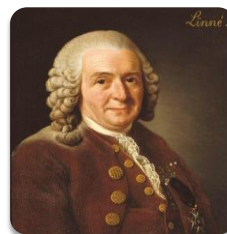
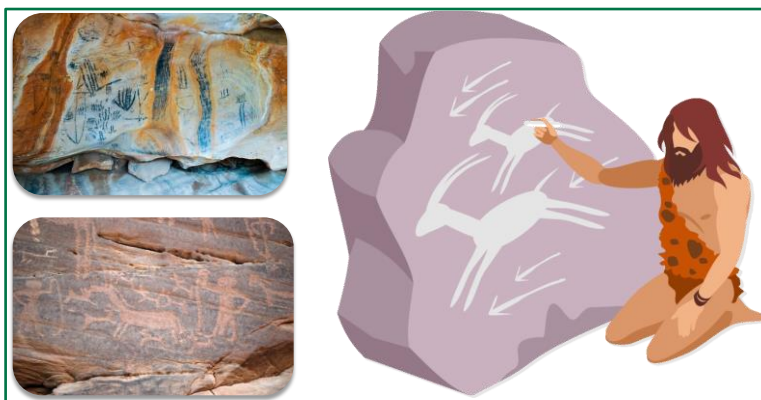


01

The Living World

01. INTRODUCTION TO BIOLOGY

- Biology is the science of life forms and living processes such as Metabolism, Growth, Reproduction *etc.* Biology is the story of life on earth. Biology is the story of evolution of living organisms on earth.
- The living world comprises an amazing diversity of living organisms.
- Early man could easily perceive the difference between inanimate matter and living organisms.
- Early man **deified** (worshiped) some of the inanimate matter (wind, sea, fire *etc.*) and some among the animals and plants.
- A common feature of all such forms of inanimate and animate objects was the sense of awe or fear that they evoked.
- The **description of living organisms** including human beings began much later in human history. Societies which indulged in **anthropocentric** view of biology could register limited progress in biological knowledge because they were describing and studying human only.
- Systematic and monumental description of life forms brought in, out of necessity, **detailed systems of identification, nomenclature and classification**. And human starts describing living things in scientific way.
- **The biggest spin off (outcome) of such studies (incidental outcome of detailed studies of systematic) was the recognition of the sharing of similarities among living organisms both horizontally (existing organisms) and vertically (among organisms in the evolutionary sequence).**

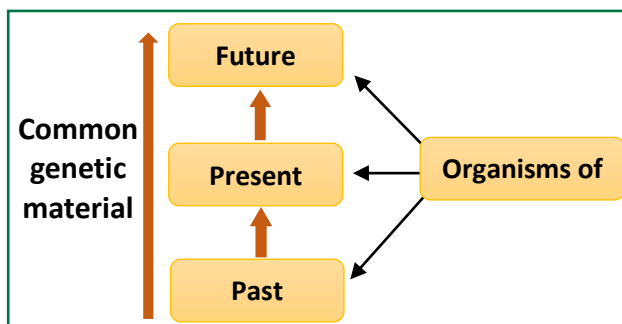


Linnaeus



A.P. de Candolle

- All present-day living organisms are related to each other and also to all organisms that ever lived on this earth, was a revelation which humbled man and led to cultural movements for conservation of biodiversity.
- All living organisms – present, past and future, are linked to one another by the sharing of the common genetic material, but to varying degrees. In the following chapters of this unit, you will get a description, including classification, of animals and plants from a taxonomist's perspective.
- The living world is wonderful. The living organisms resides in extraordinary habitats (place where organism lives) in which we find living organisms, be it cold mountains, deciduous forests, oceans, fresh water lakes, deserts or hot springs, leave us speechless.



- The beauty of a galloping horse, of the migrating birds, the valley of flowers or the attacking shark evokes awe and a deep sense of wonder.
- The ecological conflict and cooperation among members of a population and among populations of a community or even the molecular traffic inside a cell make us deeply reflect on – what indeed is life?
- This question has two implicit (inbuilt) questions within it.
- The **first** is a **technical** or **scientific** one and seeks answer to **what living is as opposed to the non-living**, and the **second** is a **philosophical** one, and seeks answer to what the purpose of life is being a science student, we will try to reflect here with the first one only.

What Is 'Living'?

- When we try to define 'living', we conventionally look for distinctive characteristics exhibited by living organisms. Growth, reproduction, ability to sense environment and mount a suitable response come to our mind immediately as unique features of living organisms. One can add a few more features like **metabolism, ability to self-replicate, self-organise, interact** and **emergence** to this list.

