

Taxonomy and Classification

How many species are there on earth and in the ocean?

- **1.25 million** kinds or species have been described so far.
- Many more species are still unknown and not described.
- Recent study estimated that the number of species can reach **8.7 million**.
- This means only **%14** of species were described - only **%9** of them are from ocean.
- **75%** of known species in the world are animals.
- May be there were over **500 million** of animals were lived on the earth throughout last **billion years**.

Reference:

- Mora C, Tittensor DP, Adl S, Simpson AGB, Worm B (2011) **How Many Species Are There on Earth and in the Ocean?** *PLoS Biology* 9(8): e1001127.

The expected numbers of species might be present on the earth:

- ▶ **Animals:** **7.77 million** (of which **953,434** have been described - 12% described)
- ▶ **Plants:** **298,000** (of which **215,644** have been described - 70% described)
- ▶ **Fungi:** **611,000** (of which **43,271** have been described - 7% described)
- ▶ **Protozoa:** **36,400** (of which **8,118** have been described - 2% described)
- ▶ **Chromists:** **27,500** (including brown algae, diatoms, and water molds, of which **13,033** have been described - **50%** described)

Why do we need to classify organisms?

- Millions of species were identified.
- Every day, new species are discovered and recorded.
- It becomes too difficult to identify, study, and understand the lives, behaviors of so many different kinds of organisms.
- Scientists **classify** living things into groups based on **how they are the same** and **how they differ**.

Taxonomy

- From ancient Greek *taxis* = Arrangement & *nomos* = Law or Method.
- **Taxonomy**: is a branch of biology concerned with **identification**, **nomenclature** (naming), and **classification** of organisms into groups based on shared characteristics that reflect **evolution**.
- **Taxonomists** are people who work in organism taxonomy.

History of classification

- Classification of organisms is an **ancient** activity of human.
- Human classified organisms into **animal** & **plant**.

Methods of classification

There are **two** major methods:

1. **Artificial classification**.
2. **Natural classification**.

Artificial classification

- An **old** method.
- Based on the **similarity** in **shape of structure** or **color** or **behavior**.

Aristotle (384-322 BC) was **first** to classify all **known** organisms (about **520** animals).

Aristotle classification of animal based on:

- A. **Way of living**. B. **Action** C. **Habit** D. **Body parts**.

Aristotle **classified animals** into:

- Animal **without** blood (**Anaima**) = **Invertebrate**.
- Animal **with** blood (**Enaima**) = **Vertebrate**.

Animal with blood was divided into:

- **Live-bearing** animal (= **mammale**).
- **Egg-bearing animal** (= **bird & fish**).

Aristotle is regarded as (**Father of biological classification**).

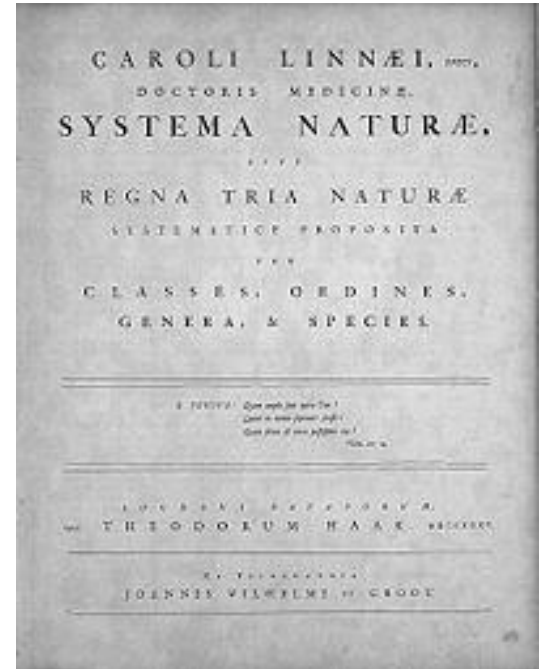
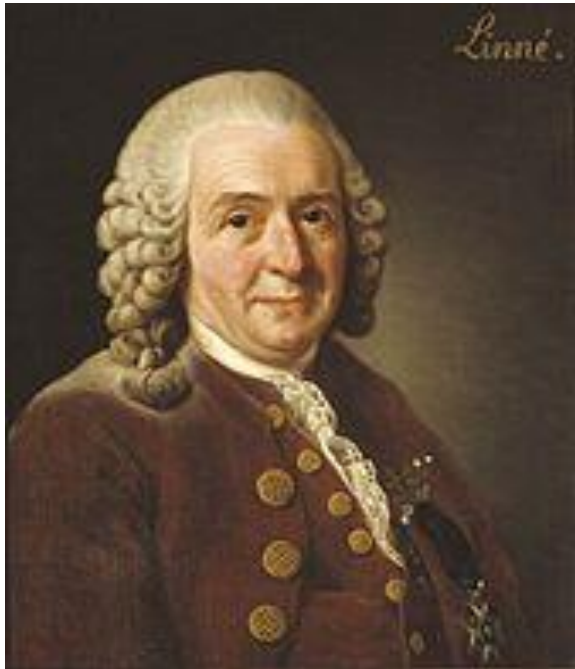
Aristotle's method was applied for 2000 years.

