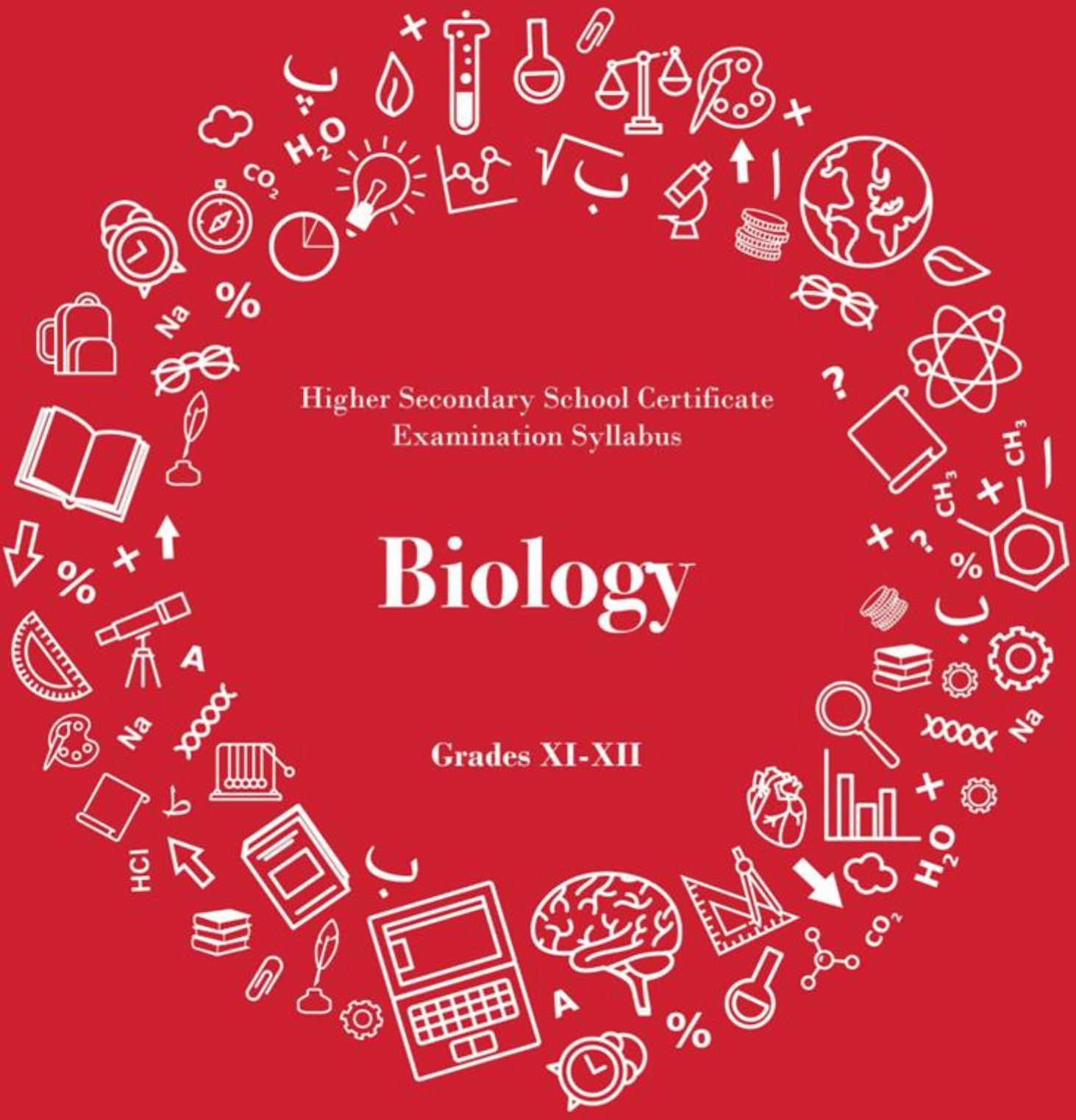
آغا خان یونیورسٹی ایگزامینیشن بورڈ

AGA KHAN UNIVERSITY EXAMINATION BOARD



Higher Secondary School Certificate
Examination Syllabus

Biology

Grades XI-XII

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Block - C, IED - PDC, 1-5/B-VII
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Higher Secondary School Certificate Examination Syllabus

BIOLOGY

GRADES XI-XII

This syllabus will be examined in both Annual and Re-sit Examination sessions from Annual Examinations 2023

Table of Contents	Page No.

For queries and feedback

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Preface

Established in 2002 through the Pakistan government's ordinance, the Aga Khan University Examination Board (AKU-EB) is country's first private autonomous qualification awarding body for secondary (SSC) and higher secondary (HSSC) school certifications. Its vision is to be a model of excellence and innovation in education in Pakistan and the developing world.

AKU-EB achieves its vision by developing examination syllabi which inculcate conceptual thinking and higher order learning and are aligned with National/ trans-provincial curricula and international standards. AKU-EB revises its syllabi periodically to support the needs of students, teachers and examiners.

The aims of the syllabus review of SSC and HSSC are to:

- Ensure continued compatibility with the goals of the trans-provincial curricula of Pakistan.
- Review the content for inclusion of new knowledge and deletion of obsolete knowledge.
- Review the content for clarity and relevance as per the changing needs of students, teachers and examiners.
- Enhance and strengthen continuation and progression of content both within and across grades IX - XII (SCC and HSSC).
- Ensure the readiness of students for higher education.

During the syllabus review, the needs of all the stakeholders were identified through a needs-assessment survey. Students and teachers of AKU-EB affiliated schools from across Pakistan participated in the survey. Thereafter, a revision panel, which consisted of examiners, teachers of affiliated and non-affiliated schools, teacher trainers and university academicians, reviewed and revised the syllabus following a planned, meticulous and standardised syllabi review process.

The syllabus is organised into topics and subtopics. Each subtopic is further divided into achievable student learning outcomes (SLOs). The SLOs of the cognitive domain are each assigned a cognitive level on which they have to be achieved. These cognitive levels are 'knowledge', 'understanding' and 'application', the latter also including other higher order skills. This is followed by the Exam Specification which gives clear guidance about the weightage of each topic and how the syllabus will be assessed.

The development of the revised syllabus has been made possible by the creativity and relentless hard work of Curriculum and Examination Development unit and the constant support provided by all the other units of AKU-EB. We are particularly thankful to Dr Sohail Qureshi for his very useful feedback on revising the syllabus review process, to Dr Naveed Yousuf for his continued guidance and support throughout the syllabus revision process and to Raabia Hirani for leading the syllabi revision. We are also thankful to all the students and teachers who took part in the needs-assessment survey and to the principals of AKU-EB affiliated schools who made this endeavour possible by facilitating and encouraging their teachers to be a part of the survey and the syllabus revision panel.

With your support and collective hard work, AKU-EB has been able to take the necessary steps to ensure effective implementation of the best international and trans-provincial standards through this syllabus. We are confident that this syllabus will continue to provide the support that is needed by students to progress to the next level of education and we wish the very best to our students and teachers in implementing this syllabus.

Dr Shehzad Jeeva
Chief Executive Officer (CEO), Aga Khan University Examination Board
Associate Professor of Practice, Faculty of Arts and Sciences, Aga Khan University

Understanding of AKU-EB Syllabi

1. The AKU-EB syllabi guide the students, teachers, parents and other stakeholders regarding the topics that will be taught and examined in each grade (IX, X, XI and XII). In each syllabus document, the content progresses from simple to complex, thereby, facilitating a gradual, conceptual learning of the content.

2. The topics of the syllabi are divided into subtopics and **student learning outcomes (SLOs)**. The subtopics and the SLOs define the depth and the breadth at which each topic will be taught, learnt and examined. The syllabi also provide enabling SLOs where needed to scaffold student learning.

3. Each SLO starts with an achievable and assessable **command word** such as describe, relate, evaluate, etc. The purpose of the command words is to direct the attention of teachers and students to specific tasks that the students are expected to undertake in the course of their studies. The examination questions are framed using the same command words or their connotations to elicit evidence of these competencies in students' responses.

4. The topics of the syllabi are grouped into themes derived from the national/ trans-provincial curricula. The connection between various themes and topics is highlighted in the '**concept map**' provided at the beginning of each syllabus. This ensures that students begin to understand the interconnectedness of knowledge, learn conceptually and think critically.

5. The SLOs are classified under three **cognitive levels**: knowledge (K), understanding (U) and application and other higher order skills (A) for effective planning during teaching and learning. Furthermore, it will help to derive multiple choice questions (MCQs), constructed response questions (CRQs) and extended response questions (ERQs) on a rational basis from the subject syllabi.

6. By focusing on the achievement of the SLOs, these syllabi aim to counter the culture of rote memorisation as the preferred method of examination preparation. While suggesting relevant, locally available textbooks for achieving these outcomes, AKU-EB recommends that teachers and students use multiple teaching and learning resources for achieving these outcomes.

7. The syllabi follow a uniform layout for all subjects to make them easier for students and teachers to follow. They act as a bridge between students, teachers and assessment specialists by providing a common framework of student learning outcomes and **exam specifications**.

8. On the whole, the AKU-EB syllabi for Secondary School Certificate (SSC) provide a framework that helps students to acquire conceptual understanding and learn to critically engage with it. This lays a solid foundation for HSSC and beyond.

Subject Rationale of AKU-EB Biology

What will you learn in AKU-EB Biology?

- On a wider note, biology links students to the living world; the different forms of life. It orients them about the variety of living organisms and their specific role to maintain the distinctive ecosystems.

- Biology brings awareness about the right choice of food in students' daily lives. The concepts of balanced diet, malnutrition, deficiency diseases guide them to make more informed decisions about their health.

- Since Pakistan is an agricultural country, it is very beneficial for students to learn about the favourable conditions for increased productivity. Biology helps them to understand the different textures of soil, requirement of mineral nutrition in plants, use of genetically modified crops, factors responsible for flood and soil erosion.

- Biology makes students aware about the importance of conservation of nature. It forces students to think about leaving a better planet for the next generations by following the principles of reduce, reuse and recycle.

