



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**

Class IX examination in 2010 and onwards  
Class X examination in 2011 and onwards

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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)<sup>1</sup>**

### **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.

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<sup>1</sup> 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 according to which the total marks for the SSC examination have been increased from 850 to 1100 from the year 2008 and onwards. 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, but not necessarily the same content, to elicit evidence of these competencies in candidates’ responses. The definitions of command words used in this syllabus are given in Section 8. 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 <sup>2</sup>		
		K	U	A
<b>1. Introduction to Biology</b>	<b>Candidates should be able to:</b>			
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 define the branches of biology i.e. morphology, anatomy, physiology, embryology, taxonomy, cell biology, histology, paleontology, environmental biology, biotechnology, socio-biology, parasitology, immunology, entomology, genetics, pharmacology and their significance;	*		
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) with examples;		*	
1.4 Impact of Biological Studies on Human Welfare	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;			*
	1.4.2 identify and evaluate the impact of scientific advancements in technology on society (disease control, hereditary diseases, cloning, bio-pesticides);			*
1.5 Quran Instructs to Reveal the Study of Life	1.5.1 state at least three verses from Holy Quran, instructing for the study of the origin and the characteristics of life;	*		

<sup>2</sup> K = Knowledge, U = Understanding, A= Application (for explanation see Section 8: Definition of command words used in Student Learning Outcomes and in Examination Questions).

**NOTES**

		<b>K</b>	<b>U</b>	<b>A</b>	
1.6	Contribution of Scientists	1.6.1	Relate the contributions of Jaber Bin Hayan, Abdul Malik Asmai and Bu Ali Sina with the current knowledge about plants and animals;	*	
1.7	The Levels of Organization	1.7.1	describe bioelements as the most basic level of biological organization;	*	
		1.7.2	define biomolecules and distinguish them with examples as micromolecules and macromolecules;	*	
		1.7.3	describe the level of organization of life (organelles, cells, tissues, organs, organ systems and individuals);	*	
		1.7.4	construct a linkage chart connecting different organs with the relative organ system;		* CA*
		1.7.5	explain division of labour among cells and tissues in a multicellular organism;		*
1.8	Unicellular and Multicellular Organisms	1.8.1	differentiate between unicellular and multicellular organisms;	*	
		1.8.2	describe cellular organization in unicellular organisms i.e. Amoeba;	*	
		1.8.3	describe the cellular organization in multicellular organisms (mustard and frog) (Only brief description referring to cellular organization is required. Details of organs and organs-systems of frog and mustard should be avoided).	*	
<b>2. Solving a Biological Problem</b>		<b>Candidates should be able to:</b>			
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**

		<b>K</b>	<b>U</b>	<b>A</b>
	2.1.2 Solve a biological problem following the scientific method; <ul style="list-style-type: none"> <li>• formulate and test a working hypothesis;</li> <li>• write instructions for conducting investigations or following a procedure;</li> <li>• select appropriate instruments and materials to conduct an investigation;</li> <li>• describe safe laboratory procedures;</li> <li>• organize data appropriately using techniques such as tables and graphs;</li> <li>• analyze data to make predictions, decisions, or draw conclusions;</li> <li>• confirm, modify, or reject a hypothesis using data analysis;</li> <li>• use ratio and proportion in appropriate situations to solve problems.</li> </ul>			*
<b>3. Biodiversity</b>	<b>Candidates should be able to:</b>			
3.1 Introduction	3.1.1 define biodiversity; 3.1.2 describe the major variety of life on the planet earth; 3.1.3 relate the importance of biodiversity with natural ecosystems (land and water) through examples;	*	*	
3.2 Aims and Principles of Classification	3.2.1 describe the bases of classification of living organisms (with reference to homology, analogy, morphology, anatomy and embryology); 3.2.2 explain the aims and principles of classification with its historical background;	*	*	
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 bases for establishing five kingdoms; 3.3.3 compare Two-kingdom and Five-kingdom classification systems; 3.3.4 rationalize that Five-kingdom classification system better explains diversity of living organisms; 3.3.5 describe the contributions of Abu Usman Umer Aljahiz in unfolding the characteristics of animal species;	*	*	*

**NOTES**

		<b>K</b>	<b>U</b>	<b>A</b>
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 (For examples see list of practicals)	3.5.1 describe the salient features of Kingdom Prokaryotae with examples;		*	
	3.5.2 describe the salient features of Kingdom Protoctista with examples;		*	
	3.5.3 describe the salient features of Kingdom Fungi with examples;		*	
	3.5.4 describe the salient features of Kingdom Plantae with examples (a brief description of the structural features of Bryophytes, Tracheophytes, Pteridophytes, Gymnosperms and Angiosperms should be included);		*	
	3.5.5 describe the salient features of Kingdom Animalia with examples (a brief description of structural features of Invertebrates and Vertebrates should be included);		*	
	3.5.6 describe the acellular structure of virus and justify why virus are excluded from the Five Kingdom classification system;		*	
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 the concept of conservation and its importance;	*		
	3.7.2 explain the impact of human beings on biodiversity;	*		
	3.7.3 identify causes of deforestation and hunting and its effects on biodiversity;	*		
	3.7.4 describe the reason why a named animal species becomes endangered due to human interference.			* CA
<b>4. Cells and Tissues</b>	<b>Candidates should be able to:</b>			
4.1 Microscopy and the Emergence of Cell Theory	4.1.1 explain the concepts of light microscopy and electron microscopy;		*	
	4.1.2 explain the relationship between developments in imaging technology and the current understanding of the cell;	*		
	4.1.3 trace the development of the cell theory: from Aristotle to Hooke, Pasteur, Brown, and Schwann and Schleiden;	*		

