The Living World - Part 1

Objectives

After going through this lesson, the learners will be able to understand the following:

- What is living?
- Diversity in the living world
- Taxonomy
- Introduction to classification
- Nomenclature

Content Outline

- Introduction
- What is Living?
- Diversity in Living World
- Classification of Living Organism
- Taxonomic Categories
- Summary

Introduction

One of the most intricate questions in biology is what is it that makes something alive? What is the difference between the living and the dead? What is life? We only have to look around us to see that our planet is completely covered with different forms of life. Much of biological Science (the Study of living things) focuses on unifying all aspects of the living system. All living things share one origin and some processes of life are the same or very similar in everything alive. Life is seen in extraordinary habitats from cold mountains to deep ocean, from evergreen tropical rainforests to dry deserts, from freshwater lakes to running rivers, and even hot water springs and volcanic vents. In this module, we will try to find answers to what is living? What is biodiversity and how do we classify life forms?

What is Living? "What is Life"

To qualify as a living thing a creature must meet some criteria. Most biologists agree to the fact that living things tend to be complex and highly organized. They have the ability to take in energy in the form of food and transform it for growth and reproduction, they have the

ability to respond to stimulus, and they have a cellular body with features of metabolism, self-replication, and a tendency towards homeostasis. Let us take each feature one by one for an in-depth study.

a) **Living things grow** - Every living organism begins life as a single cell. Unicellular organisms may stay as one cell but they grow too. Multicellular organisms divide more and more cells to form more tissues and organs as they grow. The growth and development of living organisms are not one and the same things. Growth is the increase in size and mass of the organism. Development involves transformation of the organism as it goes through the growth process. In the case of a butterfly. It starts off as a cell (egg). Then it transforms itself into a caterpillar, then into a pupa (chrysalis), and then finally comes out as a beautiful butterfly.

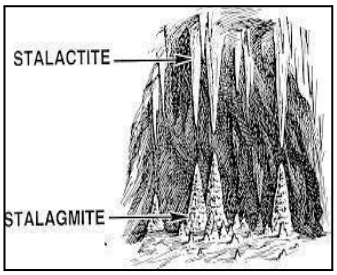
Plants often start from a single tiny seed and grow into a big tree. One thing common between all organisms is that they grow and develop traits just like their parent species, although there may be some slight variations present due to the mixing of reproductive cells by the parents. Cell growth and development include its repair. Cells also have the ability to repair themselves by growing new cells by the process called **Mitosis**. As living things grow, they undergo a process called aging (age). As they get close to the end of their lifespan, their ability to carry out life functions get reduced. Eventually, they die to end the process of life.

However, growth is hardly exclusive to living organisms. Several non-living things - such as crystals, icicles and glaciers - grow by the continuous accumulation of the same material out of which they are made.

Example: **Stalactites and Stalagmites** - Stalactites and stalagmites are formed by continuous deposition of calcium carbonate, the main component of limestone.

Icicles and Glaciers -

- **Icicles** grow from snow-melt flowing off ledges which refreezes when temperature goes below the freezing point. Glaciers, on the other hand, grow from the snowfall.
- **Crystals** grow through a process known as "nucleation,". Crystals grow when a nucleus attracts more of the same substance from a solution until the crystal and the solvent reach an equilibrium point.



(A)

(C)

(B)

(D)

A) Stalactites & Stalagmites, B) Icicles, C) Crystal, D) Glacier

Thus there are a number of such examples as mentioned above amongst the non-living world which show the characteristic feature of growth thus it cannot be taken as a defining property of living organisms.

b) **Living things reproduce -** Reproduction is the process by which new organisms (offspring) are produced. Reproduction is not an essential life process for survival of an individual, however, it is required for continuity of a species.

There are two main types of reproduction: *Sexual reproduction* and *Asexual reproduction*.

Sexual Reproduction:

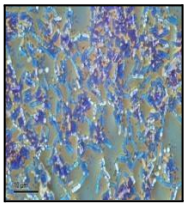
This involves two individuals of the same species, usually a male and female. Here the male and female gametes come together for fertilization to form zygote. The zygote then continuously divides to become a new organism, the offspring. This form of reproduction is seen in multicellular organisms.

