITY EXAMINATION BOARD

Higher Secondary School Certificate  
Examination Syllabus

# Biology

Grades XI - XII

(Based on New National Curriculum 2022-2023)

# Student Learning Outcomes of AKU-EB HSSC Biology Syllabus

## Part I (Grade XI)

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level <sup>1</sup>		
			R	U	A and beyond
<b>1. Biological Molecules</b>					
1.1 Introduction to Molecular Biology	1.1.1 1.1.2 1.1.3	define molecular biology and biological molecules; differentiate between organic and inorganic compounds; differentiate between condensation (dehydration synthesis) and hydrolysis reactions;	*	FA <sup>2</sup> *	
1.2 Properties of Carbon	1.2.1	describe properties of carbon, i.e., tetravalency, isomerism, and catenation;		FA	
1.3 The Significance of Water's Chemical Nature in Supporting Life Processes	1.3.1 1.3.2	describe the polarity of water molecules that results in hydrogen bonding; discuss the properties of water that contribute to the sustainability of life on Earth, i.e., a. cohesion and adhesion, b. high specific heat, c. anomalous behaviour of water, d. high heat of vapourisation, e. hydrophobic exclusion, f. ionisation of water;		*	E

<sup>1</sup>R = Remember, U = Understand, A = Apply and beyond [Apply (A), Analyse (An), Evaluate (E), Create (C)]

<sup>2</sup>FA= Formative Assessment, not to be assessed under examination conditions

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level'		
			R	U	A and beyond
1.4 Carbohydrates	1.4.1	define carbohydrates;	*		
	1.4.2	classify carbohydrates as monosaccharides, disaccharides, oligosaccharides and polysaccharides with examples;		FA	
	1.4.3	compare the properties and roles of monosaccharides with their formulae;		FA	
	1.4.4	distinguish between D and L forms of glucose (stereoisomers) based on the spatial arrangement of hydroxyl (-OH) groups around their chiral carbons;		*	
	1.4.5	illustrate the structure of $\alpha$ -D-glucose and $\beta$ -D-glucose based on the position of the hydroxyl group at the anomeric carbon;			A
	1.4.6	illustrate the condensation (dehydration synthesis) and hydrolysis (breakdown) of disaccharides (sucrose, lactose and maltose) and polysaccharides (amylose, amylopectin, cellulose, starch and glycogen) by formation and breakage of glycosidic bonds;			A
	1.4.7	relate the structures of starch (amylose and amylopectin), glycogen and cellulose molecules to their functions in living organisms;		*	
1.5 Lipids	1.5.1	define lipids;	*		
	1.5.2	describe the properties of triglycerides (triacylglycerols), phospholipids, terpenoids (terpenes, carotenoids and steroids) and waxes with examples;		*	
	1.5.3	differentiate between saturated and unsaturated fatty acids;		*	
	1.5.4	illustrate the condensation and hydrolysis of a triglyceride molecule;			A
	1.5.5	illustrate the molecular structure of triglycerides, phospholipids, terpenoids (terpenes, carotenoids and steroids) and waxes;			A

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level <sup>1</sup>		
		R	U	A and beyond
1.6 Proteins	1.6.1	define proteins and amino acids;	*	
	1.6.2	illustrate the structure of amino acids;		A
	1.6.3	explain that the amphoteric nature of amino acids enables them to function as buffers;		*
	1.6.4	illustrate the condensation (dehydration synthesis) and hydrolysis (breakdown) of peptide linkages;		A
	1.6.5	differentiate between: <ul style="list-style-type: none"> <li>a. essential and non-essential amino acids,</li> <li>b. acidic and basic amino acids,</li> <li>c. polar and non-polar amino acids;</li> </ul>		*
	1.6.6	describe the types of interaction that hold protein molecules in shape: <ul style="list-style-type: none"> <li>a. hydrophobic interactions,</li> <li>b. hydrogen bonding,</li> <li>c. ionic bonding,</li> <li>d. covalent bonding (including disulfide bonds),</li> <li>e. Van der Waals forces;</li> </ul>		*
	1.6.7	differentiate among levels of organisation of proteins, i.e., primary, secondary, tertiary and quaternary with examples;		*
	1.6.8	differentiate between fibrous and globular proteins with examples;		*
	1.6.9	relate the structure of haemoglobin (globular protein) and collagen (fibrous protein) to their functions;		*
	1.6.10	explain that change of amino acid sequence in a polypeptide chain leads to sickle cell anaemia;		*
	1.6.11	describe the functions of proteins in living organisms;		FA

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level'			
		R	U	A and beyond	
1.7 Nucleic Acid	1.7.1	define nucleic acid;	*		
	1.7.2	illustrate the basic structure of a nucleotide and a nucleoside;			A
	1.7.3	analyse the structure of deoxyribonucleic acid (DNA) molecule as a double helix, including: <ul style="list-style-type: none"> <li>a. the importance of complementary base pairing between the 5' to 3' strand and the 3' to 5' strand (antiparallel strands),</li> <li>b. differences in hydrogen bonding between C–G and A–T base pairs,</li> <li>c. linking of nucleotides by phosphodiester bonds,</li> <li>d. synthesis and breakdown of polynucleotides by the formation and breakage of phosphodiester bonds;</li> </ul>			An
	1.7.4	classify nucleotides based on their sugar molecules and nitrogen bases;		*	
	1.7.5	compare the structure and function of messenger RNA (mRNA), ribosomal RNA (rRNA) and transfer RNA (tRNA);		*	
	1.7.6	differentiate between DNA and RNA;		*	
1.8 Conjugated Molecules	1.8.1	define conjugated molecules;	*		
	1.8.2	describe the functions of glycolipids, glycoproteins, lipoproteins and nucleoproteins with examples;		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level'		
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1.9 Structural Biology	1.9.1	define structural biology;	*		
	1.9.2	explain the process of X-ray crystallography, including the generation of X-rays, crystal preparation, diffraction pattern collection and structure determination;		*	
	1.9.3	describe the contribution of Rosalind Franklin's in the discovery of the DNA double helix structure particularly through her X-ray diffraction images;		FA	
	1.9.4	define biological databases;	*		
	1.9.5	describe the purpose of biological databases;		*	
	1.9.6	state different primary biological databases [(e.g., GenBank, UniProt, Protein Data Bank (PDB), Protein Information Resource (PIR))].	*		

FOR ANNUAL EXAMINATION 2024-25

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
<b>2. Enzymes</b>	Students should be able to:				
2.1 Structure of Enzyme	2.1.1	describe the following terms: a. enzyme, b. apoenzyme, c. holoenzyme, d. active site, e. allosteric site;		*	
	2.1.2	classify cofactors based on their characteristic features into prosthetic groups, essential ions or activators and coenzymes, with examples;		*	
	2.1.3	analyse the effects of absence or deficiency of specific cofactors on enzyme function including common examples (i.e., Fe <sup>2+</sup> , Zn <sup>2+</sup> , Mg <sup>2+</sup> and B-complex vitamins);			An
2.2 Mechanism of Enzyme Action	2.2.1	analyse the mode of action of enzymes in terms of: a. an active site, b. enzyme–substrate complex, c. lowering of activation energy, d. enzyme specificity, with the help of lock-and-key and induced-fit hypotheses;			An
2.3 Factors Affecting Enzyme Action	2.3.1	evaluate the effect of different factors, i.e., temperature, pH, substrate concentration, enzyme concentration on the rate of enzyme action;			E
	2.3.2	analyse the effect of temperature on the rate of enzyme action in human body and thermophilic bacteria;			An

