

# Table of Contents

Unit	Title	Page No	Month
1	Measurement	1	June
2	Motion	14	July
3	Fluids	26	August
4	Electric charge and Electric current	39	October
5	Magnetism and Electromagnetism	52	November
6	Light	66	December
7	Heat	80	January
8	Sound	91	February
9	Universe	102	March
10	Matter Around Us	113	June
11	Atomic Structure	125	July
12	Periodic Classification of Elements	138	August
13	Chemical Bonding	148	October
14	Acids, Bases and Salts	162	November
15	Carbon and its Compounds	172	January
16	Applied Chemistry	185	February
17	Animal Kingdom	199	June
18	Organisation of Tissues	210	July
19	Plant Physiology	226	August
20	Organ Systems in Animals	233	October
21	Nutrition and Health	247	November
22	World of Microbes	258	November
23	Economic Biology	273	January
24	Environmental Science	290	February
25	Computer - LibreOffice Impress	302	September
	Practicals	309	
	Glossary	318	



E - book



Assessment



DIGI links

## UNIT

## 17

## ANIMAL KINGDOM

 Learning Objectives


After completing this lesson, students will be able to:

- understand the classification of animal kingdom.
- identify and study the different groups of animals.
- list out the general characteristics of animals based on grades of organization, types of symmetry, coelom and various body activity.
- recognize that binomial classification has Latin and Greek words.
- identify the first name as genus and second name as species.
- recall the salient features of each phylum.

### Introduction

The variety of living organisms surrounding us is incomprehensible. Nearly 1.5 million species of organism which have been described are different from one another. The uniqueness is due to the diversity in the life forms whether it is microbes, plants or animals. Every organism exhibits variation in their external appearance, internal structure and behavior, mode of living etc. This versatile nature among the living animals forms the basis of diversity. The diversity among the living organisms can be studied in an effective way by arranging animals in an orderly and systematic manner. The study of various organisms would be difficult without a suitable method of classification.

The method of arranging organism into groups on the basis of similarities and differences is called **classification**. Taxonomy is the science of classification which makes the study of wide variety of organisms easier. It helps us to

understand the relationship among different group of animals. The first systematic approach to the classification of living organisms was made by a Swedish botanist, Carolus Linnaeus. He generated the standard system for naming organisms in terms of genus, species and more extensive groupings using Latin terms.

### 17.1 Classification of Living Organisms

Classification is the ordering of organism into groups on the basis of their similarities, dissimilarities and relationships. The five kingdom classification are Monera, Protista, Fungi, Plantae and Animalia. These groups are formed based on cell structure, mode of nutrition, body organization and reproduction. On the basis of hierarchy of classification, the organisms are separated into smaller and smaller groups which form the basic unit of classification.

**Species:** It is the lowest taxonomic category. For example, the large Indian parakeet (*Psittacula eupatra*) and the green parrot (*Psittacula krameri*) are two different species of birds. They belong to different species *eupatra* and *krameri* and cannot interbreed.

**Genus:** It is a group of closely related species which constitute the next higher category called genus. For example, the Indian wolf (*Canis pallipes*) and the Indian jackal (*Canis aureus*) are placed in the same genus *Canis*.

**Family:** A group of genera with several common characters form a family. For example, leopard, tiger and cat share some common characteristics and belong to the larger cat family *Felidae*.

**Order:** A number of related families having common characters are placed in an order. Monkeys, baboons, apes and Man although belong to different families, are placed in the same order Primates. Since all these animals possess some common features, they are placed in the same order.

**Class:** Related or similar orders together form a class. The orders of different animals like those of rabbit, rat, bats, whales, chimpanzee and human share some common features such as the presence of skin and mammary glands. Hence, they are placed in class Mammalia.

**Phylum:** Classes which are related with one another constitute a phylum. The classes of different animals like mammals, birds, reptiles, frogs and fishes constitute Phylum Chordata which have a notochord or back bone.

**Kingdom:** It is the highest category and the largest division to which microorganisms, plants and animals belong to. Each kingdom is fundamentally different from one another, but has the same fundamental characteristics in all organisms grouped under that Kingdom.

The taxa of living organisms are in a hierarchy of categories as follows.

**Kingdom**  
**Phylum**  
**Class**  
**Order**  
**Family**  
**Genus**  
**Species**

### 17.1.1 Basis for Classification

We can divide the Animal kingdom based on the level of organization (arrangement of cells), body symmetry, germ layers and nature of coelom.

**Level of organization:** Animals are grouped as unicellular or multicellular based on cell, tissue, organ and organ system level of organization

**Symmetry:** It is a plane of arrangement of body parts. Radial symmetry and bilateral symmetry are the two types of symmetry. In radial symmetry the body parts are arranged around the central axis. If the animal is cut through the central axis in any direction, it can be divided into similar halves. e.g. Hydra, jelly fish and star fish. In bilateral symmetry, the body parts are arranged along a central axis. If the animal is cut through the central axis, we get two identical halves e.g. Frog.

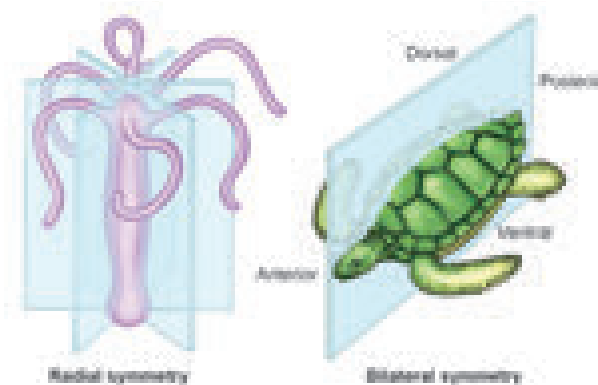
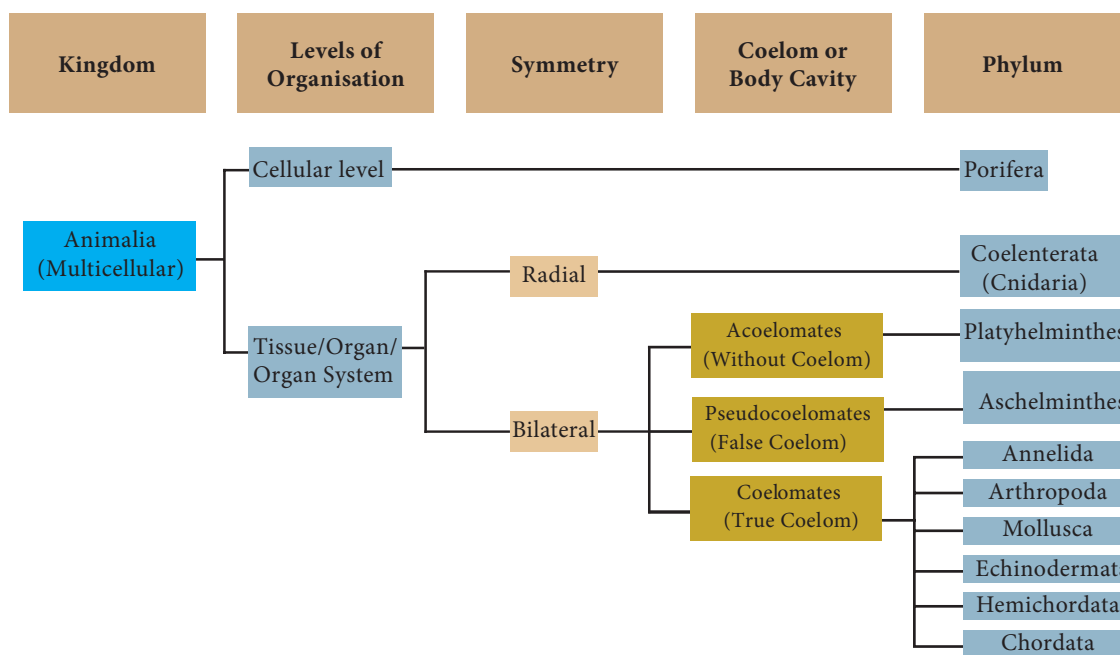


Figure 17.1 Radial and Bilateral Symmetry

**Germ layers:** Germ layers are formed during the development of an embryo. These layers give rise to different organs, as the embryo becomes an adult.

Organisms with two germ layers, the ectoderm and the endoderm are called

**Classification of kingdom Animalia based on fundamental features**



**diploblastic** animals. e.g Hydra. Organisms with three germ layers, ectoderm, mesoderm and endoderm are called **triploblastic** animals. e.g Rabbit

**Coelom:** It is a fluid-filled body cavity. It separates the digestive tract from the body wall. A true body cavity or coelom is one that is located within the mesoderm. Based on the nature of the coelom, animals are divided into 3 groups.

1. Acoelomates do not have a body cavity e.g Tapeworm.
2. Pseudocoelomates have a false body cavity e.g Roundworm.
3. Coelomates or Eucoelomates have a true coelom e.g Earthworm, Frog.

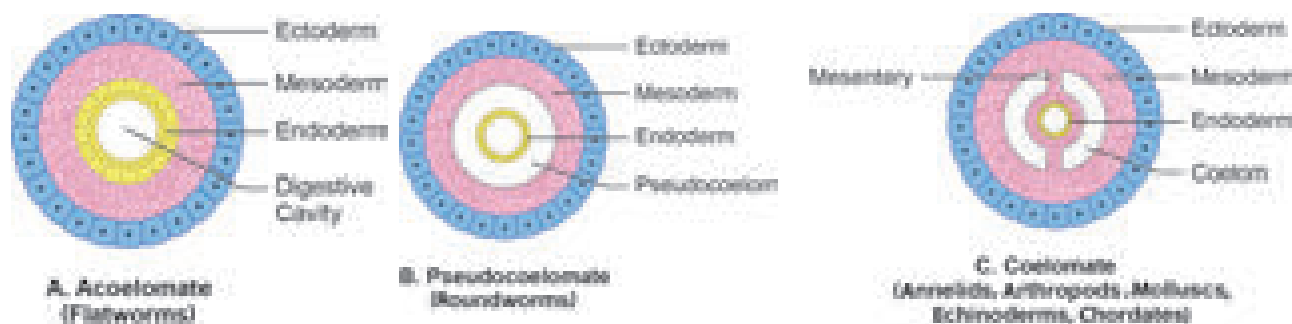
Animal Kingdom is further divided into two groups based on the presence or absence of notochord as below.

1. Invertebrata
2. Chordata-Prochordata and Vertebrata

Animals which do not possess notochord are called as **Invertebrates** or **Non- chordates**. Animals which possess notochord or backbone are called as **Chordates**. You have already studied the characters of single celled protozoans.

**More to Know**

**Notochord** is a rod like structure formed on the mid-dorsal side of the body during embryonic development. Except primitive forms in which the notochord persists throughout life in all other animals it is replaced by a backbone.



**Figure 17.2** Types of Coelom

### 17.1.2 Binomial Nomenclature

Carolus Linnaeus introduced the method of naming the animals with two names known as binomial nomenclature. The first name is called **genus** and the first letter of genus is denoted in capital and the second one is the **species** name denoted in small letter. The binomial names of some common animals are as follows.

Common name	Binomial name
Amoeba	<i>Amoeba proteus</i>
Hydra	<i>Hydra vulgaris</i>
Tapeworm	<i>Taenia solium</i>
Roundworm	<i>Ascaris lumbricoides</i>
Earthworm	<i>Lampito mauritii</i> / <i>Perionyx excavatus</i>
Leech	<i>Hirudinaria granulosa</i>
Cockroach	<i>Periplaneta americana</i>
Snail	<i>Pila globosa</i>
Star fish	<i>Asterias rubens</i>
Frog	<i>Rana hexadactyla</i>
Wall lizard	<i>Podarcis muralis</i>
Crow	<i>Corvus splendens</i>
Peacock	<i>Pavo cristatus</i>
Dog	<i>Canis familiaris</i>
Cat	<i>Felis felis</i>
Tiger	<i>Panthera tigris</i>
Man	<i>Homo sapiens</i>

## 17.2 Invertebrata

### 17.2.1 Phylum Porifera (Pore bearers)

These are multicellular, non-motile aquatic organisms, commonly called as sponges. They exhibit **cellular grade of organization**. Body is perforated with many pores called **ostia**. Water enters into the body through ostia and leads to a **canal system**. It circulates water throughout the body and carries food, oxygen. The body wall contains **spicules**, which form the skeletal framework. Reproduction is by both asexual and sexual methods. e.g- *Euplectella*, *Sycon*.



Euplectella



Sycon

Figure 17.3 Pore bearers

### 17.2.2 Phylum Coelenterata (Cnidaria)

Coelenterates are aquatic organisms, mostly marine and few fresh water forms. They are multicellular, radially symmetrical animals, with **tissue grade of organization**. Body wall is **diploblastic** with two layers. An outer ectoderm and inner endoderm are separated by non-cellular jelly like substance called **mesoglea**. It has a central gastrovascular cavity called **coelenteron** with mouth surrounded by short **tentacles**. The tentacles bear stinging cells called **cnidoblast** or **nematocyst**.



Figure 17.4 Jelly fish

Many coelenterates exhibit **polymorphism**, which is the variation in the structure and function of the individuals of the same species. They reproduce both asexually and sexually. e.g. Hydra, Jellyfish.

### 17.2.3 Phylum Platyhelminthes (Flat worms)

They are bilaterally symmetrical, triploblastic, **acoelomate** (without body cavity) animals. Most of them are **parasitic** in nature. **Suckers** and **hooks** help the animal to attach itself to the body of the host. Excretion occurs by specialized cells called **flame cells**. These worms are **hermaphrodites** having



Liver fluke



Tape worm

Figure 17.5 Flat worms

both male and female reproductive organs in a single individual. e.g- Liverfluke, Tapeworm.

### 17.2.4 Phylum Aschelminthes (Round worms)

Aschelminthes are bilaterally symmetrical, triploblastic animals. The body cavity is a **pseudocoelom**. They exist as **free-living soil forms** or as **parasites**. The body is round and pointed at both the ends. It is unsegmented and covered by **thin cuticle**. Sexes are separate. The most common diseases caused by nematodes in human beings are **elephantiasis** and **ascariasis**. e.g- *Ascaris*, *Wuchereria*.



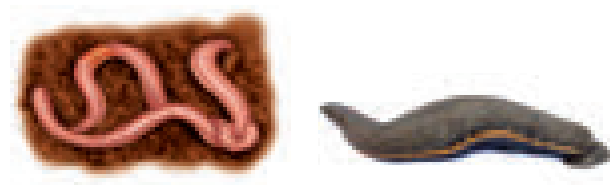
Male

Female

Figure 17.6 Round worms

### 17.2.5 Phylum Annelida (Segmented worms)

These are bilaterally symmetrical, triploblastic, **first true coelomate animals** with **organ-system grade of organization**. Body is externally divided into segments called **metameres** joined by ring like structures called **annuli**. It is covered by moist thin cuticle. **Setae** and **parapodia** are locomotor organs. Sexes may be separate or united (hermaphrodites). e.g- *Nereis*, *Earthworm*, *Leech*.



Earthworm

Leech

Figure 17.7 Segmented worms

### 17.2.6 Phylum Arthropoda (Animals with jointed legs)

Arthropoda is the largest phylum of the animal kingdom. They are bilaterally

symmetrical, triploblastic and coelomate animals. The body is divisible into head, thorax and abdomen. Each thoracic segment bears paired **jointed legs**. Exoskeleton is made of **chitin** and is shed periodically as the animal grows. The casting off and regrowing of exoskeleton is called **moulting**.

Body cavity is filled with **haemolymph** (blood). The blood does not flow in blood vessels and circulates throughout the body (open circulatory system). Respiration is through body surface, **gills** or **tracheae** (air tubes). Excretion occurs by **malphigian tubules** or **green glands**. Sexes are separate. E.g., Prawn, Crab, Cockroach, Millipede, Centipedes, Spider, Scorpion.



Centipede

Millipede

Figure 17.8 Animals with jointed legs

**DO YOU KNOW?** Centipede means 'hundred legs'. But most species have only 30 pairs. Millipedes have two pairs of legs on each segment. This name means 'thousand legs'. But, most millipedes have only about a hundred.

#### Activity 1

Identify the following pictures of Arthropods.



### 17.2.7 Phylum Mollusca (Soft Bodied Animals)

They are diversified group of animals living in marine, fresh water and terrestrial habitats. Body is bilaterally symmetrical, soft and without segmentation. It is divided into **head, muscular foot** and **visceral mass**. The foot helps in locomotion. The entire body is covered with fold of thin skin called **mantle**, which secretes outer hard **calcareous shell**. Respiration is through gills (**ctenidia**) or lungs or both. Sexes are separate with larval stages during development. e.g- Garden snail, Octopus.

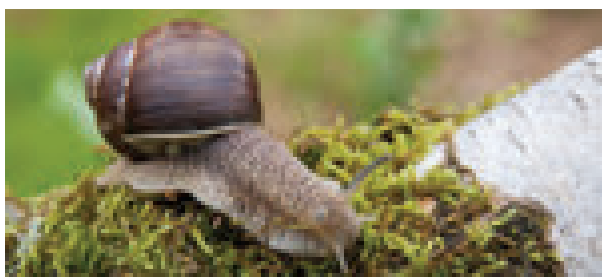


Figure 17.9 Garden Snail



Octopus is the only invertebrate that is capable of emotion, empathy, cognitive function, self awareness, personality and even relationships with humans. Some speculate that without humans, octopus would eventually take our place as the dominate life form on earth.

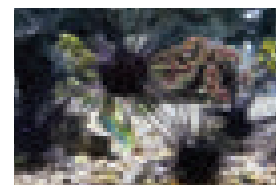


### 17.2.8 Phylum Echinodermata (Spiny Skinned Animals)

They are exclusively free-living marine animals. These are triploblastic and true coelomates with organ-system grade of organization. **Adult animals** are **radially symmetrical** but **larvae** remain **bilaterally symmetrical**. A unique feature is the presence of fluid filled **water vascular system**. Locomotion occurs by **tube feet**. Body wall is covered with spiny hard **calcareous ossicles**. e.g- Star fish, Sea urchin.



Star Fish



Sea Urchin

Figure 17.10 Spiny Skinned Animals

### 17.2.9 Phylum Hemichordata

Hemichordates are marine organisms with soft, vermiform and unsegmented body. They are bilaterally symmetrical, coelomate animals with **non-chordate** and **chordate features**. They have gill slits but **do not have notochord**. They are **ciliary feeders** and mostly remain as **tubicolous forms**. E.g- *Balanoglossus* (Acorn worms).

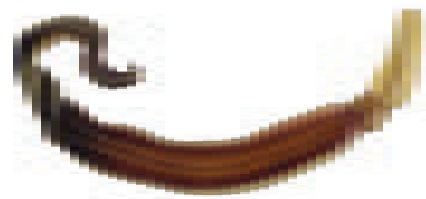


Figure 17.11 Balanoglossus

## 17.3 Chordata

Chordates are characterized by the **presence of notochord, dorsal nerve cord** and **paired gill pouches**. **Notochord** is a long rod like support along the back of the animal separating the gut and nervous tissue. All chordates are triploblastic and coelomate animals. **Phylum Chordata** is divided into two groups: **Prochordata** and **Vertebrata**.

### 17.3.1 Prochordata

The prochordates are considered as the forerunners of vertebrates. Based on the nature of the notochord, prochordata is classified into subphylum Urochordata and subphylum Cephalochordata.

#### Subphylum Urochordata

**Notochord** is present only in the **tail region** of free-living larva. Adults are sessile forms and mostly degenerate. The body is covered with a **tunic** or **test**. e.g. *Ascidian*

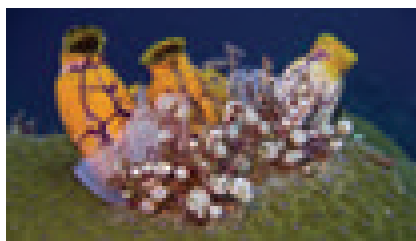


Figure 17.12 Ascidian

### Subphylum Cephalochordata

Cephalochordates are small fish like marine chordates with unpaired dorsal fins. The notochord extends throughout the entire length of the body. E.g. *Amphioxus*

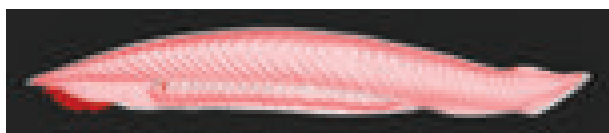


Figure 17.13 Amphioxus

### 17.3.2 Vertebrata

This group is characterized by the presence of vertebral column or backbone. Notochord in an embryonic stage gets replaced by the vertebral column, which forms the chief skeletal axis of the body. Vertebrata are grouped into six classes.

#### Class: Cyclostomata

Cyclostomes are jawless vertebrates (mouth not bounded by jaws). Body is elongated and eel like. They have circular mouth. Skin is slimy and scaleless. They are ectoparasites of fishes. E.g. *Hagfish*.



Figure 17.14 Lamprey

#### Class: Pisces

Fishes are poikilothermic (**cold-blooded**), aquatic vertebrates with jaws. The **streamlined**

**body** is divisible into head, trunk and tail. Locomotion is by **paired** and **median fins**. Their body is covered with **scales**. Respiration is through **gills**. The heart is two chambered with an auricle and a ventricle. There are two main types of fishes.

- (i) **Cartilaginous fishes**, with skeleton made of cartilages e.g. Sharks, Skates.
- (ii) **Bony fishes** with skeleton made of bones e.g. Carps, Mulletts.

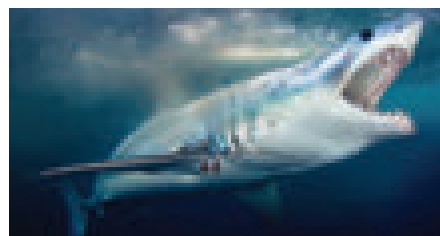


Figure 17.15 Shark

#### More to Know

The smallest vertebrate, Philippine goby/dwarf pygmy goby is a tropical species fish found in brackish water and mangrove areas in south East Asia, measuring only 10 mm in length.



#### Class: Amphibia (amphi- both; bios- life)

These are the first four legged (**tetrapods**) vertebrates with **dual adaptation** to live in both land and water. The body is divisible into head and trunk. Their skin is moist and have **mucus glands**. Respiration is through **gills, lungs, skin** or **buccopharynx**. The heart is three chambered with two auricles and one ventricle. Eggs are laid in water. The **tadpole larva**, transforms into an adult. e.g-Frog, Toad.



The Chinese giant salamander



*Andrias davidians* is the largest amphibian in the world. Its length is about five feet and eleven inches. It weighs about 65 kg, found in Central and South China.



### Class: Reptilia (repere- to crawl or creep)

These vertebrates are fully adapted to live on land. Their body is covered with **horny epidermal scales**. Respiration is through **lungs**. The heart is three chambered with an exemption of crocodiles, which have four-chambered heart. Most of the reptiles lay their eggs with tough outer shell e.g Calotes, Lizard, Snake, Tortoise, Turtle.

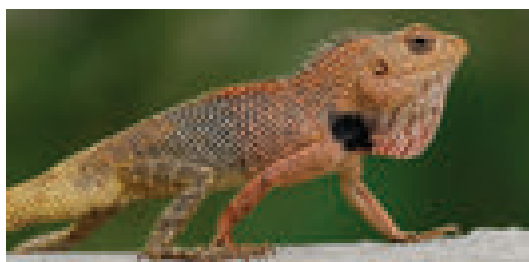


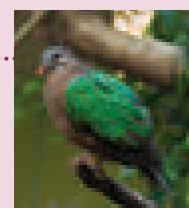
Figure 17.16 Calotes



Figure 17.17 Pigeon

#### More to Know

State bird of Tamil Nadu  
Common Emerald dove.  
(*Chalcophaps indica*)



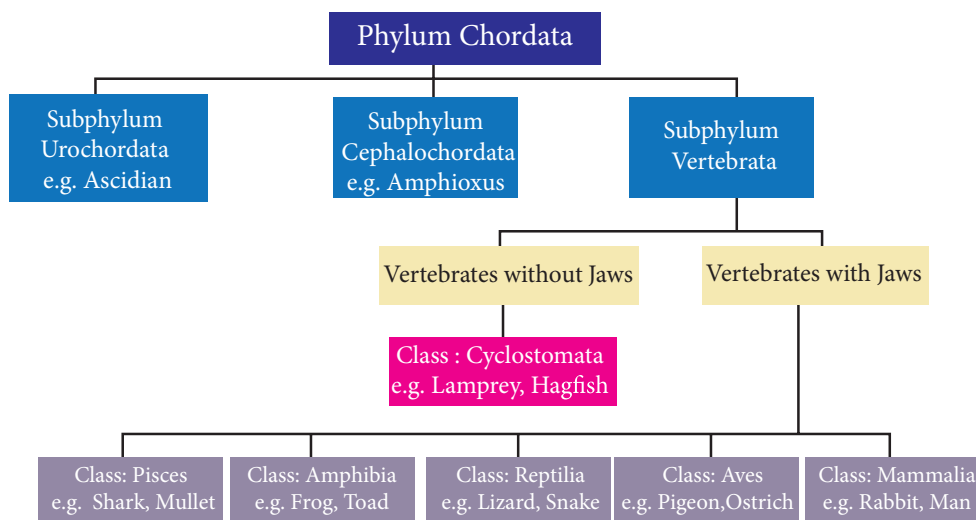
### Class: Aves (avis – bird)

Birds are **homeothermic (warm-blooded)** animals with several adaptations to fly. The **spindle or boat shaped body** is divisible into head, neck, trunk and tail. The body is covered with **feathers**. **Forelimbs** are modified into **wings** for flight. Hindlimbs are adapted for walking, perching or swimming. The respiration is through lungs, which have **air sacs**. Bones are filled with air (**pneumatic bones**), which reduces the body weight. They lay large yolk laden eggs. They are covered by hard **calcareous shell**. e.g. Parrot, Crow, Eagle, Pigeon, Ostrich .

### Class: Mammalia (mamma-breast)

Mammals are **warm-blooded animals**. The skin is covered with **hairs**. It also bears **sweat** and **sebaceous** (oil) glands. The body is divisible into head, neck, trunk and tail. Females have **mammary glands**, which secrete milk for feeding the young ones. The **external ears** or **pinnae** is present. Heart is four chambered and they breathe through lungs. Except egg laying mammals (Platypus, and Spiny anteater), all other mammals give birth to their young ones (**viviparous**). Placenta is the unique characteristic feature of mammals.e.g Rat, Rabbit, Man.

#### Classification of Phylum Chordata





**Figure 17.18** Rabbit

### More to Know

The gigantic **Blue whale** which is 35 meters long and 120 tons in weight is the biggest vertebrate animal.



### Points to Remember

- ❖ Classification is the ordering of organism into groups on the basis of their similarities, dissimilarities and relationships.
- ❖ Animals are grouped as unicellular or multicellular based on cell, tissue, organ and organ system level of organization.
- ❖ In radial symmetry the body parts are arranged around the central axis.
- ❖ In bilateral symmetry, the body parts are arranged along a central axis.
- ❖ Coelom is a fluid-filled body cavity. It separates the digestive tract from the body wall.
- ❖ Animals which do not possess notochord structure are called as Invertebrates or Non- chordates.
- ❖ Animals which possess notochord or backbone are called as Chordates.
- ❖ The prochordates are considered as the forerunner of vertebrates.

## A-Z GLOSSARY

<b>Acoelomates</b>	Animals which do not have a body cavity.
<b>Amphibian</b>	Cold-blooded vertebrate animal of a class that comprises the frogs, toads, newts, salamanders.
<b>Annelida</b>	Phylum that comprises the segmented worms which include earthworms and leeches.
<b>Aves</b>	Vertebrates which comprises the birds.
<b>Coelomates</b>	Animals which have a true coelom e.g Earthworm, Frog.
<b>Classification</b>	Arrangement of groups of animals, the members of which have one or more characteristics in common.
<b>Mammals</b>	Warm-blooded vertebrate animals that possess hairs, mammary glands and feed their young ones.
<b>Pseudocoleomates</b>	False body cavity which is not bounded by true epithelial lining. e.g Roundworm
<b>Toads</b>	Anurans with smooth skin than that of frogs, terrestrial and leap rather than jump.



## TEXTBOOK EXERCISES



### I. Choose the correct answer.

- Find the group having only marine members.
  - Mollusca
  - Coelenterata
  - Echinodermata
  - Porifera
- Mesoglea is present in
  - Porifera
  - Coelenterata
  - Annelida
  - Arthropoda
- Which one of the following pairs is not a poikilothermic animal?
  - Fishes and Amphibians
  - Amphibians and Aves
  - Aves and Mammals
  - Reptiles and Mammals
- Identify the animal having four chambered heart.
  - Lizard
  - Snake
  - Crocodile
  - Calotes
- The animal without skull is
  - Acrania
  - Acephalia
  - Apteria
  - Acoelomate
- Hermaphrodite organisms are
  - Hydra, Tape worm, Earthworm, Amphioxus
  - Hydra, Tape worm, Earthworm, Ascidian
  - Hydra, Tape worm, Earthworm, Balanoglossus
  - Hydra, Tape worm, Ascaris, Earthworm
- Poikilothermic organisms are
  - Fish, Frog, Lizard, Man
  - Fish, Frog, Lizard, Cow
  - Fish, Frog, Lizard, Snake
  - Fish, Frog, Lizard, Crow

- Air sacs and Pneumatic bones are seen in
  - fish
  - frog
  - bird
  - bat
- Excretory organ of tape worm is
  - flame cells
  - nephridia
  - body surface
  - solenocytes
- Water vascular system is found in
  - Hydra
  - Earthworm
  - Star fish
  - Ascaris

### II. Fill in the blanks.

- The skeletal framework of Porifera is \_\_\_\_\_.
- Ctenidia are respiratory organs in \_\_\_\_\_.
- Skates are \_\_\_\_\_ fishes.
- The larvae of an amphibian is \_\_\_\_\_.
- \_\_\_\_\_ are jawless vertebrates.
- \_\_\_\_\_ is the unique characteristic feature of mammal.
- Spiny anteater is an example for \_\_\_\_\_ mammal.

### III. State whether true or false. If false, correct the statement.

- Canal system is seen in coelenterates.
- Hermaphrodite animals have both male and female sex organs.
- Trachea are the respiratory organ of Annelida.
- Bipinnaria is the larva of Mollusca.
- Balanoglossus is a ciliary feeder.
- Fishes have two chambered heart.
- Skin of reptilians are smooth and moist.

8. Wings of birds are the modified forelimbs.
9. Female mammals have mammary glands.

#### IV. Match the following.

PHYLUM	EXAMPLES
(A) Coelenterata	(i) Snail
(B) Platyhelminthes	(ii) Starfish
(C) Echinodermata	(iii) Tapeworm
(D) Mollusca	(iv) Hydra

#### V. Answer very briefly.

1. Define taxonomy.
2. What is nematocyst?
3. Why coelenterates are called diploblastic animals?
4. List the respiratory organs of amphibians.
5. How does locomotion take place in starfish?
6. Are jellyfish and starfish similar to fishes? If no justify the answer.
7. Why are frogs said to be amphibians?

#### VI. Answer briefly.

1. Give an account on phylum Annelida.
2. Differentiate between flat worms and round worms?
3. Outline the flow charts of Phylum Chordata.
4. List five characteristic features of fishes.
5. Comment on the aquatic and terrestrial habits of amphibians.
6. How are the limbs of the birds adapted for avian life?

#### VII. Answer in detail.

1. Describe the characteristic features of different Prochordates.
2. Give an account on phylum Arthropoda.



### REFERENCE BOOKS

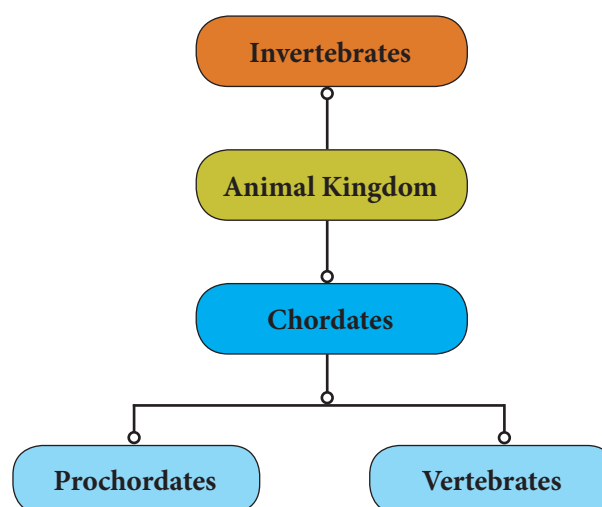
1. Manual of Zoology Vol. I. Part I. (Invertebrata), M. Ekambaranatha Ayyar and T.N. Ananthakrishnan, Reprint 2003. S. Viswanathan (Printers and Publishers) Pvt. Ltd Chennai.
2. Manual of Zoology Vol. I. Part. II. (Invertebrata), M. Ekambaranatha Ayyar and T.N. Ananthakrishnan, Reprint 2003. S. Viswanathan (Printers and Publishers) Pvt. Ltd Chennai.
3. Manual of Zoology Vol. II. Chordata M. Ekambaranatha Ayyar and T.N. Ananthakrishnan, Reprint 2003. S. Viswanathan (Printers and Publishers) Pvt. Ltd Chennai.
4. Chordate Zoology E. L. Jordan and P. S. Verma. Reprint 2003. S. Chand .and Company, New Delhi.



### INTERNET RESOURCES

- <http://home.pcisys.net/~dlblanc/taxonomy.html>
- [http://can-do.com/uci/lessons 98/Invertebrates.html](http://can-do.com/uci/lessons%2098/Invertebrates.html)
- <http://www.student.loretto.org/zoology/chordates.html>

### Concept Map



## UNIT

## 18

## Organization of Tissues

 Learning Objectives

After completing this lesson, students will be able:

- know the different types of tissues and their morphology.
- identify how tissues are organized in specific patterns to form organs.
- understand how tissues perform life activities in plants and animals.
- gain knowledge about the structural organisation of tissues.
- get familiarized with the process, types and significance of cell division.



## Introduction

Unicellular organisms like bacteria and protozoans are made of single cells. On the other hand, multicellular organisms, like higher plants and animals, are composed of millions of different types of cells that are grouped into different levels of organization. Multicellular organisms have specialized cells, tissues, organs and organ systems that perform specific functions.

Group of cells positioned and designed to perform a particular function is called a tissue. An organ is a structure made up of a collection of tissues that carry out specialized functions. For example, in plants the root, stem and leaves are organs, whereas xylem and phloem are tissues. Similarly in animals stomach, for example, is an organ that consists of tissues made of epithelial cells, gland cells and muscle cells. In this chapter, you will learn about different types of plant and animal tissues and how they are modified to coordinate life activities.

## 18.1 Plant Tissues

Plants are made up of vegetative and reproductive tissues. In general, plant tissues are classified into two types namely:

- i. Meristems or Meristematic tissues.
- ii. Permanent tissues

**18.1.1 Meristematic Tissues  
(Meristems)**

The term 'meristem' is derived from the greek word 'Meristos' which means divisible or having cell division activity. Meristematic tissues are group of immature cells that are capable of undergoing cell division. In plants, meristem is found in zones where growth can take place. Example: apex of stem, root, leaf primordia, vascular cambium, cork cambium, etc.,

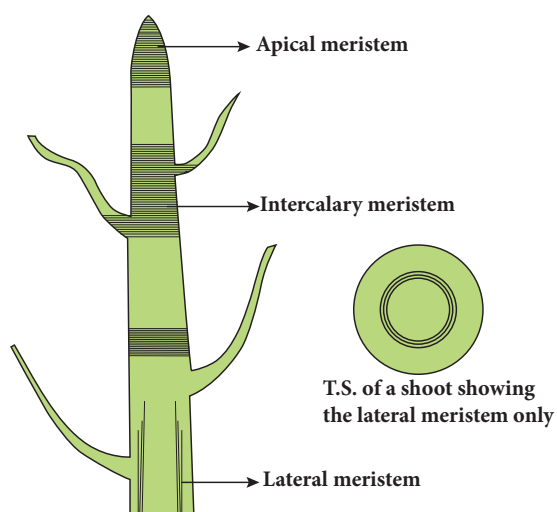
**Characteristic features:**

- a) They are living cells.
- b) Cells are small, oval, polygonal or round in shape.
- c) They are thin walled with dense cytoplasm, large nuclei and small vacuoles.

- d) They undergo mitotic cell division.  
e) They do not store food materials.

### A. Types of Meristems based on position

On the basis of their position in the plant, meristems are of three types: Apical meristem, Intercalary meristem and Lateral meristem.



**Figure 18.1** Longitudinal section of shoot apex showing location of meristems and young leaves.

**Apical meristem:** These are found at the apices or growing points of root and shoot and bring about increase in length.

**Intercalary meristem:** It lies between the region of permanent tissues and is part of primary meristem. It is found either at the base of leaf (e.g. pinus) or at the base of internodes (e.g. grasses).

**Lateral Meristem:** These are arranged parallel and causes the thickness of the plant part.

### B. Functions

Meristems are actively dividing tissues of the plant, that are responsible for primary (elongation) and secondary (thickness) growth of the plant.

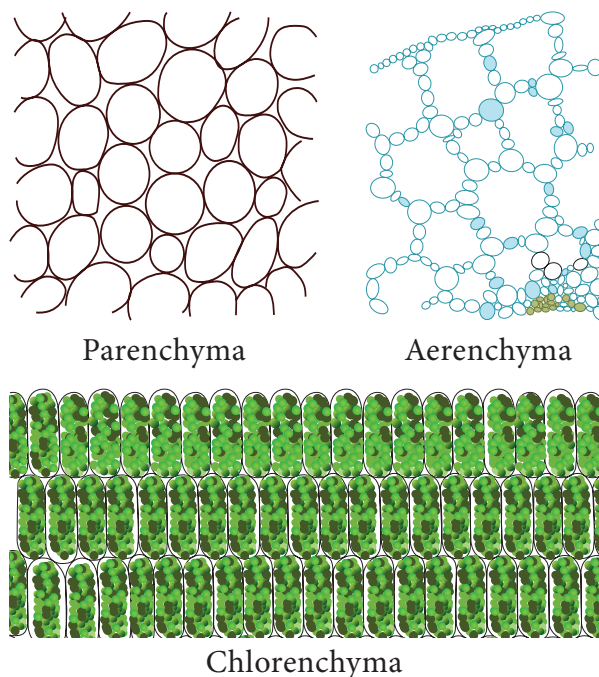
#### 18.1.2 Permanent Tissues

Permanent tissues are those in which, growth has stopped either completely or for the time being. At times, they become meristematic partially or wholly. Permanent tissues are of two types, namely: simple tissue and complex tissue.

### A. Simple Tissues

Simple tissues are homogeneous tissues composed of structurally and functionally similar cells. eg., Parenchyma, Collenchyma and Sclerenchyma.

**Parenchyma:** Parenchyma are simple permanent tissues composed of living cells. Parenchyma cells are thin walled, oval, rounded or polygonal in shape with well developed spaces among them. In aquatic plants, parenchyma possesses intercellular air spaces, and is named as Aerenchyma. When exposed to light, parenchyma cells may develop chloroplasts and are known as Chlorenchyma.



**Figure 18.2** Types of Parenchyma

Parenchyma may store water in many succulent and xerophytic plants. It also serves the functions of storage of food reserves, absorption, buoyancy, secretion etc.,



In potato, parenchyma vacuoles are filled with starch. In apple, parenchyma stores sugar

**Collenchyma:** Collenchyma is a living tissue found beneath the epidermis. Cells are elongated with unevenly thickened walls.