**NOTES**

		<b>K</b>	<b>U</b>	<b>A</b>
4.2 Cellular Structures and Functions	4.1.4	construct a time line that traces the development of the cell theory from the first observations by Robert Hooke to our current understanding of cell structure;	*	
	4.1.5	rationalize that there are sub-cellular particles, such as viruses and prions, which have some characteristics of living things;	*	
	4.2.1	describe the structure and functions of the components of plant and animal cell (cell wall, cell membrane, nucleus, cytoplasm, Golgi bodies, mitochondria, lysosomes, vacuole, ribosomes, endoplasmic reticulum, centromere, plastids);		*
	4.2.2	differentiate between plant and animal cell;	*	
	4.2.3	explain how the cells of the leaf system have a variety of specialized structures and functions;		*
	4.2.4	state the relationship between cell structure and cell function (for absorption - root hair cells; conduction and support - xylem vessels; transport of oxygen - red blood cells);		*
	4.2.5	describe the cell as a structural and functional unit of life;		*
	4.2.6	determine ways in which various types of cells contribute to the healthy functioning of the human body;		*
	4.2.7	assess the capabilities of animal and plant cell types, owing to the presence or absence of chloroplasts and cell wall;		*
	4.2.8	describe the differences in the structure and function of prokaryotic and eukaryotic cells;		*
	4.2.9	describe the capabilities of prokaryotic and eukaryotic cells, owing to the presence or absence of nucleus and mitochondria;		*
4.2.10	describe cell size and shape as they relate to surface area to volume ratio;		*	
4.2.11	explain how surface area to volume ratio limits cell size (e.g., compare nerve cells and blood cells in animals, or plant root hair cells and chloroplast-containing cells on the surface of leaves);		*	

**NOTES**

		<b>K</b>	<b>U</b>	<b>A</b>	
4.3 Active and Passive Transport of Matter	4.3.1	define the terms diffusion, osmosis, active transport, hypertonic solution, hypotonic solution and isotonic solution;	*		
	4.3.2	describe different types of membranes (permeable, partial-permeable and impermeable);		*	
	4.3.3	describe the phenomena of diffusion, facilitated diffusion, osmosis, filtration, active transport, endocytosis and exocytosis with daily life 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 how knowledge about partially-permeable or differentially permeable membranes, diffusion and osmosis is applied in various contexts (e.g., separation of bacteria from viruses, purification of water, cheese making, use of honey as an antibacterial agent);			* CA
	4.3.6	define turgor and describe its importance;	*	*	
	4.3.7	describe the phenomena of plasmolysis and deplasmolysis and explain its relationship with osmosis;		*	
	4.3.8	describe the role of the cell membrane in maintaining equilibrium while exchanging matter;		*	
4.4 Tissues (Types of Plant and Animal Tissues)	4.4.1	describe tissue as the group of similar cells, performing the same function;		*	
	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, permanent tissues including epidermal, parenchyma, collenchyma and sclerenchyma) and compound tissues (xylem tissues and phloem tissues) 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;		*	

**NOTES**

		<b>K</b>	<b>U</b>	<b>A</b>
	4.4.6 justify why a colony of cells does not get tissue level of organization, in spite of having many cells.		*	
<b>5. Cell Cycle</b>	<b>Candidates should be able to:</b>			
5.1 Cell Cycle (Interphase and Division)	5.1.1 define cell cycle and describe 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 describe 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 enlist 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 state 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 state the role of mitosis 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 taking place in Metaphase-I; 5.3.3 explain what happens during Anaphase-I; 5.3.4 describe the events of Telophase-I; 5.3.5 explain the events occurring during the second meiotic division;		* * * * *	

**NOTES**

		<b>K</b>	<b>U</b>	<b>A</b>
5.4 Necrosis and Apoptosis	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;		*	
	5.3.9 contrast mitosis and meiosis, emphasizing the events that lead to different outcomes;		*	
	5.4.1 describe necrosis and apoptosis;		*	
	5.4.2 correlate necrosis and apoptosis with cell cycle.		*	
<b>6. Enzymes</b>	<b>Candidates should be able to:</b>			
6.1 Characteristics of Enzymes	6.1.1 define metabolism and differentiate between catabolism and anabolism;	*	*	
	6.1.2 describe enzymes as the proteins that speed up biochemical reactions;		*	
	6.1.3 categorize enzymes as intra and extracellular;		*	
	6.1.4 comprehend that enzymes increase rate of reaction;		*	
	6.1.5 state that small quantity of enzyme is effective for large amount of 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 enzyme;		*	
6.2 Factors Affecting Activity of Enzyme	6.2.1 explain the effect of pH, temperature and concentration of substrate on the activity of an enzyme;		*	
	6.2.2 draw graph showing the effect of pH, temperature and concentration of substrate on the activity of an enzyme;			*

**NOTES**

		<b>K</b>	<b>U</b>	<b>A</b>
6.3	Mechanism of Enzyme Action (Lock-n-Key Model)		*	
	6.3.1 describe, through equation, that enzyme substrate complex is formed and release of enzyme takes place after completing the reaction;			
	6.3.2 describe the action of enzyme through Lock-and-Key model;		*	
6.4	Specificity of Enzymes		*	
	6.4.1 describe the specificity of different enzymes for different substrates;		*	
	6.4.2 relate that specificity of enzyme is due to its shape;		*	
	6.4.3 categories that proteases will act on proteins only and lipases will act on lipids or fats only.		*	
<b>7.</b>	<b>Bioenergetics</b>			
	<b>Candidates should be able to:</b>			
7.1	Bioenergetics and ATP	*		
	7.1.1 define bioenergetics as the study of energy relationships and energy conversions in living organisms;			
	7.1.2 describe the importance of Oxidation-Reduction reactions for the flow of energy through living systems;		*	
	7.1.3 explain ATP as a molecule that is the chief energy currency of all cells;		*	
	7.1.4 describe the synthesis and breaking of ATP through ATP-ADP cycle;		*	
7.2	Photosynthesis	*		
	7.2.1 state that photosynthesis is the fundamental process by which plants manufacture carbohydrates from raw materials;			
	7.2.2 state the equation (in words or symbols) for photosynthesis;	*		
	7.2.3 reason out 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 outline the processes (Light and Dark reactions) involved in photosynthesis;		*	
	7.2.6 <i>explain how the structure of the leaf is adapted for photosynthesis;</i>		*	
7.3	Factors Affecting Rate of Photosynthesis		*	
	7.3.1 explain the concept of limiting factors in photosynthesis;		*	
	7.3.2 state the effect of varying light intensity, carbon dioxide concentration and temperature on the rate of photosynthesis;		*	

