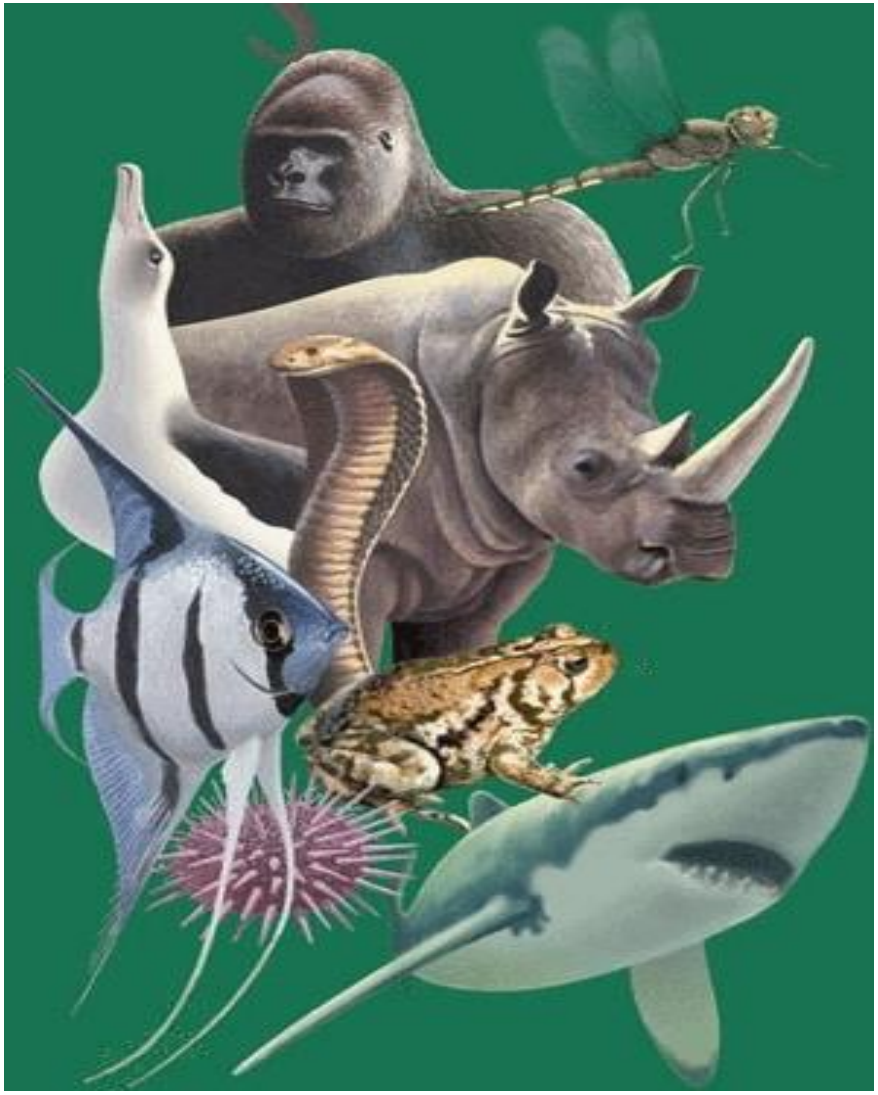
Introduction to Biodiversity

Topics Covered :

- **Biodiversity and its Importance**
- **Principles of Animal Classification**
- **Species**

What is Biodiversity???



- **Biodiversity is Variability among living organisms**
- **Biological diversity**
- **Simply means the diversity, or variety, of plants and animals and other living things in a particular area or region**
- **Also means the number, or abundance of different species living within a particular region**
- **The term Biodversity was coined in 1985 by Walter Rosen**

- **How many species are there?**
  - -- **1.4 million *named* species (70% of which are invertebrates)**
  - -- **Estimated 3 to 50 million species alive!**



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What is biodiversity?

- About 50 million sps. of plants, animals & microbes are existing in the world
- Among that only 2 million are identified so far
- Biodiversity also includes:
  - Variability of genus
  - Varieties
  - Species
  - Population in different ecosystems
  - Relative abundance of species

Why Is It Important?

- Everything that lives in an ecosystem is part of the web of life, including humans
- Each species of vegetation and each creature has a place on the earth and plays a vital role in the circle of life
- Plant, animal, and insect species interact and depend upon one another for what each offers, such as food, shelter, oxygen, and soil enrichment
- "It is reckless to suppose that biodiversity can be diminished indefinitely without threatening humanity itself." -Edward O. Wilson (Father of Biodiversity)

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What is biodiversity?

- Knowledge of biodiversity is essential for sustainable utilization of resources
- Biological resources provide us:
  - ***Nourishment***
  - ***Clothing***
  - ***House***
  - ***Fuel***
  - ***Medicine***
  - ***Revenue***

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Levels of biodiversity

- Biodiversity can be considered in THREE levels

    1. ***Genetic diversity***
    2. ***Species diversity***
    3. ***Ecosystem / community diversity***

(1). Genetic diversity:

- Genetic variation within species, both among individuals within single population and among geographically separated populations

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Levels of biodiversity

(2). Species diversity:

- Biodiversity covers the full range of species on earth
- Includes all the species, microbes, viruses, bacteria to animals and plants

(3). Ecosystem / community diversity

- Biodiversity also includes variations in the geographical communities
- This includes:
  - Variations in the community in which the species lives
  - The ecosystem in which the community exists
  - Interaction within and between biotic and abiotic components

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Types of biodiversity

- There are different types of biodiversity:
  - **Genetic diversity:** alleles of a single gene
  - **Organismal diversity:** differences in morphology, anatomy, behaviour
  - **Population diversity:** quantitative ecology- frequency, density etc.
  - **Species diversity:** species number in different genera
  - **Community diversity:** diversity in ecological interactions
  - **Ecosystem diversity:** interdependence of biotic and abiotic factors
  - **Landscape diversity:** species composition in different landscapes
  - **Biogeographic diversity:** diversity in geological and geographic history

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Measuring biodiversity:

- At simplest level: biodiversity is the **species richness**
- Various levels of measuring the biodiversity are:

1. ***Alpha diversity***
2. ***Beta diversity***
3. ***Gamma diversity***

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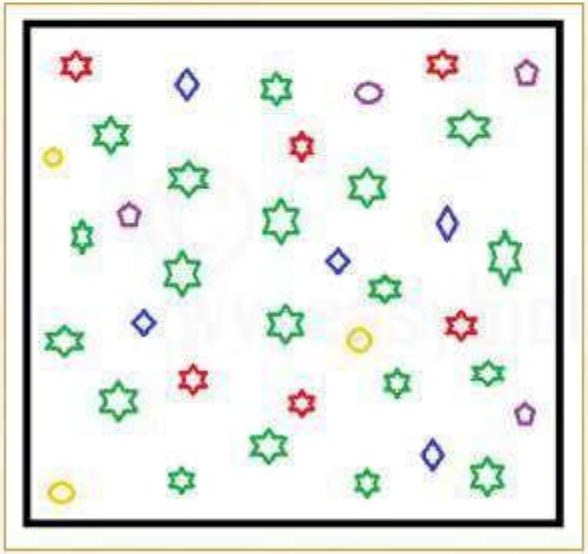
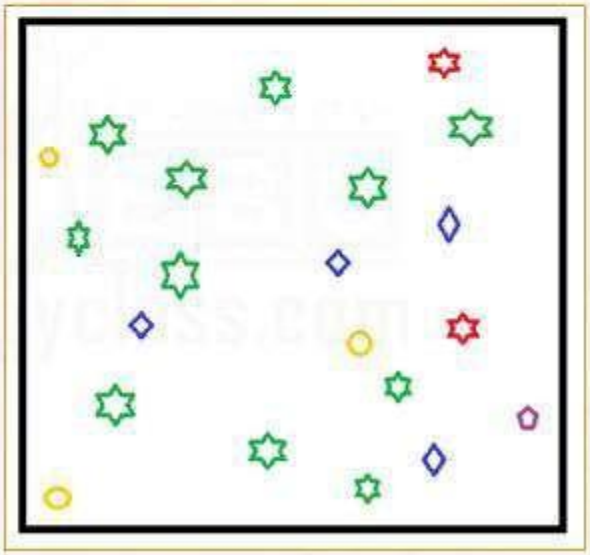
Measuring biodiversity:

