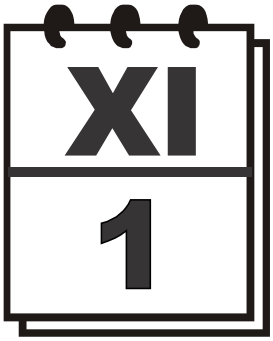


THE LIVING WORLD

SYLLABUS

What is living? ; Biodiversity; Need for classification; Three domains of life; Taxonomy & Systematics; Concept of species and taxonomical hierarchy; Binomial nomenclature; Tools for study of Taxonomy – Museums, Zoos, Herbaria, Botanical gardens.

KEY CONCEPTS

WHAT IS LIVING?

* Life is a unique, complex organisation of molecules expressing itself through chemical reactions (metabolism) which lead to growth, development, responsiveness, adaptation and reproduction. Hence, "the object by itself exhibiting the growth, development, death, consciousness, reproduction etc. is designated as living being."

Characteristics of Living Beings

* All the living beings share certain unique and basic characteristics which set them apart from non-living objects. These characteristics are:
  1. Growth
  2. Reproduction
  3. Metabolism
  4. Cellular structure
  5. Consciousness

1. Growth:

* Increase in mass and increase in number of cells are twin characters of growth. Growth refers to irreversible increase in mass or overall size of a tissue, an organism or its parts.
* Growth is the result of difference between **anabolism** (building up reactions) and **catabolism** (breakdown reactions).
* Growth occurs when anabolism or synthetic processes exceeds catabolism.
* Non-living objects also grow if we take increase in body mass as a criterion of growth. But in these objects extrinsic growth is present *i.e.* increase in the mass of body from outside *e.g.*, mountains,boulders and sand mounds. Growth, therefore,cannot be taken as a defining property of living organisms.

2. Reproduction:

* Reproduction is the formation of new individuals of similar kind. It is, however, required for survival of the population as it compensates for the loss of life due to death.
* Reproduction is of two types, asexual and sexual. Asexual reproduction is uniparental multiplication that occurs through binary fission, multiple fission, spore formation, fragmentation and vegetative multiplication.
* Fungi multiply by asexual spores, yeast and *Hydra* show budding, *Planaria* exhibits true regeneration. Fungi, filamentous algae, protonema of mosses easily multiplies by fragmentation. But, when we notice single-celled organisms like bacteria, unicellular alga and *Amoeba,* we are not clear about the usage of these two terms -growth and reproduction, *i.e.*, increase in number of cells.
* Hence, reproduction also cannot be an all inclusive property of living organisms.

Still, no nonliving object is capable of reproducing or replicating by itself. Further, there are some organisms which do not reproduce at all, *e.g.*, worker bees, mules etc.

3. Metabolism:

* Metabolism is the sum of all chemical reactions occurring in an organism due to specific interactions amongst different types of molecules within the interior of cells.
* Metabolism is a defining feature of all living organisms.

4. Cellular structure:

* Body of all living organisms consists of cells and their products. Hence, cellular organisation of the body is the defining feature of life forms.

5. Consciousness:

* All living beings, plants and animals, are aware of their environment. All organisms sense their surroundings and respond to sudden or smooth changes in it.
* All organisms from prokaryota to eukaryota can sense and respond.
* Humans also have "self-consciousness" hence, this becomes the defining property of living beings.
* It is most obvious and technically complicated feature of all living organisms.

DIVERSITY IN THE LIVING WORLD

* From a current estimation, approximately 1.7 million species have been scientifically named and classified. These include nearly 1.2 million animals and over 0.5 million species of plants.
* A clearer understanding of this huge variety of organisms can be studied by dividing these into smaller groups or sub-groups **(categories)** and each group or sub-group comprising of organisms with more or less similar characters.
* Method of placing organisms into groups or sub-groups depending upon extent of similarities and differences is called **classification.**
* The division of organisms into different groups follows certain rules, that is why the term called **taxonomy** is used for classification of organisms following certain rules or principles.
* Classification is just like systematically arranged library where we can easily find out the required book, in the same way, if the organisms are arranged according to a system, it makes their study easy.

Three Domains of life

* Based on the sequence of 16 S ribosomal RNA genes, Woese found that the six kingdoms naturally cluster into three domains. These domains are *Archae, Bacteria* and *Eukarya*, and are believed to be originated from common ancestor called *Progenate*. Domain is a category higher than kingdom.

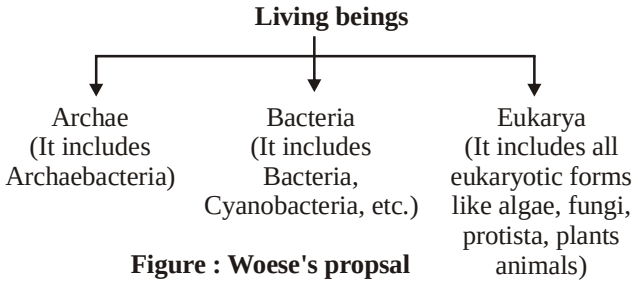
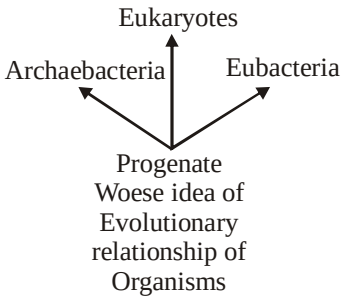


Figure : Woese's propsal



Taxonomy and Systematics

* **Taxonomy:** The branch of science dealing with the study of principles and procedures of classification is called taxonomy.
* The term taxonomy was coined by **A.P. de Candolle.**
* **Linnaeus** is considered as **Father of Taxonomy.**
* **Santapau** is considered as **Father of Indian Taxonomy.**

The fundamental elements of taxonomy are as follows :

* **Characterisation and identification :** It is the determination of the similarities of an organism

with an already known organism, based upon specific characters.

* **Nomenclature:** It is the determination of correct name of an organism according to established universal rules.
* **Classification:** It is grouping of organisms into convenient categories on the basis of easily observable characters.
* The word **"systematics"** is derived from Latin word ***systema*** which means systematic arrangement of organisms.
* It was first used by **Carolus Linnaeus.** According to him, "systematics is the discipline of biology which deals with the kind and diversity of all organisms and the existing relationships amongst them."
* Generally, the terms such as classification, systematics and taxonomy are used interchangeably but some taxonomists like **Simpson (1961)** relate them with a separate field. He defined systematics as "The study of diversity of organisms and all their comparative and evolutionary relationships based on comparative anatomy, comparative ecology, comparative physiology and comparative biochemistry."
* **New systematics / Biosystematics / Neosystematics** is based upon all characters *i.e.*,morphological, cytological, ecological, biochemical, genetical etc. The term was coined by **Julian Huxley**.

NOMENCLATURE

* There is a need to standardize the naming of living organisms, such that a particular organism is known by same name all over the world.

International Code of Nomenclature

* Scientific names have been standardised through some international agencies, *viz.*, International Code of Botanical Nomenclature (ICBN, 1961) and International Code of Zoological Nomenclature (ICZN, 1964), International Code for Nomenclature of Bacteria (ICNB), International Code of Nomenclature for Cultivated Plants (ICNCP) and currently being developed is International Committee for the Taxonomy of Viruses (ICTV).

Binomial system

* **Carolus Linnaeus** : Linnaeus used this nomenclature system for the first time on large scale and proposed scientific name of all the plants and animals.
* Linnaeus is the founder of binomial system.
* Linnaeus proposed scientific name of plants in his book "**Species Plantarum**".
* It was published on 1 May, 1753. So this was the initiation of binomial system for plants.
  So any name proposed (for plants) before this date is not accepted today.
* Linnaeus proposed scientific name of animals in his book "**Systema Naturae**" (10^{th} edition).
* This 10^{th} edition of Systema Naturae was first published on 1 August, 1758. So initiation of binomial system for animals is believed to be started on 1 August, 1758.

ICBN : "International Code of Botanical Nomenclature"

* Collection of rules regarding scientific nomenclature of **plants** is known as **ICBN**.
* ICBN was first accepted in **1961**.

Main rules of ICBN

* According to binonial system name of any species consists of **two names** -
  Generic name - Name of genus
  Specific epithet - Trival name

  eg. ***Solanum*** ***tuberosum*** (Potato)
  ↓ ↓
  Generic name Specific epithet

  Mangifera ***indica*** (Mango)
  ↓ ↓
  Generic name Specific epithet
* **First** letter of **generic** name should be in **capital letter** and **first** letter of **specific epithet** should be **in small letter**.eg. ***Mangifera indica.***

* But if specific epithet is based on the name of some **person**, its first letter should be **capital** letter. eg. ***Chaetomium Subramaniella***
* Length of generic name or specific epithet should **not be less than 3 letters** and **not more than 12 letters**.eg. ***Mangifera indica***
* **Exception :** ***Riccia pathankotensis***
  In plant nomenclature (ICBN) **tautonyms** are **not valid** i.e. generic name and specific epithet should **not be same in plants.**
  eg. ***Mangifera mangifera***
* But tautonyms are **valid** in **animal** nomenclature (**ICZN**-International Code of Zoological Nomenclature). eg. ***Naja naja*** (Indian cobra), ***Rattus rattus*** (Rat)
* When written with free hand or **typed**, then **generic** name and **specific** epithet should be **separately underlined**. But during printing name should be **italized**. It show its Latin origin.
* Name of scientist (who proposed nomenclature) should be written in short after the specific epithet. eg.***Mangifera indica*** Lin.
* Name of scientist should be **neither underlined nor** written in **italics**, but written in **roman** letters (simple alphabets)
* If any scientist has **proposed wrong** name then his name should be written **in bracket** and the name of the scientist **who corrected** the name should be written **after the bracket**.
  eg. ***Tsuga canadensis*** (Lin.) Salisbury
  Note : Linnaeus named this plant as **Pinus canadensis**
* Scientific names should be derived from latin or Greek language because they are **dead** languages.

