CHAPTER- 1

THE LIVING WORLD

INTRODUCTION

Life can be defined as a unique aggregation of molecules. These molecules tend to express themselves through various chemical reactions collectively called metabolic reactions. The basic purpose of these reactions is to transform or produce and utilize energy. The term used to define these reactions cumulatively is metabolism.

Through metabolism, various biomolecules are synthesized resulting in growth, development, responsiveness, adaptations, and reproduction. The forms that possess and express all these features are called living beings. These living beings live in almost all possible habitats like forests, mountains, deserts, oceans, freshwater bodies, hot springs, polar regions, etc.

They are linked to one another by sharing the common genetic material. All living beings share characteristics like organization, energy utilization, regulation or homeostasis, growth, development, reproduction, and adaptation.

WHAT IS GROWING?

Life has maintained certain fixed properties that life exhibits today and are very different from those that were present at its origin.

Characteristics of living organisms:

The most outstanding features that have arisen during life's history include

- Growth
- Reproduction
- Ability to sense the environment
- Metabolism
- Cellular organization
- Consciousness.

Labelling

1. GROWTH: It is the increase in number & mass of cells by cell division.

All living organisms can grow.

Growth of an individual organism has two characteristics-

a. Increase in body mass
b. Increase in number.

In plants, growth occurs continuously throughout their lifespan. In animals, growth is only up to a certain age. However, cell division occurs to replace lost cells. Unicellular organisms also grow by cell division. Non-living objects grow by the accumulation of material (increase in mass) on the surface.

For example mountains, boulders, sand mounds, etc. So growth cannot be taken as a defining property of living organisms alone. A dead organism does not grow.

2. REPRODUCTION:

In living organisms reproduction means the formation of new individuals from their parents.

Fungi multiply and spread easily by producing millions of asexual spores. Hydra and yeast multiply by budding.

Planaria, a flatworm, regenerates the lost part of its body and becomes a new one. Filamentous algae, protonema (a branched filamentous structure) of mosses, and fungi also multiply by fragmentation.

In unicellular organisms, reproduction is synonymous with growth, i.e., an increase in the number of cells. Therefore in unicellular organisms, there is no distinction in the usage of the terms growth and reproduction.

Many organisms do not reproduce - e.g. mules, worker bees, infertile human couples, etc. Hence, reproduction is not a perfect defining characteristic of living organisms.

3. METABOLISM:

A variety of biochemical changes are constantly occurring in a living organism leading to the formation and interconversion of chemicals. All the chemical reactions taking place in our body come under metabolism.

Nonliving things do not metabolize. All living organisms show metabolism. However, metabolic reactions can be mimicked under *in vitro* (work that's performed outside of a living organism) conditions.

4. CELLULAR ORGANIZATION:

All living organisms are made up of cells. The cells perform all functions in the organism.

Non-living things do not have a cellular organization.

Therefore, it can be seen that a cellular organization gives rise to the functions of life-like metabolism, growth, reproduction, etc. Thus the cellular organization is a defining characteristic of living organisms.

5. CONSCIOUSNESS:-

It is the awareness of one's environment, actions and, intentions. It is present in living organisms. Human beings sense the environment through sense organs. Plants respond to external factors like light, temperature, water, pollutants, other organisms, etc. In both plants and animals, photoperiod (duration of light) affects the reproduction in seasonal breeders.

Therefore, all organisms are 'aware' of their surroundings. So, it is the defining property of living organisms.

Human is the only organism having **self-consciousness i.e. aware of himself. Therefore consciousness is the defining property of living organisms.**

All living organisms are linked to one another by the sharing of common genetic material to a varying degree.

DIVERSITY IN THE LIVING WORLD

Earth provides the physical base for living beings. There are millions of varieties of living organisms in the world around us. There are also many organisms that we cannot see with our naked eye around us. They are found in varied habitats like mountains, oceans, forests, lakes, deserts, and even hot water springs.

Several species identified and studied is **1.7-1.8 million.**
All organisms which live on earth together make up the natural diversity of life in the world. This natural diversity of life on earth is generally called biological diversity or biodiversity.