(A) Growth :

- Growth is an irreversible permanent increase in size of an organ or its parts or even of an individual cell.
- Increase in mass and increase in number of individuals are twin characteristics of growth.

(B) Reproduction :

- In multicellular organisms, reproduction refers to the production of progeny possessing features more or less similar to those of parents. Invariably and implicitly (absolutely) we refer to sexual reproduction.
- Organisms reproduce by asexual means also. Fungi multiply and spread easily due to the millions of asexual spores they produce.

(C) Cellular Organisation :

- Cell is the basic unit of life. All living organisms are composed of living cells. Some are composed of a single cell and are called unicellular organisms while others like us composed of many cells, are called multicellular organisms.

(D) Metabolism : **Anabolism + Catabolism = Metabolism**

(E) Consciousness :

- Perhaps, the most obvious and technically complicated feature of all living organisms is this ability to sense their surroundings or environment and respond to these environmental stimuli which could be physical, chemical or biological.

(F) Emergent Properties of Life and Homeostasis :

- 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.
- 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 of responding to external stimuli.

- Homeostasis or self regulation refers to the ability of the body to maintain a stable internal environment despite changes in external conditions.
- Adaptation is morphological physiological or behavioural feature of an organism that is essential for survival and reproduction in its habitat.

02. DIVERSITY IN THE LIVING WORLD

- If you look around you will see a large variety of living organisms, be it potted plants, insects, birds, your pets or other animals and plants. There are also several organisms that you cannot see with your naked eye but they are all around you (*i.e.* naturally growing microorganisms).
- If you were to increase the area that you make observations in, the range and variety of organisms that you see would increase.
- We should remember here that as we explore new areas, and even old ones, new organisms are continuously being identified.
- Each different kind of plant, animal or organism that you see, represents a species.
- The number of species that are known and described range between **1.7-1.8 million**.
- **Biodiversity** :- Occurrence of the number and types of organisms present on earth, is called biodiversity.

NCERT Question :

Why are living organisms classified?

Need of Taxonomy :

- As stated earlier, there are millions of plants and animals in the world, we know these plants and animals in our own area by their local names.
- These local names would vary from place to place, even within a country.
- Probably you would recognise the confusion that would be created if we did not find ways and means to talk to each other, to refer to organisms we are talking about. Moreover it also helps us categorise organisms so we can more easily communicate biological information.



(A) TAXONOMY : (Taxis = arrangement, nomos = law)

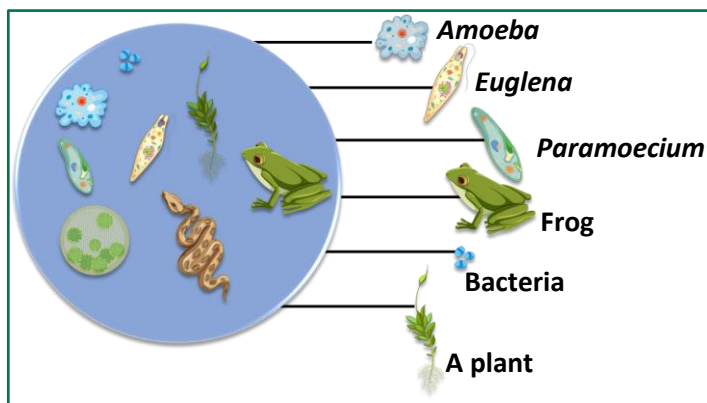
- This word was proposed by A.P. de. Candolle in his book '*Theories elementaire de la botanique*' (Theory of elementary botany).
- Branch of biology dealing with identification, nomenclature and classification of organisms is called taxonomy.
- Characterisation, identification, classification and nomenclature are the processes basic to taxonomy.

NCERT Question :

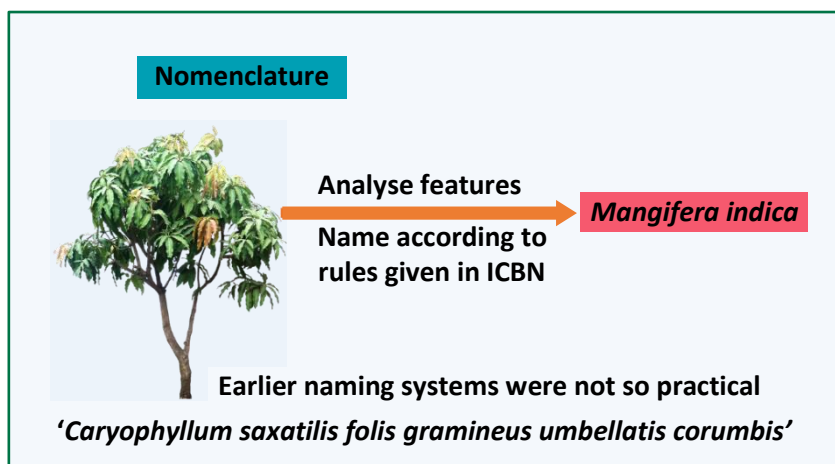
What do we learn from identification of individuals and populations?

