Trishna's

Pearson SUCCESS COMPANION

Pearson Foundation Series

Biology

CLASS 8

- Provides learner-friendly content, application-analyse based questions and hints and solutions for strong foundation
- Uses a graded approach to generate, build and retain interest in concepts and knowledge simulation

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CLASS

8

Pearson Foundation Series

Biology

Trishna Knowledge Systems

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Brief Contents

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Contents

Preface

Pearson Foundation Series has evolved into a trusted resource for students who aspire to be a part of the elite undergraduate institutions of India. This new Biology series is an addition to the existing Foundation series particularly targeted for Medical and other related examinations. Each title in this series providing authentic and class-tested content for effective preparation—strong foundation, and better scoring.

The structure of the content is designed in such a manner that it motivates students to go beyond the usual school curriculum, and acts as a source of higher learning to strengthen the fundamental concepts of Biology.

The core objective of the series is to be a one-stop solution for faster and effective preparation for various competitive examinations. Irrespective of the field of study that the student may choose to take up later, it is important to understand that Mathematics and Science form the basis for most modern-day activities. Hence, utmost effort has been made to develop student interest in these basic blocks through real-life examples, critical thinking skills, and asking questions based on application-analyze from the key concepts. Ultimately, the aim is to ingrain the art of problem-solving in the mind of the reader.

To ensure high level of accuracy and practicality, this series has been authored by a team of highly qualified teachers with a rich experience, and are actively involved in grooming young minds. That said, we believe that there is always scope for doing things better and hence invite you to provide us with your feedback and suggestions on how this series can be improved further.

Chapter Insights

REMEMBER

Before beginning this chapter, you should be able to:

- Recall the basic features of a cell
- Remember the meaning and organization of tissue

Remember section will help them to memories and review the previous learning on a particular topics

Key points will help the students to identify the essential points in a chapter

KEY IDEAS

After completing this chapter, you should be able to:

- Understand the role of cell in maintaining life
- Identify the different cell organelles and their functions
- Differentiate between mitosis and meiosis

Microorganisms in Medicinal Industry

Microorganisms are used to make antibiotics. These antibiotics are used to kill or stop the growth of other disease-causing microorganisms. A simple example is penicillin. Penicillin can be obtained from the fungus *Penicillium*. These antibiotics can be used to cure many diseases that are caused by microorganisms, (except viral diseases). Microorganisms can also be used in the production of vaccine. A vaccine is a biological preparation that consists of either dead or weakened microbes. When a vaccine is introduced into the body, the body produces antibodies against the vaccine, which remains in the body and protects the body from attack by the same microbe in the future. The common examples are rabies and tuberculosis vaccines.

Concepts are explained in a well structured and lucid manner

Info boxes are some add-on information on related topics

Info Box!

There are more bacterial cells in human body than human cells!

If we look around, we see many different objects, some of tl and some are non-living. However, both living and non-liv composed of certain basic chemical elements, such as Carbc Oxygen and Nitrogen. These chemical elements are found ir manner in the form of cells in the living beings, which disti from non-living. Cells are the basic structural and functional cell is the smallest individual unit of matter capable of performi life processes by itself.

QUICK RECAP

1. **Define tissue with one example.**

   Groups of cells either similar or dissimilar and which perform a specific function are called tissue. for example, muscular tissue in humans aids in movement and locomotion.

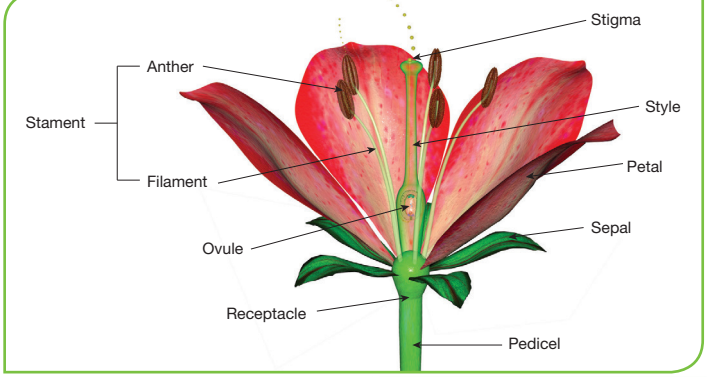
2. **Differentiate between apical meristem and lateral meristem**

   Meristems are the plant tissues that can divide throughout their life.

Apical meristem	Lateral meristem
Seen at the growing tips of roots and shoots	Seen along the sides of the stem and the root
Increases the length of root and stem	Increases the girth of plant body
Involved in primary growth of plants	Involved in secondary growth of plants

Quick Recap section will help to review all important concepts, discussed in that particular chapter

Each section contains detailed diagrams, images, real life microscopic views for better understanding and conceptual clarity.



TEST YOUR CONCEPTS

Directions for questions 1 to 20: Fill in the blanks in each question.

1. The first living cell was discovered by _____
2. _____ is the basic structural and functional unit of life.
3. Take the odd one out.

   Amoeba, Bacteria, Plant, Honeybee.
4. The concept '*Omnis cellula e cellula*' was put forward by _____.

23. Which of the following can change its shape?

    (i) Amoeba (ii) Neuron
    (iii) WBC (iv) RBC
    (a) (i) only (b) (i) and (ii)
    (c) (i) and (iii) (d) (i), (ii), (iv)
24. Nucleoid is the region where _____ is/are located

    (a) Genetic material (b) Proteins
    (c) Pigments (d) Nutrients

Different levels of questions have been included in the *Test Your Concept* as well as on *Mastering the Concepts* which will help students to develop the problem-solving skill

'Test Your Concepts' at the end of the chapter for classroom preparations

MASTERING THE CONCEPTS

Knowledge and Understanding

1. What are stomata and what are their significance in a plant?
2. Make a comparison between the three types of simple permanent tissue based on their structures.
3. Differentiate between xylem and phloem.
4. Write the significance of collenchyma in plants?
5. How permanent tissue is formed from meristematic tissue?
6. What is a permanent tissue and how it is classified?
10. Differentiate between mitosis and meiosis.
11. Differentiate between bone and cartilage.
12. How epithelial tissues have been classified according to their shape?
13. What is ciliated epithelium, and why are they important in the respiratory tract?
14. Make a comparison between tendon and ligament.
15. Which type of tissue is blood and what is its function?
16. Give a note on the structure of neuron.

Mastering the concepts are further divided as per Knowledge/ Understanding, and Application/Analyze

Knowledge and Understanding

1. Science plays a major role in everyday life. It has made our communication easy, even if we are at far away places. It has also made our transportation easy and comfortable. Through science, it is now possible to treat millions of diseases, thereby increasing the lifespan of people.
2. Communicating the results obtained after data analysis to let others know about it is the last step in a scientific method. The results can be presented as written or oral reports. Communicating the results to peers may lead to new questions every time which may in turn lead to another investigation.
3. **Vikram Sarabhai:** Father of Indian space programme.

   Srinivasa Ramanujan: Indian mathematician who made major contributions to number theory, infinite series, etc.

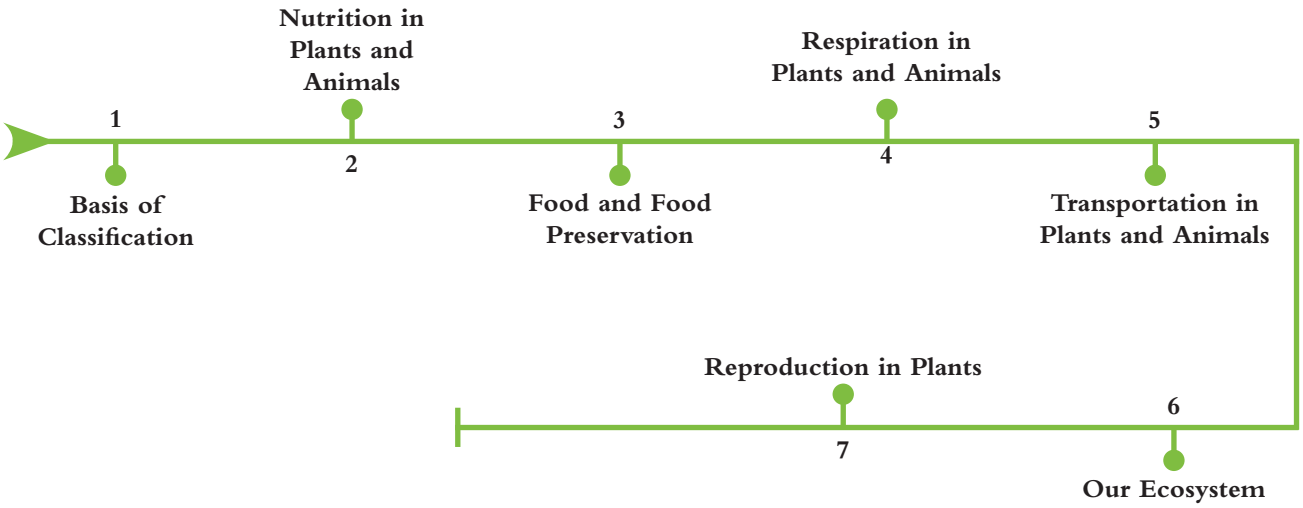
   CV Raman: Indian physicist who carried out major work in the field of light scattering

HINTS AND EXPLANATION

Hints and Explanation for key questions along with highlights on the common mistakes that students usually make in the examination

Series Chapter Flow

Class 7



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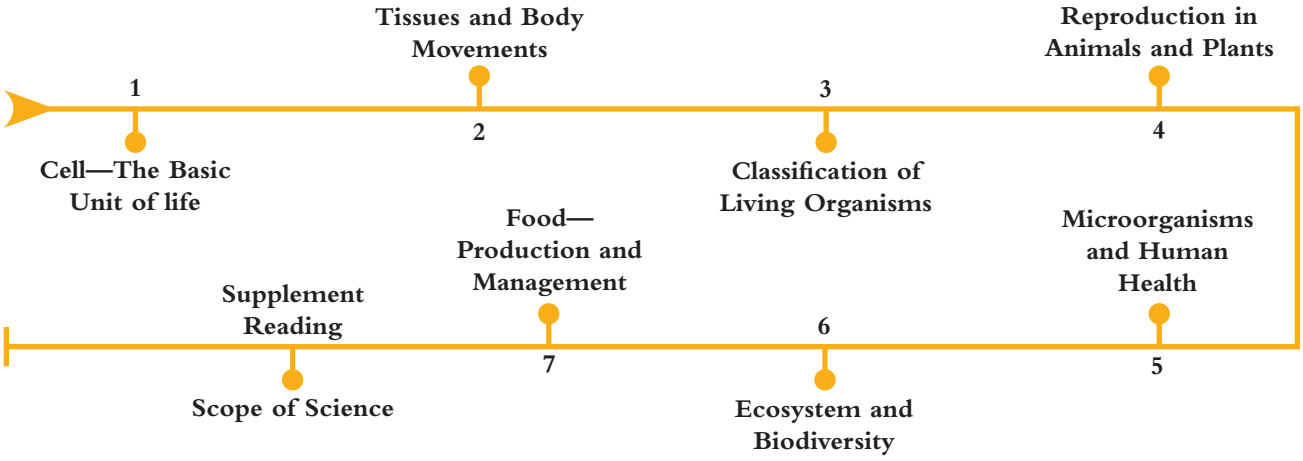

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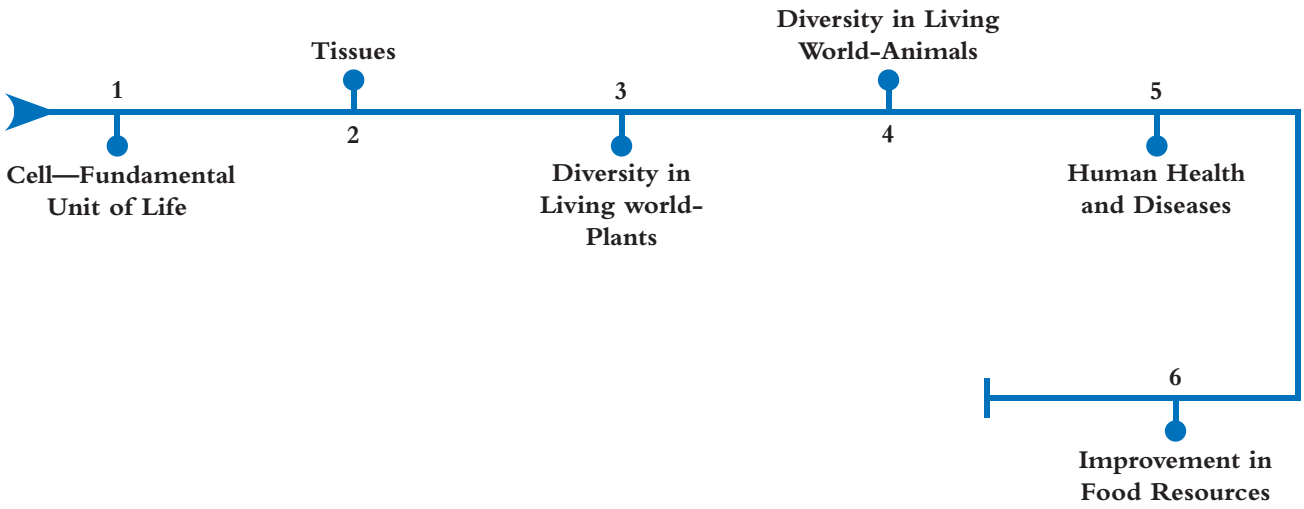

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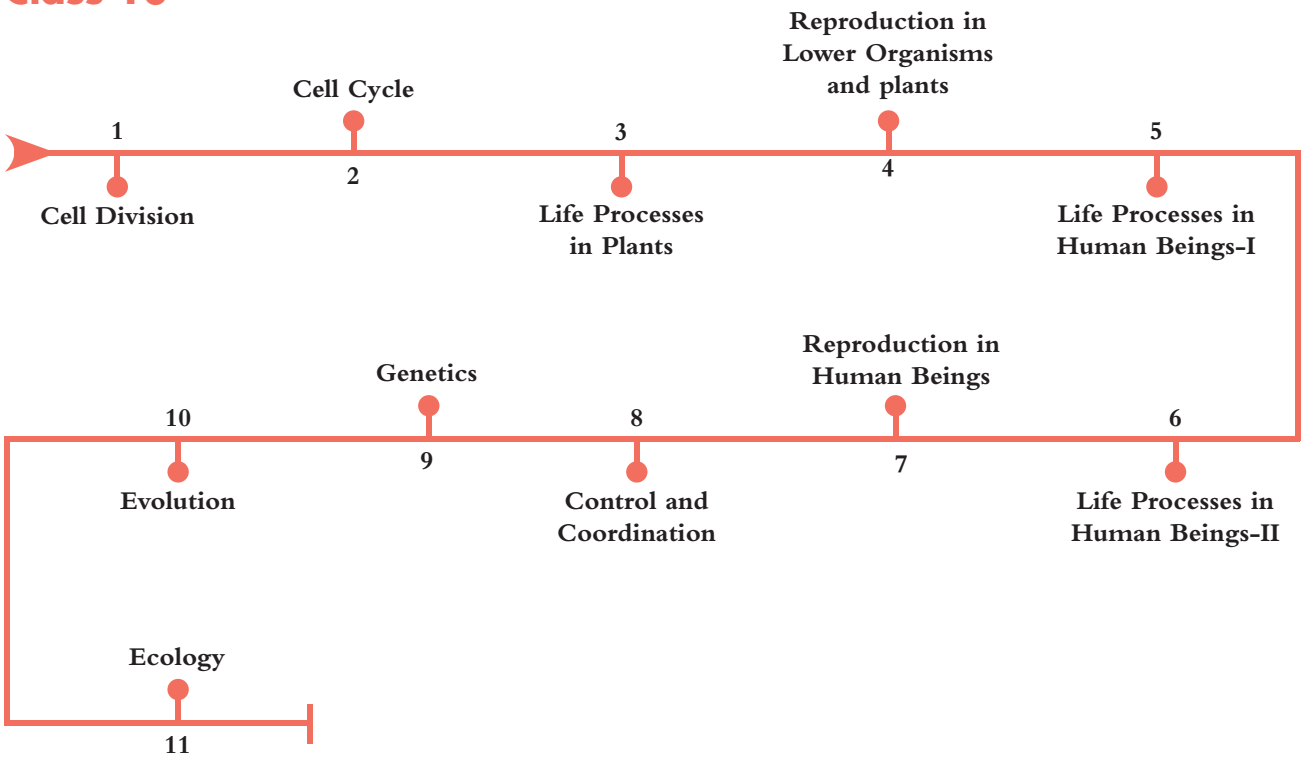

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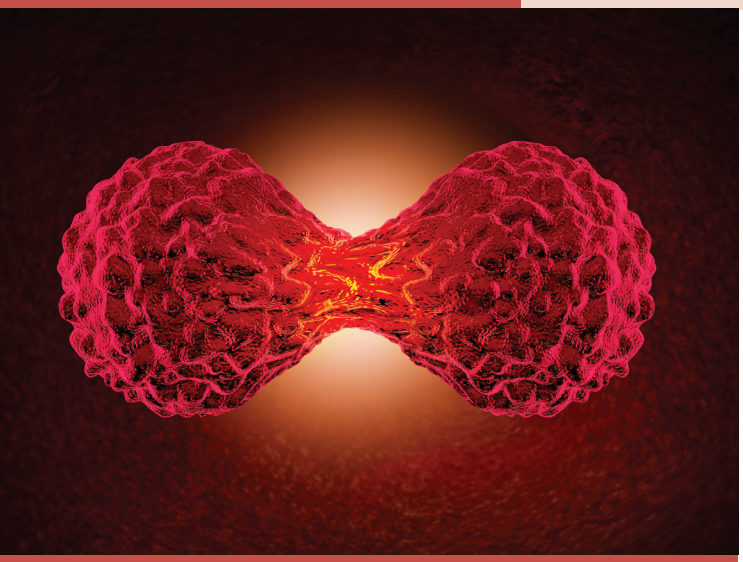
Chapter

1

Cell—The Basic Unit of Life



REMEMBER

Before beginning this chapter, you should be able to:

- Recall the cellular organization in humans
- Remember important cell organelles and their functions

KEY IDEAS

After completing this chapter, you should be able to:

- Understand the role of cell in maintaining life
- Identify the different cell organelles and their functions
- Differentiate between mitosis and meiosis

INTRODUCTION

Info Box!

There are more bacterial cells in human body than human cells!

If we look around, we see many different objects, some of them are living and some are non-living. However, both living beings and non-living things are composed of certain basic chemical elements, such as Carbon, Hydrogen, Oxygen and Nitrogen. These chemical elements are found in an organized manner in the form of cells in the living beings, which distinguishes them from non-living. Cells are the basic structural and functional units of life. A cell is the smallest individual unit of matter capable of performing all essential life processes by itself.

CELL—THE BASIC UNIT OF LIFE

The term 'cell' is derived from Latin word *cellula*, meaning 'little room'. The term cell was coined by Robert Hooke in 1665. A cell is the smallest building block of life. It is defined as the basic structural and functional unit of a living organism. A cell is capable of performing all vital functions to sustain life.

Discovery of Cell

In 1665, Robert Hooke observed the thin slices of cork under a microscope. He noticed several small compartment-like structures that resembled the structure of a honeycomb.

FIG. 1.1 Microscope used by Robert Hooke to make his observations of cells

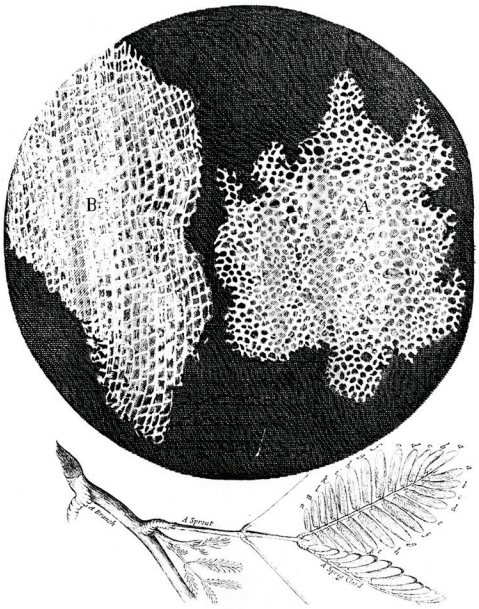


FIG. 1.2 Robert Hooke's observations of cellular structure of cork

Unicellular and Multicellular Organisms

Cell is the basic structural and functional unit of life. All living organisms are made up of cells. In one case, a single cell may constitute an organism (unicellular) and in other case, an organism may consist of many cells (multicellular). According to this, organisms can be divided into two types:

1. **Unicellular organisms:** Organisms with only one cell, for example, *Amoeba*, *Chlamydomonas*, *Paramoecium*, bacteria, etc.

Info Box!

In 1674, Anton Van Leeuwenhoek observed free living cells in pond water.

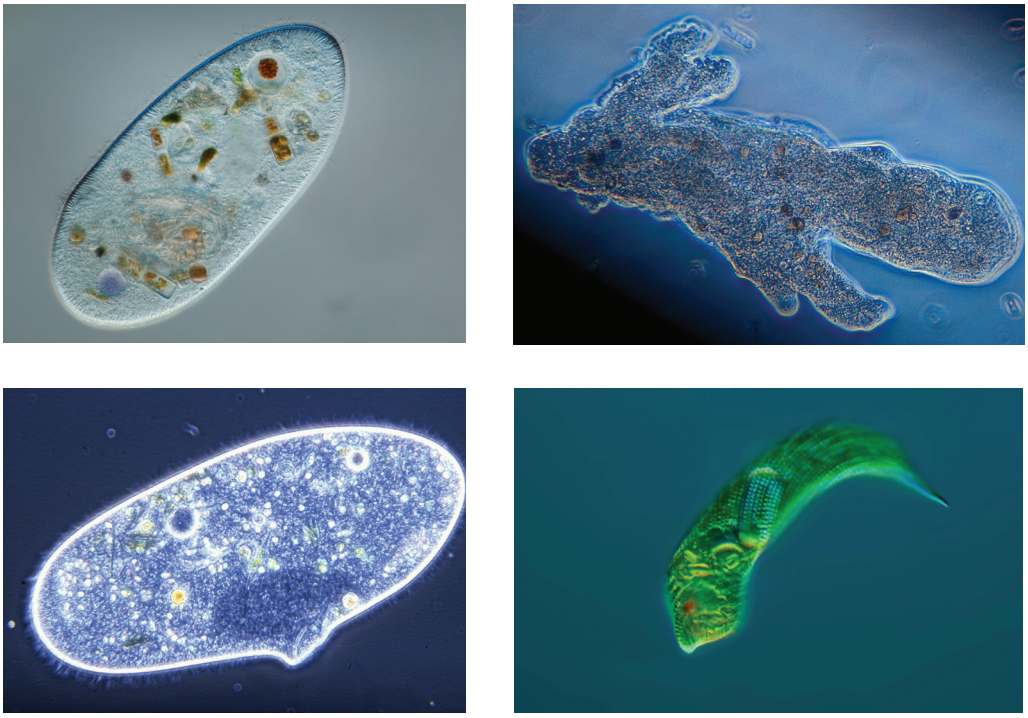


FIG. 1.3 Some common unicellular organisms

2. **Multicellular organisms:** Organisms with many cells, for example, plants and animals, are called multicellular organisms.

Info Box!

The number and type of cells in a given tissue is called cellularity.

Size and mass of a typical cell are 10 micrometre and 1 nanogram.

Cell Theory

Cell theory was proposed by Matthias Jakob Schleiden (1838) and Theodor Schwann (1839) and was later modified by Rudolf Virchow. The two main postulates are:

1. All organisms are made up of cells.
2. Cell is the basic structural and functional unit of life.

An important addition to the Cell Theory was made by Rudolph Virchow in 1868. He stated that new cells arise from pre-existing cells (in Latin: *omnis cellula e cellula*).

Table 1.1 Some famous scientists and their contribution to the field of cell biology

Scientist	Contribution
Robert Hooke	Discovered cell
Anton Van Leeuwenhoek	Observed first living cell
Robert Brown	Discovered cell nucleus
Purkinje	Coined the term 'protoplasm'
Schleiden, Schwann, Virchow	Cell theory
Camillo Golgi	First described Golgi apparatus

Info Box!

Smallest cell: *Mycoplasma*
Largest cell: Ostrich's egg
Longest cell: Neuron (in humans)

Size of Cell

Most cells are minute and are visible only under the microscope. They are only a few micrometres in diameter. The cells range in size from micrometers to as long as 1 m. There are some cells which are big enough to be seen with naked eye. For example, egg of an ostrich is about 15-cm long and 13-cm wide.

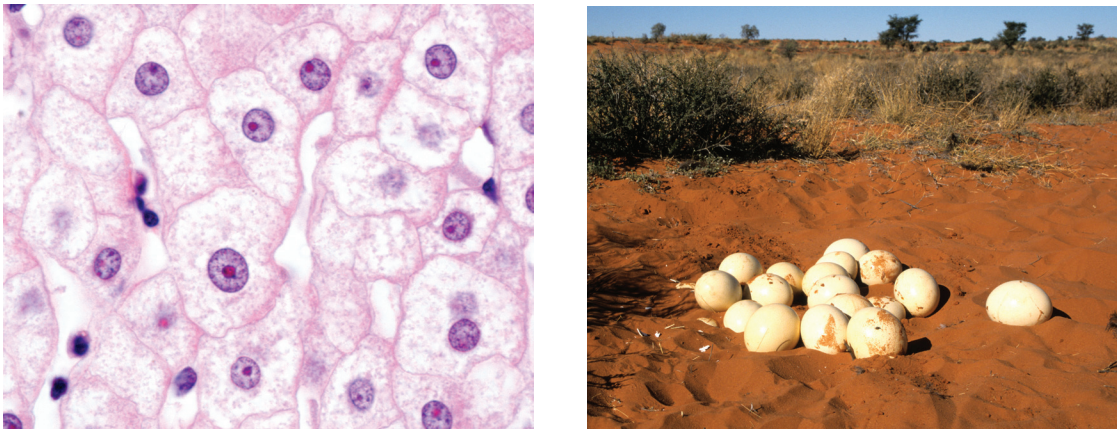


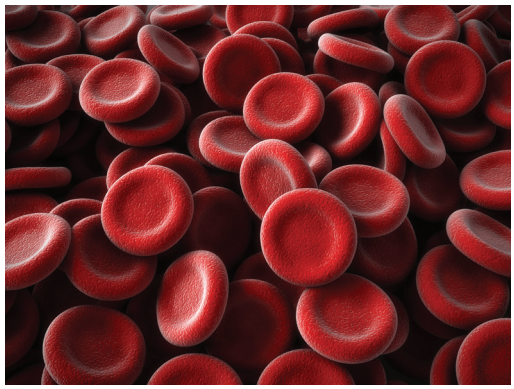
FIG. 1.4 (Left) Microscopic view of cells that are not visible to naked eye (Right) Ostrich eggs in in nest, Kalahari desert (Africa)

Info Box!

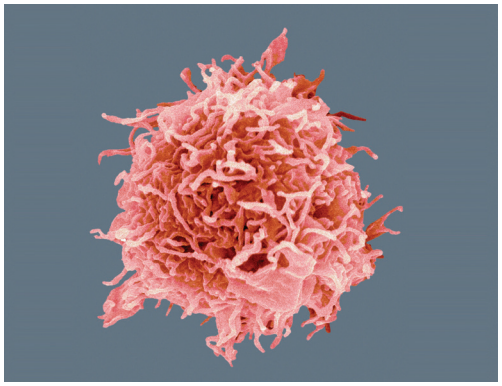
Naked eye means an unaided vision, without a telescope, microscope or other optical device

Shape of Cell

The shape of the cells varies according to their function. They may be disc-like, polygonal, columnar, cuboid or thread-like. Nerve cells have an elongated structure and this helps them in conducting impulses quickly. Similarly, there are cells that have a flexible shape, for example, *Amoeba* and some blood cells. The flexibility in *Amoeba's* shape helps it to perform various activities, such as movement, feeding, etc. The change in shape of *Amoeba* is due to the formation of pseudopodia that are projections on its body.

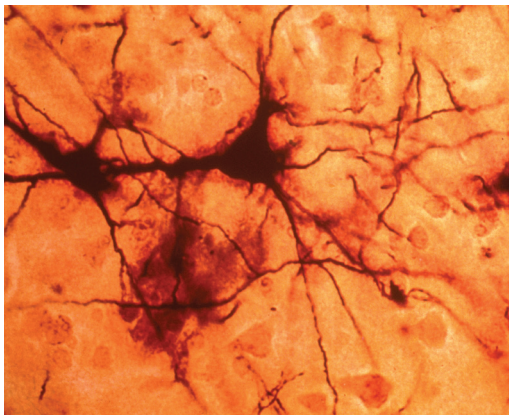


Red blood cells
(round and biconcave)



White blood cells
(amoeboid)

Columnar epithelial cells
(long and narrow)



Nerve cells
(branched and long)

FIG. 1.5 Different types of cells showing different shapes

Types of Cells

The cells can be divided into two types: prokaryotic and eukaryotic, according to the differences in their cellular organization. The cells which posses a true nucleus along with membrane-bound organelles are called eukaryotic cells, example plant cell and animal cell. The cells which do not possess a well-defined nucleus as well as membrane-bound organelles are called prokaryotic cells, example bacterial cell.

Prokaryotic Cells

Prokaryotic cells are primitive and lack a true nucleus. Their genetic material is not surrounded by a nuclear membrane and is confined to a particular region known as nucleoid.

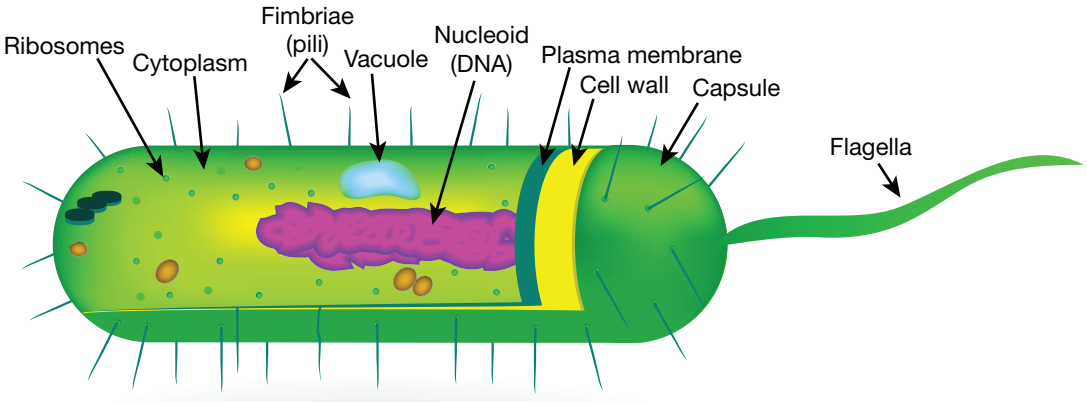


FIG. 1.6 A prokaryotic cell

Prokaryotic cells are generally smaller than eukaryotic cells. There are four basic shapes for prokaryotes (bacteria) listed as follows:

1. Coccus 2. Bacillus 3. Vibrio 4. Spirillum

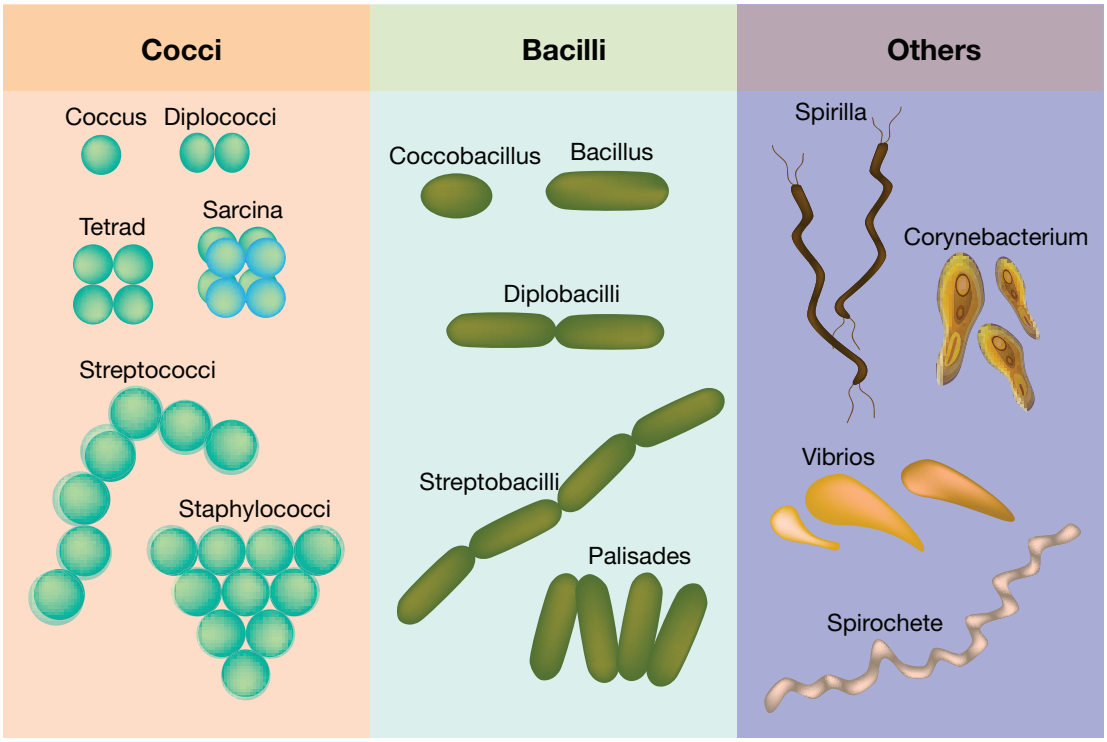


FIG. 1.7 Illustration of types of bacterial shapes

Though their shapes and sizes vary, all cells possess a common structure. All prokaryotic cells have major components that are discussed below.

Cell Wall

It forms the outermost layer of the cell. It provides integrity to the cell. It is made up of peptidoglycan, which in turn is made up of carbohydrates. It is absent in *Mycoplasma*.

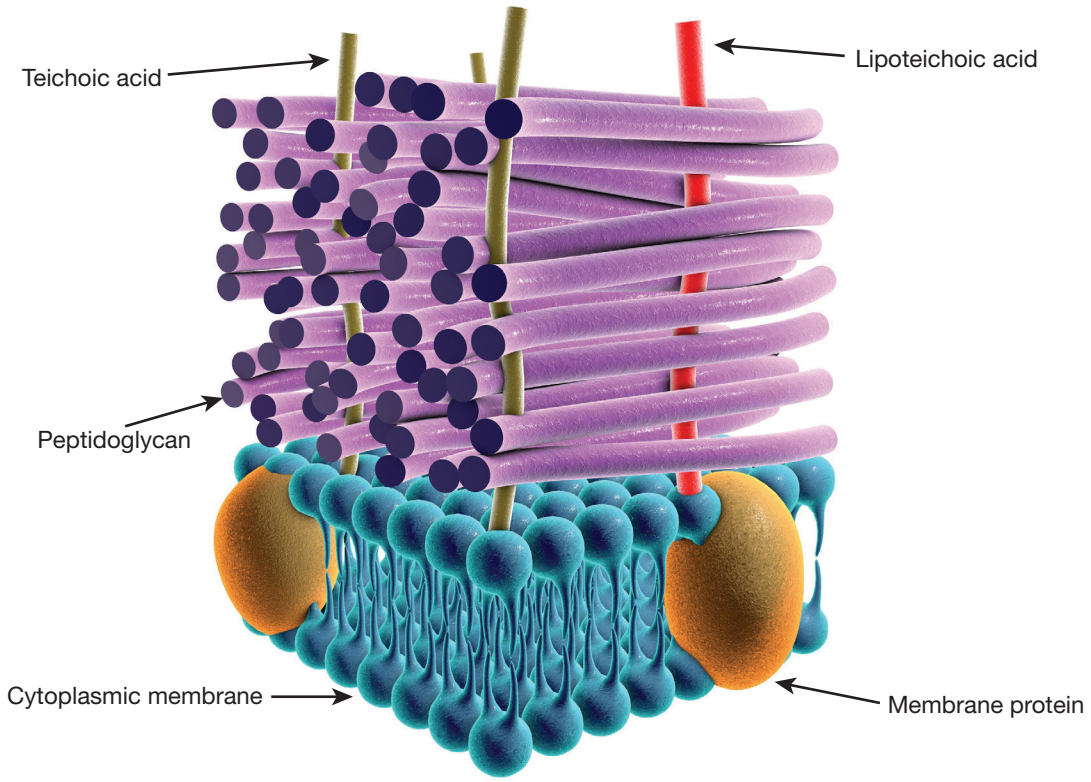


FIG. 1.8 Structure of cell wall of bacteria

Plasma Membrane

It lies just inside the cell wall. It isolates the cell's content from the outside environment and forms a barrier to substances entering in and out of the cell. Membranes are semipermeable, meaning they allow only certain substances to pass through it while preventing others. It is made up of a phospholipid bilayer.

Info Box!

Bacteria are divided into Gram-positive and Gram-negative depending upon Gram staining method developed by Christian Gram

Cytoplasm

All of the fluid substance present inside the cell constitutes its cytoplasm. It comprises all kinds of cell organelles present in a cell, with the exception of no nucleus in a prokaryotic cell.

Mesosomes

These are formed by the plasma membrane extension into the cell. They help in processes, such as cell wall formation, respiration, etc.

Ribosomes

These are the sites of protein synthesis. Ribosomes are found to be associated with plasma membrane. They are not bound by any membrane system.

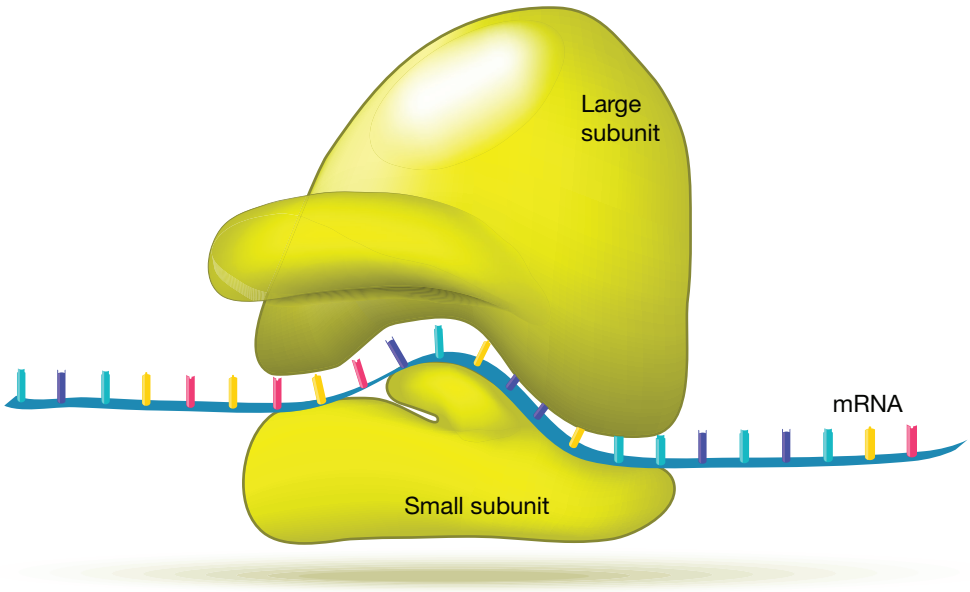


FIG. 1.9 Diagram showing ribosome structure

Cytoplasmic Inclusions

Inclusion bodies lie free in the cytoplasm. They help in storage of reserve materials, for example, phosphate granules.

Eukaryotic Cells

All eukaryotic cells possess a true nucleus, that is, their genetic material is surrounded by a nuclear envelope. All protists, fungi, plants and animals are eukaryotes. They possess membrane bound organelles, such as endoplasmic reticulum, mitochondria, Golgi bodies, etc.

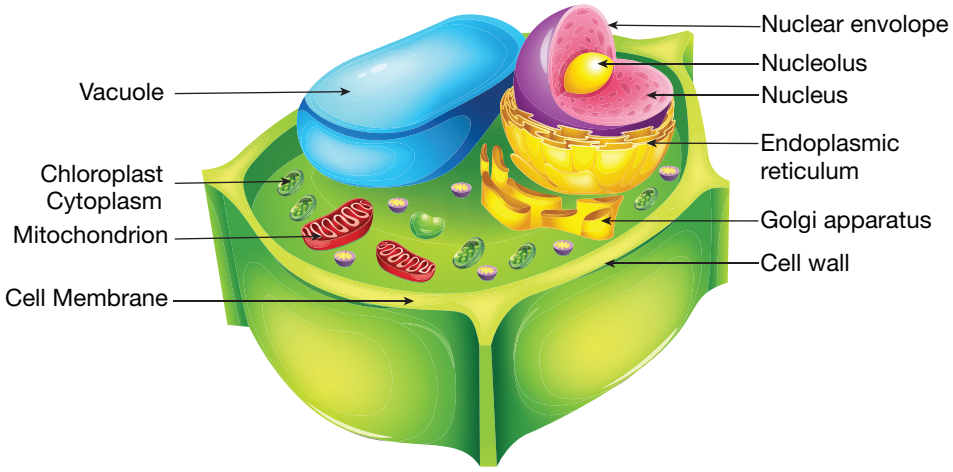


FIG. 1.10 A typical plant (eukaryotic) cell

All eukaryotic cells typically have:

Cell Wall

Plant cells are surrounded by a non-living, rigid, permeable outer layer known as a cell wall. It provides structural integrity and protection to the cell. It is made up of cellulose. Cell walls of adjacent cells are joined together by a jelly-like substance called middle lamella.

Cell Membrane

It is made up of proteins and lipids. Cell membrane is semi-permeable which means that it allows entry and exit of only some materials.

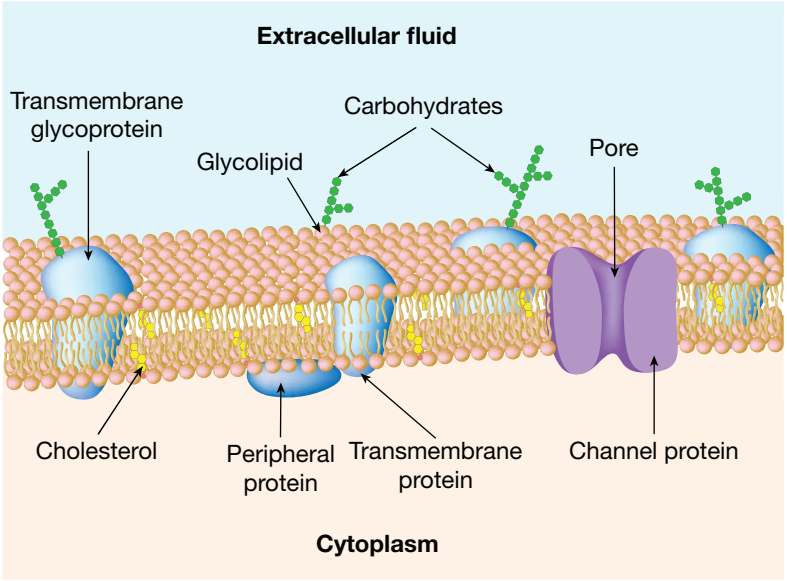


FIG. 1.11 Plasma membrane structure

Protoplasm

The living material comprising cytoplasm, nucleus and other organelles is called protoplasm.

Cytoplasm

Fluid content inside the cell membrane. Contains many membrane-bound organelles. These are discussed in detail in the following section.

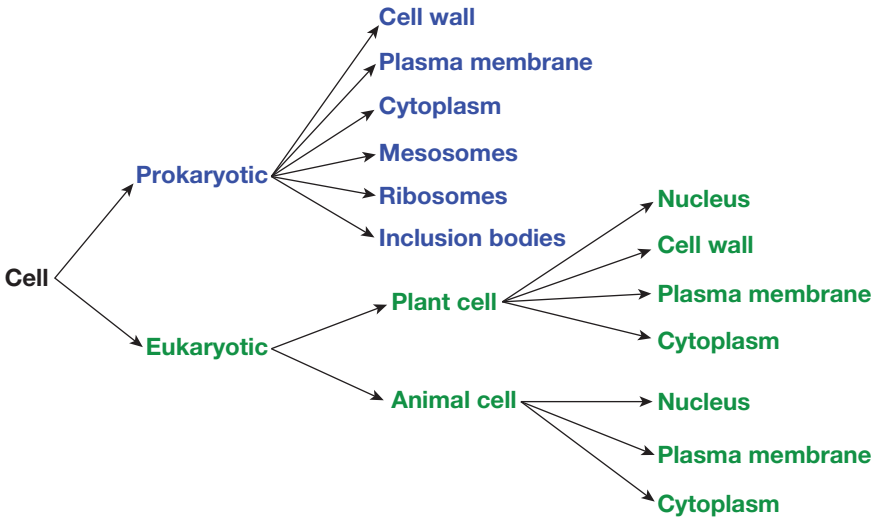


FIG. 1.12 Cellular organization in prokaryotes and eukaryotes

Table 1.2 Differences between prokaryotic and eukaryotic cell

Prokaryotic cell	Eukaryotic cell
Size generally small (1–10 μm)	Size generally large (5–100 μm)
True nucleus is absent	Nucleus is present
Contains single chromosome	Contains more than one chromosome
Membrane-bound cell organelles absent, such as endoplasmic reticulum, Golgi complex, etc.	Membrane-bound cell organelles present

Cell Organelles

An organelle is a unit inside the cell that performs a special function. The various functions performed by a cell are actually divided among the organelles, that is, there is a division of labour inside the cell in eukaryotic cells. This division of labour is absent in prokaryotic cells. For example, energy production is performed by mitochondria, photosynthesis by plastids, etc. The various cytoplasmic organelles are given below:

Endoplasmic Reticulum

It is a large network or reticulum of membrane-bound tiny tubular structures that start at the nuclear membrane and extend into the cytoplasm. They are mainly involved with the synthesis, folding, modification and transport of proteins.

Endoplasmic reticulum is of two types:

1. **Rough Endoplasmic Reticulum (RER):** which possesses ribosomes on its surface and helps in protein synthesis.
2. **Smooth Endoplasmic Reticulum (SER):** which lacks ribosomes on its surface. They are a major site for lipid synthesis and also involved in the detoxification of poisons.

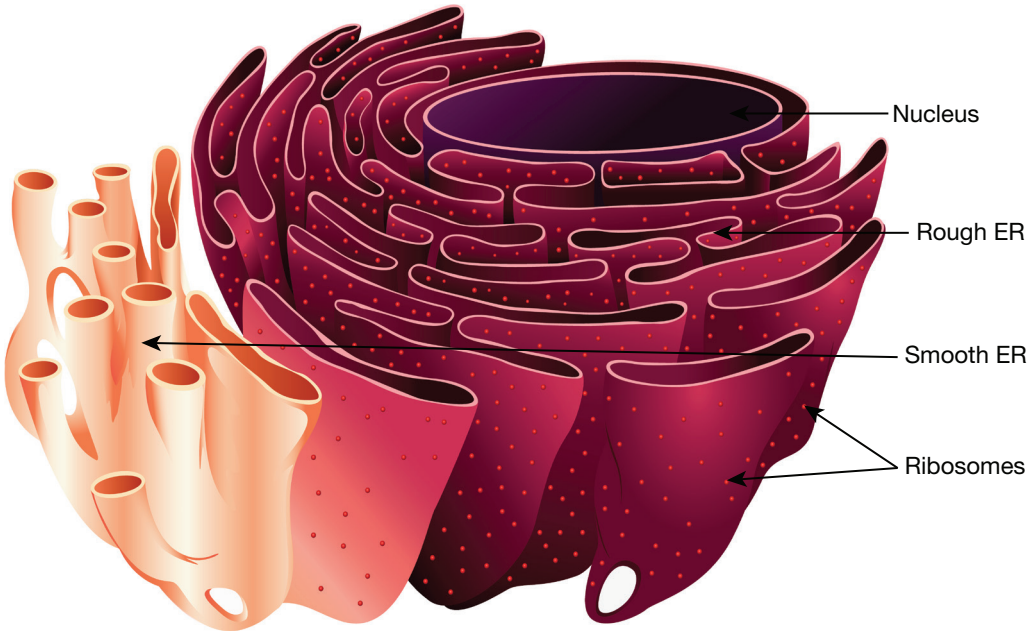


FIG. 1.13 Rough ER and Smooth ER

Ribosomes

It consists of dense and spherical particles which are present in both prokaryotic and eukaryotic cells. These are the sites of protein manufacture. They are found either free in cytoplasm or attached with RER. These are not bound by any membrane and are complex of ribonucleic acid (RNA) and proteins.

Golgi Apparatus

It was first described by Camillo Golgi in 1898. It consists of a system of many, flat disc-shaped sacs called cisternae, which are arranged parallel to each other. Its functions include packaging, storing and dispatching of various products received from endoplasmic reticulum.

It remains in close association with endoplasmic reticulum. It is involved in synthesis of complex sugars and lysosome.

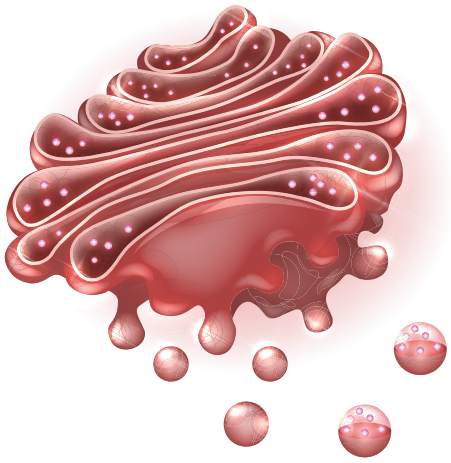


FIG. 1.14 Golgi Apparatus

Lysosomes

These are composed of tiny spherical structures surrounded by a single membrane. They contain many digestive enzymes that are manufactured in RER. Lysosomes are known as waste disposal system of the cell as they help in cleaning the cell by removing the worn out or damaged cellular organelles. They are also called suicide bags of cells as they can digest their own cell, if anything happens to the cell structure or if the cell gets damaged.

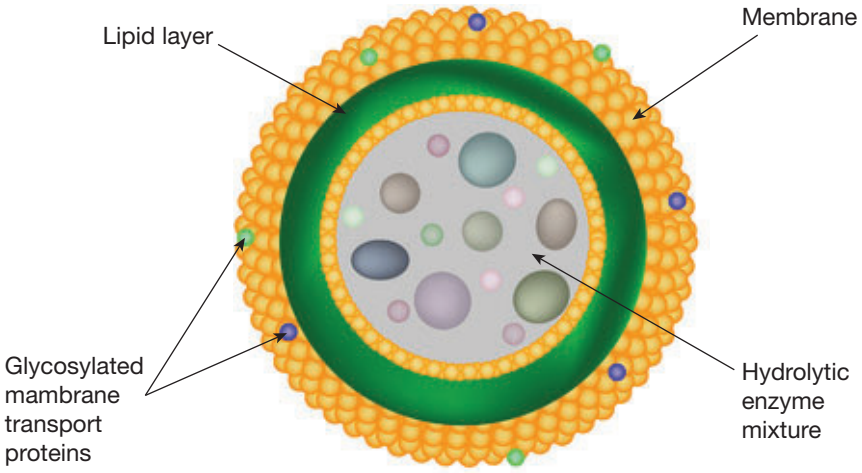


FIG. 1.15 Lysosome structure

Mitochondria

They are referred to as the powerhouses of the cell. They are the main sites for energy production. They produce energy in the form of adenosine triphosphate (ATP). ATP is known as energy currency of the cell. Number of mitochondria per cell vary according to the physiological activity of the cell.

Structure of a typical mitochondrion is characterized by the following features.

- It is surrounded by a double membrane covering.
- Its outer membrane is porous and inner membrane is deeply folded.
- The foldings of inner membrane are called cristae which increase the surface area.
- The compartment enclosed by inner membrane is called matrix.
- Mitochondrion possesses its own DNA (single circular DNA) and ribosomes.

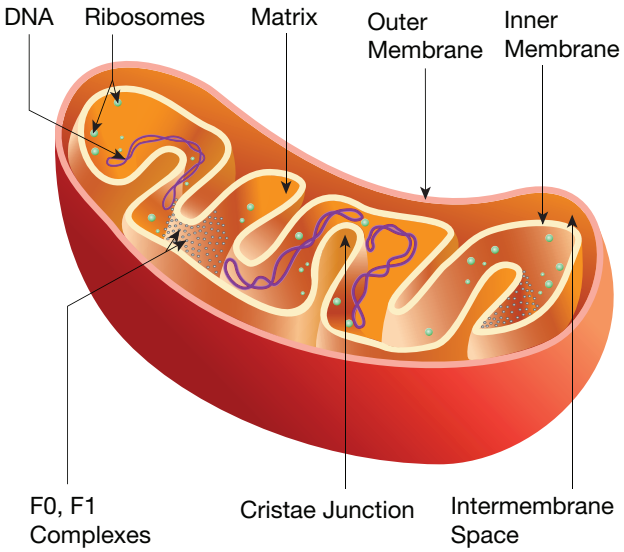


FIG. 1.16 Structure of mitochondria

Info Box!

Green chilly is converted into red chilly due to conversion of chloroplast into chromoplast.

Plastids

Plastids are present in most plant cells and are absent in animal cells. Like mitochondria, plastids contain their own DNA and ribosomes. Plastids are of three types as detailed below:

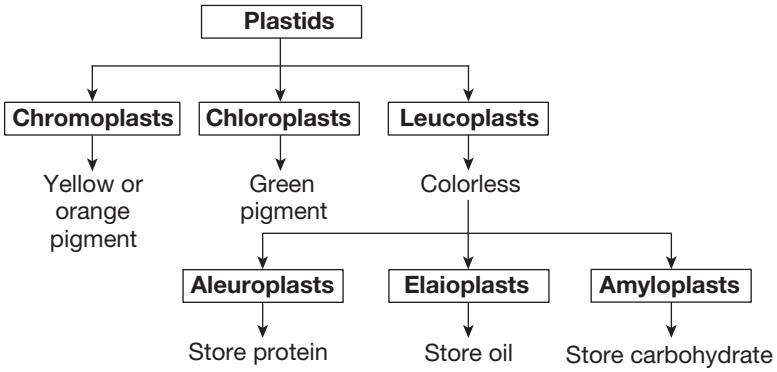


FIG. 1.17 Division of plastids on the basis of presence or absence of pigments

1. **Chromoplasts**: Coloured plastids in which chlorophyll is absent and contain yellow or orange pigment. They are found in fruits, flowers, etc.
2. **Chloroplasts:** Consist of a green pigment called chlorophyll and it mainly functions in **photosynthesis**. Chloroplast is also known as kitchen of the cell.
3. **Leucoplasts:** They are white or colourless and mainly function in storage. Depending upon the storing material, leucoplasts are of three types; Aleuroplast (store protein), elaioplast (stores oil), amyloplast (stores carbohydrate).

