LESSON

THE LIVING WORLD

Introduction

The term 'living', can be defined by certain distinctive characteristics exhibited by the living organisms. Growth, reproduction, ability to sense environment and mount a suitable response are the unique features of living organisms. These characteristics of living organisms have been discussed below in detail.

Characteristics of Living Organisms

All living organisms exhibit the following characteristics which distinguish them from the non-living:

(i) Growth (ii) Reproduction (iii) Metabolism

(iv) Ability to sense the surrounding and respond to the stimuli

(i) Growth

Definition: Growth is defined as an irreversible increase in the number of cells and / or mass of the living structure.

In plants growth occurs continuously throughout life, while in animals, growth is restricted to a certain period only, but cell divisions occur in certain tissues to replace the old and worn out cells. Unicellular organisms also grow by cell division. If increase in body mass is considered as growth. Non-living objects also grow if we take increase in body mass as a criterion for growth. Mountains, boulders land sand mounds do grow. However, this kind of growth exhibited by non-living objects is by accumulation of material on the surface. In living organisms, growth is from inside. Growth, therefore, cannot be taken as a defining property of living organisms.

(ii) Reproduction

In multicellular organisms, reproduction refers to the production of progeny possessing features more or less similar to those of parents.

- Reproduction may be asexual or sexual.
- Asexual reproduction is shown by lower groups of animals like Hydra (budding), sponges (gemmules) and Planaria (regeneration).
- In many fungi, filamentous algae and protonema of mosses, asexual/ vegetative reproduction is by fragmentation.
- When it comes to unicellular organisms like bacteria, unicellular algae or Amoeba, reproduction is synonymous with growth, i.e., increase in number of cells.

* We have already defined growth as equivalent to increase in cell number or mass. Hence, we notice that in single-celled organisms, we are not very clear about the usage of these two terms – growth and reproduction. Further, there are many organisms which do not reproduce (mules, sterile worker bees, infertile human couples, etc.). Hence, reproduction also cannot be an all-inclusive defining characteristic of living organisms.

(iii) Metabolisn

- Metabolism refers to the sum total of all the chemical reactions occurring in a living body.
- All living organisms are made up of small and large chemical compounds, which carry out different functions; they are constantly being synthesised and used.

* No non-living object exhibits metabolism. Metabolic reactions can be demonstrated outside the body in cell-free systems. An isolated metabolic reaction(s) outside the body of an organism, performed in a test tube is neither living nor non-living. Hence, while metabolism is a defining feature of all living organisms without exception, isolated metabolic reactions in vitro are not living things but surely living reactions. Hence, cellular organisation of the body is the defining feature of life forms.

(iv) <u>Response to Stimuli /Consciousness</u>

- The most obvious and technically complicated feature of all living organisms is the ability to sense their surroundings or environment and respond to these environmental stimuli which could be physical, chemical or biological.
- All organisms, from the prokaryotes to the most complex eukaryotes can sense and respond to environmental cues.
- All organisms therefore, are 'aware' of their surroundings. Human being is the only organisms who is aware of himself, i.e. has self-consciousness.

* Thus, all living phenomena are due to underlying interactions. Properties of tissues are not present in the constituent cells but arise as a result of interactions among the constituent cells. Similarly, properties of cellular organelles are not present in the molecular constituents of the organelle but arise as a result of interactions among the molecular components comprising the organelle. These interactions result in emergent properties at a higher level of organisation. This phenomenon is true in the hierarchy of organisational complexity at all levels. Therefore, we can say that living organisms are self-replicating, evolving and self-regulating interactive systems capable or responding to external stimuli. All living organisms – present, past and future, are linked to one another by the sharing of the common genetic material, but to varying degrees.

Diversity in the Living World

→ Diversity in the living world or biodiversity is the occurrence of variety of life forms differing in morphology, size, colour, anatomy, habitats and habits. Each different kind of plant, animal or organism represents a species. Currently there are some 1.7–1.8 million living organisms known to science. Out of these 1.25 million are animals. The plants number about 0.5 million. The single group of insects, however, outnumber all the plants and other animals. It is estimated that any number between 5 to 30 million species of living organisms are present on earth.