- Taxonomy includes study of following points :

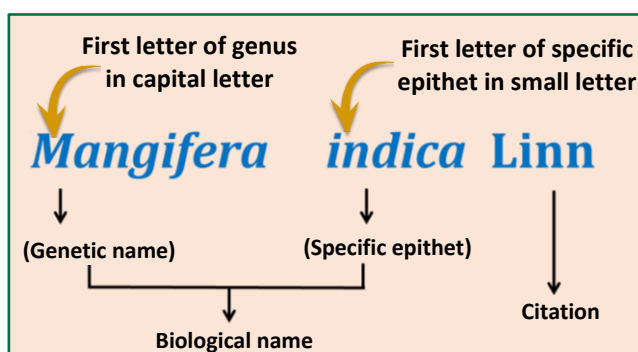
- (a) Identification :** A process by which an organism is recognised from the other by already known organisms by the help of characters.



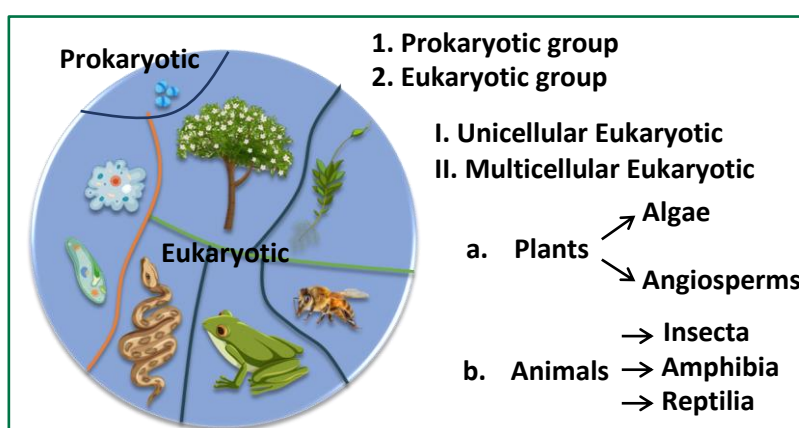
- (b) Nomenclature :** Naming of organisms according to international scientific rules is called nomenclature. During nomenclature both vegetative & reproductive and external & internal characteristics are used.

Binomial Nomenclature :

- Biologists follow universally accepted principles to provide scientific names to known organisms.
- Each name has two components – the Generic name and the specific epithet.
- This system of providing a name with two components is called Binomial nomenclature.
- This naming system given by Carolus Linnaeus is being practised by biologists all over the world.
- This naming system using a two-word format was found convenient.
- Let us take the example of mango to understand the way of providing scientific names better. The scientific name of mango is written as *Mangifera indica*. Let us see how it is a binomial name. In this name *Mangifera* represents the genus while *indica*, is a particular species, or a specific epithet.



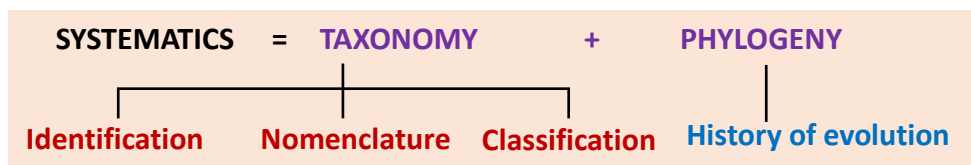
- (c) **Classification** : A process by which any organism is grouped into convenient categories on the basis of some easily observable characters. To study all these points, characters of organisms are necessary to be used, so use of characters for description of organisms is called **characterisation**.



For plants, scientific names are based on agreed principles and criteria, which are provided in **International Code of Botanical Nomenclature (ICBN)**. Similarly, animal taxonomists have evolved **International Code of Zoological Nomenclature (ICZN)**.

Types of Classification :

- (i) **Artificial classification** : In this type of classification plants are classified on the basis of **one or few superficial morphological characters like habit, colour, number and shape of leaves**. *i.e.* over all morphology is not considered.
- (ii) **Natural non-phylogenetic** : In this classification, the phylogeny of the plants is not considered. *i.e.* only the gross morphology of the plant is considered.
- (iii) **Natural phylogenetic** : In this classification, both **gross morphology** and **phylogeny** are considered. In phylogenetic classification, the plants are arranged on the basis of their **evolution** (organisms belong same taxa have a common ancestor.)
- (iv) **Phenetic classification or Numerical classification** : This classification is easily carried out by using **computers** and it is based on **all observable characteristics**.