Where will it take you?

The focus of the AKU-EB biology examination syllabus is more towards conceptual understanding of the phenomena of life which prepares students appropriately for higher secondary or tertiary level studies of biology-related fields.

The following non-exhaustive list suggests the diversity of careers which graduates in biological science can pursue:

- Biotechnology
- Medicine
- Environmental rehabilitation
- Agriculture
- Fisheries
- Bioengineering
- Forestry
- Animal husbandry
- Food technology
- Nursing
- Plant pathology
- Animal pathology
- Science teaching
- Forensic science

How to approach the syllabus?

The concept map of the syllabus gives an overview of the entire syllabus. The topics and the student learning outcomes (SLOs) guide regarding the details about what has to be achieved. And finally, the exam specification guides regarding what will be expected in the examination.

What is the concept map telling you?

Putting (Electron) Microscope on Life

DNA is the architectural blueprint of biological life. Its discovery revolutionised science and technology. Your DNA is a map which determines how you are you, and not anyone else. Similarly, the concept map of AKU-EB HSSC Biology shows a 'code' for all that is included in this syllabus. Each theme of the syllabus is represented by one spiral of the DNA that serves as a backbone of life on the biosphere. The apex of the DNA symbolises all that we see around us, i.e. application of biology. As we unfold it, we see levels of biological organisation that has made this possible, i.e. diversity of living organisms, ecosystems, continuity in life, life processes and, finally, cell biology. Get ready to explore!

BIOLOGY

CONCEPT MAP - HSSC I & II

MAP KEY

Theme..... **BIO**

Topic..... •Biology

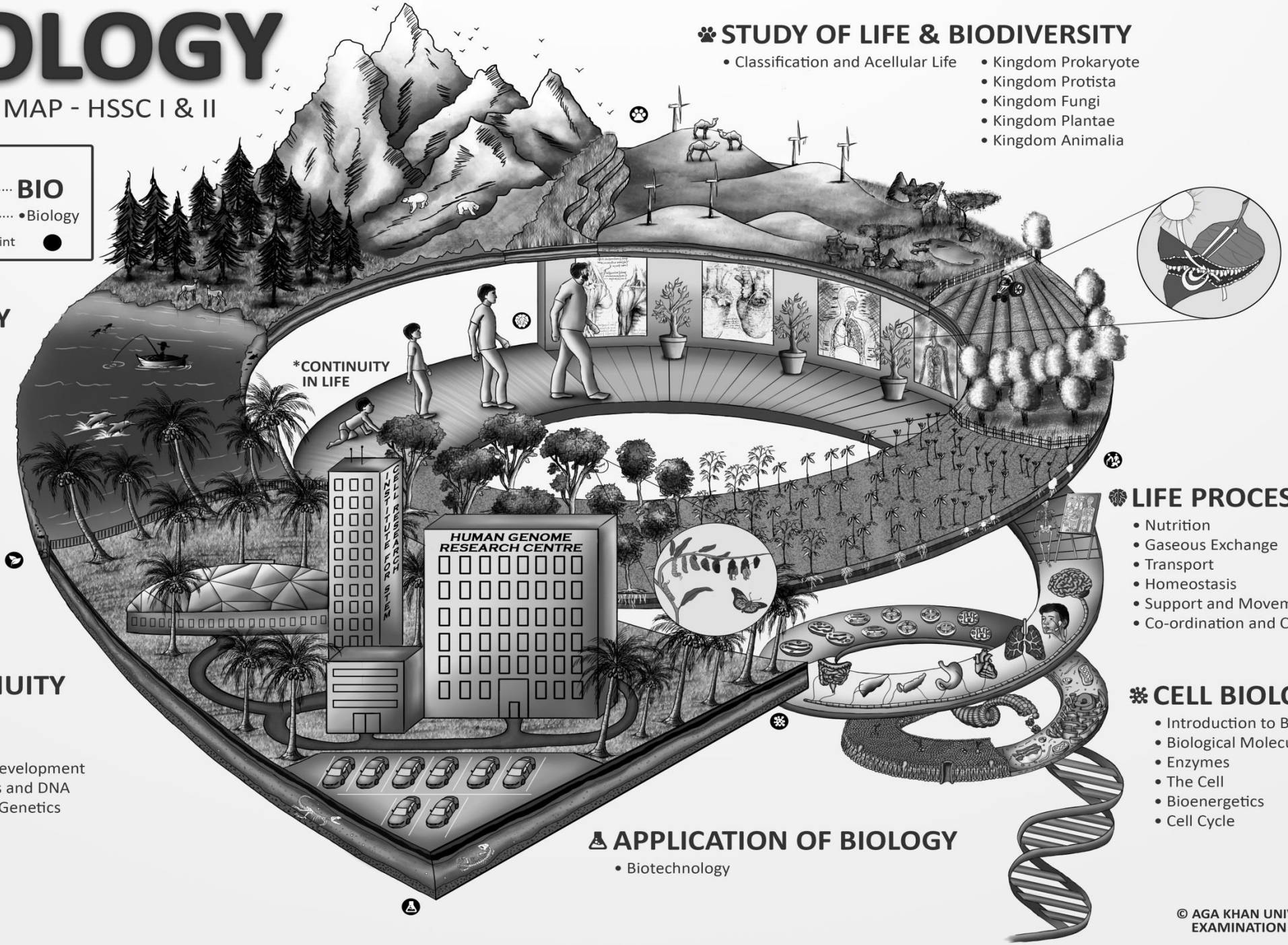
Theme Starting Point ●

STUDY OF LIFE & BIODIVERSITY

- Classification and Acellular Life
- Kingdom Prokaryote
- Kingdom Protista
- Kingdom Fungi
- Kingdom Plantae
- Kingdom Animalia

ECOLOGY

- Ecosystem
- Some Major Ecosystem
- Man and his Environment



LIFE PROCESSES

- Nutrition
- Gaseous Exchange
- Transport
- Homeostasis
- Support and Movement
- Co-ordination and Control

*CONTINUITY IN LIFE

- Reproduction
- Growth and Development
- Chromosomes and DNA
- Variation and Genetics
- Evolution

CELL BIOLOGY

- Introduction to Biology
- Biological Molecules
- Enzymes
- The Cell
- Bioenergetics
- Cell Cycle

APPLICATION OF BIOLOGY

- Biotechnology

Student Learning Outcomes of AKU-EB HSSC Biology Syllabus

Part I (Grade XI)

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level[1]		
				K	U	A
1. Introduction to Biology		Students should be able to:				
1.1	Major Fields of Specialisation in Biology	1.1.1	differentiate among the branches of biology, i.e. fresh water biology, marine biology, sociobiology, veterinary science and bioclimatology;		*	
1.2	Levels of Biological Organisation	1.2.1	differentiate among the levels of biological organisation from subatomic particles to biosphere;		*	
1.3	Biological Method	1.3.1 1.3.2	exemplify deductive and inductive reasoning; differentiate among hypothesis, theory and scientific law;		* *	
1.4	Services of Biology	1.4.1	discuss the role of biology with respect to disease control in plants and animals (preventive measures, immunisation, drug treatment, biological control, integrated disease management and integrated pest management).		*	

[1] K = Knowledge, U = Understanding, A = Application and other higher-order cognitive skills

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
2. Biological Molecules		Students should be able to:				
2.1	Introduction to Biochemistry	2.1.1	define biochemistry and biological molecules;	*		
		2.1.2	state the chemical composition of protoplasm;	*		
		2.1.3	differentiate between organic and inorganic molecules;		*	
		2.1.4	differentiate among covalent, ionic bond and hydrogen bond;		*	
2.2	Properties of Carbon	2.2.1	describe properties of carbon, i.e. tetra-valency, isomerism and catenation;		*	
2.3	Chemical Nature and Importance of Water	2.3.1	describe polarity of water molecules that results in hydrogen bonding;		*	
		2.3.2	discuss properties of water that contribute to the sustainability of life on Earth, i.e. a. cohesion b. specific heat c. low density of ice d. heat of vapourisation e. hydrophobic exclusion;		*	
2.4	Carbohydrates	2.4.1	define carbohydrates;	*		
		2.4.2	describe properties of monosaccharides, disaccharides and polysaccharides with examples;		*	
		2.4.3	differentiate between condensation and hydrolysis;		*	
		2.4.4	illustrate the formation and breakage of disaccharides, i.e. maltose, sucrose and lactose;			*
		2.4.5	compare structure and function of starch, cellulose, glycogen and chitin;		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			K	U	A
	Students should be able to:				
2.5 Lipids	2.5.1	define lipids;	*		
	2.5.2	describe the properties of acylglycerols, phospholipids, terpenoids and waxes;		*	
	2.5.3	illustrate the molecular structure of an acylglycerol (triglyceride), a phospholipid and a terpene;			*
	2.5.4	describe the roles of steroids and prostaglandins in living organisms;		*	
2.6 Proteins	2.6.1	define proteins and amino acids;	*		
	2.6.2	illustrate the structure of amino acids;			*
	2.6.3	illustrate synthesis and breakage of peptide linkage;			*
	2.6.4	differentiate between: a. essential and non-essential amino acids b. acidic and basic amino acids c. polar and non-polar amino acids;		*	
	2.6.5	explain amphoteric property of amino acids;		*	
	2.6.6	differentiate between dipeptides and polypeptides;		*	
	2.6.7	differentiate among levels of organisation of proteins, i.e. a. primary b. secondary c. tertiary d. quaternary;		*	
	2.6.8	define fibrous and globular proteins;	*		
	2.6.9	exemplify significance of sequence of amino acids in a polypeptide chain through sickle cell anaemia;		*	
	2.6.10	list functions of proteins in the body;	*		