→ With such a large number of living and extinct organisms, it is essential to have a proper universal system of nomenclature, identification and classification that can bring out their true relationships

→ Systematics is a branch of Biology that deals with cataloguing of plants, animals and other organisms into categories that can be named, remembered, compared and studied.

→ The terms systematics, taxonomy and classification are often held as synonyms but technically they carry different meanings. Simpson, (1961) has defined systematics as the branch of biology that deals with the diversity of organics at every level of classification. Taxonomy, systematics or classification of organisms is based on the study of their comparative morphology (form, external and internal structure), cytology embryology, fossil relatives, biochemical analysis and ecological relationships. The knowledge is required by all biologists working in different fields, e.g., agriculture, forestry, industry, industry, ecology, medicines, genetics, physiology, etc. It also helps in developing evolutionary relationships, with or without the help of taxonomic studies of fossils.

Terminology

- **Systematics : (**Gk.**systema– order, sequence)**. Systematics is a term often used interchangeably with taxonomy. According to Simpson (1961), systematics is the science that deals with diversity of organisms and all their comparative and evolutionary relationship based on study of comparative anatomy, development, comparative biochemistry, comparative physiology and comparative ecology by grouping of organisms at every level of classification right from species to the kingdom.

- **Taxonomy : (**Gk.**taxis – arrangement, nomos – law, de Candolle, 1813)**. It is the branch of study that deals with principles and procedures of identification, nomenclature and classification of organisms.

- **Identification :**

- Identification of an organism is carried out to determine its similarity with known organisms.
- A study is carried out to recognise the characteristic features of various parts of an organism.
- These features are compared with those of the already known species to determine their similarities and differences.
- This implies that identification is assigning the organism to a particular group.

- **Nomenclature : (L. nomen – name, calare – call)**. It is the science of providing distinct and proper names to organisms so that they can be easily recognised and differentiated from others. Through nomenclature each organism is given a two word name, generic and specific, e.g., Mangifera Indica (Mango).

- Once the organism is fully described, it is given a scientific name.
- Names are based on certain observable/ morphological and distinct characters as well as the similarities with the already known organism.
- It is not possible to identify the enormous number of organisms, based on their common / vernacular names.
- So scientists/biologists have established procedures to assign a scientific name to each known organism.
- Since the scientific names are based on agreed principles and criteria, they are acceptable all over the world.
- The rules of nomenclature are provided in the **International Code of Botanical Nomenclature (ICBN)** for plants and in the **International Code of Zoological Nomenclature (ICZN)** for animals.
- The scientific names are unique to species and are universal.

(a) **Binomial Nomenclature**

  - This method was introduced by **Carolus Linnaeus.**
  - In this method, every organism is given a scientific name, which has two parts, the first is the name of the genus (generic name) and the second is the name of the species (specific epithet)
    e.g. Mangifera indica for mango. Homo sapiens for human being.

  - In the above Mangifera and Homo are generic names, while indica and sapiens are the names of the species belonging to Mangifera and Homo respectively.

(b) Guidelines / Principles for nomenclature

(i) Scientific names are generally in Latin or derived from Latin, irrespective of their origin.
(ii) The scientific names are written in Italics or underlined.
(iii) The first-word denotes the name of the genus and the second word denotes the specific epithet.
(iv) The generic name starts with a capital letter, while the specific name starts with a small letter only ; if the species names of a plant starts with a capital, it indicates the name of a person or place.
(v) The name of the author is written in an abbreviated form after the specific name e.g. Mangifera indica Linn. – it indicates that this species was first described by Linnaeus
(vi) The name should be short, precise and easy to pronounce.

■ Classification

- Once the organism is identified and given a name, it is grouped along with the similar ones.
- The following steps are involved in classifying an organism.
  (i) The organism has to be described for all its morphological and other characteristics.
  (ii) Based on its characteristics, it is identified for its similarities or differences to any known group or taxon.
  (iii) It is then placed in a known taxon based on its similar characters.
  (iv) If it is different from the ones already described anywhere in the world, it is placed in a new group and then named.
  (v) If the organism has not been described before, it is given a new name; or its correct name is determined.
- Thus characterisation, identification, classification and nomenclature and the processes that are basic to taxonomy.