Cells have rectangular oblique or tapering ends and persistent protoplast. They possess thick primary non-lignified walls. They provide mechanical support for growing organs.

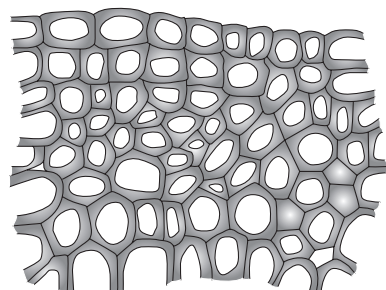


Figure 18.3 Collenchyma

**Sclerenchyma:** Sclerenchyma consists of thick walled cells which are often lignified. Sclerenchyma cells are dead and do not possess living protoplasts at maturity. Sclerenchyma cells are grouped into fibres and sclereids.

Fibres are elongated sclerenchymatous cells, usually with pointed ends. Their walls are lignified. Fibres are abundantly found in many plants. The average length of fibres is 1 to 3 mm, however in plants like *Linum usitatissimum* (flax), *Cannabis sativa* (hemp) and *Corchorus capsularis* (jute), fibres are extensively longer, ranging from 20 mm to 550 mm.

Sclereids are widely distributed in plant body. They are usually broad, may occur in single or in groups. Sclereids are isodiametric, with lignified walls. Pits are prominent and seen along the walls.

Lumen is filled with wall materials. Sclereids are also common in fruits and seeds.

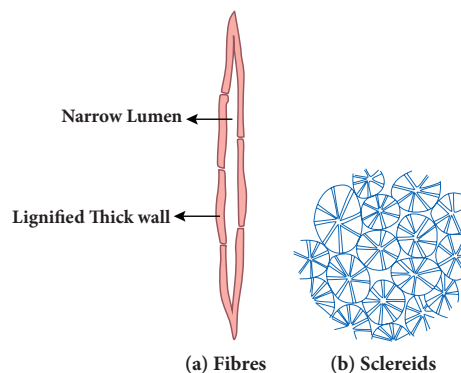


Figure 18.4 Sclerenchyma (a) Fibres, (b) Sclereids

## B. Complex tissues

Complex tissues are made of more than one type of cells that work together as a unit. Complex tissues consist of parenchyma and sclerenchyma cells. However, collenchymatous cells are not present in such tissues. Common examples are xylem and phloem.

### i. Xylem

Xylem is a conducting tissue which conducts water, mineral nutrients upward from root to leaves. Xylem gives mechanical support to the plant body. Xylem is composed of: (i) xylem tracheids (ii) xylem fibres (iii) xylem vessels and (iv) xylem parenchyma.

**Xylem tracheids:** These are elongated or tube-like dead cells with hard, thick and

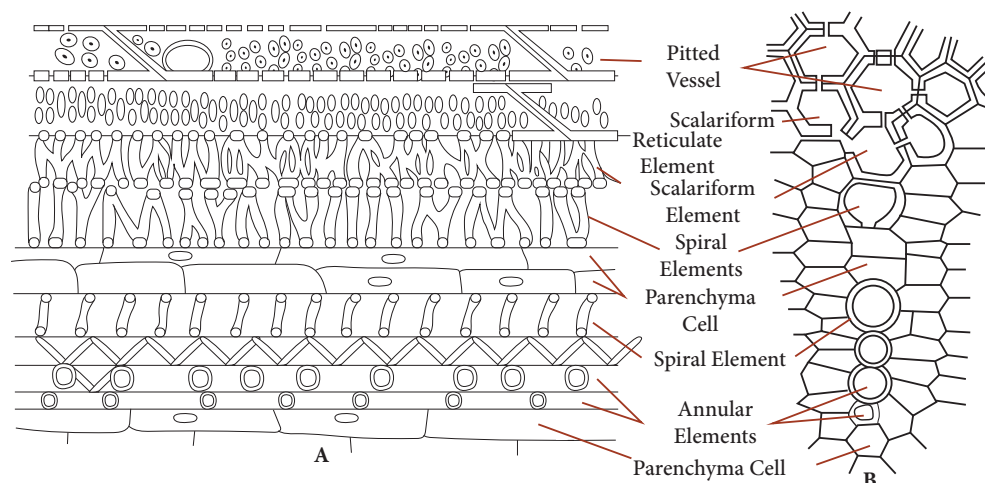


Figure 18.5 A. xylem longitudinal section B. xylem transverse section

lignified walls. Their ends are tapering, blunt or chisel-like and devoid of protoplast. They have large lumen without any content. Their function is conduction of water and providing mechanical support to the plant.

**Xylem fibres:** These cells are elongated, lignified and pointed at both the ends. Xylem fibres provide mechanical support to the plant.

**Xylem vessels:** These are long cylindrical, tube like structures with lignified walls and wide central lumen. These cells are dead as these do not have protoplast. They are arranged in longitudinal series in which the partitioned walls (transverse walls) are perforated, and so the entire structure looks-like a water pipe. Their main function is to transport of water and also to provide mechanical strength.

**Xylem parenchyma:** These are living and thin walled cells. The main function of xylem parenchyma is to store starch and fatty substances.

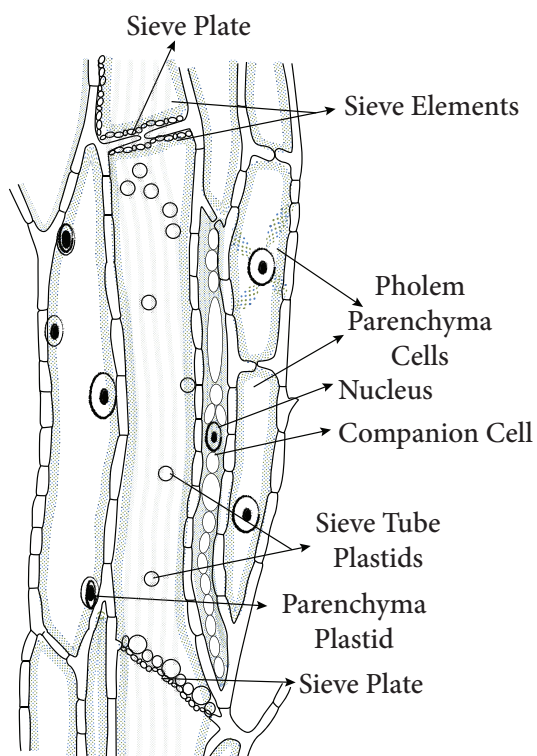
## ii. Phloem

Phloem is a complex tissue and consists of the following elements: Sieve elements, Companion cells, Phloem fibres, and Phloem parenchyma.

**Sieve elements:** The conducting elements of phloem are collectively called as Sieve elements. Sieve tubes are elongated, tube-like slender cells placed end to end. The transverse walls at the ends are perforated and are known as sieve plates. The main function of sieve tubes is translocation of food, from leaves to the storage organs of the plants.

**Companion cells:** These are elongated cells attached to the lateral wall of the sieve tubes. A companion cell may be equal in length to the accompanying sieve tube element or the mother cell may be divided transversely forming a series of companion cells.

**Phloem parenchyma:** The phloem parenchyma are living cells which have cytoplasm and nucleus. Their function is to store food materials.



**Figure 18.6** Longitudinal section of Phloem tissue

**Table 18.1** Differences between Xylem and Phloem.

Xylem	Phloem
Conducts water and minerals.	Conducts organic solutes or food materials.
Conduction is mostly unidirectional i.e., from roots to apical parts of the plant.	Conduction may be bidirectional from leaves to storage organs and growing parts or from storage organs to growing parts of plants.
Conducting channels are tracheids and vessels.	Conducting channels are sieve tubes.
Component of xylem include tracheid vessels, xylem parenchyma and xylem fibres.	Components are sieve elements, companion cells, phloem parenchyma and phloem fibres.



**Phloem fibers:** Sclerenchymatous cells associated with primary and secondary phloem are commonly called phloem fibers. These cells are elongated, lignified and provide mechanical strength to the plant body.

**Table 18.2** Differences between Meristematic tissue and Permanent tissue.

Meristematic tissue	Permanent tissue
Cell wall is thin and elastic.	Cell wall is thick.
Component cells are small, spherical or polygonal and undifferentiated.	Component cells are large, differentiated with different shapes.
Cytoplasm is dense, and vacuoles are nearly absent.	Usually large central vacuole is present in living permanent cells.
Intercellular spaces absent.	Intercellular spaces present.
Nucleus is large and prominent.	Nucleus is less conspicuous.
Cells grow and divide regularly.	Cells do not normally divide.
Provides mechanical support and elasticity to the plant body.	Provides only mechanical support.

## 18.2 Animal Tissues

An assemblage of one or more types of specialized cells held together with extracellular material constitute the tissue. The study of tissues is known as **Histology**.

**Simple tissue:** A group of cells that are similar in origin, form, structure and work together to perform a specific function.

**Compound tissue:** A group of cells different in their structure and function but co-ordinate to perform a specific function

Animal tissues can be grouped into four basic types on the basis of their structure and functions.

- Epithelial tissue.
- Connective tissue
- Muscular tissue
- Nervous tissue

### 18.2.1 Epithelial Tissues

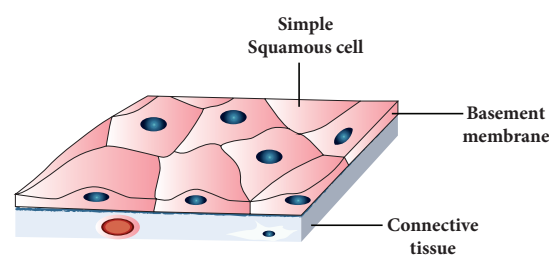
It is the simplest tissue composed of one or more layers of cells covering the external surface of the body and internal organs. The cells are arranged very close to each other with less extracellular material. Epithelial cells lie on a non-cellular basement membrane. The epithelial tissue generally lacks blood vessels. The epithelium is separated by the underlying connective tissue which provides it with nutrients. There are two types of epithelial tissues. **Simple epithelium** is composed of single layer of cells resting on a basement membrane. **Compound epithelium** is composed of several layers of cells. Only the cells of the deepest layer rest on the basement membrane.

#### Functions of epithelial tissues

- The skin which forms the outer covering of the body protects the underlying cells from drying, injury and microbial infections.
- They help in absorption of water and nutrients.
- They are involved in elimination of waste products.
- Some epithelial tissues perform secretory function (Secretion of sweat, saliva, mucus and enzymes).

#### A. Simple Epithelium

It is formed of **single layer** of cells. It forms a lining for the body cavities and ducts. Simple epithelium is further divided into following types.



**Figure 18.7** Squamous Epithelium

**Squamous Epithelium:** It is made up of thin, flat cells with prominent nuclei. These cells have irregular boundaries and bind with neighbouring cells. The squamous epithelium is also known as **pavement membrane**, which form delicate lining of the buccal cavity, alveoli of lungs, proximal tubule of kidneys and covering of the skin and tongue. It protects the body from mechanical injury, drying and invasion of germs.

**Cuboidal Epithelium:** It is composed of single layer of **cubical** cells. The nucleus is round and lies in the centre. This tissue is present in the thyroid vesicles, salivary glands, sweat glands and exocrine pancreas. It is also found in the intestine and tubular part of the nephron (kidney tubules) as microvilli that increase the absorptive surface area. Their main function is secretion and absorption.

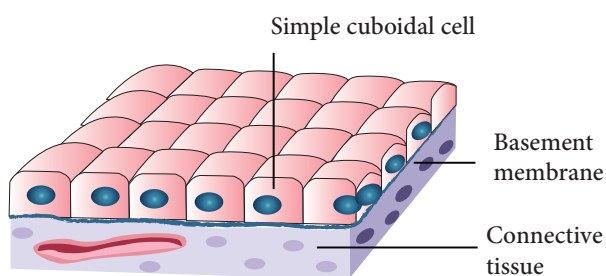


Figure 18.8 Cuboidal Epithelium

**Columnar Epithelium:** It is composed of a single layer of **slender, elongated** and **pillar** like cells. Their nuclei are located at the base. It is found lining the stomach, gall bladder, bile duct, small intestine, colon, oviducts and also forms the mucous membrane. They are mainly involved in secretion and absorption.

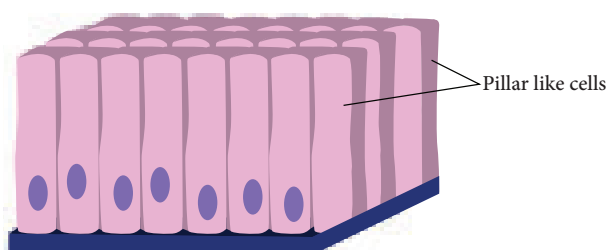


Figure 18.9 Columnar Epithelium

**Ciliated Epithelium:** Certain columnar cells bear numerous delicate hair like out growths called **cilia** and are called ciliated epithelium. Their function is to move particles or mucus in a specific direction over the epithelium. It is seen in the trachea of wind-pipe, bronchioles of respiratory tract, kidney tubules and fallopian tubes of oviducts.

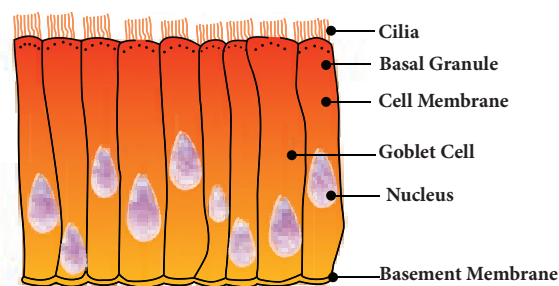


Figure 18.10 Ciliated Epithelium

**Glandular Epithelium:** Epithelial cells are often modified to form **specialized gland** cells which secrete chemical substances at the epithelial surface. This lines the gastric glands, pancreatic tubules and intestinal glands.

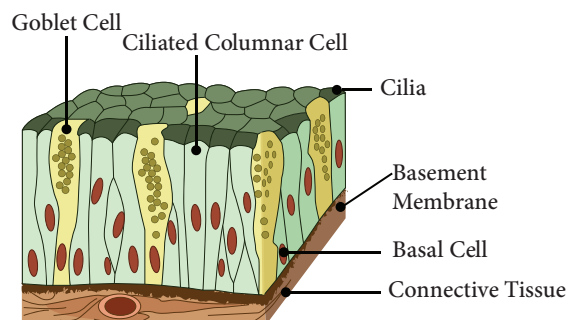


Figure 18.11 Glandular epithelium

## B. Compound Epithelium

It consists of **more than one layer** of cells and gives a **stratified appearance**. Hence, they are also known as stratified epithelium. The main function of this epithelium is to give protection to the underlying tissues against mechanical and chemical stress. They also cover the dry surface of the skin, the moist surface of the buccal cavity and pharynx.



Epithelial tissue in the skin functions as a water-proof membrane.

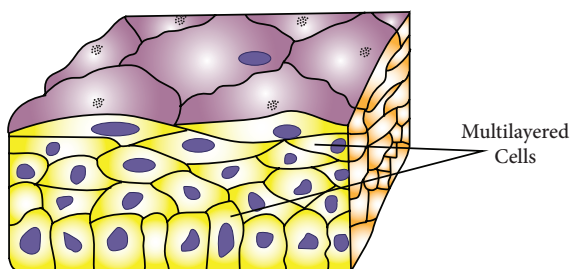


Figure 18.12 Compound Epithelium

### Activity 1

Rinse your mouth with water. Using a tooth pick or ice-cream stick, scrap superficial cells from inner side of the cheek and spread it on a clean glass slide. Dry the glass slide with the scrap cells taken from the inner side of cheek. Add two drops of methylene blue stain. Identify the cells under low and high power of the microscope.

### 18.2.2 Connective Tissues

It is one of the most abundant and widely distributed tissue. It provides **structural framework** and gives **support** to different tissues forming organs. It prevents the organs from getting displaced by body movements.

The components of the connective tissue are the intercellular substance known as the matrix, connective tissue cells and fibres. Connective tissue is classified as follows:

- Connective tissue proper (Areolar and Adipose tissue)
- Supportive connective tissue (Cartilage and Bone)

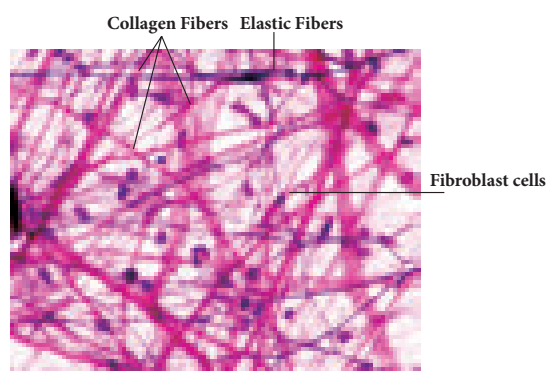


Figure 18.13 Areolar tissue

- Dense connective tissue (Tendons and Ligaments)
- Fluid connective tissue (Blood and Lymph)

#### i. Connective tissue proper:

Connective tissue proper consist of collagen fibres, elastin fibres and fibroblast cells.

**Areolar tissue:** It has cells and fibres loosely arranged in a semi-fluid ground substance called **matrix**. It takes the form of fine threads crossing each other in every direction leaving small spaces called areolae. It joins skin to muscles, fills space inside organs and is found around muscles, blood vessels and nerves. It helps in repair of tissues after injury and fixes skin to underlying muscles.

**Adipose Tissue:** Adipose tissue is the aggregation of **fat cells** or **adipocytes**, spherical or oval in shape. It serves as fat reservoir.

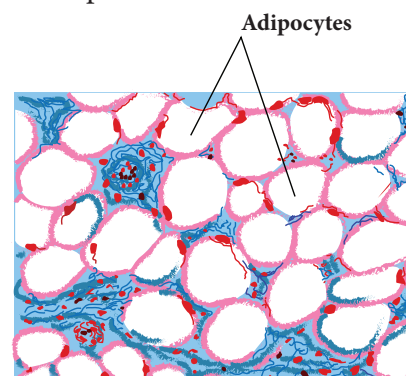


Figure 18.14 Adipose tissue

They are found in subcutaneous tissue, between internal organs around the heart and kidneys. They act as **shock absorbers** around the kidneys and eye balls. They also regulate the body temperature by acting as **insulator**.

#### ii. Supportive Connective Tissue:

The supporting or skeletal connective tissues forms the endoskeleton of the vertebrate body which protect various organs and help in locomotion. The supportive tissues include cartilage and bone.

**Cartilage:** They are soft, semi-rigid, flexible and are less vascular in nature. The matrix is composed of large cartilage cells called **chondrocytes**. These cells are present in fluid filled spaces known as **lacunae**.

Cartilage is present in the tip of the nose, external ear, end of long bones, trachea and larynx. It provides support and flexibility to the body parts.

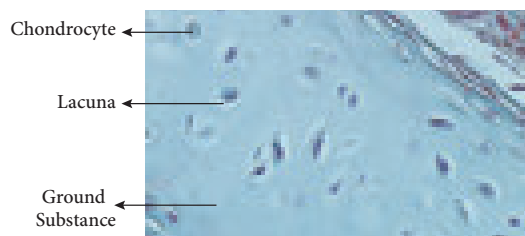


Figure 18.15 Cartilage

**Bone :** It is solid, rigid and strong, **non-flexible** skeletal connective tissue. The matrix of the bone is rich in calcium salts and collagen fibres which gives the bone its strength. The matrix of the bone is in the form of concentric rings called **lamellae**. The bone cells present in lacunae are called **osteocytes**. They communicate with each other by a network of fine canals called **canaliculi**. The hollow cavities of spaces are called marrow cavities filled with **bone marrow**. They provide shape and structural framework to the body. Bones support and protect soft tissues and organs.



Figure 18.16 T.S of Bone

**iii. Dense Connective Tissue:**

It is a fibrous connective tissue densely packed with fibres and fibroblasts. It is the principal component of tendons and ligaments.

**Tendons:** They are cord like, strong, structures that join skeletal muscles to bones. Tendons have great **strength** and **limited flexibility**. They consist of parallel bundles of collagen fibres, between which are present rows of fibroblasts.

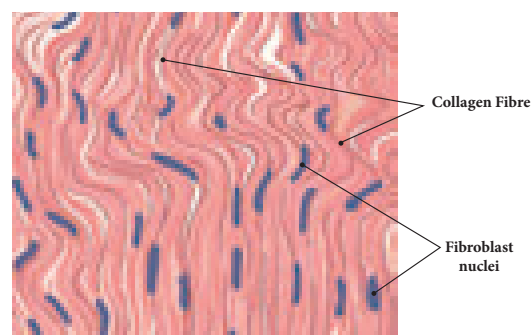


Figure 18.17 Tendon

**Ligaments:** They are **highly elastic** structures and have great strength which connect bones to bones. They contain very little matrix. They strengthen the joints and allow normal movement.

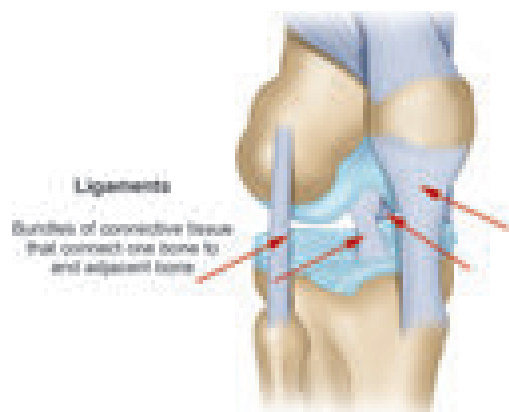


Figure 18.18 Ligament

**DO YOU KNOW?** Sprain is caused by excessive pulling (stretching) of ligaments.

**iv. Fluid connective tissue:**

The blood and the lymph are the fluid connective tissues which link different parts of the body. The cells of the connective tissue are loosely spaced and are embedded in an intercellular matrix.

**a. Blood**

Blood contains corpuscles which are red blood cells (**erythrocytes**), white blood cells (**leucocytes**) and **platelets**. In this fluid connective tissue, blood cells

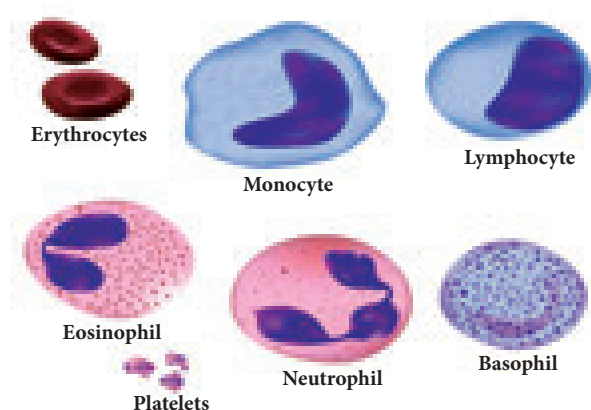


are present in a fluid matrix called **plasma**. The plasma contains inorganic salts and organic substances. It is a main circulating fluid that helps in the transport of nutrient substances.

**Red blood corpuscles (Erythrocytes):** The red blood corpuscles are circular, biconcave disc-like cells and **lack nucleus** when mature (mammalian RBC). They contain a respiratory pigment called **haemoglobin** which is involved in the transport of oxygen to tissues.

**White blood corpuscles (Leucocytes):** They are larger in size, contain **distinct nucleus** and are **colourless**. They are capable of amoeboid movement and play an important role in body's defense mechanism. They engulf or destroy foreign bodies. WBC's are of two types: Granulocytes and Agranulocytes. **Granulocytes** have irregular shaped nuclei and cytoplasmic granules. They include the **neutrophils**, **basophils** and **eosinophils**. **Agranulocytes** lack cytoplasmic granules and include the **lymphocytes** and **monocytes**.

**Blood platelets:** They are minute, anucleated, fragile fragments of giant bone marrow called **mega karyocytes**. They play an important role in **blood clotting** mechanism.



**Figure 18.19** Blood cells

### b. Lymph

Lymph is a colourless fluid filtered out of the blood capillaries. It consists of plasma and white blood cells. It mainly helps in the exchange of materials between blood and tissue fluids.

### 18.2.3 Muscular Tissues

Muscular tissues are made of muscle cells and form the major part of contractile tissue. They are composed of numerous **myofibrils**. Each muscle is made up of many long cylindrical fibres arranged parallel to one another.

According to their structure, location and functions there are three main types of muscles: Skeletal muscle (or) striated muscle, Smooth muscle (or) non-striated muscle and Cardiac muscle.

**Skeletal muscle:** These muscles are attached to the bones and are responsible for the body movements and are called skeletal muscles. They work under our control and are also known as **voluntary muscles**. The muscle fibres are elongated, cylindrical, unbranched with alternating dark and light bands, giving them the **striped** or **striated** appearance. They possess many nuclei (**multinucleate**). For example they occur in the biceps and triceps of arms and undergo rapid contraction.

**Smooth muscle:** These muscles are spindle shaped with broad middle part and tapering ends. There is a single centrally located nucleus (**uninucleate**). These fibrils do not bear any stripes or striations and hence are called **non-striated**. They are not under the control of our will and so are called **involuntary muscles**. The walls of the internal organs such as the blood vessels, gastric glands, intestinal villi and urinary bladder contain this type of smooth muscle.

**Cardiac muscle:** It is a special contractile tissue present in the heart. The muscle fibres are **cylindrical**, **branched** and **uninucleate**. The branches join to form a network called as **intercalated disc** which are unique distinguishing features of the cardiac muscles. The contraction of cardiac muscle is involuntary and rhythmic.

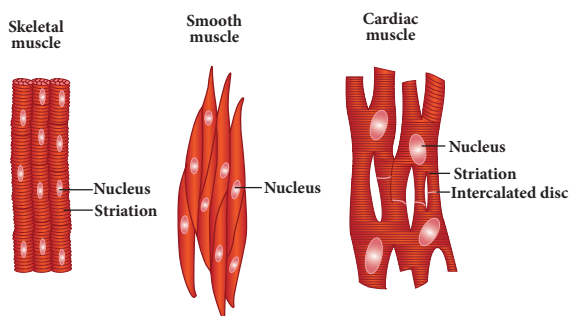


Figure 18.19 Muscle tissue

### 18.2.4 Nervous Tissue

Nervous tissue comprises of the nerve cells or neurons. They are the longest cells of the body. **Neurons** are the structural and functional units of the nervous tissue. The elongated and slender processes of the neurons are the nerve fibres. Each neuron consists of a **cell body** or **cyton** with nucleus and cytoplasm. The **dendrons** are short and highly branched protoplasmic processes of cyton. The **axon** is a single, long fibre like process that develops from the cyton and ends up with fine terminal branches.

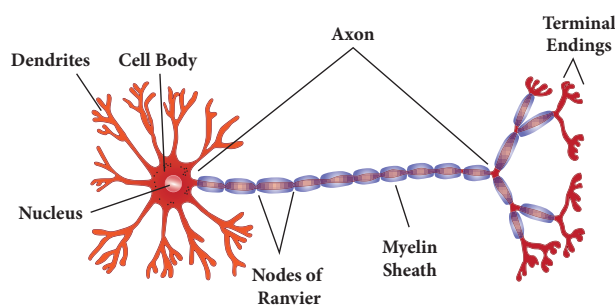


Figure 18.20 Neuron

#### INFO BIT

##### Age of our body cells

- Cells of the eye lens, nerve cells of cerebral cortex and most muscle cells last a life time but once dead are not replaced.
- Epithelial cells lining the gut last only about 5 days.

##### Duration of cell replacement

- Skin cells- about every 2 weeks.
- Bone cells- about every 10 years.
- Liver cells- about every 300 – 500 days.
- Red blood cells last for about 120 days and are replaced.

They have the ability to receive stimuli from within or outside the body and send signals to different parts of the body.



Nerve cells do not undergo cell division due to the absence of centrioles, but they are developed from glial cells by neurogenesis

## 18.3 Cell Division

Are you aware that all living organisms start their life from a single cell? You may wonder how a single cell then goes to form such a large organism. All cells reproduce by division and division of cells into daughter cells is called cell division.

### 18.3.1 Types of Cell Division

The three types of cell division that occur in animal cells are:

- I. Amitosis - Direct Division
- II. Mitosis - Indirect Division
- III. Meiosis - Reduction Division

#### I. Amitosis

It is the simplest mode of cell division and it occurs in unicellular animals, ageing cells and in foetal membranes. During amitosis, nucleus elongates first, and a constriction appears in it which deepens and divides the nucleus into two. Followed by this cytoplasm divides resulting in the formation of two daughter cells.

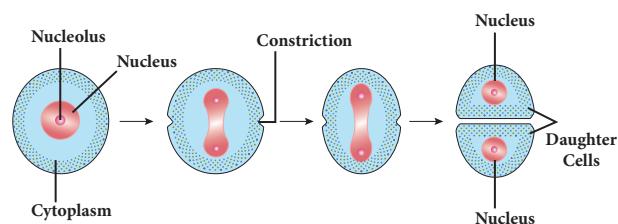
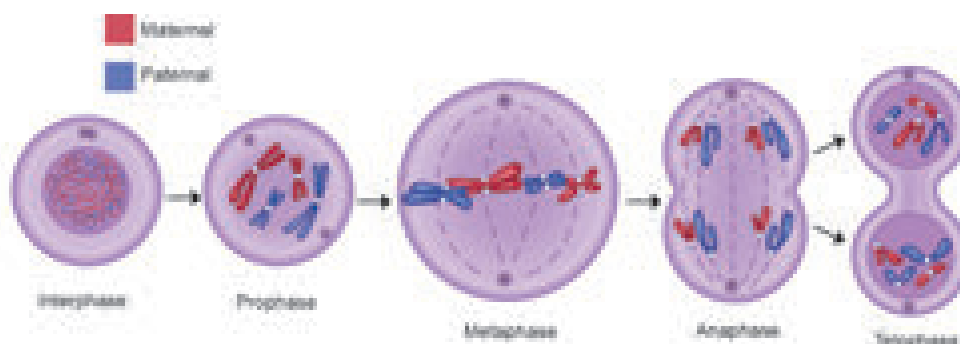


Figure 18.21 Amitosis

#### II. Mitosis

It was first discovered by Fleming in 1879. In this cell division one parent cell divides into two identical daughter cells, each with a nucleus having the same amount of DNA,



**Figure 18.22** Events of Mitosis

same number of chromosomes and genes as the parent cells. It is also called as **equational division**. Mitosis consists of two events, they are: 1. Karyokinesis 2. Cytokinesis

**Interphase:** It is the **resting phase** of the nucleus. It is the interval between two successive cell divisions. The cell prepares itself for the next cell division.

### 1. Karyokinesis

The division of the nucleus into two daughter nuclei is called Karyokinesis. It consists of four phases. They are: Prophase, Metaphase, Anaphase and Telophase.

**Prophase (pro-first):** During this stage chromosomes become short and thick and are clearly visible inside the nucleus. Centrosome splits into centrioles and occupy opposite poles of the cell. Each centriole is surrounded by **aster rays**. Spindle fibres appear between the two centrioles. Nuclear membrane and nucleolus disappear gradually.

**Metaphase (meta – after):** The duplicated chromosomes arrange on the equatorial plane and form the metaphase plate. Each chromosome gets attached to a spindle fibre by its centromere. The centromere of each chromosome divides into two each being associated with a chromatid.

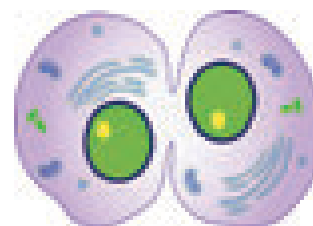
**Anaphase (ana – up, back):** The centromeres attaching the two chromatids divide and the two daughter chromatids of each chromosome separate and migrate towards the two opposite poles.

**Telophase (tele – end):** Each chromatid (or) daughter chromosome lengthens, becomes

thinner and turns into a network of chromatin threads. Spindle fibres breakdown and disappear. Nuclear membrane and nucleolus reappear in each daughter nucleus.

### 2. Cytokinesis

The division of the cytoplasm into two daughter cells by constriction of the cell membrane is called cytokinesis.



**Figure 18.23** Cytokinesis

### Significance of Mitosis

1. This equational division results in the production of diploid daughter cells ( $2n$ ) with equal distribution of genetic material (DNA).
2. In multicellular organisms growth, organ development and increase in body size are accomplished through the process of mitosis
3. Mitosis helps in repair of damaged and wounded tissues by renewal of the lost cells.

### III. Meiosis

The term meiosis was coined by Farmer in 1905. It is the kind of cell division that produces the sex cells or the gametes. It is also called reduction division because the chromosome number is reduced to haploid ( $n$ ) from diploid ( $2n$ ). Meiosis produces four daughter cells from a parent cell.

Meiosis consists of two divisions. They are:

- **Heterotypic Division** or First Meiotic Division
- **Homotypic Division** or Second Meiotic Division

### A. Heterotypic division

It divides the diploid cell into two haploid cells. The daughter cells resulting from this division are different from the parent cell in the chromosome number (Heterotypic). This consists of 5 stages:

- a. Prophase I
- b. Metaphase I
- c. Anaphase I
- d. Telophase I
- e. Cytokinesis I

#### a. Prophase I

Prophase I takes a longer duration and is sub divided into five stages. They are: Leptotene, Zygotene, Pachytene, Diplotene and Diakinesis.

**Leptotene:** The chromosomes become uncoiled and assume long thread like structures and take up a specific orientation inside the nucleus. They form a **bouquet stage**.

**Zygotene (Zygon-adjointing):** Two homologous chromosomes approach each other and begin to pair. Pairing of homologous chromosomes is called as **synapsis**.

**Pachytene (Pachus-thick):** The chromosomes are visible as long paired twisted threads. The pairs so formed are called **bivalents**. Each bivalent now contains four chromatids (**tetrad stage**).

Homologous chromosomes of each pair begin to separate. They do not completely separate, but remain attached together at one or more points by X-shaped arrangements known as **chiasmata**. The chromatids break at these points and the broken segments may be interchanged (crossing over). As a result, the **genetic recombination** takes place.

**Diplotene:** Each individual chromosome of each bivalent begins to split longitudinally into two similar chromatids. The homologous chromosomes repel each other and separate. Chiasmata begin to move along the length of the chromosome from the centromere towards the end resulting in **terminalization**.

**Diakinesis:** The paired chromosomes are shortened and thickened. The nuclear membrane and nucleolus begin to disappear. Spindle fibres make their appearance.

#### b. Metaphase I

The chromosomes move towards the equator and finally they orient themselves on the equator. The two chromatids of each chromosome do not separate. The centromere does not divide.

#### c. Anaphase I

Each homologous chromosome with its two chromatids and undivided centromere move towards the opposite poles of the cell. This stage of the chromosome is called **Diad**.

#### d. Telophase I

The haploid number of chromosomes after reaching their respective poles become uncoiled

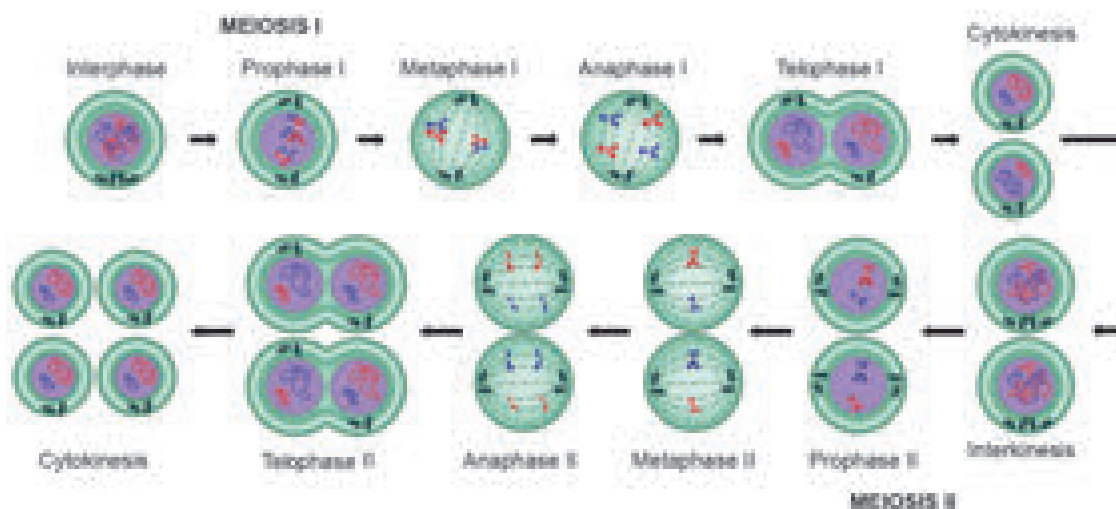


Figure 18.24 Events of Meiosis



and elongated. The nuclear membrane and the nucleolus reappear and thus two daughter nuclei are formed.

**e. Cytokinesis I:** The cytoplasmic division occurs and two haploid cells are formed.

### B. Homotypic Division

In this division, the two haploid cells formed during first meiotic division divide into four haploid cells. The daughter cells are similar to parent cell in the chromosome number (Homotypic). It consists of five stages.

- |                     |                   |
|---------------------|-------------------|
| a. Prophase – II    | b. Metaphase – II |
| c. Anaphase – II    | d. Telophase – II |
| e. Cytokinesis – II |                   |

**a. Prophase II:** The centriole divides into two, each one moves to opposite poles. Asters and spindle fibres appear. Nuclear membrane and nucleolus disappear.

**b. Metaphase II:** The chromosomes get arranged on the equator. Two chromatids are separated.

**c. Anaphase II:** The separated chromatids become daughter chromosomes and move to opposite poles

**d. Telophase II:** The daughter chromosomes are centered. The nuclear membrane and the nucleolus appear.

**e. Cytokinesis II:** Two cells are formed from each haploid daughter cell, resulting in the formation of four cells with haploid number of chromosomes.

### Significance of Meiosis

- The constant number of chromosomes in a given species is maintained by meiotic division.
- Genetic variation is produced due to crossing over within the species which is transmitted from one generation to next generation.

**Table 18.3** Differences between Mitosis and Meiosis

Mitosis	Meiosis
Occurs in somatic cells.	Occurs in reproductive cells.
Involved in growth and occurs continuously throughout life.	Involved in gamete formation only during the reproductively active age.
Consists of single division.	Consists of two divisions.
Two diploid daughter cells are formed.	Four haploid daughter cells are formed.
The chromosome number in the daughter cell is similar to the parent cell (2n).	The chromosome number in the daughter cell is just half (n) of the parent cell.
Identical daughter cells are formed.	Daughter cells are not similar to the parent cell and are randomly assorted.

### Points to Remember

- ❖ In general plant tissues are classified into two types namely Meristems or Meristematic tissues and Permanent tissues.
- ❖ Permanent tissues are of two types: simple tissue and complex tissue.
- ❖ Simple tissues are homogeneous-composed of structurally and functionally similar cells. eg., Parenchyma, Collenchyma and Sclerenchyma.
- ❖ Complex tissues are made of more than one type of cells that work together as a unit. They are Xylem and Phloem
- ❖ Animal tissues can be grouped into four basic types on the basis of their structure and functions. Epithelial tissue, Connective tissue, Muscular tissue and Nervous tissue.
- ❖ Simple epithelium formed of single layer of cells is divided into following types. They are squamous epithelium cuboidal epithelium, columnar epithelium, ciliated epithelium and glandular epithelium
- ❖ Compound Epithelium consists of more than one layer of cells and gives a stratified appearance.
- ❖ The three types of cell division that occur in animal cells are Amitosis, Mitosis and Meiosis.

