

National Curriculum for

# **BIOLOGY**

Grades XI – XII

2006

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GOVERNMENT OF PAKISTAN  
MINISTRY OF EDUCATION  
ISLAMABAD

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# **NATIONAL CURRICULUM**

## **BIOLOGY**

### **XI-XII**

**2006**

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## **NATIONAL CURRICULUM FOR BIOLOGY XI-XII**

### **INTRODUCTION:**

The National Curriculum for Biology-2006 for grades XI and XII recognizes the primacy of students' experiences, their voices and their active involvement in the process of learning. Learning experiences at higher secondary level should pave the way for construction of knowledge and fostering creativity and should become a source of joy, not stress. Examination system seeks a shift from content based testing to problem solving and competency based assessment. These are what the National Curriculum Biology targets. In essence, our aspiration is to;

**“Enable all students to develop their capacities as successful learners, confident individuals, responsible citizens and effective contributors to society.”**

## Chapter 1:

# RATIONALE:

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The Federal Ministry of Education, Islamabad aspired to review the National Curriculum for Biology to make it more vibrant and responsive to the modern socio-economic, technical, professional, and labor market needs of the country and comparable with international standards. The Ministry went for it through;

- Analysis of current practice and comparative review with materials from other selected countries
- Formulation of policies and development of strategies
- Setting up an institutional and organizational structure
- Development of the national curriculum Framework

The National Curriculum Development Team for Biology for grades IX-XII was framed involving scholars, subject experts and teachers. The Team held several meetings and deliberated on the ideas reflected in the meetings with the Ministry of Education and formulated the curriculum framework.

## THE STRATEGY ADOPTED:

The Curriculum Development Team evolved a scientific methodology of designing / revising the curriculum that included undertaking basic research for developing new model of curriculum planning, implementation and evaluation. The Team established rapport with educational organizations; like major public and private schools and colleges, teacher training institutes and other academic institutions. Involvement of professionals from the world of work has been one of the salient features in taking appropriate decisions in curriculum design / review. Following strategy was adopted in designing/revising the curriculum.

- Identification of potential areas of study
- Identification of standards and benchmarks for communicating the potential areas
- Arriving at competency profile, based on comprising knowledge, skills and attitudes
- Deriving curriculum areas from competency profile
- Preparation of detailed contents in the light of competencies to be developed
- Preparation of study and evaluation scheme for implementing the curriculum
- Working out local and non-local available resources required (physical, human, information) for effective implementation of curriculum

The team followed the “**Context, Input, Process and Product model**” to obtain feedback in respect of each component, identifying gaps and take decisions for bringing about modification.

## **COMPARATIVE ANALYSES:**

The Team carried out comparative analyses with the following curricula and textbooks while formulating the themes and structuring the chapters.

### **Curricula:**

- Existing Curriculum of the Government of Pakistan
- Curricula of various States of USA
- Australian curricula
- A-level curricula of London University
- Senior Cambridge and HSC courses of the Cambridge University
- Curricula of Korea
- Grade 9-12 curricula of Ontario (Canada)
- Hong Kong curricula for School Education
- National Curriculum for Secondary and Higher Secondary Classes, India

### **Textbooks:**

- Pacific Science Series, Singapore
- The Inquiry into Life, USA
- FEP Modern Science Series, Singapore
- Malaysian Textbooks
- A-level textbooks of UK

## **NEED ASSESSMENT:**

The Team went through a number of case studies encompassing the needs on which the curricula should be revised. A comprehensive feedback survey for the purpose of need assessment was carried out through college teachers and other stakeholders. Data about the current trends in the process of curriculum revision / development the world over was collected and analyzed. Newspaper articles / reports / NEWS were collected to ensure a reflexive involvement of stakeholders.

The Team worked out the focusing areas, through this need assessment. It suggested the curriculum should;

- **Reduce over-crowding in the curriculum and make learning more enjoyable**
- **Develop better linkage between the various stages of the curriculum from VI to XII**
- **Equip young people with the skills they will need in tomorrow's workforce**
- **Make sure that examination system supports learning**
- **Allow more choice to meet the needs of individual young people**

Web-based access was made to the following organizations for valuable guidelines.

#### **☐ The Daily Dawn; Karachi**

- ☛ Reflective Feedbacks about the Shortcomings in the curriculum policies
- 📄 [www.dawn.com](http://www.dawn.com)

#### **☐ Education and Manpower Bureau, Government of Hong Kong**

- ☛ The Aims of a Successful Curriculum
- 📄 [www.emb.gov.hk](http://www.emb.gov.hk)

#### **☐ The Curriculum Review Group, Ministry of Education Scotland**

- ☛ The Characteristics of the Curriculum of Excellence
- 📄 [www.scotland.gov.uk/library5/education](http://www.scotland.gov.uk/library5/education)

- ▣ **National Institute of Health (NIH) and Howard Hughes Medical Institute, USA**
  - ☛ Transforming Undergraduate Education for Future Research Biologists
  - 🌐 [www.nap.edu/books](http://www.nap.edu/books)
- ▣ **The Curriculum Council; Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan**
  - ☛ National Curriculum Standards Reforms
  - 🌐 [www.mext.go.jp/english](http://www.mext.go.jp/english)
- ▣ **Department of Education, USA**
  - ☛ National Science Education Standards (K-12)
  - 🌐 [www.nap.edu/html/nses](http://www.nap.edu/html/nses)

## **THE PROBLEMS RECOGNIZED:**

Most importantly, although the curriculum revised in 2000 has many strengths, a significant proportion of students are not achieving all that they are capable of. We need a curriculum which will enable all young people to understand the world they are living in, reach the highest possible levels of achievement, and equip them for work and learning throughout their lives.

1. Often, curricula – especially those in science – tend to be at once over-specified and under-specified.
2. The case studies on the teaching of science recommend a pedagogy that is hands-on, minds-on and inquiry-based. While practice in Pakistan has tended to be dominated by chalk and talk methods.
3. In a hands-on way of learning science, we start with things that are directly related to the student's experience, and are therefore specific. From this we progress to the general. This means that 'topics' have to be reordered to reflect this.

## **THE DESIGN OF THE CURRICULUM:**

- The new curriculum emphasizes reasoning and conceptual grasp at every stage. The new approach uses hands-on experiences and utilization of resources available in the student's environment.
- Built on the ideas introduced at lower levels, the curriculum introduces the contemporary areas of Biology stressing on connections of study of Biology to real life problems covering use of discoveries / innovations in everyday life - in environment, industry, medicine, health and agriculture. It unfolds the underlying principles that are common to both animals and plants, as well as the inter-relationships of Biology with other areas of knowledge. The new curriculum permits clear and sequential flow of concepts without jarring jumps.
  - The exercise of revising the syllabus for Biology has been carried out with;
    - ☛ "Learning without burden" as a guiding light and
    - ☛ "Latest trends in curriculum development" as points of reference
- In each chapter after giving the various sub topics, "**Science, Technology and Society Connections**" are given in the form of bulleted sentences. These, we believe, will serve as a guide for the development of the skills of application, reasoning, analysis and evaluation.
- The teaching time in terms of number of periods is indicated for each chapter. These should be especially considered at the textbook writing stage to avoid overburdening and expansion beyond available teaching time.

- Each chapter in the theory course carries suggestions for skills. It is expected that the practical aspects will be integrated into the chapters in the textbook such that the rationale for doing them is evident and the understanding gained from them would help in furthering the understanding of the concepts.
- The students would get an exposure to the various branches of Biology in a more contextual and friendly manner as they studied various chapters of the curriculum.
- The description of the diverse/various tools and techniques used in the study of Biology has not been collated to form a distinct chapter in the curriculum. It is envisaged that the teachers who teach this curriculum and the textbooks prepared based on it, will discuss techniques in a contextual manner rather than distanced from real experimental situations.

**“The aim is to make the syllabus an enabling document for the creation of textbooks that are interesting and challenging without being loaded with factual information. Overall, Biology has to be presented as a live and growing body of knowledge rather than a finished product.”**

The format of the curriculum has been evolved to address the under-specification mentioned above. Instead of merely listing ‘topics’ and the overall ‘learning outcomes’ of each topic, the curriculum is presented in an inclusive form e.g;

- Main ‘themes’ were identified,
- Each theme has been targeted by constructing ‘chapters’ in it,
- The structuring of a chapter involves;
  - Presenting its Overview
  - Drawing its Conceptual Linkages
  - Creating indicators for previous knowledge Recalling
  - Creating a hierarchy of Major Concepts for the chapter
  - Devising the learning outcomes with instantly recognizable domains of;
    - Knowledge
    - Comprehension
    - Analysis
    - Synthesis and
    - Evaluation
  - Formulating the skill outcomes with instantly recognizable domains of;
    - Initiating and Planning,
    - Analyzing and Interpreting,
    - Performing and Recording and
    - Communication
  - Signifying the Science-Technology-Society connections for each major concept.
- Chapter-wise and concept-wise weightage and number of periods has been proposed for each chapter.
- Assessment strategies for the overall learning have been described.
- A separate chapter-wise list of practical work has been mentioned.

- An overall list of the required apparatus, chemicals, prepared slides, animations, charts, and models has been included.
- General instructions to authors have been included.

## **STANDARDS, BENCHMARKS AND LEARNING OUTCOMES:**

In the 21<sup>st</sup> century, students will remain the most important natural resource to ensuring the continual improvement and ultimate progress of humankind. It is critical that all involved in education prepare students to meet the challenges of a constantly changing global society. It is time to call for a raising in the expectations of student learning.

Preparing students for success in the new millennium and beyond, calls for increasing rigor and relevance in the curriculum. In adult roles, individuals are expected to work with others in a team setting, have an acquired knowledge base, be able to extend and refine knowledge, be able to construct new knowledge and applications and have a habit of self-assessing their assimilation of each dimension in their everyday decision making process.

The curriculum of Biology XI-XII is built upon Standards, Benchmarks, and Learning Outcomes for the benefit of student growth and progress.

**STANDARDS** are what students should know and be able to do. Standards are broad descriptions of the knowledge and skills students should acquire in a subject area. The knowledge includes the important and enduring ideas, concepts, issues, and information. The skills include the ways of thinking, working, communication, reasoning, and investigating that characterize a subject area. Standards may emphasize interdisciplinary themes as well as concepts in the core academic subjects.

Standards are based on:

- **Higher Order Thinking:**  
It involves students in manipulating information and ideas by synthesizing, generalizing, explaining or arriving at conclusions that produce new meaning and understanding for them.
- **Deep Knowledge:**  
It addresses central ideas of a topic or discipline with enough thoroughness to explore connections and relationships and to produce relatively complex understanding.
- **Substantive Conversation:**  
Students engage in extended conversational exchanges with the teacher and / or peers about subject matter in a way that builds an improved and shared understanding of ideas or topics.
- **Connections to the World Beyond the Classroom:**  
Students make connections between substantive knowledge and either public problems or personal experiences.

**BENCHMARKS** indicate what students should know and be able to do at various developmental levels. Overall the benchmarks are built as per the restructured schemes of study and are split into 5 developmental levels:

- ☆ Kindergarten to Grade 3
- ☆ Grade 4 to Grade 5
- ☆ Grade 6 to Grade 8
- ☆ Grade 9 to Grade 10
- ☆ Grade 11 to Grade 12

**LEARNING OUTCOMES** indicate what students should know and be able to do for each topic in any subject area at the appropriate developmental level. The Learning Outcomes sum up the total expectations from the student.

The Standards and the accompanying Benchmarks will assist in the development of comprehensive curriculum, foster diversity in establishing high quality Learning Outcomes, and provide an accountability tool to individuals involved in the education marketplace. These provide a common denominator to determine how well students are performing and will assure that all students are measured on the same knowledge and skills using the same method of assessment.

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## Chapter 2:

# AIMS AND OBJECTIVES:

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## AIMS:

The curriculum of Biology at grade XI-XII 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.

### **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 any 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.

## STANDARDS AND BENCHMARKS: BIOLOGY XI-XII: \_\_\_\_\_

### STANDARDS:

#### 1. USING SCIENTIFIC KNOWLEDGE

Students of biology are better able to understand and appreciate the biotic and a-biotic world around them and are also better able to make calculated decisions and take informed actions. Activities that beg scientific thought include the ***description*** and ***explanation*** of the living objects, systems, or events; the ***prediction*** of future events or observation; and ***design*** of systems or courses of action that help individuals adapt to and modify (for better) the living around them.

In biology the specification of real-world objects often focuses on biodiversity and life processes.

#### Standard 1.a

Students will be able to understand the principles of biology, diversity in life forms, structure and functions of cells, the processes of life, continuity in life, how living things interact with each other and their environment and the applications of biology for human welfare.

### BENCHMARKS:

**Students will be able to understand the principles of biology and diversity in life forms. They will be able to;**

1. Explain viruses and viral diseases and the importance, evolutionary position, structure, modes of nutrition, reproduction and major groups of prokaryotes, protists and fungi.
2. Describe the general characteristics and model life cycles of major plant groups.
3. Analyze the diversity in animals in terms of invertebrate phyla and vertebrate classes.

**Students will be able to understand the structure and functions of cells. They will be able to;**

1. Analyze the structural and functional details of organelles and rationalize the use of latest techniques in cytology.
2. Explain the classification of enzymes, mechanism of enzyme action, enzyme sensitivity and enzyme inhibition.
3. Justify the roles and structures of organic molecules present in protoplasm.

4. Interpret photosystems and distinguish the raw materials and products of each step of dark and light reactions and of glycolysis, Krebs cycle and electron transport chain.

**Students will be able to understand the processes of life. They will be able to;**

1. Describe the functional details and abnormalities in the regions of human alimentary canal and identify the hormonal control of gut secretions.
2. Evaluate and describe the transportation in plants and in man. Explain the control of heartbeat and the principles of electrocardiogram. Explain cardiovascular diseases and the latest treatments.
3. Describe the functioning of the components of the first line of defense, the nonspecific defenses and the inborn and acquired immunity.
4. Identify the properties of leaves that make gaseous exchange possible and identify the properties of the air passage way in man relating with the mechanism of breathing and respiratory volumes, transportation of gases and respiratory disorders.
5. Analyze the adaptations in plants and animals, including man for osmotic adjustments and thermoregulation. Evaluate the structure of human kidney, relate it with its functioning and with infections, stones and kidney failure and evaluate the principles of dialysis and kidney transplant.
6. Explain the generation and transmission of nerve impulse and analyze the properties of receptors responsible for smell, tastes and touch, pain etc. Categorize nervous disorders and relate them with EEG, CT scan and MRI.
7. Compare the important human endocrine glands, their hormones, their functions, chemical nature, modes of action, feedback control and imbalance.
8. Introduce the nature of behavior and relate different examples with the innate behavior, learning and social behavior.
9. Identify the bones of human skeleton, ball-n- socket and hinge joints. Explain the action of antagonistic muscles at knee joint and describe the disorders of skeletal system.
10. Differentiate the types of muscles and describe the sliding filament model of muscle contraction.
11. Identify the structures in plants responsible for support and analyze the effects of plant growth regulators.

**Students will be able to understand the continuity in life. They will be able to;**

1. Describe the human male and female reproductive systems, their hormonal regulation and relate these with infertility and STDs.
2. Describe human embryonic development and birth and evaluate the concepts of postnatal development and aging.
3. Describe the chromosomal theory of inheritance and justify DNA as the hereditary material, the replication of DNA and explain gene expression and regulation.
4. Evaluate the results of genetic crosses using the formula of probabilities and quote examples to explain the patterns of inheritance other than Mendelism.
5. Analyze gene linkage, sex linkage and crossing over and compare different mechanisms of sex determination.
6. Describe and evaluate the concepts and evidences of evolution.

**Students will be able to understand how living things interact with each other and their environment. They will be able to;**

1. Analyze trophic levels and productivity and relate these with the water and nitrogen cycles. Describe ecological succession and population dynamics. Analyze human impacts on environment and identify environmental resources and evaluate their depletion.

**Students will be able to understand the technologies used in the applications of biology for human welfare. They will be able to;**

1. Describe the principles and application of recombinant DNA technology, polymerase chain reaction, DNA sequencing, DNA analysis, tissue culturing and constructing genome maps.
2. Evaluate the importance of vaccination and the role of microbes in human welfare.
3. Evaluate the techniques used in animal husbandry; to enhance crop and fruit yields and in home gardening.



## **Standard 1.b**

Students will be able to understand the processes of scientific investigation. They will be able to identify a problem, design and conduct experiments and communicate their findings using a variety of conventional and technological tools.

### **BENCHMARKS:**

**Students will observe and identify. They will be able to;**

1. Identify cellular and tissue level structure from prepared slides, cultures, preserved materials, living materials and diagrams.

**Students will design and conduct experiments. They will be able to;**

1. Investigate and/or demonstrate the phenomena of life and the effects of variables e.g. effect of boiled and un-boiled enzymes, measurements in micrometry, extraction of pigments, growth responses in plants, blood groups and blood agglutinations.
2. Compare the ECGs and MRIs and measure blood pressure
3. Prepare slides of cells using differential staining
4. Recording of instincts by providing it various stimuli to a spider's web

**Students will communicate the findings. They will be able to;**

1. Describe the specificities of flowers and draw evolutionary trees.
2. Evaluate the inheritance of genes through mathematical probabilities.
3. Constructing pie chart and histogram to present the collected data.



## 2. CONSTRUCTING NEW SCIENTIFIC KNOWLEDGE

Students of biology possess the ability to **ask** questions about life and can also **develop solutions** to problems that they encounter or questions they ask, by using their knowledge and techniques. In the process of finding solutions, students may use their **own knowledge and reasoning** abilities, seek out **additional knowledge** from other sources, and engage in the **empirical investigation** of the living world. These students can also learn by **interpreting** text, graphs, tables, pictures, or other representations of biology data and knowledge. Finally such students can **remember** key points and use sources of information to **reconstruct** previously learned knowledge, rather than try to remember every detail of what they study. Finally they can describe **the limitations** of their own knowledge and biology knowledge in general.

### Standard 2.a

Students will be able to display a sense of curiosity and wonder about the natural world and demonstrate an increasing awareness that this has led to new developments in science and technology.

#### BENCHMARKS:

**Students will display a sense of curiosity and wonder about the natural world. They will be able to;**

1. Ask questions that can be investigated empirically.

**Students will demonstrate an increasing awareness that this has led to new developments in science and technology. They will be able to;**

1. Justify plans or explanations on a theoretical or empirical basis.
2. Describe some general limitations of scientific knowledge.
3. Discuss the historical developments of biological concepts and principles.
4. Develop an awareness of and sensitivity to the living world.



### 3. REFLECTING ON SCIENTIFIC KNOWLEDGE

Students of biology are able to “step back” and analyze or reflect on their own knowledge. One such analysis is the **justification** of personal knowledge or beliefs using either theoretically or empirically based arguments. The students also **show an appreciation** for scientific knowledge and the patterns it reveals the living world. They are also able to take **a historical and cultural perspective** on biology concepts and theories or to discuss institutional relationships among **science, technology and society**.

#### Standard 3.a

Students will be able to demonstrate an understanding of the impact of science and technology on society and use science and technology to identify problems and creatively address them in their personal, social and professional lives.

#### BENCHMARKS:

**Students will demonstrate an understanding of the impact of science and technology on society. They will be able to;**

1. Explain the social and economic advantages and disadvantages / risks of new technologies.

**Students will use science and technology to identify problems and creatively address them in their personal, social and professional lives. They will be able to;**

1. Show how common themes of science, mathematics and technology apply in surrounding world.
2. Creatively address the problems in personal, social and professional life by using the principles of biological methodology.
3. Describe the historical, political and social factors affecting developments in biological research.

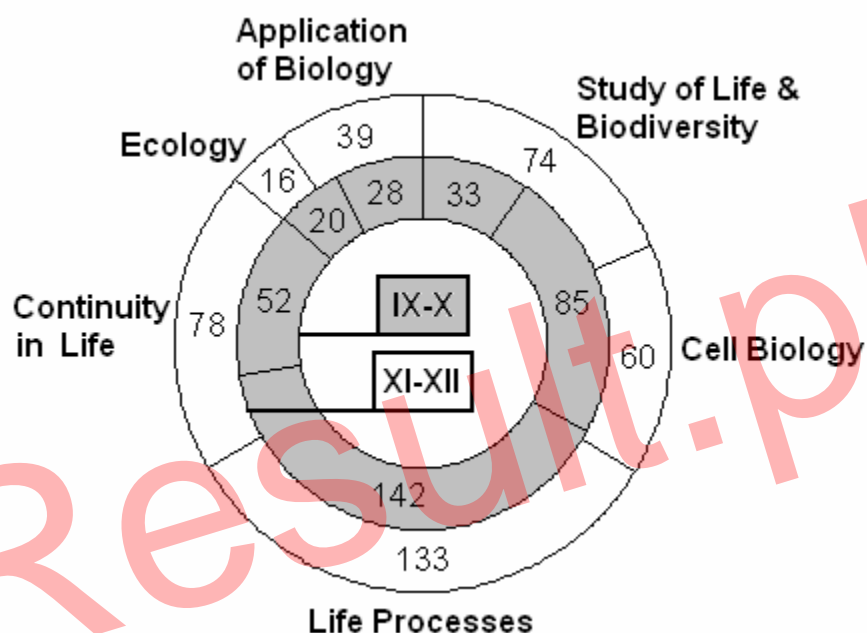


## The Themes in Biology Curriculum:

There is general agreement that Biology content up to grade X should not be framed along disciplinary lines, but rather organized around themes that are potentially cross-disciplinary in nature. In the present revision exercise, it was decided that the same set of themes would be used, right from grade IX-X to grade XI-XII. The themes finally chosen are; Study of Life, Cell Biology, Life Processes, Continuity in Life, Ecology and Application of Biology. While these run all through, in the higher grades there is a consolidation of content which leads to some themes being absent, e.g. Study of Life from Grade XI.