Structure of Chloroplasts

It is surrounded by a double membrane covering. It consists of many membrane-bound flat discs called thylakoids which has chlorophyll. Thylakoids are arranged in stacks called grana. The matrix found inside the chloroplast is called stroma. Thylakoids of different grana are connected by stromal lamellae

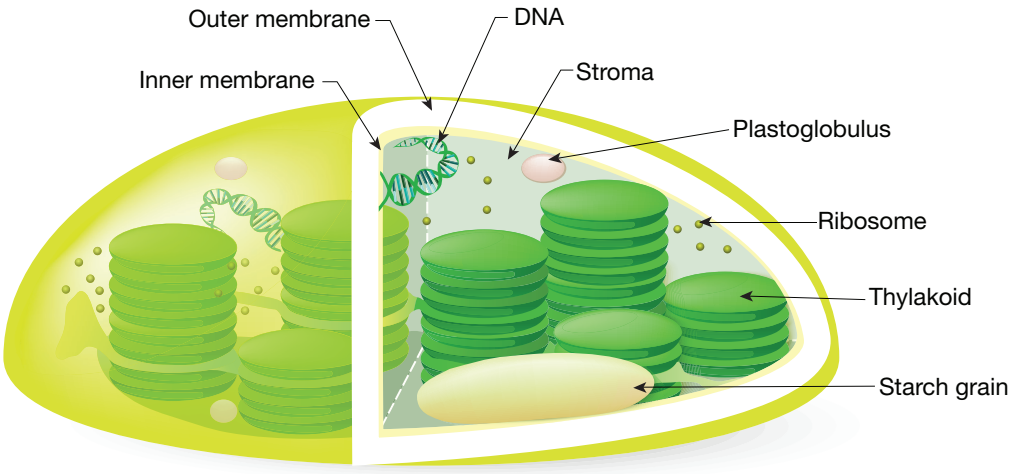


FIG. 1.18 Structure of choloroplast

Vacuoles

These are membrane bound spaces seen in the cytoplasm of mainly plant and fungal cells. These are the storage sacs that store proteins, amino acids, water and other nutrients. They can occupy up to 90% of the cell volume in plant cells. In animal cells, vacuoles are either very small or absent. It is surrounded by a single membrane called tonoplast. The substance present inside the vacuole is called cell sap. It provides turgidity and rigidity to the plant cell.

Microbodies

Microbodies are a kind of organelles present in plants, animals and protozoa. They include peroxisomes, glyoxysomes, glycosomes and hydrogenosomes.

1. **Peroxisomes:** Present in cytoplasm and mainly function in the detoxification of toxic substances.
2. **Glyoxysomes:** Specialized peroxisomes in plants.
3. **Glycosomes:** Specialized peroxisomes present in protists.
4. **Hydrogenosomes:** Found in anaerobic eukaryotes.

Centrosomes

They are only found in animal cells. They are not bounded by a membrane and consist of two centrioles. Centrosomes help in cell division.

Nucleus

It was first described by Robert Brown in the year 1831. It is a large, spherical, centrally placed organelle found in eukaryotic cells which is the central controlling unit of all the activities of a cell.

Structure of nucleus

It is surrounded by a double membrane called nuclear envelope or nuclear membrane. Nuclear envelope contains many pores called nuclear pores. Nuclear pores allow transport of materials across nucleus that is, from nucleus to cytoplasm and from cytoplasm to nucleus. Liquid substance present inside the nucleus is called nucleoplasm. It contains nucleolus and chromatin material.

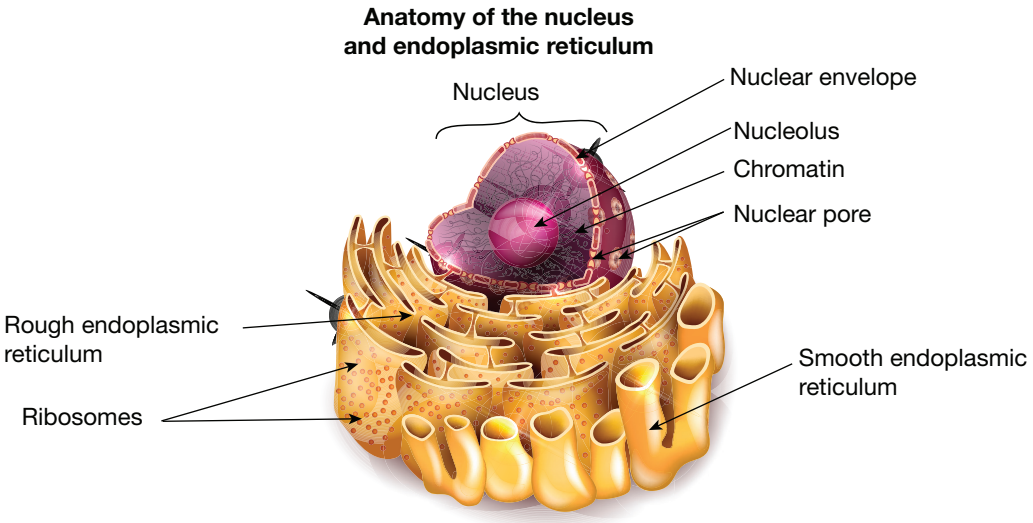


FIG. 1.19 Nucleus

Nucleolus is the place where ribosomes are synthesized, it is rich in protein and RNA molecules. Chromatin material consists of thin, thread-like, entangled structure composed of deoxy-ribonucleic acid (DNA) and proteins. At the time of cell division, chromatin condenses to form rod-shaped chromosomes.

DNA stores information necessary for the inheritance of characters from parents to offsprings. Functional segments of DNA are called genes.

Nucleus is the control centre of the cell as it controls the metabolic activities of the cell. Usually there is only one nucleus per cell, but there are exceptions where more than one nucleus is present, for example, *Paramoecium*. Some mature cells even lack nucleus, for example, RBCs.

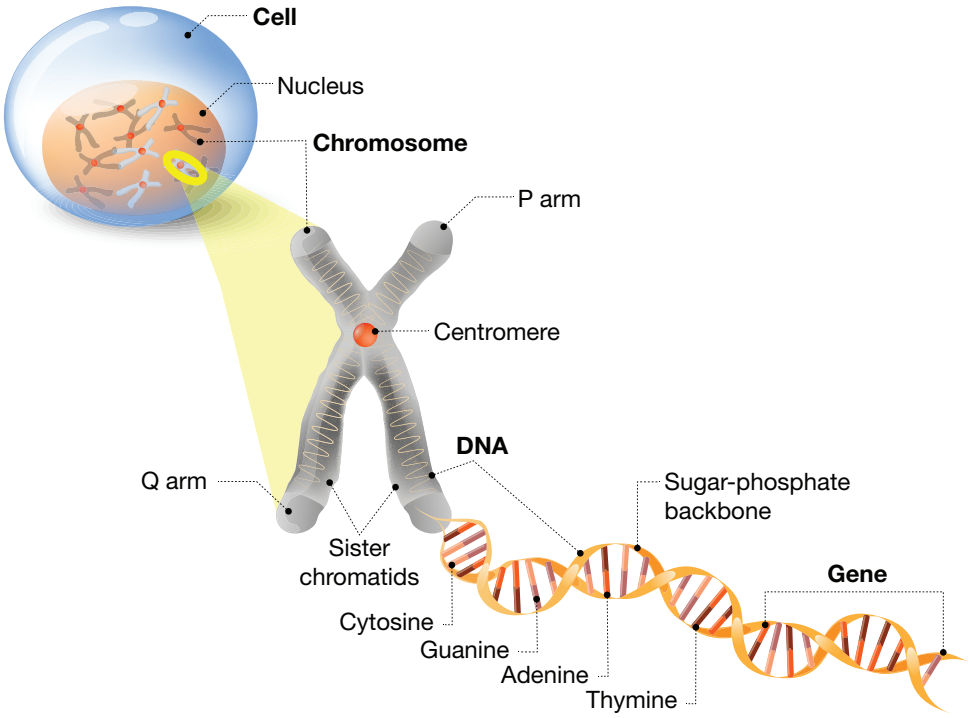


FIG. 1.20 Organization and compaction of DNA inside nucleus

Comparative Study of Animal and Plant Cells

Animal and plant cells show considerable variations in their structure. Plant cells are surrounded by an outer cell wall, whereas cell wall is absent in animal cells. Similarly, plastids and large central vacuoles are present in plant cells but are absent in animal cells.

Table 1.3 Differences between animal and plant cell

Animal cell	Plant cell
Usually smaller in size and oval in shape	Comparatively larger in size and rectangular in shape
Cell wall is absent	Present (cellulose)
Vacuoles are either absent or very small	Large central vacuole
Golgi complex is well developed and is present near the nucleus	Components of Golgi complex in plant cells are called dictyosomes
Centrosome and centrioles are present	Absent
Plastids are absent	Present
Reserve food is stored in the form of glycogen	Stored in the form of starch or oil

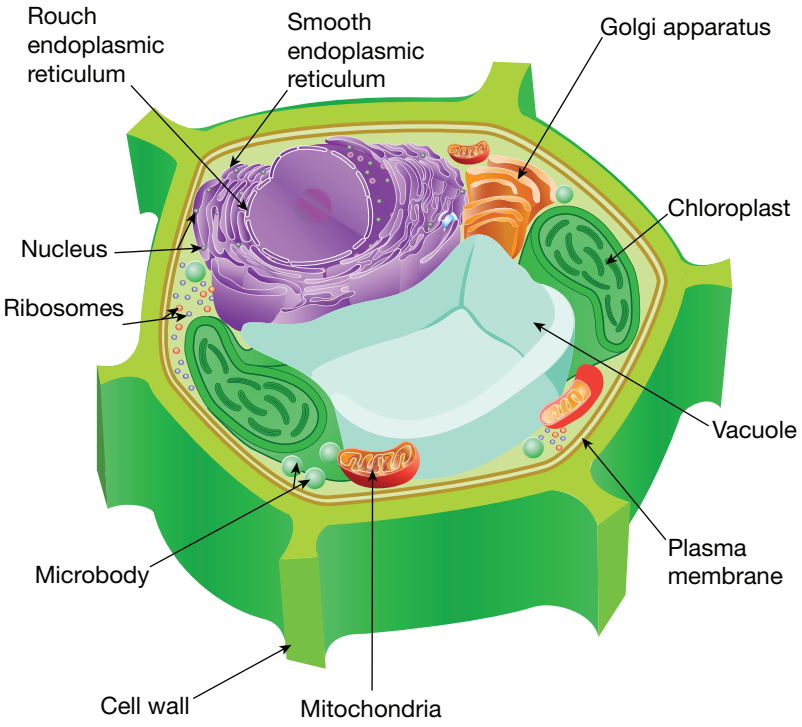


FIG. 1.21 A typical plant cell showing all major organelles

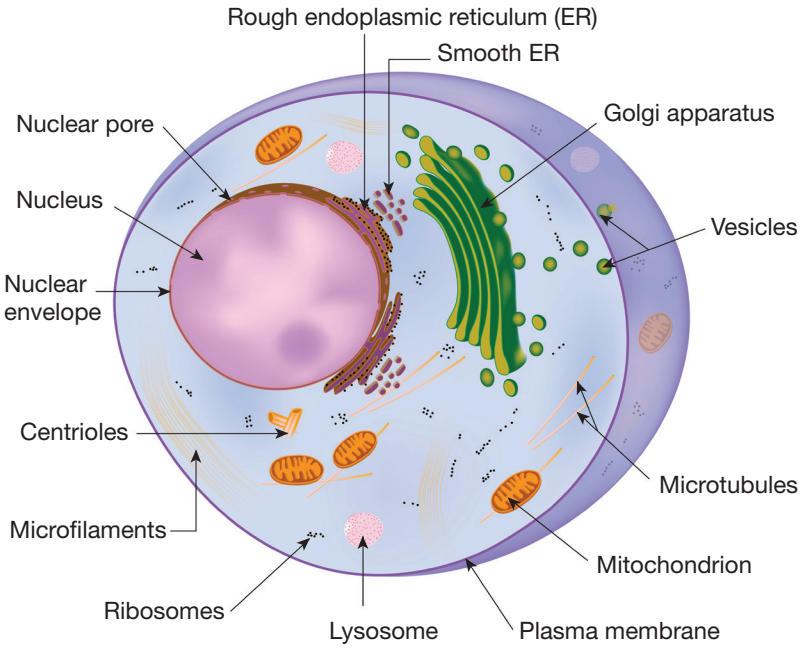


FIG. 1.22 A typical animal cell showing all major organelles

Various Organelles and their Role in Cell

Functions of all the cell organelles are collaborated in the table below.

Table 1.4 Functions of different organelles in a cell

Organelle	Functions
Endoplasmic reticulum	Protein and lipid synthesis
Ribosome	Protein manufacture
Golgi complex	Packaging, storing and dispatching of materials received from the endoplasmic reticulum
Lysosome	Waste disposal system of the cell
Vacuole	Storage sac, provides rigidity and turgidity to the plant cell
Mitochondria	Power house of the cell
Chloroplast	Photosynthesis
Centrosome	Cell division
Nucleus	Control centre of the cell, contains chromosomes

QUICK RECAP

1. The size and shape of cell vary. Justify the statement.

The size and shape of cells vary according to their function. For example, nerve cells have an elongated structure that helps them to conduct nerve impulses quickly.

2. List out the various shapes of bacteria and give examples for each.

There are basically four different shapes for bacteria:

(i) Rod-shaped or bacillus, *Lactobacillus*.
(ii) Spherical-shaped or coccus bacteria, *Staphylococcus*.
(iii) Spiral-shaped bacteria, for example, *Treponema*.
(iv) Comma-shaped bacteria, for example, *Vibrio cholerae*.

QUICK RECAP

3. What are inclusion bodies?

Inclusion bodies are structures that lie free in the cytoplasm and help in storage of reserve materials, for example, phosphate granules, glycogen granules, etc.

4. Differentiate between rough and smooth endoplasmic reticulum.

Rough endoplasmic reticulum	Smooth endoplasmic reticulum
Looks rough under the microscope	Looks smooth under the microscope
Ribosomes are present on the surface	Ribosomes are absent
Involved in protein synthesis	Major site for lipid synthesis and is also involved in the detoxification of poisons

5. Which organelle is the waste disposal system of the cell and why is it called so?

Lysosome is known as the waste disposal system of the cell. Lysosome encloses many digestive enzymes and it helps in cleaning the cell by removing the worn out or damaged cellular organelles. It also helps in destroying foreign materials such as bacteria and virus entering the cell. Hence, lysosome is also known as the waste disposal system of the cell.

6. Give a note on the structure of mitochondria.

Mitochondria are surrounded by a double membrane covering. The outer membrane is porous and the inner membrane is deeply folded. The folding seen inside the inner membrane is called crista and it helps in increasing the surface area. The compartment enclosed by inner membrane is called matrix. Mitochondria possess their own DNA (single circular DNA) and ribosomes.

7. What are leucoplasts and what are their various types?

Leucoplasts are white or colourless plastids that mainly function in storage. Depending upon the storage material, leucoplasts are of three types:

Aleuroplasts: Store protein
Elaioplasts: Store oil
Amyloplasts: Store carbohydrates

8. What are the main functions of nucleus?

Nucleus is the control centre of the cell, and controls the metabolic activities of the cell. Nucleus contains the genetic material, thus stores information necessary for the inheritance of characters from parents to offsprings. It also plays a major role in cellular reproduction, that is, the formation of new cells from the parent cell.

CELL DIVISION

The process in which a cell divides into two daughter cells is called cell division. In single celled organisms, one cell division results in the formation of two new organisms, for example, *Amoeba*, bacteria, etc. Cell division in prokaryotes is much simpler as compared to that in eukaryotes.

Cell Division in Prokaryotes

The common type of cell division seen in prokaryotes is binary fission**.** The fully grown parent divides into two halves resulting in two new cells.

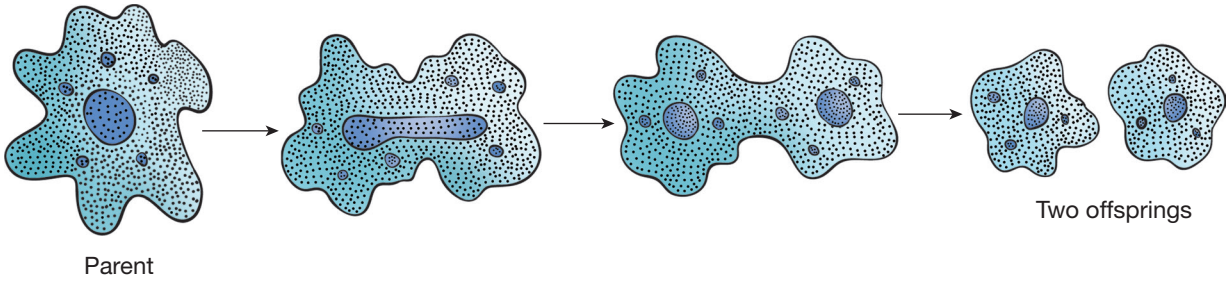


FIG. 1.23 Binary fission

Significance of Cell Division

Reproduction: A cell must divide in order to reproduce. Hence, cell division is responsible for continuity of life.

Replacement of cells: All cells have a limited lifespan. They die after completing their lifetime. New cells are needed to replenish this loss. Hence, cell division helps in replacement of dead cells by producing new cells.

Growth: We observe that an infant grows into an adult, a small seed grows into a big tree, etc. These changes are possible only when the number of cell increases in order to increase the size of the organism. Hence, cell division enables the living organisms to grow.

Cell Division in Eukaryotes

Cell division in eukaryotes is more complex than in prokaryotes and involves two processes:

1. **Karyokinesis**: Division of nucleus
2. **Cytokinesis**: Division of cytoplasm

There are two different types of cell division:

1. Mitosis
2. Meiosis

Mitosis

A kind of cell division that results in the formation of daughter cells that are genetically identical to the parent cell. Daughter cells produced by mitosis possess the same number of chromosomes as that of parent cell. Mitosis can be divided into four stages:

1. Prophase
2. Metaphase
3. Anaphase
4. Telophase

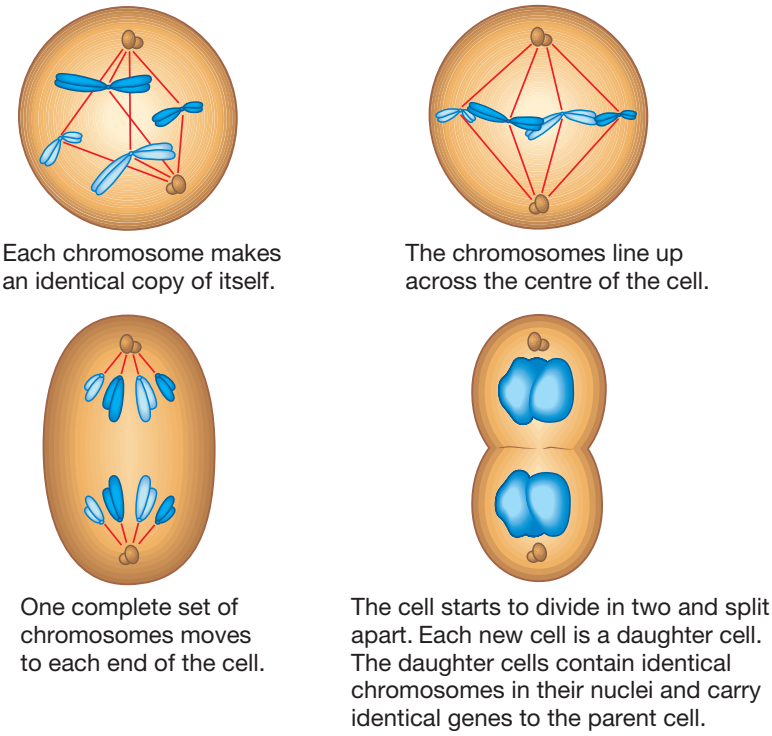


FIG. 1.24 Phases of mitosis

In animals, mitosis occur generally only in diploid somatic cells, whereas in some lower plants, mitosis can occur in haploid cells also. A cell that contains two sets of chromosomes (two copies of the same chromosome) is called diploid cell, whereas a cell with only one set of chromosome is called haploid cell. Mitosis occurs as a part of normal cell growth and to replace worn out cells.

Info Box!

A somatic cell is any cell other than reproductive cells or germ cells.

Meiosis

Meiotic cell division occurs during sexual reproduction leading to gamete formation. The daughter cells formed possess half the number of chromosomes than the parent cell. Meiosis involves two sequential cycles of divisions:

1. Meiosis I
2. Meiosis II

Both meiosis I and II can be again subdivided into four stages as given below.

Meiosis I	Meiosis II
Prophase I	Prophase II
Metaphase I	Metaphase II
Anaphase I	Anaphase II
Telophase I	Telophase II

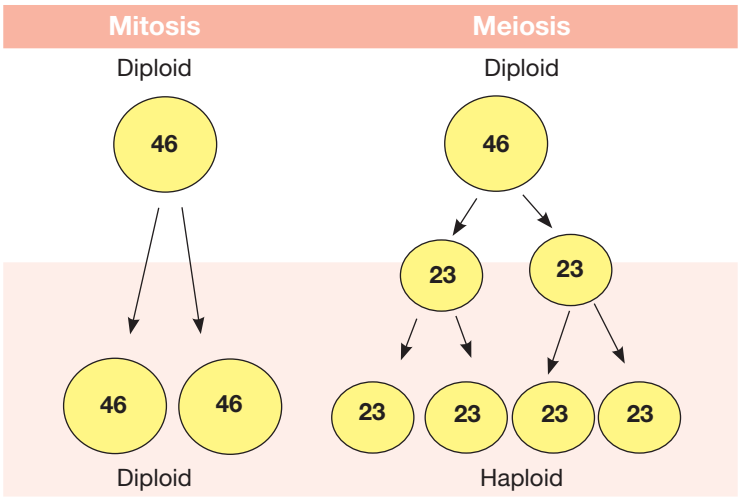


FIG. 1.25 Diagrammatic representation of Mitosis and Meiosis

Main differences between mitosis and meiosis are given in the table below.

Table 1.5 Differences between Mitosis and Meiosis

Mitosis	Meiosis
Occurs generally in somatic cells	Occurs in germ cells
During normal growth of cell	During gamete formation
Chromosome number remains the same	Chromosome number reduces to half
Two daughter cells are formed	Four daughter cells are formed

QUICK RECAP

1. Who discovered cell and how?

Robert Hooke in 1665 discovered cell while he was observing a thin slice of cork under a microscope. He observed a structure similar to honeycomb and named this structure 'cell'.

2. Give a brief note on the differences between unicellular and multicellular organisms.

Unicellular organisms	Multicellular organisms
Composed of only one cell	Contain many cells
Single cell performs the entire functions	Various functions are performed by many cells
For example, *Amoeba* and bacteria	For example, plants and animals

3. Give a note on binary fission.

Binary fission is a kind of cell division seen in prokaryotes. The fully grown parent cells divide into two halves producing two new cells. It involves division of nucleus followed by division of cytoplasm, ultimately resulting in two daughter cells.

QUICK RECAP

4. Define mitosis and write its significance.

Mitosis is the kind of cell division that results in the formation of two daughter cells that are genetically identical to the parent cell. Daughter cells possess the same number of chromosomes as of parent cell. Mitosis occurs as a part of normal cell growth and to replace worn out cells.

5. Give a note on diploid cell and haploid cell with an example.

A cell that contains two sets of chromosomes, that is, two copies of the same chromosome, one from each parent is called diploid cell. Haploid cell contains only one set of chromosomes, for example in human diploid cells (any cell other than gametes), there are 46 chromosomes whereas human gamete is haploid with 23 chromosomes.

POINTS TO REMEMBER

- A cell is the smallest individual unit of matter capable of performing all essential life processes by itself.
- Cell theory was proposed by Matthias Jakob Schleiden (1838) and Theodor Schwann (1839)
- Rudolph Virchow stated that new cells arise from pre-existing cells
- Prokaryotic cells are primitive type of cells which lack a true nucleus and membrane bound organelles.
- Eukaryotic cells possess a true nucleus, that is, their genetic material is surrounded by a nuclear envelope and have membrane bound organelles, example, plant cell.
- The process in which a cell divides into two daughter cells is called cell division
- Cell division is required for growth, reproduction and repair.
- Mitosis is that type of cell division that results in the formation of daughter cells that are genetically identical to the parent cell.
- Meiosis is that type of cell division which occurs during sexual reproduction leading to gamete formation.

TEST YOUR CONCEPTS

Directions for questions 1 to 20: Fill in the blanks in each question.

1. The first living cell was discovered by _____
2. _____ is the basic structural and functional unit of life.
3. Take the odd one out.

   Amoeba, Bacteria, Plant, Honeybee.
4. The concept '*Omnis cellula e cellula*' was put forward by _____.
5. The term 'protoplasm' was coined by _____.
6. The smallest cell is _____.
7. The largest cell is _____.
8. Lactobacillus is _____ shaped.
9. Mycoplasma lacks _____.
10. Phosphate granules are examples for _____.
11. The inner foldings of the mitochondrial inner membrane are called _____.
12. Chlorophylls are present in _____.
13. _____ is known as the energy currency of the cell.
14. Detoxification of poisons takes place in _____.
15. Thylakoids of different grana are connected by _____.
16. Specialized peroxisomes in plants are called _____.
17. Thin thread-like structure present inside the nucleus is called _____.
18. The membrane surrounding vacuole is called _____.
19. In plant, reserve food is stored in the form of _____.
20. Plant cell wall is made up of _____.

Directions for questions 21 to 40: For each of the following questions, four choices have been provided. Select the correct alternatives.

21. Site for protein manufacture is

    (a) Cell wall (b) Cytoplasm
    (c) Ribosome (d) Inclusion bodies

22. The longest cell is

    (a) Mycoplasma (b) Neuron
    (c) PPLO (d) Ostrich egg

23. Which of the following can change its shape?

    (i) Amoeba (ii) Neuron
    (iii) WBC (iv) RBC
    (a) (i) only (b) (i) and (ii)
    (c) (i) and (iii) (d) (i), (ii), (iv)

24. Nucleoid is the region where _____ is/are located

    (a) Genetic material (b) Proteins
    (c) Pigments (d) Nutrients

25. Bacterial cell wall is made up of

    (a) Cellulose (b) Peptidoglycan
    (c) Hemicellulose (d) Pectin

26. Match the following

A. Inclusion bodies	(i) Eukaryotic
B. Mesosome	(ii) Protein manufacture
C. Ribosome	(iii) Cell wall formation
D. Golgi complex	(iv) Nutrient reservoir

	A	B	C	D
(a)	(iii)	(ii)	(i)	(iv)
(b)	(iv)	(iii)	(i)	(ii)
(c)	(iii)	(i)	(iv)	(ii)
(d)	(iv)	(iii)	(ii)	(i)

27. Select the wrong statement.

    (a) Plant cells are surrounded by a living, rigid outer layer called cell wall.
    (b) Plant cell wall is made up of cellulose.
    (c) Bacterial cell wall is made up of peptidoglycan.
    (d) Both prokaryotic and eukaryotic plasma membranes are composed of lipids and proteins.

28. Adjacent plant cells are joined together by

    (a) Middle lamella (b) Plasmodesmata
    (c) Mesosomes (d) Plasma membrane

29. Which of the following is the correct statement?

    (a) Endoplasmic reticulum is the site of protein manufacture in bacteria.

PRACTICE QUESTIONS

(b) The membrane-bound inclusion bodies help in the storage of nutrients in prokaryotes.

(c) The living material inside the cell is called protoplasm.

(d) Mesosome is the cell wall extension that helps in photosynthesis.

30. Which one of the followings are included in protoplasm?

(i) Nucleus (ii) Cytoplasm

(iii) Organelles (iv) Nucleoplasm

(a) (i) and (ii) (b) (i), (ii), (iii)

(c) (ii) only (d) (i), (ii), (iii), (iv)

31. Ribosomes are composed of _____ and _____

(a) Lipids, proteins (b) RNA, proteins

(c) DNA, proteins (d) Proteins only

32. The organelle that is involved in the formation of lysosome is

(a) Golgi apparatus (b) Mitochondria

(c) Endoplasmic reticulum (d) Vacuole

33. Which of the following organelles are covered by single membrane?

(a) Ribosome and lysosome

(b) Lysosome and nucleus

(c) Ribosome and vacuole

(d) Lysosome and vacuole

34. Select the correct statements.

A. Ribosomes are covered by a double-layered membrane.

B. Ribosomes are composed of RNA and proteins.

C. Chlorophyll is absent in chromoplast.

D. Elaioplasts store protein.

(a) A and D (b) B and C

(c) C and D (d) B and D

35. Which of the following organelles possess their own DNA and ribosomes?

(a) Mitochondria and plastids

(b) Plastids and endoplasmic reticulum

(c) Mitochondria and Golgi complex

(d) Golgi complex and endoplasmic reticulum

36. Energy is produced in the form of _____

(a) ATP (b) GTP

(c) AMP (d) ADP

37. Which of the following statement is wrong?

(a) Vacuoles are either absent or small in animal cells.

(b) Centrosomes are absent in animal cells.

(c) Centrosomes are absent in plant cells.

(d) Centrosomes help in cell division.

38. Glycosomes are specialized peroxisomes found in

(a) Animals (b) Plants

(c) Protists (d) Bacteria

39. Functional segments of DNA are called

(a) Genes (b) Chromosomes

(c) Chromatin (d) Centrosome

40. Which of the following cell lacks nucleus?

(a) Mature RBC (b) Mature WBC

(c) Neutrophils (d) *Paramoecium*

MASTERING THE CONCEPTS

Knowledge and Understanding

1. Who postulated cell theory and what are the main postulates?

2. How does *Staphylococcus* differ from *Lactobacillus* in shape?

3. What are mesosomes and write their significance in the cells?

4. Differentiate between prokaryotic and eukaryotic cells.

5. Unlike prokaryotes, all eukaryotic cells are not identical. Justify the statement.

6. Why plasma cell membranes are said to be semi-permeable in nature?

7. Explain the structure of chloroplast.
8. Make a comparison between the three types of leucoplasts.
9. Differentiate between nucleolus and nucleoid.
10. Which organelles are known as semi-autonomous organelles and why are they called so?
11. Give a note on Golgi apparatus and its functions.
12. Which organelle is known as 'power house' of the cell and why is it called so?
13. What are vacuoles and what is their role in a cell?
14. Explain the structure of cell nucleus.
15. Differentiate between animal cell and plant cell based on structure.

Application and Analysis

1. Complete the table given below:

Structure	Features
(a) _____	Plasma membrane extension
(b) Ribosome	Site of _____
(c) _____	Joins adjacent plant cells
(d) Plasma membrane	Made up of _____ and _____
(e) _____	Living material inside the cell
(f) _____	Fluid content inside the cell membrane

2. Why Golgi apparatus is seen associated with endoplasmic reticulum inside the cell?
3. Why lysosomes are also called 'suicide bags' of cells?
4. Animal cells differ from plant cells in a number of ways. What is one specific characteristic that makes their mode of nutrition significantly different?
5. Both bacteria and plants contain cell walls yet they are entirely different from each other. Justify.
6. A eukaryotic cell has mitochondria in their cytoplasm which are specially organized organelles that perform respiration. Whereas prokaryotic cells lack mitochondria yet they perform respiration. How?
7. There are two substances, namely 'A' and 'B' which are present outside a cell. Substance 'A' is able to pass through the cell and 'B' is not able to do so. How can you justify this selective movement of substances in and out of a cell?
8. After one round of division, a cell receives half the number of chromosomes as in the parent cell. What can be inferred about the nature of the parent cell?

PRACTICE QUESTIONS

TEST YOUR CONCEPTS

1. Anton Van Leeuwenhoek
2. Cell
3. Bacteria (all others are eukaryotes)
4. Rudolf Virchow
5. Purkinje
6. Mycoplasma
7. Ostrich egg
8. Rod
9. Cell wall
10. Inclusion bodies
11. Cristae
12. Thylakoids
13. ATP
14. Smooth endoplasmic reticulum
15. Stroma lamellae
16. Glyoxysomes
17. Chromatin material
18. Tonoplast
19. Starch
20. Cellulose
21. (c)
22. (b)
23. (c)
24. (a)
25. (b)
26. (d)
27. (a)
28. (a)
29. (c)
30. (d)
31. (b)
32. (a)
33. (d)
34. (b)
35. (a)
36. (a)
37. (b)
38. (c)
39. (a)
40. (a)

MASTERING THE CONCEPTS

Knowledge and Understanding

1. Cell theory was proposed by Matthias Jakob Schleiden (1838) and Theodor Schwann (1839) and was later modified by Rudolf Virchow. The main postulates are:
   - All organisms are made up of cells.
   - Cell is the basic structural and functional unit of life.
   - All cells arise from pre-existing cells only (*Omnis cellula e cellula*)
2. *Staphylococcus* is spherical in shape whereas *Lactobacillus* is rod shaped.
3. Mesosomes are the structures seen in prokaryotes, which are formed by the plasma membrane extension into the cell. Mesosomes help in cellular activities, such as cell wall formation, respiration, etc.
4.

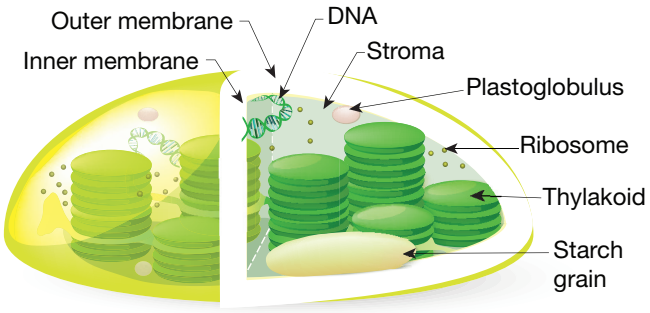
Prokaryotic cell	Eukaryotic cell
Size generally small (1–10 μm)	Size generally large (5–100 μm)
Nucleus is absent	Nucleus is present
Contains single chromosome	Contains more than one chromosome
Membrane-bound cell organelles, such as endoplasmic reticulum, Golgi complex, etc., are present	Membrane-bound cell organelles are present

HINTS AND EXPLANATION

5. Eukaryotic cells include protista, plants, animals, fungi, etc. All of them show considerable difference in their structure and organization. For example, plant cells are surrounded by an outer cell wall, whereas cell wall is absent in animal cells. Similarly, plastids and large central vacuoles are present in plant cells but are absent in animal cells, and if vacuoles are present in animal cells, they will be very small.

6. Plasma cell membranes are made up of proteins and lipids. They are said to be semi-permeable membranes, as they allow entry and exit of only some materials and prevent others.

7. Chloroplast is the plastid that contains a green pigment called chlorophyll. It mainly functions in photosynthesis. Chloroplast is surrounded by a double membrane covering, an outer membrane and an inner membrane. It consists of many membrane-bound flat discs called thylakoids that have chlorophyll molecules. Thylakoids are arranged in stacks called grana. The matrix found inside the chloroplast is called stroma. Thylakoids of different grana are connected by stromal lamellae.



Internal structure of chloroplast

8. Leucoplasts are colourless plastids that mainly function in storage. Leucoplasts are of three types, such as aleuroplasts, elaioplasts and amyloplasts. Aleuroplasts store protein, elaioplasts store oil, whereas amyloplasts store carbohydrates (starch).

9.

Nucleolus	Nucleoid
Present in eukaryotes	Present in prokaryotes
Region inside the nucleus that is rich in RNA and protein	Region in the cytoplasm where genetic material is present

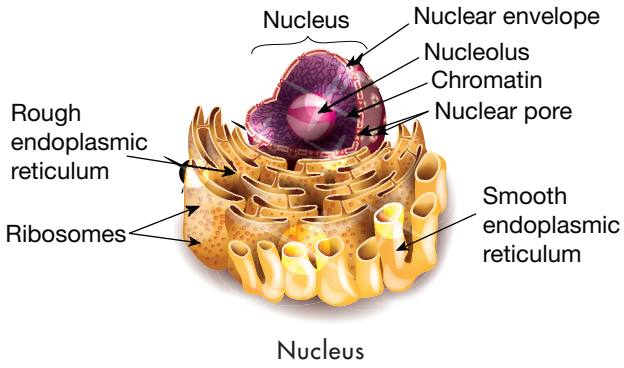
10. Mitochondria and plastids are known as semiautonomous organelles as they contain their own DNA and ribosomes. Both of them can synthesize some of the proteins required for the function on their own.

11. Golgi apparatus comprises a system of many, flat disc-shaped sacs called cisternae. They are arranged parallel to each other. Major functions of Golgi apparatus include packaging, storing and dispatching of various products received from the endoplasmic reticulum. For this reason, Golgi apparatus remains in close association with endoplasmic reticulum. Golgi apparatus is also involved in synthesis of complex sugars and lysosomes.

12. Mitochondria are known as powerhouses of the cell as they are the main sites for energy production. Mitochondria produce energy required for various chemical activities in the form of adenosine triphosphate (ATP). ATP is known as energy currency of the cell. The number of mitochondria per cell vary according to the physiological activity of the cell.

13. Vacuoles are membrane-bound spaces seen in the cytoplasm. They are the storage sacs that store proteins, amino acids, water and other nutrients. In plant cells, vacuoles can occupy up to 90% of the volume, whereas in animal cells, vacuoles are either very small or absent. Vacuoles are surrounded by a single membrane called tonoplast and the substance inside a vacuole is called cell sap. Vacuoles provide turgidity and rigidity to the plant cell.

14. Nucleus is the large, spherical, centrally placed organelle found in eukaryotic cells. It is surrounded by a double membrane called nuclear envelope. Nuclear envelope contains many pores called nuclear pores, which allow the transport of materials across the nucleus. The liquid substance present inside the nucleus is called nucleoplasm, which contains nucleolus and chromatin material. Nucleolus is the region, which is rich in RNA and protein and not enclosed by a membrane. Chromatin is the thread-like structure composed of DNA and proteins. DNA stores information necessary for the inheritance of characters from parents to offsprings.



15.

Animal cell	Plant cell
Usually smaller in size and oval in shape	Comparatively larger in size and rectangular in shape
Cell wall is absent	Present (cellulose)
Vacuoles are either absent or very small	Large central vacuole
Golgi complex are well developed and present near nucleus	Components of Golgi complex in plant cells are called dictyosomes
Centrosome and centrioles are present	Absent
Plastids are absent	Present

Application and Analysis

1.

Structure	Features
(a) Mesosome	Plasma membrane extension
(b) Ribosome	Site of protein manufacture
(c) Middle lamella	Joins adjacent plant cells
(d) Plasma membrane	Made up of lipids and proteins
(e) Protoplasm	Living material inside the cell
(f) Cytoplasm	Fluid content surrounded by the cell membrane

2. Main functions of Golgi apparatus include packaging, storing and dispatch of various products received from the endoplasmic reticulum. It modifies the proteins and lipids received from the endoplasmic reticulum and also directs these products to various targets. For this reason, Golgi apparatus remains in close association with the endoplasmic reticulum.

3. Lysosomes are tiny, spherical structures that contain many digestive enzymes. If any kind of disturbance is caused to the cell structure and its organization, lysosomes burst releasing their enzymes. These enzymes are capable of digesting their own cell. Therefore, lysosomes are also known as 'suicide bags' of cells.

4. Plant cells contain a specialized organelle, chloroplast which contains chlorophyll, while animal cells do not contain chloroplast. Plants are capable of synthesizing their own food with the help of chloroplast in the presence of sunlight and water, whereas animal cell is not able to do so. Hence, plants show autotrophic mode of nutrition and animals show heterotrophic mode of nutrition.

5. Bacterial cell walls are different from the cell walls of plants in terms of composition. Major component of bacterial cell wall is peptidoglycan while the major component of plant cell walls is cellulose.

6. The plasma membranes of prokaryotic cells (bacterial cells) have special ingrowths that are called mesosomes which are the sites for respiration. Therefore, a prokaryotic cell is able to carry out the process of respiration even without mitochondria.

7. Cells are surrounded by a selectively permeable membrane called plasma membrane. This membrane is designed such that it allows certain specific molecules to pass through it while not allowing certain molecules to do so. Hence, this selective nature of plasma membrane guides the entry and exit of substances around the cell.

8. Since the number of chromosomes is reduced to half in the process of division, it can be inferred that the division is through meiosis. We know that meiosis occurs only in germ cells. Hence, the parent cell is a germ cell.

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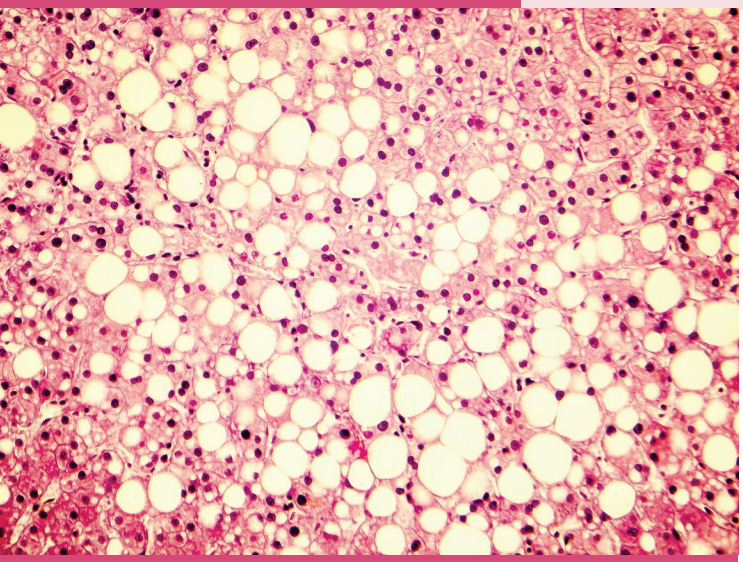
Chapter

2

Tissues and Body Movements



REMEMBER

Before beginning this chapter, you should be able to:

- Recall the basic features of a cell
- Remember the meaning and organization of tissue

KEY IDEAS

After completing this chapter, you should be able to:

- Understand different types and functions of plant tissues
- Understand different types and functions of animal tissues
- Describe human skeletal system

INTRODUCTION

All living organisms are made up of cells, and the living world comprises both unicellular and multicellular organisms. In unicellular organisms, a single cell performs all functions or activities needed for the survival and in multicellular organisms, the work is divided among group of cells, i.e., there is a division of labour. Tissue can be defined as a group of cells either similar or dissimilar that perform a specific function, for example, muscular tissue in humans is involved in movement or locomotion, and blood connective tissue helps in transport of respiratory gases and nutrients.

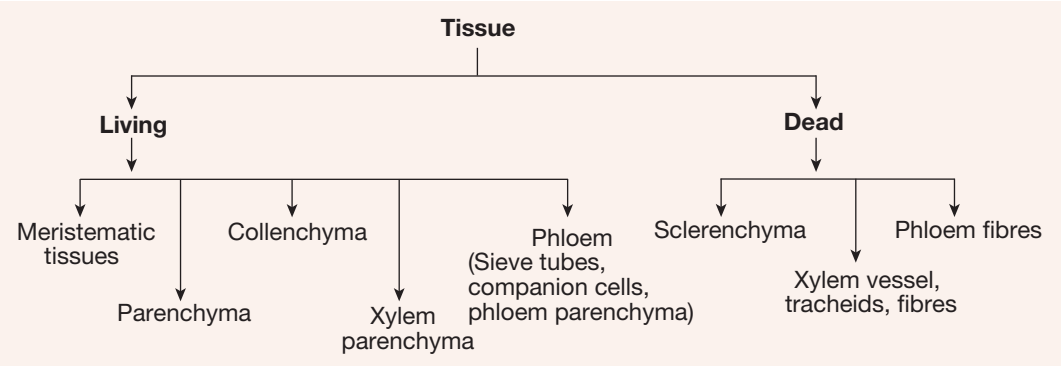


FIG. 2.1 Classification of tissues—in general

PLANT TISSUE

Plant body is composed of different types of tissues, like meristematic tissues, vascular tissues, etc. Unlike animals, plant body is abundant in dead supportive tissues. Plants are adapted for a sedentary existence as they do not move. Because of this reason, the main requirement is structural support which can be provided by dead tissues with least maintenance.

In plant body, the growth is not uniform, that is, their growth is confined to particular regions. Plant tissues according to their dividing abilities can be divided into two:

1. Meristematic tissue
2. Permanent tissue

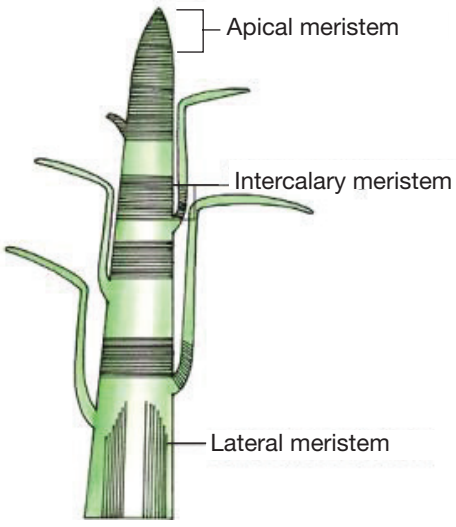


FIG. 2.2 Location of different types of meristem on a plant

Meristematic Tissue

The plant tissue that can be divided throughout its life is called meristematic tissue. Meristematic tissues can be again divided according to their position as:

1. **Apical meristem:** Seen at the growing tips of roots and shoots and helps in increasing length of root and stem.

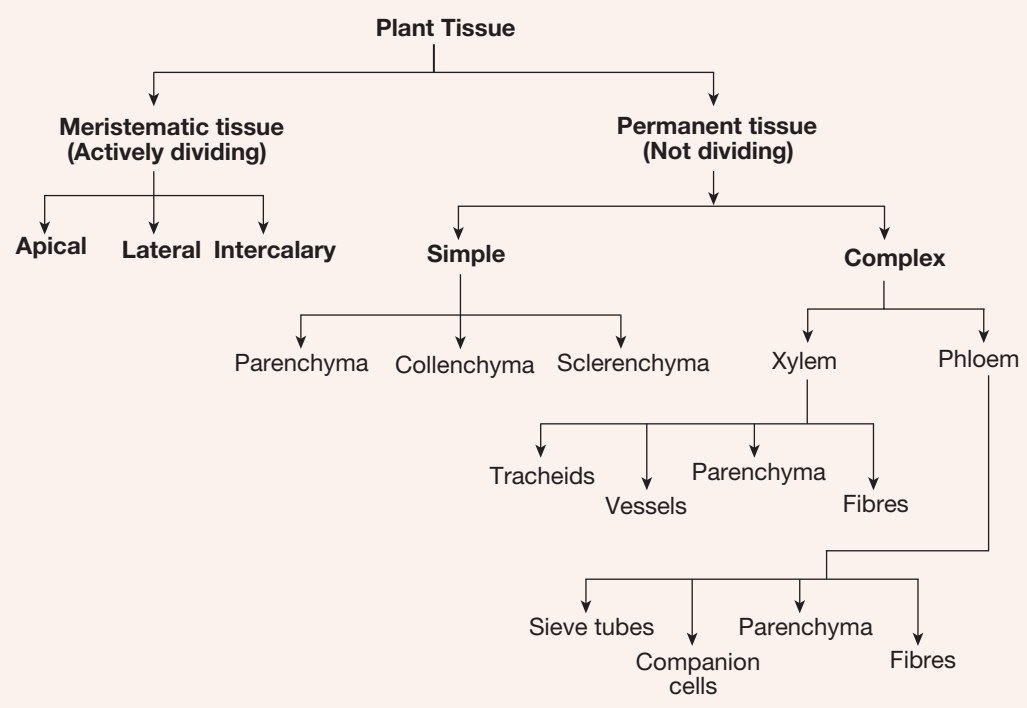


FIG. 2.3 Classification of plant tissue

2. **Intercalary Meristem:** It occurs between mature tissues. In grasses, it is responsible for the regeneration of parts eaten by grazing herbivores.
3. **Lateral Meristem:** It is responsible for increase in girth of plant body.

Info Box!

The term 'meristem' is derived from a Greek word 'meritos' meaning 'divided'.

Permanent Tissue

The tissues that do not undergo division are called permanent tissues. Meristematic tissue loses its ability to divide and takes up a permanent shape, size and function. This process is called differentiation. Thus, meristematic tissue undergoes differentiation to form permanent tissue.

Depending on whether they are made of one type of cell or different types of cells, permanent tissues can be divided into two:

1. Simple permanent tissue
2. Complex permanent tissue

Simple Permanent Tissue

Simple permanent tissue is made up of only one type of cell. Simple permanent tissues are of different types listed as follows.

1. Parenchyma
2. Collenchyma
3. Sclerenchyma

Parenchyma

They are living tissues. The cells of parenchyma can be spherical, oval, polygonal or elongated. Parenchymatous cells have a thin cell wall and dense cytoplasm. They are involved in a variety of functions, like photosynthesis, gaseous exchange, food storage and other specialized functions.

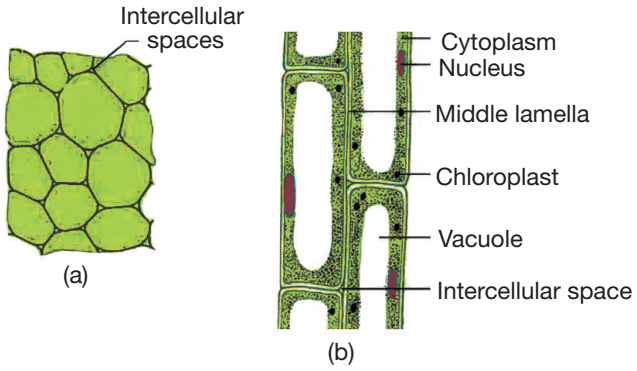


FIG. 2.4 (a) Transverse section and (b) Longitudinal section of parenchyma

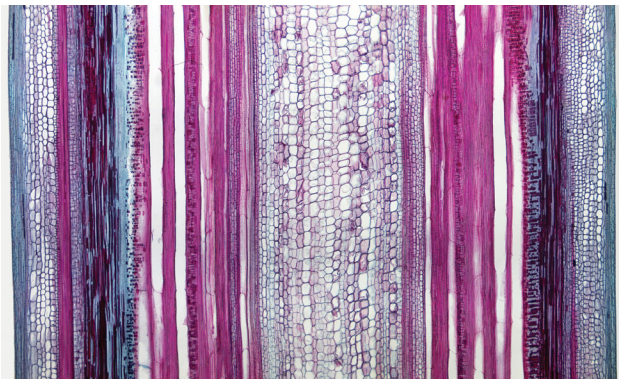


FIG. 2.5 Longitudinal section of parenchyma tissue in pumpkin (cucurbits) stem

Collenchyma

Collenchyma tissue consists of living cells. Their cell wall is irregularly thickened at the corners. Their cells can be oval, spherical or polygonal. It gives mechanical support and flexibility to the plants. They allow the plant to bend without breaking.

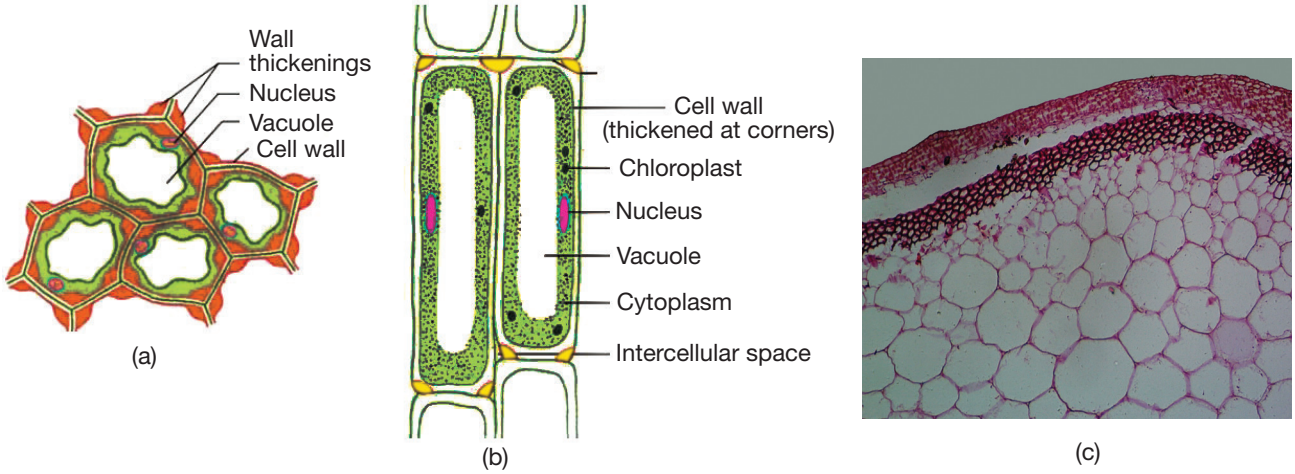


FIG. 2.6 (a) Transverse section, (b) Longitudinal section of collenchyma and (c) Light microscopic cross-section of stem collenchyma

Sclerenchyma

Sclerenchyma are dead tissues. Their cells are long with narrow lumen. Their wall is thick due to lignin deposition. Sclerenchyma provides mechanical support to the organs. It is in the fruit walls of nuts, seed coats of legume, etc., for example, in coconut husk.

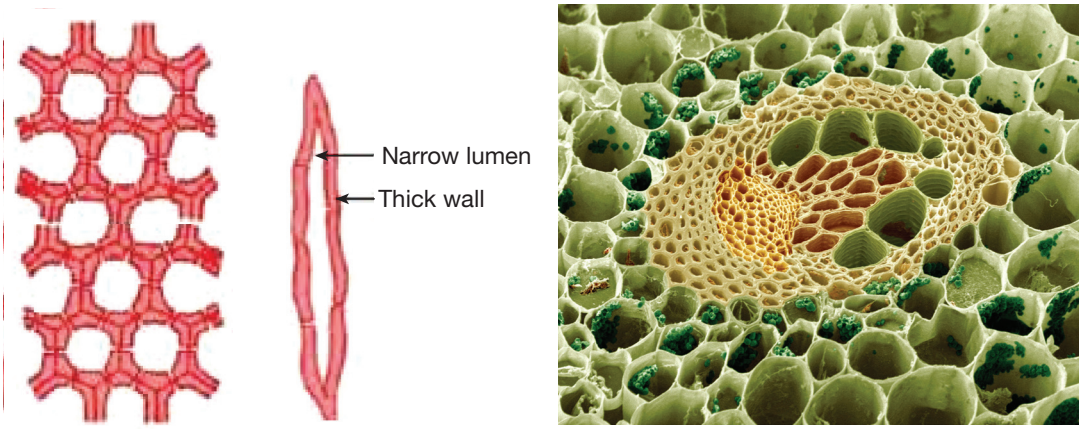


FIG. 2.7 (a) Transverse section, (b) Longitudinal section of sclerenchyma and (c) Electron micrograph of cross-section of a stem of a Buttercup, showing vascular bundle embedded in parenchyma cells (yellow). At the outer edge of the vascular bundle is sclerenchyma tissue

Complex Permanent Tissues

Permanent tissue that is made up of more than one type of cell is called complex permanent tissue. There are two different types of complex permanent tissues: xylem and phloem.

