

CHAPTER 4: Student Learning Outcomes of Biology Class-IX

Unit 1: Biology and Science

Introduction to Biology		1 Lecture
Understand→	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none">• Introduce science as a mother of Biology and relate it to daily life.	
Branches of Biology		1 Lecture
Understand→	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none">• Differentiate groups of organisms and branches of Biology.	
Relationship of Biology with other sciences		1 Lecture
Understand→	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none">• Relate interdependence of different disciplines of science and Biology i-e Biomechanics, Biochemistry, Biometrics, Biogeography	
Careers in Biology		1 Lecture
Understand→	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none">• Elaborate career builds up in Medicine / Surgery, Pharmacy, Physiotherapy Fisheries, Agriculture, Horticulture, Animal Husbandry, Biotechnology, Farming, Forestry, Paramedics	
Biology as in Quran		1 Lecture
Understand→	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none">• State three verses from Holy Quran highlighting Biology as life science.	
Biologist as a scientist		1 Lecture
Understand→	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none">• Recall the contributions of biologists like Abdul Malik Asmai, Bu Ali Sina, Al Razi for Biology.	
Levels of Organization		2 Lectures
Understand→	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none">• Identify and differentiate levels of biological organization with examples in ascending order. Also elaborate concept of "Organism".	
Analysis and Interpretation→	<ul style="list-style-type: none">• Recognize and label different tissues in the photomicrographs of different organs.• Draw a linkage chart connecting different organs with the relative organs systems.	

Unicellular organisation, colonial organisation and multicellular organisation		1 Lecture
Understand Analyze→	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> • Compare cellular organization in organisms i.e. unicellular (Amoeba), colonial (Volvox) and multicellular (mustard and frog). Also discuss division of labour in colony leading to multicellular organization. (Only brief comparison referring to cellular organization is required. Details of organs and organs-systems of animals and plants should be avoided) 	
Steps involved in biological method		3 Lectures
Understand Application→	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> • Apply the steps involved in biological method in solving biological problems such as malaria i.e. recognition of a biological problem, observation and identification, building up hypotheses, devising experiments and inferring results taking the example of Malaria. 	
Initiating and planning→	<ul style="list-style-type: none"> • Recognize and collect observations of any biological problem around you. 	
Data Analysis		1 Lecture
Understand→	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> • Explain importance of data analysis for confirming, modifying, or rejecting a hypothesis. 	

Unit 2: Biodiversity

Biodiversity		1 Lecture
Understand →	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> • Define Biodiversity and describe its role in sustainability 	
Organisms Classification (6 concepts)		2 Lectures
Understand Application→	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> • Classify organisms according to taxonomic lineage • Recall, compare and review old and new classification systems highlighting a diagnostic feature of Eight Kingdom classification system • Draw a hierarchical flow chart of different classification systems. 	

Taxonomic importance of viruses		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> • Discuss classification method of viruses given by International Committee on Taxonomy of Viruses concluding viruses as unique organisms. 	
Binomial Nomenclature		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> • System of naming organisms: Binomial nomenclature • Describe the need of Binomial Nomenclature using three local examples. 	
Analysis and interpreting	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> • Find out the scientific names of some local plants and animals and sort out their generic and specific names. 	
Impact of human beings on biodiversity		1 Lecture
Understand Application →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> • Recognize the negative and positive impact of human activities on biodiversity. • Recall the role of government and NGOs for awareness of general public on biodiversity. 	
Importance of conservation of biodiversity		1 Lecture
Understand Analysis →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> • Realize the importance of conservation of Biodiversity and steps to be taken for this task. • Differentiate between endangered and extinct species giving examples of plants and animals of Pakistan • Enlist endangered extinct species of Pakistan including restricted areas for their protection. 	
STS Connections	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> • Write a short article for publication for preservation of endangered species. • Visit a zoo, herbarium, and garden and apply understanding on classifying the organisms being observed. 	

