Chapter 1

The Living World

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Introduction

The living world around us exhibits a vast range of life-forms which make this planet a wonderful and amazing place to dwell.

The variety of living organisms flourishing on earth is infinite. Their habitats, habits, behaviour are also countless and surprising. Not only this, the habitats in which extreme type of environment is found as in cold mountains, hot deserts, hot-springs, salty lakes, etc. which seem to be challenging for most of the life forms, there also exists some unique kind of life-forms.

The nature which we see and experience around us is really beautiful and amazing that its every glimpse like horse galloping, birds chirping, flowers blooming, honeybees dancing or sharks predating, make us over-awed. Besides, our nature also exhibits countless relationships like cooperation, conflict, nursing, predation etc. which occur among various members of a population and among various populations of a community.

A variety of relationships are known to occur at micro level, *i.e.*, cellular level too. Such molecular interactions occur inside, around and among the cells, which reveal astonishing facts about life.

Therefore, when we want to understand what life is really, we get many aspects of it. But a few among them are mainly understood and well-defined. The first aspect defines life in technical term, *i.e.*, as the power an organism possesses to maintain and reproduce itself on earth. It holds that life is unique, complex organisation of different molecules which organise in a specific pattern to form its basic unit, *i.e.*, cell. In turn, various kinds of chemical reactions occur inside cells which ultimately lead to the availability of energy, growth, development, responsiveness, metabolism and reproduction, in living beings.

The second approach is a philosophical one, which mainly focuses on purpose of life to living organisms.

Biologists study and explain various life-forms from technical aspect. They also try to classify living organisms from non-living things on the basis of some important criteria. They have also developed some universal norms and processes which make study of diverse life-forms easier for us.

WHAT IS LIVING?

Living organisms show some unique and distinctive characteristics which help us in recognising and differentiating them from other non-living things.

The characteristics which we observe commonly in all living beings are growth, reproduction, sensitivity. There are some other features which are not seen from outside but we know that they are taking place inside their bodies like metabolic reactions, self-replication, self-organisation, etc. These living organisms also have capability to interact and evolve, which can be observed and studied in them.

Characteristics of Living Beings

Growth

Growth is a fundamental characteristic of all living organisms. It is regarded as an **intrinsic** property of living organisms through which they can increase both in mass and in number of cells, in their body.

All living organisms whether unicellular or multicellular grow by cell division. The pattern and duration of growth is distinct in different organisms, like in plants, growth can occur throughout their life span whereas animals have only a limited period of growth, in their life span.

In unicellular organisms like bacteria, *Amoeba*, growth occurs by cell division and such cell division also leads to the growth of their population. Although, by such process of cell division reproduction of the individual also occurs. Hence, growth and reproduction are **mutually inclusive events**, in unicelled organisms. One can observe, cell division in unicellular organisms like bacteria, ***in-vitro*** (outside the body of an organisms), *i.e.*, in a test tube or petridish in an artificial medium, under microscope and can even count number of cells, increased during it, manually. In higher animals and plants, growth and reproduction are linked but are **mutually exclusive events**.

However, cell division not only occurs in living organisms at time of growth and reproduction but also during maintenance to replace lost cells due to some injury, etc. from the body. Hence, to maintain original size, shape and structure of a body, new cells are formed by division in various living beings.

Hence, growth involves both increase in mass and number of cells which takes place from inside the body of living organisms and is irreversible. On the other hand, non-living objects can also be seen growing like snow mountains grow by addition of snow on them, crystals increase in size by addition of molecules on its surface, sand-dunes increase by frequent transport of more material from its native bed by natural agencies like river, etc. But such growth in non-living objects happens externally by addition of some material from any outside source. So, we can say in non-living objects growth is extrinsic as compared to intrinsic growth in living organisms. Therefore, non-living objects can increase their mass by accumulation of material on surface by any external agency which can be reversed.

Growth, therefore, cannot be taken as defining property of living organisms, though it takes place in all living organisms and is absent in dead organisms. Growth is a characteristic of all living organisms, when all the conditions are well-understood and properly examined from a scientific point of view.

Example 1 : *What is growth?*

Solution : Growth is an intrinsic property of living organisms through which it increases mass and number of cells in their bodies.