**A-Z GLOSSARY**

<b>Bivalent</b>	Homologous chromosomes before their duplication in meiosis.
<b>Centromere</b>	kinetochore or primary constriction.
<b>Chiasma</b>	Point of contact and interchange between chromatids of two homologous chromosomes.
<b>Chromatids</b>	Two identical longitudinal halves of a chromosome which share a common centromere with a sister chromatid.
<b>Diploid</b>	Cell having two complete sets of chromosomes.
<b>Haploid</b>	Cell having a single complete set of chromosome.
<b>Interphase</b>	Resting phase of the cell between two cell divisions.
<b>Isodiametric</b>	Having equal diameter of cells or other structures.
<b>Osteocytes</b>	Bone cells present between the lamellae in fluid filled spaces called lacunae.
<b>Synapsis</b>	Pairing of homologous chromosomes during meiosis.
<b>Tetrad</b>	Four haploid cells arising from meiosis formed from four associated chromatids during synapsis.

**TEXTBOOK EXERCISES****I. Choose the correct answer.**

- The tissue composed of living thin walled polyhedral cell is
  - parenchyma
  - pollenchyma
  - pclerenchyma
  - None of above
- The fibres consists of
  - parenchyma
  - sclerenchyma
  - collenchyma
  - None of above
- Companion cells are closely associated with
  - sieve elements
  - vessel elements
  - trichomes
  - guard cells.
- Which of the following is a complex tissue?
  - Parenchyma
  - Collenchyma
  - Xylem
  - Sclerenchyma
- Aerenchyma is found in
  - epiphytes
  - hydrophytes
  - halophytes
  - xerophytes
- Smooth muscles occur in
  - uterus
  - artery
  - vein
  - All of the above.

- Nerve cell does not contains
  - axon
  - nerve endings
  - tendons
  - dendrites

**II. Match the following.**

Sclereids	Chlorenchyma
Chloroplast	Sclerenchyma
Simple tissue	Collenchyma
Companion cell	Xylem
Trachieds	Phloem

**III. Fill in the blanks.**

- \_\_\_\_\_ tissues provide mechanical support to organs.
- Parenchyma, collenchyma, Sclerenchyma are \_\_\_\_\_ type of tissue.
- \_\_\_\_\_ and \_\_\_\_\_ are complex tissues.
- Epithelial cells with cilia are found in \_\_\_\_\_ of our body.
- Lining of small intestine is made up of \_\_\_\_\_.

**IV. State whether true or false. If false, correct the statement.**

1. Epithelial tissue is protective tissue in animal body.
2. Bone and cartilage are two types of areolar connective tissues.
3. Parenchyma is a simple tissue.
4. Phloem is made up of tracheids.
5. Vessels are found in collenchyma.

**V. Answer briefly.**

1. What are intercalary meristems? How do they differ from other meristems?
2. What is complex tissue? Name the various kinds of complex tissues.
3. Mention the most abundant muscular tissue found in our body. State its function.
4. What is skeletal connective tissue? How is it helpful in the functioning of our body?
5. Why should gametes be produced by meiosis during sexual reproduction?
6. In which stage of mitosis the chromosomes align in an equatorial plate? How?

**VI. Answer in detail.**

1. What are permanent tissues? Describe the different types of simple permanent tissues.
2. Write about the elements of Xylem.
3. List out the differences between mitosis and meiosis.

**VII. Higher Order Thinking Skills.**

1. What is the consequence that occur if all blood platelets are removed from the blood?
2. Which are not true cells in the blood? Why?



**REFERENCE BOOKS**

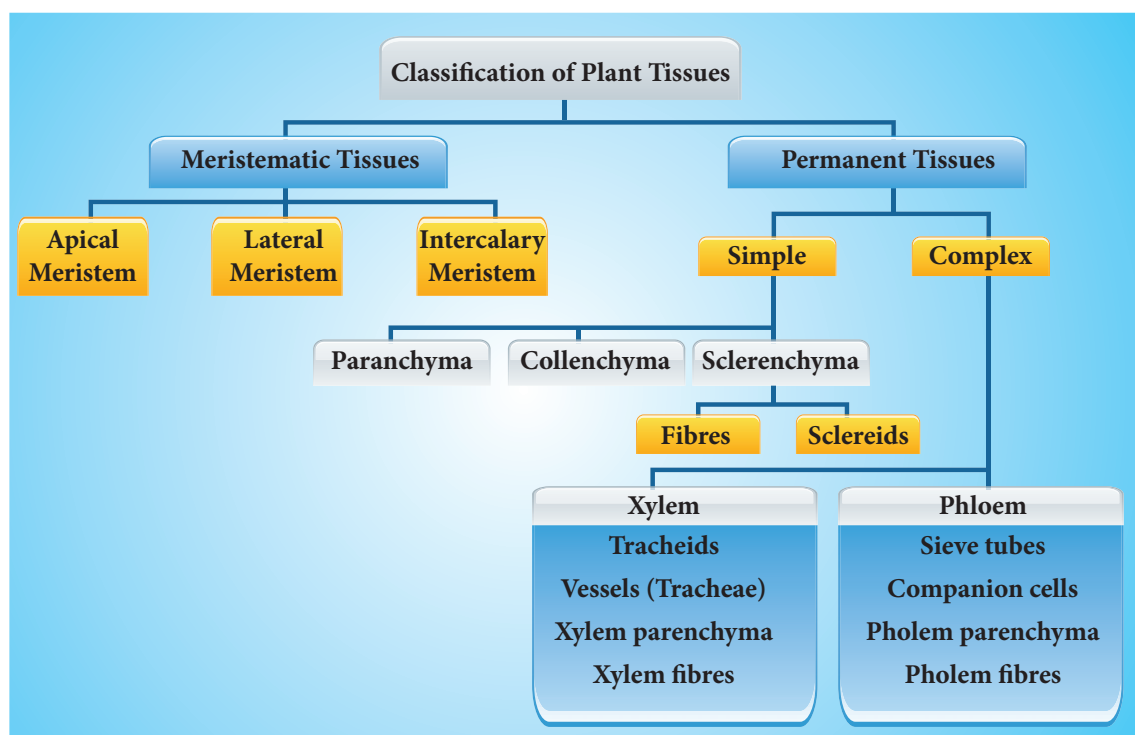
1. Pandey B.P. -Plant Anatomy. S.Chand and Company Ltd, New Delhi.
2. Verma P.S. and Agarwal V.K. -Cytology. S.Chand and Company Ltd, New Delhi.

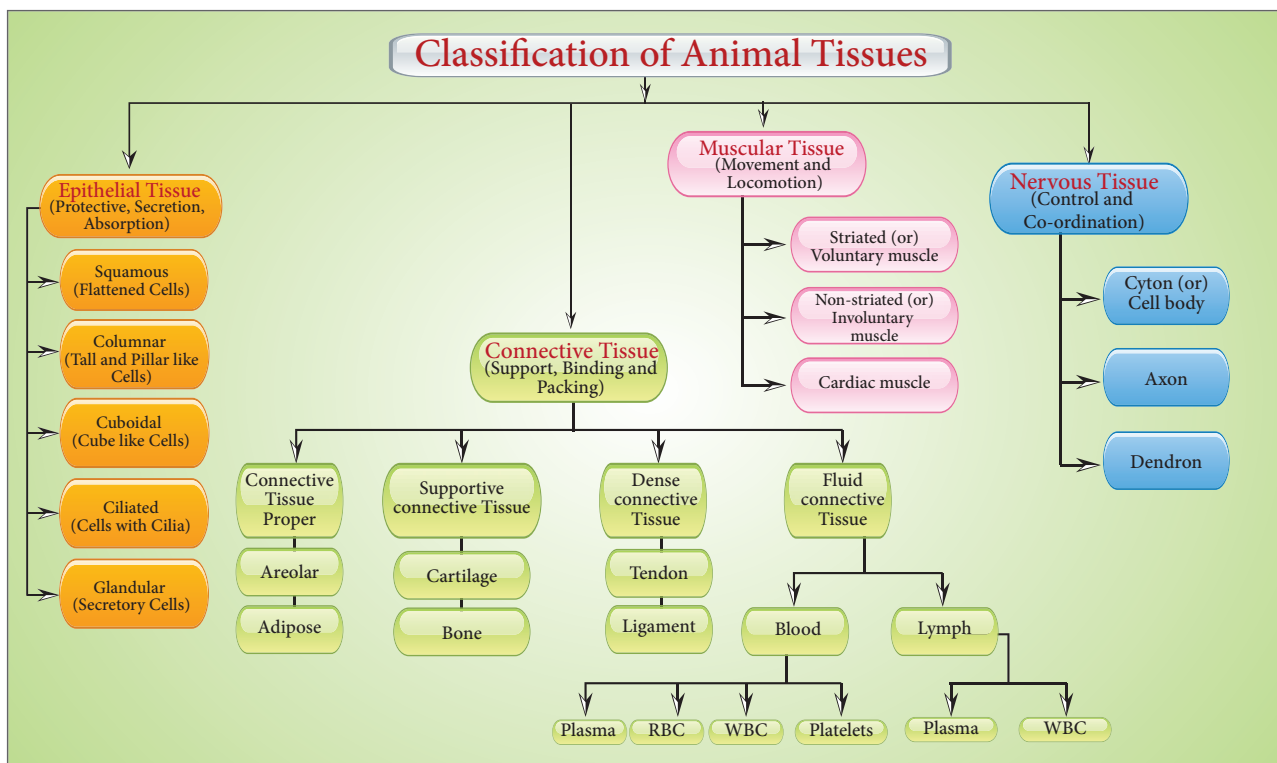


**INTERNET RESOURCES**

- <https://www.britannica.com/science>  
<https://biologydictionary.net>

**Concept Maps**





## ICT CORNER

## Tissues and Organs

Explore this activity to know about the various types of tissues.

- Step 1:** Copy and paste the link given below or type the URL in the browser. Allow 'Adobe Flash Player' to run in the system.
- Step 2:** Then choose an organ from the list to know about the tissues that are in a particular organ.
- Step 3:** Keep selecting the tissues by clicking the 'Use this' option, if you need that particular tissue for that organ.
- Step 4:** Once you finish selecting the tissues you will find a pop-up called 'Happy with this choice.' Click on it to know whether your choice is correct or you should try again. In this way you can build different organs.

### Browse in the link:

URL: <https://www.centreofthecell.org/learn-play/games/build-an-organ/>



B567\_9\_SCI\_EM\_T3

## Learning Objectives

After completing this lesson, students will be able to:

- know that plants too have certain autonomic movements.
- understand different types of movement in plants.
- differentiate tropic movement from nastic movement.
- gain knowledge on transpiration.
- understand that plants produce their food through the process of photosynthesis.
- understand the process of transpiration.



## Introduction

Animals move in search of food, shelter and for reproduction. Do plants show such movement? Have you observed the leaves of *Mimosa pudica* (touch-me-not plant) closes on touching, whereas *Helianthus annuus* (sunflower) follows the path of the sun from dawn to dusk, (from east to west). These movements are triggered by an external stimuli. Unlike animals, plants do not move on their own from one place to another, but can move their body parts for getting sunlight, water and nutrients. They are sensitive to external factors like light, gravity, temperature etc. In this lesson, we will study about various movements in plants, photosynthesis and transpiration.

### 19.1 Tropism in Plants

Tropism is a unidirectional movement of a whole or part of a plant towards the direction of stimuli.

#### 19.1.1 Types of Tropism

Based on the nature of stimuli, tropism can be classified as follows.

**Phototropism:** Movement of a plant part towards light. e.g. shoot of a plant.

**Geotropism:** Movement of a plant in response to gravity. e.g. root of a plant.

**Hydrotropism:** Movement of a plant or part of a plant towards water. e.g. root of a plant.

**Thigmotropism:** Movement of a plant part due to touch. e.g. climbing vines.

**Chemotropism:** Movement of a part of plant in response to chemicals. e.g. growth of a pollen tube in response to sugar present on the stigma.

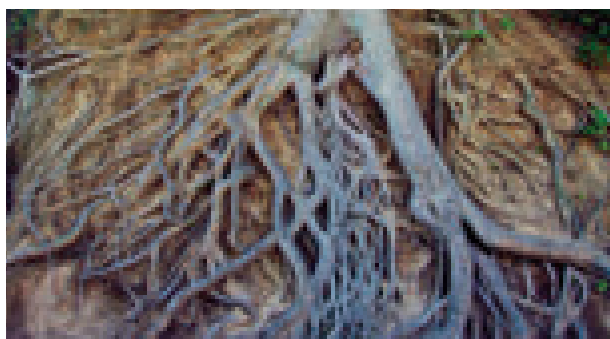
Tropism is generally termed **positive** if growth is **towards the signal** and **negative** if it is **away from the signal**.

Shoot of a plant moves towards the light, the roots move away. Thus the shoots are **positively phototropic**.



**Figure 19.1** Positive phototropism (Negatively geotropic)

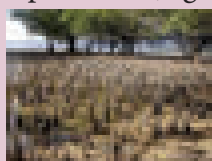
Usually shoot system of a plant is positively phototropic and negatively geotropic and root system is negatively phototropic and positively geotropic.



**Figure 19.2** Negative phototropism (Positively geotropic)



Some halophytes produce negatively geotropic roots (e.g. *Rhizophora*). These roots turn 180° upright for respiration.

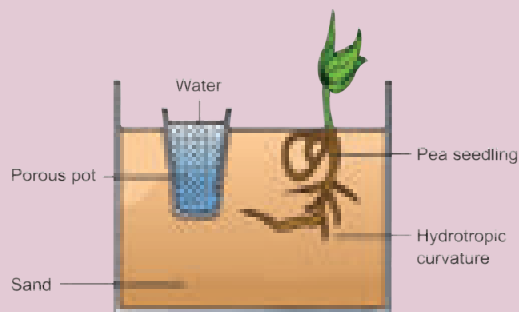


## 19.2 Nastic Movements

Nastic movements are non-directional response of a plant or part of a plant to stimulus. Based on the nature of stimuli, nastic movements are classified as follows.

### Activity 1

Take a glass trough and fill it with sand. Keep a flower pot containing water, plugged at the bottom at the centre of the glass trough. Place some soaked pea or bean seeds around the pot in the sand. What do you observe after 6 or 7 days? Record your observation.



### Activity 2

Take pea seeds soaked in water overnight. Wait for the pea seeds to germinate. Once the seedling has grown put it in a box with an opening for light on one side. After few hours, you can clearly see how the stem has bent and grown towards the light.

**Photonasty:** Movement of a part of a plant in response to light. e.g. *Taraxacum officinale*, blooms in morning and closes in the evening. Similarly, *Ipomea alba* (Moon flower), opens in the night and closes during the day.



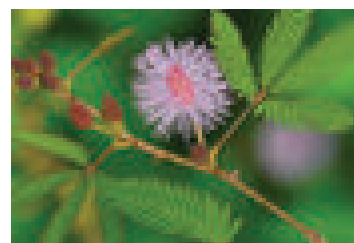
Night



Day

**Figure 19.3** Photonasty in Moon flower

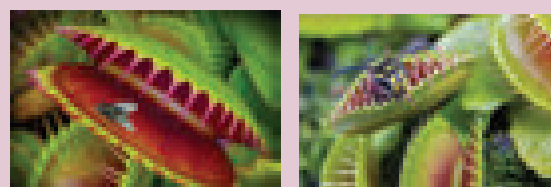
**Thigmonasty:** Movement of a part of plant in response to touch. e.g. *Mimosa pudica*, folds leaves and droops when touched. It is also known as Seismonasty.



**Figure 19.4** Thigmonasty in *Mimosa pudica*



The Venus Flytrap (*Dionaea muscipula*) presents a spectacular example of thigmonasty. It exhibits one of the fastest known nastic movements.



**Table 19.1** Differences between Tropic and Nastic movements

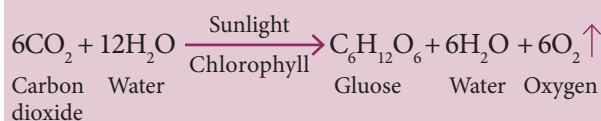
Tropic movements	Nastic movements
Unidirectional response to the stimulus.	Non-directional response to the stimulus.
Growth dependent movements.	Growth independent movements.
More or less permanent and irreversible.	Temporary and reversible.
Found in all plants.	Found only in a few specialized plants.
Slow action.	Immediate action.

**Thermonasty:** Movement of part of a plant is associated with change in temperature. e.g. *Tulip* flowers bloom as the temperature increases.

**Figure 19.5** Thermonasty in Tulip

## 19.3 Photosynthesis

'Photo' means 'light' and 'synthesis' means 'to build'. Thus photosynthesis literally means 'building up with the help of light'. During this process, the light energy is converted into chemical energy. Green plants are autotrophic in their mode of nutrition because they prepare their food materials through a process called photosynthesis. The overall equation of photosynthesis can be given as below:



Do the insects also trap solar energy? Tel Aviv University Scientists have found out that *Vespa orientalis* (Oriental Hornets) have similar capabilities to trap solar energy. They have a yellow patch on its abdomen and an unusual cuticle structure which is a stack of 30 layers thick. The cuticle does not contain chlorophyll but it contains the yellow light sensitive pigment called xanthopterin. This works as a light harvesting molecule transforming light energy into electrical energy.

The end product of photosynthesis is glucose which will be converted into starch and stored in the plant body. Plants take in carbon dioxide for photosynthesis; but for its living, plants also need oxygen to carry on cellular respiration.

### 19.3.1 Requirements for Photosynthesis'

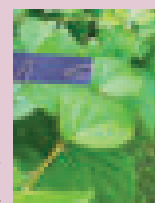
#### Activity 3

Pluck a variegated leaf from *Coleus* plant kept in sunlight. De-starch it by keeping in dark room for 24 hours. Draw the picture of this leaf and mark the patches of chlorophyll on the leaf. Immerse the leaf in boiling water followed by alcohol and test it for starch using iodine solution. Record your observation.



#### Activity 4

Place a potted plant in a dark room for about 2 days to de-starch its leaves. Cover one of its leaves with the thin strip of black paper as shown in the picture. make sure that the leaf is covered on both sides. Keep the potted plant in bright sunlight for 4 to 6 hours. Pluck the selected covered leaf and remove the black paper. Immerse the leaf in boiling water for a few minutes and then in alcohol to remove chlorophyll. Test the leaf now with iodine solution for the presence of starch. The covered part of the leaf does not turn blue-black whereas the uncovered part of the leaf turns blue-black colour. Why are the changes in colour noted in the covered and uncovered part of the leaf?



These activities show that certain things are necessary for photosynthesis. They are:

1. Chlorophyll - Green pigment in leaves
2. Water
3. Carbon dioxide (from air)
4. Sun light

## 19.4 Transpiration

The loss of water in the form of water vapour from the aerial parts of the plant body is called as transpiration. The leaves have tiny, microscopic pores called **stomata**. Water evaporates through these stomata. Each stomata is surrounded by guard cells. These guard cells help in regulating the rate of transpiration by opening and closing of stomata.

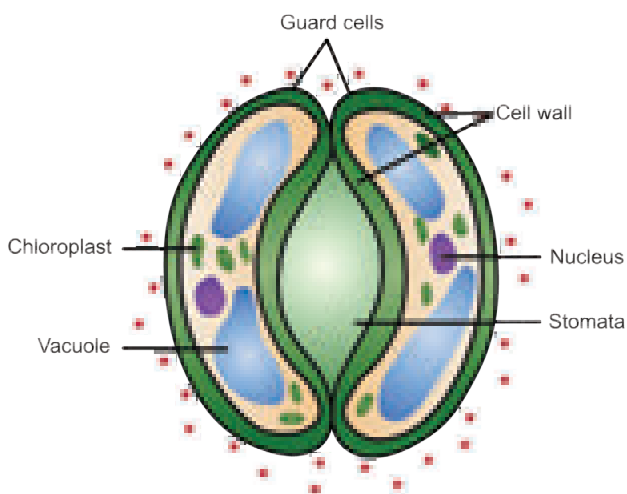


Figure 19.6 Structure of Stomata

### 19.4.1 Types of Transpiration

There are three types of transpiration:

**Stomatal transpiration:** Loss of water from plants through stomata. It accounts for 90-95% of the water transpired from leaves.

**Cuticular transpiration:** Loss of water in plants through the cuticle.

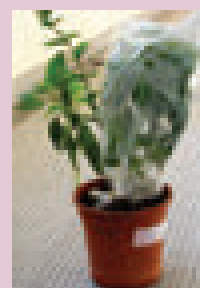
**Lenticular transpiration:** Loss of water from plants as vapour through the lenticels. The lenticels are tiny openings that protrude from the barks in woody stems and twigs as well as in other plant organs.

But transpiration is necessary for the following reasons.

1. It creates a pull in leaf and stem.
2. It creates an absorption force in roots.
3. It is necessary for continuous supply of minerals.
4. It regulates the temperature of the plant.

### Activity 5

Take a plastic bag and tie it over a leaf and place the plant in light. You can see water condensing inside the plastic bag. The water is let out by the leaves. Why does this occur?



### 19.4.2 Exchange of Gases

How does the plant get air? The leaves have minute pores called **stomata** through which the exchange of air takes place. These minute pores can be seen through a microscope. Air exchange takes place continuously through the stomata. Plants exchange gases ( $\text{CO}_2$  to  $\text{O}_2$ ) continuously through these stomata. You will study more about these physiological process in your higher classes.

#### Points to Remember

- ❖ Growth movement whose direction is determined by the direction of the stimulus is called Tropism.
- ❖ Non-directional, response of a plant part to stimulus is called nastic movement.
- ❖ The process by which plants prepare their food material is called photosynthesis.
- ❖ The loss of water in the form of water vapour from the aerial parts of the plant body is called transpiration.
- ❖ Stomata are minute opening on the leaves.



**A-Z GLOSSARY**

<b>Phototropism</b>	Unidirectional movement of a plant part to light stimulus.
<b>Geotropism</b>	Response of a plant part to gravity stimulus.
<b>Hydrotropism</b>	Response of a plant part to water stimulus.
<b>Thigmotropism</b>	Response of a plant part to touch stimulus.
<b>Chemotropism</b>	Response of a plant part to chemical stimulus.
<b>Thigmonasty</b>	Non-directional movement of a plant part in response to touch of an stimulus.
<b>Photonasty</b>	Non-directional movement of a plant part in response to light stimulus.

**TEXTBOOK EXERCISES****I. Choose the correct answer.**

- The tropic movement that helps the climbing vines to find a suitable support is \_\_\_\_\_.  
a. Phototropism      b. Geotropism  
c. Thigmotropism      d. Chemotropism
- The chemical reaction occurs during photosynthesis is \_\_\_\_\_.  
a.  $\text{CO}_2$  is reduced and water is oxidized  
b. water is reduced and  $\text{CO}_2$  is oxidized  
c. both  $\text{CO}_2$  and water are oxidized  
d. both  $\text{CO}_2$  and water are produced
- The bending of root of a plant in response to water is called \_\_\_\_\_.  
a. Thigmonasty      b. Phototropism  
c. Hydrotropism      d. Photonasty
- A growing seedling is kept in the dark room. A burning candle is placed near it for a few days. The tip part of the seedling bends towards the burning candle. This is an example of \_\_\_\_\_.  
a) Chemotropism      b) Geotropism  
c) Phototropism      d) Thigmotropism
- The root of the plant is \_\_\_\_\_.  
i) positively phototropic but negatively geotropic  
ii) positively geotropic but negatively phototropic  
iii) negatively phototropic but positively hydrotropic  
iv) negatively hydrotropic but positively phototropic  
a) (i) and (ii)      b) (ii) and (iii)  
c) (iii) and (iv)      d) (i) and (iv)
- The non-directional movement of a plant part in response to temperature is called \_\_\_\_\_.  
a) Thermotropism      b) Thermonasty  
c) Chemotropism      d) Thigmonasty
- Chlorophyll in a leaf is required for \_\_\_\_\_.  
a) photosynthesis      b) tropic movement  
c) transpiration      d) nastic movement
- Transpiration takes place through \_\_\_\_\_.  
a) fruit      b) seed      c) flower      d) stomata

**II. Fill in the blanks.**

- The shoot system grows upward in response to \_\_\_\_\_
- \_\_\_\_\_ is positively hydrotropic as well as positively geotropic.
- The green pigment present in the plant is \_\_\_\_\_
- The solar tracking of sunflower in accordance with the path of sun is due to \_\_\_\_\_.
- The response of a plant part towards gravity is \_\_\_\_\_.
- Plants take in carbondioxide for photosynthesis but need \_\_\_\_\_ for their living.

**III. Match column A with column B.**

Column A	Column B
Roots growing downwards into soil.	Positive phototropism
Shoots growing towards the light.	Negative geotropism
Shoots growing upward.	Negative phototropism
Roots growing downwards away from light.	Positive geotropism

**IV. State whether true or false. If false, correct the statement.**

- The response of a part of plant to the chemical stimulus is called phototropism.
- Shoot is positively phototropic and negatively geotropic.
- When the weather is hot, water evaporates lesser which is due to opening of stomata.
- Photosynthesis produces glucose and carbon dioxide.
- Photosynthesis is important in releasing oxygen to keep the atmosphere in balance.
- Plants lose water when the stomata on leaves are closed.

**V. Answer very briefly.**

- What is nastic movement?
- Name the plant part
  - Which bends in the direction of gravity but away from the light.
  - Which bends towards light but away from the force of gravity.
- Differentiate phototropism from photonasty.
- Photosynthesis converts energy X into energy Y.
  - What are X and Y?
  - Green plants are autotrophic in their mode of nutrition. Why?
- Define transpiration.
- Name the cell that surrounds the stoma.

**VI. Answer briefly.**

- Give the technical terms for the following:
  - Growth dependent movement in plants.
  - Growth independent movement in plants.
- Explain the movement seen in Pneumatophores of Avicennia.
- Fill in the blanks:
 
$$6\text{CO}_2 + \text{---} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \text{---} + 6\text{O}_2 \uparrow$$
- What is chlorophyll?
- Name the part of plant which shows positive geotropism. Why?
- What is the difference between movement of flower in sunflower plant and closing of the leaves in the *Mimosa pudica*?

7. Suppose you have a rose plant growing in a pot, how will you demonstrate transpiration in it?
8. Mention the differences between stomatal and lenticular transpiration
9. To which directional stimuli do (a) roots respond (b) shoots respond?

### VII. Answer in detail.

1. Differentiate between tropic and nastic movements
2. How will you differentiate the different types of transpiration?

### VIII. Higher Order Thinking Skills.

1. There are 3 plants A, B and C. The flowers of A open their petals in bright light during the day but closes when it gets dark at night. On the other hand, the flowers of plant B open their petals at night but closes during the day when there is bright light. The leaves of plant C fold up and droop when touched with fingers or any other solid object.
  - a) Name the phenomenon shown by the flowers of plant A and B.
  - b) Name one plant each which behaves like the flowers of plant A and B.
  - c) Name the phenomenon exhibited by the leaves of plant C.
  - d) Name the plant which behaves like the leaves of plant 'C'?

2. Imagine that student A studied the importance of certain factors in photosynthesis. He took a potted plant and kept it in dark for 24 hours. In the early hours of the next morning, he covered one of the leaves with dark paper in the centre only. Then he placed the plant in sunlight for a few hours and tested the leaf which was covered with black paper for starch.
  - a) What aspect of photosynthesis was being investigated?
  - b) Why was the plant kept in the dark before the experiment?
  - c) How will you prove that starch is present in the leaves?
  - d) Name the raw materials needed for photosynthesis.



### REFERENCE BOOKS

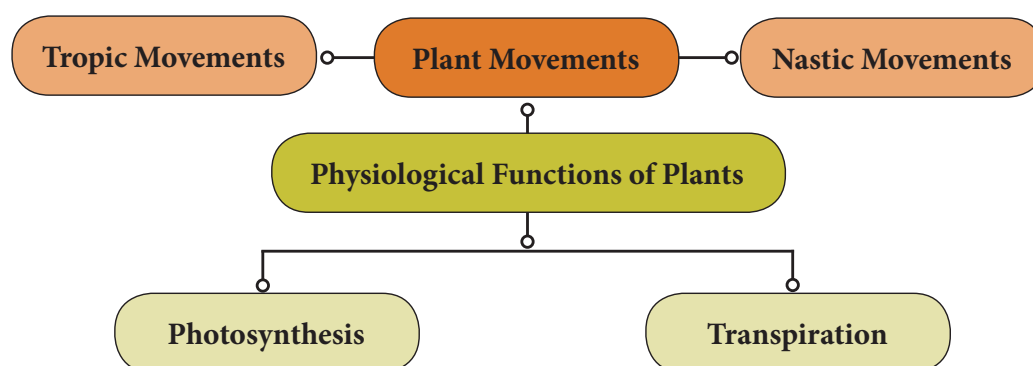
1. Devlin and Witham, 1986. Plant Physiology, 1st edition
2. B.P. Pandey 2003 Modern Practical Botany Vol. II.
3. V.K. Jain 2003 Plant physiology.



### INTERNET RESOURCES

- <http://web.mit.edu/esgbio>  
<http://www.bioedonline.org/>  
<http://www.biology.arizona.edu/default.html>

### Concept Map



## UNIT

## 20

## ORGAN SYSTEMS IN ANIMALS

 Learning Objectives

After completing this lesson, student will be able to:

- define the terms digestion, excretion and reproduction.
- understand the various parts of the alimentary canal and the process of digestion.
- understand the role of enzymes in the process of digestion.
- know the organs involved in the process of excretion.
- understand the role of skin in excretion.
- understand the parts and functions of excretory system.
- learn the functions of male and female human reproductive system.



### Introduction

Living organisms are evolved from the simplest form to complex level of organization. Cells are the basic fundamental units of an organism. These are grouped to form tissues, the tissues into organs and the organs form the organ systems forming an entire organism. The different organs and organ systems of an organism function by depending on one another with harmonious coordination. When we ride a bicycle, our muscular system and skeletal system work together to move our arms for steering and legs for pedalling. Our nervous system directs our arms and legs to work. Simultaneously, respiratory, digestive and circulatory systems work to provide energy to the muscles. All the systems work together in coordination to maintain

the body in a homeostatic condition of an organism.

Organ and organ systems have appeared first in the Phylum platyhelminthes and continues till mammals. Similar groups of cells form tissues like muscle tissue, nervous tissue, etc. Tissues are organised to form organs like heart, brain, etc. Two or more organs together form organ systems and perform common functions like digestion, circulation, nerve impulse transmission in coordination via digestive system, circulatory system, nervous system respectively. Division of labour is found among the various organ systems.

In this chapter we shall learn about the structure and functions of various organ systems like digestive system, excretory system and reproductive system in human beings.

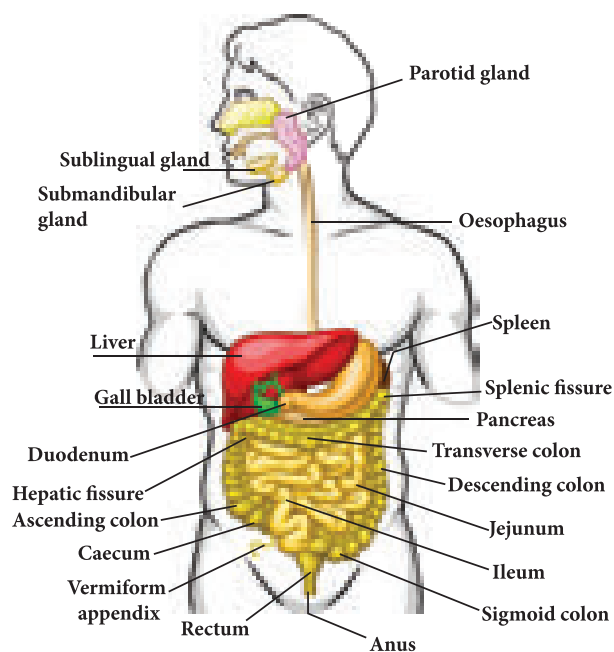
**Table 20.1** Organ Systems in Animals

Organ Systems	Organs	Functions
<b>Integumentary system</b>	Skin and skin glands	Protection, Excretion, etc.
<b>Skeletal system</b>	Skull, Vertebral column, Sternum, Girdles and Limbs	Give support, shape and form to the body.
<b>Muscular system</b>	Muscle fibres	Contraction and relaxation resulting movement.
<b>Nervous system</b>	Brain, spinal cord and nerves.	Conduction of nerve impulse.
<b>Circulatory system</b>	Heart, blood and blood vessels	Transportation of respiratory gases, nutritive substances and waste products.
<b>Respiratory system</b>	Respiratory tract and Lungs	Breathing
<b>Digestive system</b>	Digestive tract and digestive glands	Digestion, Absorption, Egestion
<b>Excretory system</b>	Kidneys, ureters, urinary bladder and urethra.	Elimination of nitrogenous waste products.
<b>Reproductive system</b>	Testes and ovary	Gamete formation and development of secondary sexual characters.
<b>Sensory system</b>	Eyes, nose, ears, tongue and skin	Sight, smell, hearing, taste and touch.
<b>Endocrine system</b>	Pituitary, Thyroid, Parathyroid, Adrenals, Pancreas, Pineal body, Thymus, Reproductive glands, etc.	Co-ordinates the functions of all organ systems.

## 20.1 Human Digestive System

The food we eat contain not only simple substances like vitamins and minerals but also complex substances such as carbohydrates, proteins and fats. The body cannot use these complex substances unless they are converted into simple substances. The five stages of nutrition process include ingestion, digestion, absorption, assimilation and egestion.

The process of nutrition begins with intake of food, called **ingestion**. The breakdown of large complex insoluble food molecules into small, simpler soluble and diffusible particles by the action of digestive enzymes is called **digestion**. Parts of the body concerned with the digestion of food form the **digestive system**.



**Figure 20.1** Parts of human digestive system

The digestive system consists of two sets of organs. They are as follows:

**Alimentary canal (digestive tract/gastro-intestinal tract):** It is a passage starting from the mouth and ending with the anus.

**Digestive glands:** Glands associated with the alimentary canal are the salivary glands, gastric glands, pancreas, liver and intestinal glands.

### 20.1.1 Structure of the Alimentary Canal

Alimentary canal is a muscular coiled, tubular structure. It consists of mouth, buccal cavity, pharynx, oesophagus, stomach, small intestine (consisting of duodenum, jejunum and ileum), large intestine (consisting of caecum, colon and rectum) and anus.

**Mouth:** The mouth leads into the buccal cavity. It is bound by two soft, movable upper and lower lips. The **buccal cavity** is a large space bound above by the palate (which separates the wind pipe and food tube), below by the throat and on the sides by the jaws. The jaws bear teeth.

**Teeth:** Teeth are hard structures meant for holding, cutting, grinding and crushing the food. In human beings two sets of teeth (**Diphyodont**) are developed in their life time. The first appearing set of 20 teeth called temporary or milk teeth are replaced by the second set of thirty two permanent teeth, sixteen in each jaw. Each tooth has a root fitted in the gum (**Thecodont**). Permanent teeth are of four types (**Heterodont**), according to their structure and function namely **incisors, canines, premolars and molars**.

**Table 20.2** Types of teeth and their functions

Types of teeth	Number of teeth	Functions
Incisors	8	Cutting and biting
Canines	4	Tearing and piercing
Premolars	8	Crushing and grinding
Molars	12	Crushing, grinding and mastication

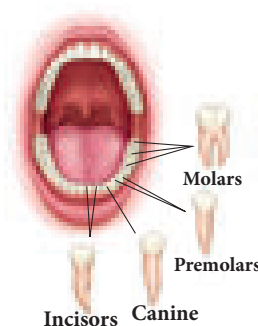
Dental formula represents the number of different type of teeth present in each half of a jaw (upper and lower jaw). The types of teeth are denoted as incisors (i), canine (c), premolars (pm) and molars (m). The dental formula is presented as:

For Milk teeth in each half of upper and lower jaw:

$$\frac{2, 1, 2}{2, 1, 2} = 10 \times 2 = 20$$

For Permanent teeth in each half of upper and lower jaw:

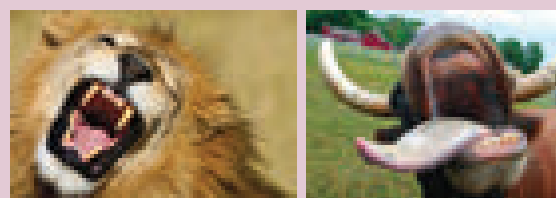
$$\frac{2, 1, 2, 3}{2, 1, 2, 3} = 16 \times 2 = 32$$



**Figure 20.2** Different kinds of teeth

#### Activity 1

Look at the pictures given below and answer the questions that follow:

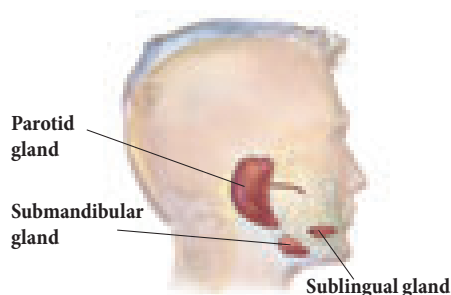


1. Are the teeth of animals similar to ours?
2. How is the shape of their teeth related to their food habit?

**Salivary glands:** Three pairs of salivary glands are present in the mouth cavity. They are: parotid glands, sublingual glands and submaxillary or submandibular glands

- a. **Parotid glands** are the largest salivary glands, which lie in the cheeks in front of the ears (in Greek Par - near ; otid - ear).

- b. **Sublingual glands** are the smallest glands and lie beneath the tongue.
- c. **Submaxillary or Submandibular glands** lie at the angles of the lower jaw.



**Figure 20.3** Salivary glands

The salivary glands secrete a viscous fluid called saliva, approximately 1.5 liters per day. It digests starch by the action of the enzyme **ptyalin** (amylase) in the saliva which converts starch (polysaccharide) into maltose (disaccharide). Saliva also contains an antibacterial enzyme called **lysozyme**.

**Tongue:** The tongue is a muscular, sensory organ which helps in mixing the food with the saliva. The taste buds on the tongue help to recognize the taste of food. The masticated food in the buccal cavity becomes a bolus which is rolled by the tongue and passed through pharynx into the oesophagus by swallowing. During swallowing, the epiglottis (a muscular flap-like structure at the tip of the glottis, beginning of trachea) closes and prevents the food from entering into trachea (wind pipe).

**Pharynx:** The pharynx is a membrane lined cavity behind the nose and mouth, connecting them to the oesophagus. It serves as a pathway for the movement of food from mouth to oesophagus.

**Oesophagus:** Oesophagus or the food pipe is a muscular-membranous canal about 22 cm in length. It conducts food from pharynx to the stomach by peristalsis (wave-like movement) produced by the rhythmic contraction and relaxation of the muscular walls of alimentary canal.

**Stomach:** The stomach is a wide J-shaped muscular organ located between oesophagus and the small intestine. The gastric glands present in the inner walls of the stomach secrete gastric juice. The gastric juice is colourless, highly acidic, containing mucus, hydrochloric acid and enzymes rennin (in infants) and pepsin.

Inactive pepsinogen is converted to active **pepsin** which acts on the proteins in the ingested food. **Hydrochloric acid** kills the bacteria swallowed along with food and makes the medium acidic while the mucus protects the wall of the stomach. The action of the gastric juice and churning of food in the stomach convert the bolus into a semi-digested food called **chyme**. The chyme moves to the intestine slowly through the pylorus.

