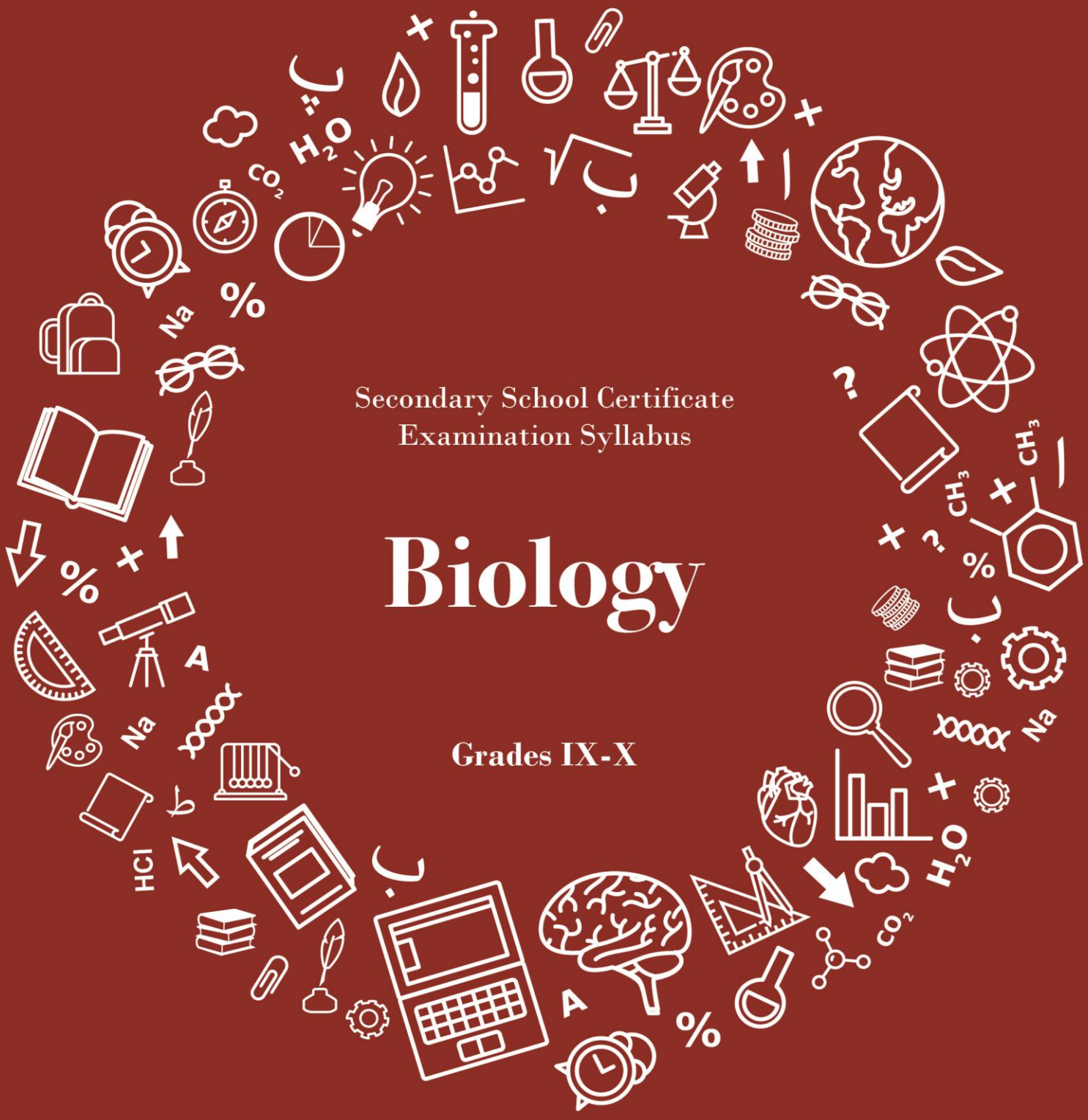
آغا خان یونیورسٹی ایگزامینیشن بورڈ

AGA KHAN UNIVERSITY EXAMINATION BOARD



Secondary School Certificate
Examination Syllabus

Biology

Grades IX-X

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

BIOLOGY

GRADES IX-X

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

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 you to the variety of living organisms and their specific role(s) to maintain distinctive ecosystems.

- Biology brings awareness about the right choice of food in students' daily lives. The concepts of a 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 encourages students to think about leaving a better planet for future 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 focused on 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 on the next page will give you an overview of your entire syllabus. After this, the topics and Student Learning Outcomes (SLOs) will tell you the details about what you have to achieve. And finally, the Exam Specification will tell you what to expect in your examination.

What is the concept map telling you?

Cell, the basic structural and functional unit of life, is used as an analogy to represent the AKU-EB SSC Biology syllabus. Each theme of the syllabus is represented by a part of the cell which symbolises its function; for example, the nucleus is used to denote Continuity in Life. As the nucleus plays an important role in reproduction and inheritance, so the parts of nucleus reveal these two major topics. The use of a cell to develop this concept map is to help students understand the very elementary concept of a cell in biology as well as to help understand the syllabus at a glance.

BIOLOGY

CONCEPT MAP - SSC I & II

MAP KEY
Theme..... BIO
Topic..... Biology
Sub-topic..... • Biology

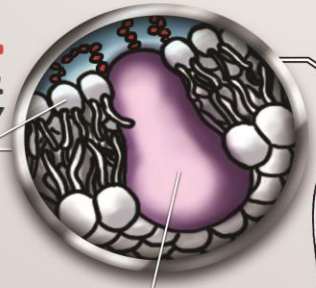
6 APPLICATION OF BIOLOGY

Biotechnology
- Fermentation
- Genetic engineering
- Single cell proteins

Pharmacology
- Medicinal & addictive drugs
- Antibiotics & vaccines

5 ECOLOGY

Man & his Environment
- The ecosystems
- Flow of materials and energy in the ecosystem
- Biogeochemical cycles
- Interactions in the ecosystem
- Ecosystem balance and human impact on environment
- Pollution, its consequences and control
- Conservation of resources

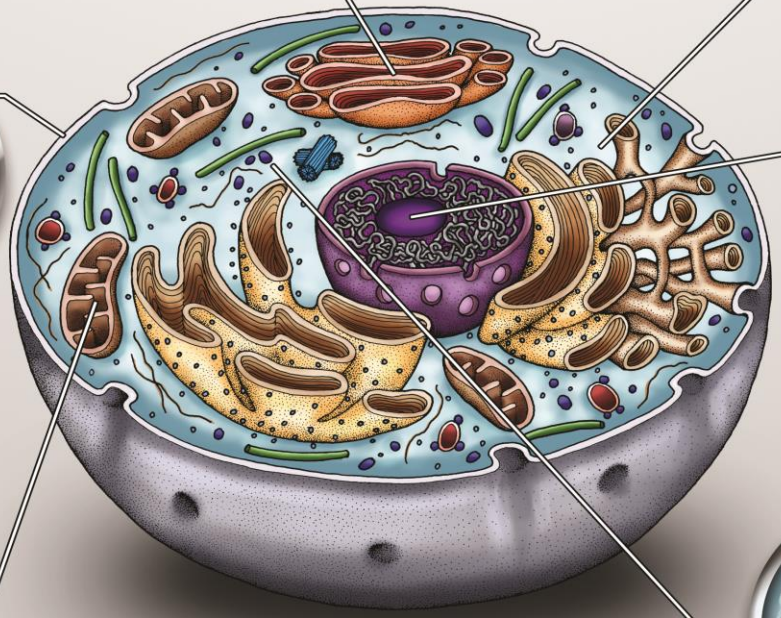


1 STUDY OF LIFE & BIODIVERSITY

Introduction to Biology
- Introduction
- Levels of organisation

Biodiversity
- Classification
- Binomial nomenclature
- 5 – kingdom system
- Conservation of biodiversity

