آغا خان یونیورسٹی ایگزامینیشن بورڈ

AGA KHAN UNIVERSITY EXAMINATION BOARD

Secondary School Certificate Examination Syllabus

BIOLOGY

CLASSES IX-X

(based on National Curriculum 2006)

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Secondary School Certificate
Examination Syllabus

BIOLOGY
CLASSES IX-X

This subject is examined in both
May and September Examination sessions

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PREFACE

In pursuance of National Education Policy (1998-2010), the Curriculum Wing of the Federal Ministry of Education has begun a process of curriculum reform to improve the quality of education through curriculum revision and textbook development (Preface, National Curriculum documents 2000 and 2002).

AKU-EB was founded in August 2003 with the same aim of improving the quality of education nationwide. As befits an examination board it seeks to reinforce the National Curriculum revision through the development of appropriate examinations for the Secondary School Certificate (SSC) and Higher Secondary School Certificate (HSSC) based on the latest National Curriculum and subject syllabus guidance.

AKU-EB has a mandate by Ordinance CXIV of 2002 to offer such examination services to English and Urdu medium candidates for SSC and HSSC from private schools anywhere in Pakistan or abroad, and from government schools with the relevant permissions. It has been accorded this mandate to introduce a choice of examination and associated educational approach for schools, thus fulfilling a key objective of the National Curriculum of Pakistan: "Autonomy will be given to the Examination Boards and Research and Development cells will be established in each Board to improve the system" (ibid. para. 6.5.3 (ii)).

AKU-EB is committed to creating continuity of educational experience and the best possible opportunities for its students. In consequence it offered HSSC for the first time in September, 2007 to coincide with the arrival of its first SSC students in college or higher secondary school. Needless to say this is not an exclusive offer. Private candidates and students joining AKU-EB affiliated schools and colleges for HSSC Part 1 are eligible to register as AKU-EB candidates even though they have not hitherto been associated with AKU-EB.

This examination syllabus exemplifies AKU-EB's commitment to national educational goals.

- It is in large part a reproduction, with some elaboration, of the Class IX and X National Curriculum of the subject.
- It makes the National Curriculum freely available to the general public.
- The syllabus recommends a range of suitable textbooks already in print for student purchase and additional texts for the school library.
- It identifies areas where teachers should work together to generate classroom activities and materials for their students as a step towards the introduction of multiple textbooks, another of the Ministry of Education's policy provisions for the improvement of secondary education (ibid. para. 6.3.4).

This examination syllabus brings together all those cognitive outcomes of the National Curriculum statement which can be reliably and validly assessed. While the focus is on the cognitive domain, particular emphasis is given to the application of knowledge and understanding, a fundamental activity in fostering "attitudes befitting useful and peaceful

citizens and the skills for and commitment to lifelong learning which is the cornerstone of national economic development" (Preface to National Curriculum documents 2000 and 2002).

To achieve this end AKU-EB has brought together university academics, teacher trainers, writers of learning materials and above all, experienced teachers, in regular workshops and subject panel meetings.

AKU-EB provides copies of the examination syllabus to subject teachers in affiliated schools to help them in planning their teaching. It is the syllabus, not the prescribed text book which is the basis of AKU-EB examinations. In addition, the AKU-EB examination syllabus can be used to identify the training needs of subject teachers and to develop learning support materials for students. Involving classroom teachers in these activities is an important part of the AKU-EB strategy for improving the quality of learning in schools.

The Curriculum Wing of the Federal Ministry of Education has recently released new subject specifications and schemes of study to take effect in September, 2008. These documents are a major step forward towards a standards-related curriculum and have been welcomed by AKU-EB. Our current SSC syllabuses have been revised to ensure conformity with the new National Curriculum 2006.

We stand committed to all students entering the SSC course as well as those who have recently embarked upon the HSSC course in facilitating their learning outcome. Our examination syllabus document ensures all possible support.

Dr. Thomas Christie
Director,
Aga Khan University Examination Board
July 2009

1. Aims/Objectives of the National Curriculum (2006)[1]

Aims

The curriculum for Biology for grades IX-X aims to help individual students develop:

- A scientific understanding of the living world
- Mental and motor abilities appropriate to the acquisition and use of biological understanding
- An appreciation of the products and influences of science and technology, balanced by a concern for their wise application
- An understanding of the nature and limitations of scientific activity
- An ability to apply biological understanding to appropriate problems (including those of everyday life) and to approach those problems in rational ways
- Respect for evidence, rationality and intellectual honesty
- Capacities to express themselves coherently and logically, both orally and in writing, and to use appropriately modes of communication characteristic of scientific work
- An ability to work effectively with others.

Objectives

A statement of objectives relevant to each of the general aims is listed below. The sequence of objectives used here should not be taken as indicating relative weightings.

Understanding the Living World

Students should understand the scientific concepts inherent in the theme for each chapter to be covered well enough to be able to:

- State, exemplify and interpret the concept
- Use appropriately, fundamental terms and classifications related to the concept
- Cite, and explain or interpret, scientific evidence in support of the concept.

Appropriate Mental and Motor Abilities

Students should show some ability to:

- Formulate questions that can be investigated by gathering first or second-hand data
- Find relevant published background information
- Formulate hypotheses and make predictions from them
- Plan an investigation and carry out the planned procedures
- Use the motor skills required to carry out investigations
- Observe phenomena, and describe, measure and record these as data
- Classify, collate and display data
- Interpret and construct visual representations of phenomena and relationships (diagrams, graphs, flow charts, physical models etc.)
- Analyze data and draw conclusions
- Evaluate investigative procedures and the conclusions drawn from investigations.

[1] Government of Pakistan (2006), *National Curriculum; Biology Classes IX-X, Islamabad,* Ministry of Education (Curriculum Wing)

Understanding the Nature and Limitations of Scientific Activity
For each of the facets of scientific activity selected for study, students should:

- Describe and exemplify it
- Use appropriately and fundamental terms and classifications related to it
- Recognize that the problem-solving nature of science has limitations
- Acknowledge that people engaged in science, a particularly human enterprise, have the characteristics of people in general.

Appreciation of the Influences of Science and Technology
Students should:

- Recognize that the technology resulting from scientific activity influences the quality of lifestyle and economic development through or by improvements in medical/health care, nutrition, agricultural techniques
- Understand that these influences may be the result of unforeseen consequences, rapid exploitation or rapid cultural change
- Realize that advances in technology require judicious application.

Ability to Apply Understanding to Problems
Students should:

- Recognize that biological knowledge and scientific approaches have relevance to many situations in everyday life
- Recognize when biological knowledge is relevant to a problem
- Recognize when a scientific approach is relevant to a problem
- Select and apply appropriate biological knowledge and skills to clarify and help produce solutions to problems, especially the personal and social problems of everyday life to which such knowledge and skills can apply
- Use thoughtful, rational strategies for decision-making in those everyday situations to which both biological knowledge and value positions are relevant.

Respect for Evidence, Rationality and Intellectual Honesty
Given the number of emotive issues in the area of biology, students should display respect for evidence, rationality and intellectual honesty.

Capacities to Communicate
Students should:

- Comprehend the intention of a scientific communication, the relationships between its parts and its relationship to what they already know
- Select the relevant parts from a communication
- Translate information from communications in particular modes (e.g. spoken word, written word, tables, graphs, flow sheets, diagrams) to other modes
- Structure information and use appropriate modes (including the spoken word, writing and diagrams) to communicate it.

Ability to Work with Others
Students should participate in group work in such a way that he or she:

- Shares the responsibility for achieving a group task shows concern for the fullest possible participation of each group member.

2. Rationale of the AKU-EB Examination Syllabus

2.1 General Rationale

2.1.1 In 2007, the Curriculum Wing of the Federal Ministry of Education (MoE) issued a revised part-wise Scheme of Studies. All subjects are to be taught and examined in both classes IX and X. It is therefore important for teachers, students, parents and other stakeholders to know:

(a) that the AKU-EB Scheme of Studies for its SSC examination (Annex A) derives directly from the 2007 Ministry of Education Scheme of Studies;
(b) which topics will be examined in Class IX and in Class X;
(c) at which cognitive level or levels (Knowledge, Understanding, Application and other higher order skills) the topics and sub-topics will be taught and examined;

2.1.2 This AKU-EB examination syllabus addresses these concerns. Without such guidance teachers and students have little option other than following a single textbook to prepare for an external examination. The result is a culture of rote memorization as the preferred method of examination preparation. The pedagogically desirable objectives of the National Curriculum which encourage "observation, creativity and other higher order thinking skills" are generally ignored. AKU-EB recommends that teachers and students use multiple teaching-learning resources for achieving the specific objectives of the National Curriculum reproduced in the AKU-EB examination syllabuses.

