LEVELS OF BIOLOGICAL ORGANIZATION CLASSIFICATION AND CHARACTERISTICS OF LIVING THINGS

BIO 101

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LEVELS OF ORGANIZATION

- This is the hierarchical arrangement of biological structures and systems
- The biological levels of organization of living things arranged from the simplest to most complex are:
  - organelle, cells, tissues, organs, organ systems, organisms, populations, communities, ecosystem, and biosphere

- The Cell is the smallest structural and functional unit of living organisms
- The Biosphere is the largest

Cells • Life’s fundamental unit of structure and function • unicellular • multicellular

Organelles • Functional components within a cell

Molecules and Atoms •

Molecule - A chemical structure consisting of two or more small chemical units called atoms

Atom – the smallest unit of matter that retains the chemical properties of an element

IMPORTANCE OF COMPLEXITY

- The complexity of organization in multicellular organisms is significant because
  - it allows for greater specification and
  - efficiency of different cell types within an organism leading to increased survival and reproductive success
  - Emergence complexity/ Emergent property – complex systems or patterns arise from the interaction of simpler components
    - When units of biological materials are put together, the properties of the new materials are not always additive or equal to the sum of the properties of the components. Instead, at each level, new properties and rules emerge that cannot be predicted by observation and full knowledge of the lower levels. e.g Macromolecules and whole organism
  - **The concept of integrative levels of organization believe that units of matter are organized and integrated into levels of increasing complexity**

INTEGRATIVE LEVELS OF ORGANIZATION

Does emergence only stop at the organism level? • No –populations can work together to carryout complex activities – think of a colony of Ants; emergent properties are present at all levels of life

Reductionism vs. Systems

• Reductionism - Reducing complex systems to simpler components that are more manageable to study •

Systems Biology – attempts to model the dynamic behavior of whole biological systems based on a study of the interactions among the system's parts

Reductionism could allow for the discovery of a drug that lowers blood pressure –

Systems biology would make sure that the drug did not have an adverse affect on the rest of the body.

CLASSIFICATION OF LIVING THINGS

- a true classification system for the diversity of life is more like a branching tree than a stairway to perfection.
- Plants are not inferior to animals, for example, but have simply taken a different strategy towards survival.
- All organisms alive today are successfully adapted to their respective environments, since they have stood the test of time.
- In fact, there are even some extinct forms, like the trilobites and the dinosaurs, that lived for so long that you could hardly call them failures.

LINNAEUS CLASSIFICATION SYSTEM

- The Linnaean classification system provides a hierarchical structure for the naming and classification of all living beings. It is used to classify species of animals along different classification levels (called taxa).
- It is important because it provides a universal system of classification common to all scientists, and because it allows close relations between living organisms to be examined.
- Linnaeus' method of classification was based on similarities and differences.
  Kingdoms Phyla, Classes. Orders. Families. Genera, Species.

IMPORTANCE OF CLASSIFICATION

- REASONS FOR CLASSIFICATION

  Studying just 1 or 2 organisms is not enough to know vital features of a group.

  • All kinds of organisms do not occur in one locality.

  • Helps in knowing the relationship between the different groups of organisms.

  • Helps in knowing the evolutionary relationship between organisms

CLASSIFICATION SYSTEMS

- A. Two Kingdom Classification System proposed by Linnaeus (1758)
- He is also known as the father of taxonomy system
- He divided all the living organisms into two kingdoms.
- These are Plantae and Animalia.

CLASSIFICATION SYSTEM

B. Three Kingdom Classification System

- In the year 1866, Ernst Haeckel, classified living organisms into three kingdoms i.e. Plantae, Protista, and Animalia. The new kingdom Protista included all those organisms, which lack the capability of tissue differentiation. This group included algae, fungi, and Protozoa. Later, kingdom Protista was reserved only for the unicellular organism.
- Limitations of Three Kingdom Classification System
- No separation of Prokaryotes and eukaryotes.
- Both unicellular and multicellular organisms are classified under Protista.

CLASSIFICATION SYSTEM

C. Four Kingdom Classification System proposed by Copeland (1956)

- In addition to Protista, Plantae and Animalia, the four kingdom classification system included Monera.
- The studies with electron microscope made it clear that bacteria and related organisms have a different nuclear structure as compared to others.
- These are the prokaryotes
- Introduction of the kingdom-Monera.
- Fungi continued to remain with Plantae in this system.

CLASSIFICATION SYSTEM

D. Five Kingdom Classification System proposed by R.H. Whittaker (1969)

- Separate group for fungi.