(B) SYSTEMATICS :

- The term systematics was given by Linnaeus. The word systematics is derived from Latin word "**Systema**" which means "systematic arrangement of organisms". Linnaeus used "**Systema Naturae**" as a title of his publication.
- The term systematics was referred to study of diversity of organisms and their evolutionary relations.
- In modern taxonomical studies, taxonomists use **external and internal structure, along with the structure of cell, developmental processes and ecological information of organisms**.
- The scope of systematics was later enlarged to include identification, nomenclature and classification of organisms. So now the systematics includes taxonomy and study of evolutionary relations (phylogeny) in organism.

NCERT Question :

Given below is the scientific name of Mango. Identify the correctly written name.

Mangifera Indica, *Mangifera indica*

Other universal rules of nomenclature are as follows :

1. Biological names are generally in Latin and written in italics. They are Latinised or derived from Latin irrespective of their origin.
2. The first word in a biological name represents the genus while the second component denotes the specific epithet.
3. Both the words in a biological name, when handwritten, are separately underlined, or printed in italics to indicate their Latin origin.
4. The first word denoting the genus starts with a capital letter while the specific epithet starts with a small letter. It can be illustrated with the **e.g.** of *Mangifera indica*.
5. Name of scientist is neither underlined nor italicized, but written in Roman letters (simple alphabets).

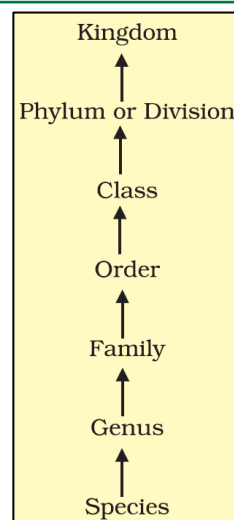
NCERT Question :

Define and understand the following terms :

(i) Phylum (ii) Class (iii) Family (iv) Order (v) Genus

03. TAXONOMIC CATEGORIES

- There are **7 main** taxonomic categories. They are **obligate** or **broad categories** i.e. they are essentially used at the time of any plant classification. However, taxonomists have also developed sub categories or extra categories to facilitate more sound placement of various taxa, like **sub division**, **sub order** etc.
- They are not regularly used. They are used only when they are needed.
- **Taxonomic hierarchy** - Descending or ascending arrangement of taxonomic categories is known as taxonomic hierarchy.



NCERT Fig. 1.1 Taxonomic categories showing hierarchical arrangement in ascending order

Classification of Mango and Human :-

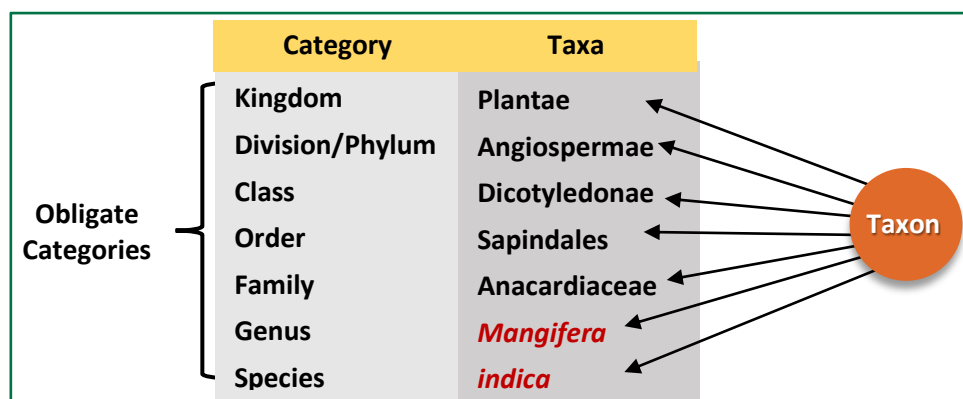
↑ Taxonomic Categories ↓	Categories	Mango	← Taxa (Sing. Taxon) →
	Kingdom	Plantae	
	Division	Angiospermae	
	Class	Dicotyledonae	
	Order	Sapindales	
	Family	Anacardiaceae	
	Genus	<i>Mangifera</i>	
	Species	<i>M.indica</i>	

↑ Taxonomic Categories ↓	Categories	Human	← Taxa (Sing. Taxon) →
	Kingdom	Animalia	
	Phylum	Chordata	
	Class	Mammalia	
	Order	Primata	
	Family	Hominidae	
	Genus	<i>Homo</i>	
	Species	<i>Homo sapiens</i>	

NCERT Question :

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

- Taxon (singular) / Taxa (plural)** – Plant group or animal groups included in category are called Taxon/Taxa.