Try Yourself

1. Which of the following shows extrinsic growth?
   (1) Snow mountain (2) Bacteria
   (3) *Euglena* (4) *Spirogyra*
2. Growth in living organisms occurs by
   (1) Division of cells
   (2) Increase in mass of the living structure
   (3) Accumulation of material by external agency
   (4) Both (1) & (2)

Reproduction

Reproduction is one of the fundamental characteristics of living organisms. It can be defined as the production of new individuals of same kind by the grown up individuals.

It is the characteristic exhibited by living organisms which can produce new young ones of their own kind. There are two modes of reproduction – **asexual** and **sexual**. In asexual mode, new individuals are produced from specialised or any unspecialised part of a single parent (*i.e.*, with or without the involvement of gamete formation). For instance, unicellular organisms like bacteria, algae or *Amoeba* divide by **fission** to produce new individuals. In such processes, parent body undergoes division to form two or more individuals, *i.e.*, number of cells increases. Hence, **in unicellular organisms reproduction is synonymous with growth.**

In lower organisms like yeasts and *Hydra*, budding takes place in which new individuals are produced by the formation of an outgrowth known as **"bud"**. These buds first grow on parent's body, and then separates from it, to give rise new individual. **Fragmentation** is also an another mode of asexual reproduction, as in this, body of an organism (parent body) breaks up into two or more parts (known as fragments) each of which grows into a new individual. It is also quite common in filamentous algae, fungus, bryophytes (at protonema stage which occurs during life cycle in mosses). *Planaria* (flat worms) exhibit an extraordinary ability to regenerate its lost body parts completely (which is known as **true regeneration**). This is a method of reproduction as new planarians develop by splitting of parent planarian body either lengthwise or transversely. In higher organisms like plants, animals sexual mode of reproduction is quite common which involves formation of gametes (*i.e.*, sex cells) from two parents of opposite sexes but same species. These gametes then fuse to form zygote (2n) which develops to form a new organism of same kind.

Hence, reproduction is shown by all living organisms except a few which are either sterile or infertile, like mule, worker-bees, infertile human couples, etc., do not reproduce at all. So, these cannot produce their offspring but show all other characteristics of living organisms. Although, no non-living object can replicate itself by its own, *i.e.*, power of replication or production of new individual of their own kind, is totally absent in them.

Hence, reproduction can be regarded as characteristic of living organisms but it is not their exclusive defining characteristic.

Example 2 : *Give two examples of organisms which reproduce by fragmentation.*

Solution : Filamentous algae and fungi

Try Yourself

3. *Amoeba* reproduces by
   (1) Regeneration (2) Fragmentation
   (3) Fission (4) Budding
4. Which of the following pairs is correctly matched?
   (i) Fungi – Regeneration
   (ii) Mosses – Fragmentation
   (iii) *Planaria* – Budding
   (1) (i) & (ii) (2) Both (i) & (iii)
   (3) Only (ii) (4) Only (iii)

Metabolism

All living organisms are made up of chemicals. These chemicals may be small and large, belonging to various classes, sizes, functions etc. These biomolecules are constantly synthesized and broken down into some other biomolecules in the body of living organisms through various kinds of reactions.

Such thousands of chemical reactions which occur inside living organisms during various processes like photosynthesis, respiration, etc., help them to maintain their living state. The sum total of all the chemical reactions occurring in the body of living organisms is known as **"Metabolism"**. All living organisms from unicellular to multicellular, *i.e.*, bacteria to multicellular fungi, plants and animals, possess metabolism of their own kind. The metabolic processes which involve the synthesis of molecules are called **"anabolism"**, *e.g.*, synthesis of proteins from amino acid, whereas those metabolic processes in which large molecules are broken down into smaller are known as **"catabolism"**, *e.g.*, sugars broken down into molecules of water and carbon dioxide, to liberate energy, *i.e.*, ATP.

On the other hand, non-living objects do not show metabolism. So, metabolism can be regarded as defining feature of all living organisms. Although, some of these reactions can be made to occur outside the body (*in-vitro*) in cell free system. These reactions occurring outside the body is not living but are living reactions.

Hence, the way cell performs all its functions or processes to organise or constitute the body of an organism (cellular organisation) is unique and that can be regarded as **defining feature** of all life forms.

Example 3 : *What is metabolism?*

Solution : Metabolism is defined as the sum total of all chemical reactions that occur in an organism.

