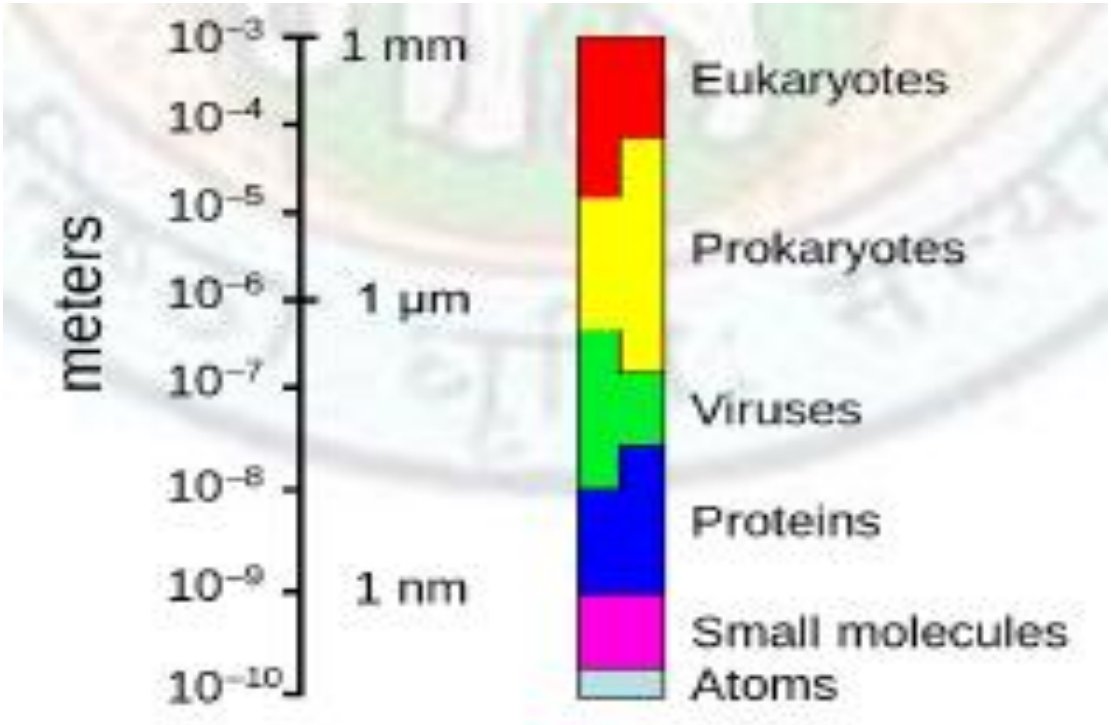
## *Taxonomy/Systematics*

The science for studying classification is called **Taxonomy** (*Greek: taxis = arrangement; nomos = law) AND is further divided into three working groups:* ***Classification****,* ***Identification*** *and* ***Nomenclature****.*

***Classification*** *: placing organisms within groups with members exhibiting similarities (structure, physiological or evolutionary relatedness). These groups are termed as* ***taxa (s. taxon)***

***Nomenclature*** *is assigning of scientific names to taxonomic groups in accordance with accepted rules.*

*The term* ***systematics*** *sometimes is referred synonymously with taxonomy. While****, taxonomy*** *is plainly referred to identification, classification and naming of organisms; systematics is the evolutionary history of organisms through time.*




**Some important facts about microorganisms are that:**

**⍰ The presence of microbes is ubiquitous**

**⍰ Most of the microbes are harmless to us. Instead, they help us by secreting various economically useful metabolites.**

**⍰ They keep the biosphere running by performing biodegradation and cycles of carbon, nitrogen, oxygen, sulfur, etc.**

**⍰ Microorganisms can also harm humans. They cause diseases in plants as well as animals and food spoilage.**

- The importance of taxonomy has been ever increasing.
- In 2000, a project called “All Species Inventory” was started (http://www.all-species.org/).
- Aim : to identify and record every species of life by 2025.
- Very challenging; till now 1.5 million species- identified
- Estimated mumber of species: between 7 to 100 million.
- For This mind boggling number : important of cataloguing the species in a proper and scientific way.
- Thus taxonomy is important for