Xylem

Xylem is involved in the transport of water and mineral nutrients that are absorbed through roots from the soil. It also provides mechanical support to the plant. Xylem is composed of four different elements as listed below.

1. Xylem tracheids } Main conducting elements
2. Xylem vessels
3. Xylem parenchyma (Storage tissue and helps in lateral conduction of water)
4. Xylem fibres (Support)

Among the xylem elements, except xylem parenchyma, all others are dead cells.

Phloem

Phloem tissues help in the transport of photosynthesis products to various parts of the plant body. Phloem tissue is made up of four different types of elements.

1. Sieve tubes
2. Companion cells
3. Parenchyma
4. Fibres

Among the phloem elements except phloem fibres, all are living cells. Sieve tube elements are long, tube-like and are placed end to end. Companion cells are seen associated with sieve tube elements. Phloem parenchyma mainly functions in storage. Phloem fibres provide mechanical strength.

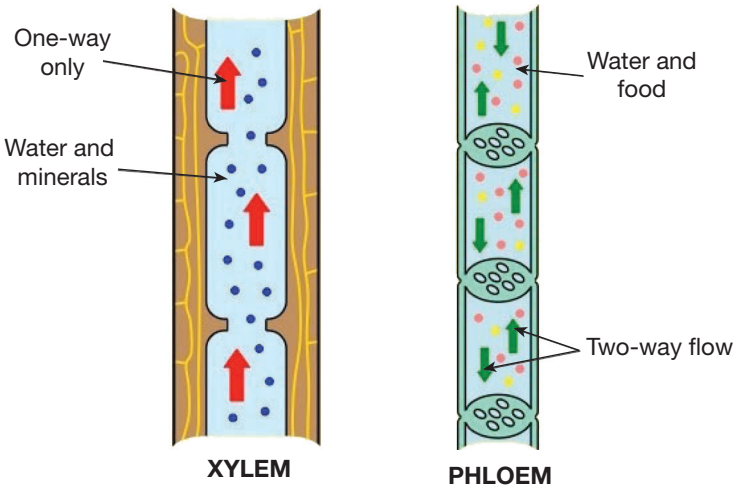


FIG. 2.8 (a) Xylem and (b) Phloem

Epidermal Tissue

It forms the outermost covering of the plant body. It consists of compactly arranged cells. It is usually found as single continuous layer. Epidermal surface is coated with a thick waxy layer called cuticle, which prevents water loss. The specialized openings present on the epidermis are called stomata. Stomata are enclosed by a pair of kidney-shaped cells called guard cells. Guard cells regulate the opening and closing of stomata. Transpiration (loss of water in the form of water vapour) and gaseous exchange takes place through stomata.

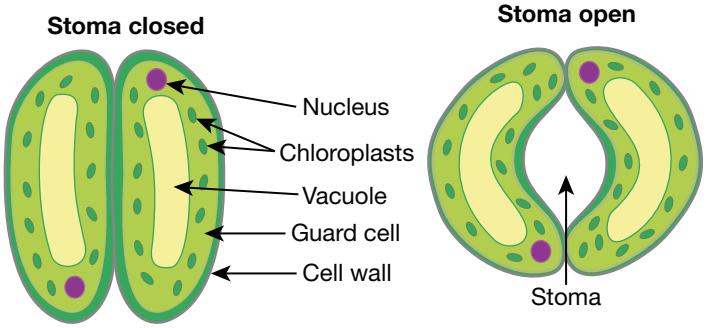


FIG. 2.9 Illustration of opening and closing of stomata

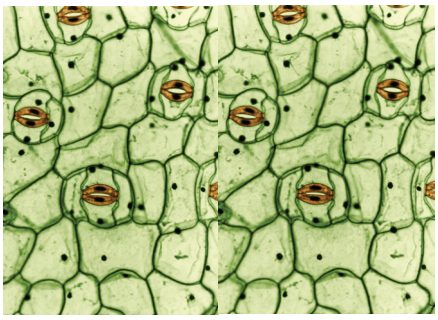


FIG. 2.10 Microscopic view of guard cells and stomata in Spiderwort

ANIMAL TISSUE

Animals consist of four basic types of tissues which differ in location, structure and function as mentioned below.

1. Epithelial tissue
2. Connective tissue
3. Muscular tissue
4. Nervous tissue

These tissues are organized in a specific manner to form different types of organs.

Epithelial Tissue

Epithelial tissue provides a covering or lining for various internal and external body parts. The cells are compactly arranged with little intercellular spaces. According to the number of cell layers, epithelial tissue is divided into two types:

1. **Simple epithelium**
   - Composed of single layer of cells.
   - Forms lining of body cavities, ducts and tubes.
2. **Compound epithelium or stratified epithelium**
   - Consists of two or more cell layers.
   - Has protective function.

According to the shape, epithelial tissue can be divided into 4 types:

1. **Squamous epithelium**
   - It consists of flat cells
   - It is found in walls of blood vessels, skin, etc.
2. **Cuboid epithelium:** It consists of cube-shaped cells and is found in lining parts of the body, such as kidney tubules and the walls of respiratory bronchioles.
3. **Columnar epithelium**
   - It consists of tall pillar like cells
   - It is found in lining of stomach and intestine
4. **Ciliated epithelium**
   - If the columnar or cuboidal cells bear cilia on their free surface, they are called ciliated epithelium.
   - Cilia (hair-like projections) move back and forth to move particles out of our body.
   - It is found in respiratory tract.

Info Box!

Columnar or cuboidal cells **specialized for secretion** are called glandular epithelium, for example, salivary glands.

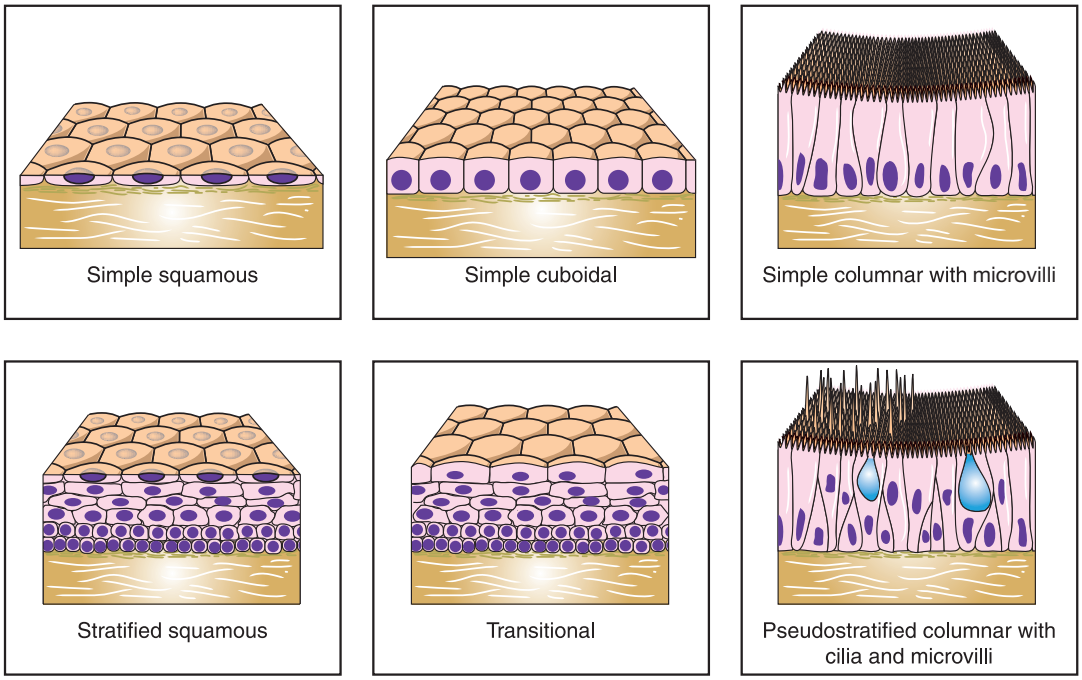


FIG. 2.11 Types of epithelium

Connective Tissue

Connective tissues are most abundant and function in linking, connecting or supporting other tissues or organs in the body. The cells in connective tissues are loosely packed and are embedded in an intercellular matrix.

Different types of connective tissues are given below.

Areolar Tissue

- It is present beneath the skin, around blood vessels, nerves, etc.
- It acts as a packing or supporting tissue and fills space inside organs.

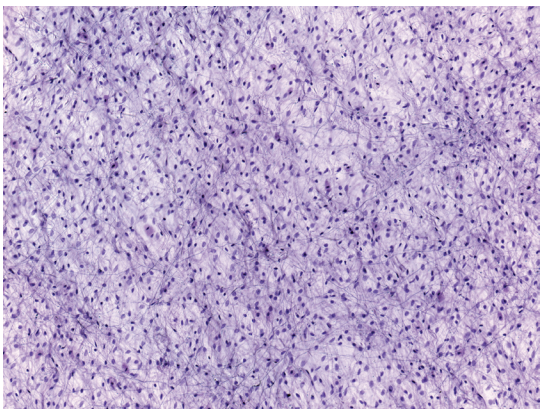


FIG. 2.12 Microscopic view of areolar tissue

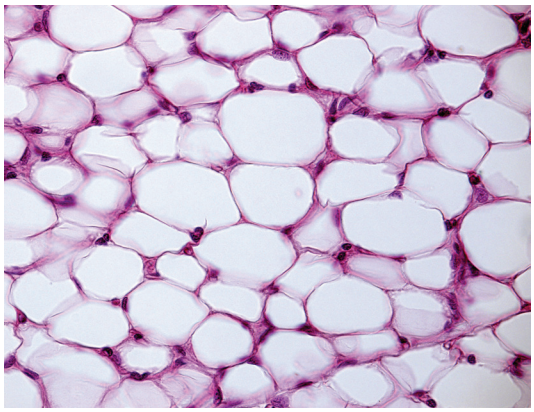


FIG. 2.13 Microscopic view of adipose tissue

Adipose Tissue

- It is found beneath the skin and between internal organs.
- The excess nutrients in the body are converted into fats and are stored in this tissue.
- The cells are called adipocytes.

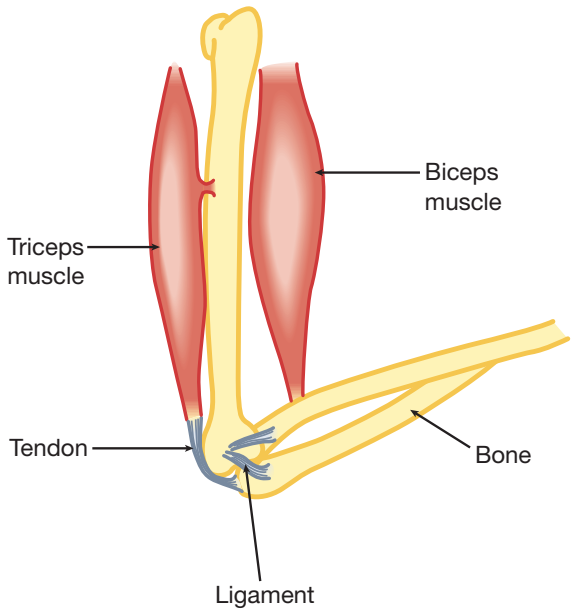


FIG. 2.14 Illustration of tendon and ligament

Tendon

- The tissues that attach muscles to bones are called tendons.
- They have great tensile strength and less flexibility.

Ligament

- This tissue bones to bones.
- It is elastic in nature.
- It has great strength.
- It strengthens the joint and allows normal movement.

Bone

- They provide structural framework to the body.
- They anchor the muscles and supports the main organs of the body.

Blood

- It is a fluid connective tissue.
- It consists of cells, like RBCs, WBCs and platelets.
- Blood circulates through the blood vessels – arteries, veins and capillaries.
- Its function include transport of respiratory gases, nutrients, hormones and vitamins to various parts of body and excretory products from various parts to kidney and liver.

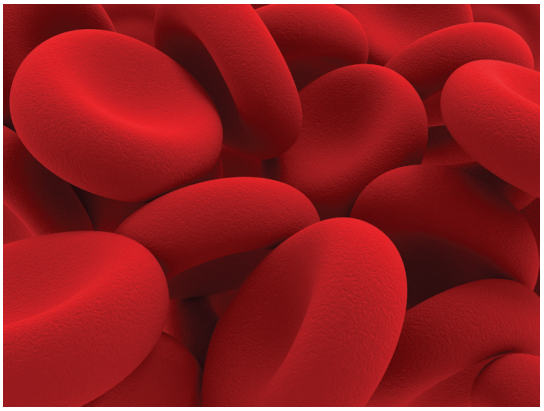


FIG. 2.15 Red blood cells

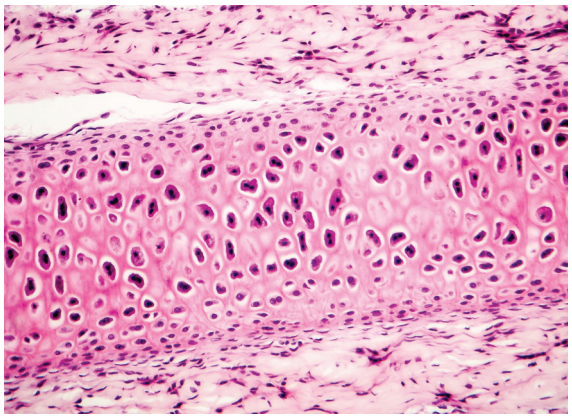


FIG. 2.16 Microscopic view of bone tissue

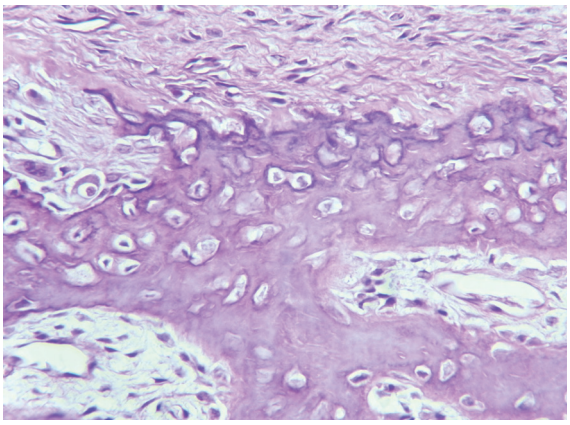


FIG. 2.17 Microscopic view of cartilage

Cartilage

- It smoothens bone surfaces at joints.
- It is found in nose and ear.

Table 2.1 Differences between bone and cartilage

Bone	Cartilage
Hard	Soft
Non-elastic	Elastic
Tough	Flexible
Cells are called osteocytes	Cells are called chondrocytes
Matrix made of calcium and phosphate	Matrix made of proteins and sugar
Protects body against mechanical damage and assists in movement. Provides framework and shape for the body	Reduces friction at joints

Muscular Tissue

Muscle tissue consists of many cylindrical, elongated cells called muscle fibres. Muscle fibres contract and relax in a coordinated fashion to cause movement. Muscles are of three types:

1. **Skeletal muscle**
   - They are attached to bones (muscles of limbs).
   - These are also known as voluntary muscles as we can contract these muscles according to our will.

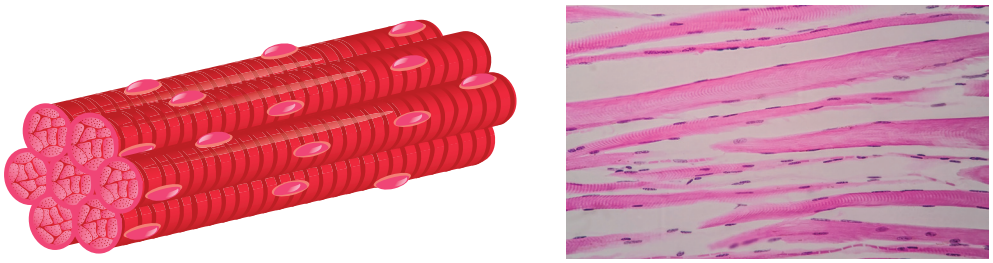


FIG. 2.18 Skeletal muscle

2. **Smooth muscle**
   - They are found in the wall of alimentary canal, blood vessels, etc.
   - It is not possible to contract these muscles according to our will, so these are also known as involuntary muscles.

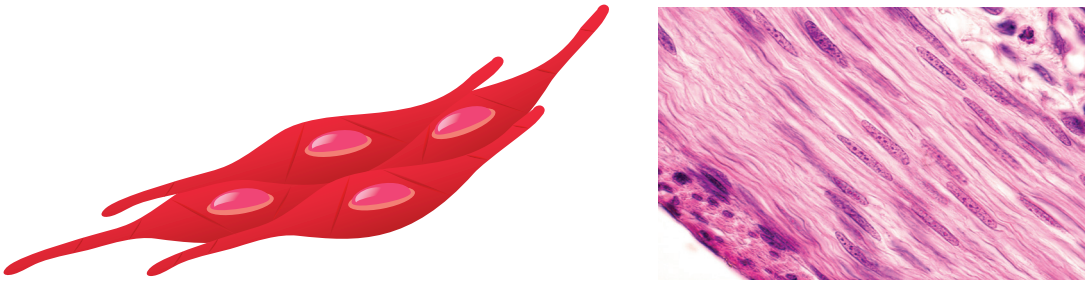


FIG. 2.19 Smooth muscle

3. **Cardiac muscle**
   - They are found only on heart walls.
   - They are involuntary in nature.
   - These muscles show rhythmic contraction and relaxation throughout life.

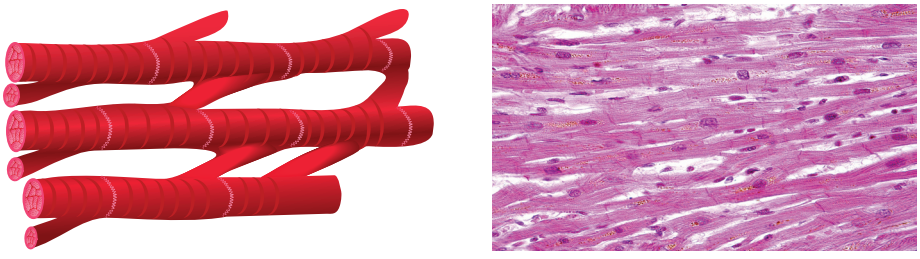


FIG. 2.20 Cardiac muscle

Nervous Tissue

Cells of nervous tissue are called neurons. Neurons transmit information through electrical and chemical signals. Brain, spinal cord and nerves are made up of neurons. Neurons are protected by another type of cell called neuroglial cell. Neurons consist of three major parts:

1. **Cell body:** Contains nucleus and cytoplasm.
2. **Axon:** Longest part and carries impulses away from the cell body.
3. **Dendrites:** Short and branched parts arising from the cell body. They carry impulses towards cell body.

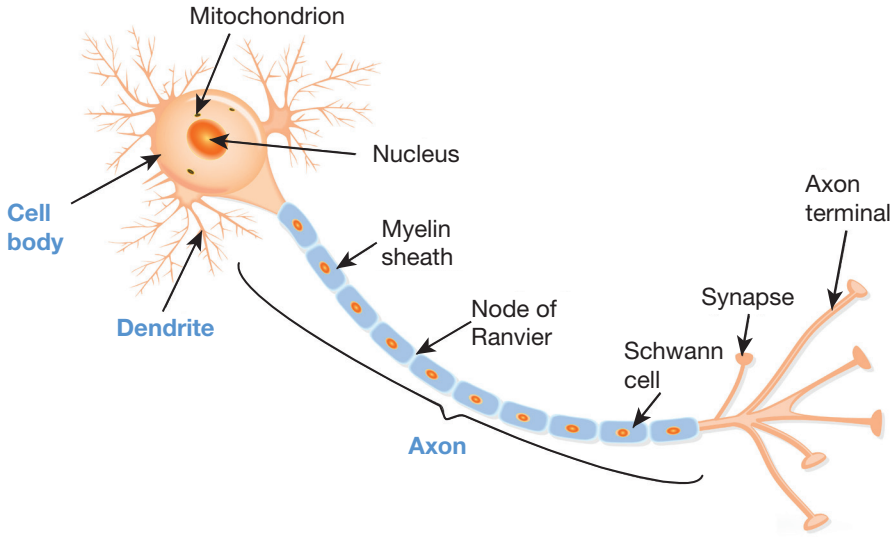


FIG. 2.21 A typical neuron showing all parts

QUICK RECAP

1. Define tissue with one example.

Groups of cells either similar or dissimilar and which perform a specific function are called tissue. for example, muscular tissue in humans aids in movement and locomotion.

2. Differentiate between apical meristem and lateral meristem.

Meristems are the plant tissues that can divide throughout their life.

Apical meristem	Lateral meristem
Seen at the growing tips of roots and shoots	Seen along the sides of the stem and the root
Increases the length of root and stem	Increases the girth of plant body
Involved in primary growth of plants	Involved in secondary growth of plants

BODY MOVEMENTS

One of the important distinguishing features of living beings is movement. Movements can be observed in both animals and plants. Movements that result in change in position is called locomotion. Animals move usually for food, shelter, mating, etc. and the methods of locomotion depend upon their habitat and the demand of situation.

There are different kinds of structures that help in movement, such as cilia, flagella, pseudopodia and muscles.

Cilia

Cilia are minute hair-like organelles in eukaryotic cells. Ciliary movement can be observed in protozoans like *Paramecium* and also in most of our internal organs that are lined by ciliated epithelium. For example, the coordinated movement of cilia in respiratory tract helps us in removing dust particles and foreign materials inhaled along with the atmospheric air.

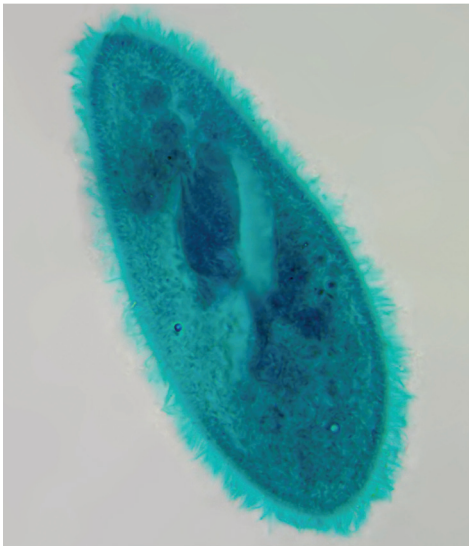


FIG. 2.22 High power microscopic view of *Paramecium* to display hair-like cilia

Flagella

Flagella are lash-like appendages that protrude from eukaryotic and prokaryotic cells. Mammalian sperm cell is an example for eukaryotic cell bearing flagella. Sperm cell uses its flagellum to travel through the female reproductive tract.

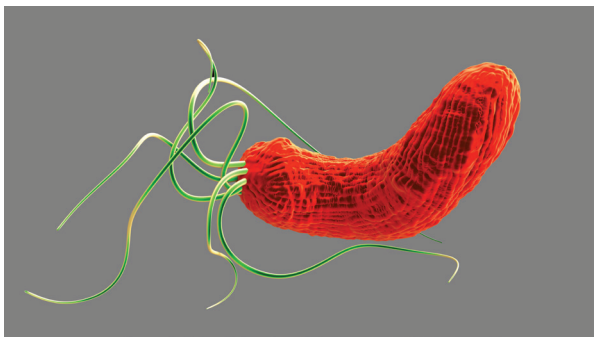


FIG. 2.23 *Helicobacter* bacteria showing multiple flagella

Pseudopodia (False Feet)

Pseudopodia are temporary projections of plasma membrane seen in eukaryotes. Cells that show pseudopodia are usually referred to as amoeboids. Some blood cells in our body (leucocytes) exhibit amoeboid movement. The unicellular protozoa, (amoeba) performs various activities by the formation of pseudopodia.

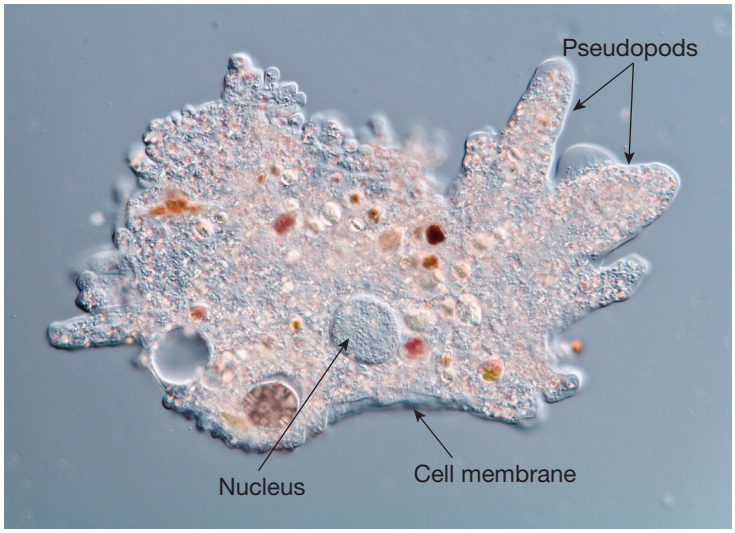


FIG. 2.24 *Amoeba* moves with the help of pseudopodia

Muscles

Muscles are specialized tissues that contract and relax to cause movement. Muscles are of three types skeletal, smooth and cardiac muscles. There are over 600 muscles in our body.

Skeletal muscles attach to bones at various locations and aid in movement. The contraction and relaxation occur with the help of two proteins actin and myosin.

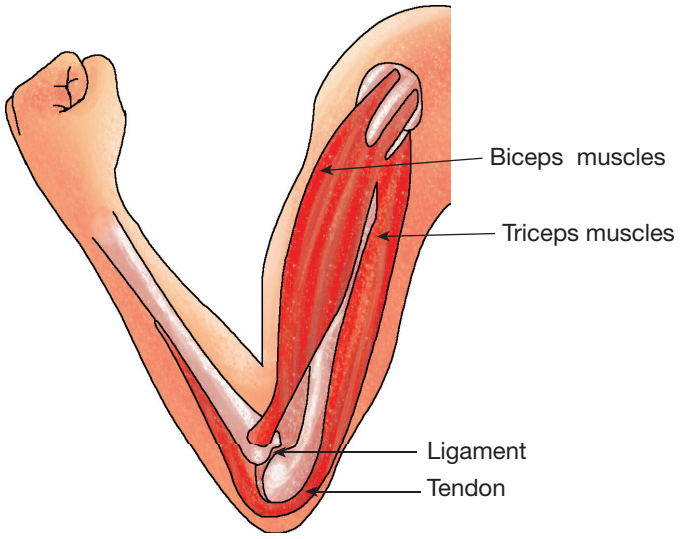


FIG. 2.25 Illustration of human muscle

SKELETAL SYSTEM

Skeletal system comprises a framework of bones and few cartilages. Human body (adult) comprises 206 bones and the skeletal system is divided in two:

1. Axial skeleton
2. Appendicular skeleton

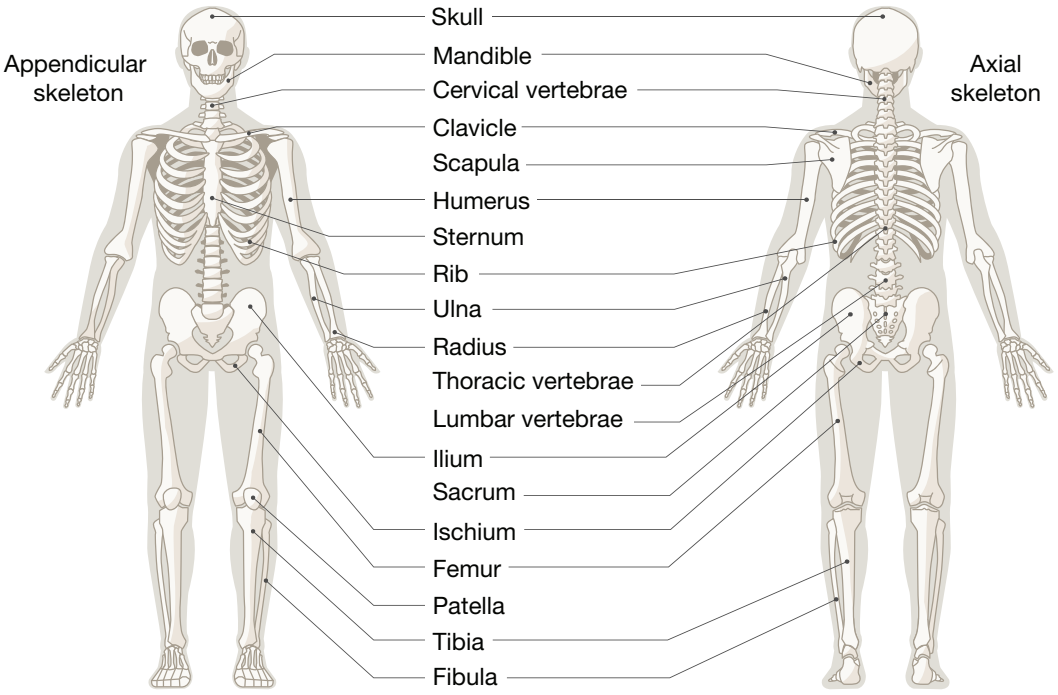


FIG. 2.26 Human skeleton system

Axial Skeleton

It consists of 80 bones that are distributed along the main axis of the body. Axial skeleton includes:

- **Skull:** hard protective skeleton of head.
- **Vertebral column:** extends from base of the skull and protects the spinal cord.
- **Sternum:** flat bone found in the centre of chest.
- **Ribs:** long curved bones which form the ribcage.

Appendicular Skeleton

It supports the appendages, for example, limbs. In human body, each limb is made up of 30 bones. The bones of hands are:

- Humerus
- Radius
- Ulna
- Carpals (wrist bones)
- Metacarpals (palm bones)
- Phalanges (digits)

The bones of lower limbs are:

- Femur (thigh bone)
- Patella
- Tibia
- Fibula
- Tarsals
- Metatarsals
- Phalanges

Joints

A joint is the area where two bones are attached for the purpose of permitting movement of body parts. They are essential for all types of movements. There are three types of joints:

1. **Fibrous joints:** do not allow movement, for example, joints between skull bones.
2. **Cartilaginous joints:** permit limited movement, for example, joints in vertebral column.
3. **Synovial joints:** allow considerable movement. Contain a fluid-filled cavity called **synovial cavity**. for example, knee joint.

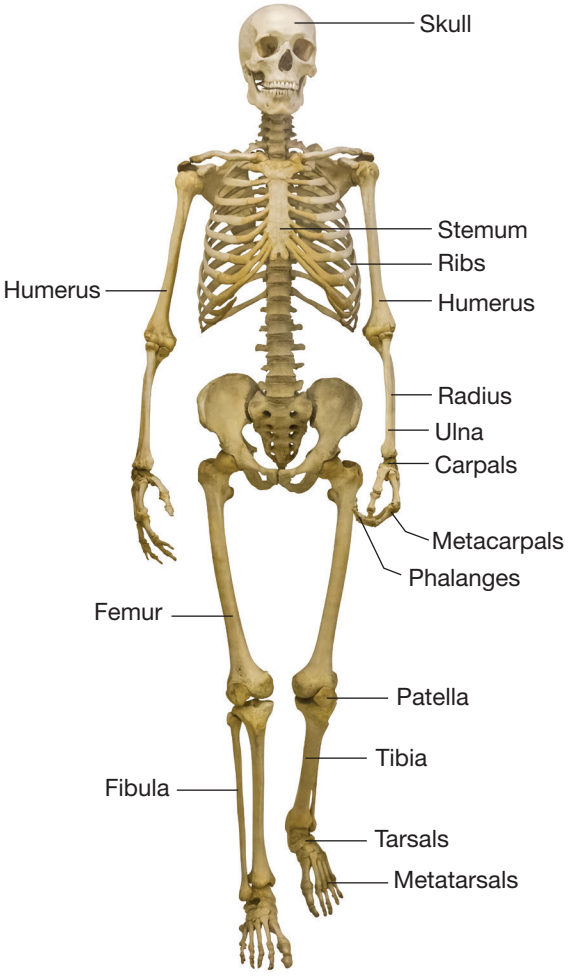


FIG. 2.27 Human skeleton showing major bones in our body

POINTS TO REMEMBER

- Tissue is defined as a group of cells either similar or dissimilar that perform a specific function, example epithelial tissue, muscular tissue, etc.
- Multicellular organisms exhibit division of labour.
- The plant tissue that can be divided throughout its life is called meristematic tissue.
- The plant tissues that do not undergo division are called permanent tissues. Examples are parenchyma, collenchyma, xylem, phloem, etc.
- Animals consist of four basic types of tissues which are Epithelial, Connective, Muscular and Nervous.
- Movements that result in change in position is called locomotion.
- Pseudopodia are temporary projections of plasma membrane seen in eukaryotes
- Muscles are specialized tissues that contract and relax to cause movement.
- Skeletal system comprises a framework of bones and few cartilages.
- A joint is the area where two bones are attached for the purpose of permitting movement of body parts.

TEST YOUR CONCEPTS

Directions for questions 1 to 40: Fill in the blanks in each question.

1. The second phase of mitosis is _____.
2. Meristematic tissue that increases width of plant body is _____.
3. The dead simple permanent tissue is _____.
4. The element of xylem that provides structural support is _____.
5. The thick waxy coating present on the surface of epidermal cells is _____.
6. Phloem parenchyma mainly functions in _____.
7. Meristematic tissue converts to permanent tissue through a process called _____.
8. After meiosis _____ daughter cells are produced.
9. In binary fission _____ division occurs first.
10. Mode of cell division in prokaryotes is _____.
11. Bone tissue constitutes cells called _____.
12. Muscles seen on heart wall are _____.
13. The part of neuron which contains nucleus is _____.
14. Locomotory structure present in *Paramoecium* is _____.
15. Axial skeleton of the human body is made up of _____ bones.
16. The wrist bones are also known as _____
17. Long curved bones that form the ribcage are _____.
18. The joints that allow limited movement are _____.
19. The longest bone in human body is _____.
20. Skeletal muscles are under _____ control.

Directions for questions 21 to 41: For each of the following questions, four choices have been provided. Select the correct alternatives.

21. Meiosis results in the formation of daughter cells with
    (a) Half the number of chromosomes.
    (b) Double the number of chromosomes.
    (c) One chromosome less than the parent.
    (d) One chromosome higher than the parent.

22. Type of cell division that occurs during gamete formation is
    (a) Mitosis (b) Meiosis
    (c) Binary fission (d) Budding

23. Which of the following statements are wrong?
    (i) Mitosis involves two sequential divisions, mitosis I and mitosis II.
    (ii) Meiosis results in the formation of four daughter cells with half the number of chromosomes.
    (iii) Simple permanent tissues are made up of only one type of cell.
    (iv) Collenchyma provides stiffness to the plant body.
    (a) B and C (b) A and D
    (c) C and D (d) B and D

24. Meristem that occurs between mature tissues is
    (a) Lateral meristem (b) Cambium
    (c) Intercalary meristem (d) Apical meristem

25. Which one the following is a dead tissue?
    (a) Parenchyma (b) Collenchyma
    (c) Sieve-tube cells (d) Xylem tracheids

26. Match the following

A	Coconut husk	i	Xylem parenchyma
B	Thin cell wall	ii	Collenchyma
C	Irregularly thickened cell wall	iii	Sclerenchyma
D	Lateral conduction of water	iv	Parenchyma

	A	B	C	D
(a)	i	ii	iii	iv
(b)	ii	i	iv	iii
(c)	iii	iv	ii	i
(d)	iii	i	ii	iv

PRACTICE QUESTIONS

27. The type of tissue present in coconut husk is
(a) Sclerenchyma (b) Collenchyma
(c) Parenchyma (d) Meristem

28. Which one of the following is not an element of xylem tissue?
(a) Sieve tube (b) Parenchyma
(c) Fibre (d) Vessels

29. Which of the following is a dead tissue?
(a) Sieve tube (b) Companion cells
(c) Parenchyma (d) Fibres

30. The stomata are enclosed by
(a) Parenchyma (b) Cuticle
(c) Lignin (d) Guard cells

31. **Assertion (A):** Meiosis is also known as reduction division.
Reason (R): Meiosis involves formation of daughter cells with half the number of chromosomes than that of parent cell.
(a) Both A and R are true and R is the correct explanation for A.
(b) Both A and R are true and R is the not the correct explanation for A.
(c) A is true and R is false.
(d) A is false and R is true.

32. Cells present in nervous tissue that protect neurons are
(a) Axons (b) Neuroglial cells
(c) Osteocytes (d) Chondrocytes

33. The matrices of bones are made up of
(a) Calcium and magnesium
(b) Magnesium and phosphate
(c) Calcium and potassium
(d) Calcium and phosphate

34. Which one of the following muscles shows rhythmic contraction and relaxation throughout life?
(a) Skeletal muscle (b) Cardiac muscle
(c) Heart muscle (d) Both (b) and (c)

35. The tissues that prevent friction between bones are
(a) Cartilage (b) Blood tissue
(c) Epithelial tissue (d) Muscle tissue

36. The tissue that connects bone to bone is
(a) Tendon (b) Areolar tissue
(c) Ligament (d) Adipose tissue

37. Match the following

A	Adipose tissue	i Chondrocytes
B	Bone	ii Blood
C	Cartilage	iii Fat cell
D	Platelets	iv Osteocyte

	A	B	C	D
(a)	iii	iv	i	ii
(b)	iv	i	ii	iii
(c)	iii	i	iv	ii
(d)	iv	ii	iii	i

38. Which one of the following is a correct statement?
(a) Sperm cells use cilia to travel through female reproductive tract.
(b) Red blood corpuscles are capable of showing amoeboid movement.
(c) Palm bones are also known as metacarpals.
(d) Knee joint is an example for cartilaginous joint.

39. The hard protective covering of brain is called
(a) Vertebral column (b) Cranium
(c) Sternum (d) Ribs

40. Adult human body comprises
(a) 206 bones (b) 300 bones
(c) 204 bones (d) 200 bones

41. The kind of epithelium seen in respiratory tract is
(a) Squamous epithelium
(b) Ciliated epithelium
(c) Glandular epithelium
(d) Cuboidal epithelium

PRACTICE QUESTIONS

PRACTICE QUESTIONS

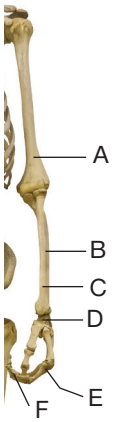
MASTERING THE CONCEPTS

Knowledge and Understanding

1. What are stomata and what are their significance in a plant?
2. Make a comparison between the three types of simple permanent tissue based on their structures.
3. Differentiate between xylem and phloem.
4. Write the significance of collenchyma in plants?
5. How permanent tissue is formed from meristematic tissue?
6. What is a permanent tissue and how is it classified?
7. What is phloem tissue, and explain its various elements with their function.
8. Give a note on cuticle.
9. Give a brief note on xylem tissue.
10. Differentiate between mitosis and meiosis.
11. Differentiate between bone and cartilage.
12. How epithelial tissues have been classified according to their shape?
13. What is ciliated epithelium, and why are they important in the respiratory tract?
14. Make a comparison between tendon and ligament.
15. Which type of tissue is blood and what is its function?
16. Give a note on the structure of neuron.
17. Define pseudopodia.
18. Give a note on axial skeleton.
19. What are the different types of joints and give an example for each?

Application and Analysis

1. You might have seen that even after grazing by herbivores, grasses regenerate from the remaining parts. Which tissue is responsible for this and where it is located?
2. Further growth of an onion root stops after the removal of tip portion. Why?
3. Identify the parts.



4. It is possible to move the elbow freely. Which types of joints are present here that help in this movement?
5. Plants require less energy than animals. Do you think that this statement is correct? Explain your answer.
6. Aakanksha was shown two slides of plant tissues; parenchyma and sclerenchyma. How did she identify sclerenchyma?
7. Generally shrubs and herbs are grown in open places and are exposed to strong winds. But they do not break. Why?
8. Arthritis is a common problem in aged people. Explain its connection with movement.
9. How is an earthworm able to move without having bones?

TEST YOUR CONCEPTS

1. Metaphase
2. Lateral meristem
3. Sclerenchyma
4. Xylem fibres
5. Cuticle
6. Storage
7. Differentiation
8. Four
9. Nuclear division
10. Binary fission
11. Osteocytes
12. Cardiac muscle
13. Cell body
14. Cilia
15. 80 bones
16. Carpal bones
17. Ribs
18. Cartilaginous joints
19. Thigh bone or femur
20. Voluntary
21. (a)
22. (b)
23. (b)
24. (c)
25. (d)
26. (c)
27. (a)
28. (a)
29. (d)
30. (d)
31. (a)
32. (b)
33. (d)
34. (d)
35. (a)
36. (c)
37. (a)
38. (c)
39. (b)
40. (a)
41. (b)

MASTERING THE CONCEPTS

Knowledge and Understanding

1. Stomata are the specialized openings present on the epidermis of leaves and stems. They are enclosed by a pair of kidney-shaped cells called guard cells. Transpiration of water and gaseous exchange takes place through stomata.

2.

Parenchyma	Collenchyma	Sclerenchyma
Cells can be spherical, oval, polygonal or elongated	Cells can be oval, spherical or polygonal	Long cells with narrow lumen
Thin cell wall	Irregularly thickened cell wall	Thick cell wall
Living tissue with nucleus	Living tissue with nucleus	Dead tissue without nucleus

3.

Xylem	Phloem
Transports water and mineral nutrients	Transports products of photosynthesis
Transport is unidirectional, that is, from root to upper part of the plant body	Multidirectional transport from leaves to various parts of the plant body

PRACTICE QUESTIONS

Made up of four elements such as: Xylem tracheids Xylem vessels Xylem parenchyma Xylem fibre	Made up of four elements such as: Sieve tube Companion cells Phloem parenchyma Phloem fibres
Main conducting elements are xylem tracheids and vessels	Sieve tube elements mainly function in conduction
Three of the elements are dead (xylem tracheids, xylem vessels, xylem fibres)	Three of the elements are living (sieve tube, companion cells, phloem parenchyma)

4. Collenchyma is a type of simple permanent tissue. It provides mechanical support and flexibility to the plants. It also allows the plant to bend without breaking.

5. Permanent tissue is formed by the differentiation of meristematic tissue. The process of taking up a permanent shape, size and specific function is called differentiation.

6. The tissues that do not undergo division are called permanent tissues. Depending on whether they are made of one type of cell or different types of cells, they can be classified into two types:

   Simple permanent tissue: made up of only one type of cell, for example, parenchyma, collenchyma and sclerenchyma.

   Complex permanent tissues are made up of many types of cells, for example., xylem and phloem.

7. Phloem tissue is a type of complex permanent tissue that helps in the transport of the photosynthesis products to various parts of the plant body. Phloem tissue is made up of four different elements such as:

   Sieve tubes: main conducting element.

   Companion cells: seen associated with sieve tube cells and control the functioning of sieve tube cells

   Phloem parenchyma: helps in storage

   Phloem fibre: provides mechanical strength

8. The thick waxy layer present in epidermal surface is called cuticle. It prevents water loss.

9. Xylem is a type of complex permanent tissue and is involved in the transport of water and mineral nutrients that are absorbed through roots from the soil. It also provides mechanical support to the plant. Xylem is composed of four different elements:

   Xylem tracheids, Xylem vessels } Main conducting elements

   Xylem parenchyma → Storage tissue and helps in lateral conduction of water

   Xylem fibres → Support

   Among the xylem elements, except xylem parenchyma, all others are dead cells.

10.

Mitosis	Meiosis
Involves one cycle of division	Involves two sequential cycles of division
Occurs in somatic cells	Occurs in sex cells
During normal cell growth	During gamete formation
Chromosome number remains the same	Chromosome number reduces to half
Two daughter cells formed	Four daughter cells formed

11.

Bone	Cartilage
Hard tissue	Comparatively soft
Not elastic	Elastic
Tough	Flexible
Cells are called osteocytes	Cells are called chondrocytes
Matrix made of calcium and phosphate	Matrix made of proteins and sugar
Protects body against mechanical damage, assist movement	Smoothens bone surfaces at joints
Provides framework and shape for body	Reduces friction of joints

12. Epithelial tissues have been classified into three types according to their shape, such as squamous, cuboidal and columnar epithelium. Squamous epithelial tissues are made up of flat cells and are usually found in the walls of blood vessels, skin, etc. Cuboidal cells are made up of cube-shaped cells that are found in ducts of glands. Columnar cells are made up of tall pillar-like cells and are usually found in the linings of stomach and intestine.

13. The columnar or cuboidal epithelial cells that possess cilia on the free surface are called ciliated epithelial tissues. Cilia in the respiratory tract move back and forth and help in removing the dust particles that are inhaled during breathing.

14.

Tendon	Ligament
Connective tissue that attaches muscles to bones	Connective tissue that attaches bones to bones
Less flexibility and has great tensile strength	Elastic and has great strength

15. Blood is the fluid connective tissue and is made up of plasma (matrix) and cells, such as RBCs, WBCs and platelets. Blood helps in transport of various nutrients, hormones and vitamins to different parts of the body and also excretory products from various parts to kidney and liver.

16. Neurons are the basic unit of nervous tissue and are made up of three major parts: cell body, axons and dendrites. Cell body contains nucleus and cytoplasm and possesses many short, branched parts called dendrites. Dendrites carry impulses towards the cell body. The longest part of neurons that arises from cell body is called axon and it carries impulses away from the cell body.

17. Pseudopodia are temporary projections of plasma membrane seen in eukaryotes. Cells that show pseudopodia are usually referred to as amoeboids. *Amoeba* perform various activities, such as movement, food capturing, etc., with the help of pseudopodia. Amoeboid movement is also shown by some blood cells, such as leucocytes in human body.

18. Human axial skeleton is made up of 80 bones that are distributed along the main axis of the body. It includes skull, vertebral column, sternum and ribs. Skull functions as a hard protective covering of the brain, whereas vertebral column extends from base of the skull and protects the spinal cord. The flat bone found in the centre of the chest is called sternum and the long curved bones that form the ribcage are called ribs.

19. Joints can be classified into three types depending on whether they allow movement or not

Fibrous joints: do not allow movement, for example, joints between skull bones.

Cartilaginous joints: permit limited movement, for example, joints in the vertebral column.

Synovial joints: allow considerable movement and contain a fluid-filled cavity called synovial cavity, for example, knee joint.

Application and Analysis

1. The tissue responsible for the regeneration of parts eaten by grazing herbivores is intercalary meristem. It is a kind of meristematic tissue that has the ability to divide. Intercalary meristem is seen between mature tissues, on either side of the nodes and is also responsible for the increase in length of internodes.

2. The apical meristem, meristematic tissue responsible for the increase in length of a plant body (or here in this case root) is located at the root tip. Removal of root tip causes the removal of apical meristem and thus the growth of root stops.

3. A – Humerus B – Radius
C – Ulna D – Carpals
E – Metacarpals F – Phalanges

4. The elbow contains synovial joint that allows considerable movement. It contains a fluid-filled cavity with synovial fluid. This fluid helps in lubrication.

5. Plants do not have to move in search of food as they prepare their own food through the process of photosynthesis. Whereas, animals are dependent on plants and other animals for food and have to travel fulfill this requirement.

6. She could identify sclerenchyma by the thickness of cell walls. The walls of sclerenchyma tissues are thickened due to lignin.

7. Aerial young parts of shrubs and herbs contain collenchyma tissues which provide flexibility and elasticity to plants to withstand winds.

8. Arthritis condition is marked by pain in joints. Hence, people find it difficult to move from one place to another as joints are primarily involved in movement of body parts.

9. During a movement, earthworm first extends front part of the body keeping the rear portion fixed to the ground. Then it fixes the front and releases the rear end of the body. Earthworm has muscles which repeatedly expand and contract to do so.

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Chapter

3

Classification of Living Organisms

REMEMBER

Before beginning this chapter, you should be able to:

- Understand the need for classifying organisms
- Remember the rules for writing scientific names
- Remember the basics of two- and three-kingdom systems of classification

KEY IDEAS

After completing this chapter, you should be able to:

- Identify the hierarchy of classification
- Explain and apply the rules of binomial nomenclature
- Understand the five-kingdom classification
- Define the basic features of all the five kingdoms

INTRODUCTION

There are a large variety of living organisms in the world. It is nearly impossible to study all of them individually, but grouping them into convenient categories makes their studies possible. This process is known as classification. Grouping or classification is done on the basis of some observable characters. The scientific term used to represent these categories is called taxa. Classification of living organisms into different taxa on the basis of their characteristics is called taxonomy.

HIERARCHY OF CLASSIFICATION

Hierarchy is the taxonomical classification of living organisms into successive levels of complexity. There are seven levels of categories where 'kingdom' is the highest level and species is the lowest level. The various categories are as follows:

Species: A group of individual organisms with fundamental similarities is called species, for example, all mango plants are included in one species.

Genus: It consists of a group of related species that have some common characters, for example, tiger and lion come under the same genus '*Panthera*'.

Family: It consists of a group of related genera, for example, lion, tiger and cat are included in the same family, that is, *Felidae*.

Order: A group of related families constitutes an order, for example, family *Canidae* (dogs) and *Felidae* (cats) come under the same order Carnivora.

Class: It consists of related orders, for example, class Mammalia includes orders Carnivora and Primata (apes, monkeys and humans).

Phylum: In animals, related classes are categorized into the phylum, whereas in plants they are categorized into divisions, for example, phylum Chordata constitutes of mammals along with birds, reptiles, amphibians and fish.

Kingdom: Phyla that have common characters are grouped into various kingdoms, such as plant kingdom (Plantae) or animal kingdom (Animalia).

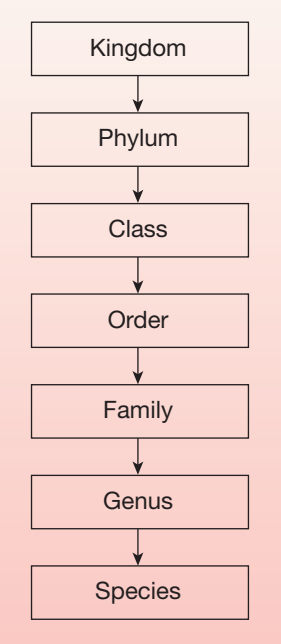


FIG. 3.1 Taxonomic hierarchy in increasing order

The levels of taxonomic hierarchy are explained with examples in the following figure:

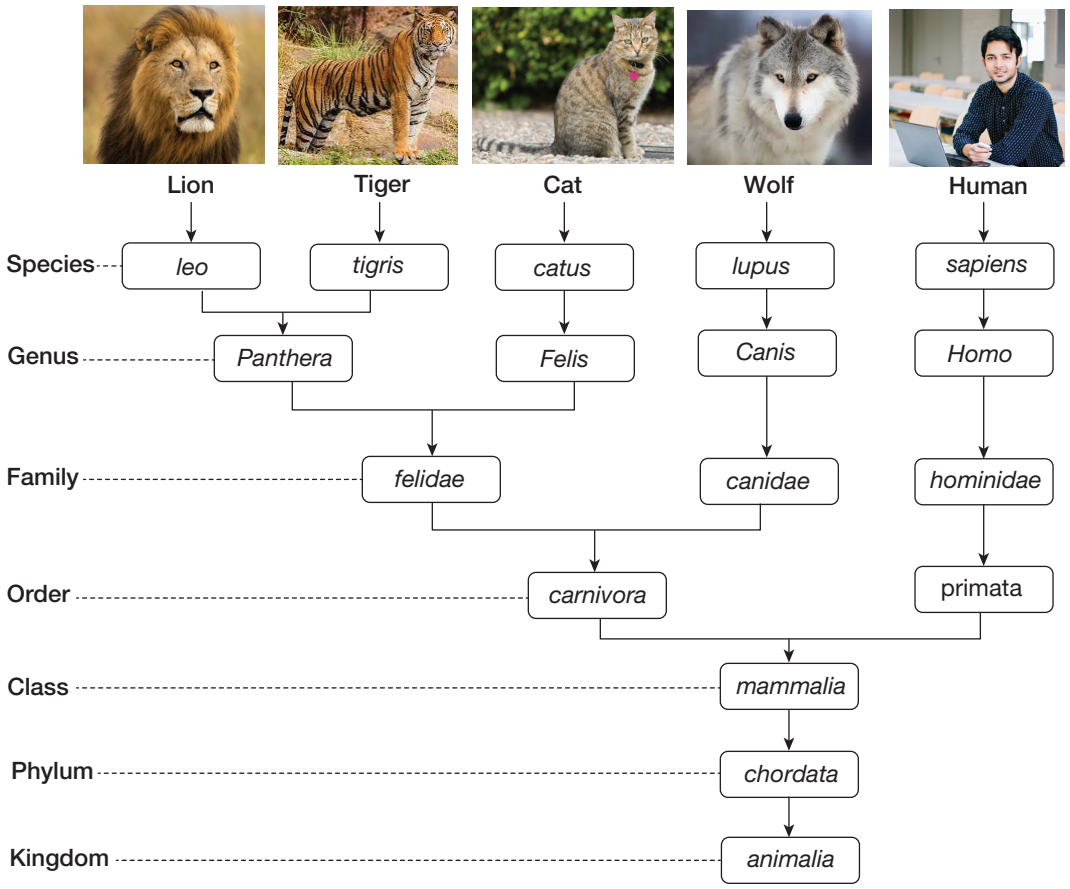


FIG. 3.2 Taxonomic hierarchy of different animals

BINOMIAL NOMENCLATURE

The formal system of naming a living organism by giving it a name composed of two parts is called binomial nomenclature. This naming system was put forward by Carolus Linnaeus in his book *Systema Naturae* in the year 1758. He is regarded as the 'father of taxonomy'. Binomial names or scientific names are mostly derived from latin but they can be based from other languages too. The first part of a scientific name represents the genus to which the species belong and the second part represents the species within the genus. When handwritten, the first letter of the first part, the genus, is always capitalized while the species name is not. However, both the genus and species name are always italicized.

For example, the scientific name of human is *Homo sapiens*, where *Homo* represents the genus and *sapiens* represents the name of species. Similarly, the scientific name of mango is *Mangifera indica*, where *Mangifera* represents genus and *indica* represents species.

The taxonomic hierarchy of human beings is explained as an example for better understanding.

Table 3.1 Taxonomic hierarchy of human beings

Taxonomic Rank	Example
Kindom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Primate
Family	Hominidae
Genus	*Homo*
Species	*sapiens*
Common name	Human

Universal Rules of Nomenclature

The rules followed while giving scientific names to organisms are explained below:

- Biological names are generally Latin and are printed in italics and if handwritten, the genus and species names are separately underlined.
- The genus name starts with a capital letter, whereas the species name is written in lower case.
- Name of the author appears after the species name and is written in an abbreviated form, for example, *Mangifera indica* Linn. indicates that the species was first described by Linnaeus.