Try Yourself

5. Metabolic reaction involves
   (1) Synthesis of biomolecules only
   (2) Breakdown of some biomolecules only
   (3) All physical changes which occur in objects around us
   (4) All chemical reactions which occur inside an organism
6. When green plants capture sunlight and utilise it to synthesize glucose, the reactions involved during this process are said to be
   (1) Catabolic reactions (2) Anabolic reactions
   (3) Decomposition reactions (4) Chain reactions

Consciousness

Most obvious and technically complicated feature of all living organism. All living organisms are able to detect changes, *i.e.*, sense their surroundings and can also respond to them. This is known as sensitivity which is defined as the ability to detect changes in the environment and to give response towards it accordingly. Any change that can be detected by an organism is called stimulus. This can be physical (like intensity, duration, direction of light, sound, change in temperature, duration of day length, *i.e.*, photoperiod, etc.), chemical (like acids, pollutants, etc.) or biological (like other organisms).

All organisms from the prokaryotes like bacteria to the complex eukaryotes like plants, animals and fungi, can sense various changes upto variable degrees in their surroundings. They can also respond by showing movements or behavioural changes in respect to stimuli. For instance, some plants like soyabean, radish etc. or animals like sheep, goat, horse, etc. breed or reproduce at specific seasons only, like in winters, summers, autumn. Hence, they are known as seasonal breeders as their reproductive behaviour changes with length of day, *i.e.*, photoperiod. Therefore, they mate or reproduce during their specific breeding season only. Plants are sensitive to external factors like light, water, temperature, pollutants and other organisms etc.

Besides, human being is the only organism, who is aware of himself. He has **self-consciousness** too with awareness of the surroundings. He can relate his mind to the changes taking place in the world. He is an intelligent animal with thoughts, feelings and self-hood.

Sensitivity or awareness is regarded as **defining property** of living organisms as non-living things do not have power of sensing their surroundings and give response according to it. However, patients lying in coma in hospitals virtually supported by machines which replace heart and lungs are neither living nor dead otherwise brain-dead.

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, the living organisms can be said to be self-replicating, evolving and interactive systems capable of 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.**

Example 4 : *Give an instance to show that plants respond to stimuli.*

Solution : Plants are sensitive to light, water, gravity, touch etc., like external stimuli as sunflower orients towards the sun in day time, also roots grow towards gravity, *i.e.*, underground.

Try Yourself

7. Sensitivity is the
   (1) Ability to grow
   (2) Ability to reproduce
   (3) Ability to detect changes in the environment
   (4) Ability to capture sunlight
8. Which is not a feature of all living organisms?
   (1) Metabolism (2) Cellular organisation
   (3) Self-consciousness (4) Consciousness

DIVERSITY IN THE LIVING WORLD

A large variety of living organisms such as herbs, shrubs, trees, insects, dogs, birds, cats or other animals and plants are easily seen around us. Also, there are many other organisms which are present around us but we cannot see them with naked eyes like viruses, bacteria etc. These are visible only under microscope.

Although, when we consider vast areas like forest, desert, plateau etc. we find that number and kinds of living organisms increase many folds. These different kinds of plants, animals and other organisms are referred to as **'Biodiversity'** of this earth.

Biodiversity is the number and various kinds of organisms found on earth. It stands for the variability found among living organisms inhabiting this world. Diversity differs from place to place as each habitat has its distinct biota (*i.e.*, life). So, every time we explore some new or even old areas, new organisms are found or discovered. It is so because environmental conditions of the area vary with time as well as the range of tolerance of species also varies which determine whether or not a particular species can occur in that area.

Hence, **biodiversity (Greek word *bios* = life; *diversity* = forms)** or **biological diversity** can be defined as the vast array of species of microorganisms, algae, fungi, plants, animals occurring on the earth either in the terrestrial or aquatic habitats and the ecological complexes of which they are a part.

Content Builder

Species is defined as a group of closely related organisms which are capable of interbreeding to produce fertile offsprings.

According to IUCN (International Union of Conservation of Nature and Natural resources), currently known and described species of all organisms are between **1.7–1.8 million**. There are millions of plants, animals and other organisms in the world that cannot be recognised, studied or described by an individual on its own. As we recognise the plants or animals in our own area by their local names, which vary from place to place even within a city, state or country as the persons inhabiting in different regions have different languages and perspective. Hence, there is need to standardise the names of all living organisms after proper identification, in order to study such diverse life forms. Therefore, for better understanding of biodiversity scientists have established a definite system of principles, procedures and terms which identifies, categories and assigns specific name to each and every organism known to us. Such systems are acceptable to all biologists all over the world.

