BIODIVERSITY

SLOs: After completing this lesson, the student will be able to:

1. Define biodiversity and classification.
2. Describe advantages of classification.
3. Discuss the history of classification schemes.
4. List the three distinct domains into which living organisms are broadly classified into.
5. List the taxonomic ranks of classification.
6. Define species
7. Outline the binomial nomenclature system.
8. Describe the complications of classifying viruses.

In the previous chapter we have learned that biology is the study of living organisms. The living organisms have been divided into major groups so that they can be studied easily.

2.1 DEFINITION AND INTRODUCTION TO BIODIVERSITY

The similarity among living organisms is that they share all the characteristics of life, i.e., movement, respiration, sensitivity, nutrition, excretion, reproduction and growth. At the same time these living things differ from one another and their variety is enormous.

2.1.1 Biodiversity

If you look around you will find variety of various kinds of organisms. The term biodiversity comes from 'biological diversity'. Biodiversity has ecological and economic importance. It provides us with nourishment, housing, fuel, clothing etc. Biodiversity is defined as "the variety of living organism on earth".

2.1 Biodiversity

STEAM ACTIVITY 2.1

Take a chart paper. Cut pictures of various plants and animals from old newspapers or magazines and paste on the chart paper. You have placed all the organisms together at one place. What is it? This is biodiversity.

The natural biodiversity provides us oxygen, clean water and air. They help carbon cycle and fix nutrients. They enable the plants to grow. Pests are controlled by organisms such as by insects, birds and fungi. They help protect against flooding and regulate climate. They help in pollination and crop production. Biodiversity provides our food stuff and medicines derived mainly from plants. The industrial materials such as building materials, fibres, dyes, resins, gums, adhesives, rubber and oil etc., are derived directly from plants.

2.2 CLASSIFICATION

Classification is the grouping of related facts into classes. It is a process which brings together like things and separates unlike things.

STEAM ACTIVITY 2.2

Write the names of the organisms in their respective groups on the basis of having similar characteristics.

Rose, guava, fowl, pigeon, mango, sparrow, snake, crocodile, sunflower, lizard, cat, tiger, cow, tortoise, goat, dove. For example, rose, fowl, snake and goat have been placed in separate groups.

Group 1	Groups 2	Group 3	Group 4
Rose, ...	Fowl, ...	Snake, ...	Goat, ...

Why did you put rose and mango in one group whereas, fowl and pigeon in another group?

You placed the organisms of similar characteristics in groups. For example, you made a group of flowering plants with Rose, mango, guava and sunflower. You made another group of fowl, pigeon, dove, and sparrow. All of them have the similar characteristics in each group.

You have separated the organisms into groups on the basis of similarities and differences. Thus, you have classified the organisms.

To put organisms into separate groups on the basis of similarities and differences is called classification.

2.2.1 Advantages of Classification

Biologists have devised ways of grouping organisms. The grouping of organisms is called **classification. Taxonomy** is the branch of biology concerned with identification, naming and classification of organisms. Suppose you were asked to classify the living organisms of your surroundings. What criteria would you use to classify the organisms? The scientific study of diversity of organisms and their evolutionary relationship is called **systematics**.

The main aims and objectives of classification are: (1) To determine similarities and differences between organisms. (2) To arrange organisms on the basis of similarities and differences. (3) Identify the organisms to study them systematically. (4) To find out evolutionary relationships among organisms.

2.3 HISTORY OF CLASSIFICATION

The Greek philosopher Aristotle was the first person who classified the living organisms. In 700s, Abu Usama Aljahiz described 350 species of animals. In the end of 15th century many biologists worked Classification method.

Andrea Caesalpino (1519-1603): He divided plants into fifteen groups and called them genera.

John Ray (1627-1705): He published important works on the classification of plants.

Tournefort (1656-1708): He introduced the taxa of class and species

Carolus Linnaeus (1707-1778): He grouped species according to similar physical characteristics.

According to earlier classification system, organisms were classified into two kingdoms, then three-kingdom and then five-kingdom system.