2.1.3 The AKU-EB examination syllabuses use a uniform layout for all subjects to make them easier for teachers to follow. Blank sheets are provided in each syllabus for writing notes on potential lesson plans. It is expected that this arrangement will also be found helpful by teachers in developing classroom assessments as well as by question setters preparing material for the AKU-EB external examinations. The AKU-EB aims to enhance the quality of education through improved classroom practices and improved examinations.

2.1.4 The Student Learning Outcomes (SLOs) in Section 3 start with command words such as list, describe, relate, explain, etc. The purpose of the command words is to direct the attention of teachers and students to specific tasks that candidates following the AKU-EB examination syllabuses are expected to undertake in the course of their subject studies. The examination questions will be framed using the same command words or the connotation of the command words to elicit evidence of these competencies in candidates' responses. The definitions of command words used in this syllabus are given in Section 7. It is hoped that teachers will find these definitions useful in planning their lessons and classroom assessments.

2.1.5 The AKU-EB has classified SLOs under the three cognitive levels Knowledge (K), Understanding (U) and Application of knowledge and skills (A) in order to derive multiple choice questions and constructed response questions on a rational basis from the subject syllabuses ensuring that the intentions of the National Curriculum should be met in full. The weighting of marks to the Multiple Choice and Constructed Response Papers is also derived from the SLOs, command words and cognitive levels. In effect the SLOs derived from the National Curriculum determine the structure of the AKU-EB subject examination set out in Section 4 and 5.

2.1.6 Some topics from the National Curriculum have been elaborated and enriched for better understanding of the subject and/or to better meet the needs of students in the twenty-first century. These additional topics have been italicized in Section 3 of this syllabus.

2.2 Specific Rationale of the AKU-EB Biology Examination Syllabus

2.2.1 The National Education Policy (1998-2010) outlines the following objectives for secondary education:

a. To prepare the students well for the pursuit of professional and specialized education;

b. To make available such teaching and learning materials that will make learning rewarding and attractive.

c. To introduce a system of evaluation that emphasizes learning of concepts and discourages rote memorization.

2.2.2 In line with National Education Policy, the AKU-Examination Board syllabuses in science subject focus on the following:

a. Broadening student's conceptual understanding through opportunities for enhancing their scientific skills, inquiry and experimentation.

b. Allocating marks for each cognitive level of learning such as knowledge, understanding and application. The importance of content has been clearly elaborated as Student Learning Outcomes.

c. Reducing overloading and repetition. There is a need to look at the syllabus critically with due consideration to the fundamental concepts of secondary level science.

3. Topics and Student Learning Outcomes of the Examination Syllabus

Part I (Class IX)

Topic		Student Learning Outcomes		Cognitive Level[2]		
				K	U	A
1. Introduction to Biology		**Candidates should be able to:**				
1.1	Introduction to Biology	1.1.1	define biology and its major divisions i.e. botany, zoology and microbiology;	*		
1.2	Divisions and Branches of Biology	1.2.1	determine the significance of the branches of biology i.e. morphology, anatomy, physiology, embryology, taxonomy, cell biology, histology, palaeontology, environmental biology, biotechnology, socio-biology, parasitology, immunology, entomology, genetics and pharmacology with suitable examples;			*
1.3	Relation of Biology to Other Sciences	1.3.1	explain the relationship of biology with other branches of science (physics, chemistry, mathematics, geography and economics) and relate with suitable examples from daily life;		*	
1.4	Scope of Biological Studies	1.4.1	explain how the study of biology can lead to medicine and surgery, fisheries, agriculture, animal husbandry, biotechnology, horticulture, farming, forestry and pollution control;		*	
1.5	Study of Life from the Perspective of the Holy Quran	1.5.1	explain the 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;		*	

[2] K = Knowledge, U = Understanding, A= Application (for explanation see Section 7: Definition of command words used in Student Learning Outcomes and in Examination Questions).

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			K	U	A
1.6 Contribution of Scientists	1.6.1	identify the contribution of *Abdul Malik Asmai* and *Bu Ali Sina* in the field of biology;	*		
1.7 The Levels of Organization	1.7.1 1.7.2 1.7.3 1.7.4	describe bio-elements as the most basic level of biological organization; define bio-molecules and distinguish between them with examples as micro-molecules and macro-molecules (on the basis of molecular mass); describe the levels of organization of life (organelles, cells, tissues, organs, organ systems and individuals); draw a linkage chart connecting different organs with the relative organ system;		* * * *	 *CA
1.8 Unicellular and Multicellular Organisms	1.8.1 1.8.2 1.8.3 1.8.4	differentiate between unicellular and multicellular organisms; describe cellular organization in unicellular organisms i.e. amoeba; describe the concept of division of labour; describe cellular organization in multicellular organisms (any dicotyledonous flower and frog) (Only brief description referring to cellular organization is required. Details of organs and organs-systems of frog and flower should be avoided).		* * * *	
2. Solving a Biological Problem	**Candidates should be able to:**				
2.1 Biological Method	2.1.1	describe the steps involved in biological method i.e. recognition of a biological problem, observation and identification, building up hypotheses, drawing deductions, devising experiments and inferring results (malaria as an example);		*	

* Class Activity

NOTES

			K	U	A
	2.1.2	solve a biological problem following the scientific method; a. formulate and test a working hypothesis; b. write instructions for conducting investigations or following a procedure; c. select appropriate instruments and materials to conduct an investigation; d. describe safe laboratory procedures; e. organize data appropriately using techniques such as tables and graphs; f. analyze data to make predictions, decisions or draw conclusions; g. confirm, modify or reject a hypothesis using data analysis.			*
3. Biodiversity	**Candidates should be able to:**				
3.1 Introduction	3.1.1	define biodiversity;	*		
	3.1.2	highlight the importance of biodiversity (producing food, obtaining drugs, getting industrial products, maintaining ecosystems; regulating resources and recycling nutrients);		*	
3.2 Aims and Principles of Classification	3.2.1	describe the basis of classification of living organisms (with reference to homology, analogy, morphology, anatomy and embryology);		*	
	3.2.2	describe the aims and principles of classification;		*	
3.3 History of Classification Systems	3.3.1	identify the contribution of Aristotle as the founder of biological classification;	*		
	3.3.2	explain the basis for establishing five kingdoms;		*	
	3.3.3	compare Two-kingdom and Five-kingdom classification systems;		*	
	3.3.4	rationalise that Five-kingdom classification system better explains diversity of living organisms;			*
	3.3.5	state the contributions of *Abu Usman Umer Aljahiz* in unfolding the characteristics of animal species;	*		

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				K	U	A
3.4	Units of Classification	3.4.1	define the units of classification (species, genus, family, order, class, division/phyla, kingdom);	*		
3.5	The Five Kingdoms	3.5.1	describe the acellular structure of virus and justify why virus are excluded from the Five Kingdom classification system;		*	
		3.5.2	describe the salient features of prokaryotes taking bacteria as an example;		*	
		3.5.3	describe the salient features of protists taking chlamydomonas as an example;		*	
		3.5.4	describe the salient features of fungi taking rhizopus as an example;		*	
		3.5.5	describe the salient features of plants taking mosses, ferns and flowering plants (monocot and dicot) as examples (salient features of each group should be described only);		*	
		3.5.6	describe the salient features of invertebrates taking paramaecium, sycon, jellyfish, tapeworm, roundworm, earthworm, snail, butterfly and sea star as examples;		*	
		3.5.7	describe the salient features of vertebrates taking fish, frog, lizard, bird and cat as examples;		*	
3.6	Binomial Nomenclature	3.6.1	describe the aims and principles of binomial nomenclature with examples;		*	
3.7	Conservation of Biodiversity	3.7.1	define conservation and highlight its importance;		*	
		3.7.2	identify the causes of deforestation and over-hunting;	*		
		3.7.3	explain the impact of human activities such deforestation, over-hunting, introduction or removal of a species and pollution on biodiversity;		*	
		3.7.4	explore some plant and animal species which have become endangered or are extinct due to human interference.			* *CA