**NOTES**

		<b>K</b>	<b>U</b>	<b>A</b>	
7.4	Respiration	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 describe the importance of anaerobic respiration with reference to the examples of athletes during race or a person doing strenuous exercise; 7.4.5 discuss the fate of lactic acid in the body; 7.4.6 explain the mechanism of respiration while defining Glycolysis, Krebs cycle and Electron Transport Chain; 7.4.7 compare aerobic and anaerobic respiration; 7.4.8 describe ways in which respiratory energy is used in the body.	*	*	
<b>8.</b>	<b>Nutrition</b>	<b>Candidates should be able to:</b>			
8.1	Mineral Nutrition in Plants	8.1.1 define mineral nutrition in plants; 8.1.2 categorize minerals nutrients into macronutrients and micronutrients; 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 fertilizers (manure and chemical) 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 specify the food sources and metabolic functions of Vitamins A, C and D; 8.2.3 describe the food sources and metabolic functions of Calcium and Iron; 8.2.4 describe the deficiency symptoms of Vitamins A, C and D and of Calcium and Iron; 8.2.5 specify the sources and metabolic functions of Water and Dietary fibers;	*	*	

**NOTES**

		<b>K</b>	<b>U</b>	<b>A</b>	
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	identify and 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	sort out the action of enzymes in specific regions of alimentary canal, with respect to their substrates and products;	*	
		8.5.6	state 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 lacteals;	*	
		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;	*	

**NOTES**

		<b>K</b>	<b>U</b>	<b>A</b>
8.6 Disorders of Gut	8.6.1 state the signs and symptoms, causes, treatments and preventions of the disorders of gut i.e. diarrhea, constipation, and ulcer.	*		
<b>9. Transport</b>	<b>Candidates should be able to:</b>			
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;		*	
	9.2.3 define root pressure, capillary action and transpiration pull;	*		
	9.2.4 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 explain the mechanism of food translocation by the theory of Pressure Flow Mechanism;		*	
9.4 Transport in Animals; Blood	9.4.1 list the components of blood;	*		
	9.4.2 describe the functions of the components of blood;		*	
	9.4.3 describe the blood groups in ABO and Rh blood group systems, with reference to the presence / absence of antigens and antibodies;		*	
	9.4.4 state the risk of incompatibility in blood transfusion due to antigen-antibody reactions;		*	
	9.4.5 list the appropriate donors and recipients for each of the four blood groups;	*		

**NOTES**

		<b>K</b>	<b>U</b>	<b>A</b>	
9.5 Human Heart	9.4.6	state the signs and symptoms, causes and treatments of the diseases of blood (leukemia and thalassaemia);	*		
	9.5.1	describe the external and internal structure of 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 how the heart is structurally adapted to its functions;		*	
	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 materials between capillaries and tissue fluid;		*	
9.7 General Plan of Human Blood Circulatory System	9.7.1	describe the major pathway of blood through circulatory system;		*	
	9.7.2	describe the origins, locations and target areas of main arteries i.e. pulmonary arteries, aorta with hepatic artery, renal arteries and femoral arteries;		*	
	9.7.3	describe the originating areas, locations and target heart chambers of main veins i.e. pulmonary veins, superior vena cava, inferior vena cava with femoral veins, renal veins and hepatic vein;		*	
	9.7.4	identify the main arteries and veins in charts, diagrams, models etc.;			* CA
	9.7.5	discuss the contributions of Ibn-al-Nafees and William Harvey in revealing the knowledge about the circulation of blood in human body;	*		
9.8 Cardiovascular Disorders	9.8.1	define cardiovascular disorders and differentiate between atherosclerosis and arteriosclerosis;	*	*	
	9.8.2	state the causes, treatments and prevention of myocardial infarction.	*		

**NOTES**

**Part II (Class X)**

Topic	Student Learning Outcomes	Cognitive Level <sup>3</sup>		
		K	U	A
<b>10. Gaseous Exchange</b>	<b>Candidates should be able to:</b>			
10.1 Introduction	10.1.1 differentiate among respiration, gaseous exchange 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 <i>explain how alveoli are adapted for gaseous exchange by diffusion between air in the lungs and blood in the capillaries;</i>		*	
	10.3.2 describe the mechanism of breathing in term of movements of ribs and diaphragm		*	
	10.3.3 Analyze the effect of exercise on the rate of breathing;			*
	10.3.4 differentiate between the composition of inspired and expired air;		*	
10.4 Respiratory Disorders and their Causes (Asthma, Bronchitis, Pneumonia, Lung Cancer)	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.		*	

<sup>3</sup> K = Knowledge, U = Understanding, A= Application (for explanation see Section 8: Definition of command words used in Student Learning Outcomes and in Examination Questions).