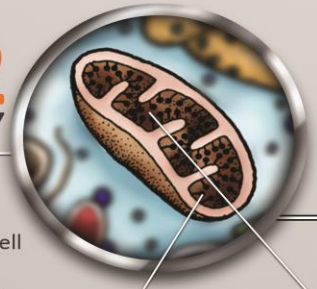
Solving a Biological Problem
- Biological method



4 CONTINUITY IN LIFE

Reproduction
- Reproduction in plants
- Reproduction in animals
- Sexually transmitted diseases

Inheritance
- Chromosomes & genes
- Mendel's laws
- Variation & evolution



2 CELL BIOLOGY

Cell & Tissues
- Microscopy & emergence of cell theory
- Cellular structures & functions
- Passage of molecules
- Tissues

Cell Cycle
- Mitosis
- Meiosis
- Necrosis & apoptosis

Enzymes
- Characteristics of enzymes
- Factors affecting activity of enzymes
- Mechanism of enzyme action

Bioenergetics
- Photosynthesis
- Respiration

3 LIFE PROCESSES

Homeostasis
- Homeostasis in plants
- Homeostasis in man
- Urinary system of man
- Disorders of human excretory system

Gaseous Exchange
- Gaseous exchange in plants
- Gaseous exchange in man
- Respiratory disorders
- Effects of smoking

Support & Movement
- Human skeleton
- Muscles
- Disorders of skeleton
- Movement in plants

Coordination & Control
- Types of coordination
- Human nervous system
- Receptors of man
- Endocrine system
- Nervous disorders

Nutrition & Digestion
- Nutrition in plants
- Nutrition in animals
- Digestion in man
- Disorders of gut

Transport
- Transport in plants
- Transport in animals

Student Learning Outcomes of AKU-EB SSC Biology Syllabus

Part I (Grade IX)

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level[1]		
				K	U	A
1. Introduction to Biology		Students should be able to:				
1.1	Introduction to Biology	1.1.1 1.1.2	define biology; differentiate among the major divisions of biology, i.e. botany, zoology and microbiology;	*	*	
1.2	Divisions and Branches of Biology	1.2.1	discuss the significance of the branches of biology, i.e. morphology, anatomy, physiology, embryology, taxonomy, cell biology, histology, palaeontology, environmental biology, biotechnology, sociobiology, parasitology, immunology, entomology, genetics and pharmacology with suitable examples;		*	
1.3	Relationship of Biology to Other Science Subjects	1.3.1	relate biology to other branches of science (physics, chemistry, mathematics, geography and economics) using suitable examples from daily life;		*	
1.4	Scope of Biological Studies	1.4.1	recognise the contribution of biology in medicine and surgery, fisheries, agriculture, animal husbandry, biotechnology, horticulture, farming and forestry;		*	
1.5	Study of Life from the Perspective of the Holy Quran	1.5.1	explain instructions about the origin and the characteristics of life given in the verses (*Sura-e-Ambia*, verse: 30, *Sura-e-Rehman*, verse 14, *Sura-e-Al-Mominoon*, verse 14, *Sura-e-Al-Nur*, verse 45) of the Holy Quran;		CA[2]	

[1] K = Knowledge, U = Understanding, A = Application and other higher-order cognitive skills
[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:				
1.6	Contribution of Scientists	1.6.1	state the contributions of *Abdul Malik Asmai* and *Bu Ali Sina* in the field of biology;	CA		
1.7	The Levels of Organisation	1.7.1	describe bioelements as the most basic level of biological organisation;		*	
		1.7.2	describe biomolecules and their types, i.e. micromolecules and macromolecules (on the basis of molecular mass);		*	
		1.7.3	differentiate among the levels of organisation of life (organelles, cells, tissues, organs, organ systems and individuals);		*	
1.8	Unicellular and Multicellular Organisms	1.8.1	differentiate between unicellular and multicellular organisms;		*	
		1.8.2	describe cellular organisation in unicellular organisms, i.e. amoeba;		*	
		1.8.3	discuss the concept of division of labour;		*	
		1.8.4	describe cellular organisation in multicellular organisms (any dicotyledonous plant and frog) [Only brief description referring to cellular organisation is required. Details of organs and organ-systems of frog and plant should be avoided].		*	

Topics and Sub-topics		Student Learning Outcomes	Cognitive Level		
			K	U	A
2. Solving a Biological Problem		Students should be able to:			
2.1 Biological Method	2.1.1	explain steps involved in the biological method, i.e. recognition of a biological problem, observation (qualitative and quantitative), building up hypotheses, drawing deductions, devising experiments, inferring results, proposing theory and putting forward law/ principle (malaria can be taken as an example);		*	
	2.1.2	solve a biological problem following the scientific method; a. formulate a working hypothesis; b. write instructions for conducting investigations or following a procedure; c. select appropriate instruments and materials to conduct an investigation; d. demonstrate safety rules in the laboratory; e. organise data appropriately using techniques such as tables and graphs; f. analyse data to make predictions, decisions or draw conclusions; g. confirm, modify or reject a hypothesis using data analysis.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
3. Biodiversity		Students should be able to:				
3.1	Introduction	3.1.1	define biodiversity;	*		
		3.1.2	recognise importance of biodiversity for producing food, obtaining drugs, getting industrial products, maintaining ecosystems and recycling nutrients;		*	
3.2	Aims and Principles of Classification	3.2.1	describe aims and principles of classification;		*	
		3.2.2	describe basis of classification of living organisms with reference to homology and analogy;		*	
3.3	History of Classification Systems	3.3.1	state contribution of Aristotle in biological classification;	CA		
		3.3.2	describe basis for establishing five kingdoms;		*	
		3.3.3	compare two-kingdom and five-kingdom classification systems;		*	
		3.3.4	discuss how the five-kingdom classification system better explains diversity of living organisms;		*	
		3.3.5	state contribution of *Abu Usman Umer Aljahiz* in unfolding the characteristics of animal species;	CA		
3.4	Units of Classification	3.4.1	exemplify units of classification (species, genus, family, order, class, division/ phyla, kingdom);		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
3.5	The Five Kingdoms	3.5.1	describe the general structure of virus;		*	
		3.5.2	justify why viruses are excluded from the five-kingdom classification system;		*	
		3.5.3	describe salient features of prokaryotes taking bacteria as an example;		*	
		3.5.4	describe salient features of protists taking chlamydomonas and paramecium as examples;		*	
		3.5.5	describe salient features of fungi taking Rhizopus as an example;		*	
		3.5.6	differentiate among plants (mosses, ferns, monocots and dicots) based on their salient features;		*	
		3.5.7	differentiate among invertebrates (sycon, jellyfish, tapeworm, roundworm, earthworm, snail, butterfly and sea star) based on their salient features;		*	
		3.5.8	differentiate among vertebrates (fish, frog, lizard, bird and cat) based on their salient features;		*	
3.6	Binomial Nomenclature	3.6.1	describe aims and principles of binomial nomenclature with examples;		*	
3.7	Conservation of Biodiversity	3.7.1	discuss conservation for the sustainability of nature;		*	
		3.7.2	identify causes of deforestation and over-hunting;		*	
		3.7.3	discuss the impact of human activities such as deforestation, over-hunting, introduction or removal of a species and pollution on biodiversity;		*	
		3.7.4	list some animal species which have become endangered or are extinct due to human interference.	*		