Asexual reproduction:

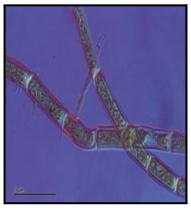
In this form of reproduction, a single parent is involved. Asexual reproduction is very common in single cell organisms, some simple multicellular life forms and in many plants. There are many forms of asexual reproduction.

S. No.	Forms of Asexual Reproduction	Organism
1.	Fission	*Amoeba (Binary Fission)*
2.	Budding	*Hydra, Yeast*
3.	Fragmentation	*Spirogyra*
4.	Sporulation	*Rhizopus*
5.	Vegetative Propagation (Leaf Buds)	*Bryophyllum*
6.	Vegetative Propagation (Stem)	Sugarcane, Potato
7.	Vegetative Propagation (Roots)	*Dahlia*
8.	True Regeneration	*Planaria*

Archaebacteria



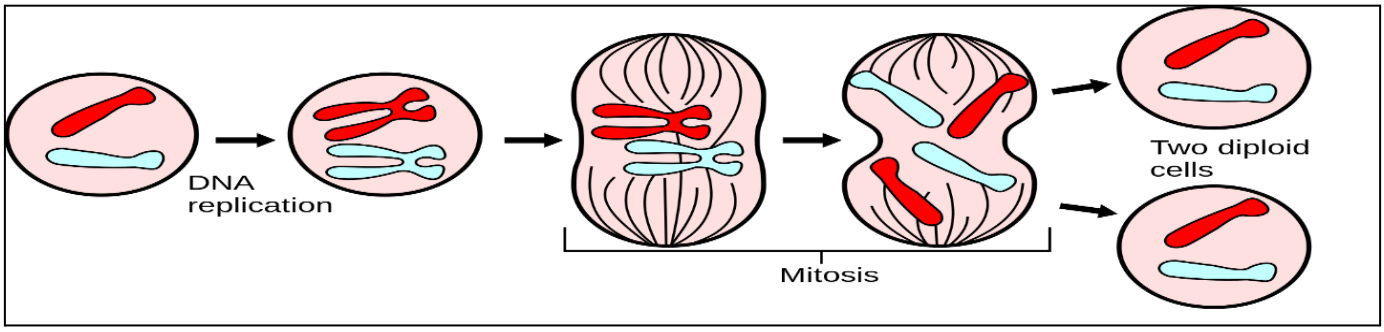
Eubacteria

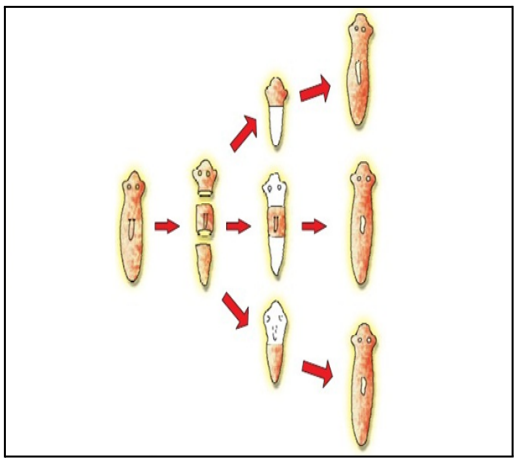


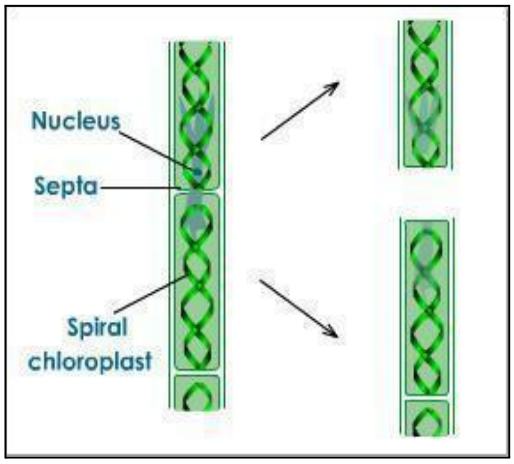
Protista

Bryophyllum

Fungi







Living organisms do not live forever. Some live for many years, others live for a few years and some live for a few days. The term for the length of time an organism lives is called their 'Lifespan'. Some organisms and their life span are given in the below-mentioned table.