The scientific need for simple, stable and internationally accepted systems for naming the living organisms of the world has generated, a process called **"Nomenclature"**. And, before assigning a specific name to an organism, one should determine or know its kind or features correctly, so that one can identify it in each and every part of the world. This is known as **"Identification"**.

Rules and Recommendations of Nomenclature

Various biologists follow a definite procedure or criteria while studying these variety of organisms which include – **identification**, **nomenclature** and **classification**. Their study is also facilitated by agreed principles and criteria set by biologists all over the world. Likewise, the set of rules and recommendations dealing with the formal names of plants is given or set in **International Code of Botanical Nomenclature (ICBN)**, while the rules of scientific naming of animals is assigned in **International Code of Zoological Nomenclature (ICZN)**. Such names which are kept by consent of scientists under codes set by **ICBN** or **ICZN** are known as **scientific names**. These are universally accepted and each species has only one name, *i.e.*, they are unique for every individual species. Also, all the people all over the world are able to correctly identify the name of various living organisms, describe to them. So, these names avoid any kind of ambiguity in names of variety of organisms. Similarly **International Code of Nomenclature of Bacteria (ICNB)**, **International Code of Nomenclature for Cultivated Plants (ICNCP)** and **International Code of Virus Classification and Nomenclature (ICVCN)** also exist.

Example 5 : *What do you mean by biodiversity?*

Solution : Biodiversity is the degree of variation of life forms on earth.

Example 6 : *What do you mean by nomenclature?*

Solution : The process of naming the living organisms which are identified is known as nomenclature.

Try Yourself

9. Identification is the process of
   (1) Naming living organism
   (2) Recognising the characteristic features of an organism
   (3) Categorising living organism
   (4) Discovering new species of plants and animals
10. International Code of Zoological Nomenclature set rules for scientific naming of
   (1) Plants (2) Fungi
   (3) Animals (4) Virus

Binomial Nomenclature

All biologists follow internationally agreed and accepted codes of rules or principles while assigning scientific name to known or newly discovered organisms. Binomial nomenclature for scientific naming of organisms was developed by **Carolus Linnaeus**. This system provides distinct and proper scientific names to variety of organisms. Each name has two parts, *i.e.*, the first part comprises of its **generic name**, while the second part is the **specific epithet**. This naming system which uses two word format is universally accepted and used, as it is more convenient to understand and follow.

Rules of Binomial Nomenclature : Some universal rules of Nomenclature framed under codes of ICZN, ICBN, etc. are as follows :

1. Biological names are generally taken from Latin language irrespective of their origin. New names are now derived either from Latin language or Latinised.
2. Each organism is given only one name consisting of two words. The first word in a biological name represents its genus while the second component denotes the specific epithet.
3. The scientific name is printed in italics or underlined separately when handwritten to indicate their Latin origin.
4. The first word denoting genus starts with a capital letter, while the specific epithet starts with a small letter.
5. The name of the author or discoverer is written after specific epithet in abbreviated form. For example, *Mangifera indica* Linn., it indicates that this species was first described by **Linnaeus**.
6. All the three words (generic name, species epithet and author citation) collectively form **binomial epithet**.
7. **Principle of priority :** It is the most important of all the rules of ICBN. If first name given to the organism is valid (in terms of rules), that will be considered at the first preference. Any other valid name given after that will be considered as synonym. No names are recognised prior to those used by Linnaeus in 1758 in the 10th edition of **Systema Naturae** for animals and 1753 for plants in Species Plantarum.

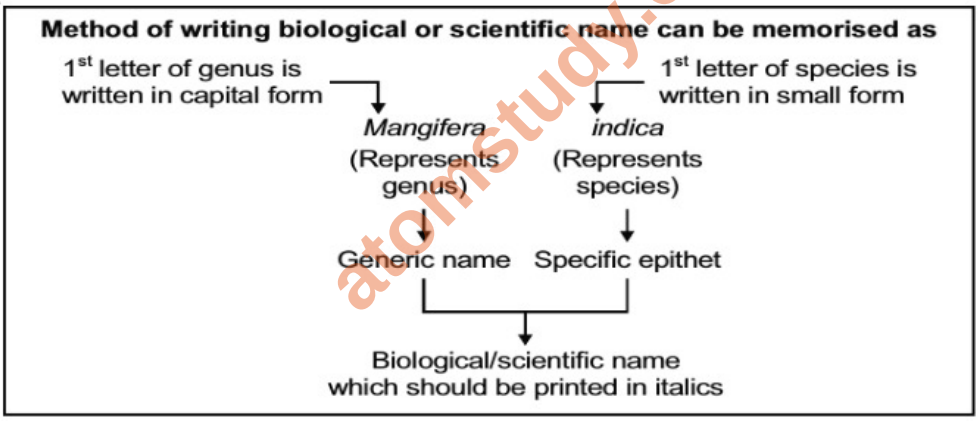


Table shows common and scientific names of different common plants and animals.