## Weightage of Themes in IX-X & XI-XII:

(in terms of number of periods)





**CONTENTS XI - XII:** \_\_\_\_\_

Ch: Chapter, MC: Major Concept, ST: Sub-Topic

Ch	MC	ST	BIOLOGY XI-XII
<b>SECTION 1: CELL BIOLOGY</b>			
<b>1</b>			<b>CELL STRUCTURE AND FUNCTION</b>
⊙	1.1		Techniques used in Cell Biology
⊙	1.2		Cell Wall and Plasma Membrane – The Boundary Wall
⊙	1.3		Cytoplasm and Organelles
⊙	1.4		Prokaryotic and Eukaryotic Cells
<b>2</b>			<b>BIOLOGICAL MOLECULES</b>
⊙	2.1		Biological Molecules in Protoplasm
⊙	2.2		Importance of Water (Importance in Protoplasm and in Environment)
⊙	2.3		Carbohydrates
	▶	2.3.1	Classification (Monosaccharides, Disaccharides and Polysaccharides)
	▶	2.3.2	Role of Carbohydrates
⊙	2.4		Proteins
	▶	2.4.1	Structure of Proteins (Amino Acids and Peptide Linkages)
	▶	2.4.2	Classification of Proteins (Globular and Fibrous Proteins)
	▶	2.4.3	Role of Proteins
⊙	2.5		Lipids
	▶	2.5.1	Classification (Acylglycerols, Phospholipids, Waxes and Terpenes)
	▶	2.5.2	Role of Lipids
⊙	2.6		Nucleic Acids
	▶	2.6.1	Structure of Nucleic Acids (Nucleotides and Phosphodiester Linkage)
	▶	2.6.2	Classification (RNA and DNA)
	▶	2.6.3	Role of Nucleic Acids and nucleotides (DNA, RNA, ATP and NAD)
⊙	2.7		Conjugated Molecules (Glycolipids, Glycoproteins, Lipoproteins and Nucleoproteins)
<b>3</b>			<b>ENZYMES</b>
⊙	3.1		Structure of Enzymes
⊙	3.2		Mechanism of Enzyme Action
⊙	3.3		Factors affecting the Rate of Enzymatic Action (Temperature, pH, Enzyme Concentration and Substrate Concentration)
⊙	3.4		Enzyme Inhibition (Competitive and Noncompetitive Inhibitors)
⊙	3.5		Classification of Enzymes
<b>4</b>			<b>BIOENERGETICS</b>
⊙	4.1		Photosynthesis
	▶	4.1.1	Role of Light
	▶	4.1.3	Role of Photosynthetic Pigments – Absorption Spectrum and Action Spectrum
	▶	4.1.3	Role of Carbon dioxide
	▶	4.1.4	Role of Water

- ▶ 4.1.5 Mechanism of Photosynthesis
- ◎ 4.2 Cellular Respiration
  - ▶ 4.2.1 Aerobic and Anaerobic respiration
  - ▶ 4.2.2 Mechanism of Respiration
  - ▶ 4.2.3 Synthesis of ATP – Chemiosmosis and Substrate-level Phosphorylation
- ◎ 4.3 Photorespiration

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## SECTION 2: BIODIVERSITY

### 5 ACCELLULAR LIFE

- ⊙ 5.1 Viruses - Discovery and Structure
- ⊙ 5.2 Parasitic Nature of Viruses
- ⊙ 5.3 Life Cycle of Bacteriophage
- ⊙ 5.4 Life Cycle of HIV
- ⊙ 5.5 Viral Diseases (Hepatitis, Herpes, Polio and Leaf curl virus disease of cotton)
- ⊙ 5.6 Prions and Viroids (Structure and examples of Diseases caused by them)

### 6 PROKARYOTES

- ⊙ 6.1 Taxonomy of Prokaryotes
- ⊙ 6.2 Archaea
- ⊙ 6.3 Bacteria; Ecology and Diversity
- ⊙ 6.4 Structure; Shape and Size of Bacteria
- ⊙ 6.5 Modes of Nutrition in Bacteria
- ⊙ 6.6 Growth and Reproduction in Bacteria
- ⊙ 6.7 Importance of Bacteria (Beneficial and Harmful bacteria)
- ⊙ 6.8 The Bacterial Flora of Humans
- ⊙ 6.9 Control of Harmful Bacteria

### 7 PROTISTS AND FUNGI

- ⊙ 7.1 Protists – The Evolutionary Relationships
- ⊙ 7.2 Major groups of Protists (protozoa, algae, myxomycota, oomycota)
- ⊙ 7.3 General characteristics of Fungi
- ⊙ 7.4 Diversity among Fungi (zygomycota, ascomycota, basidiomycota)
- ⊙ 7.5 Importance of Fungi

### 8 DIVERSITY AMONG PLANTS

- ⊙ 8.1 The Evolutionary Origin of Plants
- ⊙ 8.2 Nonvascular Plants (General characteristics)
- ⊙ 8.3 Seedless Vascular Plants (General characteristics)
  - ▶ 8.3.1 Evolution of Leaf
- ⊙ 8.4 Seed Plants
  - ▶ 8.4.1 Evolution of Seed
  - ▶ 8.4.2 Gymnosperms (General characteristics)
  - ▶ 8.4.3 Angiosperms (General characteristics and Life cycle)

### 9 DIVERSITY AMONG ANIMALS

- ⊙ 9.1 Characteristics of animals
- ⊙ 9.2 Criteria for animal classification
- ⊙ 9.3 Diversity in Animals
  - ▶ 9.3.1 Invertebrates
  - ▶ 9.3.2 Vertebrates

## SECTION 3: LIFE PROCESSES

### 10 FORM AND FUNCTIONS IN PLANTS

- ⊙ 10.1 Nutrition in Plants
- ⊙ 10.2 Gaseous Exchange in Plants
- ⊙ 10.3 Transport in Plants
  - ▶ 10.3.1 Uptake of Water by Roots and Pathways
  - ▶ 10.3.2 Ascent of Sap
  - ▶ 10.3.3 Opening and Closing of Stomata
  - ▶ 10.3.4 Translocation of Organic Matter
- ⊙ 10.4 Homeostasis in Plants (Osmotic adjustments and Thermoregulation in Plants)
- ⊙ 10.5 Support in Plants (Support in Herbaceous and Woody Plants)
- ⊙ 10.6 Growth and Development in Plants
  - ▶ 10.6.1 Tissues for Growth – Apical and Lateral Meristems
  - ▶ 10.6.2 Primary and Secondary Growth
- ⊙ 10.7 Growth Responses in Plants
  - ▶ 10.7.1 Plant Growth Regulators (PRGs)
  - ▶ 10.7.2 Geotropism and Phototropism
  - ▶ 10.7.3 Photoperiodism
  - ▶ 10.7.4 Vernalization

### 11 DIGESTION

- ⊙ 11.1 Digestive System of Man
  - ▶ 11.1.1 Alimentary Canal; Structural and Functional details
  - ▶ 11.1.2 Role of Accessory Glands (Liver and Pancreas)
- ⊙ 11.2 Disorders related to Digestive system and Food habits (Ulcer, Food Poisoning, Dyspepsia, Obesity, Anorexia Nervosa, Bulimia Nervosa)

### 12 CIRCULATION

- ⊙ 12.1 Blood Circulatory System of Man
  - ▶ 12.1.1 Heart
    - ▶ 12.1.1.1 Structure of Heart
    - ▶ 12.1.1.2 Passage of Blood through Heart
    - ▶ 12.1.1.3 Heartbeat and its Control
    - ▶ 12.1.1.4 Electrocardiogram
  - ▶ 12.1.2 Blood Vessels (Arteries, Capillaries and Veins)
    - ▶ 12.1.2.1 Vascular Pathway
    - ▶ 12.1.2.2 Rate of Blood Flow in Blood Vessels
  - ▶ 12.1.3 Blood Pressure and its Measurement
- ⊙ 12.2 Cardiovascular Disorders
  - ▶ 12.2.1 Thrombosis
  - ▶ 12.2.2 Heart Problems
    - ▶ 12.2.2.1 Causes and Diagnosis (Angiography)
    - ▶ 12.2.2.2 Treatment (Coronary Bypass, Angioplasty, Open Heart Surgery) and Preventions
  - ▶ 12.2.3 Hypertension (Causes, Related Diseases and Preventions)
- ⊙ 12.3 Lymphatic System of Man

### 13 IMMUNITY

- ⊙ 13.1 First Line of Defense (Skin, Digestive Tract, Air Passageway)
- ⊙ 13.2 Second Line of Defense – The Nonspecific Defenses
  - ▶ 13.2.2 Killing Cells of Blood
  - ▶ 13.2.3 Protective Proteins
  - ▶ 13.2.4 Inflammatory Response
  - ▶ 13.2.5 Temperature Response
- ⊙ 13.3 Third Line of Defense – The Specific Defenses
  - ▶ 13.3.1 Inborn and Acquired immunity
  - ▶ 13.3.2 Cell mediated and Antibody mediated immunity
  - ▶ 13.3.3 Disorders of Immune system (Allergies, Autoimmune Diseases, Transplant Rejections)

### 14 RESPIRATION

- ⊙ 14.1 Respiratory System of Man
  - ▶ 14.1.1 Air Passage Way and Lungs
  - ▶ 14.1.2 Mechanism of Breathing
  - ▶ 14.1.3 Respiratory Volumes
  - ▶ 14.1.4 Transport of Gases (Transport of Oxygen and Carbon dioxide)
- ⊙ 14.2 Respiratory Disorders
  - ▶ 14.2.1 Upper Respiratory Infections (Sinusitis, Otitis Media)
  - ▶ 14.2.2 Lower Respiratory Infections and Disorders (Pneumonia, Emphysema, Pulmonary Tuberculosis, Lung Cancer)

### 15 HOMEOSTASIS

- ⊙ 15.1 Osmoregulation (in Freshwater, Marine and Terrestrial Environments)
- ⊙ 15.2 Excretion
  - ▶ 15.2.1 Relationship between Excretory Products and Habitat
- ⊙ 15.3 Excretory System of Man
  - ▶ 15.3.1 Structure and Function of Kidney
- ⊙ 15.4 Disorders of Urinary Tract
  - ▶ 15.4.1 Urinary Tract Infections
  - ▶ 15.4.2 Kidney Stones (Causes and Treatments)
  - ▶ 15.4.3 Kidney Failure (Causes and Treatments)
    - ▶ 15.4.3.1 Dialysis; Mechanism and Problems
    - ▶ 15.4.3.2 Kidney Transplant; Process and Problems
- ⊙ 15.5 Thermoregulation

### 16 SUPPORT AND MOVEMENT

- ⊙ 16.1 Human Skeleton (Axial Skeleton, Appendicular Skeleton, Types of Joints)
- ⊙ 16.2 Disorders of Skeleton (Disc slip, Spondylosis, Sciatica, Arthritis, Bone Fractures)
- ⊙ 16.3 Muscles (Smooth Muscles, Cardiac Muscles and Skeletal Muscles)
  - ▶ 16.3.1 Ultra-structure of Skeletal Muscles
  - ▶ 16.3.2 Antagonistic Arrangement of Skeletal Muscles
  - ▶ 16.3.3 Muscle Contraction - Sliding Filament Model

### 17 NERVOUS COORDINATION

- ⊙ 17.1 Nervous System of Man
  - ▶ 17.1.1 Steps involved in nervous coordination
  - ▶ 17.1.2 Neurons (Structure and Types)

- ▶ 17.1.3 Nerve Impulse
- ▶ 17.1.4 Transmission of Action Potential between Cells – Synapse
- ▶ 17.1.5 Basic Organization of human nervous system (CNS and PNS)
- ▶ 17.1.6 Sensory Receptors and their working (Receptors for Smell, Tastes and Touch, Pain etc)
- ◎ 17.2 Effects of Drugs on Nervous Coordination (Effects of Heroine, Nicotine, Caffeine, Alcohol and inhalants – Nail polish remover and Glue)
- ◎ 17.3 Disorders of Nervous System
  - ▶ 17.3.1 Vascular Disorders (Stroke, Hematoma)
  - ▶ 17.3.2 Infections (Meningitis, Encephalitis)
  - ▶ 17.3.3 Structural Disorders (Brain or Spinal Cord Injury, Brain or Spinal Cord Tumors)
  - ▶ 17.3.4 Functional Disorders (Headache, Epilepsy, Neuralgia)
  - ▶ 17.3.5 Degenerative Disorders (Parkinson's Disease, Multiple Sclerosis, Huntington's Disease, Alzheimer's Disease)
  - ▶ 17.3.6 Diagnostic Tests for Nervous Disorders (EEG, CT Scan and MRI)

## 18 CHEMICAL COORDINATION

- ◎ 18.1 Hormones- The chemical messengers
- ◎ 18.2 Endocrine System of Man (Glands with location, secretions and imbalance)
  - ▶ 18.2.1 Pituitary gland and the Role of Hypothalamus
  - ▶ 18.2.2 Thyroid
  - ▶ 18.2.3 Parathyroid
  - ▶ 18.2.4 Pancreas
  - ▶ 18.2.5 Adrenal
  - ▶ 18.2.6 Gonads
  - ▶ 18.2.7 Other Endocrine Tissues / Cells
- ◎ 18.3 Feedback Mechanism

## 19 BEHAVIOR

- ◎ 19.1 The nature of Behavior
- ◎ 19.2 Innate Behavior
- ◎ 19.3 Learning
- ◎ 19.4 Social Behavior

## SECTION 4: CONTINUITY IN LIFE

### 20 REPRODUCTION

- ⊙ 20.1 Reproductive System of Man
  - ▶ 20.1.1 Male Reproductive System and its Hormonal Regulation
  - ▶ 20.1.2 Female Reproductive System and its Hormonal Regulation
- ⊙ 20.2 Disorders of Reproductive System (Infertility, Imbalance of Male Sex Hormones)
- ⊙ 20.3 Sexually Transmitted Diseases (Syphilis, Gonorrhea, AIDS)

### 21 DEVELOPMENT AND AGING

- ⊙ 21.1 Embryonic Development (Cleavage, Gastrulation, Neurulation)
- ⊙ 21.2 Control of Development (Role of Nucleus, Cytoplasm and Neighboring cells)
- ⊙ 21.3 Human Embryonic Development
- ⊙ 21.4 Birth and Nursing
- ⊙ 21.5 Disorders during Embryonic Development
- ⊙ 21.6 Postnatal Development
- ⊙ 21.7 Aging

### 22 INHERITANCE

- ⊙ 22.1 Law of Independent Assortment
  - ▶ 22.1.1 Probabilities
- ⊙ 22.2 Incomplete Dominance, Multiple Alleles and Co-dominance
- ⊙ 22.3 ABO Blood Group System
- ⊙ 22.4 Rh Blood Group System and *Erythroblastosis foetalis*
- ⊙ 22.5 Polygenic Inheritance and Epistasis
- ⊙ 22.6 Gene Linkage and Crossing Over
- ⊙ 22.7 Sex Determination (XX-XY System, ZW-ZZ System and XX-XO System)
- ⊙ 22.8 Sex Linkage
  - ▶ 22.8.1 Sex Linkage in *Drosophila* and Man
  - ▶ 22.8.2 X-linked Disorders – Color Blindness, Hemophilia, Muscular Dystrophy
  - ▶ 22.8.3 Sex-limited and Sex-Influenced Traits

### 23 CHROMOSOME AND DNA

- ⊙ 23.1 Chromosomal Theory of Inheritance
- ⊙ 23.2 DNA as the Hereditary Material
- ⊙ 23.3 DNA Replication
  - ▶ 23.3.1 Meselson and Stahl Experiment
  - ▶ 23.3.2 Mechanism of DNA Replication
- ⊙ 23.4 Gene Expression
  - ▶ 23.4.1 Genetic Code
  - ▶ 23.4.2 Transcription
  - ▶ 23.4.3 Translation
- ⊙ 23.5 Regulating Gene Expression
- ⊙ 23.6 Mutations
  - ▶ 23.6.1 Chromosomal Mutations
  - ▶ 23.6.2 Gene Mutations

## **24 EVOLUTION**

- ⦿ 24.1 The evolution of the concepts of evolution
- ⦿ 24.2 Evidences of evolution
- ⦿ 24.3 Evolution from Prokaryotes to Eukaryotes
- ⦿ 24.4 Lamarckism
- ⦿ 24.5 Darwinism
- ⦿ 24.6 Neo-Darwinism

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## SECTION 5: ECOLOGY

### 25 MAN AND HIS ENVIRONMENT

- ⦿ 25.1 Biogeochemical Cycle (Water Cycle and Nitrogen Cycle)
- ⦿ 25.2 The Flow of Energy (Productivity, Trophic levels)
- ⦿ 25.3 Ecological Succession
- ⦿ 25.4 Population Dynamics
- ⦿ 25.5 Human Impacts on Environment
  - ▶ 25.5.1 Nuclear Power
  - ▶ 25.5.2 CO<sub>2</sub> and Global Warming
  - ▶ 25.5.3 Acid Rain
  - ▶ 25.5.4 Ozone Depletion
  - ▶ 25.5.5 Common pollution sources
- ⦿ 25.6 Environmental Resources and their Depletion

## SECTION 6: APPLICATION OF BIOLOGY

### 26 BIOTECHNOLOGY

- ⦿ 26.1 Gene Cloning (Recombinant DNA Technology and Polymerase Chain Reaction)
- ⦿ 26.2 DNA Sequencing
- ⦿ 26.3 DNA Analysis
- ⦿ 26.4 Genome Maps
- ⦿ 26.5 Tissue Culture
- ⦿ 26.6 Transgenic Bacteria, Plants and Animals
- ⦿ 26.7 Biotechnology and Healthcare
- ⦿ 26.8 Scope and Importance of Biotechnology

### 27 BIOLOGY AND HUMAN WELFARE

- ⦿ 27.1 Vaccination and Integrated disease management
- ⦿ 27.2 Animal Husbandry
- ⦿ 27.3 Latest techniques applied to enhance crop and fruit yields
- ⦿ 27.4 Home Gardening
- ⦿ 27.5 Role of Microbes in Human Welfare

## **LEARNING OUTCOMES:** \_\_\_\_\_

The development of a major concept is a complex process; therefore we must necessarily abandon the notion that acquisition of a specified learning outcome will be the outcome of any single classroom transaction, whether it is a lecture or an activity. A number of learning outcomes may be touched upon in a single lecture or activity and similarly more than one activity or lecture may be required to get a single learning outcome.

The caption of skill lists experiments, as normally understood in the context of science, as well as other classroom processes in which students may be actively engaged. When someone reads the learning outcomes of the domain of skills together with the learning outcomes of the domain of understanding, the reader finds that they delineate the breadth and depth of coverage expected.

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SECTION 1:

# CELL BIOLOGY

# CELL STRUCTURE AND FUNCTIONS

16 Periods

## Overview:

This chapter aims at the in-depth knowledge of the cell structure and functions and also at the basic techniques essential for cell study. The major concepts in this chapter are;

- Techniques used in Cell Biology (02 Periods)
- Cell Wall and Plasma Membrane – The Boundary Wall (02 Periods)
- Cytoplasm and Organelles (10 Periods)
- Prokaryotic and Eukaryotic Cells (02 Periods)

### Conceptual Linkages:

This chapter is built on;

- Cells and Tissues (Grade IX-X)

## MAJOR CONCEPTS AND LEARNING OUTCOMES

### 1- Techniques used in Cell Biology

#### ➤ Understanding

*Student will:*

- List the principles and identify the apparatus used in the techniques of fractionation, differential staining, centrifugation, microdissection, tissue culture, chromatography, electrophoresis and spectrophotometry.
- Describe the terms of resolution and magnification with reference to microscopy.
- Explain the use of graticule and micrometer and define the units used in micrometry.

#### ➤ Skills

**(Performing and Recording)**

*Student will:*

- Use graticule and micrometer to study stomata and the cells of paramecium and onion.

### 2- Cell Wall and Plasma Membrane – The Boundary Wall

#### ➤ Understanding

*Student will:*

- Describe the locations, chemical compositions and significance of the primary and secondary cell walls and of middle lamella.
- Explain the chemical composition of plasma membrane.
- Rationalize the authenticity of the fluid mosaic model of plasma membrane.
- Relate the lipid foundation and the variety of proteins of the membrane structure with their roles.
- Identify the role of glycolipids and glycoproteins as the cell surface markers.
- Explain the role of plasma membrane in regulating cell's interactions with its environment.

#### ➤ Skills

**(Analyzing, Interpreting and Communication)**

*Student will:*

- Draw and label the fluid mosaic model of plasma membrane.
- Measure the size of cells by micrometry.

### 3- Cytoplasm and Organelles

#### ➤ Understanding

*Student will:*

- Describe the chemical nature and metabolic roles of cytoplasm.
- Distinguish between smooth and rough endoplasmic reticulum in terms of their structures and functions.
- Explain the structure, chemical composition and function of ribosome.
- Describe the structure and functions of the Golgi complex.

- State the structure and functions of the peroxysomes and glyoxysomes in animal and plant cells.
- Describe the formation, structure and functions of the lysosomes.
- Interpret the storage diseases with reference to the malfunctioning of lysosomes.
- Explain the external and internal structure of mitochondrion and interlink it with its function.
- Explain the external and internal structure of chloroplast and interlink it with its function.
- Describe the structure, composition and functions of centriole.
- Describe the types, structure, composition and functions of cytoskeleton.
- Explain the structure of cilia and flagella and the mechanisms of their movement.
- Describe the chemical composition and structure of nuclear envelope.
- Compare the chemical composition of nucleoplasm with that of cytoplasm.
- Explain that nucleoli are the areas where ribosomes are assembled.
- Describe the structure, chemical composition and function of chromosome.