Taxonomy: The systematic arrangement of organisms that includes characterization, identification, nomenclature, and classification of organisms is called taxonomy.

Systematics is a branch of science that deals with the identification, nomenclature, classification, and evolutionary history of an organism. Thus systematic includes evolutionary history along with taxonomic characteristics of an organism. Systematics is as old as human civilization. **The term taxonomy was first introduced by A.P de Candolle in 1813. Systematic**s (Latin 'systema') means the systematic arrangement of organisms. ***Systema Naturae*** is a book written by Linnaeus.

Neosystematics is a concept of systematics that considers a species to be the product of evolution. This concept was developed by Julia Huxley in 1940. It takes into consideration all the known characteristics of organisms and all the known pieces of evidence from different fields of biology.

Identification: is to determine the exact place or position of an organism in the set plan of classification. It is carried out with the help of taxonomic keys.

Classification: It is the placing of an organism or a group of organisms in the category according to a particular system and in conformity with a nomenclature system.
Characterization: The understanding of characters of organisms like external and internal structure (morphology and anatomy), the structure of the cell (cytology), developmental process (embryology), and ecological information (ecology) of the organism.

Nomenclature (naming): The naming of living organisms is called nomenclature. The names are of two types-vernacular (common names) and scientific.

Local names-Locally used names are called as local names. Local names are in local languages or common language. Local names are easy to use by local people, but these local names cannot be used by biologists due to the following drawbacks.

1. A single local name is often used for many species.
2. The local names sometimes lead to incorrect meanings about the organism.
3. Different local names are used to recognize an organism in different regions of the country or world. These local names also vary with the language.

Scientific names: These are the names given to the organisms by biologists based on agreed principles and criteria. These are acceptable all over the world. To accomplish this, certain international codes have been established.

These codes are :

- **ICBN-International Code of Botanical Nomenclature**
- **ICZN-International Code of Zoological Nomenclature**
- **ICVN-International Code of Viral Nomenclature**

ICBN/ICNB-International Code for Bacteriological Nomenclature or Nomenclature of Bacteria

BINOMIAL NOMENCLATURE:

Carolus Linnaeus used this nomenclature system for the first time and proposed the scientific name of all the plants and animals. He is the founder of the binomial system.

Linnaeus proposed scientific name of plants in his book " **Species Plantarum**"
In binomial nomenclature, each scientific name has two components-generic names (genus) and specific name (species) E.g., *Mangifera indica* Linn. Mangifera is the genus name and indica is the species name. Linn indicates that this species was first described by Linnaeus

Who can give scientific names: Anyone can study, describe, identify, and give a name to an organism provided certain universal rules are followed.

RULES:

i. A scientific name generally has two components (words) in Latin or derived from Latin irrespective of their origin.
ii. The first word of the biological name denotes the genus name whereas the second one denotes for species.the
iii. Names are printed in italics or when handwritten they are separately underlined to indicate their Latin origin.
iv. Genus name starts with a capital letter and a specific name starts with a , small letter.
v. The name of the author is written in an abbreviated form after the species name and it is printed in Roman.
vi. Each taxonomic group can have only one correct name.
vii. The name should be short, precise, and easy to pronounce.

Eg: *Mangifera indica* - Mangifera is the genus name and indica is the species name.

TAXONOMIC CATEGORIES:

The term taxon was introduced by ICBN in 1956.

Mayr in 1964 defined Taxon as a taxonomic group of any rank that is sufficiently distinct to be worthy of being assigned a definite category.

TAXONOMIC HIERARCHY:

The system of arranging organisms in a definite sequence of various taxonomic categories arranged in a proper descending order is called taxonomic hierarchy.

It is also called the Linnaean hierarchy as it was first proposed by **Carolus Linnaeus, the Father of Systematic Botany**. The hierarchy includes seven obligate categories. They are as follows-

Kingdom - Animalia
↑
Phylum - Chordata
(Division in case of plants)
↑
Class - Mammalia
↑
Order - Primata
↑
Family - Hominidae
↑
Genus - Homo
↑

Species – sapiens

Species:

The lowest taxon or category in the biological classification is the species. So the basic unit of taxonomy is species. So the basic unit of taxonomy is species.