1. Alpha diversity:

- Refers to **number of species** in a single community
- It is better called as species richness
- Used to **compare number** of **species** in different communities



Community I



Community II

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Measuring biodiversity:

2. Beta diversity:

- Degree of **change in species composition** along an environmental gradient
- *Example:* Beta diversity is high, if the species composition of moss communities changes successively at higher elevations on a mountain slope
- Beta diversity is low if same species of moss occupy the whole mountain side

High Beta Diversity

Low Beta Diversity

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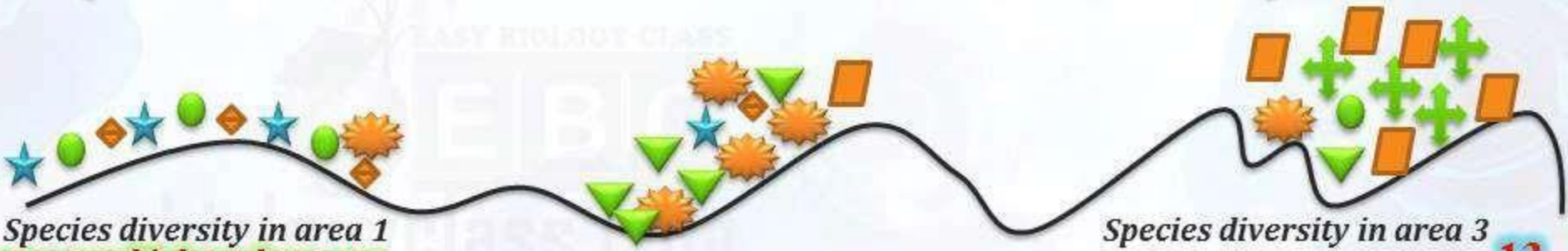
Measuring biodiversity:

3. Gamma diversity:

- Gamma diversity applies to large geographic scale
- "The rate at which additional species are encountered as geographical replacements within a habitat type in different localities"
- "Gamma diversity is a species turnover rate with distance between sites of similar habitat or with expanding geographic areas"

Gamma Diversity in a Large Geographical Area



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Uses of biodiversity:

- Biodiversity (besides its ecological significance) provides a socio-economic asset to the nation

- Uses related to biodiversity can be grouped into three categories:

1. ***Productive use***
2. ***Consumptive use***
3. ***Indirect use***

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Uses of biodiversity:

1. Productive use:

- Products commercially harvested for exchange in market
- This value of biodiversity is concerned with national income
- Biodiversity provides: fuel, timber, fish, fodder, fruits, cereals, medicinal plants etc.
- In India, income from biodiversity is nearly 30% (736.88 billion rupees, 1994-95)

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Uses of biodiversity:

2. Consumptive use:

- Deals with natural products that are consumed directly
- They are goods which do not come under normal circulation of trade
- Example: non timber forest products, Honey collected from forests

Natural Beehive

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Uses of biodiversity:

3. Indirect use:

- Most significant
- This value is related primarily with **functions of ecosystem**
- Biodiversity is very essential for:
  - Ecological balance
  - Constancy of climatic features
  - Soil maintenance

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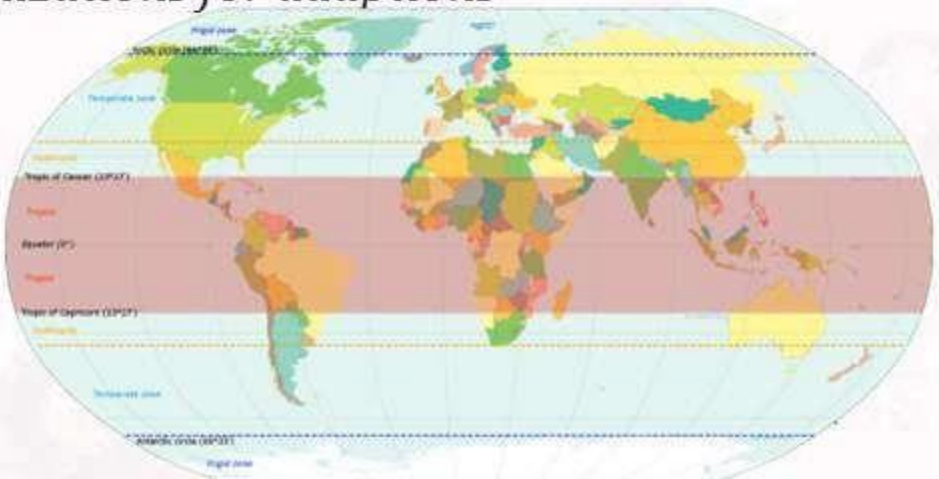
Why biodiversity is rich in the tropics?

- Tropical regions are rich in biodiversity than temperate region because:

1. *Warm temperature and high humidity- favourable for most of the species*
2. *Have more stable climate than temperate*
3. *Tropical communities are older than temperate communities*
4. *Thus tropical communities got more time to evolve*
5. *Thus they have more specializations for adaptions*

Tropical Area



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Why biodiversity is rich in the tropics?

- Tropical regions are rich in biodiversity than temperate region because:

6. *In tropics there is greater pressure from pests, parasites and disease. This does not allow a single species to predominate*
7. *Tropical areas receive more solar energy over the year than temperate*
8. *Thus tropical communities are more productive*
9. *Tropical soil is the most fertile soil*
10. *Thus this soil supports a wider range of species*

Tropical Rain Forest

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Importance of biodiversity:

- Biodiversity indicates variations of life forms (species, ecosystem, biome)
- Biodiversity indicate the **health of ecosystem**
- Biodiversity is in part a **functioning of climate**
- Biodiversity provides services like:

Deep Forest Biodiversity

- Air quality and purity
- Climate and seasons
- Water purification
- Pollination and seed dispersal
- Prevention of erosion

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Importance of biodiversity:

- Non material benefits of biodiversity:
  - ❖ Spiritual values
  - ❖ Aesthetic values
  - ❖ Education and knowledge systems

Moss Diversity

- Agriculture: recovery when dominant cultivar is attacked by diseases/pests
- Biodiversity act as a store house of germplasm
- ~ 80% of humans' food supply comes from 20 kinds of plants, but human uses at least 40,000 species
- There are more plant products to be discovered from diversity

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Importance of biodiversity:

- Biodiversity support in drug discovery
- Most of the drugs are derived, directly or indirectly, from biological sources
- ~ 50% of drugs used in US are derived from biodiversity
- ~ 80% of world population depends on medicines from nature
- Many industrial materials are derive from biological sources
- These include building materials, fibbers, dyes, rubber and oil
- Provide security of resources such as water, timber, paper, fibre and food

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Importance of biodiversity:

- Biodiversity support leisure activities (bird watching and trucking)
- Biodiversity inspires musicians, painters and writers
- Gardening, fishing & specimen collecting depends on biodiversity
- Biodiversity supports many ecosystem services that are not readily visible
- Regulate the chemistry of our atmosphere and water supply
- Helps in water purification, recycling nutrients and providing fertile soil

Threats to Biodiversity

- **Habitat destruction** (slash and burn agric. Or felling of old-growth forests)

- **Overexploitation** (fishing, hunting)

- **Pollution** (domestic and industrial emissions)