Islamic scholars have applied this method in their classification of animals, such as:

- الجاحظ (768-873 C) in his book: (كتاب الحيوان).
- القزويني (1203-1283 C) in his book: (عجائب المخلوقات و غرائب الموجودات).
- الدميري (1360-1426 C) in his book: (حياة الحيوان الكبرى).

Natural classification

- Modern method.
- Depends on multiple features to compare organisms & build relationships between them:
Morphology, Anatomy, Physiology, Biochemistry, Reproduction, Cytology, Embryology & Molecular Biology (including genetics).



- This method reduced all disadvantages of old artificial method.
- Makes the identification of organisms easier.
- Helps to understand the evolutionary relationships between organisms.
- **Carolus Linnaeus** (1707-1778) introduced natural classification by **grouping** organisms based on: **Morphological similarities**.
- He applied this method in his book (*Systema Naturae*) which was published in 1758.

Binomial Nomenclature

Bi = Two & **nomial** = Name

Carolus Linnaeus applied **Binomial nomenclature system** for **naming** both animal & plant.

This system includes (**two-part-name**):

1. **Genus** (Plural: **genera**) = the **name** of organism in **Latin**.
2. **Species** = the **adjective** of organism.

Both genus & species use **Latin grammatical** form and written in **Italic** form.

Example; **Human** belongs to:

Genus: *Homo* or Homo.

species: *sapiens* or sapiens.

Homo sapiens = **wise human**.

Example; **Domestic dog**:

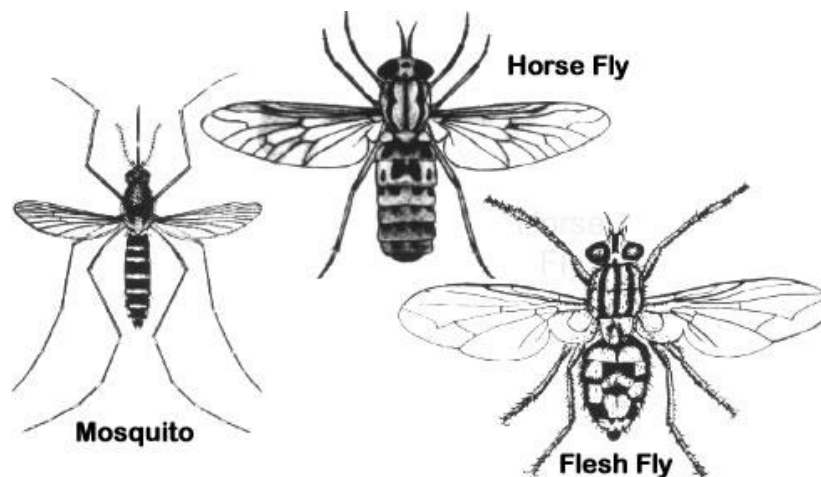
Genus: *Canis* or Canis.

species: *familiaris* or familiaris.