S. No.	Organism	Life Span in years
1.	CAT (*Feliuscatus*)	21
2.	Chimpanzee(*Pan troglodytes*)	37
3.	Elephant, Indian (*Elephas Maximus*)	57
4.	Pigeon (*Columba livia domestica*)	35
5.	Alligator (*Alligator mississippiensis*)	56
6.	Giant Turtle (*Testudo elephantopus*)	177
7.	Frog (*Rana* species)	5-15
8.	Ant (*Lasius* species)	15
9.	Banana Tree	25
10.	Banyan Tree	200

Beside all this, as we already know that there are many organisms which do not reproduce like the mules, sterile worker bees, Infertile couples etc. Thus, reproduction can also not be an all inclusive defining characteristic of living organisms and of course no nonliving object is capable of reproduction.

c) **Metabolism: A Key Feature of all living organisms -** First let's try to understand what metabolism is. All living organisms need energy to grow, develop, reproduce, maintain their body structures, and respond to their surroundings. Metabolism is the set of life-sustaining chemical processes or reactions that enables organisms transform the

chemical energy stored in molecules into energy that can be used for various cellular processes. Animals consume food to obtain energy; their metabolism breaks down the carbohydrates, lipids, proteins, and nucleic acids to provide chemical energy for these processes. Plants convert light energy from the sun into chemical energy stored in carbohydrates during the process of photosynthesis. The living cells of every organism constantly use energy derived by breakdown of food in order to survive and grow. Thus, making it essential for all living organisms without exception.

d) **Cellular Organization** - For metabolic reaction a cell body is required. Thus, the cell body wherein these reactions take place makes it a most important defining feature of all living organisms. "All lifeforms have cellular organization" or as stated in the cell theory that "All living organisms are made of cells.". Cells are basic building blocks of the living organisms.

e) **All living organisms respond to stimulus-** Organism responds to their environment. Organisms detect and respond to stimuli from their environment. A stimulus is a signal to which an organism responds. Animals respond to many types of external stimuli such as light, sound, odors and heat. Humans perceive the world with many senses including sight, smell, touch, taste and hearing. Other animals have different senses and may respond to stimuli that we are not equipped with for example some birds can detect Earth's magnetic field and use it for navigation, Mexican bulldog bat uses high pitched sounds that humans cannot hear etc. even plants like Touch me not show in some plants like *Mimosa*, commonly known as 'touch-me-not', leaves close or fold when someone touches them. Flowers of some plants bloom only at night. In some plants flowers close after sunset. These are all examples of response to stimulus characteristics of the important characteristics of living organisms.

f) **Evolution** - Biology is the story of evolution of living organisms on earth. In all living organisms – present, past and future are linked to one another by the sharing of the common genetic material but to varying degrees.

g) **Homeostasis** - Living things actively maintain their complex structure and their constant internal structure through a process called homeostasis. The term 'Homeostasis' was coined by American physiologist Walter Bradford Cannon in 1929.

Diversity of Living World

Life has an amazing ability to adapt to different environments. It can develop mechanisms for surviving from extreme heat to extreme cold, from extremely humid regions to long prolonged droughts, high mountain altitudes to deep ocean depths. Each habitat provides a unique set of conditions to which different organisms adapt and develop features and behaviors to be able to live there successfully. This innate capacity of living life forms to adapt to its environment has led to evolution of millions of life forms, it's been approximately 3.8 billion years since life began and it has changed and evolved more variations than we can ever imagine. a group of living organisms consisting of similar individuals are capable of exchanging genes or interbreeding. The species is the principal natural taxonomic unit, ranking below a genus and denoted by a Latin binomial, e.g. *Homo sapiens*. **Biological diversity** – or **biodiversity** – is the term given to the variety of life forms on Earth. It is the variety within and between all species of plants, animals and micro-organisms and the ecosystems within which they live and interact. However, biodiversity is a huge concept which can be approached at any level, from the chemistry of DNA to the variations within one species to the classification of species themselves.