- **Global climate change** (the greenhouse effect and destruction of the ozone layer)

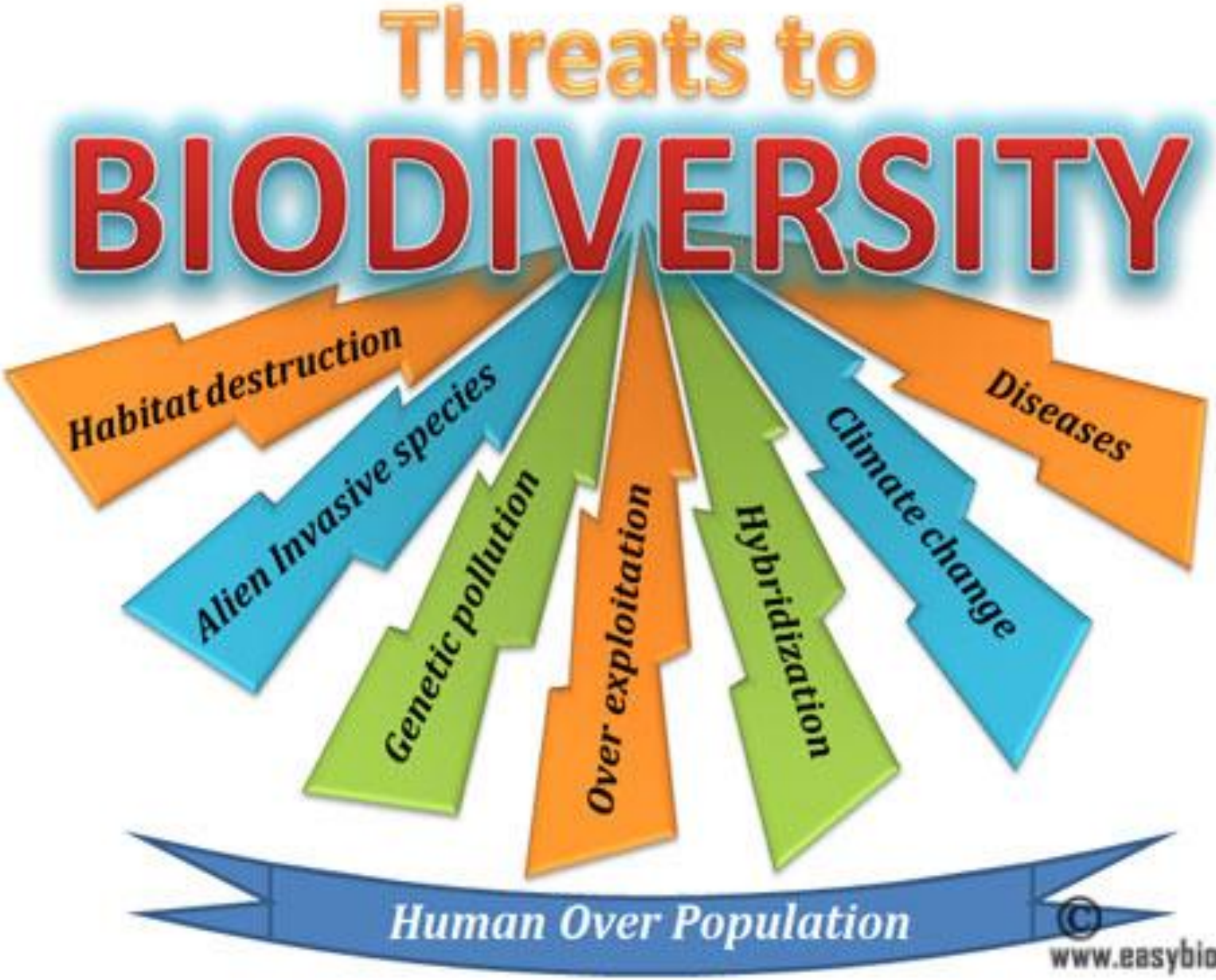
- **Invasion by introduced species** (displacement of native species

- **Underlying social conditions** (increased per-capita consumption, poverty, rapid population growth, unsound economic and social policies)

  - **Habitat degradation**
    - Some 93% of coral reefs damaged directly or indirectly by human activities
    - During the 1990s between 130,000 and 150,000 km^2 of forest cover lost each year

  - Changes in atmospheric composition.