A species is a group of individuals resembling one another in all major vegetative and reproductive characteristics. The individuals of a species resemble so closely that they may be regarded as having been derived from the same parents.

In 1964, Ernst Mayr defined species as a group of potentially interbreeding populations that are reproductively isolated from other such groups.

The term species was first introduced by **John Ray.**

Eg: sapiens

Genus:

- **A group of related species**.
- All the species in a genus have many common characteristics and all have evolved from a common ancestor.

E.g.: Homo

Generic name Specific epithet Common name

Mangifera indica Mango
Solanum tuberosum Potato
Solanum nigrum Nightshade
Panthera leo Lion
Panthera tigris Tiger
Homo sapiens Man

Family:

- **A family is an assemblage of related genera.**

E.g.: Hominidae

Order or Cohort:

- **An order is a group of related Families.**

E.g.: Primata

Class:

- **Several related orders having certain common characters form a higher category called the class.**

E.g.: Mammalia

Phylum/Division:

- **Classes having the same features in common constitute a Phylum.** The term **phylum is used in the case of classification of animals and the term division is used in plant classification**.
  E.g.: Chordata

Kingdom:

The highest taxon or category in biological classification is the Kingdom. It includes one or more related divisions or phyla. Plants are put in Kingdom Plantae and animals are put in the Kingdom Animalia.
E.g.: Plantae, Animalia.

TAXONOMICAL AIDS:

They are useful in agriculture, forestry, and industry. These studies are essential for knowing our bioresources and biodiversity. Taxonomic work involves studies both in the field and in the laboratory.

Taxonomists have developed different types of taxonomic aids to help in identification, nomenclature, and classification of organisms.

The important taxonomic aids are herbaria, botanical gardens, museums, zoological parks, and keys.

(A). Herbarium:

It is a depository of plant specimens in dry.conditions, specimens are dried, mounted on a paper and properly labelled.

Procedure:

- Collection of specimens
- Pressing and drying: to remove moisture content
- Sterilization or poisoning: to prevent fungal attack
- Mounting: Pasting or stitching on a sheet
- Labelling of specimens: Local name, Common English name, Binomial nomenclature, Family name, Place of collection, Date and time of collection, Collectors name.
- Storage of herbarium sheets.
- Each herbarium sheet is to be labelled properly to avoid confusion. The label should carry the scientific name along with the author's name, local name, name of family, locality, date of collection, name of the collector, etc. The label is pasted on the right-hand corner at the bottom of the herbarium sheet.
- Information about the collected specimens is published in the form of a book called flora.

- It gives a list of total plant species in a particular region together with a brief description of the same.
- Some important floras of India **are Flora of British India, Flora of Delhi, Flora of Madras, Flora of Travancore, etc.**
- The largest Herbarium of the world is the **Herbarium of Royal Botanical Garden at Kew in England**.
- The largest Herbarium in India is **Central National Herbarium in the Indian Botanical Garden at Kolkata established in 1787.**

(B).Botanical gardens:

Botanical gardens are places or institutions that maintain the living plant specimens of different varieties of plants for reference.

A botanical garden contains plant species from various corners of the world. Plant species in the botanical garden are grown for identification purposes. Each plant is labelled. The label should carry its botanical name and its family. The botanical garden has greenhouses, a library, a herbarium, a research laboratory, etc. It is, therefore, not merely a garden but a botanical institution. At present, there are over 600 botanical gardens in the world**.**

The Hanging Gardens of Babylon are considered among the wonders of the ancient world.

The largest Botanical Garden of the world is the Royal **botanical garden at Kew in England. It is called the botanical capital of the world**. Bentham and Hooker were associated with this garden.

The largest botanical garden of **India is the Indian Botanical garden at Kolkata**. The largest tropical botanical garden in Asia is **Tropical Botanical Garden at Thiruvananthapuram** in Kerala. **KEW GARDEN**, a botanical garden located at Kew in London.