Classification Systems

Two Kingdom System   Three Kingdom System   Five Kingdom System
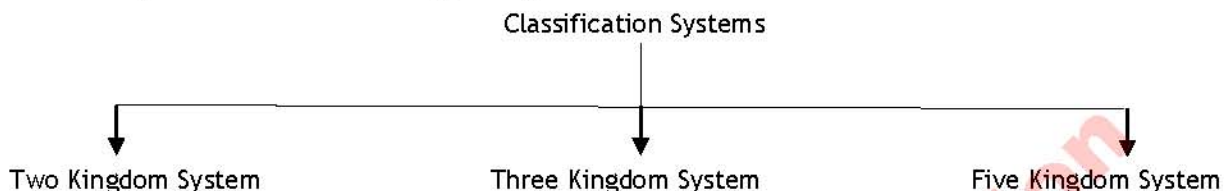
1. **Two-kingdom classification system:** It is the oldest system and classifies organisms into two kingdoms, the Plantae and Animalia. The kingdom Plantae includes the autotrophs. Bacteria, fungi and algae were also included in the kingdom. The organisms which depend on autotrophs or other heterotrophs are included in the kingdom Animalia.

Many unicellular organisms like *Euglena* have both plant like (presence of chlorophyll) and animal like (heterotrophic mode of nutrition in darkness and lack of cell wall) characteristics. So separate kingdom was introduced for such organisms.

2. **Three-kingdom classification system:** The German **Scientist** Ernst Haeckel proposed a third kingdom, Protista to accommodate *Euglena* like organisms and to separate unicellular microscopic organisms from multicellular ones.

3. **Five-kingdom classification system:** In 1937 E-Chatton suggested the terms 'Procariotique' to describe bacteria 'Eucariotique' to describe plant and animal cells. In 1967 Robert Whittekar introduced five-kingdom classification system. The five kingdoms are: Monera, Protista, Fungi, Plantae and Animalia. In the five kingdom system bacteria

> The organisms which lack nucleus in their cells are called **prokaryotes** while the organisms which have nucleus in their cells are called **eukaryotes.**

and archaea were combined in a single kingdom Monera, because they shared the prokaryotic form of cell structure.

2.4 CLASSIFICATION- THE THREE DOMAINS SYSTEM

In biology, a domain means the largest of all groups in the classification of life. **Domain** is group of kingdoms or taxonomic category above the kingdom. in 1990 Carl Woese introduced a three domains system of classification. The three domains of life are Archaea, Bacteria and Eukarya.

Classification into three domains is based on difference in the sequence of nucleotides in the rRNA (ribosomal Ribonucleic acid) of the cell, the cell's membrane lipid structure and its sensitivity to antibiotics.
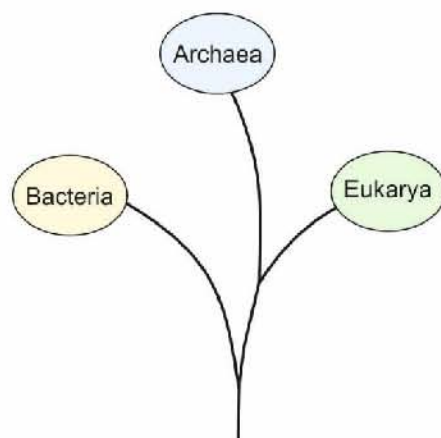
Fig. 2.2 The three domains of life

1. The Domain Archaea

The domain Archaea have the following characteristics:

a. Archaea are prokaryotic cells.
b. The cell walls of Archaea contain no peptidoglycan.
c. The rRNA (ribosomal RNA) are not found in Bacteria and Eukarya.
d. Archaea are not sensitive to some antibiotics that affect bacteria. They are sensitive to some antibiotics that affect the Eukarya.
e. Archaea often live in extreme environmnet.
f. Archae membrane can withstand higher temperature and stronger acid concentration.
g. Archaeal creatures include : Methanogens, Halophiles, Thermoacidophiles.

> Peptidoglycan or murein is a polysaccharide, consisting of sugar and amino acids that form a layer outside the rigid cell wall.

2. The Domain Bacteria

The domain bacteria have the following characteristics:

a. Bacteria are prokaryotic cells.
b. The cell walls of bacteria contain peptidoglycan.
c. They contain rRNA that is unique to bacteria.
d. Bacteria are sensitive to traditional antibacterial antibiotics but are resistant to most antibiotics that affect eukarya.

3. The Domain Eukarya

The domain Eukarya (also spelled Eucarya) have the following characteristics:

a. Eukarya have eukaryotic cells.
b. Not all Eukarya have cells with a cell wall. Their cell wall contains no peptidoglycan.
c. Eukarya contains rRNA that is unique to Eukarya.
d. Eukarya are resistant to traditional antibacterial antibiotics but are sensitive to most antibiotics that affect eukaryotic cells.