  - **Siltation, Pollution of air and water by toxic chemicals**


Threats to
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Habitat destruction
Alien Invasive species
Genetic pollution
Over exploitation
Hybridization
Climate change
Diseases
Human Over Population
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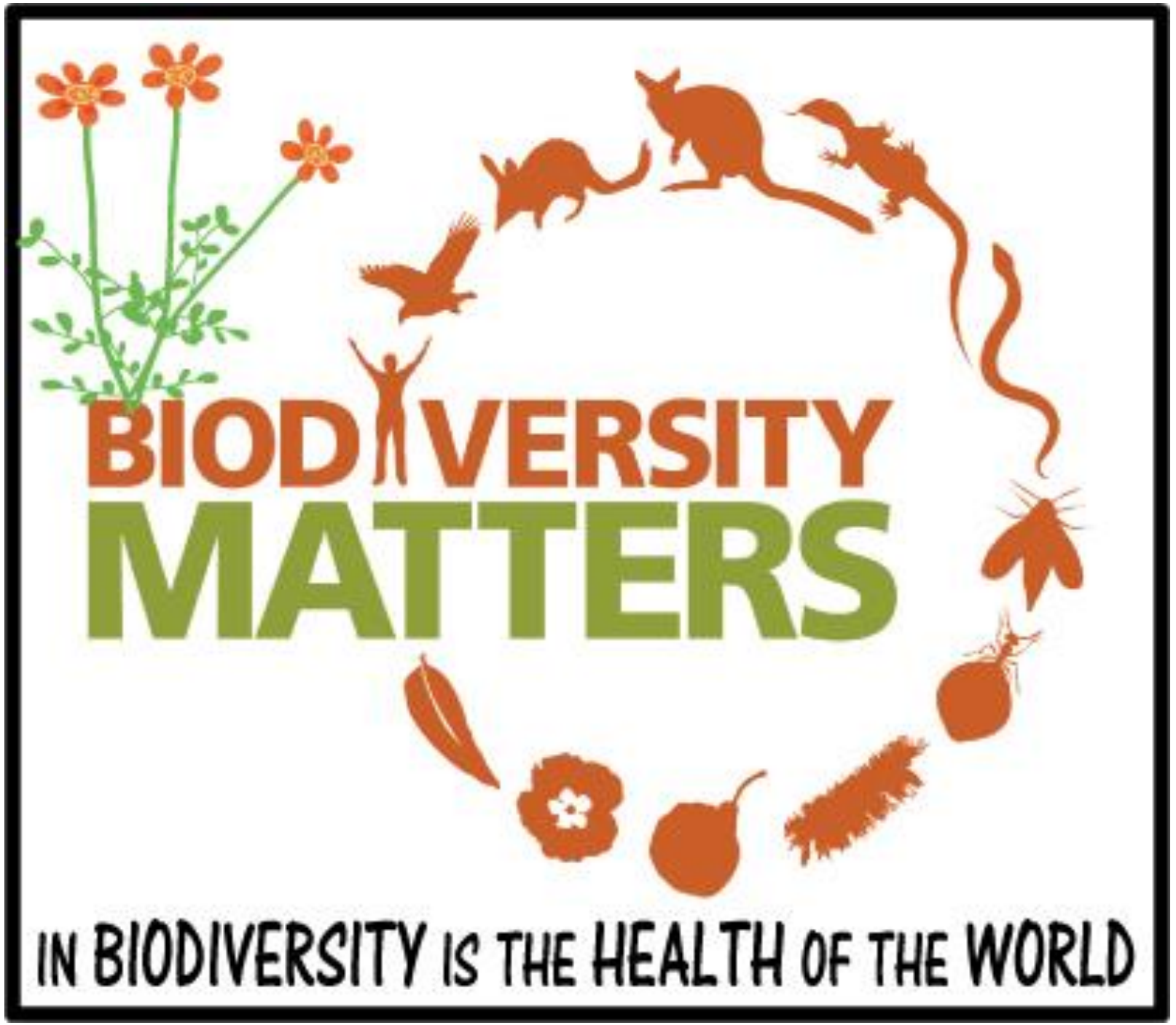
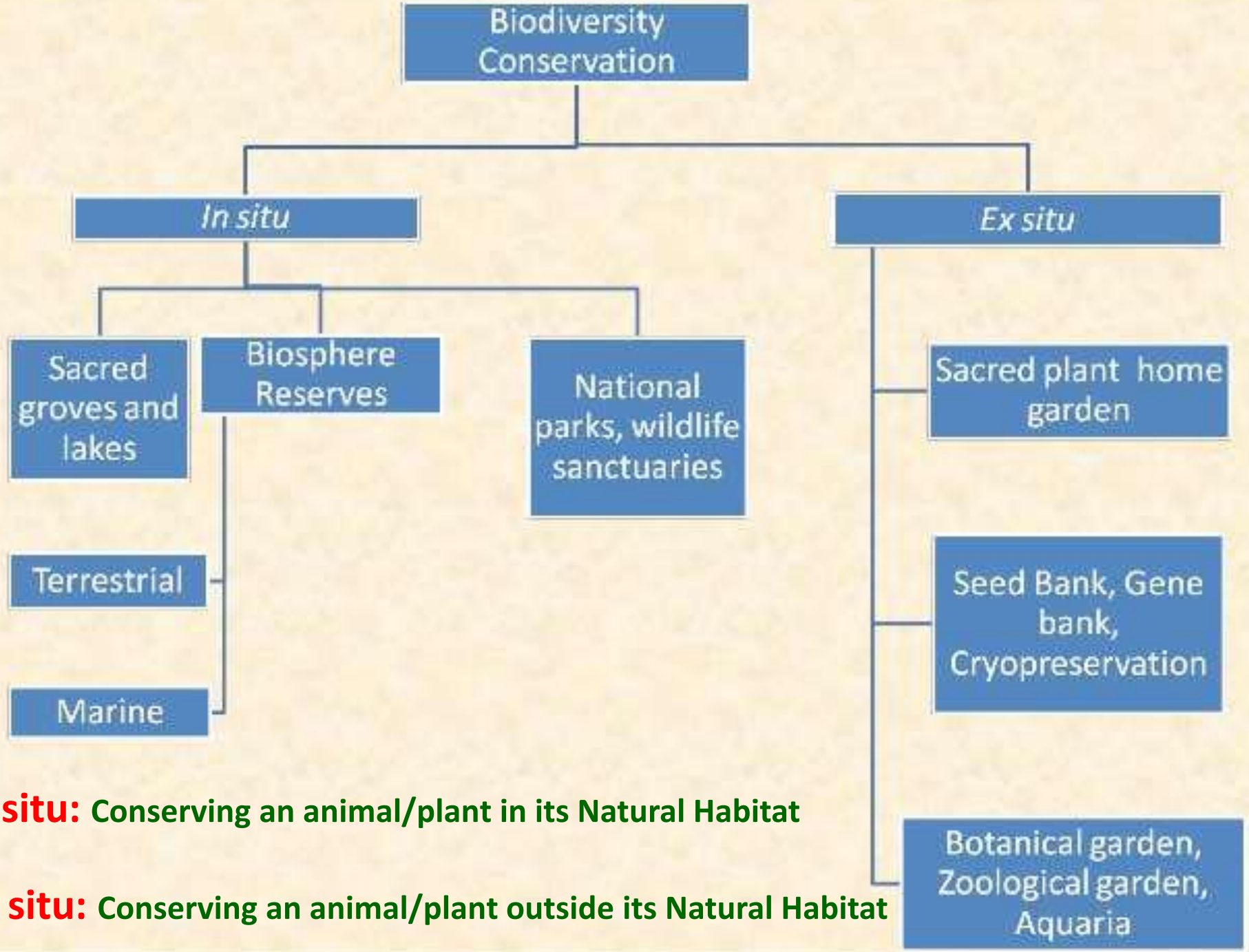

BIODIVERSITY
MATTERS
IN BIODIVERSITY IS THE HEALTH OF THE WORLD



In situ: Conserving an animal/plant in its Natural Habitat

Ex situ: Conserving an animal/plant outside its Natural Habitat

What is species?

- In biology, a **species** is one of the basic units of biological classification .

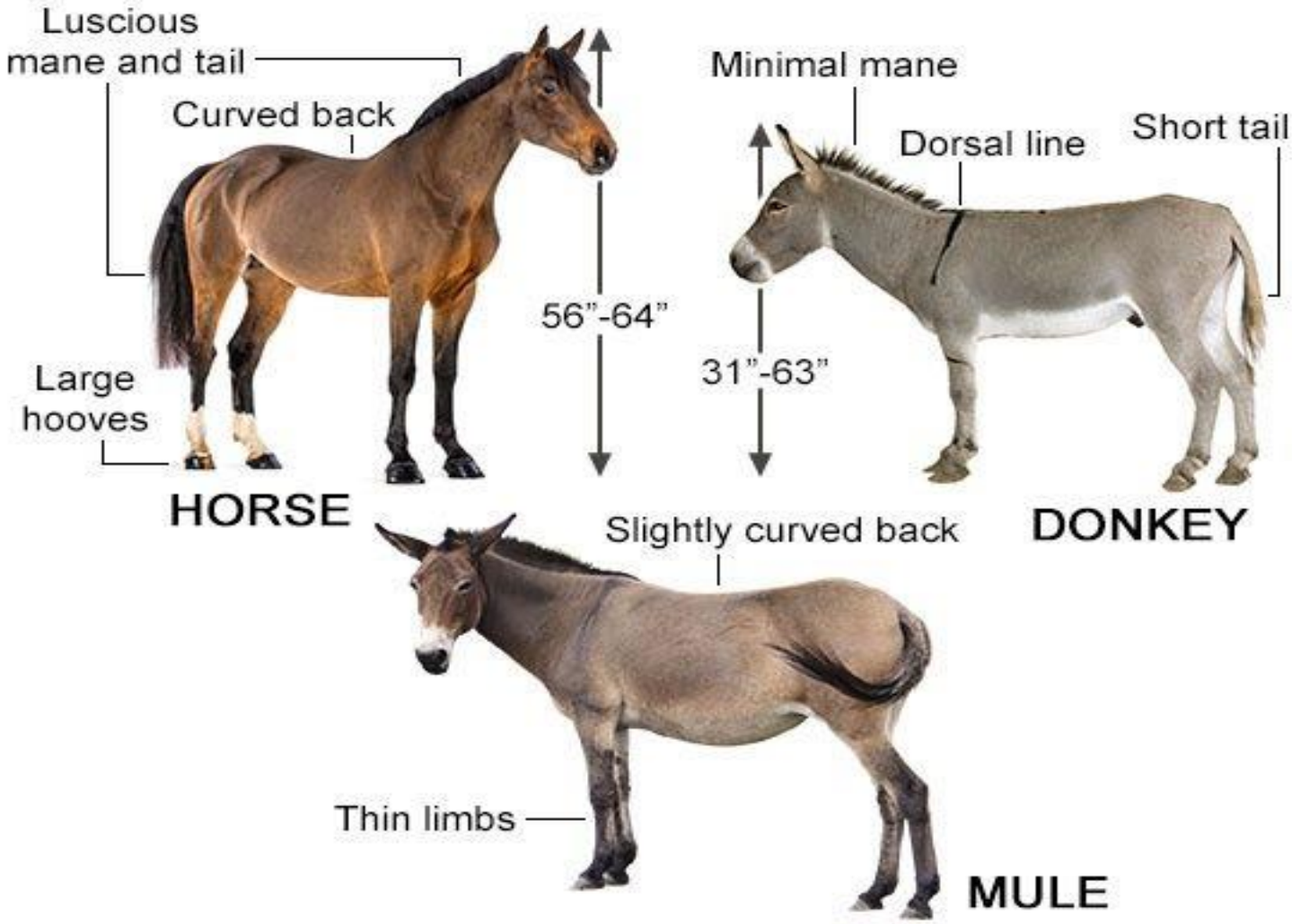
- A species is often defined as a group of organisms capable of interbreeding and producing fertile offspring.