#### More to Know

- ❑ **Rennin:** Causes curdling of milk protein caesin and increases digestion of proteins.
- ❑ **Renin:** Converts angiotensinogen to angiotensin and regulate the absorption of water and  $\text{Na}^+$  from glomerular filtrate.

**Small intestine:** The small intestine is the longest part of the alimentary canal, which is a long coiled tube measuring about 5 – 7 m. It comprises three parts- duodenum, jejunum and ileum.

- a. **Duodenum** is C-shaped and receives the bile duct (from liver) and pancreatic duct (from pancreas).
- b. **Jejunum** is the middle part of the small intestine. It is a short region of the small intestine. The secretion of the small intestine is intestinal juice which contains the enzymes like **sucrase**, **maltase**, **lactase** and **lipase**.
- c. **Ileum** forms the lower part of the small intestine and opens into the large intestine. Ileum is the longest part of the small

intestine. It contains minute finger like projections called **villi** (one millimeter in length) where absorption of food takes place. They are approximately 4 million in number. Internally, each villus contains fine blood capillaries and lacteal tubes,

The small intestine serves both for digestion and absorption. It receives the bile from liver and the pancreatic juice from pancreas in the duodenum. The intestinal glands secrete the intestinal juices.



**William Beaumont**  
(1785-1853)

William Beaumont was a surgeon who was known as the 'Father of Gastric Physiology'. Based on his observations he concluded that the stomach's strong hydrochloric acid played a key role in digestion.

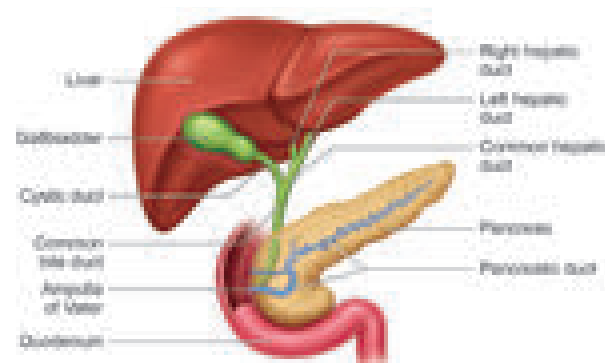
**Liver:** It is the largest digestive gland of the body which is reddish brown in colour. It is divided into two main lobes, right and left lobes. The right lobe is larger than the left lobe. On the under surface of the liver, gall bladder is present. The liver cells secrete **bile** which is temporarily stored in the gall bladder. Bile is released into small intestine when food enters in it. It has **bile salts** (sodium glycolate and sodium tauraglycolate) and **bile pigments** (bilirubin and biliviridin). Bile salts help in the digestion of fats by bringing about their **emulsification** (conversion of large fat droplets into small ones).

#### Functions of Liver

- Controls blood sugar and amino acid levels.
- Synthesizes foetal red blood cells.
- Produces fibrinogen and prothrombin, used for clotting of blood.
- Destroys red blood cells.
- Stores iron, copper, vitamins A and D.

- Produces heparin (an anticoagulant).
- Excretes toxic and metallic poisons.
- Detoxifies substances including drugs and alcohol.

**Pancreas:** It is a lobed, leaf shaped gland situated between the stomach and duodenum. **Pancreas** acts both as an **exocrine gland** and as an **endocrine gland**. The exocrine part of the pancreatic gland secretes pancreatic juice which contains three enzymes- lipase, trypsin and amylase which acts on fats, proteins and starch respectively. The gland's upper surface bears the **islets of Langerhans** which have endocrine cells and secrete hormones in which  **$\alpha$  (alpha) cells** secrete **glucagon** and  **$\beta$  (beta) cells** secrete **insulin**.



**Figure 20.4** Bile duct and Pancreatic duct opening into duodenum

The intestinal glands secrete intestinal juice called **succus entericus** which contains enzymes like maltase, lactase, sucrase and lipase which act in an alkaline medium. From the duodenum the food is slowly moved down to ileum, where the digested food gets absorbed

**a. Absorption of food:** Absorption is the process by which nutrients obtained after digestion are absorbed by villi and circulated throughout the body by blood and lymph and supplied to all body cells according to their requirements.

**b. Assimilation of food:** Assimilation means the incorporation of the absorbed food materials into the tissue cells as their internal and homogenous component. The final products of fat digestion (fatty acids and glycerol) are again converted into fats and



excess fats are stored in adipose tissue. The excess sugars are converted into a complex polysaccharide, glycogen in the liver. The amino acids are utilized to synthesize different proteins required for the body.



The small intestine is about 5 m long and is the longest part of the digestive system. The large intestine is a thicker tube, but is about 1.5 m long.

**Large intestine:** The unabsorbed and undigested food is passed into the large intestine. It extends from the ileum to the anus. It is about 1.5 meters in length. It has three parts- **caecum, colon** and **rectum**.

The caecum is a small blind pouch like structure situated at the junction of the small and large intestine. From its blind end a finger – like structure called **vermiform appendix** arises. It is a **vestigial (functionless) organ** in human beings.

The colon is much broader than ileum. It passes up the abdomen on the right (**ascending colon**), crosses to the left just below the stomach (**transverse colon**) and down on the left side (**descending colon**). The rectum is the last part which opens into the anus. It is kept closed by a ring of muscles called anal sphincter which opens when passing stools.

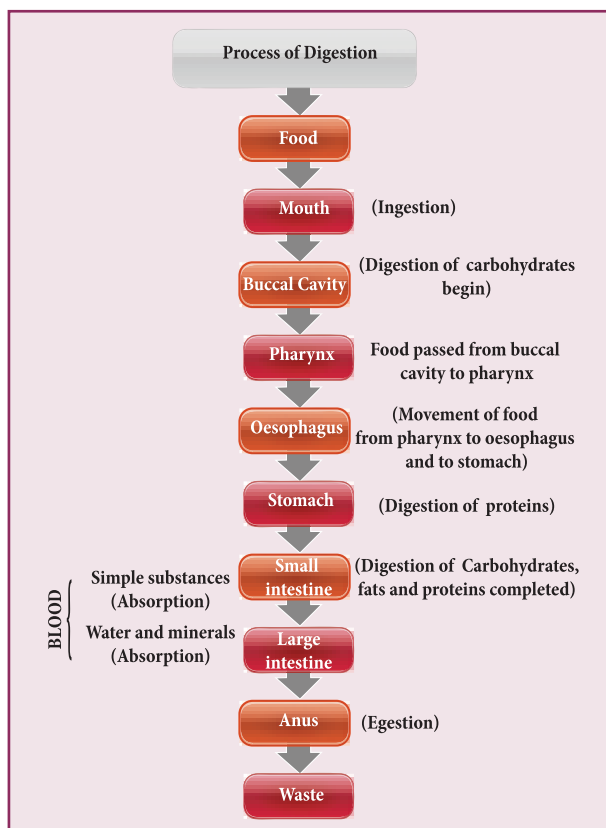
The undigested or unassimilated portion of the ingested food material is thrown out from the body through the anal aperture as faecal matter. This is known as **egestion** or **defaecation**.

### Activity 2

Construct a model of the human digestive system using simple materials like funnel, pipe, cellotape and clean bag. Label its parts and write which parts help in the various steps of digestion.

**Table 20.3** Chart showing the Digestive Enzymes

Digestive glands	Enzymes	Substrate (nutrient)	Products of digestion
<b>Salivary glands</b>	Ptyalin (Salivary amylase)	Starch	Maltose
<b>Gastric glands</b>	Pepsin	Proteins	Peptones
	Rennin (in infants)	Milk protein or caseinogen	Curdles milk to produce casein protein
<b>Pancreas</b>	Pancreatic amylase	Starch	Maltose
	Trypsin	Proteins and peptones	Peptides and amino acids
	Chymotrypsin	Protein	Proteoses, Peptones, Polypeptide, tri and dipeptides
	Pancreatic lipase	Emulsified fats	Fatty acids and Glycerol
<b>Intestinal glands</b>	Maltase	Maltose	Glucose and Glucose
	Lactase	Lactose	Glucose and Galactose
	Sucrase	Sucrose	Glucose and Fructose
	Lipase	Fats	Fatty acids and Glycerol



## 20.2 Human Excretory System

Metabolic activities continuously take place in living cells. All metabolic products produced by the biochemical reactions are not utilized by the body because certain nitrogenous toxic waste substances are also produced. They are called excretory products. In human beings **urea** is the major excretory product. The tissues and organs associated with the removal of waste products constitute the excretory system.

The human excretory system consists of a pair of kidney, which produce the urine, a pair of ureters which conduct the urine from kidneys to the urinary bladder, where urine is stored temporarily and urethra through which the urine is voided by bladder contractions.

If the waste products are accumulated and not eliminated, they become harmful and poisonous to the body. Hence, excretion plays an important role in maintaining the homeostatic condition of the body.

Some of the excretory organs other than kidneys are **skin** (removes small amounts of

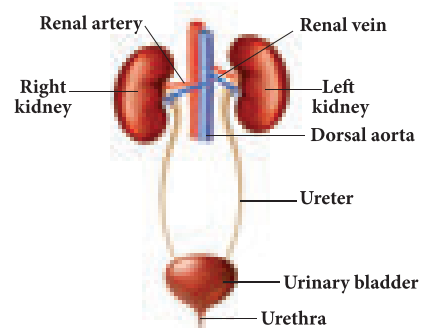


Figure 20.5 Excretory system

water, urea and salts in the form of sweat) and **lungs** (eliminate carbon-dioxide and water vapour through exhaling).

### 20.2.1 Skin

Skin is the outer most covering of the body. It stretches all over the body in the form of a layer. It accounts for 15% of an adult's human body weight. There are many structures and glands derived from the skin. It eliminates metabolic wastes through perspiration.

The human body functions normally at a temperature of about 37 °C. When it gets hot sweat glands start secreting sweat, which contains water with small amounts of other chemicals like ammonia, urea, lactic acid and salts (mainly sodium chloride). The sweat passes through the pores in the skin and gets evaporated.

### 20.2.2 Kidneys

Kidneys are bean-shaped organs reddish brown in colour. The kidneys lie on either side of the vertebral column in the abdominal cavity attached to the dorsal body wall. The right kidney is placed lower than the left kidney as the liver takes up much space on the right side. Each kidney is about 11 cm long, 5 cm wide and 3 cm thick. The kidney is covered by a layer of fibrous connective tissue, the renal capsules, adipose capsule and a fibrous membrane.

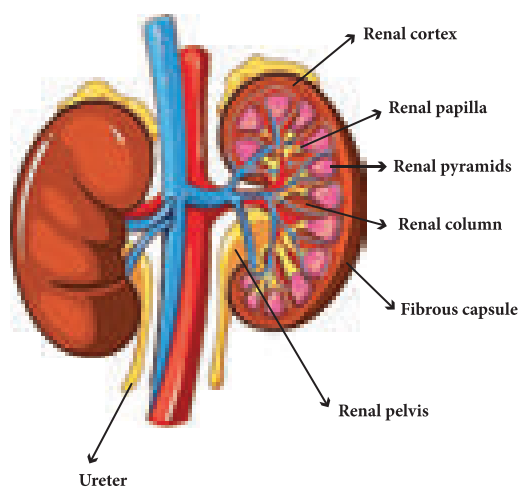
Internally the kidney consists of an outer dark region, the **cortex** and an inner lighter region, the **medulla**. Both of these regions contain **uriniferous tubules** or **nephrons**. The

medulla consists of multitubular conical masses called the medullary pyramids or renal pyramids whose bases are adjacent to cortex. On the inner concave side of each kidney, a notch called **hilum** is present through which blood vessels and nerves enter in and the urine leaves through the Ureter.

**Ureters:** Ureters are thin muscular tubes emerging out from the hilum. Urine enters the ureter from the renal pelvis and is conducted along the ureter by peristaltic movements of its walls. The ureters carry urine from kidney to urinary bladder.

**Urinary bladder:** Urinary bladder is a sac-like structure, which lies in the pelvic cavity of the abdomen. It stores urine temporarily.

**Urethra:** Urethra is a membranous tube, which conducts urine to the exterior. The urethral sphincters keep the urethra closed and opens only at the time of **micturition** (urination).



**Figure 20.6** Longitudinal section of human kidney

### Functions of kidney

1. Maintains the fluid and electrolytes balance in our body.
2. Regulates acid-base balance of blood.
3. Maintains the osmotic pressure in blood and tissues.
4. Helps to retain the important plasma constituents like glucose and amino acids.



### 20.2.3 Structure of Nephron

Each kidney consists of more than one million nephrons. **Nephrons or uriniferous tubules** are structural and functional units of the kidneys. Each nephron consists of **Renal corpuscle** or **Malpighian corpuscle** and **renal tubule**. The renal corpuscle consists of a cup-shaped structure called **Bowman's capsule** containing a bunch of capillaries called **glomerulus**. Blood enters the glomerular capillaries through **afferent** arterioles and leaves out through **efferent** arterioles. The Bowman's capsule continues as the renal tubule which consists of three regions **proximal convoluted tubule**, U-shaped hair pin loop, the **loop of Henle** and the **distal convoluted tubule**. The distal convoluted tubule opens into the **collecting tubule**. The nitrogenous wastes are drained into renal pelvis which leads to ureters and stored in the urinary bladder. Urine is expelled out through the urethra.

### 20.2.4 Mechanism of Urine Formation

The process of urine formation includes the following three stages.

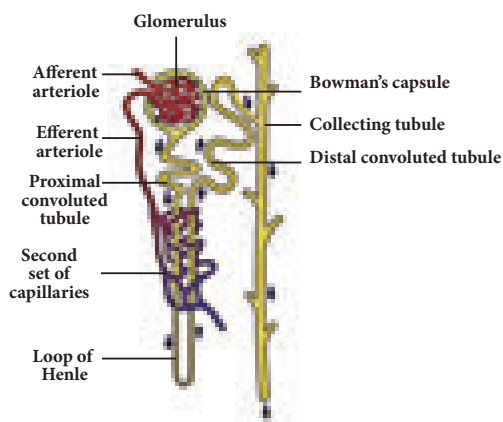
- Glomerular filtration
- Tubular reabsorption
- Tubular secretion

**Glomerular filtration:** Urine formation begins with the filtration of blood through epithelial walls of the glomerulus and Bowman's capsule. The filtrate is called as the glomerular filtrate. Both essential and non-essential substances present in the blood are filtered.

**Tubular reabsorption:** The filtrate in the proximal tubule consists of essential substances such as glucose, amino acids, vitamins, sodium, potassium, bicarbonates and water that are reabsorbed into the blood by a process of **selective reabsorption**.

**Tubular secretion:** Substances such as  $H^+$  or  $K^+$  ions are secreted into the tubule. This tubular filtrate is finally known as urine, which is **hypertonic** in man. Finally the urine passes

into collecting ducts to the pelvis and through the ureter into the urinary bladder. When the urinary bladder is full the urine is expelled out through the urethra. This process is called **micturition**. A healthy person excretes one to two litres of urine per day.



**Figure 20.7** Structure of Nephron



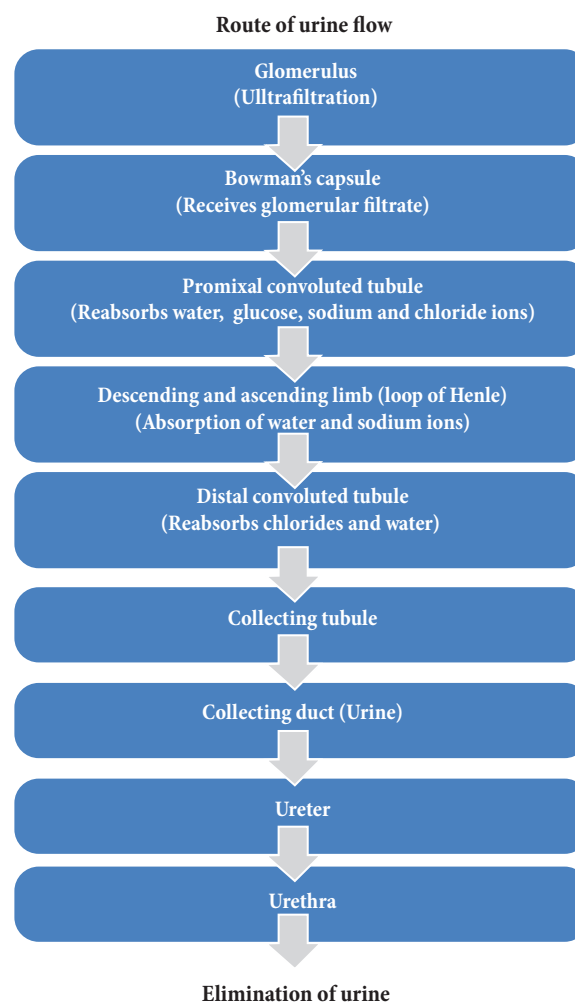
Two healthy kidneys contain a total of about 2 million nephrons, which filter about 170-180 litres of blood per day. The kidneys reabsorb and redistribute 99% of the blood volume and only 1% of the blood filtered becomes urine.

**Dialysis or Artificial kidney :** When kidneys lose their filtering efficiency, excessive amount of fluid and toxic waste accumulate in the body. This condition is known as **kidney (renal) failure**. For this, an artificial kidney is used to filter the blood of the patient. The patient is said to be put on dialysis and the process of purifying blood by an artificial kidney is called **haemodialysis**. When renal failure cannot be treated by drug or dialysis, the patients are advised for kidney transplantation.



**First kidney transplant**

In 1954, Joseph E. Murray and his colleagues at Peter Bent Brigham Hospital in Boston, USA performed first successful kidney transplant between Ronald and Richard Herrick who were identical twins. The recipient Richard Herrick died after 8 years of transplantation



**20.3 Human Reproductive System**

The capacity to reproduce is one of the most important characteristics of living beings. There is a distinct sexual dimorphism in human beings i.e., males are visibly different from females in physical build up, external genital organs and secondary sexual characters.

The reproductive systems of male and female consist of many organs which are distinguished as primary and secondary sex organs. The primary sex organs are gonads, which produce gametes (sex cells) and secrete sex hormones. The secondary sex organs include the genital ducts and glands which help in the transportation of gametes and enable the reproductive process.

The reproductive organs become functional after attaining sexual maturity. In males, sexual

maturity is attained at the age of 13-14 years. In females, it is attained at the age of 11-13 years. This age is known as the age of puberty. During sexual maturity, hormonal changes take place in males and females and secondary sexual characters are developed under the influence of these hormones.

### 20.3.1 Male Reproductive System

Human male reproductive system consists of testes (primary sex organs), scrotum, vas deferens, urethra, penis and accessory glands.

**Testes:** A pair of testes lies outside the abdominal cavity of the male. These testes are the male gonads, which produce male gametes (**sperms**) and male sex hormone (**Testosterone**). Along the inner side of each testis lies a mass of coiled tubules called **epididymis**. The **Sertoli cells** of the testes provide nourishment to the developing sperms.

**Scrotum:** The scrotum is a loose pouch-like sac of skin which is divided internally into right and left **scrotal sacs** by muscular partition. The two testes lie in the respective scrotal sacs. It also contains many nerves and blood vessels. The **scrotum** acts as a **thermoregulator organ** and provides an optimum temperature for the formation of sperms. The sperms develop at a temperature of 1-3°C lower than the normal body temperature.

**Vas deferens:** It is a straight tube which carries the sperms to the **seminal vesicles**. The sperms are stored in the seminal plasma of seminal vesicle, which is rich in fructose, calcium and enzymes. Fructose is a source of energy for the sperm. The **vas deferens** along with seminal vesicles opens into ejaculatory duct which expels the sperm and its secretions from seminal vesicles into the urethra.

**Urethra:** It is contained inside the penis and conveys the sperms from the vas deferens which pass through the urethral opening. The accessory glands associated with the male reproductive system consist of seminal vesicles, prostate gland and Cowper's glands. The secretions of these glands form seminal fluid and mixes with the sperm to form

semen. This fluid provides nutrition and helps in the transport of sperms.

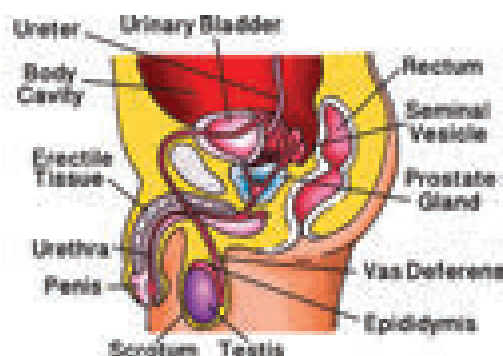


Figure 20.8 Male reproductive system



The sperm is the smallest cell in the male body. A normal male produces more than 500 billion sperm cells in his life time. The process of formation of sperms is known as spermatogenesis.

### 20.3.2 Female Reproductive System

The female reproductive system consists of ovaries (primary sex organs), oviducts, uterus and vagina.

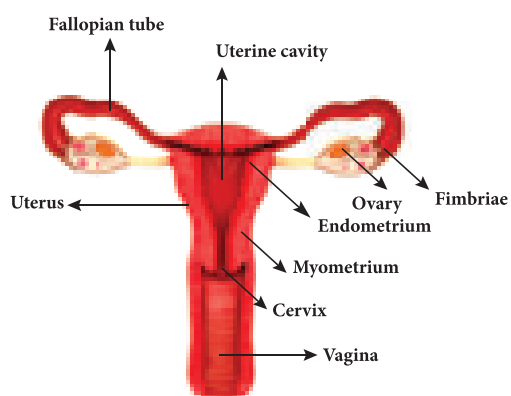
**Ovaries:** A pair of almond-shaped ovaries is located in the lower part of abdominal cavity near the kidneys in female. The ovaries are the female gonads, which produce female gametes (**eggs or ova**) and secrete female sex hormones (**Oestrogen and Progesterone**). A mature ovary contains a large number of ova in different stages of development.

**Fallopian tubes (Oviducts):** These are paired tubes originating from uterus, one on either side. The terminal part of **fallopian tube** is funnel-shaped with finger-like projections called **fimbriae** lying near the ovary. The fimbriae pick up the ovum released from ovary and push it into the fallopian tube.

**Uterus:** Uterus is a pear-shaped muscular, hollow structure present in the pelvic cavity. It lies between urinary bladder and rectum.

Development of foetus occurs inside the uterus. The narrower lower part of uterus is called **cervix**, which leads into vagina.

**Vagina:** The uterus narrows down into a hollow muscular tube called vagina. It connects cervix and the external genitalia. It receives the sperms, acts as birth canal during child birth (**parturition**).



**Figure 20.9** Female reproductive system

### Points to Remember

- ❖ All the organ systems work together in coordination to maintain the body in a homeostatic condition of an organism.
- ❖ Alimentary canal consists of mouth, buccal cavity, pharynx, oesophagus, stomach, small intestine (consisting of duodenum, jejunum and ileum), large intestine (consisting of caecum, colon and rectum) and anus.
- ❖ The five stages of nutrition process include ingestion, digestion, absorption, assimilation and egestion.
- ❖ The small intestine serves both for digestion and absorption.
- ❖ The human excretory system consists of a pair of kidney, which produce the urine.
- ❖ The process of urine formation includes the following three stages: Glomerular filtration, tubular reabsorption and tubular secretion.
- ❖ The reproductive organ of male is testis and female is ovary which are distinguished as primary sex organs.

### More to Know

An ovum is the largest human cell. The process of formation of ova is known as **oogenesis**.

## A-Z GLOSSARY

<b>Emulsification</b>	Conversion of large fat droplets into smaller ones.
<b>Enzymes</b>	Substances produced by living organisms which acts as a catalyst to bring about specific biochemical reactions.
<b>Homeostasis</b>	Tendency of the body to seek and maintain a balance condition or equilibrium within its internal environment.
<b>Mastication (Chewing)</b>	Process by which food is crushed and ground by teeth.
<b>Metabolism</b>	Sum total of all chemical and energy changes taking place in an organism.
<b>Osmoregulation</b>	Maintenance of constant osmotic pressure in the fluids of an organism by the control of water and salt concentration.
<b>Regurgitation</b>	Act of bringing swallowed food back into the mouth.
<b>Toxic substance</b>	Substances that can be poisonous or cause health effects to living organisms.



## TEXTBOOK EXERCISES



### I. Choose the correct answer.

- Which of the following is not a salivary gland?
  - Sublingual
  - Lachrymal
  - Submaxillary
  - Parotid
- Stomach of human beings mainly digests \_\_\_\_\_
  - carbohydrates
  - proteins
  - fat
  - sucrose
- To prevent the entry of food into the trachea, the opening is guarded by \_\_\_\_\_
  - epiglottis
  - glottis
  - hard palate
  - soft palate
- Bile helps in the digestion of \_\_\_\_\_
  - proteins
  - sugar
  - fats
  - carbohydrates
- The structural and functional unit of the kidney is \_\_\_\_\_
  - villi
  - liver
  - nephron
  - ureter
- Which one of the following substance is not a constituent of sweat?
  - Urea
  - Protein
  - Water
  - Salt
- The common passage meant for transporting urine and sperms in male is \_\_\_\_\_
  - ureter
  - urethra
  - vas deferens
  - scrotum
- Which of the following is not a part of female reproductive system?
  - Ovary
  - Uterus
  - Testes
  - Fallopian tube

### II. Fill in the blanks.

- The opening of the stomach into the intestine is called \_\_\_\_\_.

- The muscular and sensory organ which helps in mixing the food with saliva is \_\_\_\_\_.
- Bile, secreted by liver is stored temporarily in \_\_\_\_\_.
- The longest part of alimentary canal is \_\_\_\_\_.
- The human body functions normally at a temperature of about \_\_\_\_\_.
- The largest cell in the human body of a female is \_\_\_\_\_.

### III. State whether true or false. If false, correct the statement.

- Nitric acid in the stomach kills microorganisms in the food.
- During digestion, proteins are broken down into amino acids.
- Glomerular filtrate consists of many substances like amino acids, vitamins, hormones, salts, glucose and other essential substances.

### IV. Match the following.

Organ	Elimination
Skin	a. Urine
Lungs	b. Sweat
Intestine	c. Carbon dioxide
Kidneys	d. Undigested food

### V. Differentiate the following.

- Excretion and Secretion
- Absorption and Assimilation
- Ingestion and Egestion
- Diphyodont and Heterodont
- Incisors and Canines

**VI. Answer briefly.**

- How is the small intestine designed to absorb digested food?
- Why do we sweat?
- Mention any two vital functions of human kidney.
- What is micturition?
- Name the types of teeth present in an adult human being. Mention the functions of each.
- Explain the structure of nephron.

**VII. Answer in detail.**

- Describe the alimentary canal of man
- Explain the structure of kidney and the steps involved in the formation of urine

**VIII. Assertion and reason type questions.**

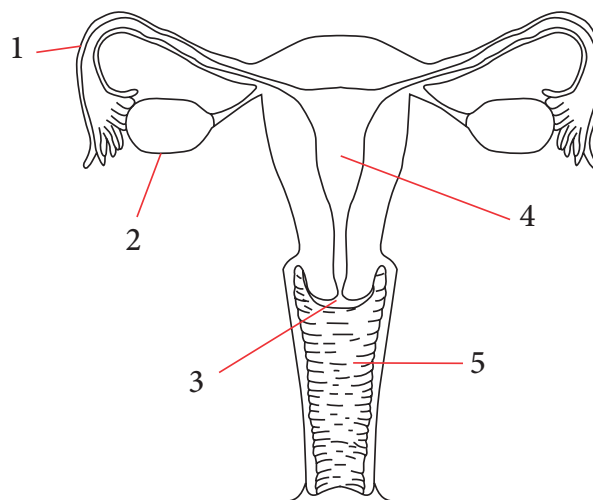
Mark the correct answer as:

- If both Assertion and Reason are true and Reason is the correct explanation of Assertion.
  - If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
  - If Assertion is true but Reason is false.
  - If both Assertion and Reason are false.
- Assertion: Urea is excreted out through the kidneys.  
Reason: Urea is a toxic substance.
  - Assertion: In both the sexes gonads perform dual function.  
Reason: Gonads are also called primary sex organs.

**IX. Higher Order Thinking Skills**

- If pepsin is lacking in gastric juice, then which event in the stomach will be affected?
  - digestion of starch into sugars.
  - breaking of proteins into peptides.
  - digestion of nucleic acids.
  - breaking of fats into glycerol and fatty acids.
- Name the blood vessel that (a) enter malphigian capsule and (b) leaves malphigian capsule.
- Why do you think that urine analysis is an important part of medical diagnosis?
- Why your doctor advises you to drink plenty of water?
- Can you guess why there are sweat glands on the palm of our hands and the soles of our feet?

**X. Match the parts of the given figure with the correct option.**



1	2	3	4	5
a. Fallopian tube	Oviduct	Uterus	Cervix	Vagina
b. Oviduct	Cervix	Vagina	Ovary	Vas deferens
c. Ovary	Oviduct	Uterus	Vagina	Cervix
d. Fallopian tube	Ovary	Cervix	Uterus	Vagina





**REFERENCE BOOKS**

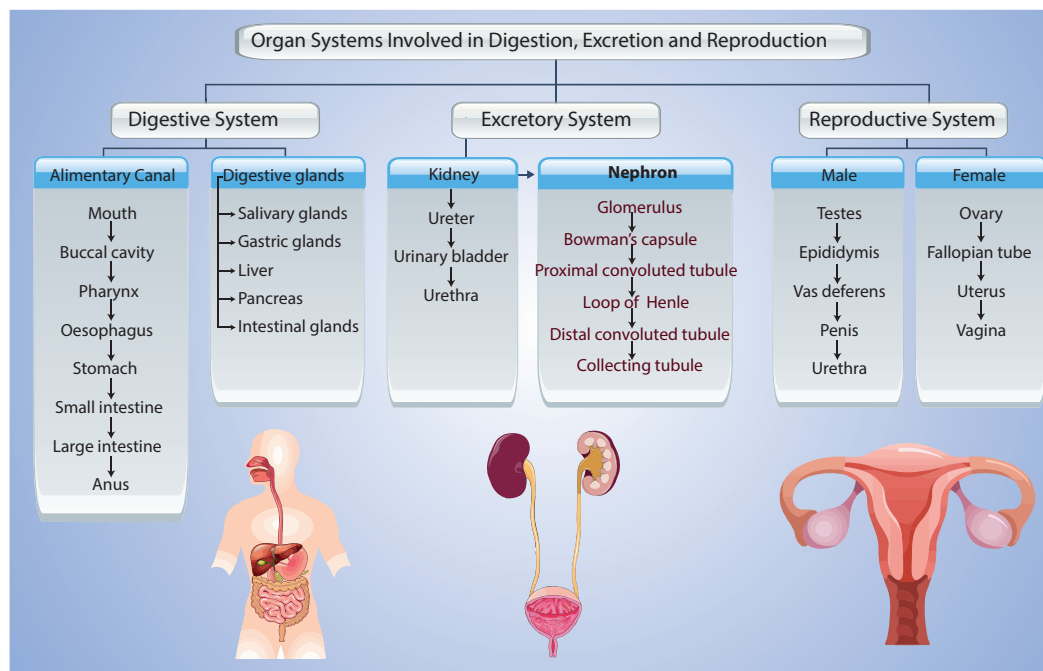
Verma P.S and Agarwal, V.K. Animal Physiology, S. Chand and Company, New Delhi



**INTERNET RESOURCES**

https://www.britannica.com/science/human-digestive-system  
 https://biologydictionary.net/excretory-system/  
 https://www.britannica.com/science/human-reproductive-system

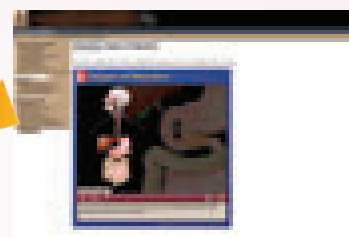
**Concept Map**



**ICT CORNER**

**Human digestive system**

This activity enables to explore the functions of every part in the digestive system



**Steps**

- Type the URL link given below in the browser or scan the QR code. You can view “the digestive system”.
- Click the **go to interactive mode** to explore the functions of each part you want to learn.
- Every part and its function can be learnt by clicking that particular part that we want to learn.
- Also you can see the process of digestion by clicking **go to animation mode**.

**Browse in the link:**

URL: [http://higher.ed.mheducation.com/sites/0072495855/student\\_view0/chapter26/animation\\_\\_organs\\_of\\_digestion.html](http://higher.ed.mheducation.com/sites/0072495855/student_view0/chapter26/animation__organs_of_digestion.html)



## NUTRITION AND HEALTH

 Learning Objectives


After completing this lesson, students will be able to:

- understand the classification of nutrients.
- list the sources, functions and deficiency disorders of vitamins and minerals.
- gain knowledge about different methods of food preservation.
- identify the adulterants in food.
- explain the role of different food quality certifying agents of our country.

## Introduction

Food is the basic necessity of life. Food is defined as any substance of either plant or animal origin consumed to provide nutritional support for an organism. It contains essential nutrients that provide energy, helps in normal growth and development, repair the worn out tissues and protect the body from diseases.

Food contamination with microorganisms is a major source of illness either in the form of infections or poisoning. Food safety is becoming a major concern these days. Adulteration of foodstuffs is commonly practiced in India by traders. Food is contaminated or adulterated from production to consumption for financial gain. The normal physiological functions of a consumer are affected due to either addition of a deleterious substance or the removal of a vital component. Food laws have come into existence to maintain the quality of food produced in our country. Let us study about them in detail.

## 21.1 Classes of Nutrients

Nutrients are classified into the following major groups as given below.

- Carbohydrates
- Proteins
- Fats
- Vitamins
- Minerals

### 21.1.1 Carbohydrates

Carbohydrates are organic compounds composed of carbon, hydrogen and oxygen. Carbohydrate is an essential nutrient which provides the chief source of energy to the body. Glucose, sucrose, lactose, starch, cellulose are examples for carbohydrates.

Carbohydrates are classified as monosaccharide (Glucose), disaccharide (Sucrose) and polysaccharide (Cellulose). The classification is based on the number of sugar molecules present in each group.

### 21.1.2 Proteins

Proteins are the essential nutrients and also the building blocks of the body. They are essential for growth and repair of body cells and tissues. Proteins are made of amino acids.

Essential amino acids are those that cannot be biosynthesized by the body and must be obtained from the diet. The nine essential amino acids are phenylalanine, valine, threonine, tryptophan, methionine, leucine, isoleucine, lysine and histidine.

### 21.1.3 Fats

Fat in the diet provides energy. They maintain cell structures and are involved in metabolic functions.

Essential fatty acids cannot be synthesized in the body and are provided through diet. Essential fatty acids required in human nutrition are omega fatty acids.

### 21.1.4 Vitamins

Vitamins are the vital nutrients, required in minute quantities to perform specific physiological and biochemical functions.



#### More to Know

Dr. Funk introduced the term vitamin. Vitamin A was given the first letter of the alphabet, as it was the first vitamin discovered.

**DO YOU KNOW?** Human skin can synthesize Vitamin D when exposed to sunlight (especially early morning). When the sun rays fall on the skin dehydrocholesterol is converted into Vitamin D. Hence, Vitamin D is called as **Sunshine vitamin**. Vitamin D improves bone strength by helping body to absorb calcium.

### 21.1.5 Minerals

Minerals are inorganic substances required as an essential nutrient by organisms to perform various biological functions necessary for life. They are the constituents of teeth, bones, tissues, blood, muscle and nerve cells.

The **macrominerals** required by the human body are calcium, phosphorus, potassium, sodium and magnesium. The **microminerals** required by the human body also called **trace elements** are sulfur, iron, chlorine, cobalt, copper, zinc, manganese, molybdenum, iodine and selenium.

## 21.2 Protein Energy Malnutrition (PEM)

Absence of certain nutrients in our daily diet over a long period of time leads to deficiency diseases. This condition is referred as Malnutrition. Deficiency of proteins and energy leads to severe conditions like: Kwashiorkar and Marasmus.

**Table 21.1** Dietary sources of major foodstuffs

Major food stuffs	Dietary sources	Daily requirements (grams)
Carbohydrates	Honey, sugarcane, fruits, whole grains, starchy vegetables, rice	150-200
Proteins	Legumes, pulses, nuts, soya bean, green leafy vegetables, fish, poultry products, egg, milk and dairy products	40
Fats	Egg yolk, saturated oil, meat	35

**Table 21.2** Vitamins-Dietary sources, Deficiency disorders and Symptoms

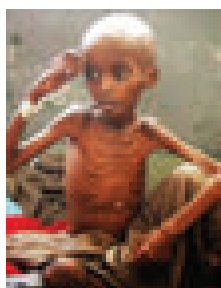
Vitamins	Sources	Deficiency disorders	Symptoms
<b>Fat Soluble Vitamins</b>			
<b>Vitamin A</b> (Retinol)	Carrot, papaya, leafy vegetables, fish liver oil, egg yolk, liver, dairy products	Xerophthalmia Nyctalopia (Night blindness)	Dryness of Cornea Unable to see in the night (dim light) Scaly skin
<b>Vitamin D</b> (Calciferol)	Egg, liver, dairy products, Fish, synthesized by the skin in sunlight	Rickets (in children)	Bow legs, defective ribs, development of pigeon chest
<b>Vitamin E</b> (Tocopherol)	Whole wheat, meat, vegetable oil, milk	Sterility in rats, Reproductive abnormalities	Sterility
<b>Vitamin K</b> (Derivative of Quinone)	Leafy vegetables, soyabeans, milk	Blood clotting is prevented	Excessive bleeding due to delayed blood clotting
<b>Water Soluble Vitamins</b>			
<b>Vitamin B1</b> (Thiamine)	Whole grains, yeast, eggs, liver, sprouted pulses	Beriberi	Degenerative changes in the nerves, muscles become weak, paralysis
<b>Vitamin B2</b> (Riboflavin)	Milk, eggs, liver, green vegetables, whole grains	Ariboflavinosis (Cheilosis)	Irritation in eyes, dry skin, inflammation of lips, fissures in the corners of the mouth
<b>Vitamin B3</b> (Niacin)	Milk, eggs, liver, lean meat, ground nuts, bran	Pellagra	Inflammation of skin, loss of memory, diarrhoea
<b>Vitamin B6</b> (Pyridoxine)	Meat, fish, eggs, germs of grains and cereals, rice polishings	Dermatitis	Scaly skin, nervous disorders
<b>Vitamin B12</b> (Cyanocobalamine)	Milk, meat, liver, pulses, cereals, fish	Pernicious anaemia	Decrease in red blood cell production, degeneration of spinal cord
<b>Vitamin C</b> (Ascorbic acid)	Leafy vegetables, sprouts, citrus fruits like goose berry (Amala), lemon, orange	Scurvy	Swollen and bleeding gums, delay in healing of wounds, teeth and bones malformed

**Table 21.3** Minerals - Dietary sources, Functions and Deficiency disorders

Minerals	Sources	Functions	Deficiency disorders
<b>Macronutrients</b>			
<b>Calcium</b>	Dairy products, beans, cabbage, eggs, fish	Constituent of bones and enamel of teeth, clotting of blood and controls muscle contraction.	Bone deformities, poor skeletal growth, osteoporosis in adults.
<b>Sodium</b>	Common salt	Maintains fluid balance and involved in neurotransmission.	Muscular cramps, nerve impulses do not get transmitted.
<b>Potassium</b>	Banana, sweet potato, nuts, whole grains, citrus fruits	Regulates nerve and muscle activity.	Muscular fatigue, nerve impulses do not get transmitted.
<b>Micronutrients</b>			
<b>Iron</b>	Spinach, dates, greens, broccoli, whole cereals, nuts, fish, liver	Important component of haemoglobin.	Anaemia
<b>Iodine</b>	Milk, Seafood, Iodised salt	Formation of thyroid hormones.	Goitre

**Kwashiorkar:** It is a condition of severe protein deficiency. It affects children between 1-5 years of age, whose diet mainly consists of carbohydrates but lack in proteins.