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
	2.3.3	analyse the effect of pH on the activity of different enzymes, i.e., amylase, trypsin, pepsin, lipase and papain;			An
2.4 Enzyme Inhibition	2.4.1 2.4.2 2.4.3 2.4.4 2.4.5 2.4.6	define enzyme inhibition; differentiate between reversible and irreversible inhibitors with examples; analyse the effects of reversible inhibitors, i.e., competitive and non-competitive on enzyme activity; define end product inhibition (feedback inhibition); explain the mechanism of end product inhibition; describe the significance of inhibitors in regulation of enzymatic activity, medical applications and industrial processes such as preserving food;	*   *	*   *	An
2.5 Classification of Enzymes	2.5.1 2.5.2	classify enzymes based on their substrates, i.e., lipases, diastase, amylase and proteases with examples; classify enzymes based on reactions they catalyse and nature of substrate, i.e., oxidoreductases, transferases, hydrolases, isomerases and ligases with examples.		* *	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
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<b>3. The Cell</b>	Students should be able to:				
3.1 Discovery of Cell	3.1.1	state classical cell theory;	FA		
	3.1.2	describe exceptions to classical cell theory, i.e., status of virus and the first cell, which could not have arisen from a pre-existing cell;		FA	
	3.1.3	describe the process of validating cell theory with historical and modern evidence, i.e., early microscopes provide initial evidence and modern techniques like electron microscopy and molecular biology further support it;		FA	
	3.1.4	compare classical and modern cell theory;		FA	
	3.1.5	state the contributions of different scientists in the discovery of cell (Robert Hooke 1665 to August Weismann 1880);	FA		
3.2 Microscopes	3.2.1	compare the resolution and magnification of light microscope and electron microscope (including transmission electron microscope and scanning microscope);		*	
	3.2.2	evaluate the suitability of different microscopy techniques based on their magnification and resolution capabilities for specific applications (e.g., viewing live cells vs. fixed tissues);			E
	3.2.3	calculate magnification, image size and actual size of the specimen by using the formula: Magnification = Image size (viewed under microscope) ÷ Actual size;			A

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
		R	U	A and beyond
3.3 Structure of Animal and Plant Cell	<p>3.3.1 describe that cells are the basic unit of life with respect to properties of life, i.e., movement, respiration, homeostasis, growth, reproduction, excretion, nutrition;</p> <p>3.3.2 explain the structure, chemical composition and functions of the cellular organelles of eukaryotic cell as revealed through the electron microscope:</p> <ol style="list-style-type: none"> <li>cell wall,</li> <li>cell membrane with reference to Fluid Mosaic Model,</li> <li>cytoplasm,</li> <li>rough endoplasmic reticulum and smooth endoplasmic reticulum,</li> <li>ribosomes,</li> <li>mitochondria,</li> <li>Golgi apparatus,</li> <li>lysosomes,</li> <li>vacuoles,</li> <li>cytoskeleton (microfilaments, microtubules and intermediate filaments),</li> <li>cilia and flagella,</li> <li>centrioles,</li> <li>plastids and its types,</li> <li>nucleus,</li> <li>peroxisomes,</li> <li>glyoxisomes;</li> </ol>		FA	
			*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
	3.3.3	compare the structure of animal and plant cells;		*	
	3.3.4	assess that different organelles interact to maintain cellular functions, i.e., protein synthesis and transport;			E
	3.3.5	analyse the effect of malfunctioning of a specific organelle on the overall function of cell;			An
3.4 Cell Membrane and Cell Signalling	3.4.1	describe the role of phospholipids, cholesterol, glycolipids, proteins and glycoproteins in cell surface membranes, with reference to stability, fluidity, permeability, transport proteins (e.g., carrier proteins and channel proteins), cell signalling (e.g., cell surface receptors) and cell recognition (e.g., cell surface antigens);		*	
	3.4.2	define the terms cell signalling and ligands;	*		
	3.4.3	explain the main stages of cell signalling, i.e., reception, transduction, transmission to effector and response;		*	

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level			
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3.5 Mechanisms of Cellular Transport	3.5.1	compare mechanisms of passive transport (e.g., simple diffusion, facilitated diffusion and osmosis) and active transport;		FA	FA
	3.5.2	explain the factors influencing the rate of diffusion, i.e., concentration gradient, temperature, molecular size, medium of diffusion, surface area, distance, solvent density, permeability of the membrane, pressure and chemical nature of the molecule;		FA	
	3.5.3	analyse the roles of active and passive transport mechanisms in the movement of substances across cell membranes and their impact on homeostasis, nutrient uptake, waste removal and overall cell survival;			
	3.5.4	explain the steps involved in endocytosis and exocytosis, i.e., vesicle formation, movement and membrane fusion;		*	
	3.5.5	explain the types of endocytosis, i.e., phagocytosis and pinocytosis;		*	
	3.5.6	elaborate the significance of endocytosis and exocytosis in maintaining cellular function;		FA	
3.6 Lysosomal Disorders	3.6.1	describe storage diseases with reference to the malfunctioning of lysosomes, i.e., Tay-Sachs disease, Gaucher's disease, Krabbe's disease, glycogenosis type-II disease;		*	
3.7 Stem Cells	3.7.1	state the characteristic features of stem cells;	*		
	3.7.2	explain different types of stem cells based on their potency, i.e., totipotent, pluripotent and multipotent;		*	
	3.7.3	describe the advantages and disadvantages of using induced pluripotent stem cells.		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
<b>4. Classification and Acellular Life</b>	Students should be able to:				
4.1 Classification of Living Organisms	4.1.1	describe the basis of classification of living organisms, i.e., homology, biochemistry, cytology and genetics;		*	
4.2 Binomial Nomenclature and Phylogenetic Trees	4.2.1	describe the hierarchical structure of biological classification including domain, kingdom, phylum/ division, class, order, family, genus and species;		*	E
	4.2.2	describe the principles of binomial nomenclature;		*	
	4.2.3	assess the importance of standardising binomial nomenclature in scientific communication and research across different disciplines;			
	4.2.4	define the basic terms related to phylogenetic trees: a. common ancestor, b. clade, c. monophyletic group, d. paraphyletic group, e. polyphyletic group;		*	
	4.2.5	identify the key components of a phylogenetic tree, i.e., nodes, branches, clades and common ancestors;			*
	4.2.6	differentiate between monophyletic, paraphyletic and polyphyletic groups within phylogenetic trees;			*
	4.2.7	analyse phylogenetic trees to reveal the evolutionary relationships between organisms;			