The primary criterion for classification here were:

- Cell structure
- Modes of nutrition
- Reproduction
- Thallus organization
- Phylogenetic relationships

CLASSIFICATION SYSTEM

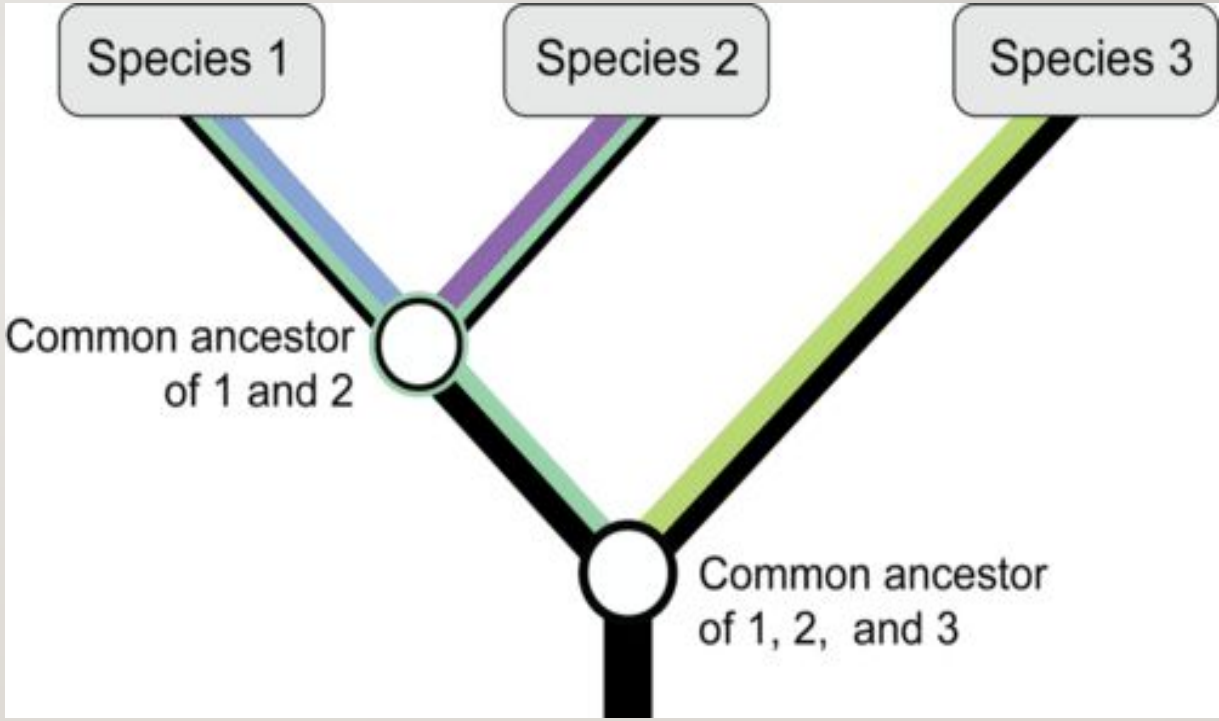
- E. Six Kingdom Classification System proposed by Carl Woese (1990)
- It was also known as the three-domain system as in it organism classification was done in three domains, i.e., Archaea, Bacteria and Eukarya.
- It majorly used the basic principles of the five kingdom system but divides the Monera into two domains
  - Archaebacteria,
  - Eubacteria and
  - other eukaryotes in the third kingdom.

ARCHAEBACTERIA, BACTERIA AND EUKARYA

- 1. Archaea; Archaea domain includes prokaryotic organisms. These have a monolayer core of lipids in the cell membrane and distinct nucleotides in their 16S RNA. It contains a single kingdom called Archaebacteria. This kingdom includes early prokaryotes. These are methanogens, halophiles and thermoacidophiles.
- 2. Bacteria: The bacteria domain consists of typical prokaryotes that lack membrane covered cell organelles. These do not have microchambers for separating various metabolic activities. It also has a single kingdom-Eubacteria.
- 3. Eukarya: The domain eukarya contain all the eukaryotes.
- The four kingdoms of this domain are: Protista, Animalia, Plantae, Fungi

PHYLOGENY AND CLADISTICS

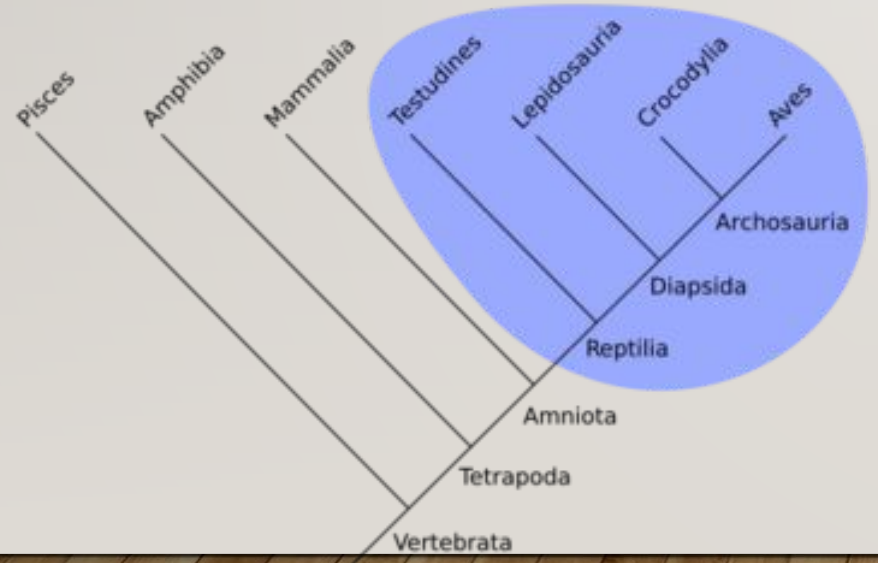
- Phylogeny is a kind of classification in which organisms can be classified with the help of their basic physical traits
- Phylogeny involves making groups with the help of physical characteristics of organisms, but cladistics talks about the actual traits of the organisms
- Phylogeny is presented with the help of a tree diagram known as a phylogenetic tree. It's a pattern in use to show the evolutionary past of organisms.
- Cladistics is a method of hypothesizing relationships among organisms
- Cladistic classification includes the comparison of traits of one species with another and finding similarities among ancestors to create a relationship