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			K	U	A
	Students should be able to:				
2.7 Nucleic Acids	2.7.1	define nucleic acid;	*		
	2.7.2	differentiate between nucleotide and nucleoside;		*	
	2.7.3	illustrate structure of deoxyribonucleic acid (DNA);			*
	2.7.4	classify nucleotides on the basis of their sugar molecules and nitrogen bases;		*	
	2.7.5	differentiate between a mononucleotide, i.e. adenosine triphosphate (ATP) and a dinucleotide, i.e. nicotinamide adenine di nucleotide (NAD);		*	
	2.7.6	define genetic code;	*		
	2.7.7	differentiate among different types of ribonucleic acid (RNA) molecules with reference to their role in protein synthesis;		*	
2.8 Conjugated Molecules	2.8.1	define conjugated molecules;	*		
	2.8.2	describe functions of glycolipids, glycoproteins, lipoproteins and nucleoproteins.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
3. Enzymes		Students should be able to:				
3.1	Structure of Enzyme	3.1.1	describe enzyme, cofactor (prosthetic group and coenzyme with examples), apoenzyme and holoenzyme;		*	
3.2	Characteristics of Enzymes	3.2.1	describe characteristics of enzymes;		*	
3.3	Mechanism of Enzyme Action	3.3.1	compare lock and key model and induced fit model of enzyme action;		*	
		3.3.2	illustrate the mechanism of enzyme action through lock and key model and induced fit model;			*
		3.3.3	define energy of activation;	*		
		3.3.4	explain that enzymes speed up a chemical reaction by lowering the energy of activation using graphs;		*	
3.4	Factors Affecting Enzyme Action	3.4.1	verify the effect of different factors, i.e. pH and temperature on the rate of enzyme action using graph;			*
		3.4.2	compare optimum temperature of human body enzymes and thermophilic bacteria;		*	
		3.4.3	compare optimum pH of different enzymes like trypsin and pepsin;		*	
3.5	Enzyme Inhibition	3.5.1	classify inhibitors into competitive and non-competitive inhibitors;		*	
		3.5.2	describe the significance of inhibitors;		*	
		3.5.3	explain feedback inhibition;		*	
3.6	Classification of Enzymes	3.6.1	classify enzymes on the basis of reactions they catalyse and nature of substrate.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
4. The Cell		Students should be able to:				
4.1	Discovery of Cell	4.1.1	state the contributions of different scientists in the discovery of cell (Robert Hooke 1665 to August Weismann 1880);	CA[2]		
4.2	Microscope	4.2.1	apply the concept of resolution versus magnification of a microscope;			*
4.3	Techniques used in Cell Biology	4.3.1	describe the techniques used in cell biology, i.e. a. cell fractionation b. differential staining c. centrifugation;		*	
4.4	Structure of Animal and Plant Cell	4.4.1	explain structure, chemical composition and functions of the cellular organelles of animal and plant cell as revealed through the electron microscope: a. cell wall b. cell membrane with reference to Fluid Mosaic Model c. cytoplasm d. endoplasmic reticulum e. ribosomes f. mitochondria g. Golgi apparatus h. lysosomes i. vacuoles j. cytoskeleton k. centrioles l. plastids m. nucleus;		*	

[2] CA=Classroom Activity, not to be assessed under examination conditions

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			K	U	A
	Students should be able to:				
	4.4.2	describe storage diseases with reference to the malfunctioning of lysosomes;		*	
	4.4.3	compare the structure and function of: a. glyoxisome and peroxisome b. cell wall and cell membrane c. chloroplast and chromoplast d. animal cell and plant cell e. prokaryotic cell and eukaryotic cell.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
5. Classification and Acellular Life		Students should be able to:				
5.1	Classification of Living Organisms	5.1.1	describe basis of classification of living organisms, i.e. homology, biochemistry, cytology and genetics;		*	
		5.1.2	exemplify hierarchy of biological classification (species, genera, family, order, class, phylum/ division and kingdom);		*	
5.2	Nomenclature	5.2.1	describe binomial nomenclature;		*	
		5.2.2	describe the significance of binomial nomenclature;		*	
5.3	Two and Five-Kingdom System	5.3.1	compare kingdoms of living organisms, i.e. a. two-kingdom system b. five-kingdom system of Whittaker c. five-kingdom system of Lynn Marguilis and Karlene Schwartz;		*	
5.4	Characteristics of Viruses	5.4.1	trace the discovery of viruses;		*	
		5.4.2	state characteristic features of viruses;	*		
		5.4.3	explain how viruses survive inside a host cell;		*	
5.5	Classification of Viruses	5.5.1	classify viruses on the basis of their structure, type of nucleic acid and host;		*	
		5.5.2	list diseases caused by viruses in animals and plants;	*		
5.6	Life Cycle of Viruses	5.6.1	compare lytic and lysogenic life cycle of a bacteriophage;		*	
		5.6.2	discuss use of a bacteriophage in genetic engineering;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
5.7	Viral Diseases	5.7.1	describe causative agent, symptoms, treatment and preventive measures of viral diseases: a. hepatitis b. polio c. bird flu d. tobacco mosaic disease e. acquired immune deficiency syndrome (AIDS);		*	
5.8	Prions and Viroids	5.8.1 5.8.2	differentiate between prions and viroids; list diseases caused by prions and viroids;	*	*	
5.9	Economic and Human Loss by Viruses	5.9.1	discuss the loss of economic and human resources caused by viral epidemics using Zika and Ebola as examples.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
6. Kingdom Prokaryotae		Students should be able to:				
6.1	Characteristic Features of Prokaryotes	6.1.1	state characteristic features of prokaryotes;	*		
6.2	Morphology of Bacteria	6.2.1	state characteristic features of archaebacteria (thermophilic, acidophilic and hallophilic);	*		
		6.2.2	describe discovery, occurrence and habitat of bacteria;		*	
		6.2.3	describe morphological diversity (shapes) of bacteria;		*	
		6.2.4	differentiate between gram positive and gram negative bacteria with reference to their colour and composition of cell wall;		*	
		6.2.5	relate the function of each component of bacterial cell with its structure, i.e. a. cell wall b. cell membrane c. cytoplasm d. mesosomes e. chromatin f. endospore g. plasmid h. ribosomes i. flagella j. capsule;		*	
6.3	Nutrition in Bacteria	6.3.1	differentiate between the types of nutrition in bacteria: a. autotrophic and heterotrophic nutrition b. symbiotic and parasitic nutrition;		*	
		6.3.2	differentiate between the chlorophyll present in bacteria and plants;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
6.4	Respiration in Bacteria	6.4.1	describe obligatory aerobes, micro-aerobes, facultative and obligatory anaerobes;		*	
6.5	Locomotion in Bacteria	6.5.1	compare methods of locomotion in bacteria, i.e. chemotaxis and magnetotaxis;		*	
6.6	Growth in Bacteria	6.6.1	explain different phases of growth in bacteria using graph;		*	
6.7	Reproduction in Bacteria	6.7.1	differentiate among different modes of reproduction in bacteria, i.e. a. binary fission b. endospore formation c. genetic recombination, i.e. conjugation, transduction and transformation;		*	
6.8	Economic Importance of Bacteria	6.8.1	discuss role of beneficial bacteria in: a. medicine b. agriculture c. industry d. symbiosis e. research and technology;		*	
		6.8.2	discuss role of harmful bacteria in: a. human and animal health b. food spoilage;		*	

Topics and Sub-topics		Student Learning Outcomes	Cognitive Level		
			K	U	A
	Students should be able to:				
6.9 Control and Prevention of Bacteria	6.9.1	describe different physical and chemical methods to control bacteria;		*	
	6.9.2	describe immunisation (vaccination);		*	
	6.9.3	list uses and misuses of antibiotics;	*		
6.10 Cyanobacteria	6.10.1	list general characteristics of cyanobacteria;	*		
	6.10.2	describe habitat, structure, nutrition and reproduction in nostoc;		*	
	6.10.3	describe role of cyanobacteria in nitrogen fixation.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
7. Kingdom Protista (Protoctista)		Students should be able to:				
7.1	Unifying Features	7.1.1	describe characteristics of protists;		*	
7.2	Diversity among Protists	7.2.1	trace evolutionary relationship among protists;		*	
7.3	Animal-like Protists	7.3.1	describe salient features of animal-like protists;		*	
		7.3.2	classify animal-like protists on the basis of their locomotory organelles with examples;		*	
		7.3.3	list the pathogenic protozoan and diseases caused by them;	*		
7.4	Plant-like Protists	7.4.1	describe salient features of plant-like protists;		*	
		7.4.2	classify photosynthetic protists;		*	
		7.4.3	differentiate among brown, red and green algae;		*	
7.5	Fugus-like Protists	7.5.1	compare features of myxomycota and oomycota;		*	
		7.5.2	state importance of *Phytophthora infestans*.	*		

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
8. Kingdom Fungi		Students should be able to:				
8.1	General Characteristics	8.1.1	differentiate between fungi and organisms of other kingdoms on the basis of their characteristic features;		*	
		8.1.2	describe structure and nutrition in fungi;		*	
		8.1.3	compare lichens with mycorrhizae;		*	
		8.1.4	explain different methods of asexual and sexual reproduction in fungi;		*	
8.2	Classification of Fungi	8.2.1	differentiate among main groups of fungi based on their reproductive structures and methods of reproduction;		*	
8.3	Land Adaptations of Fungi	8.3.1	describe adaptive features of fungi in the land habitat;		*	
8.4	Importance of Fungi	8.4.1	discuss ecological and commercial importance of fungi;		*	
		8.4.2	discuss economic losses due to fungi.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
9. Kingdom Plantae		Students should be able to:				
9.1	Diversity among Plants	9.1.1	state general characteristics of plants;	*		
		9.1.2	describe phylogeny of kingdom plantae;		*	
		9.1.3	classify kingdom plantae;		*	
9.2	Bryophytes	9.2.1	state characteristic features of bryophytes;	*		
		9.2.2	classify bryophytes as musci, hepaticae or anthocerotae;		*	
		9.2.3	explain the life cycle of mosses;		*	
		9.2.4	describe the significance of alternation of generation in bryophytes;		*	
		9.2.5	discuss the adaptive characteristics of bryophytes in the land habitat;		*	
9.3	Tracheophyta	9.3.1	compare major groups of tracheophyta, i.e. a. psilopsida b. lycopsida c. sphenopsida d. pteropsida;		*	
		9.3.2	explain evolution of single-veined (microphyllus) and multi-veined (megaphyllus) leaf;		*	
		9.3.3	differentiate between homospory and heterospory;		*	
		9.3.4	explain the evolution of seed;		*	
9.4	Seed Plants	9.4.1	describe general characteristics of gymnosperms and angiosperms;		*	
		9.4.2	explain life cycle of pinus (gymnosperm) with diagram;		*	
		9.4.3	explain life cycle of an angiosperm with diagram;		*	
		9.4.4	compare dicotyledonous and monocotyledonous plant;		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			K	U	A
	Students should be able to:				
	9.4.5	discuss that vascular plants are the most successful group of land plants;		*	
9.5 Angiospermic Families	9.5.1	differentiate among vegetative characteristics, floral characteristics and economic importance of angiospermic families, i.e. a. Rosaceae b. Solanaceae c. Fabaceae d. Caesalpiniaceae e. Mimosaceae f. Poaceae.		*	