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
4. Cells and Tissues		Students should be able to:				
4.1	Microscopy and the Emergence of Cell Theory	4.1.1	compare light microscope and electron microscope;		*	
		4.1.2	trace development of the cell theory from Aristotle to Robert Hooke, Antonie van Leeuwenhoek, Robert Brown and Schwann and Schleiden;		*	
4.2	Cellular Structures and Functions	4.2.1	describe structure, composition and function of the components of a plant cell (cell wall, cell membrane, nucleus, cytoplasm, Golgi bodies, mitochondria, vacuole, ribosomes, endoplasmic reticulum and plastids);		*	
		4.2.2	describe structure, composition and function of the components of an animal cell (cell membrane, nucleus, cytoplasm, Golgi bodies, mitochondria, lysosomes, vacuole, ribosomes, endoplasmic reticulum and centrioles);		*	
		4.2.3	compare plant and animal cell;		*	
		4.2.4	relate structure of specialised cells with their function (for absorption - root hair cells; for conduction and support - xylem vessels; for transport of oxygen - red blood cells);		*	
		4.2.5	compare the structure of prokaryotic and eukaryotic cells;		*	
		4.2.6	calculate surface area to volume ratio to find out its relationship with cell size;			*
		4.2.7	relate surface area to volume ratio with cell size (e.g. root hair cell in plants and nerve cell in animals);		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
4.3	Active and Passive Transport of Matter	4.3.1	differentiate among hypertonic solution, hypotonic solution and isotonic solution with examples;		*	
		4.3.2	differentiate among different types of membranes (permeable, partially permeable and impermeable);		*	
		4.3.3	compare the phenomena of diffusion, facilitated diffusion, osmosis, active transport, endocytosis and exocytosis with examples;		*	
		4.3.4	compare passive transport with active transport (e.g. diffusion of glucose from intestine to villus epithelium and active transport of sodium ions from nerve cell to outside);		*	
		4.3.5	describe importance of turgor for cells;		*	
		4.3.6	differentiate between the phenomena of plasmolysis and deplasmolysis;		*	
4.4	Tissues (Types of Plant and Animal Tissues)	4.4.1	describe tissue as a group of cells with similar size, shape and function;		*	
		4.4.2	differentiate between simple and compound tissues;		*	
		4.4.3	compare major animal tissues (epithelial, connective, muscular and nervous) in terms of their cell specificities, locations and functions;		*	
		4.4.4	compare major plant tissues, i.e. simple tissues (meristematic tissues and permanent tissues including epidermal, parenchyma, collenchyma and sclerenchyma) and compound tissues (xylem and phloem) in terms of their cell specificities, locations and functions;		*	
		4.4.5	justify why a colony of cells does not get tissue level of organisation, in spite of having many cells.			*

Topics and Subtopics		Student Learning Outcomes		Cognitive Level		
				K	U	A
5. Gaseous Exchange		Students should be able to:				
5.1	Introduction	5.1.1	differentiate between respiration and breathing;		*	
5.2	Gaseous Exchange in Plants	5.2.1	compare photosynthesis and respiration in plants;		*	
5.3	Gaseous Exchange in Human Beings	5.3.1	identify organs of the respiratory system in human being;		*	
		5.3.2	relate the structure of each part of respiratory system with its function;		*	
		5.3.3	explain the adaptation of alveoli for gaseous exchange by diffusion between air in the lungs and blood in the capillaries;		*	
		5.3.4	describe mechanism of breathing in terms of movement of ribs and diaphragm;		*	
		5.3.5	determine the effect of exercise on the rate of breathing;			*
		5.3.6	differentiate between the composition of inspired and expired air;		*	
5.4	Respiratory Disorders	5.4.1	describe diseases related to respiratory system (bronchitis, emphysema, pneumonia, asthma and lung cancer) with their causes, symptoms, treatment and prevention;		*	
		5.4.2	describe the effects of smoking on lungs and circulatory system.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
6. Enzymes		Students should be able to:				
6.1	Characteristics of Enzymes	6.1.1	define metabolism;	*		
		6.1.2	differentiate between catabolism and anabolism with examples;		*	
		6.1.3	describe enzymes as the proteins that speed up biochemical reactions;		*	
		6.1.4	explain how enzymes increase rate of reaction by lowering energy of activation;		*	
		6.1.5	explain how small quantity of an enzyme is effective for large amount of a substrate;		*	
		6.1.6	explain that enzymes are specific for specific substrates due to their shape;		*	
		6.1.7	explain how some enzymes require cofactor for their functioning;		*	
		6.1.8	differentiate between intracellular and extracellular enzymes with examples;		*	
6.2	Factors affecting Activity of Enzymes	6.2.1	relate pH, temperature and concentration of substrate with enzyme activity;		*	
		6.2.2	illustrate the graphical representation of effect of pH, temperature and concentration of substrate on the activity of an enzyme;			*
6.3	Mechanism of Enzyme Action	6.3.1	describe, through equation, that enzyme substrate complex is formed and the release of enzyme takes place after completing the reaction;		*	
		6.3.2	differentiate between the lock and key model and induced-fit model of enzyme action;		*	

Topics and Subtopics		Student Learning Outcomes		Cognitive Level		
				K	U	A
7. Bioenergetics		Students should be able to:				
7.1	Bioenergetics	7.1.1	define bioenergetics;	*		
		7.1.2	describe the importance of oxidation-reduction reactions for the flow of energy through living systems;		*	
		7.1.3	describe adenosine triphosphate (ATP) as the chief energy currency of all cells;		*	
		7.1.4	describe synthesis and breaking of ATP through adenosine triphosphate - adenosine diphosphate (ATP-ADP) cycle;		*	
7.2	Photosynthesis	7.2.1	define photosynthesis;	*		
		7.2.2	state equation (in words and symbols) for photosynthesis;	*		
		7.2.3	describe that all forms of life are completely dependent on photosynthesis;		*	
		7.2.4	describe that chlorophyll traps light energy and converts it into chemical energy for the formation of carbohydrates and their subsequent storage;		*	
		7.2.5	explain processes (light and dark reactions) involved in photosynthesis;		*	
		7.2.6	explain how the structure of a leaf is adapted for photosynthesis;		*	
7.3	Factors Affecting Rate of Photosynthesis	7.3.1	explain the concept of limiting factors in photosynthesis;		*	
		7.3.2	predict the effect of varying light intensity, carbon dioxide concentration and temperature on the rate of photosynthesis using graph;			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
7.4	Respiration in Human Beings	7.4.1	define respiration;	*		
		7.4.2	describe aerobic respiration by means of word and symbol equation;		*	
		7.4.3	describe anaerobic respiration by means of word and symbol equation;		*	
		7.4.4	explain the mechanism of cellular respiration;		*	
		7.4.5	analyse the importance of anaerobic respiration with reference to the examples of athletes during a race or a person doing strenuous exercise;			*
		7.4.6	describe the fate of lactic acid in the body;		*	
		7.4.7	compare aerobic and anaerobic respiration;		*	
		7.4.8	state ways in which respiratory energy is used in the body.	*		