* **The binomial nomenclatures of common plants are:**

Common Name	Scientific Names
Sunflower	*Helianthus annuus*
Mango	*Magnifera indica*
Neem	*Azadicta indica*
Rose	*Rosa*
Tulsi	*Ocimum tenuiflorum*
Rice	*Oryza sativa*
Wheat	*Triticum spp.*
Finger millet	*Eleusine coracana*
Barley	*Hordeum vulgare*
Coriander	*Coriandrum sativum*
Cashew nut	*Anacardium occidentale*
Ginger	*Asarum*
Orange	*Citrus sinensis*
Papaya	*Carica papaya*
Pine apple	*Ananas comosus*
Cinnamon	*Cinnamomum zeylanicum*

* **The binomial nomenclatures of common animals are:**

Common Name	Scientific Names
Dog	*Canis lupus*
Housefly	*Musca domestica*
Tiger	*Panthera tigris*
Lepoard	*Panther pardus*
Lion	*Panthera leo*
Bear	*Ursidae carnivora*
Crow	*Corvus splendens*
Ant	*Hymenopetrous formicidae*
Bat	*Chiroptera*
Buffalo	*Bison bonasus*
Cat	*Felis catus*
Cheetah	*Acinonyx jubatus*
Crocodile	*Crocodilia niloticus*
Elephant	*Proboscidea elepahantidae*
Dolphin	*Delphinidae delphis*
Goat	*Capra hircus*
Frog	*Anura ranidae*

Trinomial system

* According to this system name of any plant or species is composed of **three names** -
  - **Generic** name
  - **Specific** epithet
  - **Subspecific** name (Name of **variety**)
* When members of any species have large **variations** then trinomial system is used.

* On the basis of dissimilarities this species is classified into sub species.
  eg. ***Brassica oleracea botrytis*** (Cauliflower)
  Brassica oleracea capitata (Cabbage)
  Brassica oleracea. caulorapa (Knol-Khol)
  Corvus splendens splendens – Indian crow
  Gorilla gorilla gorilla – Gorilla (animal)
  Acacia nilotica* var. *indica – Indian Babul
* **Synonyms:** In case two or more names are given, the oldest, *i.e.*, the name given first is recognised as valid name and all other names are called **synonyms.** *e.g, Albugo candida* (= *Cystopus candidus)*
* **Tautonyms :** When generic and specific name are same, *e.g., Rattus rattus.* Tautonyms are not recognised by botanists.
* **Autonyms:** When species and subspecies or variety names are same, *e.g., Corvous splendens splendens, Acacia nilotica nilotica.*
* **Homonyms:** One name for two different plants. *e.g., Prunus dulsi,* (For both almond and plum)

BIOLOGICAL CLASSIFICATION

* The art of identifying distinctions among organisms and placing them into groups that reflect their most significant features and **relationship** is called **biological classification**.
* The purpose of biological classification is to organize the vast number of known living organism into categories that could be named, remembered and studied.

(i) Practical classification

* In this type of classification, plants are classified on the basis of their **economic importance**.
* e.g. Oil yielding plants → Coconut, Groundnut (Pea nut), Soyabean
  Fibre yielding plants → Jute, Cotton
  Medicinal plants → Rauwolfia, Cinchona

(ii) Artificial classification

* In this type of classification plants are classified on the basis of **one or two morphological characters**/Few morphological characters.
* For eg.- Classification proposed by **Linnaeus.**
  Note: In the book "Genera Plantarum" Linnaeus classified the plant kingdom into 24 classes on the basis of stamen so, Linnaeus classification is also called sexual classification.
  Note: Linnaeus divided flowering plants into 23 classes starting with class monandria with a single stamen (eg. *Canna*) and plants with twenty or more stamens attached with calyx were assigned to class **Icosandria**. He also included all non-flowering plants such as algae, fungi, mosses and ferns in a separate class called cryptogamia.

(iii) Natural classification

* In this type, plants are classified on the basis of their **complete morphology**.
* In it the characters of whole plant are included (stem, leaf, flower, root etc.)
* Maximum characters are taken as base in this classification.
* Natural classification is believed to be the **best classification**.
* **Natural classification is of two types**

(a) **Natural formal :** In this classification, the phylogeny (evolutionary history) of the plant is not considered i.e. only the morphology of the plant is considered.

(b) **Natural phylogenetic :** In this classification, both morphology and phylogeny are considered. In phylogenetic classification, the plants are arranged on the basis of their evolution.

* **Lamarck** – Proposed the term phylogeny.
* **Charles Darwin** – Gave detailed explanation of phylogeny in his book "Origin of species" (1859). It was most popular book of it's time.
  Thallophyta → Bryophyta → Pteridophyta → Gymnosperm → Angiosperm (most advanced plants).
  Note : Phylogenetic classification is also known as cladistic classification.

(iv) Adansonian system or phenetic classification or Numerical classification

* Proposed by "**Sokel** and **Sneath**"
* In it plants are classified on the basis of **number of similarities** and **dissimilarities**.
* In this, importance to any **one** character is **not** given, **all characters have same importance.**
* While in **natural** classification **floral characters** have importance than morphological characters.

TAXONOMIC CATEGORIES

* Classification is not a single step process. It involves hierarchy of steps in which each step represents a rank or category.
* The category is a part of overall taxonomic arrangement. All categories together make **taxonomic hierarchy.**
* Each category is also termed as a unit of classification.
* It represents a rank and is commonly called as **taxon.**
* The taxon must be recognisable and order should belong to a category.
* Taxonomic hierarchy is a series of different ranks placed in ascending or descending order.
* It was **Linnaeus** who for the first time introduced five categories in the taxonomic hierarchy, *viz.*, class, order, genus, species and variety.
* Later on three more categories, *viz.*, kingdom, division or phylum and family were added.
* Variety was Species discarded to make a hierarchy of **seven obligate categories.**
* Taxonomic categories **kingdom -division (in plants) or phylum (in animals) -class -order - family -genus -species.** (descending order)

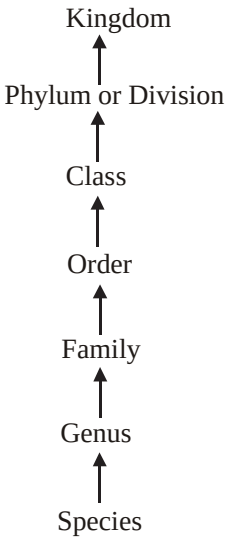


Figure : Taxonomic categories showing hierarchial arrangement in ascending order.

* Higher the category, higher is the number of organisms in it. Higher the category, fewer will be the number of common characters and greater is the difficulty of determining the relationship to other taxa at the same level. Hence, the problem of classification becomes more complex.
* 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.
* Similarly, mammals represent animals with external ears, body hairs, mammary glands etc. Dog, mammals, animals are all taxa but of different categories.
* Taxon dog, mammals and animals represent categories like species, class and kingdom respectively.

Species

* Term given by **John Ray.** It is lowest category of classification. It is a group of closely related individuals with similar morphological, anatomical, biochemical and cytological characters.
* It is a group of naturally interbreeding population with the ability to produce fertile offsprings. Individuals of a species share common gene pool.
* It is reproductively isolated, thus genetically closed system.

  e.g, *Pisum sativum* – Pea
  Mangifera indica – Mango
  Solanum tuberosum – Potato
  Panthera leo – Lion
  Homo sapiens – Human being
* In these, *sativum, indica, tuberosum, leo, sapiens* represent the specific epithet, while *Pisum, Mangifera, Solanum, Panthera* and *Homo* represent genus.

Genus

* Genus is a group of related species. Species has more characters in common in comparison to species of other genera.
* *e.g.,* Potato, *(Solanum tuberosum),* makoi *(S. nigrum)* and brinjal *(S. melongena)* are three different species belonging to same genus *Solanum.*

* Lion, leopard and tiger with several common features belong to the same genus *Panthera.*

Family

* It is 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 plants.**
* For example, four related genera *Solanum, Petunia, Datura* and *Atropa* belong to the family Solanaceae. Genus *Panthera* and *Felis* (cat) are put together in family Felidae.

Order

* It is a group of related families which exhibit a few similar characters. The similar characters are less in number as compared to different genera included in a family.
* For example, plant families like Convolvulaceae and Solanaceae are included in order Polymoniales mainly based on floral characters.
* In animals, order carnivora includes families like Felidae (cat) and Canidae (dog).