#### ➤ Skills

##### (Analyzing, Interpreting and Communication)

*Student will:*

- Compare and contrast the structure and function of mitochondria with those of chloroplasts.
- Compare in tabular form, the functions of organelles with the processes occurring in animals and plants.
- List the structures and molecules, which can cross the nuclear envelope.

##### (Performing and Recording)

*Student will:*

- Prepare the slides of animal and plant cells using differential staining.

## 4- Prokaryotic and Eukaryotic Cell

#### ➤ Understanding

*Student will:*

- List the structures missing in prokaryotic cells.
- Describe the composition of cell wall in a prokaryotic cell.
- Differentiate between the patterns of cell division in prokaryotic and eukaryotic cells.
- Relate the structure of bacteria as a model prokaryotic cell.



**BIOLOGICAL MOLECULES**

21 Periods

**Overview:**

Students have got a very brief introduction about the biological molecules in IX-X biology course. This chapter caters the detailed study of carbohydrates, proteins, lipids and nucleic acids as well as the importance of water and the role of conjugated molecules. Skills and knowledge about the biochemical test for the detection of a particular class of biological molecules from the given organic matter is also targeted in this chapter. The major concepts in this chapter are;

- Biological Molecules (02 Period)
- Importance of Water (01 Periods)
- Carbohydrates (04 Periods)
- Proteins (04 Periods)
- Lipids (04 Periods)
- Nucleic acids (05 Periods)
- Conjugated Molecules (01 Period)

**Conceptual Linkages:**

This chapter is built on;

- Levels of Organization (Grade IX-X)

This chapter leads to;

- Genetics (Grade XI-XII)
- Bioenergetics (Grade XI-XII)

**MAJOR CONCEPTS AND LEARNING OUTCOMES****1- Biological Molecules****➤ Understanding**

*Student will:*

- Introduce biochemistry and describe the approximate chemical composition of protoplasm.
- Distinguish carbohydrates, proteins, lipids and nucleic acids as the four fundamental kinds of biological molecules.
- Describe and draw sketches of the dehydration-synthesis and hydrolysis reactions for the making and breaking of macromolecule polymers.

**2- Importance of Water****➤ Understanding**

*Student will:*

- Explain how the properties of water (high polarity, hydrogen bonding, high specific heat, high heat of vaporization, cohesion, hydrophobic exclusion, ionization and lower density of ice) make it the cradle of life.

**➤ Skills**

**(Analyzing, Interpreting and Communication)**

*Student will:*

- Draw model diagrams to describe the hydrogen bonding.
- Develop a table to align the properties of water with benefits to life.

**3- Carbohydrates****➤ Understanding**

*Student will:*

- Define carbohydrates and classify them.
- Distinguish the properties and roles of monosaccharides, write their empirical formula and classify them.
- Compare the isomers and stereoisomers of glucose.
- Distinguish the properties and roles of disaccharides and describe glycosidic bond in the transport disaccharides.

- Distinguish the properties and roles of polysaccharides and relate them with the molecular structures of starch, glycogen, cellulose and chitin.
- Justify that the laboratory-manufactured sweeteners are “left-handed” sugars and cannot be metabolized by the “right-handed” enzymes.

#### ➤ Skills

##### (Analyzing, Interpreting and Communication)

*Student will:*

- Draw the ring forms of alpha and beta glucose.
- Illustrate the formation and breakage of maltose, sucrose and lactose.

##### (Performing and Recording)

*Student will:*

- Perform Benedict’s test for reducing sugars.
- Confirm the presence of starch through Iodine test.

### 4- Proteins

#### ➤ Understanding

*Student will:*

- Define proteins and amino acids and draw the structural formula of amino acid.
- Outline the synthesis and breakage of peptide linkages.
- Justify the significance of the sequence of amino acids through the example of sickle cell hemoglobin.
- Classify proteins as globular and fibrous proteins.
- List examples and the roles of structural and functional proteins.

#### ➤ Skills

##### (Analyzing, Interpreting and Communication)

*Student will:*

- Draw table to illustrate different structural and functional proteins with the roles of each.
- Illustrate the synthesis and breakage of peptide linkages.

##### (Performing and Recording)

*Student will:*

- Confirm the presence of proteins through Biuret test.

### 5- Lipids

#### ➤ Understanding

*Student will:*

- Define lipids and describe the properties and roles of acylglycerols, phospholipids, terpenes and waxes.
- Illustrate the molecular structure (making and breaking) of an acylglycerol, a phospholipid and a terpene.
- Evaluate steroids and prostaglandins as important groups of lipids and describe their roles in living organisms.

#### ➤ Skills

##### (Performing and Recording)

*Student will:*

- Confirm the presence of lipids through Emulsion test.

## 6- Nucleic Acids

### ➤ Understanding

*Student will:*

- Define nucleic acids and nucleotides.
- Describe the molecular level structure of nucleotide.
- Distinguish among the nitrogenous bases found in the nucleotides of nucleic acids.
- Outline the examples of a mononucleotide (ATP) and a dinucleotide (NAD).
- Illustrate the formation of phosphodiester bond.
- Explain the double helical structure of DNA as proposed by Watson and Crick.
- Define gene is a sequence of nucleotides as part of DNA, which codes for the formation of a polypeptide.
- Explain the general structure of RNA.
- Distinguish in term of structures and roles, the three types of RNA.

### ➤ Skills

#### (Analyzing, Interpreting and Communication)

*Student will:*

- Draw the Watson - Crick Model of DNA.
- Illustrate the formation of phosphodiester bond.

#### (Performing and Recording)

*Student will:*

- Demonstrate the presence of nucleic acids in biological materials.

#### (Initiating and Planning)

*Student will:*

- Hypothesize which came first, DNA or RNA.

## 7- Conjugated Molecules

### ➤ Understanding

*Student will:*

- Define conjugated molecules and describe the roles of common conjugated molecules i.e. glycolipids, glycoproteins, lipoproteins and nucleoproteins.

### ➤ STS Connections

*Student will:*

- List the career opportunities in the field of biochemistry.
- Relate the role of prostaglandins in inflammation and pain with the inhibition of prostaglandin synthesis through the use of aspirin.
- Correlate the scanning-tunneling microscope as the latest advancement for seeing the atoms of DNA.





**ENZYMES**

09 Periods

**Overview:**

There is complete check and balance on the chemistry of cell, which is exhibited through various enzymatic reactions going on within a cell. The concepts developed, as follows will construct the level of knowledge where student will be able to analyze comprehend and apply that knowledge. The following concepts are developed in this chapter.

The major concepts in this chapter are;

- Enzyme Structure (02 Periods)
- Mechanism of Enzyme Action (01 Period)
- Factor effecting Enzyme Action (03 Periods)
- Enzyme Inhibition (01 Period)
- Enzyme Classification (02 Periods)

**Conceptual Linkages:**

This chapter is built on;

- Enzyme (Biology IX –X)

This chapter leads to;

- Life Processes (Biology XI-XII)

**MAJOR CONCEPTS AND LEARNING OUTCOMES****1- Enzyme Structure****➤ Understanding**

*Student will:*

- Describe the structure of enzyme.
- Explain the role and component parts of the active site of an enzyme.
- Differentiate among the three types of co-factors i.e. inorganic ions, prosthetic group and co-enzymes, by giving examples.

**➤ Skills**

**(Performing and Recording)**

*Student will:*

- Demonstrate by performing chemical test, that enzymes are proteins.

**2- Mechanism of Enzyme action****➤ Understanding**

*Student will:*

- Explain the mechanism of enzyme action through Induced Fit Model, comparing it with Lock and Key Model.
- Explain how an enzyme catalyzes specific reactions.
- Define energy of activation and explain through graph how an enzyme speeds up a reaction by lowering the energy of activation.

**3- Factors effecting Enzyme action****➤ Understanding**

*Student will:*

- Describe the effect of temperature on the rate of enzyme action
- Compare the optimum temperatures of enzymes of human and thermophilic bacteria.
- Describe the range of pH at which human enzymes function
- Compare the optimum pH of different enzymes like trypsin, pepsin, pepsane.
- Describe how the concentration of enzyme affects the rate of enzyme action.
- Explain the effect of substrate concentration on the rate of enzyme action.

### ➤ Skills

#### (Analyzing, Interpreting and Communication)

Student will:

- Construct and interpret graphs based on data about the effect of temperature, enzyme concentration and substrate concentration on the rate of enzyme action.

#### (Performing and Recording)

Student will:

- Demonstrate the sensitivity of enzymes by performing amylase tests on starch (with boiled and un-boiled amylase).

## 4- Enzyme Inhibition

### ➤ Understanding

Student will:

- Describe enzymatic inhibition, its types and its significance.
- Name the molecules which act as inhibitors.
- Categorize inhibitors into competitive and non-competitive inhibitors.
- Explain feedback inhibition.

### ➤ Skills

#### (Analyzing)

Student will:

- Identify the competitive and noncompetitive inhibitors from the given list of chemicals.

## 4- Enzyme Classification

### ➤ Understanding

Student will:

- Classify enzymes on the basis of the reactions catalyzed (oxido-reductases, transferases, hydrolases, hydrolyases, isomerases, and ligases).
- Classify enzymes on the basis of the substrates they use (lipases, diastase, amylase, proteases etc).

### ➤ STS Connections

Student will:

- List the diagnostic uses of enzymes.
- Describe venoms as enzyme inhibitors.



**BIOENERGETICS**

14 Periods

**Overview:**

This chapter deals with the most fundamental metabolic processes i.e. photosynthesis and respiration. Students already have the general concept of these processes. The detailed learning would foster the skills of analysis and evaluation. The chapter also develops the basic concept of photorespiration, the process that reduces a plant's productivity.

The major concepts in this chapter are;

- Photosynthesis (08 Periods)
- Cellular Respiration (05 Periods)
- Photorespiration (01 Period)

**Conceptual Linkages:**

This chapter is built on;

- Bioenergetics (Grade IX-X)
- Chloroplast (Grade XI-XII)

This chapter leads to;

- Plant Physiology (Grade XI-XII)

**MAJOR CONCEPTS AND LEARNING OUTCOMES****1- Photosynthesis****➤ Understanding**

*Student will:*

- Explain the role of light in photosynthesis.
- Identify the two general kinds of photosynthetic pigments (carotenoids and chlorophylls).
- Describe the roles of photosynthetic pigments in the absorption and conversion of light energy.
- Differentiate between the absorption spectra of chlorophyll 'a' and 'b'.
- Describe the arrangement of photosynthetic pigments in the form of photosystem-I and II.
- State the role of CO<sub>2</sub> as one of the raw materials of photosynthesis.
- Explain, narrating the experimental work done, the role of water in photosynthesis.
- Describe the events of non-cyclic photophosphorylation and outline the cyclic photophosphorylation.
- Explain the Calvin cycle (the regeneration of RuBP should be understood in outline only).

**➤ Skills**

**(Analyzing, Interpreting and Communication)**

*Student will:*

- Draw the molecular structure of chlorophyll, showing the porphyrin head and the phytol tail.
- Develop the graphical interpretation of the wavelengths of light along with the percentage absorption by chlorophyll 'a' and 'b'.
- Draw the Z-scheme for explaining the events of the light-dependent reactions.
- Develop a flow chart for explaining the events of the light-independent reactions.

**(Performing and Recording)**

*Student will:*

- Extract the leaf pigments and separate them by paper chromatography.

**2- Cellular Respiration****➤ Understanding**

*Student will:*

- Explain the process of anaerobic respiration in terms of glycolysis and conversion of pyruvate into lactic acid or ethanol.
- Outline (naming the reactants and products of each step of) the events of glycolysis.

- Illustrate the conversion of pyruvate to acetyl-CoA.
- Outline (naming the reactants and products of each step of) the steps of Krebs cycle.
- Explain the passage of electron through electron transport chain.
- Describe chemiosmosis and relate it with electron transport chain.
- Explain the substrate-level phosphorylation during which exergonic reactions are coupled with the synthesis of ATP.
- Justify the importance of PGAL in photosynthesis and respiration.
- Outline the cellular respiration of proteins and fats and correlate these with that of glucose.

#### ➤ Skills

#### (Analyzing, Interpreting and Communication)

*Student will:*

- Draw the flow charts showing the events of glycolysis and Krebs cycle.
- Illustrate the net energy output during glycolysis, oxidation of pyruvate and Krebs cycle.

### 3- Photorespiration

#### ➤ Understanding

*Student will:*

- Define photorespiration and outline the events occurring through it.
- Rationalize how the disadvantageous process of photorespiration evolved.
- Explain the effect of temperature on the oxidative activity of RuBP carboxylase.
- Outline the process of  $C_4$  photosynthesis as an adaptation evolved in some plants to deal with the problem of photorespiration.

#### ➤ Skills

#### (Initiating and Planning)

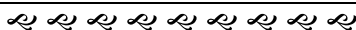
*Student will:*

- Justify why photorespiration is interference in the successful performance of the Calvin cycle.

#### ➤ STS Connections

*Student will:*

- Analyze the impact of photorespiration on the agricultural yield in the tropic climates.



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SECTION 2:

# BIODIVERSITY

# ACELLULAR LIFE

10 Periods

## Overview:

The topic includes an insight into the nature of viruses, prions and viroids as acellular level of organization and the role they play in the economy of a country by causing preventable and fatal infectious diseases.

The following concepts are developed in this chapter;

- Viruses - Discovery and Structure (02 Periods)
- Parasitic Nature of Viruses (02 Periods)
- Life cycle of Bacteriophage (01 Period)
- Life cycle of Human Immunodeficiency Virus (02 Periods)
- Viral Diseases (02 Periods)
- Prions and Viroids (01 period)

## Conceptual Linkages:

This chapter is built on;

- Biodiversity (Grade IX-X)
- Biological molecules (Grade IX-X)

This chapter leads to;

- Biotechnology (Grade XI-XII)
- Biology and Human Welfare (Grade XI-XII)

## MAJOR CONCEPTS AND LEARNING OUTCOMES

### 1-Viruses - Discovery and Structure

#### ➤ Understanding

*Student will:*

- Justify the status of viruses among living and non-living things.
- Trace the history of viruses since their discovery.
- Classify viruses on the bases of their hosts and structure.
- Explain the structure of a model bacteriophage, flu virus and HIV.

#### ➤ Skills

**(Interpreting and Recording)**

- Make a list of names of at least five viruses each in plants and animals that have DNA or RNA.
- Draw labeled diagrams of bacteriophage, flu virus and HIV.

### 2-Parasitic Nature of Viruses

#### ➤ Understanding

*Student will:*

- Justify why a virus must have a host cell to parasitize in order to complete its life cycle.
- Explain how a virus survives inside a host cell, protected from the immune system.
- Determine the method a virus employs to survive/ pass over unfavorable conditions when it does not have a host to complete the life cycle.

#### ➤ Skills

**(Interpreting and Recording)**

- Record the symptoms of flu in any individual.
- Make a list of names of at least five viruses each in plants and animals that are specific for a specific host.

### 3-Life Cycle of a Bacteriophage

#### ➤ Understanding

*Student will:*

- Describe the Lytic and Lysogenic life cycles of a virus.
- Outline the usage of bacteriophage in genetic engineering.

### ➤ Skills

#### (Interpreting and Recording)

- Make a list of the sequences involved in the lytic life cycle of a bacteriophage.

## 4- Life Cycle of Human Immunodeficiency Virus

### ➤ Understanding

*Student will:*

- Explain the life cycle of HIV.
- Justify the name of the virus *i.e.*, “Human Immunodeficiency Virus” by establishing T-helper cells as the basis of immune system.
- Reason out the specificity of HIV on its host cells.
- List the symptoms of AIDS.
- Explain opportunistic diseases that may attack an AIDS victim.
- Describe the treatments available for AIDS.
- List some common control measures against the transmission of HIV.

### ➤ Skills

#### (Interpreting and Recording)

- Predict from the given data the incidence and prevalence of AIDS over a period of next five years.
- List the factors responsible for the spread of this disease.

## 5- Viral Diseases

### ➤ Understanding

*Student will:*

- Describe the causative agent, symptoms, treatment and prevention of the following viral diseases: hepatitis, herpes, polio and leaf curl virus disease of cotton.
- List the sources of transmission for each of the above-mentioned diseases.
- Assess from the given data the economic loss from viral infections (cotton leaf curl virus disease and bird flu virus) in Pakistan.

### ➤ Skills

#### (Interpreting and Communicating)

- Compare from the data given in the book, the number of fatalities caused by hepatitis, herpes and polio combined with the total fatalities caused by AIDS.
- Give reasons in favor of the statement “Prevention is better than cure” and present the arguments in the class.

## 6- Prions and Viroids

### ➤ Understanding

*Student will:*

- Describe the structure of prions and viroids.
- List the diseases caused by prions and viroids.

### ➤ STS Connections

*Student will:*

- Interpret how viral infections cause global economic loss.
- Justify how the invention of electron microscope revolutionized the science of microscopic organisms.
- Suggest ways to rid human civilization of viruses.
- Correlate the social and cultural values of a country with the prevalence of AIDS.
- Describe the limitations of the vaccine for the common cold / flu virus.



Result.pk



# PROKARYOTES

14 Periods

## Overview:

This chapter is an introduction to the world of cellular organisms that lack a membrane bound nucleus – the prokaryotes, which have a profound effect on human health, economy and environment.

The prokaryotes are being extensively used these days in research and technology, and this chapter lays due emphasis on this important aspect of prokaryotes. This chapter includes:

- Taxonomy of Prokaryotes (02 Periods)
- Archaea (01 Period)
- Bacteria; Ecology and Diversity (03 Periods)
- Structure; Shape and Size of Bacteria (02 Periods)
- Modes of Nutrition in Bacteria (02 Periods)
- Growth and Reproduction in Bacteria (01 Period)
- Importance of Bacteria (02 Periods)
- Control of Harmful Bacteria (01 Period)

## Conceptual Linkages:

This chapter is built on;

- Cell (Grade IX-X)
- Biodiversity (Grade IX-X)

This chapter leads to;

- Biotechnology (Grade XI-XII)
- Ecology (Grade XI-XII)

## MAJOR CONCEPTS AND LEARNING OUTCOMES

### 1- Taxonomy of Prokaryotes

#### ➤ Understanding

*Student will:*

- Outline the taxonomic position of prokaryotes in terms of domains archaea and bacteria and in terms of kingdom monera.
- Explain the phylogenetic position of prokaryotes.

#### ➤ Skills

**(Performing and Recording)**

*Student will:*

- Identify bacteria from curd, mouth, or bacterial culture.

### 2- Archaea

#### ➤ Understanding

*Student will:*

- List the unifying archeal features that distinguish them from bacteria.
- Explain that most Archaea inhabit extreme environments.

### 3- Bacteria: Ecology and Diversity

#### ➤ Understanding

*Student will:*

- Justify the occurrence of bacteria in the widest range of habitats.
- List the diagnostic features of the major groups of bacteria.
- Justify why cyanobacteria are considered as the most prominent of the photosynthetic bacteria.

**➤ Skills****(Performing and Recording)***Student will:*

- Identify the characteristics of *Nostoc*, *Ocillatoria* and *Anabaena* through observation from fresh or preserved material.

**4- Structure; Shape and Size of Bacteria****➤ Understanding***Student will:*

- Describe detailed structure and chemical composition of bacterial cell wall and other coverings.
- Compare cell wall differences in Gram-positive and Gram-negative bacteria.
- Explain the great diversity of shapes and sizes found in bacteria.
- Justify the endospore formation in bacteria to withstand unfavorable conditions.
- Explain motility in bacteria.
- Describe structure of bacterial flagellum.
- Describe genomic organization of bacteria.

**➤ Skills****(Performing and Recording)***Student will:*

- Stain bacteria using Grams staining technique.
- Observe bacterial culture for different shapes and sizes.

**5- Modes of Nutrition in Bacteria****➤ Understanding***Student will:*

- Classify bacteria on the basis of methods of obtaining energy and carbon.
- Describe autotrophic and heterotrophic nutrition in bacteria.
- Explain the pigment composition in cyanobacteria.
- Differentiate between the photosynthesis mechanisms in cyanobacteria and other photosynthetic bacteria.

**➤ Skills****(Performing and Recording)***Student will:*

- Prepare and observe temporary mount of root nodule bacteria.

**6- Growth and Reproduction in Bacteria****➤ Understanding***Student will:*

- List the phases in the growth of bacteria.
- Describe different methods of reproduction in bacteria.
- Explain how mutations and genetic recombinations lend variability to bacterial reproduction.

**➤ Skills****(Interpreting and Communication)***Student will:*

- Draw a graph to present the time taken in each phase of bacterial growth and the number of bacteria.

**7- Importance of Bacteria****➤ Understanding***Student will:*

- Describe bacteria as recyclers of nature.

- Outline the ecological and economic importance of bacteria.
- Explain the use of bacteria in research and technology.
- Describe important bacterial diseases in man e.g. cholera, typhoid, tuberculosis, and pneumonia; emphasizing their symptoms, causative bacteria, treatments, and preventative measures.
- Describe important bacterial diseases in plants in terms of spots, blights, soft rots, wilts, and galls; emphasizing their symptoms, causative bacteria, and preventative measures.

## 8- The Bacterial Flora of Humans

### ➤ Understanding

*Student will:*

- Define the term normal flora.
- List the important bacteria that make the normal bacterial flora residing in the oral cavity, respiratory and urinogenital tracts and large intestine of man.
- Describe the benefits of the bacterial flora of humans.

## 9- Control of Harmful Bacteria

### ➤ Understanding

*Student will:*

- List the chemical and physical methods used to control harmful bacteria.

### ➤ Skills

#### (Initiating and Planning)

*Student will:*

- Acquire some basic microbiological and safety techniques.

### ➤ STS Connections

*Student will:*

- Relate the causes of food poisoning and the sanitation conditions in restaurants.
- Justify why it is important to disinfect articles of food and utensils before use.
- Narrate how bacterial diseases have affected human societies in the past.
- Suggest how we can stop any epidemic to occur in future.
- List some biotechnologies utilizing bacteria.