Unit 3: Cells and Tissues

Light and electron microscopy		2 Lectures
Understand →	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> • Argue concepts of light and electron microscopy by comparing their features. • Investigate the diagnostic and research applications of the electron microscope 	
Cell - basic unit of life		2 Lectures
Understand →	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> • Trace the development of the cell theory presenting discovery of cell as basic unit of life, in a hierarchical pattern. • State and differentiate features of prokaryotic and eukaryotic cells 	
Main components of cells		2 Lectures
Understand →	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> • Identify the structure and describe, in general terms, the functions of main components of cells viz. Plasma membrane, cell wall, nucleus, cytoskeleton, cytoplasm 	
Cytoplasmic organelles of plant and animal cell		3 Lectures
Understand →	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> • List organelles in animal and plant cells and state their structures and functions • Identify, from diagrams or photomicrographs, different organelles in an animal and plant cell. 	
Mechanisms of active and passive transport		3 Lectures
Understand Analysis→	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> • Describe the phenomenon of diffusion, facilitated diffusion, osmosis, filtration, active transport, endocytosis and exocytosis with examples • Compare passive transport of matter by diffusion and osmosis with active transport (e.g. diffusion of glucose from intestine to villus epithelium and active transport of Sodium ions from nerve cell to outside). 	
Turgor and its importance		1 Lecture
Understand Analysis→	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> • Differentiate between turgor and turgor pressure, osmosis and osmotic pressure and their role in 	

	movement of ions and liquids in the cellular organization	
Role of cell membrane		1 Lecture
Understand Application→	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> Investigate the role of cell membrane in maintaining equilibrium while exchanging matter. 	
Tissues		4 Lectures
Understand Assess→	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> Relate term tissue as the group of similar cells, performing the same function. Identify, classify and compare the major animal (epithelial, connective, muscular and nervous) and plant tissues (simple and compound) along with their types in terms of their cell specificities, locations and functions. Justify why a colony of cells does not get tissue level of organization, in spite of having many cells. 	
STS Connections	<ul style="list-style-type: none"> Investigate careers that require an understanding of Cell Biology. Describe how knowledge about semi-permeable or differentially permeable membranes, diffusion and osmosis is applied in various contexts (e.g., separation of bacteria from viruses, purification of water, cheese making, use of honey as an antibacterial agent). 	

Unit 4: Cell Cycle

Cell cycle and its phases		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> Elaborate life cycle of a cell with the help of phases. 	
Events of mitosis and its significance		2 Lectures
Understand Analysis→	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> Illustrate and explain different events of Mitosis with labelled diagrams Compare the details of events during mitosis in animal and plant cells. Utilize basic concepts of mitotic divisions to explain significance of mitosis including disorders. 	
Meiosis and its comparison with mitosis		2 Lectures
Understand Analysis→	<i>After reading this topic the student will be able to:</i>	

	<ul style="list-style-type: none"> • Illustrate and explain different events of Meiosis with help of labelled diagrams. • Compare the Second Meiotic division with mitosis. 	
Significance of meiosis		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> • Signify meiosis with reference to disorders. 	
Cell death		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> • Differentiate mechanisms, causes and importance of Necrosis and Apoptosis • Draw a schematic diagram showing events of necrosis and apoptosis 	

Unit 5: Enzyme

Enzyme and its function		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> • Define and Justify necessity of enzymes in biochemical reactions. 	
Characteristics of enzyme		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> • Enlist and learn the general characteristics of enzymes. • Illustrate through a diagram, the lowering of energy of activation by enzyme. 	
Factors affecting enzyme activity		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> • Explain the baselines of pH, temperature and concentration of substrate on the activity of an enzyme. 	
Action of enzyme		1 Lecture
Understand Analysis→	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> • Compare the action of enzyme illustrated through Lock-n-Key Model and Induced Fit Model • Build or design model of enzyme to demonstrate the working of an enzyme. 	
Specificity of Enzyme		1 Lecture
Understand Create→	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> • Describe enzyme specificity according to shape of its substrate • Devise an activity to fit an enzyme to its substrate based on shape. 	