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
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4.3 Two and Five-Kingdom Classification Systems	4.3.1	compare the following classification systems of living organisms: a. two-kingdom and five-kingdom classification system of Whittaker, b. five-kingdom classification by Whittaker and five-kingdom classification system by Lynn Margulis and Karlene Schwartz;		*	
4.4 Characteristics of Viruses	4.4.1 4.4.2 4.4.3	describe the discovery of viruses; describe the structural features of viruses; describe the survival of viruses inside a host cell;		FA * *	
4.5 Classification of Viruses	4.5.1 4.5.2	classify viruses based on their structure, type of nucleic acid and host; list diseases caused by viruses in animals and plants;	FA	FA	
4.6 Life Cycle of Viruses	4.6.1 4.6.2 4.6.3 4.6.4	describe the structure of a bacteriophage and human immunodeficiency virus (HIV); illustrate lytic and lysogenic life cycles of bacteriophage; illustrate different stages of HIV life cycle; justify the name of the virus, i.e., 'Human Immunodeficiency Virus' by establishing linkage with T-helper cells as the basis of immune system;		*	A A E

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
		R	U	A and beyond
4.7 Viral Diseases	4.7.1 describe causative agent, symptoms, treatment, preventive measures and source of transmission of the following viral diseases: a. hepatitis, b. polio, c. herpes, d. acquired immunodeficiency syndrome (AIDS), e. leaf curl disease of cotton;		FA	
	4.7.2 define antivirals and antiretroviral drugs;	*		
4.8 Prions and Viroids	4.8.1 differentiate between prions and viroids;		*	
	4.8.2 list diseases caused by prions and viroids;	*		
	4.8.3 evaluate the potential risks posed by prions and viroids to public health and agriculture, considering factors such as transmissibility, environmental persistence and host susceptibility.			FA

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
<b>5. Kingdom Prokaryotae</b>	Students should be able to:				
5.1 Characteristic Features of Prokaryotes	5.1.1	state the characteristic features of prokaryotes;	*		
5.2 Morphology of Bacteria	5.2.1	state the discovery, occurrence and habitat of bacteria;	FA		
	5.2.2	describe the unique features of the following types of archaeobacteria: a. methanogens, b. halophiles, c. thermophiles;		*	
	5.2.3	describe morphological diversity (shapes) of bacteria;		*	
	5.2.4	differentiate between Gram-positive and Gram-negative bacteria with reference to their colour and composition of cell wall;		*	

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
		R	U	A and beyond
	5.2.5 relate the structure of each component of bacterial cell with its function: <ol style="list-style-type: none"> <li>glycocalyx,</li> <li>capsule and slime,</li> <li>cell wall,</li> <li>cell membrane,</li> <li>cytoplasmic matrix,</li> <li>mesosomes,</li> <li>chromatin,</li> <li>nucleoid,</li> <li>plasmid,</li> <li>endospore,</li> <li>ribosomes,</li> <li>flagella,</li> <li>pili;</li> </ol>		*	
	5.2.6 compare prokaryotes with eukaryotes;		*	
	5.2.7 differentiate between archaeobacteria and eubacteria in the following aspects: <ol style="list-style-type: none"> <li>habitat,</li> <li>cell wall composition,</li> <li>membrane lipids,</li> <li>genetic material,</li> <li>sensitivity to antibiotics;</li> </ol>		*	
	5.2.8 analyse the effect of specific cellular components, i.e., cell wall and flagella, on the survival and reproduction of bacteria in various environmental conditions;			An

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
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5.3 Nutrition in Bacteria	5.3.1	differentiate between the following types of nutrition in bacteria: a. autotrophic and heterotrophic nutrition, b. symbiotic and parasitic nutrition;		*	
	5.3.2	compare the chlorophyll present in bacteria and plants;		FA	
5.4 Respiration in Bacteria	5.4.1	describe obligatory aerobes, micro-aerobes, facultative and obligatory anaerobes with examples;		*	
5.5 Locomotion in Bacteria	5.5.1	compare chemotaxis and magnetotaxis methods of locomotion in bacteria in the following aspects: a. stimulus for locomotion, b. key locomotory structures, c. direction of movement, d. purpose;		*	
5.6 Growth in Bacteria	5.6.1	illustrate the different phases of growth in bacteria;			A
	5.6.2	describe endospore formation in bacteria as a mechanism of survival to withstand unfavourable conditions;		*	
5.7 Reproduction in Bacteria	5.7.1	describe the different modes of reproduction in bacteria: a. asexual reproduction (binary fission, budding and spore formation), b. genetic recombination (conjugation, transduction and transformation);		*	
5.8 Economic Importance of Bacteria	5.8.1	explain the economic importance of bacteria in: a. medicine, b. agriculture, c. industry, d. symbiosis, e. research and technology;		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
	5.8.2	explain the role of harmful bacteria in: <ol style="list-style-type: none"> <li>human and animal health,</li> <li>food spoilage;</li> </ol>		*	
5.9 Control and Prevention of Bacteria	5.9.1	describe the following physical methods to disrupt bacterial structures or metabolic processes by inhibiting growth or killing bacteria: <ol style="list-style-type: none"> <li>heat (e.g., autoclaving, pasteurisation),</li> <li>filtration,</li> <li>irradiation (e.g., use of UV light);</li> </ol>		*	E
	5.9.2	describe the action of following chemical agents to prevent growth or kill bacteria: <ol style="list-style-type: none"> <li>disinfectants (e.g., chlorine, alcohol),</li> <li>antiseptics (e.g., iodine, hydrogen peroxide),</li> <li>antibiotics (e.g., bactericidal and bacteriostatic);</li> </ol>		*	
	5.9.3	evaluate the consequences of misuse of antibiotics, including antimicrobial resistance of antibiotics;			
	5.9.4	describe the symptoms, causative agent, treatments and preventive measures of bacterial diseases in man, i.e., cholera, typhoid, tuberculosis and pneumonia;		FA	
	5.9.5	describe the symptoms, causative bacteria and preventive measures of bacterial diseases in plants, i.e., spots, blights, soft rots, wilts and galls;		FA	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
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5.10 Cyanobacteria	5.10.1	list general characteristics of cyanobacteria;	FA		
	5.10.2	describe the habitat, structure, nutrition and reproduction in <i>Nostoc</i> ;		FA	
	5.10.3	describe the ecological role of cyanobacteria [(e.g., contribution to primary production, nutrient cycling (especially nitrogen fixation), oxygen production and symbiotic relationships)] in aquatic ecosystems.		FA	

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Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
<b>6. Kingdom Protista (Protoctista)</b>	Students should be able to:				
6.1 Unifying Features	6.1.1	describe the general characteristics of protists;		*	
6.2 Diversity among Protists	6.2.1	describe the evolution of diversity among protists;		*	E
	6.2.2	justify protists as a polyphyletic group of organisms;			
6.3 Animal-like Protists	6.3.1	describe the salient features of different classes of animal-like protists, i.e., flagellates/ zooflagellates, sarcodina/ rhizopoda, ciliata/ ciliophora, suctoria and sporozoa/ apicomplexan;		*	
	6.3.2	describe the importance of animal-like protist with reference to their ecological roles, i.e., in nutrient cycling, predation on bacteria and other protists and as food sources for larger organisms;		*	
	6.3.3	describe the common pathogenic animal-like protists (e.g., entamoeba, plasmodium, trypanosoma and giardia) and the diseases caused by them (e.g., amoebic dysentery, malaria, African sleeping sickness and giardiasis);		*	
6.4 Plant-like Protists	6.4.1	compare the salient features of plant-like protists, i.e., euglenoids, dinoflagellates, diatoms, brown, red and green algae with examples;		*	
	6.4.2	describe the importance of plant-like protists in food webs as primary producers and impact of algal blooms on aquatic ecosystem and in food industries such as (e.g., algal products, biofuel production);		*	