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				K	U	A
4. Cells and Tissues		**Candidates 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 the development of the cell theory from Aristotle to Robert Hooke, Antonie van Leewenhoek, Robert Brown and Schwann and Schleiden;		*	
4.2	Cellular Structures and Functions	4.2.1	describe the structure and functions of the components of a plant cell (cell wall, cell membrane, nucleus, cytoplasm, Golgi bodies, mitochondria, food vacuole, ribosomes, endoplasmic reticulum and plastids);		*	
		4.2.2	describe the structure and functions of the components of an animal cell (cell membrane, nucleus, cytoplasm, Golgi bodies, mitochondria, lysosomes, contractile vacuole, ribosomes, endoplasmic reticulum and centrioles);		*	
		4.2.3	differentiate between plant and animal cell;		*	
		4.2.4	explain the variety of specialized structures and their function in cells of the leaf system;		*	
		4.2.5	relate the structure of specialized cells with their function (for absorption - root hair cells; for conduction and support - xylem vessels; for transport of oxygen - red blood cells);		*	
		4.2.6	determine ways in which various types of cells contribute to the healthy functioning of the human body;			*
		4.2.7	describe differences in the structure of prokaryotic and eukaryotic cells;		*	
		4.2.8	describe cell size and shape as they relate to surface area to volume ratio;		*	
		4.2.9	explain how surface area to volume ratio limits cell size (e.g., root hair cell in plants and nerve cell in animals);		*	

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				K	U	A
4.3	Active and Passive Transport of Matter	4.3.1	define diffusion, osmosis, active transport, hypertonic solution, hypotonic solution and isotonic solution;	*		
		4.3.2	describe different types of membranes (permeable, partially-permeable and impermeable);		*	
		4.3.3	describe the phenomena of diffusion, facilitated diffusion, osmosis, active transport, endocytosis and exocytosis with examples;		*	
		4.3.4	compare passive transport of matter by diffusion and osmosis 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 the importance of turgor;		*	
		4.3.6	describe the phenomena of plasmolysis and deplasmolysis and explain its relationship with osmosis;		*	
4.4	Tissues (Types of Plant and Animal Tissues)	4.4.1	describe tissue;		*	
		4.4.2	differentiate between simple and compound tissues;		*	
		4.4.3	describe the major animal tissues (epithelial, connective, muscular and nervous) in terms of their cell specificities, locations and functions;		*	
		4.4.4	describe the 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	relate the function of a particular tissue to its structure and ultimately to the function of the cells constituting it;		*	

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			K	U	A
	4.4.6	justify why a colony of cells does not get tissue level of organization, in spite of having many cells.		*	
5. Cell Cycle	**Candidates should be able to:**				
5.1 Cell Cycle (Interphase and Division)	5.1.1	define cell cycle and its main phases i.e. interphase and division;	*		
	5.1.2	describe the sub-phases of the interphase of cell cycle;		*	
	5.1.3	explain the importance of S-phase of the interphase;		*	
	5.1.4	differentiate between the two types of cell division in eukaryotic cells i.e. mitosis and meiosis;		*	
	5.1.5	differentiate between haploid and diploid cells with examples;		*	
5.2 Mitosis	5.2.1	summarise the events through which mitotic apparatus is formed in prophase in animal and plant cells;		*	
	5.2.2	describe the formation of metaphase plate and the division of centromere, during metaphase;		*	
	5.2.3	describe the separation of chromatids during anaphase;		*	
	5.2.4	describe the reformation of nuclei during telophase;		*	
	5.2.5	describe the physical division of cytoplasm during cytokinesis in animal and plant cells;		*	
	5.2.6	compare the details of events during mitosis in animal and plant cells;		*	
	5.2.7	describe the 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;		*	
5.3 Meiosis	5.3.1	describe the events of Prophase-I;		*	
	5.3.2	describe the events of Metaphase-I;		*	
	5.3.3	describe the events of Anaphase-I;		*	
	5.3.4	describe the events of Telophase-I;		*	
	5.3.5	explain the events occurring during the second meiotic division;		*	

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			K	U	A
	5.3.6 compare the second meiotic division with mitosis;			*	
	5.3.7 describe the significance of meiosis as leading to the formation of haploid cells that may function directly as gametes as in animals or may divide by mitosis as in plants, fungi and many protists;			*	
	5.3.8 describe the significance of meiosis with reference to the recombination of genes that leads to variations;			*	
5.4 Necrosis and Apoptosis	5.4.1 describe necrosis and apoptosis;			*	
	5.4.2 correlate necrosis and apoptosis with cell cycle.			*	
6. Enzymes	**Candidates 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 describe that enzymes increase rate of reaction;			*	
	6.1.5 state how small quantity of an enzyme is effective for large amount of a substrate;		*		
	6.1.6 infer that enzymes are specific for specific substrates;			*	
	6.1.7 explain some enzymes require co-factor for their functioning;			*	
	6.1.8 describe the concept of energy of activation and how it is lowered by enzymes;			*	
	6.1.9 categorise enzymes as intra and extracellular with examples;			*	
6.2 Factors Affecting Activity of Enzymes	6.2.1 explain the effect of pH, temperature and concentration of substrate on the activity of an enzyme;			*	
	6.2.2 show graphically the effect of pH, temperature and concentration of substrate on the activity of an enzyme;				*

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				K	U	A
6.3	Mechanism of Enzyme Action	6.3.1 6.3.2	describe, through equation, that enzyme substrate complex is formed and release of enzyme takes place after completing the reaction; describe the action of enzyme through lock-and-key model and induced-fit model;		* *	
6.4	Specificity of Enzymes	6.4.1 6.4.2 6.4.3	describe the specificity of different enzymes for different substrates; relate that specificity of enzyme is due to its shape; describe that proteases will act on proteins only and lipases will act on lipids or fats only.		* * *	
7. Bioenergetics		**Candidates should be able to:**				
7.1	Bioenergetics	7.1.1 7.1.2 7.1.3 7.1.4	define bioenergetics; describe the importance of oxidation-reduction reactions for the flow of energy through living systems; explain ATP as a molecule that is the chief energy currency of all cells; describe the synthesis and breaking of ATP through ATP-ADP cycle;	* 	 * * *	
7.2	Photosynthesis	7.2.1 7.2.2 7.2.3 7.2.4 7.2.5 7.2.6	state that photosynthesis is the fundamental process by which plants manufacture carbohydrates from raw materials; state the equation (in words or symbols) for photosynthesis; reason out that all forms of life are completely dependent on photosynthesis; describe that chlorophyll traps light energy and converts it into chemical energy for the formation of carbohydrates and their subsequent storage; outline the processes (light and dark reactions) involved in photosynthesis; *explain how the structure of a leaf is adapted for photosynthesis;*	* * 	 * * * *	
7.3	Factors Affecting Rate of Photosynthesis	7.3.1 7.3.2	explain the concept of limiting factors in photosynthesis; predict the effect of varying light intensity, carbon dioxide concentration and temperature on the rate of photosynthesis using graph;		*	 *

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				K	U	A
7.4	Respiration in Man	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	describe the importance of anaerobic respiration with reference to the examples of athletes during 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	describe ways in which respiratory energy is used in the body.		*	
8. Nutrition		**Candidates should be able to:**				
8.1	Mineral Nutrition in Plants	8.1.1	define mineral nutrition in plants;	*		
		8.1.2	categorise minerals into macro-nutrients and micro-nutrients with examples;		*	
		8.1.3	state 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 fertilizer in agriculture;		*	
		8.1.6	discuss environmental hazards related to chemical fertilizers' use;			*
8.2	Components of Human Food	8.2.1	distinguish 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 and D;	*		
		8.2.3	identify food sources and metabolic functions of calcium and iron;	*		
		8.2.4	describe the deficiency symptoms of vitamin A, C and D and of calcium and iron;		*	
		8.2.5	identify functions of water in the body;	*		
		8.2.6	identify sources and function of dietary fibre;	*		

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				K	U	A
8.3	Balanced Diet	8.3.1	describe the concept and need for a balanced diet;		*	
		8.3.2	explain the components of a balanced diet with relation to age, sex and activity;		*	
		8.3.3	explain why diet, especially energy intake, should be related to age, sex and activity of an individual;		*	
8.4	Problems Related to Nutrition	8.4.1	describe the problems of Protein Energy Malnutrition (PEM), Mineral Deficiency Diseases (MDD) and Over Intake of Nutrients (OIN);		*	
		8.4.2	state the effects of malnutrition in relation to starvation, heart disease, constipation and obesity;	*		
		8.4.3	rationalize the 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 Man	8.5.1	describe the needs of ingestion, digestion, absorption, assimilation and egestion;		*	
		8.5.2	describe the structures of the main regions of the alimentary canal and the associated organs;		*	
		8.5.3	describe the main functions of these parts in relation to ingestion, digestion, absorption, assimilation and egestion of food;		*	
		8.5.4	describe swallowing and peristalsis;		*	
		8.5.5	describe the action of enzymes in specific regions of the alimentary canal with respect to their substrates and products;		*	
		8.5.6	highlight the role of the liver in the metabolism of glucose and amino acids and in the formation of urea;		*	
		8.5.7	describe the structure of a villus, including the roles of capillaries and lacteal;		*	
		8.5.8	describe the significance of villi in increasing the internal surface area;		*	
		8.5.9	state the function of the hepatic portal vein as the route taken by most of the food absorbed from the small intestine;	*		
8.6	Disorders of Gut	8.6.1	state the signs and symptoms, causes, treatment and preventions of the disorders of gut i.e. diarrhea, constipation and ulcer.	*		