Class

* It is a group of related orders.
* For example , plants order like Sapindales (mango) and Polymoniales are included in Class -Dicotyledonae, Order -Volvocales *(Volvox)* and Conjugales *(Spirogyra)* are included in Class -Chlorophyceae (green algae).
* In animals, order Primata (man, monkey) and Carnivora (cat, dog) are included in class - Mammalia.

Phylum/Division

* It is a group of related classes.
* The phylum **Chordata** of animals contains not only the class mammalia but also aves (birds), reptilia (reptiles) amphibia (amphibians) and osteichthyes (fishes).
* In case of plants, classes with few similar characters like dicots and monocots constitute division -Angiospermae.
* The category phylum is used in animalia while division is used in plantae.

Kingdom

* It is highest category in hierarchy with related phylums or divisions.
* Kingdom animalia includes all animals belonging to different phyla. Kingdom Plantae includes all plants of various divisions.
* The classification of any plant or animal is written in **descending order of categories.**

Classification of Mango

Categories		Taxon (Pl. Taxa)
Kingdom	–	Plantae
Division	–	Angiospermae
Class	–	Dicotyledonae
Order	–	Sapindales
Family	–	Anacardiaceae
Genus	–	Mangifera
Species	–	*Mangifera indica*

NOTE :

* **Hierarchy** - Descending arrangement of taxonomic categories is known as **hierarchy**.
* **Taxon -** Plant groups or animal groups included in categories are called Taxon.
* **Adolf Mayer -** First proposed the term **"Taxon"** for **animals**
* **H.J. Lan -** First propsed the term **"Taxon"** for **plants**.
* **7 main** taxonomic categories are **obligate categories** i.e. they are strictly used at the time of any plant classification. There are some extra categories, like **tribe, sub order** etc.
* They are not regularly used. They are used only when they are needed.
* **Suffix for taxa (Taxon)**

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

* There is **no suffix** for **Genus, Species** and **Kingdom.**

* **Organisms with their Taxonomic categories:**

Common Name	Biological Name	Genus	Family	Order	Class	Phylum/Division
Man	*Homo sapiens*	*Homo*	Hominidae	Primata	Mammalia	Chordata
Housefly	*Musca domestica*	*Musca*	Muscidae	Diptera	Insecta	Arthropoda
Mango	*Mangefera indica*	*Mangifera*	Anacardiaceae	Sapindales	Dicotyledonae	Angiospermae
Wheat	*Triticum aestivum*	*Triticum*	Poaceae	Poales	Monocotyledonae	Angiospermae

SPECIES CONCEPT

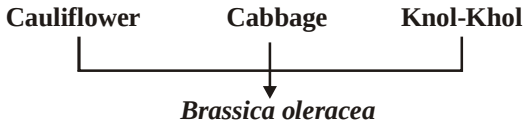
* **Jon Ray :** Proposed the **term** and **concept of species**.

Biological concept of species

* Ernst **Mayr (Darwin of 20th century)** proposed the **biological concept of species**.
* Mayr defined **"species"** in the form of biological concept.
* According to Mayr **"All the members that can interbreed among themselves and can produce fertile offsprings are the members of same species"**
* But this definition of Mayr was **incomplete** because this definition is applicable to **sexually reproducing** living beings but there are many organisms that have **only asexual** mode of reproduction. eg. **Bacteria, Mycoplasma, Blue green algae.**
* The main character in determination of any species is **interbreeding**.But this character is not used in taxonomy.In taxonomy the determination of species is mainly based on morphological characters.

Taxonomic concept of species

* When the species are determined on basis of morphological character then it is called as taxonomic species.
  eg. If two plants have almost same morphological character, then they belong to same species.



* These 3 have same morphological characters.Therefore they belong to same taxonomic species i.e. one taxonomic species.
* In higher plants, the determination of species is mainly based on the morphology of flower (floral morphology). Because floral (reproductive) characters are more conservative as compared to vegetative (Root, Stem, Leaf etc.) characters i.e. they do not show any major changes.

Types of Species

1. ***Morphospecies* :** Species erected on the basis of morphological characters only.
2. ***Taxonomic species* :** Species having a definite binomial name.
3. ***Sibling species* :** True species which do not interbreed, but are otherwise difficult to separate on the basis of morphological characters alone.
4. ***Allopatric species* :** Species having exclusive areas of geographic distribution.
5. ***Sympatric species* :** Species having overlapping areas of geographic distribution.
6. ***Parapatric species* :** Species with adjacent geographic ranges meeting in very narrow zone of overlap.
7. ***Neontological species* :** Living species
8. ***Allochronic species* :** Species belonging to different time period.
9. ***Synchronic species* :** Species belonging to same period of time.
10. ***Polytypic species* :** Species which have more than one ideal types (subspecies) according to their geographically isolated areas.

* **Some important interspecific hybrids (exception of biological concept of species)**

(i) **Sterile Hybrid** (under natural conditions)
Mule = Between male donkey and female horse (Mare)
Hinny = Between male horse (Stallion) and female donkey

(ii) **Fertile Hybrid** (under captive conditions)
Tigon = Between male tiger and female lion
Liger = Between male lion and female tiger.

TAXONOMICAL AIDS

* The laboratory and field studies are required for identification of various species and their placement in taxonomical hierarchy.
* The information thus gathered about the species, needs to be stored for future use.
* The taxonomical aids developed by biologists have established certain procedures and techniques to store and preserve the information as well as the specimens.

1. Herbarium (Dry Garden)

* It is defined as "a store house of collected plant specimens that are dried, pressed and preserved on sheets."
* These sheets are arranged in the sequence of an accepted classification system.
* These specimens, along with their description on herbarium sheets, become a store house or repository for future use. The herbarium sheet contains a label on the right-hand side at lower corner.
* Label provides 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.
* The herbarium technique involves the following steps: (a) Collection (b) Drying (c) Poisoning (d) Mounting (e) Stitching (f) Labelling (g) Deposition
* The international size of the herbarium sheet is 41× 29 cm (16.5 ×11.5 inches)

Functions of a Herbarium

* The two primary functions of herbarium are accurate identification and alpha taxonomic research (based on gross morphology).
* The secondary functions include closer interaction between the student of general systematics and the herbarium.
* **Other important functions of a herbarium are**
  - To preserve plant wealth including type material and palaeobotanical collections.
  - To carry out exchange and loan of preserved plant material for research, exhibitions etc.

2. Botanical Gardens

* From the time of Theophrastus, gardens have contributed to the science of botany. But, there was an impetus to the botanical explorations only in the Post-Linnean period.
* In ancient Indian culture, cultivation of food and medicinal plants is known since 4000 to 2000B.C. The 'Hanging Gardens of Babylon' are amongst the wonders of the ancient world.
* During the Middle Ages, from A.D. 600-1600, there was a lapse in learning and introduction of plants.
* In the seventeenth century, there was a revival in the interest and by eighteenth century, most of the famous Botanical Gardens known today had already been established.

The functions of a botanical garden are:

(i) Provide records of local flora for monographic work.

(ii) Provide facilities for collections and identification of living plant material for biosystematic studies / references.

(iii) Supply seeds and material for botanical investigations.

(iv) Botanical gardens have an aesthetic appeal and attract a large number of visitors for observing general plant diversity.

(v) **Provides means of *ex-situ* conservation strategies.**
There are about 525 botanical gardens in various countries, but only about 125 have documented collections of authenticated taxa.

(vi) The **International Association of Botanical Gardens** was established in 1962.

This association has published the International Directory of Botanical Gardens (1983).

Some of the important Botanical Gardens are:

(i) Royal Botanical Garden, Kew, England

(ii) Orto Botanico (Padua Gardens), Italy

(iii) Villa Taranto, Italy

(iv) Main Botanical Garden, Moscow(Largest Botanical Garden)

(v) The Indian Botanical Garden, Kolkata, India: It was founded in **1787, by Lt.Col. Robert Kyd.** It covers an area of 273 acres and contains collections of world's **tropical plants.**

* It is one of the greatest botanical gardens of the world and **one of the first to be established intropics.**
* **William Roxburgh, 'Father of Indian Botany'** was its director from 1793 to 1813.
* It has the **largest herbarium of east** and is famous for the **Great Banyan tree, *Ficus benghalensis***, which is two centuries old, the palm houses, nurseries and the Amazon lily, *Victoria amazonica* (Nymphaeaceae), the plant with the largest leaves.
* It is now under control of BSI (Botanical Survey of India).

Other botanical gardens of India are -
Lloyd Botanical Garden – Darjeeling
National Botanical Garden – Lucknow
Lalbag Gardens – Bangalore
Saharanpur Botanical Gardens – Saharanpur

3. Museums

* These have collections of preserved plants and animals for study and reference.
* Specimens are preserved in jars or containers in preservative solution.
* Plant and animal specimens may also be preserved as dry specimens.
* Insects are preserved in insect boxes after collecting, killing and pinning.
* Larger animals are usually stuffed and preserved.
* These often have collections of skeletons of animals too.
* Museums are prepared to preserve algae, fungi, mosses, ferns and organs of gymnosperms since they cannot be kept in herbaria. These differs from parks because no living object is displayed in museums.