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
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6.5 Fungi-like Protists	<p>6.5.1 describe the salient features of fungi-like protists with examples;</p> <p>6.5.2 describe the life cycle of slime molds (myxomycota) and water molds (oomycota);</p> <p>6.5.3 describe the contribution of fungi-like protists in the decomposition of organic material and nutrient cycling in ecosystems;</p> <p>6.5.4 justify the classification of animal-like protists, plant-like protists and fungi-like protists by comparing them with animals, plants and fungi respectively;</p> <p>6.5.5 describe plant diseases caused by fungi-like protists, i.e., potato blight (caused by <i>Phytophthora infestans</i>) and their impact on agriculture and food security.</p>		* * *  FA	E

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Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
		R	U	A and beyond
<b>7. Kingdom Fungi</b>	Students should be able to:			
7.1 General Characteristics	7.1.1 compare the cellular features of fungi, animals and plants;		*	
	7.1.2 describe the basic structures of fungi, i.e., hyphae, mycelium, spores and fruiting bodies;		*	
	7.1.3 describe the structure of hyphae, i.e., septate and coenocytic hyphae along with their role in nutrient absorption and growth;		*	
	7.1.4 identify the unique components of fungal cell walls, i.e., chitin and glucans along with their role in providing structural support and protection;		*	
	7.1.5 explain mutualistic relationships in fungi, i.e., lichens and mycorrhizae (ectomycorrhiza and endomycorrhiza);		*	
	7.1.6 describe different methods of asexual reproduction in fungi, i.e., spores, conidia, fragmentation and budding;		*	
	7.1.7 describe different steps of sexual reproduction in fungi, i.e., plasmogamy, karyogamy, meiosis and spore formation;		*	

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
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7.2 Classification of Fungi	7.2.1		*	
	7.2.2		*	
	7.2.3		*	
	7.2.4		*	
	7.2.5	*		
	7.2.6		*	
	7.2.7		*	

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
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7.3 Land Adaptations of Fungi	7.3.1 describe specific structural adaptations that enable fungi to thrive in diverse environments such as in: a. arid deserts: (e.g., thick cell walls, spore formation, fast-spreading hyphae, lack of flagellated cells, thick-walled zygote), b. extreme temperatures: (e.g., production of cryoprotective compounds such as glycerol and trehalose to protect from freezing damage, heat-shock proteins, thermophilic enzymes and specialised pigment melanin);		*	
7.4 Importance of Fungi	7.4.1 explain ecological and commercial importance of fungi (e.g., economic gains and losses).		FA	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
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<b>8. Kingdom Plantae</b>	Students should be able to:				
8.1 Diversity among Plants	8.1.1	state general characteristics of plants;	*		
	8.1.2	classify kingdom plantae;		*	
8.2 Bryophytes (Non-vascular Plants)	8.2.1	describe the salient features of bryophytes (non-vascular plants) along with their sub-divisions, i.e., musci, hepaticae and anthocerotae;		*	A
	8.2.2	illustrate the life cycle of moss (polytrichum);			
	8.2.3	describe the significance of alternation of generation in bryophytes;		*	
	8.2.4	explain the adaptive characteristics of bryophytes in the land habitat;		*	
8.3 Tracheophytes (Vascular Plants)	8.3.1	state characteristic features of tracheophytes;	*		A
	8.3.2	compare the characteristic features of major groups of tracheophyta, i.e.: a. psilopsida, b. lycopsida, c. sphenopsida, d. pteropsida;		*	
	8.3.3	explain evolution of single-veined (microphyllus) and multi-veined (megaphyllus) leaf;		FA	
	8.3.4	differentiate between homosporous and heterosporous;		*	
	8.3.5	explain the evolution of seed;		FA	
	8.3.6	illustrate the life cycle of ferns;			
	8.3.7	describe general characteristics of gymnosperms and angiosperms with examples;		*	

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
		R	U	A and beyond
8.4 Spermatophytes (Seed-producing Plants)	8.4.1 describe the development of male and female gametophytes in angiosperms and gymnosperms; 8.4.2 illustrate the life cycles of gymnosperm and angiosperm plants; 8.4.3 compare the features of dicotyledonous and monocotyledonous plants; 8.4.4 analyse specific adaptations in vascular plants that make them successful land plants, i.e., root systems, lignified cell walls, cuticle layer, xylem, phloem and seed production;		*  FA	A  An
8.5 Angiospermic Families	8.5.1 explain the inflorescence**, floral characteristics and economic importance of the following angiospermic families: ( <b>Note: **Only Racemose and cymose inflorescence, further description of sub types is not required.</b> ) a. Brassicaceae, b. Solanaceae, c. Poaceae; 8.5.2 derive the floral formulae and floral diagrams of the flowers of angiospermic families (given in SLO 8.5.1).		*	A

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
		R	U	A and beyond
<b>9. Kingdom Animalia</b>	Students should be able to:			
9.1 Introduction	9.1.1 describe the general characteristics of animals;		FA	
9.2 Criteria for Animal Classification	9.2.1 explain the body plan of various phyla of kingdom animalia based on the following aspects: a. type of symmetry (radial and bilateral symmetry), b. tissue organisation (diploblastic and triploblastic), c. body cavities (acoelomates, pseudocoelomates and coelomates), d. pattern of development (protostomes and deuterostomes);		*	
9.3 Phyla and Comparative Anatomy of Invertebrates <ul style="list-style-type: none"> <li>• Phylum Porifera</li> <li>• Phylum Coelentrata</li> <li>• Phylum Platyhelminthes</li> <li>• Phylum Aschelminthes/ Nematoda</li> <li>• Phylum Annelida</li> <li>• Phylum Arthropoda</li> <li>• Phylum Mollusca</li> <li>• Phylum Echinodermata</li> </ul>	9.3.1 explain the general characteristics and economic importance of poriferans;		*	
	9.3.2 explain coelenterates with reference to their: a. general characteristics, b. origin of diploblastic organisation, c. radial symmetry, d. polymorphism and alternation of generation, e. formation of coral reefs, f. economic importance;		*	
	9.3.3 explain the general characteristics, parasitic adaptations and economic importance of platyhelminthes;		*	