# PROTISTS AND FUNGI

11 Periods

## Overview:

This chapter aims at the basic knowledge about protists, the most diverse eukaryotes structurally and in terms of their life cycles. The learners are also expected to get fundamental knowledge about fungi. This chapter includes:

- Protists – The Evolutionary Relationships (01 Period)
- Major groups of Protists (04 Periods)
- General characteristics of Fungi (01 Period)
- Diversity among Fungi (03 Periods)
- Importance of Fungi (02 Periods)

### Conceptual Linkages:

This chapter is built on;

- Biodiversity (Grade IX-X)

## MAJOR CONCEPTS AND LEARNING OUTCOMES

### 1- Protists – The Evolutionary Relationships

#### ➤ Understanding

*Student will:*

- Explain protists as a diverse group of eukaryotes that has polyphyletic origin and defined only by exclusion from other groups.

### 2- Major Groups of Protists

#### ➤ Understanding

*Student will:*

- Describe the salient features with examples of protozoa, algae, myxomycota and oomycota as the major groups of protists.
- Justify how protists are important for humans.

#### ➤ Skills

**(Performing and Recording)**

*Student will:*

- Observe and draw representative members of each group of protists.

### 3- General Characteristics of Fungi

#### ➤ Understanding

*Student will:*

- List the characteristics that distinguish fungi from other groups and give reasons why fungi are classified in a separate kingdom.

### 4- Diversity among Fungi

#### ➤ Understanding

*Student will:*

- Classify fungi into zygomycota, ascomycota and basidiomycota and give the diagnostic features of each group.

#### ➤ Skills

**(Performing and Recording)**

*Student will:*

- Observe black bread mold and *Penicillium* from fresh culture and prepared slides and draw labeled diagrams of their life cycles.

## 5- Importance of Fungi

### ➤ Understanding

*Student will:*

- Explain yeast as unicellular fungi that are used for baking and brewing and are also becoming very important for genetic research.
- Name a few fungi from which antibiotics are obtained.
- Explain the mutualism established in mycorrhizae and lichen associations.
- Give examples of edible fungi.
- Describe the ecological impact of fungi causing decomposition and recycling of materials.
- Explain the pathogenic role of fungi.

### ➤ STS Connections

*Student will:*

- Explain what clues protists provide with respect to the evolution of the other three kingdoms of eukaryotes.
- Describe how helpful fungi have been for us as source of antibiotics and other useful chemicals.



Result.pk

# DIVERSITY AMONG PLANTS

21 Periods

## Overview:

Plants dominate the terrestrial environment and provide services for all living things. Humans depend on plants for their food and many other products.

Keeping in view the diversity and importance of plants, following major concepts are discussed to provide the basic knowledge;

- Evolutionary Relations in Plants (01 Period)
- Non-Vascular Plants (04 Periods)
- Seedless Vascular Plants (05 Periods)
- Seed Plants (10 Periods)

## Conceptual Linkages:

This chapter is built on;

- Biodiversity (Grade IX-X)
- Plant biology (Grade IX-X)

This chapter is built on;

- Ecosystem (Grade XI-XII)
- Evolution (Grade XI-XII)

## MAJOR CONCEPTS AND LEARNING OUTCOMES

### 1- The Evolutionary Relations in Plants

#### ➤ Understanding

Student will:

- Outline the evolutionary origin of plants.
- List the diagnostic features shared by all plants, with emphasis on alternation of generation.

### 2- Non-Vascular Plants

#### ➤ Understanding

Student will:

- Describe the general characteristics of bryophytes.
- Outline the life cycle of moss.
- Explain the land adaptations of bryophytes.
- List the advantages/uses of bryophytes.

#### ➤ Skills

(Analyzing and Recording)

Student will:

- Identify the vegetative and reproductive structures of *Marchantia* and *Funaria* by examining the fresh and preserved material.

### 3- Seedless Vascular Plants

#### ➤ Understanding

Student will:

- Describe the general characteristics of vascular plants.
- List the characters of seedless vascular plants with examples of whisk ferns, club mosses, horsetails and ferns.
- Explain the evolution of leaf in vascular plants.
- Outline the life cycle of ferns.
- Describe vascular plants as successful land plants.
- Summarize the importance of seedless vascular plants.

### ➤ Skills

#### (Performing and Recording)

Student will:

- Identify the vegetative and reproductive structures of a local fern and relate these with its life cycle.

## 4- Seed Plants

### ➤ Understanding

Student will:

- Describe the evolution of seed.
- Describe the general characteristics and uses of gymnosperms.
- Define angiosperms and explain the difference between monocots and dicots.
- Explain the life cycle of a flowering plant.
- Explain how this life cycle demonstrates an adaptation of angiosperms on land.
- Define inflorescence and describe its major types.
- Describe the significance/benefits of angiosperms for humans.

### ➤ Skills

#### (Performing and Recording)

Student will:

- Identify the vegetative and reproductive structures of a *Pinus* and relate these with its life cycle.
- Identify different types of inflorescence of *Cassia*, *Brassica*, *Achyranthus*, *Morus*, Candytuft, *Helianthus* and *Avena sativa*
- In general terms describe the flower of Rose, *Cassia fistula*, *Solanum nigrum* and *Avena sativa*

### ➤ STS Connections

Student will:

- Describe the formation and importance of peat bogs.
- Justify plants as a medical treasure.



# DIVERSITY AMONG ANIMALS

18 Periods

## Overview:

This chapter deals with classification of animals and general characteristics of different animal groups. The major concepts in this chapter are;

- Characteristics of Animals (01 Period)
- Criteria for Animal Classification (03 Periods)
- Invertebrates (08 Periods)
- Chordates (06 Periods)

## Conceptual Linkages:

This chapter is built on;

- Biodiversity (Grade IX-X)

This chapter leads to;

- Evolution (Grade XI-XII)

## MAJOR CONCEPTS AND LEARNING OUTCOMES

### 1- Characteristics of Animals

#### ➤ Understanding

*Student will:*

- Describe the general characteristics of animals.

### 2- Criteria for Animal Classification

#### ➤ Understanding

*Student will:*

- Classify animals on the base of presence and absence of tissues.
- Differentiate the diploblastic and triploblastic levels of organization.
- Describe the types of symmetry found in animals.
- Differentiate pseduocoelomates, acoelomates and coelomates.
- Classify coelomates into protostomes and deuterostomes.

#### ➤ Skills

**(Interpreting and Communication)**

*Student will:*

- Draw the evolutionary tree of sponges, butterfly and monkey.

### 3- Invertebrates

#### ➤ Understanding

*Student will:*

- Describe the general characteristics, importance and examples of sponges, cnidarians, platyhelminths, aschelminths (nematodes), mollusks, annelids, arthropods and echinoderms.
- Describe the evolutionary adaptations in the concerned phyla for digestion, gas exchange, transport, excretion, and coordination.

#### ➤ Skills

**(Analyzing and Interpreting)**

*Student will:*

- Classify the given animals into phyla by using classification key.



## 4- Chordates

### ➤ Understanding

*Student will:*

- Describe the characteristics of invertebrate chordates and vertebrates.
- List the diagnostic characteristics of jawless fishes, cartilaginous fishes and bony fishes.
- Describe the general characteristics of amphibians, reptiles, birds and mammals.
- Differentiate among monotremes, marsupials, and placentals.
- Describe the evolutionary adaptations in concerned groups for gas exchange, transport and coordination.

### ➤ Skills

**(Communication and Teamwork)**

*Student will:*

- Classify the given vertebrates into classes by using classification key and described characteristics.

### ➤ STS Connections

*Student will:*

- Trace his position in the phylogeny of major groups of animals.
- Explain the role of invertebrates in the field of research and daily life.
- Demonstrate an understanding of the connection of extinction of species with that of human activities.



Result.pk

Result.pk

SECTION 3:

# LIFE PROCESSES

# FORM AND FUNCTIONS IN PLANTS

27 Periods

**Overview:**

This chapter provides the knowledge about the basic life processes in plants. Learners are expected to get well equipped with the use of experimental instruments and in the skills of performing and recording. The following concepts are developed in this chapter;

- Nutrition in Plants (01 Period)
- Gaseous Exchange in Plants (02 Periods)
- Transport in Plants (10 Periods)
- Homeostasis in Plants (03 Periods)
- Support in Plants (01 Period)
- Growth and Development in Plants (03 Periods)
- Growth Responses in Plants (07 Periods)

**Conceptual Linkages:**

This chapter is built on;

- Levels of organization (Grade IX-X)
- Cell (Grade XI-XII)

## MAJOR CONCEPTS AND LEARNING OUTCOMES

### 1- Nutrition in Plants

#### ➤ Understanding

*Student will:*

- List the macro and micronutrients of plants highlighting the role of each nutrient.
- State the examples of carnivorous plant.

### 2- Gases exchange in Plant

#### ➤ Understanding

*Student will:*

- Explain the role of stomata and palisade tissue in the exchange of gases in plants.
- Relate transpiration with gas exchange in plants.

#### ➤ Skills

**(Performing and Recording)**

*Student will:*

- Perform to demonstrate with the help of indicator (hydrogen carbonate) evolution of CO<sub>2</sub> from leaf discs placed in dark and light.

### 3- Transport in Plants

#### ➤ Understanding

*Student will:*

- Describe the structure of xylem vessel elements, sieve tube elements, companion cells, tracheids and relate their structures with functions.
- Explain the movement of water between plant cells, and between the cells and their environment in terms of water potential.
- Explain the movement of water through roots in terms of symplast, apoplast and vacuolar pathways.
- Explain the movement of water in xylem through TACT mechanism.
- Describe the mechanisms involved in the opening and closing of stomata.
- Explain the movement of sugars within plants.

**➤ Skills****(Performing and Recording)***Student will:*

- Identify vessel elements and phloem sieve tubes from the microscopic slides of LS of a dicot stem.
- Illustrate diagrammatically the pathway of water in root, stem and leaf.

**4- Homeostasis in Plants****➤ Understanding***Student will:*

- Define osmotic adjustment.
- Explain movement of water into or out of cell in isotonic, hypotonic, and hypertonic conditions.
- Describe osmotic adjustments in hydrophytic (marine and freshwater), xerophytic and mesophytic plants.
- Explain the osmotic adjustments of plants in saline soils.
- List the adaptations in plants to cope with low and high temperatures.

**➤ Skills****(Interpreting and Analyzing)***Student will:*

- Interpret the adaptive differences through survey of xerophytic, mesophytic and hydrophytic plants.
- Illustrate the structure and position of stomata in xerophytic, mesophytic and hydrophytic plants.

**5- Support in Plants****➤ Understanding***Student will:*

- Explain the turgor pressure and explain its significance in providing support to herbaceous plants.
- Describe the structure of supporting tissues in plants.

**6- Growth and Development in Plants****➤ Understanding***Student will:*

- Define growth and explain primary and secondary growth in plants.
- Describe the role of apical meristem and lateral meristem in primary and secondary growth.
- Explain how annual rings are formed.
- Explain influence of apical meristem on the growth of lateral shoots.

**➤ Skills****(Performing and Recording)***Student will:*

- Locate annual rings in the log of a tree.
- Calculate the age of a plant by counting number of annual rings.

**7- Growth Responses in Plants****➤ Understanding***Student will:*

- Explain the role of important plant growth regulators.
- Explain the types of movement in plants in response to light, force of gravity, touch and chemicals.
- Define photoperiodism.
- Classify plants on the basis of photoperiodism and give examples.

- Describe the mechanism of photoperiodism with reference to the mode of action of phytochrome.
- Explain the role of low temperature treatment on flower production especially to biennials and perennials.

### ➤ Skills

#### (Performing and Recording)

*Student will:*

- Demonstrate through simple experiments the phototropism, geotropism and thigmotropism in plants.
- Demonstrate folding of *Mimosa* leaf after touch.

### ➤ STS Connections

*Student will:*

- Identify some major symptoms of mineral deficiencies in plants e.g. necrosis, chlorosis, stunted growth etc.
- Correlate climatic record with tree growth.
- Describe the reasons for bushy and cylindrical growth.



Result.pk

**DIGESTION**

13 Periods

**Overview:**

This chapter targets the more detailed study of the digestive system of man, the basic knowledge of which has been dealt with in biology IX-X course.

Common dietary and infectious diseases are also discussed in this chapter. The major concepts in this chapter are;

- Digestive System of Man (09 Periods)
  - Alimentary Canal; Structural and Functional details
  - Role of Accessory Glands
- Disorders related to Digestive system and food habits (ulcer, food poisoning, dyspepsia, obesity, anorexia nervosa, bulimia nervosa) (04 Periods)

**Conceptual Linkages:**

This chapter is built on;

- Digestion (Grade IX-X)
- Enzymes (Grade XI-XII)

**MAJOR CONCEPTS AND LEARNING OUTCOMES****1- Alimentary Canal; Structural and Functional details****➤ Understanding**

*Student will:*

- Describe the mechanical and chemical digestion in oral cavity.
- Explain swallowing and peristalsis.
- Describe the structure of stomach and relate each component with the mechanical and chemical digestion in stomach.
- Explain the role of nervous system and gastrin hormone on the secretion of gastric juice.
- Describe the major actions carried out on food in the three regions of the small intestine.
- Explain the absorption of digested products from the small intestine lumen to the blood capillaries and lacteals of the villi.
- Describe the component parts of large intestine with their respective roles.
- Correlate the involuntary reflex for egestion in infants and the voluntary control in adults.

**➤ Skills**

**(Analyzing, Interpreting and Communication)**

*Student will:*

- List structural features that increase surface area of small intestine.
- Identify the components of villi by observing the transverse section of intestine under microscope.

**2- Role of Accessory Glands****➤ Understanding**

*Student will:*

- Explain the storage and metabolic role of liver.
- Describe composition of bile and relate the constituents with respective roles.
- Outline the structure of pancreas and explain its function as an exocrine gland.
- Relate the secretion of bile and pancreatic juice with the secretin hormone.

**➤ Skills**

**(Analyzing and Interpreting)**

*Student will:*

- Identify and draw the sections of liver and pancreas from prepared slides.

### 3- Disorders related to Digestive System and Food Habits

#### ➤ Understanding

*Student will:*

- Describe the causes, prevention, and treatment of the following disorders; ulcer, food poisoning, dyspepsia.
- Describe obesity in terms of its causes, preventions and related disorders.
- Explain the symptoms and treatments of bulimia nervosa and anorexia nervosa.

#### ➤ STS Connections

*Student will:*

- Relate hepatitis and jaundice with the functions of liver.
- Relate ulcer, food poisoning and dyspepsia with the eating habits of the society.



Result.pk

## CIRCULATION

14 Periods

**Overview:**

This chapter targets the more detailed study of the circulatory system of man, the basic knowledge of which has been dealt with in biology IX-X course. Cardiovascular disorders and the lymphatic system have been discussed in detail. The major concepts in this chapter are;

- Blood Circulatory System of Man
  - Heart (04 Periods)
  - Blood Vessels (02 Periods)
  - Blood Pressure and its Measurement (03 Periods)
  - Cardiovascular Disorders (03 Periods)
- Lymphatic System of Man (02 Periods)

**Conceptual Linkages:**

This chapter is built on;

- Transport (Grade IX-X)

This chapter leads to;

- Immunity (Grade XI-XII)

**MAJOR CONCEPTS AND LEARNING OUTCOMES****Blood Circulatory System of Man****1- Heart****➤ Understanding**

*Student will:*

- State the location of heart in the body and define the role of pericardium.
- Describe the structure of the walls of heart and rationalize the thickness of the walls of each chamber.
- Describe the flow of blood through heart as regulated by the valves.
- State the phases of heartbeat.
- Explain the role of SA node, AV node and Purkinji fibers in controlling the heartbeat.
- List the principles and uses of Electrocardiogram.

**➤ Skills**

**(Analyzing, Interpreting and Communication)**

*Student will:*

- Correlate the *lub-dub* sounds of the closing of heart valves with the monitoring of the heartbeat.
- Identify the phases of heartbeat on a printed ECG.
- Compare the ECG of a cardiac patient with that of a healthy man.

**(Performing and Recording)**

*Student will:*

- Dissect the heart of sheep / goat and describe its internal structure.

**2- Blood Vessels****➤ Understanding**

*Student will:*

- Describe the detailed structure of arteries, veins and capillaries.
- Describe the role of arterioles in vasoconstriction and vasodilation.
- Describe the role of precapillary sphincters in regulating the flow of blood through capillaries.
- Trace the path of the blood through the pulmonary and systemic circulation (coronary, hepatic-portal and renal circulation).
- Compare the rate of blood flow through arteries, arterioles, capillaries, venules and veins.



### ➤ Skills

#### (Analyzing and Interpreting)

Student will:

- Differentiate between an artery and a vein by observing prepared slides.
- Justify how vasoconstriction or vasodilation is reflective of emotions.

### 3- Blood Pressure and its Measurement

#### ➤ Understanding

Student will:

- Define blood pressure and explain its periods of systolic and diastolic pressure.
- State the role of baroreceptors and volume receptors in regulating the blood pressure.

### ➤ Skills

#### (Performing and Recording)

Student will:

- Measure blood pressure by using sphygmomanometer.

### 4- Cardiovascular Disorders

#### ➤ Understanding

Student will:

- Define the term thrombus and differentiate between thrombus and embolus.
- Identify the factors causing atherosclerosis and arteriosclerosis.
- Categorize *Angina pectoris*, heart attack, and heart failure as the stages of cardiovascular disease development.
- State the congenital heart problem related to the malfunctioning of cardiac valves.
- Describe the principles of angiography.
- Outline the main principles of coronary bypass, angioplasty and open-heart surgery.
- Define hypertension and describe the factors that regulate blood pressure and can lead to hypertension and hypotension.
- List the changes in life styles that can protect man from hypertension and cardiac problems.

### 5- Lymphatic System of Man

#### ➤ Understanding

Student will:

- Describe the formation, composition and function of intercellular fluid.
- Compare the composition of intercellular fluid with that of lymph.
- State the structure and role of lymph capillaries, lymph vessels and lymph trunks.
- Describe the role of lymph vessels (lacteals) present in villi.
- Describe the functions of lymph nodes and state the role of spleen as containing lymphoid tissue.

### ➤ Skills

#### (Initiating and Planning)

Student will:

- Justify in what way the blood circulatory system is dependent on the lymphatic system.
- Interpret why the swelling of the lymph nodes is a cause of concern.

#### (Analyzing and Interpreting)

Student will:

- Trace the path of lymph from a lymph capillary until it is returned to the blood.

### ➤ STS Connections

*Student will:*

- Rationalize the use of artificial pacemaker in patients of cardiac arrhythmias.
- Hypothesize the role and effects of diuretic drugs in regulating blood pressure.
- List major hospitals of cardiology working in his/her province.
- List the advantages and disadvantages of coronary bypass surgery.



Result.pk

**IMMUNITY**

12 Periods

**Overview:**

Detailed knowledge about the body's defense is given in this chapter. More emphasis would be on the immune system.

The major concepts in this chapter are;

- First Line of Defense (Skin, Digestive Tract, Air Passageway) (02 Periods)
- Second Line of Defense – The Nonspecific Defenses (03 Periods)
- Third Line of Defense – The Specific Defenses (07 Periods)

**Conceptual Linkages:**

This chapter is built on;

- Composition of Blood (Grade IX-X)
- Lymphatic System (Grade XI-XII)

**MAJOR CONCEPTS AND LEARNING OUTCOMES****1- First Line of Defense****➤ Understanding**

*Student will:*

- Describe the structural features of human skin that make it impenetrable barrier against invasion by microbes.
- Explain how oil and sweat glands within the epidermis inhibit the growth and also kill microorganisms.
- Recognize the role of the acids and enzymes of the digestive tract in killing the bacteria present in food.
- State the role of the ciliated epithelium of nasal cavity and of the mucous of the bronchi and bronchioles in trapping air borne microorganisms.

**2- Second Line of Defense (The Nonspecific Defenses)****➤ Understanding**

*Student will:*

- Describe the role of macrophages and neutrophils in killing bacteria.
- Explain how the Natural Killer (NK) cells kill the cells that are infected by microbes and also kill cancer cells.
- State how the proteins of the complement system kill bacteria and how the interferons inhibit the ability of viruses to infect cells.
- State the events of the inflammatory response as one of the most generalized nonspecific defenses.
- Outline the release of pyrogens by microbes and their effect on hypothalamus to boost the body's temperature.
- List the ways the fever kills microbes.

**➤ Skills****(Initiating and Planning)**

*Student will:*

- Rationalize the inflammatory response in arthritis as an example of a misdirected immune response.
- Justify why the physicians prescribe antipyretic drugs, when fever is a nonspecific defense against microbial infections.

**3- Third Line of Defense (The Specific Defenses)****➤ Understanding**

*Student will:*

- Categorize the immune system that provides specific defense and acts as the most powerful means of resisting infection.

- Identify monocytes, T-cells and B-cells as the components of the immune system.
- State the inborn and acquired immunity as the two basic types of immunity.
- Differentiate the two types of acquired immunity (active and passive immunity).
- Identify the process of vaccination as a means to develop active acquired immunity.
- Describe the roles T-cells in cell-mediated immunity.
- Describe the role of B-cells in antibody-mediated immunity.
- Draw the structural model of an antibody molecule.
- Explain the role of memory cells in long-term immunity.
- Define allergies and correlate the symptoms of allergies with the release of histamines.
- Describe the autoimmune diseases.
- Describe the role of T-cells and B-cells in transplant rejections.

### ➤ Skills

#### (Initiating and Planning)

*Student will:*

- Justify why physicians prescribe antihistamine therapy to the patients of runny nose or skin rashes.
- Explain why a transplant recipient is given immune suppressant drugs and determine what implications does this have on his life.