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
8. Nutrition and Digestion		Students should be able to:				
8.1	Mineral Nutrition in Plants	8.1.1	describe the concept of mineral nutrition in plants;		*	
		8.1.2	classify minerals into macronutrients (C, H, O, K, N, P and Mg) and micro-nutrients (Fe, Mn, Cu, B and Zn);		*	
		8.1.3	describe that nitrogen is important in protein synthesis and magnesium for chlorophyll formation;		*	
		8.1.4	state the effect of lack of nitrate and magnesium ions on plant growth;	*		
		8.1.5	describe the importance of fertiliser in agriculture;		*	
		8.1.6	explain environmental hazards related to the use of chemical fertilisers;		*	
8.2	Components of Human Food	8.2.1	differentiate among carbohydrates, proteins and fats in terms of their sources, energy values and metabolic functions;		*	
		8.2.2	identify food sources and metabolic functions of vitamins A, C, D and K;		*	
		8.2.3	identify food sources and metabolic functions of calcium and iron;		*	
		8.2.4	describe the deficiency diseases of vitamins A, C, D and K and of calcium and iron;		*	
		8.2.5	identify sources and functions of water and dietary fibre in the body;		*	
		8.2.6	describe the effects of deficiency of dietary fibre;		*	
8.3	Balanced Diet	8.3.1	describe the concept and need for a balanced diet;		*	
		8.3.2	relate the need of balanced diet and energy requirements with age, gender and activity;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
8.4	Problems Related to Nutrition	8.4.1	describe problems of protein energy malnutrition (marasmus, kwashiorkor) and over intake of nutrients (obesity and diabetes);		*	
		8.4.2	rationalise unequal distribution of food, drought and flooding and increasing population as the factors that contribute to famine;			*
8.5	Ingestion, Digestion and Absorption of Food in Human Beings	8.5.1	describe importance of digestion in terms of absorption and assimilation of food;		*	
		8.5.2	relate the structures of parts of alimentary canal with their functions;		*	
		8.5.3	describe swallowing and peristalsis;		*	
		8.5.4	describe action of enzymes in specific regions of the alimentary canal with respect to their substrates and products;		*	
		8.5.5	state role of the liver in the metabolism of glucose and amino acids and in the formation of bile juice;	*		
		8.5.6	describe structure of a villus, including the roles of capillaries and lacteal;		*	
		8.5.7	discuss significance of villi in increasing the internal surface area;		*	
		8.5.8	trace the route taken by most of food absorb from small intestine to liver;		*	
8.6	Disorders of Gut	8.6.1	state symptoms, causes, treatment and preventions of the disorders of the gut, i.e. diarrhoea, constipation and ulcer.	*		

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
9. Transport		Students should be able to:				
9.1	Introduction	9.1.1	describe importance of the transport system in living organisms;		*	
9.2	Transport in Plants	9.2.1	describe the internal structure of root and root hair;		*	
		9.2.2	define root pressure, capillary action and transpiration pull;	*		
		9.2.3	explain how roots take up water and mineral salts by active and passive absorption;		*	
9.3	Transpiration	9.3.1	describe the internal structure of a stem (specifically vascular bundles);		*	
		9.3.2	define transpiration;	*		
		9.3.3	relate transpiration with stomatal opening and closing;		*	
		9.3.4	describe temperature, wind and humidity as the factors affecting the rate of transpiration;		*	
		9.3.5	describe significance of transpiration;		*	
		9.3.6	relate wilting with excessive transpiration;		*	
		9.3.7	trace the pathway of water and food in stem;		*	
		9.3.8	explain the movement of water from stem to leaves;		*	
		9.3.9	describe mechanism of food translocation in plants using the theory of Pressure Flow Mechanism;		*	
9.4	Transport in Animals; Blood	9.4.1	state the components of blood;	*		
		9.4.2	describe functions of plasma (soluble proteins, dissolved mineral salts, food substances, excretory products and gases), white blood cells (neutrophils, eosinophils, basophils, monocytes and lymphocytes), red blood cells and platelets;		*	
		9.4.3	discuss blood groups in ABO and Rh blood group systems, with reference to the presence or absence of antigens and antibodies;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
		9.4.4	determine the risk of incompatibility in blood transfusion due to antigen-antibody reactions;			*
		9.4.5	state appropriate donors and recipients for each of the four blood groups;	*		
		9.4.6	state symptoms, causes and treatment of the diseases of blood (leukaemia and thalassemia);	*		
9.5	Human Heart	9.5.1	describe the external and internal structure of human heart;		*	
		9.5.2	relate the structure of heart with its function;		*	
		9.5.3	describe the circulation of blood through atria and ventricles of the heart, explaining the role of the bicuspid, tricuspid and semilunar valves;		*	
		9.5.4	describe the reason for low-pressure circulation to the lungs and a high-pressure circulation to the body tissues;		*	
		9.5.5	explain structural adaptations in heart;		*	
		9.5.6	define the terms heartbeat, heart rate and pulse rate;	*		
9.6	Blood Vessels	9.6.1	compare the structure and function of an artery, a vein and a capillary;		*	
		9.6.2	describe transfer of material between capillaries and tissue fluid;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
9.7	General Plan of Human Blood Circulatory System	9.7.1	state contributions of *Ibn-al-Nafees* and William Harvey in revealing the knowledge about the circulation of blood in human body;	CA		
		9.7.2	trace the major pathway of blood through circulatory system;		*	
		9.7.3	identify origin, location and target areas of main arteries, i.e. pulmonary arteries, aorta with hepatic artery, renal arteries and femoral arteries;		*	
		9.7.4	identify origin, location and target areas of main veins, i.e. pulmonary veins, superior vena cava, inferior vena cava with femoral veins, renal veins and hepatic vein;		*	
9.8	Cardiovascular Disorders	9.8.1	differentiate between atherosclerosis and arteriosclerosis;		*	
		9.8.2	state causes, symptoms, treatment and preventions of myocardial infarction.	*		

Part II (Grade X)