**NOTES**

		K	U	A
<b>11. Homeostasis</b>	<b>Candidates should be able to:</b>			
11.1 Introduction	11.1.1 define homeostasis and describe its importance;	*	*	
11.2 Homeostasis in Plants	11.2.1 describe the mechanisms / adaptations in plants for the excretion / storage of CO <sub>2</sub> , H <sub>2</sub> O, O <sub>2</sub> , latex, resins and gums;		*	
	11.2.2 explain osmotic adjustments in plants;		*	
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 role of skin in regulating body temperature;		*	
	11.3.3 describe how lungs keep the carbon dioxide concentration down to certain level		*	
	11.3.4 explain that kidneys control the blood composition;		*	
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 nephrons and relate them with their function		*	
	11.4.5 state that main role of kidney is urine formation;		*	
	11.4.6 describe that urine formation involves three processes i.e. filtration, selective reabsorption and secretion;		*	
	11.4.7 discuss the role of kidney in osmoregulation;		*	
11.5 Disorders of Human Excretory System	11.5.1 identify the causes of kidney stone;	*		
	11.5.2 describe lithotripsy and surgery as the methods to remove kidney stones;		*	
	11.5.3 outline the causes of kidney failure;		*	
	11.5.4 explain that dialysis is one of the treatments in kidney failure;		*	
	11.5.5 describe the contributions of Al-Farabi and Abul-Qasim in introducing the method of removing stone from the urinary bladder.	*		

**NOTES**

		K	U	A
<b>12. Coordination</b>	<b>Candidates should be able to:</b>			
12.1 Introduction	12.1.1 define coordination;	*		
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 and hormonal (chemical);		*	
	12.2.2 differentiate between the modes of coordination i.e., electrical in case of nervous and chemical in case of hormonal;		*	
	12.2.3 identify the main organs responsible for coordination and control;	*		
	12.2.4 state that receptors receive stimuli and transmit information to effectors through central nervous system;		*	
12.3 Human Nervous System	12.3.1 label the diagram of human brain;	*		
	12.3.2 explain the function of the parts of brain; cerebrum, cerebellum, pituitary gland, thalamus, hypothalamus, 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 name the three types of neuron involved in reflex action;	*		
	12.3.9 trace the path of a nervous impulse in case of a reflex action with examples from daily life;			*
12.4 Receptors of Man (Eyes and Ears)	12.4.1 describe the structure of human auditory and visual receptors;		*	
	12.4.2 describe the pupil reflex in dim and bright light;		*	
	12.4.3 explain the defects of eye (short sightedness and long sightedness);		*	
	12.4.4 state how short and long sightedness can be treated;	*		

**NOTES**

		<b>K</b>	<b>U</b>	<b>A</b>
12.5 Endocrine System	12.4.5		*	
	12.4.6	*		
	12.5.1	*		
	12.5.2	*		
	12.5.3		*	
	12.5.4			*
	12.6 Nervous Disorders (Paralysis and Epilepsy)	12.6.1		*
	12.6.2		*	
<b>13. Support and Movement</b>	<b>Candidates should be able to:</b>			
13.1 Human Skeleton (Axial Skeleton and Appendicular Skeleton)	13.1.1	*	*	
	13.1.2		*	
	13.1.3		*	
	13.1.4	*		
	13.1.5	*		

**NOTES**

		<b>K</b>	<b>U</b>	<b>A</b>
13.2 Ball-and- Socket and Hinge Joints	13.2.1	define joint;	*	
	13.2.2	differentiate between moveable joints and immovable joints;		*
	13.2.3	state the role of ligaments and tendons;	*	
	13.2.4	describe the location and movement of hinge joints;		*
	13.2.5	identify ball-n-socket joints in the human body;	*	
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 effect of deficiency of calcium on bones and relate this deficiency with osteoporosis;		*
	13.4.2	discuss the causes, symptoms, and treatment of arthritis;	*	
	13.4.3	relate the onset of arthritis with age and weight-bearing joints.		*
<b>14. Reproduction</b>	<b>Candidates should be able to:</b>			
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 cuttings and grafting);		*
	14.2.5	rationalize how parthenogenesis is a type of asexual reproduction;		*
	14.2.6	define cloning;	*	

**NOTES**

		<b>K</b>	<b>U</b>	<b>A</b>
14.3 Sexual Reproduction in Plants (Pollination and Fertilization)	14.3.1	define pollination and its types;	*	
	14.3.2	describe sexual reproduction in plants by explaining the life cycle of a flowering plant;		*
	14.3.3	describe the adaptations in the structure of wind-pollinated and insect-pollinated flowers;		*
14.4 Germination of Seed	14.4.1	describe the structure of seed (monocot and dicot);		*
	14.4.2	distinguish between epigeal and hypogeal germination;		*
	14.4.3	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	define fertilization and differentiate between external and internal fertilization;	*	*
	14.6.2	describe different organs of the male and female reproductive systems of rabbit;		*
	14.6.3	describe the processes of gametogenesis in rabbit;		*
	14.6.4	rationalize the need for population planning;		*
14.7 Sexually Transmitted Diseases (AIDS)	14.7.1	explain AIDS as an example of sexually transmitted diseases;		*
	14.7.2	state the role of National AIDS Control Program and different NGOs in educating people with reference of AIDS.	*	
<b>15. Inheritance</b>	<b>Candidates should be able to:</b>			
15.1 Introduction	15.1.1	define genetics;	*	
	15.1.2	explain how genes control inheritance of characters;		*

**NOTES**

		<b>K</b>	<b>U</b>	<b>A</b>	
15.2 Chromosomes and Genes	15.2.1	define chromosomes and chromatids;	*		
	15.2.2	describe the composition of chromatin material;		*	
	15.2.3	<i>describe a DNA molecule as two strands coiled to form a double helix, the strands being linked by a series of paired bases;</i>		*	
	15.2.4	state the difference between a gene and an allele;		*	
	15.2.5	describe the central dogma stating the role of gene in protein synthesis;		*	
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;		*	
15.4 Variation and Evolution	15.4.1	describe the sources of variation ( <i>genetic, environmental, or both</i> );		*	
	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;		*	