Some important Museums:

(i) Natural History Museum, London (England)
(ii) United States National Museum, Washington
(iii) National Museum of Natural History (NMNH), Delhi
(iv) Prince of Wales Museum, Mumbai etc.

4. Zoological Parks

* Zoos or zoological gardens (parks) are protected areas or enclosed space where live wild animals are kept, under human care. This enables us to learn their food habits and behaviour.
* Objectives are public exhibition to understand *ex situ* conservation and breeding of rare fauna.
* Largest zoo of the world is situated in Kruger (S. Africa).
* National Zoological Park (Delhi) is one of the finest zoo of Asia.

5. Keys [Given by John Ray]

* The scheme for identification of plants and animals based upon similarities and dissimilarities is known as a key.
* It is based on the set of contrasting characters known as **couplet**, each character of couplet is called as **lead**.
* Separate taxonomic keys are required for each taxonomic category. Keys are generally analytical in nature

6. Flora, Manuals, Monographs and Catalogues

* **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.
* **Some important flora are given below:**

(i) Flora of British India by J.D. Hooker.
(ii) Flora of Delhi by J.K. Maheshwari.
(iii) Flora Indica byWilliam Roxburgh.
(iv) Flora Simlensis by H. Collet

* **Manuals:** The complete listing and description of the plants growing in a particular area. *e.g.*, Manual of Cultivated Plants by L.H. Bailey.

* **Monographs:** Contain information on anyone ..... *e.g.,* The Genus *Pinus* by N.T. Mirov.
* **Catalogues:** This includes the alphabetical arrangements of species describing their features.

IMPORTANT POINTS

* A group of interbredding organisms is species.
* The term phylum was given by theophrastus.
* Binomial nomenclature means one scientific name consisting of a generic and specific epithet.
* Species is less general in characters as compared to genus.
* Phylum covers the largest number of organisms.
* Hierarchy of categories of Carolus Linnaeus had categories except phylum and family.
* The generic name of mango is *mangifera*.
* **Classification of *Solanum melongena* (Brinjal).**
  Kingdom – Plantae
  Division – Angiospermae
  Class – Dicotyledonae
  Order – Solanales
  Family – Solanaceae
  Genus – *Solanum*
  Species – *melongena*
* **Classification of *Columba livia* (Blue rock Dove).**
  Kingdom – Animalia
  Phylum – Chordata
  Class – Aves
  Order – Columbiformes
  Family – Columbidae
  Genus – *Columba*
  Species – *livia*

* Father of Botany	Theophrastus
* Father of Zoology	Aristotle
* Father of Biology	Aristotle
* Father of Modern Botany	Linnaeus
* Father of Genetics	GJ Mendel
* Father of Modern Genetics	TH Morgan
* Father of Biodiversity	EO Wilson
* Father of Cytology	Robert Hooke
* Father of Gene Therapy	Anderson
* Father of Anatomy	Herophilus
* Father of Plant Physiology	Stephan Hales
* Father of Indian Ecology	R Mishra
* Father of Mutation	Hugo De Vries
* Father of Genetic Engineering	Paul Berg
* Father of Ayurveda	Charka
* Father of Polio Vaccine	Jonas Salk
* Father of Taxonomy	Carolus Linnaeus
* Father of Blood Circulation	William Harvey
* Father of Medicine	Hippocrates
* Father of Blood Groups	Karl Landsteiner
* Father of DNA Finger Printing	Garrod
* Father of Antibiotics	Alexander Fleming
* Father of Pathology	Rudolph Virchow
* Father of Homeopathy	Hahnemann
* Father of Indian botany	William Roxburgh
* Father of Indian ecology	Ramdeo Misra
* Father of Indian taxonomy	Henry Santapau

* **Ontogeny** is the life history of organisms.
* **Phylogeny** is the evolutionary history of organisms.
* Systematics is taxonomy along with phylogeny.
* Names of some families are changed according to ICBN rules for suffixes.

Old Name	**New Name**
Palmae	Arecaceae
Graminae	Poaceae
Leguminosae	Fabaceae
Compositae	Asteraceae
Cruciferae	Brassicaceae
Umbelliferae	Apiaceae
Labiatae	Lamiaceae
Guttiferae	Clusiaceae

* The genera which have more than one specific epithets, are known as polytypic.
  Lion – *Panthera leo*
  Leopard – *Panthera pardus*
  Tiger – *Panthera tigris*
* Species name is given on the basis of some characters or habit, colour and distribution, *e.g., niger* (black), *alba* (white), *tuberosum* (tuber).
* Category is an abstract term and represents only rank or level in a hierarchy and does not represent the living organisms. *Example:* Reptile is taxon but reptilia is category.

SOME BRANCHES OF BOTANY

1. Anatomy - Study of internal structure
2. Phycology - Study of Algae

	or Algology		
3.	Agrostology	-	Study of grass
4.	Anthology	-	Study of flowers
5.	Aerobiology	-	Study of substances of plants, found in air.
6.	Agronomy	-	Study of crops plants
7.	Arboriculture	-	Study of culture of decorated plants,
8.	Bacteriology	-	Study of bacteria
9.	Bryology	-	Study of bryophytes
10.	Bio technology	-	Study of isolation of protoplasm their culture
11.	Cytology	-	Study of structure & functions of cell
12.	Cecidology	-	Study of diseased knots in plants
13.	Dendrology	-	Study of tree
14.	Dendro chronology	-	Study of age of trees
15.	Embryology	-	Study of gametes formation fertilization & formation of embryo.
16.	Ecology	-	Study of inter relations between living organism & their atmosphere.
17.	Evolution	-	Study of different development process of living organism.
18.	Ethenobotany	-	Study of uses of plants by Tribals.
19.	Exobiology	-	Study of presence of possible organism on other planet.
20.	Euphenics	-	Study of control of Heridity disease
21.	Edaphology	-	Study of organism in soil
22.	Genetics	-	Study of hereditory & Variations
23.	Gymnology	-	Study of Gymnosperm
24.	Gerentology	-	Study of changes in cell with age
25.	Genetic Engineering	-	Study of artificial genes & their transfers
26.	Histology	-	Study of structure of tissues
27.	Horticulture	-	Study of culture of garden plant, Fruits & Vegetables
28.	Lichenology	-	Study of Lichens
29.	Limnology	-	Study of fresh water plants
30.	Karyology	-	Study of Nucleus
31.	Morphology	-	Study of external characters of plants
32.	Mycology	-	Study of fungi
33.	Microbiology	-	Study of micro organisms
34.	Mycoplasmology	-	Study of mycoplasma
35.	Molecular Biology	-	Study of Nucleic Acid
36.	Morphogenesis	-	Study of development
37.	Nematology	-	Study of relation of plants & Nematodes
38.	Olericulture	-	Study of culture of vegetables
39.	Oncology	-	Study of plant cancer
40.	Physiology	-	Study of Biotic activity of plants
41.	Paleobotany	-	Study of fossil plants
42.	Pteriodology	-	Study of pteridophytes
43.	Pedology	-	Study of soil

* **IMPORTANT DATES**

• Antileprosy day	30th January
• Blood Donation day	1st October
• Doctor's day	1st July
• Human Rights day	10th December
• International day of Biodiversity	29th December
• International Thalassaemia day & World Red Cross day	8th May
• Kisan Divas (National Farmer's Day)	23rd December
• National Pollution Prevention day	2nd December
• Van Mahotsava (Festival of tree Plantation)	1st week of February and July
• Vigyan Divas (National Science day)	28 February
• World AIDS day	1st December
• World Conservation day	3rd December
• World Earth day	22nd April
• World Environment day	5th June
• World Forest day	21st March
• World Health day	7th April
• World Literacy day	8th September
• World Ozone day	16th September
• World Population day	11th July
• World Wild Life Week	1st Monday of October.

QUESTION BANK

EXERCISE - 1 (LEVEL-1) [NCERT EXTRACT]

SECTION - 1 (VOCABULARY BUILDER)

Choose one correct response for each question.

For Q.1-Q.4

Match the column I with column II.

Q.1

	Column I		Column II
(a)	Classification	(i)	the evolutionary history of a group of organisms
(b)	Taxon	(ii)	an arrangement of organisms into hierarchical groups.
(c)	Binomial nomenclature	(iii)	the system in which species are assigned a two-part name
(d)	Phylogeny	(iv)	the group of organisms at a given taxonomic level

(A) (a) - ii, (b)-iv, (c)-iii, (d)-i
(B) (a) - i, (b)-ii, (c)-iii, (d)-iv
(C) (a) - ii, (b)-i, (c)-iii, (d)-iv
(D) (a) - i, (b)-iii, (c)-ii, (d)-iv

Q.2

	Column I		Column II
(a)	Taxonomy	(i)	an illustration that identifies likely evolutionary relationships among species
(b)	Taxonomic hierarchy	(ii)	the science devoted to naming and classifying organisms.
(c)	Phylogenetic tree	(iii)	a Latinized two-part name
(d)	Binomial	(iv)	an arrangement of organisms into ever more inclusive groups.