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
		R	U	A and beyond
	9.3.4 explain the general characteristics, parasitic adaptations and economic importance of nematodes;		*	
	9.3.5 explain general characteristics of annelids with reference to their: <ul style="list-style-type: none"> <li>a. general characteristics,</li> <li>b. segmentation and its advantages,</li> <li>c. coelom and its advantages</li> <li>d. economic importance;</li> </ul>		*	
	9.3.6 explain the general characteristics of arthropods and insects;		*	
	9.3.7 describe the types of metamorphosis in insects with examples;		*	
	9.3.8 explain the key adaptations in insects that enable them to survive in diverse habitats;		*	
	9.3.9 explain the economic importance (beneficial and harmful) of insects;		*	
	9.3.10 explain the general characteristics and economic importance of molluscs;		*	
	9.3.11 explain the general characteristics of spiny skinned animals (echinoderms) and their affinities;		*	
	9.3.12 compare the characteristics of different invertebrate phyla;		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
9.4 Phylum Chordata	9.4.1	describe the fundamental characteristics of chordates;		*	
	9.4.2	classify chordates with examples;		*	
	9.4.3	differentiate between: a. acraniata and craniata, b. urochordata and cephalochordata;		FA	
9.5 Sub-phylum Vertebrata	9.5.1	describe the general characteristics of super-class pisces;		*	
	9.5.2	differentiate among cyclostomes, chondrichthyes (cartilaginous) and osteichthyes (bony fishes) with examples;		*	
	9.5.3	describe aquatic adaptations of super-class pisces;		*	
	9.5.4	list some familiar edible fish in Pakistan;	FA	*	
	9.5.5	describe the general characteristics of amphibians with examples;		*	
	9.5.6	elaborate that amphibians are unsuccessful land vertebrates;		*	
	9.5.7	explain general characteristics of reptiles;		*	
	9.5.8	elaborate reptiles as successful land vertebrates;		*	
	9.5.9	describe general characteristics of birds;		*	
	9.5.10	explain the adaptations of birds for aerial mode of life (flight adaptations);		*	
	9.5.11	differentiate between running and flying birds;		FA	
	9.5.12	describe general characteristics and classification of mammals (e.g., prototheria, metatheria and eutheria);		*	
	9.5.13	compare prototheria, metatheria and eutheria based on their reproductive strategies, anatomical features, geographic distribution and examples;		*	
	9.5.14	compare the characteristics of various classes of vertebrates, i.e., fish, amphibians, reptiles, birds and mammals.		*	



Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
	10.2.9	illustrate the different phases of Calvin cycle/ light independent reactions/ dark reactions, i.e., carbon fixation, reduction and regeneration;			A
	10.2.10	summarise the products formed at each step of light dependent and light independent reactions by detailing the specific molecules produced and their quantities;			A
	10.2.11	explain the process and importance of photorespiration;		*	
	10.2.12	describe the effect of temperature on the oxidative activity of RuBP carboxylase;		*	
	10.2.13	compare C <sub>3</sub> , C <sub>4</sub> (Hatch-Stack pathway) and CAM plants;		*	
10.3 Cellular Respiration	10.3.1	define the following terms: a. cellular respiration, b. substrate level phosphorylation, c. oxidative phosphorylation and chemiosmosis;	*		
	10.3.2	differentiate between alcoholic and lactic acid fermentation;		*	
	10.3.3	relate the structure of the mitochondrion, [including the inner mitochondrial membrane (cristae, ATP synthase and electron transport chain complexes), intermembrane space, matrix and outer membrane] to their roles in ATP production during the electron transport chain and chemiosmosis;		*	
	10.3.4	analyse the steps involved in the mechanism of cellular respiration: a. glycolysis, b. pyruvic acid oxidation/ link reaction (formation of acetyl CoA), c. Krebs cycle (Citric acid cycle), d. respiratory chain (oxidative phosphorylation);			An

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
		R	U	A and beyond
	10.3.5 explain the substrate-level phosphorylation during which exergonic reactions coupled with the synthesis of ATP, i.e., glycolysis and Krebs cycle;		*	
	10.3.6 relate chemiosmosis with electron transport chain and oxidative phosphorylation;		*	
	10.3.7 summarise the products formed at each step of cellular respiration, i.e., glycolysis, the link reaction, the Krebs cycle and oxidative phosphorylation by detailing the specific molecules produced and their quantities;			A
	10.3.8 describe the formation of acetyl CoA from fats through $\beta$ oxidation;		FA	
	10.3.9 compare the cellular respiration of fats and glucose.		FA	

FOR ANNUAL EXAMINATION 2024/2025

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
		R	U	A and beyond
<b>11. Nutrition</b>	Students should be able to:			
11.1 Nutrition in Plants	11.1.1 define nutrition; 11.1.2 list the macro and micronutrients of plants; 11.1.3 describe the role and deficiency symptoms of: a. nitrogen, b. phosphorus, c. potassium, d. magnesium; 11.1.4 assess leaf colour and growth patterns of various plants to diagnose specific nutrient deficiencies; 11.1.5 explain different modes of heterotrophic nutrition in plants, i.e., saprophytic, parasitic, symbiotic and insectivorous;	* FA	*	E
11.2 Digestive System of Human Beings	11.2.1 relate the structure of each organ of human digestive system with its function: a. gastrointestinal tract (GIT): i. oral cavity, ii. pharynx, iii. oesophagus, iv. stomach, v. small intestine, vi. large intestine, vii. rectum and anus, b. accessory digestive organs: i. tongue, ii. salivary glands (composition of saliva), iii. liver (composition of bile), iv. gall bladder, v. pancreas (composition of pancreatic juice);		*	

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
		R	U	A and beyond
11.3 Human Dentition	11.3.1		*	An
	11.3.2			
	11.3.3		*	
	11.3.4		*	FA
	11.3.5		*	
	11.3.6			
11.4 Swallowing	11.4.1		*	
	11.4.2		*	

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
		R	U	A and beyond
11.5 Digestion	11.5.1 explain the processes of mechanical and chemical digestion of carbohydrates, proteins and lipids in different parts of human digestive system; 11.5.2 describe the role of gastrin, secretin and cholecystokinin (CCK) hormones in stimulating secretion of digestive enzymes and production of gastric acid; 11.5.3 analyse the following: a. impact of gastric glands malfunction on acid and enzyme secretion, b. symptoms of acid reflux in relation to the malfunction of lower oesophageal sphincter/ cardiac sphincter, c. role of the pyloric sphincter in regulating food passage, d. consequences of damage to the mucosal lining in terms of protection against acidic content;		*	An

FOR ANNUAL EXAMINATION 2022 AND ONWARDS

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
		R	U	A and beyond
11.6 Absorption and Egestion	<p>11.6.1 compare the mechanisms of absorption of nutrients, i.e., amino acids, monosaccharides and fatty acids by small intestine;</p> <p>11.6.2 explain the role of the lymphatic system in lipid absorption;</p> <p>11.6.3 evaluate the consequences of structural damage to the small intestine on nutrient absorption, i.e., loss of any structural component of villi;</p> <p>11.6.4 identify the regions of the large intestine, i.e., caecum, appendix, ascending colon, transverse colon, descending colon, sigmoid colon, rectum and anus;</p> <p>11.6.5 describe the structural features of the large intestine, including its thick muscular walls that facilitate movement of waste and the presence of goblet cells that secrete mucus to aid in lubrication;</p> <p>11.6.6 assess the role of the large intestine in the absorption of water and electrolytes, formation and storage of faeces and role of gut microbiota in synthesising essential vitamins like vitamin K and certain B vitamins;</p>		* * * *	E    E
11.7 Gastrointestinal Disorders	11.7.1 describe causes, symptoms, treatment and preventive measures of gastrointestinal disorders, i.e., diarrhoea, dysentery, constipation, piles, dyspepsia, peptic ulcer, food poisoning, anorexia and bulimia nervosa.		FA	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
<b>12. Gaseous Exchange</b>	Students should be able to:				
12.1 Gaseous Exchange in Plants	12.1.1	describe gaseous exchange in plants through stomata, lenticels and the leaf surface;		*	
12.2 Respiratory System of Human Beings	12.2.1	relate the structure of each respiratory organ with its function: a. upper respiratory tract: i. nose (nasal cavity), ii. pharynx, iii. larynx, b. lower respiratory tract: i. trachea, ii. bronchi and bronchioles, iii. chest cavity, ribs, external and internal intercostal muscles, diaphragm, iii. lungs, iv. pleurae;		*	
	12.2.2	explain structural adaptations in alveoli that collectively optimise the efficiency of gaseous exchange, i.e., large surface area, single layer of epithelial cells, rich capillary network, thin layer of moisture, surfactant and presence of macrophages;		*	
	12.2.3	explain the mechanism of breathing, i.e., inspiration and expiration;		*	