Example : 1

- The Cross between Tiger & Lion is Liger
- Liger is not fertile i.e. It can not produce further ofsprings
- Hence Tiger and Lion do not belong to same Species

Example : 2

- **The Cross between Horse & Donkey is called Mule**
- **Mule is not fertile i.e. It can not produce further offsprings**
- **Hence Horse and Donkey do not belong to same Species**



Definitions

Extinct

- Species species of plant or animal that is no longer living.

Endangered

- Species in immediate danger of becoming extinct and needs protection to survive.

Threatened

- Species is likely to become endangered if not protected

Animal Classification

Initially, an attempt was made to classify plants and animals on their habitat, distribution (air, land, and water), beneficial and harmful basis.

Aristotle (384-332 B.C.) who is known as "Father of Zoology" classified animals on the basis of their morphology and categorized into three groups namely as:

1. **Verms**
2. **Insecta**
3. **Vertebrata**

He classified a total of 520 species of animals in his book **"Histiria Animalium".**

John Ray (1627-1705) was first coined the term **“Species"** and described 18000 plants in his book **entitled "Historia Generalis Plantarum"** which was published in three volumes between 1686 to 1704. He was the first person who made a differentiation between genus and species.

Theophrastus (370-385 B. C.), who was the student of Plato and Aristotle known as **"Father of Botany" classified 480 plants into four groups into his famous book "Historia Plantarum".** These four groups as follows:

1. **Trees**
2. **Shrubs**
3. **Under shrubs**
4. **Herbs**

- However, it was followed by a Swedish Naturalist **Carolus Linnaeus (1707-1778),** who used **"Binomial Nomenclature"** system of classification instead of using common name of plants and animals both in his famous book entitled **"Systema Naturae".**

- **He listed 9378 species of** plants and animals in his book which had published in **1735.** Because of using a scientific system of classification firstly, Carolus Linnaeus has been crowned with the title of **"Father of Modern Taxonomy".**

- **TAXONOMY: (Gk., Taxis -arrangement, nomos - law).** The term taxonomy was first **coined by A. P. de Candolle** in **1813**.

- **Taxonomy may be defined as the branch of science which deals with the identification, nomenclature and classification of any plant or animal all over the world is called taxonomy.**

The study of taxonomy can be done under the following headings:

1. **IDENTIFICATION:** To determine the exact place or position of any plant or animal according to the system of classification (systematics) is called identification.

2. **NOMENCLATURE:** Nomenclature may be defined as a process of giving a name to plants and animals according to the systematics.

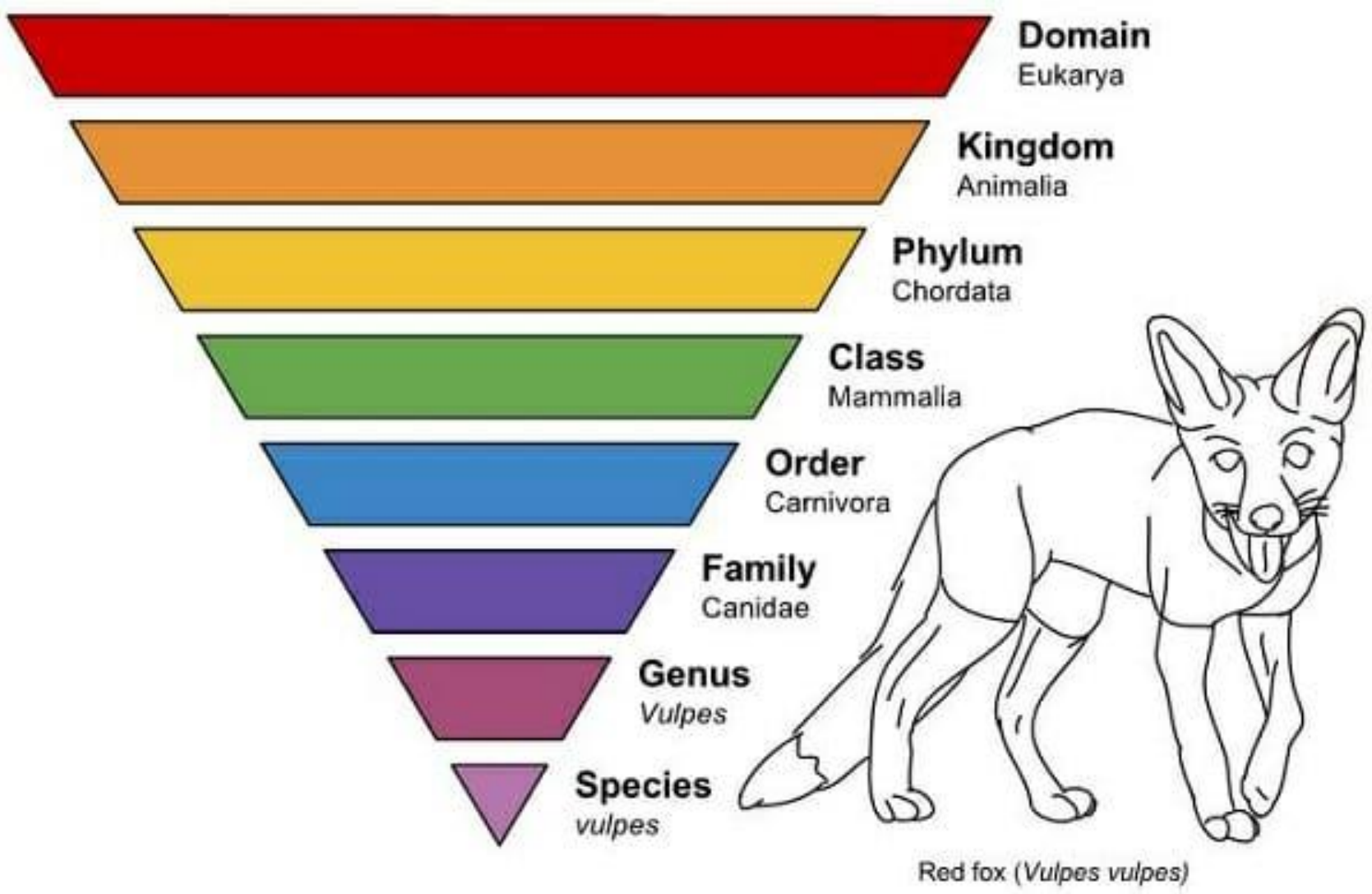
3. **CLASSIFICATION:** Classification may be defined as a system of arrangement of individuals into various categories which exhibit a relationship with each other.

4. **KEY:** Those distinguishing or diagnostic characters which help in the identification of any plant or animal in the systematics are called key.

Organisms are grouped together into **Taxa (singular: taxon)** and these groups are given a taxonomic rank. Groups of a given rank can be aggregated to form a super group of lower rank, thus creating a **taxonomic hierarchy.**

The Swedish botanist **Carl Carolus Linnaeus** is regarded as the **"Father of Taxonomy",** as he developed a system known as **Linnean classification** for categorization of organisms and **Binomial Nomenclature** for naming organisms.