Unit 6: Bioenergetics

Introduction to bioenergetics		1 Lecture
Understand →	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> Argue energy conversions and energy relationships in living organisms and define bioenergetics Draw a diagram of energy cycle illustrating there is no waste in nature. 	
The Redox reactions		1 Lecture
Understand →	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> Describe the importance of oxidation-reduction reactions for the flow of energy through living systems. 	
ATP as energy currency		1 Lecture
Understand Application→	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> Relate structure of ATP as major energy transfer molecule in living cells Design the molecular model of ATP using low-cost no-cost materials and label its components and high-energy P-P bonds 	
Photosynthesis		2 Lectures
Understand →	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> Explain that photosynthesis as the fundamental process of food production by which plants manufacture carbohydrates along with definition and balanced chemical equation for photosynthesis. Relate the structure of the leaf and chloroplast with its function. 	
Light and Dark reactions		2 Lectures
Understand →	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> Outline, compare and illustrate the processes (Light and Dark reactions) involved in photosynthesis. Design a model of chloroplast by low-cost no-cost materials. 	
Limiting factors in Photosynthesis		1 Lecture
Understand →	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> Explain the concept of limiting factors in photosynthesis. 	

	<ul style="list-style-type: none"> State the effect of varying light intensity, carbon dioxide concentration and temperature on the rate of photosynthesis. 	
Cellular Respiration		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> Introduce respiration at cellular level along with balanced chemical equation 	
Aerobic and Anaerobic Respiration		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> Classify types of cellular respiration along with their importance, word or symbol equation and examples. 	
Mechanism of Respiration		3 Lectures
Understand Analysis →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> Outline the mechanism of respiration while defining Glycolysis, Krebs cycle and Electron transport Chain. Compare aerobic and anaerobic respiration with reference to the amount of energy released. Compare respiration and photosynthesis. 	

Unit 7: Nutrition

Nutrition and Nutrient		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> Introduce need and interaction of different nutrients for body functions leading to nutrition. 	
Plant nutrition - Micro and Macro Nutrients		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> Categorize mineral nutrients into macronutrients and micronutrients. 	
Importance of Nitrogen and Magnesium		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> Elaborate importance of nitrogen in protein synthesis and magnesium for chlorophyll formation. State the effects of deficiency of nitrates and magnesium ions on plant growth. 	
Importance of fertilizers		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> Describe the importance of fertilizers (organic manure and chemical) in agriculture. 	
Nutrient Supply, Energy value and Metabolic functions		1 Lecture

Understand Analysis→	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> • Distinguish between carbohydrates, proteins and fats in terms of their sources, energy values and metabolic functions. 	
Diseases related to deficiencies		2 Lectures
Understand →	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> • Specify the food sources, metabolic functions and deficiency symptoms of Vitamins A, C and D, Calcium, Iron, water and dietary fibre. 	
Skills	<ul style="list-style-type: none"> • Investigate and present in a tabulated form the required daily food intake (in terms of nutrients and calories) of a healthy adult. 	
Concept, need and components of balance diet		1 Lecture
Understand →	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> • Describe the concept and need for a balanced diet. • Explain the components of a balanced diet with relation to age, sex and activity. 	
Problems related to Nutrition		2 Lectures
Understand →	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> • Describe the problems of Protein Energy Malnutrition (PEM), Mineral Deficiency Diseases (MDD), and Over Intake of Nutrients (OIN). • State the effects of malnutrition in relation to starvation, heart disease, constipation and obesity. 	
Steps of Nutrition		1 Lecture
Understand →	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> • Introduce the needs of ingestion, digestion, absorption, assimilation and egestion. 	
Alimentary canal		1 Lecture
Understand →	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> • Describe the structures and functions of the main regions of the alimentary canal and the associated organs. • Name and number Human teeth and describe general structure of tooth. • Tell common practices for Oral cavity and dental hygiene. 	