**NOTES**

		<b>K</b>	<b>U</b>	<b>A</b>
	15.4.6 assess selection as a possible means of evolution; 15.4.7 develop an understanding of artificial selection as a means of improvement of yield in economically important plants, like wheat, rice etc.		*	
			*	
<b>16. Man and his Environment</b>	<b>Candidates should be able to:</b>			
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 define ecosystem; 16.1.3 describe components of the ecosystem; 16.1.4 describe the interrelationships between biotic and abiotic components of the ecosystem;	*	*	
16.2 Flow of Materials and Energy in the Ecosystem	16.2.1 explain 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 Cycle & Nitrogen Cycle)	16.3.1 describe carbon and nitrogen cycles; 16.3.2 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;		*	*

**NOTES**

		<b>K</b>	<b>U</b>	<b>A</b>
16.5 Ecosystem Balance and Human Impact on Environment (Population growth, Urbanization, Industrialization, Deforestation)	16.5.1 describe the importance of balance in nature; 16.5.2 explain the human impact on environment; 16.5.3 explain the damages caused by some global and regional environmental problems (population growth, urbanization, global warming, deforestation, acid rain and <i>eutrophication</i> );		*	
16.6 Pollution, its Consequences and Control	16.6.1 explain causes of air, water, and land pollution; 16.6.2 describe effects of pollution on plants, animals and human beings  16.6.3 describe possible actions to control pollution;		*	
16.7 Conservation of Nature	16.7.1 explain conservation of nature; 16.7.2 explain different strategies for conservation of nature (reduced resource use, reuse and recycling of materials, control over hunting specially of rare species).	*	*	
<b>17. Biotechnology</b>	<b>Candidates should be able to</b>			
17.1 Introduction	17.1.1 define biotechnology and explain its importance; 17.1.2 relate biotechnology with genetic engineering and fermentation; 17.1.3 <i>explain that plants and animals with desired characteristics can be developed by selective breeding;</i>	*	*	
17.2 Fermentation and Baking Industry	17.2.1 define fermentation; 17.2.2 explain the method of fermentation by yeast and bacteria; 17.2.3 measure 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;	*	*	*

**NOTES**

		<b>K</b>	<b>U</b>	<b>A</b>
17.3 Genetic Engineering	17.2.4	explain the use of fermenter in large-scale production of micro-organisms and their products;	*	
	17.2.5	describe the procedure of using fermenters;	*	
	17.2.6	describe the advantages / profitability of using fermenters in preparing medical products;		*
	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 in curing animal diseases (Foot-and-Mouth disease, Coccidiosis, Trypanosomiasis) and in animal propagation (animal cloning);		*
17.4 Single Cell Protein and its Uses	17.3.5	describe the application of genetic engineering in the production of human insulin and growth hormones;		*
	17.4.1	describe single-cell protein and its importance;		*
	17.4.2	describe the significance of single-cell protein in animal feed;		*
	17.4.3	state the significance of single-cell protein in human food.	*	
<b>18. Pharmacology</b>	<b>Candidates should be able to:</b>			
18.1 Introduction	18.1.1	define pharmacology as the detailed study of drugs;	*	
	18.1.2	define the term 'drug' (the substance or product that is used to modify physiological systems of the body);	*	
	18.1.3	enlist 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;		*

**NOTES**

		<b>K</b>	<b>U</b>	<b>A</b>	
18.2 Medicinal Drugs and Addictive Drugs	18.1.5	state the contributions of Joseph Lister in the discovery of antiseptics and of Alexander Fleming in the discovery of penicillin;	*		
	18.2.1	categorize addictive drugs and describe their effects (sedatives, narcotics and hallucinogens);		*	
	18.2.2	define hallucinogen (drugs that alter ordinary mental and emotional processes) and relate it with Marijuana;	*		
	18.2.3	define narcotics (drugs that produce semi-consciousness and sleep to get relieve from pain) and relate it with Morphine and Heroine (as the most widely used / abused);	*		
	18.2.4	state the associated problems of drugs addictions i.e. severe social abandonment and crimes;	*		
	18.2.5	identify the symptoms of addiction;	*		
18.3 Antibiotics and Vaccines	18.2.6	name different plants, which are common in Pakistan and used for getting hallucinogens and narcotics;	*		
	18.3.1	categorize sulfonamides, tetracyclines and cephalosporins as the major groups of antibiotics being used;	*		
	18.3.2	identify major antibiotics as per their bactericidal and bacteriostatic effects;		*	
	18.3.3	rationalize the resistance developed in bacteria against the widely used antibiotics;		*	
	18.3.4	describe the role 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	7	5	3	15
2	Solving a Biological Problem	1	-	1	1	2
3	Biodiversity	7	9	11	2	23
4	Cells and Tissues	4	4	25	2	31
5	Cell Cycle	4	1	22	-	23
6	Enzymes	4	1	14	1	16
7	Bioenergetics	4	5	15	-	20
8	Nutrition	6	5	21	2	28
9	Transport	8	9	23	1	33
	<b>Total</b>	<b>46</b>	<b>41</b>	<b>137</b>	<b>12</b>	<b>190</b>
	<b>Percentage</b>		<b>22</b>	<b>72</b>	<b>6</b>	