(A) (a) - ii, (b)-iv, (c)-iii, (d)-i
(B) (a) - i, (b)-ii, (c)-iii, (d)-iv
(C) (a) - ii, (b)-iv, (c)-i, (d)-iii
(D) (a) - i, (b)-iii, (c)-ii, (d)-iv

Q.3

	Column I		Column II
a.	Herbarium	i.	Preserved plant and animal specimen and also artistic and educational material
b.	Botanical Garden	ii.	Living wild animal in their natural habitat.
c.	Zoological Park	iii.	Preserved plant specimen on sheet.
d.	Museum	iv.	Diversityof living plant

Codes
(A) a-iii, b-iv, c-ii, d-i (B) a-iv, b-iii, c-i, d-ii
(C) a-i, b-iv, c-ii, d-iii (D) a-iv, b-i, c-ii, d-iii

Q.4

	Column-I	Column-II
a.	Binomial nomenclature	(i) Hippocrates
b.	The Darwin of the 20th century	(ii) Earnst Mayr
c.	Father of Botany	(iii) Linnaeus
d.	Father of medicine	(iv) Theopharastus

(A) a-(iii), b-(ii), c-(iv), d-(i)
(B) a-(iii), b-(ii), c-(i), d-(iv)
(C) a-(i), b-(ii), c-(iii), d-(iv)
(D) a-(ii), b-(iii), c-(iv), d-(i)

SECTION - 2 (BASIC CONCEPTS BUILDER)

For Q.5 to Q.9 :

Choose one word for the given statement from the list.

Taxon, Species, Hierarchy, Family, Taxonomy

Q.5 Ascending or descending arrangement of taxonomic categories is known as _____.

Q.6 ___ is the branch of science dealing with identification, nomenclature and classification of organisms.

Q.7 A group of organisms with similar trait of any rank is _____.

Q.8 A group of interconnected genera is called a ___

Q.9 A group of inbreeding plant or animals is ____.

SECTION - 3 (ENHANCE PROBLEM SOLVING SKILLS)

Choose one correct response for each question.

PART - 1 : DIVERSITY IN THE LIVING WORLD

Q.10 What is the basic unit of classification?
(A) Family (B) Order
(C) Species (D) Genus

Q.11 Biodiversity can be best defined as
(A) occurrence of number and type of organisms
(B) species and ecosystem of a region
(C) variety of life in an ecosystem
(D) totality of genes, species and ecosystem of a given region

Q.12 In *Mangifera indica*, the word Mangifera is a
(A) genus (B) species
(C) variety (D) order

Q.13 Who proposed binomial system of nomenclature?
(A) Candolle (B) Linnaeus
(C) Bentham (D) Hutchinson

Q.14 The scientific name of banyan is written as *Ficus bengalensis* L. Which of the following statements is correct regarding this?
(A) Letter L. signifies Latin language.
(B) The name should be written reverse with *bengalensis* preceding *Ficus*.
(C) Letter L. signifies the taxonomist linnaeus.
(D) *bengalensis* is generic name.

Q.15 Diversity of organisms and their evolutionary relationships is studied scientifically under.
(A) Morphology (B) Anatomy
(C) Taxonomy (D) Systematics

Q.16 Who coined the term 'Species'?
(A) John Ray (B) Aristotle
(C) Linnaeus (D) Cuvier

Q.17 Binomial system of classification was based on
(A) Embryology (B) Morphology
(C) Cytology (D) Anatomy

Q.18 ICBN stands for –
(A) Indian Congress of Biological Name
(B) International Code for Botanical Nomenclature
(C) International Congress of Biological Name
(D) Indian Code of Botanical Nomenclature

Q.19 Which one is correctly written scientific name?
(A) *Panthera Tigris* (B) *Mangifera indica*
(C) *Pucnthera Leo* (D) *Columba LIVEA*

Q.20 A species is a group of organisms which
(A) can interbreed freely
(B) do not interbreed
(C) can live together
(D) can interbreed occassionally

PART - 2 : TAXONOMIC CATEGORIES

Q.21 A taxon is a
(A) group of related species
(B) group of related families
(C) type of living organism
(D) taxonomic group of any ranking

Q.22 In the zoological name of fish *Catla catla*, the specific name is identical with the generic name, thus it is an example of
(A) antonym (B) tautonym
(C) synonym (D) homonym

Q.23 In which one of the following Carolus Linnaeus binomial nomenclature was first published.
(A) *Systema Naturae* (B)*Genera Plantarum*
(C) *Genera Animalium*(D) *Species Plantarum*

Q.24 In a taxonomic hierarchy, family is interpolated between
(A) kingdom and class (B) class and order
(C) order and genus (D) class and genus.

Q.25 Species is considered as
(A) largest taxon of taxonomy/classification
(B) key of taxonomy/classification
(C) smallest taxon of taxonomy/classification
(D) both small and largest unit of taxonomy/ classification

Q.26 The 'birds' taxonomically represent a
(A) family (B) order
(C) class (D) phylum

Q.27 In hierarchial classification, class occupied a place between
(A) kingdom and phylum (B) order and family
(C) phylum and order (D) family and genus

Q.28 Arrange the following in Linnaean hierarchy.
(A) Kingdom–Order–Species–Genus–Class–Family–Phylum
(B) Kingdom-Family-Genus-Species--Class-Phylum-Order
(C) Kingdom-Phylum-Order- Genus-Class-Family-Species
(D) Species-Genus-Family-Order-Class-Phylum-Kingdom

Q.29 Related genera belong to the same
(A) species (B) variety
(C) family (D) breed

Q.30 Term 'Taxonomy' was coined by
(A) de Candolle (B) Takhtajan
(C) Linnaeus (D) Aristotle

PART - 3 : TAXONOMICAL AIDS

Q.31 A place where dried, pressed and preserved plant specimens are kept.
(A) Herbarium (B) Museum
(C) Botanical garden (D) Both (A) and (C)

Q.32 Important function of botanical garden –
(A) Allow ex *situ* conservation of germ plasm
(B) Are place for recreation
(C) Plant diversity can be observed
(D) Provide natural habitat for wildlife

Q.33 'Key' is a taxonomical aid used for the identification of organisms. Each statement in key is called ____.
(A) couplet (B) lead
(C) both (A) and (B) (D) none of these

Q.34 Largest herbarium in the world is
(A) Conservatory and Botanical Garden, Geneva
(B) New York Botanical Garden
(C) Royal Botanical Garden, Kew (London)
(D) British Museum of Natural History

Q.35 What size of herbarium sheet and label is recommended generally?
(A) 30×40cm, 6×12cm(B) 41×29 cm, 7×12 cm
(C) 45×30 cm, 7×12cm (D) 20×30cm, 5×0cm

Q.36 _____ is a book (taxonomic aid) which contain information about habitat, distribution, climate description and index of plant found in a particular area.
(A) Manual (B) Flora
(C) Monograph (D) Key

Q.37 Where was the first herbarium set up?
(A) London in Great Britain (B) Pisa in Italy
(C) New York in USA (D) Tokyo in Japan

Q.38 Where labelling is done/pasted on herbarium sheet?
(A) Lower RHS (B) Lower LHS
(C) Upper RHS (D) Upper LHS

Q.39 Which taxonomical aid provide all information about a particular taxon like order or family.
(A) Herbarium (B) Catalogue
(C) Taxonomic key (D) Monograph

Q.40 Largest herbarium in India is
(A) Madras Herbarium Coimbatore (TN)
(B) Central National Herbarium (Indian Botanical Garden) Sibpur, Kolkata (WB)
(C) Herbarium of National Botanical Research Institute, Lucknow (UP)
(D) Forest Research Institute, Dehradun (UA)

EXERCISE - 2 (LEVEL-2)

Choose one correct response for each question.

Q.1 True regeneration is found in
(A) *Amoeba* (B) *Hydra*
(C) Planaria (D) Bacteria

Q.2 Who is regarded as Father of Zoology and Biology?
(A) Aristotle (B) Theophrastus
(C) Darwin (D) Linnaeus

Q.3 A germplasm is a –
(A) collection of seeds or plants consists diverse alleles of all genes in a crop
(B) collection of specimens of all the species of botanical garden.
(C) collection of hybrid varieties of plants.
(D) seed or pollen collection of threatened species of a group.