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				K	U	A
9. Transport		**Candidates should be able to:**				
9.1	Introduction	9.1.1	describe the importance of transport system in living organisms;		*	
9.2	Transport in Plants	9.2.1	explain the internal structure of root and root hair;		*	
		9.2.2	define root pressure, capillary action and transpiration pull;	*		
		9.2.3	describe how roots take up water and mineral salts by active and passive absorption;		*	
9.3	Transpiration	9.3.1	define transpiration and relate this process with cell surface;		*	
		9.3.2	relate transpiration with stomatal opening and closing;		*	
		9.3.3	describe temperature, wind and humidity as the factors affecting the rate of transpiration;		*	
		9.3.4	describe the significance of transpiration;		*	
		9.3.5	relate wilting with excessive transpiration;		*	
		9.3.6	describe the pathway of water and food in stem;		*	
		9.3.7	explain the movement of water in terms of transpiration pull;		*	
		9.3.8	describe the mechanism of food translocation by the theory of Pressure Flow Mechanism;		*	
9.4	Transport in Animals; Blood	9.4.1	state the components of blood;	*		
		9.4.2	describe the functions of plasma (soluble proteins, dissolved mineral salts, food substances, excretory products and carbon dioxide), white blood cells (neutrophils, eosinophils, basophils, monocytes and lymphocytes), red blood cells and platelets;		*	
		9.4.3	describe the blood groups in ABO and Rh blood group systems, with reference to the presence or absence of antigens and antibodies;		*	
		9.4.4	describe the risk of incompatibility in blood transfusion due to antigen-antibody reactions;		*	
		9.4.5	state the appropriate donors and recipients for each of the four blood groups;	*		

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				K	U	A
		9.4.6	state the signs and symptoms, causes and treatment of the diseases of blood (leukemia and thallassemia);	*		
9.5	Human Heart	9.5.1	describe the external and internal structure of a human heart;		*	
		9.5.2	describe the circulation of blood through atria and ventricles of the heart, explaining the role of the bicuspid, tricuspid and semilunar valves;		*	
		9.5.3	describe the low-pressure circulation to the lungs and a high-pressure circulation to the body tissues and relate these differences to the different functions of the two circuits;		*	
		9.5.4	explain the structural adaptations in heart;		*	
		9.5.5	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 the transfer of material between capillaries and tissue fluid;		*	
9.7	General Plan of Human Blood Circulatory System	9.7.1	state the contributions of *Ibn-al-Nafees* and William Harvey in revealing the knowledge about the circulation of blood in human body;	*		
		9.7.2	describe the major pathway of blood through circulatory system;		*	
		9.7.3	describe the origin, location and target areas of main arteries i.e. pulmonary arteries, aorta with hepatic artery, renal arteries and femoral arteries;		*	
		9.7.4	describe the origin, location and target areas of main veins i.e. pulmonary veins, superior vena cava, inferior vena cava with femoral veins, renal veins and hepatic vein;		*	
		9.7.5	identify the main arteries and veins in charts, diagrams, models etc.;	*		CA*
9.8	Cardiovascular Disorders	9.8.1	define cardiovascular disorders and differentiate between atherosclerosis and arteriosclerosis;		*	
		9.8.2	state the causes, treatment and preventions of myocardial infarction.	*		

*Class Activity

NOTES

Part II (Class X)

Topic		Student Learning Outcomes		Cognitive Level		
				K	U	A
10. Gaseous Exchange		**Candidates should be able to:**				
10.1	Introduction	10.1.1	differentiate between respiration and breathing;		*	
10.2	Gaseous Exchange in Plants	10.2.1	describe the process of gaseous exchange in plants by comparing photosynthesis and respiration;		*	
10.3	Gaseous Exchange in Man	10.3.1	*identify the organs of the respiratory system in man;*	*		
		10.3.2	*describe the structure and function of each part of the respiratory system;*		*	
		10.3.3	*explain how alveoli are adapted for gaseous exchange by diffusion between air in the lungs and blood in the capillaries;*		*	
		10.3.4	describe the mechanism of breathing in term of movements of ribs and diaphragm;		*	
		10.3.5	analyze the effect of exercise on the rate of breathing;			*
		10.3.6	differentiate between the composition of inspired and expired air;		*	
10.4	Respiratory Disorders and their Causes	10.4.1	describe briefly diseases related to respiratory system like bronchitis, emphysema, pneumonia, asthma, and lung cancer;		*	
		10.4.2	describe the biological consequences of smoking in relation to the lungs and circulatory system.		*	

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				K	U	A
11. Homeostasis		**Candidates should be able to:**				
11.1	Introduction	11.1.1	define homeostasis and describe its importance;		*	
11.2	Homeostasis in Plants	11.2.1	describe the mechanism / adaptations in plants for the excretion of carbon dioxide, water, oxygen, latex, resins and gums;		*	
		11.2.2	explain osmotic adjustments in plants (hydrophytes, xerophytes and halophytes);		*	
11.3	Homeostasis in Man	11.3.1	state skin, lungs and kidneys as the major organs involved in homeostasis;	*		
		11.3.2	explain the structure and role of skin in regulating body temperature;		*	
		11.3.3	describe the role of lungs to keep the carbon dioxide concentration down to a certain level;		*	
		11.3.4	outline the role of kidneys to keep the blood composition constant;		*	
11.4	Urinary System of Man	11.4.1	identify the different organs of urinary system;	*		
		11.4.2	relate the structure of kidney with its function;		*	
		11.4.3	state that nephron is the excretory unit of kidney;	*		
		11.4.4	locate the different parts of nephron and relate them with their function;		*	
		11.4.5	describe that urine formation involves three processes i.e. filtration, selective reabsorption and secretion;		*	
		11.4.6	describe the role of kidneys in osmoregulation;		*	
11.5	Disorders of Human Excretory System	11.5.1	state the contribution of *Al-Farabi* and *Abul-Qasim* in introducing the method of removing stones from the urinary bladder;	*		
		11.5.2	identify the causes of kidney stone;	*		
		11.5.3	describe lithotripsy and surgery as the methods to remove kidney stones;		*	
		11.5.4	outline the causes of kidney failure;		*	
		11.5.5	explain the process of peritoneal and haemodialysis.		*	

NOTES

				K	U	A
12. Coordination		**Candidates should be able to:**				
12.1	Introduction	12.1.1	give an account of importance of coordination with every day examples;		*	
12.2	Types of Coordination (Nervous and Chemical Coordination)	12.2.1	describe the two main types of coordination in living organisms, i.e. nervous (electrical) and hormonal (chemical);		*	
		12.2.2	identify the 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 the function of the parts of brain; cerebrum, cerebellum, pituitary gland, hypothalamus and medulla oblongata;		*	
		12.3.3	differentiate between the cross sectional views of brain and spinal cord with reference to white and grey matter;		*	
		12.3.4	define neuron and describe the structure of a general neuron;		*	
		12.3.5	describe the types of neurons (sensory, motor and relay);		*	
		12.3.6	define 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;		*	
12.4	Receptors of Man (Eye and Ear)	12.4.1	describe the structure of human auditory (ear) and visual (eye) receptors;		*	
		12.4.2	describe the pupil reflex in dim and bright light;		*	
		12.4.3	state the contribution of *Ibn-al-Haitham* and *Al-lbn-lsa* with knowledge about the structure of eye and treatment of various ophthalmic diseases;	*		
		12.4.4	explain the defects of eye (short sightedness and long sightedness);		*	
		12.4.5	describe how short and long sightedness can be treated using ray diagrams;		*	