Topics and Sub-topics		Student Learning Outcomes	Cognitive Level		
			K	U	A
10. Kingdom Animalia		Students should be able to:			
10.1 Introduction	10.1.1	describe general characteristics of animals;		*	
10.2 Criteria for Animal Classification	10.2.1	differentiate among various phyla of kingdom animalia on the basis of their body plan, i.e. 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);		*	
10.3 Phylum Porifera	10.3.1 10.3.2	explain general characteristics of poriferans; describe the economic importance of poriferans;		* *	
10.4 Grade Radiata Phylum Coelenterata	10.4.1 10.4.2	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; describe the economic importance of coelenterates;		* *	
10.5 Grade Bilateria Triploblastic Animals-Acoelomates Phylum Platyhelminthes	10.5.1 10.5.2	explain general characteristics of platyhelminthes; describe the adaptations for parasitic mode of life in platyhelminthes;		* *	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			K	U	A
	Students should be able to:				
	10.5.3	describe infestation and disinfestations of tapeworms;		*	
10.6 Grade Bilateria Triploblastic Animals-Pseudocoelomates Phylum Aschelminthes (Nematoda)	10.6.1	explain nematodes with reference to their a. general characteristics b. parasitic adaptations;		*	
	10.6.2	describe the importance of nematodes;		*	
10.7 Grade Bilateria Triploblastic Animals-Coelomates Phylum Annelida	10.7.1	explain annelides with reference to their a. general characteristics b. segmentation and its advantages c. coelom and its advantages;		*	
	10.7.2	classify annelides up to classes;		*	
	10.7.3	describe the importance of annelides;		*	
10.8 Phylum Arthropoda	10.8.1	explain general characteristics of arthropodes;		*	
	10.8.2	describe the major classes of arthropodes, i.e. a. arachnida b. crustaceae c. insecta d. myriapoda;		*	
	10.8.3	describe metamorphosis in insects;		*	
	10.8.4	discuss economic importance (beneficial and harmful) of insects;		*	
	10.8.5	discuss insects as a successful group of animals;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
10.9	Phylum Mollusca	10.9.1	explain general characteristics of molluscs;		*	
		10.9.2	describe characteristics of classes of molluscs, i.e. a. gastropoda b. bivalvia c. cephalopoda;		*	
		10.9.3	describe the economic importance of molluscs;		*	
10.10	Phylum Echinodermata	10.10.1	explain general characteristics of spiny skinned animals (echinoderms) and their affinities;		*	
10.11	Phylum Hemichordata	10.11.1	describe the basic characteristics of hemichordates;		*	
10.12	Phylum Chordata	10.12.1	describe fundamental characteristics of chordates;		*	
		10.12.2	classify chordates;		*	
		10.12.3	differentiate between: a. acraniata and craniata b. urochordata and cephalochordata;		*	
10.13	Sub-phylum Vertebrata	10.13.1	describe general characteristics of super-class pisces;		*	
		10.13.2	differentiate among cyclostomes, chondrichthyes (cartilaginous) and osteichthyes (bony fishes);		*	
		10.13.3	describe aquatic adaptations of super-class pisces;		*	
		10.13.4	list some familiar edible fishes in Pakistan;	*		
		10.13.5	explain origin and general characteristics of amphibians;		*	
		10.13.6	discuss amphibians as unsuccessful land vertebrates;		*	
		10.13.7	explain general characteristics of reptiles;		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			K	U	A
	Students should be able to:				
	10.13.8	discuss reptiles as successful land vertebrates;		*	
	10.13.9	describe general characteristics of birds;		*	
	10.13.10	explain the adaptations of birds for aerial mode of life (flight adaptations);		*	
	10.13.11	exemplify running and flying birds;		*	
	10.13.12	trace the evolutionary origin of birds with reference to archaeopteryx;		*	
	10.13.13	trace the evolutionary origin of mammals;		*	
	10.13.14	describe general characteristics and classification of mammals (prototheria, metatheria and eutheria).		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
11. Bioenergetics		Students should be able to:				
11.1	Role of ATP	11.1.1	define bioenergetics;	*		
		11.1.2	describe the role of ATP as currency of energy in metabolism;		*	
11.2	Photosynthesis	11.2.1	define photosynthesis;	*		
		11.2.2	describe the significance of photosynthesis;		*	
		11.2.3	state the reactants and products of photosynthesis;	*		
		11.2.4	describe chromatography and spectrophotometry;		*	
		11.2.5	explain the role of chlorophyll and other photosynthetic pigments, light, carbon dioxide and water in photosynthesis;		*	
		11.2.6	describe main events of light dependent reactions (energy conversion, formation of ATP and NADPH);		*	
		11.2.7	compare cyclic and non-cyclic phosphorylation in light dependent reactions;		*	
		11.2.8	describe three phases of light independent (dark) reactions;		*	
		11.2.9	compare C_3, C_4 and CAM plants;		*	
11.3	Respiration	11.3.1	define cellular respiration, oxidative phosphorylation, aerobic respiration and fermentation;	*		
		11.3.2	differentiate between alcoholic and lactic acid fermentation;		*	
		11.3.3	state the role of mitochondria in respiration;	*		
		11.3.4	explain the steps involved in the mechanism of cellular respiration, i.e. a. glycolysis b. pyruvic acid oxidation (formation of acetyl CoA) c. Krebs cycle (citric acid cycle) d. respiratory chain.		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			K	U	A
12. Nutrition	Students should be able to:				
12.1 Nutrition in Plants	12.1.1	define nutrition;	*		
	12.1.2	differentiate between autotrophic and heterotrophic nutrition in plants;		*	
	12.1.3	describe various conditions caused by the deficiency of: a. nitrogen b. phosphorus c. potassium d. magnesium;		*	
	12.1.4	differentiate among various modes of heterotrophic nutrition in plants, i.e. a. saprophytic nutrition b. parasitic nutrition c. symbiotic nutrition d. insectivorous nutrition;		*	
12.2 Nutrition in Animals	12.2.1	differentiate among various forms of heterotrophic nutrition in animals, i.e. a. saprotrophic nutrition b. parasitic (ectoparasitic and endoparasitic) nutrition c. holozoic nutrition;		*	
	12.2.2	classify holozoic heterotrophs, i.e. a. herbivores b. carnivores c. omnivores;		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			K	U	A
	Students should be able to:				
	12.2.3	classify the types of heterotrophic nutrition on the basis of size of food particle: a. microphagous feeding b. macrophagous feeding c. fluid feeding d. filter feeding;		*	
	12.2.4	differentiate between intercellular and intracellular digestion;		*	
12.3 Nutrition in Non-Chordates	12.3.1	describe nutrition in amoeba, hydra, planaria and cockroach;		*	
	12.3.2	differentiate between complete and incomplete alimentary canal;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
12.4	Digestion in Human Beings	12.4.1	relate the function of each organ of digestive system of the human with its structure: 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. dentition ii. tongue iii. salivary glands (composition of saliva) iv. liver (gall bladder and composition of bile) v. pancreas (composition of pancreatic juice);		*	
		12.4.2	discuss the process of digestion of carbohydrates, proteins and lipids in human being;		*	
		12.4.3	describe dental diseases;		*	
		12.4.4	state causes and preventive measures of different types of dental diseases;	*		
		12.4.5	describe disorders of GIT, i.e. diarrhoea, dysentery, constipation, piles, dyspepsia, peptic ulcer, food poisoning, anorexia and bulimia nervosa;		*	
		12.4.6	discuss causes and preventive measures of gastrointestinal disorders.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
13. Gaseous Exchange		Students should be able to:				
13.1	Gaseous Exchange in Plants	13.1.1	define respiration;	*		
		13.1.2	describe conditions necessary for gaseous exchange;		*	
		13.1.3	differentiate between gaseous exchange in plants through stomata and lenticels;		*	
		13.1.4	describe process and importance of photorespiration;		*	
13.2	Gaseous Exchange in Animals	13.2.1	describe properties of respiratory surface;		*	
		13.2.2	describe process of gaseous exchange in hydra, earthworm and cockroach;		*	
		13.2.3	explain the mechanism of gaseous exchange in fish, frogs and birds;		*	
		13.2.4	differentiate between complete and incomplete ventilation;		*	
13.3	Respiratory System of Human Being	13.3.1	relate the function of each organ of respiratory system of human being with its function, i.e. a. upper respiratory tract i. nose ii. pharynx iii. larynx b. lower respiratory tract i. trachea ii. bronchi and bronchioles iii. lungs iv. pleurae;		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			K	U	A
	Students should be able to:				
	13.3.2	explain mechanism of breathing in human beings;		*	
	13.3.3	differentiate between voluntary and involuntary control of breathing;		*	
	13.3.4	explain transportation of carbon dioxide and oxygen by the blood;		*	
13.4 Respiratory Disorders	13.4.1	discuss causes, symptoms and preventive measures of: a. upper respiratory tract infections i. sinusitis ii. otitis media b. lower respiratory tract infections i. pneumonia ii. tuberculosis iii. emphysema iv. lung cancer;		*	
	13.4.2	explain the effects of smoking on respiratory system.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
14. Transport		Students should be able to:				
14.1	Introduction	14.1.1	define transport in living organisms;	*		
		14.1.2	describe the importance of transport of material in living organisms;		*	
14.2	Transportation in Plants	14.2.1	explain uptake of water and minerals by roots and pathways (apoplast, symplast and vacuolar) involved in it;		*	
		14.2.2	define water potential, osmotic potential and pressure potential;	*		
		14.2.3	calculate water potential of living cells;			*
		14.2.4	differentiate between plasmolysis and deplasmolysis;		*	
14.3	Ascent of Sap	14.3.1	define ascent of sap;	*		
		14.3.2	explain factors affecting ascent of sap, i.e. a. cohesion b. adhesion c. xylem vessels;		*	
		14.3.3	explain mechanism of transpiration pull with reference to cohesion tension theory, root pressure and imbibition;		*	
		14.3.4	define bleeding in plants;	*		
14.4	Transpiration	14.4.1	define transpiration;	*		
		14.4.2	differentiate among types of transpiration, i.e. cuticular, lenticular and stomatal transpiration;		*	
		14.4.3	explain mechanisms involved in opening and closing of stomata, i.e. a. starch sugar hypothesis b. influx of potassium ions;		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			K	U	A
	Students should be able to:				
	14.4.4	analyse the effect of various factors affecting the rate of transpiration, i.e. a. light b. wind c. humidity d. temperature e. availability of soil water f. carbon dioxide concentration;			*
	14.4.5	discuss why transpiration is considered as a necessary evil;		*	
14.5 Translocation	14.5.1	define translocation;	*		
	14.5.2	explain mechanism of phloem translocation, i.e. diffusion and pressure flow hypothesis;		*	
14.6 Transportation in Animals	14.6.1	describe the process of transportation in amoeba, hydra and planaria;		*	
	14.6.2	describe circulatory system of vertebrates;		*	
	14.6.3	exemplify open and closed circulatory system;		*	
	14.6.4	differentiate between single circuit and double circuit circulation;		*	
	14.6.5	describe evolutionary variation in vertebrates' heart, i.e. fish, amphibians, reptiles, birds and mammals;		*	
	14.6.6	compare circulatory systems of fishes, amphibians, reptiles, birds and mammals;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
14.7	Circulatory System of Human Beings	14.7.1	describe the composition and functions of blood in human beings;		*	
		14.7.2	describe disorders of blood, i.e. a. leukaemia b. thalassemia c. oedema;		*	
		14.7.3	discuss preventive measures and treatment of blood disorders;		*	
		14.7.4	describe structure and function of human heart;		*	
		14.7.5	explain cardiac cycle (sequence of events and mechanism of heart excitation and contraction);		*	
		14.7.6	relate the function of the artificial pace maker with that of the sino-atrial node;		*	
		14.7.7	describe causes of blue babies;		*	
		14.7.8	differentiate among artery, vein and capillary on the basis of their structure and function;		*	
		14.7.9	differentiate between blood pressure and pulse pressure;		*	
		14.7.10	describe lymphatic system, lymph vessels and lymph node;		*	
		14.7.11	describe functions of lymphatic system;		*	
14.8	Cardiovascular Disorders	14.8.1	describe atherosclerosis, arteriosclerosis, thrombus formation embolus, coronary thrombosis, myocardial infarction, stroke and hypertension;		*	
		14.8.2	describe causes, effects and preventive measures of atherosclerosis, arteriosclerosis, myocardial infarction and hypertension;		*	
		14.8.3	define haemorrhage;	*		