**Marasmus:** It usually affects infants below the age of one year when the diet is poor in carbohydrates, fats and proteins.

**Kwashiorkar****Marasmus****Figure 21.1** Malnutrition

## 21.3 Food Hygiene

Food spoilage is an undesirable change in the normal state of food and is not suitable for human consumption. Poor personal hygiene may allow pathogenic microorganisms to cause food spoilage. Signs of food spoilage include a changes in appearance, colour, texture, odour

and taste. Factors responsible for Food Spoilage are given below.

**Internal factors:** It includes enzymatic activities and moisture content of the food.

**External factors:** It includes adulterants in food, contaminated utensils and equipment, unhygienic cooking area and lack of storage facilities.

## 21.4 Food Preservation

Food preservation is the process of prevention of food from decay or spoilage, by storing in a condition fit for future use. Food is preserved to:

- increase the shelf life of food
- retain the colour, texture, flavour and nutritive value
- increase food supply
- decrease wastage of food

### 21.4.1 Methods of Food Preservation

The various method of food preservation are explained below.

**Drying:** Drying is the process of preservation of food by removal of water/moisture content in the food. It can be done either by sun-drying, (e.g. cereals, fish) or vacuum drying (e.g. milk powder, cheese powder) or hot air drying (e.g. grapes, dry fruits, potato flakes). Drying inhibits the growth of microorganism such as bacteria, yeasts and moulds.

**Smoking:** In this process, food products like meat and fish are exposed to smoke. The drying action of the smoke tends to preserve the food.

**Irradiation:** Food irradiation is the process of exposing food to optimum levels of ionizing radiations like x-rays, gamma rays or UV rays to kill harmful bacteria and pests and to preserve its freshness.

**Cold storage:** It is a process of storing the perishable foods such as vegetables, fruits and fruit products, milk and milk products etc. at low temperature. Preserving the food products at low temperature slows down the biological and chemical reactions and prevents its spoilage.

**Freezing:** Freezing is one of the widely used methods of food preservation. This process involves storing the food below 0°C at which microorganisms cannot grow, chemical reactions are reduced and metabolic reactions are also delayed.

**Pasteurization:** Pasteurization is a process of heat treatment of liquid food products. e.g. For preservation of milk and beverages. This process also involves boiling of milk to a temperature of 63°C for about 30 minutes and suddenly cooling to destroy the microbes present in the milk.



Bananas are best stored at room temperature. When it is kept in a refrigerator, the enzyme responsible for ripening becomes inactive. In addition, the enzyme responsible for browning and cell damage becomes more active thereby causing the skin colour change from yellow to dark brown.

**Canning:** In this method of food preservation, most vegetables, fruits, meat and dairy products, fruit juices and some ready-to-eat foods are processed and stored in a clean, steamed air tight containers under pressure and then sealed. It is then subjected to high temperature and cooled to destroy all microbes.

### 21.4.2 Addition of Preservatives

Food can be preserved by adding natural and synthetic preservatives.

#### A. Natural preservatives

Some naturally available materials like salt, sugar and oil are used as food preservatives.

**Addition of salt:** It is one of the oldest methods of preserving food. Addition of salt removes the moisture content in the food by the process of osmosis. This prevents the growth of bacteria and reduces the activity of microbial enzymes. Meat, fish, gooseberry, lemon and raw mangoes are preserved by salting. Salt is also used as a preservative in pickles, canned foods etc.

**Addition of sugar:** Sugar/Honey is added as a preservative to increase the shelf life of fruits and fruit products like jams, jellies, squash, etc. The hygroscopic nature of sugar/honey helps in reducing the water content of food and also minimizing the process of oxidation in fruits.

**Addition of oil:** Addition of oil in pickles prevents the contact of air with food. Hence microorganisms cannot grow and spoil the food.

#### B. Synthetic preservatives

Synthetic food preservatives like sodium benzoate, citric acid, vinegar, sodium meta bisulphate and potassium bisulphate are added to food products like sauces, jams, jellies, packed foods and ready-to-eat foods. These preservatives delay the microbial growth and keep the food safe for long duration.

### More to Know

October 16<sup>th</sup> is World Food Day. It emphasizes on food safety and avoiding food wastage.

## 21.5 Food Adulteration

Adulteration is defined as the addition or subtraction of any substance to or from food, so that the natural composition and the quality of food substance is affected. **Adulterant** is any material which is used for the purpose of adulteration.

Some of the commonly adulterated foods are milk and milk products, cereals, pulses, coffee powder, tea powder, turmeric powder, saffron, confectionary, non-alcoholic beverages, spices, edible oils, meat, poultry products etc. The adulterants in food can be classified in three categories:

1. Natural adulterants
2. Incidental/unintentionally added adulterants
3. Intentionally added adulterants

### 1. Natural adulterants

Natural adulterants are those chemicals or organic compounds that are naturally present in food. e.g. toxic substances in certain poisonous mushrooms, Prussic acid in seeds of apples and cherry, marine toxins, fish oil poisoning, environmental contaminants

### 2. Incidental/unintentionally added adulterants

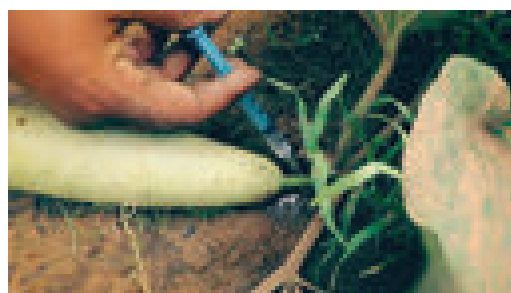
These types of adulterants are added unknowingly due to ignorance or carelessness during food handling and packaging. It includes:

- a. Pesticide residues
- b. Droppings of rodents, insects, rodent bites and larva in food during its storage
- c. Microbial contamination due to the presence of pathogens like *Escherichia coli*, *Salmonella* in fruits, vegetables, ready-to-eat meat and poultry products

### 3. Intentionally added adulterants

These adulterants are added intentionally for financial gain and have serious impact on the health of the consumers. These types of adulterants include:

- a. Additives and preservatives like vinegar, citric acid, sodium bicarbonate (baking soda), hydrogen peroxide in milk, modified food starch, food flavours, synthetic preservatives and artificial sweeteners.
- b. Chemicals like calcium carbide to ripen bananas and mangoes.
- c. Non certified food colours containing chemicals like metallic lead are used to give colours to vegetables like green leafy vegetables, bitter gourd, green peas etc. These colours are added to give a fresh look to the vegetables.



- d. Edible synthetic wax like shellac or carnauba wax is coated on fruits like apple, pear to give a shining appearance.

### 21.5.1 Health Effects of Adulterated Foods

Consumption of these adulterated foods may lead to serious health effects like fever, diarrhoea, nausea, vomiting, gastrointestinal disorders, asthma, allergy, neurological disorder, skin allergies, immune suppression, kidney and liver failure, colon cancer and even birth defects.

## 21.6 Food Quality Control

The government always ensures that pure and safe food is made available to the consumers. In 1954, the Indian Government enacted the Food Law known as Prevention of Food Adulteration Act and the Prevention of Food Adulteration Rules in 1955 with the objective of ensuring pure and wholesome food to the consumers and protect them from fraudulent trade practices.

Minimum standards of quality for food and strict hygienic conditions for its sale are clearly outlined in the Act.

**DO YOU KNOW?** A slogan **From farm to plate, make food safe** was raised on World Health Day (7<sup>th</sup> April 2015) to promote and improve food safety.

- Distributing food grains throughout the country.
- Maintaining satisfactory levels of operational and buffer stock of food grains to ensure national security.
- Regulate the market price to provide food grains to consumers at reliable price.

### 21.6.1 Food Quality Control Agencies

ISI, AGMARK, FPO, FCI and other health departments enforce minimum standards for the consumer products. **FCI (Food Corporation of India)** was set up in the year 1965 with the following objectives:


- Effective price support operations for safeguarding the interest of farmers.



#### Activity 1

Let each of the student bring any food packet (jam, juice, pickle, bread, biscuit, etc). Note down the details like name of the product, manufacturer's details, contents/ingredients, net weight, Maximum Retail Price (MRP), date of manufacture, date of expiry/usage from the date of manufacture and standardized marks (ISI, AGMARK or FPO) printed on the label for each of the item. What is the aim of such practice?

### Food Control Agencies- Their Standardized Mark and Role in Food Safety

	ISI - (Indian Standards Institution) known as Bureau of Indian Standard (BIS)	Certifies industrial products like electrical appliances like switches, wiring cables, water heater, electric motor, kitchen appliances etc.
	AGMARK - (Agricultural Marking)	Certifies agricultural and livestock products like cereals, essential oils, pulses, honey, butter etc.
	FPO - (Fruit Process Order)	Certifies the fruit products like juice, jams, sauce, canned fruits and vegetables, pickles etc.
	Food Safety and Standards Authority of India	Responsible for protecting and promoting the public health through regulation and supervision of food safety.

#### Activity 2

##### Some simple techniques used to detect adulterants at home

1. Milk: Place a drop of milk on a slanting polished surface. Pure milk flows slowly leaving a trail behind while the milk adulterated with water will flow fast without leaving a trail.



2. Honey: Dip a cotton wick in honey and light it with a match stick. Pure honey burns while adulterated honey with sugar solution gives a cracking sound.
3. Sugar: Dissolve sugar in water. If chalk powder is added as an adulterant, it will settle down.
4. Coffee powder: Sprinkle a few pinches of coffee powder in a glass of water. Coffee powder floats. If it is adulterated with tamarind powder it settles down.
5. Food grains: They have visible adulterants like marble, sand grit, stones, etc. These are removed by sorting, hand picking, washing etc.

### Points to Remember

- ❖ Food is necessary for normal growth and development of living organisms.
- ❖ Prolonged deficiency of certain nutrients cause deficiency diseases leading to malnutrition.
- ❖ Drying, smoking, irradiation, refrigeration, freezing, pasteurization and canning are some of the methods of food preservation.
- ❖ Adulterants are undesirable substances added to the food against the Food Safety Standards.
- ❖ Prevention of Food Adulteration Act, 1954 laid down the minimum standards for consumer products.

### A-Z GLOSSARY

<b>Fatigue</b>	Extreme tiredness due to mental or physical illness.
<b>Hygroscopic</b>	The property of absorbing moisture from the air.
<b>Muscular cramps</b>	Sudden and involuntary contractions of one or more muscles.
<b>Nutrients</b>	Substance that provide nourishment for normal growth and development.
<b>Nerve impulse</b>	Electric signals that travels along a nerve fibre.
<b>Nourishment</b>	Food that you need to grow and stay healthy.
<b>Osteoporosis</b>	A diseases which weakens the bones and makes it brittle.
<b>Paralysis</b>	Loss of muscle function in any part of our body which can be either temporary or permanent.
<b>Shelf life</b>	Time for which a food can be kept fresh.
<b>Toxins</b>	Any poisonous substance produced by bacteria, animals or plants.



### TEXT BOOK EXERCISES



#### I. Choose the correct answer.

1. The nutrient required in trace amounts to accomplish various body functions is \_\_\_\_\_  
 a) carbohydrate      b) protein  
 c) vitamin              d) fat
2. The physician who discovered that scurvy can be cured by ingestion of citrus fruits is \_\_\_\_\_  
 a) James Lind      b) Louis Pasteur  
 c) Charles Darwin      d) Isaac Newton

3. The sprouting of onion and potatoes can be delayed by the process of \_\_\_\_\_  
 a) freezing                      b) irradiation  
 c) salting                        d) canning
4. Food and Adulteration Act was enforced by Government of India in the year \_\_\_\_\_  
 a) 1964                            b) 1954  
 c) 1950                            d) 1963
5. An internal factor responsible for spoilage of food is \_\_\_\_\_  
 a) wax coating  
 b) contaminated utensils  
 c) moisture content in food  
 d) synthetic preservatives

### II. Fill in the blanks.

1. Deficiency diseases can be prevented by taking \_\_\_\_\_ diet.
2. The process of affecting the natural composition and the quality of food substance is known as \_\_\_\_\_
3. Vitamin D is called as \_\_\_\_\_ vitamin as it can be synthesised by the body from the rays of sunlight.
4. Dehydration is based on the principle of removal of \_\_\_\_\_.
5. Food should not be purchased beyond the date of \_\_\_\_\_
6. AGMARK is used to certify \_\_\_\_\_ and \_\_\_\_\_ products in India.

### III. State whether true or false. If false, correct the statement.

1. Iron is required for the proper functioning of thyroid gland.
2. Vitamins are required in large quantities for normal functioning of the body -

3. Vitamin C is a water soluble vitamin
4. Lack of adequate fats in diet may result in low body weight
5. ISI mark is mandatory to certify agricultural products.

### IV. Match the following.

#### Column A

1. Calcium
2. Sodium
3. Potassium
4. Iron
5. Iodine

#### Column B

- a. Muscular fatigue
- b. Anaemia
- c. Osteoporosis
- d. Goitre
- e. Muscular cramps

### V. Fill in the blanks with suitable answers.

Vitamins	Dietary Source	Deficiency Disease
Calciferol		Rickets
	Papaya	Night blindness
Ascorbic acid		
	Whole grains	Beriberi

### VI. Give abbreviations for the following.

- i. ISI \_\_\_\_\_
- ii. FPO \_\_\_\_\_
- iii. AGMARK \_\_\_\_\_
- iv. FCI \_\_\_\_\_
- v. FSSAI \_\_\_\_\_

### VII. Assertion and reason type questions.

Direction: In the following question, a statement of a Assertion is given and a corresponding Reason is given just below it. Of the statements given below, mark the correct answer as:

- If both Assertion and Reason are true and the Reason is the correct explanation of Assertion
- If both Assertion and Reason are true but Reason is not the correct explanation of Assertion
- If Assertion is true but Reason is false
- If both Assertion and Reason is false

1. **Assertion:** Haemoglobin contains iron.

**Reason:** Iron deficiency leads to anaemia

2. **Assertion:** AGMARK is a quality control agency

**Reason:** ISI is a symbol of quality

### VIII. Give reasons for the following statements.

- Salt is added as a preservative in pickles \_\_\_\_\_
- We should not eat food items beyond the expiry date \_\_\_\_\_
- Deficiency of calcium in diet leads to poor skeletal growth \_\_\_\_\_

### IX. Answer briefly.

- Differentiate
  - Kwashiorkar from Marasmus
  - Macronutrients from Micronutrients
- Why salt is used as preservative in food?
- What is an adulterant?
- Name any two naturally occurring toxic substances in food.
- What factors are required for the absorption of Vitamin D from the food by the body?
- Write any one function of the following minerals

- Calcium
- Sodium
- Iron
- Iodine

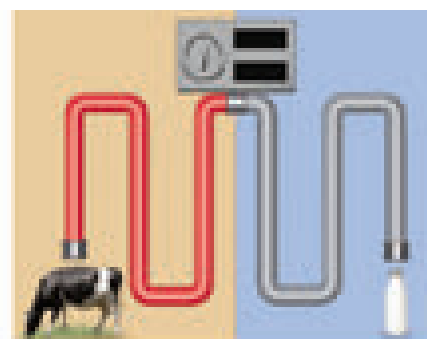
- Explain any two methods of food preservation.
- What are the effects of consuming adulterated food?

### X. Answer in detail.

- How are vitamins useful to us? Tabulate the sources, deficiency diseases and symptoms of fat soluble vitamins
- Explain the role of food control agencies in India.

### XI. Higher Order Thinking Skills.

- Look at the picture and answer the question that follows



- Name the process involved in the given picture.
  - Which dairy food is preserved by this process?
  - What is the temperature required for the above process?
- The doctor advises an adolescent girl who is suffering from anaemia to include more of leafy vegetables and dates in her diet. Why so
  - Sanjana wants to buy a jam bottle in a grocery shop. What are the things she should observe on the label before purchasing it?



## REFERENCE BOOKS

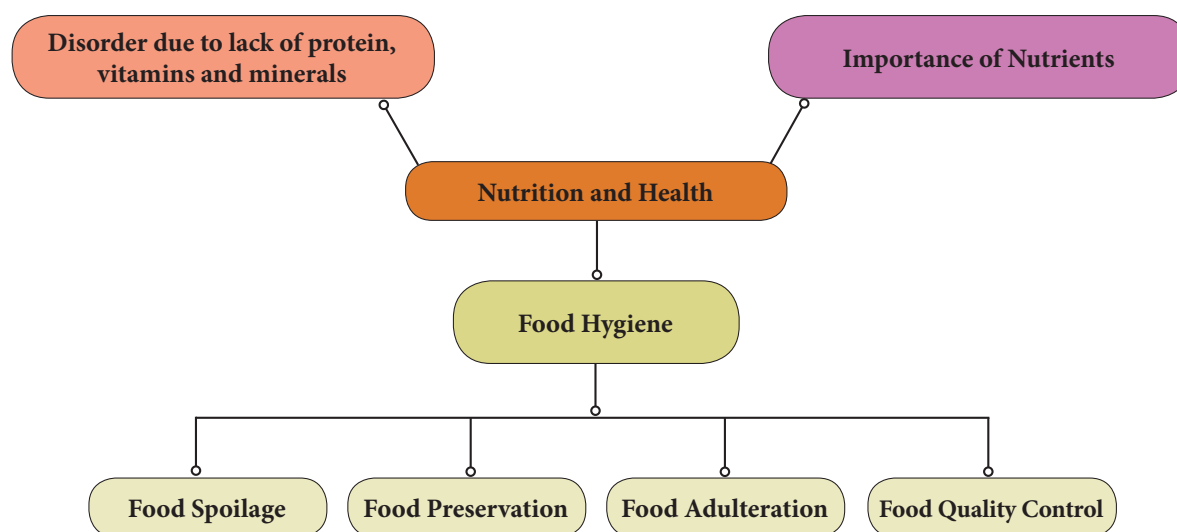
1. Swaminathan M 1995: "Food & Nutrition", The Bangalore Printing & publishing co ltd., Vol I, Second Edition, Bangalore.
2. Srilakshmi 1997: "Food Science", New Age International (P) Ltd, Publishers, Pune.
3. Mudambi .R. Sumathi and Rajagpal M.V 1983, "Foods & Nutrition", Willey Eastern Ltd, Second Edition, New Delhi.
4. Shubhangini A. Joshi, 1992 "Nutrition and Dietetics" Tata Mc Grow- Hill publishing Company Ltd, New Delhi.
5. Srilakshmi. B - "Nutrition Science", V Edn, New Age International (P) Ltd, Publishers, Chennai
6. Thangam.E.Philip 1965: Modern Cookery, Orient Longman, II edition. Vol II, Bombay.



## INTERNET RESOURCES

- [http://en.wikipedia.org/wiki/food\\_preservation](http://en.wikipedia.org/wiki/food_preservation)  
<https://en.m.wikipedia.org/wiki/louispasteur>  
<http://pfa.delhigovt.nic.in>  
[www.fao.org/fao-who-codexalimentarius](http://www.fao.org/fao-who-codexalimentarius)

### Concept Map



### ICT CORNER

#### Steps

1. Type the following URL in the browser or scan the QR code from your mobile.
2. A home of ICMR opens, Select Nutri Guide you can find various nutrients like Vitamins, Minerals Proteins.
3. Now Click on the Vitamins and you can find different types of Vitamins.
4. Click on any Vitamins button and a new screen will open with Vitamin chart with Biochemical, RDA, Dietary Sources Signs & Symptoms.

URL: <http://218.248.6.39/nutritionatlas/home.php>



B567\_9\_SCI\_EM\_T3

### Deficiency Diseases



## Learning Objectives

After completing this lesson, students will be able to

- identify different groups of bacteria based on their shape and structure.
- categorize types of viruses.
- know the role of microbes in agriculture, food industries and medicine.
- gain knowledge on modes of infection and disease transmission.
- describe the spectrum of diseases on the basis of the causative agents.
- know disease control and preventive measures.

## Introduction

Microbiology (greek words: mikros -small, bios- life bearing, logy- study), is a branch of biology that deals with living organisms of microscopic size, which include bacteria, fungi, algae, protozoa and viruses. Microbes are found in habitats like terrestrial, aquatic, atmospheric or in living hosts. Some of them survive in extreme environments like hot springs, ice sheets, water bodies with high salt content and low oxygen, and in arid places with limited water availability.

Some of the microorganisms are beneficial to us and they are used in the preparation of curd, bread, cheese, alcohol, vaccines and vitamins, while some others are harmful causing diseases to plants and animals including human being. This lesson will explore the beneficial and harmful effects of microbes in relation to welfare of human kind.

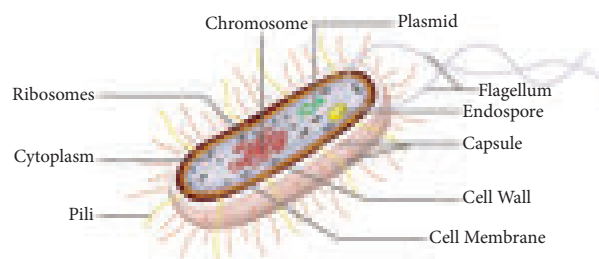
## 22.1 Microbes and their Types

Microorganisms differ from each other in size, morphology, habitat, metabolism

and several other features. Microbes may be unicellular (Bacteria), multicellular (Fungi), acellular (not composed of cells-Virus). Types of microbes include bacteria, viruses, fungi, microscopic algae and protists.

### 22.1.1 Bacteria

Bacteria are microscopic, single celled prokaryotic organisms without nucleus and other cell organelles. Although majority of bacterial species exist as single celled forms, some appear to be filaments of loosely joined cells. The size varies from less than 1 to 10  $\mu\text{m}$  in length and 0.2 to 1  $\mu\text{m}$  micrometer in width. Bacteria may be motile or non-motile. Special structures called flagella are found on the cell surfaces for motility



**Figure 22.1** Structure of a bacterial cell

### a. Shapes of bacteria

Based on the shapes, bacteria are grouped as:

1. Spherical shaped bacteria called as cocci (or coccus for a single cell).
2. Rod shaped bacteria called as bacilli (or bacillus for a single cell).
3. Spiral shaped bacteria called as spirilla (or spirillum for single cell).

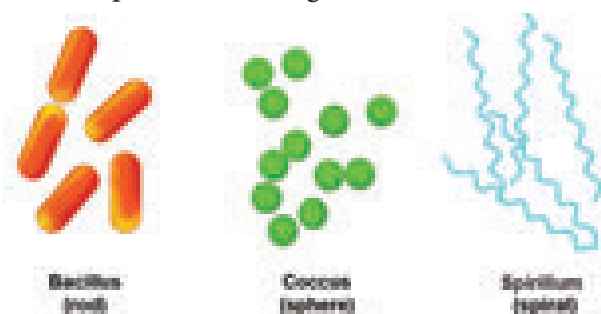


Figure 22.2 Shapes of bacteria



Antonie Van Leeuwenhoek, the first microbiologist designed his own microscope. In 1674, he took plaque from his own teeth and observed it under the microscope. He was astonished to see many tiny organisms moving around, which was otherwise invisible to naked eyes.

### b. Structure of a bacterial cell

Bacterial cell has cell membrane, covered by strong rigid cell wall. In some bacteria, outside the cell wall there is an additional slimy protective layer called **capsule** made up of **polysaccharides**. The plasma membrane encloses the cytoplasm, **incipient nucleus** (nucleoid), ribosomes and DNA which serve as genetic material. Ribosomes are the site of protein synthesis. They lack membrane bound organelles. In addition to this, a small extra chromosomal circular DNA called plasmid is found in the cytoplasm.

#### 22.1.2 Viruses

The term 'virus' in Latin means 'venom' or 'poisonous fluid'. Viruses are non-cellular, **self-replicating parasites**. They are made up of a **protein** that covers a central **nucleic acid** molecule, either RNA or DNA. The amount of protein varies

from 60% to 95% and the rest is nucleic acid. Nucleic acid is either DNA (T4 bacteriophage) or RNA (Tobacco mosaic virus, TMV).

A simple virus particle is often called a **virion**. They grow and multiply only in living cells. They are the smallest among the infective agents varying over a wide range from 18-400 nm (nanometre). They can live in plants, animals, human being and even bacteria. They can be easily transmitted from one host to another.

### a. Characters of Viruses

Viruses exhibit both living and non-living characters.

#### Living characters of viruses

1. They have the nucleic acid (DNA or RNA) i.e., the genetic material that can replicate.
2. They can multiply in the living cells of the host.
3. They can attack specific hosts.

#### Non-living characters of viruses

1. Viruses remain as inert material outside their hosts.
2. They are devoid of cell membrane and cell wall. Viruses are devoid of cellular organelles like ribosomes, mitochondria, etc.
3. They can be crystallised.

#### More to Know

The protein free pathogenic RNA of virus is Viroids. They are found in plant cells and cause disease in plants.

### b. Types of Viruses

Viruses are categorised as given below:

**Plant virus:** Virus that infect plants. e.g. Tobacco mosaic virus, Cauliflower mosaic virus, Potato virus.

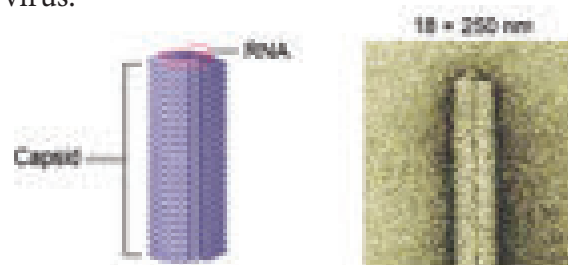
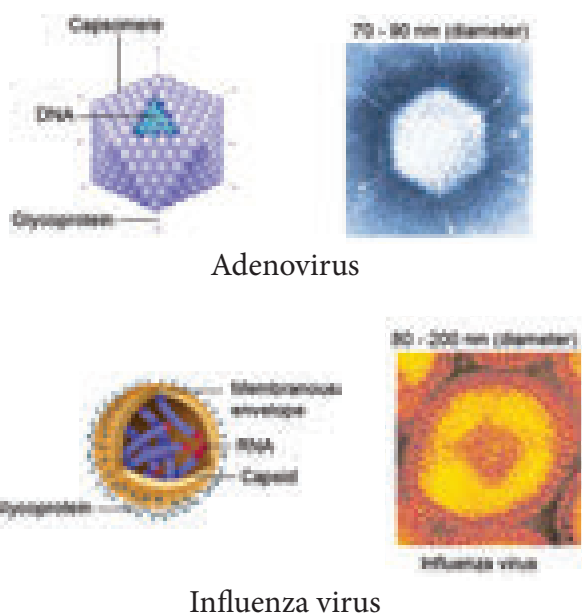


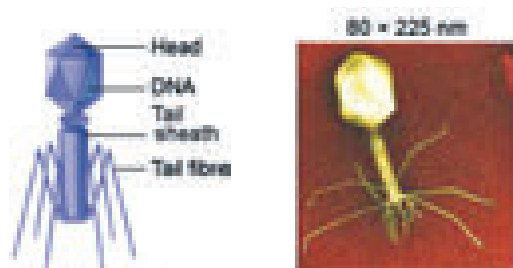
Figure 22.3 Tobacco mosaic virus

**Animal virus:** Virus that infect animals. e.g. Adenovirus, Retrovirus(HIV), Influenza virus, Polio virus.



**Figure 22.4** Animal virus

**Bacteriophages:** Virus that infect bacterial cells. e.g. T4 bacteriophage.



**Figure 22.5** T4 bacteriophage

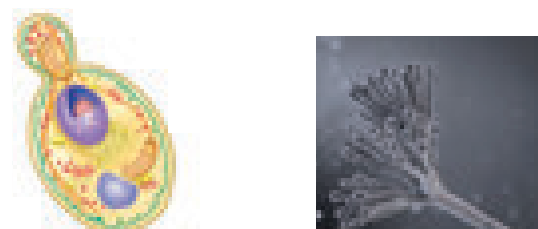
### 22.1.3 Fungi

They lack chlorophyll, hence depend on living or dead host for their nutritional needs. Fungi living on living hosts are called parasites, and those living on dead organic matter are called saprophytes. The body of the fungus is called **thallus**.

Single celled yeast ranges from 1 to 5  $\mu\text{m}$  in width. They are spherical in shape. Flagella are absent and hence they are non-motile. In the case of multicellular forms, thallus is called mycelium. **Mycelium** is a complex of several thin filaments called **hyphae** (singular: Hypha).

Each hypha is 5 to 10  $\mu\text{m}$  wide. They are tube like structures filled with protoplasm and cellular organelles. Cell wall is made up of cellulose or chitin. Cytoplasm contains small vacuoles filled with cell sap, nucleus, mitochondria, golgi body, ribosomes, and endoplasmic reticulum. Food material is stored in the form of glycogen or oil globules.

They reproduce vegetatively (binary fission, budding and fragmentation), asexually (spore formation-conidia) and sexually (male and female gametangium are called antheridium and oogonium).

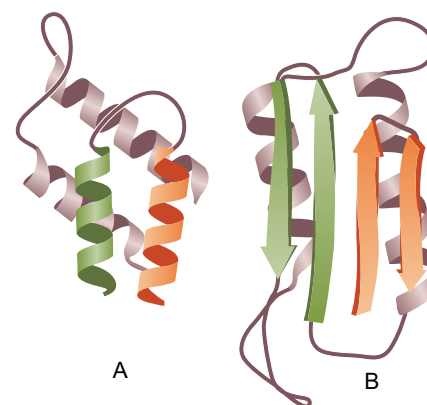


Yeast cell *Penicillium*

**Figure 22.6** Structure of fungi

### 22.1.4 Prions

The term 'prion' was coined by Stanley B. Prusiner in 1982. Prions are **viral particles** which contain only proteins. They do not contain nucleic acid. They are infectious and smaller than viruses. Prions are found in neurons and are rod shaped. Prions induce changes in normal proteins. This results in the degeneration of nervous tissue.



**Figure 22.7** Normal (A) and Abnormal (B) prion protein

## 22.2 Applications of Microbes

Microorganisms contribute to human welfare in many ways. In this section we will study about the diversified usefulness of microbes.



### 22.2.1 Microbes in Agriculture

Microbes play an important role in agriculture as biocontrol agents and biofertilizers. Microbes play a vital role in the cycling of elements like carbon, nitrogen, oxygen, sulphur and phosphorus. These are called biological scavengers.

**Microbes as biofertilizers:** Microorganisms which enrich the soil with nutrients are called as biofertilizers. Bacteria, cyanobacteria and fungi are the main sources of biofertilizers. Nitrogen is one of the main source of plant nutrients. Atmospheric nitrogen has to be converted to available form of nitrogen. This is done by microbes either in free living conditions or by having symbiotic relationship with the plants. e.g. *Azotobacter*, *Nitrosomonas*, *Nostoc* (free living), symbiotic microbes like *Rhizobium*, *Frankia*.

#### Activity 1

Take the root nodules of any pulse or leguminous plant available in your locality. Wash it thoroughly with water. Crush the nodules on a clean glass slide. Add a drop of distilled water to the crushed material on the glass slide. Observe the preparation under compound microscope.

**Microbes as biocontrol agents:** Microorganisms used for controlling harmful or pathogenic organisms and pests of plants are called as biocontrol agents (Biopesticides). *Bacillus thuringiensis* (Bt) is a species of bacteria that produces a protein called as 'cry' protein. This protein is toxic to the insect larva and kills them. Spores of *B.thuringiensis* are available in sachets, which are dissolved in water and sprayed on plants infected with insect larva.

### 22.2.2 Microbes in Industries

Microorganisms play an important role in the production of wide variety of valuable products for the welfare of human beings.

**Production of fermented beverages:** Beverages like wine are produced by fermentation of grape fruits by *Saccharomyces cerevisiae*.

**Curing of coffee beans, tea leaves and tobacco leaves:** Beans of coffee and cocoa, leaves of tea and tobacco are fermented by the bacteria *Bacillus megaterium*. This gives the special aroma.

**Production of curd:** *Lactobacillus sp.* converts milk to curd.

**Production of organic acids, enzymes and vitamins:** Oxalic acid, acetic acid and citric acid are produced by fungus *Aspergillus niger*. Enzymes like lipases, invertase, proteases, and glucose oxidase are derived from microbes. Yeasts are rich source of vitamin-B complex.

### 22.2.3 Microbes in Medicine

**Antibiotics:** These are metabolic products of microorganisms, which in very low concentration are inhibitory or detrimental to other microbes. In 1929, Alexander Fleming produced the first antibiotic penicillin. In human beings antibiotics are used to control infectious diseases like cholera, diphtheria, pneumonia, typhoid, etc.

**Table 22.1** Antibiotics produced by microorganisms

Class of Microorganisms	Type of Microorganism	Antibiotic produced
Bacteria	<i>Streptomyces griseus</i>	Streptomycin
	<i>Streptomyces erythreus</i>	Erythromycin
	<i>Bacillus subtilis</i>	Bacitracin
Fungi	<i>Penicillium notatum</i>	Penicillin
	<i>Cephalosporium acremonium</i>	Cephalosporin

**Vaccines:** These are prepared by killing or making the microbes inactive (attenuated). These inactive microbes are unable to cause



disease, but stimulate the body to produce antibodies against the antigen in the microbes.

**Table 22.2** Vaccines produced against diseases

Type of Vaccine	Name of the vaccine	Disease
Live attenuated	MMR	Measles, Mumps and Rubella
	BCG (Bacillus Calmette Guerin)	Tuberculosis
Inactivated (Killed antigen)	Inactivated polio virus (IPV)	Polio
Subunit vaccines (Purified antigens)	Hepatitis B vaccine	Hepatitis B
Toxoid (Inactivated antigen)	Tetanus toxoid (TT)	Tetanus
	Diphtheria toxoid	Diphtheria

## 22.3 Microbes and Diseases

Disease (dis = against; ease = comfort) can be defined as an impairment or malfunctioning of the normal state of the living organism that disturbs or modifies the performance of vital functions of the body. Disease can be categorized based on:

- The extent of occurrence (endemic, epidemic, pandemic or sporadic).
- Whether infectious or non-infectious.
- Types of pathogen – whether caused by bacterial, viral, fungal or protozoan infections.
- Transmitting agent – whether air borne, water borne or vector borne.



World Health Day – 7<sup>th</sup> April  
 World Malaria Day – 25<sup>th</sup> April  
 World AIDS Day – 1<sup>st</sup> December  
 World Anti-Tuberculosis Day – 24<sup>th</sup> March

### 22.3.1 Classification of Disease based on Occurrence

**Endemic:** Disease which is found in a certain geographical area affecting a fewer number

of people (low incidence). e.g. Occurrence of goitre in Sub-Himalayan regions.

**Epidemic:** Disease which breaks out and affects large number of people in a particular geographical region and spreads at the same time. e.g. Influenza.

**Pandemic:** Disease which is widely distributed on a global scale. e.g. Acquired Immuno deficiency Syndrome (AIDS).

**Sporadic:** Disease which occur occasionally. e.g. Malaria and Cholera.

### 22.3.2 Manifestation of Disease

#### Communicability of diseases

Infectious diseases are communicable diseases. They are caused by external factors like pathogenic organisms (bacteria, virus, vectors, parasites) invading the body and causing diseases. e.g. Influenza, Tuberculosis, Chickenpox, Cholera, Pneumonia, Malaria, etc

Non-infectious diseases are non-communicable diseases. They are caused by internal factors like malfunctioning of organs, genetic causes, hormonal imbalance and immune system defect. e.g. Diabetes, Coronary heart diseases, Obesity, Cancer, Goitre, etc

#### Point of entry and place of infection

The disease causing microbes enter the body through different means. An infection develops when these pathogens enter the human body through contaminated air, water, food, soil, physical contact, sexual contact and through infected animals. They may be organ specific or tissue specific within our body where microbes reside.

#### Reservoir of infection

Reservoir of infection refers to the specific environment in which the pathogens can thrive well and multiply without causing diseases. eg. Water, soil and animal population.

#### Incubation period

The interval between infection and first appearance of the diseases is called incubation period. It may vary from few hours to several days.

## Infection

Infection is the entry, development or multiplication of an infectious agent in the human body or animals.

### 22.3.3 Harmful Effects of Microbes

Pathogens cause disease in two ways. They are tissue damage and toxin secretion.

**Tissue Damage:** Many pathogens destroy the tissues or organs of the body causing morphological and functional damage. For example, bacterium of pulmonary tuberculosis damages the cells of the lungs, and virus causing hepatitis destroys liver tissue.

**Toxin Secretion:** Many pathogens secrete poisonous substances called toxins which cause tissue damage leading to diseases.

Let us now study about the causative organism, mode of infection, occurrence, symptoms and preventive measures of a few airborne, waterborne, vectorborne and sexually transmitted diseases.



**Robert Koch** (Father of Bacteriology) is the first German physician to study how pathogens cause diseases. In 1876, he showed that the disease called anthrax of sheep was due to *Bacillus anthracis* which exist in pastures in the form of protective spores.

## 22.4 Airborne Diseases

Human beings inhale atmospheric air. Due to continuous inhalation of contaminated air the chances for airborne microorganisms to find a host and cause infection are higher.

Most of the respiratory tract infections are acquired by inhaling air containing the pathogen that are transmitted through droplets caused by cough or sneeze, dust and spores.

Airborne diseases are caused by bacteria and viruses. A few air borne diseases and their modes of transmission are given in the table below.

**Table 22.3** Airborne diseases caused by virus

Disease	Causative Organism	Mode of Transmission	Tissue/ Organ Affected	Symptoms
Common Cold	<i>Rhino virus</i>	Droplet infection	Upper respiratory tract (Inflammation of nasal chamber)	Fever, cough, running nose, sneezing and headache
Influenza	<i>Myxovirus</i>	Droplet Infection	Respiratory tract, (Inflammation of nasal mucosa, pharynx)	Fever, body pain, cough, sore throat, nasal discharge, respiratory congestion
Measles	<i>Rubeola virus</i>	Droplet infection, droplet nuclei and direct contact with infected person	Respiratory tract	Eruption of small red spots or rashes in skin, cough, sneezing, redness of eye (conjunctiva), pneumonia, bronchitis
Mumps	<i>Myxovirus parotidis</i>	Droplet infection, droplet nuclei and direct contact with infected person	Upper respiratory tract	Enlargement of parotid gland, movement of jaw becomes difficult
Chicken Pox	<i>Varicella zoster virus</i>	Droplet infection, droplet nuclei and direct contact with infected person	Respiratory tract	Eruptions of the skin, fever and uneasiness

**Table 22.4** Airborne diseases caused by bacteria

Disease	Causative Organism	Mode of Transmission	Tissue/ Organ Affected	Symptoms
Tuberculosis	<i>Mycobacterium tuberculosis</i>	Droplet infection from sputum of infected persons	Lungs	Persistent cough, chest pain, loss of weight and appetite
Diphtheria	<i>Corynebacterium diphtheriae</i>	Droplet infection, droplet nuclei	Upper Respiratory tract (nose, throat)	Fever, sore throat, choking of air passage
Whooping Cough	<i>Bordetella pertussis</i>	Droplet infection, direct contact with infected person	Respiratory tract	Mild fever, severe cough ending in whoop (loud crowing inspiration)

## 22.5 Waterborne Diseases

Microbes present in the contaminated water cause various infectious diseases. Some of the water borne diseases are cholera, typhoid,

infectious hepatitis, poliomyelitis, diarrhoea, etc. The most common waterborne diseases and their causative microbial agents, symptoms of these diseases and preventive measure are given in the tables below .