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			K	U	A
	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 the location and function of major glands of the endocrine system (pituitary, parathyroid, thyroid, pancreas, adrenal, testes, ovary);		*	
	12.5.3	describe the problems associated with the hyper or hypo secretion of somatotrophin, thyroid-stimulating hormone, vasopressin, oxytocin, thyroxin, calcitonin, parathormone, adrenaline, corticosteroids, insulin, glucagon, testosterone, estrogen and progesterone;		*	
	12.5.4	describe the term "negative feedback" with reference to insulin and glucagon;		*	
	12.5.5	explain how adrenaline may be involved in exercise and emergency conditions;		*	
12.6 Nervous Disorders	12.6.1	explain the common kinds of nervous disorders (vascular i.e. paralysis and functional i.e. epilepsy);		*	
	12.6.2	state some of the symptoms and treatment of paralysis and epilepsy.	*		
13. Support and Movement	**Candidates should be able to:**				
13.1 Human Skeleton (Axial and Appendicular Skeleton)	13.1.1	define skeleton and differentiate between cartilage and bone;		*	
	13.1.2	describe the role of skeleton in support and movement;		*	
	13.1.3	explain that skeleton system is actually a dynamic, living tissue that is capable of growth, adapts to stress and repairs itself after injury;		*	
	13.1.4	state the contribution of Vi Salius in describing the bones and muscles in human;	*		
	13.1.5	describe the 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;		*	

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				K	U	A
13.2	Types of Joints	13.2.1	define joint;	*		
		13.2.2	differentiate among different types of joints (immoveable, slightly moveable and moveable joints);		*	
		13.2.3	state the role of ligaments and tendons;	*		
		13.2.4	describe the location and working of hinge joints;		*	
		13.2.5	describe the location and working of ball and socket joints;		*	
13.3	Muscles and Movement	13.3.1	define antagonism;	*		
		13.3.2	describe the action of flexors and extensors as a pair of opposing muscles selecting biceps and triceps as example;		*	
13.4	Disorders of Skeletal System	13.4.1	describe the effects of deficiency of calcium on bones and relate this deficiency with osteoporosis;		*	
		13.4.2	highlight the causes, symptoms and treatment of arthritis;		*	
		13.4.3	discuss the onset of arthritis with age and weight-bearing joints.			*
14. Reproduction		**Candidates should be able to:**				
14.1	Introduction	14.1.1	define reproduction and describe its importance;		*	
		14.1.2	differentiate between asexual and sexual reproduction;		*	
14.2	Asexual Reproduction in Protists, Bacteria and Plants	14.2.1	describe different types of asexual reproduction i.e. binary fission, budding, spore formation and vegetative propagation;		*	
		14.2.2	distinguish between vegetative propagation and artificial propagation;		*	
		14.2.3	explain vegetative propagation in plants (through stem, suckers and leaves);		*	
		14.2.4	describe the 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;	*		

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				K	U	A
14.3	Sexual Reproduction in Plants (Pollination and Fertilization)	14.3.1 14.3.2 14.3.3 14.3.4	define pollination and its types (self and cross pollination); describe the structure and function of each whorl of a flower with reference to pollination, fertilization and fruit formation; describe sexual reproduction in plants by explaining the life cycle of a flowering plant (from pollination to fruit formation); describe the adaptations in the structure of wind-pollinated and insect-pollinated flowers;	*	 * * *	
14.4	Germination of Seed	14.4.1 14.4.2 14.4.3	describe the structure of seed (monocot and dicot); distinguish between epigeal and hypogeal germination; describe the conditions necessary for germination of seeds;		* * *	
14.5	Asexual Reproduction in Animals	14.5.1	describe the 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	define fertilization and differentiate between external and internal fertilization; describe different organs of the male and female reproductive systems of rabbit; describe the processes of gametogenesis in rabbit;		* * *	
14.7	Sexually Transmitted Disease (AIDS)	14.7.1	give an account of a sexually transmitted disease, AIDS.		*	

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				K	U	A
15. Inheritance		**Candidates should be able to:**				
15.1	Introduction	15.1.1	define genetics;	*		
		15.1.2	explain control of inheritance of characters by genes;		*	
15.2	Chromosomes and Genes	15.2.1	define chromosomes and chromatids;	*		
		15.2.2	describe the composition of chromatin material;		*	
		15.2.3	*describe a DNA molecule as two strands coiled to form a double helix, the strands being linked by a series of paired bases;*		*	
		15.2.4	differentiate between a gene and an allele;		*	
		15.2.5	outline the process of DNA replication;		*	
15.3	Mendel's Law of Segregation and Independent Assortment	15.3.1	describe complete dominance using the terms dominant, recessive, phenotype, genotype, homozygous, heterozygous, P1, F1, F2 generations and proving it diagrammatically through a monohybrid genetic cross;			*
		15.3.2	describe complete and incomplete dominance with examples;		*	
		15.3.3	demonstrate that the 3:1 monohybrid F-2 phenotypic ratio is an evidence of segregation of alleles;			*
		15.3.4	state Mendel's Law of Segregation;	*		
		15.3.5	demonstrate that 9:3:3:1 dihybrid F-2 phenotypic ratio is an evidence of independent assortment;			*
		15.3.6	state Mendel's Law of Independent Assortment;	*		
		15.3.7	explain co-dominance selecting the example of ABO blood group system;		*	
		15.3.8	explain incomplete dominance in Japanese 4 O' Clock plant;		*	

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15.4	Variation and Evolution	15.4.1	describe the sources of variation (*genetic, environmental or both*);		*	
		15.4.2	relate meiosis with variation;		*	
		15.4.3	describe variation and explain difference between continuous and discontinuous variation by giving examples like, height, weight, IQ, gender, tongue rolling, ear lobes and blood groups in population;		*	
		15.4.4	define organic evolution and explain how variation can lead to evolution;		*	
		15.4.5	describe how variation leads to competition in a population and differential survival by best fitting the environment;		*	
		15.4.6	assess 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, like wheat, rice etc.		*	
16. Man and his Environment		**Candidates should be able to:**				
16.1	The Ecosystem: Levels of Ecological Organization; Components	16.1.1	describe levels of ecological organization (species, population, community, habitat, ecosystem, biosphere);		*	
		16.1.2	describe components of the ecosystem;		*	
		16.1.3	describe the interrelationships between biotic and abiotic components of the ecosystem;		*	
16.2	Flow of Materials and Energy in the Ecosystem	16.2.1	describe that the sun is the principal source of energy for all biological systems;		*	
		16.2.2	compare and contrast the flow of materials (cyclic) and the flow of energy (non-cyclic) in the ecosystem;		*	
		16.2.3	construct and describe food chains and food webs;			*
		16.2.4	describe and compare energy relations between different trophic levels;		*	
		16.2.5	interpret pyramids of numbers 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;		*	

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				K	U	A
16.4	Interactions in the Ecosystem (Competition; Predation; Symbiosis)	16.4.1 16.4.2	explain competition, predation and symbiosis (parasitism, mutualism, commensalisms); relate competition, predation, and parasitism with population growth;		* *	
16.5	Ecosystem Balance and Human Impact on Environment	16.5.1 16.5.2	describe the importance of balance in nature; explain the damages caused by overpopulation, urbanization, global warming, deforestation and acid rain;		* *	
16.6	Pollution, its Consequences and Control	16.6.1 16.6.2 16.6.3	explain causes of air, water, and land pollution; describe effects of pollution on plants, animals and human beings; describe possible actions to control pollution;		* * *	
16.7	Conservation of Resources	16.7.1	*demonstrate environmental care through acting upon the principle of 'The 3Rs' (reduce, reuse and recycle).*			*
17. Biotechnology		**Candidates should be able to**				
17.1	Introduction	17.1.1 17.1.2 17.1.3	define biotechnology and explain its importance; relate biotechnology with genetic engineering and fermentation; *explain that plants and animals with desired characteristics can be developed by selective breeding;*		* * *	
17.2	Fermentation and Baking Industry	17.2.1 17.2.2	explain the method of fermentation by yeast and bacteria; rationalise the significance of different fermentation products and their importance in daily life i.e. yogurt making, bread making, making of cheese and production of alcohol;		*	*