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
14.9	Immune System	14.9.1	define immunity;	*		
		14.9.2	explain innate defence, i.e. barrier defence and internal defence;		*	
		14.9.3	explain adaptive immune system, i.e. humoral response and cell mediated response;		*	
		14.9.4	differentiate between primary and secondary immune responses;		*	
		14.9.5	differentiate between active and passive immunity.		*	

Part II (Grade XII)

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
15. Homeostasis		Students should be able to:				
15.1	Introduction	15.1.1	define homeostasis;	*		
		15.1.2	describe the significance of homeostasis;		*	
15.2	Feedback System	15.2.1	define feedback system;	*		
		15.2.2	describe components of feedback system;		*	
		15.2.3	compare positive and negative feedback with examples;		*	
15.3	Osmoregulation in Plants and Animals	15.3.1	define osmosis, water potential, pressure potential and solute potential;	*		
		15.3.2	explain osmoregulation in plants, i.e. a. hydrophytes b. halophytes c. mesophytes d. xerophytes;		*	
		15.3.3	differentiate among hypotonic, isotonic and hypertonic solution;		*	
		15.3.4	explain osmoregulation in aquatic (fresh water and marine) and terrestrial animals;		*	
15.4	Excretion in Plants	15.4.1	define excretion;	*		
		15.4.2	explain different excretory products in plants and methods by which they are stored and removed from the plant body;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
15.5	Excretion in Animals	15.5.1	differentiate among types of excretory products and relationship of these products to the habitat of animals;		*	
		15.5.2	explain the process of excretion in hydra, planaria, earthworm and cockroach;		*	
15.6	Excretion in Man	15.6.1	describe metabolic waste and excretory organs in man (kidney, liver, skin);		*	
		15.6.2	explain role of liver in urea formation (urea cycle or ornithine cycle);		*	
		15.6.3	discuss the role of liver in homeostasis;		*	
		15.6.4	relate the structure of each part of urinary system of man with its function;		*	
		15.6.5	relate the internal structure of nephron with its function (simple filtration, reabsorption, secretion, counter current);		*	
		15.6.6	describe the a. effect of hormones on the working of kidneys b. composition of urine c. variation in the composition of urine		*	
		15.6.7	describe the significance of variation in the composition of urine;		*	
15.7	Kidney Problems	15.7.1	describe kidney problems, i.e. kidney stone and renal failure;		*	
		15.7.2	discuss the treatment of kidney problems, i.e. a. lithotripsy b. dialysis c. kidney transplantation;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
15.8	Thermoregulation in Plants	15.8.1	describe adaptations of plants to low and high temperature;		*	
15.9	Thermoregulation in Animals	15.9.1	classify animals on the basis of thermoregulation;		*	
		15.9.2	describe structural, physiological, behavioural adaptations in animals for temperature regulation;		*	
		15.9.3	explain thermoregulation in mammals (human) in cold and hot environment;		*	
		15.9.4	describe thermostatic function of brain and feedback control in humans;		*	
		15.9.5	describe pyrexia (fever).		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
16. Support and Movement		Students should be able to:				
16.1	Support in Plants	16.1.1	differentiate among supporting structures in plants, i.e. parenchyma, collenchyma and sclerenchyma;		*	
		16.1.2	differentiate between primary and secondary growth in plants;		*	
		16.1.3	describe the significance of primary and secondary growth in plants;		*	
16.2	Movement in Plants	16.2.1	describe the types of plant movements, i.e. growth and turgor movements;		*	
		16.2.2	differentiate between types of growth movements, i.e. autonomic and paratonic movements;		*	
		16.2.3	describe the autonomic movement of nutation;		*	
		16.2.4	differentiate between types of paratonic movement, i.e. tropic and nastic movement;		*	
		16.2.5	describe types of tropic movements, i.e. geotropism, thigmotropism, hydrotropism, chemotropism and phototropism;		*	
		16.2.6	differentiate between types of nastic movement, i.e. photonasty and thermonasty;		*	
		16.2.7	describe the type of turgor movement, i.e. haptonastic movement;		*	
		16.2.8	describe the role of growth substances (plant hormones) in plant movement;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
16.3	Support and Locomotion in Animals	16.3.1	define skeleton;	*		
		16.3.2	exemplify types of skeleton, i.e. hydrostatic skeleton, exoskeleton and endoskeleton;		*	
		16.3.3	describe advantages and disadvantages of the process of ecdysis or moulting;		*	
16.4	Human Skeleton	16.4.1	differentiate between bone and cartilage on the basis of their structure and function;		*	
		16.4.2	describe human skeletal system, i.e. axial and appendicular skeleton;		*	
		16.4.3	discuss functions of human skeleton;		*	
		16.4.4	describe joints (articulation) and its types with examples;		*	
		16.4.5	explain structure of synovial joint with diagram;		*	
		16.4.6	differentiate between a. tendon and ligament b. origin and insertion;		*	
		16.4.7	describe deformities of skeleton, i.e. a. cleft palate b. microcephaly c. rickets;		*	
		16.4.8	discuss skeleton related diseases and their preventive measures, i.e. a. disc slip b. spondylitis c. sciatica d. osteoarthritis;		*	
		16.4.9	explain repairing of broken bones;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
16.5	Muscular System	16.5.1	describe muscular tissue;		*	
		16.5.2	differentiate between voluntary and involuntary muscles;		*	
		16.5.3	differentiate among types of muscles and their occurrence, i.e. skeletal, smooth and cardiac muscles;		*	
		16.5.4	describe structure of skeletal muscles;		*	
		16.5.5	explain the mechanism of muscle contraction (sliding filament theory of Huxley, cross bridge cycle and regulation of muscle contraction);		*	
		16.5.6	describe all or no response of muscles and muscle fatigue;		*	
		16.5.7	describe abnormal muscle contraction (tetany and cramps);		*	
		16.5.8	define antagonistic muscles;	*		
		16.5.9	describe different types of antagonistic muscles which help to move shoulder in man;		*	
16.6	Locomotion in Protozoa and Animals	16.6.1	define locomotion;	*		
		16.6.2	exemplify amoeboid, flagellary and cilliary movement in protozoa;		*	
		16.6.3	describe locomotion in invertebrates, i.e. a. jelly fish b. earth worm c. snail d. starfish e. cockroach;		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			K	U	A
	Students should be able to:				
	16.6.4	compare locomotion in vertebrates, i.e. a. fishes b. amphibians c. reptiles d. birds e. mammals.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
17. Coordination and Control		Students should be able to:				
17.1	Introduction	17.1.1	define the general concept of coordination and control;	*		
		17.1.2	discuss the need for coordination;		*	
17.2	Coordination in Plants	17.2.1	describe control through hormones in plants;		*	
		17.2.2	explain biological clock and circadian rhythm;		*	
		17.2.3	describe plant hormones and their commercial application;		*	
17.3	Coordination in Animals	17.3.1	define nervous coordination, receptors and neurons;	*		
		17.3.2	classify receptors with examples;		*	
		17.3.3	explain working of sensory receptors with reference to skin;		*	
		17.3.4	relate the function of each type of neuron with its structure, i.e. a. sensory b. relay/ interneuron c. motor neuron;		*	
		17.3.5	explain reflex arc;		*	
		17.3.6	exemplify monosynaptic and polysynaptic reflexes;		*	
		17.3.7	define nerve impulse;	*		
		17.3.8	illustrate different steps involved in the action potential and propagation of nerve impulse;			*
		17.3.9	describe synapse, pre synapse, post synapse and neurotransmitter;		*	
		17.3.10	explain synaptic transmission of nerve impulse;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
17.4	Evolution of Nervous System	17.4.1	differentiate between diffused and centralised nervous system taking example of nervous system of hydra and planaria;		*	
		17.4.2	explain different parts and functions of human brain;		*	
		17.4.3	relate the function of each part of spinal cord with its structure;		*	
		17.4.4	describe peripheral nervous system;		*	
		17.4.5	differentiate between sympathetic and parasympathetic nervous system;		*	
		17.4.6	describe nervous disorders, i.e. Parkinson's disease, epilepsy and Alzheimer's disease;		*	
		17.4.7	discuss effects of drugs (nicotine and caffeine) on nervous activity;		*	
17.5	Chemical Coordination	17.5.1	describe chemical nature of hormones;		*	
		17.5.2	differentiate between nervous and chemical coordination;		*	
		17.5.3	explain endocrine glands of mammals, hormones secreted from them and their disorders;		*	
		17.5.4	exemplify feedback mechanism with reference to endocrine glands;		*	
