

SLO 1: Introduction to Biology

1.1 Introduction

1.1.1 Define 'Biology'

Biology is the scientific study of life. The word "biology" has been derived from two Greek words; 'bios' meaning 'life' and 'logos' meaning 'thought or reasoning'.

1.1.2 Differentiate Among the Major Divisions of Biology

Zoology	Botany	Microbiology
This division of biology deals with the study of animals.	This division of biology deals with the study of plants.	This division of biology deals with the study of microorganisms.

1.2 Divisions and Branches of Biology

1.2.1 Explain The Significance Of Branches Of Biology

- Morphology:** This branch deals with study of external form and structure of organisms.
- Anatomy:** This branch deals with study of internal structure of body of living organisms.
- Physiology:** This branch deals with the study of the functions of different parts of living organisms.
- Embryology:** the study of process of development of organism from fertilized egg.
- Taxonomy:** The study of the rules, principles, grouping and naming the living organisms.
- Cytology (cell biology):** The study of cell and its organelle.
- Histology:** The study of structure of tissues of plant and animals.
- Paleontology:** The study of remote past organic life, with the help of fossils.
- Pathology:** the study of diseases, their causes and effects.
- Ecology:** The study of relationship between living organisms and non-living factors of environment.
- Socio-biology:** The study of social behavior of living organisms. i.e., interaction between themselves.
- Molecular biology:** The study of organic molecules which constitute cell and its organelles.
- Immunology:** The study of immune system of animals, which defends body against invading microbes.
- Genetics:** The study of heredity, that is transferring of characters from parents to offspring.
- Pharmacology:** The study about action of drugs.
- Marine biology:** the study of life in oceans.
- Freshwater biology:** the study of life in aquatic reservoirs on land.

1.3 Relationship of Biology with Other Sciences

1.3.1 Relate Biology To Other Branches Of Science

Biophysics:

It deals with the study of the principles of physics, which are applicable to biological phenomena.

Biochemistry:

It deals with the study of chemistry of different compounds and processes occurring in living organisms.

Biostatistics:

It deals with the study of the distribution of living organisms in different in different geographical regions of the world. The influence of climate change on the distribution of organisms is also studied in biogeography.

Biomathematics/Biometry:

It deals with the study of biological processes using mathematical techniques and tools. For example, to analyze the data gathered after experimental work, biologists have to apply the rules of mathematics.

Biogeography:

It deals with the distribution of different living organisms in different geographical regions of the world. Many living organisms are restricted to particular geographical regions due to environmental conditions.

Bio-economics:

It deals with the study of organisms from economical point of view. For example, the cost value and profit value of the yield of wheat can be calculated through bioeconomics and benefits or losses can be determined.

Computational biology:

In computational biology, scientists use mathematical models, algorithms, and computer simulations to understand biological systems and relationships. It involves analyzing biological data, such as sequence of amino acids in a protein.

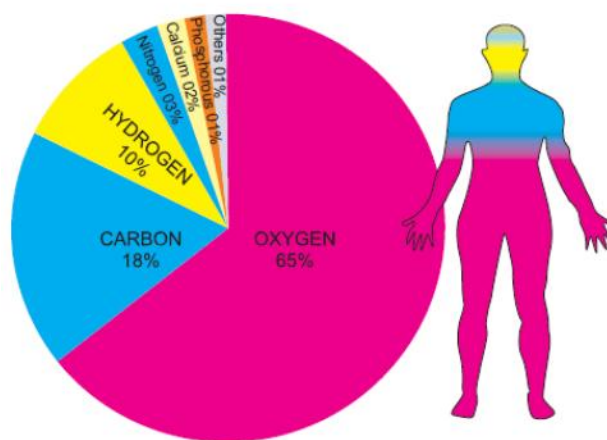
Biotechnology:

It deals with the use of living organisms or their components to develop beneficial products or processes for various fields, including healthcare, agriculture, environmental management. Bacteria to produce insulin.

1.6 The Levels of Organization

1.6.1 Describe Bio Elements As The Most Basic Level Of Biological Organization

Out of the 92 kinds of elements that occur in nature, 16 are called bioelements. These take part in making the body mass of a living organism. Out of these bioelements; Only six (O, C, H, N, Ca, & P) make 99% of the total mass. Other ten (K, S, Cl, Na, Mg, Fe, Cu, Mn, Zn, & I) collectively make 01% of the total mass.