Q.4 Who is regarded as Father of Taxonomy?
(A) Hooker (B) Linnaeus
(C) Aristotle (D) de Candolle

Q.5 Third name in trinomial nomenclature indicate
(A) species (B) sub-species
(C) sub-genus (D) ecotype of organism

Q.6 Who coined the term 'Phylum"?
(A) Cuvier (B) Aristotle
(C) Ernst Haeckel (D) Hooker

Q.7 Who had written *Systema Naturae*?
(A) Ernst Mayr (B) Carolus Linnaeus
(C) RH Whittaker (D) WM Stanley

Q.8 New systematics introduced by Sir Julian Huxley is also called as
(A) phenetics (B) cladistics
(C) biosystematics (D) numerical taxonomy

Q.9 *Solanum* and *Panthera* are
(A) genus and species (B) genus and genus
(C) species and species (D) only species

Q.10 By which chemical, specimen for herbaria are treated to prevent fungal attack
(A) 0.1% mercuric chloride
(B) 0.1% mercurous chloride
(C) carbon disulphide
(D) acetic acid

Q.11 A defining property or characteristic of living organisms is –
(A) increase in mass
(B) development
(C) response to external stimuli
(D) growth

Q.12 Reproduction is synonymous with growth in which of the following set of organisms?
(A) Bacteria, unicellular algae and Amoeba
(B) Bacteria, *Amoeba* and fungi
(C) Unicellular algae and fungi
(D) Unicellular algae and filamentous algae

Q.13 A 'taxa' differ from 'taxon' due to
(A) being a higher taxonomic category than taxon
(B) being a lower taxonomic category than taxon
(C) being a plural of taxon
(D) being singular of taxon

Q.14 Which one of the following taxonomic categories can categorise rest all others?
(A) Family (B) Genus
(C) Class (D) Order

Q.15 Who has written the book *Historia Generalis Plantarum*?
(A) Hutchinson (B) Lamarck
(C) John Ray (D) Linnaeus

Q.16 A taxon that comprises related genera.
(A) class (B) family
(C) species (D) order

Q.17 In the binomial system of nomenclature, the first part of an organism's name designates the
(A) species epithet (B) genus
(C) class (D) kingdom

Q.18 Taxonomists use to prepare and disseminate taxonomic informations –
(A) Manuals and monographs
(B) Museum and herbarium
(C) Zoological park and herbarium
(D) Keys and herbarium

Q.19 Largest Botanical garden. Indian Botanical Garden and National Botanical Research Institute are situated respectively at –
(A) Kew, Lucknow, Howrah
(B) Kew, Howrah, Lucknow
(C) Lucknow, Howrah, Kew
(D) Howrah, Lucknow, Kew

Q.20 In the binomial name for rainbow trout, *Oncorhynchus mykiss*, the species name is–
(A) *Oncorhynchus*
(B) *mykiss*
(C) *Oncorhynchus mykiss*
(D) None of these

Q.21 Metabolism –
(A) is the sum of all the chemical activities of an organism.
(B) results from an increase in the number of cells.
(C) is characteristic of plant and animal kingdoms only.
(D) refers to chemical changes in an organism's environment.

Q.22 In the names *Mangifera indica*, *Solanum tuberosum* and *Panthera leo*, the words indica, tuberosum and leo represent
(A) Generic name (B) Generic epithet
(C) Specific name (D) Specific epithet

Q.23 An increase in the size or number of cells best describes
(A) homeostasis
(B) biological growth
(C) chemical level of organization
(D) asexual reproduction

Q.24 Which of the following is a correct sequence of levels of biological organization?
(A) cell, organ, tissue, organ system
(B) chemical, cell, organ, tissue
(C) chemical, cell, tissue, organ
(D) tissue, organ, cell,organ system

Q.25 The mold that produces penicillin is *Penicillium notatum*. *Penicillium* is the name of its
(A) genus (B) order
(C) family (D) species

Q.26 What are the essential basis of modern taxonomic studies
(A) External and internal structure.
(B) Structure of cell.
(C) Developmental process and ecological information.
(D) All of these

Q.27 The word "Systematics" is derived from the latin word "systema", what does it mean?
(A) System present in plants and animals.
(B) Systems used to make physiological study.
(C) Systematic arrangement of organisms.
(D) Systems written in any book.

Q.28 Closely related genera may be grouped together in a single
(A) phylum (B) domain
(C) species (D) family

Q.29 Which of the following is not used as taxonomic aid
(A) Zoological park (B) Soil
(C) Herbarium (D) Museum

Q.30 Related classes are grouped together in the same
(A) genus (B) phylum
(C) order (D) paraphyletic taxon

Q.31 The number & types of organisms present on earth make
(A) Taxonomy (B) Plant diversity
(C) Animal diversity (D) Biodiversity

Q.32 The process by which anything is grouped into convinient categories based on some easily observable characters is called as –
(A) Biodiversity (B) Classifications
(C) Identification (D) Nomenclature

Q.33 The process in which biologists follow universally accepted principles to provide name of any organism is called as –
(A) Identification (B) Classification
(C) Nomenclature (D) Systematics

Q.34 Characterisation of families is done on the basis of –
(A) Vegetative feautres
(B) Reproductive features
(C) Both (A) and (B)
(D) None of them

Q.35 In which group of taxonomic aids only the means of recording descriptions are included –
(A) Botanical gardens, Museum, Keys
(B) Botanical Gardens. mesbarium, Keys
(C) Flora, manual, Monograph
(D) Botanical Garden Museum, Monographs

Q.36 Which of the following taxonomic aid is useful only in case of animals –
(A) Botanical gardens (B) Museum
(C) Keys (D) Zoological parks

Q.37 The science of describing, naming, and classifying organisms is –
(A) systematics
(B) taxonomy
(C) cladistics (phylogenetic systematics)
(D) phenetics

Q.38 Using the binomial system of nomenclature, the scientific name of each species consists of two parts –
(A) class, specific epithet (B) family, genus
(C) genus, specific epithet (D) family, species

Q.39 All the categories used in classification of organism constitute –
(A) Taxonomy (B) Systematics
(C) Taxonomic hierarchy (D) Taxonomic affinity

Q.40 The term new systematics was introduced by –
(A) Linnaeus (B) Bentham
(C) Hutchinson (D) Huxley

Q.41 Group of organisms that closely resemble each other and freely interbreed in nature, constitute a
(A) Species (B) Genus
(C) Family (D) Taxon

Q.42 ICBN was first revised in –
(A) 1961 (B) 1964
(C) 1975 (D) 1753

Q.43 The term taxon refers to –
(A) Name of a species
(B) Name of genus
(C) Name of family
(D) A taxonomic group of any rank

Q.44 The herbarium specimen on whose basis a new species is described for the first time is called as
(A) Syntype (B) Holotype
(C) Paratype (D) Neotype

Q.45 The scientific naming of plants began with publication of Linnaeus book –
(A) Genera plantarum (B) Systema naturae
(C) Species plantarum (D) Charaka sanhita

Q.46 Most of the botanical names are drawn from the following language –
(A) German (B) Greek
(C) Latin (D) Spanis

Q.47 Which of the following statements regarding nomenclature is correct –
(A) Generic name always begins with capital letter whereas specific name with small letter.
(B) Scientific name should be printed in italics.
(C) Scientific name when typed or handwritten should be underlined.
(D) All the above

Q.48 The systematic arrangement of taxa is called –
(A) Key (B) Taxonomy
(C) Geneology (D) Hierarchy

EXERCISE - 3 (LEVEL-3)

Choose one correct response for each question.

Q.1 The genus *Felis* includes
(A) tiger (B) fish
(C) cat (D) frog

Q.2 Match the column.

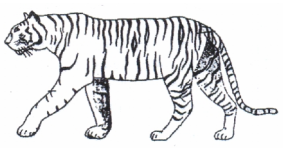
Column I (Branches of biology)		Column II (Area of study)
(a)	Helminthology	(p) Study of insects
(b)	Entomology	(q) Study of fungi
(c)	Ornithology	(r) Study of algae
(d)	Phycology	(s) Study of birds
		(t) Study of worms

(A) a = p, b = s, c = q, d = t
(B) a = t, b = p, c = s, d = r
(C) a = s, b = t, c = r, d = p
(D) a = r, b = p, c = s, d = q

Q.3 Select the incorrect statement with respect to the taxon, 'genus'.
(A) It is a group or assemblage of related species.
(B) A genus essentially possesses more than one number of species.
(C) Lion, Tiger, Leopard, Jaguar are closely related species which have been placed in the genus *Panthera* and are respectively named as *Panthera leo*, *P. tigris*, *P. pardus* and *P. onca*.
(D) *Solanum, Penicillium, Withania* and *Canis* are the examples of genera.

Q.4 Two or more species which occupy the same or overlapping area are known as
(A) sympatric (B) allotropic
(C) sibling (D) sub-species

Q.5 Which of the following options represents the correct classification for the given animal?



(A) Phylum-Chordata, Class -Vertebrata, Order -Chiroptera Family-Felidae, Genus-*Canis*, Species-*tigris*
(B) Phylum-Chordata, Class -Mammalia, Order -Carnivora Family-Felidae, Genus-*Panthera*, Species-*tigris*
(C) Phylum-Vertebrata, Class -Mammalia, Order -Carnivora Family-Felidae, Genus-*Panthera*, Species-*tigris*
(D) Phylum-Mammalia, Class -Felidae, Order -Carnivora Family-Feliaceae, Genus-*Panthera*, Species-*lea*

Q.6 Select true and false statement and choose correct answer from the option given below.
I. Taxon is a group of related organism.
II. *Homo sapiens* is the scientific name of man.
III. Royal Botanical Garden is located in Bristol (England).
IV Dudhwa National Park is located at Lakhimpur in UP.
V. There are about 89 wildlife sanctuaries and 492 National Parks in India.
VI When specific name is identical to generic name it is an example of tautonym.
(A) True-I, III, V, False-II, IV, VI
(B) True-I, II, III, False-IV, V, VI
(C) True-II, IV, VI, False-V, III, I
(D) True-VI, V, IV, False-III, II, I

Q.7 Match Column-I with Column-II

Column-I		Column-II
a.	John Ray	(i) Gave the concept of new systematics
b.	C. Linnaeus	(ii) First described species as a unit of classification
c.	Aristotle	(iii) Father of Zoology
d.	Julian Huxley	(iv) Introduced binomial nomenclature

(A) a-(i), b-(ii), c-(iii), d-(iv)
(B) a-(iv), b-(ii), c-(iii), d-(i)
(C) a-(ii), b-(iii), c-(i), d-(iv)
(D) a-(ii), b-(iv), c-(iii), d-(i)

Q.8 Match the following columns.