Domain Eukarya

Protista   Fungi   Plantae   Animalia
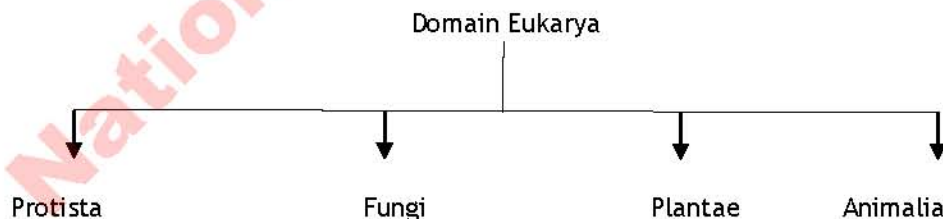
The domain Eukarya are divided into four kingdoms: Protista, Fungi, Plantae and Animalia.

1. **Protista**: Protists include eukaryotic organisms with unicellular or colonial organization. These are mostly aquatic. It is a diverse group of organisms. It includes: Animal like protists called protozoa e.g., *Amoeba*. Plant like protists called algae e.g., *Euglena*. Fungi like protists e.g., slime molds.

2. **Fungi**: Fungi are eukaryotic organisms which have chitin in their cell wall. Fungi are saprotrophic decomposers. Mostly fungi are multicellular. Some fungi are unicellular. The examples of fungi are black bread mold, yeast, mushroom, etc.

3. **Plantae**: The members of kingdom plantae are eukaryotic multicellular and autotrophic with chloroplasts containing chlorophyll. Their cell wall is made up of cellulose e.g., moss, mustard.

4. **Animalia**: Animals are multicellular heterotrophic eukaryotes. Animals lack cell wall and chlorophyll. They can generally move from place to place. This kingdom includes invertebrates e.g., insects, star fish and vertebrates e.g., fish, frogs and man.

The organisms that are capable of producing their own food are called **autotrophs** (photosynthetic mode of nutrition) e.g., green plants, autotrophic bacteria, and algae. These are producers.

Organisms which eat other things as food are called **heterotrophs** (ingestive mode of nutrition) e.g., animals, animal like protists, etc. These are consumers

The organisms that depend on dead, decaying matter are called **saprotrophs** (absorptive mode of nutrition) e.g., fungi, bacteria. These are decomposers.

2.5 TAXONOMIC RANKS OF CLASSIFICATION

The group into which organisms are classified are known as taxonomic categories or **taxa** (singular 'taxon'). The taxa form a ladder, called **taxonomic hierarchy**. There are eight main taxonomic ranks: kingdom, phylum or division, class, order, family, genus and species. In addition **domain** is now usually used as a fundamental rank.

The kingdom is the largest taxon or rank. Each kingdom is further divided into smaller taxa in the following way:

Phylum (Division: for plants and fungi): A phylum is a group of related classes.

Class: A class is a group of related orders.

Order: An order is group of related families.

Family: A family is a group of related genera.

Genus: A genus is a group of related species.
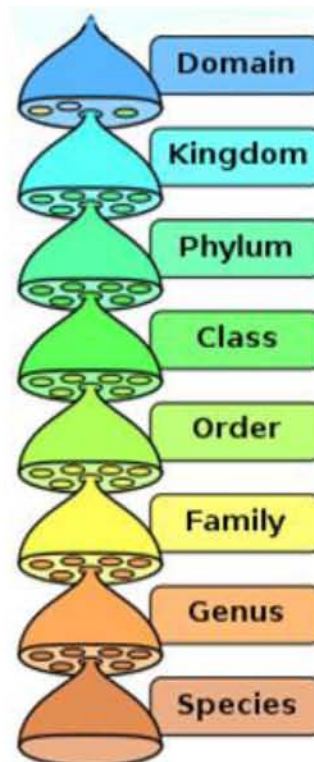
Species: A species is a group of similar organisms.

Fig2.3: Taxonomic ranks of classification

Taxa	Human	Taxa	Pea
	Table 2.1: Simple classification of human and pea		
Kingdom	Animalia	Kingdom	Plantae
Phylum	Chordata	Phylum	Magnoliophyta
Class	Mammalia	Class	Magniopsida
Order	Primate	Order	Fabales
Family	Homonidae	Family	Fabaceae
Genus	*Homo*	Genus	*Pisum*
Species	*Homo sapiens*	Species	*Pisum sativum*

2.6 SPECIES

Species is a group of similar organisms individuals capable of interbreeding or exchanging genes among themselves and producing fertile offspring.

Cross between a male donkey and a female horse produces mule. It is infertile, because of the odd number of chromosomes, they can't reproduce. So, it is not a species. Species is the most basic unit of classification, as well as a taxonomic rank.