- 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 categories and hierarchy can be illustrated by an example:
- Insects represent a group of organisms sharing common features like three pairs of jointed legs.
- It means insects are recognisable concrete objects which can be classified, and thus were given a rank or category. Can you name other such groups of organisms? (answer: molluscs, mammals, angiosperms, gymnosperms etc.)

- Remember, groups represent categories. Category further denotes rank. Each rank or taxon, in fact, represents a unit of classification.
- **These taxonomic groups/ categories are distinct biological entities and not merely morphological aggregates rather they are group of living organisms.**
- Taxonomical studies of all known organisms have led to the development of common categories such as kingdom, phylum or division (for plants), class, order, family, genus and species.
- All organisms, including those in the plant and animal kingdoms have species as the lowest category. Now the question you may ask is, how to place an organism in various categories? The basic requirement is the knowledge of characters of an individual or group of organisms.
- This helps in identifying similarities and dissimilarities among the individuals of the same kind of organisms as well as of other kinds of organisms.

Suffix for taxa (Taxon)

Division	–	phyta
Class	–	opsida, phyceae, ae
Order	–	ales
Family	–	aceae

- There is no suffix for Genus, Species and Kingdom

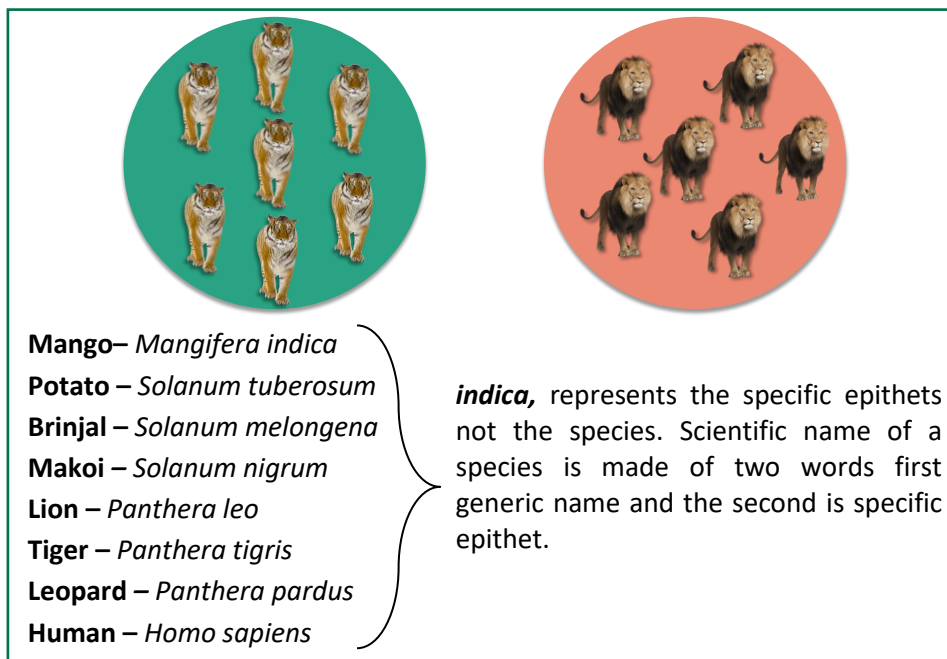
NCERT Question :

Can you identify the correct sequence of taxonomical categories?

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

(A) SPECIES :

- Taxonomic studies consider a group of individual organisms with fundamental similarities as a species.
- One should be able to distinguish one species from the other closely related species based on the distinct morphological differences.



Species Concept :

John Ray :- Proposed the **term** and **concept of species**

To explain the species different concepts were proposed.

(a) Biological concept of species :-

- (i) **Ernst Mayr** (Darwin of 20th Century) proposed the **biological concept of species**.
- (ii) He pioneered the currently accepted definition of a biological species.
- (iii) Group of members which can interbreed naturally and produce fertile progeny is called **biological species**.
- (iv) When species is determined on the basis of interbreeding, then it is called "biological species".
- (v) This concept cannot be applied in case of prokaryotes because they do not reproduce by sexual reproduction.