(C)Museum:

It is the institution where artistic and educational plants or animals are preserved, stored, and exhibited to the public.

There are natural science a museum, a Science , a museum, and a Zoological museum.
All colleges maintain museums in Botany and Zoology Departments. Animals are also preserved in museums.

The specimens are fixed in the jars or containers in chemical solutions and are preserved for a longer duration.

The specimens are correctly identified and labelled. They are stored and a catalogue behaviour is prepared for future reference.

Plants and animal specimens are also preserved as dry specimens. Insects are preserved in insect boxes after collecting, killing, and pinning. Birds and mammals are stuffed and preserved. Animal skeletons are also kept in museums.

(D).Keys:

A key is a tool by which each species in a group of organisms may be identified. It is prepared by a taxonomist to help other biologists to identify the species.

Taxonomic keys are based on contrasting characters. The characters are in a pair called a couplet.

The key may be of two types-**indented key and bracketed key.**

If a key provides a sequence of choices between two or more statements of characters of species, it is called an **indented key**. Each statement in a key is called **a lead.**

If the pairs of contrasting characters are not repeated by subdividing characters and each character is given a number in bracket, it is called a **bracketed key.**

(E). Zoological parks:

Zoological parks are the places where **animals are kept in a protected environment under human care.**

These enable us to learn about their food habits and behaviour**.**

The largest zoo in the world is **the zoological park of Kruger in South Africa.**
The largest zoo in India is **the Zoo of Kolkata.**

OTHER TAXONOMIC AIDS:

Besides the above mentioned taxonomic aids**, flora, manuals, monographs, and catalogs** also serve as taxonomic aids for correct identification.

Flora: These contain the actual account of habitat and distribution of plant species of a given area. It provides the index to plants occurring in a particular area. Hooker compiled the first complete flora of India.

Monograph: These are handbooks that provide the available information of anyone taxon (family or genus).

Manuals: These provide information for the identification of names of species occurring in an area. They also help incorrect identification.
Catalogue: These provide a list of publications. The publications publish books, periodicals, and dictionaries that provide new information for taxonomic studies.

IMPORTANT TERMS

Classification – it is the process of assigning creatures in specific classes or groups considering some defined characters. These groups are known as taxa

Taxonomy – it is the process of identification, nomenclature, and organization of life forms considering the inner and outer cell structure, biological data and advancement process

Systematics – investigating life forms in association with identification, nomenclature, arrangement, and evolutionary correspondence. Linnaeus used Systema Naturae as the title of his publication

Herbarium

A herbarium is the storeroom of assembled plant samples. These samples are dried, squeezed, and protected on sheets after which they are systematically ordered following the classification system universally accepted. The Herbarium sheet consists of marks concerning the scientific name, date, the spot of gathering, name of the collector, family and much more concerning the sample

Museums

It is a repository having an assembly of different plant and animal samples preserved for study and further information source. Here the entities are preserved either as dry samples or in additive arrangements. It usually has an accumulation of skeletons of animals too

Zoological park

Here, wild animals are ensured with secured conditions of nature. Renders a good chance of behavioural aspects and sustenance inclinations for these animals.

Botanical Garden

It consists of an accumulation of living plant species developed to identify and also as an information source. Every plant has marks exhibiting its scientific name and family name.

Key

Use for identifying both plants and animals in light of similarities and dissimilar

alpha taxonomy – concerns with collecting and identifying organisms based on gross morphology, field and herbarium studies helping to compile monographs and flora and also in identifying plants

beta taxonomy – concerns with collecting and identifying based on morphology and evidence from anatomy, genetics, cytology, physiology, etc

omega taxonomy – considers all microscopic observations and biochemical evidence equal to new systematics based on the phonetic classification

Cohort – a group of individuals of the same age within a population

Sympatric species – genetically unrelated individuals of species possessing the same or adjacent area of geographical distribution

Allopatric species – genetically related species having a different area of geographical distribution

Polytypic species – species with two or more varieties/subspecies

Monotypic species – species having no variety or race or subspecies