Classification of Living Organism

The diversity of living organisms on earth is remarkable. Humans have come up with ways of organizing, or classifying, biological diversity throughout human history. Though

taxonomists have been successful in describing about 1 million species with many million yet to be described. Along with numerical diversity, organisms differ widely and along numerous criteria — including morphological appearance, ecological functions, feeding habits, mating behaviors, and physiologies. In recent years with great scientific work happening at the level of genes scientists have also added molecular genetic differences to this list.

Classification - In order to facilitate the study, a number of scientists have established procedures to assign a scientific name to each known organism. It is nearly impossible to study all the living organisms, so it is necessary to devise some means to make this possible. This process is called classification. It is the process by which anything is grouped into convenient categories based on some easily observable characters. It is the arrangement of organisms into groups on the basis of their affinities or relationships. The modern system of classification began in 1758, when Carolus Linnaeus (1707-1778), a Swedish botanist published his book *SystemaNaturae.*

Need of Classification:

The organisms should be classified due to following reasons:

1. Classification makes identification and the study of a wide variety of biological organisms easy.
2. It reveals inter-relationships among different groups of organisms.
3. It gives information about the organisms and fossils of other localities.
4. It also describes evolutionary relationships.

Importance of Classification:

The contribution of classification is complementary to all branches of basic and applied biology directly or indirectly.

1. **Understanding the diversity:** Classification helps in knowing about biological resources, extent of their diversity and how they have evolved.
2. **Understanding phylogeny:** Classification helps in finding evolutionary relationships (phylogeny) among the organisms.
3. **Inter-relations:** Classification is essential to understand the inter-relationships among different groups of organisms.
4. **Development of other Biological Science:** Classification provides information for the development of other branches of biology, e.g., biogeography, ecology, ethology, forestry etc.

5. **In agriculture and forestry:** Taxonomic knowledge provides vital information about the pests, pathogens and hosts.
6. **Mineral Prospecting:** Taxonomy gives the correct sequence of geological events in a particular area. It is basic to any search for fossil fuels and mineral deposits.
7. **Biological Control:** Taxonomic knowledge is essential for accurate identification of pests and pathogens. Nowadays, instead of insecticides (chemical control), natural enemies of pests are introduced for biological control.
8. **Conservation of wildlife:** Due to human greed and ignorance, many species of flora and fauna have become extinct. Taxonomists help to identify these endangered species and help in initiating the wildlife conservation programs.
9. **Quarantine:** The spreading of new pests and diseases from one country to the other through infected humans can be restricted through quarantine. It can be checked by establishing quarantine laboratories at airports, seaports, railway stations etc.

Taxonomy is that branch of biology which deals with the identification and naming of organisms. The ancient Greek philosopher Aristotle apparently began the discussion on taxonomy. British naturalist John Ray is credited with revising the concept of naming and describing organisms. The term 'Taxonomy' was coined by AP de Candolle, Carolus Linnaeus is known as Father of Taxonomy and Father of Systematic Botany, whereas Santapau is known as Father of Indian Taxonomy. During the 1700s, Swedish botanist **Carolus Linnaeus** classified all then-known organisms into two large groups: the kingdoms Plantae and Animalia. Robert Whittaker in 1969 proposed five kingdoms: Plantae, Animalia, Fungi, Protista, and Monera. 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.**

Advanced Forms of Taxonomy

Phenetic Classification - It is based on the overall similarity of organisms evaluated without regard to phylogeny. A modern method of classification called cladistics, is based on evolutionary history. Arranging organisms on the basis of their shared similar or derived characters that differ from ancestral characters will produce a phylogenetic tree called **cladogram**. The phylogenetic tree is also known as a genealogical tree or **dendrogram.**

Systematics - It is the branch of Biology concerned with reconstructing phylogenies and with naming and classifying species. The term 'Systematics' was coined by Linnaeus and G Simpson (1961) distinguished systematics, taxonomy and classification. Julian Huxley (1940) proposed the term 'New systematics'. It deals with the study of the diversity of organisms and all their comparative and evolutionary relationships based on comparative anatomy, ecology, physiology and biochemistry.