The taxonomic hierarchy or hierarchy of categories was first established by Linnaeus (1758) in the animal kingdom. The seven major categories, in descending order, are:



TYPES OF TAXONOMY

1. **α (ALPHA) TAXONOMY:**

   If taxonomy is concerned with characterization and naming of any species is called alpha-taxonomy.

2. **β (BETA) TAXONOMY:**

   If taxonomy is concerned with the arrangement of species according to the law of systematics is called beta taxonomy.

3. **γ (GAMA) TAXONOMY:**

   Ultimately when taxonomy is concerned with some biological aspects like texa, evolutionary rate and trends then it is called gamma taxonomy.

- Zoological nomenclature is a language that we use to communicate ideas and information about the diversity of life. It is an information retrieval system conveying information about diversity and relationships.

- In 1898 International Congress of Zoology organized an International Commission of Zoological Nomenclature and suggests some rules and regulations for nomenclature.

- These rules were revised in 1948 and 1950 in International Congress of Zoology and International Congress of Botany respectively.

- 12th International Congress on Nomenclature in 1975 laid down some general principals in the form of **International Code of Botanical Nomenclature (ICBN)** and **International Code of Zoological Nomenclature (ICZN)** which are as followings:

1. **Binomial and Trinomial** system of nomenclature should be adopted.
2. Name of the **genus should start with capital** letter followed by **species with small letters.**
3. The name of the genus should be a **single word** and should not be difficult and long.
4. Genus name should be read as a **generic name** followed species as a **specific name.**
5. The scientific name must be derived from **Latin language only.**
6. The scientific name must be always written in **italics** or **underlined only.**
7. In scientific name **first word will be** represented by **genus** and **second and third** (if present) will be represented as **species and subspecies** respectively.

8. The plants and animals should have **independent and different names.**
9. Within animal kingdom **no two genera should have the same name** and within the genus, **no two species should have the same name.**
10. A scientific name must have its original spellings and errors must be corrected.
11. The name of author should be written in **Roman script after the species without comma** between them.
12. The scientific name should be **easy to pronounce.**
13. The scientific name should not have less than **three and not more than twelve letters.**
14. The scientific name of plant or animal should be **self explanatory in its characters.**

15. Every species should have a **generic name.**
16. Other components of taxonomy like **phylum, class, order** should also start with a **capital letter.**
17. Species should not be identified with its size.
18. The name of **family should start with capital letter** and should be suffix –**IDEA** and **subfamily by INAE.**
19. The generic or specific name first published is the only one recognized. All duplicate names are **synonyms.**
20. The formations of family and subfamily names follow rules which are different in the **Zoological and Botanical Codes.**
21. A name may be based on **any part of an animal or a plant, or on any stage of an Organism's life history.**
22. In case of discovery of different name of same genus and species by different Scientists, the name **first published should be accepted.**

RULES FOR SCIENTIFIC NAMES

1. **Each organism to be given a single scientific name. However, species having subspecies,** varieties or races are given a **trinomial name.**

2. The scientific name should be printed in **italics. (If handwritten or typed, the name is underlined).**

3. The first (generic) name should always begin with **capital letter. It is often abbreviated** by using only its first initial. For example; *C. familiaris for Canis familiaris (dog).*

4. **The first letter in a species should always begin with a small letter.**

5. The names of the division above the genus are not printed in italics. However, they are started with a **capital letter. For example: The order and the class of humans are written** as **Primates and Mammalia respectively.**

6. The generic name appears **only once whereas the specific name may appear many times,** but each time with a separate genus. For example: *Mangifera indica and Tamarindus indicus are the names of mango and tamarind respectively.*

7. **Two species belonging to the same genus cannot have the same specific name.**

Sometimes, the scientific name is also written in the honor of scientist is followed by a specific name.

- If the person honored is a man the specific name ends in **"i".** For example, the earthworm, ***Lumbricus friendi*** *is named after Rev.* ***H. Friend.***
- *If the person honored is a woman, the specific* name ends **"ae".**
- Sometimes, the specific name indicates a locality as **indica for India** or color as **niger for black** etc…

1. **ICZN: International Code of Zoological Nomenclature (1999)**
2. **ICBN: International Code of Botanical Nomenclature (1994)**
3. **ICNB: International Code of Nomenclature of Bacteria (1976)**
4. **ICNCP: International Code of Nomenclature for Cultivated Plants (1980)**

Trinomial Nomenclature

Whenever the system of nomenclature is usually adopted by three words called trinomial nomenclature. There are some species which contain subspecies.

Subspecies is generally followed by species and also written in Latin word always. These subspecies usually found in the different region of the world containing different characteristics.

For example, the common specific name of crow is ***Corvus splendens,*** but its three species are generally found in **India, Burma,** and **Sri Lanka.**

- ✓**In India**, it is named as ***Corvus splendens splendens.***
- ✓*in* **Burma *Corvus splendens insolens.***
- ✓and in ***SriLanka, Corvus splendens protegatus.***

Sometimes, the name of a scientist is followed by trinomial nomenclature as ***Columba livia intermedia Strickland*** *(Prof. Strickland),* ***Panthera leo persica Linn****. etc. The scientific names* provided are often descriptive and also indicate some important characteristics of the organisms.

Advantages of using scientific names for an organism are as follows:

1. **The scientific name remains the same worldwide, hence is easily recognizable.**

2. **The possibility of confusion due to multiple names were given to the same organism in different parts of the world is eliminated by scientifically naming the organism.**

3. **A relationship between different species of organisms in a particular genus can be deduced by scientific names.**

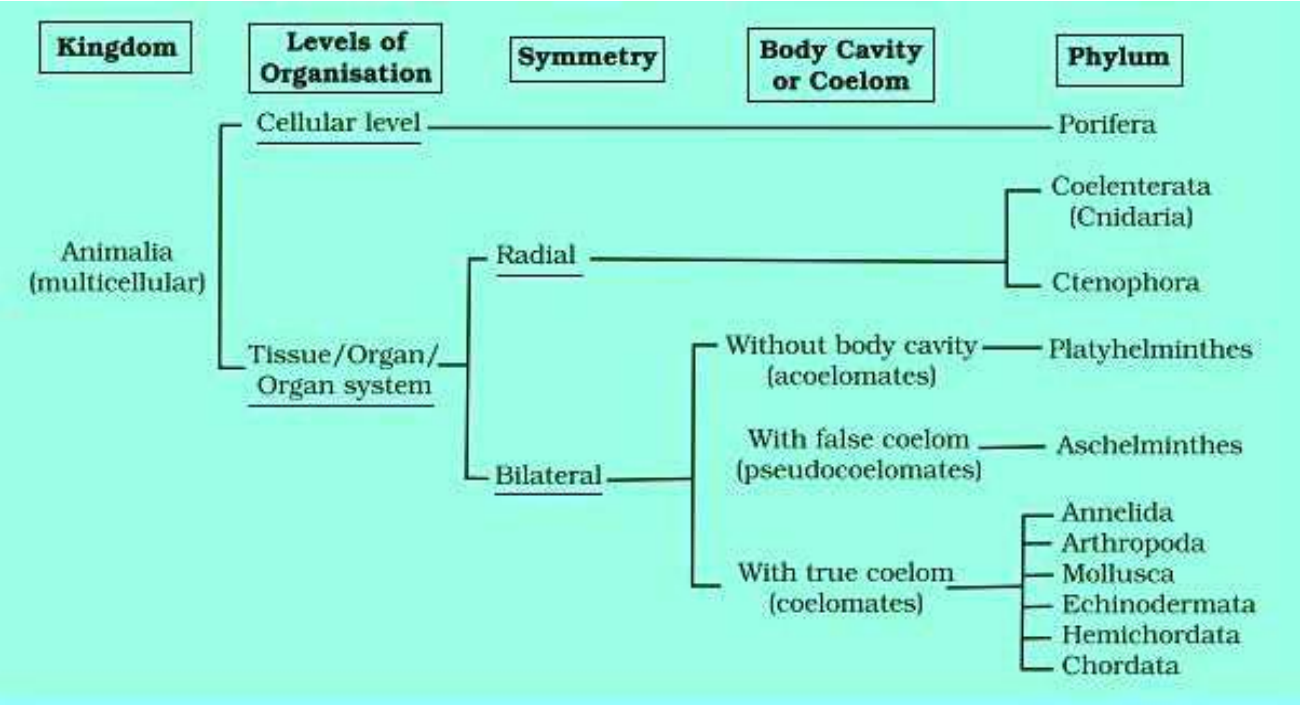
4. **It also helps in recognizing or identifying any new organisms discovered.**

5. **Any incorrect name to a particular organism can be corrected.**

PRINCIPLES OF CLASSIFICATION

The broad classification of Animalia or animal kingdom is based on the following common fundamental features.