Common names	Scientific names	Generic names	Specific epithet
Human	*Homo sapiens*	*Homo*	*sapiens*
Lion	*Panthera leo*	*Panthera*	*leo*
Dog	*Canis familiaris*	*Canis*	*familiaris*
Onion	*Allium cepa*	*Allium*	*cepa*
Wheat	*Triticum aestivum*	*Triticum*	*aestivum*
Brinjal	*Solanum melongena*	*Solanum*	*melongena*
Rose	*Rosa indica*	*Rosa*	*indica*
Pigeon	*Columba livia*	*Columba*	*livia*

Example 7 : *Who developed the system of binomial nomenclature?*

Solution : Carolus Linnaeus (1751) developed a system of naming of organisms known as binomial nomenclature.

Try Yourself

11. Naming system accepted universally, is known as
    (1) Vernacular names (2) Zoological nomenclature
    (3) Binomial nomenclature (4) Botanical nomenclature
12. Scientific names are generally taken from
    (1) Sanskrit language (2) Latin language
    (3) Hindi language (4) Greek language

Need for Classification

As we know that a huge variety of plants, animals and other organisms with different form and structures exist on this earth. Therefore, it is impossible to study all of these variable creatures individually. Hence, to make their study easier, simpler, we have divided them into different ranks or categories on basis of some similarities and differences found among them. Thus, inspite of great diversity, organisms are categorised and arranged in hierarchial series of groups and subgroups, on basis of some easily observable characters. Hence, classification categorises every organism known to us into specific scientific arrangement to make its study easier.

Classification

Once the organism is identified and given a name, it is grouped along with its similar ones, so that its study becomes easier and simpler.

Biological classification is the scientific arrangement of each and every organism, identified and described in a hierarchial series of groups and sub-groups. This is done on the basis of similarities and differences in their traits (or characters) found in them. The process of categorising different organisms, on the basis of some easily observable characters is known as **"Classification"**.

When we say, wheat, dog or rat, etc., we recognise each of them with its specific characters and are able to discriminate it from others on the basis of some other characteristics. These specific characteristics shown by the specific organism help us to assign a category to it. The specific term for these categories is **"taxa"**. Hence, all living organisms can be classified into different taxa on the basis of specific characteristics exhibited by them. The branch of science which deals with the study of principles and procedures of classification is known as **"Taxonomy"**.

The **classical taxonomy** is based on observable morphological characters whereas **modern taxonomic studies** are based on some essential features like study of both external and internal structure of organisms along with their cell structure, development process and ecological information of organisms.

Hence, characterisation, identification, classification and nomenclature are the processes that are basic to taxonomy.

Taxonomic studies are not recently started but are done from very ancient times by humans, as he is curious about nature. So, he is always interested to know more and more about the nature and the variety of organisms found in it. Not only this, he also exploits some organisms vastly studied, for his own benefit. For instance, early human beings need to find sources of food, clothing and shelter for their survival. Later, they classified them on the basis of their usage. In vedic literature, 740 plants and 250 animals are being identified and classified. Aristotle (384–322 BC) divided living beings into animals, human beings and plants.

Human beings had not only studied different kinds of organisms but also tried to find out relationships among them. This led to the development of a new branch of study in science field, known as **"Systematics"**. The word systematics is derived from Latin word **"Systema"** which means systematic arrangement of organisms. It was first used by **Carolus Linnaeus** in the title of his book published as **"Systema Naturae"**. Systematics is more wider field of science as with identification, nomenclature and classification, it also takes into account evolutionary relationships between various organisms. **"Systematics"** is the science which deals with diversity of organisms and all their comparative and evolutionary relationships amongst them.

Taxonomy	Systematics
1. Derived from two Greek words 'taxis' and 'nomos'.	1. Derived from Latin word 'systema'.
2. Includes characterisation, identification, nomenclature and classification of organisms.	2. Includes characterisation, identification, nomenclature, classification of organisms alongwith their evolutionary study.