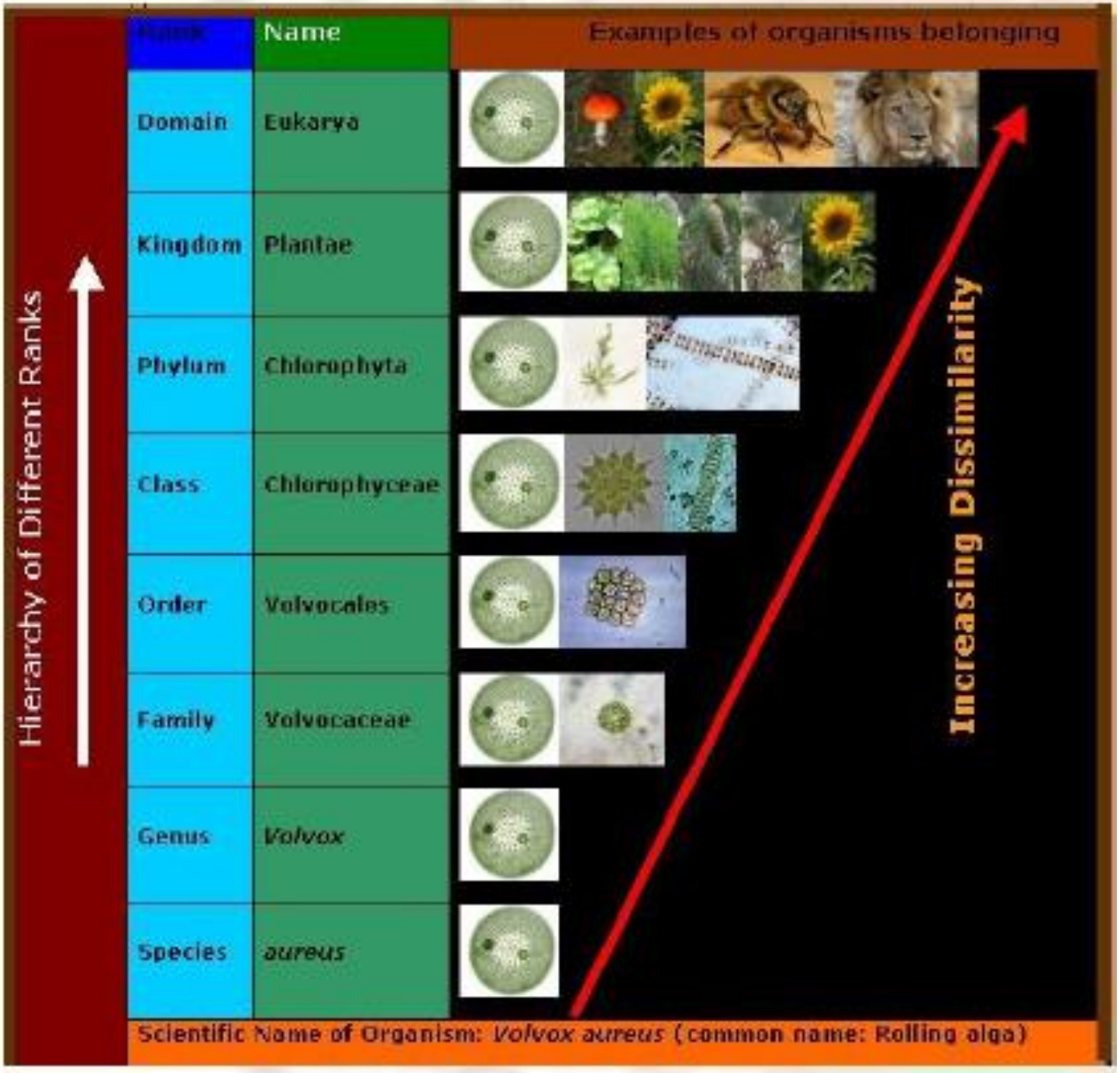
(i) effective communication among scientists about the identity of a particular microbe