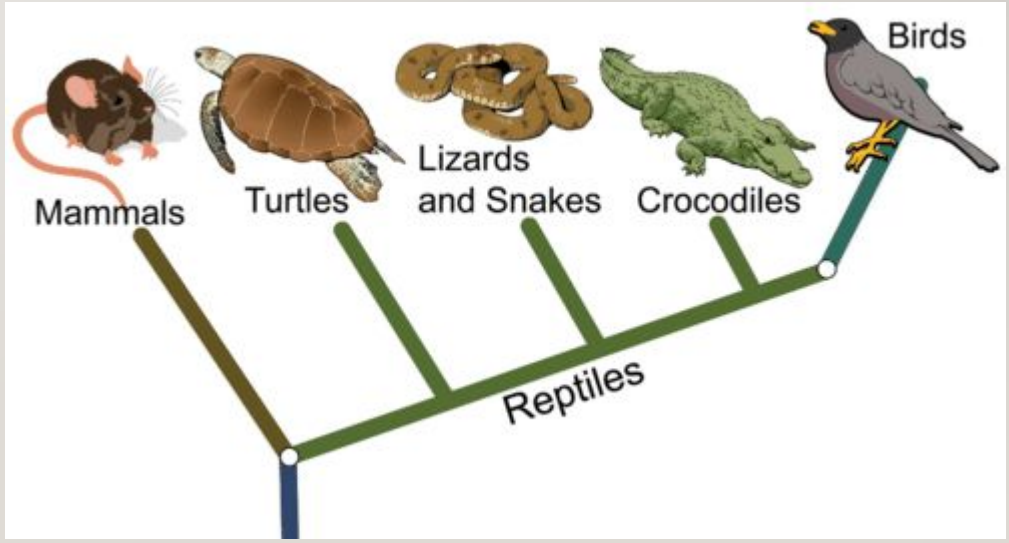


Phylogenetic tree

CLADISTICS

- Clades are based on cladistics classification.
- A clade is a group of organisms that includes an ancestor and its descendants.
- Types: Monophyletic, Paraphyletic and Polyphyletic





- **Monophyletic:** monophyletic clades means a group of organisms with a single clade in it. Here you will find only one ancestor for many descendants.
- **Paraphyletic:** this clade includes an ancestor and multiple descendants, removing some 2-3 groups.
- **Polyphyletic:** in this clade, organisms possess homoplasy traits. It means organisms in a group show similar characteristics, but they don't.

CHARACTERISTICS OF ANIMALIA
FEATURES OF KINGDOM ANIMALIA

- The cell wall is absent.
- There are no inorganic crystals present in their cells.
- Central vacuole is absent.
- Growth is limited and well-defined growing points are not present.
- Heterotrophic mode of nutrition is used.
- Show quick response to external stimuli.
- The muscular system is present.
- Locomotion is present.
- Excretory organs, nervous system and sense organs are present.
- Reserve food as glycogen.

CHARACTERISTICS OF PLANTS
FEATURES OF KINGDOM PLANTAE

- They have a cell wall.
- Autotrophic mode of nutrition is followed. The reserve food is starch.
- A big central vacuole is present.
- There aren't any excretory organs, nervous system, sense organs and muscular system.
- No locomotion is seen except in some lower algae.
- Plantae absorbs inorganic nutrients from outside.
- They experience unlimited growth but have well-defined growing points.
- The response to external stimuli is slow.

- **Kingdom-Eubacteria**
- The members of this kingdom have peptidoglycan cell wall, naked DNA in coiled form, glycogen food reserves.
- There is no sap vacuole and 70S ribosomes are present.
- The members of this kingdom are bacteria, mycoplasma, Actinomycetes, rickettsiae, spirochaetes, cyanobacteria, Firmicutes.

SOMETHING TO THINK ABOUT

How are clades classified

Why is it important to classify organisms

How can we consider two animals to belong to same species