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			K	U	A
	17.2.3	explain the use of fermenter in large-scale production of micro-organisms and their products;		*	
	17.2.4	describe the procedure of using fermenters;		*	
	17.2.5	describe the advantages / profitability of using fermenters in preparing medical products;		*	
17.3 Genetic Engineering	17.3.1	define genetic engineering and describe its objectives;		*	
	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 e.g. production of insulin, human growth hormone, thymosin, beta-endorphin, vaccine against foot-and-mouth disease, interferon and urokinase and in animal propagation (animal cloning);		*	
	17.3.5	explore the application of genetic engineering in the production of human insulin and growth hormones;			*
17.4 Single Cell Protein and its Uses	17.4.1	describe single-cell protein and its importance;		*	
	17.4.2	state the significance of single-cell protein in animal feed;	*		
	17.4.3	state the significance of single-cell protein in human food.	*		
18. Pharmacology	**Candidates should be able to:**				
18.1 Introduction	18.1.1	define pharmacology;	*		
	18.1.2	define the term 'drug';	*		
	18.1.3	state the various sources of drugs i.e. minerals, animals, plants, synthetics, microorganisms;	*		
	18.1.4	describe the principle usages of painkillers, antibiotics, vaccines and sedatives;		*	

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	18.1.5	state the contributions of Joseph Lister in the discovery of antiseptics and of Alexander Fleming in the discovery of penicillin;	*		
18.2 Medicinal Drugs and Addictive Drugs	18.2.1	categorise addictive drugs and describe their effects (sedatives, narcotics and hallucinogens);		*	
	18.2.2	define hallucinogen and relate it with marijuana;	*		
	18.2.3	define narcotics and relate it with morphine and heroine (as the most widely used / abused);	*		
	18.2.4	describe the associated problems of drug addiction i.e. severe social abandonment and crimes;		*	
	18.2.5	identify the symptoms of addiction (heroine);	*		
	18.2.6	identify different plants, which are common in Pakistan and used for getting hallucinogens and narcotics;	*		
18.3 Antibiotics and Vaccines	18.3.1	identify sulfonamides, tetracyclines and cephalosporins as the major groups of antibiotics being used;	*		
	18.3.2	define bactericidal and bacteriostatic effect of antibiotics;	*		
	18.3.3	describe the resistance developed in bacteria against the widely used antibiotics;		*	
	18.3.4	describe the nature and mode of action of vaccines in producing immunity against specific diseases.		*	

NOTES

4. Scheme of Assessment

Class 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	2	11	1	14
2.	Solving a Biological Problem	1	-	1	1	2
3.	Biodiversity	7	5	15	2	22
4.	Cells and Tissues	4	1	21	1	23
5.	Cell Cycle	4	1	21	-	22
6.	Enzymes	4	2	13	1	16
7.	Bioenergetics	4	4	15	1	20
8.	Nutrition	6	10	16	2	28
9.	Transport	8	8	24	-	32
	Total	**46**	**33**	**137**	**9**	**179**
	Percentage		**18**	**77**	**5**	**100**

Table 2: Allocation of Marks for Multiple Choice Questions (MCQs), Constructed Response Questions (CRQs) and Extended Response Questions (ERQs)

Topic No.	Topics	No. of Sub-topics	Marks			Total
			Multiple Choice Questions	Constructed Response Questions	Extended Response Questions	
2.	Solving a Biological Problem	1	2	4	-	6
1.	Introduction to Biology	8	9	5	7	21
3.	Biodiversity	7				
4.	Cells and Tissues	4				
5.	Cell Cycle	4	4	3	-	7
6.	Enzymes	4	2	2	-	4
7.	Bioenergetics	4	8	11	8	27
8.	Nutrition	6				
9.	Transport	8				
	Total	**46**	**25**	**25**	**15**	**65**
	Practical (see annex B)					10
	Total					**75**

Table 3: Paper Specifications

Topic No.	Topics	Marks Distribution			Total Marks
2.	Solving a Biological Problem	MCQs 2 @ 1 Mark CRQ 1 @ 4 Marks			6
1.	Introduction to Biology	MCQs 9 @ 1 Mark CRQ 1 @ 5 Marks *ERQ 1 @ 7 Marks Choose any ONE from TWO			21
3.	Biodiversity				
4.	Cells and Tissues				
5.	Cell Cycle	MCQs 4 @ 1 Mark CRQ 1 @ 3 Marks			7
6.	Enzymes	MCQs 2 @ 1 Mark CRQ 1 @ 2 Marks			4
7.	Bioenergetics	MCQs 8 @ 1 Mark CRQs 2 @ 3 Marks CRQ 1 @ 5 Marks *ERQ 1 @ 8 Marks Choose any ONE from TWO			27
8.	Nutrition				
9.	Transport				
	Total	**MCQs**	**CRQs**	**ERQs**	**65**
		25	**25**	**15**	
	Practical				10
	Total Marks				**75**

* Extended response questions (ERQs) will require answers in more descriptive form. The answers will be in a paragraph rather than a word or a single sentence.

Class X

Table 4: Number of Student Learning Outcomes by Cognitive Level

Topic No.	Topics	No. of Sub-topics	SLOs			Total
			K	U	A	
10.	Gaseous Exchange	4	1	8	1	10
11.	Homeostasis	5	5	13	0	18
12.	Coordination	6	8	17	0	25
13.	Support and Movement	4	4	10	1	15
14.	Reproduction	7	2	18	0	20
15.	Inheritance	4	4	15	3	22
16.	Man and his Environment	7	0	16	3	19
17.	Biotechnology	4	2	12	2	16
18.	Pharmacology	3	10	5	0	15
	Total	**44**	**36**	**114**	**10**	**160**
	Percentage		**23**	**71**	**6**	**100**

Table 5: Allocation of Marks for Multiple Choice Questions (MCQs), Constructed Response Questions (CRQs) and Extended Response Questions (ERQs)

Topic No.	Topics	No. of Sub-topics	Marks			Total
			Multiple Choice Questions	Constructed Response Questions	Extended Response Questions	
10.	Gaseous Exchange	4	8	8	7	23
11.	Homeostasis	5				
12.	Coordination	6				
13.	Support and Movement	4	3	4	0	7
14.	Reproduction	7	10	8	8	26
15.	Inheritance	4				
16.	Man and his Environment	7				
17.	Biotechnology	4	4	5	0	9
18.	Pharmacology	3				
	Total	**44**	**25**	**25**	**15**	**65**
	Practical (see annex B)					10
	Total					**75**

Table 6: Paper Specifications

Topic No.	Topics	Marks Distribution			Total Marks
10.	Gaseous Exchange	MCQs 8 @ 1 Mark CRQs 2 @ 4 Marks each *ERQ 1 @ 7 Marks Choose any ONE from TWO			23
11.	Homeostasis				
12.	Coordination				
13.	Support and Movement	MCQs 3 @ 1 Mark CRQ 1 @ 4 Marks			7
14.	Reproduction	MCQs 10 @ 1 Mark CRQs 2 @ 4 Marks each ERQ 1 @ 8 Marks Choose any ONE from TWO			26
15.	Inheritance				
16.	Man and his Environment				
17.	Biotechnology	MCQs 4 @ 1 Mark CRQ 1 @ 5 Marks			9
18.	Pharmacology				
	Total	**MCQs**	**CRQs**	**ERQs**	**65**
		25	**25**	**15**	
	Practical				10
	Total Marks				**75**

* Extended response questions (ERQs) will require answers in more descriptive form. The answers will be in a paragraph rather than a word or a single sentence.

4.1 Tables 1 and 4 summarize the number and nature of SLOs in each topic in classes IX and X. This will serve as a guide in the construction of the examination paper. It also indicates that more emphasis has been given to Understanding (77% and 71%), Application and higher order skills (5% and 6%) to discourage rote memorization. Tables 1 and 4 however do not translate directly into marks.

4.2 There will be two examinations, one at the end of Class IX and one at the end of Class X.

4.3 In each class, the theory paper will be in two parts: paper I and paper II. Both papers will be of duration of 3 hours.

4.4 Paper I theory will consist of 25 compulsory, multiple choice items. These questions will involve four response options.

4.5 Paper II theory will carry 40 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.

4.6 Practical examination will be conducted separate from the theory paper. It will be based on the list of practical activities listed in the examination syllabus.

4.7 All constructed response questions will be in a booklet which will also serve as an answer script.

4.8 Practical exams to assess performance skills will carry 10 marks in class IX and 10 marks in class X.

4.9 It is essential for each school to equip its laboratories with chemicals, instruments, apparatus, specimens etc. according to the requirements of the practicals. Each school will be responsible to make sure that each student is provided the opportunity to do the practicals.

List of practicals is attached as annex B.