(ii) catalogue a large number of species in a systematic manner,

(iii) help in predictions and further research about a particular isolate if little is known about it and it shows some similarities with microbes of particular group

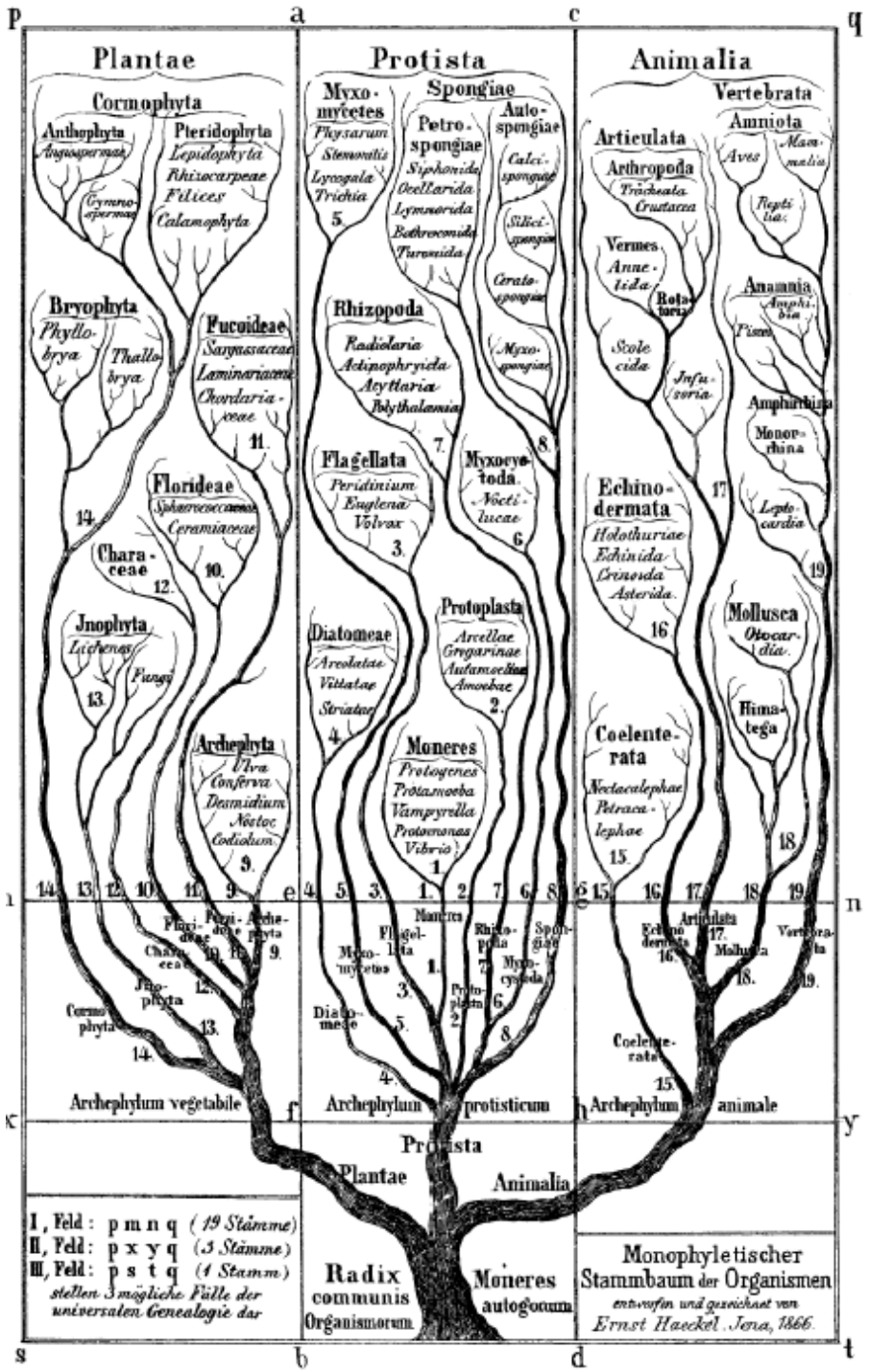
- **2. Binomial nomenclature**
- For millions of organisms, common names - lead to misunderstanding as different names are used for same organism in different places.
- a naming system –introduced : termed "**scientific nomenclature".**
- **Every organism is given a binomial latin name first described by Carolus Linnaeus.**
- **The first part : genus which is followed by species. For example; humans are assigned scientific name as *Homo sapiens.***
- ***alwaysitalicized (Homo sapiens), where genus name starts with a capital letter.***
- ***Abbreviated as H. Sapiens***