Content Builder

1. The reasons for **large scale biodiversity** amongst living beings are :
   (a) Adaptations in organisms to diverse habitat in order to reduce competition.
   (b) Change in genetic constitution.
   (c) Isolation
2. **Ontogeny** is the life history of organisms. **Phylogeny** is the evolutionary history of organisms.
3. **Systematics** is taxonomy alongwith phylogeny.
4. **Classical** or **old** or **descriptive systematics** is based upon morphological characters. According to it basic unit of classification is **species**. **Pioneer workers** are Aristotle and Linnaeus.
5. **New systematics / Biosystematics / Neosystematics** is based upon all characters, *i.e.*, morphological, cytological, ecological, biochemical, genetical etc. The term was coined by **Julian Huxley.** Basic unit of classification is **population** or **sub-species** for the new systematics.
6. **Trinomial nomenclature :** Proposed by **Lamarck**, it involves the use of three words for a name so that the names of subspecies (animals) or varieties (plants) can also be incorporated. For example, *Brassica oleracea* var. *botrytis*, *Corvus splendens splendens*.
   Some examples of subspecies and varieties are given below :

Corvus splendens splendens	–	Indian crow
Gorilla gorilla gorilla	–	Gorilla (animal)
Brassica oleracea var. *capitata*	–	Cabbage
Acacia nilotica var. *indica*	–	Indian Babul

Knowledge Cloud

(i) Founder of taxonomy / Father of biology / Zoology – Aristotle
Father of Botany – Theophrastus
Father of Indian Botany/Indian herbaria - William Rouxburgh.

(ii) About 5–30 million species of living organisms exist today.
Taxonomically or scientifically known number of species is 1.7 million or 13 percent.

EXERCISE

1. Select **incorrect** statement w.r.t. growth
   (1) Increase in body mass is criterion for growth in non-living objects
   (2) Animals grow upto a certain age
   (3) Growth in plants is definite always
   (4) In living organisms, growth is from inside
2. Regeneration can be observed in
   (1) Fungi (2) *Planaria*
   (3) *Hydra* (4) More than one option is correct
3. Taxonomically known number of species is
   (1) 1.7 billion (2) 17 lakh
   (3) 5 to 30 million (4) 17 million
4. Which one of the following character is common in classical taxonomy and modern taxonomic studies ?
   (1) Morphological characters (2) Development process
   (3) Genetical characters (4) Ecological information of organisms
5. Term systematics was derived from _____ word "systema" which means
   (1) Greek, Evolutionary classification
   (2) Latin, systematic arrangement of organisms
   (3) English, Taxonomy of organisms
   (4) Both (1) & (3)
6. No names are recognised prior to those used by Linnaeus in 1758 in the 10th edition of
   (1) Systema Naturae (2) Species Plantarum
   (3) Genera Plantarum (4) Philosophia Botanica
7. Select **incorrect** statement w.r.t. binomial nomenclature
   (1) Biological names are generally in italics and written in Latin
   (2) Generic name starts with capital letter
   (3) Both names are separately underlined to indicate their Latin origin
   (4) Author's name is written after the scientific name in Roman type
8. Correct binomial epithet of garden pea is
   (1) *Pisum sativum* (2) Pisum sativum Linn.
   (3) *Pisum sativum* Linn. (4) *Pisum Sativum Linn.*
9. Which one of the following scientific name represents trinomial nomenclature of an animal?
   (1) *Acacia nilotica indica* (2) *Brassica oleracea botrytis*
   (3) *Corvus splendens splendens* (4) More than one option is correct
10. Standardisation of scientific name for plants is done by
    (1) ICBN (2) ICNB
    (3) ICNCP (4) Both (1) & (3)

TAXONOMIC CATEGORIES

The process of classification of living organisms is not a single step process but it involves a number of steps, *i.e.*, 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 **"taxonomic category"** and all categories together constitute the taxonomic hierarchy. Therefore, each category is referred to as a unit of classification. It also represents a rank in taxonomic hierarchy.

Taxon (plural : taxa) represents any level of grouping of organisms based on certain easily observable common characteristics like insects represent a group of organisms which share some common features like three pairs of jointed legs, hence insects can be uniquely recognised and classified. So, they were given a definite rank or category in taxonomic hierarchy. Likewise, birds represent that group of organisms which have feathers, beak, hollow bones, etc., due to which they are kept in separate rank or category in taxonomic hierarchy.