Taxonomic Categories

Classification is not a single step process but involves hierarchy of steps in which each step represents a rank or category. 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).

Taxonomic Hierarchy

- It is the framework in which the taxonomic groups (taxa) are arranged in ia definite order, from higher to lower categories.
- Species is the basic unit of classification.
- Kingdom is the highest category/unit in classification.
- In plant Kingdom, division is the category equivalent to phylum in animal kingdom and cohort is used in place of order.
- All the members of a taxon have similar characteristics, which are different from that of other taxa.
- Higher the category, lesser will be the number of similar characteristics of organisms belonging to that category.
- The different taxonomic categories are described below :-

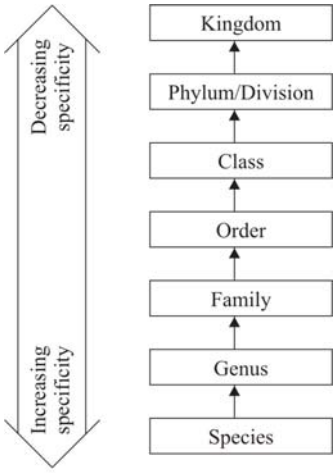

Fig.1 Taxonomic Hierarchy

(i) Species

It is a group of individuals with similar morphological characters and are able to freely interbreed among themselves to produce fertile offspring of their own kind. The individuals of a species also represent a population of that species in a given place and do not breed with individuals of other species, i.e., reproductively isolated.

(ii) Genus

Genus is a group of related species, that have more characters in common as compared to individuals of species of other genera. e.g. potato and brinjal belong to the genus Solanum (S. tuberosum and S.melongena respectively). Lion, Leopard and tiger belong to the genus Panthera, (P. leo, P. pardus and P. tigris respectively).

(iii) Family

A family represents a group of related genera, that are more similar to each other than with the genera of other families e.g. Petunia, Solanum and Atropa belong to the family Solanaceae.
Panthera and Felis belong to the family Felidae, while dogs and fox belong to Cancidae.

(iv) Order

An order is an assemblage of families related to one another in a few characters. e.g. Solanaceae and Convolvulaceae belong to the order Polemoniales. Felidae and Cancidae belong to the order Carnivora.

(v) Class

A class represents organisms of related orders. e.g. Carnivora and Primata belong to class Mammalia.

(vi) Phylum

A phylum includes all organisms belonging to different classes having a few characters in common. e.g. Phylum Chordata includes classes Osteichthyes, Chondrichthyes, Amphibia, Reptilia, Aves and Mammalia.

(vii) Kingdom

A kingdom includes all organisms that share a set of distinguishing characters. e.g. All plants (algae, bryophytes, pteridophytes, gymnosperms and angiosperms) are included in the Kingdom Plantae.

- The following table shows the systematic position of few examples :-

Common Name	**Mango**	**Man**	**Wheat**	**Housefly**
Kingdom	Plantae	Animalia	Plantae	Animalia
Phylum	Tracheophyta	Chordata	Angiospermae	Arthropoda
Class	Dicotyledonae	Mammalia	Monocotyledonae	Insecta
Order	Sapindales	Primata	Poales	Diptera
Family	Anacardiaceae	Hominidae	Poaceae	Muscidae
Genus	Mangifera	Homo	Triticum	Musca
Species	Indica	Sapiens	aestivum	domestica