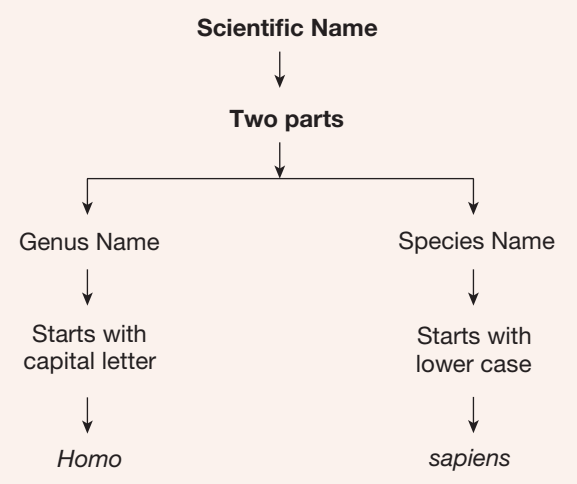


FIG. 3.3 Division of a scientific name

Need for Binomial Nomenclature

The living organisms, plants or animals, are usually known by their local names in a particular locality. The local names may vary from place to place, which can lead to confusion in identifying the organisms. So in order to avoid this confusion, standardized naming is required. Providing a standard name that is universally accepted will help us in identifying the organism with the same name all over the world.

HISTORY OF CLASSIFICATION

Aristotle, the Greek scientist, was one of the earliest scientists to classify living organisms on the basis of some simple morphological characters. He is known as the 'father of biology/zoology'. He classified the living organisms into two groups, plants and animals. He further divided plants into trees, shrubs and herbs. Similarly, animals are divided into two groups: one with red blood and the other one without red blood. He also classified animals on the basis of their habitats, such as aquatic, terrestrial and aerial.

Aristotle's Classification

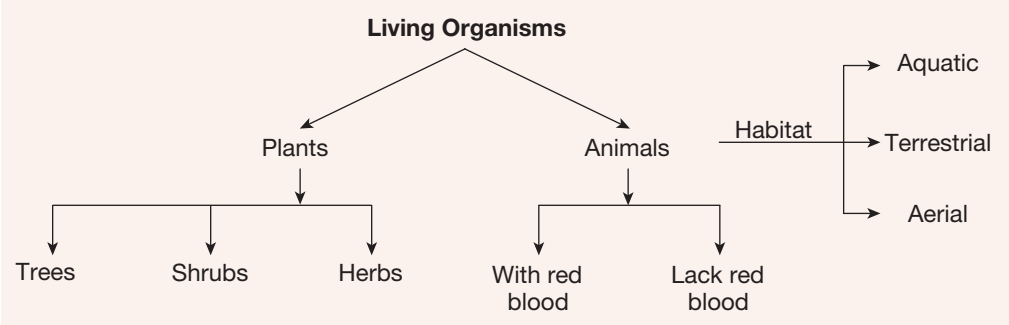


FIG. 3.4 Aristotle's classification of living organisms

Theophrastus, Aristotle's student, is known as the 'father of botany' for his works on plants. Contributions of Theophrastus are also profound in the history of plant classification. Aristotle's classification had many demerits as many organisms do not fit to the groups. For example, frogs, when born, live in water and adult frogs live on land. Even with the limitations, Aristotle's system of classification was used until it was replaced by the classification system proposed by Carolus Linnaeus.

Two-kingdom Classification

Two-kingdom classification, which was used until recently, was introduced by Linnaeus. He classified all organisms into two kingdoms on the basis of nutrition and locomotion. The two kingdoms were Animalia (for animals) and Plantae (for plants).

Linnaeus Two-kingdom Classification

In the 18th century, Carolus Linnaeus published a system for classification of organisms. He classified the organisms into 2 kingdoms—Animal kingdom and Plant kingdom, on the basis of their nutrition and locomotion.

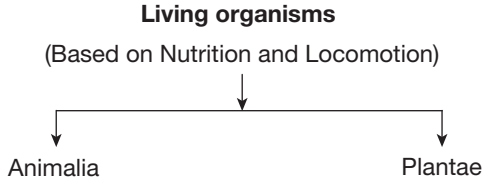


FIG. 3.5 Division of organisms in two-kingdom classification

However their were certain demerits of the two-kingdom classification which are listed below:

- This system did not distinguish between
  - prokaryotes and eukaryotes
  - unicellular and multicellular organisms
  - photosynthetic and non-photosynthetic organisms
- A large number of organisms did not fall into any category, for example, *Euglena* (unicellular) had characters of both plants and animals.

Three-kingdom Classification

Since the two-kingdom classification proposed by Linnaeus was not so successful, a new three-kingdom classification was developed by a German biologist Ernst Haeckel in 1886. The three kingdoms according to Haeckel were:

1. Kingdom Plantae
2. Kingdom Animalia
3. Kingdom Protista

While the first two kingdoms were same as in the older classification, a new kingdom of unicellular microorganisms was introduced. Kingdom Protista included protozoa, fungi, bacteria and other microorganisms. Protists are primarily aquatic in nature.

Five-kingdom Classification

Five-kingdom classification was proposed by an American ecologist, R.H. Whittaker (1969).

The main criteria for this classification were as follows:

- Cell type
- Cell wall
- Nuclear membrane
- Body organization
- Mode of nutrition

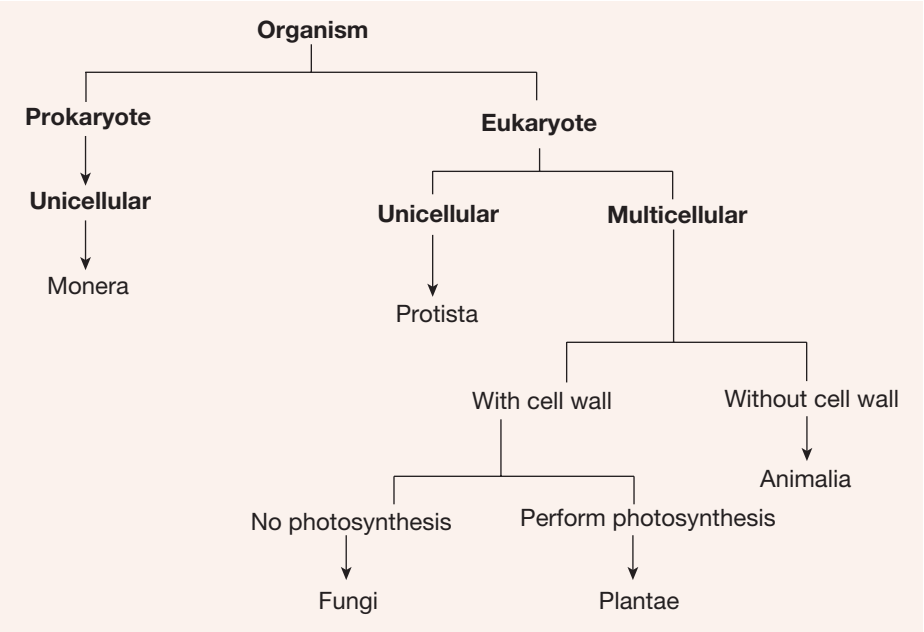


FIG. 3.6 Flow chart showing five-kingdom classification

The five kingdoms are as follows:

1. Monera
2. Protista
3. Fungi
4. Plantae
5. Animalia

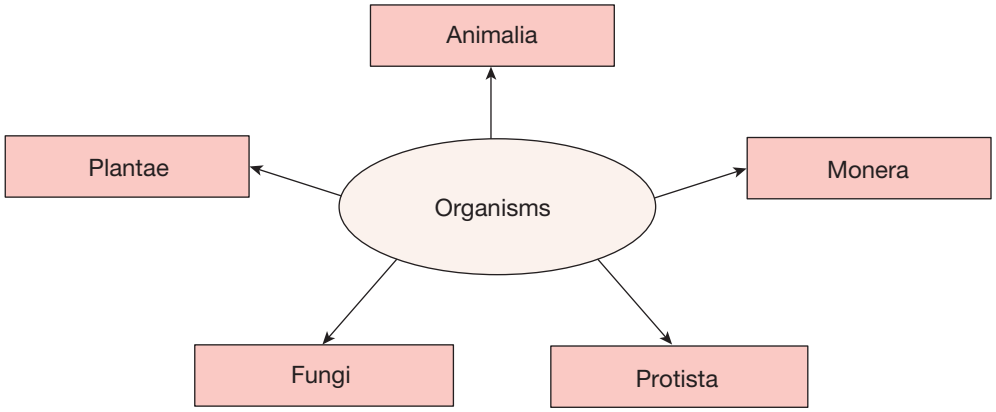


FIG. 3.7 The five-kingdom classification of organisms

Monera

It includes prokaryotic organisms (bacteria), that is, both archaebacteria and eubacteria. Archaebacteria are found in most harsh habitats, such as extremely salty area. Eubacteria are the true bacteria, which are found everywhere including the human body.

It has the following features:

- Prokaryotic
- Mostly unicellular
- Cell wall present
- Nuclear membrane absent
- Mode of nutrition can be autotrophic (produce their own food) or heterotrophic (depend on others for food)

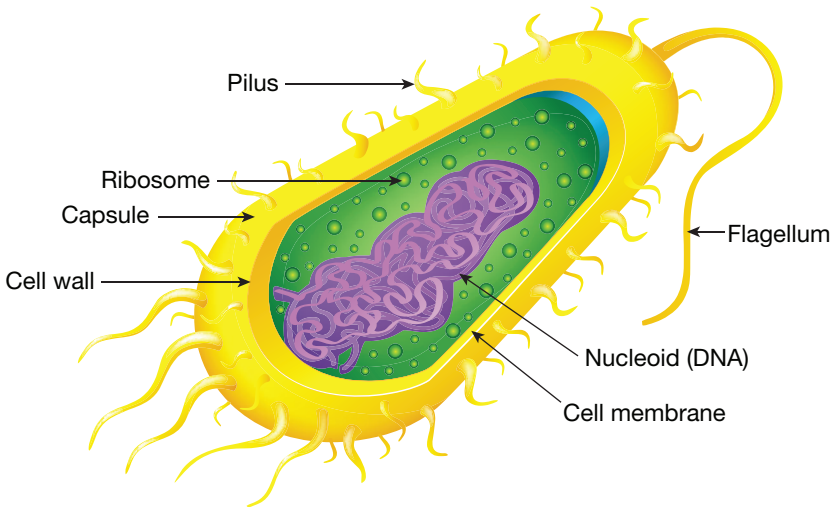


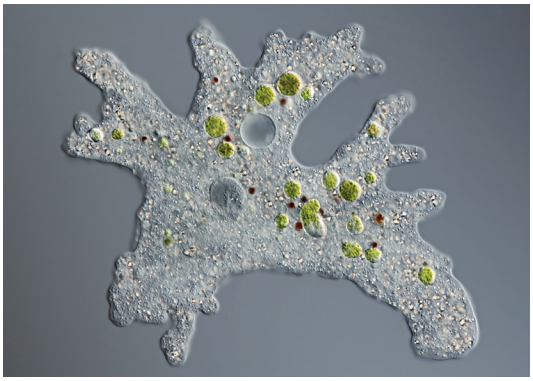
FIG. 3.8 Bacterium—A Moneran

Protista

All single-celled eukaryotes are included in this kingdom. Members of this kingdom are mostly aquatic. It has the following features:

- Eukaryotic and unicellular
- Presence of cell wall in some members
- Presence of nuclear membrane
- Cellular level of body organization
- Both autotrophic and heterotrophic organisms come under this kingdom, for example, *Amoeba* and *Paramoecium*.

Paramoecium—A Protist



Amoeba—A protist

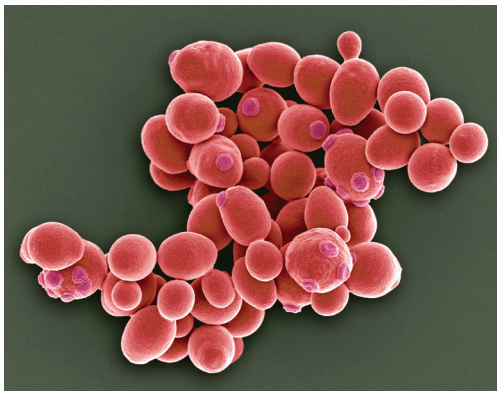
FIG. 3.9 Some common protists

Fungi

Most of the fungi are multicellular organisms but unicellular fungi are also found such as yeast.

It has the following features:

- Eukaryotic in nature
- Presence of cell wall which is made up of chitin
- Nuclear membrane present
- Heterotrophic in nature, either saprophytic (feeds on dead and decaying matter) or parasitic (derives food from host organisms), for example, yeast and mushrooms.



Yeast—A unicellular fungi

Mushroom—A multicellular fungi

FIG. 3.10 Some common fungi

Plantae

All eukaryotic, chlorophyll-containing organisms are included in this kingdom, that is, all plants. They are multicellular and contain cells with cell wall.

Kingdom Plantae includes the following:

1. Algae
2. Bryophytes
3. Pteridophytes
4. Gymnosperms
5. Angiosperms

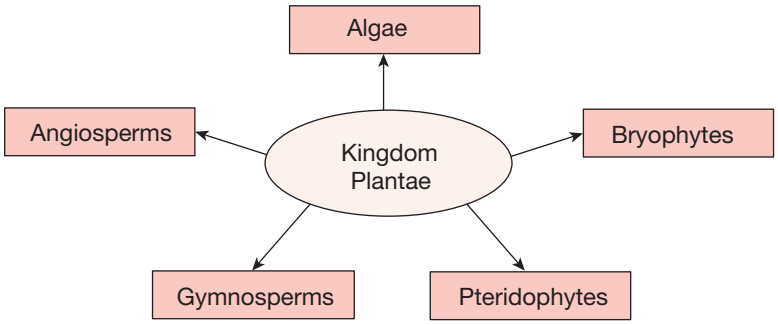


FIG. 3.11 Divisions of plant kingdom

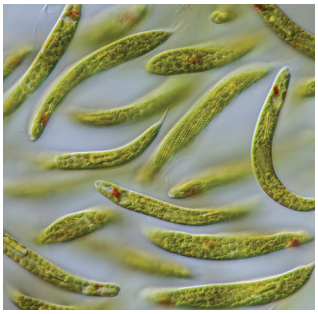
Algae: They are simple, chlorophyll-bearing organisms that range from unicellular to multicellular. Plant body is in the form of a thallus, i.e no clear distinction of true roots, stems and leaves. Most of the algae are autotrophs (synthesize their own food by the process of photosynthesis). They are mostly aquatic, for example, *Spirogyra*. Some of them are also found on rocks or within plants and animals, for example, lichens.

Bryophytes: It is the collective term used for hornworts, liverworts and mosses. They are the simplest and most primitive land plants. As, they are terrestrial but need water for completing their life cycle, they are called amphibians of plant kingdom. In these, plants possess stem-like and leaf-like structures but lack xylem and phloem (vascular tissues), for example, moss. They prefer to grow in shady and damp places.

Pteridophytes: These were the first plant group to have true vascular system for the conduction of water, minerals and food. The word pteridophyte comes from the word 'Pteron' meaning feather and 'phyton' meaning plant. Thus, pteridophytes are those plants which possess feather like leaves, for example, ferns.

Gymnosperms: These are vascular plants which produce naked seeds (not encased), that is seeds are not enclosed in fruits. Gymnosperms produce male and female cones, which produce pollen grains and eggs, respectively. Male cones are generally smaller than female cones, for example, pines.

Angiosperms: These are flowering plants which reproduce through seeds which develop inside fruits. The reproductive structure i.e. the flower houses both the male and female reproductive organs. The flower which has both male and female organs are called perfect flower, for example, apples, cherries, orchids, etc. The flower which has only either male or female organ is called imperfect flower, for example, cucumber and corn.



Euglena
(Algae)

Moss
(Bryophytes)

Fern
(Pteridophytes)

Pine
(Gymnosperm)

Orchid flower
(Angiosperm)

FIG. 3.12 Examples of different divisions under plant kingdom

Animalia

All eukaryotic, multicellular and heterotrophic animals come under this category. They lack cell wall. Most of them show mobility. Kingdom 'Animalia' is divided into different phyla as described below:

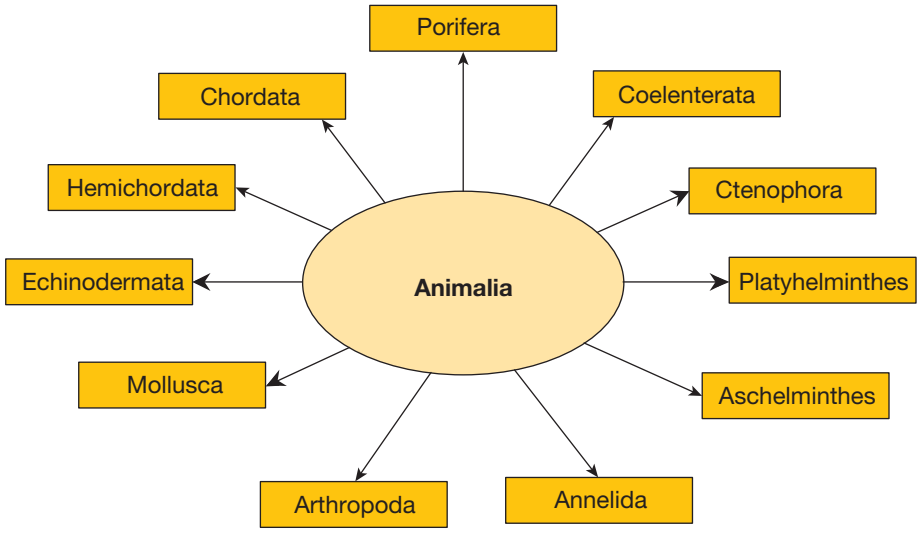
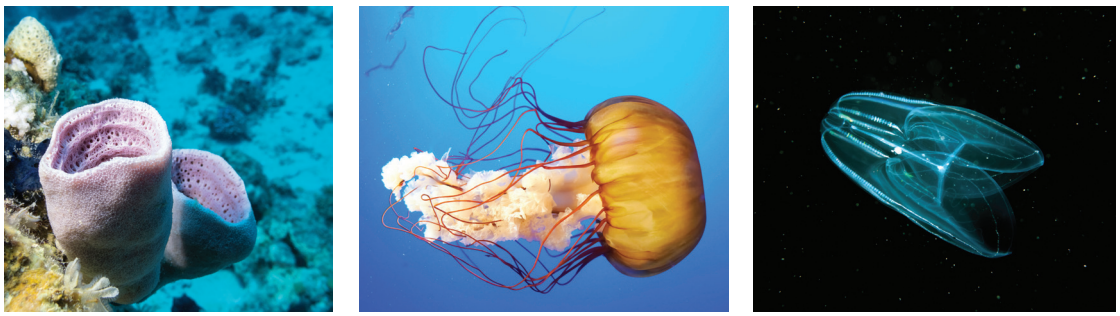


FIG. 3.13 Different phyla under animal kingdom

Porifera: They are pore-bearing organisms (i.e., they have holes on their body). They are commonly known as sponges. The food, oxygen, etc., reach the body by a water current through the holes.

Coelenterata (Cnidaria): They are aquatic animals that can be either nonmotile or free swimming. They got the name due to the presence of specialized cells called cnidoblasts or cnidocytes on their body, for example, *Hydra* and jellyfish.

Ctenophora: They are commonly known as comb jellies and are exclusively marine. They have the ability to emit light (bioluminescence), for example, *Ctenoplana* and *Pleurobrachia*.



Sycon (Porifera) *Jellyfish* (Cnidaria) *Comb jelly* (Ctenophora)

FIG. 3.14 Examples of phylum porifera, cnidaria and ctenophora

Platyhelminthes: They are commonly known as flatworms as they have a flattened body. They are mostly found as endoparasites in animal's body, for example, tapeworm.

Aschelminthes: They are also called roundworms as their cross-sections are round in shape. They can be aquatic or terrestrial, free living or parasitic, for example, *Ascaris*.

Annelida: They may be aquatic or terrestrial. Their body is divided into many segments, and this type of segmentation is called metamerism, for example, earthworm.

Liver fluke (Platyhelminthes) Ascaris (Aschelminthes) Earthworm (Annelida)

FIG. 3.15 Examples of phylum platyhelminthes, aschelminthes and annelida

Arthropoda: They are the largest group of animals. They show segmentation in their body. The significant feature of phylum 'Arthropoda' is the presence of 'jointed legs', for example, prawns and butterflies.

Mollusca: They are the second largest phylum of animal kingdom. They can be terrestrial, marine or freshwater, for example, octopus and snails.


Honey bee


Spider


Prawn


Millipede


Crab

FIG. 3.16 Some examples of phylum arthropoda

Echinodermata: They are spiny-skinned organisms and are exclusively marine animals, for example, starfish.

Hemichordata: This group includes worm-like marine animals, for example, *Balanoglossus*.


Snail (Mollusca)


Starfish (Echinodermata)

FIG. 3.17 Examples of phylum mollusca, echinodermata and hemichordata

Chordata: The organisms under this phylum are characterized by the presence of notochord (flexible rod-like structure), which later develops into a vertebral column. Notchord appears in the embryonic stage and in adults is converted to backbone.

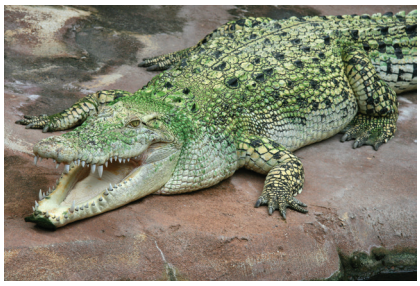
Phylum chordata includes the following classes:

1. Pisces (fish)
2. Amphibia (frogs)
3. Reptilia (crocodiles)
4. Aves (birds)
5. Mammalia (humans)

Fish (Pisces)

Frog (Amphibian)

FIG. 3.18 Examples of classes pisces and amphibia



Crocodile (Reptilia)

Flock of birds (Aves)

Humans (Mammalia)

FIG. 3.19 Examples of classes reptilia, aves and mammalia

Table 3.2 Characteristics of five kingdoms

Characters	Monera	Protista	Fungi	Plantae	Animalia
Cell type	Prokaryote	Eukaryote	Eukaryote	Eukaryote	Eukaryote
Cell wall	Present	Present in some	Present (chitin)	Present (cellulose)	Absent
Nuclear membrane	Absent	Present	Present	Present	Present
Body organization	Unicellular	Unicellular	Unicellular/ multicellular	Multicellular	Multicellular
Mode of nutrition	Autotrophic and heterotrophic	Autotrophic and heterotrophic	Heterotrophic	Autotrophic	Heterotrophic
Examples	Bacteria	*Amoeba*	Yeast	All green plants	Birds, humans, etc.

QUICK RECAP

1. Define the terms taxonomy and taxa.

The wide variety of living organisms present on the earth can be grouped into different categories on the basis of some observable characters. The scientific terms used to represent these categories are called taxa. The classification of living organisms into different taxa on the basis of their characteristics is called taxonomy.

2. What does it mean by hierarchy of classification?

The taxonomical classification of living organisms into successive levels of complexity is called hierarchy of classification. There are seven levels of categories, such as species, genus, family, order, class, phylum and kingdom. Species is the lowest level, whereas kingdom is the highest level.

3. What is genus and give an example?

A group of related species sharing some common characters constitutes the genus, for example, genus *Panthera* includes species of tigers and lions.

4. What is binomial nomenclature?

Naming a living organism by giving it a scientific name made up of two parts is called binomial nomenclature. Each name consists of two parts, that is, genus and species names. This system was introduced by Carolus Linnaeus, for example, the scientific name of human is *Homo sapiens*, where *Homo* represents genus and *sapiens* represents species.

5. A brief note on five-kingdom classification.

Five-kingdom classification is the classification of living organisms into five kingdoms, such as Monera, Protista, Fungi, Plantae and Animalia. This method of classification was proposed by R. H. Whittaker. The main criteria for classification are as follows:

- Cell type
- Cell wall
- Nuclear membrane
- Body organization
- Mode of nutrition

6. What are different phyla under kingdom 'Animalia' and give examples for each?

Porifera	–	Sponges
Coelenterata	–	*Hydra*
Ctenophora	–	*Ctenoplana*
Platyhelminthes	–	Tapeworms
Aschelminthes	–	*Ascaris*
Annelida	–	Earthworms
Arthropoda	–	Insects
Mollusca	–	Octopus
Echinodermata	–	Starfish
Hemichordata	–	*Balanoglossus*
Chordata	–	Humans

7. Write a note on the phylum 'Arthropoda'.

They are the largest group of animals. They show segmentation in their body. The significant feature of phylum 'Arthropoda' is the presence of 'jointed legs', for example, prawns and butterflies.

QUICK RECAP

8. What is the unique character of phylum 'Chordata'?

The organisms under this phylum are characterized by the presence of notochord (flexible rod-like structure), which later develops into a vertebral column. Notochord appears in the embryonic stage and in adults it is converted to backbone.

9. What are roundworms and why are they called so?

The organisms that come under phylum 'Aschelminthes' are also called roundworms as their cross-sections are round in shape. They can be aquatic or terrestrial, for example, *Ascaris*.

10. Define metamerism and give an example of organisms that show metamerism.

Metamerism is the segmentation of body into a number of segments, for example, earthworms.

POINTS TO REMEMBER

- Classification of living organisms into different taxa on the basis of their characteristics is called taxonomy.
- Hierarchy is the taxonomical classification of living organisms into successive levels of complexity. There are seven levels of categories where 'kingdom' is the highest level and 'species' is the lowest level.
- The formal system of naming a living organism by giving it a name composed of two parts is called binomial nomenclature.
- Five-kingdom classification is the classification of living organisms into five kingdoms, such as Monera, Protista, Fungi, Plantae and Animalia.
- Kingdom Monera includes single-celled prokaryotic organisms (bacteria), that is, both archaebacteria and eubacteria.
- Kingdom Protista includes all single-celled eukaryotes, like *Amoeba* and *Paramoecium*.
- Kingdom Fungi includes saprotrophytic and multicellular organisms like mushrooms but unicellular fungi are also found such as yeast.
- All eukaryotic, chlorophyll-containing organisms are included in plant kingdom, that is all plants.
- All eukaryotic, multicellular and heterotrophic animals come under animal kingdom, example tiger, octopus, insects, etc.

TEST YOUR CONCEPTS

Directions for questions 1 to 20: Fill in the blanks in each question

1. A group of related genera is called _____.
2. Cat and tiger belong to the family _____.
3. Monkeys and humans come under the order _____.
4. Binomial nomenclature was introduced by _____.
5. The part of scientific name that starts with capital letter is _____.
6. _____ is known as the father of botany.
7. Organisms that can synthesize their own food are called _____.
8. The cell wall of fungi is made up of _____.
9. Chlorophyll-bearing eukaryotes come under the kingdom _____.
10. _____ are known as amphibians of plant kingdom.
11. Platyhelminthes are also called _____.
12. _____ is the largest phylum of animals.
13. Spiny skinned organisms come under the phylum _____.
14. The flexible rod-like structure present in organisms under phylum 'Chordata' is _____.
15. According to the mode of nutrition, organisms under kingdom 'Animalia' are _____.
16. Pore-bearing organisms come under the phylum '_____'.
17. The ability to emit light is called _____.
18. Octopus comes under the phylum _____.
19. Jelly fish comes under the phylum _____.
20. The presence of jointed legs is the characteristic feature of phylum '_____'.

Directions for questions 21 to 40: For each of the following questions, four choices have been provided. Select the correct alternative.

21. Which one of the following is not a name of family?
    (a) *Felidae* (b) *Canidae*
    (c) *Mammalia* (d) *Hominidae*

22. Select the mismatch
    A Lion - *Panthera*
    B Catus - *Felis*
    C Wolf - *Felis*
    D Tiger - *Canis*
    (a) A and B (b) C and D
    (c) A and C (d) B and C

23. Identify the wrong statement.
    (a) If handwritten, the genus and the species names are underlined together.
    (b) Genus name always starts with a capital letter.
    (c) Species name starts with lower case.
    (d) Binomial nomenclature was proposed by Carolus Linnaeus.

24. The father of zoology is
    (a) Carolus Linnaeus (b) Theophrastus
    (c) Aristotle (d) Whittaker

25. Which one of the following comes under the kingdom 'Monera'?
    (a) Yeast (b) Algae
    (c) Mosses (d) *Rhizobium*

26. The organisms that feed on dead and decaying matter are known as
    (a) Autotrophs
    (b) Parasites
    (c) Saprophytes
    (d) None of the above

27. Find out the word pair relationship.
    _____: Monera
    Mushroom: _____

28. *Amoeba* and *Paramoecium* come under the kingdom
    (a) Plantae (b) Protista
    (c) Monera (d) Fungi

29. Plants that lack xylem and phloem are called
    (a) Bryophytes (b) Angiosperms
    (c) Gymnosperms (d) Pteridophytes

PRACTICE QUESTIONS

30. Match the following

A	Aristotle	i Two-kingdom classification
B	Theophrastus	ii Father of zoology
C	Linnaeus	iii Five-kingdom classification
D	Whittaker	iv Father of botany

	A	B	C	D
(a)	iv	iii	i	ii
(b)	ii	iv	i	iii
(c)	ii	i	iii	iv
(d)	iii	i	ii	iv

31. Which one of the following is exclusively marine?

(a) Mollusca (b) Echinodermata
(c) Aschelminthes (d) Coelenterata

32. Organisms under phylum 'Ctenophora' are also known as

(a) Roundworms (b) Comb jellies
(c) *Ctenoplana* (d) Flatworms

33. Match the following:

A.	*Octopus*	i Reptilia
B	Starfish	ii Hemichordata
C	*Balanoglossus*	iii Mollusca
D	*Chelone*	iv Echinodermata

Option

	A	B	C	D
(a)	iii	iv	ii	i
(b)	iv	iii	i	ii
(c)	iii	ii	iv	i
(d)	ii	iv	i	iii

34. Bioluminescence was shown by the phylum

(a) Porifera (b) Ctenophora
(c) Coelentrata (d) Mollusca

35. Identify the word pair relationship.

_____: Annelida

Jointed legs: _____

36. The second largest phylum is

(a) Arthropoda (b) Chordata
(c) Echinodermata (d) Mollusca

37. Which one of the following is not a member of phylum 'Chordata'?

(a) Crocodile (b) *Columba*
(c) *Macropus* (d) *Pleurobrachia*

38. Phylum 'Porifera' is commonly called

(a) Colelenterata (b) Sponges
(c) Comb jellies (d) Vertebrata

39. Class 'Mammalia' includes

(a) Fish (b) Frogs
(c) Birds (d) Humans

40. Worm-like marine animals come under the phylum

(a) Hemichordata (b) Pisces
(c) Echinodermata (d) Flat worms

MASTERING THE CONCEPTS

Knowledge and Understanding

1. Write a note on the various features of kingdom 'Monera'.

2. What are the differences between organisms under kingdom 'Plantae' and kingdom 'Fungi'?

3. Write a note on Linnaeus' two-kingdom classification.

4. What are main criteria for five-kingdom classification?

5. Write a note on the various features of kingdom 'Protista'.

6. What are bryophytes and pteridophytes?

7. Write a note on the phylum 'Cnidaria'.

8. What is notochord and write its significance.

9. List out the main features of kingdom 'Animalia'.

10. What are the different classes under phylum 'Chordata'? Give examples for each.

PRACTICE QUESTIONS

Application and Analysis

1. Whittaker's five-kingdom classification was a more logical method of classification as compared to two-kingdom classification. Justify the statement.

2. Some of the organism's names are jumbled in the box given below. Arrange these terms correctly in the column that follows.

Ascaris	Snails	Roundworms	*Ctenoplana*
Jellyfish	*Pleurobrachia*	Starfish	Octopus
Balanoglossus	*Rana*	*Macropus*	*Chelone*

Phylum	Example
Cnidaria	_____
Ctenophora	_____
Aschelminthes	_____
Mollusca	_____
Echinodermata	_____
Hemichordata	_____
Chordata	_____

3. Ravi decides to make notes on a group of 20 different living organisms which he observes on a daily basis. How can the knowledge of taxonomy be helpful in this exercise?

4. Dogs and cats are different from each other. At the levels of hierarchy, are they grouped under any common taxon?

5. Tiger and lion have scientific names, *Panthera tigris* and *Panthera leo*, respectively. What similarities could be identified?

6. Bryopsida is called amphibian of the plants. What can be inferred about this plant?

7. Plant body in higher plants is well-developed. Roots are the organs used for absorbing water and minerals. What is the equivalent of roots in the less developed lower plants?

PRACTICE QUESTIONS

TEST YOUR CONCEPTS

1. Family
2. Felidae
3. Primata
4. Carolus Linnaeus
5. Generic name
6. Theophrastus
7. Autotrophs
8. Chitin
9. Plantae
10. Bryophytes
11. Flatworms
12. Arthropoda
13. Echinodermata
14. Notochord
15. Heterotrophs
16. Porifera
17. Bioluminescence
18. Mollusca
19. Cnidaria
20. Arthropoda
21. (c)
22. (b)
23. (a)
24. (c)
25. (d)
26. (c)
27. Bacteria, Fungi
28. (b)
29. (a)
30. (b)
31. (b)
32. (b)
33. (a)
34. (b)
35. Metamerism, Arthropoda
36. (d)
37. (d)
38. (b)
39. (d)
40. (a)

MASTERING THE CONCEPTS

Knowledge and Understanding

1. Kingdom 'Monera' includes both archaebacteria and eubacteria. The main features are as follows:
   - Unicellular Body Organization
   - All are prokaryotic in nature (without a well-defined nucleus).
   - Presence of cell wall around the cell.
   - Absence of nuclear membrane.
   - Some of the organisms that come under kingdom 'Monera' can produce their own food (autotrophs) and some other organisms depend on others for food (heterotrophs).

2.

Plantae	Fungi
Include multicellular organisms	Include both unicellular and multicellular organisms
Cell wall made up of cellulose	Cell wall made up of chitin
Autotrophs	Heterotrophs
For example, Fern, mosses	For example, yeast, mushroom

HINTS AND EXPLANATION

3. Linnaeus classified living organisms into two kingdoms based on nutrition and locomotion. The two kingdoms were as follows: Animalia and Plantae.

   The organisms that are autotrophs (produce their own food) and are not capable of locomotion were placed under kingdom 'Plantae' and the organisms that are heterotrophs (or depend on others for food) and can move were placed under the kingdom 'Animalia'. The two-kingdom classification had some demerits as the system failed to distinguish between

   - Prokaryotes and eukaryotes.
   - Unicellular and multicellular organisms.

   Besides this, a large number of organisms do not fall into any category, for example, *Euglena,* as they have characters of both animals and plants.

4. Five-kingdom classification was proposed by R. H. Whittaker and the main criteria for classification were as follows:

   - Cell type (prokaryote or eukaryote).
   - Body organization: unicellular or multicellular.
   - Cell wall (whether cell wall is present or not).
   - Nuclear membrane (whether a well-defined nucleus surrounded by nuclear membrane is present or not).
   - Mode of nutrition (autotrophs or heterotrophs).

5. All single-celled eukaryotes are included in the kingdom 'Protista'. Members are mostly aquatic.

   Features are as follows:

   - Presence of cell wall in some members.
   - Presence of nuclear membrane.
   - Cellular level of body organization.
   - Both autotrophic and heterotrophic organisms come under kingdom 'Protista', for example, *Amoeba* and *Paramoecium*.

6. Bryophytes and pteridophytes come under kingdom 'Plantae'. Bryophytes are usually known as 'amphibians of plant kingdom'. They possess stem and leaf-like structure but lack vascular tissues (xylem and phloem), for example, moss. Pteridophytes possess root, stem, leaves and also specialized tissues for conduction of water and other substances, for example, fern.

7. They are aquatic animals that can be either non-motile or free swimming. They got the name due to the presence of specialized cells called cnidoblasts or cnidocytes on their body, for example, *Hydra* and jellyfish.

8. Notochord is the flexible rod-like structure that later develops into a vertebral column. The organisms that possess notochord come under the phylum 'Chordata'. Notochord appears in the embryonic stage and is later converted into backbone (vertebral column).

9. The main features of organisms under kingdom 'Animalia' are given as follows:

   - All are eukaryotic with a well-defined nucleus.
   - Multicellular.
   - Heterotrophic nutrition (depend on others for food).
   - Lack cell wall.
   - Most of them show mobility.
   - For example, birds and human.

10. The different classes under phylum 'Chordata' are as follows:

Pisces	–	Fish
Amphibia	–	Frogs
Reptilia	–	Crocodiles
Aves	–	Birds
Mammalia	–	Humans

Application and Analysis

1. Two-kingdom classification was proposed by Carolus Linnaeus. He classified all organisms into two kingdoms on the basis of nutrition and locomotion. The two kingdoms were 'Animalia' (for animals) and 'Plantae' (for plants).

   His system of classification had some demerits such as:

   - This system did not distinguish between:
     - eukaryotes and prokaryotes,
     - unicellular and multicellular organisms,
     - photosynthetic and non-photosynthetic organisms.
   - A large number of organisms did not fall into any category, for example, *Euglena* (unicellular) had characters of both plants and animals.

HINTS AND EXPLANATION

These demerits were rectified in five-kingdom classification, which was proposed by R. H Whittaker. The main criteria for classification were as follows:

- Cell type
- Cell wall
- Nuclear membrane
- Body organization
- Mode of nutrition

Organisms that are prokaryotes and unicellular in nature were placed under kingdom 'Monera'. Eukaryotic unicellular organisms were placed under kingdom 'Protista'. Eukaryotic heterotrophic organisms that included both unicellular and multicellular organisms were placed under kingdom 'Fungi'. Multicellular organisms that can perform photosynthesis were placed under kingdom 'Plantae'. Eukaryotic organisms that are multicellular and heterotrophic in nature were placed under kingdom 'Animalia'. They lack cell wall. Thus, more accurate method for classification was possible through five-kingdom classification.

2.

Phylum	Example
Cnidaria	Jellyfish
Ctenophora	*Ctenoplana, Pleurobrachia*
Aschelminthes	*Ascaris*, Roundworms
Mollusca	*Octopus*, Snails
Echinodermata	Starfish
Hemichordata	*Balanglossus*
Chordata	*Rana*, *Macropus*, *Chelone*

3. Ravi can broadly classify the organisms on the basis of the kingdom they belong to. After categorizing them into plants and animals, he can further group them according to their specific physical characters and features. For example, he can group trees and shrubs under kingdom Plantae and all the animals under kingdom Animalia. And so on, he can make further sub-groups with the help of knowledge of hierarchy of classification.

4. Cats and dogs are grouped under the same order Carnivora. Both the animals are meat-eating organisms. On the basis of this similarity, they are grouped under the same order.

5. Both lion and tiger belong to the same Genus, that is, *Panthera*. They are characterized by similar cranial (related to brain) features.

6. Since Bryopsida is called amphibian of the plant kingdom, it must be a bryophyte. Bryophytes live in soil (land) but they require water as a medium to reproduce. Hence, they are called amphibians of plant kingdom.

7. Lower plants have thallus-like structures, for example, algae. Thallus has root-like structures called rhizoids that serve the purpose of roots.

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Chapter

4

Reproduction in Animals and Plants

REMEMBER

Before beginning this chapter, you should be able to:

- Recall the basic concept of evolution
- Remember different modes of reproduction

KEY IDEAS

After completing this chapter, you should be able to:

- Describe the process of reproduction in animals
- Understand the concepts of adolescence and puberty
- Describe the process of reproduction in plants

INTRODUCTION

The world we live in consists of living as well as non-living components and the striking difference between these two is the ability of living organisms to produce individuals of their own kind. This ability of living organisms is essential for their survival. Reproduction is a biological process by which an organism gives birth to its younger ones. It is important for the continuation of generations of living organisms on earth. It is a vital process without which species cannot survive for long. Reproduction is mainly of two types:

1. **Asexual reproduction:**
   - (i) Simple mode of reproduction.
   - (ii) Usually only one parent is involved.
   - (iii) Younger ones produced are exactly identical to parents and are called clones.
2. **Sexual reproduction:**
   - (i) Not as simple as asexual reproduction.
   - (ii) Usually two parents are involved.
   - (iii) Younger ones produced are not identical to parents but resemble both parents.

REPRODUCTION IN ANIMALS

There are two modes of reproduction in animals. They can reproduce either by asexual reproduction in which only one individual is involved or sexual reproduction in which two individuals are involved. These are explained in detail in the following section.

Asexual Reproduction

Asexual reproduction can be observed in small animals, like hydra, amoeba, etc. There are different modes of asexual reproduction. Some of them are given below:

Binary Fission

- This involves division of a parent organism into two younger ones, for example, *Amoeba* and *Paramoecium*.
  - Reproduction in amoeba involves division of nucleus into two nuclei, followed by division of cytoplasm into two; so that each part receives a nucleus.
  - Other organism that can reproduce by binary fission is *Paramoecium*.

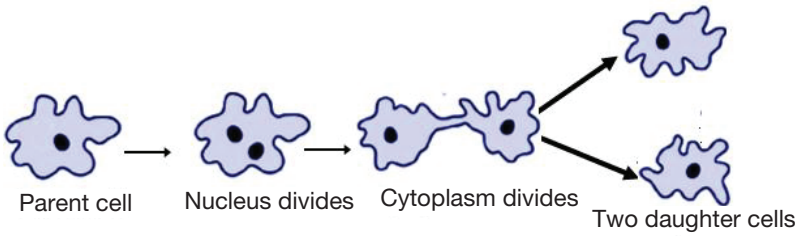


FIG. 4.1 Binary fission in *Amoeba*

Budding

- Involves development of a new organism from the buds formed in parent's body, for example, Hydra, yeast, etc.
  - In hydra, a bud develops as an outgrowth that later on develops into new hydra. New offspring remains attached to parent body and detaches only after it is fully matured.

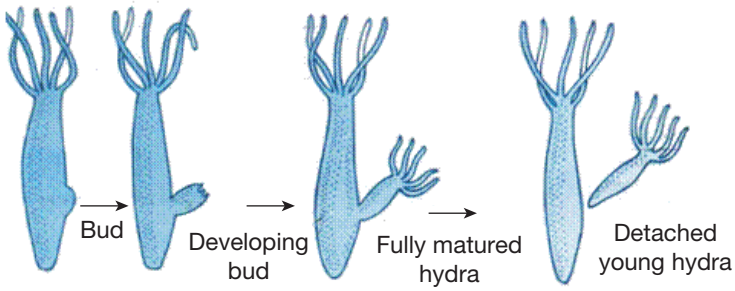


FIG. 4.2 Budding in hydra

Fragmentation

- Here, the parent body breaks into different fragments and each fragment develops into an organism, for example, star fish.

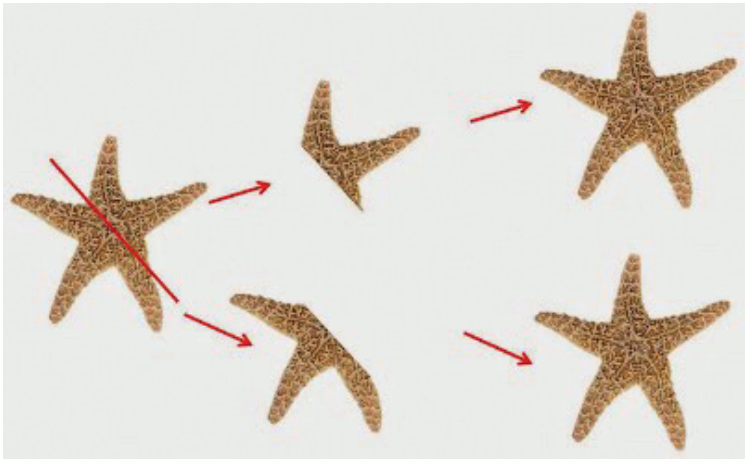


FIG. 4.3 Fragmentation in starfish

Sexual Reproduction

Sexual reproduction is a kind of reproduction where two parents are involved with fusion of male and female gametes. Gamete is a cell that can fuse with another gamete of opposite sex to form zygote that develops into a younger one. Usually the male and female gametes are produced by two different individuals. But in some cases, both are produced by a single organism. Such organisms are called hermaphrodites (bisexual). A hermaphrodite possesses both male and female reproductive organs, for example, earthworm. Organisms that possess either male or female reproductive organs alone are called unisexual organisms, for example, humans.

Male Reproductive Organs

In humans, the male reproductive organs include testes, scrotum, sperm ducts, accessory sex glands and penis.

Testes: A pair of testes are the male gonads that produce the male gametes called sperms. Millions of sperms are produced by the testes. They also produce testosterone, which is the primary male sex hormone.

Scrotum: It is a sac-like organ that houses the testes. It is present outside the body and maintains a low temperature required for sperm production.

Sperm ducts: They transport sperms from testes to penis.

Accessory sex glands: They produce various substances that nourish the sperm, for example, prostate gland, seminal vesicles and bulbourethral gland.

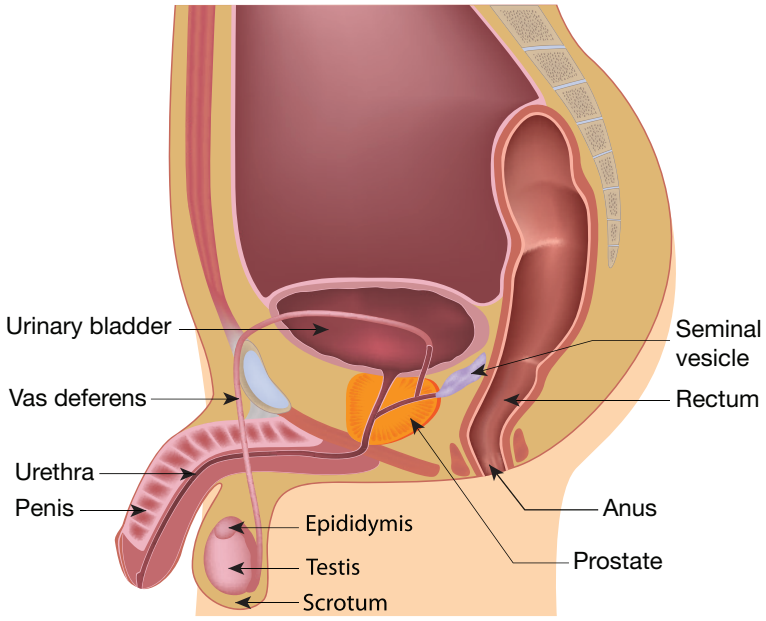


FIG. 4.4 Male reproductive system

Penis: Penis is the male external genitalia, which transfers and releases urine. It also transfers semen from the male reproductive tract into the reproductive tract of female during sexual intercourse.

Semen: Semen is the fluid that contains sperm. Apart from sperms, semen also contains other substances, like citric acid, free amino acids, fructose, enzymes, prostaglandins, etc., that nourish the sperm and also make their movement easy.

Sperm: Sperm is the male gamete. It is a single cell with three main parts:

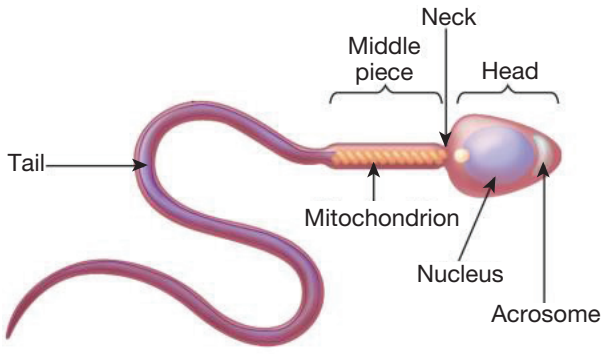


FIG. 4.5 Structure of sperm

1. **Head:** Possesses nucleus and contains a structure called acrosome (which contains hydrolytic enzymes, like acrosin and hyaluronidase), that helps in penetrating female gamete.
2. **Middle piece:** Contains numerous mitochondria which produce energy for the movement of sperm tail and thereby facilitating sperm movement inside the female reproductive tract, which is essential for fertilization.
3. **Tail:** Helps in sperm movement inside the female reproductive tract.

Female Reproductive Organs

Female reproductive organs in human include a pair of ovaries, oviducts (fallopian tubes), uterus, cervix and vagina.

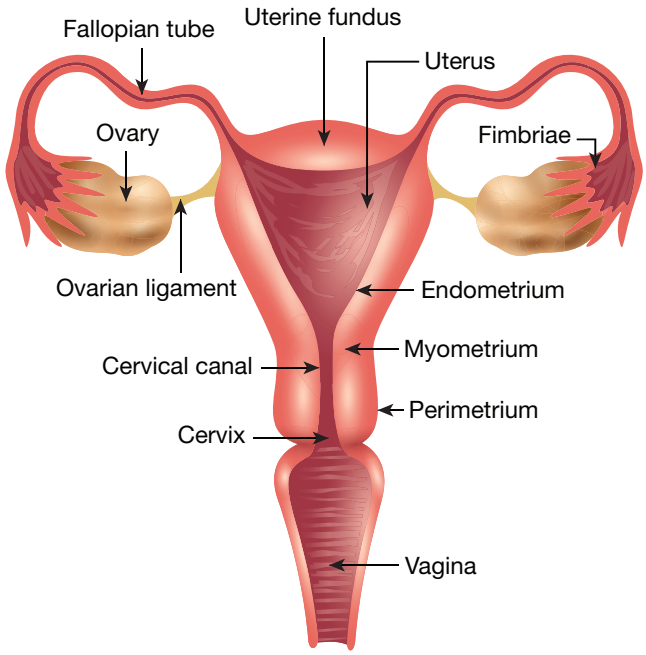


FIG. 4.6 Female reproductive system

Ovaries: They produce female gamete that is known as female egg or **ovum**. There are two ovaries, right and left ovary. Every month a single matured egg is released from only one of the ovaries.

Oviduct or fallopian tube: The tube structure present between the ovaries and uterus is called fallopian tube. Ovum released from ovary reaches uterus through fallopian tube.

Uterus: It is shaped as an inverted pear and is supported by ligaments attached to the pelvis. It is the site for implantation of the zygote and complete foetal development.

Cervix: Cervix is the lower part of uterus and connects uterus and vagina. The cavity of cervix is called cervical canal.

Vagina: Vagina is a tube-like structure that extends from the cervix to outside of the body. It is the site for sperm deposition at the time of coitus. It functions as a way for the menstrual flow and also as a passage for the baby to come out during vaginal delivery.

Ovum or Egg

The female gamete is known as an ovum or egg. It is spherical in shape. Egg is a single cell and its size varies depending on the species. For example, the human egg is very small while ostrich egg is the largest cell.

The release of eggs from the ovaries is called ovulation.

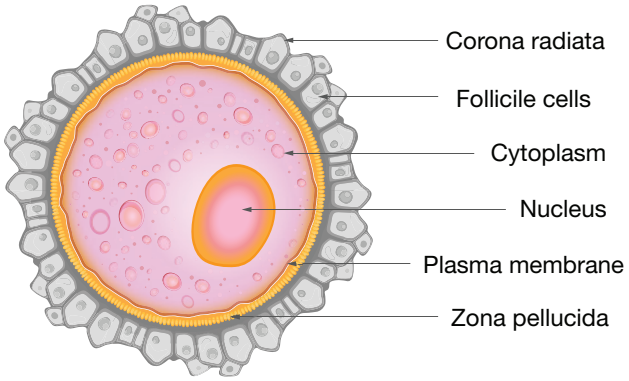


FIG. 4.7 Structure of ovum

Fertilization

The fusion of male (sperm) and female gamete (ovum) is known as fertilization. During fertilization, nuclei of sperm and ovum fuse to form the zygote, which is the beginning of an individual. With the fusion of nucleus, the newly formed individual inherits characters of both parents, that is, mother and father. In humans, fertilization takes place at the fallopian tube. The sperms that are deposited inside the vagina by the penis during sexual intercourse move toward the fallopian tube and meet the egg that is released from the ovary after ovulation. The deposition of semen into the female vagina during copulation is called insemination. A single ejaculation of semen contains around 300 million sperms, out of which, only one sperm succeeds in fertilizing the egg.

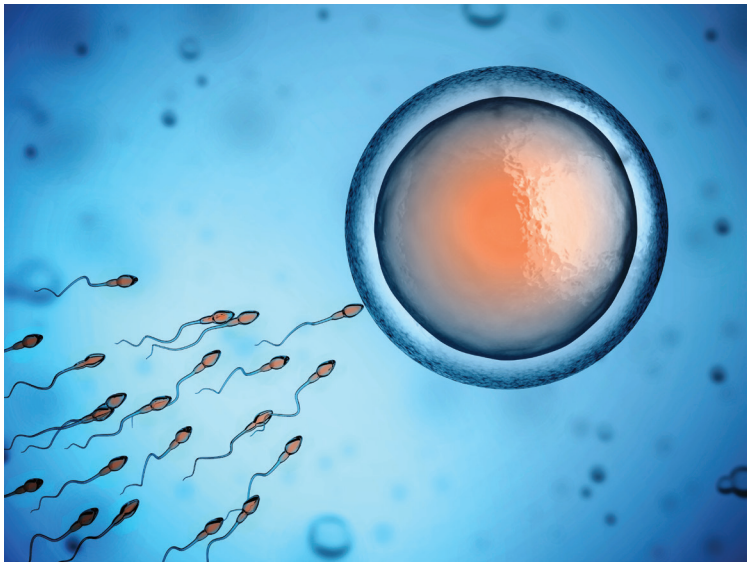


FIG. 4.8 Fertilization of ovum by one sperm

Types of Fertilization

According to the place of fertilization, whether inside or outside the body. There are two types of fertilizations:

1. **Internal fertilization:**
   - Takes place inside the female body.
   - Male gametes are transferred to the body of female.
   - For example, humans, cows, dogs, hens, etc.
2. **External fertilization:**
   - Fertilization takes place outside the female body.
   - Usually takes place in the aquatic medium where gametes are released into the water.
   - For example, frog, fish, etc.

Development of Zygote to Embryo

Zygote formed after fertilization is a single cell, which then divides repeatedly to form embryo.

Initial cell divisions of zygote take place at the fallopian tube, after which, the embryo moves to the uterus and gets embedded in the wall of the uterus and this process is called implantation. To enable implantation, the uterus goes through many changes, one of which is the increase in thickness of the inner lining of the uterus (endometrium). The embryo gradually develops inside the uterus and starts forming organs, such as hands, legs, head, eyes, etc. The nourishment required for the development of foetus is provided by the mother through the placenta. Placenta is an organ that connects the developing baby and mother. This structure provides oxygen and nutrients to the baby and also removes wastes from the baby's body. The stage of embryo in which all body parts can be identified is called foetus. Usually it takes around 38 weeks for complete development of the baby inside the uterus in humans. When the development is complete, mother gives birth to the baby.