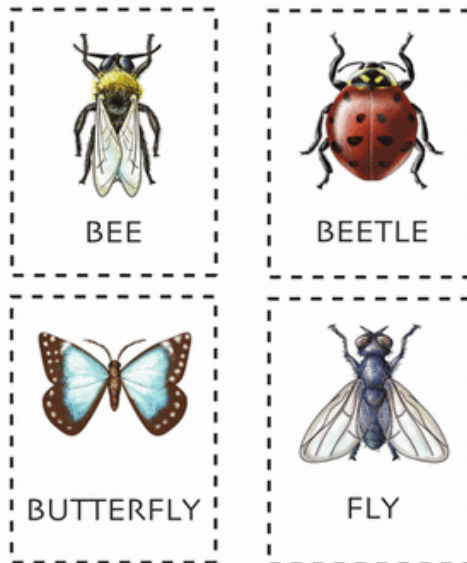
- Linnaeus recognised that **different species** could be grouped into **broad categories** (called **taxa**) (**hierarchic system**) based on **morphological similarities**.

Taxon (Plural: Taxa)

- All these **insects** have a single **pair** of **wings**; therefore they belong to **same group (Taxon)** called **Diptera**.



- All flies share certain characteristics with bees, butterflies and beetles. Thus, these animals form an even more inclusive taxon. They are all insects.



- Carolus Linnaeus recognised five taxa (Kingdom, Class, Order, Genus & species).
- Currently, eight categories (taxa) are used:
- Domain, Kingdom, Phylum, Class, Order, Family, Genus & species.

TABLE 7.1
 TAXONOMIC CATEGORIES OF A HUMAN
 AND A DOG

TAXON	HUMAN	DOMESTIC DOG
Domain	Eukarya	Eukarya
Kingdom	Animalia	Animalia
Phylum	Chordata	Chordata
Class	Mammalia	Mammalia
Order	Primates	Carnivora
Family	Hominidae	Canidae
Genus	<i>Homo</i>	<i>Canis</i>
Species	<i>sapiens</i>	<i>familiaris</i>



