# Chapter no. 1 Principles of classification



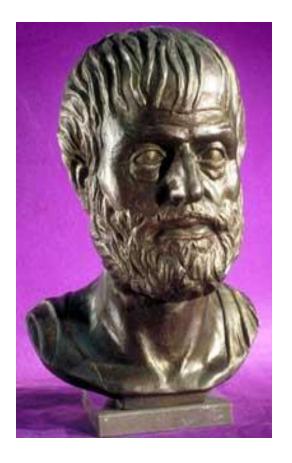
1.1 Systematic- Linnean hierarchy

1.2 Binomial nomenclature

1.3 Five kingdom classification

### Introduction

- Taxonomy is the branch of biology that names and groups organisms according to their characteristics and evolutionary history.
- Organisms were first classified more than 2,000 years ago by the Greek philosopher Aristotle.



Organism's were grouped into land dwellers, water dwellers, and air dwellers.

- Plants were placed into three categories based on the differences in their stems.
- As new organism's were discovered, his system became inadequate.
  - Categories were not specific enough.
  - Common names did not describe a species accurately.
  - Names were long and hard to remember.
- Carolus Linnaeus (mid-1700')s was a Swedish biologist who established a simple system for classifying and naming organisms.
- He developed a Hierarchy (a ranking system) for classifying organisms that is the Basis for Modern Taxonomy.

For this reason, he is considered to be "father" of modern taxonomy.

Linnaeus used an organisms morphology (form and structure), to categorize it.

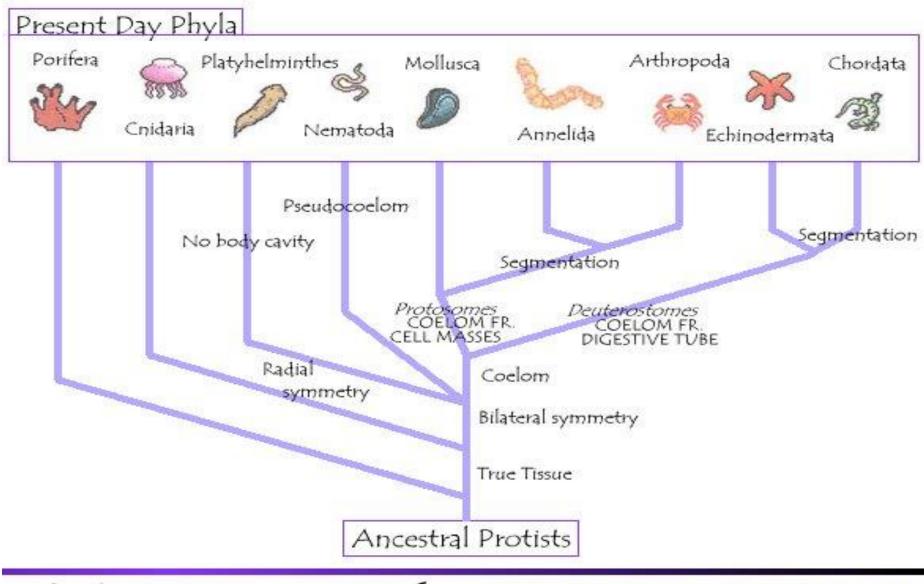
His system is still being used today. His system allowed organisms to be grouped with similar organisms.

He first divided all organisms into two Kingdoms, Plantae (Plants) AND Animalia (animals).



## **Systematics**

- <u>Systematics</u> is a system that organizes the tremendous diversity of organisms into a <u>phylogenetic</u> tree.
  - A phylogenetic tree is a family tree that's shows the evolutionary relationships thought to exist between organisms.
  - It represents a hypothesis that is based on lines of evidence such a the fossil record, morphology, embryological patterns of development, and chromosomes and macromolecules.



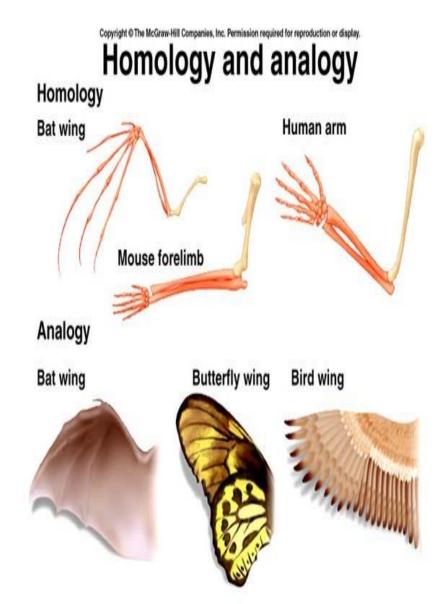
Phylogenetic Tree of KINGDOM ANIMALIA

# The Fossil Record

- The fossil record often provides clues to evolutionary relationships
- It can not be read like a story book because some fossil records are incomplete
- Systematic taxonomists consider other evidence to confirm information contained within the fossil record with other lines of evidence, like...