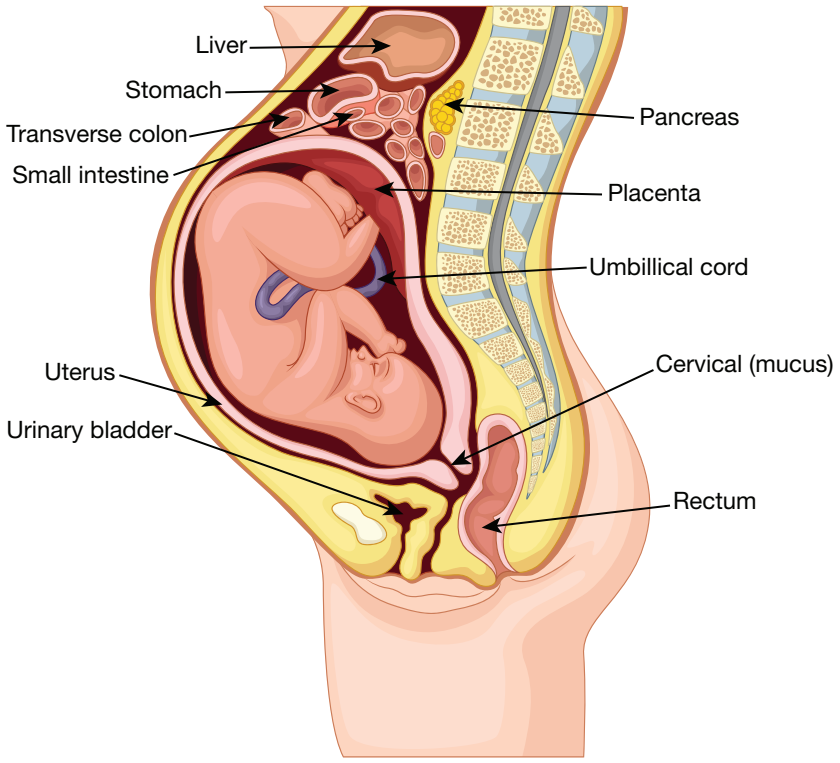


FIG. 4.9 Human foetus in uterus

Stages of Human Reproduction

The sequence of events leading to fertilization are explained in the form of a flow diagram.

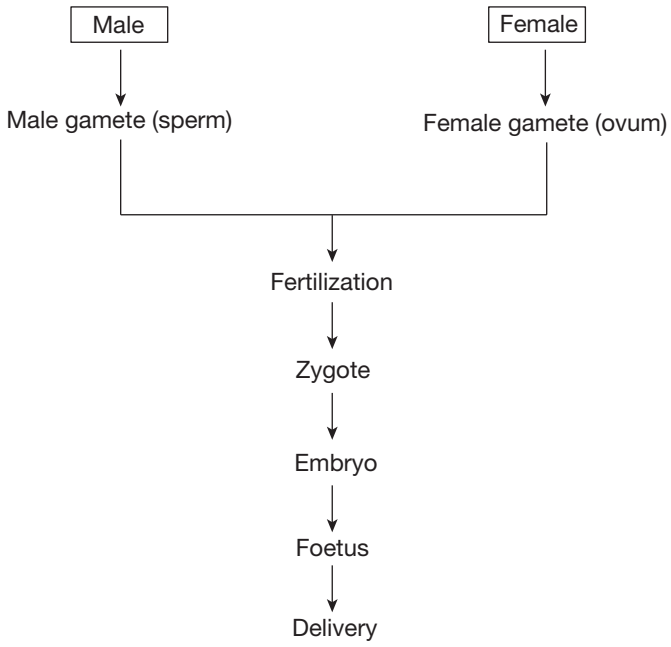


FIG. 4.10 Sequence of events taking place in human fertilization

GROWTH AND DEVELOPMENT IN HUMAN BEINGS

Growth is defined as increase in the size and number of the cells. It is a gradual process that could be divided into following stages.

Infancy

This stage starts as soon as the child is born. It lasts till the age of two years. Growth occurs rapidly in this stage. The infants learn various activities like sit, stand, walk, etc., in this stage.

Childhood

Generally, this stage ranges from the age of 2 to 12 years. Significant physical changes take place during childhood. This stage is marked by intellectual and social growth. The growth occurs at a steady rate.

Adolescence and Puberty

Adolescence meaning 'to grow up', is the period of life, where the body undergoes changes that lead to reproductive maturity. Adolescence begins around the age of 11 and lasts up to 18 or 19 years of age. It is a transitional stage from childhood to adulthood. Puberty is the time when an individual attains reproductive maturity. Many changes can be seen among children during puberty. Some of them are listed below:

- In boys, at puberty the voice box (larynx) can be seen as protruding parts of throat and is called Adam's apple.

- Increased activity of sweat and sebaceous gland is the reason why some people get acne and pimples at puberty.
- In girls, development of breasts and broadening of hips take place.

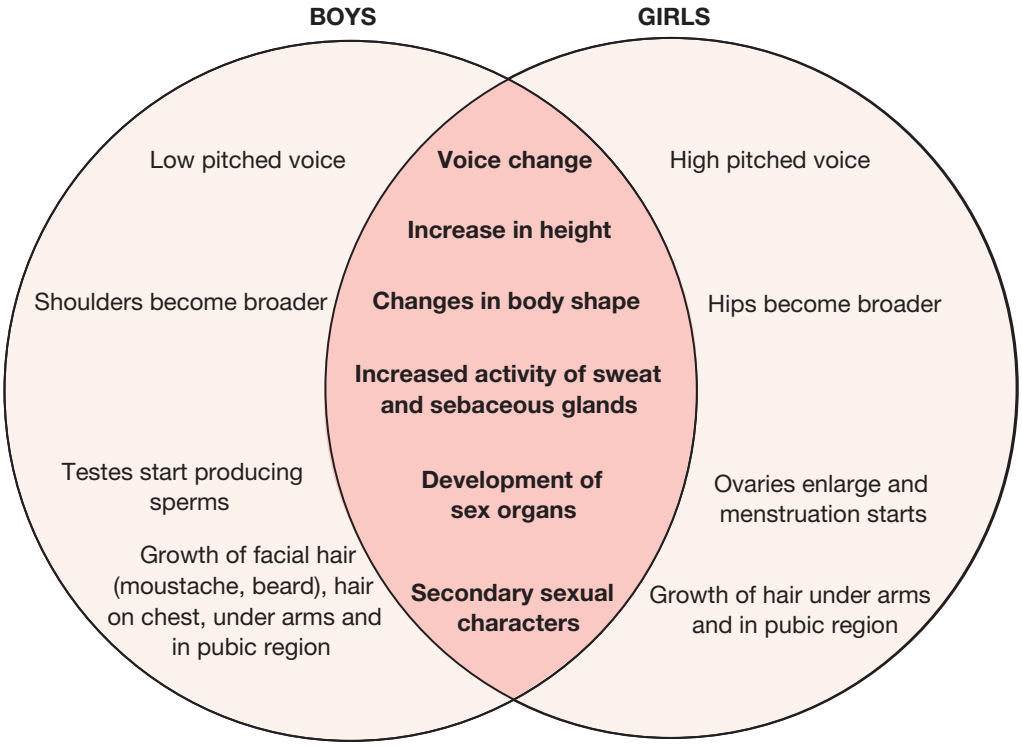


FIG. 4.11 Changes seen in boys and girls at puberty

Role of Hormones

The various features that appear during puberty are called secondary sex characters. Unlike primary sex characters (development of sex organs), these features do not have direct involvement in reproduction but they help in distinguishing male from female. They are caused by hormones released at the time of puberty.

Following are the secondary sexual changes seen in boys:

- External genitalia (penis) increase in length.
- Shoulders get broader.
- Boys become more muscular.
- Hair grows on face (moustache, beard), chest, armpit, pubic regions.
- Voice becomes low pitched.

Following are the secondary sexual changes seen in girls:

- Breast development takes place.
- Hips get broader.
- Hair grows in armpits and pubic regions.
- Voice becomes high pitched.

From the above, it is clear that some of the changes at puberty are common to boys and girls while some others are unique. The unique changes are due to the changes in hormone released in boys and girls.

Problems related to adolescence:

Adolescence is marked by significant changes at physical, emotional, sexual and intellectual levels. Shift from childhood to adolescence is marked by adjustments that may lead to many problems discussed as follows.

- One may start to worry about the physical changes in the body.
- One may get inquisitive regarding the changes and may seek incorrect sources for answers.
- One may get easily offensive or upset due to sudden hormonal changes.
- One may get hasty regarding his/her ability to take decisions and challenges.

Hormones in Puberty

Hormones are chemical substances that are released by endocrine glands directly into the blood stream. The male hormone that is responsible for puberty changes is testosterone whereas in females it is oestrogen. These are together known as sex hormones.

Glands are organs that produce various substances. They are of two types:

1. **Endocrine gland:** Releases products directly into the blood, for example, pituitary gland, thyroid gland, testes and ovary, etc.
2. **Exocrine gland:** Secretes substances onto the outer surface of body through ducts, for example, sweat glands, mammary glands, lacrimal glands, etc.

The two primary sex hormones (testosterone and oestrogen) are explained below.

1. **Testosterone:** It is the primary male sex hormone, playing key role in reproduction and maintaining secondary sexual characteristics in men. It starts getting released at puberty. It is responsible for sperm production in men.
2. **Oestrogen:** It is the primary female sex hormone, produced by the ovaries. It is required for the normal functioning of female reproductive system and the release of ovum from ovaries.

Sex hormones are under the control of hormones released from the pituitary gland. It is explained in the following flow-diagram.

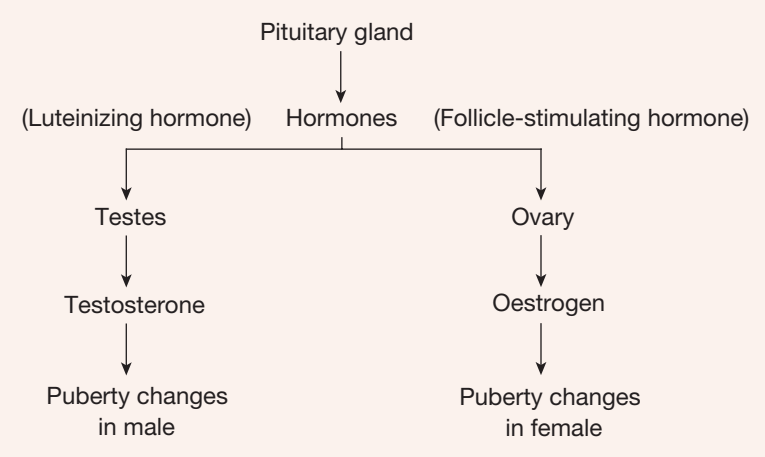


FIG. 4.12 Hormonal regulation at the time of puberty

Menstrual Cycle in Females

Menstruation is the periodic shedding of the endometrial lining which comes out of the vagina in the form of bleeding and is repeated at an interval of every 28–30 days. The cycle of various events from one menstruation to the next one is called the menstrual cycle. Usually the release of ovum from ovary (ovulation) takes place at the middle of the menstrual cycle, that is, on the 14th day. During this period, uterus is also getting ready so as to receive the egg or released ovum, if it is fertilized. The lining of uterus becomes thick to provide a proper bed for the fertilized egg or zygote. If fertilization occurs, the fertilized egg develops into a baby (foetus) in the uterus; otherwise, the uterus sheds off its thick layer along with blood vessel and unfertilized ovum, which results in bleeding through the vagina. This is called menstruation which generally lasts for 3–5 days.

Info Box!

In ovoviviparous animals, embryo develops inside the eggs and remains in the mother's body. Mother does not provide nutrition to the embryo, e,g., shark

The first menstruation at puberty in a female is called menarche. Menstrual cycle stops at the age of 45–50 years and this is called menopause. The various events taking place in the menstrual cycle are represented below:

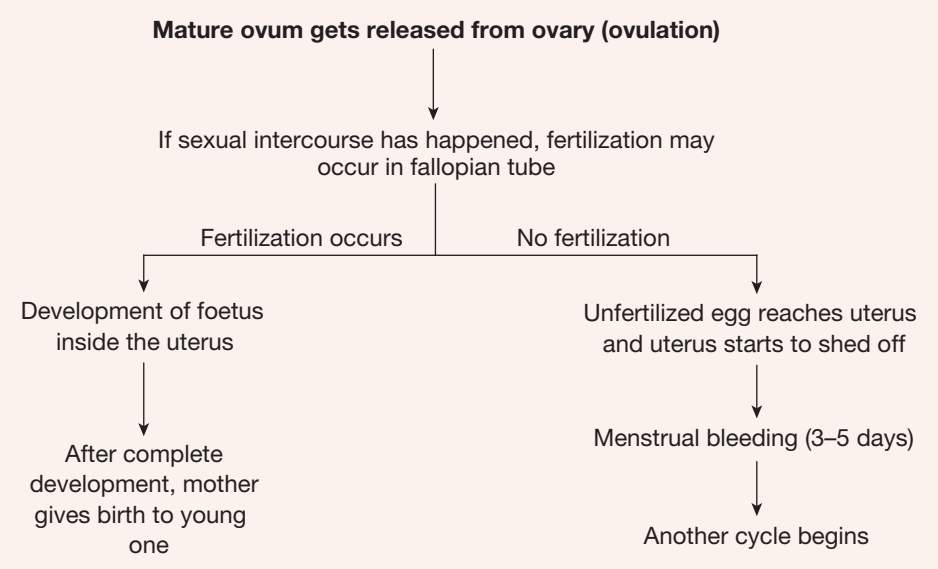


FIG. 4.13 Cycle of events during a menstrual cycle

Adulthood

At this stage of human growth and development, all the organs have achieved full growth. This stage occurs from the age of 18.

Old Age

The beginning of this stage differs in people. On an average, the age of 60 marks the onset of old age. During this phase, bones become brittle and muscles get weak.

Viviparous and Oviparous Animals

According to whether the mother lay eggs or give birth to the young ones, there are two types of animals as listed below.

- **Oviparous:** Which lay eggs. Development takes place outside mother's body.
- **Viviparous:** Which give birth to young ones directly. Development takes place inside mother's body.

FIG. 4.14 Oviparous animal—Hen

FIG. 4.15 Viviparous animal—Cow

Table 4.1 Points of difference between oviparous and viviparous animals

Oviparous animals	Viviparous animals
These animals lay eggs.	They give birth to the young ones.
Embryo development takes place outside the mother's body.	Embryo development takes place within the mother's body.
The fertilized egg covered by hard shell is laid in a safe place.	Zygote develops into the young one within the female body.
After a period of incubation, young ones are hatched out, for example, hen and lizard.	After reaching certain stages of growth, young ones are delivered out, for example, humans and cows.

Metamorphosis

After the young ones are born or hatched out, there are two scenarios:

1. Young ones show similarities with adults and all body parts are present at the time of birth itself. These organisms gradually develop into adults.
2. Younger ones formed are distinct from the adults. They look different and even lack some of the features that are present in adults. For example, the young ones of frog look entirely different from the adults. Their development goes through a larval stage.

Info Box!

In insects like silk moths, metamorphosis is controlled by insect hormones, whereas in frog it is controlled by thyroxine, produced by the thyroid gland.

Egg ⟶ Larva (Tadpole) ⟶ Adult

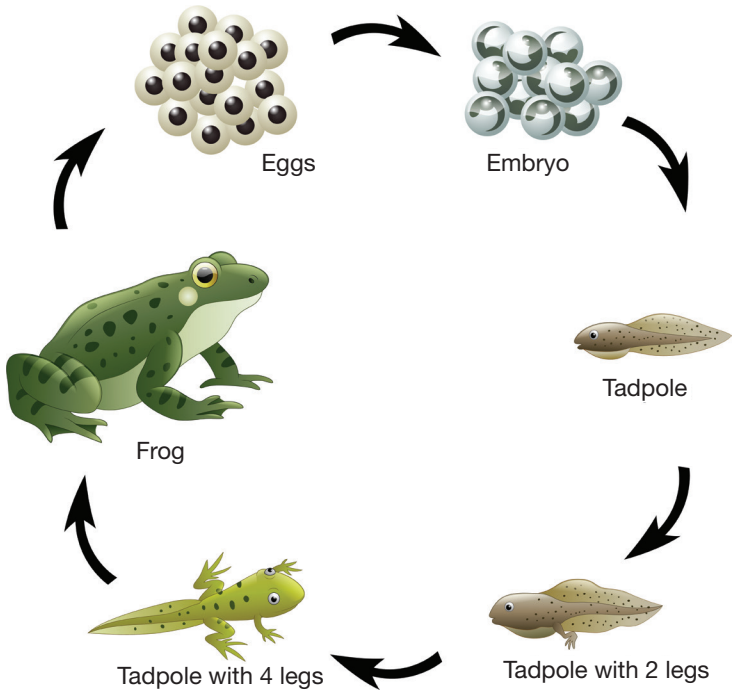


FIG. 4.16 Metamorphosis in frog

Here, tadpole larva is different from the adult frog. The transformation of larva into adult through drastic changes is called metamorphosis.

FIG. 4.17 Metamorphosis in butterfly

QUICK RECAP

1. Define binary fission. Give an example.

Binary fission is a mode of asexual reproduction in which the parent organism divides into two younger ones, for example, *Amoeba*. Reproduction in amoeba involves division of nucleus into two nuclei, followed by division of cytoplasm into two so that each part receives a nucleus.

2. Define fragmentation and give example.

Fragmentation involves breaking of parent body into several fragments and each fragment then develops into a new organism, for example, starfish.

3. What are hermaphrodites and give example?

Hermaphrodites are organisms that possess both male and female reproductive organs. Both male and female gametes will be produced in the same organism, for example, earthworm.

4. What are the male gonads and where are they located?

Male gonads are a pair of testes that produce the male gamete, sperm. They also produce male sex hormone, testosterone. Testes are located outside the body inside a sac-like structure called scrotum that helps to maintain a low temperature required for sperm production.

5. Define oviduct.

Oviduct, also known as fallopian tube is a tube-like structure present between the ovary and uterus. Ovum released from ovary reaches the uterus through the oviduct.

6. Define fertilization and what are the different types?

Fertilization is the fusion of male and female gametes, that is, sperm and ovum, to form zygote. According to the place of fertilization, whether inside the body or outside, it is of two types: internal fertilization and external fertilization. Fertilization that takes place inside the body is called internal fertilization, for example, humans and fertilization that takes place outside the body is called external fertilization, for example, frogs.

7. Define implantation.

The process by which the embryo gets embedded into the uterine wall is called implantation.

8. What is placenta and write its significance?

Organ that connects developing foetus and mother is called placenta. This structure provides oxygen and nutrients to the baby and also removes wastes from the body of foetus.

9. What is metamorphosis and give one example?

The transformation of larva into an adult through drastic changes is called metamorphosis, for example, frogs. The development in frogs goes through the larval stage. The development (metamorphosis) can be represented as:

Egg → Larva (tadpole) → Adult

10. What are secondary sexual characters?

The various features that appear during puberty are called secondary sexual characters. Unlike primary sexual characters (development of sex organs), these features do not have direct involvement in reproduction but they help in distinguishing males from females. They are caused by hormones released at the time of puberty, for example, shoulders get broader and voice becomes deeper in boys whereas in girls, hips get broader and voice becomes high pitched.

REPRODUCTION IN PLANTS

Reproduction in plants is the process by which a new plant develops from a parent plant. In plants, reproduction is of two types:

1. Asexual reproduction
2. Sexual reproduction

Asexual Reproduction

Asexual reproduction is the development of a new plant from plant parts, such as leaf, root, stem, bud, etc., that is, from vegetative parts. The young ones produced are identical to the parent plants. The formation or fusion of gametes or fertilization is absent in this mode of reproduction. This method produces a large number of plants in a short period of time.

Plants reproduce asexually in two ways: spore formation and vegetative propagation.

Spore Formation

In this method, lower plant organisms produce globular structures called sporangia (singular: *sporangium*) which contain spores. When sporangia ripe, they burst open to release spores. These spores are very light and they have a hard protective coat. The spores develop in a same way as seedlings develop into plants. These method of asexual reproduction is seen in fungi, mosses, ferns, etc.

Vegetative Propagation

Vegetative propagation can be done in two ways:

1. Natural
2. Artificial

Natural Methods of Vegetative Propagation

Most plants reproduce vegetatively in nature by the help of various parts, like root, stem and leaves. New plants can grow naturally from either of these parts, and are discussed in the following sections.

Roots

Plants like sweet potato and dahlia can be propagated vegetatively from roots. These roots contain small buds, which are capable of generating a new plant whenever they are planted in the soil.

FIG. 4.18 Tapioca plant is propagated through roots

Stem

New plants can be produced from the stem also. For example, plants, like potato and onion could be propagated using their underground stem structures called tuber and bulb, respectively. Sugarcane is also an example for plants that could be propagated by planting segments of stems.

FIG. 4.19 Plants propagated through stem

Leaves

In plants like *Bryophyllum*, adventitious buds are present on the notched margins of the leaves. When these buds fall off and come in contact with moist soil, they give rise to new plants.

FIG. 4.20 Leaf buds of *Bryophyllum*

Artificial Methods of Vegetative Propagation

Artificial means of vegetative propagation is used for those plants which produce very few seeds or non-viable seeds. These methods are done artificially for propagation of desired plants in a short period of time. Some of the examples are given below:

Cutting

Stem cutting is the most common method used in vegetative propagation. It involves cutting a portion of the stem bearing 1 or more nodes(capable of rooting) from the parent plant. This cutting is then placed in a rooting medium from where the plant either starts growing immediately or takes some time. Various chemical substances are used for promoting the growth. Examples of plants propagated by stem cutting include rose, *Hibiscus*, *Salvia*, etc.

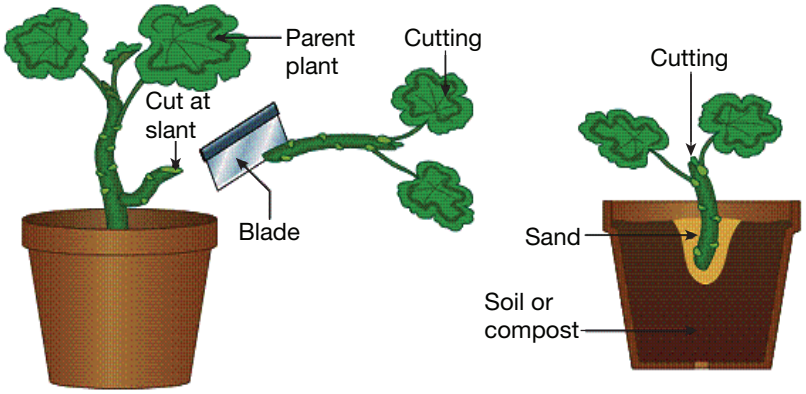


FIG. 4.21 Stem cutting in a plant

Grafting

It is a technique in which parts of two different plants are connected or united artificially which later on develops as a single unique plant. For example, root and shoot of two different plants can be used for grafting. Here the shoot of the plant with superior quality is called scion or graft and root system of good quality taken for grafting is termed as a stock. Examples of plants propagated through grafting include apples, citrus, cherries, etc.

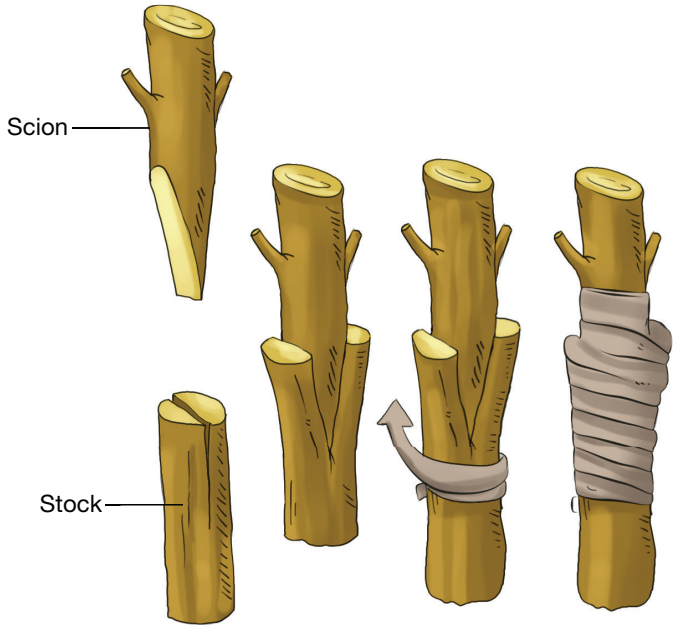


FIG. 4.22 Grafting shown in a plant

Layering

Layering is a method used to develop roots on soft stems, while they are still attached to the plant. In a simple method, the stem is bent down and allowed to touch the soil, and from the point at which it touches the soil, new roots develop. Layering can also take place naturally. Examples of plants propagated by layering include *Rhododendron*, azalea, etc.

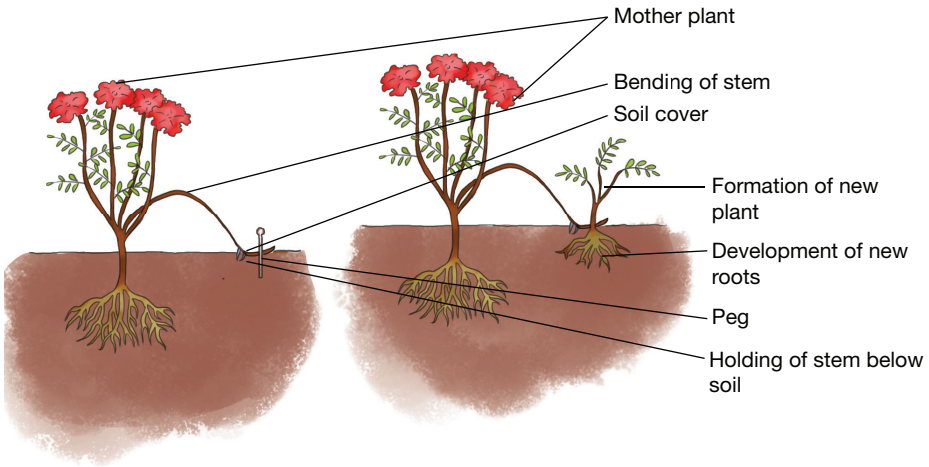


FIG. 4.23 Layering shown in a plant

Plant Tissue Culture

Plant tissue culture involves cultivation or propagation of plants by growing or culturing plant cells, tissues or organs under controlled conditions in a laboratory. All the nutrients required for proper growth will be provided artificially. After they have reached a particular stage of growth, the plantlets are transferred to separate pots or nursery to grow them into plants. Examples of plants propagated through this technique include tomato, apple, orchids, etc.

FIG. 4.24 Small plants formed in the laboratory by tissue culture

Sexual Reproduction in Plants

Most of the higher plants reproduce sexually. Sexual reproduction in flowering plants involves the fusion of male and female gamete. Flower is the reproductive organ of plants which produces the gametes.

Structure of Flower

Flower is the attractive part of a plant that is found in various colours, shapes and fragrances. It is also the reproductive organ of a plant.

Following are the 4 main parts of a flower:

1. Calyx
2. Corolla

} Accessory floral organs that do not participate in reproduction

3. Stamen (Androecium)
4. Carpel (Gynoecium)

} Reproductive parts or essential floral organs

The individual unit of calyx are called sepals (which are small green colored leaf like structure which protect the developing bud) and the individual unit of corolla are called petals (which are brightly colored structures mainly for the attraction of pollinators).

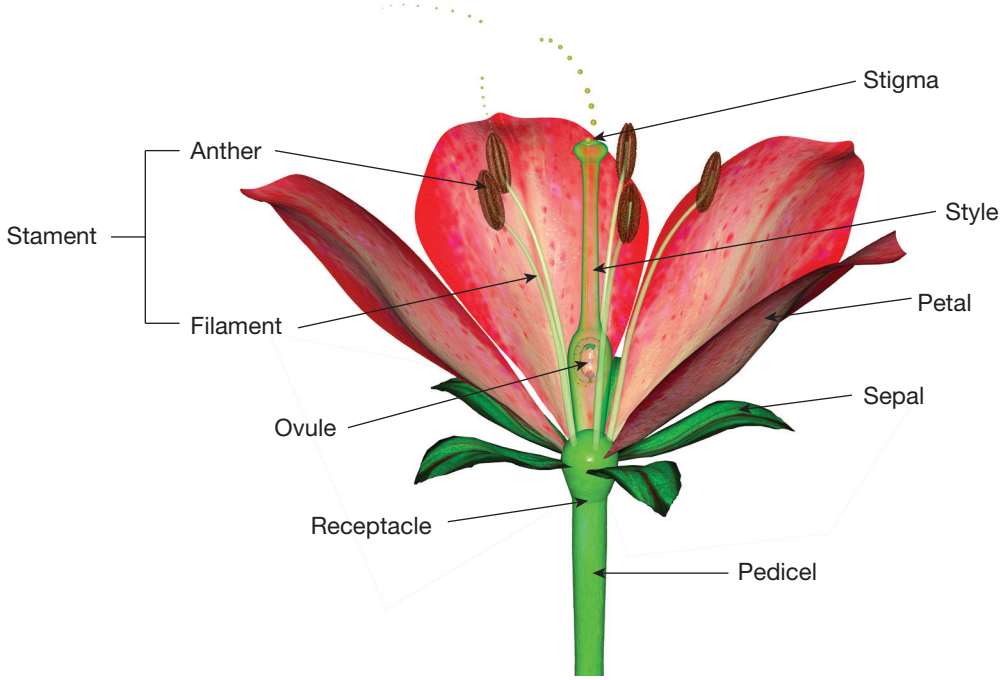


FIG. 4.25 Longitudinal section of a flower showing all parts

Stamen or Androecium

Stamen is the male reproductive organ of a flower and male gamete is produced inside the stamen. Stamen has two parts: Anther and filament

1. **Anther:** It is the structure bearing pollen grains located at the top of the filament of stamen.
2. **Filament:** It is a long stalk like structure that attaches the stamen with flower parts, such as petal.

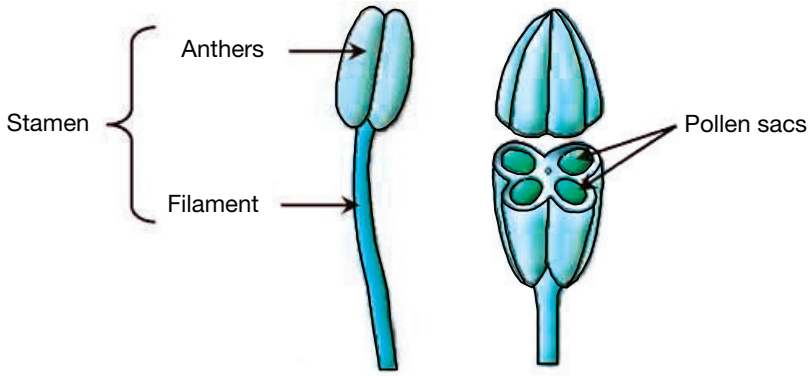


FIG. 4.26 Parts of stamen

Carpel or Gynoecium

Gynoecium is the female reproductive organ of flower and its individual unit is called pistil.

The pistil of a flower consists of the following three parts:

1. **Stigma:** It is at the tip of the pistil and forms the landing platform for pollen grains.
2. **Style:** It is the long, slender stalk which carries pollen grain from stigma to the ovary.
3. **Ovary:** This is the main reproductive organ of the flower, it encloses the unfertilized female gamete and the fertilized ovule.

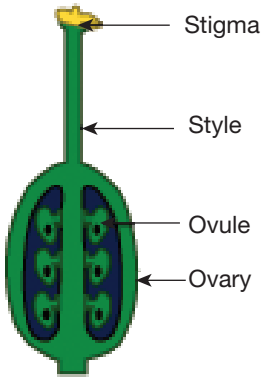


FIG. 4.27 Parts of pistil

Pollination

The transfer of pollen grains from the male anther of a flower to the female stigma is termed as pollination. As pollen grains cannot move on their own, external agents, such as wind, water or animals are required for pollination. These are called pollinating agents. According to the type of pollinating agent bringing about pollination, it is of different types, as described below:

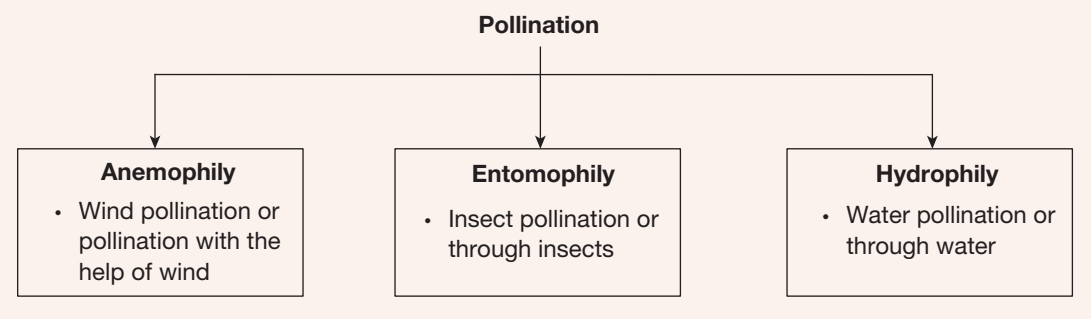


FIG. 4.28 Types of pollination based on different pollinating agents

Natural Pollination

Natural pollination is of two types:

1. **Self-pollination:** In this process, pollen grains from anthers of a flower are transferred to the stigma of the same flower, or another flower of the same plant.
2. **Cross-pollination:** In this process, pollen grains from anther of a flower are transferred to the stigma of another flower on a different plant but of the same variety. Cross-pollination can be carried out by various agents which are known as pollinating agents, for example, insects, water, wind, etc.
   - **Pollination by insects:** This is the most common method of natural pollination. Bees, butterflies and other insects sit on the flowers to collect nectar/juice. While doing so, the pollen grains from the anther get stuck onto the body of these insects. When these insects visit another flower, pollen grains get deposited on the stigma of that flower.

Flowers which are pollinated by insects are large, brightly coloured, and often scented; for example rose, marigold, night jasmine. In order to attract insects their pollen grains and stigma are usually sticky. For example, strawberry and mustard flower.

FIG. 4.29 Butterfly sitting on a flower facilitating pollination

- **Pollination by water:** This type of pollination occurs in aquatic plants, like *Hydrilla* and *Vallisneria*. Flowers which are pollinated by water are in light weight so that they can easily float on water surface. These flowers do not produce nectar.
- **Pollination by wind:** In this type of pollination, pollen grains are carried by wind and get deposited on the stigma. So, pollen grains are produced in large quantities so that at least some have a chance to reach the stigma. Most wind-pollinated flowers are small, and have dry and light pollen grains which can be easily carried by wind; for example rice, maize and grass

Artificial Pollination

In this process, two different varieties of plants are selected both with certain required characteristics, to produce a new variety of plants. This method leads to an increase in genetic diversity as different flowers will share and combine their genetic information to create unique offspring.

For example, a plant with *disease-resistance* property and another with *high-yielding* property could be selected. After selecting, they are made to cross-breed by artificial pollination to produce a new variety of plants which will have characteristics from both the parent plants.

Artificial cross pollination of rice is very common in the field of agriculture.

The three types of pollination are also explained with the help of diagrams, as given below.

Info Box!

Scientists at the Indian Botanical Garden in West Bengal's Howrah district have carried out artificial pollination of the only double coconut tree in India, which bears the largest seed known to science.

FIG. 4.30 (a) Anemophily, (b) Entomophily and (c) Hydrophily

Fertilization

The fusion of male and female gametes is called fertilization. During pollination, a large number of pollen grains are deposited on the stigma of a flower. Pollen grain starts to germinate and forms a pollen tube downwards to the ovary. The male gamete within the pollen grain reaches the ovary through pollen tube and fuses with the female gamete to form the zygote. The zygote later on develops into an embryo which in turn develops into a young plant.

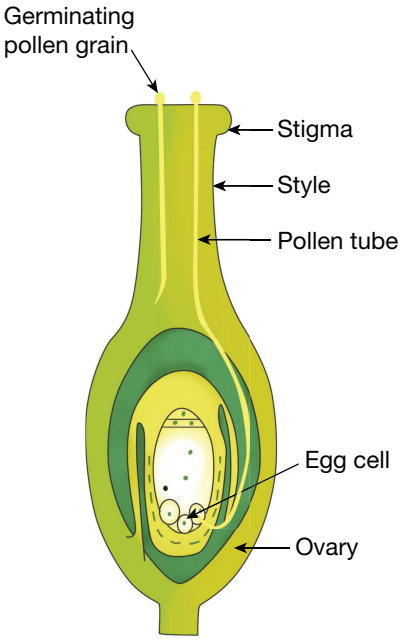


FIG. 4.31 Growth of pollen grains leading to fertilization

Seed Formation

Seed formation completes the process of reproduction in plants. Seed is an embryonic plant enclosed in a seed coat, with some food reserves (in the form of endosperm). Seed is formed inside the plant structure called fruit.

Seed Dispersal

It is the scattering of seeds over a large area so that they find a suitable place for germination. Dispersal is carried out by different agencies, like wind (Dandelion), water (coconut), animals (Cocklebur), etc.

Seed Germination

Seed germination is the process by which a new plant grows from the seed. After the seed has formed, it remains in a dormant state and waits for suitable conditions for germination. When it is provided with enough water and if temperature is also suitable, it starts germinating first giving rise to a seedling. The seedling initially attains nutrients from the seed itself, until it has grown enough to prepare its own food through photosynthesis.

There are two types of seed germination found in nature:

Epigeal germination: In this type of seed germination the cotyledons (seed) emerge out of the soil. The cotyledons turn green and act as the first leaves of the plant (carry out photosynthesis). Examples are bean, castor, etc.

FIG. 4.32 Epigeal germination

Hypogeal germination: In this type of seed germination the cotyledons (seed) remain inside the soil. They play no role in photosynthesis. Examples are pea, maize, etc.

FIG. 4.33 Hypogeal germination

QUICK RECAP

1. Define vegetative propagation.

Asexual reproduction in plants is called vegetative propagation. It is the development of new plants from plant parts, such as leaf, root, stem, bud, etc. The younger ones produced are identical to the parent plants. Large number of plants can be produced in a short period of time through vegetative propagation. It can be done in two ways: Natural as well as artificial.

2. Write a note on female reproductive structures of a flower.

Gynoecium or carpel is the female reproductive structure of a flower and its free unit is called pistil. Pistil comprises three parts known as stigma, style and ovary. Stigma functions as the landing platform for pollen grains. Ovary encloses the ovule where development of female gamete (egg) takes place. The elongated stalk that connects ovary with stigma is known as style.

3. Define fertilization.

The fusion of male and female gametes is called fertilization. Large numbers of pollen grains are deposited on the stigma of a flower during pollination. Pollen grains start to germinate and form a pollen tube downwards to the ovary. The male gamete within the pollen grain reaches the ovary through the pollen tube and fuses with the female gamete to form the zygote. The zygote later on develops into an embryo which in turn develops into a young plant.

4. What is anemophily?

Transfer of pollen grains from anther to stigma (pollination) with the help of wind is called wind pollination or anemophily.

5. Define seed.

Seed is an embryonic plant enclosed in a seed coat, with some food reserves. It is formed inside the plant structure called fruit.

POINTS TO REMEMBER

- Reproduction is an essential biological process by which an organism gives birth to its younger ones.
- Asexual Reproduction is that type of reproduction in which only 1 individual is involved, it is found in lower plants and animals, example, Binary fission in Amoeba.
- Sexual reproduction is a kind of reproduction where two parents are involved with fusion of male and female gametes. It is found in higher plants and animals, for example, Angiosperms and Humans.
- The fusion of male and female gametes is called fertilization.
- Adolescence is the period of life, where the body undergoes changes that lead to reproductive maturity.
- Vegetative propagation is the development of new plants from plant parts, such as leaf, root, stem, bud, etc.
- Plant tissue culture involves cultivation or propagation of plants by growing or culturing plant cells, tissues or organs under controlled conditions in a laboratory.
- The transfer of pollen grains from the male anther of a flower to the female stigma is termed as pollination.
- Seed germination is the process by which a new plant grows from the seed.

TEST YOUR CONCEPTS

Directions for questions 1 to 30: Fill in the blanks in each question.

1. The female gamete is called _____.
2. _____ is the male external genitalia.
3. Ovum released from ovary reaches uterus through _____.
4. Structure that connects uterus and vagina is _____.
5. _____ is an example for male accessory sex gland.
6. _____ is the male sex hormone.
7. Yeast reproduces asexually through _____.
8. _____ part of sperm helps in movement.
9. Ovum is produced by _____.
10. _____ is the largest cell.
11. In humans, fertilization takes place at _____.
12. Release of egg from ovaries is called _____.
13. In hens, fertilization takes place _____ the body.
14. The stage of embryo in which all body parts can be identified is called _____.
15. The organisms that lay eggs are _____.
16. Puberty is the time when an individual attains _____ maturity.
17. The first menstruation at puberty is called _____.
18. In frogs, metamorphosis is controlled by _____.
19. The gland that releases its contents directly into the blood are called _____.
20. Sweat gland is an example for _____.
21. Pollen grains are produced in _____.
22. The shoot part of the plant that is selected for grafting is called _____.
23. The method used to develop roots on soft stems is _____.
24. In potato, vegetative propagation can be done from _____.
25. The stalk that connects stigma and ovary is _____.
26. Ovule is located inside the _____.
27. The seedlings take in nutrients initially from _____.
28. Seed is enclosed in _____.
29. _____ act as the receiving part for pollen grains.
30. The long stalk that attaches stamen with the flower part is _____.

Directions for questions 31 to 64: For each of the following questions, four choices have been provided. Select the correct alternatives.

31. Male sex hormone is produced by
    (a) Male gonad (b) Prostate gland
    (c) Testes (d) Both (a) and (c)
32. Scrotum helps to maintain
    (a) Low pH (b) Low temperature
    (c) High temperature (d) High pH
33. Which one of the following is a wrong statement?
    (a) Testes are located outside the body.
    (b) Sperm production requires a temperature higher than normal internal temperature.
    (c) Semen constitutes sperm and also other substances that nourish the sperm.
    (d) Tail of sperm helps in the movement.
34. Match the following:

A	Yeast	(i) *Hydra*
B	*Amoeba*	(ii) Budding
C	Budding	(iii) Starfish
D	Fragmentation	(iv) Binary fission

	A	B	C	D
(a)	iv	ii	i	iii
(b)	ii	iv	iii	i
(c)	iv	ii	iii	i
(d)	ii	iv	i	iii

35. Which one of the following options are correct.
    I In *amoeba*, nucleus and cytoplasm divide simultaneously during binary fission.

PRACTICE QUESTIONS

II In budding, the new offspring detaches immediately from the parent.

III In amoeba, cytoplasm divides first followed by the division of nucleus.

V In budding, the new offspring detaches after it is fully matured.

(a) I and II (b) I and IV

(c) III only (d) IV only

36. Head of sperm contains

(a) Nucleus only

(b) Nucleus and mitochondria

(c) Mitochondria and acrosome

(d) Nucleus and acrosome

37. Ovum from the ovary reaches the uterus through

(a) Cervix (b) Oviduct

(c) Fallopian tube (d) Both (b) and (c)

38. The part of sperm that contains mitochondria

(a) Tail (b) Acrosome

(c) Middle piece (d) Head

39. The part of sperm that helps in the penetration of ovum is

(a) Acrosome (b) Nucleus

(c) Tail (d) Middle piece

40. Cervix is

(a) Upper part of the uterus

(b) Middle part of the fallopian tube

(c) Lower part of the uterus

(d) Lower part of the fallopian tube

41. **Assertion (A):** Sexual reproduction involves fusion of male and female gametes to form embryo

Reason (R): Gamete is a single cell that can fuse with another gamete of opposite sex

(a) Both A and R are true and R is the correct explanation for A.

(b) Both A and R are true but R is the not the correct explanation for A.

(c) A is true and R is false.

(d) A is false and R is true.

42. To enable implantation, usually the thickness of inner lining of the uterus

(a) Decreases

(b) Remains the same

(c) Increases

(d) First decreases and then remains the same.

43. In which of the following organisms, fertilization is not internal?

(a) Humans (b) Frogs

(c) Hens (d) Dogs

44. In a normal healthy person, a single ejaculation contains around _____ sperms

(a) 300 million (b) 150 billion

(c) 150 million (d) 300 billion

45. Sperm fuses with egg at

(a) Fallopian tube (b) Uterus

(c) Cervix (d) Vagina

46. Which one of the following is a wrong statement?

(a) Every month ovum will be released from both ovaries.

(b) Ovoviviparous animals do not provide nutrition to the developing embryo.

(c) In girls, voice becomes high pitched at puberty.

(d) Secondary sex characters do not have direct involvement in reproduction.

47. Identify the word pair relationship.

Frog: _____

Internal fertilization: _____

48. Match the following

A	Frog	i	Pituitary gland
B	Fish	ii	Metamorphosis
C	FSH	iii	External fertilization
D	LH	iv	Testes

	A	B	C	D
(a)	ii	iii	i	iv
(b)	iii	iv	i	ii
(c)	ii	iii	iv	i
(d)	iv	iii	ii	i

PRACTICE QUESTIONS

49. Usually ovulation takes place on

(a) 14th day

(b) Middle of menstrual cycle

(c) Towards the end of menstruation cycle

(d) Both (a) and (b)

50. Identify the word pair relationship

Endocrine gland : _____

_____ : Sweat gland

51. Which one of the following is not a feature of viviparous animals?

(a) They give birth to young ones.

(b) Embryo development takes place inside the female body.

(c) Less embryonic care and protection.

(d) Provides nutrition to the foetus through placenta.

52. **Assertion (A):** Hen comes under oviparous animals

Reason (R): Oviparous animals give birth to young ones

(a) Both A and R are true and R is the correct explanation for A.

(b) Both A and R are true and R is the not the correct explanation for A.

(c) A is true and R is false

(d) A is false and R is true

53. **Assertion (A):** Pituitary gland is an exocrine gland

Reason (R): It releases it secretions directly into blood

(a) Both A and R are true and R is the correct explanation for A.

(b) Both A and R are true and R is the not the correct explanation for A.

(c) A is true and R is false

(d) A is false and R is true

54. The accessory floral parts are

(a) Sepal and tepal

(b) Sepal and petal

(c) Stamen and pistil

(d) Androecium and gynoecium

55. The unit of androecium is

(a) Stamen (b) Pistil

(c) Anther (d) Stigma

56. Entomophily involves pollination through:

(a) Wind (b) Water

(c) Insects (d) Birds

57. Cultivation or propagation of plants by growing plant cells in lab is called

(a) Layering

(b) Grafting

(c) Vegetative propagation

(d) Plant tissue culture

58. Match the following

A	Sweet potato	i	Stem
B	Potato	ii	Bulb
C	Onion	iii	Root
D	Scion	iv	Graft

	A	**B**	**C**	**D**
(a)	iii	ii	iv	i
(b)	i	ii	iii	iv
(c)	iii	i	ii	iv
(d)	ii	i	iv	iii

59. Which one of the following is a wrong statement?

(a) Layering can take place naturally.

(b) Grafting is used to develop roots on soft stems.

(c) The free unit of carpel is pistil.

(d) Male gamete is produced in anther.

60. Tapioca can be propagated vegetatively using _____.

(a) Stem

(b) Root

(c) Leaves

(d) None of the above

61. In *Bryophyllum* plant, new plants can be developed from

(a) Leaves (b) Stem

(c) Root (d) Bulb

PRACTICE QUESTIONS

62. Identify the word pair relationship

_____ : Potato

Bulb : _____

63. The root taken for grafting is called

(a) Scion

(b) Graft

(c) Stock

(d) Both (a) and (b)

64. **Assertion (A):** Calyx and corolla are known as accessory floral organs.

Reason (R): Accessory floral organs do not participate directly in reproduction.

(a) Both A and R are true and R is the correct explanation for A.

(b) Both A and R are true but R is the not the correct explanation for A.

(c) A is true and R is false

(d) A is false and R is true

MASTERING THE CONCEPTS

Knowledge and Understanding

1. What is reproduction and what are the different types?

2. Explain the mode of reproduction in *Amoeba*.

3. Write a note on the structure of male gamete.

4. Write a note on reproduction of hydra.

5. Differentiate between oviparous and viviparous animals.

6. List out the major secondary sex characters in girls.

7. Explain the role of pituitary gland in puberty changes?

8. Define a gland and what are its different types?

9. What is menstruation?

10. Name the male and female sex hormones in humans and the organs that produce them.

11. Define grafting and write its significance.

12. What are the main parts of a flower?

13. Which is the male reproductive structure in a flower? Mention about its parts.

14. Explain the method that is used to develop roots on soft stem.

15. What is pollination? Explain any three modes of pollination.

16. Explain seed germination.

Application and Analysis

1. Complete the table with missing words

Characteristic	Male	Female
(a) Gamete	.....	.....
(b) Gonad	.....	.....
(c) External genitalia	.....	.....
(d) Motility of gamete	.....	.....
(e) Location of gonad	.....	.....

2. Complete the table given below.

Puberty changes	Male	Female
1. Voice change	.....	.....
2. Change in body shape	.....	.....
3. Sex organs development	.....	.....
4. Hair growth	.....	.....

3. Arrange the following events in the correct order.

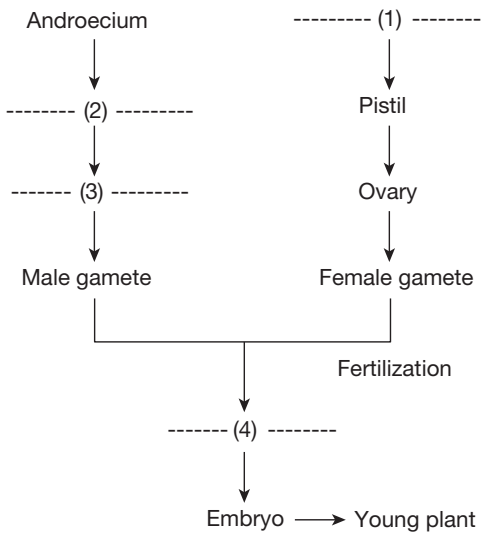
Foetus Ovulation Embryo

Zygote Delivery Fertilization

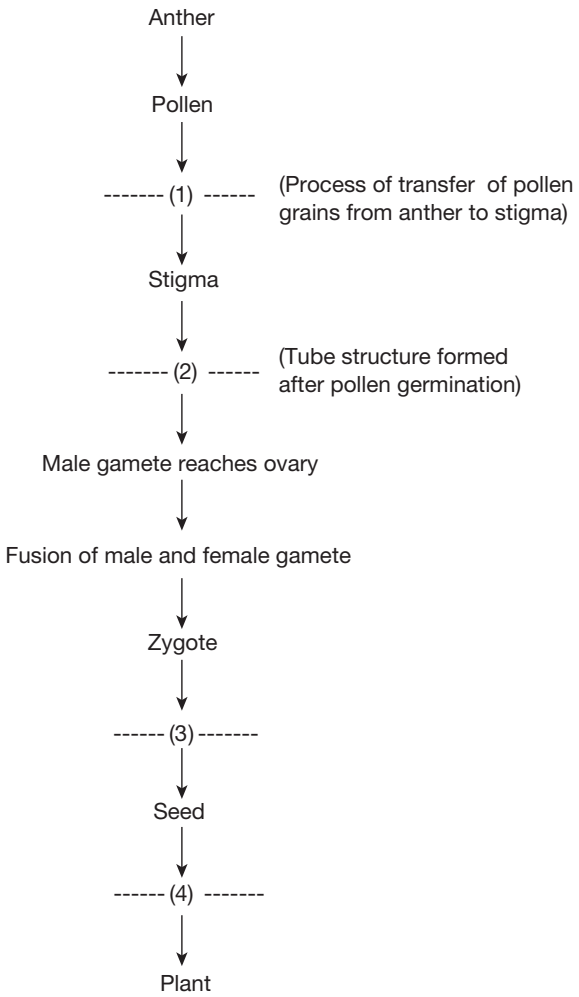
PRACTICE QUESTIONS

4. Complete the chart with missing words.

(a)



(b)



5. The temperature inside the scrotum is two degrees less than the normal human body temperature. What could be the possible reason for this?

6. A single ejaculation of semen contains around 300 million sperms, whereas fertilization involves fusion of one male and one female gamete. How is fusion of more than one sperm avoided?

7. Genetic variation brings the diversity in traits of individuals of a population. Which one of the self-pollination and cross-pollination could bring more genetic diversity?

8. A particular flower is brightly coloured and secrete nectar. The flower also secrete certain smell to attract insects. What can be inferred about its mode of pollination?

9. While growing, a seed derives nutrition from the endosperm. What happens to the mode of nutrition when the seed has matured to become a plant?

PRACTICE QUESTIONS

TEST YOUR CONCEPTS

1. Ovum or egg
2. Penis
3. Fallopian tube
4. Cervix
5. Prostate gland
6. Testosterone
7. Budding
8. Tail
9. Ovary
10. Ostrich egg
11. Fallopian tube
12. Ovulation
13. Inside the body
14. Foetus
15. Oviparous
16. Reproductive
17. Menarche
18. Thyroxine
19. Endocrine gland
20. Exocrine gland
21. Anther
22. Scion
23. Layering
24. Underground stem
25. Style
26. Ovary
27. Seed
28. Seed coat
29. Stigma
30. Filament
31. (d)
32. (b)
33. (b)
34. (d)
35. (d)
36. (d)
37. (d)
38. (c)
39. (a)
40. (c)
41. (d)
42. (c)
43. (b)
44. (a)
45. (a)
46. (a)
47. External fertilization: Human
48. (a)
49. (d)
50. Pituitary gland: Exocrine gland
51. (c)
52. (c)
53. (d)
54. (b)
55. (a)
56. (c)
57. (d)
58. (c)
59. (b)
60. (a)
61. (a)
62. Tuber, onion
63. (c)
64. (a)

MASTERING THE CONCEPTS

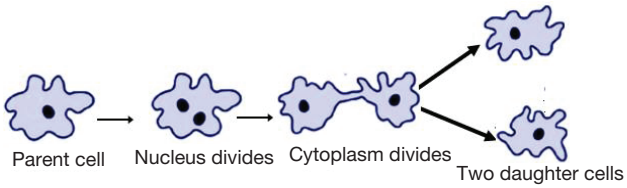
Knowledge and Understanding

1. Reproduction is the biological process by which an organism gives birth to its young ones. It is important for the perpetuation of organisms on earth. It is of two types:

   Asexual reproduction: Does not involve fusion of male and female gametes and usually one parent is involved. The younger ones produced will be exactly identical to parents and are called clones.

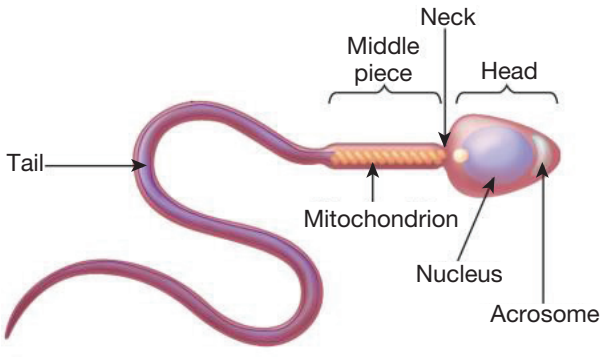
   Sexual reproduction: Involves fusion of male and female gametes to form zygote, which later on develops into a new organism. Younger ones produced will not be identical to parents but resemble both parents.