**Table 2: Allocation of Marks for the Objective Test, Constructed Response Paper and Extended Response Question**

Topic No.	Topics	No. of Sub-topics	Marks			Total
			Objective Test	Constructed Response Paper	ERQ	
1	Introduction to Biology	8	3	4	-	7
2	Solving a Biological Problem	1	5	4	5	14
3	Biodiversity	7				
4	Cells and Tissues	4	7	4	5	16
5	Cell Cycle	4				
6	Enzymes	4	5	4	5	14
7	Bioenergetics	4				
8	Nutrition	6	2	4	-	6
9	Transport	8	3	5	-	8
	<b>Total</b>	<b>46</b>	<b>25</b>	<b>25</b>	<b>15</b>	<b>65</b>
	Practical (see annex B)					10
	<b>Total</b>					<b>75</b>

**Table 3: Paper Specifications for Examination**

Topic No.	Topics	Marks Distribution			Total Marks
1.	Introduction to Biology	MCQs 3 @ 1 Mark CRQ 1 @ 4 Marks			7
2.	Solving a Biological Problem	MCQs 5 @ 1 Mark CRQ 1 @ 4 Marks *ERQ 1 @ 5 Marks Choose any ONE from TWO			14
3.	Biodiversity				
4.	Cells and Tissues	MCQs 7 @ 1 Mark CRQ 1 @ 4 Marks ERQ 1 @ 5 Marks Choose any ONE from TWO			16
5..	Cell Cycle				
6.	Enzymes	MCQs 5 @ 1 Mark CRQ 1 @ 4 Marks ERQ 1 @ 5 Marks Choose any ONE from TWO			14
7.	Bioenergetics				
8.	Nutrition	MCQs 2 @ 1 Mark CRQ 1 @ 4 Marks			6
9.	Transport	MCQs 3 @ 1 Mark CRQ 1 @ 5 Marks			8
	<b>Total</b>	<b>MCQs</b>	<b>CRQs</b>	<b>ERQs</b>	<b>65</b>
		<b>25</b>	<b>25</b>	<b>15</b>	
	Practical				<b>10</b>
	<b>Total Marks</b>				<b>75</b>

\* 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	-	7	1	8
11	Homeostasis	5	5	15	-	20
12	Coordination	6	11	14	2	27
13	Support and Movement	4	8	7	1	16
14	Reproduction	7	5	17	1	23
15	Inheritance	4	5	16	2	23
16	Man and his Environment	7	2	18	1	21
17	Biotechnology	4	4	12	2	18
18	Pharmacology	3	10	5	-	15
	<b>Total</b>	<b>44</b>	<b>50</b>	<b>111</b>	<b>10</b>	<b>171</b>
	<b>Percentage</b>		<b>29</b>	<b>65</b>	<b>6</b>	

**Table 5: Allocation of Marks for the Objective Test, Constructed Response Paper and Extended Response Question**

Topic No.	Topics	No. of Sub-topics	Marks			Total
			Objective Test	Constructed Response Paper	ERQ	
10	Gaseous Exchange	4	4	4	5	13
11	Homeostasis	5				
12	Coordination	6	4	4	-	8
13	Support and Movement	4	3	5	5	13
14	Reproduction	7				
15	Inheritance	4	4	4	-	8
16	Man and his Environment	7	6	4	-	10
17	Biotechnology	4	4	4	5	13
18	Pharmacology	3				
	<b>Total</b>	<b>44</b>	<b>25</b>	<b>25</b>	<b>15</b>	<b>65</b>
	Practical (see annex B)					10
	<b>Total</b>					<b>75</b>

**Table 6: Paper Specifications for Examination**

	Topics	Marks Distribution	Total Marks		
10.	Gaseous Exchange	MCQs 4 @ 1 Mark CRQ 1 @ 4 Marks *ERQ 1 @ 5 Marks Choose any ONE from TWO	13		
11.	Homeostasis				
12.	Coordination	MCQs 4 @ 1 Mark CRQ 1 @ 4 Marks	8		
13.	Support and Movement	MCQs 3 @ 1 Mark CRQ 1 @ 5 Marks ERQ 1 @ 5 Marks Choose any ONE from TWO	13		
14.	Reproduction				
15.	Inheritance	MCQs 4 @ 1 Mark CRQ 1 @ 4 Marks	8		
16.	Man and his Environment	MCQs 6 @ 1 Mark CRQ 1 @ 4 Marks	10		
17.	Biotechnology	MCQs 4 @ 1 Mark CRQ 1 @ 4 Marks ERQ 1 @ 5 Marks Choose any ONE from TWO	13		
18.	Pharmacology				
	<b>Total</b>	<b>MCQs</b> <b>25</b>	<b>CRQs</b> <b>25</b>	<b>ERQs</b> <b>15</b>	<b>65</b>
	Practical				10
	<b>Total Marks</b>				<b>75</b>

\* 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 (72% and 65%), Application and higher order skills (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 administered within 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 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
- 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 Texts and Reference Materials

### Recommended Books

1. National Book Foundation. *Biology Textbook for Classes IX & X*. Islamabad: National Book Foundation.
2. Malik, J.M. et al. (2004). *A Text Book of Biology*. Islamabad: National Book Foundation.
3. Jones M. (2008). *O level Biology*. New York: Oxford University Press.
4. Mackean D. G. (1998). *Introduction to Biology*, London: John Murray.
5. *Biology Practical Notebook 9<sup>th</sup> and 10<sup>th</sup>* by Dr. Farkhanda Manzoor Duggal, Star Publishers.