Table 1 : Three examples of species

Taxonomic Aids

- All those collections of actual live specimens or preserved specimens, which help in the identification or verification of a species, are called taxonomic aids.
- Some of them are listed below :
  (i) Herbaria (ii) Botanial Gardens (iii) Zoological Parks
  (iv) Museums (v) Keys (vi) Monographs
  (vii) Manuals (viii) Floras
- Taxonomic studies of various species of plants, animals and other organisms are useful in agriculture, forestry, industry and in general in knowing our bio-resources and their diversity.
- These studies would require correct classification and identification of organisms. Identification of organisms requires intensive laboratory and field studies. The collection of actual specimens of plant and animal species is essential and is the prime source of taxonomic studies.
- These are also fundamental to studies and essential for training in systematics. It is used for classification of an organism, and the information gathered is also stored along with the specimens. In some cases the specimen is preserved for future studies.
- Biologist have established certain procedures and techniques to store and preserve the information as well as the specimens. Some of these are explained below :-

(i) <u>Herbarium</u>

Herbarium is a store house of collected plant specimens that are dried, pressed and preserved on sheets. Further, these sheets are arranged according to a universally accepted system of classification. These specimens, along with their descriptions on herbarium sheets, become a store house or repository for future use The herbarium sheets also carry a label providing information about date and place of collection, English, local and botanical names, family, collector's name, etc. Herbaria also serve as quick referral systems in taxonomical studies.

(ii) <u>Botanical Gardens</u>

The specialised gardens have collections of living plants for reference. Plant species in these gardens are grown for identification purposes and each plant is labelled indicating 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).

(iii) <u>Museum</u>

Biological museums are generally set up in educational institutes such as schools and colleges. Museums have collections of preserved plant and animal specimens for study and reference. Specimens are preserved in the containers or jars in preservative solutions. Plant and animal specimens may also be preserved as dry specimens. Insects are preserved in insect boxes after collecting, killing and pinning. Larger animals like birds and mammals are usually stuffed and preserved. Museums often have collections of skeletons of animals too.

(iv) <u>Zoological Parks</u>

These are the places where wild animals are kept in protected environments under human care and which enable us to learn about their food habits and behaviour. All animals in a zoo are provided, as far as possible, the conditions similar to their natural habitats. Children love visiting these parks, commonly called Zoos.

(v) Key

Key is another taxonomical aid used for identification of plants and animals based on the similarities and dissimilarities. The keys are based on the contrasting characters generally in a pair called couplet. It represents the choice made between two opposite options. This results in acceptance of only one and rejection of the other. Each statement in the key is called a lead. Separate taxonomic keys are required for each taxonomic category such as family, genus and species for identification purposes. Keys are generally analytical in nature.

- Flora, manuals, monographs and catalogues are some other means of recording descriptions. They also help in correct identification. Flora contains the actual account of habitat and distribution of plants of a given area. These provide the index to the plant species found in a particular area. Manuals are useful in providing information for identification of names of species found in an area. Monographs contains information on any one taxon.

PROBLEMS

Exercise-I

Q.1 Why are living organisms classified ?

Q.2 Why are the classification systems changing every now and then ?

Q.3 What different criteria would you choose to classify people that you meet often ?

Q.4 What do we learn from identification of individuals and populations ?

Q.5 Given below is the scientific name of Mango. Identify the correctly written name.
Mangifera Indica
Mangifera indica

Q.6 Define a taxon. Give some examples of taxa at different hierarchical levels.

Q.7 Can you identify the correct sequence of taxonomical categories ?

(a) Species	→	Order	→	Phylum	→	Kingdom
(b) Genus	→	Species	→	Order	→	Kingdom
(c) Species	→	Genus	→	Order	→	Phylum

Q.8 Try to collect all the currently accepted meanings for the word 'species'. Discuss with your teacher the meaning of species in case of higher plants and animals on one hand, and bacteria on the other hand.

Q.9 Define and understand the following terms :
(i) Phylum (ii) Class (iii) Family (iv) Order (v) Genus

Q.10 How is a key helpful in the identification and classification of an organism ?

Q.11 Illustrate the taxonomical hierarchy with suitable examples of a plant and an animal.

Exercise-II

Q.1 What is taxonomy ?

Q.2 What is meant by nomenclature ?

Q.3 Name the highest taxonomic category.

Q.4 Mention any four uses / advantages of taxonomy.

Q.5 Describe binomial nomenclature with an example.

Q.6 Enumerate the steps involved in the classification of an organism.