2. *Amoeba* reproduces asexually through binary fission, where parent organism divides to produce two younger ones. During binary fission, the nucleus divides first followed by the division of cytoplasm or body into two, so that each part receives a nucleus.



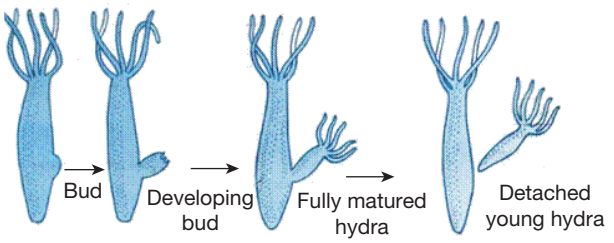
Binary fission in *Amoeba*

3. Sperm is the male gamete that consists of three main parts: a head, a middle piece and a tail. Head possesses nucleus and contains a special structure called acrosome that helps in penetrating the female gamete. Mitochondria for energy production are located in the middle piece, and the tail part helps in motility of sperm.



Structure of sperm

4. Hydra reproduces asexually through budding. Budding involves development of a new organism from the buds formed in the parent's body. In hydra, a bud develops as an outgrowth that later on develops into new hydra. New offspring remains attached to the parent body and detaches only after it is fully matured.



Budding in hydra

5.

Oviparous animals	Viviparous animals
These animals lay eggs	They give birth to young ones
Embryonic development takes place outside the mother's body	Embryonic development takes place within the mother's body
The fertilized egg covered by hard shell laid in a safe place	Zygote develops into a young one within the female body
After a period of incubation, young ones are hatched out	After reaching certain stages of growth, young ones are delivered out
For example, hens	For example., humans

6.
- Breast development
- Hips get broader
- Hair growth in armpits and pubic regions
- Voice becomes high pitched

7. The puberty changes in males and females are controlled by male hormone 'testosterone' and female hormone 'oestrogen'. These sex hormones are under the control of hormones released from the pituitary gland which produces two hormones, namely, luteinizing hormone (LH) and follicle-stimulating hormone (FSH). LH acts on the testes and induces changes in males. Similarly, FSH acts

HINTS AND EXPLANATION

on the ovaries and induces production of oestrogen that causes puberty changes in females.

8. Gland is an organ that produces various substances. They are of two types:
   - **Endocrine gland:** Releases products directly into the blood, for example, pituitary gland.
   - **Exocrine gland:** Secretes substances onto outer surface of body through ducts, for example, sweat gland.

9. Menstruation is the bleeding from uterus and is repeated at an interval of 28–30 days. The cycle of various events from one menstruation to the next one is called menstrual cycle. During these events, the uterus also gets ready so as to receive the egg or released ovum, if it is fertilized. The uterus becomes thicker to provide a proper bed for the fertilized egg or zygote. If fertilization occurs, the fertilized egg develops into a baby in the uterus; otherwise; the uterus sheds off its thick layer, along with blood vessel and unfertilized ovum, which results in bleeding through the vagina. This is called menstruation and it lasts for 3–5 days.

10. The male hormone that is responsible for puberty changes is testosterone whereas in females it is oestrogen. These are together known as sex hormones. Testosterone is produced by testes whereas oestrogen is produced by ovaries.

11. Grafting is a method used for artificial vegetative propagation. It involves joining of parts of two different plants artificially which later develop into a single unique plant. For example, Root and shoot of two different plants can be used for grafting. Here the shoot of the plant with superior quality is called scion or graft and root system of good quality taken for grafting is termed as stock.

12. The flower has four different parts, such as: calyx, corolla, androecium and gynoecium. Calyx and corolla together constitute the accessory floral parts as they do not participate in reproduction. Androecium and gynoecium are the essential parts that take part in reproduction. The units of androecium and gynoecium are stamen and pistil respectively.

13. Stamen is the male reproductive organ of a flower and male gamete is produced inside the stamen. Stamen has two parts anther and filament. Pollen grains carrying male gamete are produced in the anther. Filament is the long stalk that attaches the stamen with floral parts, such as petal.

14. Layering is a method used to develop roots on soft stems, while it is still attached to the plants. In a simple method, the stem is bent down and allowed to touch the soil, and from the point at which it touches the soil, new roots develop. Layering can also take place naturally.

15. Transfer of pollen grains from anther to stigma is called pollination. As pollen grains cannot move by their own, external agents, such as wind, water or animal are required for pollination. According to this, pollination can be water pollination called hydrophily. Pollination through wind is called anemophily whereas pollination through bees or insects is called entomophily.

16. Seed germination is the process by which a new plant grows from the seed. After the seed has formed, it remains in a dormant state and waits for suitable conditions for germination. When it is provided with enough water and if temperature is also suitable, it starts germinating first giving rise to a seedling. The seedling initially attains nutrients from the seed itself, until it has grown enough to prepare its own food through photosynthesis.

Application and Analysis

1.

Characteristic	Male	Female
(a) Gametes	Sperm	Ovum
(b) Gonads	Testes	Ovaries
(c) External genitalia	Penis	Vagina
(d) Motility of gametes	Motile	Non-motile
(e) Location of gonads	Outside the body	Inside the body

2.

Puberty changes	Male	Female
Voice change	Deeper voice	High pitched voice
Change in body shape	Shoulders become broader	Hips get broader

Sex organs development	Testes start producing sperm	Ovaries enlarge and menstruation starts
Hair growth	Hair growth on face, chest, armpit and pubic regions	Hair growth in armpit and pubic region

3. Ovulation → Fertilization → Zygote → Embryo → Foetus → Delivery

4. (a) (1) Gynoecium
(2) Stamen
(3) Anther
(4) Zygote
(b) (1) Pollination
(2) Pollen tube
(3) Embryo
(4) Seedling

5. A pair of testes are the male gonads which produce male gametes through the process of spermatogenesis. This process is affected by high temperatures (35°C). For spermatogenesis to occur under suitable conditions, temperature inside male gonads is two degrees less than normal human body temperature.

6. As soon as one male gamete (sperm) reaches the ovum and fertilizes it, the fertilized egg releases certain substances through a series of reaction that prevent further male gametes to fuse with it.

7. Self-pollination is the transfer of pollen from the anther to stigma of the same flower, or another flower on the same plant. Cross-pollination is the transfer of pollen from the anther of one flower to the stigma of another flower on a different individual of the same species. Hence, cross-pollination allows for more genetic diversity in plants.

8. From the features described above, it can be inferred that the flower is insect-pollinated. Since, the insects get attracted to colours, smell and nectar, they assist in transfer of pollens.

9. When the seed has matured to become a plant, it derives nutrition through the process of photosynthesis which happens in the leaves and results in the formation of carbohydrates.

Chapter

5

Microorganisms and Human Health

REMEMBER

Before beginning this chapter, you should be able to:

- Recall the major categories of microorganisms
- Remember the structure, shape and nutrition in common microorganisms

KEY IDEAS

After completing this chapter, you should be able to:

- Understand the basic concepts related to microorganisms
- Identify useful and harmful microorganisms
- Describe immune system and its components
- Discuss common human diseases

INTRODUCTION

The organisms that cannot be seen with the naked eyes and can be viewed only under the microscope are called microorganisms or microbes. Microbes are diverse and include bacteria, fungi, protozoa and some algae. Viruses are also microscopic but they are generally considered as non-living. They reproduce only inside a host cell, which can be bacteria, plants or animals. There are some microorganisms that are unicellular, that is, they are made up of only one cell, for example, bacteria, whereas there are some microorganisms that are made up of more than once cells and are called multicellular microorganisms, for example, moulds.

Microorganisms are broadly divided into four groups: algae, bacteria, fungi and protozoa.

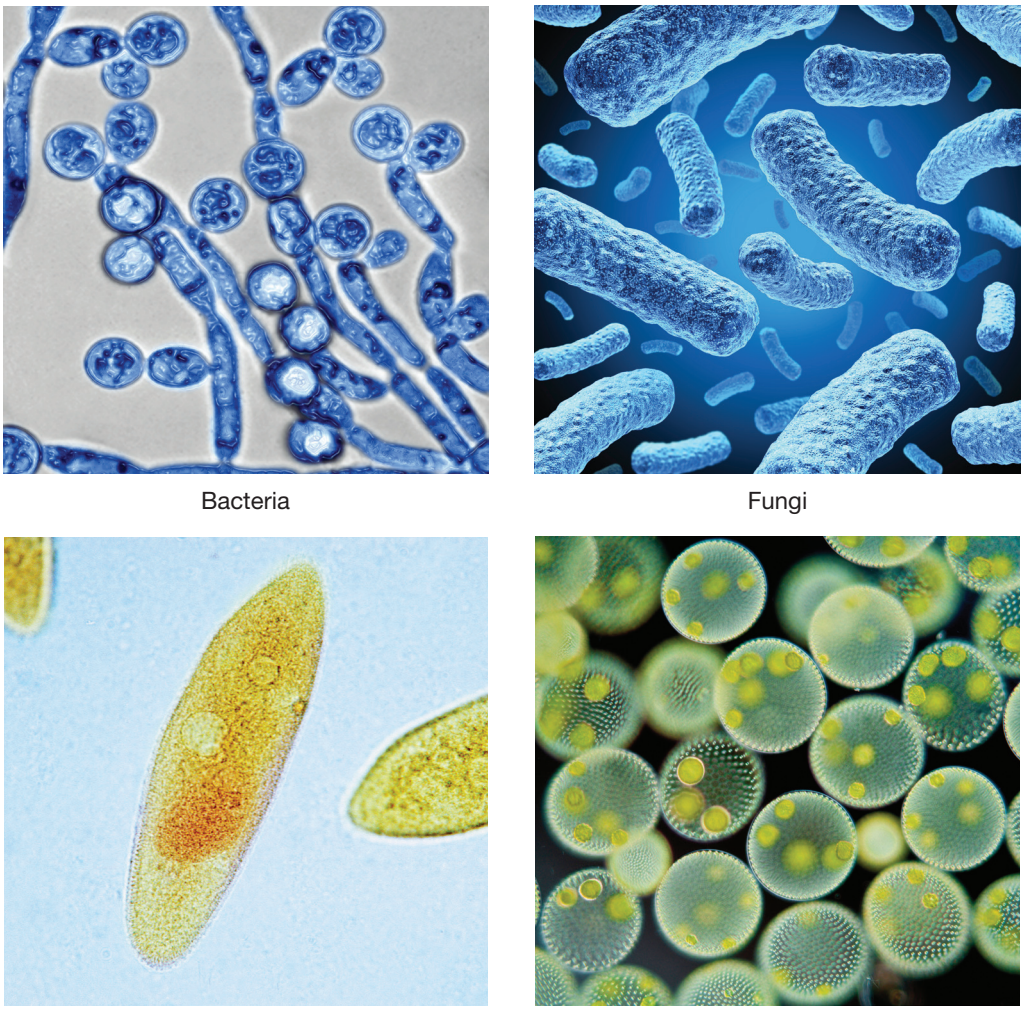


FIG. 5.1 Common microorganisms (bacteria, fungi, protozoan, algae)

Info Box!

Antonie Van Leeuwenhoek is called 'Father of Microbiology'

Microorganisms could be found anywhere in the biosphere, that is, in soil, oceans, air, hot springs, deserts, etc. They are even present inside the body of animals. The study of microorganisms is termed as microbiology. Depending upon their effects on human health, are two types of microbes, namely useful or harmful.

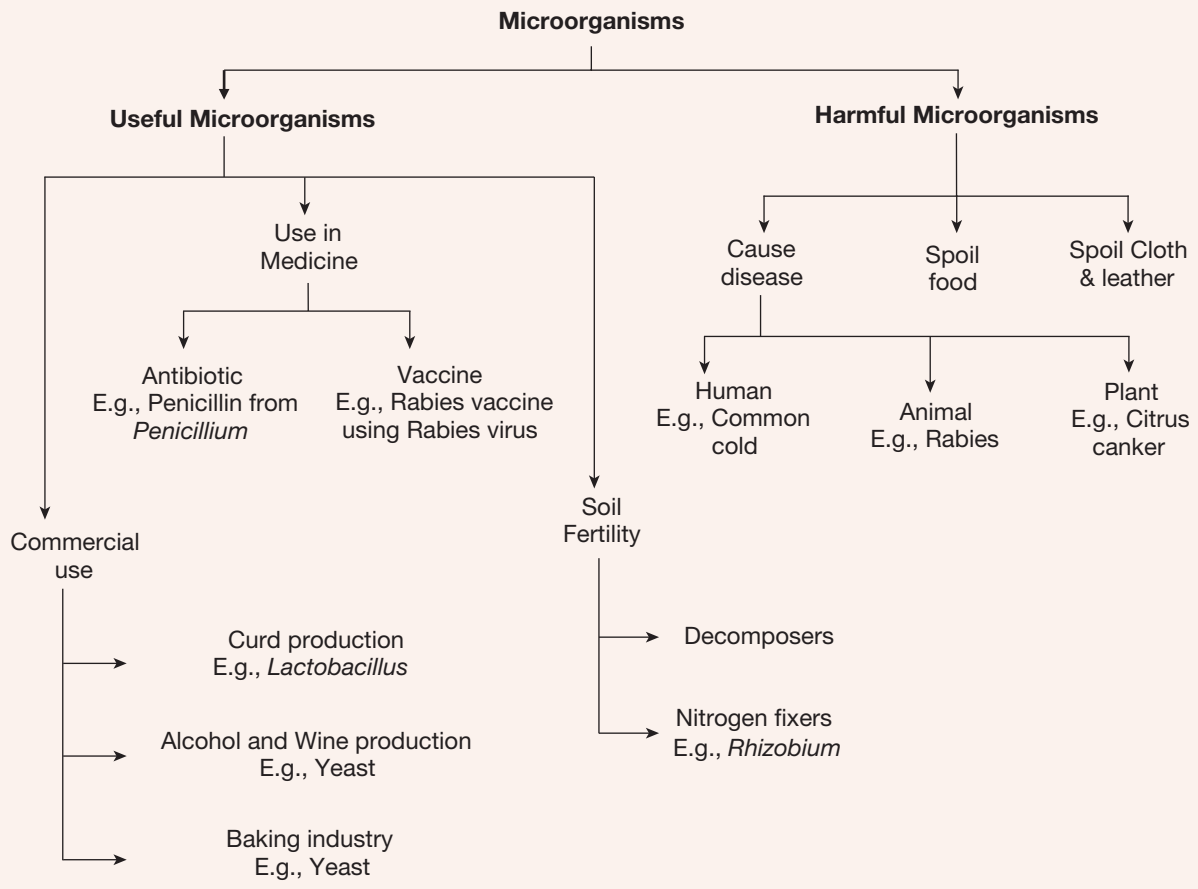


FIG. 5.2 Classification of microorganisms into useful and harmful

USEFUL MICROORGANISMS

There are many microorganisms that are beneficial to human beings. Some of the examples based on their uses are given below.

Microorganisms in Food Industry

Microorganisms are widely used for the production of curd, bread, alcohol, etc. Curd contains bacteria called *Lactobacillus* that convert milk into curd. Yeast can be used in the baking industry for making breads, pastries, cakes, etc. Yeast can also be used in the large-scale production of alcohol, wine, vinegar (acetic acid), etc. The basis of using yeast in wine production is fermentation. Fermentation is the process of converting sugar into alcohol.

Table 5.1 Useful microorganisms in food industry

Microorganism	Use
Lactobacillus	Milk production
Yeast	Bread production
Acetobacter malorum (bacteria)	Vinegar production
Gluconacetobacter azotocaptans (bacteria)	Coffee production

Info Box!

Chlorella (a green alga) is taken as a food supplement.

FIG. 5.3 Vinegar, produced by the action of bacteria, is used for pickling

Microorganisms in Medicinal Industry

Microorganisms are used to make antibiotics. These antibiotics are used to kill or stop the growth of other disease-causing microorganisms. A simple example is penicillin. Penicillin can be obtained from the fungus *Penicillium*. These antibiotics can be used to cure many diseases that are caused by microorganisms, (except viral diseases). Microorganisms can also be used in the production of vaccine. A vaccine is a biological preparation that consists of either dead or weakened microbes. When a vaccine is introduced into the body, the body produces antibodies against the vaccine, which remains in the body and protects the body from attack by the same microbe in the future. The common examples are rabies and tuberculosis vaccines.

FIG. 5.4 Medical vials containing vaccines

Info Box!

Antibodies are the substances produced by the body to fight against foreign particles called antigens.

Sir Alexander Fleming was the person who introduced to the world, the greatest discovery of that time, the antibiotic 'Penicillin'. It saved the lives of thousands of soldiers during the second world war. He was awarded the Nobel Prize in Physiology or Medicine along with Florey and Chain in the year 1945. Florey and Chain developed processes to produce penicillin in sufficient quantites to become widely available.

Microorganisms in Agricultural Practices

Microorganisms act as decomposers in the soil that decompose the dead plant and animal wastes. Decomposition releases organic nutrients to the soil that can be again used up by plants. Microbes increase soil fertility by fixing atmospheric nitrogen, for example, *Rhizobium*. This microbe lives in root nodules of leguminous plants and increases the nitrogen content in the soil.

FIG. 5.5 Root nodules of leguminous plants

Microorganisms in Commercial Industries

There are many microbes that are used in the manufacturing or processing of various products used commercially. For example, there are certain bacteria that are used to manufacture linen. Red algae produces 'Algin' that is used for thickening cosmetics and food products like jelly. Red algae also produces 'Agar' that is used as a solidifying agent in microbial research at a large scale.

HARMFUL MICROORGANISMS

Besides their several uses, microorganisms also cause some harmful effects on other living organisms. Microorganisms cause a number of diseases in humans, animals and plants. The microorganisms that cause diseases are called pathogens. The most common are viruses that cause common cold. Microorganisms also cause food spoilage and damage to clothes, leather, etc.

FIG. 5.6 Food spoilage caused by bread mold

Table 5.2 Common diseases caused by microorganisms

Microorganism	Disease
Rhinovirus	Common cold
Bordatella pertusis	Whooping cough
Rubeola virus	Measles
Varicella zoster virus	Chicken pox

As microorganisms are everywhere in the biosphere, and some can also cause diseases, it is important to maintain good health.

HUMAN HEALTH AND IMMUNITY

Health may be referred to as the well being of an individual in all aspects, that is, physically, mentally and socially. While immunity is the ability of a person to resist infections and remain disease free.

Immunity are of two types:

1. **Innate immunity:** Inborn immunity or immunity that is inherited from parents, for example, skin (prevents entry of foreign invaders).
2. **Acquired immunity:** Immunity acquired after birth is called acquired immunity or adaptive immunity, for example, Immunity to chickenpox.

Health of an individual depends on many factors. Some of them are given below:

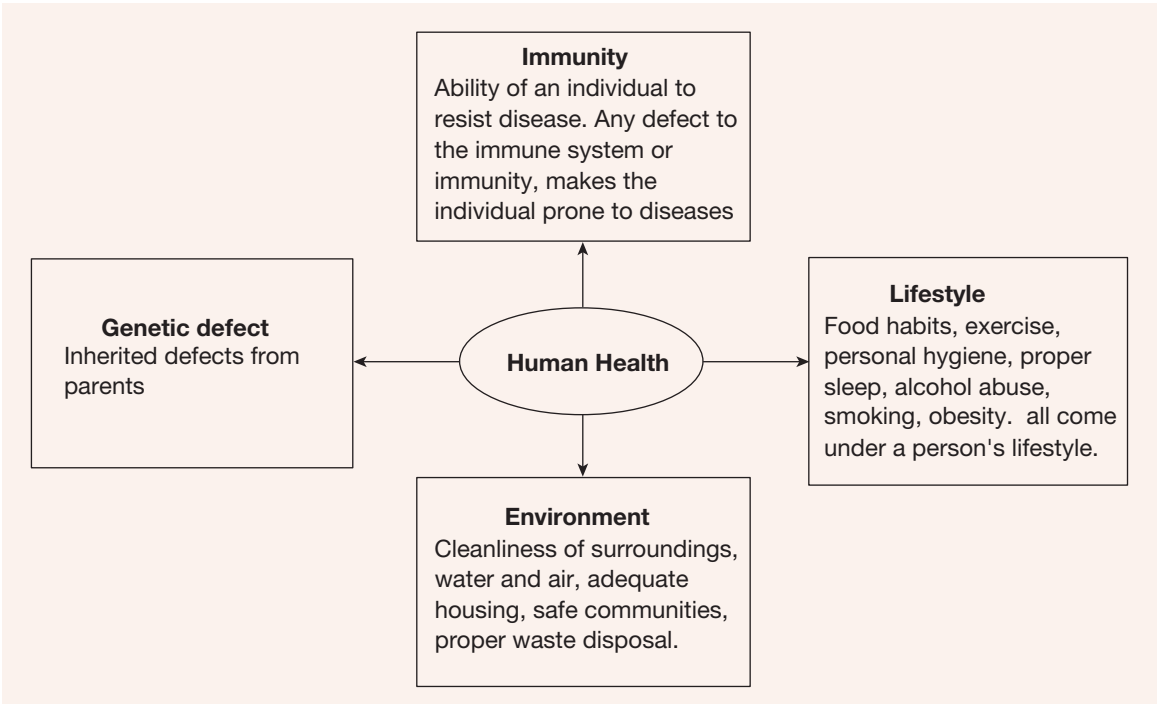


FIG. 5.7 Factors contributing towards human health

Immune System

Human immune system is composed of a network of cells, tissues, organs that function together to defend us against infectious microbes (bacteria, virus, etc.). The coordinated response of the immune system towards any foreign particles is known as immune response. The white blood cells and the various lymphatic organs constitute the components of immune system.

Components of Immune System

The immune system forms the first line of defense against foreign particles which seek entry inside our body. Skin is the first barrier of the immune system which prevents entry of disease causing microorganisms (pathogens). Upon gaining entry inside a living body, the pathogens are encountered with various blood cells which specialize in neutralizing and killing pathogens. These are discussed below in detail:

White Blood Cells

Lymphocytes, monocytes, macrophages, neutrophils, eosinophils and basophils all come under white blood cells and provide immunity to the body against infectious diseases and foreign invaders.

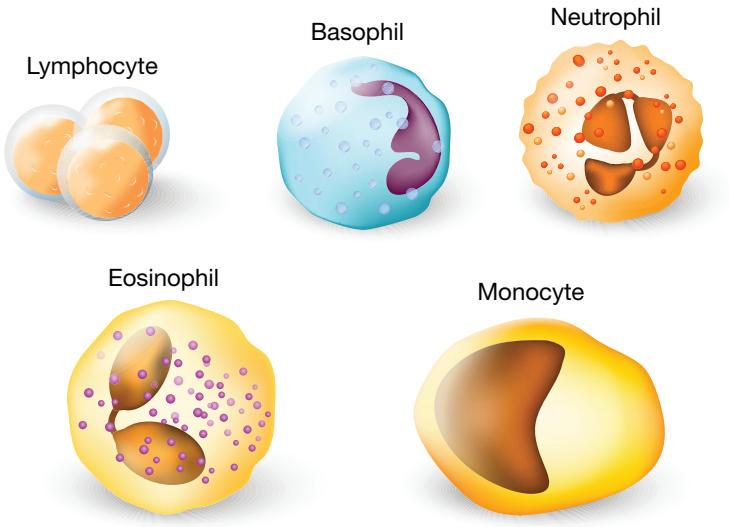


FIG. 5.8 Types of white blood cells

Organs

Thymus and bone marrow are the primary lymphoid organs where development of lymphocytes take place whereas spleen, tonsils, lymph vessels and lymph nodes are the secondary lymphoid organs where immune responses are initiated.

Working of Immune System

Our immune system must be able to differentiate self from non-self. It does so by detecting certain molecules like proteins that are found on the surface of all cells. It guides itself to ignore its own or self-proteins at an early stage. An immunogen is a substance that can initiate an immune response. In many cases, an immunogen is a bacterium, fungus, virus or toxin.

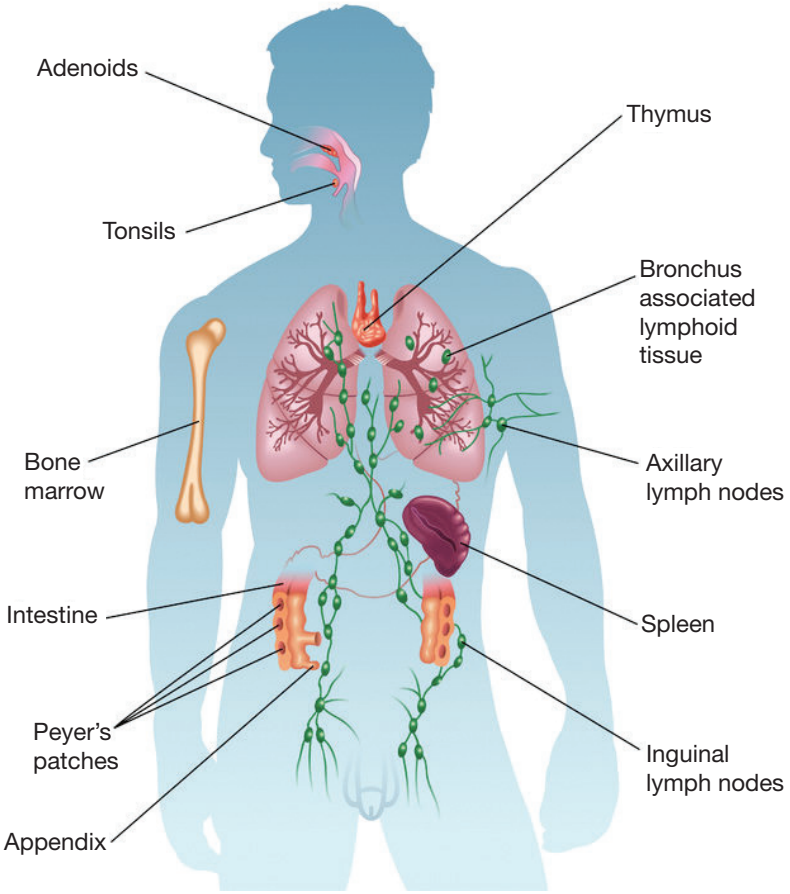


FIG. 5.9 Lymphatic system-showing all lymphoid organs present in the body

HUMAN DISEASES

Disease can be referred to as the state of disturbed ease, or being uncomfortable. Disease affects the proper functioning or structure of body organs or systems. The changes in the body due to diseases give rise to certain signs and symptoms.

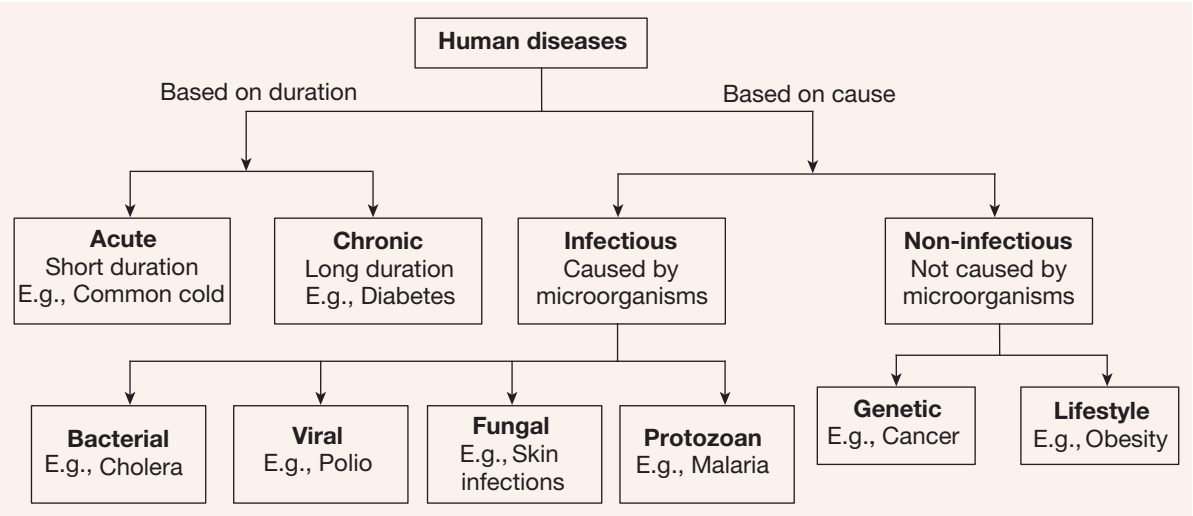


FIG. 5.10 Types of diseases based on duration and cause

Type of Diseases

According to the duration of diseases, they can be divided into two types, that is, a**cute** and **chronic**. An acute disease is the one in which the symptoms appear suddenly, worsen rapidly and then disappear as it heals, example, flu or common cold. Whereas a chronic disease is the one which develops gradually and worsens over a long period of time, example, chronic back pain.

Table 5.3 Points of difference between acute and chronic diseases

Acute diseases	Chronic diseases
Lasts for a short period often only a few days	Lasts for a long period of time, sometimes can be life-long
Sudden onset of symptoms and worsen rapidly	Develops gradually and worsens over time
Will not have time to cause major effects on human health if treated in time	Affects our normal health, for example, weight loss, tiredness, etc.
Can be cured	Require extended care or sometimes even hospitalization.
For example, common cold	For example, diabetes

According to whether or not caused by microorganisms, diseases are of two types:

1. **Infectious**
2. **Non-infectious**

Infectious Diseases

Following are the characteristics of infectious diseases:

- Infectious diseases are caused by pathogens, such as bacteria, viruses, fungi and protozoa, like chicken-pox, TB, etc.
- Multicellular organisms like worms can also cause infectious diseases like filariasis.
- Diseases that can spread from one person to another are called communicable diseases.
- Diseases that spread through air, water, food, physical contact with patient, sexual contact, aerosols (sneeze or cough droplets, etc.) also come under infectious diseases.

Non-infectious Diseases

Diseases that are not caused by microorganisms or infectious agents are called non-infectious diseases. Some of the examples, are:

Genetic diseases: Caused due to abnormalities in DNA, for example, cancer, cystic fibrosis, sickle cell anemia etc

Lifestyle diseases: Some diseases can be caused by lifestyle habits, like overeating, under eating, lack of exercise, etc., for example, obesity, nutrient deficiency diseases, high blood pressure, etc.

FIG. 5.11 Chicken pox— an infectious disease

Drug and Alcohol Abuse

Abuse of drug and alcohol can have serious consequences on human health. Nowadays, drug abuse is very common among teenagers who later on get addicted to it.

Smoking: Tobacco is mainly used for smoking and inhaling, tobacco smoke can cause diseases of heart; lungs, etc.

Alcohol abuse: Excessive alcohol consumption is called alcohol abuse. It can have many ill effects on human health, such as nutrient deficiency, liver diseases, fertility problems, etc.

Ways to Maintain Proper Health

'Health is wealth', hence maintaining proper health is very essential. Some of the measures that can be taken to maintain proper health are:

- **Healthy food habits:**
  - Eat nutrient-rich food or balanced diet
  - Avoid junk foods
  - Include more vegetables, fruits into the diet
  - Have food that is properly cooked

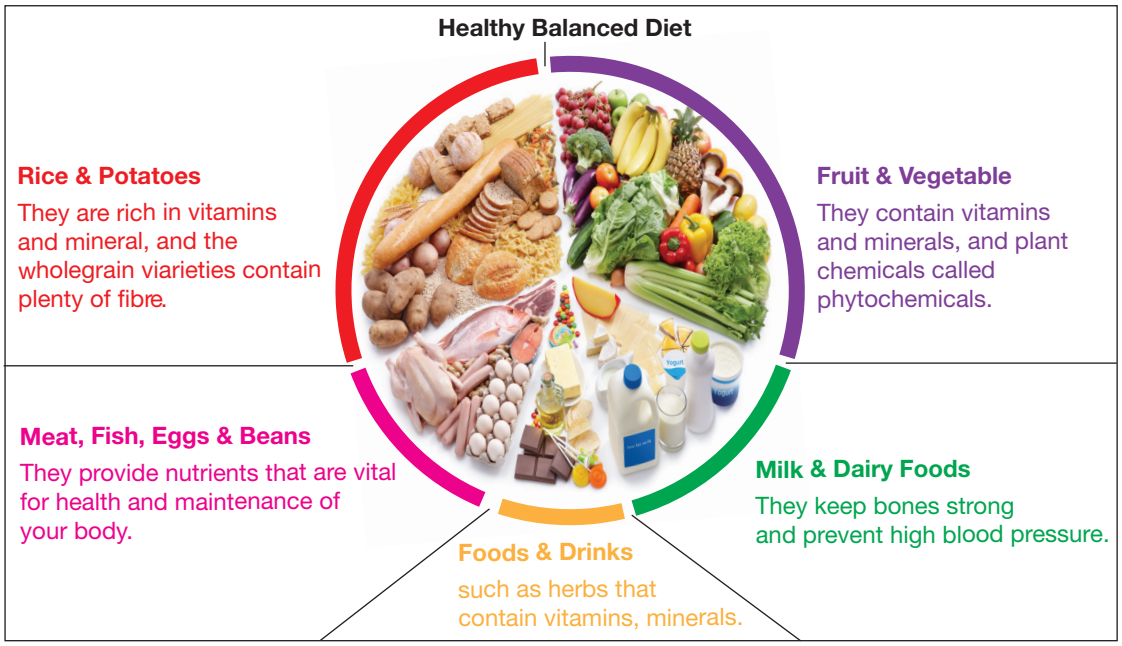


FIG. 5.12 Balanced diet components

- **Proper exercise:** Exercising regularly in any form lowers the risk of various diseases. It also helps to maintain an active metabolism.
- **Avoid drug and alcohol abuse:** Intake of drugs and excessive consumption of alcohol may lead to adverse health effects, such as liver damage, kidney diseases, neural diseases, etc.
- **Maintain personal and public hygiene**
  - Always keep personal hygiene
  - Drink boiled water
  - Do not leave food uncovered
  - Keep the surroundings clean
  - Proper waste disposal
- **Control of disease spreading**
  - Diseases spread by mosquitoes can be controlled by avoiding water stagnation, using mosquito nets, repellents, etc.
  - Diseases spread by droplets from sneezing or cough can be prevented by using towels to mask nose while sneezing.
  - Avoid breeding of flies.

QUICK RECAP

1. What are microorganisms and give examples?

The organisms that cannot be seen with the naked eyes and can be seen only through a microscope are called microorganisms, for example, bacteria, fungi, etc.

2. Generally, viruses are considered as non-living. Give reason.

Viruses are microscopic and generally considered as non-living as they can reproduce only inside a host cell, such as bacteria, plants or animals. They do not have an independent existence.

3. Define fermentation.

The process of converting sugar into alcohol is called fermentation. For example, yeast can convert sugar into alcohol and can be used widely for wine production.

4. Define vaccine.

A vaccine is a biological preparation that consists of either dead or weakened microbes. When a vaccine is introduced into the body, the body produces antibodies against the vaccine, which remains in the body and protects the body from attack by the same microbe in the future, for example, rabies vaccine, BCG vaccine, etc.

5. What are pathogens and give example?

The microorganisms that can cause disease are called pathogens, for example, viruses cause common cold.

POINTS TO REMEMBER

- The organisms which are too small to be seen by naked eye and are visible only through microscopes are called microorganisms.
- The study of microorganisms is termed as microbiology.
- Microorganisms are widely used for the production of curd, bread, alcohol, antibiotics, etc.
- Microorganisms can also be harmful and cause a number of diseases in humans, animals and plants.
- Health is referred to as the well being of an individual in all aspects, that is, physically, mentally and socially.
- Immunity is the ability of an individual to resist diseases.
- The coordinated response of the immune system towards any foreign particles is known as an immune response.
- Diseases that can spread from one person to another are called communicable diseases, example common cold.
- Diseases that do not spread from one person to another are called non-communicable diseases, for example, diabetes.
- Health can be maintained by following some good habits, such as eating nutrient-rich food or balanced diet, avoiding junk foods, including more vegetables and fruits into the diet and exercise.

TEST YOUR CONCEPTS

Directions for questions 1 to 10: Fill in the blanks in each question.

1. The study of microorganisms is called _____.
2. The antibiotic penicillin is produced by the fungus _____.
3. The conversion of sugar into alcohol is known as _____.
4. _____ is a bacterium that can fix atmospheric nitrogen.
5. Immunity to chickenpox is an example for _____ immunity.
6. Common cold is an example for _____ disease.
7. Diseases caused by microorganisms are called _____.
8. Polio is caused by _____.
9. Diseases that can spread from one person to another are called _____.
10. Genetic diseases arise due to abnormalities in _____.

Directions for questions 11 to 22: For each of the following questions, four choices have been provided. Select the correct alternatives.

11. Which one of the following is not an infectious disease?
    (a) Cholera (b) Polio
    (c) Malaria (d) Obesity
12. Select the odd one out
    (a) Neutrophils (b) RBCs
    (c) Basophils (d) Monocytes
13. Which one of the following is not a communicable disease?
    (a) Cancer (b) Common cold
    (d) Malaria (d) Dengue fever
14. Diseases can spread through
    (a) Aerosols (b) Sexual contact
    (c) Water (d) All the above
15. Bacterium that helps in milk curdling is
    (a) *Lactobacillus*
    (b) *Rhizobium*
    (c) *Lactococcus*
    (d) None of the above
16. Identify the wrong statement.
    A. A vaccine is a biological preparation that contains active or weakend microbe.
    B. Polio is an infectious disease caused by bacteria.
    C. Cancer is caused due to abnormalities in DNA.
    D. Lifestyle habits can cause diseases like obesity.
    (a) A only (b) B and C
    (c) C only (d) A and B
17. Identify the word pair relationship
    Cholera : _____
    _____ : Viral
18. Match the following.

A	*Rhizobium*	i	Antibiotic
B	*Lactobacillus*	ii	Soil fertility
C	*Penicillium*	iii	Vaccine
D	*Rabies*	iv	Milk curdling

	A	B	C	D
(a)	ii	i	iii	iv
(b)	i	iii	ii	iv
(c)	ii	iv	i	iii
(d)	i	ii	iv	iii

19. Substances that are produced by the body to fight against the invader is
    (a) Antibiotic (b) Vaccine
    (c) Antibody (d) Antigen
20. The antibiotic penicillin was discovered by
    (a) Alexander Fleming
    (b) Ernst Boris Chain
    (c) Robert Hooke
    (d) Howard Florey
21. **Assertion (A):** Yeast can be used commercially to produce alcohol
    Reason (R): Yeast can perform fermentation
    (a) Both A and R are true and R is the correct explanation for A.
    (b) Both A and R are true and R is the not the correct explanation for A.

PRACTICE QUESTIONS

(c) A is true and R is false

(d) A is false and R is true

22. **Assertion (A):** Immunity to chickenpox is considered as acquired immunity.

Reason (R): Immunity that is inherited from parents is considered as acquired immunity

(a) Both A and R are true and R is the correct explanation for A.

(b) Both A and R are true and R is not the correct explanation for A.

(c) A is true and R is false

(d) A is false and R is true

MASTERING THE CONCEPTS

Knowledge and Understanding

1. Explain the role of microorganisms in improving soil fertility.
2. Microorganisms can be harmful to humans. Justify the statement.
3. Define health and what are the different factors that affect human health?
4. Define immunity and what are the different types?
5. Write down the differences between acute and chronic diseases.
6. How can we classify diseases based on the cause?
7. Explain the use of microorganisms in medicine.
8. What are various elements in an immune system?

Application and Analysis

1. Nivin was observing his mother making wine using grapes. He saw that she is adding some amount of yeast into it. What do you think, what will be the reason for using yeast?
2. How environment affects someone's health?
3. A virus is living inside its host cell and is able to survive and reproduce. What happens when the same virus is removed out of the host cell?
4. Microorganisms like bacteria are reason behind a number of diseases some of which are even fatal. Should all microorganisms be considered harmful for humans?
5. A vaccine comprises the microbes that are able to cause diseases. How does a vaccine, then, not cause any harm when it is injected in our body?
6. Why are foreign particles called antigens?
7. Why is immunity to chicken pox an acquired immunity?

PRACTICE QUESTIONS

TEST YOUR CONCEPTS

1. Microbiology
2. *Penicillium*
3. Fermentation
4. *Rhizobium*
5. Acquired
6. Acute
7. Infectious diseases
8. Virus
9. Communicable diseases
10. DNA
11. (d)
12. (b)
13. (a)
14. (d)
15. (a)
16. (d)
17. Bacteria, polio
18. (c)
19. (c)
20. (a)
21. (a)
22. (c)

MASTERING THE CONCEPTS

Knowledge and Understanding

1. Microorganisms help to increase soil fertility in different ways. They act as decomposers in soil by decomposing the dead plant and animal wastes. Decomposition releases organic nutrients to the soil which can be again used up by plants. Microbes increase soil fertility also by fixing atmospheric nitrogen, for example, *Rhizobium*. *Rhizobium* lives in root nodules of leguminous plants and increases the nitrogen content in the soil.
2. Along with uses, microorganisms also cause some harmful effects on other living organisms. There are microorganisms that cause diseases in humans, animals and plants. The microorganisms that can cause disease are called pathogens, for example, viruses cause common cold. Microorganisms also cause food spoilage, and damage our clothes, leather, etc.
3. Health may be referred to as the well-being of an individual in all aspects, that is, physically, mentally and socially. Health of an individual depends on many factors such as,

   Immunity – Ability to resist disease.

   Genetic defects – Inherited defects from parents.

   Lifestyle – Food habits, exercise, hygiene, etc.

   Environment – Cleanliness of water we drink, air we breath, etc.
4. The ability of an individual to resist disease is called immunity. Any defect in the immune system makes the individual prone to disease. Immunity are of two types – Innate immunity and acquired immunity. The inborn immunity or immunity that is inherited from parent is called innate immunity (e.g., skin). Immunity that is acquired after birth is called acquired immunity (e.g., immunity to chicken pox).
5. According to the duration, diseases can be classified into acute and chronic diseases. The main differences are given below.

Acute diseases	Chronic diseases
Last for a short period	Lasts for a long period of time, sometimes can be life-long
Sudden onset of symptoms that worsen rapidly	Develops gradually and worsens over time
Will not have time to cause major effects on human health if treated on time	Affects our normal health, for example, weight loss, tiredness, etc.

HINTS AND EXPLANATION

Can be cured	Require extended care or sometimes even hospitalization.
For example, common cold	For example, diabetes

6. According to the causes of diseases, they can be classified into two types: Infectious and non-infectious diseases.

   Infectious diseases are caused by microorganisms, such as bacteria, fungi, etc. These could be spread from one infected person to a healthy person and are called communicable diseases, for example, common cold.

   Non-infectious diseases are not caused by microorganisms or infectious agents, for example, genetic diseases, such as cancer and lifestyle diseases like obesity.

7. In the medical field, the microorganisms can be used to make two important products, such as antibiotics and vaccines. Antibiotics are used to kill or stop the growth of other disease-causing microorganisms, for example, penicillin from *Penicillium*. Microorganisms can also be used in the production of vaccine. A vaccine is a biological preparation that consists of either dead or weakend microorganisms. Vaccines provide immunity to a particular disease, for example, rabies vaccine gives protection against the rabies virus.

8. Human immune system includes a network of cells, tissues, organs that work together to resist any attack by foreign invaders (bacteria, virus, etc.) The various components are,

   - **White blood cells:** Lymphocytes, monocytes, macrophages, neutrophils, eosinophils and basophils.
   - **Organs:** Thymus, bone marrow, spleen and lymph nodes.

Application and Analysis

1. Yeast can convert sugar into alcohol through a process called fermentation. Fermentation is a metabolic process that takes place in the absence of oxygen, in which organic molecules are converted into acids, gases or alcohol by the action of certain microorganisms, such as yeast. Nivin's mother used yeast to perform fermentation and to convert grape sugar into wine (alcohol).

2. Environment plays a key role in maintaining proper health. Along with personal hygiene, environmental hygiene is also important. Cleanliness of water and air and proper waste disposal management are also necessary for a healthy life. There are many diseases that can be caused due to unhygienic environments, such as cholera, polio, etc., so it is advised to always keep the environment clean.

3. Outside the host cell, a virus is non-living as it is unable to function and reproduce. A virus gets the suitable and necessary environment only inside its host cell for reproduction.

4. No, not all microorganisms are harmful to human bodies. There are a number of microorganisms which help human beings either as food supplement or in medicinal industry or in production of food.

5. Vaccine is a biological preparation of microbes. However, the microbe is prepared in its weak state which is unable to cause harm to human body.

6. Foreign particles are called antigens because our body is not familiar with their structure and composition. Upon encountering a foreign body, our body generates molecules (antibody) to fight against them. Since antigens cause the generation of antibodies, they are called antigens.

7. Immunity acquired after birth is called acquired immunity or adaptive immunity. When the causative agent for chicken pox attacks our body for the first time, we catch disease as our body is unable to fight against it. But, a subsequent attack of the same pathogen does not result in the same condition. Our body then fights against the antigen due to acquired immunity it has developed from the first attack.

Chapter

6

Ecosystem and Biodiversity

REMEMBER

Before beginning this chapter, you should be able to:

- Recall the definition of ecosystem and its components
- Remember the different types of terrestrial and aquatic ecosystem
- Know the harmful effects of pollutants

KEY IDEAS

After completing this chapter, you should be able to:

- Describe the various components of ecosystem
- Understand the concept of food chain and food web
- Explain the various sources and control methods of different types of pollution
- Understand the concept of biodiversity
- Understand the concept of wildlife and its conservation

INTRODUCTION

Ecosystem is the functional unit of nature comprising living organisms and non-living things. Living beings are known as biotic factors and non-living things are known as abiotic factors. Biotic factors include microbes, insects, plants, animals, etc. Abiotic factors include air, water, temperature, soil, humidity, sunlight, etc.

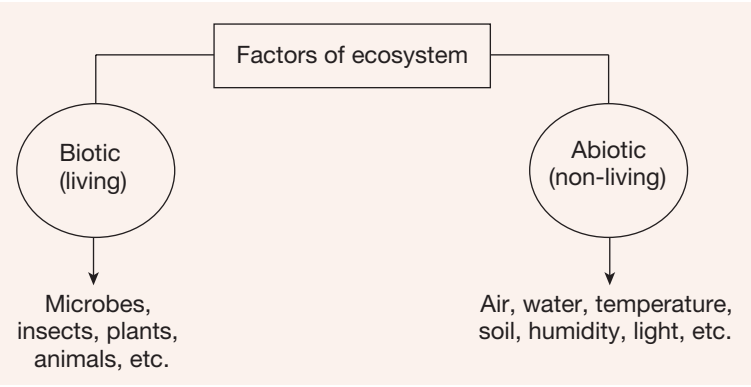


FIG. 6.1 Factors affecting an ecosystem

COMPONENTS OF AN ECOSYSTEM

In an ecosystem, biotic and abiotic factors interact with each other to meet their necessities. The components of ecosystem mainly consist of:

Producers → Consumers → Decomposers

Producers

Producers are the organisms that can synthesize their own food. These include green plants that utilize water and minerals absorbed from the soil, and sunlight trapped by chlorophyll (green-coloured pigment seen in plants) to synthesize their food. This energy in food is used by other organisms for their requirements. So green plants are called producers in an ecosystem.

Consumers

All animals that cannot synthesize their own food and depend on green plants directly or indirectly for their energy requirements are called consumers.

Consumers are of three types herbivores, carnivores and omnivores.

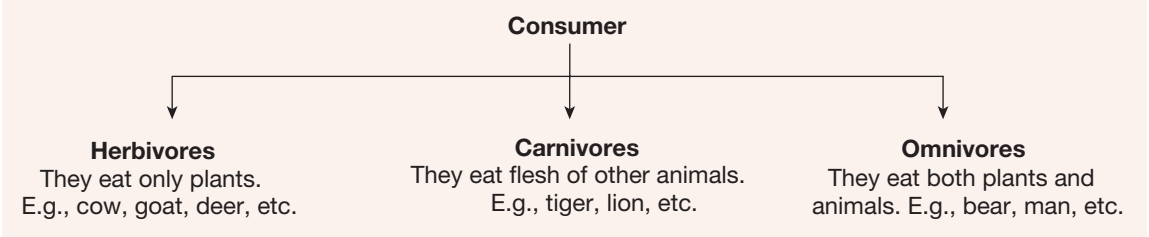


FIG. 6.2 Types of consumers based on their feeding habits

Decomposers

Decomposers are organisms that can break down dead and decaying organisms. The primary decomposers in many ecosystems are fungi.

Food Chain and Food Web

The process of eating and being eaten up in a linear manner is called food chain. In this, one organism eats other organism for its survival. Food chain results in flow of energy from one trophic level to another. The amount of energy decreases as it flows from lower trophic to higher trophic levels.

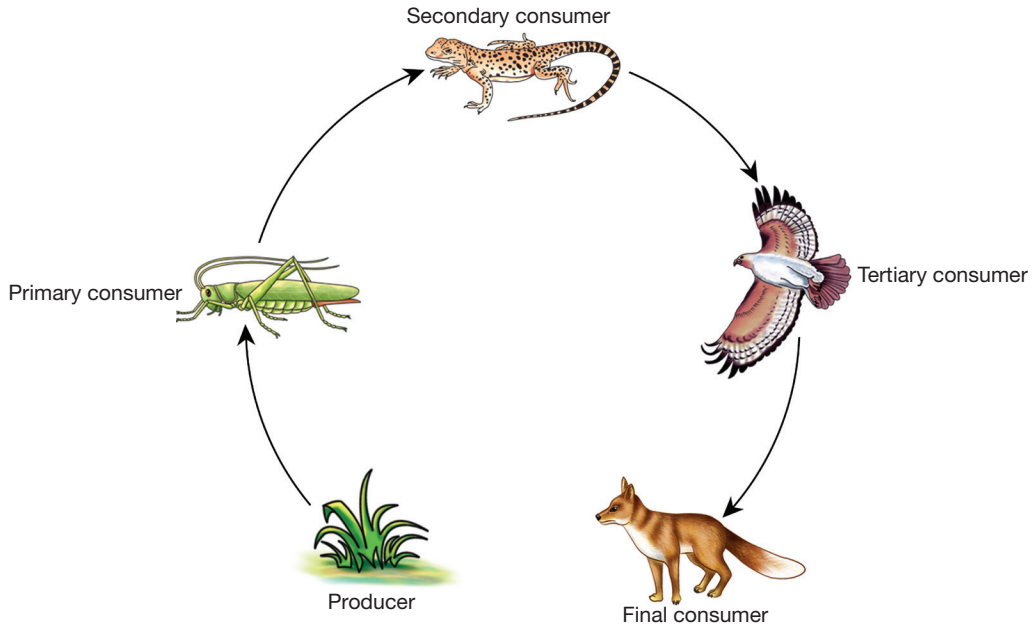


FIG. 6.3 A simple grass type food chain

Trophic Levels

It is a step or division of food chain. Number of trophic level is equal to the number of steps in a food chain. Main fundamental units of trophic levels are producers (which produce energy in the ecosystem, for example, green plants) and consumers (which either depend directly on producers or on other animals that depend on producers).

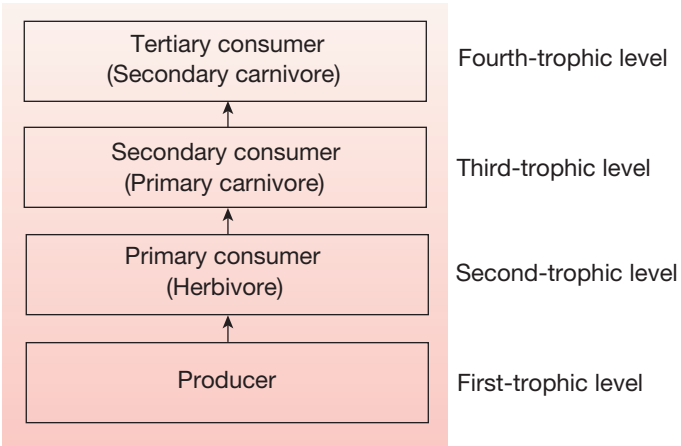


FIG. 6.4 Flow diagram showing increasing trophic levels

Interconnected food chain in an ecosystem is called food web. It includes a number of food chains. It is an important ecological concept. It represents the various feeding relationships within a community.

Info Box!

A food chain is a linear sequence of organisms, whereas food webs consist of many interconnected food chains.

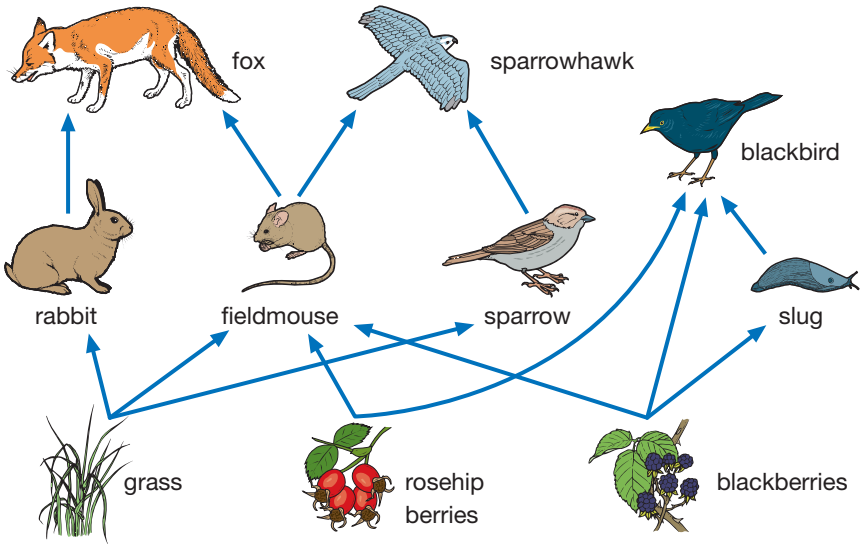


FIG. 6.5 A food web showing interconnected food chains

Biomagnification

Biomagnification is the increase or accumulation in concentration of toxic substances in the body of organisms at higher trophic levels. Biomagnification is also known as bioamplification, for example, an insecticide applied to a plant accumulates in a herbivore that feeds on it. This insecticide then enters different trophic levels through the food chain. The maximum amount of such toxic chemicals is seen in human beings, placed at the top of food chain. In an aquatic food chain, maximum DDT is found in fish-eating birds.