**Table 22.5** Waterborne diseases caused by virus

Disease	Causative Organism	Mode of Transmission	Tissue/Organ Affected	Symptoms	Preventive and Control Measures
Poliomyelitis	<i>Polio virus</i>	Droplet infection, sputum discharge, secretion from nose, throat, contaminated water, food and milk	Central nervous system	Paralysis of limbs	Salk's vaccine or Oral Polio Vaccine (OPV) is administered
Hepatitis A or Infectious Hepatitis	<i>Hepatitis A virus (HAV)</i>	Contaminated water, food and oral route	Inflammation of liver	Nausea, anorexia, acute fever and jaundice	Prevention of food contamination, drinking chlorinated boiled water, personal hygiene
Acute Diarrhoea	<i>Rotavirus</i>	Contaminated water, food and oral route	Intestine	Vomiting, fever, watery stools with mucus	Proper sanitation and hygiene

**Table 22.6** Waterborne diseases caused by bacteria

Disease	Causative Organism	Mode of Transmission	Tissue/ Organ Affected	Symptoms	Preventive and Control Measures
Cholera (Acute diarrhoeal disease)	<i>Vibrio cholerae</i>	Contaminated food, water, oral route and through houseflies	Intestinal tract	Acute diarrhoea with rice watery stools, vomiting, muscular cramps, nausea and dehydration	Hygienic sanitary condition, intake of Oral Rehydration Solution (ORS)
Typhoid (Enteric fever)	<i>Salmonella typhi</i>	Food and water contaminated with faeces of infected person and through houseflies	Small intestine	High fever, weakness, abdominal pain, headache, loss of appetite, rashes on chest and upper abdomen	Preventing contamination of food by flies and dust, improvement of basic sanitation, treatment with antibiotic drugs

## 22.6 Vector Borne Diseases

**Vector** is an agent that acts as an **intermediate carrier** of the pathogen. Many insects and animals act as vectors. Diseases transmitted by vectors are called vector borne diseases. These vectors can transfer infecting agents from an infected person to another healthy person. Some of the insect vector borne diseases are Malaria, Filaria, Chikungunya, Dengue, and the diseases which are transmitted through animals are Bird flu and Swine flu.

### 22.6.1 Malaria

Malaria continues to be one of the major health problems of developing countries. Malaria is caused by **protozoan** parasite *Plasmodium*. Four species of *Plasmodium* namely, *P.vivax*, *P.malariae*, *P.falciparum* and *P.ovale* cause malaria. Malaria caused by *Plasmodium falciparum* is malignant and fatal. Approximately 300 million people around the world get infected with Malaria every year.

It spreads through the bite of an insect vector, the female *Anopheles* mosquito which feeds on human blood and usually lasts less than 10 days. A person affected by malaria will show symptoms of headache, nausea, muscular pain, chilliness and shivering, followed by rapid rise in temperature. Fever subsides with profuse sweating. Use of Quinine drugs kills the stages of malaria parasite.

### Know your Scientist



Sir Ronald Ross, an Indian born British doctor, is famous for his work concerning malaria. He worked in the Indian Medical Service for 25 years. He identified the developing stages of malarial parasite in the gastrointestinal tract of mosquito and proved that malaria was transmitted by mosquito. In 1902, he received the Nobel Prize for Physiology or Medicine for his work on the transmission of malaria.

### 22.6.2 Chikungunya

Chikungunya is caused by virus. It is transmitted in humans by the bite of infected *Aedes aegypti* mosquito during the day time. It causes severe and persistent joint pain, body rashes, headache and fever. Joint pains can last for a very long time.

Incubation period of the virus is usually 2-12 days. Chilliness, high fever, vomiting, nausea, headache, persistent joint pain and difficulty in walking are the common symptoms associated with this disease. The joints get inflamed and the person finds it difficult to walk. Paracetamol is given to relieve pain and reduce fever.

### 22.6.3 Dengue

Dengue is known as **break bone** fever. The name break bone fever was given due to the cause of intense joint and muscle pain. Dengue fever is caused by virus. It is transmitted by *Aedes aegypti* mosquito.

Incubation period of the virus is usually 5-6 days. Onset of high fever, severe headache, muscle and joint pain, rashes, haemorrhage, fall in blood platelet count are the symptoms associated with this disease. Vomiting and abdominal pain, difficulty in breathing, minute spots on the skin signifying bleeding within the skin are also associated with dengue fever. Paracetamol is given to reduce fever and body ache. Complete rest and increased intake of fluid is essential.

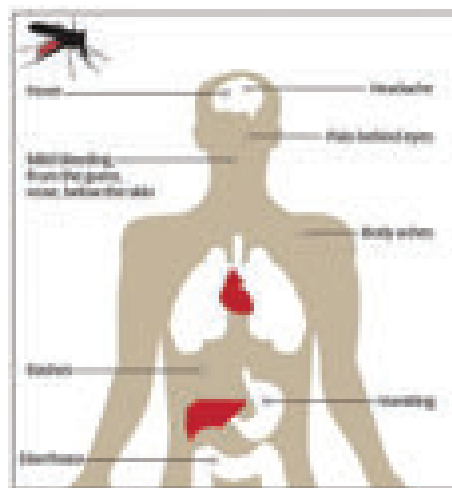


Figure 22.8 Dengue

**DO YOU KNOW?**

An extraction of tender leaves of papaya and herbal drink Nilavembu Kudineer is given to dengue patients. It is known to increase the blood platelet count. (Source: AYUSH)

### Activity 2

Observe the mosquitoes that are active during the day time. Catch them using an insect net and observe their body and legs. What do you observe?. Why are cases of Dengue reported in large numbers during post-monsoon season?

### 22.6.4 Filaria

Filariasis is a major health problem in India. This disease is caused by **nematode** worm *Wuchereria bancrofti*. The adult worms are usually found in the lymphatic system of man. It is transmitted by the bite of infected *Culex* mosquito.

Incubation period of filarial worm is 8-16 months and the symptoms include acute infection, fever and inflammation in lymph glands. In chronic infection the main feature is **elephantiasis** which affects the legs, scrotum and the arms.

### 22.6.5 Mosquitoes - Prevention and Control

- Prevention of mosquito bites by using mosquito nets, mosquito screens, mosquito repellents and ointments.
- Elimination of breeding places by providing adequate sanitation, underground waste water disposable system and drainage of stagnant water.
- Collection of water in any uncovered container such as water tank, pots, flower pots, discarded tyres should be avoided.
- Control of mosquito larvae by spraying oil on stagnated water bodies.
- Adult mosquitoes can be killed by spraying insecticides.
- Application of citronella oil or eucalyptus oil on the exposed skin.

## 22.7 Diseases Transmitted by Animals

### 22.7.1 Swine Flu

Swine Flu first originated from pigs. It is caused by virus that affects pigs and has started infecting humans. The virus spreads through air. It affects the respiratory system.

**Influeza virus H1N1** has been identified as the cause of this disease. It is transmitted from person to person by inhalation or ingestion of droplets containing virus from people sneezing or coughing. Fever, cough, nasal secretion, fatigue, headache, sore throat, rashes in the body, body ache or pain, chills, nausea, vomiting and diarrhoea, and shortness of breath are the symptoms associated with the disease.

#### Prevention and Control

- Administration of nasal spray vaccine.
- Avoiding close contact with a person suffering from flu.
- Intake of water and fruit juices will help prevent dehydration.
- Plenty of rest will help the body to fight infection.
- Always wash hands and practice good hygiene.

### More to Know

Swine flu first surfaced in April 2009 and affected millions of people. Then in June 2009 it was declared a pandemic by the World Health Organization (WHO). In 2015, India reportedly had over 31,000 people infected and 1,900 resulting deaths.

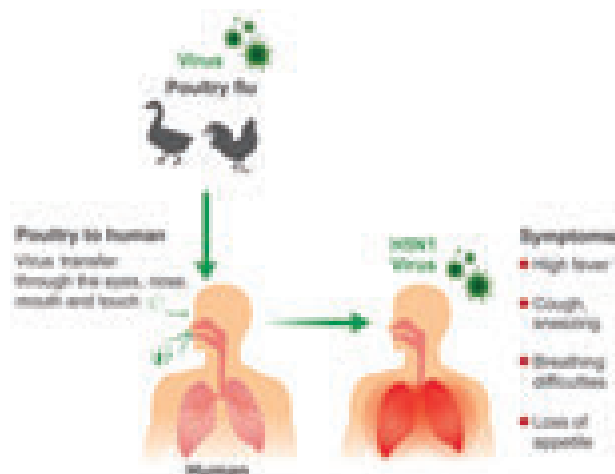
### 22.7.2 Avian Influenza

Avian influenza is a contagious bird disease caused by viruses. Birds that can carry and spread avian influenza virus include poultry (chickens, turkeys or ducks), wild birds and pet birds.

It is caused by **Influenza Virus H5N1**. The incubation period of the virus is 2-7 days. People who have close contact with infected birds or

surfaces that have been contaminated by the bird's secretion from mouth, eyes, mucus, nasal secretion or droppings (bird faeces) transmit this disease.

Fever, cough, sore throat, running nose, muscle and body aches, fatigue, headache, redness of eyes (conjunctivitis) and difficulty in breathing are the symptoms of this disease.



**Figure 22.9** Transmission of Avian influenza virus

### Prevention and Control

- Avoiding open air markets where infected birds are sold.
- Avoiding contact with infected birds or consumption of infected poultry.
- Proper cleaning and cooking of poultry.



The avian influenza virus A (H5N1) emerged in 1996. It was first identified in Southern China and Hong Kong. H5N1 was first discovered in humans in 1997 by World Health Organisation. First outbreak was in December 2003.

## 22.8 Sexually Transmitted Diseases

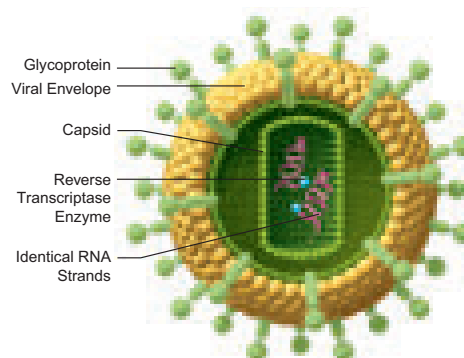
Some pathogens are transmitted by sexual contact from one partner to another and not by casual physical contact. A few sexually transmitted diseases are AIDS, Gonorrhoea, Genital warts, Genital herpes and Syphilis.

### 22.8.1 AIDS

Acquired Immunodeficiency Syndrome (AIDS) is caused by **retrovirus** (RNA virus) known as **Human Immunodeficiency Virus (HIV)**. The virus attacks the white blood cells or **lymphocytes** and weakens the body's immunity or self defence mechanism.

It is transmitted through sexual contact (from infected person to a healthy person), blood contact (transfusion of unscreened blood), by surgical equipments (infected needles and syringes), maternal – foetal transmission (from infected mother to the foetus).

Weight loss, prolonged fever, sweating at night, chronic diarrhoea are some of the important symptoms.



**Figure 22.10** Structure of HIV

### Prevention and Control

- Disposable syringes and needles should be used.
- Protected and safe sexual contact.
- Screening of blood before blood transfusion.
- Avoid sharing shaving blades/razors.
- People should be educated about AIDS transmission.



HIV was first recognised in Hatai (USA) in 1981. In India the first confirmed evidence of AIDS infection was reported in April 1986 from Tamil Nadu. The AIDS vaccine RV 144 trial was conducted in Thailand in 2003 and reports were presented in 2011.

## 22.8.2 Hepatitis -B or Serum Hepatitis

It occurs due to infection of **hepatitis-B virus** (HBV). The virus damages the liver cells causing **acute inflammation** and **cirrhosis** of liver.

It is transferred from infected mother to their babies or by sexual contact. It is also transmitted by contact with infected person's secretions such as saliva, sweat, tears, breast milk and blood.

Symptoms observed are fever, loss of appetite, nausea vomiting, yellowness of eyes and skin, light coloured stools, itching of skin, headache and joint pain.

### Prevention and Control

- Screening of blood donors before blood donation can prevent the transmission.
- Injection of drugs to be prevented.
- Having safe and protected sex.
- Sharing of razors should be avoided.
- The hepatitis B vaccine offers excellent protection against HBV. The vaccine is safe and highly effective.

Some of the other sexually transmitted diseases caused by bacteria and virus are discussed in Table 22.7.

## 22.9 Immunization

Immunization is a process of developing resistance to infections by administration of antigens or antibodies. Inoculation of vaccines into the body to prevent diseases is called as vaccination.

One effective way of controlling the spread of infection is to strengthen the host defenses. This is accomplished by immunization, which is one of the cost effective weapon of modern medicine.

When a large proportion of a community is immunized against a disease, the rest of the people in the community are benefited because the disease does not spread.

### 22.9.1 Vaccines and its Types

Vaccines are preparation of living or killed microorganisms or their products used for prevention or treatment of diseases. Vaccines are of two types: Live vaccines and Killed vaccines

**Live Vaccines:** They are prepared from living organisms. The pathogen is weakened and administered. e.g. BCG vaccine, oral polio vaccine.

**Table 22.7** Sexually transmitted diseases

Infectious agent	Disease	Causative Organism	Mode of Transmission	Tissue/ Organ Affected	Symptoms
<b>Bacteria</b>	Gonorrhoea	<i>Neisseria gonorrhoea</i>	Sexual contact	Urethra is affected	Discharge from genital openings, pain during urination
	Syphilis	<i>Treponema pallidum</i>	Sexual contact	Minute abrasion on the skin or mucosa, of genital area	Ulceration on genitals, skin eruption
<b>Virus</b>	Genital Herpes	<i>Herpes Simplex Virus</i>	Sexual contact, entry through mucous membrane of genital region	Genital organs of male and female individuals	Painful blisters in mouth, lips, face and genital region
	Genital Warts	<i>Human Papilloma virus</i>	Sexual contact (skin to skin)	Genital areas of male and female individuals	Vaginal discharge, itching, bleeding and burning



The process of vaccination was introduced by Edward Jenner. According to the World Health Organisation (WHO), Jennerian vaccination has eliminated small pox totally from the human population.

**Killed Vaccines:** Micro organisms (bacteria or virus) killed by heat or chemicals are called killed or inactivated vaccines. They require a primary dose followed by a subsequent booster dose. e.g. Typhoid vaccine, cholera vaccine, pertussis vaccine.

### Know your Scientist



Louis Pasteur is an 18th century French chemist and microbiologist. He coined the term vaccine. Pasteur developed vaccine against chicken pox, cholera, anthrax, etc.

### 22.9.2 Immunization Schedule

The World Health Organization in the year 1970 has given a schedule of immunization for children. This schedule is carried out in almost all countries. Table 22.8 gives the schedule of vaccination procedures followed in India.

**BCG (Bacillus Calmette Guerin):** This was prepared by two French workers Calmette and Guerin (1908-1921). The bacilli are weakened and used for immunization against tuberculosis.

**DPT (Triple Vaccine):** It is a combined vaccine for protection against Diptheria, Pertussis (whooping cough) and Tetanus.

**MMR:** Mumps, Measles, Rubella vaccine gives protection against viral infections.

**DT:** It is a dual antigen or combined antigen. It gives protection from Diptheria and Tetanus.

**TT (Tetanus Toxoid):** Toxin of Tetanus bacteria.

**TAB:** Combined vaccine for typhoid, paratyphi A and paratyphi B.

**Table 22.8** Immunization Schedule

Age	Vaccine	Dosage
New born	BCG	1 <sup>st</sup> dose
15 days	Oral Polio	1 <sup>st</sup> dose
6 <sup>th</sup> week	DPT and Polio	1 <sup>st</sup> dose
10 <sup>th</sup> week	DPT and Polio	1 <sup>st</sup> dose
14 <sup>th</sup> week	DPT and Polio	1 <sup>st</sup> dose
9 – 12 months	Measles	1 <sup>st</sup> dose
18 – 24 months	DPT and Polio	1 <sup>st</sup> dose
15 months – 2 years	MMR	1 <sup>st</sup> dose
2 – 3 years	TAB	2 doses at 1 month gap
4 – 6 years	DT and Polio	2 <sup>nd</sup> booster
10 <sup>th</sup> year	TT and TAB	1 <sup>st</sup> dose
16 <sup>th</sup> year	TT and TAB	2 <sup>nd</sup> booster

### Activity 3

Recently in 2018, Nipah virus was in the headlines of the daily newspaper. Collect the following information. What is Nipah virus? How it gets transmitted? Mention the preventive measures taken by the Government to check the disease.

### Points to Remember

- ❖ Bacteria are single celled prokaryotic organisms, without a well defined nucleus (nucleoid) and other cell organelles. The genetic material is DNA.
- ❖ Viruses are small microscopic infectious agents that can multiply only inside the living cells.
- ❖ Fungi are group of eukaryotic heterotrophs which are either single celled (Yeast) or multicellular (*Penicillium*, *Agaricus*).
- ❖ Microorganisms which enrich the soil with nutrients are called as biofertilizers.



- ❖ Most of the respiratory tract infections are acquired by inhaling air containing the pathogen that are transmitted through droplets caused by cough or sneeze, dust and spores.
- ❖ Some of the air borne diseases are tuberculosis, whooping cough, diphtheria, chicken pox, mumps, measles and influenza.
- ❖ Infectious diseases that can spread through water are diarrhoea, dysentery, cholera, typhoid, hepatitis and poliomyelitis.
- ❖ Diseases transmitted by vectors are called vector borne diseases. Some of them are malaria, filaria, chikungunya and dengue.
- ❖ Diseases transmitted by animal to man are swine flu and bird flu.
- ❖ Sexually transmitted diseases such as gonorrhoea, genital warts, genital herpes, syphilis, AIDS are transmitted from one person to another by close physical contact.

## A-Z GLOSSARY

<b>Antibiotics</b>	Substances that kill or prevent the growth of microorganisms.
<b>Biofertilizer</b>	Microorganisms which enrich the soil with nutrients.
<b>Biopesticides</b>	Agents which control insect pests in natural way without causing harm to the environment.
<b>Flagella</b>	Lash-like appendage protruding from the cell body of bacterial cell.
<b>Immunisation</b>	Process by which the body produces antibodies against the specific vaccine when administered.
<b>Pathogen</b>	A biological agent that causes disease to its host. e.g. bacteria, virus etc.
<b>Prions</b>	Viral particles which contain only protein. They do not contain nucleic acid.
<b>Vaccines</b>	Preparation of antigenic proteins of pathogens (weakened or killed) which on inoculation into a healthy person provides temporary / permanent immunity against a particular disease.



## TEXTBOOK EXERCISES



### I. Choose the correct answer.

- Which of the following is transmitted through air?
  - Tuberculosis
  - Meningitis
  - Typhoid
  - Cholera
- One of the means of indirect transmission of a disease is
  - sneezing
  - coughing
  - vectors
  - droplet infection
- Diphtheria affects the
  - lungs
  - throat
  - blood
  - liver
- The primary organ infected during tuberculosis is
  - bone marrow
  - intestine
  - spleen
  - lungs
- Microbes that generally enter the body through nose are likely to affect
  - gut
  - lungs
  - liver
  - lymph nodes
- The organ affected by jaundice is
  - liver
  - lungs
  - kidney
  - brain
- Poliomyelitis virus enters the body through
  - skin
  - mouth and nose
  - ears
  - eye

**II. Fill in the blanks.**

- \_\_\_\_\_ break down organic matter and animal waste into ammonia.
- Typhoid fever is caused by \_\_\_\_\_.
- H1N1 virus causes \_\_\_\_\_.
- \_\_\_\_\_ is a vector of viral disease dengue.
- \_\_\_\_\_ vaccine gives considerable protection against tuberculosis.
- Cholera is caused by \_\_\_\_\_ and malaria is caused by \_\_\_\_\_.

**III. Expand the following.**

- ORS
- HIV
- DPT
- WHO
- BCG

**IV. Pick out the odd one.**

- AIDS, Retrovirus, Lymphocytes, BCG,
- Bacterial disease, Rabies, Cholera, Common cold and Influenza.

**V. State whether true or false. If false, correct the statement.**

- Rhizobium*, associated with root nodules of leguminous plants fixes atmospheric nitrogen.
- Non-infectious diseases remain confined to the person who develops the disease and do not spread to others.
- The process of vaccination was developed by Jenner.
- Hepatitis B is more dangerous than Hepatitis A.

**VI. Match the following.**

Swine flu	Human Papilloma virus
Genital warts	Human Immunodeficiency Virus
AIDS	<i>Mycobacterium</i>
Tuberculosis	Influenza virus H1N1

**VII. Define the following.**

- Pathogen
- Bacteriophages
- Vaccines
- Prions

**VIII. Answer very briefly.**

- Distinguish between Virion and Viroid.
- Name the vector of the malarial parasite. Mention the species of malarial parasite which cause malignant and fatal malaria.
- What is triple antigen? Mention the disease which can be prevented by using the antigen.
- Name the chronic diseases associated with respiratory system.
- Name the organism causing diarrhoeal disease and give one precaution against it.
- Name two common mosquitoes and the diseases they transmit.

**IX. Answer briefly.**

- Give an account of classification of bacteria based on the shape.
- Describe the role of microbes in agriculture and industries.
- Explain the various types of viruses with examples.
- Suggest the immunization schedule for a new born baby till 12 months of age. Why it is necessary to follow the schedule?

**X. Assertion and reason type questions.**

Mark the correct statement as.

- If both A and R are true and R is correct explanation of A.
- If both A and R are true but R is not the correct explanation of A.
- If A is true but R is false.
- If both A and R are false.

**1. Assertion:** Chicken pox is a disease indicated by scars and marks in the body.

**Reason:** Chicken pox causes rashes on face and further spreads throughout the body.

**2. Assertion:** Dengue can be treated by intake of antibiotics.

**Reason:** Antibiotics blocks the multiplication of viruses.

### XI. Higher Order Thinking Skills.

1. Suggest precautionary measures you can take in your school to reduce the incidence of infectious disease.
2. Tejas suffered from typhoid while, Sachin suffered from tuberculosis. Which disease could have caused more damage and why?

2. Willey, Sherwood and Wollverton, Prescott's Microbiology, 8<sup>th</sup> edition, McGrawHill Education Pvt Ltd.
3. Ananthanarayan R. and Jayaram Paniker C.K. Text of Microbiology, 10<sup>th</sup> edition, Universities Press.



### REFERENCE BOOKS

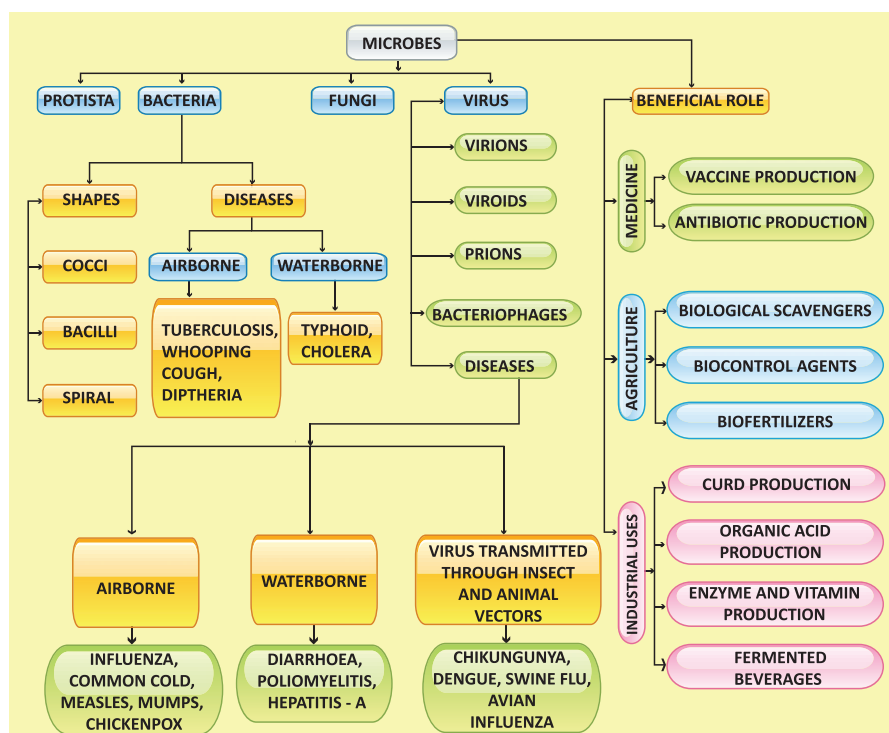
1. Michael.J Pelczar, Chan E.C.S. and Noel R Krieg, Microbiology, 5<sup>th</sup> edition, McGrawHill Education Pvt Ltd.



### INTERNET RESOURCES

- www.biology.online.org
- www.biologydiscussion.com
- www.nios.ac.in.textbook.com

### Concept Map



### ICT CORNER

### Microbes

#### Steps

- Type the following URL to reach “Cells Alive” home page and select “Start the Animation”.
- Place the pointer on the “Bacteria Cell Model” to view the parts of the cell, or click the parts given below the animation to highlight it on the diagram.
- Click the highlighted parts to get a brief description about it.
- Click the “Speaker Icon” on the bottom of the animation to read the description for you.

**Cells alive:** URL: <https://www.cellsalive.com/cells/bactcell.htm> or Scan the QR Code.



B567\_9\_SCI\_EM\_T3

## ECONOMIC BIOLOGY



### Learning Objectives

After completing this lesson, students will be able to

- know about horticulture and floriculture.
- classify biomanures and know their importance.
- differentiate between hydroponics, aquaponics and aeroponics.
- know the importance of dairy farming and cattle breeds.
- gain knowledge on the aspects of aquaculture and pisciculture.
- gain awareness on vermicomposting methods and the benefits of vermicompost.
- identify the commercial products obtained from apiculture.

### Introduction

The gift of nature is almost unlimited and thus a variety of useful products are obtained from plants. Economic uses of plants are varied and therefore the scope for improvement and their cultivation is immense. Floriculture and horticulture have gained considerable public attraction. In recent scenario more emphasis is given to the progress of economic aspects of zoology like aquaculture (culture of fish, prawn, crabs, pearl and edible oysters), vermiculture, apiculture and dairy farming which are gaining more importance as animal-based farming due to their economic and commercial values. Animal farming has now become an agrobased entrepreneurship and is beneficial to rural farmers. We will study about them elaborately in this lesson.

#### 23.1 Horticulture

Horticulture is a branch of agriculture that deals with cultivation of fruits, vegetables, and ornamental plants. The word horticulture is

derived from the latin words 'hortus' meaning garden and 'colere' meaning to cultivate. Horticulture is both a science and an art of growing plants with improved growth, quality, yield, and with resistance to diseases, insects, stress etc. There are four main classes of horticulture: (i) Pomology (fruit farming), (ii) Olericulture (vegetable farming), (iii) Floriculture (flower farming), (iv) Landscape gardening.

##### 23.1.1 Pomology or Fruit Farming

The term pomology is derived from the latin word 'pomum' means fruit and 'logy' means study. It deals with development, enhancement of fruit quality, cultivation techniques, regulation of production periods and reduction of production cost of fruits.

##### 23.1.2 Olericulture or Vegetable Farming

Olericulture is the science of growing vegetables. Vegetable farming can be classified

into: i) Kitchen or Nutrition gardening  
ii) Commercial gardening iii) Vegetable forcing.

**Kitchen gardening:** Kitchen gardening is growing of vegetables in small scale at household. e.g. Beans, Cabbage, Lady's finger, Tomato, Brinjal, Carrot, Spinach etc.



Figure 23.1 Kitchen gardening

#### INFO BIT



Government of Tamil Nadu has launched Uzhavan (farmer) mobile application. It can be used by farmers to gather information on farm subsidies, farm equipments, crop insurance and weather conditions. It also provides information on available stock of seeds and fertilizers in local government and private stores.

**Commercial gardening:** It is the production of vegetables in large scale to be sold in markets.



Figure 23.2 Commercial gardening

#### Activity 1

Discuss in your class room about the importance of crop insurance to farmers.

**Vegetable forcing :** It is the method of growing vegetables in buildings, green houses, cold farms or under other artificial growing conditions. It

is the most intensive type of vegetable growing. e.g. Cabbage, Tomato, Brinjal etc.



Figure 23.3 Vegetable forcing

**Green House or Poly House:** It is a framed structure covered with transparent material to grow crops under partially or fully controlled environmental conditions to get optimum growth and productivity. It is the fastest growing sector in the agriculture worldwide.

#### Advantages of GreenHouse

1. Disease-free plants can be produced continuously.
2. Water requirement of crops is very less.
3. Yield is very high compared to outdoor cultivation.
4. Limited pesticide is needed.
5. It protects plants from uncertain weather.

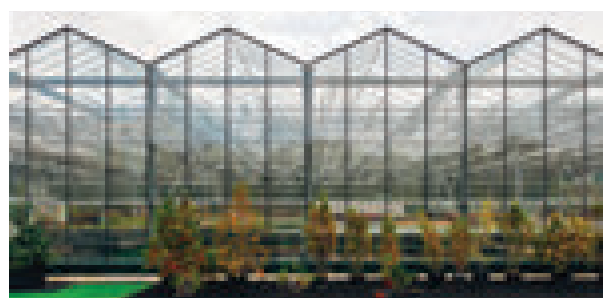


Figure 23.4 Green House

#### 23.1.3 Floriculture or Flower Farming

Floriculture is the art of cultivation of flowering and ornamental plants in garden for beauty or floristry. It is concerned with growing traditional flowers, cut flowers, bedding plants, foliage potted plants, arboriculture trees, turf grass for beautification and value added products like essential oils, pharmaceutical

and nutraceutical compounds. Examples: Geraniums (*Pelargonium*), Busy lizzies (*Impatiens*), *Chrysanthemum* and *Petunia*.



Figure 23.5 Flower Farming

#### INFO BIT

#### Pradhan Mantri Fasal Bima Yojana (PMFBY)

It is an agricultural crops insurance scheme of Indian government. Under this scheme the central government provides insurance cover and financial assistance to farmers. It was launched on 18th February 2016.

#### Uses of flowers

1. Flowers are used for decoration purpose.
2. They are also used for personal needs and, religious and ceremonial offerings.
3. They impart colour and beauty to the garden.
4. They increase country's economy.

#### 23.1.4 Landscape Gardening

Landscape horticulture is the study of designing and constructing landscapes in homes, business firms and public areas to imitate natural scenery

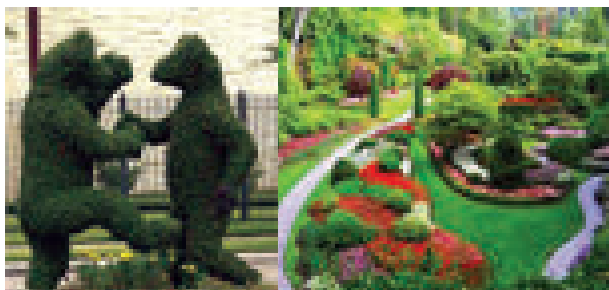


Figure 23.6 Landscape gardening

## 23.2 Manuring (Biomanuring)

Organic manures are predominantly derived from plant debris, animal faeces and microbes. They make the soil fertile by adding nutrients like nitrogen. Few of them are listed below.

### 23.2.1 Animal Manure

It consists of faeces and urine from livestock like cattle, horses, pigs, sheep, chickens, turkeys, rabbits, etc. Manures from different animals have different qualities and different applications.

**Farmyard manure:** It is a mixture of cattle dung, urine, litter material and other dairy wastes. On an average well decomposed farm yard manure contains 0.5% Nitrogen, 0.2% available phosphate and 0.5% available potash.

**Sheep and Goat manure :** It contains higher nutrients than farm yard manure. It contains 3% Nitrogen, 1% phosphorus pentoxide and 2% potassium oxide.

### 23.2.2 Compost

Compost is a soil conditioner as well as a fertilizer, that is rich in nutrients. It is produced by natural decomposition of organic matter such as crop residues, animal wastes, food wastes, industrial and municipal wastes by microorganisms under controlled conditions.

### 23.2.3 Green Manure

Green manure is obtained by collection and decomposition of green leaves, twigs of trees, field bunds etc. Green manure improves soil structure, increases water holding capacity and decreases soil loss by erosion. It also helps in reclamation of alkaline soils and reduces weed proliferation. It is a manure obtained from undecomposed green material derived from leguminous plants e.g. Sunhemp (*Crotalaria juncea*), Dhaincha (*Sesbania aculeata*), Sesbania (*Sesbania speciosa*).

## 23.3 Biofertilizers

Biofertilizers are substances that contain living microorganisms which, when applied

to seeds, plant surfaces, or soil, colonize the rhizosphere or the interior of the plant and promote growth by increasing the supply or availability of primary nutrients to the host plant.

### 23.3.1 Types of Biofertilizers

**Rhizobium:** *Rhizobium* is a soil bacterium that colonize the roots of leguminous plants to form root nodules. The bacteria fix atmospheric nitrogen and convert them to ammonia.

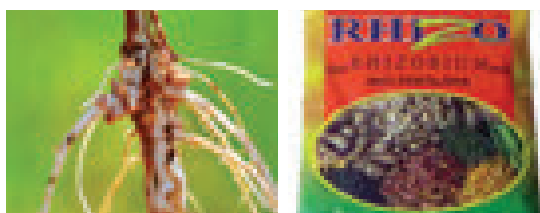


Figure 23.7 *Rhizobium* biofertilizer

**Azospirillum:** *Azospirillum* bacteria has the ability to use atmospheric nitrogen and transport this nutrient to the crop plants. It is inoculated on maize, barley, oats and sorghum crops. It increases productivity of cereals by 5 - 20%, of millets by 30% and fodder by over 50%.



Figure 23.8 *Azospirillum* biofertilizer

**Azotobacter:** Application of *Azotobacter* bacteria has been found to increase yield of wheat, rice, maize and sorghum. Apart from nitrogen fixation, these organisms are capable of producing antifungal and antibacterial compounds.



Figure 23.9 *Mycorrhizae* biofertilizer

**Mycorrhizae:** These fungi have symbiotic association with the roots of vascular plants. They increase the uptake of phosphorus. e.g. Citrus, Papaya.

**Azolla:** *Azolla* is a free floating, aquatic fern found on water surfaces having a cyanobacterial symbiotic association with *Anabaena*. It is a live floating nitrogen factory using energy from photosynthesis to fix atmospheric nitrogen.



Figure 23.10 *Azolla* biofertilizers

#### Info bits Biofertilizer Scheme

Tamil Nadu Government has recently launched 'Biofertiliser Scheme'. It is aimed at better management of natural farming and helps to boost and maintain soil fertility.

### 23.4 Medicinal Plants

The history of medicinal plants is as old as the history of human beings. Most medicines are obtained either directly or indirectly from plants. All the major system of medicines such as Ayurveda, Yoga, Unani, Siddha, Homeopathy (AYUSH) use drugs obtained from plants and animals. These drugs from medicinal plants are called secondary metabolites. Plants produce primary metabolites for their own living e.g. carbohydrates, amino acids etc., and secondary metabolites for protection, competition and species interaction. e.g. alkaloids, terpenoids, flavonoids etc. Phytochemistry is the study of phytochemicals which are chemical substances derived from various parts of the plant. Few plant derived drugs are described in (Table 23.1).

#### Activity 2

Collect at least five medicinal plants from your locality. Identify the plant and try to find out its medicinal value.

**Table 23.1** Drugs derived from Medicinal plants

S. No.	Tamil Name	Botanical Name	Drug	Parts used	Disease cured
1	Katrazhai	<i>Aloe vera</i>	Anthraquinones	Leaves	Heal wounds, Skin disease, Cancer, Psoriasis
2	Tulsi	<i>Ocimum sanctum</i>	Essential oil	Leaves	Cold, Fever, Skin disease
3	Nannari	<i>Hemidesmus indicus</i>	Terpene	Roots	Bacterial infections, Diarrhoea
4	Nilavembu	<i>Andrographis paniculata</i>	Terpenoids	All parts	Dengue fever, Diabetes, Chikungunya
5	Vetpalai	<i>Wrightia tinctoria</i>	Flavonoids	Latex, Leaves	Psoriasis, Diarrhoea, Swellings
6	Cinchona maram	<i>Cinchona officinalis</i>	Quinine	Bark	Malaria, Pneumonia
7	Chivan Amalpodi (Sarpagandha)	<i>Rauwolfia serpentina</i>	Reserpine	Root	Blood pressure, Antidote for Snake bite
8	Thaila maram	<i>Eucalyptus globulus</i>	Essential oil	Leaves	Fever, Headache
9	Pappali	<i>Carica papaya</i>	Papain	Leaf, Seed	Dengue
10	Nithya kalyani	<i>Catharanthus roseus</i>	Alkaloids	All parts	Leukemia, Cancer

**Info bits**

The Council of Scientific and Industrial Research (CSIR) and National Botanical Research Institute (NBRI) and Central Institute for Medicinal and Aromatic Plants (CIMAP) have jointly launched India's first anti diabetic ayurvedic drug **BGR -34** (BGR-Blood Glucose Regulator). It contains 34 identified active phytoconstituents from herbal resources. It works by controlling blood sugar levels.

**23.5 Mushroom Cultivation**

Mushroom cultivation is a technology of growing mushrooms using plant, animal and industrial waste. In short it is wealth out of waste technology. This technology has gained importance worldwide because of its dietary fibres and protein value. Mushroom is a fungi belonging to basidiomycetes. It is rich in proteins, fibres, vitamins and minerals. There are more than 3000 types of mushrooms. e.g. Button mushroom (*Agaricus bisporus*), Oyster mushroom (*Pleurotus* spp.), Paddy straw mushroom (*Volvariella volvacea*). The cultivation takes one to three months. Major stages of mushroom cultivation are explained below.

**Composting:** Compost is prepared by mixing paddy straw with number of organic materials like cow dung and inorganic fertilizers. It is kept at about 50 °C for one week.

**Spawning:** Spawn is the mushroom seed. It is prepared by growing fungal mycelium in grains under sterile conditions. Spawn is sown on compost.

**Casing:** Compost is covered with a thin layer of soil. It gives support to the growing mushroom, provides humidity and helps regulate the temperature.

**Pinning:** Mycelium starts to form little bud, which will develop into mushroom. Those little white buds are called pins.

**Harvesting:** Mushroom grow better in 15°C - 23°C. They grow 3 cm in a week which is the normal size for harvesting. In the third week the first flush mushroom can be harvested.

**Fig 23.11** Mushrooms

**Preservation:** Discolouration, weight and flavour loss are the main problems during harvesting of



mushrooms. The following methods are used to increase their life.

- (i) Freezing           (ii) Drying
- (iii) Canning       (iv) Vacuum Cooling
- (v) Gamma radiation and storing at 15°C.

### 23.6 Hydroponics

Hydroponics is the method of growing plants without soil, using mineral nutrient solutions in water. The containers are made of glass, metal or plastic. They range in size from small pots for individual plants to huge tank for large scale growing. It was demonstrated by a German Botanist Julius Von Sachs in 1980. Hydroponics is successfully employed for the commercial production of seedless cucumber and tomato. Plants are suspended with their roots submerged in water that contain plant nutrients. The roots absorb water and nutrients, but do not perform the anchoring function. Therefore, the plants must be mechanically supported from above.