Every **organism** belongs to a **species**,

Every **Genus** belongs to a **Family**,

Every **Order** belongs to **Class**,

Every **Phylum** belongs to a **Kingdom**,

Every **species** belongs to a **Genus**

Every **Family** belongs to an **Order**

Every **Class** belongs to a **Phylum**

Every **Kingdom** belongs to a **Domain**

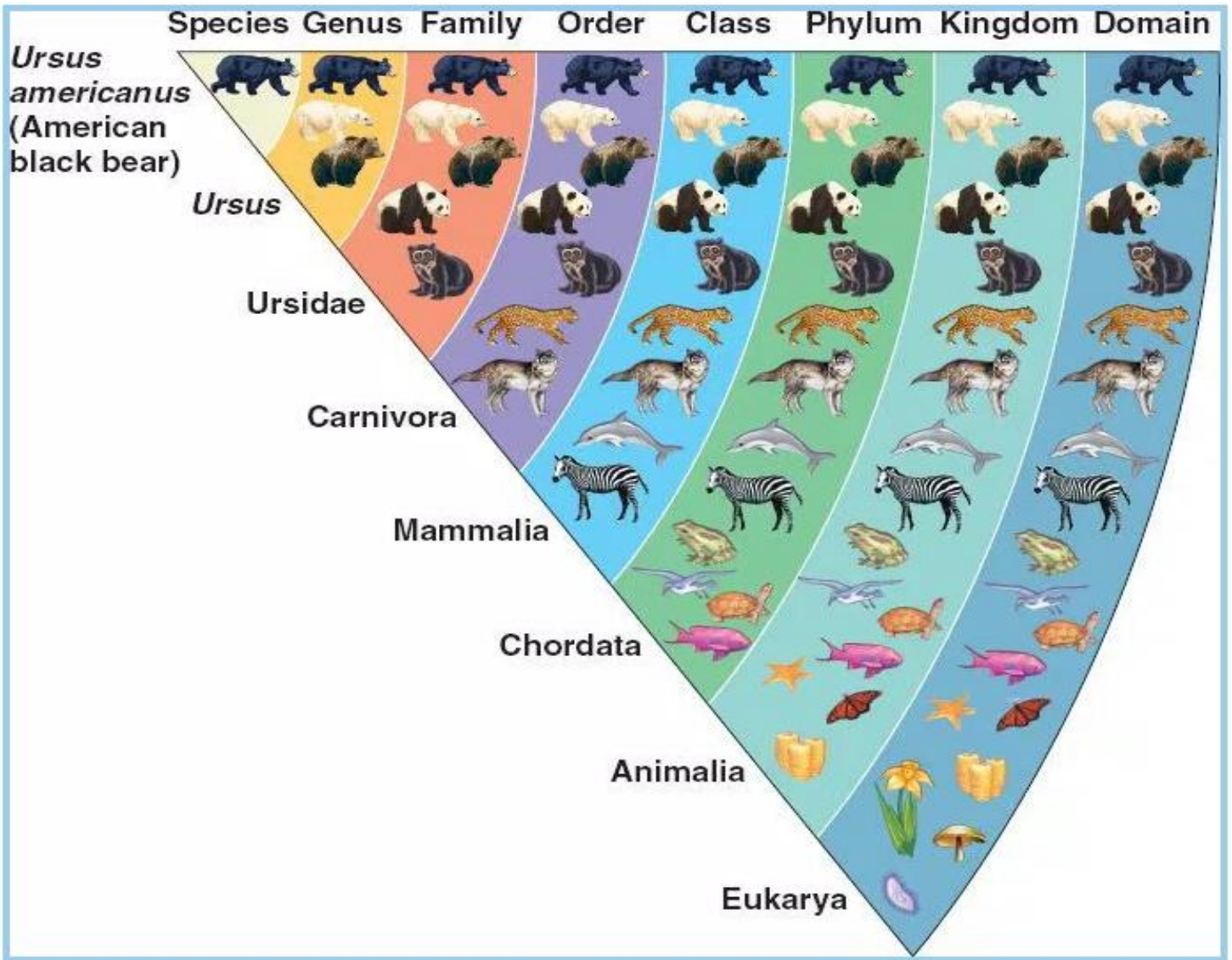
Species identification

Species is considered the most important **taxon** because it represents a **natural unit** (others are arbitrary and subject to **revision**).

Biological concept of species:

(**Species** are groups of organisms that are essentially **similar in shape and function** and can **interbreed among themselves but not with members of other closer related species**).

If interbreeding happens, then the **offspring** become **sterile** or **infertile**.



+



=



HORSE

Height 5 ft. av.
Curved back
Long mane and tail
Large hooves

DONKEY

Height 3.5 ft. av.
Straight back
Short mane and tail
Small hooves

MULE

Everything between
horse and donkey

Why using scientific nomenclature?

Naming of organisms was by using **common name** or **local name**. This became **unacceptable**:

1. The **same organism** may have **different** names in different country and even in the same country.
2. The **same name** of organism may be called for different organism in different locations or countries.
3. Many organisms do not have even **common** or **local** name.

The rules of writing scientific name

- Binomial nomenclature system is **universal** and **clearly indicates** the **level** of classification involved in any description.
- **No** two kinds of animals have **same** binomial name (genus + species).
- Genus **star** with **capital** letter (*Homo*)
- species **star** with **small** letter (*sapiens*).
- All other categories **start** with **capital letter**.
- Genus and species are **italicized** (*Italic*) or **underlined** (*Homo sapiens* = Homo sapiens).
- If the genus is understood, name can be **abbreviated** (*H. sapiens*).
- Genus & species are followed by the **name** of the **scientist** who first **described** and **named** an organism, then followed by the **year** of naming