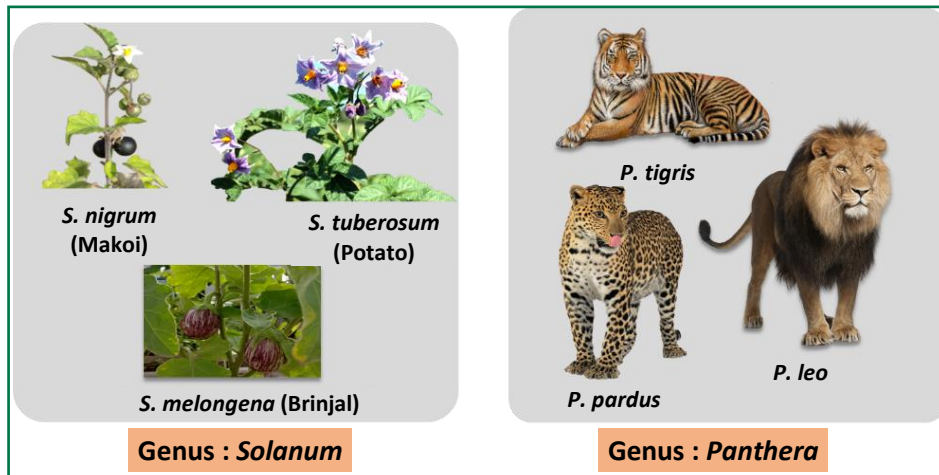
(b) Taxonomic concept of species :-

- (i) When the species is determined on the basis of morphological characters then it is called as **taxonomic species**.
- (ii) A group of individuals having fundamental morphological similarities is known as taxonomic species.

Note : Since conventional taxonomic methods are not suitable to describe species in case of microbes like prokaryotes hence many biochemical and biomolecular studies are used to identify them as species.

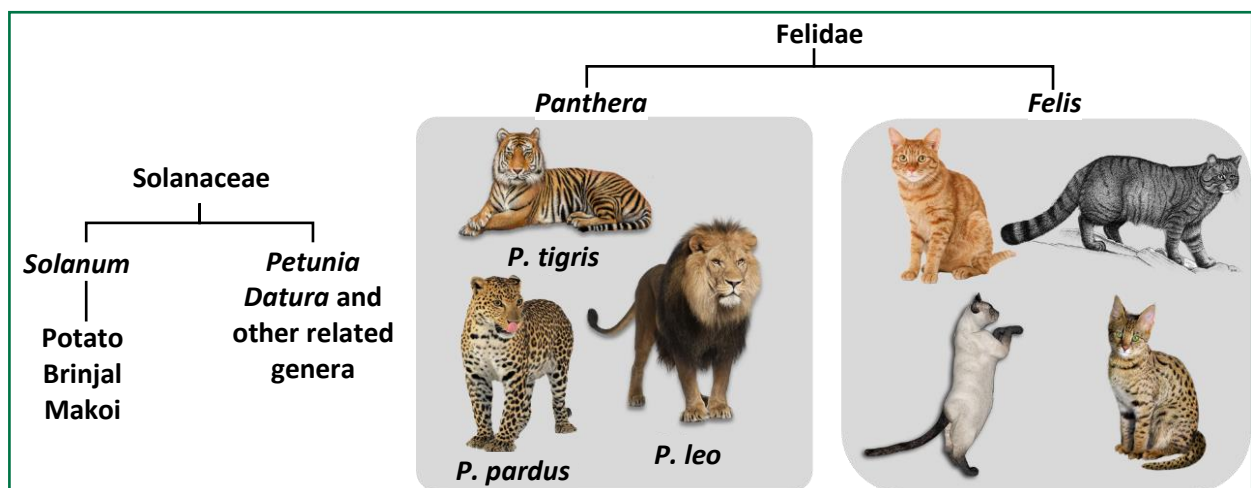
(B) GENUS :

- Genus comprises a group of related species which has more characters in common in comparison to species of other genera.



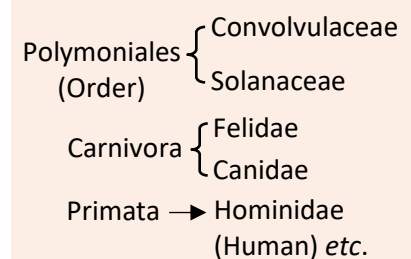
(C) FAMILY :

- Family, has a group of related genera with still less number of similarities as compared to genus and species. Families are characterised on the basis of both **vegetative and reproductive** features of plant species.



(D) ORDER :

- Categories like species, genus and families are based on a number of similar characters.
- Generally, order and other higher taxonomic categories are identified based on the aggregates of characters.**



- Order being a higher category, is the assemblage of families which exhibit a few similar characters.
- Plant families like Convolvulaceae, Solanaceae are included in the order Polymoniales mainly based on the floral character.