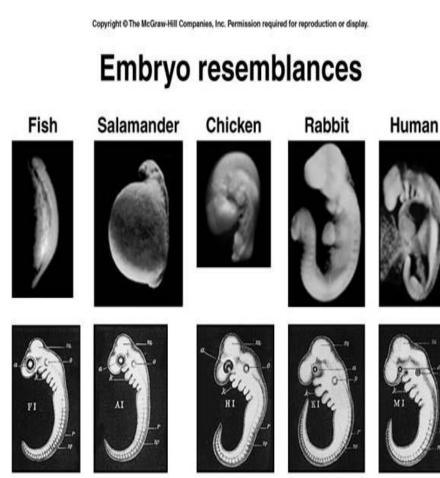
# Morphology

- Taxonomists study an organism's morphology and compare it to other living organisms.
  - Homologous features are important but it is important to separate features that are truly homologous with those the seem homologous but are actually analogous.
  - The more homologous features two organisms share, the more closely related they are thought to be.



# Embryological Patterns of Development

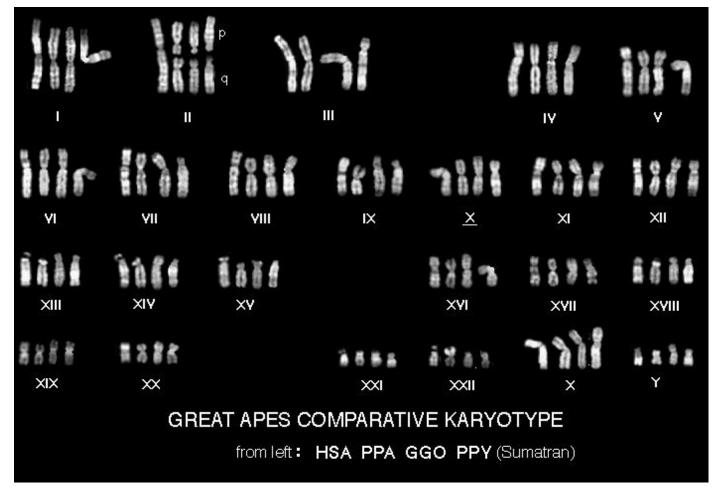
- Early pattern in embryological development provide evidence of phylogenetic relationships.
- They also provide means of testing hypotheses about relationships that have developed from other lines of evidence



# Chromosomes and Macromolecules

- Taxonomists use comparisons of macromolecules such as DNA, RNA, and proteins as a kind of "molecular clock".
- Scientists compare amino acid sequences for homologous protein molecules of different species.
- The number of amino acid differences a clue to how long ago two species diverged from a shared evolutionary ancestor.

# Comparison of Karyotypes



Human (HSA), chimpanzee (PPA), gorilla (GGO), and orangutan (PPY) chromosomes are illustrated in a comparative karyotype of the great apes.

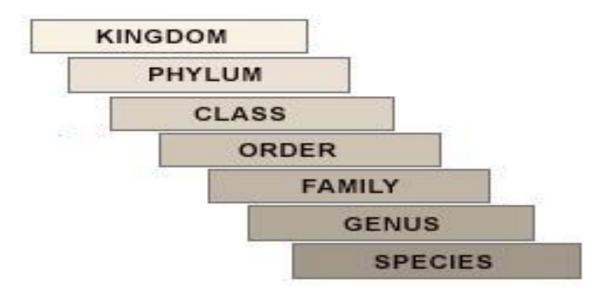
# Modern System a Nested Hierarchy-Seven Levels of Organization

- The Linnaean system of classification consists of a hierarchy of graded taxonomic (named) ranks that are called as **taxa**.
- Any given **taxon** (singular) may contain several lower taxa, which can be usually distinguished based on certain common characteristics.
- Such lower ranks may in turn be divided into a succession of progressively smaller ranks.
- The lower the rank of a group, the more similar are the organisms grouped in it.
- If any two given organisms can be grouped under the same lower rank or taxon, it implies that the two organisms are structurally, functionally, embryologically similar and that they have had a comparable evolutionary history.

- If any two given organisms can be grouped under the same lower rank or taxon, it implies that the two organisms are structurally, functionally, embryologically similar and that they have had a com.parable evolutionary history.
- Within the living world as a whole, the biggest taxonomic rank is **Kingdom**.
- The next higher rank within a kingdom is the **Phylum** or **Division**.
- It is customary to use the term phylum for major groups in the animal kingdom and the term division for major groups in the plant kingdom.
- The phylum or division is a broad grouping of more or less closely related organisms, sharing certain common characteristics.