### Reference Books

1. Punjab Textbook Board. (2007). *Biology Textbook for Classes IX & X*. Lahore: Punjab Textbook Board.
2. Sindh Textbook Board. (2007). *Biology Textbook for Classes IX & X*. Jamshoro: Sindh Textbook Board.
3. NWFP Textbook Board. (2007). *Biology Textbook for Classes IX & X*. Peshawar: NWFP Textbook Board.
4. Baluchistan Textbook Board. (2007). *Biology Textbook for Classes IX & X*. Quetta: Baluchistan Textbook Board.
5. Kwan Pang L. and Lam Eric YK (2004). *Biology A course for "O Level"*. Singapore: Federal Publication.
6. Punjab Textbook Board. (2003). *Biology Part I*. Lahore: Punjab Textbook Board.
7. Punjab Textbook Board. (2003). *Biology Part II*. Lahore: Punjab Textbook Board.
8. Mian Salma. (1997). *Exploring Biology*. Islamabad: Oxford University Press.

### Websites

<http://www.biology.arizona.edu>

<http://101science.com/>

<http://www.planet-science.com>

<http://www.sciencedaily.com/>

## **7. Definition of Cognitive Levels and Command Words in the Student Learning Outcomes in Examination Papers**

### **7.1 Definition of Cognitive Levels (Knowledge, Understanding and Application)**

#### **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, describe, 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, chart the course/direction, 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: differentiate, analyze, show relationship, propose an alternative, prioritize, give reasons for, categorize, illustrate, corroborate, compare and contrast, create, design, formulate, integrate, rearrange, reconstruct/recreate, reorganize, predict consequences etc.

### **7.2 Definition of Command Words:**

#### **Knowledge:**

- Collect:** to gather specimens or information about plants or animals and arrange them in a meaningful way.
- Define:** only a formal statement or equivalent paraphrase is required. No examples need to be given.
- Label:** to distinguish by introducing a label, to mark the specific from general

<b>Identify:</b>	describe with specific examples of how a given term or concept is applied in daily life.
<b>List:</b>	requires a number of points, generally each of one word, with no elaboration. Where a given number of points is specified, this should not be exceeded.
<b>Name:</b>	mention the commonly used word for an object.
<b>Recall:</b>	to bring back to mind and write down, as it is given in the text that you have already memorized.
<b>State:</b>	a concise answer with little or no supporting argument, e.g. a numerical answer that can be obtained “by inspection”.

### **Understanding:**

<b>Analyze:</b>	to judge the objects or events from the knowledge acquired previously
<b>Compare:</b>	to list the main characteristics of two entities clearly identifying similarities or differences.
<b>Demonstrate/ Carry out/ Design:</b>	to show how a thing is related to another, usually it is reference to theory but sometimes it is by physical manipulation or experiment.
<b>Describe:</b>	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.
<b>Differentiate:</b>	to identify those characteristics which always or sometimes differentiate two categories.
<b>Discuss:</b>	to give a critical account of the points involved in the topic.
<b>Examine:</b>	to identify and explain different aspects of a problem or concept.
<b>Explain:</b>	to reason or use some reference to theory, depending on the context.
<b>Give an account:</b>	<i>give an account of</i> 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.
<b>Investigate:</b>	to examine systematically a situation or problem in order to come to a rational conclusion.
<b>Narrate:</b>	to write down the facts and explanation as given or provided in the text.
<b>Out line:</b>	implies brevity, i.e. restricting the answer to giving essentials.

<b>Predict or deduce:</b>	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.
<b>Prove:</b>	to establish the validity of something
<b>Recognize:</b>	involves looking at a given example and stating what it most probably is.
<b>Relate:</b>	to describe how things are dependent upon, follows from or is part of another.
<b>Show:</b>	demonstration with evidence.
<b>Application:</b>	
<b>Classify:</b>	to state a basis for categorization of a set of related entities and assign examples to categories.
<b>Differentiate:</b>	to identify those characteristics which always or sometimes differentiate two categories.
<b>Draw:</b>	to make a simple freehand sketch or diagram. Care should be taken with proportions and the clear labelling of parts.
<b>Illustrate:</b>	Clarify by giving examples with the help of diagram
<b>Prepare:</b>	a practical activity in which choice of equipment, order of procedure and accuracy of measurement will all play a part.
<b>Purify:</b>	a practical activity in which the candidate is expected to apply an approved methodology with appropriate safety precautions.

## SSC Scheme of Studies<sup>4</sup>

AKU-EB as a national board offers qualifications for both English medium 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 first SSC-I part wise (Class IX) examination was held in May 2008 and SSC-II (Class X) in 2009. The Science group 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		
	Theory	Practical	Total
English	75	-	75
Urdu <b>OR</b> History and Geography of Pakistan <sup>a</sup> <b>OR</b> Urdu-I <sup>b</sup>	75	-	75
Islamiyat <b>OR</b> Ethics <sup>c</sup>	50	-	50
Pakistan Studies	50		50
Mathematics	75	-	75
Physics	65	10	75
Chemistry	65	10	75
Biology <b>OR</b> Computer Science	65	10	75
<b>Total:</b>	<b>520</b>	<b>30</b>	<b>550</b>

#### SSC Part-II (Class X) Science Group

Subjects	Marks		
	Theory	Practical	Total
English	75	-	75
Urdu <b>OR</b> History and Geography of Pakistan <sup>a</sup> <b>OR</b> Sindhi Aasan <sup>b</sup>	75	-	75
Islamiyat <b>OR</b> Ethics <sup>c</sup>	50		50
Pakistan Studies	50	-	50
Mathematics	75	-	75
Physics	65	10	75
Chemistry	65	10	75
Biology <b>OR</b> Computer Science	65	10	75
<b>Total:</b>	<b>520</b>	<b>30</b>	<b>550</b>

- Foreign students may opt HISTORY and GEOGRAPHY OF PAKISTAN in lieu of Urdu Compulsory, subject to the board's approval.
- Candidates from the province of Sindh may appear in "Urdu-I" in SSC Part I and in "Sindhi Aasan" in Part II examination.
- For non-Muslim candidates only.

