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CHAPTER

1

The Living World

Learning Objectives

At the end of this chapter, you will be able to:

- understand the characteristics of the living organisms.
- explain the diversity of the living world.
- list and define the different taxonomic categories.
- explain the utility of different taxonomical aids.

Have you ever imagined how many types of living organisms inhabit our planet? There are different types of biomes ranging from the extreme polar regions to the tropical evergreen forests. There are billions of animal, plant, and single-celled organisms that inhabit these biomes. Do you think that every organism on our planet can be studied separately? There are number of ways in which we can categorize organisms based on their morphological features and ancestry that help us in studying these organisms. Let's study this diversity and classification in detail.

CHARACTERISTICS IS 'LIVING'

Following are the main characteristics of 'living'.

- | | | |
|--------------------------|---|---|
| 1. Growth | } | Not defining properties/
characters/features |
| 2. Reproduction | | |
| 3. Metabolism | } | Defining properties/
characters/features |
| 4. Cellular Organization | | |
| 5. Consciousness | | |

The character which has no exception is known as **defining property** of life.

Growth

1. Increase in mass or overall size of a tissue or organism or its parts is called growth.
2. Increase in mass and increase in number of individuals are the twin characters of growth.

3. Growth is an irreversible permanent increase in size of an organ or its parts or even of an individual cell.
4. Growth is the result of metabolism. When the synthetic reactions or anabolism is more than that of the destructive processes or catabolism, growth occurs.
5. In the reverse situation (Anabolism ↓ Catabolism ↑) there will be 'Degrowth' or negative growth.
6. In majority of higher plants and animals, growth and reproduction are mutually exclusive events.
7. Because both living and non-living organisms exhibit growth, so, it cannot be taken as **defining property**.
8. Growth from inside (intrinsic growth) can be taken as defining property.

Reproduction

Production of new individual or progeny is known as reproduction.

1. Reproduction in case of multicellular organisms is the production of progeny possessing features more or less similar to those of parents.
2. Reproduction in case of unicellular organisms like bacteria, unicellular algae or amoeba is increase in the number of cells. In unicellular organisms the growth and reproduction are synonyms or same.
3. Reproduction is not found in any non-living object.
4. There are many living organisms which can/do not reproduce like mules, sterile human couples, worker bees.

5. So, the reproduction also cannot be taken as defining characteristic of living organisms.
6. Reproduction is of two types. They are as follows:
 - (a) **Asexual reproduction:** Reproduction in which gametic fusion or fertilization and meiosis are not involved is known as asexual reproduction. Many methods of asexual reproduction are there.
 - (i) **By asexual spores:** In algae and fungi.
 - (ii) **By budding:** In yeast and hydra.
 - (iii) **By fragmentation:** In filamentous algae, fungi and the protonema of moss plants.
 - (iv) **True regeneration:** Fragmented organisms regenerate the lost part of its body and become a new organism, for example, Planaria.



NOTES

Regeneration is a process in which only the lost part of the body is repaired or regained. For example: Star fish, Lizard.

- (b) **Sexual reproduction:** Reproduction in which gametes are formed by meiosis and fertilization also takes place to form progeny is known as sexual reproduction.

Metabolism

1. The sum total of all the chemical reactions occurring in our body is metabolism.
2. All living organisms, both unicellular and multicellular, exhibit metabolism.
3. No non-living object shows metabolism.
4. In this way, metabolism is a defining character of living organisms because it has no exceptions.
5. Now we have known most of the chemical or metabolic reactions occurring in our body. So we can demonstrate many of them in a cell free medium or in a test tube in lab.
6. The isolated metabolic reaction outside the body of an organism, performed in a test tube (*in vitro*) is neither living nor non-living.
7. These isolated reactions cannot be regarded as living things, but they are definitely living reactions because they are similar to the reactions performing in our body.
8. Here we should not forget the fact that metabolism is the total sum of all the chemical reactions performing in our body, it is not the sum of few or more living reactions.
9. All organisms are made of small or big chemicals. These chemicals perform thousands of reactions and

- form some other chemicals also in the bodies of living organisms.
10. All plants, animals, fungi and microbes exhibit metabolism.