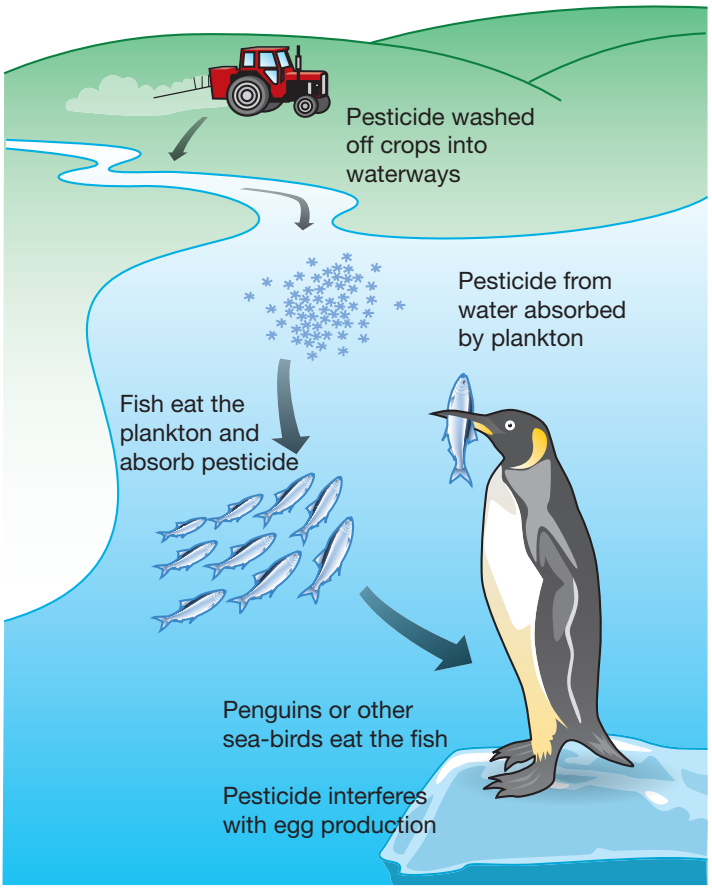


FIG. 6.6 Biomagnification of pesticides in an aquatic food chain

NATURAL RESOURCES

The term 'resource' refers to any source of supply that is kept in reserve. Natural resources are the resources that are found in nature and are used by the human beings to support and sustain life. For example, Sun (ultimate source of energy), water, soil, etc.
Natural resources are classified on the basis of their availability and time taken for them to be replenished. Based on these criteria, natural resource are classified into the following.

1. Renewable resources
2. Non-renewable resources

Renewable Resources

Renewable resources are the ones which get replenished or restocked naturally through natural cycles within an adequate timeframe. For example, sun, soil, water, wind, wildlife, forest, etc.


FIG. 6.7 Renewable resources of energy

Renewable resources are also called perpetual resources or inexhaustible resources because of their continuous availability and ability to last billions of years. However, certain resources, such as water and forest, get exhausted if they are exploited too rapidly to be replenished in adequate time interval through natural cycles.

Non-renewable Resources

Non-renewable resources are the ones which cannot be replenished or restocked within an adequate timeframe. For example, coal, petroleum, natural gas, etc.


FIG. 6.8 Non-renewable resources of energy

Non-renewable resources are called exhaustible resources because they cannot be easily replenished once they are lost.

Depletion of Natural Resources

Coal and petroleum are formed from the dead remains of plants and animals buried under the Earth for millions of years. They are still being formed under the Earth, however, the rate of their formation is significantly low.

As there have been immense technological advancements taking place in the world, a lot of it comes at the cost of exploiting our natural resources. Increase in population and hence, increase in demand for resources has put a tremendous pressure on the resources available to us. The rate at which they are being exploited has reached an alarming level that their restoration within adequate timeframe is threatened. Moreover, the ever-increasing demand for land has been leading to excessive deforestation which has further reduced their availability

Info Box!

Agriculture is the leading cause of deforestation.

FIG. 6.9 Deforestation of rainforest

Fossil Fuels

Fossil fuels are formed within the Earth's crust from the buried plants and animals over a period of millions of years. Fossil fuels include coal, petroleum, natural gas, etc. All of them essentially contain carbon.

Coal

Coal is a fossil fuel formed from the remains of plants that lived and died about 100–400 million years ago. All living plants absorb light energy from the sun through photosynthesis. After the plants die, this energy is released as the plants decay. Under conditions favorable to coal formation, the decay process is disturbed, preventing the further release of the stored solar energy. Depending on the carbon content, coal is classified into following types.

- **Anthracite:** Contains about 95% carbon.
- **Bituminous:** Contains 65–80% carbon.
- **Sub-bituminous:** Contains 30–35% carbon
- **Lignite:** Contains 25–30% carbon

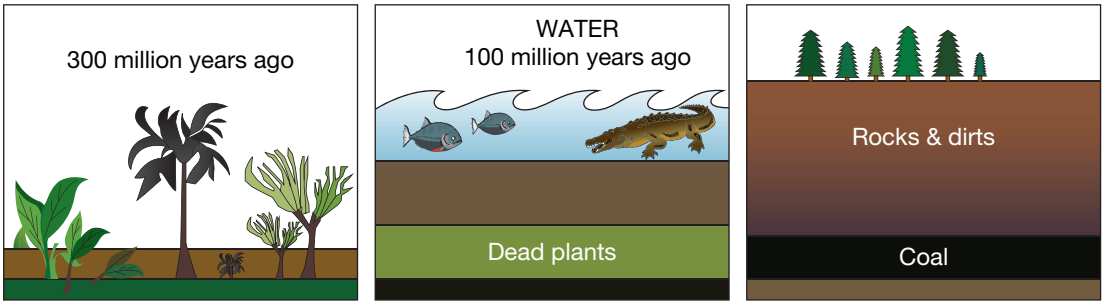


FIG. 6.10 Formation of coal

Uses of Coal

Coal has a number of uses in the industry sector. It was used extensively during industrial revolution. It is used in steel production, power generation, as a source of steam energy, etc.

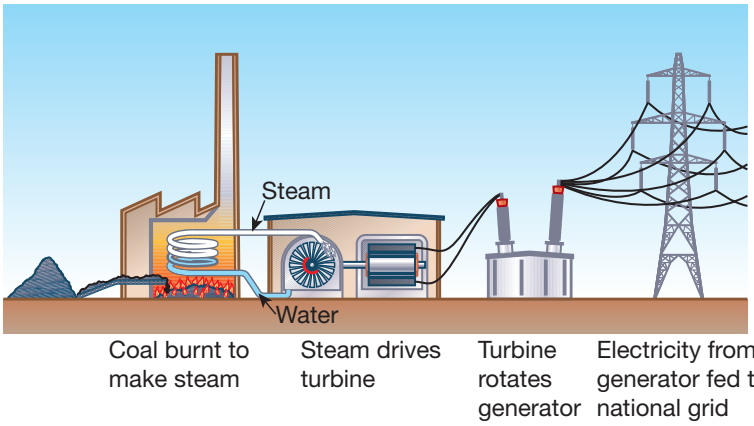


FIG. 6.11 Coal-fired power station for electricity generation

Petroleum

The term 'petroleum' is derived from combination of two Latin terms: *petra* meaning rock and *oleum* meaning oil. Petroleum is a naturally occurring, yellow-to-black coloured liquid found beneath the Earth's surface. Crude oil is refined to give useful products as mentioned in table.

Info Box!

Crude oil is the Petroleum in its natural form when first collected.

Table 6.1 Products obtained from petroleum refining

Products	Uses
Petroleum gas	Fuel for home and industries
Petrol	Automobile and aviation fuel
Kerosene	Fuel for stoves
Diesel	Heavy-motor-vehicle and generator fuel
Lubricating oil	Lubrication
Paraffin wax	Candles, Vaseline, etc.
Bitumen	Paints and building roads

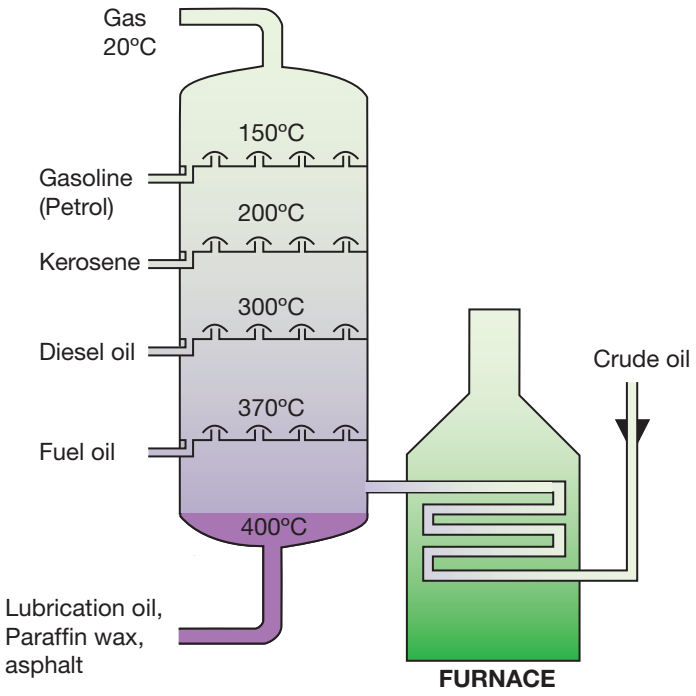


FIG. 6.12 Refining of petroleum

Conservation of Fossil Fuels

Given the variety of ways in which fossil fuels are used by humans, they have become indispensable for our day-to-day life. However, as fossil fuels are non-renewable resources, their conservation is of urgent need. They can be conserved in the following ways.

- Using fuel-efficient vehicles like the ones that run on CNG
- Use of alternative sources of energy
- Use of biogas to generate electricity
- Judicial use of electricity

Forests

Forest is a large area that is predominantly occupied by trees. Forests are the lungs of the Earth and are essential for continuity of life. They are an important renewable resource. However, their status is threatened due to their depletion at a fast rate. In the section given below, we shall take a look at importance and conservation of forests.

Importance of Trees

- We daily make use of chairs to sit, paper to make notes, tissue to clean our hands after a meal, etc. In most of our activities, we depend on forests in an unthinkable number of ways. The importance of trees can be realized with the help of following points.
- The first and foremost need for having forests is the maintenance of oxygen–carbon dioxide balance. As we know that plants take in carbon dioxide and give us oxygen through the process of photosynthesis.
- Plants release water vapours into the atmosphere through the process of transpiration. This helps in continuous movement of water cycle which helps to maintain optimum level of water in nature.
- Trees give us fruits which are an important source of nutrition.

- Forests are home/habitats to an abundant number of biodiversity of plants and animals
- Forests act as buffers during natural disasters like floods.

Info Box!

Forests are home to 80% of the world's terrestrial biodiversity.

FIG. 6.13 Forests are natural home to most of the wildlife

Deforestation

Deforestation is the cutting down of trees at a large scale over a short period of time. The over-exploitation of forests threatens the ecosystem and humanity as we heavily depend on forests for most of the ecological services. Following are the mains causes of deforestation.

Info Box!

Half of the world's tropical forests have been destroyed over the last century.

- Small- and large-scale agriculture
- Mining
- Infrastructure
- Pulp plantations
- Forest fires

Conservation of Forests

The following methods can be adopted to conserve forests.

- **Afforestation:** It is the practice of establishing a forest in an area which did not have any previous tree cover.
- **Sensible cutting of trees:** It is important that trees are cut down judiciously in order to fulfill human needs. New trees should be planted for the compensation of cut-down trees.
- **Silviculture:** It is the execution of controlling the establishment, growth, composition, health, and quality of forests to meet diverse needs.
- **Awareness:** Society should be made aware of the importance of forests and threats associated with their depletion. Society should be encouraged to make environment-friendly choices.

FIG. 6.14 Restoring forests by silviculture

POLLUTION

Pollution is any undesirable change in the physical, chemical or biological characteristics of the environment that affects the living organisms negatively or may create a potential health hazard. It is the necessary evil arising due to reckless development and the ever growing population. Substances that cause pollution are called pollutants, for example, human and animal wastes, garbage, dust, sewage waste, radiation, etc.

Pollution is mainly of three types:

1. Air pollution
2. Water pollution
3. Soil pollution

Air Pollution

Air pollution occurs when harmful substances, such as, smoke, dust, fumes, particulates, etc., are released into the atmosphere. Most of the air pollution occurs due to burning of coal, petrol, oil, exhaust from vehicles, fumes from factories, industries, brick kilns, etc. Ash from burning volcanoes, dust from storms and forest fires also contribute to air pollution but to a lesser extent.

Effects of Air pollution

Air pollution is a real problem regarding public health, environmental issues, health conditions of plants and animals, etc. The smoke released from various sources may combine with dust particles and fog in the atmosphere to form a deadly mixture called smog. Smog is very harmful to plants and causes asthma and other respiratory allergies in humans. It also causes global warming (increase in earth's temperature due to accumulation of CO_2 in the atmosphere), acid rain, etc.

FIG. 6.15 Industrial emissions causing air pollution

Info Box!

Acid rain is caused by emissions of sulphur dioxide and nitrogen oxide. These gases react with water in the atmosphere and produce acids, such as sulphuric acid and nitric acid, resulting in acid rain.

Steps to Control Air Pollution

- Controlling emission from factories, vehicles, etc.
- Protecting forest that helps in increasing the amount of oxygen in the atmosphere.
- Using public transport and reducing usage of personal vehicles.
- Avoid burning of trash, wastes, etc.
- Using natural gas instead of coal, wood, kerosene oil for cooking and heating purposes.

- Installation of devices which reduce the release of pollutants, like filters, electrostatic precipitators, etc.

Water Pollution

The contamination of water resources, such as lakes, rivers, oceans, ponds, etc., is called water pollution. This happens when pollutants are directly or indirectly discharged into the water sources. Sewages from houses, agriculture, industries, etc., are dumped directly into nearby water sources. People and animal bathing in water sources also make the water polluted. Fertilizers, pesticides, insecticides, etc., used in agriculture sometimes reach water sources due to rain which is again a pollutant.

FIG. 6.16 Trash dumped near river causing water pollution

Effects of Water Pollution

- Drinking or using polluted water can be harmful to living things. Bathing in polluted water can cause skin irritation, rashes, etc.
- Diseases like cholera, diarrhoea, typhoid, etc., spread through contaminated water.
- Stagnant sewage water becomes breeding places for insects and pests, such as mosquitoes, fleas, cockroaches, etc., which cause diseases, like dengue, malaria, chikungunya, etc.

Steps to Control Water Pollution

- Industrial wastewater should be treated well before dumping into water sources.
- Waste, whether industrial or domestic, should not be directly thrown into water sources.
- Bathing in water sources should be avoided.
- Defecating in open places should not be allowed.

Soil Pollution

Dumping wastes in open area can cause soil pollution. It degrades the soil quality and also reduces its fertility. Wastes can be of any type, such as industrial wastes, domestic wastes, wastes from slaughter houses, agricultural wastes, etc. Chemical fertilizers and pesticides from agricultural field which reach the soil as run-off also contribute to soil pollution.

FIG. 6.17 Soil pollution

Effects of Soil Pollution

- When wastes are dumped at a particular area, they start decaying and produce foul smell which destroys the natural beauty of the surroundings and makes living detrimental for the local people.
- They become breeding places for disease-causing germs, flies, insects, etc.
- The soil below also becomes infertile.
- Non-biodegredable substances like plastic never degrade and remain there for years. Disease carriers, such as flies, mosquitoes, cockroaches, etc., transfer disease causing pathogens from the waste to our food. Consuming such food can make a person sick.

Steps to Control Soil Pollution

- Dumping wastes in open should be avoided.
- Wastes should be categorized as biodegradable and non-biodegredable.
- Domestic wastes should be dumped in a compost pit.
- Necessary steps should be taken by municipality for waste treatment and disposal management of localities.
- Use of plastic bags must be banned and instead paper bags & cloth bags should be used.

QUICK RECAP

1. What are the main components of an ecosystem and why are they called so?

Ecosystem includes living and non-living things that also have their inter-relationship with each other. The main components of an ecosystem are:

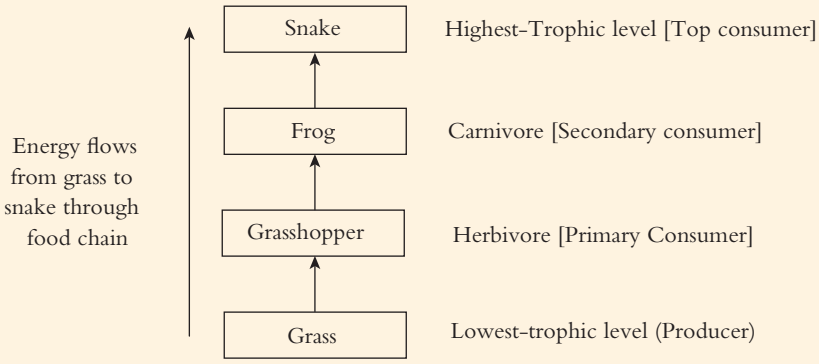
- **Producers:** These organisms can produce their own food mainly through photosynthesis. Other organisms depend either directly or indirectly on the producers.
- **Consumers:** These organisms cannot synthesize their own food and depend on producers for food.
- **Decomposers:** These organisms are involved in the decomposition of dead and decaying matter in the ecosystem.

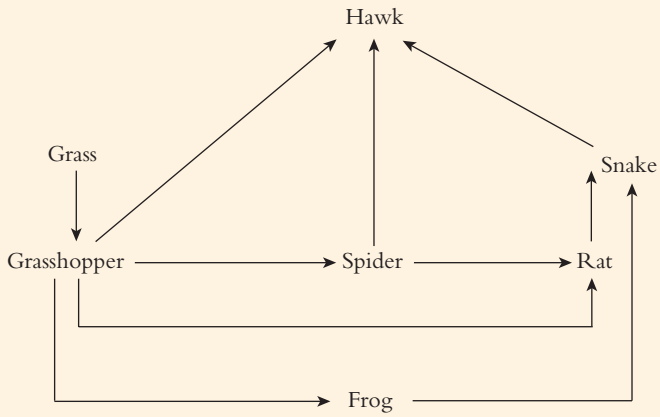
2. State the difference between food chain and food web.

Food chain is a linear sequence of organisms through which energy produced by producers flows from lower trophic to higher trophic levels. In food chain, each organism occupies different trophic levels. Food webs include interconnected food chains. The food webs are more realistic representation of energy transfer in an ecosystem.

QUICK RECAP

Two examples of food chain are mentioned below:





3. Define pollution. Name any three types of pollution.

The term 'pollution' refers to the undesirable changes in the environment due to the introduction of various contaminants. Substances that cause pollution are called pollutants, for example, industrial wastes, domestic wastes, etc. Soil, air and water are three types of pollution.

4. What are the various control measures to prevent air pollution?

- Controlling emission from factories, vehicles, etc.
- Protecting forest that helps to increase the amount of oxygen in the atmosphere.
- Using public transport and reducing usage of personal vehicles.
- Avoiding burning of trash, waste, etc.

5. What are the main causes of water pollution?

Water pollution occurs, when wastes from various industries, houses, hospitals, etc., are released into water bodies, such as rivers, lakes, etc., without any treatment. Wastes from industries contain many chemicals which add to the water bodies. Similarly, wastes from hospitals carry many disease-causing microorganisms (pathogens) that could be harmful to humans. Fertilizers and other chemicals that are used in agriculture can also cause water pollution.

BIODIVERSITY

The term 'bio' means 'life' and 'diversity' means 'forms'. The term implies the occurrence of different ecosystems, different species, organisms, their interaction with other living and nonliving forms, etc.

Biodiversity is of three types: Genetic diversity, species diversity and ecological diversity.

1. **Genetic diversity:** It is the diversity in number and types of gene and chromosomes present in different species or variation of genes within the same species, for example, India has many varieties of mangoes and rice.
2. **Species diversity:** It implies the variety in number and richness of a species in a particular region, for example, variety of amphibian species are present in Western Ghats.
3. **Ecological diversity:** It is the variation in ecosystems in a region. Variation can be in both terrestrial and aquatic ecosystems, for example, desert, tropical rainforests, etc.

Info Box!

Species is a group of organisms that have similarities in character and that can also interbreed to produce a fertile offspring. It is the basic unit of classification and taxonomy.

Biodiversity Hotspot

A region with significant levels of biodiversity, which is threatened with destruction, for example, Western Ghats is called biodiversity hotspot. There are a total of 4 hotspots in India, namely the Western Ghats, the Himalayas, the Indo-Burma region and the Sundaland.

FIG. 6.18 The himalayas—a biodiversity hotspot

They include areas with natural ecosystem that are intact and communities associated with hotspots are wild. Such regions are also homes for endemic natural species. Endemic species are those which are found only in a particular area. For example, Nilgiri tahr, also known as Nilgiri ibex or simply ibex, is endemic to the Nilgiri hills and the southern parts of western ghats in the states of Tamil Nadu and Kerala in southern India.

FIG. 6.19 Nilgiri tahr—an endemic species

Threat to Biodiversity

Significant decrease in biodiversity has taken place within the last few decades. Many organisms that were once abundant have vanished from the earth's surface. Some of the reasons that could have caused such massive destruction are given below:

- **Habitat loss:** Ruthless cutting down of the trees and destruction of forest for human necessities have caused loss of habitat of many species.
- **Over-exploitation of species:** Whether a plant or an animal reduces its population.
- **Invasion of foreign species:** Invasion of some other species or introduction of some new species for economic use sometimes drives away the local communities.
- **Intensive agriculture:** Spread of agriculture to the grasslands, wetlands, etc., destroys the habitat of many species.
- **Forestry:** Growing economically important trees, such as teak, sandalwood, etc., at the cost of normal forest trees drives away the local forest inhabitants.
- **Co-extinction:** When two different species are dependent on each other, extinction of one would affect the other species, which results in the extinction of other species also. This is called co-extinction. For example, in host-parasite relationship, if host gets extinct it will eventually lead to the extinction of parasite also.
- **Natural calamities:** Calamities such as earthquakes and tsunamis wipe away many species at once.
- **Pollution:** Is again a major factor responsible for the extinction of many species from earth as these species are unable to survive in the polluted environment.

WILDLIFE AND ITS CONSERVATION

Traditionally, wildlife refers to undomesticated animal and plant species that occur in their natural habitat or are in a state of life in wild. Wildlife resources form an important link in the survival of human species and maintenance of the ecological balance of nature. It is also an area of much curiosity, research and interest among naturalists all over the world. Most of the wildlife habitats are under severe pressure and a large number of wildlife species have become extinct or are on the verge of extinction, due to the deleterious activities of humans. So finding and implementing effective means of conservation of wildlife animals is of utmost importance.

Wildlife conservation is the practice of protecting and conserving plant and animal species in their natural habitat.

There are two main methods to conserve wildlife which are: *In situ* conservation and ex situ conservation

In Situ Conservation

It involves preserving wildlife in its natural habitat. A few examples are national parks, sanctuaries and biosphere reserves in wild regions with plentiful biodiversity which are explained separately in the following sections.

National Parks

A national park is a reserved area of land under governmental control which is preserved to protect its biodiversity from human exploitation. It provides special protection to single species of plants or animals that are rare.

For example, Silent Valley National Park in Kerala. This park protects lion-tailed macaques.

Kaziranga National Park in Assam. This park protects one-horned rhinoceros.

FIG. 6.20 Kaziranga National Park Assam protects one horned rhino

FIG. 6.21 Lion-tailed monkey is protected in Silent Valley National Park Kerala

Sanctuary

A naturally occurring area such as an island that provides protection for species from hunting, predation or competition. It is a protected area, a geographic territory within which wildlife is protected. Limited human activities are allowed inside a sanctuary. Examples are Karakoram wildlife sanctuary, Bharatpur bird sanctuary, etc.

FIG. 6.22 Great egret in Bharatpur bird sanctuary

Biosphere Reserve

A biosphere reserve is a special ecosystem with flora and fauna that requires protection. They are managed and studied for conserving the biodiversity present in that region and is a biodiversity hotspot region. At present there are 18 biosphere reserves in India.

FIG. 6.23 A herd of bisons in a biosphere reserve

Ex Situ Conservation

Ex situ conservation is conserving the components of an ecosystem outside its natural environment or in an artificially created environment. It involves conservation of not only wild and cultivated species but genetic species also, for example, gene banks, zoos, aquariums, botanical gardens, etc.

Some examples of *ex situ* conservation include:

Zoological Garden

Here animals are enclosed and bred in captivity. They are exhibited to public for recreational purposes, for example, zoological gardens in Kolkata.

FIG. 6.24 Elephants eating hay in a zoo

Botanical Garden

It is meant for protecting endangered plant species under artificial conditions away from their natural environment. They are displayed for public for education, scientific and recreational purposes, for example, Indian Botanical Garden, Howrah, West Bengal.

FIG. 6.25 Different plant species in a botanical garden

QUICK RECAP

1. **What is a biodiversity hotspot? Give one example.**
   The region having significant levels of biodiversity is called biodiversity hotspot. These regions serve as homes to a wide variety of organisms including many endemic species. These areas are threatened with destruction, for example, the Western Ghats.
2. **What does it mean by co-extinction?**
   When two different species are dependent on each other, extinction of one would affect the other species which results in its extinction. This is called co-extinction. For example, in host--parasite relationship, if host gets extinct it will eventually lead to the extinction of parasite also.
3. **Differentiate between *in situ* and *ex situ* conservation methods.**
   In situ conservation methods include conservation of wildlife in its natural habitat, for example, national parks, sanctuaries, etc.
   Ex situ conservation involves conservation of an organism outside its natural habitat, for example, zoological gardens, botanical gardens, etc.
4. **What is genetic diversity?**
   Genetic diversity is a kind of biodiversity, which shows diversity in number and types of genes, chromosomes present in different species or variations of genes within the same species.
5. **Write a brief note on national park with one example.**
   National park is a reserved area of land under governmental control preserved to protect its biodiversity from human exploitation. It provides special protection to single species of plants or animals that are rare, for example, Silent Valley National Park, Kerala protects lion-tailed macaques.

Threatened Species and Red Data Book

IUCN, International Union for Conservation of Nature and Natural Resources took a lead in focusing our attention towards declining and disappearing species. The names of such organisms have been given in 'Red Data Book' maintained by IUCN. 'Red' indicates stop. It includes all flora and fauna that are on the verge of extinction. According to the IUCN red list, the species are categorized in terms of their relative risk of extinction.

Extinct: Species that have totally disappeared from the earth's surface, for example, Passenger pigeon, Western black rhinoceros, Pyrenean ibex, Tasmanian tiger, etc.

FIG. 6.26 Passenger pigeon

Endangered: Species with low population numbers and that are in a state of extinction, for example, Indian tiger, snow leopard, asiatic lion, etc.

FIG. 6.27 Endangered species—Snow leopard, Indian Tiger and Asiatic lion

Vulnerable: Species that are likely to move into the endangered category, for example, yak, olive ridley turtle, asiatic lion, etc.

Rare species: Species with a small population, thinly scattered which is not yet endangered or vulnerable but are at risk, for example, blackbuck, lion-tailed macaque, etc.

FIG. 6.28 Blackbuck

Important Days in Nature Conservation

Table 6.2 List of important dates related to nature conservation

Date	Day
March 21	World Forest day
March 22	World Water day
April 22	World Earth day
June 5	World Environment Day
Oct 3	World Animal Day
Dec 3	World Conservation Day
Dec 29	Biological Diversity Day

Main Organizations Related to Conservation

Greenpeace: It is an international non-governmental organization which provides international assistance for nature conservation.

IUCN: International Union for Conservation of Nature and Natural Resources

WWF: The Worldwide Fund for nature

MAB: Man and biosphere, under UNESCO helps in establishing and maintaining biosphere reserves.

QUICK RECAP

1. **How does extinct species differ from endangered species?**

   Extinct species are organisms that have been totally disappeared from the earth's surface, for example, passenger pigeons. Endangered species are organisms whose number is decreasing and who have low population numbers. They are in a state of extinction, for example, tigers.

2. **How *ex situ* conservation differs from *in situ* conservation? Which method is suitable for the conservation of endangered species?**

   Ex situ conservation involves conserving the organisms outside their natural habitat, for example, zoological and botanical gardens.

   In situ conservation method involves, conservation of organisms in their natural habitat itself, for example, national parks, biosphere reserves, etc.

   Ex situ conservation is most suitable for conservation of endangered species.

3. **What is Red Data Book?**

   The record that keeps the list of all endangered species is called Red Data Book and it is maintained by IUCN.

POINTS TO REMEMBER

- Ecosystem is the functional unit of nature which consists of organisms and their environment.
- The ecosystem is made of components, like producers, consumers and decomposers.
- Pollution is any undesirable change in the physical, chemical and biological component of environment. It is mainly of three types, i.e., air, water and soil.
- Biodiversity is the occurrence of different types of ecosystems, different species and their interaction with other living and non-living forms.
- Biodiversity is of three types, i.e., genetic, species and ecological diversity.
- There has been a significant loss to biodiversity in recent times due to various threats, like habitat loss, overexploitation, pollution, etc.
- Wildlife refers to undomesticated species of plants and animals that are found in their natural habitats. Wildlife conservation is the practice of protecting and conserving these species in their natural habitats.
- National parks, wildlife sanctuaries and biosphere reserves come under the in situ method of wildlife conservation.
- Zoological and botanical gardens come under ex situ method of wildlife conservation.
- The Red Data Book maintained by IUCN enlists all the threatened and declining species of the world.

TEST YOUR CONCEPTS

Directions for questions 1 to 18: Fill in the blanks in each question.

1. Organisms that feed on plants are called _____.
2. Animals that cannot synthesize food and which depend on other organisms for food are called _____.
3. _____ is the functional unit of nature.
4. Microbes and insects are included in _____ factors of an ecosystem.
5. Interconnected food chains are called _____.
6. Organisms that feed on both plant and animals are _____.
7. Organisms that feed on dead and decaying matter are _____.
8. Biomagnification is also known as _____.
9. Substances that cause pollution are _____.
10. Animals that carry disease-causing microbes are called _____.
11. Kaziranga National Park protects _____.
12. Bharatpur Bird Sanctuary is an example for _____ conservation.
13. Organisms that are found only in a particular area are called _____.
14. Extinction of a parasite along with extinction of its specific host is an example of _____
15. Full form of IUCN is _____.
16. World environment day is _____.
17. Species that are likely to move into endangered category are _____.
18. Passenger pigeon is an example of _____.

Directions for questions 19 to 35: For each of the following questions, four choices have been provided. Select the correct alternative.

19. Which one of the following is a herbivore?
    (a) Man (b) Deer
    (c) Lion (d) Bear

20. The green pigment that traps solar energy during photosynthesis is
    (a) Anthocyanin (b) Carotenoid
    (c) Haemoglobin (d) Chlorophyll

21. Organisms that feed on herbivores are
    (a) Decomposers (b) Carnivores
    (c) Omnivores (d) Producers

22. In a food chain, energy flows from
    (a) Higher trophic to lower trophic levels.
    (b) From consumer to producer.
    (c) From lower trophic to higher trophic levels.
    (d) From higher to lower trophic levels and *vice versa*.

23. The amount of energy _____ from higher trophic to lower trophic levels.
    (a) Increases
    (b) Decreases
    (c) Remains the same
    (d) Cannot be predicted

24. Match the following

A. Gaseous emission	i Water pollution
B. Agricultural wastes	ii Mosquito
C. Cholera	iii. Air pollution
D. Carriers	iv Soil pollution

	A	B	C	D
(a)	i	iv	iii	ii
(b)	iii	iv	ii	i
(c)	iv	iii	i	ii
(d)	iii	iv	i	ii

25. Which one of the following is a wrong statement?
    (a) Accumulation of toxic substances increases from lower trophic to higher trophic levels.
    (b) Energy reduces as it flows from producer to consumer.
    (c) Energy reduces as it moves from lower trophic to higher trophic levels.
    (d) Energy content will be high in carnivores than herbivores in a food chain.

PRACTICE QUESTIONS

26. Desert and forest are examples of
(a) Genetic diversity
(b) Ecological diversity
(c) Habitat diversity
(d) None of the above

27. Deforestation will result in extinction of many species due to
(a) Overexploitation
(b) Co-extinction
(c) Habitat loss
(d) Introduction of exotic species

28. Lion-tailed macaques are protected in
(a) Silent Valley National Park
(b) Kaziranga National Park
(c) Bharatpur Bird Sanctuary
(d) Satpura National Park

29. Which one of the following is a correct statement?
(a) Overexploitation of species helps in increasing population number of many species.
(b) Silent Valley National Park is an example of *in situ* conservation method which conserves wildlife outside its natural habitat.
(c) Endemic species are organisms that are found only in a particular area.
(d) Biodiversity refers to genetic and species diversity only.

30. The record that includes all flora and fauna that are on the verge of extinction is
(a) Blue Data Book
(b) Red Data Book
(c) Green Data Book
(d) None of the above

31. *Ex-situ* conservation meant for protecting endangered plant species under artificial conditions is _____.
(a) Zoological garden
(b) Red Data Book
(c) Museum
(d) Botanical garden

32. Match the following.

A.	Endangered species	–	(i)	Species that are likely to move into endangered category
B.	Vulnerable species	–	(ii)	Species that have disappeared
C.	Extinct species	–	(iii)	Species that are on the verge of extinction
D.	Rare species	–	(iv)	Species that are thinly distributed

	A	B	C	D
(a)	(iii)	(ii)	(i)	(iv)
(b)	(ii)	(i)	(iii)	(iv)
(c)	(i)	(iii)	(iv)	(ii)
(d)	(iii)	(i)	(ii)	(iv)

33. Match the following

A.	World water day	(i)	June 5
B.	World animal day	(ii)	December 3
C.	World conservation day	(iii)	March 22
D.	World environment day	(iv)	October 3

	A	B	C	D
(a)	(i)	(iiii)	(i)	(iv)
(b)	(iii)	(iv)	(ii)	(i)
(c)	(iii)	(iv)	(iii)	(i)
(d)	(ii)	(i)	(iii)	(iv)

34. Write the full form WWF.

35. Biological diversity day is
(a) March 21
(b) December 29
(c) April 22
(d) June 5

PRACTICE QUESTIONS

MASTERING THE CONCEPTS

Knowledge and Understanding

1. Write a note on biomagnification and give one example.
2. What is air pollution and what are the major effects of air pollution on human beings?
3. How carnivores differ from herbivores?
4. What are the various control methods for soil pollution?
5. What are the various effects of water pollution and name any three diseases that are caused due to consumption of polluted water?
6. What are trophic levels and how energy transfer occurs from one trophic level to other?
7. How deforestation causes species extinction?
8. Explain biodiversity.
9. Define species.
10. Write a note on the significance of wildlife sanctuary.
11. Make a comparison between zoological and botanical garden
12. What are rare species?
13. How national park differs from a zoological garden?
14. What does it mean by *ex situ* conservation methods? Give two examples.

Application and Analysis

1. Producers are important for the proper functioning of an ecosystem. Justify the statement.
2. Analyze the food chain given below and answer the following questions.

   Grass → Grasshopper → Small bird → Snake → Owl

   (a) Which is the primary carnivore?
   (b) Which is the top consumer?
   (c) Which organism has the highest energy and the lowest energy content in body?
3. Write a note on various *in situ* conservation methods.
4. Describe the various threats to biodiversity.
5. How various species are classified according to their risk for existence?
6. Is humidity in atmosphere related to the functioning of biotic factors in an ecosystem?
7. In a grass-type food chain, what would be the level of a fish?
8. Why in an aquatic food chain, maximum DDT is found in fish-eating birds?
9. How can gases present in the atmosphere cause acid rain?
10. Does a group of organisms that are similar to each other but unable to reproduce form species?

PRACTICE QUESTIONS

HINTS AND EXPLANATION

TEST YOUR CONCEPTS

1. Herbivores
2. Consumers
3. Ecosystem
4. Biotic
5. Food webs
6. Omnivores
7. Decomposers
8. Bioamplification
9. Pollutants
10. Carriers
11. One-horned rhinoceros
12. *In situ*
13. Endemic species
14. Co-extinction
15. International Union for Conservation of Nature and Natural Resources
16. June 5
17. Vulnerable
18. Extinct species
19. (b)
20. (d)
21. (b)
22. (c)
23. (a)
24. (d)
25. (d)
26. (b)
27. (c)
28. (a)
29. (c)
30. (b)
31. (d)
32. (d)
33. (c)
34. Worldwide fund for nature
35. (b)

MASTERING THE CONCEPTS

Knowledge and Understanding

1. Biomagnification can be defined as the accumulation of toxic substances in the body of an organism as it moves from lower trophic to higher trophic levels through the food chain. For example, an insecticide applied to a plant accumulates in the body of a herbivore, which will in turn accumulate in the body of organisms present in the next trophic level, that is, carnivores, and in this way concentration of insecticide will be maximum in the body of organisms present at the highest trophic level.

2. Pollution of air due to introduction of harmful substances, such as smoke, dust, fumes, etc., is called air pollution. The pollutants such as poisonous gases reach the human body through respiration. This can cause breathing problems, damage to lungs and other respiratory organs.

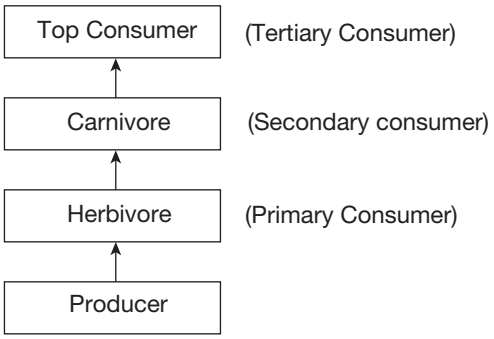
3. Herbivores feed directly on plants for energy requirements. They are present in the second trophic level of a food chain, where plants or producers constitute the first trophic level, for example, cows. Carnivores are organisms that feed on herbivores. They eat flesh of other animals. for example, tigers.

4.
   - Dumping wastes in open should be avoided.
   - Wastes should be categorized as bio-degradable and non-biodegradable.
   - Domestic waste should be dumped in a compost pit.
   - Necessary steps should be taken by municipality for waste treatment and disposal management of localities.

5. Contamination of water resources (rivers, lakes, ponds, etc.) through introduction of harmful substances is called water pollution. Drinking or using polluted water can be harmful to living things.

Bathing in polluted water can cause skin irritation, rashes, etc. Cholera, typhoid and diarrhoea spread through contaminated water.

6. The trophic level refers to the 'various steps in a food chain'. The plants or producers of an ecosystem constitute the lowest or first trophic level.



The energy synthesized by producers reaches organisms in the next trophic level or herbivores when they feed on plants. Similarly energy reaches each trophic level when organisms in one trophic level are eaten up by organisms in the next trophic level. Amount of energy decreases as it flows from lower to higher trophic levels, in other words, from producer to consumer.

7. Deforestation or ruthless cutting of trees results in loss of natural habitat of many organisms. Habitat loss is the major reason for extinction of species.

8. The occurence of a wide variety of organisms on earth is called biodiversity. Biodiversity refers to diversity in the ecosystem, species and their interaction with each other, etc.

Biodiversity is of three types:

- **Genetic diversity:** It is the diversity in number and types of genes, chromosomes present in different species or variation of genes within the same species.
- **Species diversity:** It implies to the variety in number and richness of a species in a particular region.
- **Ecological diversity:** It is the variation in ecosystems in a region. Variation can be in both terrestrial and aquatic ecosystems, for example, deserts, tropical rainforests, etc.

9. A group of organisms that have similarities in character and that can also interbreed to produce a fertile offspring.

10. Wildlife sanctuaries are a type of *in-situ* conservation methods where organisms are protected in their natural habitat. They provide protection of species from major threats, such as hunting, poaching, killing, etc. These conservation methods prevent the extinction of various species of organisms, thereby maintaining their number on earth.

11. Botanical and zoological gardens are examples for *ex situ* conservation methods where wildlife is protected outside their natural habitat.

In zoological gardens, animals are enclosed and bred in captivity. They are exhibited to public for recreational purposes, for example, Zoological Gardens in Kolkata. Botanical gardens are meant for protecting endangered plant species under artificial conditions away from their natural habitat. They are displayed for public education, recreational and scientific purposes, for example, Indian Botanical Garden, Howrah, West Bengal.

12. Species with a small population and that are thinly scattered around the world are called rare species. They are not yet endangered or vulnerable but are at risk.

13.

National park	Zoological park
In situ conservation method	*Ex situ* conservation method
Conservation in their natural habitat	Conservation outside their natural habitat
Animals (wildlife) are protected from public exploitation	Animals are exhibited to public for recreational purposes
For example, Silent Valley National Park	For example, Zoological Gardens in Kolkata

14. *Ex situ* conservation is conserving the components of an ecosystem outside its natural environment or in an artificially created environment.

Ex situ conservation includes:

Zoological gardens

Here animals are enclosed and bred in captivity. They are exhibited to public for recreational purposes, for example, Zoological Gardens in Kolkata.

Botanical Garden

It is meant for protecting endangered plant species under artificial conditions away from their natural environment. They are displayed to the public for educational, scientific and recreational purposes, for example, Indian Botanical Garden, Howrah, West Bengal.

Application and Analysis

1. Producers are the organisms that have the unique ability to produce food or energy. They produce their own food mainly through photosynthesis. Other organisms that cannot synthesize their own food depend on producers (green plants) either directly or indirectly for their energy requirements. Thus producers are the ones that make energy required by all organisms in an ecosystem.

2. (a) Primary carnivore – Small birds

   (b) Top consumer – Owl

   (c) Grass will have the highest energy as it is the producer and owl will have the lowest energy because energy level decreases as it flows from the lower trophic level to the higher trophic level.

3. *In situ* conservation includes conservation of wildlife in its natural habitat, for example, national parks, wildlife sanctuaries and biosphere reserves.

   National park: Is a reserved area of land under governmental control preserved to protect its biodiversity from human exploitation. It provides special protection to single species of plants or animals that are rare. For example, Silent Valley National Park in Kerala protects lion-tailed macaques and Kaziranga National Park in Assam protects one-horned rhinoceros.

   Sanctuary: It is a naturally occurring area such as an island that provides protection for species from hunting, predation or competition. It is a protected area, a geographic territory within which wildlife is protected. Limited human activities are allowed inside a sanctuary. For example, Bharatpur Bird Sanctuary.

   Biosphere reserve: A biosphere reserve is a special ecosystem with flora and fauna that requires protection. They are managed and studied for conserving the biodiversity present in that region and is a biodiversity hotspot region.

4. The main reasons for the loss of biodiversity have been given below:
   - **Habitat loss:** Ruthless cutting down of the trees and destruction of forest for human necessities have caused loss of habitat of many species.
   - Overe-xploitation of species, whether it is a plant or an animal, reduces its population.
   - **Invasion of foreign species:** Invasion of some other species or introduction of some new species for economic use sometimes drives away the local communities.
   - **Intensive agriculture:** Spread of agriculture to most of the grasslands, wetlands, etc., destroys the habitat of many species.
   - **Forestry:** Growing economically important trees, such as teak, sandalwood, etc., at the cost of normal forest trees drives away the local forest inhabitants.
   - **Co-extinction:** When two different species are dependent on each other, extinction of one would affect the other species which results in its extinction. This is called co-extinction. For example, in host–parasite relationship, if host gets extinct it will eventually lead to extinction of parasite also.
   - Natural calamities, such as earthquake and tsunami wipe away many species.
   - **Pollution:** Is again a major factor responsible for the removal of many species from earth as these species are unable to survive in the polluted environment.

5. **Extinct:** Species that have totally disappeared from the earth's surface, for example, passenger pigeon.

   Endangered: Species with low population numbers and are in a state of extinction, for example, Indian tigers.

   Vulnerable: Species that are likely to move into endangered category.

   Rare species: Species with a small population, thinly scattered and which are not yet endangered or vulnerable but are at risk.

6. Yes, humidity is an integral part of the functioning of the ecosystem. Humidity forms the abiotic component of an ecosystem. It is directly involved in shaping the type of vegetation in an ecosystem.

7. In a grass-type food chain, fish have no trophic level as the energy is transferred from grass to primary consumer (grasshopper), secondary consumer (frog) to tertiary consumer (snake). Fish forms part of aquatic ecosystem. Hence, they are not involved in this type of food chain.

8. DDT sprayed in fields enters the soil. From soil, it reaches the ground water and when the agri-

culture waste is dumped into water bodies, DDT enters water resources. DDT cannot get degraded biologically because of its composition and hence, it enters food chain. It is absorbed by aquatic organisms like fish. Fish, in turn, pass on DDT to the birds that prey on them. Eventually, the organisms which occupy the highest trophic level suffer the most (fish-eating birds in this case).

9. When it rains, the water reacts with the gases present in the atmosphere. This reaction of water with sulphur and nitrogen oxides results in the formation of acids viz., sulphuric and nitric acids.

10. For a group of organisms to be able to be called species, they must interbreed with each other to form fertile offspring.

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Chapter

7

Food—Production and Management

REMEMBER

Before beginning this chapter, you should be able to:

- Understand the importance of food in our life
- Remember the basics of agricultural practices
- Recall the concept of animal husbandry

KEY IDEAS

After completing this chapter, you should be able to:

- Classify crops
- Explain various agricultural practices
- Understand hybridization and genetic engineering
- Understand and describe animal husbandry

INTRODUCTION

Food is the third most basic need for life, after oxygen and water. Everyone requires food to perform normal activities of daily living. Agriculture is the practice of production of food, fibres, and other useful items by the cultivation of plants and animals. The primary objective of agriculture is the production of food. As human population has been constantly increasing, there is an increased need for food production. Rearing of animals on a large scale for fulfilling our needs for food and other products comes under animal husbandry while development of existing crop varieties to produce new varieties that are much more advanced in terms of food production and disease resistance, etc., falls under crop improvement. Animal husbandry and crop improvement programmes play a major role in increasing food production.

CROPS

Plants grown at a large scale on a piece of land are called crops. Few examples of crops are wheat, cereals, etc. Crops are usually grown to produce food at a large scale that could be sold for money in the market. Some crops are also grown as fodder crops that are used to feed the animals.

Crops can be classified into three groups according to the season in which they are cultivated.

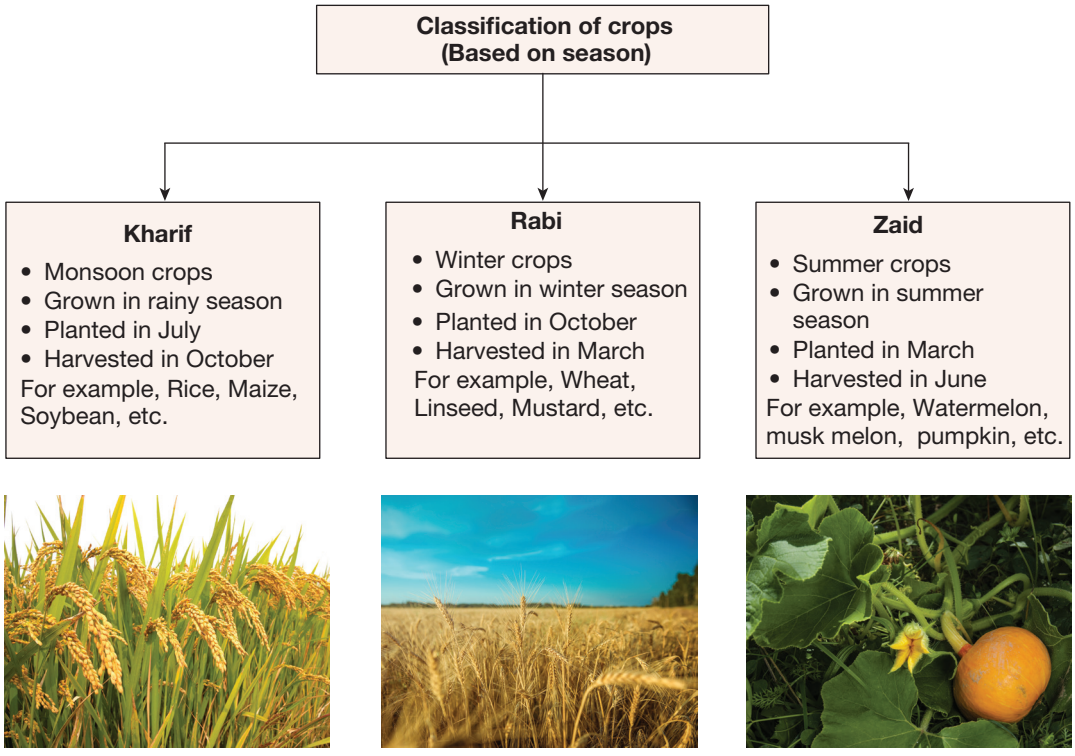


FIG. 7.1 Classification of crops on the basis of season

AGRICULTURAL PRACTICES

Various steps involved in agriculture are collectively known as agricultural practices, which include:

- Ploughing
- Sowing
- Addition of manure and fertilizer
- Irrigation
- Weeding
- Harvesting
- Storage

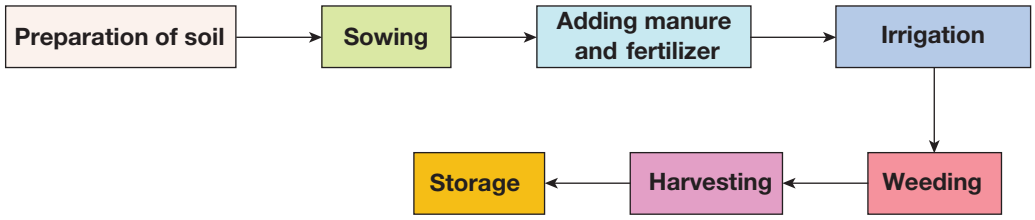


FIG. 7.2 An overview of the steps involved in cultivation of a crop

Ploughing

This is the first step in agricultural practices, which includes preparation of soil before sowing. Ploughing is done to turn or loosen the soil. The soil crumbs formed after ploughing can be broken with the help of a tool called plank. Levelling is also done after ploughing to make a uniform soil bed for sowing and irrigation. Levelling also prevents soil erosion.

FIG. 7.3 Tractor ploughing field for planting crops

Advantages of Ploughing

- It helps in bringing nutrient-rich soil to the top layer.
- It helps in removing weeds.
- It increases the growth of decomposers (microbes) and earthworms which in turn help in decomposition of plant and animal wastes.
- It helps the root to penetrate deep into the soil and allows it to breathe easily.

Tools Used for Ploughing the Field


Plough


Hoe


Cultivator

FIG. 7.4 Different tools used in ploughing

Sowing

The act of planting seeds is known as sowing. Before sowing, it has to be ensured that the seeds are of good quality. Sowing bad quality seeds or damaged seeds reduces the yield. Planting the seeds at uniform distances is also important to avoid overcrowding. This allows plants to get enough sunlight, nutrients and water.

Different methods of sowing are:

1. **Broadcasting:** It is scattering of seeds by hand.
2. **Drilling:** It is the dropping of seeds into the soil with the help of tools like seed drill.
3. **Transplanting:** In this method, seeds are grown in the nursery first and then planted into the field at seedling stage.
4. **Use of traditional tool:** In this the seeds are sowed manually by the help of funnel shaped tools.


Drilling


Transplanting


Use of traditional tool

FIG. 7.5 Different methods of sowing seeds

Addition of Manure and Fertilizers

Plants absorb nutrients from the soil. Continuous cultivation of crops at a particular piece of land reduces the soil fertility, which needs to be supplied artificially. The major nutrient-supplying sources are manures and fertilizers.

Manure: Manure is the organic matter formed by the decomposition of plant and animal wastes. Manure adds humus to the soil.

Fertilizers: Fertilizers are industrially produced chemicals that contain nutrients required by plants, for example, Nitrogen, Phosphorus, and Potassium (NPK), Urea, etc.

Table 7.1 Points of differences between manure and fertilizers

Manures	Fertilizers
Plant or animal origin	Chemically synthesized
Organic in nature	Inorganic in nature
Natural product	Artificial product
Supply all primary nutrients	Supply specific type of nutrients
Improve soil properties	Have negative effect on soil, reduce soil fertility on prolonged use

Manures and fertilizers are added to the soil to increase its fertility. However there are some natural methods to increase soil fertility. Some of them are discussed below:

Crop rotation: Growing different crops alternatively on a piece of land is called crop rotation. For example, wheat and leguminous plants could be cultivated alternatively for higher yield. Wheat requires more nitrogen from the soil. Nitrogen can be replenished naturally by cultivating legume in the next season. Leguminous plants contain a bacterium called *Rhizobium* which is located in the root nodules. These bacteria are capable of fixing atmospheric nitrogen into the soil thereby increasing the nitrogen content of the soil.

Mixed cropping: Planting two or more crops simultaneously on the same piece of land is called mixed cropping. Mixed cropping allows the crops to work together, for example, cotton and groundnut can be grown together for better yield.

Field fallowing: Leaving the land uncultivated for one or more seasons is called field fallowing. This helps the soil to replenish the nutrients on its own.

Irrigation

The artificial supply of water to the crops at regular intervals is called irrigation. Irrigation is mainly used in areas where rainfall is irregular or droughts are expected. The sources of irrigated water are numerous, like groundwater, water from springs or wells, rivers, lakes or even treated wastewater. All living organisms require water for their normal growth and functioning. Plants contain nearly 90% water. For a healthy crop, field needs to be watered regularly.

Types of Irrigation

There are different types of irrigation to supply water to the plant. It is important to water the plants as uniformly as possible, which allows the plants to get the amount of water it needs. The three different types of irrigation are:

1. **Surface irrigation:** Water moves across the surface of an agricultural field.
2. **Drip irrigation:** Water falls drop by drop at the position of roots. This can be the most efficient method of irrigation in regions with water scarcity. Water wastage is minimized by utilizing this method.

FIG. 7.6 Drip irrigation in a crop field

3. **Sprinkler irrigation:** It consists of a main pipe to which many pipes with rotating nozzles on top are attached. The nozzles rotate at regular intervals. When pressurized water flows through the main pipe, it escapes through the nozzles. Due to this, the water sprinkles on the crops and it seems as if it is raining. Sprinkled irrigation is helpful on uneven land and sandy soil.

FIG. 7.7 Sprinkler irrigation in a crop field

Weeding

The unwanted plants that grow along with crops naturally are called weeds. It is important to remove weeds as they will compete with the crops for nutrients, water, sunlight and space. The removal of weeds is called weeding. Weeding is usually done before the flowering of weeds.

Following processes are done for carrying out weeding:

- **Manual removal:** Uprooting or cutting the weeds close to the ground.

FIG. 7.8 Manual removal of weeds

- **Use of weedicides:** Chemicals used for weed control are known as weedicides, for example, 2, 4–D. They do not damage the crops.
- **Ploughing:** Ploughing helps to uproot the weeds, causing them to die.
- **Animal grazing:** Allowing animals (goats, cows) to feed on weeds.

FIG. 7.9 Weedicide being sprayed on a field

Harvesting

The process of gathering the crops after they mature to separate the useful products, such as grains is called harvesting. Separation of grains from crops includes two steps:

1. **Threshing:** Separation of grain seeds from harvested crop is called threshing. There is a machine called combine that can be used for both harvesting and threshing.
2. **Winnowing**: Separation of grains from chaff is called winnowing.

Winnowing

FIG. 7.10 Methods used in harvesting

Storage

Storage of grains after harvesting is of great importance as it will affect the yield. If they are not stored properly, there is a chance of loss of grains due to attack by insects, pests, rats or microorganisms.