5. Teaching-Learning Approaches and Classroom Activities

To promote effective teaching and learning a teacher has to play an effective and vital role as a facilitator, guide, supervisor, advisor etc. Work plan to be worked out beforehand for the speculated period. Lesson should be pre-planned keeping in view the set objectives. Theoretical concepts must be augmented by relevant practical activities. Teaching aids should be developed and tested beforehand. Classroom environment must be conducive, absorbing and friendly. Evaluation, assessment and measurement must be a regular feature for the scheme of work. Lesson evaluation should be formative and summative and to be done beforehand. Field trips to be preplanned. Short-term projects to be designed with perfection, and should be executed effectively. Lab should be properly equipped to cater to the needs of given set of practical.

- Study of prepared slides
- Identification, classification and physical features of preserved specimens
- Study of models of different organs such as eye, brain, ear, skin
- Collaborative learning (group assignments/ peer work)
- Gathering information from the internet / library/ documentary/ field visits (seashore, river, pond, forest, hospitals)
- Group and individual projects/ models
- Home assignments
- Science exhibitions/ quiz participation/ declamation contest

6. Recommended Text and Reference Material

Recommended Books

1. *Biology 9* (2010). PLD Publishers, Lahore.
2. *Biology 10* (2012). PLD Publishers, Lahore.
3. Dr. Farkhanda Manzoor (2010). *Biology Practical Notebook 9th*. Star Publishers.
4. Dr. Farkhanda Manzoor (2010). *Biology Practical Notebook 10th*. Star Publishers.

Reference Books

1. Kwan Pang L. and Lam Eric YK (2004). *Biology A course for "O Level"*. Singapore: Federal Publication.
2. Mackean D. G. (3rd Edition). *Introduction to Biology*. London: John Murray.
3. *Textbook for Biology IX* (2007). Punjab Textbook Board. Lahore.
4. *Textbook for Biology X* (2007). Punjab Textbook Board. Lahore.

Recommended Websites

http://www.learningsupport.akueb.edu.pk/
http://www.s-cool.co.uk/
http://www.bbc.co.uk/schools/gcsebitesize/science/aqa/
http://101science.com/
http://www.planet-science.com
http://faculty.fmcc.suny.edu/mcdarby/animals&plantsbook/site_map.htm

7. Definition of Cognitive Levels and Command Words

7.1 Definition of Cognitive Levels

Knowledge

This requires knowing and remembering facts and figures, vocabulary and contexts, and the ability to recall key ideas, concepts, trends, sequences, categories, etc. It can be taught and evaluated through questions based on: who, when, where, what, list, define, identify, label, tabulate, quote, name, state, etc.

Understanding

This requires understanding information, grasping meaning, interpreting facts, comparing, contrasting, grouping, inferring causes/reasons, seeing patterns, organizing parts, making links, summarizing, solving, identifying motives, finding evidence, etc. It can be taught and evaluated through questions based on: why, how, show, demonstrate, paraphrase, interpret, summarize, explain, prove, identify the main idea/theme, predict, compare, differentiate, discuss, report, solve, etc.

Application

This requires using information or concepts in new situations, solving problems, organizing information and ideas, using old ideas to create new ones, generalizing from given facts, analyzing relationships, relating knowledge from several areas, drawing conclusions, evaluating worth, etc. It can be taught and evaluated through questions based on: analyze, show relationship, propose an alternative, prioritize, give reasons for, categorise, illustrate, corroborate, create, design, formulate, integrate, rearrange, reconstruct/recreate, reorganize, predict consequences etc.

7.2 Definition of Command Words

Knowledge

Define:	Only a formal statement or equivalent paraphrase is required. No examples need to be given.
Identify:	Establish or indicate the origin, nature or definitive character of something.
State:	A concise answer with little or no supporting argument, e.g. a numerical answer that can be obtained "by inspection".

Understanding

Assess:	To evaluate or estimate the nature, ability, or quality of something.
Categorise:	To state a basis for classification of a set of related entities and assign examples.
Compare:	To list the main characteristics of two entities clearly identifying similarities or differences.
Correlate/ Relate:	To describe how things are dependent upon, follows from or is part of another.
Describe:	To state in words (using diagrams where appropriate) the main points of the topic. It is often used with reference either to particular phenomena or to particular experiments. In the former instance, the term usually implies that the answer should include reference to (visual) observations associated with the phenomena.
Differentiate/ Distinguish:	To identify those characteristics which always or sometimes differentiate two categories.
Draw:	To make a simple freehand sketch or diagram. Care should be taken with proportions and the clear labelling of parts.
Explain:	To make an idea/ situation/ problem clear by describing it in detail, revealing relevant data or facts.
Give an account:	Give an account of should be interpreted more generally, i.e. the candidate has greater discretion about the nature and the organization of the material to be included in the answer.
Highlight:	To bring to light the key features of a phenomenon or an object or living organism.
Infer:	To conclude by reasoning with the help of evidences.
Justify/Reason out:	To support opinion with evidences or reasons or provide adequate ground to rationalise one's idea.
Locate:	To determine the precise position or situation of an entity in a given context.
Outline:	Implies brevity, i.e. restricting the answer to giving essentials.

Summarise:	To identify/review the main points, relevant factors and/or arguments so that these are explained in a clear and concise manner.
Trace:	To ascertain the successive stages in the development or progress of something.

Application

Analyze:	To judge the objects or events from the knowledge acquired previously.
Construct:	To set in order or something formulated or built systematically or frame a concept, model, or schematic idea.
Demonstrate:	To show how a thing is related to another, usually it is reference to theory but sometimes it is by physical manipulation or experiment.
Determine:	To establish or ascertain definitely, as after consideration, investigation, or calculation.
Discuss:	To give a critical account of the points involved in the topic.
Explore:	To investigate or examine systematically / to attain information by searching in books / videos / websites.
Interpret:	To translate information from observation, charts, tables, graphs, and written material in a supportable manner.
Predict:	Implies that the candidate is not expected to produce the required answer by recall but by making a logical connection between other pieces of information. Such information may be wholly given in the question or may depend on answers extracted in an early part of the question.
Rationalise:	To give reasons or present logic to support the argument.
Solve:	To work out systematically the answer of a given problem.
Show:	To demonstrate with evidence i.e. by physical manipulation or experiment or illustrations (graph); how one thing is related to another.

Annex A

SSC Scheme of Studies[3]

AKU-EB as a national board offers SSC and HSSC qualifications for both English and Urdu medium schools. The revised SSC Scheme of Studies issued by the Curriculum Wing was implemented from September 2007. Accordingly, each SSC subject will be taught across both the classes IX and X. The Science and Humanities group subjects are offered at SSC level. The marks allocated to subjects in the revised National Scheme of Studies of September 2007 have been followed.

SSC I and II (Class IX and X) subjects on offer for examination

SSC Part-I (Class IX) Science Group

Subjects	Marks			Medium
	Theory	Practical	Total	
English Compulsory-I	75	-	75	English
Urdu Compulsory-I **OR** Urdu Aasan [a] **OR** History and Geography of Pakistan-I [b]	75	-	75	Urdu Urdu English
Islamiyat-I **OR** Ethics-I [c]	*30	-	*30	English / Urdu
Pakistan Studies-I	*45	-	*45	English / Urdu
Mathematics-I	75	-	75	English / Urdu
Physics-I	65	10	75	English / Urdu
Chemistry-I	65	10	75	English / Urdu
Biology-I **OR** Computer Science-I	65	10	75	English / Urdu English
Total:	***495**	**30**	***525**	

SSC Part-II (Class X) Science Group

Subjects	Marks			Medium
	Theory	Practical	Total	
English Compulsory-II	75	-	75	English
Urdu Compulsory-II **OR** Sindhi [a] **OR** History and Geography of Pakistan-II[b]	75	-	75	Urdu Sindhi English
Islamiyat-II **OR** Ethics-II [c]	*45	-	*45	English / Urdu
Pakistan Studies-II	*30	-	*30	English / Urdu
Mathematics-II	75	-	75	English / Urdu
Physics-II	65	10	75	English / Urdu
Chemistry-II	65	10	75	English / Urdu
Biology-II **OR** Computer Science-II	65	10	75	English / Urdu English
Total:	***495**	**30**	***525**	

a. Candidates from the province of Sindh may appear in "Urdu Aasan" in SSC Part I and in "Sindhi" in Part II examination.

b. Foreign students may opt HISTORY and GEOGRAPHY OF PAKISTAN in lieu of Urdu Compulsory, subject to the Board's approval.

c. For non-Muslim candidates only.

* The above will be implemented in
SSC Part I 2013 Examinations and onwards
SSC Part II 2014 Examinations and onwards

[3] Government of Pakistan September 2007. *Scheme of Studies for SSC and HSSC (Classes IX-XII).* Islamabad: Ministry of Education, Curriculum Wing.