Cellular Organization

1. Cell is the basic unit of life.
2. All living organisms are composed of cells. Some are composed of a single cell and are known as **unicellular organisms**, while others like us are composed of many cells, are called multicellular organisms.
3. Unicellular organisms are capable of independent existence and perform essential functions of life.
4. Anything less than a complete structure of a cell, does not ensure independent living. Hence, cell is the **fundamental structural and functional unit** of all living organisms.
5. In this way, the cellular organization is proved to be defining property of all living organisms.

Consciousness

1. The ability to sense the surrounding environment and respond to these environmental stimuli is known as **consciousness**.
2. Consciousness is the most obvious and technically complicated feature of all living organisms.
3. We sense these physical, chemical or biological stimuli through our sense organs.
4. Plants also sense and respond to external factors like light, water, temperature, other organisms, pollutants, etc.
5. All organisms, from the prokaryotes to complex eukaryotes, show consciousness to environmental cues.
6. Some common examples of consciousness can be seen in organisms, like plants which performs flowering in a particular season (photoperiodism), some animals perform breeding in a particular season only (seasonal breeders), and all organisms handle the chemicals entering their bodies, etc.
7. When human is concerned, a very high level of consciousness is found in us because of our very well developed nervous system and our skill of communication which is known as self-consciousness.
8. Humans are very fast to respond towards the external stimuli and even can think or predict about possible changes of surroundings also, so, they can prepare themselves according to the surrounding situations. Further humans can even change its surrounding situations up to a limit, so this topmost or climax level of consciousness is regarded as self-consciousness, which cannot be seen elsewhere.

For example: *Tsuga canadensis* (Lin.) Salisbury.

9. Scientific names should be derived from Latin or Greek languages because they are dead languages.
10. In the herbarium (Dry garden), the type specimen of the recently discovered plant should be kept.
11. Standard size of herbarium sheet is 11.5 × 16.5 inches.



NOTES

ICNB – International Code of Nomenclature for Bacteria

ICVN – International Code of Viral Nomenclature

ICNCP – International Code of Nomenclature for Cultivated Plants

Systematics (Branch Related with Taxonomy)

1. The term 'Systematics' was proposed by Linnaeus.
2. Systematics is the study of diversity of organisms and all their comparative and evolutionary relationship. The description of external morphological properties of plants or other living organisms are included in it.
For example: Morphological characters of root, stem, leaves, flowers, etc.

New Systematics or Neo-systematics or Biosystematics

1. Neo-systematics is a new branch and the term was given by Julian Huxley (1940).
2. It includes the description of all the characters (internal) including morphological characters (external) of plants or living organisms.
3. The inter-relationship among living organisms can be known by using it.



NOTES

The main basis for the new systematics is both evolutionary and genetic relationship (experimental taxonomy to that of morphological characters).

1. Maximum diversity is found in tropical rain forests.
2. Second maximum diversity is found in coral reefs.
3. Practical significance of taxonomy is identification of unknown organism.

TAXONOMIC CATEGORIES

Since the category is a part of overall taxonomic arrangement, it is called the taxonomic category and all

categories together constitute the taxonomic hierarchy. Each category, referred to as a unit of classification, in fact, represents a rank and is commonly termed as taxon (pl.: taxa). Taxonomical studies of all known organisms have led to the development of common categories such as kingdom, phylum or division (for plants), class, order, family, genus and species. All organisms, including those in the plant and animal kingdoms have species as the lowest category.

The basic requirement is the knowledge of characters of an individual or group of organisms. This helps in identifying similarities and dissimilarities among the individuals of the same kind of organisms as well as of other kinds of organisms.

Species

It consists of a group of related species which have more characters in common while compared to other species of other genera.

Genus

In this type, a group of related genera with still less number of similarities as compared to genus and species are grouped.

Family

In this type, a group of related genera with still less number of similarities as compared to genus and species are grouped. Families are characterized on the basis of both vegetative and reproductive feature of plant species.

Order

As it is a higher category, it is the assemblage of families which shows a few similar characters.

Class

It includes the organisms of related orders with less similarities than orders.