- **Levels of Organisation**
- **Symmetry**
- **Diploblastic and Triploblastic Organisation**
- **Coelom Development**
- **Segmentation of the Body**
- **Presence or Absence of Notochord**



Levels of Organisation

Though all members of Animalia are multicellular, all of them do not exhibit the same pattern of organisation of cells.

For example, in sponges, the cells are arranged as loose cell aggregates, i.e., they exhibit cellular level of organisation. Some division of labour (activities) occur among the cells.

In coelenterates, the arrangement of cells is more complex. Here the cells performing the same function are arranged into tissues, hence is called tissue level of organisation.

A still higher level of organisation, i.e., organ level [organ level of organisation] is exhibited by members of Platyhelminthes and other higher phyla where tissues are grouped together to form organs, each specialised for a particular function.

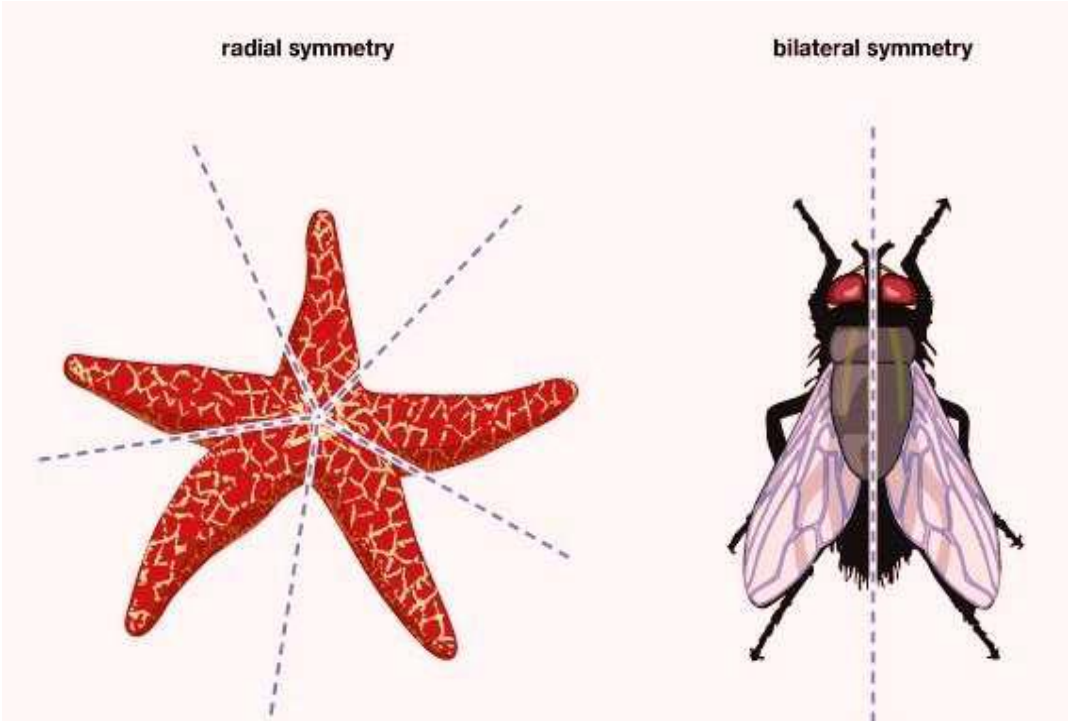
In animals like Annelids, Arthropods, Molluscs, Echinoderms and Chordates, organs have associated to form functional systems, each system concerned with a specific physiological function. This pattern is called organ system level of organisation.

Symmetry

Animals can be categorised on the basis of their symmetry. Sponges are mostly asymmetrical, i.e., any plane that passes through the centre does not divide them into equal halves.

When any plane passing through the central axis of the body divides the organism into two identical halves, it is called radial symmetry. Coelenterates, Ctenophores and Echinoderms have this kind of body plan.

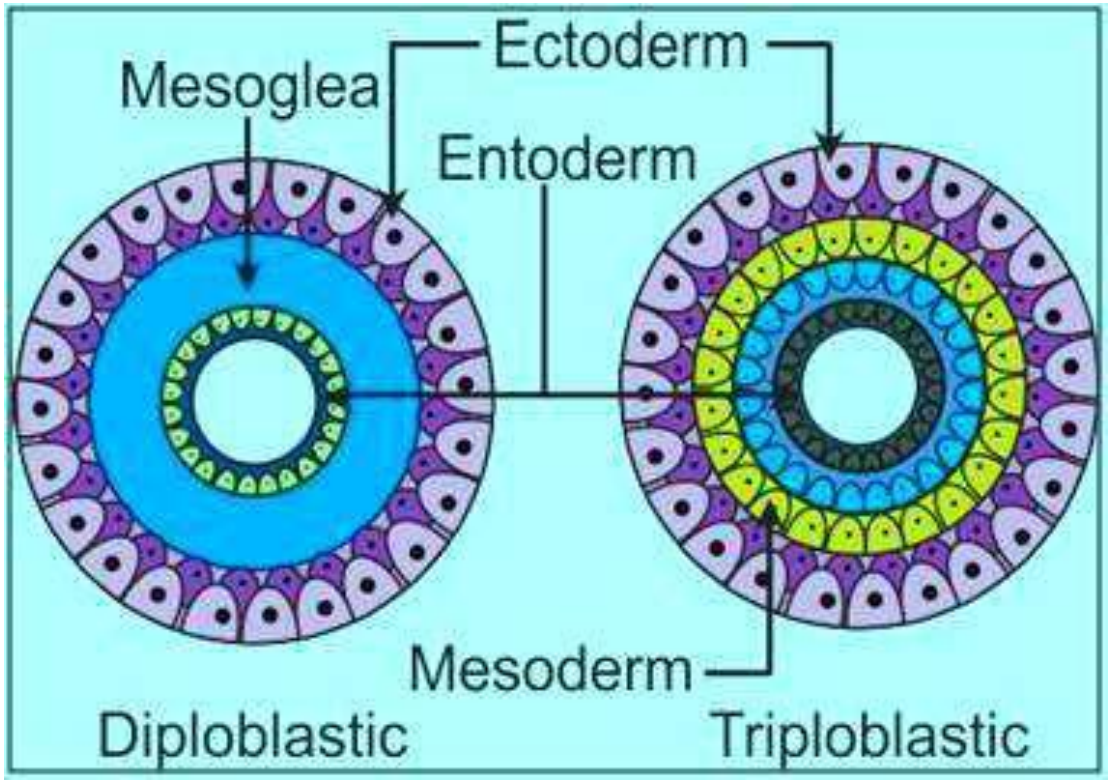
Animals like Annelids, Arthropods, etc., where the body can be divided into identical left and right halves in only one plane, exhibit bilateral symmetry.