Fig 2.4: Infertile mule

2.7 BINOMIAL NOMENCLATURE

Carolus Linnaeus introduced a naming system to give each organism a name consisting of two Latin names. The first name is genus name and the second name represents the particular species. The genus name begins with a capital letter but the species name begins with a small letter. Since each name has two parts so it is called **binomial nomenclature**, e.g., biological name of human beings is *Homo sapiens*. Our genus name is *Homo* and specie name is *sapiens*. A genus may have many species e.g., all cats belong to genus *Felis* including lion.

Importance of Binomial Nomenclature

Why do organisms need to be given a scientific name in Latin? Why can't we just use common names for organisms? A common name will vary from country to country just because different countries use different languages. Hence there was a need for a universal language such as Latin. Even those who speak the same language sometime use different common name for the same organisms. Example: Brinjal is **Baigun** in Urdu, **Bataoon** in Punjabi, **Vagton** in Sindhi. Is it not confusing? Its biological name is *Solanum melangena*. Find out the Punjabi, Sindhi, Pushto or other local names or German, French, Spanish, Arabic, Russian, Chinese names of the following organisms which will show the importance of biological name.

1. Potato - *Solanum tuberosum*
2. Rice - *Oryza sativa*

A scientific name has the advantage of standing for a single kind of animal, plant or microorganism all over the world.

2.8 COMPLICATIONS OF CLASSIFYING VIRUSES

Viruses show characteristics of both living and nonliving things. The living characteristics of viruses are:

1. They occur in different varieties.
2. They have their own genetic material in the form of either RNA or DNA.
3. They reproduce using the material of the host cell they infect.
4. They enter the cells of living organisms and cause diseases.

The non-living characteristics of viruses are:

1. They lack cellular structure and enzyme system.
2. They can be crystallized and store in bottle.
3. They do not respire.
4. Viruses behave as non-living, inert infectious particles outside the host.

Viruses are at the borderline of living and non-living. So, they are not included in any domain and kingdom under modern classification.

> Prions are composed of proteins only. Viroids are composed of circular RNA only. Both causes infectious diseases in certain plants. Both are acellular particles. They are not included in any kingdom of classification system.

SUMMARY

1. Biodiversity is the variety of organisms on Earth.
2. The grouping of organisms is called classification.
3. Taxonomy is concerned with identification, naming and classification of organisms.
4. The scientific study of diversity of organisms and their evolutionary relationship is called systematics.
5. Aristotle was the first person who classified the living organisms.
6. According to earlier classification systems organisms were classified into two kingdoms, three kingdoms and then five kingdom system.
7. Two-kingdom classification system classifies organisms into two kingdoms the Plantae and Animalia.
8. Three system classification system introduced the third kingdom Protista to separate unicellular microorganisms from multicellular ones.
9. Five-kingdom classification system includes the kingdoms Monera, Protista, fungi, Plantae and Animalia.
10. Domain is a group of kingdoms or taxonomic category above the kingdom.
11. The three domains of life are domain archaea, domain bacteria and domain Eukarya.
12. Classification into three domains is based on sequence of nucleotides in the rRNA of the cell.
13. The four kingdoms of domain Eukaya are Protista, Fungi, Plantae and Animalia.
14. The group into which organisms are classified are known as taxonomic categories or taxa.

15. The kingdom is largest taxon or rank. Each kingdom is further divided into smaller taxa which are: Phylum, Class, Order, Family, Genus and Species.
16. Species is a group of organisms that consist of similar individuals capable of interbreeding.
17. Binomial nomenclature is the biological system of naming the organisms. In it the name is composed of two terms. The first term indicates the genus and the second term indicates the species of the organism.
18. Viruses are at the borderline of living and nonliving. There are not included in any domain or kingdom under modern classification

EXERCISE

Section I: Multiple Choice Questions

Select the correct answer:

1. Into which kingdom you place a multicellular land organism that performs photosynthesis:

    A) monera   B) protista   C) plantae   D) animalia

2. Which kingdom is mismatched with the characteristics?

    A) fungi - usually saprotrophic   B) animalia - rarely ingestive

    C) protista - various modes of nutrition   D) plantae - photosynthetic

3. The kingdom to which the algae belongs is:

    A) animalia   B) protista   C) plantae   D) fungi

4. Scientific name has advantages of:

    A) same name applied to different organisms.

    B) same organisms have different name in different areas

    C) has no scientific basis.

    D) has scientific basis and is universally accepted.