#### (Analyzing and Interpreting)

*Student will:*

- Recognize phagocytes and lymphocytes under the light microscope.

### ➤ STS Connections

*Student will:*

- Describe malignant melanoma as due to the inability of tumor-infiltrating lymphocyte (TIL) to control the tumors of skin cancer and correlate it with the scientific advancements of inserting a gene of tumor necrosis factor in the lymphocyte.
- Describe the discovery of monoclonal antibodies and justify how this accomplishment revolutionized many aspects of biological research.



# RESPIRATION

16 Periods

## Overview:

The theme of this chapter is to explain the respiratory system of humans and important respiratory disorders. The chapter also discusses the important health issue associated with the hazardous effects of smoking. The chapter also sheds some light on environmental issues like pollution and carbon mono oxide poisoning. Following concepts are developed in this chapter;

- Respiratory System of Man (07 Periods)
- Mechanism of Transport of Gases (04 Periods)
- Respiratory Disorders (05 Periods)

## Conceptual Linkages:

This chapter is built on;

- Gaseous Exchange (Grade IX-X)

## MAJOR CONCEPTS AND LEARNING OUTCOMES

### 1- Respiratory System of Man

#### ➤ Understanding

*Student will:*

- Define the respiratory surface and list its properties
- Describe the main structural features and functions of the components of human respiratory system.
- Describe the ventilation mechanism in humans.
- State lung volumes and capacities.
- Explain how breathing is controlled.

#### ➤ Skills

#### (Analyzing and Interpreting)

*Student will:*

- Draw and label a diagram to illustrate the microscopic structure of human lung with the help of slides.
- Trace the path of air through different parts of human respiratory system.

#### (Analyzing and Interpreting)

*Student will:*

- Identify different parts of the respiratory system of a dissected frog (dissection would be done by the teacher).
- Examine some sheep lungs obtained from butchers' shop.

### 2- Mechanism of Transport of Gases

#### ➤ Understanding

*Student will:*

- Describe the transport of oxygen and carbon dioxide through blood.
- Describe the role of respiratory pigments.

### 3- Respiratory Disorders

#### ➤ Understanding

*Student will:*

- State the causes, symptoms and treatment of upper Respiratory Tract Infections (sinusitis, otitis media) and lower Respiratory Tract Infections (pneumonia, pulmonary tuberculosis).
- Describe the disorders of lungs (emphysema and lung cancer).
- List the effects of smoking on respiratory system.

### ➤ Skills

#### (Analyzing and Interpreting)

*Student will:*

- Compare and interpret the X-ray films of lungs of a smoker with that of a healthy man.

### ➤ STS Connections

*Student will:*

- Describe the development and working of artificial breathing apparatus (for use under water and at high altitude and by firemen).
- Justify why birds perform much better than man at high altitude.
- Describe the purpose of Mouth to Mouth method for artificial respiration in First Aid.
- Relate the transportation of gases to hiccups, sneezing and snoring.
- Describe the carbon monoxide poisoning (caused by gas heaters left on overnight in closed environments).



Result.pk

# HOMEOSTASIS

10 Periods

## Overview:

In this chapter we will see many delicate interacting and highly coordinated mechanisms that keep the body's internal environment within the extremely precise limits critical to life. Major concepts are as follows.

- Homeostasis (01 Periods)
- Osmoregulation (01 Period)
- Excretion (01 Period)
- Excretory system of Man (03 Periods)
- Disorders of Urinary Tract (03 Periods)
- Thermoregulation (01 Period)

### Conceptual Linkages:

This chapter is built on;

- Homeostasis (Grade IX –X)

## MAJOR CONCEPTS AND LEARNING OUTCOMES

### 1- Homeostasis

#### ➤ Understanding

*Student will:*

- Describe three elements i.e. receptors, control center and effectors which operate homeostatic mechanisms.
- Relate the homeostatic mechanisms with the negative and positive feedback systems.

#### ➤ Skills

##### (Initiating and Planning)

*Student will:*

- Investigate why positive feedback mechanisms in humans are sometimes associated with severe health problems.
- List some of the behavioral responses of the animals to maintain homeostasis.

##### (Interpreting and Communicating)

*Student will:*

- Draw a flow chart to show negative feedback of homeostatic mechanisms by taking an example of hormone.

### 2- Osmoregulation

#### ➤ Understanding

*Student will:*

- Differentiate between osmoconformers and osmoregulators.
- Define osmoregulation.
- Explain the problems faced by osmoregulators.
- Explain the different methods of osmoregulation found in freshwater, marine water and terrestrial habitats.

### 3- Excretion

#### ➤ Understanding

*Student will:*

- List various nitrogenous compounds excreted during the process of excretion.
- Explain the nature of excretory products in relation to habitat.

#### 4- Excretory System of Man

##### ➤ Understanding

*Student will:*

- Explain different organs of urinary system. Describe the structure of kidney and relate it with its function.
- Explain the detailed structure of nephron.
- Explain the processes of glomerular filtration, selective re-absorption and tubular secretion as the events in kidney functioning.
- Explain that concentration of urine is regulated by counter-current and hormonal mechanisms.
- Justify the functioning of kidneys as both excretion and osmoregulation.
- Compare the function of two major capillary beds in kidneys i.e. glomerular capillaries and peritubular capillaries.

#### 5- Disorders of Urinary Tract

##### ➤ Understanding

*Student will:*

- List urinary tract infections and the bacteria responsible.
- Explain the causes and treatments of kidney stones.
- Outline the causes of kidney failure.
- Explain in detail the mechanism and problems related to dialysis.
- Describe the principles and the problems associated with kidney transplant.

##### ➤ Skills

##### (Initiating and Planning)

*Student will:*

- Hypothesize kidney stone by studying the urine test of relevant patients.

#### 6- Thermoregulation

##### ➤ Understanding

*Student will:*

- Define thermoregulation and explain its needs.
- Classify animals on the basis of the source of body's heat i.e. ectotherms and endotherms.
- Classify the animals on the bases of the ability to thermoregulate i.e. poikilotherms and homeotherms.
- Describe the regulatory strategies in man for thermoregulation.

##### ➤ STS Connections

*Student will:*

- Describe the importance of kidney donation for the benefit of kidney failure patients.
- Name the important kidney transplant centers in his / her province.





**SUPPORT AND MOVEMENT**

12 Periods

**Overview:**

The theme of this chapter is to describe how muscles and skeleton support and move the body and to explain disorders of human skeletal and muscles. The knowledge of this chapter will help the student to ponder over the physics and dynamics of our skeleton and its ancillaries. Following concepts are developed in this chapter;

- Human Skeleton (05 Periods)
- Disorders of Skeleton (02 Periods)
- Muscles (05 Periods)

**Conceptual Linkages:**

This chapter is built on;

- Support and movement (Grade IX-X)

**MAJOR CONCEPTS AND LEARNING OUTCOMES****1- Human Skeleton****➤ Understanding**

*Student will:*

- Describe the structure of bone and compare it with that of cartilage.
- Explain the functions of osteoblasts, osteoclasts and osteocytes.
- Identify the main divisions of human skeleton.
- List the bones of appendicular and axial skeleton of man.
- Describe three types of joints i.e. fibrous joints, cartilaginous joints and synovial joints and give example of each.

**➤ Skills****(Initiating and Planning)**

*Student will:*

- Relate the bipedal posture of man with his skeleton and musculature.

**(Analyzing and Interpreting)**

- Identify the bones of the pelvic girdles, pectoral girdle, arms and legs by using the model of human skeleton.

**2- Disorders of Skeleton****➤ Understanding**

*Student will:*

- Describe the disorders of human skeleton (disc-slip, spondylosis, sciatica, arthritis) and their causes.
- State different types of fractures (simple, compound and complicated) and describe the repair process of simple fractures.
- Describe the injuries in joints (dislocation and sprain) and their first aid treatment.
- Describe the first-aid treatment for fracture.

**3- Muscles****➤ Understanding**

*Student will:*

- Compare smooth muscles, cardiac muscles and skeletal muscles.
- Explain the ultra-structure of the skeletal muscle.
- Explain the sliding filaments model of muscle contraction.
- Describe the action of antagonistic muscles in the movement of knee joint.

- Explain muscle fatigue, cramps and tetany.
- Differentiate between tetanus and muscle tetany.

### ➤ Skills

#### (Analyzing and Interpreting)

*Student will:*

- Compare the structure of skeletal, smooth and cardiac muscles with the help of prepared slides
- Draw a diagram of sarcomere and label its parts.
- Justify how the main functions of the skeleton are to act as a system of rods and levers, which are moved by the muscles.
- Justify why do the muscles pull but do not push.

### ➤ STS Connections

*Student will:*

- Name the techniques for joint transplantation.
- Justify why the use of calcium in teenage and twenties can be a preventive action against osteoporosis.
- Reason out the rigor mortis.
- Relate improper posture to bone/joint problems.



Result.pk

# NERVOUS COORDINATION

13 Periods

## Overview:

The topic of coordination and control is built upon the basics of nervous and hormonal coordination dealt with earlier at level IX-X. This topic emphasizes the electrochemical reception of stimuli to adjust the internal environment of an organism within narrow limits for homeostasis. The following concepts are developed in this chapter:

- Nervous System of Man (06 Periods)
  - Steps involved in Nervous Coordination
  - Neurons
  - Nerve Impulse
  - Transmission of Action Potential between cells – Synapse
  - Basic Organization of human Nervous System and Sensory Receptors
- Effects of drugs on Nervous Coordination (02 Periods)
- Disorders of Nervous System and Diagnostic tests (05 Periods)

### Conceptual Linkages:

This chapter is built on;

- Coordination and Control (Grade IX-X)

## MAJOR CONCEPTS AND LEARNING OUTCOMES

### Nervous System of Man

#### 1- Steps Involved in Nervous Coordination

#### ➤ Understanding

*Student will:*

- Recognize receptors as transducers sensitive to various stimuli.
- Trace the path of a message transmitted to the CNS for processing.
- Identify the three neurons (sensory, intermediate, motor) involved in nervous transmission.
- Identify muscles and glands as the effectors.

#### ➤ Skills

**(Initiating and Planning)**

*Student will:*

- Predict from every day experience what various kinds of receptor can be found in human body.

#### 2- Neurons

#### ➤ Understanding

*Student will:*

- Describe the detailed structure of a sensory neuron, associative and a motor neuron and relate the specialization in structures with functions.
- Differentiate between myelinated and non-myelinated neurons.
- Explain the function of the three types of neurons with the help of a reflex arc.

#### ➤ Skills

**(Interpreting and Communication)**

*Student will:*

- Draw and label the structure of three kinds of neuron.

### 3- Nerve Impulse

#### ➤ Understanding

*Student will:*

- Define nerve impulse.
- Describe the generation and transmission of nerve impulse.
- Name the factors responsible for the resting membrane potential of neuron.
- Evaluate from a graph the phenomena of polarization, depolarization and hyperpolarisation of membrane.
- Compare the velocities of nerve impulse in the axon membrane and in the synaptic cleft.
- Describe the role of local circuits in saltatory conduction of nerve impulse.

### 4- Synapse

#### ➤ Understanding

*Student will:*

- Describe the structure of synapse.
- Explain synaptic transmission of nerve impulse.
- Classify neurotransmitters as inhibitory and excitatory and list some common examples.

### 5- Basic Organization of Human Nervous System

#### ➤ Understanding

*Student will:*

- Identify the main components of the nervous system.
- Explain briefly the functions of major divisions of brain.
- Describe the architecture of human brain and compare its sectional view with that of the spinal cord.
- Describe cranial and spinal nerves in man.
- Explain the structure, types and functions of autonomic nervous system.
- Explain the structure and functioning of the receptors for smell, taste and touch / pain.

#### ➤ Skills

**(Interpreting and Communication)**

*Student will:*

- Draw a labeled diagram of the human brain.
- Identify different components in the diagram of CNS and PNS.

### 6- Effect of Drugs on Nervous Coordination

#### ➤ Understanding

*Student will:*

- Define narcotic drugs as agents that interact with the normal nervous activity.
- Compare the use and abuse of drugs with respect to heroine, *Cannabis*, nicotine, alcohol and inhalants like nail polish remover and glue.
- Define and explain the terms; drug addiction and drug tolerance with reference to caffeine and nicotine.
- Associate the effects of drug addiction and tolerance with the functioning of nervous system.
- Describe withdrawal symptoms of alcohol.

### 7- Disorders of Nervous System and Diagnostic Tests

#### ➤ Understanding

*Student will:*

- Classify nervous disorders into vascular, infectious, structural, functional and degenerative disorders.

- Describe the causes, symptoms and treatment one type of each category of disorders outlined above. (e.g., stroke as vascular, meningitis as infectious, brain tumor as structural, headache as functional, and Alzheimer disease as degenerative disorder).
- Explain the principles of the important diagnostic tests for nervous disorders i.e. EEG, CT scan and MRI.

### ➤ Skills

#### (Interpreting and Communication)

*Student will:*

- Conceptualize the activity of brain as an electrical activity, which can be recorded using magnets and tomography.
- Compare the MRI scan of the brain of a sleeping human with that of a fully awake individual.

### ➤ STS Connections

*Student will:*

- Justify the way nervous system helps to coordinate complex and intricate movements of hand to play a piano, or write alphabets.
- Ascertain the effect of nerve gas as an inhibitor of acetylcholinesterase.
- Justify that the development of a modern computer is in fact a product of the understanding of the way nervous coordination occurs in complex organisms like humans.
- Describe how this knowledge has helped humans to treat diseases like epilepsy, paralysis.



Result.pk

# CHEMICAL COORDINATION

05 Periods

## Overview:

The topic of chemical coordination is built upon the basics of hormonal coordination dealt with earlier at level IX-X. This topic emphasizes the chemical reception of stimuli to adjust the internal environment of an organism within narrow limits for homeostasis.

The following concepts are developed in this chapter:

- Hormones – The Chemical Messengers (01 Period)
- Endocrine system of Man (03 Periods)
- Feedback Mechanism (01 Period)

## Conceptual Linkages:

This chapter is built on;

- Coordination and Control (Grade IX-X)

## MAJOR CONCEPTS AND LEARNING OUTCOMES

### 1- Hormones- The Chemical Messengers

#### ➤ Understanding

*Student will:*

- State the role of hormones as chemical messengers.
- Describe the chemical nature of hormones and correlate it with important hormones.
- Trace the path of the chemical message from its release from the endocrine gland to its action at the target site.
- Explain the two modes of hormone action at the cells of target site.

### 2- The Endocrine System of Man

#### ➤ Understanding

*Student will:*

- Locate the following endocrine glands in human body; pituitary, thyroid, parathyroid, pancreas, adrenal, gonads.
- Name the hormonal secretions of the above-mentioned glands.
- Outline the major functions of the hormones of above mentioned glands and also relate the problems associated with the imbalance of these hormones.
- Explain the neurosecretory role of hypothalamus.
- Describe the functions of the hormones secreted by the endocrine tissue other than the mentioned above.

#### ➤ Skills

**(Interpreting and Communication)**

*Student will:*

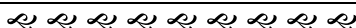
- State the role of artificially synthesized steroids in sports and their long-term effects on its users.
- Explain on what grounds some companies claim that growth is possible in people having short heights.

### 3- Feedback Mechanism

#### ➤ Understanding

*Student will:*

- Outline the concept of Feedback mechanism of hormones.
- Describe positive feedback with reference to Oxytocin and negative feedback with reference to Insulin and Glucagon.



**BEHAVIOR**

11 Periods

**Overview:**

The goal of this chapter is to get the students understand the nature of behavior and distinguish between innate behavior and learning. The development and objectives of the social behaviors in different animals will also be the subjects of this chapter. The major concepts in this chapter are;

- The Nature of Behavior (02 Periods)
- Innate Behavior (04 Periods)
- Learning (03 Periods)
- Social Behavior (02 Periods)

**Conceptual Linkages:**

This chapter is built on;

- Reproduction (Grade XI-XII)
- Mammals (Grade XI-XII)

**MAJOR CONCEPTS AND LEARNING OUTCOMES****1- The Nature of Behavior****➤ Understanding**

*Student will:*

- Define behavior as the series of activities performed by an organism in response to stimuli.
- Explain relationship between stimuli and behavior.
- Describe the relationship between heredity and behavior.
- Explain, through examples, the biological rhythms.

**2- Innate Behavior****➤ Understanding**

*Student will:*

- Define innate (inborn) behavior.
- Describe examples of innate behavior in terms of taxis shown by unicellular organisms and tropism shown by plants.
- Justify reflexes as a type of innate behavior, by giving examples from man and invertebrates.
- Define instincts and justify these as a type of innate behavior.
- Justify the fact that each species displays its own characteristic instinctive behavior through following examples; migration of salmon, dances of bees, construction of hanging nest by birds, construction of intricate web by spider and mating behavior of stickleback fish.

**➤ Skills****(Analyzing and Interpreting)**

*Student will:*

- Give examples to interpret that hormones and brain control instincts.

**(Performing and Recording)**

*Student will:*

- Observe a spider's web and record the instincts by providing it various stimuli.

**3- Learning****➤ Understanding**

*Student will:*

- Define learning and distinguish between learning and innate behavior.
- Define habituation and illustrate it through the example of squirrels' adjustment in a park.
- Explain imprinting by narrating the work of Lorenz.
- Differentiate habituation and imprinting as reversible and irreversible learned behaviors.

- Describe classical conditioning by narrating the work of Pavlov on salivary reflex in dogs.
- Describe instrumental conditioning (trial-and-error learning) by narrating the work of Skinner on rats' learning.
- Describe latent learning, through the example of a rat in a maze with no reward.
- Interpret Kohler's work on chimpanzee's insight learning to justify that reasoning and planning are involved in the insight learning.

#### ➤ Skills

#### (Analyzing and Interpreting)

*Student will:*

- Relate different examples of learning behaviors of human with habituation, conditioning, latent learning and insight learning.

### 4- Social Behavior

#### ➤ Understanding

*Student will:*

- Differentiate between animal aggregations and animal societies.
- Describe social behavior in terms of hostile and helpful interactions between animals belonging to the same species.
- Describe agonistic behavior and relate it with the maintenance of social order in terms of territories and dominance hierarchies.
- Explain territorial behavior by quoting example of the territories of monkeys and gorillas.
- Explain dominance hierarchy by quoting example of the pecking order of chicken.
- Define altruism and illustrate it through the organization of a honeybee society.

#### ➤ STS Connections

*Student will:*

- State the role of research in neurobiology in the understanding of behavior.
- Rationalize why the marine snail, *Aplysia*, has proved very helpful in the studies of neurobiology and of behavior patterns.





Result.pk

SECTION 4:

# CONTINUITY IN LIFE

# REPRODUCTION

09 Periods

## Overview:

Students already have a generalized overview of the concept of reproduction. At this stage students will learn about the human reproductive system in more detail. They will also study about the sexually transmitted diseases and their control. The major concepts are as follows. The major concepts in this chapter are;

- Reproductive system of Man (06 Periods)
- Disorders of Reproductive System (02 Periods)
- Sexually Transmitted Disease (01 Period)

## Conceptual Linkages:

This chapter is built on;

- Reproduction (Grade IX-X)

This chapter leads to;

- Evolution (Grade XI-XII)

## MAJOR CONCEPTS AND LEARNING OUTCOMES

### 1- Reproductive System of Man

#### ➤ Understanding

*Student will:*

- Describe the structures of male reproductive system identifying their functions.
- Explain the principal reproductive hormones of human male and explain their role in the maintenance and functioning of reproductive system.
- Explain the structures of female reproductive system and describe their functions.
- Describe the menstrual cycle emphasizing the role of hormones.

#### ➤ Skills

#### (Initiating and Planning)

*Student will:*

- Examine the prepared slides of histology of ovaries and draw its microscopic structures.
- Expose the reproductive system of a dissected frog (dissection would be done by the teacher).

### 2- Disorders of Reproductive System

#### ➤ Understanding

*Student will:*

- Describe the causes of female and male infertility.
- Explain that in-vitro fertilization (test tube babies) is one of the methods to solve the problem of infertility.
- Define miscarriage and state its causes.
- Relate miscarriage with abortion.

### 3- Sexually Transmitted Diseases

#### ➤ Understanding

*Student will:*

- Describe the causes, symptoms and treatment of gonorrhea and syphilis.
- Explain AIDS as a worldwide sexually transmitted disease.

### ➤ STS Connections

*Student will:*

- Realize the affect of endocrine disrupting contaminants on the reproductive abilities.
- Become aware of the ethical implications of abortion.
- List the measures that can help to prevent transmission of HIV.



Result.pk

# DEVELOPMENT AND AGING

20 Periods

## Overview:

This chapter aims at the learning of basic concepts about human development. There would be a brief learning of the concept of aging. The major concepts in this chapter are;

- Embryonic Development (08 Periods)
- Control of Development (03 Periods)
- Human Embryonic Development (03 Periods)
- Birth and Nursing (02 Periods)
- Disorders during Embryonic Development (01 Period)
- Postnatal Development (01 Period)
- Aging (02 Periods)

### Conceptual Linkages:

This chapter is built on;

- Reproduction (Grade XI-XII)
- Mammals (Grade XI-XII)

## MAJOR CONCEPTS AND LEARNING OUTCOMES

### 1- Embryonic Development

#### ➤ Understanding

*Student will:*

- Describe cleavage and relate it with amount of yolk.
- Explain the events of gastrulation.
- List the tissues and organs formed from the three germ layers.
- State the events of neurulation.
- Describe the formation of neural crest and list the structures that are derived from neural crest cells.
- Define organogenesis.

#### ➤ Skills

**(Analyzing and Interpreting)**

*Student will:*

- Identify the group of vertebrates, through diagrams of different blastula.
- Identify the different stages in chick development through observation of prepared slides.