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
10. Cell Cycle		Students should be able to:				
10.1	Cell Cycle (Interphase and Division)	10.1.1	define cell cycle;	*		
		10.1.2	differentiate between the major phases of cell cycle, i.e. interphase and division;		*	
		10.1.3	describe sub-phases of the interphase of cell cycle;		*	
		10.1.4	explain the importance of each sub-phase of the interphase;		*	
		10.1.5	compare mitosis and meiosis;		*	
		10.1.6	differentiate between chromosome and chromatid and haploid and diploid cells with examples;		*	
10.2	Mitosis	10.2.1	describe the events through which mitotic apparatus is formed in prophase in animal and plant cells;		*	
		10.2.2	describe formation of metaphase plate and the division of centromere during metaphase;		*	
		10.2.3	describe separation of chromatids during anaphase;		*	
		10.2.4	describe reformation of nuclei during telophase;		*	
		10.2.5	describe physical division of cytoplasm during cytokinesis in animal and plant cells;		*	
		10.2.6	compare details of events during mitosis in animal and plant cells;		*	
		10.2.7	recognise significance of mitosis as giving rise to genetically identical cells and in growth, repair of damaged tissues, replacement of worn out cells and asexual reproduction;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
10.3	Meiosis	10.3.1	differentiate among the events of meiosis-I i.e. prophase, metaphase, anaphase and telophase;		*	
		10.3.2	explain events occurring during the second meiotic division;		*	
		10.3.3	compare events of second meiotic division with mitosis;		*	
		10.3.4	recognise significance of meiosis with reference to the a. formation of haploid cells that may function directly as gametes as in animals or may divide by mitosis as in plants b. recombination of genes that leads to variations;		*	
10.4	Necrosis and Apoptosis	10.4.1	differentiate between necrosis and apoptosis with examples;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
11. Homeostasis		Students should be able to:				
11.1	Introduction	11.1.1	recognise the importance of homeostasis;		*	
		11.1.2	discuss negative feedback mechanism;		*	
11.2	Homeostasis in Plants	11.2.1	describe mechanism in plants for the excretion of carbon dioxide, water, oxygen, latex, resins and gums;		*	
		11.2.2	explain osmotic adjustments in hydrophytes, xerophytes and halophytes;		*	
11.3	Homeostasis in Human Beings	11.3.1	identify major organs involved in homeostasis (skin, lungs and kidneys);		*	
		11.3.2	relate the structure of skin with its function to regulate body temperature;		*	
		11.3.3	describe role of lungs in keeping the carbon dioxide concentration down to a certain level;		*	
		11.3.4	describe role of kidneys in keeping the blood composition constant;		*	
11.4	Urinary System of Human Beings	11.4.1	identify different organs of urinary system;		*	
		11.4.2	relate structure of kidney to its function;		*	
		11.4.3	state that nephron is the excretory unit of kidney;	*		
		11.4.4	relate structure of different parts of nephron with their function;		*	
		11.4.5	describe the process of urine formation, i.e. filtration, selective reabsorption and secretion;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
11.5	Disorders of Human Excretory System	11.5.1	state contributions of *Al-Farabi* and *Abul-Qasim* in introducing the method of removing stones from the urinary bladder;	CA		
		11.5.2	identify the causes of kidney stone;		*	
		11.5.3	differentiate between lithotripsy and surgery as the methods to remove kidney stones;		*	
		11.5.4	describe the causes of kidney failure;		*	
		11.5.5	explain the process of peritoneal and haemodialysis.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
12. Coordination and Control		Students should be able to:				
12.1	Introduction	12.1.1	exemplify the importance of coordination;		*	
12.2	Types of Coordination (Nervous and Chemical Coordination)	12.2.1	differentiate between two main types of coordination in living organisms, i.e. nervous (electrical) and hormonal (chemical);		*	
		12.2.2	identify main organs responsible for coordination and control;		*	
		12.2.3	state that receptors receive stimuli and transmit information to effectors through central nervous system;	*		
12.3	Human Nervous System	12.3.1	identify parts of the brain as forebrain, midbrain and hindbrain;		*	
		12.3.2	explain function of the parts of brain; cerebrum, cerebellum, pituitary gland, hypothalamus and medulla oblongata;		*	
		12.3.3	differentiate between cross sectional views of brain and spinal cord with reference to white and grey matter;		*	
		12.3.4	define neuron;	*		
		12.3.5	differentiate among sensory, motor and relay neurons on the basis of their structure and functions;		*	
		12.3.6	differentiate between voluntary and involuntary actions with examples;		*	
		12.3.7	define reflex action and reflex arc;	*		
		12.3.8	trace the path of a nervous impulse in case of a reflex action with examples from daily life;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
12.4	Receptors of Human (Eye and Ear)	12.4.1	relate the structures of human auditory (ear) and visual (eye) receptors with their functions;		*	
		12.4.2	differentiate between pupil reflex in dim and bright light;		*	
		12.4.3	relate image formation in the human eye with image formation in the dark chamber used by *Ibn-al-Haitham* in his experiment;		*[3]	
		12.4.4	differentiate between defects of eye, i.e. short sightedness and long sightedness;		*	
		12.4.5	illustrate how short and long sightedness can be treated using ray diagrams;			*
		12.4.6	relate the role of vitamin A with vision and effects of its deficiency on retina;		*	
12.5	Endocrine System	12.5.1	define the terms 'hormone' and 'endocrine system';	*		
		12.5.2	describe location and function of major glands of the endocrine system, i.e. pituitary, parathyroid, thyroid, pancreas, adrenal, testes, ovary;		*	
		12.5.3	differentiate among the problems associated with the hyper or hypo secretion of somatotrophin, thyroid-stimulating hormone, vasopressin, thyroxin, calcitonin, adrenaline, insulin, glucagon, testosterone, estrogen and progesterone;		*	
		12.5.4	describe negative feedback with reference to insulin and glucagon;		*	
		12.5.5	explain how adrenaline is involved in emergency conditions;		*	
12.6	Nervous Disorders	12.6.1	explain common kinds of nervous disorders i.e. paralysis and epilepsy;		*	
		12.6.2	state symptoms and treatment of paralysis and epilepsy.	*		

[3] This experiment can be used to enhance students' understanding of the scientific method mentioned in the topic 2 of grade IX.
Topic 2 of grade IX will **NOT** be assessed in grade X.