- Each phylum or division has the next taxon called **Class**. The members of each class exhibit certain distinguishing characters that are unique only to them.
- In the same way, using comparable criteria of similarities and relationships, each class can be divided into **orders**, each order into **families**, each family into **genera** and each genus into **species**.
- Species is normally the basic or fundamental unit of classification. A species is therefore the narrowest taxonomic category and kingdom is the broadest category in the Linnaean hierarchy.

• A typical Linnaean hierarchy has seven taxa represented as follows:



#### Remember: King Philip Came Over For Grandma's Soup

#### **Classification Hierarchy of Organisms**

TABLE 18-1	Classification Hierarchy of Organisms		
	Bobcat	Lion	Shaggy mane mushroom
Kingdom	Animalia	Animalia	Fungi
Phylum/division	Chordata	Chordata	Basidiomycota
Class	Mammalia	Mammalia	Homobasidiomycetae
Order	Carnivora	Carnivora	Agaricales
Family	Felidae	Felidae	Copricaceae
Genus	Lynx	Panthera	Coprinus
Species	Lynx rufus	Panthera leo	Coprinus comatus
	1 /		









#### Classification of Modern Humans



Homo Homo Australosapiens erectus pithecus Gorilla Elephant Fish Sea star Snail



Includes chordates, sea stars, earthworms, snails, jellyfish, sponges, clams, and insects





Includes mammals, fishes, reptiles, birds, and amphibians





Includes primates and elephants, along with cats, dogs, horses, kangaroos, whales, bats, seals, dolphins, and many others

Order Primates



Includes members of the family Hominidae, along with prosimians, monkeys, and apes such as the gorilla

Includes the genus

Homo and the extinct genus Australopithecus

Family Hominidae



Genus Homo Includes Homo sapiens along with the extinct species Homo habilis and Homo erectus (shown here)

Species Homo sapiens Modern humans belong to the species Homo sapiens.

# **Binomial Nomenclature**

- Names were based on Latin or Ancient Greek words scientist everywhere understood these languages.
- The FIRST word of the Scientific Name (Species Name) is the name of the genus to which the organism belongs.
  - The Genus name refers to the relatively small group of organisms to which a particular type of organism belongs.
- The SECOND word of the name is the species. (Species identifier)
  - The Species name is usually a Latin description of some important characteristic of the organism.

# Rules for Writing Scientific Names

- When we use the Latin name for an organism, we ALWAYS capitalize the Genus (first part) but NOT the species identifier (second part).
- We also print the name in Italics or Underline them. For example:
  - Acer rubrum (scientific name) red maple tree (common name) or <u>Acer</u> r<u>ubrum</u>
    - Acer is the Latin name for Maple (genus)
    - rubrum is the Latin word for Red (species)
  - OR the name can be abbreviated as: A. rubrum
- Humans are named: Homo sapiens
  - Homo because of our large brain and upright posture.
  - sapiens because of our intelligence and ability to speak.

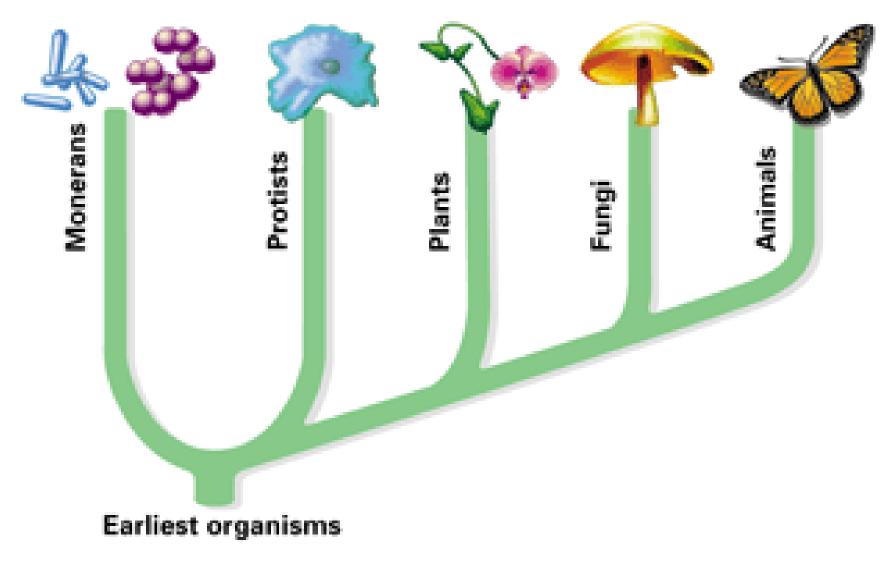
### **The Five Kingdom System of Classification**

In order to suggest a better system of classification of living organisms, **R.H. Whittaker** (1969) an American Taxonomist divided all the organisms into 5 kingdoms based on their phylogenetic relationships. This classification takes into account the following important criteria.