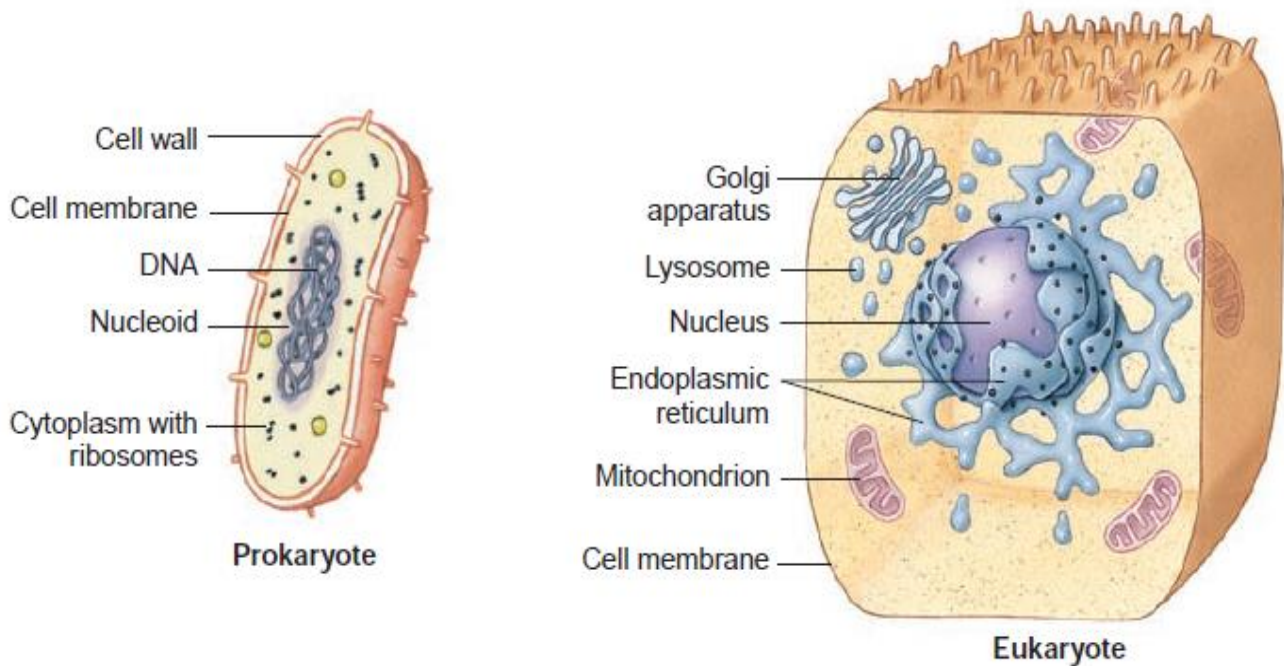
(Homo sapiens Linnaeus, 1758)
- Any collection of organisms may be **divided** into **subordinate groups intermediate** between it and that the next lower rank.

Example: **Superfamily** is a subordinate group between **Oder** & **Family**.

Subfamily is between **Family** & **Genus**.

Prokaryote & Eukaryote

There are **two** major **types** of cells: **prokaryote** and **eukaryote**:



Pro- = before or primitive

Eu = true

Karyon = nucleus

Prokaryote

- **Prokaryote** is **single-celled** organism that does **NOT** have a membrane-bounded nucleus, mitochondria, or any other membrane-bound organelle.
- The **nuclear material** consists of a **single chromosome** and lies in the cytoplasm within a location called **nucleoid**.