Division

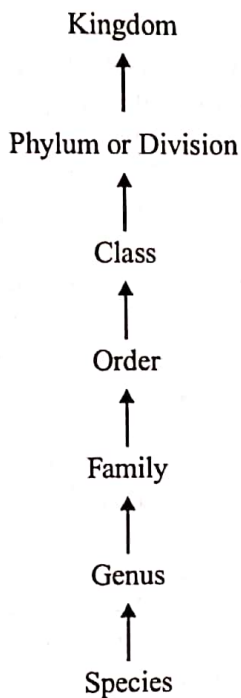
It includes all the organisms which pertain to different classes with a few common characters.

There are 7 main taxonomic categories. They are obligate categories, i.e., they are strictly used at the time of any plant classification.

There are some extra categories, like sub-division, sub-order, sub-family, tribe, sub-tribe, etc. They are not regularly used. They are used only when they are needed.

Table 1.1 Organisms with their Taxonomic Categories

Common Name	Biological Name	Genus	Family	Order	Class	Phylum/ Division
Man	<i>Homo sapiens</i>	<i>Homo</i>	Hominidae	Primata	Mammalia	Chordata
Housefly	<i>Musca domestica</i>	<i>Musca</i>	Muscidae	Diptera	Insecta	Arthropoda
Mango	<i>Mangifera indica</i>	<i>Mangifera</i>	Anacardiaceae	Sapindales	Dicotyledonae	Angiospermae
Wheat	<i>Triticum aestivum</i>	<i>Triticum</i>	Poaceae	Poales	Monocotyledonae	Angiospermae



Order	—	ales
Sub-order	—	ineae
Family	—	aceae
Sub-family	—	oideae
Tribe	—	cae
Sub-tribe	—	inae

**NOTES**

There is no suffix for Genus, Species and Kingdom.

Figure 1.1 Taxonomic Categories Showing Hierarchical Arrangement in Ascending Order

- Taxon:** Plant groups or animal groups included in categories are called Taxon.
- Adolf Mayer:** First proposed the term 'Taxon' for animals.
- H. J. Lan:** First proposed the term 'Taxon' for plants.
- The classification of any plant or animal is written in descending order.
- Hierarchy:** Descending arrangement of taxonomic categories is known as hierarchy.
- Species:** It is the smallest taxonomic category. It is the basic unit of classification.

Suffix for Taxa (Taxon)

Division	—	phyta
Sub-division	—	phytina
Class	—	opsida, phyceae, ae

Binomial System of Classification

- Binomial system was first proposed by **Gaspard Bauhin** in his book *Pinax Theatri Botanici*.
- Carolus Linnaeus:** The wide use of this nomenclature was used by him for the first time and the scientific names of all the plants and animals were also suggested.
 - Linnaeus founded the 'Binomial system'.
 - His book '*Species plantarum*' which contains the scientific names of plants was published on 1 May 1753. Since, it was the first initiation of binomial system of plants, so, the names suggested before the given date are still not accepted today.
 - The scientific name of the animals were proposed in his book *Systema naturae* (10th edition).
 - Since the first publication of this 10th edition of *Systema naturae* was on 1 August 1758, it is believed to be taken as the basis for the initiation of binomial system of animals.

Principle of Priority

The nomenclature is done by principle of priority. If two names are proposed for any plant after the 1753, the valid name is the earlier name proposed just after 1 May, 1753.

Trinomial System

- Proposed by **Huxley and Strickland**.
- According to this system, the name of any plant or species is composed of three names:
 - Generic name
 - Specific name
 - Sub-specific name (Name of variety)

When members of any species have large variations, then trinomial system is used. On the basis of dissimilarities, this species is classified into sub-species.

For example:

- Brassica oleracea var. botrytis** (Cauliflower)
Brassica oleracea var. capitata (Cabbage)
Brassica oleracea var. caulorapa (Knol-Khol)

TAXONOMICAL AIDS

Certain procedures and techniques have been established by the biologists for storing and preserving the information as well as the specimens, some of which are explained below for helping you to understand the usage of these aids.

- Herbarium:** It is a store-house where plant specimens that are dried, pressed and preserved, are collected. Its standard size is 11.5 × 16.5 inches. It also carries label which provides information about date, place of collection, English, local and botanical name, family, collector's name, etc. Herbaria can be used for quick reference in taxonomical studies.
- Botanical Gardens:** It is a place where plant species are grown for the identification purposes. Each plant is labelled showing its botanical/scientific name and its family. The famous botanical gardens are at Kew (England), Indian Botanical Garden, Howrah (India) and at National Botanical Research Institute, Lucknow (India).