(E) CLASS :

- This category includes related orders.

Mammalia (Class) { Carnivora (order)
Primata
Dicotyledonae → Sapindales, Polymoniales etc.

(F) PHYLUM/DIVISION :

- Classes comprising animals like fishes, amphibians, reptiles, birds along with mammals constitute the next higher category called Phylum.
- All these, based on the common features like presence of notochord and dorsal hollow neural system, are included in phylum Chordata. In case of plants, classes with a few similar characters are assigned to a higher category called Division.

Chordata (Phylum) : Pisces, Amphibia, Reptilia, Aves, Mammalia. (Class)

Angiosperm (Division) : Dicotyledonae, Monocotyledonae. (Class)

(G) KINGDOM :

- All animals belonging to various phyla are assigned to the highest category called Kingdom Animalia in the classification system of animals. The Kingdom Plantae, on the other hand, is distinct, and comprises all plants from various divisions. Henceforth, we will refer to these two groups as animal and plant kingdoms.
- As we go higher from species to kingdom, the number of common characteristics goes on decreasing. Lower the taxa, more are the characteristics that the members within the taxon share. Higher the category, greater is the difficulty of determining the relationship to other taxa at the same level. Hence, the problem of classification becomes more complex.

TABLE 1.1 Organisms with their Taxonomic Categories

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

NCERT Question :

Illustrate the taxonomical hierarchy with suitable examples of plants and animals.

Kindgom	Division/Phylum	Class	Order	Family	Genus	Species
Plantae	Bryophyta					
	Pteridophyta					
	Gymnospermae					
	Angiospermae	Dicotyledonae	Polymoniales	Solanaceae	<i>Solanum</i>	<i>Solanum nigrum</i> (Makoi)
					<i>Petunia</i>	<i>Solanum tuberosum</i> (Potato)
					<i>Datura</i>	<i>Solanum melongena</i> (Brinjal)
				Convolvulaceae		
			Sapindales	Anacardiaceae	<i>Mangifera</i>	<i>Mangifera indica</i> (Mango)
		Monocotyledonae				
Animalia	Non-chordata					
	Chordata	Mammalia	Primata		<i>Panthera</i>	<i>Panthera leo</i> (Lion)
		Fishes			<i>Panthera pardus</i>	<i>Panthera pardus</i> (Leopard)
		Amphibians			<i>Panthera tigris</i>	<i>Panthera tigris</i> (Tiger)
		Reptiles			<i>Felis</i>	<i>Felis domestica</i> (Cat)
		Birds			<i>Canis</i>	<i>Canis familiaris</i> (Dog)
			Carnivora	Felidae		
				Canidae		

**BEGINNER'S BOX-1****THE LIVING WORLD TO CLASSIFICATION**

1. Which is first step in Taxonomy :
 (1) Phylogeny of the organism
 (2) Identification of the organism
 (3) Nomenclature of the organism
 (4) Classification of the organism
BLW117
2. Binomial system of nomenclature given by :
 (1) A.P. de Candolle (2) Linnaeus (3) E. Mayr (4) Whittaker
BLW118
3. Linnaeus' classification of plants is mainly based on :
 (1) Stamen (2) Carpel (3) Petals (4) Sepals
BLW119
4. Dicotyledonae and monocotyledonae are taxa at the rank of?
 (1) Genus (2) Order (3) Class (4) Division
BLW120
5. Which of the following order includes family Convolvulaceae?
 (1) Sapindales (2) Polymoniales
 (3) Ranales (4) Rhamnales
BLW121
6. Sharing of characteristics among the members will be high in which of the following category?
 (1) Genus (2) Order (3) Class (4) Species
BLW122
7. Taxonomy includes :
 (1) Identification and nomenclature
 (2) Classification only
 (3) Nomenclature and classification
 (4) Identification, nomenclature and classification
BLW123
8. Which of the following statements are correct?
 (i) Genus comprises a group of related species.
 (ii) Taxon represents a taxonomic group of individual organisms.
 (iii) Family comprises a group of related genera.
 (iv) Taxonomic category class includes related orders.
 (1) (i), (ii), and (iv) (2) (ii) and (iv)
 (3) (i), (iii) and (iv) (4) (ii), (iii) and (iv)
BLW124

9. Match the taxonomic categories given in column-I with their feature given in column-II.

	Column-I		Column-II
A.	Taxon	I.	Basic unit of classification
B.	Species	II.	A taxonomic group of any rank
C.	Phylum	III.	Division is the same category in case of plants
D.	Genus	IV.	Identified based on a number of similar characters
E.	Order	V.	Group of related species having more character in common with other species