5. Binomial nomenclature was introduced by:

    A) Aristotle   B) Carolus Linnaeus

    C) Ernest Haeckel   D) R.H Whittaker

8. The organisms that feed on dead, decaying matter are called:

    A) saprotrophs   B) autotrophs   C) heterotrophs   D) parasites

10. Viruses are assigned to the kingdom:

    A) Plantae   B) Protista

    C) Fungi   D) Not included in any kingdom

11. The common characteristic of viruses, prions and viroids is:

    A) Respiration   B) Movement   C) Infectious nature   D) Excretion

12. Colonial organization is the unique feature of kingdom:

    A) Animalia   B) Protista   C) Fungi   D) Plantae

13. Which option is correct regarding the mode of nutrition of following organism?

	Animal	Prokaryote	Fungi	Plant
A)	heterotrophic	heterotrophic	ingestive	autotrophic
B)	ingestive	absorptive	autotrophic	heterotrophic
C)	ingestive	heterotrophic	absorptive	photosynthetic
D)	absorptive	autotrophic	ingestive	autotrophic

14. Viruses are included in any domain or classification as:

    A) they are poorly understood.

    B) they are too large.

    C) they are of various colours.

    D) they are not considered as organism.

15. A related groups of genera consists of:

    A) a phylum   B) a class   C) an order   D) a family

16. In which of the following the first letter is capitalized in binomial nomenclature?

    A) genus   B) class   C) species   D) family

17. If humans and cats belong to the same class, they must belong to the same:

    A) phylum   B) order   C) family   D) genus

Section II: Short Answer Questions

1. Why are the following scientists famous for?

    (a) Aristotle   (b) Carolus Linnaeus   (c) Carl Woese

2. Define:

    (a) Biodiversity   (b) Classification   (c) Taxonomy   (d) Systematics

    (e) Domain   (f) Taxa   (g) Species.

3. What is domain? Name the three domains of life.

4. What are basis of classification of life into domains?

5. Can you differentiate between? :

    (a) Bacteria and Protists   (b) Fungi and Plants   (c) Plants and animals.

6. Answer the following with supportive reasons.

   (a) Which the simplest domain?

   (b) Which is the complex domain?

   (c) Are most bacteria harmful?

   (d) Which domain/s can flourish or survive in most adverse conditions?

7. Compare the two-kingdom, three kingdom and five-kingdom system of classification.

8. Compare the three-domain system of classification.

9. Why mule is not regarded as a species.

10. Complete the following chart:
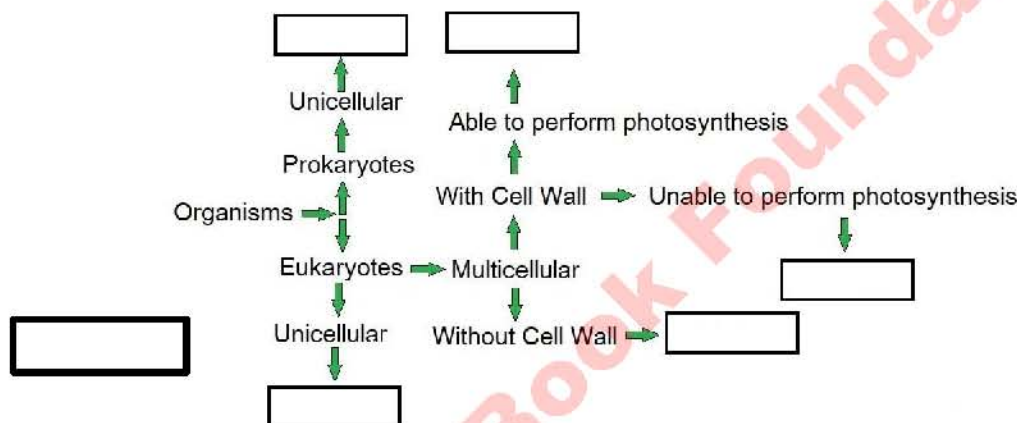
Section III: Extensive Answer Questions

1. What is biodiversity? Write the importance of biodiversity in the natural ecosystem.
2. Describe classification. How are the organisms classified?
3. What are the main aims and objectives of classification?
4. Give an account of history of classification.
5. What are the characteristics of the domain Archaea?
6. What are the characteristics of the domain (a) Bacteria (b) Eukarya ?
7. What are the diagnostic characteristics of the four kingdoms of domain Eukarya?
8. Describe the taxonomic ranks of classification.
9. Write a brief note on species.
10. What is Binomial nomenclature? Describe aims, principles and importance of Binomial nomenclature using local examples.
11. State the complications of classifying viruses.