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
13. Support and Movement		Students should be able to:				
13.1	Human Skeleton (Axial and Appendicular Skeleton)	13.1.1	define skeleton;	*		
		13.1.2	differentiate between cartilage and bone;		*	
		13.1.3	describe role of skeleton in support and movement;		*	
		13.1.4	explain that skeleton system is actually a dynamic, living tissue that is capable of growth, adapts to stress and repairs itself after injury;		*	
		13.1.5	state contribution of Vi Salius in describing the bones and muscles in human;	CA		
		13.1.6	describe main components of the axial skeleton (skull, middle ear ossicles, hyoid bone, vertebral column and ribcage) and the appendicular (pectoral girdle and pelvic girdle) skeleton;		*	
13.2	Types of Joints	13.2.1	define joint;	*		
		13.2.2	state role of ligaments and tendons;	*		
		13.2.3	differentiate among different types of joints (immoveable, slightly moveable and freely moveable joints);		*	
		13.2.4	differentiate between hinge joints and ball and socket joints on the basis of their location and working;		*	
13.3	Muscles and Movement	13.3.1	define locomotion and antagonism;	*		
		13.3.2	differentiate between locomotion and movement;		*	
		13.3.3	describe action of flexors and extensors as a pair of opposing muscles selecting biceps and triceps as example;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
13.4	Disorders of Skeletal System	13.4.1	compare the causes and symptoms of osteoporosis and osteoarthritis.		*	
13.5	Movement in Plants	13.5.1 13.5.2	define movement; differentiate among types of movement in plants, i.e. phototropism, geotropism and hydrotropism;	*	 *	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
14. Reproduction		Students should be able to:				
14.1	Introduction	14.1.1	state the importance of reproduction;	*		
		14.1.2	differentiate between asexual and sexual reproduction;		*	
14.2	Asexual Reproduction in Protists, Bacteria and Plants	14.2.1	exemplify different types of asexual reproduction, i.e. binary fission, budding, spore formation and vegetative propagation;		*	
		14.2.2	distinguish between natural vegetative propagation and artificial vegetative propagation;		*	
		14.2.3	explain natural vegetative propagation in plants (through stem, suckers and leaves);		*	
		14.2.4	describe methods of artificial vegetative propagation (stem cutting and grafting);		*	
		14.2.5	describe how parthenogenesis is a type of asexual reproduction;		*	
		14.2.6	define cloning as the process of generating genetically identical copy of a cell or an organism.	*		
14.3	Sexual Reproduction in Plants (Pollination and Fertilisation)	14.3.1	define pollination and its types (self and cross pollination);	*		
		14.3.2	describe structure and function of each whorl of a flower with reference to pollination, fertilisation and fruit formation;		*	
		14.3.3	explain the life cycle of a flowering plant (from pollination to fruit formation);		*	
		14.3.4	differentiate between adaptations in the structures of wind-pollinated and insect-pollinated flowers;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
14.4	Germination of Seed	14.4.1 14.4.2 14.4.3	differentiate between structure of monocot and dicot seeds; differentiate between epigeal and hypogeal germination; describe conditions necessary for germination of seeds;		* * *	
14.5	Asexual Reproduction in Animals	14.5.1	exemplify binary fission, multiple fission, budding and fragmentation as asexual methods of reproduction in animals;		*	
14.6	Sexual Reproduction in Animals	14.6.1 14.6.2 14.6.3 14.6.4	define fertilisation; differentiate between external and internal fertilisation; describe functions of different organs of male and female reproductive systems of rabbit; compare processes of gametogenesis in male and female rabbit;	*	 * * *	
14.7	Sexually Transmitted Disease (STD)	14.7.1	describe the cause, symptoms and prevention of Acquired Immunodeficiency Syndrome (AIDS) as an example of STDs.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
15. Inheritance		Students should be able to:				
15.1	Introduction	15.1.1	define genetics;	*		
		15.1.2	describe genes as the units of inheritance;		*	
15.2	Chromosomes and Genes	15.2.1	describe composition of chromosome;		*	
		15.2.2	illustrate the general structure of a nucleotide;			*
		15.2.3	illustrate the structure of deoxyribonucleic acid (DNA);			*
		15.2.4	differentiate between a gene and an allele;		*	
		15.2.5	describe process of DNA replication;		*	
15.3	Mendel's Law of Segregation and Independent Assortment	15.3.1	describe the terms dominant, recessive, phenotype, genotype, homozygous, heterozygous, P1, F1, F2 generations;		*	
		15.3.2	differentiate between complete and incomplete dominance with examples;		*	
		15.3.3	state Mendel's Law of Segregation;	*		
		15.3.4	determine that 3:1 monohybrid F-2 phenotypic ratio is an evidence of segregation of alleles;			*
		15.3.5	state Mendel's Law of Independent Assortment;	*		
		15.3.6	determine that 9:3:3:1 dihybrid F-2 phenotypic ratio is an evidence of independent assortment;			*
		15.3.7	determine co-dominance with examples (such as ABO blood group system);			*
		15.3.8	determine incomplete dominance with examples (such as in Japanese 4 o' clock plant);			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
15.4	Variation and Evolution	15.4.1	describe sources of variation (genetic and environmental);		*	
		15.4.2	relate meiosis with variation;		*	
		15.4.3	differentiate between continuous and discontinuous variation with examples like, height, weight, intelligence, gender, tongue rolling, ear lobes and blood groups in population;		*	
		15.4.4	explain how variation can lead to organic evolution;		*	
		15.4.5	describe how variation leads to competition in a population and differential survival by best fitting the environment;		*	
		15.4.6	describe natural selection as a possible means of evolution;		*	
		15.4.7	describe artificial selection as a means of improvement of yield in economically important plants and animals.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
16. Man and his Environment		Students should be able to:				
16.1	The Ecosystem: Levels of Ecological Organisation; Components	16.1.1	describe levels of ecological organisation i.e. species, population, community, habitat, ecosystem, biosphere;		*	
		16.1.2	differentiate between biotic and abiotic components of the ecosystem;		*	
16.2	Flow of Materials and Energy in the Ecosystem	16.2.1	describe trophic levels (producer, primary consumer, secondary consumer and tertiary consumer) of an ecosystem;		*	
		16.2.2	compare flow of materials (cyclic) and flow of energy (non-cyclic) in the ecosystem;		*	
		16.2.3	construct and describe food chains and food webs;			*
		16.2.4	describe energy relations between different trophic levels;		*	
		16.2.5	interpret pyramids of numbers, energy and biomass;			*
16.3	Biogeochemical Cycles (Carbon and Nitrogen Cycle)	16.3.1	describe carbon cycle;		*	
		16.3.2	describe nitrogen cycle;		*	
		16.3.3	relate biogeochemical cycles with flow of energy and ecological balance;		*	
16.4	Interactions in the Ecosystem (Competition, Predation, Symbiosis)	16.4.1	explain competition, predation and symbiosis (parasitism, mutualism, commensalisms);		*	
		16.4.2	relate competition, predation and parasitism with population growth;		*	
16.5	Human Impact on the Environment	16.5.1	discuss damages to the environment and human life caused by overpopulation, urbanisation, global warming, ozone depletion and acid rain;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
16.6	Pollution, its Consequences and Control	16.6.1	explain causes of air, water and land pollution;		*	
		16.6.2	describe effects of each kind of pollution on plants, animals and human beings;		*	
		16.6.3	describe possible actions to control pollution;		*	
16.7	Conservation of Resources	16.7.1	apply the concept of environmental care through acting upon the principle of 'The 3Rs' (reduce, reuse and recycle).			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
17. Biotechnology		Students should be able to:				
17.1	Introduction	17.1.1	define biotechnology;	*		
		17.1.2	describe the importance of biotechnology;		*	
17.2	Fermentation and Baking Industry	17.2.1	compare methods of fermentation by yeast and bacteria;		*	
		17.2.2	relate the working of a fermenter with its structure;		*	
		17.2.3	describe methods of production of different fermentation products (yogurt, bread, cheese and alcohol);		*	
		17.2.4	describe the advantages of using fermenters in preparing food products;		*	
17.3	Genetic Engineering	17.3.1	describe objectives of genetic engineering (for high yield of products, for production of organisms with desired characteristics, for gene therapy);		*	
		17.3.2	describe how a gene is transplanted;		*	
		17.3.3	describe major achievements of genetic engineering with reference to improvement in agricultural crops (herbicide resistance, virus resistance and insect resistance);		*	
		17.3.4	describe major achievements of genetic engineering in health and medicine, e.g. production of insulin, human growth hormone, thymosin, beta-endorphin, vaccine against foot-and-mouth disease, interferon and urokinase and cloning;		*	
17.4	Single Cell Protein and its Uses	17.4.1	describe single-cell protein;		*	
		17.4.2	state significance of single-cell protein in food;	*		