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
		R	U	A and beyond
	<p>12.2.4 describe the neural and physiological mechanisms involved in the involuntary control of breathing, i.e., the roles of medulla oblongata, pons and peripheral chemoreceptors (e.g., carotid bodies and aortic bodies);</p> <p>12.2.5 explain the transportation of carbon dioxide and oxygen by the blood;</p> <p>12.2.6 relate the structures of haemoglobin and myoglobin with their function as respiratory pigments;</p> <p>12.2.7 analyse the effect of changes in pH, temperature and carbon dioxide concentration on haemoglobin's oxygen binding and releasing capability through oxyhaemoglobin dissociation curves;</p> <p>12.2.8 evaluate the impact of environmental factors on the efficiency of breathing mechanisms and respiratory system, i.e., high altitude, air pollution and smoking;</p>		<p>*</p> <p>*</p> <p>*</p>	<p>An</p> <p>E</p>
12.3 Respiratory Disorders	<p>12.3.1 explain causes, symptoms and preventive measures of:</p> <p>a. upper respiratory tract infections:</p> <p>i. sinusitis,</p> <p>ii. otitis media,</p> <p>b. lower respiratory tract infections:</p> <p>i. Chronic Obstructive Pulmonary Disease or COPD (chronic bronchitis, emphysema and asthma),</p> <p>ii. lung cancer.</p>		FA	

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
		R	U	A and beyond
<b>13. Transport</b>	Students should be able to:			
13.1 Introduction	13.1.1 describe the importance of transport of materials in living organisms;		FA	
13.2 Transportation in Plants	13.2.1 define water potential, osmotic/ solute potential and pressure potential;	*		An  A
	13.2.2 differentiate between plasmolysis and deplasmolysis;		*	
	13.2.3 analyse the effects of different solute concentrations on plant and animal cells;			
	13.2.4 calculate water potentials of plant cells;		*	
	13.2.5 explain apoplast, symplast and vacuolar pathways through which water and minerals can move into the root system;		*	
13.2.6 relate the structure of xylem and phloem to their functions;		*		
13.3 Ascent of Sap	13.3.1 explain that ascent of sap in plants is driven by TACT mechanism (Transpiration pull, Adhesion, Cohesion, Tension), root pressure, capillary action and imbibition;		*	
13.4 Transpiration	13.4.1 define transpiration;	*		
	13.4.2 differentiate among cuticular, lenticular and stomatal transpiration;		*	
	13.4.3 explain mechanisms involved in opening and closing of stomata: a. starch sugar hypothesis, b. influx of potassium ions;		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
	13.4.4	assess the effect of following factors on the rate of transpiration: a. light, b. wind, c. humidity, d. temperature;			E
	13.4.5	explain transpiration as a necessary evil;		*	
13.5 Translocation	13.5.1	define translocation;	*		
	13.5.2	exemplify different parts of plants that function as sources or sinks in relation to the movement of nutrients;		*	
	13.5.3	explain the mechanism of phloem translocation, i.e., diffusion and pressure flow hypothesis;		*	
13.6 Circulatory System of Human Beings	13.6.1	explain the structure and function of human heart with reference to the: e. layers of heart wall, a. chambers, b. valves and associated blood vessels;		*	
• Heart					
• Blood					
• Blood Vessels					
• Blood Pressure and Pulse Pressure					
	13.6.2	explain the sequence of events in the cardiac cycle, including the contraction and relaxation of atria and ventricles;		*	
	13.6.3	describe the functioning of heart valves (tricuspid, bicuspid, pulmonary and aortic valves) in maintaining unidirectional blood flow during the cardiac cycle and producing heart sounds (lub-dub);		*	
	13.6.4	analyse the pressure changes in the left side of the heart during a cardiac cycle;			An
	13.6.5	define the terms: cardiac output, heart/ pulse rate and stroke volume;	*		

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
		R	U	A and beyond
	13.6.6 calculate cardiac output by using the formula (Cardiac Output = Heart Rate × Stroke Volume) during rest, exercise and stress;			A
	13.6.7 assess that different bodily states affect the cardiac output, i.e., resting, physical exercise or stress;			E
	13.6.8 explain the following: a. role of the sinoatrial (SA) node as the natural pacemaker, b. transmission of electrical impulses through the atrioventricular (AV) node, bundle of His and Purkinje fibres, c. sequence of electrical conduction in coordinating the contraction of atria and ventricles;		*	
	13.6.9 describe the function of an artificial pacemaker in regulating heart rhythm in cases of sinoatrial (SA) node dysfunction or conduction blockages;		*	
	13.6.10 analyse different components of ECG report, i.e., ECG waveform (P wave, QRS complex, T wave) and their relationship to cardiac cycles and electrical activity;			An
	13.6.11 explain the causes of blue babies with reference to atrial and ventricular septum defects and ductus arteriosus;		*	
	13.6.12 explain the structure, function and composition of each blood component, i.e., plasma and blood cells;		*	

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
		R	U	A and beyond
	13.6.13 describe the functions of blood;		FA	
	13.6.14 describe the causes, symptoms, preventions and treatments of disorders of blood, i.e.: a. leukaemia, b. thalassemia, c. anaemia, d. haemophilia;		FA	
	13.6.15 relate the structure of artery, vein and capillary with their functions;		*	
	13.6.16 describe the role of precapillary sphincters in regulating the flow of blood through capillaries;		*	
	13.6.17 trace the pathway of blood through the pulmonary and systemic circulation, i.e., coronary, hepatic-portal and renal circulation;		*	
	13.6.18 analyse the factors, i.e., vessel diameter and total cross-sectional area, affecting the rate of blood flow and blood pressure through arteries, arterioles, capillaries, venules and veins;			An
	13.6.19 differentiate between blood pressure and pulse pressure;		*	
	13.6.20 interpret normal and abnormal pulse pressure values and their potential health implications;			E
	13.6.21 describe the role of baroreceptors and volume receptors in regulating the blood pressure;		*	
13.7 Cardiovascular Disorders	13.7.1 describe various aspects of cardiovascular health, i.e., atherosclerosis, arteriosclerosis, thrombus formation, embolus, coronary thrombosis, stroke, haemorrhage and hypertension;		*	
	13.7.2 categorise angina pectoris, heart attack and heart failure as progressive stages in the development of cardiovascular disease;		*	