- **Rank Example of taxonomic hierarchy**
- Domain Eukarya
- Kingdom Fungi
- Phylum Ascomycota
- Class Hemiascomycetes
- Order Saccharomycetales
- Family Saccharomycetaceae
- Genus *Saccharomyces*
- Species *cerevisiae*


Name
Examples of organisms belonging
Domain
Eukarya
Kingdom
Plantae
Phylum
Chlorophyta
Class
Chlorophyceae
Order
Volvocales
Family
Volvocaceae
Genus
Volvox
Species
aureus
Hierarchy of Different Ranks
Increasing Dissimilarity
Scientific Name of Organism: Volvox aureus (common name: Rolling alga)

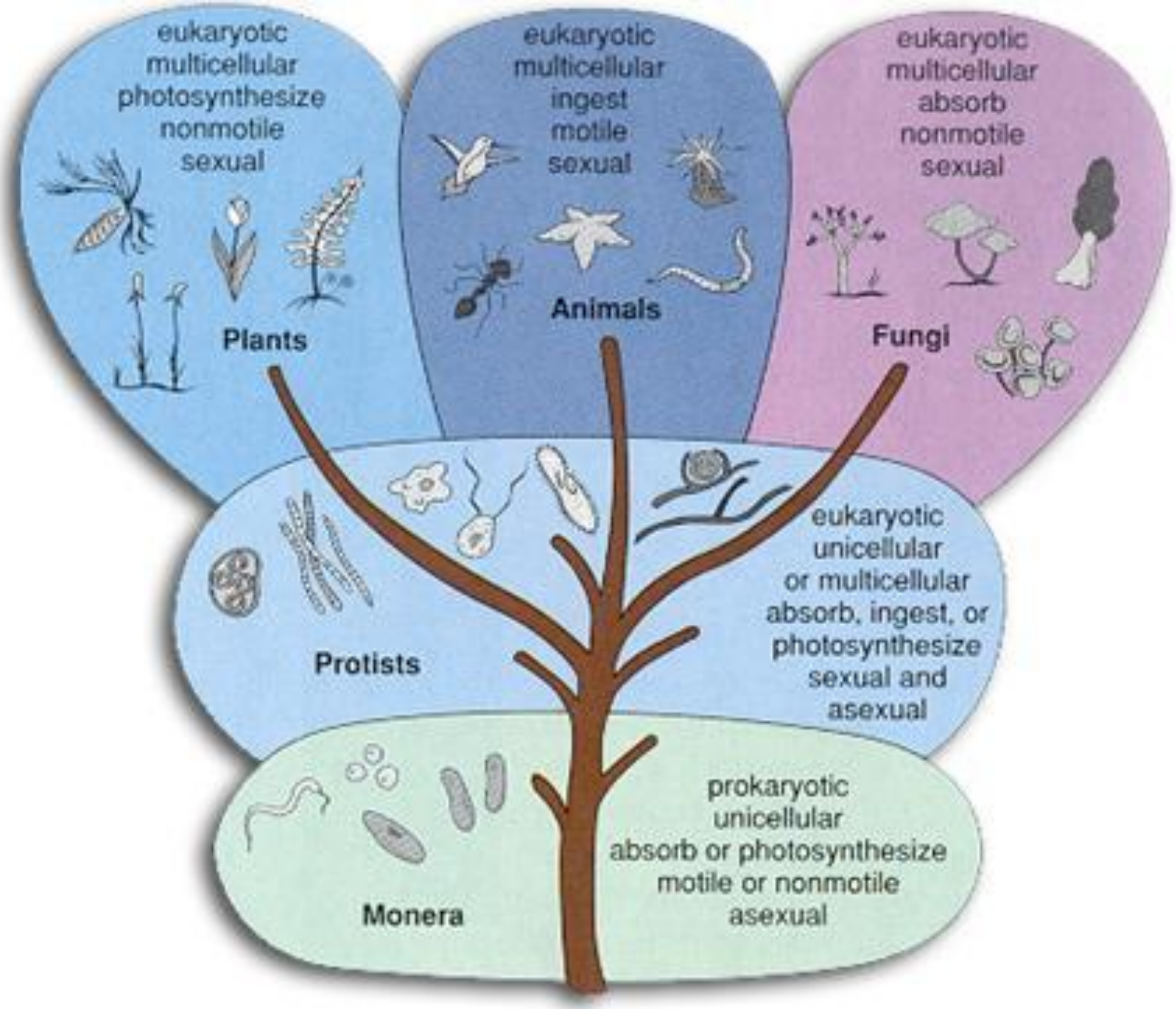
# Two kingdom classification

| Character | Kingdom | |
|---|---|---|
| | **Plantae** | **Animalia** |
| **Body organization** | Simple, Organ systems like excretory, sensory, nervous etc. absent | Well developed and organ systems like excretory, sensory, nervous etc. present |
| **Mobility** | Absent as organs of locomotion are not present | Present due to occurrence of organs of locomotion |
| **Growth and development** | Indefinite | Definite as body grows to certain size and then stop. |
| **Nutrition** | Autotrophic through ether photosynthesis or absorption | Heterotrophic through ingestion |