### 2- Control of Development

#### ➤ Understanding

*Student will:*

- Through experimental narration, describe the role of the nucleus and cytoplasm in controlling development.
- Give a brief overview of the work done by Hans Spemann in the discovery of induction.
- Define organizers and differentiate between primary and secondary induction.

### 3- Human Embryonic Development

#### ➤ Understanding

*Student will:*

- Describe the events of development in human in terms of first, second and third trimesters.
- Describe in brief the development of twins and quadruplets.
- Describe the structural details of placenta and umbilical cord.
- Differentiate the terms gestation and pregnancy.

### ➤ Skills

#### (Initiating and Planning)

*Student will:*

- Explain why proper nourishment of the mother is imperative during the third trimester of pregnancy.

#### (Communication)

*Student will:*

- Draw a table to list the events of human development in the first trimester (first, second and third month), second trimester and third trimester.

## 4- Birth and Nursing

### ➤ Understanding

*Student will:*

- Describe the role of fetal and maternal hormones in initiating labor pains and culminating in the birth of baby.
- Define the term premature birth and correlate it with the growth phases in the second and third trimesters.
- Define afterbirth and describe how umbilical cord is detached from the baby.
- Define colostrum and describe the role of prolactin in the production and of oxytocin in the secretion of milk.
- State the hormonal regulation in the end of milk production.
- Compare breast-feeding and bottle-feeding, in terms of advantages and disadvantages.

### ➤ Skills

#### (Initiating and Planning)

*Student will:*

- When oxytocin is involved in the secretion of milk, hypothesize why new mothers often experience cramps in uterus while nursing.

## 5- Disorders during Embryonic Development

### ➤ Understanding

*Student will:*

- Describe the maternal derived abnormalities (rubella, abnormal neural tube, thyroid gland and limb development).
- Relate the major genetic abnormalities in embryos with spontaneous abortion.
- Describe how fetal surgery helps to correct the detected fetal developmental problems.

## 5- Postnatal Development

### ➤ Understanding

*Student will:*

- Define the term allometric growth and correlate it with the postnatal development in human.

### ➤ Skills

#### (Analyzing and Interpreting)

*Student will:*

- Using the knowledge about the postnatal growth rates of brain and jaws; interpret why a six-month old baby has the same jaw-skull proportions as it had at the time of birth.

## 7- Aging

### ➤ Understanding

*Student will:*

- Define the term aging.
- Rationalize aging as a part of normal development.
- List the genetic and extrinsic factors responsible for aging.
- State the changes (graying, thinning hair, pigmented patches of skin, slowed movements, fading vision, impaired hearing, reduced ability to adapt to stress and decreased resistance to infections) as primary aging.
- State the changes that are the result of environmental, lifestyle factors such as disease, disuse (lack of exercise), and abuse (smoking, obesity, malnutrition, and exposure to ultra-violet light) as secondary aging.
- List some changes that occur at the system and those that occur at cellular level during aging.

### ➤ STS Connections

*Student will:*

- Describe how a blastula is divided into two (by using micromanipulator) to produce twins of animals for biological research.
- Rationalize that nursing is an important bonding time between mother and child, as it provides the child with protection by mother's immune system while its own develops.
- List some of the diseases due to aging and what medical science is doing to treat those diseases.

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Result.pk

# INHERITANCE

21 Periods

## Overview:

This topic is built upon Mendelian genetics and carries the concept forward to post-mendelian research. It also gives an insight into the inherited diseases and their subsequent symptoms and treatment. The following concepts are developed in this chapter:

- Law of Independent Assortment (02 Periods)
- Incomplete Dominance, Multiple Alleles and Co-dominance (02 Periods)
- ABO Blood Group System (02 Periods)
- Rh Blood Group System and Erythroblastosis foetalis (03 Periods)
- Polygenic Inheritance and Epistasis (02 Periods)
- Gene Linkage and Crossing Over (03 Periods)
- Sex Determination (02 Periods)
- Sex Linkage (05 Periods)

## Conceptual Linkages:

This chapter is built on;

- Cell and cell division (Grade IX-X)
- Biological molecules (Grade IX-X)
- Inheritance (Grade IX-X)
- Chromosomes and DNA (Grade IX-X)

This chapter leads to;

- Biotechnology (Grade XI-XII)
- Evolution (Grade XI-XII)

## MAJOR CONCEPTS AND LEARNING OUTCOMES

### 1- Law of Independent Assortment

#### ➤ Understanding

*Student will:*

- Associate inheritance with the laws of Mendel.
- Explain the law of independent assortment, using a suitable example.
- Express limitations in the law and its usefulness.
- State the scope of independent assortment in variation.
- Evaluate that inheritance of genes and their mixing during fertilization is based on mathematical probabilities.

#### ➤ Skills

##### (Initiating and Planning)

*Student will:*

- Hypothesize that in a dihybrid inheritance pattern of color and texture of pea seed, the two traits are not inter dependent.

##### (Performing and Recording)

*Student will:*

- Solve at least 4 genetic problems, to illustrate the law of independent assortment.
- Evaluate Mendel's likelihood of being baffled by results that would not have conformed to the 9:3:3:1 phenotypic ratio of F<sub>2</sub> self cross.
- Use the dice to calculate how many times out of 100 throws can you get sixes.

## 2- Incomplete Dominance, Multiple Alleles and Co-dominance

### ➤ Understanding

Student will:

- Describe the exceptions to the Mendel's laws of inheritance.
- Explain incomplete dominance and exemplify it through the inheritance of flower color in 4 O' clock plant.
- Differentiate between incomplete dominance and co-dominance.
- Describe multiple alleles and state the alleles responsible for the trait of ABO blood groups.
- Explain the case where two alleles have equal dominance and through the genetics of human blood group of AB.

### ➤ Skills

#### (Analyzing and Interpreting)

Student will:

- Collect data from the class or the school to see how many individuals have AB blood group and construct a pie chart and histogram for the collected data.

## 3- ABO Blood Group System

### ➤ Understanding

Student will:

- Name the various human blood group systems.
- Associate multiple alleles with the ABO blood group system.
- Investigate the reasons for O-ve individual as the Universal donor and AB +ve as the Universal recipient.
- Describe the occurrence of some other blood group systems.

### ➤ Skills

#### (Interpreting and Recording)

- Build a thematic chart for the blood groups of his/her class fellows and identify the antigens present in blood.
- Test his / her blood group using Antisera and explain which antigens and antibodies s/he has.
- Assess, based on the findings of his/ her blood test, which blood group s/he can accept or donate for transfusion.

## 4- Rh Blood Group System and *Erythroblastosis foetalis*

### ➤ Understanding

Student will:

- Associate the positive and negative blood groups with the presence and absence of Rh factor.
- Justify why Rh incompatibility could be a danger to the developing foetus and mother.
- Explain *Erythroblastosis foetalis* in the light of antigen-antibody reaction.
- Suggest measures to counter the problem of *Erythroblastosis foetalis* before it occurs.

### ➤ Skills

#### (Performing and Recording)

Student will:

- Carry out an agglutination reaction for Rh factor.

## 5- Polygenic Inheritance and Epistasis

### ➤ Understanding

Student will:

- Explain the terms; polygenic and epistasis.
- Describe polygenic inheritance, using suitable examples from plants (grain color in wheat) and animals (skin color in man).



- List at least five polygenic traits discovered in humans.
- Relate polygenic inheritance with epistasis.
- Give one example of epistasis from mammals (coat color inheritance in Labrador retrievers) and one from plants (pigment phenotype in foxgloves) and justify modified Mendelian ratios.

## 6- Gene Linkage and Crossing Over

### ➤ Understanding

Student will:

- Describe the terms gene linkage and crossing over.
- Explain how gene linkage counters independent assortment and crossing-over modifies the progeny.
- Exemplify the concept of gene linkage by quoting the example of wing length and width of abdomen in *Drosophila melanogaster*.
- Suggest why linkage could be observed / evaluated only if the number of progeny is quite large.

### ➤ Skills

#### (Interpreting and Recording)

Student will:

- Evaluate mathematically the ratio of linkage in the progeny.

## 7- Sex Determination

### ➤ Understanding

Student will:

- Explain the XX-XY mechanism of sex determination in *Drosophila* and mammals.
- Describe the XX-XO and ZZ-ZW sex determination systems and evaluate by studying the karyotype.
- Identify the difference between homogametic and heterogametic conditions in the karyotype of male and female humans.
- Identify male and female individuals from the karyotype of *Drosophila* and man.
- Solve the genetics problems related to XX-XY, XX-XO and ZZ-ZW sex determination.

### ➤ Skills

#### (Interpreting and Recording)

Student will:

- Trace the karyotype of a human being to observe and count the number and shape of chromosomes.
- Differentiate between autosomes and sex chromosomes from the karyotype.

## 8- Sex Linkage

### ➤ Understanding

Student will:

- Describe the concept of sex-linkage.
- Explain the inheritance of sex-linked traits (eye color) in *Drosophila*.
- Describe the sex-linked inheritance of male characters due to Y-chromosome and the effect of holandric genes.
- Describe sex-influenced and sex-limited traits with common examples from human genetics.
- Describe the X-linked disorders with reference to the patterns of inheritance.
- Name some of the sex-linked disorders of man and *drosophila*.
- Critically analyze the inheritance of Haemophilia, colour blindness and muscular dystrophy.

### ➤ STS Connections

*Student will:*

- Evaluate incomplete and co-dominance as variations of Mendel's research.
- Derive an idea to get alternatives of blood transfusion. (reference could be made to synthesized plasma and serum).
- Justify why a recessive blood group allele of 'i' is more frequent in population.
- Justify blood donation as a service to suffering humanity.
- Name and explain the techniques employed for embryonic screening e.g., Amniocentesis.
- Suggest ways to save lives through the knowledge gained in this chapter.
- Describe how the field of genetics has progressed to a more applied science.
- Justify the effectiveness of some of the treatments of haemophilia.



Result.pk

# CHROMOSOME AND DNA

15 Periods

**Overview:**

This chapter aims the detailed study of molecular genetics. The metabolic processes involved in gene expression and regulation would be catered in it. The major concepts in this chapter are;

- Chromosomal Theory of Inheritance (03 Periods)
- DNA as the Hereditary Material (02 Periods)
- DNA Replication (02 Periods)
- Gene Expression (04 Periods)
- Regulating Gene Expression (02 Periods)
- Mutation (02 Periods)

**Conceptual Linkages:**

This chapter is built on;

- Cell and cell division (Grade IX-X)
- Chromosomes and DNA (Grade IX-X)
- Biological Molecules (Grade XI-XII)

This chapter leads to;

- Biotechnology (Grade XI-XII)
- Evolution (Grade XI-XII)

## MAJOR CONCEPTS AND LEARNING OUTCOMES

### 1- Chromosomal Theory of Inheritance

#### ➤ Understanding

*Student will:*

- Critically analyze the history of chromosomal theory with reference to Correns' work.
- Critically analyze the experiments of T. H. Morgan in support of the above-mentioned theory.
- Annotate the detailed structure of a chromosome.
- Describe the concept of gene and gene locus.
- Explain the concept of alleles as the alternative forms of a gene.

### 2- DNA as the Hereditary Material

#### ➤ Understanding

*Student will:*

- Narrate the experimental work of Griffith and Hershey-Chase, which proved that DNA is the hereditary material.

#### ➤ Skills

**(Analyzing and Interpreting)**

*Student will:*

- Interpret an experiment in which a radio-isotope labeled DNA can be traced in the progeny of an organism.

### 3- DNA Replication

#### ➤ Understanding

*Student will:*

- Describe the three models proposed about the mechanism of DNA replication.
- Narrate the work of Meselson and Stahl to justify the semi-conservative replication as the correct method of replication.
- Describe the events of the process of DNA replication.
- Explain DNA stability and variability as two characters of the replicating DNA molecule.

### ➤ Skills

#### (Analyzing and Interpreting)

Student will:

- Interpret how DNA conserves one strand, during replication.

## 4- Gene Expression

### ➤ Understanding

Student will:

- Describe the central dogma of gene expression.
- Define gene and genetic code.
- Describe the characteristics of genetic code (universal, triplet, non-overlapping, degenerate, punctuated).
- Differentiate between the terms genetic code and codon.
- Explain the mechanism of transcription.
- Explain why the length of transcribed m-RNA molecule (in Eukaryotes) shortens as it enters the cytoplasm for translation.
- Describe the mechanism of protein synthesis.
- State the difference between protein synthesis in prokaryotes and eukaryotes.
- Suggest possible ways in which the synthesized protein can be used within or outside a cell that synthesized it.

### ➤ Skills

#### (Initiating and Planning)

Student will:

- Make a list of all the proteins that have been studied or referred to till now.
- Interpret how many types of t-RNA molecules are necessary for a living cell, if the genetic code is a triplet code.

## 5- Regulating Gene Expression

### ➤ Understanding

Student will:

- State the importance of the regulation of gene expression.
- Describe the negative control of gene expression by repressor proteins.
- Describe the positive control of gene expression by activator proteins.
- Relate gene expression with introns and exons.

## 6- Mutation

### ➤ Understanding

Student will:

- Define mutation and identify various sources of mutation.
- Differentiate between natural and induced mutations and mutagens.
- Justify that most mutations are harmful.
- Rationalize that mutations might be a contributing factor towards evolution.
- Describe the symptoms, causes and possible available treatments of some of the chromosomal mutations. (Down's, Klinefelter's and Turner's syndrome)
- Describe the symptoms, causes and possible available treatments of some of the gene mutations. (Sickle cell anemia, Phenylketonuria)

### ➤ Skills

#### (Initiating and Planning)

Student will:

- Make a list of some commonly occurring minor mutations in humans.
- Justify why mutations prevail in a population and are inherited.

### ➤ STS Connections

*Student will:*

- Describe the paradoxical nature of DNA, as a tool for geneticists and forensics.
- Describe how various scientists in the field of biotechnology or genetic engineering have used DNA replication.
- Suggest possible ways to save lives or treat genetic diseases (like diabetes) through the knowledge gained under this heading.
- Explain how harmful mutations have been eradicated by nature.



Result.pk

# EVOLUTION

13 Periods

## Overview:

The aim of this chapter is to enable the learners to analyze evolutionary mechanisms, and the processes and products of evolution. They would also be able to evaluate the scientific evidence that supports the theory of evolution. The major concepts in this chapter are;

- The Evolution of the concepts of Evolution (01 Period)
- Evidences of Evolution (03 Periods)
- Evolution of Eukaryotes from Prokaryotes (01 Period)
- Lamarckism (02 Periods)
- Darwinism (03 Periods)
- Neo-Darwinism (03 Periods)

## Conceptual Linkages:

This chapter is built on;

- Biodiversity (Grade IX-X)
- Chromosomes and DNA (Grade XI-XII)
- Inheritance (Grade XI-XII)

## MAJOR CONCEPTS AND LEARNING OUTCOMES

### 1- The Evolution of the Concepts of Evolution

#### ➤ Understanding

*Student will:*

- Describe creationism and the theory of evolution as two contradictory ideas.
- Relate Quranic injunctions to the process of the evolution of man.

### 2- Evidences of Evolution

#### ➤ Understanding

*Student will:*

- Explain how biogeography provides an evidence for evolution.
- Describe the evidences of evolution that come from paleontology, comparative anatomy and molecular biology.
- Differentiate between convergent and divergent evolution on the basis of inheritance of the homologous and analogous structures.

#### ➤ Skills

#### (Initiating and Planning)

*Student will:*

- Identify questions that arise from concepts of evolution and diversity (e.g., What factors have contributed to the dilemma that pharmaceutical companies face in trying to develop new antibiotics because so many micro-organisms are resistant to existing antibiotics?).

#### (Analyzing and Interpreting)

*Student will:*

- Interpret different homologous and analogous structures through observation in plants.

### 3- Evolution of Eukaryotes from Prokaryotes

#### ➤ Understanding

*Student will:*

- Describe the theories that have been put forwarded about the mechanism of evolution of eukaryotes from prokaryotes.

#### 4- Lamarckism

##### ➤ Understanding

*Student will:*

- Justify Lamarck as an early proponent of evolution.
- Describe the theory of inheritance of acquired characters, as proposed by Lamarck.
- Outline the steps of the evolution of the giraffe, as illustrated in Lamarckism.
- State the drawbacks in Lamarckism.

##### ➤ Skills

##### (Initiating and Planning)

*Student will:*

- Hypothesize whether Lamarck was criticized in his day for advocating the ideas of evolution or for the mechanism he proposed.

#### 5- Darwinism

##### ➤ Understanding

*Student will:*

- Briefly describe the observations Darwin made during his voyage on HMS Beagle.
- Explain the theory of natural selection as proposed by Darwin.
- Describe the ideas of Charles Lyell, James Hutton and Thomas Malthus that contributed in the early development of Darwinism.
- Describe the role of Alfred Wallace in motivating Darwin to publish the theory of natural selection.
- Justify, on the grounds that both Wallace's and Darwin's papers were published in the *Journal of the proceedings of the Linnaean Society*, why the theory was attributed to Darwin.

#### 6- Neo-Darwinism

##### ➤ Understanding

*Student will:*

- Describe the assumptions of the Hardy-Weinberg theorem and relate these to the factors that change the allelic frequencies of the population.
- Explain the concept of genetic drift (neutral selection).
- Define the concept of speciation and explain the mechanisms of speciation (allopatric, parapatric and sympatric speciation).

##### ➤ Skills

##### (Analyzing and Interpreting)

*Student will:*

- Solve problems related to gene frequencies using the Hardy-Weinberg equation.

##### ➤ STS Connections

*Student will:*

- List the vestigial structures found in man and categorize them in homologous or analogous structures.
- Describe and analyze examples of technology that have extended or modified the scientific understanding of evolution (e.g., the contribution of radiometric dating to the palaeontological analysis of fossils).



Result.pk

SECTION 5:

# ECOLOGY



# MAN AND HIS ENVIRONMENT

16 Periods

## Overview:

This chapter aims at enhancing the level of understanding about the basic concepts of ecology and enabling the students to be well informed of the activities of the very large and growing human population that is threatening the stability of the ecosystems.

The major concepts in this chapter are;

- Biogeochemical Cycle (02 Periods)
- The Flow of Energy (02 Periods)
- Ecological Succession (02 Periods)
- Population Dynamics (04 Periods)
- Human Impacts on Environment (03 Periods)
- Environmental Resources and their Depletion (03 Periods)

## Conceptual Linkages:

This chapter is built on;

- Man and His Environment (Grade IX-X)

## MAJOR CONCEPTS AND LEARNING OUTCOMES

### 1- Biogeochemical Cycle

#### ➤ Understanding

*Student will:*

- Define biogeochemical cycles and locate the primary reservoirs of the chemicals in these cycles.
- Describe water cycle in detail.
- Define the terms aquifers and water table.
- Describe nitrogen cycle in detail.
- Define the terms of nitrogen-fixation, nitrification, de-nitrification and ammonification.

### 2- The Flow of Energy

#### ➤ Understanding

*Student will:*

- Describe productivity in terms of gross primary productivity and net primary productivity.
- Explain the flow of energy in successive trophic levels.
- Interpret the pyramids of number, biomass and energy.

### 3- Ecological Succession

#### ➤ Understanding

*Student will:*

- Define ecological succession as the process through which ecosystems change from simple to complex.
- Describe primary and secondary succession.
- Differentiate between xerarch and hydrarch succession.
- Explain the xerarch succession on a bare rock starting from the small pockets of lichens to the vegetations of flowering plants.

#### ➤ Skills

#### (Initiating and Planning)

*Student will*

- Justify the fact that humans are often responsible for secondary succession.

#### 4- Population Dynamics

##### ➤ Understanding

*Student will:*

- Describe characteristics of a population, such as growth, density, distribution, carrying capacity, minimum/viable size.
- Explain, using demographic principles, problems related to the rapid growth of human populations and the effects of that growth on future generations (e.g., relate the carrying capacity of the Earth to the growth of populations and their consumption of resources).
- Analyze the role of the department of population welfare, government of Pakistan in controlling the growing population of Pakistan.

##### ➤ Skills

##### (Initiating and Planning)

*Student will:*

- Investigate the effects of human population growth on the environment and the quality of life.

#### 5- Human Impacts on Environment

##### ➤ Understanding

*Student will:*

- Relate the need of the nuclear power to the scarcity of fossil fuels.
- State the problems of using nuclear power (surety of safe operation and safe disposal of the wastes).
- Describe the causes of the increasing concentration of carbon dioxide in the world's atmosphere.
- Correlate the increasing CO<sub>2</sub> concentration with the global warming and describe its long term effects.
- Explain the causes and effects of acid rain.
- Describe the composition of the ozone layer and its role in protecting the life on earth.
- State the sources of chlorofluorocarbons and their role in the depletion of ozone.
- Explain the effects of ultraviolet radiation as a serious human health concern.
- Narrate the incidence when one of the four reactors of the Chernobyl nuclear power plant blew up in 1986.

#### 6- Environmental Resources and their Depletion

##### ➤ Understanding

*Student will:*

- Distinguish between renewable and non-renewable environmental resources.
- Describe how man is responsible for the depletion of environmental resources.
- Describe the conventional and non-conventional energy resources.
- Analyze the efforts of various government departments and NGOs to educate people for the protection of environmental resources.

##### ➤ STS Connections

*Student will:*

- Outline the advances in medical care and technology that have contributed to an increase in life expectancy, and relate these developments to demographic issues.
- Justify why science education has become necessary for everyone to understand the basis of man's continued existence and the steps man has to take to save and improve life.
- Investigate the careers related to the study of environmental resources.



Result.pk

SECTION 6:

APPLICATION OF

BIOLOGY

# BIOTECHNOLOGY

29 Periods

## Overview:

Biotechnology has been projected by many to become as dominant in the present century as electronics, including computers, were in the twenty-first century.