Basics in Biological Classification

Biological Classification involves the techniques of **characterization, identification, nomenclature, and grouping of organisms.**

Nomenclature (L. Nome = Name; Calere = To Call):

Vernacular names or common names are given to the organisms in a particular language and the region of the world. These are not valid for nomenclature. Scientific names are given to organisms by biologists based on agreed principles and criteria for their acceptability all over the world. Thus, we need to provide a standardized method of naming living organisms.

The term nomenclature means the scientific naming of organisms according to an established system. The naming of plants on a scientific basis is called botanical or plant nomenclature. In earlier days common or vernacular names were in use which generally changes with change of language. Later in the haunt of one common internationally accepted name for a species, scientific names (Technical names) have been introduced in the form of polynomial, binomial and trinomial systems of nomenclature.

(a) **Polynomial Nomenclature:**

Before 1750, taxonomists started using a string of descriptive Latin words to designate a species. For example, in the herbal of Clusius (1583) a species of willow is named Salix pumila angustifolia altera.

However polynomial nomenclature was discarded for two reasons:

(i) It was lengthy and difficult to remember.

(ii) It often differs from scholar to scholar based on the characters chosen by them.

(b) **Trinomial Nomenclature:**

Mayer (1953) introduced the concept of sub-species which meant the geographically defined aggregates of local populations. The naming of a species, especially the animals,

up to sub-species level is called trinomial nomenclature, e.g. ***Homosapienssapiens***, *Homo sapiens Neanderthals*. Botanists don't consider trinomial nomenclature.

(c) **Binomial Nomenclature:**

Carolus Linnaeus (Karl Von Linnae), the great Swedish naturalist, devised a binomial system of nomenclature in his book **PhilosophiaBotanica** (1751). Now the binomial system of scientific naming of organisms has become a common and established practice. According to binomial nomenclature, the scientific name of an organism is composed of two Latin or Latinized words i.e. the first word is called **genus (= generic name or generic epithet)** followed by the second word called **species (= specific name or specific epithet)**. For example, the botanical name of sugarcane **is *Saccharumofficinarum***. Very rarely the generic and specific names are the same. They are called tautonyms, e.g. ***Gorilla gorilla*, *Catlacatla*, *Najanaja*, *Rattus rattus*** etc. Some organisms (fossils and most microorganisms) are known by their technical names only.

Rules of Binomial Nomenclature

The rules of nomenclature are framed and standardized by five separate codes such as:

i. International Code of Botanical Nomenclature **(ICBN),**
ii. International code of Zoological Nomenclature **(ICZN),**
iii. International Code of Bacteriological Nomenclature **(ICBacN),**
iv. International Code of Viral Nomenclature **(ICVN)** and
v. International Code of Nomenclature for Cultivated Plants **(ICNCP).**

These codes help in avoiding errors, duplication, confusion and ambiguity in scientific names.

The major rules are as follows:

1. Biological names are usually written in Latin. They are written in italics.
2. A biological name usually contains two terms. The first term shows the generic name, while the second term shows the species or the specific epithet.
3. Biological name is underlined, when it is handwritten and printed in italics.
4. The first term or the generic name begins with a capital letter. The second or the species name starts with a small letter.

Summary

The living world is rich in variety. Millions of plants and animals have been identified and described but a large number still remains unknown. The very range of organisms in terms of size,colour, habitat, and physiological and morphological features make us seek the defining characteristics of living organisms. In order to facilitate the study of kinds and diversity of organisms, biologists have evolved certain rules and principles for the identification, nomenclature and classification of organisms. The branch of knowledge dealing with these aspects is referred to as taxonomy. The taxonomic studies of various species of plants and animals are useful in agriculture, forestry, industry, and in general for knowing our bio-resources and their diversity. The basics of taxonomy like identification, naming, and classification of organisms are universally evolved under international codes. Based on the resemblances and distinct differences, each organism is identified and assigned a correct scientific/biological name comprising two words as per the binomial system of nomenclature.