#### Importance of hydroponics

- (i) Conservation of water and nutrients.
- (ii) Controlled plant growth.
- (iii) In deserts and Arctic regions hydroponics can be an effective alternative method.

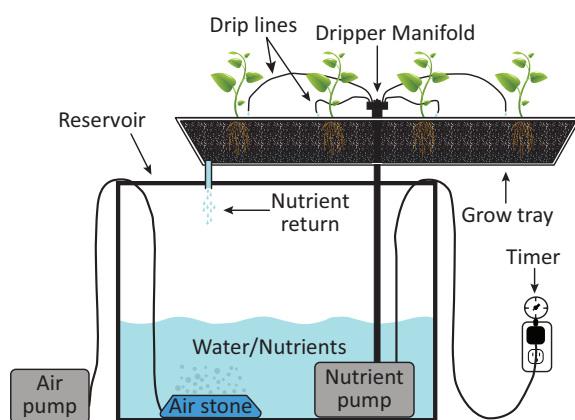


Figure 20.12 Hydroponics

### 23.7 Aeroponics

The aeroponic system is the high-tech type of hydroponic gardening. The growth medium in this type is primarily air. The roots hang in the air and are misted with nutrient solution. The misting is usually done for every few minutes,

as roots will dry out rapidly if the misting cycles are interrupted. A timer controls the nutrient pump much like other types of hydroponic systems, except that the aeroponic system needs a short cycle timer that runs the pump for a few seconds every couple of minutes.

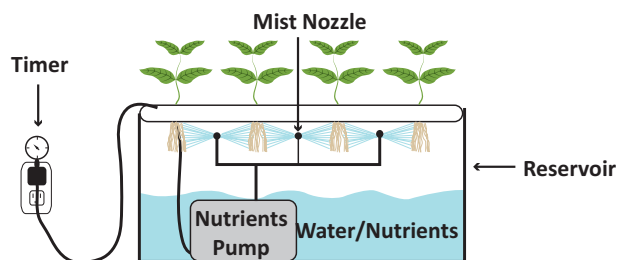


Figure 20.13 Aeroponics

### 23.8 Aquaponics

Aquaponics is a system of a combination of conventional aquaculture with hydroponics in a symbiotic environment, in which plants are fed with the aquatic animals' excreta or wastes. These wastes are broken down by nitrifying bacteria initially into nitrites and later into nitrates that are utilized by the plants as their nutrients. Thus, the wastes are utilized and water is recirculated back to the aquaculture system.



Aquaponics consists of two main parts, aquaculture- for raising aquatic animals like fish and hydroponics-for raising plants. Green leafy vegetables like chinese cabbage, lettuce, basil, coriander, parsley, spinach and vegetables like tomatoes, capsicum, chillies, bell peppers, sweet potato, cauliflower, broccoli and egg plant can be grown in aquaponics.



Figure 23.14 Aquaponics

## 23.9 Dairy Farming

Dairy farming involves rising of cattle for milk production. It involves the proper maintenance of cattle, along with collection and processing of milk and milk products which are useful to man. Dairying is the production and marketing of milk and its products.

### 23.9.1 Cattle Breeds

The Indian cattle include cows and buffaloes. They are domesticated for milk, meat, leather and transportation. They belong to two different species, *Bos indicus* (Indian cows and bulls) and *Bos bubalis* (buffaloes). These cattle animals are reared for milk and farm labour. They are classified into three types: Dairy breeds, Draught (or) Draft breeds, Dual purpose breeds.

**a. Dairy breeds:** Dairy animals are domesticated for obtaining milk. The cows (milk producing females) are high milk yielders (**milch animals**). The dairy breeds are:  
a) Indigenous breeds b) Exotic breeds.

Indigenous breeds are native of India. They include **Sahiwal, Red Sindhi, Deoni and Gir**. These cattle are well built with strong limbs, prominent hump and loose skin. Milk production depends on the duration of the lactation period (the period of milk production after the birth of a calf). These local breed animals show excellent resistant to diseases.

Exotic breeds (*Bos taurus*) are imported from foreign countries. They include **Jersey, Brown Swiss and Holstein-Friesian** etc. These foreign breeds are selected for long lactation periods.

**b. Draught (or) Draft breeds:** They are used for agricultural work, such as tilling, irrigation and carting. These include **Amritmahal, Kangayam, Umblachery, Malvi, Siri and Hallikar** breeds. Bullocks are good draft animals while the cows are poor milk yielders.

**c. Dual purpose breeds:** The cows of these breeds provide milk and the bulls are useful for farm work. In India these breeds are favoured by farmers. They include **Haryana, Ongole, Kankrej and Tharparkar**.

#### Info bits

##### Indigenous Draught breeds - Native to Tamil Nadu

**Kangayam:** It originated in Kangayam and is observed in Dharapuram, Perundurai, Erode, Bhavani and part of Gobichettipalayam taluk of Erode and Coimbatore district.

**Pulikulam:** This breed is commonly seen in Cumbum valley of Madurai district in Tamil Nadu. It is also known as Jallikattu madu, They are mainly used for penning in the field and useful for ploughing.

### 23.9.2 Composition of Cattle Feed

The food requirement for cattle should support healthy life of the animal and milk producing requirement. The feed for dairy cattle is broadly classified into two: Roughages and Concentrates

**Roughage** is a coarse and fibrous fodder. It consists of succulent feed (cultivated grass, fodder and root crops) and dry fodder (hay, straw and chaff).

**Concentrates** are low in fibre and contain high level of carbohydrates, protein and other nutrients. A variety of raw materials such as cholam (jowar), kambu (pearl millet), ragi (finger millet), rice bran, wheat bran, cotton seed cake, mustard cake, linseed cake, groundnut cake, mango seed, neem cake and yellu (sesame) cake can be used to make concentrate feed. They should also be fed on green fodder (maize, lucerne, berseem, millet, and elephant grass).

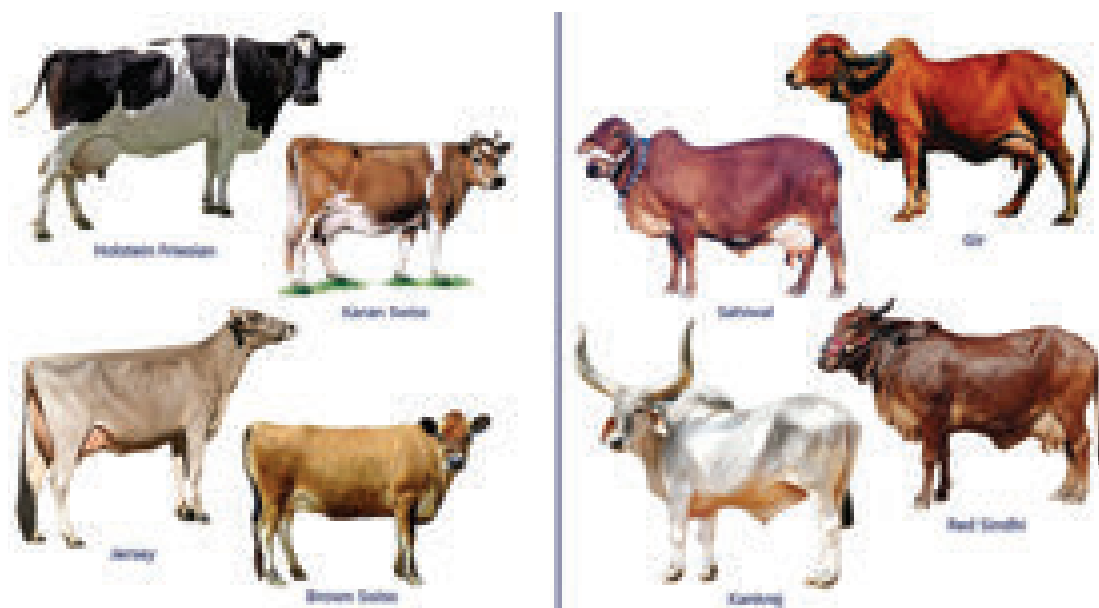


Figure 23.15 Cattle breeds

### 23.9.3 Feed Management

Dairy cattle need balanced rations containing all nutrients in proportional amounts and food additives which contain minerals, vitamins, antibiotics and hormones to promote the growth of animals, good yield of milk and to protect them from diseases. The daily average feed ratio of a milking cow is:

- (i) 15-25 kg of roughage (dry grass and green fodder)
- (ii) 4-5 kg of grain mixture
- (iii) 100-150 litres of water



**Dr. Verghese Kurein**, was the founder of National Dairy Development Board (NDDB) and was called the **Architect of India's Modern Dairy Industry** and the **Father of White Revolution**. NDDB designed and implemented the world's largest dairy development programme called **OPERATION FLOOD**.

### 23.9.4 Improvement of Livestock Development in India

Improved breeding techniques in cattle have tremendously increased the production of new breeds with high capacities.

### Intensive Cattle Development Programme:

It is based on cross breeding of indigenous cows with exotic (European) breeds to increase milk production. New methods and modern equipments are made available for machine – milking of cows.

**Operation Flood Programme:** It is based on dairy commodity aid to increase milk supply in urban areas.

## 23.10 Aquaculture

Aquaculture is the rearing of economically important aquatic organisms like fishes, prawns, shrimps, crabs, lobsters, edible oysters, pearl oysters and seaweeds under controlled and confined environmental conditions using advanced technologies.

### 23.10.1 Types of Aquaculture

Aquaculture is classified into:

1. Freshwater aquaculture
2. Marine water aquaculture (Mariculture)

**Freshwater aquaculture:** The rearing of aquatic organisms in freshwater is called freshwater aquaculture. Culture of organisms is carried out in pond, river, dam, lake and cold water. These freshwater resources remain within the land. Tilapia, carps (Catla, Rohu, Mrigal), catfishes, and air breathing fishes are cultured in freshwater.

**Info bits**

Tamil Nadu is a leading state endowed with rich fishery resources from Marine, Inland and Coastal Aquaculture. The marine fisheries potential of the state is estimated at 0.719 million tonnes. The inland fishery resources have a potential to yield 4.5 lakh metric tonnes of fishes. Tamilnadu ranks sixth among the maritime states in coastal farming.

**Marine water aquaculture:** The cultivation of aquatic organisms is in sea water. This is also referred as Mariculture or Sea farming. Culture of organisms is carried out along the sea coast (inshore area) and in deep sea. Organisms like shrimps (marine prawns), pearl oysters, edible oysters, mussels and fin fishes like salmon, sea bass, milk fishes and mullets are cultured in marine water.

**23.10.2 Prospects of Aquaculture**

Aquaculture has become the fastest growing food producing sector to meet the demands of food and nutrition to the growing population through increased production from aquatic food resources. It aims at blue revolution. It is a major source of export and foreign exchange earnings for the country. It generates employment through fish farming in rural and under developed area.

**23.11 Pisciculture**

Pisciculture or Fish culture is the process of breeding and rearing of fishes in ponds, reservoirs (dams), lakes, rivers and paddy fields. It is the farming of economically important fishes under controlled conditions.

**23.11.1 Types of Fish Culture**

**Extensive fish culture:** Culture of fishes in large areas with low stocking density and natural feeding.

**Intensive fish culture:** Culture of fishes in small areas with high stocking density and providing artificial feed to increase production.

**Info bits**

The Central Marine Fisheries Research Institute (CMFRI) was established by the Government of India in 1947 at Cochin, Kerala State. Its main focus is on marine fisheries landings, research on taxonomy and bioeconomic characteristics of marine organisms.

The Central Institute of Brackish Water Aquaculture (CIBA) was established in 1987 with its headquarters at Chennai. The objective of CIBA is management of sustainable culture system for fin fish and shell fish in brackish water. CIBA assists small aquafarmers in fin fish and shrimp farming by providing sustainable modern technologies.

**Monoculture:** It is the culture of single type of fish in a water body. It is also called mono species culture.

**Polyculture:** It is the culture of more than one type of fish in a water body. It is also called composite fish culture.

**Integrated fish farming:** It is the culture of fishes along with agricultural crops or animal husbandry farming. Rearing of fish along with paddy, poultry, cattle, pig and ducks.

**23.11.2 Types of Ponds for Fish Culture**

Fish farm requires different types of pond for the various developmental stages of fish growth. They are given below:

**Breeding pond:** Healthy and sexually mature male and female fishes are collected and introduced in this pond for breeding. The eggs released by the female are fertilized by the sperm and fertilized eggs float in water as frothy mass.

**Hatching pits:** The fertilized eggs are transferred to hatching pits or hatching hapas for hatching.

**Nursery ponds:** The hatchlings are transferred from hatching pits after 2 to 7 days. The hatchlings grow into fry and are cultured in these ponds for about 60 days with proper feeding till they reach 2 - 2.5 cm in length.

**Rearing ponds:** Rearing ponds are used to culture the fry. The fish fry are transferred from nursery pond to rearing ponds and are maintained for about three months till they reach 10 to 15 cm in length. In these rearing ponds the fry develops into fingerlings.

**Stocking pond:** The stocking pond is also called as culture pond or production pond. These ponds are used to rear fingerlings upto the marketable size.

### 23.11.3 Cultivable Food Fishes

**Freshwater cultivable fishes:** Indian major carps (Kendai) – Catla, Rohu, Mrigal, catfishes (Keluthi), Murrels (Veral) and Tilapia (Jilebi kendai) are cultured in freshwater.

**Marine water cultivable fishes:** Sea bass (Koduva), Grey mullet (Madavai) and *Chanos chanos* (Milk fish) are the fishes cultured in marine water.

### 23.11.4 Nutritional Value of Fishes

Cultivable freshwater and marine food fishes are highly nutritious, rich source of animal proteins and are easily digestible. They are rich in essential amino acids such as lysine and methionine, polyunsaturated fatty acid (PUFA),

minerals like calcium, phosphorus, iron, sodium, potassium and magnesium. Fat soluble vitamins A, D and water soluble B-complex vitamins like pyridoxine, cyanocobalamine and niacin.

### Activity 3

Visit a fish farm near your locality and collect information about the following:

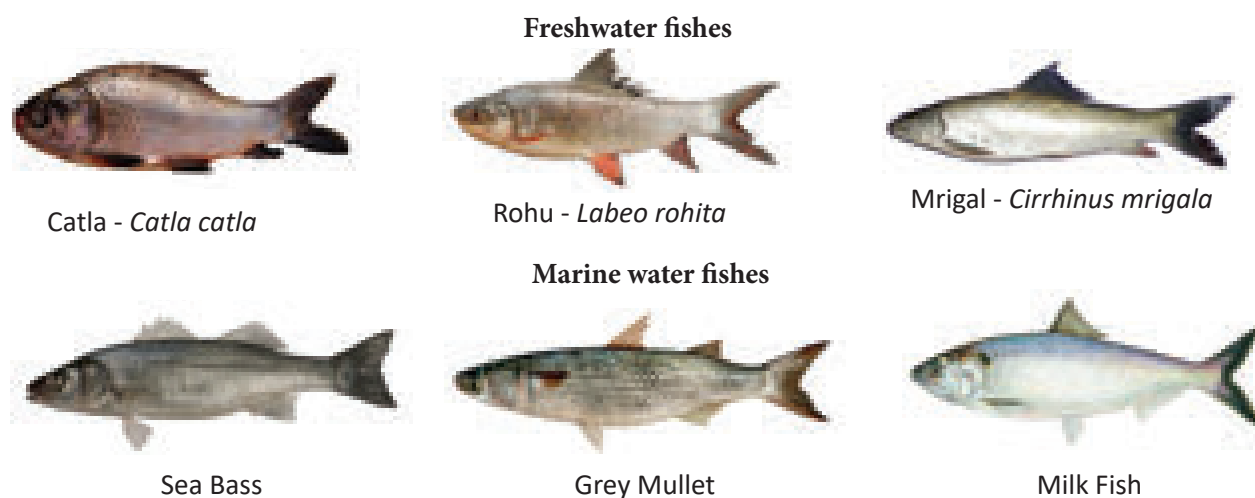
- Different types of pond you see.
- Different varieties of fishes in the pond.
- Type of feed and their ingredients used to prepare feed.

## 23.12 Prawn Culture

One of the most economically important shell fish resources of India are prawns. They are of great demand both in the local and international market. Due to their great taste, they are a cherished delicacy to be served as food. In view of their popularity and marketing avenues in foreign countries there is a need for developing advanced technology and intensify prawn culture in India.

### 23.12.1 Types of Prawn Culture

A number of species of prawns of different sizes are found distributed in water resources. Only those prawns which are good in size, weight, available in plenty and easily cultivable are commonly selected for prawn culture on commercial basis.



**Figure 23.16** Freshwater and Marine water fishes

### Marine water prawn culture

The rearing of marine penaeid prawn is called marine prawn culture or **shrimp culture**. *Penaeus indicus* and *Penaeus monodon* are cultured in marine water.



**Figure 23.17** Marine water prawn

### Freshwater prawn culture

The rearing of freshwater prawn is called freshwater prawn culture. *Macrobrachium rosenbergii* and *Macrobrachium malcomsonii* are cultured in freshwater.



**Figure 23.18** Freshwater prawn

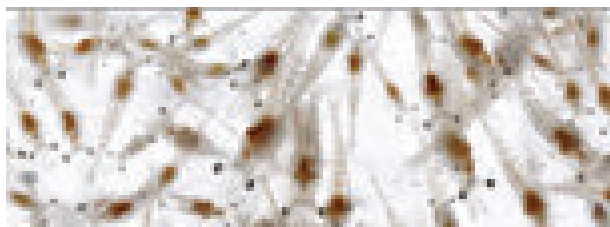
### 23.12.2 Methods of Prawn Culture

The methods employed for prawn culture are:

- Seed collection and hatchery method
- Paddy cum prawn culture method

#### Seed collection and hatchery method

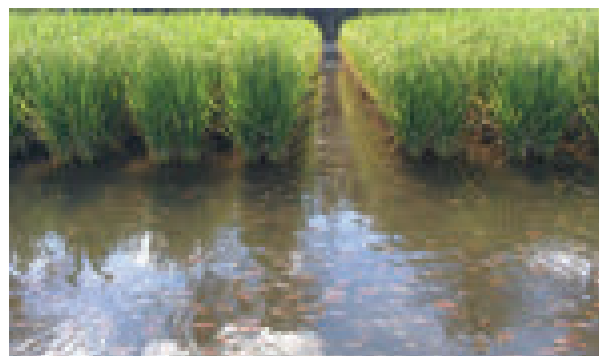
The larvae and juveniles obtained by collection from natural resources (estuaries, and backwaters) or by hatchery methods (controlled breeding). They are reared and grown into adults.



**Figure 23.19** Post larvae (Prawn seed)

### Paddy cum prawn culture

It is also called Pokkali culture. It is the oldest and traditional method of prawn culture practiced in Kerala. The low lying paddy fields along the coastal areas serve as suitable grounds for prawn culture. Prawns are cultured in these fields after the harvest of paddy.



**Figure 23.20** Paddy cum prawn/fish culture

## 23.13 Vermitechnology

The awareness of organic matter and concept of sustainable agriculture is gaining importance among our farmers in the recent years to produce good quality crops. Maintenance of soil organic matter is very important for sustainable productivity and this is attained by vermitechnology.

### 23.13.1 Vermiculture

Vermiculture involves the artificial rearing or cultivation of earthworms and using them for the production of compost from natural organic wastes.

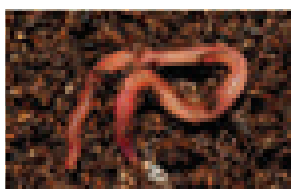
#### Earthworm Species used for Vermiculture:

The earthworms used for vermicompost production are *Perionyx excavatus* (Indian blueworm), *Eisenia fetida* (Red worms), *Eudrilus eugeniae* (African night crawler).

### 23.13.2 Vermicomposting

It is an important component of organic farming which can convert bio-wastes into nutrient rich organic manure by using earthworms. It feeds on the organic wastes



*Perionyx excavatus**Eisenia fetida**Eudrilus eugeniae*

**Figure 23.21** Earthworm species for vermicomposting

and excrete it in digested form known as castings. The compost is generally called vermicompost.

### Vermicompost

Vermicompost is the excreta (worm castings) which is a fine, granular organic matter formed by the decomposition of organic materials by the earthworm. It is an ideal fertilizer for the soil.

### Vermicomposting Materials

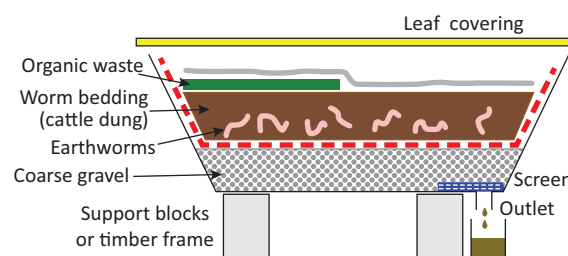
Biologically degradable organic wastes are used as potential organic resources for vermicomposting. They are:

- Agricultural wastes (crop residue, vegetables waste, sugarcane trash)
- Crop residues (rice straw, tea wastes, cereal and pulse residues, rice husk, tobacco wastes, coir wastes)
- Leaf litter
- Fruit and vegetable wastes
- Animal wastes (cattle dung, poultry droppings, pig slurry, goat and sheep droppings)
- Biogas slurry

### Vermicomposting by Bin Method

It is the rearing of earthworms in a container or bin. The container is half filled with bedding materials such as shredded cardboard, leaves, paddy husk, chopped straw, saw dust and manure. Small quantity of soil and sand is added to provide necessary grit for the worms. The bedding material should be moistened by adding water that enables free movements of the worms. The worms are gently placed and spread evenly on the bedding.

Organic wastes (kitchen wastes, vegetable and fruit wastes) are added which are fed by the earthworms. The bin is covered with coconut leaves or gunny bags to conserve moisture, provide darkness and keep out of pests. After a period of 60 days the wastes are completely transformed into nutrient rich materials that are excreted by earthworms known as **worm castings**. These castings are harvested and used as organic manure.



**Figure 23.22** Vermicomposting bin

### Activity 4

Prepare vermicompost from organic waste materials present in your school surroundings and garden. The above activity can be done in a circular container/ bin and kept in shady place with optimal temperature and light.

### Advantages of Vermicompost

Vermicompost is dark brown in colour and similar to farmyard manure in colour and appearance.

- It is a rich source of nutrients essential for plant growth. It makes the soil fertile.

- It improves the water holding capacity and helps to prevent soil erosion.
- It contains valuable vitamins, enzymes and growth regulator substances for increasing growth, vigour and yield of plants.
- It enhances decomposition of organic matter in soil.
- Vermicompost is free from pathogens and toxic elements.
- Vermicompost is rich in beneficial microflora.

## 23.14 Apiculture

Apiculture is the rearing of honey bee for honey. It is also called Bee keeping. It is a profitable rural based industry. Honey bees are domesticated by farmers to produce honey.

### 23.14.1 Types of Honey Bee

There are three types of individuals in an honey bee colony namely the queen bee, the drones and the worker bees.

**Queen Bee:** The queen is the largest member and the fertile female of the colony. They are formed from fertile eggs. The queen is responsible for laying eggs in a colony.

**Drones:** They are the fertile males. They develop from unfertilized eggs. They are larger than the workers and smaller than the queens. Their main function is to fertilize the eggs produced by the queen.

**Worker Bees:** They are sterile female bees and are the smallest members of the colony. Their function is to collect honey, look after the young ones, clean the comb, defend the hive and maintain the temperature of the bee hive.



Figure 23.23 Types of Honey bee

### 23.14.2 Varieties of Honey Bee

#### Indigenous varieties

- Apis dorsata* (Rock bee or Wild bee)
- Apis florea* (Little bee)
- Apis indica* (Indian bee)

#### Exotic varieties

- Apis mellifera* (Italian bee)
- Apis adamsoni* (African bee)

### 23.14.3 Structure of Bee Comb

The comb of the bees is formed mainly by the secretion of the wax glands present in the abdomen of the worker bee. A comb is a vertical sheet of wax with double layer of hexagonal cells.

**Formation of Honey:** The honey bees suck the nectar from various flowers. The nectar passes to the honey sac. In the honey sac, sucrose present in the nectar mixes with acidic secretion and by enzymatic action it is converted into honey which is stored in the special chambers of the hive.

Quality of honey depends upon the flowers available to the bees for nectar and pollen collection.

### 23.14.4 Products from Honey Bee

Honey bees are used in the production of honey and bee wax. Other useful products obtained from honey bees are bee pollen, royal jelly, propolis and bee venom.

**Honey:** Honey is a sweet, viscous, edible natural food product. Dextrose and sucrose gives sweet taste to the honey. It also contains amino acids, B-complex vitamins, ascorbic acid, and minerals. Formic acid is a preservative in honey. Invertase is an enzyme present in honey.

#### Uses of Honey

- Honey has an antiseptic and antibacterial property. It is a blood purifier.
- It helps in building up of haemoglobin content in the blood.
- It is used in Ayurvedic and Unani system of medicines.
- It prevents cough, cold, fever and relieves sore throat.



- It is a remedy for ulcers of tongue, stomach and intestine.
- It enhances digestion and appetite.



- Honey bee visits 50 to 100 flowers during a collection trip.
- Average bee will make only 1/12<sup>th</sup> of a teaspoon of honey in its lifetime.
- One kilogram of honey contains 3200 calories and is an energy rich food.

### Points to Remember

- ❖ Horticulture, is a branch of agriculture that deals with cultivation of fruits, vegetables, and ornamental plants.
- ❖ The organic manures are predominantly derived from plant debris, animal faeces, microbes. They make the soil fertile.
- ❖ Mushroom cultivation is a technology of growing mushrooms using plant, animal and industrial waste.
- ❖ Hydroponics is the method of growing plants without soil, using mineral nutrient solutions in water.
- ❖ The aeroponic system is high-tech type of hydroponic gardening and the growth medium is primarily air.
- ❖ Dairy farming involves raising of cattle for milk production.
- ❖ Aquaculture is the rearing of economically important aquatic organisms like fishes, prawns, shrimps, crabs, lobsters, edible oysters, pearl oysters and sea weeds under controlled and confined environmental conditions using advanced technologies.
- ❖ Pisciculture or fish culture is the process of breeding and rearing of fishes in ponds, reservoirs (dams), lakes, rivers and paddy fields.
- ❖ Vermiculture involves the artificial rearing or cultivation of earthworms and using them for the production of compost from natural organic wastes.

## A-Z GLOSSARY

<b>Aquaponics</b>	Combination of conventional aquaculture with hydroponics in a symbiotic environment in which plants are fed with the aquatic animals' excreta or wastes.
<b>Compost</b>	Soil conditioner, fertilizer, natural pesticide, a decomposed organic matter which is rich in nutrients.
<b>Floriculture</b>	Production of ornamental plants.
<b>Green manure</b>	Undecomposed green material derived mostly from leguminous plants.
<b>Hydroponics</b>	Soil less growing system in which plants grow in water.
<b>Mariculture</b>	Culture of fishes and other aquatic organism in marine water near the sea coast.
<b>Nectar</b>	Sweet viscous secretion secreted by the flower of plants.
<b>Olericulture</b>	Production of vegetables.
<b>Pisciculture</b>	Culture and rearing of fishes under controlled conditions.
<b>Polyculture</b>	Culture of more than one species of fish in a pond.
<b>Pomology</b>	Production of fruits.
<b>Vermicompost</b>	Vermicompost is the excreta of earthworm.
<b>Vermicomposting</b>	Earthworms degrade organic waste materials into useful product which can be used as a nutrient rich fertilizer.
<b>Vermiculture</b>	Artificial rearing or cultivation of earthworms for the production of vermicompost.



## TEXTBOOK EXERCISES



### I. Choose the correct answer.

- The production and management of fish is called
  - Pisciculture
  - Sericulture
  - Aquaculture
  - Monoculture
- Which one of the following is not an exotic breed of cow?
  - Jersey
  - Holstein-Friesian
  - Sahiwal
  - Brown Swiss
- Which one of the following is an Italian species of honey bee?
  - Apis mellifera*
  - Apis dorsata*
  - Apis florea*
  - Apis cerana*
- Which one of the following is not an Indian major carp?
  - Rohu
  - Catla
  - Mrigal
  - Singhara
- Drones in the honey bee colony are formed from
  - unfertilized egg
  - fertilized egg
  - parthenogenesis
  - both b and c
- Which of the following is an high milk yielding variety of cow?
  - Holstein- Friesian
  - Dorset
  - Sahiwal
  - Red Sindhi
- Which Indian variety of honey bee is commonly used for apiculture?
  - Apis dorsata*
  - Apis florea*
  - Apis mellifera*
  - Apis indica*
- \_\_\_\_\_ is the method of growing plants without soil.
  - Horticulture
  - Hydroponics
  - Pomology
  - None of these.

- The symbiotic association of fungi and vascular plants is
  - Lichen
  - Rhizobium*
  - Mycorrhizae
  - Azotobacter*
- The plant body of mushroom is
  - Spawn
  - Mycelium
  - Leaf
  - All of these

### II. Fill in the blanks.

- Quinine drug is obtained from \_\_\_\_\_.
- Carica papaya* leaf can cure \_\_\_\_\_ disease.
- Vermicompost is a type of soil made by \_\_\_\_\_ and microorganisms.
- \_\_\_\_\_ refers to the culture of prawns, pearl and edible oysters.
- The largest member in a honey bee hive is the \_\_\_\_\_.
- \_\_\_\_\_ is a preservative in honey.
- \_\_\_\_\_ is the method of culturing different variety of fish in a water body.

### III. Say true or false. If false, correct the statement.

- Mycorrhiza is an algae.
- Milch animals are used in agriculture and transport.
- Apis florea* is a rock bee.
- Ongole is an exotic breed of cattle.
- Sheep manure contains high nutrients than farm yard manure.

**IV. Differentiate the following.**

- Exotic breed and Indigenous breed
- Pollen and Nectar
- Shrimp and Prawn
- Farmyard manure and Sheep manure

**V. Match the following.**

Column A	Column B
Lobsters	Marine fish
Catla	Pearl
Sea bass	Shell fish
Oysters	Paddy
Pokkali	Fin fish
<i>Pleurotus sps</i>	Psoriasis
Sarpagandha	Oyster mushroom
Olericulture	Reserpine
<i>Wrightia tinctoria</i>	Vegetable farming

**VI. Answer briefly.**

- What are secondary metabolites?
- What are the types of vegetable garden?
- Mention any two mushroom preservation methods.
- Enumerate the advantages of vermicompost over chemical fertiliser.
- What are the species of earthworm used for vermiculture?
- List the medicinal importance of honey.

**VII. Answer in detail.**

- Enumerate the advantage of hydroponics.
- Define Mushroom culture. Explain the mushroom cultivation methods.

- What are the sources of organic resources for vermicomposting?
- Give an account of different types of fish ponds used for rearing fishes.
- Classify the different breeds of the cattle with suitable examples.

**VIII. Higher Order Thinking Skills.**

- Biomanuring plays an important role in agriculture. Justify
- Each bee hive consists of hexagonal cells. Name the material in which the cell is formed and mention the significance of the hexagonal cells.

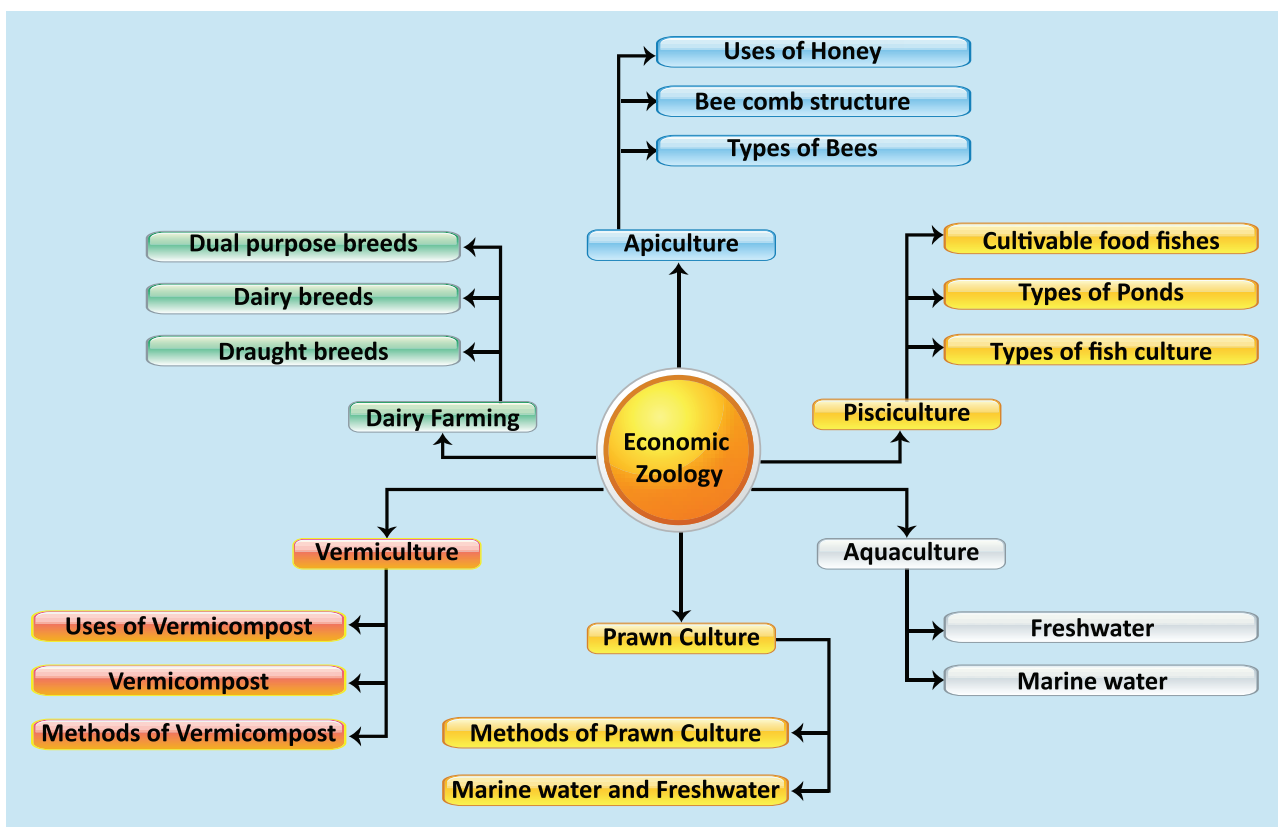
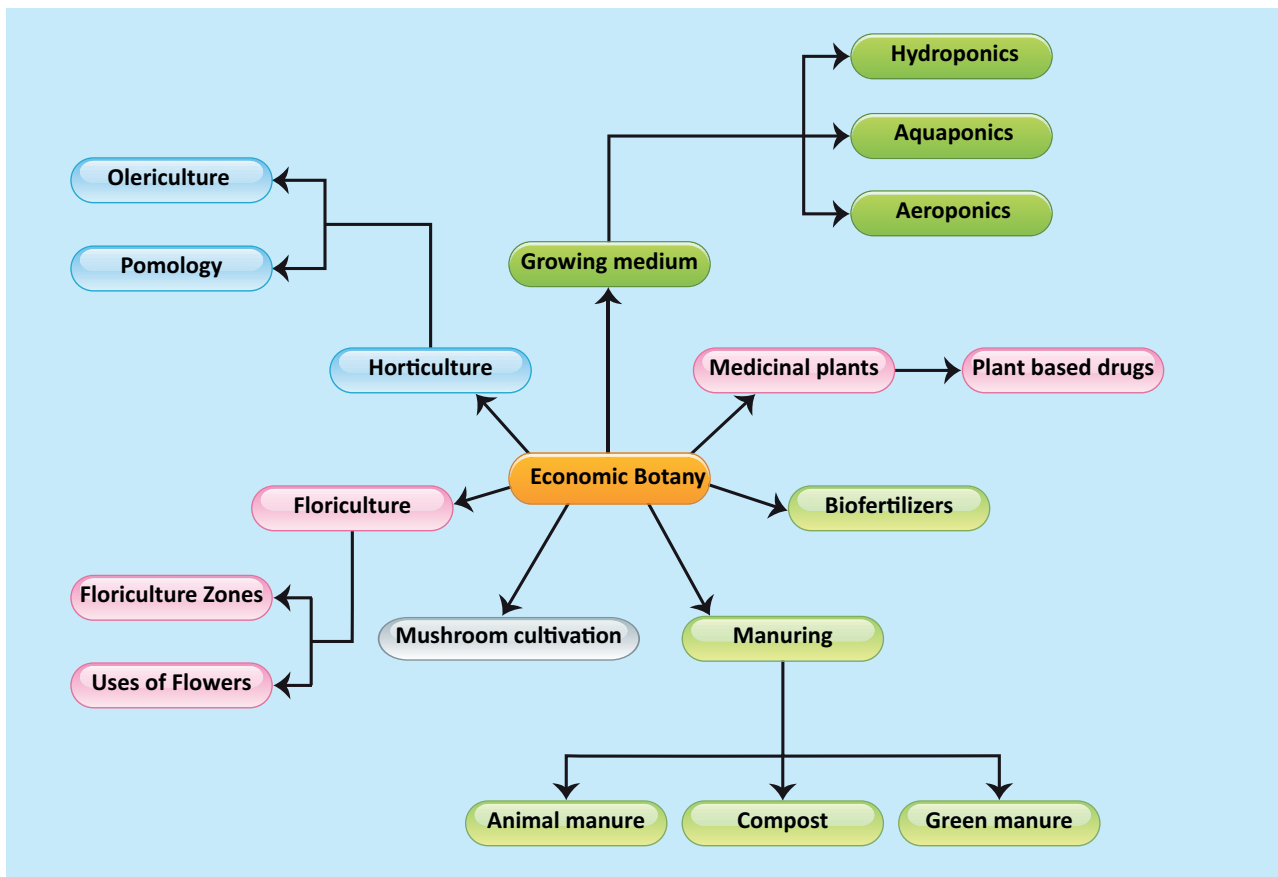
**REFERENCE BOOKS**

- Jawaid Ahsan and Subhas Prasad Sinha A Hand Book on Economic Zoology, S.Chand and Company, New Delhi
- Sharma O.P. Economic Botany Tata Mc Graw Publishing Co Ltd
- Ismail, S.A. The Earthworm Book, Other India Press, Goa

**INTERNET RESOURCES**

- [http:// www.biology.online.org](http://www.biology.online.org)  
[www.agritech.tnau.ac.in](http://www.agritech.tnau.ac.in)  
[www.fisheries.tn.gov.in](http://www.fisheries.tn.gov.in)  
[www.tnhorticulture.tn.gov.in](http://www.tnhorticulture.tn.gov.in)  
[www.biologydiscussion.com](http://www.biologydiscussion.com)  
[www.nios.ac.in.textbook.com](http://www.nios.ac.in.textbook.com)

# Concept Map



## Learning Objectives

After completing this lesson, students will be able to

- relate different aspects of environmental science.
- describe biogeochemical cycles.
- analyse the impacts of human activities on water cycle, nitrogen cycle and carbon cycle.
- correlate the adaptations of plants with the habitat.
- explain the adaptations of bat and earthworm.
- explain recycling of water its methods and importance .
- discuss the importance of water conservation and water recycling methods.



## Introduction

*“Nature has the power to refresh and renew”*  
- Helen Keller

Elements of nature continuously undergo changes and transformations. Environmental protection provides holistic knowledge about natural processes, effects of human intervention and solutions to overcome environmental problems. Environmental issues such as pollution, global warming, ozone layer depletion, acid rain, deforestation, landslide, drought and desertification have gained major focus across the world. Natural resources are recycled over and over again on earth for continued availability. At the same time, it also reminds us of our responsibility to reduce and restrain our activities that will affect the natural processes.