		17.5.5	discuss the role of reproductive hormones that cause infertility in males and females;		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			K	U	A
	Students should be able to:				
17.6 Behaviour	17.6.1	define animal behaviour;	*		
	17.6.2	differentiate between innate and learned behaviour;		*	
	17.6.3	exemplify types of innate behaviour, i.e. orientation, reflexes and instincts;		*	
	17.6.4	explain types of learned behaviour through examples and experiments performed, i.e. a. imprinting b. habituation c. conditioned reflex type I d. conditioned reflex type II/ latent learning e. insight learning.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
18. Reproduction		Students should be able to:				
18.1	Asexual Reproduction in Plants	18.1.1	define asexual reproduction and sexual reproduction in plants;	*		
		18.1.2	explain role of mitosis and meiosis in reproduction;		*	
		18.1.3	describe advantages and disadvantages of asexual reproduction;		*	
		18.1.4	describe importance of asexual reproduction;		*	
		18.1.5	exemplify natural and artificial methods of reproduction in plants, i.e. a. vegetative reproduction b. parthenocarpy c. apomixes;		*	
		18.1.6	describe the process of fruit ripening in plants;		*	
18.2	Photoperiodism	18.2.1	define photoperiodism, long day, short day and day neutral plants;	*		
		18.2.2	describe mechanism of photoperiodism with respect to mode of action of phytochromes;		*	
		18.2.3	differentiate between florigan and phytochromes;		*	
18.3	Sexual Reproduction in Plants	18.3.1	describe salient features in the life cycle of gymnosperms;		*	
		18.3.2	explain the structure of flower, pollination and its different types;		*	
		18.3.3	describe alternation of generation in plants;		*	
		18.3.4	explain process of sexual reproduction in angiosperms;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
18.4	Germination in Plants	18.4.1	describe seed dormancy;		*	
		18.4.2	explain epigeal and hypogeal germination of seeds;		*	
		18.4.3	explain process of vernalisation;		*	
18.5	Asexual Reproduction in Animals	18.5.1	exemplify different types of asexual reproduction in animals, i.e. a. fission b. budding c. regeneration d. parthenogenesis;		*	
		18.5.2	differentiate between identical and fraternal twins;		*	
18.6	Sexual Reproduction in Animals	18.6.1	differentiate between: a. asexual and sexual reproduction b. spermatogenesis and oogenesis c. unisexual and bisexual animals d. oviparity and viviparity;		*	
		18.6.2	relate external and internal fertilisation with the habitat of animals;		*	
		18.6.3	describe male and female reproductive system of humans;		*	
		18.6.4	explain different stages of reproductive cycle and its hormonal control in human female;		*	
		18.6.5	differentiate between menstrual cycle and oestrous cycle;		*	
		18.6.6	define conception, implantation, pregnancy and gestation;	*		
		18.6.7	describe the roles of placenta, umbilical cord and extra-embryonic coats;		*	
		18.6.8	explain the role of different hormones in birth;		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			K	U	A
	Students should be able to:				
	18.6.9	define lactation and colostrum;	*		
	18.6.10	explain in-vitro fertilisation;		*	
	18.6.11	describe causes, symptoms and prevention of sexually transmitted diseases, i.e. a. gonorrhoea b. syphilis c. genital herpes d. acquired immune deficiency syndrome (AIDS);		*	
	18.6.12	differentiate between spontaneous and induced abortion.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
19. Growth and Development		Students should be able to:				
19.1	Introduction	19.1.1	differentiate between: a. growth and development b. embryo and larva;		*	
19.2	Growth and Development in Plants	19.2.1	define growth and meristem in plants;	*		
		19.2.2	describe the types of meristem in plants;		*	
		19.2.3	state the roles of meristem in the development of plants;	*		
19.3	Phases of Growth in Plants	19.3.1	explain primary and secondary growth in plants;		*	
		19.3.2	describe phases of growth in plants;		*	
		19.3.3	discuss the external and internal factors affecting the growth rate in plants;		*	
		19.3.4	define cell differentiation and correlations;	*		
		19.3.5	explain growth correlation effects in plants;		*	
19.4	Growth and Development in Animals	19.4.1	describe process of development in vertebrates;		*	
		19.4.2	describe the key events which occur during development of animals;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
19.5	Development of Chick	19.5.1	differentiate between animal and vegetal pole of avian (hen) egg;		*	
		19.5.2	describe the cleavage pattern of avian (hen) egg;		*	
		19.5.3	describe development of chick up to three germinal layers;		*	
		19.5.4	explain the stages of chick development, i.e. a. morula formation b. blastulation c. gastrulation d. notochord formation e. neurulation f. somites and coelom formation;		*	
19.6	Cell Differentiation and its Mechanism	19.6.1	explain the role of cytoplasm in development through experiments performed on ascidians larva;		*	
		19.6.2	explain the role of nucleus in development through experiments performed on *Acetabularia*;		*	
		19.6.3	explain cell differentiation with examples;		*	
		19.6.4	explain embryonic induction as investigated by Hans Spemann and Hilde Mangold;		*	
		19.6.5	list genetic and extrinsic factors responsible for aging;	*		
		19.6.6	exemplify regeneration in invertebrates and vertebrate;		*	
19.7	Abnormal Development	19.7.1	state abnormalities inherited from parent to offspring;	*		
		19.7.2	relate different environmental and metabolic factors with abnormal development.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
20. Chromosomes and DNA		Students should be able to:				
	20.1 Structure and Types of Chromosomes	20.1.1	define chromosomes with examples of some organisms with different number of chromosomes (penicillium, corn, sugarcane, mosquito, honey bee, mouse and human being);	*		
		20.1.2	differentiate among types of chromosomes, i.e. a. autosomes and sex chromosomes b. homologous and non-homologous chromosomes, c. telocentric, acrocentric, metacentric and sub-metacentric chromosomes;		*	
		20.1.3	describe levels of eukaryotic chromosomal organisation;		*	
		20.1.4	describe chromosome karyotype;		*	
		20.1.5	differentiate between heterochromatin and euchromatin;		*	
	20.2 Chromosomal Theory of Inheritance	20.2.1	trace chromosomal theory of inheritance from Karl Correns 1900 to Thomas Hunt Morgan 1910;		*	
		20.2.2	infer chromosomal theory of inheritance by Hunt Morgan 1910;			*
	20.3 DNA as the Hereditary Material	20.3.1	explain deoxyribonucleic acid (DNA) as a heredity material with reference to the experiments conducted by Frederick Griffith, Colin Macleod and Maclyn McCarty and Alfred Hershey and Martha Chase;		*	
		20.3.2	describe the model of DNA as proposed by Watson and Crick;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
20.4	DNA Replication	20.4.1	illustrate semi-conservative replication of DNA;			*
20.5	Gene Expression	20.5.1	describe gene and genetic code;		*	
		20.5.2	describe one gene-one enzyme hypothesis;		*	
		20.5.3	explain mechanism of protein synthesis by means of DNA and RNA;		*	
20.6	Mutations	20.6.1	describe types of mutation;		*	
		20.6.2	differentiate between chromosomal aberration and gene mutation;		*	
		20.6.3	describe chromosomal aberration and its effects;		*	
		20.6.4	discuss gene mutation and its causes, i.e. a. ionisation radiation b. ultraviolet radiation c. chemical mutagens;		*	
		20.6.5	describe sickle cell anaemia and phenylketonuria.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
21. Cell Cycle		Students should be able to:				
21.1	Phases of Cell Cycle	21.1.1	define cell cycle;	*		
		21.1.2	differentiate between interphase and M-phase;		*	
		21.1.3	explain changes occurring during G_1 phase, G_o phase, S-phase and G_2-phase;		*	
		21.1.4	exemplify amitotic cell division, cell death, necrosis and apoptosis;		*	
		21.1.5	differentiate between karyokinesis and cytokinesis;		*	
21.2	Mitosis	21.2.1	define mitosis;	*		
		21.2.2	describe different stages of mitosis;		*	
		21.2.3	describe the significance of mitosis;		*	
		21.2.4	describe cancer as uncontrolled cell division;		*	
21.3	Meiosis	21.3.1	define meiosis;	*		
		21.3.2	describe different stages of meiosis;		*	
		21.3.3	describe the significance of meiosis;		*	
21.4	Meiotic Errors (Non-disjunction)	21.4.1	describe meiotic errors (non-disjunction) and its types;		*	
		21.4.2	describe Down's syndrome, Klinefelter's syndrome and Turner's syndrome.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
22. Variation and Genetics		Students should be able to:				
22.1	Gene and Allele	22.1.1	define gene, loci, alleles, gene pool, phenotype, genotype, homozygous, heterozygous, dominant and recessive;	*		