	Column I	Column II
a.	Kingdom	1. *Anuus*
b.	Order	2. *Helianthus*
c.	Family	3. Fungi
d.	Genus	4. Canidae
d.	Species	5. Rannales

Codes
(A) a-3, b-5, c-4, d-2, e-1
(B) a-3, b-4, c-5, d-2, e-1
(C) a-3, b-5, c-2, d-4, e-1
(D) a-1, b-5, c-2, d-4, e-3

Q.9 The name of a plant order ends with
(A) -aceae (B) -ales
(C) -idae (D) -ae

Q.10 Select true statement from the following.
I. Human's scientific name is *Homo sapiens*.
II. *Genera Plantarum* is written byJohn Ray.
III. Highest taxonomic categories is division.
IV. Taxonomic group of any rank is taxon.
V. A group of closely related species of organism represent genus.
VI. The term 'systematic' was coined by de Candolle.
(A) II, III, IV and VI (B) I, III, V and VI
(C) I, IV and V (D) II, III and VI

Q.11 Match the following columns.

	Column I	Column II
a.	Family	1. *tuberosum*
b.	Kingdom	2. Polymoniales
c.	Order	3. *Solanum*
d.	Genus	4. Plantae
e.	Species	5. Solanaceae

Codes
(A) a-5, b-4, c-2, d-3, e-1
(B) a-1, b-2, c-3, d-5, e-4
(C) a-5, b-4, c-1, d-3, e-2
(D) a-2, b-1, c-3, d-4, e-5

Q.12 Match Column-I with Column-II and select the correct option from the codes given below.

	Column-I		Column-II
a.	Ecology	(i)	Relationships of organisms & environment
b.	Herbarium	(ii)	Original specimen cited by an author
c.	Holotype	(iii)	A hierarchial unit
d.	Taxon	(iv)	Collection of wild and domestic plants

(A) a-(i), b-(ii), c-(iii), d-(iv)
(B) a-(i), b-(ii), c-(iv), d-(iii)
(C) a-(i), b-(iv), c-(ii), d-(iii)
(D) a-(iv), b-(ii), c-(iii), d-(i)

Q.13 Maintenance of physiological equilibrium in a changing environment by an organism is known–
(A) response (B) adaptation
(C) homeostasis (D) metabolism

Q.14 Why the determination of relationship becomes more complex in higher taxonomic categories –
(A) Number of common characters goes on decreasing in lower taxa.
(B) Number of common characters goes on decreasing in higher taxa.
(C) Because classification itself is very difficult process.
(D) Number of common characters goes on increasing in higher taxa.

Q.15 Match the following by using codes :

(a)	Vernalization	(1) Camerarius
(b)	Double fertilization	(2) Hofmeister
(c)	Pollination	(3) Lysenko
(d)	Alternation of Generations	(4) Nawaschin

(A) a = 1, b = 2, c = 4, d = 3
(B) a = 4, b = 1, c = 2, d = 3
(C) a = 3, b = 2, c = 1, d = 4
(D) a = 3, b = 4, c = 1, d = 2

Q.16 Which of the following is a correct sequence of levels of biological organization?
(A) organism, population, ecosystem, community
(B) organism, population, community, ecosystem
(C) population, biosphere, ecosystem, community
(D) species, population, ecosystem, community

Q.17 Match the column

Column I (Branch of biology)	**Column II (Field of study)**
(a) Palynology	(p) Silkworks
(b) Oncology	(q) Pollens
(c) Phycology	(r) Cancer
(d) Sericulture	(s) Algae

(A) a = s, b = q, c = r, d = p
(B) a = q, b = r, c = s, d = p
(C) a = s, b = r, c = q, d = p
(D) a = r, b = q, c = s, d = p

Note (Q.18-Q.21) :

(A) Statement-1 is True, S-2 is True, Statement-2 is a correct explanation for Statement -1
(B) Statement-1 is True, S-2 is True ; S-2 is NOT a correct explanation for S-1.
(C) Statement-1 is True, Statement-2 is False.
(D) Statement-1 is False, Statement-2 is False.

Q.18 **Statement 1 :** Botany deals with the study of plants and zoology deals with the study of animals.
Statement 2: Biology is the study of living beings.

Q.19 **Statement 1 :** Study of internal structure is called anatomy.
Statement 2 : It is useful for phylogentic study.

Q.20 **Statement 1 :** The science of classifiying organisms is called taxonomy.
Statement 2 : Systematics and taxonomy have same meaning.

Q.21 **Statement 1 :** Formation of new species is called speciation.
Statement 2 : The deme has a common gene pool.

EXERCISE - 4 (PREVIOUS YEARS AIPMT/NEET EXAM QUESTIONS)

Choose one correct response for each question.

Q.1 Which one of the following is not a correct statements ? **[NEET 2013]**

(A) Key is taxonomic aid for identification of specimens.
(B) Herbarium houses dried, pressed and preserved plant specimens.
(C) Botanical gardens have collection of living plants for reference.
(D) A museum has collection of photographs of plants and animals.

Q.2 Nomenclature is governed by certain universal rules. Which one of the following is contrary to the rules of nomenclature? **[NEET 2016 PHASE 1]**

(A) Biological names can be written in any language.
(B) The first word in a biological name represents the genus name and the second is a specific epithet.
(C) The names are written in Latin and are italicised.
(D) When written by hand, the names are to be underlined.

Q.3 The label of a herbarium sheet does not carry information on **[NEET 2016 PHASE 2]**

(A) Date of collection (B) Name of collector
(C) Local names (D) Height of the plant

Q.4 Match Column-I with Column-II for housefly classification **[NEET 2016 PHASE 2]**

	Column-I	**Column-II**
a.	Family	(i) Diptera
b.	Order	(ii) Arthropoda
c.	Class	(iii) Muscidae
d.	Phylum	(iv) Insecta

(A) a-(iii), b-(i), c-(iv), d-(ii)
(B) a-(iii), b-(ii), c-(iv), d-(i)
(C) a-(iv), b- (iii), c-(ii), d-(i)
(D) a-(iv), b-(ii), c-(i), d- (iii)

Q.5 Study the four statements (a–d) given below and select the two correct ones out of them:

a. Definition of biological species was given by Ernst Mayr. **[NEET 2016 PHASE 2]**
b. Photoperiod does not affect reproduction in plants.
c. Binomial nomenclature system was given by R.H. Whittaker.
d. In unicellular organisms, reproduction is synonymous with growth.

The two correct statements are

(A) b and c (B) c and d
(C) a and d (D) a and b

Q.6 Match the column **[NEET 2018]**

Column I	**Column II**
a. Herbarium	(i) It is a place having a collection of preserved plants & animals
b. Key	(ii) A list that enumerates methodically all the species found in an area with brief description aiding identification.
c. Museum	(iii) Is a place where dried and pressed plant specimens mounted on sheets are kept.
d. Catalogue	(iv) A booklet containing a list of characters and their alternates which are helpful in identification of various taxa.

(A) a-(ii), b-(iv), c-(iii), d-(i)
(B) a-(iii), b-(ii), c-(i), d-(iv)
(C) a-(i), b-(iv), c-(iii), d-(ii)
(D) a-(iii), b-(iv), c-(i), d-(ii)

ANSWER KEY

EXERCISE-1 (SECTION-1&2)

(1) (A) **(2)** (C) **(3)** (A) **(4)** (A) **(5)** Hierarchy **(6)** Taxonomy
(7) Taxon **(8)** Family **(9)** Species

EXERCISE - 1 [SECTION-3]																								
Q	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**
A	C	A	A	B	C	D	A	B	B	B	A	D	B	D	C	C	C	C	D	C	A	A	A	B	C
Q	**35**	**36**	**37**	**38**	**39**	**40**																			
A	B	B	B	A	D	B																			

EXERCISE - 2																								
Q	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
A	C	A	A	B	B	A	B	C	B	A	C	A	C	C	C	B	B	A	B	C	A	D	B	C	A
Q	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**		
A	D	C	D	B	B	D	B	C	C	C	D	B	C	C	D	A	C	D	B	C	C	D	D		

EXERCISE - 3																					
Q	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
A	C	B	B	B	B	C	D	A	B	C	A	C	C	B	D	B	B	A	B	C	B

EXERCISE - 4						
Q	**1**	**2**	**3**	**4**	**5**	**6**
A	D	A	D	A	C	D

SOLUTIONS

EXERCISE-1

(1) (A) **(2)** (C) **(3)** (A)
(4) (A) **(5)** Hierarchy **(6)** Taxonomy
(7) Taxon **(8)** Family **(9)** Species

(10) **(C).** The basic unit of classification is species. It is the lowest taxonomic category and consists one or more natural populations closely related that individual of other population.