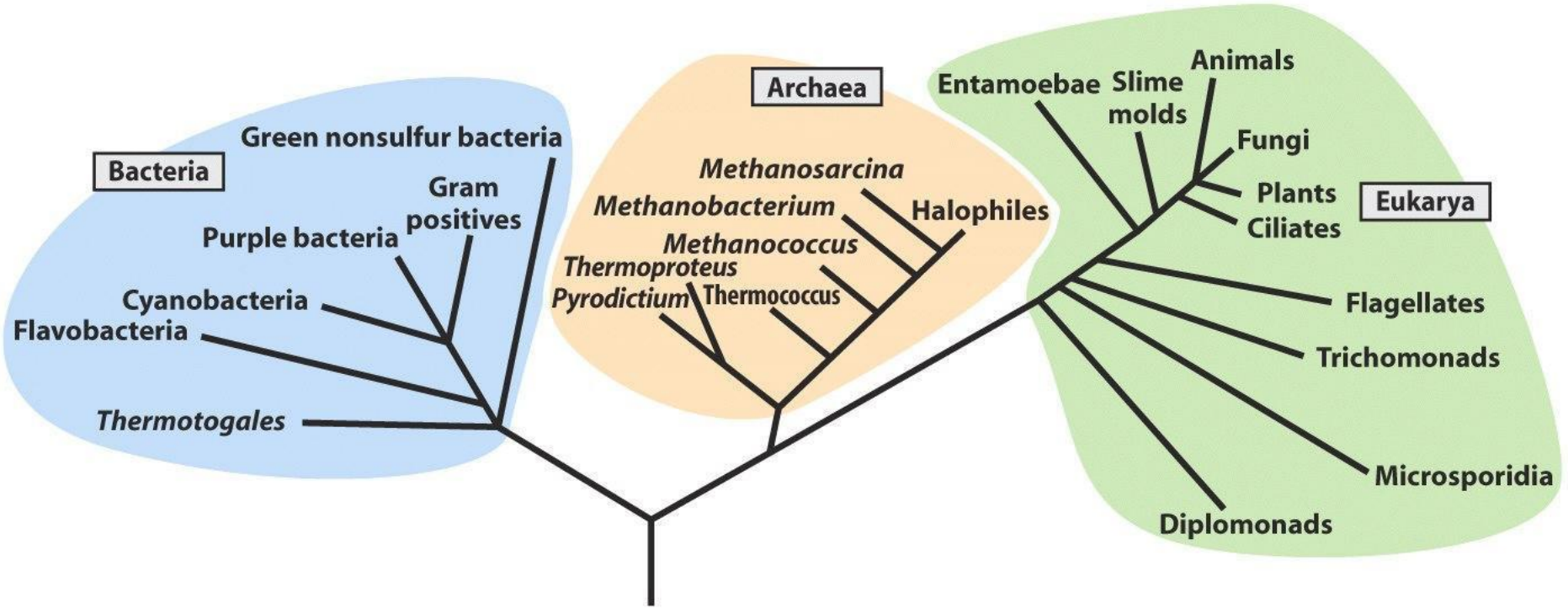

# Three kingdom classification

Ernst H. Haeckel in 1866 proposed a three-kingdom classification with a new kingdom – **Protista**


eukaryotic
multicellular
photosynthesize
nonmotile
sexual
Plants
eukaryotic
multicellular
ingest
motile
sexual
Animals
eukaryotic
multicellular
absorb
nonmotile
sexual
Fungi
Protists
eukaryotic
unicellular
or multicellular
absorb, ingest, or
photosynthesize
sexual and
asexual
Monera
prokaryotic
unicellular
absorb or photosynthesize
motile or nonmotile
asexual