(1) A-V, B-II, C-IV, D-III, E-I

(2) A-III, B-I, C-IV, D-II, E-V

(3) A-II, B-I, C-III, D-V, E-IV

(4) A-III, B-II, C-IV, D-I, E-V

BLW125



BEGINNER'S BOX

ANSWERS KEY

BEGINNER'S BOX-1	Que.	1	2	3	4	5	6	7	8	9	
	Ans.	2	2	1	3	2	4	4	3	3	



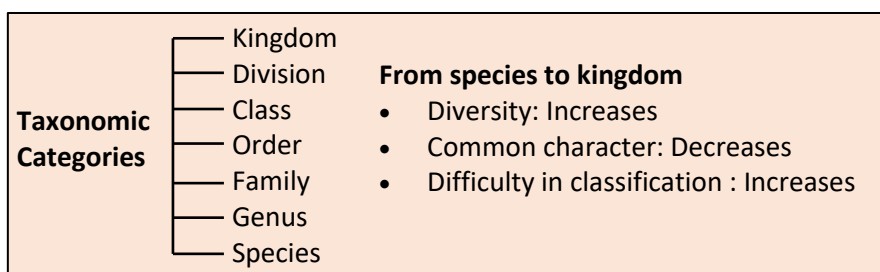
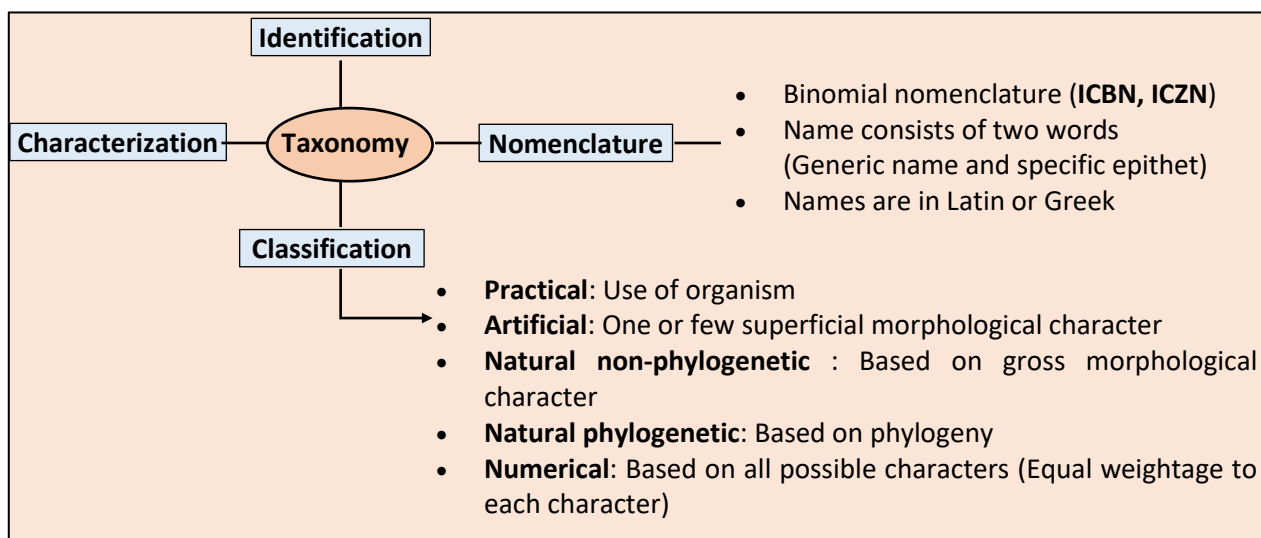
Characters of living organism

- Growth
 - Reproduction
 - Metabolism
 - Cellular organization
 - Consciousness
- } Defining characters of living
(Present in all living but not present in non-living)

Growth can be shown by non-living also

Reproduction is an exclusive character of living organisms. Certain living organisms do not show reproduction. No nonliving object show the reproduction

Taxonomy : Branch of biology deals with **Identification, Nomenclature and Classification** of organisms.



- Each category is unit of classification
- These categories represent rank and commonly called as taxa or taxon
- Animals, mammals and dogs are different taxa at different level
- Species is the smallest obligate category and smallest unit of classification

NCERT 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, 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 **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**. An organism represents/occupies a place or position in the system of classification. There are many categories/ranks and are generally referred to as **taxonomic categories or taxa**. All the categories constitute a **taxonomic hierarchy**.