22.2	Mendel's Law of Inheritance	22.2.1	state characteristics of pea plant used by Gregor Mendel in his experiment;	*		
		22.2.2	explain Mendel's law of dominance, i.e. a. law of segregation and b. law of independent assortment;		*	
		22.2.3	explain the purpose and methods of a test cross;		*	
		22.2.3	illustrate Mendel's laws through genetic crosses;			*
22.3	Incomplete Dominance and Co-dominance	22.3.1	illustrate through crosses, incomplete dominance and co-dominance with suitable examples;			*
22.4	Multiple Allele	22.4.1	describe multiple alleles with reference to ABO blood group system;		*	
		22.4.2	describe Rh factor in blood group;		*	
		22.4.3	discuss the role of Rh factor in erythroblastosis foetalis and its prevention in newborns;		*	
		22.4.4	describe epistasis, dominant and recessive epistasis;		*	
		22.4.5	exemplify pleiotropy;		*	
		22.4.6	exemplify polygenic inheritance;		*	
22.5	Linkage and Crossing over	22.5.1	describe linkage and crossing using the examples of drosophila;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
22.6	Sex Determination and Sex Linkage	22.6.1	describe the patterns of sex determination with examples, i.e. a. XO-XX type b. XY-XX type c. ZZ-ZW type;		*	
		22.6.2	compare chromosomal determination of sex between drosophila and human;		*	
		22.6.3	describe sex-linked inheritance in drosophila;		*	
		22.6.4	illustrate sex-linked inheritance in human, i.e. a. colour blindness b. haemophilia;			*
22.7	Genetic Disorder	22.7.1	describe diabetes mellitus as a genetic disorder;		*	
		22.7.2	differentiate between type I and type II of diabetes mellitus.		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			K	U	A
23. Biotechnology	Students should be able to:				
23.1 Introduction to Biotechnology	23.1.1	define biotechnology;	*		
	23.1.2	describe the importance of biotechnology;		*	
23.2 Genetic Engineering	23.2.1	explain steps of genetic engineering through recombinant DNA technology, i.e. a. isolation of the gene of interest b. amplifying the gene of interest c. insertion of the gene of interest in bacteria d. cloning of recombinant DNA;		*	
	23.2.2	explain: a. polymerase chain reactions (denaturation, annealing and extension) as a technique to amplify the gene of interest b. genome library as a collection of DNA fragments c. gel electrophoresis as a technique to analyse proteins and nucleic acids d. dideoxy chain termination method as a technique to determine the sequence of DNA fragments;		*	
23.3 Applications of Genetic Engineering	23.3.1	describe the applications of: a. polymerase chain reaction b. DNA fingerprinting;		*	
	23.3.2	describe the goals and significance of the Human Genome Project;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
23.4	Biotechnology and Health	23.4.1	describe the process of amniocentesis in the diagnosis of diseases;		*	
		23.4.2	describe genetic diseases a. Huntington's disease b. cystic fibrosis;		*	
		23.4.3	describe the process of gene therapy in the treatment of genetic diseases, i.e. a. Huntington's disease b. cystic fibrosis;		*	
		23.4.4	discuss the applications of: a. genetic counselling b. tissue culture c. cloning;		*	
23.5	Biotechnology and Agriculture	23.6.1	describe genetically modified organisms;		*	
		23.6.2	discuss the role of biotechnology in improving the quality and yield of crops;		*	
		23.6.2	discuss the social and ethical aspects of genetic engineering.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
24. Evolution		Students should be able to:				
24.1	Introduction	24.1.1	define organic evolution and give reference of Quranic verses (Al-Quran-6:98, 37:11, 4:1, 51:49);	CA		
		24.1.2	differentiate between evolution and special creation;		*	
		24.1.3	trace evolution from prokaryotes to eukaryotes;		*	
24.2	Theories of Evolution	24.2.1	describe inheritance of acquired characters as proposed by Lamarck;		*	
		24.2.2	discuss the objections put forward on Lamarck's theory;		*	
		24.2.3	describe Darwin's theory and the modern theory of evolution;		*	
24.3	Evidences of Evolution	24.3.1	describe evidences of organic evolution, i.e. a. biogeography b. paleontology c. comparative anatomy d. comparative embryology e. biochemistry;		*	
		24.3.2	differentiate between convergent and divergent evolution on the basis of inheritance of homologous and analogous structures;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
24.4	Mechanism of Evolution	24.4.1	compare artificial selection and natural selection;		*	
		24.4.2	explain natural selection as a possible mechanism for evolution;		*	
		24.4.3	discuss the role of artificial selection in the production of economically important plants and animals and controlled breeding;		*	
		24.4.4	define gene pool, allele, genotype and gene frequency;	*		
		24.4.5	describe gene frequency and its role in evolution;		*	
		24.4.6	describe factors affecting gene frequency;		*	
		24.4.7	explain Hardy Weinberg law and its implications;		*	
		24.4.8	solve problems related to gene frequencies using the Hardy Weinberg equation.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
25. Ecosystem		Students should be able to:				
25.1	Introduction	25.1.1	define ecosystem, population, community, environment, habitat, niche, biome and biosphere;	*		
		25.1.2	differentiate between autecology and synecology;		*	
25.2	Components of Ecosystem	25.2.1	differentiate between abiotic and biotic components;		*	
		25.2.2	identify climatic, topographic and edaphic factors;		*	
		25.2.3	differentiate among producers, consumers and decomposers in an ecosystem;		*	
		25.2.4	differentiate between positive and negative ecological interactions;		*	
		25.2.5	exemplify the types of ecological interactions, i.e. a. positive ecological interactions i. mutualism ii. commensalism b. negative ecological interactions i. parasitism ii. competition iii. predation;		*	
25.3	Biogeochemical Cycles	25.3.1	describe nitrogen cycle;		*	
		25.3.2	discuss factors causing nitrogen depletion and its remedies;		*	
		25.3.3	describe energy flow in an ecosystem;		*	
		25.3.4	construct pyramids of energy, biomass and number;			*
		25.3.5	differentiate among primary productivity, gross primary and net primary productivity;		*	
		25.3.6	describe advantages of short food chain;		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			K	U	A
	Students should be able to:				
25.4 Ecological Succession	25.4.1	define succession;	*		
	25.4.2	differentiate between primary and secondary succession;		*	
	25.4.3	describe main stages involved in hydrarch and xerarch;		*	
	25.4.4	describe the concept of climax in an ecosystem.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
26. Some Major Ecosystems		Students should be able to:				
26.1	Fresh Water Ecosystem	26.1.1	explain abiotic and biotic components of fresh water ecosystem;		*	
26.2	Lake Ecosystem	26.2.1	explain zonation in fresh water and their abiotic and biotic components;		*	
26.3	Terrestrial Ecosystem	26.3.1	describe abiotic and biotic components of forest ecosystems, i.e. a. tropical rain forest b. coniferous forest c. temperate deciduous forest;		*	
		26.3.2	explain grass land ecosystem;		*	
		26.3.3	describe biotic and abiotic components of savannah;		*	
		26.3.4	explain desert ecosystem (desert biome);		*	
		26.3.5	explain tundra ecosystem.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
27. Man and his Environment		Students should be able to:				
27.1	Resources	27.1.1	define renewable and non-renewable resources;	*		
		27.1.2	exemplify types of renewable and non-renewable resources;		*	
27.2	Man's Impact on Environment	27.2.1	discuss degradation and depletion of resources;		*	
		27.2.2	describe the characteristics of population, i.e. a. growth b. density c. distribution d. carrying capacity;		*	
		27.2.3	relate the effects of rising population on food resources;		*	
		27.2.4	discuss the need of population control;		*	
27.3	Pollution	27.3.1	define pollution;	*		
		27.3.2	explain different types of pollution, i.e. a. air pollution b. land pollution c. water pollution;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
27.4	Protection and Conservation of Environment and Biodiversity	27.4.1	discuss strategies for the management of: a. natural resources b. pollution free environment c. recycling of waste d. biodiversity;		*	
		27.4.2	describe bioremediation as an effective and economic way to control pollution;		*	
		27.4.3	differentiate between deforestation and afforestation;		*	
		27.4.4	discuss the factors causing species to become endangered and their risk for extinction;		*	
		27.4.5	explore the endangered species of Pakistan mentioned in The IUCN (International Union for Conservation of Nature) Red List;			CA
27.5	Health and Diseases	27.5.1	classify diseases as infectious, parasitic, nutritional, genetic and diseases related to aging (cause, transmission and control).		*	