- Complexity of Cell structure prokaryote to Eukaryote
- Mode of nutrition autotrophs and heterotroph
- Body organization -unicellular or multi-cellular
- Phylogenetic or evolutionary relationship

The Five kingdoms are Monera, Protista, Fungi, Plantae and Animalia

#### Five-Kingdom System



### 1. Kingdom Monera

The Kingdom of Prokaryotes

- This kingdom includes all prokaryotic organisms i.e. mycoplasma, bacteria, actinomycetes(filamentous bacteria) and cyanobacteria (blue green Algae).
- They show the following characters.
- They are microscopic .
- They do not possess a true nucleus.
- They lack membrane bound organelles.
- Some bacteria are parasites and others live as symbionts.
- Their mode of nutrition is autotrophic

heterotrophic. Some bacteria are autotrophic and are photosynthetic. i.e. they can synthesize their organic food in the presence of sunlight

eg. Spirillum.

- Some bacteria are chemosynthetic i.e. they can synthesize their organic food by deriving energy from some chemical reactions. eg. *Nitrosomonas* and *Nitrobacter*.
- Many other bacteria like *Rhizobium*, *Azotobacter* and *Clostridium* can fix atmospheric nitrogen into ammonia. This phenomenon is called **Biological Nitrogen Fixation**.
- Some monerans like Archaebacteria can live in extreme environmental conditions like absence of oxygen (anaerobic), high salt condition, high temperature like 800c or above and highly acidic soils.

#### 2. Kingdom Protista

This kingdom includes eukaryotic unicellular mostly aquatic cells.

They show the following characters

- They have a typical Eukaryotic cell organization.
- They often bear cilia or flagella for locomotion.
- Mostof them are photosynthetic autotrophs.
- They form the chief producers of food in oceans and in fresh water.
- All unicellular plants are collectively called as phytoplanktons and unicellular animals as zooplanktons. Phytoplanktons are photosynthetically active and have cell wall.

- Zooplanktons are mostly predatory. They lack cell wall and show holozoic mode of nutrition as in Amoeba.
- Some protists are parasitic. Some are symbionts while others are decomposers.
- Euglena, a protozoan has two modes of nutrition. In the presence of sunlight it is autotrophic and in the absence of sunlight it is heterotrophic. This mode of nutrition is known as **myxotrophic** and hence they form a border line between plants and animals and can be classified in both.

### 3. Kingdom Fungi

- This kingdom includes moulds, mushrooms, toad stools, puffballs and
- Bracket fungi.
- They have eukaryotic cell organization. They show the following characteristics.
- They are either unicellular or multi-cellular organisms.
- Their mode of nutrition is heterotrophic since they lack the green pigment
- chlorophyll. Some fungi like *Puccinia* are parasites while others like *Rhizopus* are

saprotrophic and feed on dead organic matter.

- Their body is made up of numerous filamentous structures called hyphae.
- Their cell wall is made up of chitin.

### 4. Kingdom Plantae

- It includes all multi-cellular plants of land and water.
  Major groups of Algae, Bryophytes, Pteridophytes,
  Gymnosperms and Angiosperms belong to this kingdom.
- It shows the following characteristics.
- The cells have a rigid cell wall made up of cellulose.
- They show various modes of nutrition. Most of them are autotrophs since they have chlorophyll. Some plants are heterotrophs. For eg. *Cuscuta* is a parasite. *Nepenthes* and *Drosera* are insectivorous plants.

#### 5. Kingdom Animalia

- This kingdom includes all multi-cellular eukaryotic organisms.
- They are also referred to as metazoans.
- They show the following characteristic features.
- All animals show heterotrophic mode of nutrition. They form the consumers of an ecosystem.
- They have contractibility of the muscle cells.
- They can transmit impulses due to the presence of nerve cells.
- Some groups of animals are parasites eg. tapeworms and

### Merits of the Five Kingdom Classification

- It shows the phylogenetic relationships among the organisms.
- It is based on the complexity of the cell structure from prokaryotic to eukaryotic cell organization.
- It is based on the complexity of body organization from unicellular to multi-cellular.
- It is based on the modes of nutrition: autotrophic or heterotrophic mode of nutrition.

### Demerits of Five Kingdom Classification

*Chlamydomonas* and *Chlorella* are included under the kingdom Plantae. They should have been included under kingdom Protista since they are unicellular.