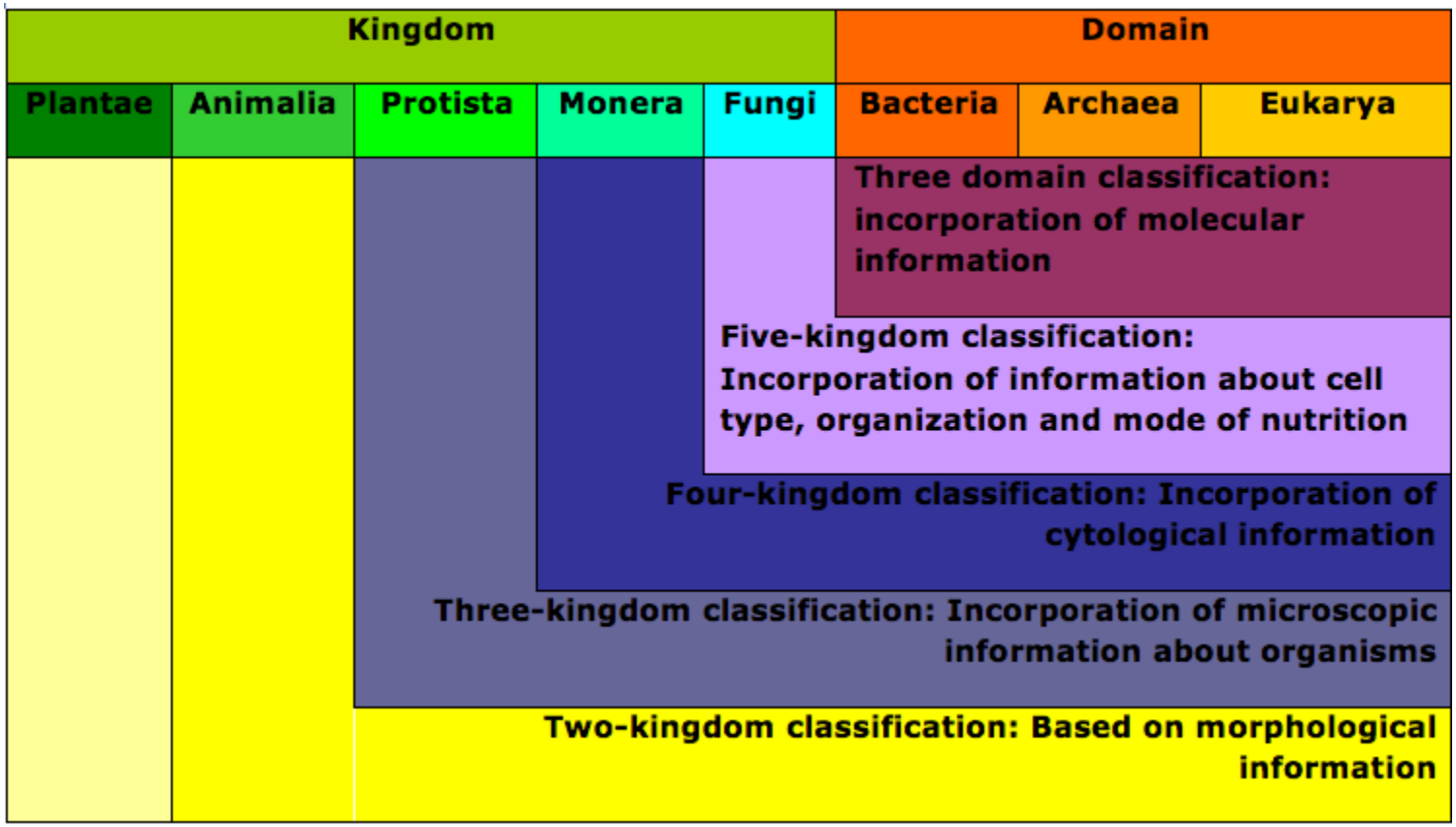
# Whittaker's 5 kingdoms

| Characters | Five Kingdoms | | | | |
|---|---|---|---|---|---|
| | Monera | Protista | Fungi | Plantae | Animalia |
| Cell type | Prokaryotic | Eukaryotic | Eukaryotic | Eukaryotic | Eukaryotic |
| Cell wall | Non-cellular | Present in some | Present | Present | Absent |
| Body organization | Cellular | Cellular | Multicellular Tissue | Tissue Organ | Tissue Organ Organ system |
| Mode of nutrition | Autotrophic Heterotrophic | Autotrophic Heterotrophic | Heterotrophic | Autotrophic | Heterotrophic |
| |  |  |  |  |  |




# Carl Woese and George Fox (1977)three kingdom classification: based on 16s/18srRNA sequencing

**Carl Woese et al. introduced a new taxon – domain above the level of kingdom in their new system of classification, in 1990. Under this system, life has been divided into three domains, the Bacteria, the Archaea and the Eukarya.**


Kingdom
Domain
Plantae
Animalia
Protista
Monera
Fungi
Bacteria
Archaea
Eukarya
Three domain classification: incorporation of molecular information
Five-kingdom classification: Incorporation of information about cell type, organization and mode of nutrition
Four-kingdom classification: Incorporation of cytological information
Three-kingdom classification: Incorporation of microscopic information about organisms
Two-kingdom classification: Based on morphological information

| Prokaryotic Cells | Eukaryotic cells |
|---|---|
| Small cells (< 5 µm) | Larger cells (> 10 µm) |
| Always unicellular | Often multicellular |
| No nucleus or any membrane-bound organelles, such as mitochondria | Always have nucleus and other membrane-bound organelles |
| DNA is circular, without proteins | DNA is linear and associated with proteins to form chromatin |
| Ribosomes are small (70S) | Ribosomes are large (80S) |
| No cytoskeleton | Always has a cytoskeleton |
| Motility by rigid rotating flagellum (made of flagellin) | Motility by flexible waving cilia or flagellae (made of tubulin) |
| Cell division is by binary fission | Cell division is by mitosis or meiosis |
| Reproduction is always asexual | Reproduction is asexual or sexual |
| Huge variety of metabolic pathways | Common metabolic pathways |

**Exception: linear choromosomes found in *Borrelia burgdorferi* (lyme dis), *Sterptomyces lividans, S. Coelicolor, Rhodococcus fascians.***
***A. tumefaciens*: one ln and one circular genome.**