1.6.2 Explain Biomolecules And Their Types

An organism is formed by enormous number of biomolecules of hundreds of different types. These molecules are the building material and are themselves constructed in great variety and complexity due to specific bonding arrangements. Biomolecules are classified as micromolecules and macromolecules. Micromolecules are with low molecular weight e.g. glucose, water etc. and macromolecules are with high molecular weights e.g. starch, proteins, lipids etc.

1.6.3 Differentiate Among The Levels Of Organization Of Life

- The biomolecules when work together in the form of suspension, it is called Protoplasm (organelle). Protoplasm is the combination of organic and specific inorganic substances.
- When protoplasm work in the form of a unit, this is called Cell. Cell is the basic unit of living organisms.
- When similar type of cells organizes together in a group, called tissues.
- The different types of tissues arranged in a particular manner to work together are called Organs.
- Organs of different types work in a coordinated manner to perform a function is called Organ-system.
- Different organ-system function in coordination in as a unit; form a body or Multicellular Organism.

- The Species is the smallest unit of taxonomic level of organization, which includes morphologically similar living organisms which inter-breed and produce fertile offspring.
- All the members of a species, living in specific habitat are called Population. A group of parrots living on tree, is called parrot population.
- The members of different species living in specific habitat are called as Community. A group of different kind of birds, living on tree, is called as bird community.
- Communities always depend upon their non-living environment in a reciprocal interaction for their survival. For example, oxygen for respiration is obtained from environment and in turn given out CO₂. This interaction is called Ecosystem or Ecological system.
- The part of earth where life exists is called biosphere. It consists of different kinds of ecosystems.

1.6.4 Identify The Types Of Tissues That Form Different Organs

The Stomach

The stomach is a prime example of tissues working for a common goal (digestion).

1. **Epithelial (Glandular) Tissue:** Lines the inner surface; it secretes gastric juice (enzymes and HCl) for the chemical breakdown of proteins.
2. **Muscular Tissue:** Thick layers of smooth muscle that perform peristalsis (churning/grinding) to mix food with enzymes.
3. **Nervous Tissue:** Controls the timing of secretions and the contraction of muscles.

The Lungs

The lungs are designed for the maximum exchange of gases.

1. **Epithelial (Squamous) Tissue:** Forms the thin walls of the alveoli to allow rapid diffusion of O₂ and CO₂.
2. **Connective (Blood/Elastic) Tissue:** Elastic fibers allow the lungs to expand and recoil, while capillaries (blood tissue) transport the gases.
3. **Nervous Tissue:** Regulates the rate of expansion and contraction (breathing rhythm).

The Leaf

1. **Epidermal Tissue:** A single outer layer that protects the leaf and contains stomata for gas exchange.
2. **Mesophyll Tissue:** The "functional" tissue of leaf containing chloroplasts; it is the site of photosynthesis.
3. **Vascular Tissue:** Transports water to the leaf (Xylem) and carries manufactured sugar away (Phloem).

The Root

1. **Epidermal Tissue (Root Hairs):** Increases surface area for the absorption of water and minerals from soil.
2. **Ground Tissue (Cortex):** Primarily used for the storage of food (starch).
3. **Vascular Tissue:** Located at the center; moves absorbed water upward to the stem.

The Stem

1. **Epidermal Tissue:** Provides a waterproof and protective outer covering.
2. **Vascular Tissue (Bundles):** Provides structural support to keep the plant upright and acts as a long-distance transport system.
3. **Ground Tissue:** Fills the space between the epidermis and vascular bundles, provides additional strength.

1.6.5 Different Organ Systems Work Together To Form A Functioning Human Body

Different organs performing related functions are organized together in the form of an organ system. In an organ system, each organ carries out its specific function and the functions of all organs appear as the function

of the organ system. For example, digestive system is an organ system that carries out the process of digestion. Major organs in its framework are oral cavity, stomach, small intestine, large intestine, liver, and pancreas. All these organs help in the process of digestion.