The excitement of this discipline is more than adequately reflected in the popularity of the subject among science students. As a result a large number of institutions in Pakistan have initiated study programs in Biotechnology. This chapter provides knowledge about the basics of Biotechnology. The major concepts in this chapter are;

- Cloning of Genes (06 Periods)
- DNA Sequencing (04 Periods)
- DNA Analysis (01 Period)
- Genomic Maps (02 Periods)
- Tissue Culture (04 Periods)
- Transgenic Bacteria, Plants and Animals (03 Periods)
- Biotechnology and Healthcare (06 Periods)
- Scope and Importance of Biotechnology (03 Periods)

## Conceptual Linkages:

This chapter is built on;

- Biotechnology (Grade IX-X)
- Chromosome and DNA (Grade XI-XII)

## MAJOR CONCEPTS AND LEARNING OUTCOMES

### 1- Cloning of Genes

#### ➤ Understanding

*Student will:*

- Define gene cloning and state the steps in gene cloning.
- Describe the techniques of gene cloning through recombinant DNA technology.
- Explain the role of restriction endonucleases and DNA ligases in gene cloning.
- Describe the selection and isolation of the gene of interest.
- Explain the properties and the role of vectors in recombinant DNA technology.
- State the steps for the integration of DNA insert into the vector.
- Briefly state the technique applied for the selection of the vectors that take up the DNA insert.
- Describe the steps involved in gene amplification through polymerase chain reaction.
- Describe the procedure for the construction of genomic library.

### 2- DNA Sequencing

#### ➤ Understanding

*Student will:*

- Explain the Maxam / Gilbert procedure and the Sanger-Coulson method of DNA sequencing.
- Describe the principles of Gel Electrophoresis as being used in gene sequencing.
- Introduce the automated DNA sequencing as based on the Sanger-Coulson method.

### 3- DNA Analysis

#### ➤ Understanding

*Student will:*

- Describe the purposes and mechanism of DNA analysis.

**➤ Skills****(Analyzing and Interpreting)***Student will:*

- Analyze and interpret the DNA of a child by comparing it with that of two individuals in a case of disputed parenthood.

**4- Genome Maps****➤ Understanding***Student will:*

- Describe the terms of genome analysis, genome map and genetic markers.
- State the history of the human genome project admiring James Watson as its first director.
- Describe the goals of the human genome project.
- Predict some of the possible benefits that can be derived after the completion of the human genome project.

**5- Tissue Culture****➤ Understanding***Student will:*

- Define following terms related to plant tissue culture; explants, callus, micro-propagation, plantlets, somatic embryogenesis, somaclonal variation.
- Explain tissue culture and differentiate between the organ culture and cell culture.
- Differentiate between the callus culture and suspension culture techniques.
- Describe the anther culture, ovary culture, meristem culture and embryo culture techniques.
- Briefly describe the techniques used for, applications and limitations of animal tissue culture.

**6- Transgenic Bacteria, Plants and Animals****➤ Understanding***Student will:*

- State the objectives of the production of transgenic bacteria, transgenic plants and transgenic animals.
- Describe different methods applied for the introduction of DNA into plant and animals cells / embryos.
- Describe the role of biotechnology in the production of insect, virus and herbicide resistant plants.
- State the notable human gene transfers in different animal species and describe their potential applications and future prospects.
- State the role of transgenic bacteria in making biotechnology products.
- List some of the ecological concerns surrounding transgenic bacteria.
- Describe the ways in which genetic engineering improves farm animals.

**7- Biotechnology and Healthcare****➤ Understanding***Student will:*

- Describe how biotechnologists are able to combat health problems by producing vaccines.
- State the role played by biotechnology in disease diagnosis (DNA/RNA probes, monoclonal antibodies).
- Describe what products biotechnologists obtain for use in disease treatment.
- Explain the current methods employed for gene therapy (ex-vivo and in-vivo methods).
- Explain with example gene therapies in the detection and treatment of some genetic diseases.
- Explain the role of successful gene therapy for cystic fibrosis.

**8- Scope and Importance of Biotechnology****➤ Understanding***Student will:*

- Explain the scope and importance of biotechnology in promoting human welfare.
- List the hazards and social / ethical implications of using gene technology in human.

### ➤ STS Connections

*Student will:*

- Describe the application of polymerase chain reaction.
- State the importance and limitations of DNA analysis in forensic medicine and paleontology.
- Justify why the human genome project is regarded as the most ambitious project ever undertaken by man.
- Describe the major findings that have arisen from the human genome project.
- Predict the applications of genetic engineering in crop improvement.
- Describe the role of genetic screening.
- Justify the need for genetic counseling.
- Describe briefly the accomplishments of the renowned genetic engineers working in private and public institutions in his / her province.
- Suggest measures s/he would take to solve related problems by using knowledge gained in this chapter.
- Describe and analyze examples of technology that have extended or modified the scientific understanding of the genetic engineering.
- Investigate careers that require an understanding of biotechnology and genetic engineering.



Result.pk

# BIOLOGY AND HUMAN WELFARE

10 Periods

## Overview:

The theme of this chapter is to make the learners well aware of the role of biological sciences for human welfare. They will also be given the fundamental know how of the various fields and it would help them in the choice of career. The major concepts in this chapter are;

- Vaccination and Integrated Disease Management (03 Periods)
- Animal Husbandry (01 Period)
- Latest Techniques applied to enhance Crop and Fruit yield (03 Periods)
- Home Gardening (01 Period)
- Role of Microbes in Human Welfare (02 Periods)

### Conceptual Linkages:

This chapter is built on;

- Plant Physiology (Grade XI-XII)
- Biotechnology (Grade XI-XII)

## MAJOR CONCEPTS AND LEARNING OUTCOMES

### 1- Vaccination and Integrated Disease Management

#### ➤ Understanding

*Student will:*

- Explain what is meant by integrated disease management
- Describe vaccination and its importance.
- List some common viral diseases against which vaccination are required e.g. polio, measles, influenza and hepatitis.
- Describe the role of vaccines in preventing polio, measles, hepatitis and tetanus.
- State the schedule of the vaccination against polio, measles, hepatitis and tetanus.

### 2- Animal Husbandry

#### ➤ Understanding

*Student will:*

- Describe animal husbandry and the role of life stock in national economy (milk, meat, eggs, wool and other miscellaneous products).
- List the outstanding milk producing breeds of cows and buffaloes.

### 3- Latest Techniques applied to enhance Crop and Fruit Yield

#### ➤ Understanding

*Student will:*

- Describe different methods adopted for plant improvements (acclimatization, selection, hybridization and back crosses etc).

#### ➤ Skills

**(Analyzing and Interpreting)**

*Student will:*

- Correlate the role of biotechnology and genetic engineering in crop improvement.

#### 4- Home Gardening

##### ➤ Understanding

*Student will:*

- Explain home gardening and its importance.
- Identify some seasonal vegetable and fruit plants suitable for home gardening.

#### 5- Role of Microbes in Human Welfare

##### ➤ Understanding

*Student will:*

- Explain the role of microbes in household food processing, industrial production, sewage treatment and energy generation.

##### ➤ STS Connections

*Student will:*

- Justify the importance of vaccination campaign observed world wide to curb the diseases.
- List the objectives of the institutions of the federal health department and UNO working for integrated disease management.
- Assess the impact of live stock in boosting up the national economy.



Result.pk



## **ATTITUDE OUTCOMES**

Along with the learning outcomes for knowledge, comprehension, skills etc. the National Curriculum Development Team desires to set up measures that can draw outcomes in the development of behavior / attitudes. Attitude outcomes are exhibited in a different way, as the attitude development is a lifelong process that involves the home, the school, the community and society at large.

Development of positive attitudes plays an important role in students' growth by interacting with their intellectual development and creating a readiness for responsible application of the learning. The curriculum expects the students to have developed;

**1– Interest in Science**

Enthusiasm and continuing interest in the study of science

**2– Mutual Respect**

Appreciation of the fact that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds

**3– Scientific Inquiry**

Support for active inquiry, problem solving and decision-making

**4– Cooperation and Teamwork**

Support for collaborative activity

**5– Custodianship**

Responsibility in the application of science and technology for a better Pakistan

**6– Safety**

A concern for safety in science and technology contexts

## Chapter 6:

# LIST OF PRACTICALS AND APPARATUS: \_\_\_\_\_

## PRACTICALS XI-XII

### Grade XI

#### **Chapter 1: Cell Structure and Functions**

1. Use of graticule and micrometer to study stomata and cells
2. Measuring the size of primary, secondary cell walls and middle lamella by micrometry
3. Preparation and examination of the slides of animal and plant cells using differential staining

#### **Chapter 2: Biological Molecules**

4. Performing Benedict's test for reducing sugars and confirmation of the presence of starch through Iodine test
5. Confirmation of the presence of proteins through Biuret test
6. Confirmation of the presence of lipids through Emulsion test
7. Demonstration of the presence of nucleic acids in biological materials

#### **Chapter 3: Enzymes**

8. Performing of chemical test to demonstrate that enzymes are proteins
9. Performing amylase test on starch with boiled amylase and un-boiled amylase in separate test tubes and confirmation through iodine test

#### **Chapter 4: Bioenergetics**

10. Extraction of the leaf pigments and their separation by paper chromatography

#### **Chapter 5: Acellular Life**

- No Practical Activity

#### **Chapter 6: Prokaryotes**

11. Identification of bacteria from curd, mouth, or bacterial culture and observation of bacterial culture for different shapes and sizes
12. Staining bacteria using Grams staining technique
13. Preparation and observation of the temporary mount of root nodule bacteria
14. Study of Nostoc, Oscillatoria and Anabaena from fresh or preserved material

#### **Chapter 7: Protists and Fungi**

15. Observation and drawing of representative members of each group of protists
16. Observation and drawing labeled diagrams of the life cycle of black bread mold and *Penicillium* from fresh culture and prepared slides

### **Chapter 8: Diversity among Plants**

17. Identification of the vegetative and reproductive structures of *Marchantia* and *Funaria* by examining the fresh or preserved material
18. Identification of the vegetative and reproductive structures of a local fern and a *Pinus* and relate them with the concerned life cycles
19. Study of different types of inflorescence of *Cassia*, *Brassica*, *Achyranthus*, *Morus*, Candytuft, *Helianthus* and *Avena sativa*
20. Describing the flowers of Rose, *Cassia fistula*, *Solanum nigrum* and *Avena sativa*

### **Chapter 9: Diversity among Animals**

21. Classifying the given invertebrates into phyla and given chordates into classes by using classification key

### **Chapter 10: Form and Functions in Plants**

22. Demonstration of the evolution of CO<sub>2</sub> from leaf discs placed in dark and light, with the help of indicator (hydrogen carbonate)
23. Microscopic observation of the slide of LS of a dicot stem, identifying and drawing vessel element, vessel, and phloem sieve tubes
24. Locating annual rings in the log of a tree and calculation of the age of a plant by counting number of annual rings
25. Demonstration of phototropism, geotropism and thigmotropism in plants
26. Demonstration of the folding of leaf after touch in *Mimosa pudica*

### **Chapter 11: Digestion**

27. Tests to locate buds on tongue for detection of salt, sweet, sour and bitter taste
28. Microscopic observation of the villi, liver and pancreas from prepared slides

### **Chapter 12: Circulation**

29. Correlating the *lub-dub* sounds of the closing of heart valves with the monitoring of the heartbeat
30. Identification of the phases of heartbeat on a printed ECG and comparison of the ECG of a cardiac patient with that of a healthy man
31. Dissection of the heart of sheep and describing its internal structure
32. Differentiation of an artery and a vein by observing prepared slides
33. Measuring blood pressure by using sphygmomanometer

### **Chapter 13: Immunity**

34. Recognizing phagocytes and lymphocytes while observing prepared slides

## **Grade XII**

### **Chapter 14: Respiration**

35. Identification of different parts of the respiratory and reproductive system of a dissected frog (dissection would be done by the teacher)
36. Examination of sheep lungs
37. Comparison and interpretation of the X-ray films of lungs of a smoker with that of a healthy man

## **Chapter 15: Homeostasis**

- ☛ No Practical Activity

## **Chapter 16: Support and Movement**

- 38. Identification of the bones of the pelvic girdles, pectoral girdle, arms and legs by using the model of human skeleton
- 39. Comparison of the structure of skeletal, smooth and cardiac muscles with the help of prepared slides

## **Chapter 17: Nervous Coordination**

- 40. Observation of the MRI scan of the brain of a sleeping human and compare it with that of a fully awake individual

## **Chapter 18: Chemical Coordination**

- ☛ No Practical Activity

## **Chapter 19: Behavior**

- 41. Observation of a spider's web and recording the instincts by providing it various stimuli.

## **Chapter 20: Reproduction**

- 42. Examination of the prepared slides of histology of ovaries and drawing its structures

## **Chapter 21: Development and Aging**

- 43. Identification of the group of vertebrates, through diagrams of different blastula.
- 44. Identification of the different stages in chick development through observation of prepared slides

## **Chapter 22: Inheritance**

- 45. Evaluation of the inheritance of genes and their mixing during fertilization as based on mathematical probabilities
- 46. Calculation of probability by using the dice to calculate how many times out of 100 throws can students get sixes
- 47. Data collection from the class to see how many individuals have AB blood group and construction of a pie chart and histogram for the collected data
- 48. Testing of blood group using Antisera and performing agglutination reaction for Rh factor

## **Chapter 23: Chromosomes and DNA**

- ☛ No Practical Activity

## **Chapter 24: Evolution**

- 49. Interpretation of different homologous and analogous structures through observation in plants

## **Chapter 25: Man and His Environment**

- ☛ No Practical Activity

## **Chapter 26: Biotechnology**

- ☛ No Practical Activity

☛ **Chapter 27: Biology and Human Welfare**  
No Practical Activity

Result.pk

## REQUIRED APPARATUSES, CHEMICALS, CHARTS, MODELS AND ANIMATIONS

| Sr. No. | APPARATUSES                                                      | Qty        |
|---------|------------------------------------------------------------------|------------|
| 1.      | Balance                                                          | 10         |
| 2.      | Beaker (50ml, 100ml, 250ml, 500ml, 1000 ml)                      | 10 Each    |
| 3.      | Bell jar                                                         | 20         |
| 4.      | Blades (Safety razor)                                            | 20         |
| 5.      | Burner (Bunsen)                                                  | 10         |
| 6.      | Burner (Spirit Lamp)                                             | 20         |
| 7.      | Conical Flask                                                    | 20         |
| 8.      | Cotton Wool                                                      | 04         |
| 9.      | Differential air Thermometer                                     | 10         |
| 10.     | Dissecting Board                                                 | 20         |
| 11.     | Dissecting Box                                                   | 20         |
| 12.     | Dissecting Tray                                                  | 20         |
| 13.     | Dropper                                                          | 20         |
| 14.     | Funnel 4" and 6" dm                                              | 20 Each    |
| 15.     | Glass Tube                                                       | 04 Packets |
| 16.     | Incubator                                                        | 01         |
| 17.     | Inoculation Loop                                                 | 06         |
| 18.     | Insect Net                                                       | 12         |
| 19.     | Lens Paper                                                       | 06         |
| 20.     | Light Source                                                     | 10         |
| 21.     | Magnifying Glass                                                 | 10         |
| 22.     | Measuring Cylinder                                               | 10         |
| 23.     | Microscope (Compound: 10X eye piece, 4X, 10X and 40X objectives) | 20         |
| 24.     | Microscope (Dissecting)                                          | 20         |
| 25.     | Microscope Cover Slip                                            | 04 Packets |
| 26.     | Microscope Slide                                                 | 04 Packets |
| 27.     | Petri Dish                                                       | 20         |
| 28.     | Pipette (10 ml)                                                  | 10         |
| 29.     | Plant Presser                                                    | 04         |
| 30.     | Plate (Glass)                                                    | 06         |
| 31.     | Potometer                                                        | 04         |
| 32.     | Preserved Specimens of representative animals                    | 01 Each    |
| 33.     | Reagent Bottles                                                  | 20         |

|     |                  |    |
|-----|------------------|----|
| 34. | Specimen Jars    | 10 |
| 35. | Sphygmomanometer | 02 |
| 36. | Stop Watch       | 05 |
| 37. | Stopper (Cork)   | 20 |
| 38. | Syringe          | 10 |
| 39. | Test Tube Rack   | 08 |
| 40. | Thermometer      | 20 |
| 41. | Thermos Flask    | 20 |
| 42. | Tripod Stand     | 10 |
| 43. | Watch Glass      | 20 |

| Sr. No. | PREPARED SLIDES                                              | Qty |
|---------|--------------------------------------------------------------|-----|
| 44.     | Bacteria                                                     | 02  |
| 45.     | Cells of onion epidermis and <i>Hydrilla</i> Leaf            | 02  |
| 46.     | Conjugation in <i>Paramecium</i>                             | 02  |
| 47.     | Mitosis and Meiosis in Onion root tip                        | 02  |
| 48.     | Nerve Cell                                                   | 02  |
| 49.     | Rhizopus and Mushroom                                        | 02  |
| 50.     | Section of Mammalian kidney                                  | 02  |
| 51.     | Sections of animal tissues                                   | 02  |
| 52.     | Transverse Section of Artery, Vein and Capillary             | 02  |
| 53.     | Transverse Section of Human Small Intestine                  | 02  |
| 54.     | Transverse Section of Leaf, Root and Stem of <i>Brassica</i> | 02  |
| 55.     | Transverse Section of Mammalian Air sacs                     | 02  |
| 56.     | Transverse Section of Woody stem                             | 02  |

| Sr. No. | CHEMICALS                 | Qty       |
|---------|---------------------------|-----------|
| 57.     | Acetic acid               | 2.5 Liter |
| 58.     | Alcohol                   | 2.5 Liter |
| 59.     | Ascorbic acid             | 2.5 Liter |
| 60.     | Benedict's solution       | 2.5 Liter |
| 61.     | Bromothymol blue solution | 2.5 Liter |
| 62.     | Chloroform                | 2.5 Liter |
| 63.     | Copper sulfate solution   | 2.5 Liter |

|     |                                        |           |
|-----|----------------------------------------|-----------|
| 64. | Diastase                               | 2.5 Liter |
| 65. | Distilled water                        | 2.5 Liter |
| 66. | Eosine                                 | 2.5 Liter |
| 67. | Ethanol                                | 2.5 Liter |
| 68. | Formaline                              | 2.5 Liter |
| 69. | Glucose solution 01%                   | 2.5 Liter |
| 70. | Glycerine                              | 2.5 Liter |
| 71. | Hydrogen carbonate indicator           | 2.5 Liter |
| 72. | Iodine solution 01%                    | 2.5 Liter |
| 73. | Lime water                             | 2.5 Liter |
| 74. | Methylene Potassium hydroxide blue 01% | 2.5 Liter |
| 75. | Starch                                 | 2.5 Liter |
| 76. | Sudan III solution                     | 2.5 Liter |
| 77. | Trypsin                                | 2.5 Liter |
| 78. | Wax                                    | 2.5 Liter |

| <b>Sr. No.</b> | <b>CHARTS</b>                   | <b>Qty</b> |
|----------------|---------------------------------|------------|
| 79.            | Animal and Plant Cell           | 01         |
| 80.            | Biodiversity                    | 01         |
| 81.            | Biogeochemical Cycles           | 01         |
| 82.            | Cell Division                   | 01         |
| 83.            | Germination                     | 01         |
| 84.            | Human Body Systems              | 01         |
| 85.            | Mendelian Genetics              | 01         |
| 86.            | Mechanism of Enzyme Action      | 01         |
| 87.            | Plant Propagation               | 01         |
| 88.            | Reflex Arc                      | 01         |
| 89.            | Sexual Reproduction in Plants   | 01         |
| 90.            | Structure of DNA                | 01         |
| 91.            | Transport of Material in Plants | 01         |



| <b>Sr. No.</b> | <b>MODELS</b>                           | <b>Qty</b> |
|----------------|-----------------------------------------|------------|
| 92.            | DNA                                     | 01         |
| 93.            | Human Brain                             | 01         |
| 94.            | Human Diaphragm and Intercostal Muscles | 01         |
| 95.            | Human Ear                               | 01         |
| 96.            | Human Eye                               | 01         |
| 97.            | Human Kidney                            | 01         |
| 98.            | Human Skeleton                          | 01         |
| 99.            | Neuron                                  | 01         |
| 100.           | Skeleton of Rabbit                      | 01         |

| <b>Sr. No.</b> | <b>ANIMATIONS</b>          | <b>Qty</b> |
|----------------|----------------------------|------------|
| 101.           | Antagonistic Muscles       | 01         |
| 102.           | Ascent of Sap              | 01         |
| 103.           | Crossing Over              | 01         |
| 104.           | DNA Replication            | 01         |
| 105.           | Heartbeat                  | 01         |
| 106.           | Kidney Function            | 01         |
| 107.           | Nerve Impulse              | 01         |
| 108.           | Photosynthesis             | 01         |
| 109.           | Polymerase Chain Reaction  | 01         |
| 110.           | Pressure Flow Mechanism    | 01         |
| 111.           | Recombinant DNA Technology | 01         |
| 112.           | Swallowing and Peristalsis | 01         |
| 113.           | Transcription              | 01         |
| 114.           | Translation                | 01         |

## Chapter 7:

**CHAPTER-WISE TIME ALLOCATION:** \_\_\_\_\_

| Chapter                                  | Number of Periods |           |
|------------------------------------------|-------------------|-----------|
| Chapter 1: Cell Structure and Functions  | 16                | GRADE XI  |
| Chapter 2: Biological Molecules          | 21                |           |
| Chapter 3: Enzymes                       | 09                |           |
| Chapter 4: Bioenergetics                 | 14                |           |
| <b>SECTION 1: CELL BIOLOGY</b>           |                   |           |
| Chapter 5: Acellular Life                | 10                |           |
| Chapter 6: Prokaryotes                   | 14                |           |
| Chapter 7: Protists and Fungi            | 11                |           |
| Chapter 8: Diversity among Plants        | 21                |           |
| Chapter 9: Diversity among Animals       | 18                |           |
| <b>SECTION 2: BIODIVERSITY</b>           |                   |           |
| Chapter 10: Form and Functions in Plants | 27                | GRADE XII |
| Chapter 11: Digestion                    | 13                |           |
| Chapter 12: Circulation                  | 14                |           |
| Chapter 13: Immunity                     | 12                |           |
| <b>TOTAL</b>                             | <b>200</b>        |           |
| Chapter 14: Respiration                  | 16                |           |
| Chapter 15: Homeostasis                  | 10                |           |
| Chapter 16: Support and Movement         | 12                |           |
| Chapter 17: Nervous Coordination         | 13                |           |
| Chapter 18: Chemical Coordination        | 05                |           |
| Chapter 19: Behavior                     | 11                |           |
| <b>SECTION 3: LIFE PROCESSES</b>         |                   |           |
| Chapter 20: Reproduction                 | 09                | GRADE XII |
| Chapter 21: Development and Aging        | 20                |           |
| Chapter 22: Inheritance                  | 21                |           |
| Chapter 23: Chromosome and DNA           | 15                |           |
| Chapter 24: Evolution                    | 13                |           |
| <b>SECTION 4: CONTINUITY IN LIFE</b>     |                   |           |
| Chapter 25: Man and His Environment      | 16                |           |
| <b>SECTION 5: ECOLOGY</b>                |                   |           |
| Chapter 26: Biotechnology                | 29                |           |
| Chapter 27: Biology and Human Welfare    | 10                |           |
| <b>SECTION 6: APPLICATION OF BIOLOGY</b> |                   |           |
| <b>TOTAL</b>                             | <b>200</b>        |           |
| <b>Grand Total</b>                       | <b>400</b>        |           |

Total Time Allocation for BIOLOGY XI-XII = 400 Periods

## Chapter 8:

# ASSESSMENT AND EVALUATION: \_\_\_\_\_

Being an integral part of the learning process, assessment and evaluation devices are an important chapter of the curriculum document. Assessment devices enable teachers not only to verify students' learning but also to diagnose the shortcomings in the learning process.