We can memorise this, by remembering that each rank or taxon represents a group of organisms which share some unique features among members of their group or category which are distinct from organisms kept in various other ranks or taxon. Hence, these taxonomic groups or categories form distinct biological entities and should not be thought as random aggregates of animals based on their morphological features.

Example 8 : *Define taxonomy.*

Solution : The branch of science which deals with the study of principles and procedures of classification is known as **"Taxonomy"**.

Try Yourself

13. Classification of organisms is required because
    (1) It makes the study of organisms easier and simpler
    (2) It enables us to study geographical distribution of some organisms
    (3) It makes the study of organisms complex
    (4) It leads to ambiguity in study of various organisms
14. The word 'taxon' signifies
    (1) Scientific name of an organism (2) Developmental process of an organism
    (3) Taxonomic group of any rank (4) Ecological importance of an organism

Diverse kinds of organisms known to scientists are studied from taxonomical aspect which led to the development of some definite categories. These definite categories or ranks in classification of plants, animals and other organisms are :

1. Kingdom
2. Phylum (for animals) or division (for plants)
3. Class
4. Order
5. Family
6. Genus
7. Species

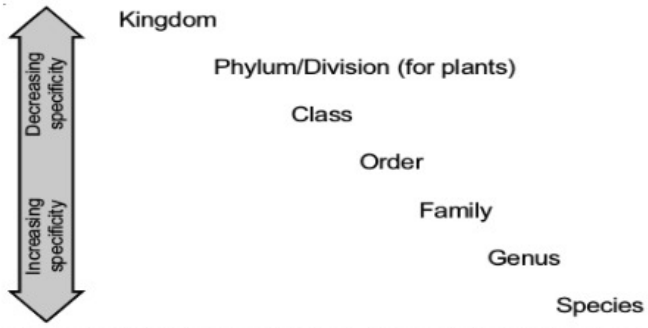
These **seven obligate categories** in which all living organisms are classified are arranged in a **descending sequence** starting from kingdom upto species or in an **ascending order** from species to kingdom. The number of similar characters of categories decreases from lowest rank, *i.e.*, species; to highest rank, *i.e.*, kingdom.

Specificity decreases when we go from species to kingdom, *i.e.*, the higher the category, lesser will be the number of similar characteristics of organisms belonging to that category, while when we go from kingdom to species, *i.e.*, in an descending order the number of similar characteristics of organisms increases, *i.e.*,

specificity increases. In taxonomic hierarchy, taxonomic groups, *i.e.*, taxa are arranged in a definite order, from higher to lower categories and in which **species serves as the basic and lowest category.**

To categorise an individual or group of organisms in a definite rank, we should have all the basic knowledge of its characteristics. This would help us in identifying the similarities and dissimilarities among the individuals of the same kind of organisms as well as of other kinds of organisms. Here, we will explain all the seven broad or obligate categories of taxonomic hierarchy.

However, taxonomists have also developed some sub-categories like sub-phylum or sub-division, etc. in this hierarchy to make this arrangement more transparent and scientifically useful.



Taxonomic categories showing hierarchial arrangement in descending and ascending order.

Example 9 : *What do you understand by taxonomic hierarchy?*

Solution : The serialwise or orderly arrangement of taxonomic categories or rank is known as taxonomic hierarchy.

Try Yourself

15. How many obligate categories are there in taxonomic hierarchy?
    (1) Five (2) Six
    (3) Seven (4) Four
16. Lowest category of taxonomic hierarchy is
    (1) Taxon (2) Rank
    (3) Species (4) Genus

Species

It is a natural population of individuals or group of populations which resemble one another in all essential morphological (*i.e.*, body form, size, shape, etc.) and reproductive characters so that they are able to interbreed freely in nature to produce fertile offsprings. On the basis of taxonomic studies, a group of individuals/populations with fundamental similarities are referred to as **species**. A species can be easily distinguished from other closely related species on the basis of their distinct morphological differences. Let us consider, *Solanum tuberosum* (*i.e.*, potato), *Canis familiaris* (dog) and *Panthera leo* (lion). In all these three names, *i.e.*, *tuberosum*, *familiaris* and *leo* represent the species, while the first words or names *Solanum*, *Canis* and *Panthera* represent the genus, which is next higher taxon than species in the taxonomic hierarchy.

Due to the similarities in some morphological features, one or more species are kept in a genus. For example, *Solanum* has another specific epithets than *tuberosum*, like *nigrum* and *melongena*. *Canis* has another specific epithets than *familiaris* like *lupus* and *aureus*. *Panthera* has another specific epithets than *leo* like *tigris* and *pardus*.