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
18. Pharmacology		Students should be able to:				
18.1	Introduction	18.1.1	define pharmacology;	*		
		18.1.2	define the term drug;	*		
		18.1.3	identify various sources of drugs, i.e. minerals, animals, plants, synthetics, microorganisms;		*	
		18.1.4	describe principle usages of painkillers, antibiotics, vaccines and sedatives;		*	
		18.1.5	state the contribution of Joseph Lister in the discovery of antiseptics;	CA		
		18.1.6	describe how penicillin was discovered by Alexander Fleming;		*[4]	
18.2	Medicinal Drugs and Addictive Drugs	18.2.1	describe addictive drugs and their effects (sedatives, narcotics and hallucinogens);		*	
		18.2.2	describe hallucinogen using marijuana as an example;		*	
		18.2.3	describe morphine and heroine as the most widely used/ abused narcotics;		*	
		18.2.4	describe associated problems of drug addiction, i.e. severe social abandonment and crimes;		*	
		18.2.5	list withdrawal symptoms of addiction to heroine;	*		
		18.2.6	list different plants which are common in Pakistan and used for getting hallucinogens and narcotics;	*		

[4] This discovery can be used to enhance students' understanding of the scientific method mentioned in the topic 2 of grade IX. Topic 2 of grade IX will **NOT** be assessed in grade X.

Topics and Subtopics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
18.3	Antibiotics and Vaccines	18.3.1	describe sulfonamides, tetracyclines and cephalosporins as the major groups of antibiotics being used;		*	
		18.3.2	differentiate between bactericidal and bacteriostatic effects of antibiotics;		*	
		18.3.3	discuss resistance developed in bacteria against the widely used antibiotics;		*	
		18.3.4	describe nature and mode of action of vaccines in producing immunity against specific diseases.		*	

Scheme of Assessment

Grade IX

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	8	1	11	0	12
2.	Solving a Biological Problem	1	0	1	1	2
3.	Biodiversity	7	2	19	0	21
4.	Cells and Tissues	4	0	18	2	20
5.	Gaseous Exchange	4	0	9	1	10
6.	Enzymes	3	1	10	1	12
7.	Bioenergetics	4	5	13	2	20
8.	Nutrition and Digestion	6	3	21	1	25
9.	Transport	8	7	24	1	32
	Total	**45**	**19**	**126**	**9**	**154**
	Percentage		**12**	**82**	**6**	**100**

Table 2: Exam Specifications

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

Grade X

Table 3: Number of Student Learning Outcomes by Cognitive Level

Topic No.	Topics	No. of Sub-topics	SLOs			Total
			K	U	A	
10.	Cell Cycle	4	1	17	0	18
11.	Homeostasis	5	1	16	0	17
12.	Coordination and Control	6	5	19	1	25
13.	Support and Movement	5	5	10	0	15
14.	Reproduction	7	4	17	0	21
15.	Inheritance	4	3	13	6	22
16.	Man and his Environment	7	0	14	3	17
17.	Biotechnology	4	2	10	0	12
18.	Pharmacology	3	4	11	0	15
	Total	**45**	**25**	**127**	**10**	**162**
	Percentage		**16**	**78**	**6**	**100**

Table 4: Exam Specifications

Topic No.	Topics	Marks Distribution			Total Marks
		MCQs	CRQs	ERQs	
10.	Cell Cycle	4	Total 3 Marks (1 CRQ)		7
11.	Homeostasis	5	Total 4 Marks (1 CRQ)		9
12.	Coordination and Control	6		6 Marks Choose any ONE from TWO	17
14.	Reproduction	5			
13.	Support and Movement	3	Total 3 Marks (1 CRQ)		6
15.	Inheritance	6	Total 3 Marks (1 CRQ)	6 Marks Choose any ONE from TWO	20
16.	Man and his Environment	5			
17.	Biotechnology	3			6
18.	Pharmacology	3			
	Total	**40**	**13**	**12**	**65**
	Practical *				**10**
	Total				**75**

- 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 IX and X respectively. This will serve as a guide in the construction of the examination paper. It also indicates that more emphasis has been given to the Understanding (82% in IX and 78% in X), Application and higher order skills (6% in IX and 6% in X) to discourage rote memorisation. Tables 1 and 3, however, do not translate directly into marks.

- There will be two examinations, one at the end of grade IX and one at the end of grade X.

- In each grade, the theory paper will be of 3 hours and will consist of two parts: paper I and paper II.

- Paper I theory will consist of 40 compulsory, multiple choice items. These questions will involve four response options.

- Paper II theory will carry 25 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 10 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 IX

S. No.	SLO No.	PRATICAL ACTIVITIES	APPARATUS/ SLIDE/ SPECIMEN	CHEMICAL/ MATERIAL
		Topic 1: Introduction to Biology		
1.	1.8.2	Study of amoeba as a unicellular organism.	Prepared slide of amoeba, microscope	
2.	1.8.4	Study of frog as a multicellular organism.	Specimen/ model of frog, forceps, pointer/ needle	
		Topic 3: Biodiversity		
3.	3.5.3	Study of different types of bacteria (cocci, bacilli) with the help of prepared slides/ charts.	Prepared slides of cocci and bacilli, microscope	
4.	3.5.4 - 3.5.8	Identification of living organisms on the basis of their taxonomic characteristics (referring to kingdom and phylum).	Prepared slides of chlamydomonas, rhizopus, paramaecium Specimens of funaria, pinus, monocot and dicot plant, sycon, jellyfish/ hydra, tape worm/ liver fluke, round worm, earthworm/ leech, butterfly/ centipede/ prawn, snail/ unio, sea star/ sea urchin, fish, frog, lizard, bird, cat	