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
		R	U	A and beyond
	<p>13.7.3 describe the purpose of angiography, including its role in visualising blood vessels and diagnosing conditions such as blockages or aneurysms (localised, abnormal dilation or bulging of a blood vessel due to a weakened vessel wall);</p> <p>13.7.4 describe the basic procedure of angiography, including the use of contrast dye and imaging techniques to obtain detailed pictures of blood vessels;</p> <p>13.7.5 describe the main principles of angioplasty and open-heart surgery (coronary bypass);</p> <p>13.7.6 describe the causes of hypertension and hypotension;</p> <p>13.7.7 design a lifestyle modification plan that includes dietary changes, physical activity, stress management and smoking cessation strategies tailored to individuals at risk of or suffering from hypertension or cardiovascular diseases;</p>		<p>FA</p> <p>FA</p> <p>FA</p> <p>*</p>	C
13.8 Lymphatic System of Human Beings	<p>13.8.1 explain the lymphatic system with respect to:</p> <ol style="list-style-type: none"> <li>formation of lymph,</li> <li>lymph vessels,</li> <li>lymph trunk,</li> <li>lymph nodes,</li> <li>lymphoid organs/ masses/ tissues (e.g., bone marrow, thymus, adenoids, tonsils, spleen, Peyer’s patches and appendix);</li> </ol> <p>13.8.2 compare intercellular fluid (tissue fluid) and lymph;</p> <p>13.8.3 explain the functions of lymphatic system;</p> <p>13.8.4 assess that malfunctioning of lymphatic system leads to oedema.</p>		<p>*</p> <p>*</p> <p>*</p>	E

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
		R	U	A and beyond
<b>14. Immune System</b>	Students should be able to:			
14.1 Introduction and Types of Immune System	14.1.1 define immunity; 14.1.2 classify immune system as innate [first (non-specific) and second line of defense)] and adaptive [(specific) antibody-mediated and cell-mediated as third line of defense)] immune systems; 14.1.3 identify the major routes pathogens may take when entering the body; 14.1.4 differentiate between: a. antigen and antibodies, b. self-antigens and non-self-antigens;	*	*	
14.2 Innate Immune System	14.2.1 explain the role of physical barriers (e.g., skin, ciliated epithelium, nasal hairs and mucous membrane) and chemical barriers (e.g., stomach acid, tears, mucus, saliva) in protecting the body from infection as the first line of defense; 14.2.2 describe the structure and mode of action of phagocytes, i.e., neutrophils, macrophages, natural killer cells and antigen-presenting cells; 14.2.3 identify the roles of cytokines, opsonin, phagosomes and lysosomes in immune response; 14.2.4 explain the non-specific responses of the body to infection, including inflammation, lysozyme action, interferon and phagocytosis; 14.2.5 compare the bacterial-killing function of complement system proteins and the virus-inhibiting role of interferons; 14.2.6 describe the release of pyrogens by microbes and their effect on the hypothalamus to boost the body's temperature; 14.2.7 describe different ways in which fever impacts microbes;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
14.3	Antibody Mediated (Humoral) Immune Response	14.3.1	describe the structural features of an antibody, i.e., variable and constant regions, heavy and light chains and antigen-binding sites;		*	
		14.3.2	describe the role of B-cells in recognising antigens, producing antibodies and retaining memory for the long-term immunity;		*	
		14.3.3	explain the process of clonal selection and expansion of B-cells in response to an antigen;		*	
		14.3.4	describe that antibodies neutralise pathogens, opsonise them for phagocytosis and activate the complement system;		*	
14.4	Cell Mediated Immune Response	14.4.1	describe the role of T-cells in recognising and responding to infected or abnormal cells;		*	
		14.4.2	identify the different types of T-cells (helper T-cells, cytotoxic or killer T-cells and regulatory or suppressor T-cells) and their specific functions in the immune response;		*	
		14.4.3	describe that cytotoxic T-cells destroy infected or cancerous cells by releasing perforins and granzymes;		*	
		14.4.4	explain the process of T-cell activation, including the roles of antigen-presenting cells (APCs) and major histocompatibility complex (MHC) molecules;		*	
		14.4.5	explain the role of helper T-cells in supporting the activation and function of other immune cells, including B-cells and macrophages;		*	
		14.4.6	state the role of T-cells and B-cells in transplant rejections;	*		

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
		R	U	A and beyond
14.5 Primary and Secondary Immune Responses	14.5.1 describe the primary immune response, including the lag phase, production of antibodies and gradual increase in antibody concentration; 14.5.2 explain the secondary immune response, highlighting the faster and more robust production of antibodies, due to the presence of memory B cells; 14.5.3 illustrate the differences between primary and secondary immune responses in terms of antibody concentration and response time;		*	A
14.6 Active and Passive Immunity (Natural and Artificial)	14.6.1 differentiate between active (natural and artificial) and passive (natural and artificial) immunity; 14.6.2 identify immunisation strategies for active immunity (e.g., first exposure to a pathogen, vaccination) and passive immunity (e.g., administration of antibodies through antiserum or immunoglobulin injections and the natural transfer of antibodies from mother to infant through breastfeeding or placental transfer); 14.6.3 evaluate real-life scenarios to decide whether a patient should receive active or passive immunity or both immunities, i.e., exposure to rabies, snakebite, tetanus wound, hepatitis B virus, newborn protection, measles in an unvaccinated individual and immune deficiency disorder); 14.6.4 describe the role of histamines in producing allergy symptoms in humans;		*	E

Topics and Sub-topics	Student Learning Outcomes	Cognitive Level		
		R	U	A and beyond
14.7 Autoimmune Diseases	14.7.1 define autoimmune diseases; 14.7.2 exemplify autoimmune diseases, i.e., rheumatoid arthritis, lupus, multiple sclerosis and type-1 diabetes;	*	*	
14.8 Monoclonal Antibodies	14.8.1 define monoclonal antibodies; 14.8.2 describe the steps of production of monoclonal antibodies through hybridoma method, i.e., immunisation, cell fusion, selection and cloning, production and purification); 14.8.3 describe the applications of monoclonal antibodies in the following: a. disease treatment, i.e., cancer, autoimmune disorders and infectious diseases, b. diagnostic tests, i.e., pregnancy tests, blood tests and viral infection tests.	*	*	*

## Topic-Wise Practical Activities

### Grade XI

S. No.	Topic-Wise Practical Activities	Apparatus/ Slide/ Material	Chemicals
<b>Topic 1: Biological Molecules</b>			
1.	Perform Benedict's test to confirm the presence of reducing sugar	Bunsen burner, test tubes, test tube stand, test tube holder, droppers, tripod stand, wire gauze, graduated pipettes, beaker	Solutions of glucose and starch, Benedict's solution, iodine solution
2.	Perform iodine test to confirm the presence of starch		
3.	Perform emulsion test to confirm the presence of lipids	Test tubes, dropper, graduated pipettes	A fat source (coconut oil/ peanuts), ethyl alcohol, distilled water
4.	Perform Biuret test to confirm the presence of proteins	Bunsen burner, test tubes, test tube stand, test tube holders, droppers, graduated pipettes, beaker	5% sodium hydroxide solution, 1% copper sulphate solution
<b>Topic 2: Enzymes</b>			
5.	Perform amylase test on starch with boiled and un-boiled amylase and confirm the presence of starch through iodine test	Bunsen burner, test tubes, test tube stand, test tube holders, droppers, tripod stand, wire gauze, graduated pipettes, beaker	Starch solution, amylase solution, iodine solution