SSC Part-I (Class IX) Humanities Group

Subjects	Marks	Medium
English Compulsory-I	75	English
Urdu Compulsory-I **OR** Urdu Aasan [a] **OR** History and Geography of Pakistan-I [b]	75	Urdu Urdu English
Islamiyat-I **OR** Ethics-I [c]	*30	English / Urdu
Pakistan Studies-I	*45	English / Urdu
General Mathematics-I	75	English / Urdu
Any three of the following Elective Subjects	225 (75 each)	
1. **Geography-I		English / Urdu
2. General Science-I		English / Urdu
3. Computer Science-I (65+10 practical)		English
4. Economics-I		English / Urdu
5. Civics-I		English / Urdu
6. **History of Pakistan-I		English / Urdu
7. **Elements of Home Economics-I		English / Urdu
8. **Food and Nutrition-I (65+10 practical)		English / Urdu
9. **Art & Model Drawing-I		English
10. **Business Studies-I		English
11. **Environmental Studies-I		English
Total:	***525**	

SSC Part-II (Class X) Humanities Group

Subjects	Marks	Medium
English Compulsory-II	75	English
Urdu Compulsory-II **OR** Sindhi [a] History and Geography of Pakistan-II [b] **OR**	75	Urdu Sindhi English
Islamiyat-II **OR** Ethics-II [c]	*45	English / Urdu
Pakistan Studies-II	*30	English / Urdu
General Mathematics-II	75	English / Urdu
Any three of the following Elective Subjects	225 (75 each)	
1. **Geography-II		English / Urdu
2. General Science-II		English / Urdu
3. Computer Science-II (65+10 practical)		English
4. Economics-II		English / Urdu
5. Civics-II		English / Urdu
6. **History of Pakistan-II		English / Urdu
7. **Elements of Home Economics-II		English / Urdu
8. **Food and Nutrition-II (65+10 practical)		English / Urdu
9. **Art & Model Drawing-II		English
10. **Business Studies-II		English
11. **Environmental Studies-II		English
Total:	***525**	

SSC Part-I and Part-II (Class IX-X) (Additional Subjects)

SSC Part I	SSC Part II	Marks	Medium
1. **Literature in English-I [d]	1. **Literature in English-II [d]	75 each	English
2. **Commercial Geography-I [d]	2. **Commercial Geography-II [d]		English
3. **Additional Mathematics-I [d]	3. **Additional Mathematics-II [d]		English

a. Candidates from the province of Sindh may appear in "Urdu Aasan" in SSC Part I and in "Sindhi" in Part II examination.

b. Foreign students may opt HISTORY and GEOGRAPHY OF PAKISTAN in lieu of Urdu Compulsory, subject to the Board's approval.

c. For non-Muslim candidates only.

d. Subject will be offered as Additional Subject.

* The above will be implemented in

SSC Part I 2013 Examinations and onwards SSC Part II 2014 Examinations and onwards

****These subjects are offered <u>ONLY</u> in the May examination.**

Annex B

List of Practical Activities

Class IX

S. No.	SLO No.	Objective	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	
3.	1.8.4	Identification of the vegetative parts (root, stem, leaf) and reproduction parts (flower, sepal, petals, gynoecium and androecium) of a dicotyledonous plant.	Magnifying glass, forceps, pointer/needle	Dicotyledonous plant
		Topic 3: Biodiversity		
4.	3.5.2	Study of different types of bacteria (cocci, bacilli) with the help of prepared slides/charts.	Prepared slides of cocci and bacilli, microscope	
5.	3.5.3 3.5.4 3.5.5 3.5.6 3.5.7	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 and cat	

S. No.	SLO No.	Objective	Apparatus/ Slide/ Specimen	Chemical/ Material
		Topic 4: Cells and Tissues		
6.	4.1.1	Examination and handling of a microscope.	Microscope	
7.	4.2.1 4.2.2	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, dye, microscope	
8.	4.2.8	Calculation of surface area to volume ratio of cubes of different sizes.	Petri dish, forceps, meter scale, dye	Potato
9.	4.4.3	Identification of different types of animal tissues (epithelial, connective, muscle and nervous) with the help of prepare slides/ charts/ photomicrographs.	Prepared slides /charts/ photomicrographs of animal tissues (epithelial, connective, muscle 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.	Objective	Apparatus/ Slide/ Specimen	Chemical/ Material
		Topic 5: Cell Cycle		
11.	5.2.1 5.2.2 5.2.3 5.2.4 5.2.5	Study of different stages of mitosis with the help of prepared slides/charts/photomicrographs.	Prepared slides /charts/ photomicrographs of different stages of mitosis, microscope	
12.	5.3.1 5.3.2 5.3.3 5.3.4 5.3.5	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 6: Enzymes		
13.	6.1.3	Investigation of the action of amylase on starch at room temperature.	Beaker, test tubes, dropper	Starch solution, amylase, iodine solution, distilled water
14.	6.1.6	Investigation of the action of pepsin on proteins at room temperature.	Beaker, test tubes, dropper	Food item containing proteins, pepsin, iodine solution
15.	6.2.1	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

S. No.	SLO No.	Objective	Apparatus/ Slide/ Specimen	Chemical/ Material
16.	6.2.1	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		
17.	7.2.4	Investigation of the release of oxygen during photosynthesis using hydrilla plant.	Beaker, short stem funnel, test tube, match box	Hydrilla plant, sodium bicarbonate
18.	7.3.2	Investigation of light, chlorophyll carbon dioxide as necessary factors for photosynthesis using destarch 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.	Objective	Apparatus/ Slide/ Specimen	Chemical/ Material
		Topic 8: Nutrition		
19.	8.2.1	Performance of food tests including: • Benedicts test for reducing sugar • Iodine test for starch • Spot test for fats • 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 fats: Tracing paper, source of light (torch)	Butter
			For proteins: Test tube, test tube holder, test tube stand, dropper	Egg albumin, water, sodium or potassium hydroxide solution, dilute copper sulphate solution
20.	8.5.7	Microscopic examination of a transverse section of villi.	Prepared slide of transverse section of villi, microscope	
		Topic 9: Transport		
21.	9.3.1	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

Class X

S. No.	SLO No.	Objective	Apparatus/ Slide/ Model	Chemical/ Material
		Topic 10: Gaseous Exchange		
1.	10.3.6	Investigation of the release of heat during aerobic respiration in germinating seeds.	Thermos flask, cotton wool, thermometer	Germinating seeds, dead seeds
		Topic 11: Homeostasis		
2.	11.4.2	Examination of the structure of kidney using model/chart.	Model/ chart of kidney	
		Topic 12: Coordination		
3.	12.3.2 12.3.3	Examination of the structure of brain using model/chart.	Model/ chart of brain	
4.	12.4.1	Examination of the structure of eye using model/chart.	Model/ chart of eye	
5.	12.4.1	Examination of the structure of ear using model/chart.	Model/ chart of ear	
		Topic 13: Support and Movement		
6.	13.1.5	Examination of the human skeleton using model/chart.	Model/ chart of human skeleton	

S. No.	SLO No.	Objective	Apparatus/ Slide/ Model	Chemical/ Material
		Topic 14: Reproduction		
7.	14.2.3	Examination of a bulb (onion), rhizome (ginger) and tuber (potato).	Petri dish, pointer/needle	Onion, ginger, potato
8.	14.2.3 14.3.2	Study of vegetative and reproductive parts of a dicotyledonous plant.	Petri dish, pointer/needle	Dicotyledonous plant
9.	14.4.1	Examination of the structure of maize and gram seeds.	Petri dish, pointer/needle	Maize and gram seeds
10.	14.4.3	Investigation of the conditions (water) necessary for seed germination.	Petri dish, beaker, filter paper, refrigerator	Seeds of wheat/ gram/ pea
11.	14.5.1	Observation of binary fission in amoeba using prepared slide/chart/photomicrograph.	Prepared slide/chart/photomicrograph of binary fission in amoeba	
12.	14.5.1	Observation of budding in yeast using prepared slide/chart/photomicrograph.	Prepared slide/chart/photomicrograph of budding in yeast	
		Topic 15: Inheritance		
13.	15.2.3	Examination of the human DNA using model/chart.	Model/ chart of human DNA	
14.	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 (either histogram or bar chart).	Pencil, eraser, meter scale, graph paper	

S. No.	SLO No.	Objective	Apparatus/ Slide/ Model	Chemical/ Material
		Topic 16: Man and his Environment		
15.	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		
16.	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