S. No.	SLO No.	PRATICAL ACTIVITIES	APPARATUS/ SLIDE/ SPECIMEN	CHEMICAL/ MATERIAL
		Topic 4: Cells and Tissues		
5.	4.1.1	Examination and handling of a microscope.	Microscope	
6.	4.2.3	Preparation of a temporary slide of animal cells (squamous epithelial of frog) and plant cells (onion epidermal peel) using an appropriate temporary staining technique.	Glass slide, cover slips, pointer, forceps, microscope	dye
7.	4.2.6	Calculation of surface area to volume ratio of cubes of different sizes.	Petri dish, forceps, meter scale	Potato, dye
8.	4.3.3	Demonstration of the process of osmosis using a semi-permeable membrane.	Beaker, iron stand, cellophane paper, thistle funnel	Sugar solution, distilled water
9.	4.4.3	Identification of different types of animal tissues (epithelial, connective, muscular and nervous) with the help of prepared slides/ charts/ photomicrographs.	Prepared slides/ charts/ photomicrographs of animal tissues (epithelial, connective, muscular and nervous), microscope	
10.	4.4.4	Identification of different types of plant tissues (epidermal, collenchyma, sclerenchyma, parenchyma, xylem and phloem) with the help of prepared slides/ charts/ photomicrographs.	Prepared slides/ charts/ photomicrographs of plant tissues (epidermal, collenchyma, sclerenchyma, parenchyma, xylem and phloem), microscope	

S. No.	SLO No.	PRACTICAL ACTIVITIES	APPARATUS/ SLIDE/ SPECIMEN	CHEMICAL/ MATERIAL
		Topic 6: Enzymes		
11.	6.2.2	Investigation of the action of amylase on starch at room temperature.	Beaker, test tubes, dropper	Starch solution, amylase, iodine solution, distilled water
12.	6.2.2	Investigation of the action of pepsin on proteins at room temperature.	Beaker, test tubes, dropper	Food item containing proteins, pepsin, iodine solution
13.	6.2.2	Investigation of the effect of pH on enzyme action.	Beaker, test tubes, dropper	0.1 M sodium hydroxide, 0.1 M hydrochloric acid, distilled water, food items containing carbohydrates and proteins (separately), amylase, pepsin, distilled water, iodine solution
14.	6.2.2	Investigation of the effect of temperature on enzyme action.	Beaker, test tubes, dropper, thermometer, ice bath	Starch solution, amylase, iodine solution, distilled water
		Topic 7: Bioenergetics		
15.	7.2.3	Investigation of the release of oxygen during photosynthesis using hydrilla plant.	Beaker, short stem funnel, test tube, match box	Hydrilla plant, sodium bicarbonate
16.	7.3.2	Investigation of light, chlorophyll carbon dioxide as necessary factors for photosynthesis using destarched plants.	For light: Black card paper, cellophane tape/ clips	Potted plant, iodine solution
			For chlorophyll: Water bath, dropper, petri dish	Potted plant with variegated leaves, iodine solution
			For carbon dioxide: Wide-mouthed bottle, split cork, retort stand, beaker	Potted plant, potassium hydroxide, iodine solution, vaseline

S. No.	SLO No.	PRACTICAL ACTIVITIES	APPARATUS/ SLIDE/ SPECIMEN	CHEMICAL/ MATERIAL
17.	7.4.4	Investigation of the release of heat during aerobic respiration in germinating seeds.	Thermos flask, cotton wool, thermometer	Germinating seeds, dead seeds
		Topic 8: Nutrition and Digestion		
18.	8.2.1	Performance of food tests including: • Benedict's test for reducing sugar • Iodine test for starch • Emulsion test for lipids • Biuret test for proteins	For reducing sugar: Test tube, test tube holder, test tube stand, beaker or water bath, Bunsen burner, match box	Benedict's solution, water, orange juice/ breakfast cereal/ bread
			For starch: Petri dish, dropper	Iodine solution, potato
			For lipids: Test tube, thermometer	Butter/ peanuts, Ethanol or 95% ethyl alcohol, distilled water
			For proteins: Test tube, test tube holder, test tube stand, dropper	Egg albumin, water, sodium or potassium hydroxide solution, dilute copper sulphate solution
19.	8.5.7	Microscopic examination of a transverse section of villi.	Prepared slide of transverse section of villi, microscope	
		Topic 9: Transport		
20.	9.3.2	Investigation of the rate of water loss at the two surfaces of a leaf by a simple experiment using cobalt chloride.	Potted plant, paper clips/ cellophane tape	Cobalt chloride paper

Grade X

S. No.	SLO No.	PRACTICAL ACTIVITIES	APPARATUS/ SLIDE/ MPDEL	CHEMICAL/ MATERIAL
		Topic 10: Cell Cycle		
1.	10.2.1-10.2.5	Study of different stages of mitosis with the help of prepared slides/ charts/ photomicrographs.	Prepared slides/ charts/ photomicrographs of different stages of mitosis, microscope	
2.	10.3.1 and 10.3.2	Study of different stages of meiosis with the help of prepared slides/ charts/ photomicrographs.	Prepared slides/ charts/ photomicrographs of different stages of meiosis, microscope	
		Topic 11: Homeostasis		
3.	11.4.2	Examination of the structure of kidney using model/ chart.	Model/ chart of kidney	
		Topic 12: Coordination and Control		
4.	12.3.2 and 12.3.3	Examination of the structure of brain using model/ chart.	Model/ chart of brain	
5.	12.4.1	Examination of the structure of eye using model/ chart.	Model/ chart of eye	
6.	12.4.1	Examination of the structure of ear using model/ chart.	Model/ chart of ear	

S. No.	SLO No.	PRACTICAL ACTIVITIES	APPARATUS/ SLIDE/ MPDEL	CHEMICAL/ MATERIAL
		Topic 13: Support and Movement		
7.	13.1.6	Examination of the human skeleton using model/ chart.	Model/ chart of human skeleton	
		Topic 14: Reproduction		
8.	14.2.3	Examination of a bulb (onion), rhizome (ginger) and tuber (potato).	Petri dish, pointer/ needle	Onion, ginger, potato
9.	14.2.3 14.3.2	Study of vegetative and reproductive parts of a dicotyledonous plant.	Petri dish, pointer/ needle	Dicotyledonous plant
10.	14.4.1	Examination of the structure of maize and gram seeds.	Petri dish, pointer/ needle	Maize and gram seeds
11.	14.4.3	Investigation of the conditions (water) necessary for seed germination.	Petri dish, beaker, filter paper, refrigerator	Seeds of wheat/ gram/ pea
12.	14.5.1	Observation of binary fission in amoeba using prepared slide/ chart/ photomicrograph.	Prepared slide/ chart/ photomicrograph of binary fission in amoeba	
13.	14.5.1	Observation of budding in yeast using prepared slide/ chart/ photomicrograph.	Prepared slide/ chart/ photomicrograph of budding in yeast	

S. No.	SLO No.	PRACTICAL ACTIVITIES	APPARATUS/ SLIDE/ MPDEL	CHEMICAL/ MATERIAL
		Topic 15: Inheritance		
14.	15.2.3	Examination of the human DNA using model/ chart.	Model/ chart of human DNA	
15.	15.4.3	Recording the heights of class fellows to predict which kind of variation is it and presentation of the data of class fellows' heights in graphical form (histogram).	Pencil, eraser, meter scale, graph paper	
		Topic 16: Man and his Environment		
16.	16.2.3	Investigation of an ecosystem, e.g. a balanced aquarium/ pond and construct food chains and food webs.	Note book, pencil, magnifying glass, aquarium/ pond	
		Topic 17: Biotechnology		
17.	17.2.1	Investigation about the role of yeast and bacteria in the fermentation of flour and milk.	Beaker, water, glass lid	Flour, sugar, milk

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