Scheme of Assessment

Grade XI

Table 1: Number of Student Learning Outcomes by Cognitive Level

Topic No.	Topics	No. of Sub Topics	SLOs			Total
			K	U	A	
1.	Introduction to Biology	4	0	5	0	5
2.	Biological Molecules	8	10	20	5	35
3.	Enzymes	6	1	10	2	13
4.	The Cell	4	0	4	1	5
5.	Classification and Acellular Life	9	3	13	0	16
6.	Kingdom Prokaryotae	10	4	16	0	20
7.	Kingdom Protista	5	2	8	0	10
8.	Kingdom Fungi	4	0	8	0	8
9.	Kingdom Plantae	6	2	16	0	18
10.	Kingdom Animalia	13	1	40	0	41
11.	Bioenergetics	3	5	10	0	15
12.	Nutrition	4	2	14	0	16
13.	Gaseous Exchange	4	1	13	0	14
14.	Transport	9	8	32	2	42
	Total	**89**	**39**	**209**	**10**	**258**
	Percentage		**15**	**81**	**4**	**100**

Table 2: Exam Specifications

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

Grade XII

Table 3: Number of Student Learning Outcomes by Cognitive Level

Topic No.	Topics	No. of Sub Topics	SLOs			Total Marks
			K	U	A	
15.	Homeostasis	9	4	24	0	28
16.	Support and Movement	6	3	33	0	36
17.	Co-ordination and Control	6	4	26	1	31
18.	Reproduction	6	4	26	0	30
19.	Growth and Development	7	5	18	0	23
20.	Chromosomes and DNA	6	1	15	2	18
21.	Cell Cycle	4	3	11	0	14
22.	Variation and Genetics	7	2	14	3	19
23.	Biotechnology	5	1	12	0	13
24.	Evolution	4	1	13	1	15
25.	Ecosystem	4	2	14	1	17
26.	Some Major Ecosystems	3	0	9	0	9
27.	Man and his Environment	5	2	12	0	14
	Total	**72**	**32**	**227**	**8**	**267**
	Percentage		**12**	**85**	**3**	**100**

Table 4: Exam Specifications

Topic No.	Topics	Marks Distribution			Total Marks
		MCQs	CRQs	ERQs	
15.	Homeostasis	5	Total 3 Marks (1 CRQ)	7 Marks Choose any ONE from TWO	22
16.	Support and Movement	5	Total 2 Marks (1 CRQ)		
17.	Co-ordination and Control	5	Total 2 Marks (1 CRQ)	7 Marks Choose any ONE from TWO	21
22.	Variation and Genetics	5	Total 2 Marks (1 CRQ)		
18.	Reproduction	3	Total 2 Marks (1 CRQ)		10
19.	Growth and Development	3	Total 2 Marks (1 CRQ)		
20.	Chromosomes and DNA	4	Total 2 Marks (1 CRQ)		13
21.	Cell Cycle	4	Total 3 Marks (1 CRQ)		
23.	Biotechnology	4	Total 3 Marks (1 CRQ)		7
24.	Evolution	4			4
25.	Ecosystem	3			8
26.	Some Major Ecosystems	3			
27.	Man and his Environment	2			
	Total	**50**	**21**	**14**	**85**
	Practical*				**15**
	Total				**100**

- 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.

- Tables 1 and 3 indicate the number and nature of SLOs in each topic in grades XI and XII. This will serve as a guide in the construction of the examination paper. It also indicates that more emphasis has been given to Understanding (81% in HSSC I and 85% in HSSC II), Application and higher order skills (4% in HSSC I and 3% in HSSC II) to discourage rote memorisation. Tables 1 and 2 however do not translate directly into marks.
- There will be two examinations, one at the end of grade XI and one at the end of grade XII.
- In each grade, the theory paper will be in two parts: paper I and paper II. Both papers will be of duration of 3 hours.
- Paper I theory will consist of 50 compulsory, multiple choice items. These questions will involve four response options.
- Paper II theory will carry 35 marks and consist of a number of compulsory, structured questions and a number of extended response questions. Each extended response question will be presented in an either/or form.
- All constructed response questions will be in a booklet which will also serve as an answer script.

***Practical:**

- In each grade, practical examination will be conducted separate from the theory paper and will consist of 15 marks.
- Practical examination 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.
- 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.
- 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.

Annex A: Practical Activities

Grade XI

S. No.	SLO No.	OBJECTIVE	APPARATUS/ SLIDE/ MATERIAL	CHEMICALS
		Topic 2: Biological Molecules		
1.	2.4.2	Performing Benedict's test for reducing sugar and confirmation of the presence of starch through iodine test	Bunsen burner, test tubes, test tube stand, test tube holder, dropper, tripod stand, wire gauze, graduated pipettes, beaker	Solutions of glucose, starch, Benedict's solution, iodine solution
2.	2.5.2	Confirmation of the presence of lipids through emulsion test	Test tubes	A fat source (coconut oil/ peanuts), ethyl alcohol, distilled water
3.	2.6.3	Confirmation of the presence of proteins through Biuret test	Bunsen burner, test tubes, test tube stand, test tube holder, dropper, tripod stand, wire gauze, graduated pipettes, beaker	5% sodium hydroxide solution, 1% copper sulphate solution
		Topic 3: Enzymes		
4.	3.4.1	Performing amylase test on starch with boiled amylase and un-boiled amylase in separate test tubes and confirmation through iodine test	Bunsen burner, test tubes, test tube stand, test tube holder, dropper, tripod stand, wire gauze, graduated pipettes, beaker	Starch, amylase solution, iodine solution
		Topic 4: The Cell		
5.	4.4.1	Preparation and examination of the slides of animal cells (frog epithelial cells) and plant cells (onion epidermal and leaf epidermis)	Microscope, glass slide, nichrome wire, blade, cover slip and dropper	Any dye

S. No.	SLO No.	OBJECTIVE	APPARATUS/ SLIDE/ MATERIAL	CHEMICALS
		Topic 6: Kingdom Prokaryotae		
6.	6.2.4	Staining bacteria using Gram staining technique	Microscope, glass slide, nichrome wire, Bunsen burner, cover slip, dropper	Crystal violet, iodine, safranin, alcohol, distilled water, immersion oil
7.	6.10.2	Study of nostoc from fresh or preserved material	Specimen of nostoc	-
		Topic 7: Kingdom Protista		
8.	7.3.1	Observation and drawing of representative members of each group of protists	Slide of amoeba, euglena, paramaecium, chlorella, spirogyra and microscope	-
		Topic 8: Kingdom Fungi		
9.	8.1.1 8.2.1	Study of mushroom from fresh or preserved material and prepare temporary slides of fungi	Specimen of mushroom, Preserved sample/ culture of rhizopus, yeast and penicillium, microscope, glass slide, nichrome wire, Bunsen burner, cover slip, dropper	Any dye
		Topic 9: Kingdom Plantae		
10.	9.2.2	Study the morphology of male and female plant of marchantia	Specimen of male and female plant of marchantia	-
11.	9.4.2	Study the morphology of male and female cones of pinus	Specimen of male and female cones of pinus	-

S. No.	SLO No.	OBJECTIVE	APPARATUS/ SLIDE/ MATERIAL	CHEMICALS
12.	9.5.1	Describing the flowers of Rosa indica, Cassia fistula, Acacia nilotica, Solanum nigrum/ Datura alba and Avena sativa/ Clitoria ternatea	Flowers of Rosa indica, Cassia fistula, Acacia nilotica, Solanum nigrum/ Datura alba and Avena sativa/ Clitoria ternatea	-
		Topic 10: Kingdom Animalia		
13.	10.4.1 – 10.13.14	Study the specimen/ model of invertebrates and vertebrates	Specimen of sycon, hydra/ obelia, liver fluke/ planaria, tapeworm, roundwork, earthworm, leech, crab, butterfly/ wasp, spider, mussel, snail/ slug, brittle star/ sea star specimen/ model of fish, frog/ toad, lizard/ snake, bird, mouse/ squirrel	-
		Topic 11: Bioenergetics		
14.	11.2.2	Extraction of the leaf pigments and their separation by 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	Pigment solution, 80% acetone, 90% acetone-petroleum, ether mixture (1:9), ethyl alcohol
		Topic 13: Gaseous Exchange		
15.	13.3.1	Examination of goat/ sheep lungs	Goat/ sheep lungs, dissecting tray, pointer	-
		Topic 14: Transport		
16.	14.2.1 14.5.2	Microscopic observation of the slide of transverse section (T.S) of a dicotyledonous stem, identifying and drawing vessel element, vessel and phloem sieve tubes	Slide of T.S of dicotyledonous stem, microscope, needle/ pointer	-

S. No.	SLO No.	OBJECTIVE	APPARATUS/ SLIDE/ MATERIAL	CHEMICALS
17.	14.6.6	Examination of the heart of goat/ sheep and describing its internal structure	Goat/ sheep heart, dissecting tray, pointer	-
18.	14.7.1	Recognising neutrophils and lymphocytes while observing prepared slides	Slides of neutrophils and lymphocytes	-
19.	14.7.9	Measuring blood pressure by using sphygmomanometer	Sphygmomanometer, stethoscope	-

Grade XII

S. No.	SLO No.	OBJECTIVE	APPARATUS/ SLIDE/ MATERIAL	CHEMICALS
		Topic 16: Support and Movement		
1.	16.1.1	Locating annual rings in the log of a tree and calculation of the age of a plant by counting number of annual rings	Log of a tree	-
2.	16.2.5	Demonstration of phototropism and geotropism in plants	Wooden box, potted plant	-
3.	16.4.2	Identification of the bones of the pelvic girdle, pectoral girdle, arms and legs by using the model of human skeleton	Model of human skeleton	-
4.	16.5.3	Preparation of temporary slides of skeletal, smooth and cardiac muscles of frog	Slides, cover slips, forceps, microscope, specimen of frog	dye
		Topic 18: Reproduction		
5.	18.6.3	Identification of different parts of the reproductive system of a female rabbit	Model of reproductive system of a female rabbit	-
6.	18.6.3	Examination of the prepared slides of histology of mammalian ovaries and drawing their structures	Slide of histology of ovaries, microscope	-

S. No.	SLO No.	OBJECTIVE	APPARATUS/ SLIDE/ MATERIAL	CHEMICALS
		Topic 19: Growth and Development		
7.	19.5.2	Identification of the different stages (48 and 72 hours) in chick development using photomicrographs	Photomicrographs of stages of development in chick	-
		Topic 22: Variation and Genetics		
8.	22.2.2	Evaluation of the inheritance of genes and their mixing during fertilisation as based on mathematical probabilities	Dice, note book, pencil	-
9.	22.2.2	Study of continuous variations in the height in man and representing the result as histogram	Drawing paper, pencil, ruler	-
10.	22.4.1	Data collection from the class to see how many individuals have AB blood group and construction of a pie chart for the collected data	Drawing paper, pencil, ruler	-
		Topic 25: Ecosystem		
11.	25.3.5	Investigation of food chains and food web of ecosystem	Samples for different food chains and food webs	-

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