All the species represent the different organisms which are kept in the same genus due to some similarities in their morphological features but are assigned to different specific epithet due to some other distinct features like habitat or colour or size, etc.

It is summarised in the given table.

Genus	Specific epithet	Common names
1. *Solanum*	*tuberosum*	Potato
	nigrum	Black nightshade or Makoi
	melongena	Brinjal, Egg plant
2. *Canis*	*familiaris*	Dog
	lupus	Wolf
	aureus	Jackal
3. *Panthera*	*leo*	Lion
	tigris	Tiger
	pardus	Leopard

Biological Concept of Species: Ernst Mayr gave most accepted biological concept of species which defines species as a group of actually or potentially interbreeding populations that are reproductively isolated from other such groups.

Example 10 : *Define species.*

Solution : Species is defined as a group of organisms capable of interbreeding and producing fertile offsprings.

Try Yourself

17. Pick the incorrect statement about species.
    (1) Each species has some distinct morphological features than other species
    (2) The group of organisms in a particular species freely interbreed among themselves
    (3) The second part of biological name consists of specific name
    (4) Each species may have one or more genus
18. The specific epithet in *Solanum tuberosum* and *Canis familiaris* respectively is
    (1) *tuberosum* and *Canis* (2) *Solanum* and *familiaris*
    (3) *tuberosum* and *familiaris* (4) *Solanum* and *Canis*

Genus

Genus is a group of related species, which has more characters in common in comparison to species of another genera. For example, potato, makoi and brinjal are three different species but all belong to the same genus *Solanum*. Species like *lupus*, *familiaris* and *aureus* belong to genus *Canis*. Likewise, genus *Panthera* consists of species like *leo*, *tigris* and *pardus* which have ability to roar as a similar character. The different species of *Canis* genus resemble to each other in some characters but are different and easily distinguishable from many other species of *Panthera* genus. So, we can conclude that all the related species in one genus have a common ancestory, so that they have a few differences but many similarities, to be grouped in one genus. Hence, the aggregates of closely related species is a genus.

When we consider human beings, they belong to the species *sapiens*, which is grouped in genus *Homo*. Thus, our scientific name is written as *Homo sapiens*.

Did You Know?

Monotypic genus : Genus with only one species. *e.g.*, *Homo sapiens.*

Polytypic genus : Genus with more than one species. *e.g.*, *Solanum nigrum*, *Solanum melongena.*

Example 11 : *Name the genus to which potato, brinjal and makoi belong.*

Solution : *Solanum*

Try Yourself

19. All related species are kept under
    (1) One common genus
    (2) Different genus due to different evolutionary courses
    (3) Various groups according to the similarities and differences
    (4) Different higher taxa on basis of morphological differences
20. Find the correct match.
    (a) *tuberosum* – *Panthera* (b) *pardus* – *Canis*
    (c) *lupus* – *Canis* (d) *aureus* – *Solanum*
    (1) Only (a) & (c) (2) (a), (b) & (c)
    (3) (b), (c) & (d) (4) Only (c)

Family

The next higher category in the taxonomic hierarchy after genus is family. It includes various groups of related genera, which share less number of similarities as compared to that at genus and species level. As we have already studied that when we move from lower taxon towards higher one in hierarchy, the number of similar characters decreases. For instance, on basis of vegetative and reproductive features of some plant species, they are grouped into three different genera – *Solanum*, *Petunia*, *Datura* and these three different genera are kept in a single family, *i.e.*, **Solanaceae** due to some other common features or correlated characters. They all are distinguishable from the genera of the related family **Liliaceae** which includes two different but related genera, *i.e.*, *Allium* and *Colchicum*. Similarly, among animals, the genus *Felis* of cats and the genus *Panthera* including lion, tiger and snow leopard are placed under a common family – **Felidae**. At same time, if we observe the features of a cat and a dog, we will find that they both are quite distinct. So, these are kept in separate families – Felidae (cats) and Canidae (dogs).

Example 12 : *Name the higher category in taxonomic hierarchy which comes immediately after Genus.*

Solution : Family

Try Yourself

21. Various groups of related genera are kept in
    (1) A single species (2) A single family
    (3) Many species but single family (4) In taxon which comes lower to genus
22. Solanaceae is a
    (1) Single family of related genera
    (2) Species name of potato
    (3) Taxon of similar genus like *Allium*, *Colchicum*
    (4) Local name of tomato