### **Continuous Assessment Devices:**

The continuous assessment should be a part of the classroom learning. Following may be the devices on which the said objectives can be achieved.

- ☛ **Lab completion**
- ☛ **Identification**
- ☛ **Objective enhancement-worksheets, quizzes, and tests**
- ☛ **Diagram completion**
- ☛ **Observation**
- ☛ **Review questions**
- ☛ **Classroom discussions**

The continuous assessment should be cumulative and comprehensive and cover all objectives as per the curriculum. Grading of students should be done through the use of assessment instruments that cover the expectations as defined by the objectives of the curriculum.

### **Evaluation Strategy:**

An external examination is recommended at the end of the course. This evaluation should measure all the domains of learning and through it the attainment of the objectives can be measured. The weightage of the different domains of learning is given below;

| <b>Learning Domains for Measurement</b>                                                          | <b>Weightage in Evaluation</b> |
|--------------------------------------------------------------------------------------------------|--------------------------------|
| • Knowledge, Comprehension, Analysis, Evaluation, Synthesis, Application:                        | 85 %                           |
| • Skills of Communication, Initiating and Planning, Designing Experiments and Interpreting Data: | 05 %                           |
| • Sensorimotor Skills (Performing Lab Work):                                                     | 10 %                           |

For the final evaluation of the learning outcomes, following weightage is recommended for the contents of 6 sections:

| <b>Section</b>                                        | <b>Weightage in Evaluation</b> |
|-------------------------------------------------------|--------------------------------|
| • Section 1: Cell Biology (Chapter 1 - 4)             | 15                             |
| • Section 2: Biodiversity (Chapters 5 - 9)            | 18                             |
| • Section 3: Life Processes (Chapters 10 - 19)        | 33                             |
| • Section 4: Continuity in Life (Chapter 20 - 24)     | 20                             |
| • Section 5: Ecology (Chapter 25)                     | 04                             |
| • Section 6: Application of Biology (Chapter 26 & 27) | 10                             |
| Total                                                 | 100                            |

- Assessment pattern is subject to the requirement, policies, and procedures of the Examination Boards.
- Question paper will be based on the curriculum not on a particular textbook.
- Questions involving unfamiliar contexts or daily-life experiences may be set to assess candidates' problem-solving and higher-order processing skills. In answering such questions, sufficient information will be given for candidates to understand the situation or context. Candidates are expected to apply their knowledge and skills included in the syllabus to solve the problems.
- In general, SI units and terminology will be used.

Result.pk

## Chapter 9:

# INSTRUCTIONS AND SUGGESTIONS: \_\_\_\_\_

### Execution of the Curriculum:

The curriculum implies changes and developments, which will mean:

#### **For Students:**

- ☛ Higher standards of achievement through, leading through to broader choices as they progress to next grades

#### **For Parents:**

- ☛ A clear understanding of the learning opportunities their children should have, ways in which they can support their children's learning; the purposes of these activities; and the recognition which children will receive for their achievements

#### **For Teachers and Schools:**

- ☛ Clarity about what education is seeking to achieve for each student; flexibility to apply professional judgment in planning programs and activities to respond to the needs of individual students

#### **For the Education System:**

- ☛ A responsibility to ensure that teaching, learning and assessment are directed to achieving the purposes and principles set out in the curriculum and that qualifications reflect this fully; a responsibility to ensure that initial training and continuing professional development of teachers and educators equip them fully for their task

#### **For Society:**

- ☛ Confidence that students are being enabled to reach the highest levels of achievement as successful learners, confident individuals, responsible citizens and effective contributors to society

### Instructions for Textbook Writing:

- A team of a dozen or more authors should not be engaged in developing the text material. It results in loss of coherence and consistency in the book. The task of developing a textbook should be given to **Two or Three authors** who can compile the book making each part of it coherent and developing **Consistency** in it. Each of all the O-level and A-level Biology books is written by one or two authors.
- It should be tried to engage the same experts in textbook writing who developed the **Learning Expectations in the Curriculum** of that particular subject and grade.
- The curriculum wing should manage to **train the Authors and Editors** of the textbook, before the onset of the task.
- At the end of each chapter addresses of relevant **Websites** and **Online Learning Centers** should be mentioned so that students and teachers can get update information about the concepts.
- For IX-X and XI-XII grades, Textbook boards should publish **Color Acetate Transparencies** of the lessons that teachers can use to supplement classroom lectures.

- Textbook board should develop a **Biology Test Item CD-ROM** for instructors and students. It should contain multiple-choice questions and the instructor's manual for each chapter.
  - Textbook board should publish **supplementary learning materials** for example;
1. **Laboratory Manual**  
It should be corollary to the text and should incorporate many learning aids. It should include illustrations and photographs, and activities on scientific method, cladistics, ecological and evolutionary principles, and animal structure and function.
  2. **Instructor's Manual**  
It should provide lesson plans/reading schedules for the course with various emphases. In addition, it should include detailed outline, purpose, objectives, key terms, summary, resources for audiovisual materials and computer software.

While developing the text material of the books, the authors should pay attention to the following points.

- ☛ **The textbook authors should retain and limit the textual material as prescribed in the learning outcomes details. The contents must be time factor controlled as per periods allotted to the concepts / topics.**
- ☛ Each chapter should be opened with a brief recalling statement, and then it should move to a brief introduction to its contents. Afterwards the introduction should be given continuity with knowledge and comprehension of the content.
- ☛ At the end each chapter should have reference for further reading and should also have website addresses for the purpose of developing the habits of acquiring knowledge.
- ☛ Continuity of concepts should be in a way as the scientific process is carried out in the real world.
- ☛ Explanation of science concepts should be written in ways to make them interesting and easy to understand.
- ☛ Examples should be carefully chosen so that students can relate them easily.
- ☛ Textbook should be attractive and have colorful illustrations to captivate students.
- ☛ Quranic Ayats may be quoted where relevance is found.
- ☛ There should be a chapter-outline in the beginning of each chapter, describing the task to be achieved in the chapter.
- ☛ Biology Tits Bits should be provided in each chapter. It will provide children useful knowledge, which may not lie in the syllabus.
- ☛ Each chapter should have, in its exercise, the Think Tank. It consists of open-ended questions, which encourage students to think critically and creatively.
- ☛ Glossary of technical terms should be given at the end of the book.
- ☛ **Concept Mapping** - Concept map should be drawn to show the relationship between concepts within a topic, making it easier to relate new information to what students already know.
- ☛ **Chapter Organizing system** - A consistent numbering system leads the students through each chapter at a glance in the beginning to conceptual heading throughout and finally to the summary of key concepts at the end. Each chapter should be organized in the following pattern:

**Outline:****Major Concepts:**

- 1.1 .....
- 1.2 .....
- 1.3 .....

*Introduction***1.1 MAJOR CONCEPT**

(Depth of the topic should be kept with the teaching periods advised in the curriculum)

Tit Bits:

 STS  
Connections:
**Subheading #1.1.1****Subheading # 1.1.2**
 Critical  
Thinking:
**EXERCISE:**

**The exercise should include;**

- Multiple Choice Questions
- Short Questions
- Extensive Questions

**(Questions should be made that can check learning outcomes in all the domains i.e. knowledge, comprehension, application, evaluation, synthesis and connection with technology and society.)**

## **Criteria for the Selection of Learning Material:**

National Curriculum Development Team (Biology) recommends the following parameters to be considered while selecting the learning material.

1. Do the materials focus on big ideas and/or essential questions:
2. Do the materials require learners to be thoughtful, reflective and use high-level skills?
3. Do the materials include valid and varied assessments- both traditional and performance based?
4. Do the materials contain effective and engaging activities?
5. Do the materials continually revisit big ideas?
6. Do the materials reflect a “developmentally appropriate” approach to student learning?
7. Are the materials geared to the diverse abilities, interests and needs of students?
8. Is the curriculum program based on text alone, or does it include many different types of materials, including technology-based learning
9. Do the materials encourage interdisciplinary connections?
10. Are outside experiences, including family involvement, part of the learning experience?

## **Electronic Instructional Material:**

Electronic instructional material is gaining popularity in the developed world. Educational technology providers are successfully marketing courseware with instructional management, assessment, individualized learning paths and professional development. Growing numbers of teachers have convenient and immediate access to entire libraries of instructional video correlated to curriculum. As far the educational scenario in Pakistan and other developing countries is concerned, lack of resources (particularly in schools) would hold back the evolution of electronic publishing in place of or along with printing.

It may be considered that a good ratio of the students of intermediate grades has access to computer technologies. They should be given chances of self learning (rather exploring the knowledge) and it can be made true by converting the data of the IX-X and XI-XII textbooks into electronic formats e.g. CD-ROMs. The CD-ROMs should be made available at the retail outlets. Where students don't have computers at schools/colleges or at homes, they may explore the CD-ROM at internet café, as they are very much seen at internet cafés wasting their potential while chatting with friends, looking movies etc.

In biology subject diagrams and photographs are more important to convey the desired learning. Printed textbooks cannot tackle the diagrams that need 3-dimensional view for their understanding. Similarly a student can get comprehensive learning of a life phenomenon through animations. Diagrams, photographs and animations should be published in electronic format i.e. CD-ROM that can be made an accessory item with the printed textbook. Such a CD should also have installed software for students' assessment and evaluation in the form of tests, quizzes and games.



## **Suggestions for Assessment and Evaluation Tools:**

| <b>More Emphasis should be on;</b>                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Less Emphasis should be on;</b>                                                                                                                                                                                                                                                                                                                                           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Assessing what is most highly valued</li><li>• Assessing rich, well-structured knowledge</li><li>• Assessing scientific understanding and reasoning</li><li>• Assessing to learn what students do understand</li><li>• Assessing achievement and opportunity to learn</li><li>• Students engaged in ongoing assessment of their work and that of others</li><li>• Teachers involved in the development of external assessments</li></ul> | <ul style="list-style-type: none"><li>• Assessing what is easily measured</li><li>• Assessing discrete knowledge</li><li>• Assessing scientific knowledge</li><li>• Assessing to learn what students do not know</li><li>• Assessing only achievement</li><li>• End of term assessments by teachers</li><li>• Development of external assessments by experts alone</li></ul> |

## **Teaching-Learning Program:**

The topics, or objectives within topics, can be taught in any order in keeping with the needs of teachers and students. The teaching approaches and materials used should:

- represent biology as part of the process of scientific inquiry (rather than a rhetoric of conclusions)
- use inquiry-based teaching strategies where possible
- be student-centered, assisting students to derive their own concepts from evidence and providing practical opportunities to develop individual reasoning abilities and motor skills
- exemplify the concept from local scenario.
- when beginning a new area of study, provide very direct, concrete experience – through classroom, laboratory and field work – or the next best substitute when direct experience is not feasible
- provide rewarding opportunities to apply scientific understanding and ways of thinking to problems, especially everyday ones
- provide opportunities to refine ideas through dialogue with others, and work with them in ways likely to foster cooperative abilities
- provide opportunities to develop skills of written and oral communications
- use testing as a diagnostic as well as an achievement tool.

## **Teachers' Training and Refresher Courses:**

Effective and meaningful biology education can only be guaranteed if the teacher, the key pivot of the change, is developed enough in contents as well as methodology. In-service trainings may help the teachers to become familiar with a variety of strategies for successful delivery of the curriculum.

The curriculum development and revision is a continuous process in all stages of education so is the process of updating the teacher education programs at pre-service as well as at in-service stages. If the teacher is not fully equipped and trained to handle the new curricula, the curriculum

transaction would not be appropriate and consequently, the learning will be inadequate. Teacher's training needs the following actions:

1. Pre-service teacher training institutions be strengthened and their curricula be revised to meet the demands of fast changing and developing world.
2. In-service trainings should cover contents and methodologies. Content upgrading in biology is an urgent need for effective teaching. Emphasis should specifically be laid on learner-centered and activity based approaches. Laboratory practices, classroom demonstrations, active participation by the students, and field interactions should become major components of in-service training programs. Workshops, seminars and extension lectures should be organized more frequently and regularly and particularly in summer vacation.
3. Well-equipped resource centers should be established at the training institutions for a ready help to the needy teachers.

Result.pk

## Chapter 10:

# **SALIENT FEATURES OF THE CURRICULUM: \_\_\_\_\_**

The Curriculum is fully in harmony with the National Priorities, and will provide an important momentum for achieving our vision for students.

### **Configuration with the restructured Schemes of Study:**

The Ministry of Education went through an arduous exercise for restructuring the National Schemes of Study. The Curriculum Development Team; while designing the curriculum, selecting the syllabi contents, carving the learning outcomes (including practical skills) and suggesting the timeframes and evaluation strategies for the contents; maintained a concrete configuration with the restructured schemes of study.

### **The Focused Areas:**

It has been focused that the curriculum provides to the students; challenges and enjoyment, breadth, progression, depth, personalization and choice, coherence, and relevance.

### **Reduction in Load:**

The quality of Biology education at the higher secondary level was not compromised in any way and the Team chose to leave topics out if:

- **The question about why the student needs to study the topic at the particular stage could not be answered;**
- **If the topic had no direct relevance to the student i.e. was not contextual;**
- **If the content was repetitive across stages with no change in expected understanding, and**
- **If any topic was in isolation with no evident horizontal or vertical linkages**

While deciding the depth of each topic for the higher secondary level, a holistic view of the syllabus from the secondary to the higher secondary was taken. The use of too many technical terms was reduced and large numbers of examples were also avoided.

The proposed syllabus provides substantial orientation to the students to professional/career opportunities available in medicine, agriculture, research, teaching, and industry.

### **Reasoning Vs Comprehension:**

In secondary and higher secondary grades, abstraction and quantitative reasoning come to occupy a more central place. We have to avoid the attempt to be comprehensive. In the present revision, no attempt is made to be comprehensive.

This stage also sees a certain consolidation of knowledge within themes. As a result, a theme may get a lot of space in one IX-X while being absent from the XI-XII.

## Chapter 11:

# GLOSSARY OF TERMS: ---

Attention is paid to the wording of learning outcomes to ensure it as concise and as unambiguous as possible. In many instances, Examiners are able to make appropriate allowance for an interpretation that differs, but acceptably so, from the one intended.

The Curriculum Development Team thinks it necessary to make clear the intended learning outcomes it has predicted. It can be so through explaining the meanings of important words stated in the learning outcomes. It is hoped that the glossary will prove helpful to teachers, evaluators and students as a guide (i.e. it is neither exhaustive nor definitive).

1. **Define (the term(s)...) is** intended literally, only a formal statement or equivalent paraphrase being required.
2. **What is meant by (the term(s)...) normally** implies that a definition should be given, together with some relevant comment on the significance or context of the term(s) concerned, especially where two or more terms are included in the question. The amount of supplementary comment intended should be interpreted in the light of the indicated mark value.
3. **State** implies a concise answer with little or no supporting argument (e.g. a numerical answer that can readily be obtained 'by inspection').
4. **List** 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.
5. **(a) Explain** may imply reasoning or some reference to theory, depending on the context. It is another way of asking candidates to give reasons for. The candidate needs to leave the examiner in no doubt why something happens.  
**(b) Give a reason/Give reasons** is another way of asking candidates to explain why something happens.
6. **(a) Describe**, the data or information given in a graph, table or diagram, requires the candidate to state the key points that can be seen in the stimulus material. Where possible, reference should be made to numbers drawn from the stimulus material.  
**(b) Describe**, a process, requires the candidate to give a step by step written statement of what happens during the process.  
Describe and explain may be coupled, as may state and explain.
7. **Discuss** requires the candidate to give a critical account of the points involved in the topic.
8. **Outline** implies brevity (i.e. restricting the answer to giving essentials).
9. **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 earlier part of the question.

Predict also implies a concise answer, with no supporting statement required.

10. **Deduce** is used in a similar way to predict except that some supporting statement is required (e.g. reference to a law/principle, or the necessary reasoning is to be included in the answer).
11. **Suggest** is used in two main contexts (i.e. either to imply that there is no unique answer (e.g. in chemistry, two or more substances may satisfy the given conditions describing an 'unknown') or to imply that candidates are expected to apply their general knowledge to a 'novel' situation, one that may be formally 'not in the syllabus').
12. **Find** is a general term that may variously be interpreted as calculate, measure, determine, etc.
13. **Calculate** is used when a numerical answer is required. In general, working should be shown, especially where two or more steps are involved.
14. **Measure** implies that the quantity concerned can be directly obtained from a suitable measuring instrument (e.g. length, using a rule, or mass, using a balance).
15. **Determine** often implies that the quantity concerned cannot be measured directly but is obtained by calculation, substituting measured or known values of other quantities into a standard formula.
16. **Estimate** implies a reasoned order of magnitude statement or calculation of the quantity concerned, making such simplifying assumptions as may be necessary about points of principle and about the values of quantities not otherwise included in the question.
17. **Sketch**, when applied to graph work, implies that the shape and/or position of the curve need only be qualitatively correct, but candidates should be aware that, depending on the context, some quantitative aspects may be looked for.

In diagrams, sketch implies that a simple, freehand drawing is acceptable; nevertheless, care should be taken over proportions and the clear exposition of important details.

In the examining system, in all questions, the number of marks allocated are shown on the examination paper and should be used as a guide by students to how much detail to give. In describing a process the mark allocation should guide the student about how many steps to include.

**Acknowledgement:**

Extracted from Biology A/AS Level 2007 of Cambridge University, England

## Chapter 12:

### NATIONAL CURRICULUM DEVELOPMENT TEAM: \_\_\_\_\_

- The National Curriculum Development Team (Biology) comprises of experts from diverse areas of the profession of education;

▣ **Mr. Hamid Saeed;**

- Chairman; Department of Biological Sciences / Registrar, Forman Christian College University, Lahore

▣ **Mr. M Nadeem Asghar;**

- Subject Specialist (Biology); Punjab Textbook Board, Lahore

▣ **Mr. Shah Nawaz Cheema;**

- Associate Professor; Department of Biological Sciences, Forman Christian College University, Lahore

▣ **Mr. Farrukh Shahbaz Hussain;**

- Associate Prof. of Botany, currently working as Director; Girls Primary Education Project-II

▣ **Mrs. Rehana Johar;**

- Senior Subject Specialist (Biology); Punjab Textbook Board, Lahore

▣ **Mr. Nasir Jalal;**

- Assist. Prof.; Department of Biological Sciences, Forman Christian College University, Lahore

▣ **Mrs. Raheela Nadeem;**

- Head; Department of Zoology, Himayat-e-Islam Degree College, Lahore

▣ **Mr. Saghir-ul-Hassnain Syed;**

- Assist. Subject Specialist (Biology); Punjab Textbook Board, Lahore

▣ **Mrs. Robeela Shabbir;**

- Assist. Subject Specialist (Biology); Punjab Textbook Board, Lahore

## TEAM OF ADVISORS: ---

- ▣ **Professor Dr. Muhammad Riaz Bhatti**
  - Head of Academic Department of Psychiatry and Behavioral Sciences; King Edward Medical College, Lahore
- ▣ **Dr. Irshad Hussain**
  - Associate Professor (Medicine); King Edward Medical College, Lahore
- ▣ **Dr. Mahmood-UL-Hassan**
  - Lecturer (Zoology and Wildlife); University of Veterinary and Animal Sciences, Lahore
- ▣ **Professor Dr. Muhammad Amjad**
  - Services Institute of Medical Sciences (SIMS), Lahore
- ▣ **Professor Dr. Zaheer-ud-Din Khan**
  - Government College University, Lahore
- ▣ **Mr. Shahzad Ashraf**
  - Manager Conservation / Environment Education; WWF Pakistan
- ▣ **Dr. Cusrow J. Dubash**
  - Vice Rector; Forman Christian College University, Lahore

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