<b>Topic 3: The Cell</b>			
6.	Prepare samples of frog epithelial cells, onion epidermal cells and leaf epidermal cells, handling specimens gently to avoid damage	Microscope, glass slide, cover slip, petri dish, watch glass, needle, brush and dropper	Dye for staining, i.e., methylene blue/ safranin/ iodine solution and glycerin
7.	Prepare temporary slides of animal cells (squamous epithelial of frog) and plant cells (onion epidermal and leaf epidermis) by using appropriate temporary staining and mounting techniques		
8.	Demonstrate microscope focusing techniques to identify the key cellular features of specimen		
<b>Topic 5: Kingdom Prokaryotae</b>			
9.	Perform Gram staining technique to differentiate between Gram-positive and Gram-negative bacteria	Microscope, glass slides, nichrome wire, Bunsen burner, cover slip, dropper	Crystal violet, iodine, safranin, alcohol, distilled water, immersion oil
10.	Observe fresh or preserved <i>Nostoc</i> slide/ specimen	Slide/ specimen of <i>Nostoc</i> , Microscope/ magnifying glass, pencil, notebook	-
11.	Draw labelled diagrams of <i>Nostoc</i> as observed under the microscope		
<b>Topic 6: Kingdom Protista</b>			
12.	Observe permanent slides of each group of protists	Microscope, slides of amoeba, euglena, paramecium, chlorella, spirogyra, pencil and notebook	-
13.	Draw labelled diagrams of each group of protists as observed under the microscope		

<b>Topic 7: Kingdom Fungi</b>			
14.	Observe fresh or preserved mushroom specimen	Specimen of mushroom,	Dye for staining, i.e., methylene blue/ safranin/ iodine solution and glycerin
15.	Prepare temporary slides of rhizopus, yeast and penicillium	Preserved samples/ culture of rhizopus, yeast and penicillium, microscope, glass slide, nichrome wire, Bunsen burner, cover slip, dropper, watch glass, petri dish, needle, brush, pencil, notebook	
16.	Draw labelled diagrams of each specimen/ slide as observed under the microscope		
<b>Topic 8: Kingdom Plantae</b>			
17.	Examine the male and female plant specimen of marchantia and draw labelled diagrams	Specimen of male and female plant of marchantia, pencil, notebook	-
18.	Observe the key features of male and female cones of pinus and draw labelled diagrams	Specimen of male and female cones of pinus, pencil, notebook	-
19.	Examine the floral parts of Brassica campestris, Solanum nigrum/ Datura alba and Avena sativa	Flowers or images of Brassica campestris, Solanum nigrum/ Datura alba and Avena sativa, pencil, notebook	-
20.	Draw floral diagrams of the given flowers		
21.	Construct the floral formula for the given flowers by using standard botanical symbols and numbers to represent symmetry, number and arrangement of floral organs		

<b>Topic 9: Kingdom Animalia</b>			
22.	Observe the specimen/ models of invertebrates and vertebrates	Specimen of sycon, hydra/ obelia, liver fluke/ planaria, tapeworm, roundworm,	-
23.	Record observations with labelled diagrams	earthworm, leech, crab, butterfly/ wasp, spider, mussel, snail/ slug, brittle star/ sea star specimen/ model of fish, frog/ toad,	
24.	Classify each specimen into its respective phylum and class, using observed characteristics as a basis for classification	lizard/ snake, bird, mouse/ squirrel, pencil, notebook	
<b>Topic 10: Bioenergetics</b>			
25.	Separate the leaf pigments using paper chromatography	Test tubes with stopper, test tube stand, test tube holder, pestle and mortar, pins, chromatography paper or filter paper, droppers, tripod stand, Bunsen burner, beaker, glass, wool, funnel, forceps, measuring cylinder, pencil, ruler	Pigment solution, 80% acetone, 90% acetone-petroleum, ether mixture (1:9), ethyl alcohol
<b>Topic 11: Gaseous Exchange</b>			
26.	Examine the lungs of goat/ sheep	Goat/ sheep lungs, dissecting tray,	-
27.	Draw a labelled diagram of the respiratory system of goat/ sheep	pointer, pencil, notebook	
<b>Topic 13: Transport</b>			
28.	Observe the slide of transverse section (T.S) of a dicotyledonous stem	Slide of T.S of dicotyledonous stem, microscope, needle/ pointer, pencil, notebook	-
29.	Draw labelled diagrams of vessel element, vessels and phloem sieve tubes		

S. No	Topic-Wise Practical Activities	Apparatus/ Slide/ Material	Chemicals
30.	Examine the heart of goat/ sheep	Goat/ sheep heart, dissecting tray, pointer, pencil, notebook	-
31.	Draw a labelled diagram of the internal structure of goat's heart		
32.	Measure the blood pressure by using sphygmomanometer	Sphygmomanometer, stethoscope, pencil, notebook	-
<b>Topic 14: Immune System</b>			
33.	Observe prepared slides of neutrophils and lymphocytes	Slides of neutrophils and lymphocytes, pencil, notebook	-
34.	Record observation in the form of labelled diagrams		

<b>Topic 18: Reproduction</b>			
8.	Examine different parts of the female reproductive system of rabbit and draw labelled diagram	Model/ chart of female reproductive system of rabbit, pencil, notebook	-
9.	Observe prepared slides of mammalian ovaries	Slide of histology of ovaries, microscope, pencil, notebook	-
10.	Record observations in the form of labelled diagram		
<b>Topic 19: Growth and Development</b>			
11.	Observe the different stages (48 and 72 hours) of chick development using photomicrographs/ permanent slides	Photomicrographs/ permanent slides of stages of development in chick	-
<b>Topic 22: Variation and Genetics</b>			
12.	Set up a controlled experiment using dice to simulate genetic inheritance, ensuring accurate representation of dominant and recessive alleles	Dice, notebook, pencil	-
13.	Record each combination of alleles (e.g., TT, Tt, tt) by rolling the dice		
14.	Calculate the probability of each genotype occurring based on the results		
15.	Collect data on the height of individuals within a given population to study continuous variation	Pencil, ruler, graph paper, notebook, measuring tape or stadiometer	-
16.	Organise and record the height data clearly in a table, categorising the measurements into appropriate intervals		
17.	Calculate the frequency of individuals within each height range		

## Scheme of Assessment

### Grade XI

Table 1: Exam Specifications

Topic No.	Topics	Marks Distribution			Total Marks
		MCQs	CRQs	ERQs	
1.	Biological Molecules	6	-	7 Marks Choose any ONE from TWO	19
3.	The Cell	6	-		
2.	Enzymes	3	Total 3 Marks (1 CRQ)	-	6
4.	Classification and Acellular Life	4	-	-	4
5.	Kingdom Prokaryotae	2	Total 3 Marks (1 CRQ)	-	5
6.	Kingdom Protocista	3	-	-	3
7.	Kingdom Fungi	3	-	-	3
8.	Kingdom Plantae	2	Total 3 Marks (1 CRQ)	-	5
9.	Kingdom Animalia	2	Total 3 Marks (1 CRQ)	-	5
10.	Bioenergetics	6	-	7 Marks Choose any ONE from TWO	20
13.	Transport	7	-		
11.	Nutrition	2	Total 3 Marks (1 CRQ)	-	5
12.	Gaseous Exchange	2	Total 3 Marks (1 CRQ)	-	5
14.	Immune System	2	Total 3 Marks (1 CRQ)	-	5
<b>Total</b>		<b>50</b>	<b>21</b>	<b>14</b>	<b>85</b>
<b>Practical*</b>					<b>15</b>
<b>Total</b>					<b>100</b>