Diploblastic and Triploblastic Organisation

Animals in which the cells are arranged in two embryonic layers, an external ectoderm and an internal endoderm, are called diploblastic animals, e.g., Coelenterates.
An undifferentiated layer, mesoglea, is present in between the ectoderm and the endoderm.

Those animals in which the developing embryo has a third germinal layer, mesoderm, in between the ectoderm and endoderm, are called triploblastic animals (Platyhelminthes to Chordates).



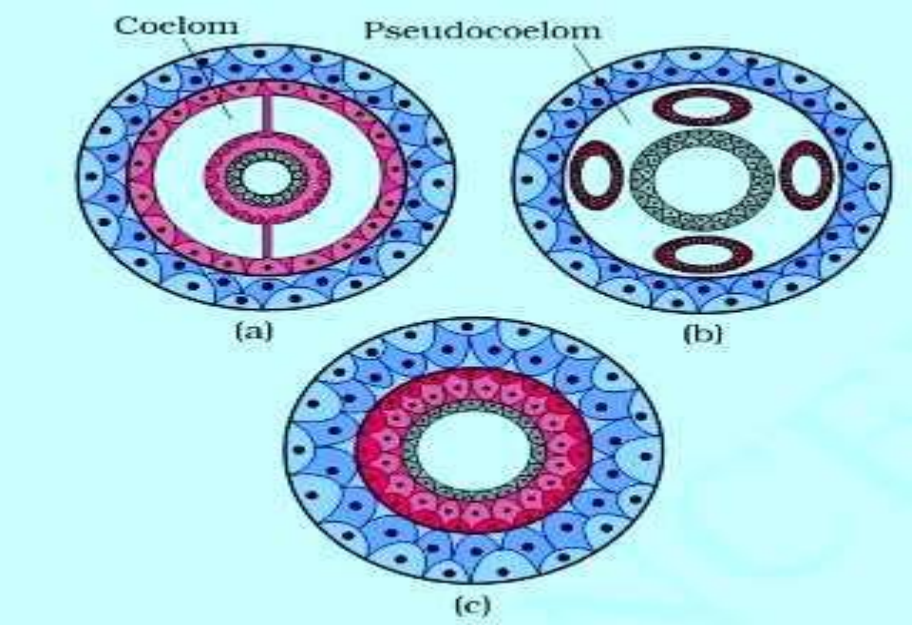
Coelom

Presence or absence of a cavity between the body wall and the gut wall is very important in classification. The body cavity, which is lined by mesoderm is called coelom.

Animals possessing coelom are called coelomates, examples include Annelids, Molluscs, Arthropods, Echinoderms, Hemichordates and Chordates.

In some animals, the body cavity is not lined by mesoderm, instead the mesoderm is present as scattered pouches in between the ectoderm and endoderm. Such a body cavity is called pseudocoelom and the animals possessing them are called pseudocoelomates, example includes Aschelminthes.

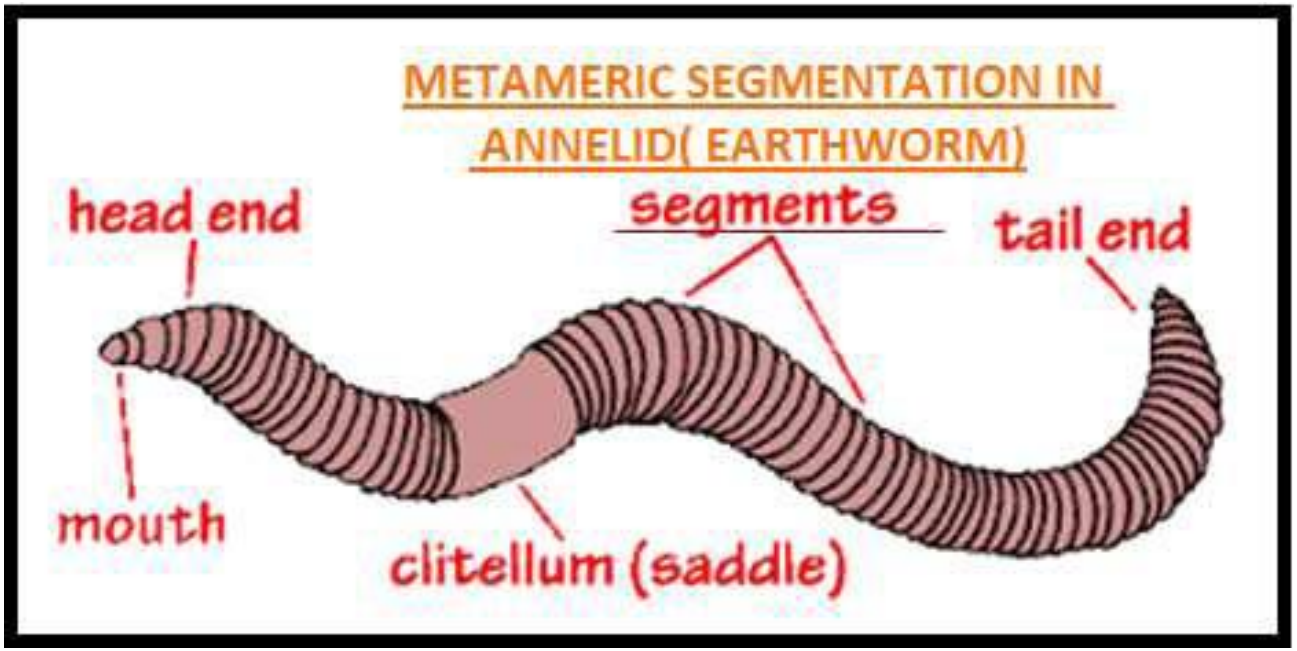
The animals in which the body cavity is absent are called acoelomates, such as Platyhelminthes.



Segmentation

In some animals, the body is externally and internally divided into segments with a serial repetition of at least some organs.

For example, in earthworm, the body shows this pattern called metameric segmentation and the phenomenon is known as metamerism

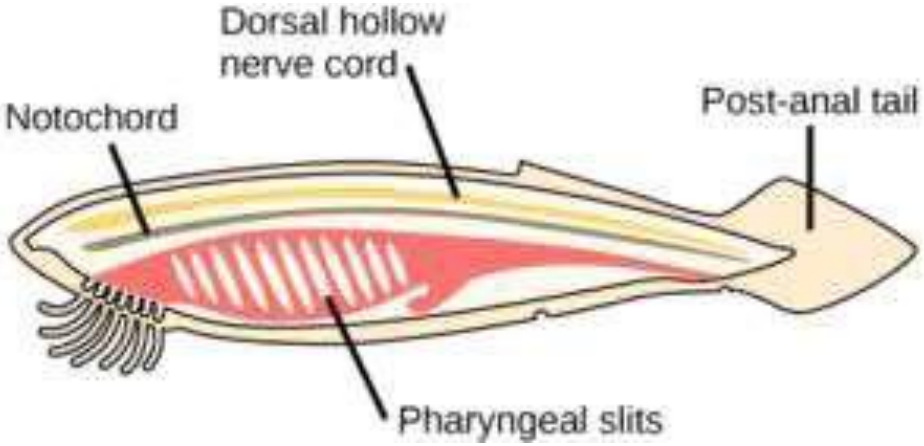


Notochord

The notochord is a flexible rod made out of a material similar to cartilage. If a species has a notochord at any stage of its life cycle, it is, by definition, a chordate.

In vertebrates the notochord becomes part of the vertebral column. Notochord is typically a mesoderm, i.e., the middle layer of cells or tissues of an embryo, or the parts derived from this, such as cartilage, muscles, and bone. These are the derived rod-like structure formed on the dorsal side [posterior] during embryonic development in some animals.

Animals with notochord are called chordates and those animals which do not form this structure are called non-chordates, namely Porifera to Echinoderms.



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