1.7 Division of Labor in Unicellular and Multicellular Organisms

1.7.1 Define 'Division Of Labor' In Living Organisms

Division of labor in living organisms refers to the specialization of cells, tissues, or organs to perform specific functions. This helps the organism operate more efficiently.

1.7.2 Compare Division Of Labor In Unicellular And Multicellular Organisms

In unicellular organisms, only one cell makes the life of an organism. All the life activities are carried out by the only cell. Amoeba, Paramecium, and Euglena are common examples.

In colonial type of cellular organization, many unicellular organisms live together but do not have any division of labor among them. Each unicellular organism in a colony lives its own life and does not depend on other cells for its vital requirements. Volvox; a green alga found in water that shows colonial organization.

In multicellular organization, cells are organized in the form of tissues, organs and organ systems which work together and are highly dependent on each other for complete functioning of the organism. Frog and mustard are the familiar examples of multicellular organization.

1.7.3 Differentiate Between Colony-Level And Tissue-Level Organization

Feature	Volvox (Colony-Level Organization)	Frog (Tissue-Level Organization)
Cell Specialization	Cells are mostly identical (vegetative). Each cell performs all life functions itself.	Cells are highly specialized (e.g., muscle, nerve, blood) to perform specific tasks.
Interdependence	Cells are physiologically independent. An individual cell can survive if separated.	Cells are interdependent. A single heart or brain cell cannot survive on its own.
Division of Labor	Minimal. Coordination is limited to movement (flagella) and reproduction.	High. Different tissues collaborate to form organs (e.g., stomach) and systems.
Structure	A hollow sphere of independent cells held together by a gelatinous matrix.	Complex layers of specialized tissues (epithelial, muscular, etc.) forming a body.
Level of Complexity	Simple; a "collection" of individuals.	Highly complex; a single integrated individual.

1.7.4 Justify That The Volvox Colony Does Not Meet The Criteria For Having The True Tissue-Level Organization

Although Volvox consists of thousands of cells working together, it fails to meet the "Tissue Level" criteria.

1. Lack of Cellular Specialization

In true tissue-level organization, cells undergo differentiation to perform specific, exclusive functions (e.g., muscle cells only contract, nerve cells only signal). Most cells in a Volvox colony are vegetative cells that are identical in structure and function. Each cell performs its own photosynthesis, respiration, and excretion.

2. Physiological Independence

In a tissue, cells are interdependent. If separated, an individual cell from a complex tissue usually cannot survive because it lacks the machinery to perform all life processes. Each individual cell in the colony possesses its own flagella, chloroplast, and contractile vacuoles. If a vegetative cell is isolated from the colony, it remains physiologically independent and capable of staying alive on its own.

3. Absence of Division of Labor

Tissues involve a "division of labor" where different groups of cells take on different roles for the survival of the whole organism. While there is slight coordination for movement (using flagella), there is no complex division of labor where one group forms a digestive system and other forms a protective skin. They are simply a collection of individual organisms living together for protection and better locomotion.

1.7.5 Evaluate The Role Of Different Cell Types Within A Specific Tissue/Organ For Its Overall Functioning.

The Human Stomach		
Cell Type	Role	Contribution to the Organ
Glandular Epithelial Cells	Secretion of HCl and Pepsinogen.	Creates an acidic environment to kill bacteria and begin protein digestion.
Goblet Cells	Secretion of a thick mucus layer.	Protects the stomach's own muscular walls from being digested by HCl.
Smooth Muscle Cells	Arranged in longitudinal and circular layers.	Contract to "churn" food, physically breaking it down and mixing it with enzymes.
Nervous Tissue Cells	Coordination of signals.	Ensures the stomach only secretes acid and contracts when food is actually present.
The Plant Leaf		
Cell Type	Role	Contribution to the Organ
Palisade Mesophyll Cells	Packed with chloroplasts.	Maximizes the absorption of sunlight for the light-dependent reactions of photosynthesis.
Spongy Mesophyll Cells	Loosely packed with large air spaces.	Facilitates the diffusion of CO ₂ to the palisade cells and O ₂ out of the leaf.
Guard Cells (Epidermis)	Opening and closing of stomata.	Regulates gas exchange and prevents excessive water loss (transpiration).
Xylem & Phloem Cells	Transport of fluids.	Xylem brings the "raw material" (water), and Phloem exports the "product" (sugar).