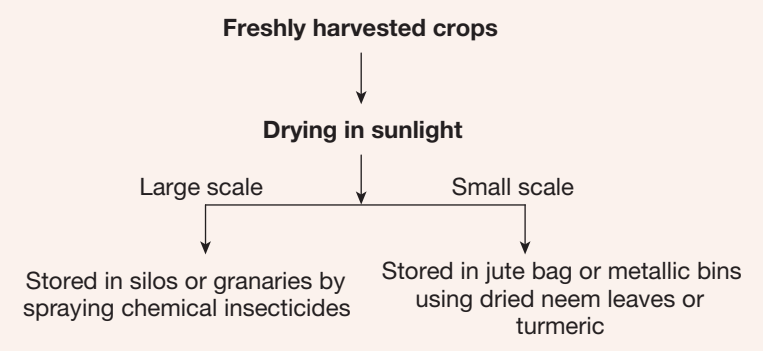


FIG. 7.11 Steps involved in storage of harvested crops

Different methods to store grains are given below:

- Before storing, grains should be dried properly in sunlight to reduce moisture content. If freshly harvested grains are stored without drying, they may get spoilt or attacked by microorganisms losing their germination capacity.
- Grains can be stored at a large scale in silos or granaries, by spraying chemical insecticides.
- On small-scale production, grains can be stored in jute bags or metallic bins. Instead of chemical insecticides, dried neem leaves or turmeric can be used to repel insects, pests, etc.

Granaries

Silos

FIG. 7.12 Large scale storage of grains

QUICK RECAP

1. What are crops and how are they classified?

Plants that are cultivated at a large scale on a piece of land are called crops. Crops can be classified into three groups according to the season in which they are cultivated.

Kharif crops: Crops that are grown in rainy seasons are called kharif crops. They are grown in the period from July to October, for example, rice, maize, etc.

Rabi crops: Crops that are grown in winter season are called rabi crops. They are usually planted in October and are harvested in March, for example, wheat, linseed, etc.

Zaid crops: Crops that are grown in summer season are called zaid crops. They are cultivated in the period of March to June, for example, watermelon, muskmelon, etc.

2. Which is the first step in agricultural practice?

Ploughing is the first step in agricultural practices. It is done to turn or loosen the soil. Ploughing can be done using tools, such as plough, hoe and cultivator.

3. Define crop rotation.

Growing different crops alternatively on a piece of land is called crop rotation. For example, wheat and leguminous plants can be cultivated alternatively for higher yield. Wheat requires more nitrogen from the soil. Nitrogen can be replenished naturally by cultivating legume in the next season. Leguminous plants contain a bacterium called *Rhizobium* in the root nodules. These bacteria are capable of fixing atmospheric nitrogen into the soil thereby increasing the soil nitrogen content.

4. Define field fallowing.

Leaving the land uncultivated for one or more seasons is called field fallowing. This helps the soil to replenish the nutrients on its own.

5. Write the difference between threshing and winnowing.

Threshing is done to separate grain seeds from harvested crop whereas winnowing is done to separate grains from chaff.

PLANT IMPROVEMENT PROGRAMMES

Plant improvement or crop improvement programmes include, production of desired plant variety that gives better yield, and possesses qualities, such as disease resistance, resistance to climatic conditions, etc.

Crop variety that has desired quality can be produced by various methods such as:

Hybridization

It is the process of crossing of two dissimilar plants. Hybridization helps to bring qualities of two parent plants together in the daughter plant. For example, Jaya and Ratna are two rice varieties that have been developed through hybridization.

FIG. 7.13 Hybrid cocoa trees

Genetic Engineering

Development of plant varieties expressing the desired agronomic characteristic is the ultimate goal of a plant breeder. Since traditional methods of plant breeding were not reliable enough and did not give satisfactory results, a new technology called genetic engineering was introduced in plant breeding. Genetic engineering is that technique which involves introduction of a gene (or DNA) that would impart the desired quality to the crop. It does not always involve inserting DNA from other organisms, plants can also be modified by switching off their own genes, to produce a particular trait.

FIG. 7.14 Developing plants through genetic engineering

ANIMAL HUSBANDRY

A branch of agriculture dealing with rearing of animals for their products is called animal husbandry. It includes dairy farming, poultry, pisciculture, etc. Domesticated animals for commercial purposes are called livestock, for example, cow, sheep, etc.

Animals are domesticated mainly for:

- **Dairy products:** Cow and goat
- **Meat:** Cattle and chicken
- **Land management:** Animal grazing to control weed growth
- **Wool:** Sheep
- **Labour:** Horse and donkey

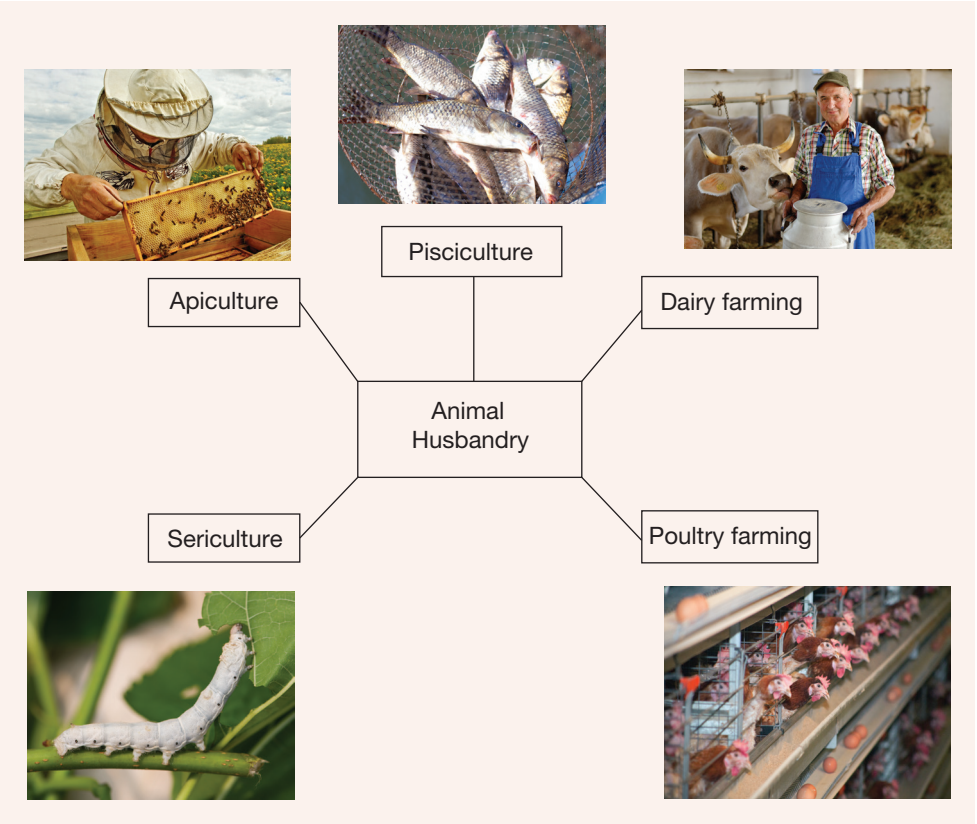


FIG. 7.15 Various divisions under animal husbandry

Dairy Farming

Management of animals for milk and milk products is called dairy farming. The main domesticated animals for dairy farming are cows, sheeps, buffaloes and goats. The yield of milk mainly depends upon the breed quality. So it is important to select breed of good quality and also breeds with disease resistance.

FIG. 7.16 Cows in a dairy farm

Following are some of the measures that can be taken to increase milk yield:

- Select good quality breed.
- Select breed with disease resistance.
- Take good care of the farm animals by maintaining proper hygiene and by providing them with good feeds.
- Maintain proper hygiene while milking, storage and transport of the milk and its products.
- Regular visits by veterinary doctor.

Poultry Farming

Domesticating birds for their products is called poultry farming, for example, domesticating chicken for their meat and eggs. Other birds that are domesticated include duck, turkey, geese, etc. Factors that affect yield in poultry farming are:

- Selection of disease-free breeds
- Proper and safe farm conditions
- Proper feed and water
- Maintenance of proper hygiene and health of farm birds

FIG. 7.17 Chickens in a poultry farm

Types of Chickens

Depending on the utility, poultry chicken are classified into two types as follows.

1. **Broilers:** Chickens that are reared for their meat are called broilers. They are given a protein-rich diet. They are reared in groups are raised in well-maintained conditions of surroundings. Once the batch is reared, the whole area is sterilized and made ready for a new batch/group.
2. **Egg-layers:** Chickens that are reared for their eggs are called egg-layers. They are bred in individual cages. They are fed on wheat and other mashed cereals. They are bred on a sloping floor such that when an egg is laid, it rolls down and easily comes out of the cage and get collected.

Sericulture

The rearing of silkworm for the production of silk is called sericulture. Sericulture is also called silk farming. Most widely used silkworm for sericulture is mulberry silkworm *Bombyx mori*.

FIG. 7.18 Silkworms feeding on mulberry leaves

Life Cycle of Bombyxmori

Bombyxmori has a short life cycle consisting of four stages described as below.

Egg stage: The female silk moth lays eggs (thousands in number). These eggs are grown under suitable environment for growth. It takes about 14 days to hatch.

Larval stage: After hatching, larva comes out of the eggs. These larvae are then placed on the mulberry leaves which are specifically cultivated for this purpose. The larvae feed on mulberry leaves.

Pupal stage: After five weeks of eating mulberry leaves, larva climbs a twig of the tree and starts spinning cocoon. Larvae secrete saliva that contains liquid form of the fibre. Larvae spins large amount of fibre around themselves forming cocoons. Inside cocoons, larvae undergo changes to form pupa.

Adult stage: Pupa grows inside the cocoon and undergoes changes. It breaks open the cocoon and emerges as an adult moth. The adult silk moths mate, lay eggs and die within a few days.

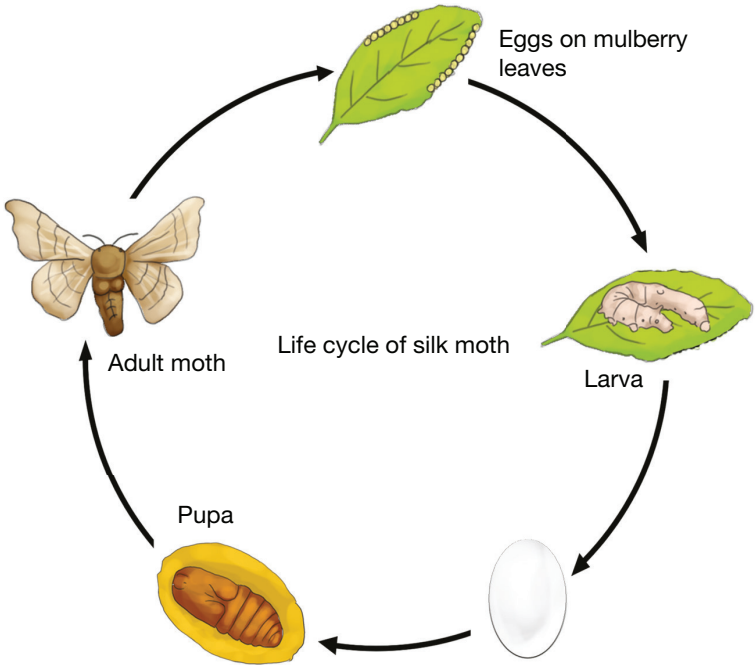


FIG. 7.19 Life cycle of silk moth

Production of Silk

Cocoons are harvested within 10 days from pupal stage before the pupa emerges. Cocoons are then put in boiling water. Pupa are killed by boiling water and the silk fibres are loosened. These fibres are then spun into silk threads. Each silk fibre processed from one cocoon produces a filament.

Apiculture

Rearing of honey bees for the production of honey and bee wax is called apiculture. Honey is a sweet, edible fluid that has important medicinal values. It contains sugars, minerals, viamins, etc. Similarly, bee wax is of great industrial importance. It has been used in many cosmetics, ointments, furniture, polishes, etc.

FIG. 7.20 Working bees on a honeycomb

Pisciculture

Pisciculture is also known as fish farming which includes rearing of fish usually for food. There are many uses of fish such as:

- **Food:** It is an excellent source of protein, vitamins, etc.
- **For controlling diseases:** There are some fish like Gambusia that can feed on mosquito larvae, thereby help in controlling disease spread by mosquito, such as malaria.

FIG. 7.21 Fishes underwater in a fish farm

Animal Breeding

The term 'breed' refers to a group of animals that are similar in most characters, such as appearance, features, size, etc. Producing improved breeds of domesticated animals is called animal breeding. The factors that are mainly considered for animal breeding are:

- Increased yield of products, such as milk, meat, egg, wool, etc.
- Increased quality of products.
- Increased resistance of animals to diseases.

Animal breeding involves artificially selecting animals of superior quality and allowing them to mate to produce progeny with improved quality.

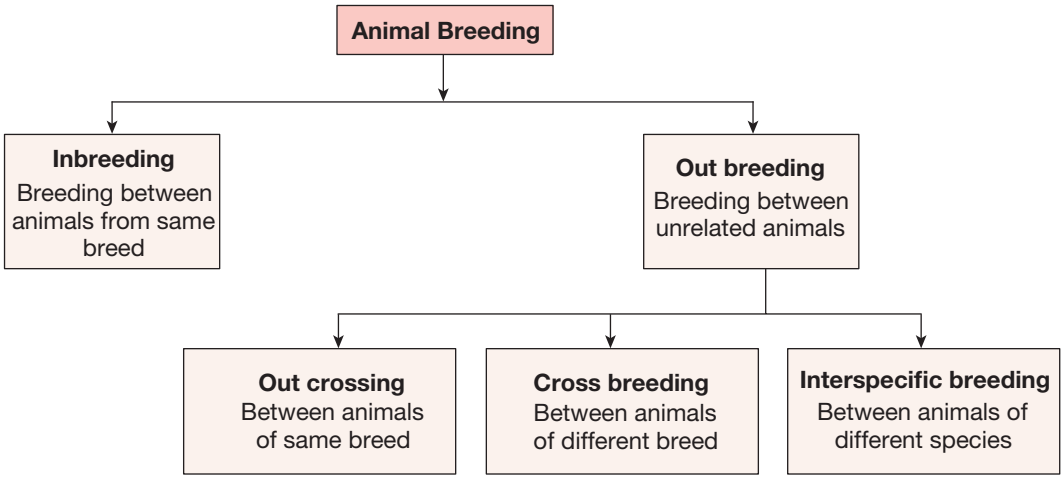


FIG. 7.22 Branches under animal breeding

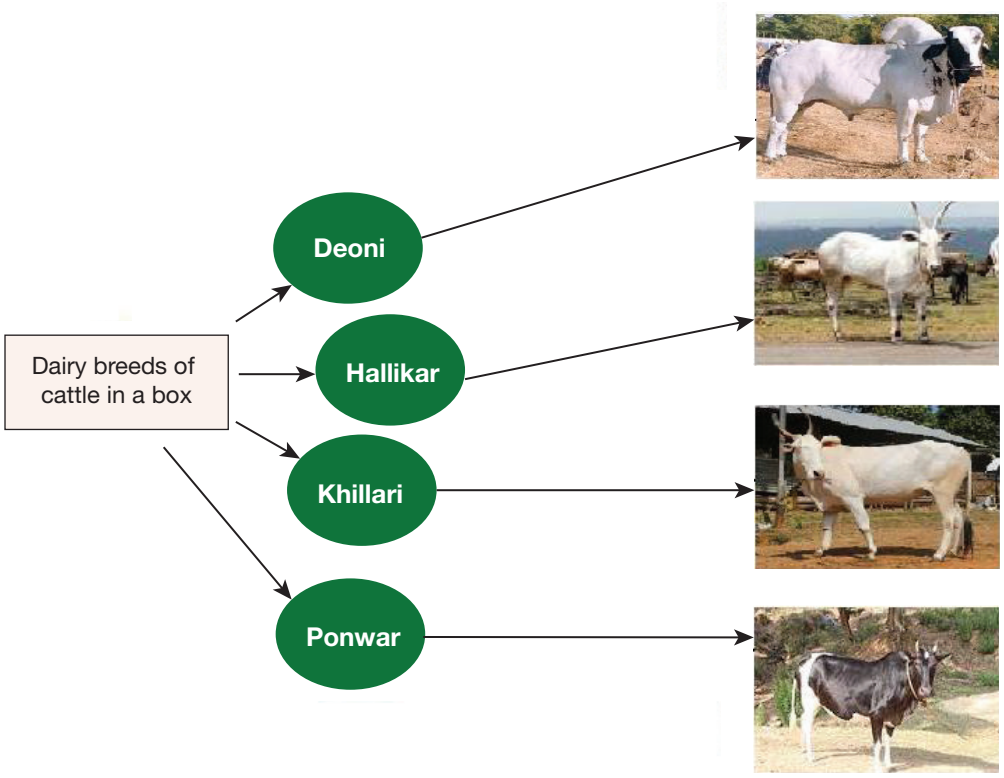


FIG. 7.23 Indigenous dairy breeds of cattle

Animal breeding can be done in various ways:

- **Inbreeding:** Involves mating of superior animals that are from the same breed, for example, in case of cattle, superior female that can yield more milk can be mated with superior male from the same breed to get progeny that has qualities of both parents.
- **Outbreeding:** Outbreeding involves breeding between unrelated animals.

Outbreeding is of three types:

1. **Outcrossing:** Breeding between unrelated animals of the same breed.
2. **Crossbreeding:** Breeding between animals of different breeds.
3. **Interspecific breeding:** Breeding between animals of different species.

Draught Animals

Draught animals are the ones that are used to carry heavy burden or pull vehicles. For example, horses, bullock, donkeys, camels, etc. These animals carry and transport people/goods from one place to another.

- Elephants are used to transport heavy items like logs of wood.
- Donkeys and camels are used for pulling carts.
- Bullocks are also used for ploughing in agricultural field.
- Horses are also used for riding for recreational purposes

FIG. 7.24 Bullock cart

Green Revolution

Green revolution refers to increased agricultural production worldwide through the development of technologies, beginning most markedly in the late 1960's. Norman Borlaug, who took the initiative, is known as 'Father of Green Revolution.' It involved the introduction of high yielding varieties of seeds, increased use of fertilizers, etc.

ANIMAL DISEASES

As humans, animals are also prone to illness and diseases caused by a number of reasons. Some of the major diseases are discussed below.

Livestock Diseases

There are various common diseases which cattle suffer from. Some of them are given below.

Disease	Symptom
Anthrax	High fever, swelling of body parts; this disease is highly infectious
Cowpox	Appearance of nodules on skin
Rinderpest	Discharge from eyes and nostrils
Foot-and-mouth disease	Blisters on mouth and feet
Black quarter	Fever, loss of appetite, difficult breathing

Poultry Diseases

The most common diseases that birds suffer from are Fowl pox and Ranikhet disease. Virus H5N1 causes avian flu and sometimes the infection passes to humans.

Silkworm Diseases

The most common disease affecting silkworms is Pebrine disease (also called pepper disease). It is caused by *Nosema bombycis* (a protozoan). Affected larvae have dots on their body and are unable to produce silk fibre. This disease mainly occurs during rainy and winter season.

Honeybee Diseases

Common diseases affecting honeybees are:

- **American Foulbrood:** It is caused by bacterium *Paenibacillus* larvae. The bacteria infects the larvae which die before becoming adults.
- **European Foulbrood:** It is caused by the bacterium *Melissococcusplutonius*.
- **Chalk Brood:** It is caused by fungus, *Ascosphaeraapis*. This disease is most prevalent in spring during which brood area is expanding

Info Box!

Run-offs of fertilizers deplete oxygen dissolved in water thereby increasing the ammonia content. As a result, fish do not get enough oxygen and their gills turn purplish. This is called ammonia poisoning.

Fish Diseases

Poor quality of water and low oxygen content cause diseases in fish. For example, Whirling disease of salmons caused by *Myxobolus cerebralis*.

USEFUL MICROORGANISMS

There are certain microorganisms which are used for manufacture or processing of different food items. There are many species of algae, bacteria and fungi which are commonly used in food industry. We shall take a look at how food production and management is done with the help of these organisms.

Algae

There are certain genera of algae which are used in cultivation and production of different food products.

Algae are a rich source of vitamins and minerals, which makes them suitable as nutritional supplements. Some species of genus *Chlorella* have more vitamins than many cultivated plants. Members of the genus *Spirulina* are rich in β-carotene vitamin B12. Hence, these genrera are used as nutritive supplements. Algae are also used as a source of natural colours. Pigments, such as chlorophylls, carotenoids and phycobiliproteins, found in algae are used as natural colourant in food industry.

Agar, obtained from red algae, is a jelly-like substance used as a medium of growth in laboratories to grow a number of microorganisms.

FIG. 7.25 Bacteria grown on agar medium in laboratory

FIG. 7.26 *Chlorella* tablets

Fungi

Various species of fungi are used in processing of food products. The most commonly used fungus is Baker's yeast, a unicellular fungus, that is used to make wheat-based products like bread. Yeasts are also used in making wine and beer by the process of fermentation. Different varieties of cheese are produced using different species of fungi. Members of the genus *Aspergillus niger* are used in production of citric acid. Fungi like mushrooms are eaten as food as they are rich in nutrients.

FIG. 7.27 Bakers' yeast is used in production of bread

FIG. 7.28 *Armillaria mellea*—edible mushroom

Bacteria

There are many bacteria that are used to process cheese, coffee and tobacco. *Acetobacter aceti* is used in production of vinegar. Members of the genus *Lactobacillus* are used in production of milk and yogurt.

QUICK RECAP

1. **Define hybridization and write its significance.**

   The process of crossing of two dissimilar plants is called hybridization. It helps in bringing qualities of two parent plants together in the daughter plant. Hybridization can be done to increase the yield by developing improved crop varieties that have disease resistance, resistance to climate conditions, etc.

2. **Differentiate between outcrossing and crossbreeding.**

   Outbreeding and crossbreeding, both are done for developing animals with superior qualities. Outcrossing involves breeding between unrelated animals of same breed whereas crossbreeding involves breeding between animals of different breeds.

3. **What is apiculture and why it is done?**

   Rearing of honey bees for honey and bee wax is called apiculture. Honey is sweet, edible fluid that has important medicinal values. It contains sugars, minerals, vitamins, etc. Similarly, bee wax is of greater industrial importance. It has been used in many cosmetics, ointments, furniture, polishes, etc.

POINTS TO REMEMBER

- Agriculture is the practice of production of food, fibre and other commercial crops.
- There are three types of crops based on the type of season they are grown in, viz., Kharif, Rabi and Zaid.
- There are a number of steps involved in agricultural practice starting from ploughing, sowing, addition of manure and fertilizer, irrigation, weeding to harvesting and storage of cultivated crops.
- Techniques like hybridization and genetic engineering have increased the crop yield manifolds and made some varieties disease resistant.
- Animal husbandry is the branch of agriculture dealing with rearing and maintenance of animals for their products.
- Animal husbandry includes sericulture, apiculture, pisciculture, poultry farming and dairy farming.
- Animal breeding involves artificial selection of animals of superior characters and their mating for increasing yield and quality of products obtained from them.
- Inbreeding and outbreeding are the two types of animal breeding.

TEST YOUR CONCEPTS

Directions for questions 1 to 15: Fill in the blanks in each question.

1. Mustard is a _____ crop.
2. Scattering the seeds by hand is called _____.
3. Organic matter formed by the decomposition of plant wastes is called _____.
4. The most efficient method of irrigation is _____.
5. The tool used to break soil crumbs is _____.
6. Zaid crops are grown in _____ season.
7. The bacterium that is capable of performing nitrogen fixation is _____.
8. Planting different crops on the same land simultaneously is called _____.
9. _____ irrigation is helpful in sandy soil.
10. Chemicals that are used to control weeds are called _____.
11. _____ is the widely used silk worm for sericulture.
12. Pisciculture involves rearing of _____.
13. Sericulture is also called _____.
14. Breeding between animals of same breed is called _____.
15. Domesticated animals for commercial purposes are called _____.

Directions for questions 16 to 38: For each of the following questions, four choices have been provided. Select the correct alternative.

16. Grains produced at a large scale can be stored in
    (a) Silos (b) Jute bags
    (c) Granaries (d) Both (a) and (c)
17. Dried leaves can be used to _____
    (a) To repel insects
    (b) To control weeds
    (c) To increase soil fertility
    (d) None of the above
18. Separation of grains from chaff is called
    (a) Threshing (b) Harvesting
    (c) Winnowing (d) Weeding
19. Identify the word--pair relationship.
    Seed drill : _____
    _____ : Breaking of soil crumbs
    Plough : _____
20. Match the following

A	2,4, D	i	Organic matter
B	Manure	ii	Transplantation
C	NPK	iii	Fertilizer
D	Sowing	iv	Weedicide

	A	B	C	D
(a)	i	ii	iii	iv
(b)	iv	ii	i	iii
(c)	i	iv	ii	iii
(d)	iv	i	iii	ii

21. Which one of the following is not a rabi crop?
    (a) Maize (b) Wheat
    (c) Linseed (d) Mustard
22. Identify the wrong statement.
    (a) Fertilizers add humus to the soil.
    (b) Manure provides all primary nutrients.
    (c) Long-term use of fertilizer reduces soil fertility.
    (d) Crop rotation avoids depletion of a particular nutrient from the soil.
23. In _____ irrigation water falls drops by drop at the position of roots.
    (a) Surface (b) Drip
    (c) Sprinkler (d) Manual
24. NPK is an example of
    (a) Weedicide (b) Manure
    (c) Fertilizer (d) Insecticide
25. Leaving the land uncultivated for one or more seasons is called
    (a) Crop rotation (b) Inter cropping
    (c) Field fallowing (d) Both (a) and (b)

PRACTICE QUESTIONS

26. **Assertion (A):** Maize is a kharif crop
Reason (R): Maize is grown in rainy season
(a) Both A and R are true and R is the correct explanation for A.
(b) Both A and R are true and R is the not the correct explanation for A.
(c) A is true and R is false
(d) A is false and R is true

27. **Assertion (A):** Leguminous plants help in increasing the soil fertility
Reason (R): Leguminous plants can perform nitrogen fixation
(a) Both A and R are true and R is the correct explanation for A.
(b) Both A and R are true and R is the not the correct explanation for A.
(c) A is true and R is false
(d) A is false and R is true

28. **Assertion (A):** Grains should be dried properly before storing.
Reason (R): Moisture content increases the chances of spoilage due to micro-organisms.
(a) Both A and R are true and R is the correct explanation for A.
(b) Both A and R are true and R is the not the correct explanation for A.
(c) A is true and R is false
(d) A is false and R is true

29. Select the wrongly matched pairs.
(a) Apiculture – Honey bee
(b) Sericulture – Fish
(c) Dairy farming – Milk
(d) Poultry farming – Meat

30. Breeding between unrelated animals of different species is called
(a) Intraspecific breeding
(b) Interspecific breeding
(c) Intergeneric breeding
(d) Crossbreeding

31. Ponwar is an example for _____ breed
(a) Chicken
(b) Foreign cow
(c) Indian cow
(d) None of the above

32. Select the mismatch
(a) *Bombyx mori* – Sericulture
(b) *Gambusia* – Pisciculture
(c) Hallikar – Poultry farming
(d) Bee wax – Cosmetics

33. Genetic engineering involves manipulation in
(a) DNA (b) RNA
(c) Gamete (d) Protein

34. Which of the following is a wrong statement?
(a) Animal grazing can be used to control weed growth.
(b) Fish farming of *Gambusia* can be used to control the spread of malaria.
(c) *Bombyx mori* is the widely used honey bee variety used for apiculture.
(d) Bee wax can be used in many cosmetics, polishes, etc.

35. Match the following

A. *Gambusia*	(i) Cow
B. Silk worm	(ii) Wool
C. Sheep	(iii) Sericulture
D. Khillari	(iv) Disease control

	A	B	C	D
(a)	(iv)	(ii)	(i)	(iii)
(b)	(ii)	(iv)	(iii)	(i)
(c)	(iii)	(ii)	(i)	(iv)
(d)	(iv)	(iii)	(ii)	(i)

36. Identify the one which is not used for dairy farming.
(a) Deoni (b) Hallikar
(c) Khillari (d) Bombyx

37. Select the correctly matched pair.
(a) Outbreeding: Breeding between related animals
(b) Crossbreeding: Inbreeding between animals of same breed
(c) Outbreeding: Breeding between unrelated animals of same breed
(d) Inbreeding: Breeding between animals of different breeds

38. Jaya and Ratna are examples of _____ varieties
(a) Maize (b) Rice
(c) Wheat (d) Barley

PRACTICE QUESTIONS

MASTERING THE CONCEPTS

Knowledge and Understanding

1. Differentiate between rabi and kharif crops.
2. Write which one is the best method for sowing and give reason.

   (a) Broadcasting (b) Drilling
3. Write the significance of ploughing.
4. Differentiate between rabi and zaid crops with one example.
5. What does it mean by mixed cropping?
6. Differentiate between manures and fertilizers.
7. Growing different crops alternatively can increase the yield. Justify the statement.
8. Write a note on sprinkler irrigation.
9. What is weeding and what are the different methods for weeding?
10. Describe the various methods to increase the yield in dairy farming.
11. What is animal breeding and what is its importance?
12. What are the main factors that affect the yield in poultry farming?
13. Compare between the various outbreeding methods.
14. Write about the significance of pisciculture.

Application and Analysis

1. Describe any one method that can increase the crop yield.
2. What kind of precautions should be taken to avoid loss during storage of grains?
3. Maintenance of proper hygiene and health can increase the yield in animal husbandry. Justify the statement.
4. Why are broilers fed protein-rich diet?
5. Generally, wheat and leguminous plants could be cultivated alternatively. Why?
6. How can water waste be minimized during irrigating the field?
7. Why our dried neem leaves or turmeric added to grains stored in jute bags?
8. Why is rice grown in the period from July to October?

TEST YOUR CONCEPTS

1. Rabi
2. Broadcasting
3. Manure
4. Drip irrigation
5. Plank
6. Summer season
7. Rhizobium
8. Mixed cropping
9. Sprinkler irrigation
10. Weedicide
11. *Bombyx mori*
12. Fish
13. Silk farming
14. Inbreeding
15. Livestock
16. (d)
17. (a)
18. (c)
19. Sowing, plank, turning and loosening the soil
20. (d)
21. (a)
22. (a)
23. (b)
24. (c)
25. (c)
26. (a)
27. (c)
28. (a)
29. (b)
30. (b)
31. (c)
32. (c)
33. (a)
34. (c)
35. (d)
36. (d)
37. (c)
38. (b)

MASTERING THE CONCEPTS

Knowledge and Understanding

1.

Kharif crops	Rabi crops
Monsoon crops	Winter crops
Grown in rainy season	Grown in winter season
Planted in July	Planted in October
Harvesting in October	Harvesting in March
For example, rice and maize	For example, wheat and linseed

2. Sowing using seed drill is more appropriate as it helps in planting the seeds in uniform depth and distance. Sowing seeds at uniform distance prevents overcrowding and sowing seeds at appropriate depth reduces the damage caused by birds.
3. Ploughing is done to turn or loosen the soil and this is the first step followed in agricultural practices. Advantages of ploughing are:
   - Helps in bringing nutrient-rich soil to the top layer.
   - Helps in removing weeds.
   - Increases the growth of decomposers (microbes) and earthworms which in turn help in decomposition of plant and animal wastes.
   - Helps the root to penetrate deep into the soil and allows it to breathe easily.

4.

Rabi crops	Zaid crops
Winter crops	Summer crops
Grown in winter season	Grown in summer season
Planted in October	Planted in March
Harvested in March	Harvested in June
For example, wheat, linseed, mustard, etc.	For example, watermelon, musk melon, etc.

5. Planting two or more crops simultaneously on the same piece of land is called mixed cropping. Mixed cropping allows the crops to work together, for example, cotton and groundnut can be grown together for better yield.

6. Manure is the organic matter formed by the decomposition of plants and animal wastes whereas fertilizers are industrially produced chemicals. The main differences are given below:

Manures	Fertilizers
Plant or animal origin	Chemically synthesized
Organic in nature	Inorganic in nature
Natural product	Artificial product
Supply all primary nutrients	Supply specific types of nutrients
Improve soil properties	Have negative effect on soil and reduce soil fertility

7. Growing different crops alternatively on a piece of land is called crop rotation. For example, wheat and leguminous plants could be cultivated alternatively for higher yield. Wheat requires more nitrogen from the soil. Nitrogen can be replenished naturally by cultivating legume in the next season. Leguminous plants contain a bacterium called '*Rhizobium*' which is located in the root nodules. These bacteria are capable of fixing atmospheric nitrogen into the soil thereby increasing the nitrogen content of the soil.

8. It consists of a main pipe to which many pipes with rotating nozzles on top are attached. The nozzles rotate at regular intervals. When pressurized water flows through the main pipe, it escapes through the nozzles. Due to this, the water sprinkles on the crops and it seems as if it is raining. Sprinkled irrigation is helpful on uneven land and sandy soil.

9. The removal of weeds from the field is called weeding. It is important to remove weeds as they will compete with the crops for nutrients, water, sunlight and space.

Methods of weeding:

- *Manual removal*: Uprooting or cutting the weeds close to the ground.
- *Use of weedicides:* Chemicals used for weed control are known as weedicides, for example, 2, 4–D. They do not damage the crops.
- *Ploughing:* Ploughing helps in uprooting the weeds, causing them to die.
- *Animal grazing:* Allowing animals (goats, cows) to feed on weeds.

10. Management of animals for milk and milk products is called dairy farming. The animals that are mainly domesticated are—cows, sheeps, buffaloes and goats.

The yield can be increased by the following methods:

- Select good quality breed.
- Select breed with disease resistance.
- Take good care of the farm animals by maintaining proper hygiene and by providing them with good feed.
- Maintain proper hygiene while milking, storage and transport of the milk and its products.
- Regular visits by veterinary doctor.

11. Producing improved breeds of domesticated animals are called animal breeding. Animal breeding is done to develop improved animal varieties that have superior qualities, such as disease resistance, improved yield, improved product quality, etc.

12. Factors that affect yield in poultry farming are:

- Selection of disease-free breeds
- Proper and safe farm conditions
- Proper feed and water
- Maintenance of proper hygiene and health of farm birds

13. Breeding between unrelated animals is called outbreeding. It can be done in three ways: Outcrossing, crossbreeding and interspecific breeding.

Outcrossing	Crossbreeding	Interspecific breeding
Breeding between animals of same breed	Breeding between animals of different breeds	Breeding between animals of different species

14. Rearing of fish or fish farming is called pisciculture. It is mainly done for two purposes:
    - Food – as they are excellent source of protein, vitamin, etc.
    - Farming of fish such as Gambusia is also done as it can feed on mosquito larva and thus can control diseases spread by mosquitoes.

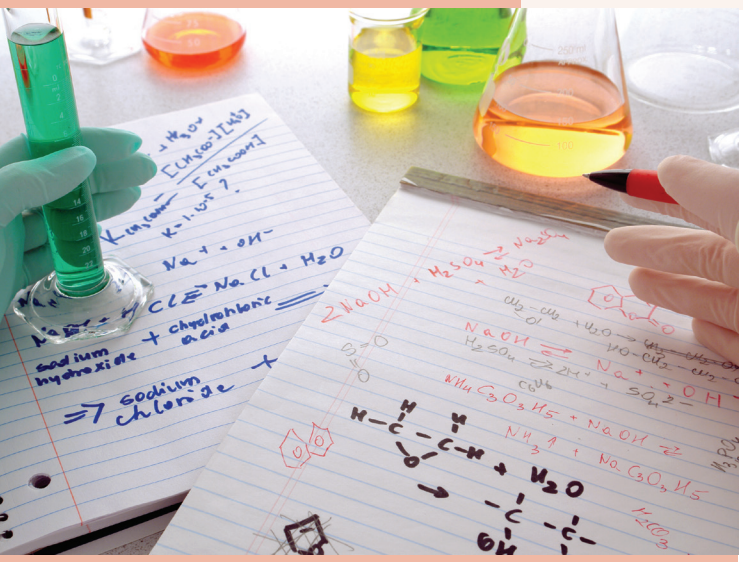
Application and Analysis

1. Crop rotation is a method for naturally replenishing nutrients in the soil. It involves growing different crops alternatively.

   For example, wheat and leguminous plants could be cultivated alternatively for higher yield. Wheat requires more nitrogen from the soil. Nitrogen can be replenished naturally by cultivating legume in the next season. Leguminous plants contain a bacterium called *Rhizobium* which is located in the root nodules. These bacteria are capable of fixing atmospheric nitrogen into the soil thereby increasing the nitrogen content of the soil.
2. Storage of grains after harvesting is of great importance as it will affect the yield. If the grains are not stored properly, there is a chance of their loss due to attack by insects, pests, rats or microorganisms. Before storing, grains should be dried properly in the sunlight to reduce moisture content. If freshly harvested grains are stored without drying, they may get spoilt or attacked by microorganisms losing their germination capacity. Insecticides are also utilized to repel insects while storing. Chemical insecticides are used while storing grains in silos or granaries. Insecticides of biological origin such as turmeric or neem leaves can be used in small-scale storages, such as storage in jute bags or metallic bins. Suitable temperature and hygienic conditions are also maintained in storage areas.
3. Maintenance of proper hygiene will help to keep the animals healthy and disease free. It will help to reduce mortality rate. Proper hygiene in the housing, product transport facilities, etc. will in turn increase the quality of products.
4. Broilers are raised for meat production. Hence, they are given protein-rich diet so that they are grown healthy. They are grown to suitable health and size to produce a quality product for the consumers.
5. Wheat and leguminous plants could be cultivated alternatively for higher yield. Wheat requires more nitrogen from the soil. Nitrogen can be replenished naturally by cultivating legume in the next season. Leguminous plants contain a bacterium called *Rhizobium* which is located in the root nodules. These bacteria are capable of fixing atmospheric nitrogen into the soil thereby increasing the nitrogen content of the soil.
6. Water waste can be minimized during irrigating the field by drip irrigation. Water falls drop-by-drop at the position of roots. This can be the most efficient method of irrigation in regions with water scarcity. Water wastage is minimized by utilizing this method.
7. Dried neem leaves or turmeric can be used to repel insects, pests, etc., which could harm the stored grains.
8. To grow under optimal condition, rice requires rainy season. As it is a Kharif crop, it is rice grown in the period from July to October.

Supplement Reading

Scope of Science



REMEMBER

Before beginning this chapter, you should be able to:

- Recall the basic disciplines of science
- Understand the importance of science in everyday phenomena

KEY IDEAS

After completing this chapter, you should be able to:

- Define science and know its branches
- Describe the techniques involved in a scientific methodology
- Apply scientific phenomena in everyday life

INTRODUCTION

From the time Humans came on earth, they were fascinated and curious about the natural phenomena happening in the world (like the formation of a rainbow, birth of a child, changes in the weather, etc.). People since time immemorial had been attempting to understand and explain the world around them with all its processes and mechanisms. So, to cater to all these queries and curiosity of mankind a specific branch of study developed called science. Science was an approach to understand and explain the immediate world around us.

SCIENCE

The English term 'science' has been derived from the Latin term 'scientia' meaning 'knowledge'. It involves the study of natural world and how it works, by observing and experimenting. It is a tool for searching and exploring the nature.

Branches of Science

Science is divided into many branches according to the area of study such as:

- **Natural science:** Study of natural phenomenon (biological science, physical science, etc.)
- **Social science:** Study of human behaviour and societies
- **Applied science:** Applies scientific knowledge to develop technologies (e.g., engineering, medicine, etc.)
- **Formal science:** Concerned with logic, mathematics, etc.

How do Scientists Work?

A person engaged in observing and experimenting to gain knowledge about nature is called scientist. Scientists follow a specific way for their innovations and this is called scientific method. Scientific method involves a series of techniques such as:

- Observation
- Asking questions
- Making hypotheses
- Experimentation
- Data analysis and making conclusions
- Communicating the results

Observation

Observation involves receiving knowledge about a natural phenomenon through our senses and recording the questions that we would like to answer.

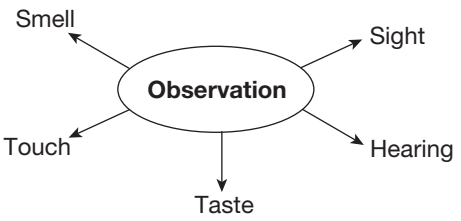


FIG. S.1 Means through which observations can be made

Asking Questions

After making an interesting observation, a scientific mind will be more curious to know about it. And this curiosity would lead to asking questions, like what, why, how, when and where?

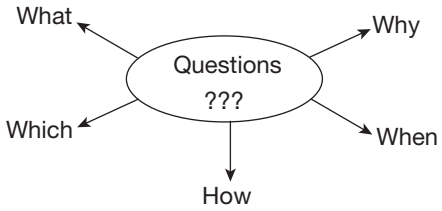


FIG. S.2 Types of questions asked after making an observation

Hypothesis

A hypothesis is a proposed explanation (guess) about a phenomenon on the basis of evidences as a starting for further investigation. It is provisionally accepted and provides guidance for further investigations, to find out the possible solutions for the problem you observed.

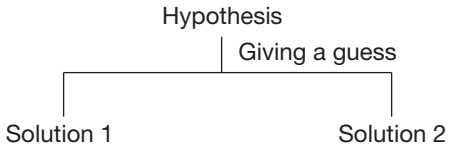


FIG. S.3 Possible explanations for a hypothesis

Experimentation

To conduct experiments is one of the most important steps in the scientific method. It involves testing of hypotheses made on the basis of observations. Experiments help in proving whether hypothesis is right or wrong and also to formulate scientific theories.

FIG. S.4 A student performing experiment in chemistry lab

Data Analysis and Conclusion

Results or data obtained after several trials of experiment are analyzed thoroughly. With this, we come to a conclusion to know whether the hypothesis is right or wrong. If the experiment results prove hypothesis, then the original question is answered otherwise the research continues, forming new hypothesis and then conducting an experiment to test it.

Communicate Results

This step involves reporting the results of experiments to let others know about it. The results could be presented as written reports or oral reports. Communicating the results among peers may lead to a new question which may in turn lead to another investigation.

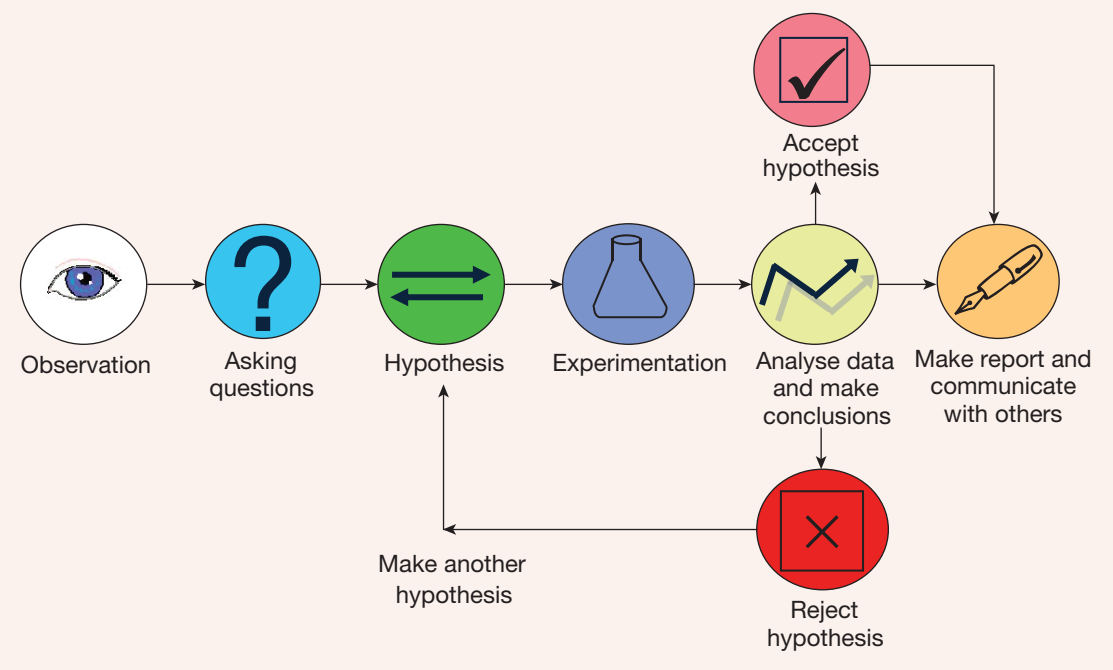


FIG. S.5 Series of techniques followed in a scientific method

Work of a Scientist: An Example

The methodology followed by scientists while working on any hypothesis is explained in the following steps.

- When you place a plant near a window, after a few days, you can observe that the plant bends towards the window.
  - This phenomenon makes you curious and you start asking questions like:
    - Why did the plant bend?
    - What is this phenomenon?
- Based on the observation, you make a hypothesis about the possible reasons for this, such as:
  - Plant bends to get enough air.
    or
  - Plant bends to get sunlight
- Experiments were conducted to prove this, by placing the plants in different surroundings and it was observed that in all the experiments, plant was bending towards the light source.

- You analysed your data and came to a conclusion that it was sunlight that made the plant to bend towards the window. And also, you found that all plants show these kinds of movements in which they bend towards the light source.
- After getting a proper conclusion you then make a report and present it, so that others will get to know about it.

Famous Scientists and their Contributions

The world has witnessed some very great scientists since the historic times who have made a huge impact on our understanding and reasoning of scientific phenomena. A few of these great scientists are mentioned in this section along with their contributions.

Table S.1 Some famous scientists and their important contributions

Name	Year	Country	Contribution
Aristotle	(384–322 BC)	Ancient Greek philosopher and scientist	One of the earliest scientists to classify living organisms
Charles Darwin	(1809–1882)	English naturalist, geologist and biologist	Developed theories of evolution
Gregor Mendel	(1822–1884)	Founder of modern science of genetics	Developed laws of inheritance
James Watson	(b. 1928)	Molecular biologist, zoologist	One of the codiscoverers of the DNA structure.
Robert Hooke	(1635–1703)	English natural philosopher	Discovered cell
Sir Isaac Newton	(1643–1727)	English physicist and mathematician	Formulated laws of motion and universal gravitation
Vikram Sarabhai	(1919–1971)	Indian scientist	Widely regarded as the father of India's space programme.
Albert Einstein	(1879–1955)	Physicist	Contribution to modern physics and best known for the formula E = mc2
Thomas Alva Edison	(1847–1931)	American inventor	Developed devices including motion picture camera, electric light bulb, etc.
CV Raman	(1888–1970)	Indian physicist	Carried out groundbreaking work in the field of light scattering
Dmitri Ivanovich Mendeleev	(1834–1907)	Russian chemist	Formulated periodic law and created periodic table of elements.
Srinivasa Ramanujan	(1887–1920)	Indian mathematician	Made substantial contributions to mathematical analysis number theory, infinite series

SCIENCE IN EVERYDAY LIFE

Almost everything that makes our life easy is the outcome of science and scientific studies. It is impossible to lead a life without science and its innovations. Science has gifted us with innovations such as:

Info Box!

The first ever email was sent in 1971.

The Internet took four years to reach its first 50 Million Users.

- **It makes communication easy:** Science has made the communication possible and easy even if we are far away. Major inventions in this field include mobile phones, internet, etc.
- **Helps us to find cure for many diseases:** Through science and its innovations, we have found cure for millions of diseases. It has also become possible to prevent some diseases through methods like vaccinations. Doctors are able to view inside the body with the help of various techniques, such as x-rays, MRI scans, etc., and all of these are a result of science and innovations.
- **Helps us to reduce the work load:** Most of the work in everyday life can be done using machines. Starting from using a calculator for simple calculations to a washing machine for washing, everything is a product of science.
- **Makes our transportation easy:** With the inventions of vehicles, it made our transportation easy. After the invention of aeroplanes, it became possible for us to travel around the world in less time.

SCIENCE FOR HUMAN WELFARE

The ultimate aim of science is human welfare. It has made our life comfortable. It has provided us with many amenities of life. Science has made our life better than what it was in the past.

Table S.2 List of agricultural revolutions

Type of revolution	Goal
Green Revolution	Food grain production
White Revolution	Milk Production
Black Revolution	Petroleum Production
Blue Revolution	Fish Production
Silver Revolution	Egg/Poultry Production

Info Box!

Dr. Norman Borlaug is known as the 'Father of Green Revolution' and Dr. M.S.Swaminathan is the 'Father of Indian Green Revolution'.

- Now we are able to produce more food to meet the requirements of world through developments in agriculture, such as green revolution, blue revolution, white revolution, etc.
- We are able to travel across the world by land, air and water.
- It is possible for us to dress better than our forefathers.
- We live in a better, safe place than in the past. Our houses, villages, town everything has improved through science.
- Science has also increased the lifespan of individuals through inventions in the medical field.
- Science has made us capable of surviving natural calamities to a great extent.
- In fact all the basic requirements of life are now fulfilled by science and its innovations.

FUTURE OF SCIENCE

Researches in science are going on to explore the hidden truths about the world. New technologies and tools provide new ways to discoveries. The main goal of all these studies is to make the life comfortable on earth. Even research is going on to find out whether life is possible in other planets, such as mars. Through science we aim for a better future, keeping in mind the studies should not harm the environment we live in and also it should not cause harm to the human race and other life forms.

QUICK RECAP

1. What is science? What are the main branches?

Science involves the study of natural world and how it works. It is a tool for searching and exploring the nature by observing and experimenting. The various branches according to the area of study are:

- **Natural science:** Study of natural phenomenon (biological science, physical science, etc.)
- **Social science:** Study of human behaviour and societies
- **Applied science:** Applies scientific knowledge to develop technologies (e.g., engineering, medicine, etc.)
- **Formal science:** Concerned with logics, mathematics, etc.

2. What does it mean by a hypothesis?

A hypothesis is a proposed explanation (guess) about a phenomenon on the basis of evidences. It is the initial stage of investigation. It is provisionally accepted and provides guidance for further investigations, to find out the possible solutions of the problems you observed.

POINTS TO REMEMBER

- Science involves the study of the natural world through observation and experimentation.
- A scientific method involves a series of techniques to create an innovation.
- The world has seen many great scientists, like Darwin and Newton whose discoveries have made a huge contribution in improving the life on this planet.
- Science have made our life much easy by its many inventions, like mobile phones, MRI scans, trains, etc.
- Still further researches are going on to make our lives better by more advanced technologies.

PRACTICE QUESTIONS

TEST YOUR CONCEPTS

Directions for questions 1 to 5: Fill in the blanks in each question.

1. The scientist who introduced the formula $E = mc^2$ is _____.
2. Cell was discovered by _____.
3. The proposed explanation or guess for the possible solution for a problem observed is _____.
4. The first step in a scientific study is _____.
5. Study of human behaviour and societies comes under _____ branch of science.

Directions for questions 6 to 11: For each of the following questions, four choices have been provided. Select the correct alternative.

6. The branch of science related to developing technologies is
   (a) Formal science (b) Natural science
   (c) Social science (d) Applied science
7. Observation involves
   (a) Observing a natural phenomenon
   (b) Recording the questions to be solved.
   (c) Asking questions about the observed phenomenon
   (d) Both (a) and (b)
8. Match the following

A	Gregor Mendel	i	Laws of motion
B	Mendeleev	ii	Indian physicist
C	CV Raman	iii	Laws of inheritance
D	Sir Isaac Newton	iv	Periodic table

	A	B	C	D
(a)	iv	i	ii	iii
(b)	iii	ii	i	iv
(c)	iv	iii	ii	i
(d)	iii	iv	ii	i

9. Which one of the following is a wrong statement?
   (a) Science has made our communication easy.
   (b) Green revolution and blue revolution are revolutions that have happened in IT industry.
   (c) Thomas Alva Edison invented electric bulb.
   (d) Vikram Sarabhai is considered as a father of Indian space programme.
10. Indian mathematician who contributed to number theory is
    (a) Vikram Sarabhai
    (b) CV Raman
    (c) Gregor Mendel
    (d) Srinivasa Ramanujan
11. Complete the table with the name of scientist or his contribution accordingly.

Scientist	Contribution
_____	Motion picture camera
Dimitri Ivanovich Mendeleev	_____
_____	Infinite series
Albert Einstein	_____
_____	Universal gravitation
Charles Darwin	_____
_____	DNA structure

MASTERING THE CONCEPTS

Knowledge and Understanding

1. Write a note on various advantages of science in everyday life.
2. Which is the last step in a scientific method?
3. Name any three scientists from India and their contributions.
4. Explain how scientists work with one suitable example.

TEST YOUR CONCEPTS

1. Albert Einstein
2. Robert Hooke
3. Hypothesis
4. Observation
5. Social science
6. (d)
7. (d)
8. (d)
9. (b)
10. (d)
11.

Scientist	Contribution
Thomas Alva Edison	Motion picture camera
Dmitri Ivanovich Mendeleev	Periodic table and periodic law
Srinivasa Ramanujan	Infinite series
Albert Einstein	$E = mc^2$
Sir Isaac Newton	Universal gravitation
Charles Darwin	Theories of evolution
James Watson	DNA structure

MASTERING THE CONCEPTS

Knowledge and Understanding

1. Science plays a major role in everyday life. It has made our communication easy, even if we are at far away places. It has also made our transportation easy and comfortable. Through science, it is now possible to treat millions of diseases, thereby increasing the lifespan of people.
2. Communicating the results obtained after data analysis to let others know about it is the last step in a scientific method. The results can be presented as written or oral reports. Communicating the results to peers may lead to new questions every time which may in turn lead to another investigation.
3. **Vikram Sarabhai:** Father of India's space programme.

   Srinivasa Ramanujan: Indian mathematician who made major contributions to number theory, infinite series, etc.

   CV Raman: Indian physicist who carried out major work in the field of light scattering.
4. Scientists follow a specific pathway for their innovations, which is known as a scientific method. It involves a series of techniques such as:
   - Observation
   - Asking questions
   - Making hypothesis
   - Experimentation
   - Data analysis and making conclusions
   - Communicating the results to others

   Example:
   - Ram tried to germinate pea seed in water. He observed that pea seed did not germinate.
   - He made hypothesis for the possible reasons behind this.
     - Hypothesis I—pea seeds do not require water for germination
     - Hypothesis II—pea seeds require air for germination
     - Hypothesis III—pea seeds require adequate amount of both water and air for germination.
   - He conducted experiments to prove his hypotheses. He tried to germinate pea seeds in three different conditions.
     - Exp I—placing pea seeds completely in water without air for germination.
     - Exp II—placing pea seeds in a plate without water and provided only air for germination.
     - Exp III—pea seeds are provided with both water and air in sufficient amount.
   - The result obtained were
     - Exp I—no seed germination
     - Exp II—no seed germination
     - Exp III—Seed germinated
   - He analyzed the experiment results and made conclusion that pea seeds require both air and water for germination.

HINTS AND EXPLANATION

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