Action of enzymes		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> Sort out the action of enzymes in specific regions of alimentary canal, with respect to their substrates and products. 	
Significance of villi, capillaries and function of hepatic portal vein		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> Describe the structure and significance of a villus, including the roles of capillaries and lacteals. State the function of hepatic portal vein as the route taken by most of the food absorbed from small intestine. 	
Disorders of gut		2 Lectures
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> State the signs and symptoms, causes, treatments and preventions of the disorders of gut i.e. diarrhoea, constipation, and ulcer. 	
STS Connections	<ul style="list-style-type: none"> Explain why farmers use chemical fertilizers for better growth of their plants. Describe ways in which research about nutrition has brought about improvements in human health (e.g., development of nutritional supplements, and diets based on the needs of age, sex, and activity). Exemplify the societies suffering from famine due to unequal distribution of food and due to over-population. 	

Unit 8: Transportation

Transportation and its need in plant		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> Conceptualize transportation and its need. 	
Structure and function of root		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> Recognize the internal structure of root and root hair. Illustrate how roots take up water and mineral salts by active and passive absorption. 	
Significance of transpiration		2 Lectures
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> Discuss process and importance of transpiration. 	

Factors affecting transpiration		2 Lectures
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> • Recognize temperature, wind and humidity as the factors affecting the rate of transpiration. 	
Transpiration pull and mechanism of food translocation		1 Lecture
Understand →	<ul style="list-style-type: none"> • Describe the movement of water in terms of transpiration pull. • Explain the mechanism of food translocation by the theory of Pressure Flow Mechanism. 	
Transportation in Man		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> • Introduce cardiovascular system in humans. 	
Components of blood and blood groups		2 Lectures
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> • List the functions of the components of blood. • Determine blood groups in ABO and Rh blood group systems, with reference to the presence or absence of antigens and antibodies. • State the risk of incompatibility in blood transfusion due to antigen-antibody reactions. 	
Donor recipient relation with reference to antigen antibody reaction		2 Lectures
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> • List the appropriate donors and recipients for each of the four blood groups. 	
Diseases related to blood		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> • State the signs and symptoms, causes and treatments of the diseases of blood (leukemia, hemophilia and thalassemia). 	
Gross anatomy of heart		1 Lecture
Understand →	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> • Identify and describe the external and internal structure of human heart. 	
Double pump action of heart		2 Lectures
Understand Application→	<i>After reading this topic the student will be able to:</i> <ul style="list-style-type: none"> • Plot the circulation of blood through atria and ventricles of the heart, explaining the role of the bicuspid, tricuspid and semilunar valves. • Differentiate the low-pressure circulation to the lungs and a high-pressure circulation to the body tissues and 	

	<p>relate these differences to the different functions of the two circuits.</p> <ul style="list-style-type: none"> • Define the terms heartbeat, heart rate and pulse rate. 	
Skills	<ul style="list-style-type: none"> • Identify in a diagram of the heart the right atrium, right ventricle, left atrium, left ventricle, bicuspid valve, tricuspid valve, semi-lunar valves, pulmonary artery, pulmonary vein, aorta, superior and inferior vena cava and septum. 	
Veins, arteries and capillaries		2 Lectures
Understand Analysis→	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> • Compare the structure and function of an artery, a vein and a capillary. • Describe the transfer of materials between capillaries and tissue fluid. 	
General Plan of arterial and venous system		3 Lectures
Understand →	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> • Describe the origins, locations and target areas of main arteries i.e. pulmonary arteries, aorta with hepatic artery, renal arteries and femoral arteries. • Describe the originating areas, locations and target heart chambers of main veins i.e. pulmonary veins, superior vena cava, inferior vena cava with femoral veins, renal veins and hepatic vein. • Describe the contributions of Ibn-al-Nafees and William Harvey in revealing the knowledge about the circulation of blood in human body. 	
Skills	<ul style="list-style-type: none"> • Identify the main arteries and veins in charts, diagrams, models etc. 	
Cardiovascular Disorders		2 Lectures
Understand →	<p><i>After reading this topic the student will be able to:</i></p> <ul style="list-style-type: none"> • Define cardiovascular disorders and differentiate between Atherosclerosis and Arteriosclerosis • State the causes, treatments and prevention of Myocardial infarction. 	
STS Connections	<ul style="list-style-type: none"> • State vascular surgery as one of the major fields in medical career. 	