SOLVED EXAMPLES

EXAMPLE 1

Which one of the following aspects is an exclusive characteristic of living things?

- Isolated metabolic reactions occurs in vitro.
- Increase in mass from inside only.
- Perceptions of events happening in the environment and their memory.
- Increase in mass by accumulation of material both on surface as well as internally.

ANSWER KEY

The correct answer is option (B).

- Museum:** Plant and animal specimens which have been preserved are collected here for studies and reference. The containers or jars contain the specimens in preservative solutions.
- Zoological Parks:** It is a place where wild animals are sheltered in protected environments under human care to enable us to learn about their food habits and behaviour.
- Key:** It is used for the identification of plants and animals based on the similarities and dissimilarities.
 - They are based on the contrasting characters generally in a pair called couplet. It highlights the choice made between the two opposite options which results in the acceptance of only one and rejection of the other.
 - In the key, each statement is called a lead.
 - They are generally analytical in nature.
- Flora, Manuals, Monographs and Catalogues
 These flora, manuals, monographs, etc. are recorded descriptions of plants, animals and other organisms. They provide correct identification and description of variety of living organisms.
 - Flora:** It is a book containing information about plants found in a particular area. It gives the actual account of habitat and distribution of various plants of a given area. These provide the index to the plant species found in a particular area. For example, Flora of Delhi by J.K. Maheshwari.
 - Manual:** It is a book containing complete listing and description of the plants growing in a particular area. They provide useful information for identification of names of various species found in an area.
 - Monograph:** It contains information of any one taxon.
 - Catalogue:** It includes the alphabetical arrangement of species of a particular place describing their features.

EXAMPLE 2

The system of classification based on evolutionary and genetic relationships amongst organisms, ignoring the morphological similarities or differences is called

- Cladistics
- Phenetics
- Classical systematics
- New systematic

ANSWER KEY

The correct answer is option (A).

EXAMPLE 3

Term systematics was derived from _____ word 'systema' which means

- (A) Greek, evolutionary classification
- (B) Latin, systematic arrangement of organisms.
- (C) English, taxonomy of organisms
- (D) Both (A) and (C)

ANSWER KEY

The correct answer is option (B).

EXAMPLE 4

Which one of the following is not a correct statement?

- (A) Herbarium houses dried pressed and preserved plant specimens.
- (B) Botanical gardens have collection of living plants for reference.
- (C) A museum has collection of photographs of plants and animals.
- (D) Key is a taxonomic aid for identification of specimens.

ANSWER KEY

The correct answer is option (C).

EXAMPLE 5

Nomenclature is governed by certain universal rules. Which one of the following is contrary to the rules of nomenclature?

- (A) Biological names can be written in any language.
- (B) The first word in a biological name represents the genus name and the second is a specific epithet.
- (C) The names are written in Latin and are italicized.
- (D) When written by hand, the names are to be underlined.

ANSWER KEY

The correct answer is option (A).

EXAMPLE 6

The label of a herbarium sheet does not carry information on

- (A) Name of collector
- (B) Local names
- (C) Height of the plant
- (D) Date of collection

ANSWER KEY

The correct answer is option (C).

EXAMPLE 7

Given below are the various taxonomic aids used in taxonomy which facilitate the identification and classification of organisms. Which one of the following is wrong?

- (A) Keys, floras, manuals, monographs and catalogues are useful aids for identification of plants and animals.
- (B) Herbarium is created to house live specimens of plants material.
- (C) Museums are established to keep preserved specimens of animals and plants.
- (D) Botanical gardens and zoological parks are established to conserve and preserve live plants and animals respectively.

ANSWER KEY

The correct answer is option (C).

EXAMPLE 8

Study the four statements (a–d) given below and select the two correct ones out of them.

- (a) Definition of biological species was given by Ernst Mayr.
- (b) Photoperiod does not affect reproduction in plants.
- (c) Binomial nomenclature system was given by R. H. Whittaker.
- (d) In unicellular organisms, reproduction is synonymous with growth.

The two correct statements are:

- (A) (c) and (d)
- (B) (a) and (d)
- (C) (a) and (b)
- (D) (b) and (c)

ANSWER KEY

The correct answer is option (B).