<sup>4</sup> Government of Pakistan September 2007 and May 2003. *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
English	75
Urdu <b>OR</b> History and Geography of Pakistan <sup>a</sup> <b>OR</b> Urdu-I <sup>b</sup>	75
Islamiyat <b>OR</b> Ethics <sup>c</sup>	50
Pakistan Studies	50
General Mathematics	75
<b>Any three of the following Elective Subjects</b>	225
1. Geography	(75 each)
2. General Science	
3. Computer Science (65+10 practical)	
4. Economics	
5. Civics	
6. History of Pakistan	
7. Sindhi Elective	
8. Elements of Home Economics	
9. Food and Nutrition (65+10 practical)	
10. Art & Model Drawing	
11. Business Studies	
12. Environmental Studies	
13. English Literature <sup>d</sup>	
14. Commercial Geography <sup>d</sup>	
<b>Total:</b>	<b>550</b>

**SSC Part-II (Class X) Humanities Group**

Subjects	Marks
English	75
Urdu <b>OR</b> History and Geography of Pakistan <sup>a</sup> <b>OR</b> Sindhi Aasan <sup>b</sup>	75
Islamiyat <b>OR</b> Ethics <sup>c</sup>	50
Pakistan Studies	50
General Mathematics	75
<b>Any three of the following Elective Subjects</b>	225
1. Geography	(75 each)
2. General Science	
3. Computer Science (65+10 practical)	
4. Economics	
5. Civics	
6. History of Pakistan	
7. Sindhi Elective	
8. Elements of Home Economics	
9. Food and Nutrition (65+10 practical)	
10. Art & Model Drawing	
11. Business Studies	
12. Environmental Studies	
13. English Literature <sup>d</sup>	
14. Commercial Geography <sup>d</sup>	
<b>Total:</b>	<b>550</b>

- a. Foreign students may opt HISTORY and GEOGRAPHY OF PAKISTAN in lieu of Urdu Compulsory, subject to the board's approval.
- b. Candidates from the province of Sindh may appear in "Urdu-I" in SSC Part I and in "Sindhi Aasan" in Part II examination.
- c. For non-Muslim candidates only.
- d. Subject will be offered as Additional Subject.

**List of Practical Activities****Class IX**

1. Examination and handling of a microscope.
2. Study of amoeba and volvox with the help of prepared slides/charts.
3. Identification of the vegetative parts (root, stem, leaf) and reproduction parts (flower, sepal, petals, gynoecium and androecium) of a plant.
4. Identification of major organs and organ system in the given dissected frog (digestive, respiratory and circulatory system).
5. Study of different types of bacteria (cocci, bacilli) with the help of prepared slides/charts.
6. Identification of following on the basis of their taxonomic characteristics (referring to kingdom and phylum):
  - nostoc
  - chlamydomonas and spirogyra
  - rhizopus and mushroom
  - funaria, pinus, monocot and dicot plant
  - sponge, sycon, jellyfish, hydra, tape worm/liver fluke, round worm, earthworm/leech, butterfly/centipede/prawn, snail/unio and star fish/sea urchin
  - fish, frog, lizard, bird, cat
7. Preparation of a temporary slide of rhizopus and spirogyra from fresh culture material.
8. Preparation of a temporary slide of animal cells (squamous epithelial of frog) and plant cells (onion epidermal peel) using an appropriate temporary staining technique.
9. Identification of different types of animal tissues (epithelial, connective, muscle and nervous) with the help of prepared slides/charts/photomicrographs.
10. Identification of different types of plant tissues (epidermal, collenchyma, sclerenchyma, parenchyma, xylem and phloem) with the help of prepared slides/charts/photomicrographs.
11. Calculation of surface area to volume ratio of cubes of different sizes.
12. Study of the effect of hypotonic and hypertonic solution on red blood cells of a frog.
13. Study of different stages of mitosis with the help of prepared slides/charts/photomicrographs.
14. Study of different stages of meiosis with the help of prepared slides/charts/photomicrographs.
15. Investigation of the action of amylase on starch at room temperature.
16. Investigation of the action of pepsin on proteins at room temperature.
17. Investigation of the effect of pH on enzyme action.
18. Investigation of the effect of temperature on enzyme action.
19. Investigation of the release of oxygen during photosynthesis using hydrilla plant.
20. Investigation of light, chlorophyll carbon dioxide as necessary factors for photosynthesis using destarch plants.
21. Performance of iodine test to confirm the presence of starch in leaves.
22. Performance of food tests including:
  - Benedicts test for reducing sugar
  - Iodine test for starch
  - Spot test for fats
  - Biuret test for proteins

23. Microscopic examination of a transverse section of small intestine to show the villi.
24. Investigation of the rate of water loss at the two surfaces of a leaf by a simple experiment using cobalt chloride.

### **Class X**

1. Investigation of the release of heat during aerobic respiration in germinating seeds.
2. Microscopic observation of the structure and number of stomata in an epidermal peel of a leaf.
3. Examination of the structure of kidney using model/chart.
4. Examination of the structure of eye using model/chart.
5. Examination of the structure of ear using model/chart.
6. Examination of the structure of brain using model/chart.
7. Examination of the human skeleton using model/chart.
8. Examination of the human DNA using model/chart.
9. Observation of binary fission in amoeba using prepared slide/chart/photomicrograph.
10. Observation of budding in yeast using prepared slide/chart/photomicrograph.
11. Examination of a bulb (onion), rhizome (ginger) and tuber (potato).
12. Study of vegetative and reproductive parts of a plant.
13. Examination of the structure of maize and gram seeds.
14. Investigation of the conditions necessary for seed germination.
15. 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).
16. Investigation of an ecosystem e.g. a balanced aquarium/pond and construct food chains and food webs.
17. Investigation about the role of yeast and bacteria in the fermentation of flour and milk.