Eukaryote

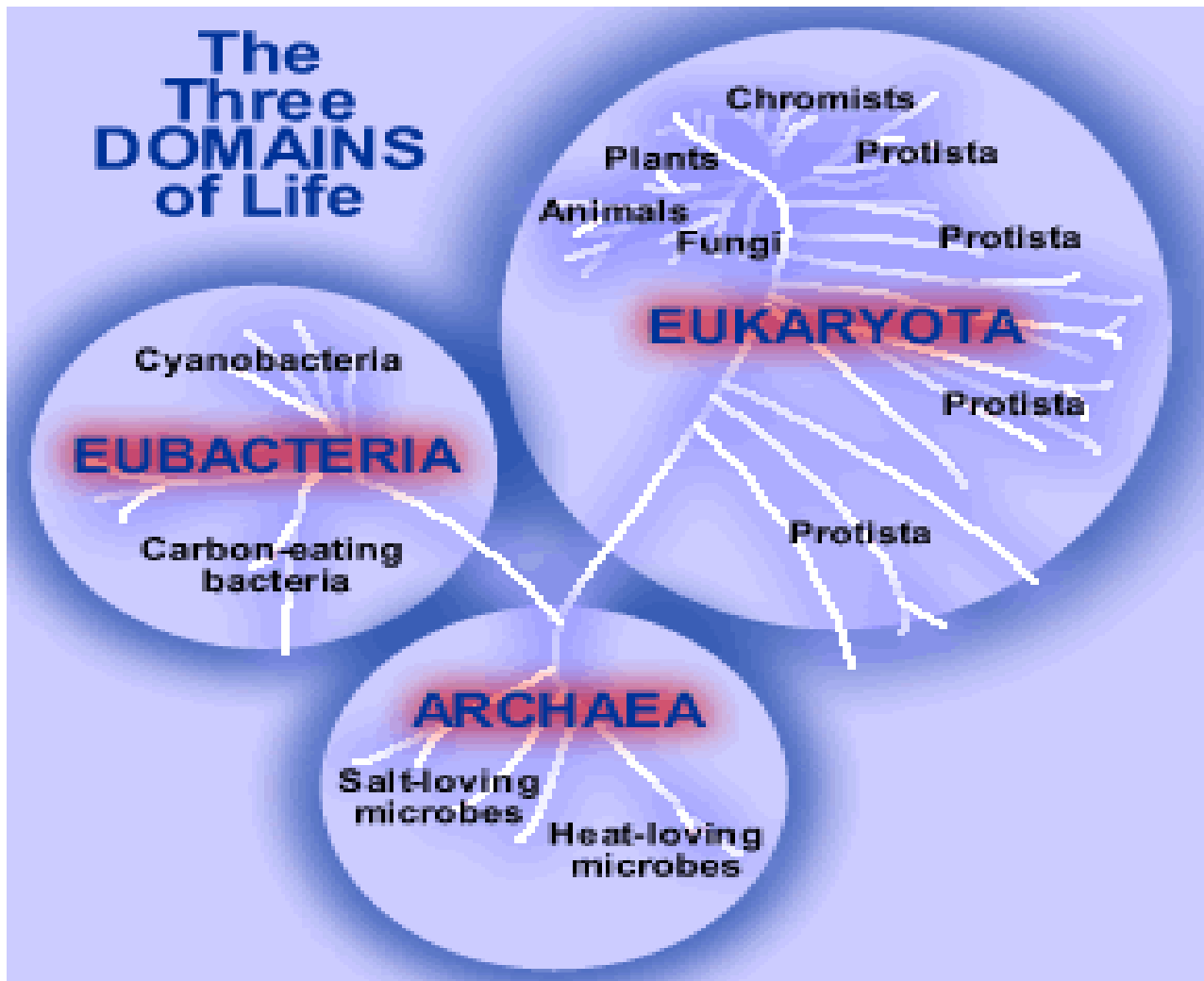
- **Eukaryote** is any organism whose cells contain a **nucleus** and other **organelles enclosed within membrane**.

TABLE 2.1**COMPARISON OF PROKARYOTIC AND EUKARYOTIC CELLS**

COMPONENT	PROKARYOTE	EUKARYOTE
Cell wall	Present	Absent in animals (present in plants)
Centrioles and microtubule organizing center	Absent	Present in animals (absent in plants)
Chloroplasts	Present in some cells	Present in some cells
Genetic material	Single circular chromosome of DNA	Arranged in multiple chromosomes; DNA associated with protein
Cilia (9 + 2)	Absent	Present in some cells
Cytoskeleton	Absent	Present
Endoplasmic reticulum	Absent	Present
Flagellum	Often present	Present in some cells
Glycocalyx	Absent	Present
Golgi apparatus	Absent	Present
Lysosomes	Absent	Present
Mitochondria	Absent	Present
Nucleus	Absent	Present
Plasma membrane	Present	Present
Ribosomes	Present	Present
Vacuoles	Present	Present
Vesicles	Present	Present

The three domains of the life

- According to recent **molecular studies**, all organisms can be divided to **three domains**:



- **Archaea**: (= primitive bacteria) are prokaryotic microorganisms that live in **extreme environments**, such as high temperature, or high-salt or acidic environments. All members of the *Archaea* inhabit **anaerobic** environments.
- **Eubacteria** (= true bacteria) are prokaryotic microorganisms such as cyanobacteria (blue green algae) and bacteria.
- These two groups of microorganisms (Archaea & Eubacteria) were divided into two because of the major **differences** in their **structure** and **genetics**.
- **Eukaryota** include all eukaryotic organisms such as **Protista**, **chromists**, **fungi**, **plants** and **animals**.