(11) **(A).** Biodiversity refers to the number and types of organisms present on the earth.

(12) **(A).** *Mangifera* is the generic name of mango.

(13) **(B).** Binomial system of nomenclature was proposed by Carolus Linnaeus. Binomial system approve two name for an organism, i.e., generic and specific name.

(14) (C) **(15)** (D) **(16)** (A)
(17) (B) **(18)** (B)

(19) **(B).** *Mangifera indica*, scientific name consists of two words a generic and another specific name. It is binomial system of nomenclature. The first word denoting the genus start with capital letter, while specific epithets start with small letter.

(20) (A) **(21)** (D)

(22) **(B).** Tautonyms are the scientific names in which both generic and specific epithets are same. Tautonyms are used in zoological nomenclature. However, in the current rules for nomenclature of living organisms, tautonyms are explicitly prohibited. Examples of tautonyms are *Rattus rattus* (Rat), *Catla catla* (Catla), *Gorilla gorilla* (Western gorilla), etc.

(23) **(D).** The system of binomial nomenclature was published for first time in book Species Plantarum and in the 10th edition of his book Systema *Naturae*.

(24) (C) **(25)** (C)

(26) **(C).** The class-Aves (or Birds) belongs to kingdom-Animalia and phylum-Chordata.

(27) **(C).** Hierarchial classification is
Kingdom → Division/Phylum → Class → Order → Family → Genus → Species

(28) **(D).** Correct sequence of hierarchy is
Species → Genus → Family → Order → Class → Phylum → Kingdom.
The above hierarchial sequence is in ascending order.

(29) **(C).** Family is a taxonomic category which contains one or more related genera. All the genera of a family have some common features and they are separable from genera of a related family by important characteristic differences. The family Solanaceae includes a number of genera like *Solanum, Petunia, Atropa*, etc. due to certain similarities.

(30) (A) **(31)** (A)
(32) (A) **(33)** (B)

(34) **(C).** Largest herbarium in the world is herbarium of Royal Botanical Garden, Kew (London) which contains more than 6,000,000 specimens.

(35) (B)

(36) **(B).** Flora is a book or taxonomic aid which have adequate information about habitat, distributions of climate and index of plants present in a particular region.

(37) **(B).** Luca Ghini, a professor of Botany set-up the first herbarium at Pisa in Italy.

(38) **(A).** The correct labelling place on a herbarium sheet is lower corner of page of RHS and generally its size is 7 × 12cm.

(39) **(D).** **Taxonomic aid** monograph is treatise having complete information about a particular rank level of a taxonomic category. Key or taxonomic key contain list of traits or characters and their alternate which are helpful in taxonomic studies. Catalogue registers the species, present in a particular place with brief description.

(40) **(B).** Largest herbarium in India is Central National Herbarium (Indian Botanial Garden) at Sibpur, Kolkata (WB).

EXERCISE-2

(1) **(C).** Regeneration is a process in which a lost part of the body is recreated by the organism to become a new organism. It can be best observed in flatworm Planaria.

(2) **(A).** Aristotle (384-322 BC) described structure, habit, reproduction and classification of animals in his book *Historia Animalium*. He is regarded as father of zoology and biology.

(3) **(A).** Germplasm is a collection of seeds/plants which consists diverse alleles of all gene in a crop.

(4) **(B).** Carolus Linnaeus was a Swedish botanist who is regarded as Father of Taxonomy. Binomial nomenclature was published by him in *Species Plantarum*.

(5) **(B).** In trinomial nomenclature a third name is written or printed after two words name, which indicate sub-species or variety or race of the organism, e.g., Indian babul (*Acacia nilotica indica*). Where indica means Indian species of babul.

(6) **(A).** Term phylum was coined by Cuvier. Aristole is regarded as Father of Zoology as well as Biology. Earnst Haeckel proposed Biogenetic Law. Bentham and Hooker are pioneer workers in classification of organisms.

(7) **(B).** *Systema Naturae* was a work of Carolus Linnaeus. He describe about 4330 species of animal in this, while around 6000 species of plant had been described in Species Plantarum.

(8) **(C).** New systematics or biosystematics is concept of systematics which brings out taxonomic affinities on the basis of evolutionary, genetic and morphological traits. New systematics brings out cladistics or phylogenetic classification.

(9) **(B).** *Solanum* and *Panthera* are genera of family- Solanaceae and Felidae, respectively.

(10) **(A).** 0.1% mercuric chloride solution is used to prevent fungal attack on herbarium nepthalene and carbon disulphide are common pesticides.

(11) **(C).** All living organism from prokaryotes to the most complex eukaryotes can responds to external stimuli. The non-living things do not have this property at all.

(12) **(A).** In unicellular organisms like bacteria, algae (unicellular) and Amoeba reproduction is increase in number of cells, i.e., synonymous with growth.

(13) **(C).** Taxa is plural of taxon. A taxon represents a grouping in a systematic classification of organism (whatever its rank).

(14) **(C).** Out of four given categories, class is the largest category. Therefore, can categorise rest three categories; order, family and genus.
Kingdom → Division/Phylum → Class → Order → Family → Genus → Species

(15) **(C).** John Ray (1627-1705) an english biologist described about 18,500 plants in three volumes of his book, *Historia Generalis Plantarum*.

(16) (B)	**(17)**(B)	**(18)**(A)	**(19)** (B)
(20) (C)	**(21)**(A)	**(22)**(D)	**(23)** (B)
(24) (C)	**(25)**(A)	**(26)**(D)	**(27)** (C)
(28) (D)	**(29)**(B)	**(30)**(B)	**(31)** (D)
(32) (B)	**(33)**(C)	**(34)**(C)	**(35)** (C)
(36) (D)	**(37)**(B)	**(38)**(C)	**(39)** (C)
(40) (D)	**(41)**(A)	**(42)**(C)	**(43)** (D)
(44) (B)	**(45)**(C)	**(46)**(C)	**(47)** (D)
(48) (D)			

EXERCISE-3

(1) **(C).** The genus *Felis* is used to represent cats.

(2) **(B).** Helminthology - Study of worms
Entomology - Study of insects
Ornithology - Study of birds
Phycology - Study of algae

(3) **(B).**

(4) **(B).** Allotropic species are those group of individuals, which occupy the same or overlapping area in the different habitat and involve geographical isolation. While sympatric species occur without geographic isolation. Sibling have same ancestors and when species have subgroup, it is called subspecies or variety.

(5) **(B).**

(6) **(C).** Taxon is used to represent any rank in taxonomic hierarchy.
Royal Botanical Garden is located at (Kew) London in England.
There are about 492 (approximately 504) wildlife sanctuaries and 89 national park in India. Rest three statement are true.

(7) **(D).**

(8) **(A).** Kingdom : Fungi ; Order : Rannales
Family : Canidae ; Genus : *Helianthus*
Species : *anuus*

(9) **(B).** Order includes one or more related families e.g. the family Solanaceae is placed in the order Polemoniales along with four related families (Convolvulaceae, Boraginaceae, Hydrophyllaceae and Polemoniaceae). Name of a plant order usually ends with 'ales'.

(10) **(C).** Genera *Plantarum* was written by Bentham and Hooker, highest taxonomic category is kingdom in hierarchy. Term 'Systematics' was first time used by Linnaeus.

(11) **(A).**

(12) **(C).** A particular specimen or illustration designated by the author to represent the type of a species is referred to as holotype. It is now essential to designate a holotype when publishing a new species.

(13) (C) **(14)** (B)

(15) (D) **(16)** (B)

(17) **(B).** Palynology - Study of spores and pollen grains.
Oncology - Study of cancer/tumorus
Phycology - Study of algae
Sericulture - Rearing of silkworm

(18) **(A).**

(19) **(B).** Anatomy is the study of internal structure which can be observed with unaided eye after dissection. By studying anatomy of large number of organisms, it is useful for knowing phylogenetic similarity (homology) and phylogenetic dissimilarity (analogy).

(20) **(C).** Taxonomy is the science of identification, nomenclature and classification of organisms. But taxonomy and systematics are different terms. Systematics is the branch of biology that deals with diversity of organisms at every level of classification.

(21) **(B).** All new species develop from the pre-existing species. The phenomenon of development of a new species from pre-existing one is called speciation. A species is a collections of demes. The deme is a groups of populations with a common gene pool.

EXERCISE-4

(1) **(D).** Museums have collections of preserved plant and animal specimens for study and reference.

(2) **(A).** Biological names originate from latin language and printed in italics.

(3) **(D).** The herbarium sheets carry a label providing information about date and place of collection, english, local and botanical names, family, collector's name.

(4) **(A).** Housefly belongs to
(i) Phylum - Arthropoda
(ii) Class - Insecta
(iii) Order - Diptera
(iv) Family - Muscidae

(5) **(C).** Photoperiod affect reproduction in plants. Bionomial nomenclature system was given by Carolus Linnaeus

(6) **(D).** Herbarium–Dried and pressed plant specimen.
Key – Identification of various taxa.
Museum– Plant and animal specimen are preserved.
Catalogue – Alphabetical listing of species.