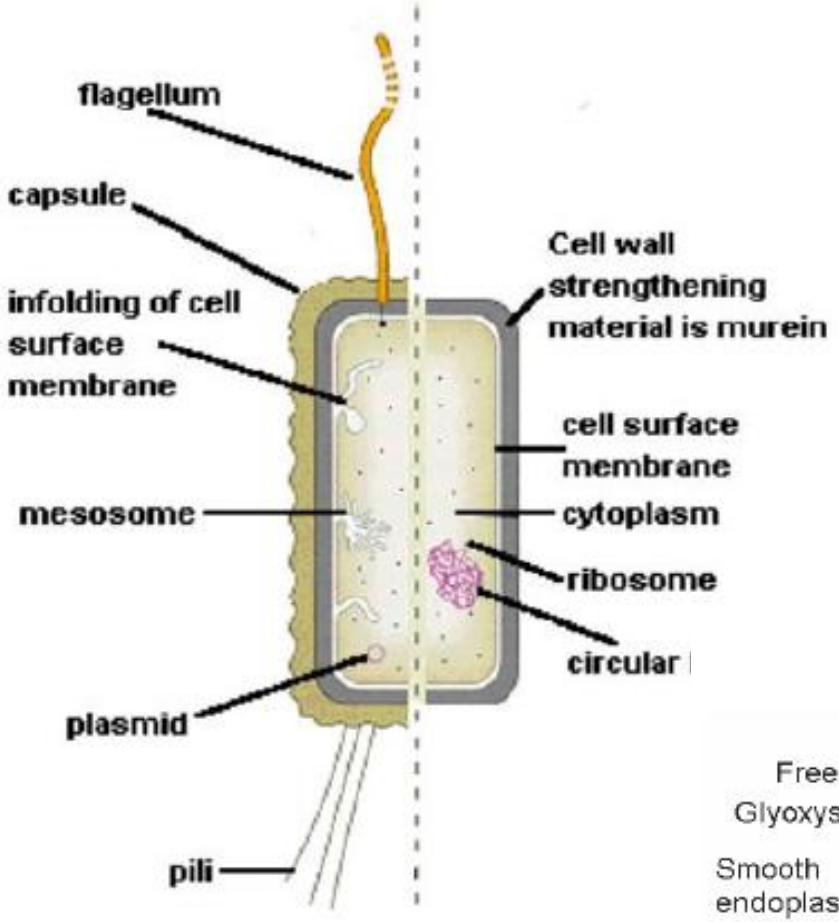
**Linear plasmids in bacteria: *S. rochei, Nocardia opaca, Thiobacillus versutus***

- DNA Polymerases in prok. I, II, III, IV, V
- In eukaryotes: alpha, delta, epsilon, gamma

- Prokaryotes:
- no introns in genome
- Transcription and translation are coupled
- Polycistronic mRNA

**Table :** Characteristic features of three domains.

| Character | Bacteria | Archaea | Eukarya |
|---|---|---|---|
| Cell type | Prokaryotic | Prokaryotic | Eukaryotic |
| Cell wall | Present; contain peptidoglycan | Present; peptidoglycan absent | Present/absent; peptidoglycan absent |
| Membrane lipids | Diacyl glycerol diesters | isoprenoid glycerol diethers or diglycerol tetraethers | Glycerol fattyacyl diesters |
| Genetic material | Small circular DNA not associated with histones | Small circular DNA associated with histones like proteins | Large linear DNA associated with histones |
| Translation (first amino acid) | Formylmethionine | Methionine | Methionine |
| RNA polymerase | One; simple | One; complex | Three; complex |
| tRNA (TψC arm) | Thymine present | Thymine absent | Thymine present |
| Intron | Absent | Present rarely | Present |
| Antibiotic sensitivity | Yes | No | No |
| Diphtheria toxin sensitivity | No | Yes | Yes |
| Reproduction | Spore formation present | Spore formation absent | Spore formation present or absent |
| Habit | Variable | Extremophile | Variable |




# Eukaryotic Cells