Living organisms adjust themselves according to their habitat and changes in the ecosystem. All living organisms develop certain morphological, anatomical, physiological and reproductive adaptations which help them to survive better and to withstand environmental conditions.

This lesson deals with bio-geo-chemical cycles, adaptations by the plants and animals, water conservation and recycling of water.

### 24.1 Biogeochemical Cycles (bio – life; geo – earth)

Biosphere is the part of the earth where life exists. All resources of biosphere can be grouped into two major categories namely:

- (i) Biotic or living factors which include plants, animals and all other living organisms.
- (ii) Abiotic or non-living factors which include all factors like temperature, pressure, water, soil, air and sunlight which affect the ability of organisms to survive and reproduce.

There is a constant interaction between biotic and abiotic components in the biosphere and that makes the biosphere a dynamic and stable system. Cyclic flow of nutrients between non-living and living factors of the environment are termed as bio-geo-chemical cycles. Some of the important biogeochemical cycles are:

1. Water cycle
2. Nitrogen cycle
3. Carbon cycle

### 24.1.1 Water Cycle

Water cycle or hydrological cycle is the continuous movement of water on earth. In this process, water moves from one reservoir to another by processes such as evaporation, sublimation, transpiration, condensation, precipitation, surface runoff and infiltration, during which water converts itself to various forms like liquid, solid and vapour (Fig. 24.1).

**Evaporation:** Evaporation is a type of vaporization, where liquid is converted to gas before reaching its boiling point. Water evaporates from the surface of the earth and water bodies such as the oceans, seas, lakes, ponds and rivers.

**Sublimation:** Sublimation is conversion of solid to gas, without passing through the intermediate liquid phase. Ice sheets and ice caps from north and south poles, and icecaps on mountains, get converted into water vapour directly, without converting into liquid.

**Transpiration:** Transpiration is the process by which plants release water vapour into the atmosphere through stomata in leaves and stems.

**Condensation:** Condensation is the changing of gas phase into liquid phase and is the reverse of

vaporisation. At higher altitudes, the temperature is low. The water vapour present there condenses to form very tiny particles of water droplets. These particles come close together to form clouds and fog.

**Precipitation:** Due to change in wind or temperature, clouds combine to make bigger droplets, and pour down as precipitation (rain). Precipitation includes drizzle, rain, snow and hail.

**Run off:** As the water pours down, it runs over the surface of earth. Runoff water combines to form channels, rivers, lakes and ends up into seas and oceans.

**Infiltration:** Some of the precipitated water moves deep into the soil. Then it moves down and increases the ground water level.

**Percolation:** Some of the precipitated water flows through soil and porous or fractured rock.

Infiltration and percolation are two related but different processes describing the movement of water through soil.

#### Human impacts on water cycle

Major human activities affecting the water cycle on land are urbanisation, dumping of plastic waste on land and into water, polluting water bodies and deforestation.

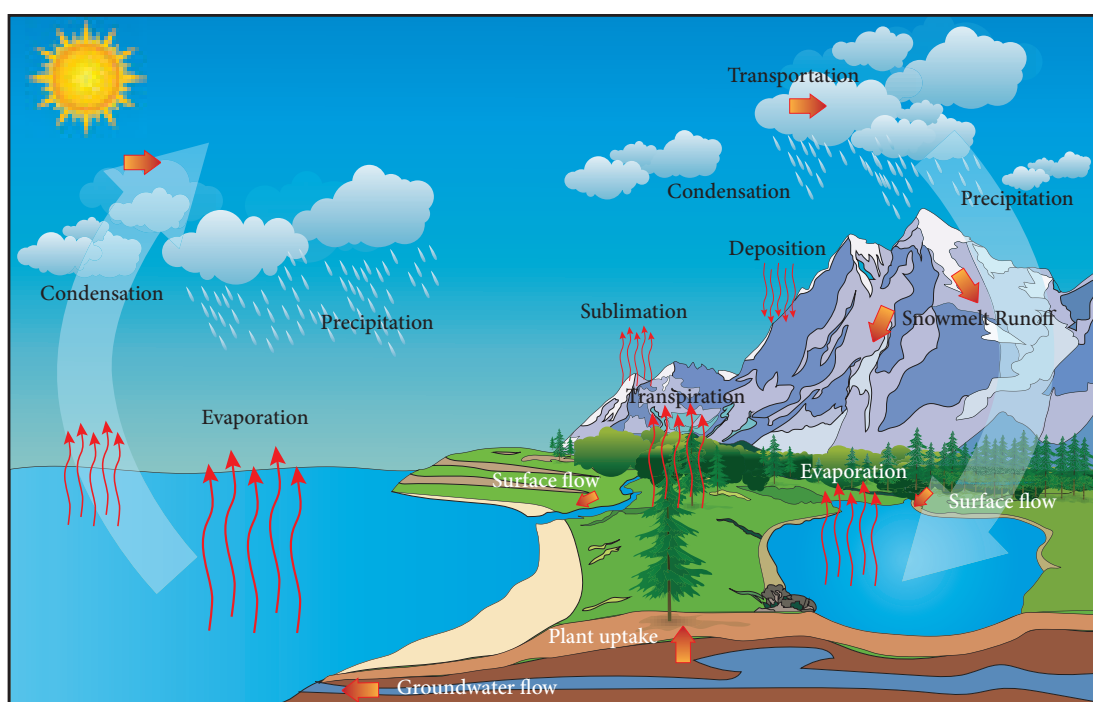


Figure 24.1 Water cycle

### Activity 1

#### Create your own water cycle

Take a small container and place it in the middle of the large bowl. Fill water in the large container and cover it with plastic wrap. Fasten the plastic wrap around the rim of the large container with the rubber band. Place a stone on the top of the plastic wrap. Keep this under sun for few hours.

Record your observation.

### 24.1.2 Nitrogen Cycle

Nitrogen is the important nutrient needed for the survival of all living organisms. It is an essential component of proteins, DNA and chlorophyll. Atmosphere is a rich source of nitrogen and contains about 78% nitrogen. Plants and animals cannot utilize atmospheric nitrogen. They can use it only if it is in the form of ammonia, amino acids or nitrates.

Processes involved in nitrogen cycle are explained below.

**Nitrogen fixation :** Nitrogen fixation is the conversion of atmospheric nitrogen, which is in inert form, to reactive compounds available to living organisms. This conversion is done by a number of bacteria and **blue green algae** (Cyanobacteria). **Leguminous plants** like pea and beans have a symbiotic relationship with nitrogen fixing bacteria *Rhizobium*. *Rhizobium* occur in the root nodules of leguminous plants and fixes nitrogenous compounds.

**Nitrogen assimilation:** Plants absorb nitrate ions and use them for making organic matter like proteins and nucleic acids. Herbivorous animals convert plant proteins into animal proteins. Carnivorous animals synthesize proteins from their food.

**Ammonification:** The process of decomposition of nitrogenous waste by putrefying bacteria and fungi into ammonium compounds is called ammonification. Animal proteins are excreted in the form of urea, uric acid or ammonia. The putrefying bacteria and fungi decompose these animal proteins, dead animals and plants into ammonium compounds.

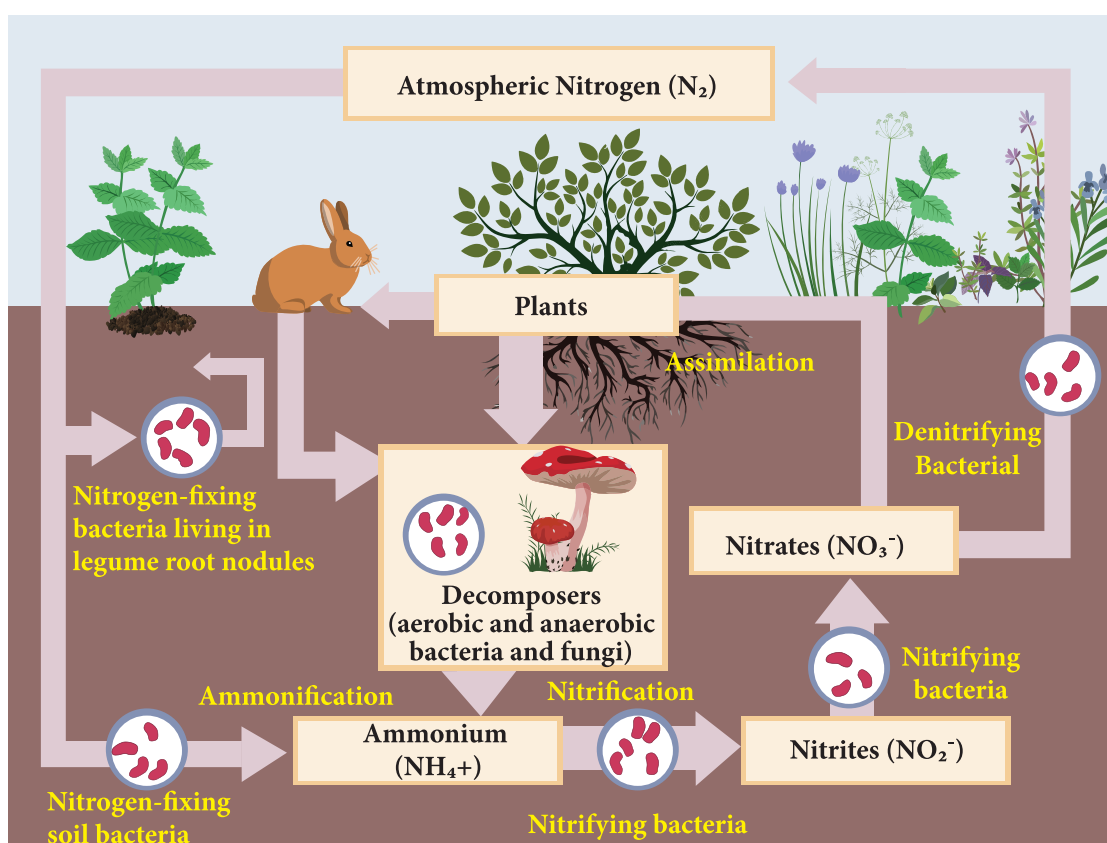


Figure 24.2 Nitrogen cycle

**Nitrification:** The ammonium compounds formed by ammonification process are oxidised to soluble nitrates. This process of nitrate formation is known as nitrification. The bacteria responsible for nitrification are called as nitrifying bacteria.

**Table 24.1** Microorganisms involved in nitrogen cycle

Role played in nitrogen cycle	Name of the microorganisms
Nitrogen fixation	<i>Azotobacter</i> (in soil) <i>Rhizobium</i> (in root nodules) Blue green algae- <i>Nostoc</i>
Ammonification	Putrefying bacteria, Fungi
Nitrification	Nitrifying bacteria i. <i>Nitrosomonas</i> ii. <i>Nitrobacter</i>
Denitrification	Denitrifying bacteria <i>Pseudomonas</i>

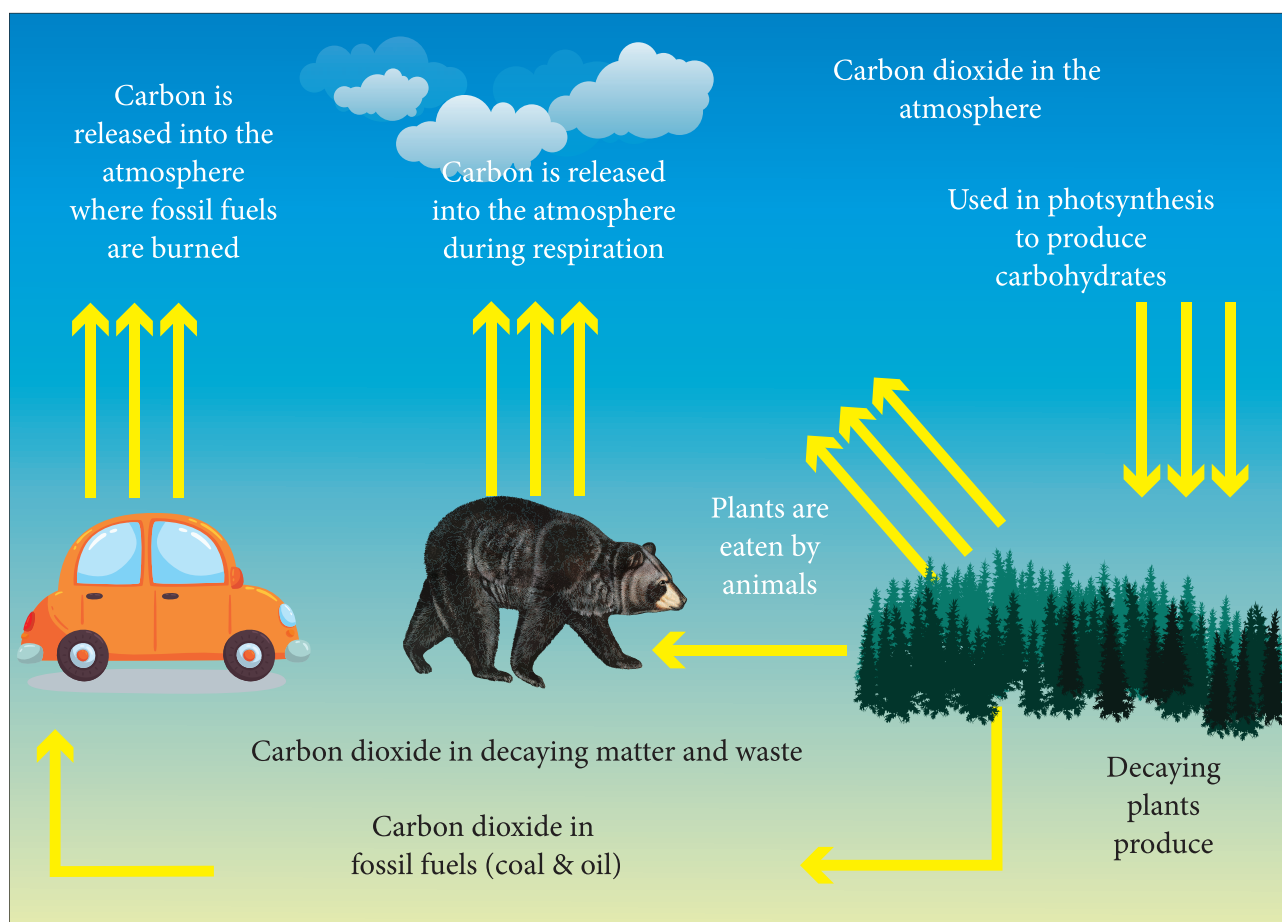
**Denitrification:** Free living soil bacteria such as *Pseudomonas sp.* reduce nitrate ions of soil into gaseous nitrogen which enters the atmosphere.

### Human impacts on nitrogen cycle

Burning fossil fuels, application of nitrogen-based fertilizers and other activities can increase the amount of biologically available nitrogen in an ecosystem. Nitrogen applied to agricultural fields enters rivers and marine systems. It alters the biodiversity, changes the food web structure and destroys the general habitat.

### 24.1.3 Carbon Cycle

Carbon occurs in various forms on earth. Charcoal, diamond and graphite are elemental forms of carbon. Combined forms of carbon include carbon monoxide, carbon dioxide and carbonate salts. All living organisms are made up of carbon containing molecules like proteins and nucleic acids. The atmospheric carbon dioxide enters into the plants through the process of photosynthesis to form carbohydrates. From plants, it is passed on to herbivores and carnivores. During respiration, plants and



**Figure 24.3** Carbon cycle



animals release carbon into atmosphere in the form of carbon dioxide. Carbon dioxide is also returned to the atmosphere through decomposition of dead organic matter, burning fossil fuels and volcanic activities.

### Human impacts on carbon cycle

More carbon moves into the atmosphere due to burning of fossil fuels and deforestation. Most of the carbon in atmosphere is in the form of carbon dioxide. Carbon dioxide is a greenhouse gas. By increasing the amount of carbon dioxide, earth becomes warmer. This leads to greenhouse effect and global warming.

## 24.2 Adaptations of Plants

Any feature of an organism or its part that enables it to exist under conditions of its habitat is called adaptation. On the basis of water availability, plants have been classified as:

- (i) Hydrophytes
- (ii) Xerophytes
- (iii) Mesophytes



### 24.2.1 Hydrophytes

Plants growing in or near water are called hydrophytes. Hydrophytes may be free floating or submerged plants living in lakes, ponds, shallow water, marshy lands and marine habitat. Hydrophytes face certain challenges in their habitat. They are:

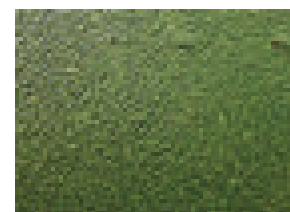
- (i) Availability of more water than needed.
- (ii) Water current may damage the plant body.
- (iii) Water levels may change regularly.
- (iv) Maintain buoyancy in water.

#### Adaptations of hydrophytes

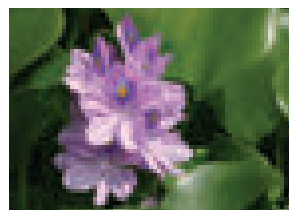
1. Roots are poorly developed as in *Hydrilla* or absent as in *Wolffia*.
2. Plant body is greatly reduced as in *Lemna*.
3. Submerged leaves are narrow or finely divided. e.g. *Hydrilla*.



*Hydrilla*



*Wolffia*



*Eichhornia*



*Lemna*

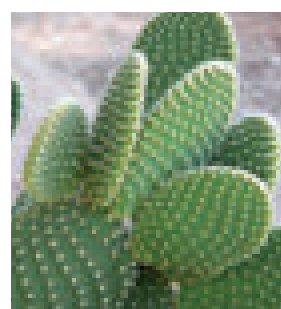
**Figure 24.4** Hydrophytes

4. Floating leaves have long leaf stalks to enable the leaves move up and down in response to changes in water level. e.g. Lotus.
5. Air chambers provide buoyancy and mechanical support to plants as in *Eichhornia* (swollen and spongy petiole).

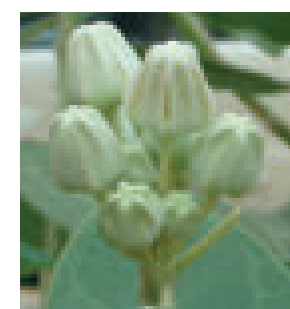
### 24.2.2 Xerophytes

Plants that grow in dry habitat are called xerophytes. These plants develop special structural and physiological characteristics to meet the following conditions:

- (i) To absorb as much water as they can get from the surroundings.
- (ii) To retain water in their organs for very long time.
- (iii) To reduce the transpiration rate.
- (iv) To reduce consumption of water.



*Opuntia*



*Calotropis*

**Figure 24.5** Xerophytes

### Adaptations of xerophytes

1. They have well developed roots. Roots grow very deep and reach the layers where water is available as in *Calotropis*.
2. They store water in succulent water storing parenchymatous tissues. e.g. *Opuntia*, *Aloe vera*.
3. They have small sized leaves with waxy coating. e.g. *Acacia*. In some plants, leaves are modified into spines. e.g. *Opuntia*.
4. Some of the xerophytes complete their life cycle within a very short period when sufficient moisture is available

### 24.2.3 Mesophytes

Mesophytes are common land plants which grow in situations that are neither too wet nor too dry. They do not need any extreme adaptations.

### Adaptations of mesophytes

1. The roots of mesophytes are well developed and are provided with root caps.
2. The stem is generally straight and branched.
3. The leaves are generally broad and thin.
4. The presence of waxy cuticle in leaves traps the moisture and lessens water loss.
5. Leaves have stomata which close in extreme heat and wind to prevent transpiration.

## 24.3 Adaptations of Animals

Animals can adapt themselves according to their habitat. Temperature and light are forms of energy which influence various stages of life activities such as growth, metabolism, reproduction, movement, distribution and behaviour. Animals develop special features or behaviour patterns to escape from extreme conditions of temperature and light. In this context, let us study about the adaptive features of bat and earthworm.

### 24.3.1 Adaptations of Bat

Bats are the only mammals that can fly. Mostly, bats live in caves. Apart from caves, bats also live in trees, hollowed logs and rock

crevices. They are extremely important to humans as they reduce insect population and help to pollinate plants. Adaptations of bat in relation to their habitat are explained below.

### Nocturnality

Bats are active at night. This is a useful adaptation for them, as flight requires a lot of energy during day. Their thin, black wing membrane (Patagium) may cause excessive heat absorption during the day. This may lead to dehydration.

### Flight adaptation

Forelimbs are modified serve wings. Tail supports and controls movements during flight. Muscles are well developed and highly powerful and achieve in beating of wings. Tendons of hind limbs provide a tight grasp when the animals are suspended upside down at rest.

### Hibernation

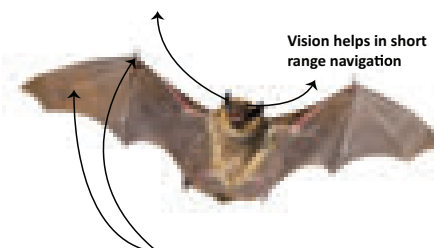
Hibernation is a state of inactivity in which the body temperature drops with a lowered metabolic rate during winter. Bats are warm blooded animals but unlike other mammals, they let their internal temperature reduce when they are resting. They go to a state of decreased activity to conserve energy.

### Echolocation

Bats use a remarkable high-frequency system called echolocation. Bats give out high-frequency sounds (ultrasonic sounds). These sounds are reflected back from its prey and perceived by the ear. Bats use these echoes to locate and identify the prey.



Bats emit ultrasonic pulses of sound at objects and listen for echoes.



Bats wings are a thin skin membrane stretched between extra long finger bones.

Figure 24.6 Bats

### 24.3.2 Adaptations of Earthworm

It is commonly found in soil, feeding on live and dead organic matter. Earthworm plays a vital role in maintaining soil fertility. It facilitates aeration, water infiltration and producing organic matter to increase crop growth. Some of the adaptations of earthworm are:

#### Stream-lined body

The earthworm has a cylindrical, elongated and segmented body. This helps them to live in narrow burrows underground and for easy penetration into the soil.

#### Skin

Mucus covers the skin which does not allow soil particles to stick to it. Moist skin helps in oxygenation of blood.

#### Burrowing

Its body is flexible having circular and longitudinal muscles which help in movement and subsoil burrowing. Each segment on the lower surface of the body has number of **setae**. They help the earthworm to move through the soil and provide anchor in the burrows.

#### Aestivation

When the soil becomes too hot or dry, earthworms become inactive and undergo a process called aestivation. Earthworm moves deeper into the soil. It secretes mucus and lowers their metabolic rate in order to reduce water loss. They remain dormant until conditions become favourable. They come out of their burrow during rainy season.



Earthworms are referred as '*Farmer's friend*'. After digesting organic matter, earthworms excrete a nutrient-rich waste product called castings which is used as Vermicompost.

#### Nocturnality

Earthworms are sensitive to light. It has no eyes but can sense light through light sensitive cells (**Photoreceptors**) present in their skin. They react negatively to bright light

(Photophobic). It remains in its burrow during the day to avoid light.

## 24.4 Water Conservation

Water conservation is the preservation, control and management of water resources. It also includes activities to protect the hydrosphere and to meet the current and future human demand.

### 24.4.1 Importance of Water Conservation

- It creates more efficient use of the water resources.
- It ensures that we have enough usable water.
- It helps in decreasing water pollution.
- It helps in increasing energy saving.

### 24.4.2 Water Conservation Measures

#### Industrial conservation

Water conservation measures that can be taken by industries are:

- using dry cooling systems.
- if water is used as cooling agent, reusing the water for irrigation or other purposes.

#### Agricultural conservation

Agricultural water is often lost due to leaks in canals, run off and evaporation. Some of the water conserving methods are:

- using lined or covered canals that reduce loss of water and evaporation.
- using improved techniques such as sprinklers and drip irrigation.
- encouraging the development of crops that require less water and are drought resistant.
- mulching of soil in vegetable cultivation and in horticulture.



World Water Day on 22<sup>nd</sup> March every year, is about focusing attention on the importance of water.

## Domestic conservation

All of us have the responsibility to conserve water. We can conserve water by the following activities:

- Using a bucket of water to take bath than taking a shower.
- Using low flow taps.
- Using recycled water for lawns.
- Repairing the leaks in the taps.
- Recycling or reusing water wherever it is possible.

### 24.4.3 Strategies adopted to conserve Water

- Rain water harvesting.
- Improved irrigation techniques.
- Active use of traditional water harvesting structures.
- Minimising domestic water consumption.
- Awareness on water conservation.
- Construction of farm ponds.
- Recycling of water.

## 24.5 Farm Ponds

Farm ponds are used as one of the strategies to support water conservation. Much of the rainfall runs off the ground. The run off not only causes loss of water but also washes away precious top soil. Farm ponds help the farmers to store water and to use it for irrigation.

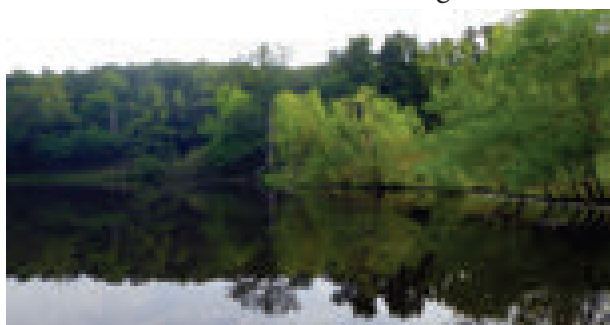


Figure 24.7 Farm pond

### 24.5.1 Layout of a Farm Pond

Farm pond is a dugout structure with definite shape and size. They have proper inlet and outlet structures for collecting the surface runoff flowing from the farm area. The stored water is used for irrigation.

### 24.5.2 Advantages of Farm Ponds

The advantages of farm ponds are:

- They provide water to growing crops, without waiting for rainfall.
- They provide water for irrigation, even when there is no rain.
- They reduce soil erosion.
- They recharge ground water.
- They improve drainage.
- The excavated soil can be used to enrich soil in fields and levelling lands.
- They promote fish rearing.
- They provide water for domestic purposes and livestock.

## 24.6 Water Recycling

Water recycling, apart from rain water harvesting, is also one of the key strategies to conserve water. Water recycling is reusing treated wastewater for beneficial purposes such as agricultural and landscape irrigation, industrial processes, flushing in toilets and ground water recharge.

### 24.6.1 Wastewater Recycling Stages

Conventional waste water treatment consists of a combination of physical, chemical and biological processes which remove solids, organic matter and nutrients from waste water. The waste water treatment involves the following stages:

#### Primary treatment

Primary treatment involves temporary holding of the wastewater in a tank. The heavy solids get settled at the bottom while oil, grease and lighter solids float over the surface. The settled and floating materials are removed. The remaining liquid undergoes secondary treatment.

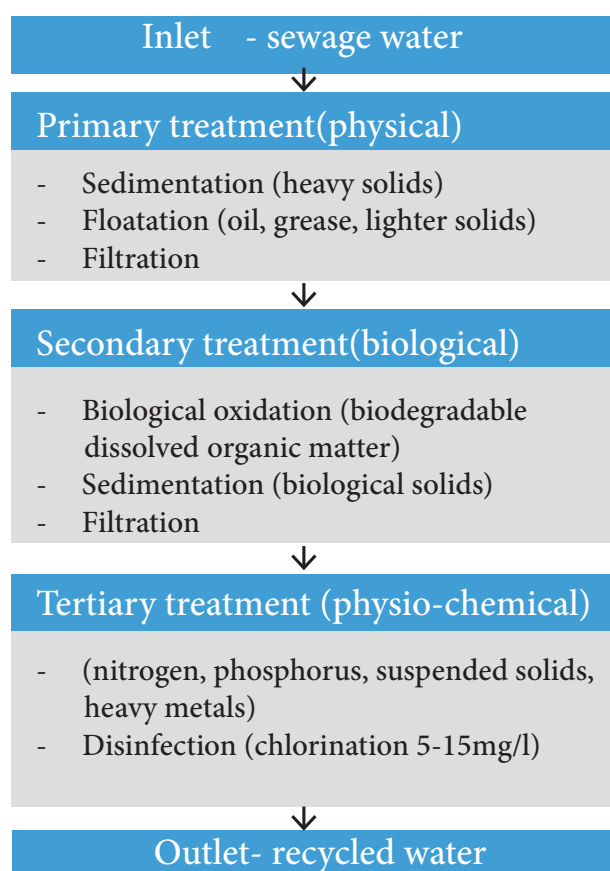
#### Secondary treatment

Secondary treatment is used to remove the biodegradable dissolved organic matter. This is performed in the presence of oxygen by aerobic microorganisms (Biological oxidation). The microorganisms must be separated from treated

water waste by sedimentation. After separating the sediments of biological solids, the remaining liquid is discharged for tertiary treatment.

### Tertiary treatment

Tertiary or advanced treatment is the final step of sewage treatment. It involves removal of inorganic constituents such as nitrogen, phosphorus and microorganisms. The fine colloidal particles in the sewage water are precipitated by adding chemical coagulants like alum or ferric sulphate.



### 24.6.2 Uses of Recycled Water

- Agriculture
- Landscape
- Public parks
- Cooling water for power plants and oil refineries
- Toilet flushing
- Dust control
- Construction activities

## 24.7 IUCN (International Union for Conservation of Nature and Natural Resources)

IUCN is an international organization working in the field of nature conservation and sustainable use of natural resources. IUCN is the global authority on the status of the natural world and the measures needed to safeguard it.

### Vision of IUCN

The vision of IUCN is ‘A just world that values and conserves nature’.

### Mission of IUCN

The mission of IUCN is to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable.

The organization is best known to the wider public for compiling and publishing the IUCN red list of threatened species, which assesses the conservation status of species worldwide.

India, a mega diverse country with only 2.4 % of world’s land area, accounts for 7-8% of all recorded species. It includes over 45,000 species

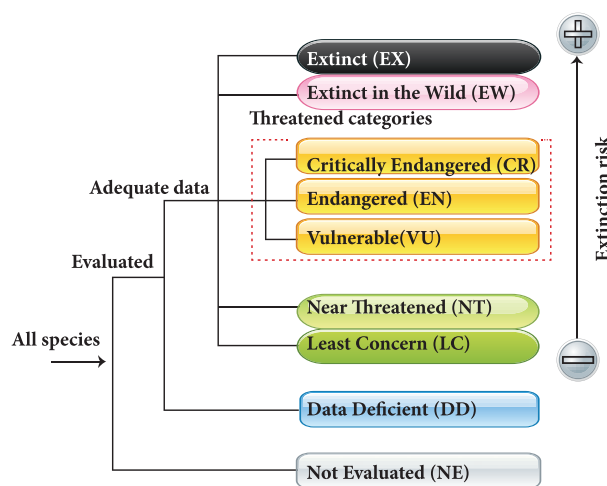


Figure 24.8 Red list categories of IUCN

of plants and 91,000 species of animals. The country's diverse physical features and climatic conditions have resulted in a variety of ecosystems such as forests, wetlands, grasslands, desert, coastal and marine ecosystems. Four of 34 globally identified biodiversity hotspots are found in India. They are:

- The Himalayas
- The Western ghats
- The North-East
- The Nicobar islands

India became state member of IUCN in 1969, through the Ministry of Environment, Forest and Climate change (MoEFCC).

**DO YOU KNOW?** IUCN was founded on 5<sup>th</sup> October 1948 at Gland, Switzerland.



CR: Himalayan brown/red bear



EN: Red Panda

**Figure 24.9** Animals in Red List

### Points to Remember

- ❖ Cyclic flow of nutrients between non-living environment and living organisms are termed as biogeochemical cycles.
- ❖ The ammonium compounds formed by ammonification process is oxidised to soluble nitrates. The process of nitrate formation is known as nitrification.
- ❖ Hydrophytes may be free floating or submerged plants living in lakes, ponds, shallow water, marshy lands and marine habitat.
- ❖ Plants that grow in dry habitat are called xerophytes.
- ❖ Mesophytes are common land plants which grow in situations that are neither too wet nor too dry.
- ❖ Animals develop special features or behaviour patterns to escape from the extreme conditions of temperature and light.
- ❖ Farm pond is a dugout structure with definite shape and size for collecting the surface runoff flowing from the area around the farm.
- ❖ Water recycling is reusing treated wastewater for beneficial purposes
- ❖ IUCN is the global authority on the status of the natural world and the measures needed to safeguard it.

## A-Z GLOSSARY

<b>Aestivation</b>	State of inactivity and a lowered metabolic rate in animals, during summer.
<b>Assimilation</b>	Conversion of nutrients into usable form that is incorporated into the tissues and organs.
<b>Buoyancy</b>	Capacity to remain afloat in liquid or gas.
<b>Echo location</b>	Use of sound waves and their echoes to determine the location of objects.
<b>Hibernation</b>	State of inactivity and a lowered metabolic rate in animals, during winter.
<b>Infiltration</b>	Process by which water on the ground surface enters the soil.
<b>Precipitation</b>	Product of condensation of atmospheric water vapour that falls on earth.
<b>Setae</b>	Hair-like locomotory structure, present in each segment of an earthworm.
<b>Stomata</b>	Minute pores in the epidermis of leaves which facilitate gaseous exchange and transpiration.
<b>Sublimation</b>	Conversion of solid state into vapour state without going through a liquid state.



## TEXTBOOK EXERCISES



### I. Choose the correct answer.

- All the factors of biosphere which affect the ability of organisms to survive and reproduce are called as \_\_\_\_\_.
  - biological factors
  - abiotic factors
  - biotic factors
  - physical factors
- The ice sheets from the north and south poles and the icecaps on the mountains, get converted into water vapour through the process of \_\_\_\_\_.
  - evaporation
  - condensation
  - sublimation
  - infiltration
- The atmospheric carbon dioxide enters into the plants through the process of \_\_\_\_\_.
  - photosynthesis
  - assimilation
  - respiration
  - decomposition
- Increased amount of \_\_\_\_\_ in the atmosphere, results in greenhouse effect and global warming
  - carbon monoxide
  - sulphur dioxide
  - nitrogen dioxide
  - carbon dioxide

### II. Match the following.

Microorganism	Role Played
<i>Nitrosomonas</i>	Nitrogen fixation
<i>Azotobacter</i>	Ammonification
<i>Pseudomonas species</i>	Nitrification
Putrefying bacteria	Denitrification

### III. State whether true or false. If false, correct the statement.

- Nitrogen is a greenhouse gas.
- Poorly developed root is an adaptation of mesophytes.
- Bats are the only mammals that can fly.
- Earthworms use the remarkable high frequency system called echoes.
- Aestivation is an adaptation to overcome cold condition.

### IV. Give reason for the following.

- Roots grow very deep and reach the layers where water is available. Which type of plants develops the above adaptation? Why?
- Why streamlined bodies and presence of setae is considered as adaptations of earthworm?
- Why is it impossible for all farmers to construct farm ponds in their fields?

### V. Answer briefly.

- What are the two factors of biosphere?
- How do human activities affect nitrogen cycle?
- What is adaptation?
- What are the challenges faced by hydrophytes in their habitat?
- Why is it important to conserve water?
- List some of the ways in which you could save water in your home and school.
- What are the uses of recycled water?
- What is IUCN? What is the vision of IUCN?

### VI. Answer in detail.

- Describe the processes involved in the water cycle.
- Explain carbon cycle with the help of a flow chart.
- List out the adaptations of xerophytes.
- How does a bat adapt itself to its habitat?
- What is water recycling? Explain the conventional wastewater recycling treatment methods.



## REFERENCE BOOKS

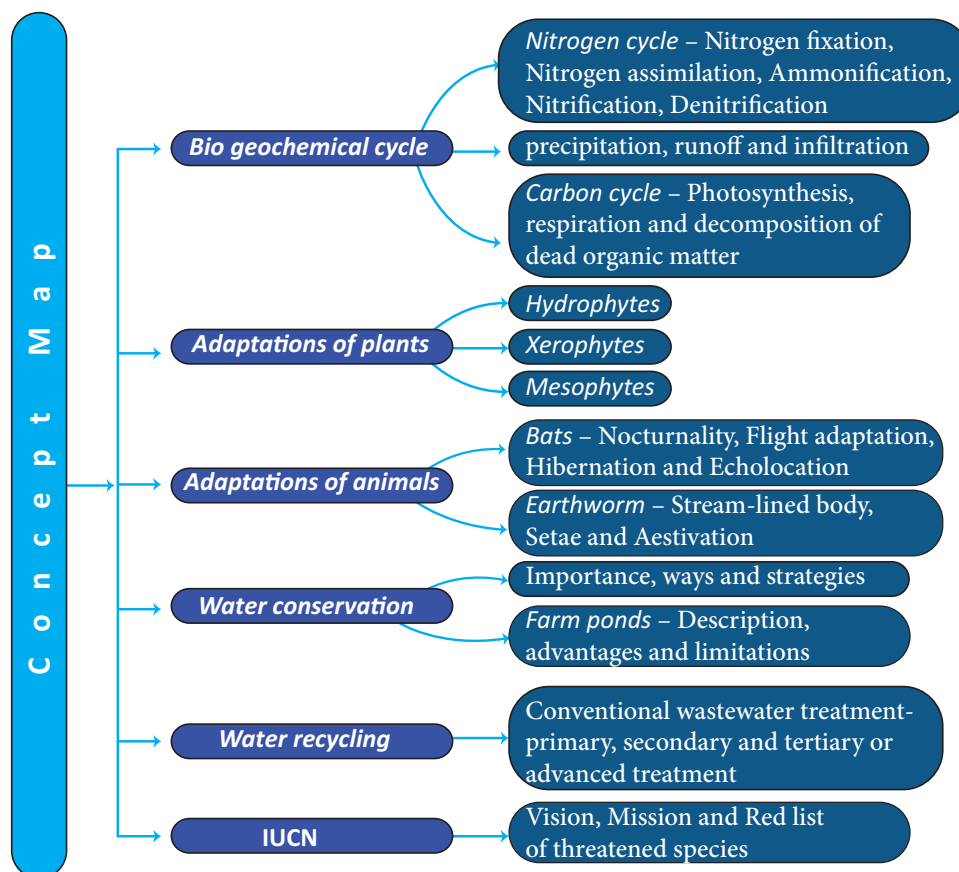
1. Shukla R.S and Chandel. P.S. A textbook of Plant Ecology including Ethnobotany and Soil Science.
2. Verma, P.S and Agarwal. V.K. Environmental Biology, S.Chand and Company, New Delhi.
3. Kotpal R.L Zoology- Phylum - Annelida - Rastogi Publications, Meerut.



## INTERNET RESOURCES

- www.freedrinkingwater.com  
 www.nature.com  
 www.sciencefocus.com  
 www.sciencelearn.org  
 www.IUCN.org

## Concept Map



## ICT CORNER

## Environmental Science

### Steps

- Type the given URL to reach “The Carbon Cycle” simulation page.
- Press “Run Decade” button to observe the carbon cycle accumulating every 10 years.
- Select “Curb Emission” from “lesson” tab and adjust the simulation parameters to watch the effect of cycle.
- Select “Feedback Effects” from “lesson” tab and run the cycle and analyze the carbon accumulation result.

### Carbon cycle

URL: <https://www.learner.org/courses/envsci/interactives/carbon/carbon.html>  
 or Scan the QR Code.



B567\_9\_SCI\_EM\_T3