Characteristics of microorganisms

Microbes and the Origin of Life on Earth

- Life on Earth is thought to have **originated** from the oldest **single-cell archaea and bacteria**.

- Scientific evidence suggests that life began on Earth some **3.5 billion years** ago. Earth is 4.5 billion years old.

Types of Microorganisms

- Microorganisms or microbes are **microscopic organisms** that exist as **unicellular, multicellular,** or **cell clusters**.

- Microorganisms make up a large part of the planet's living material and play a major role in maintaining the **Earth's ecosystem.**

- Microorganims are widespread in nature and are **beneficial to life,** but some can cause **serious harm**.

An ecosystem is a geographic area where plants, animals, and other organisms, as well as weather and landscape, work together to form a bubble of life.

The **microorganisms (microbes)** are generally divided into **six major types**:

1. **Bacteria**
2. **Archaea**
3. **Fungi**
4. **Protozoa**
5. **Algae**
6. **Viruses**

Bacteria

- Bacteria are **unicellular** organisms.

- The cells are described as **prokaryotic** because they **lack a proper nucleus.**

- They exist in **six** major shapes:

  -- **Bacillus** (rod shape)

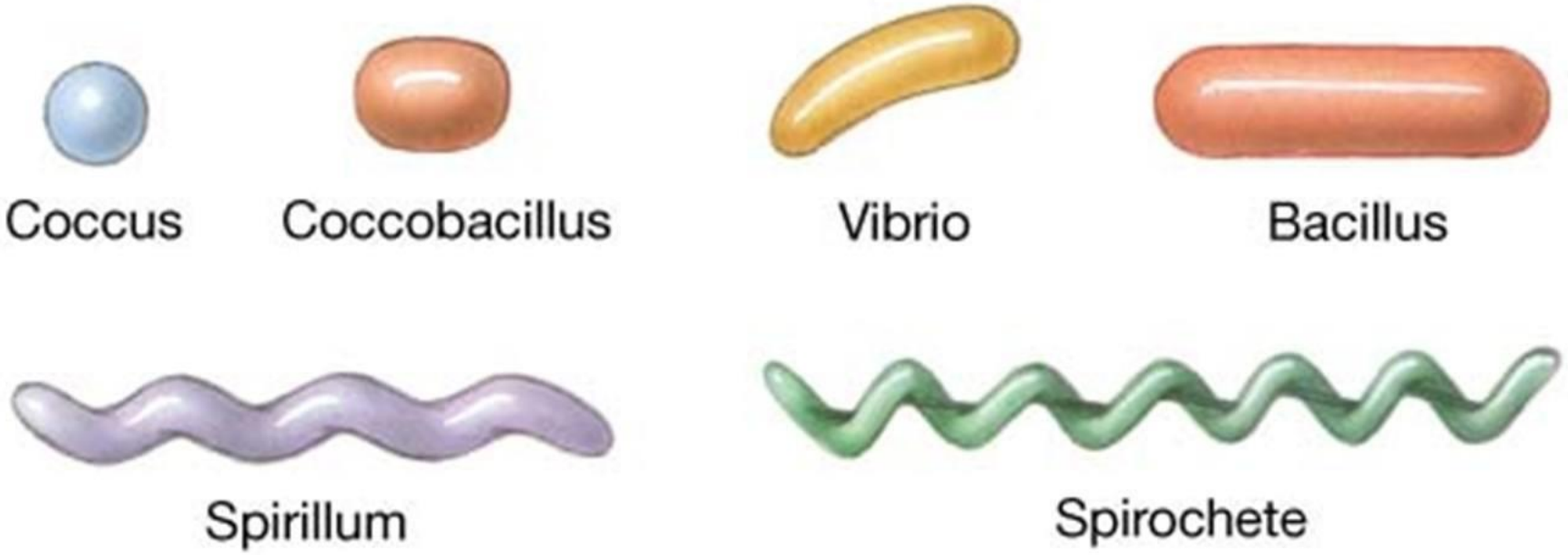
  -- **Coccus** (spherical shape)

  -- **Coccobacillus** (oval shaped)

  -- **Vibrio** (curved shape)

  -- **Spirilla** (spiral shape -- short)

  -- **Spirochetes** (spiral shape -- long)


Coccus
Coccobacillus
Vibrio
Bacillus
Spirillum
Spirochete

- Bacteria have:

  -- a **peptidoglycan cell wall**;

  -- they **divide by binary fission**;

  -- and they **may possess flagella** for motility.

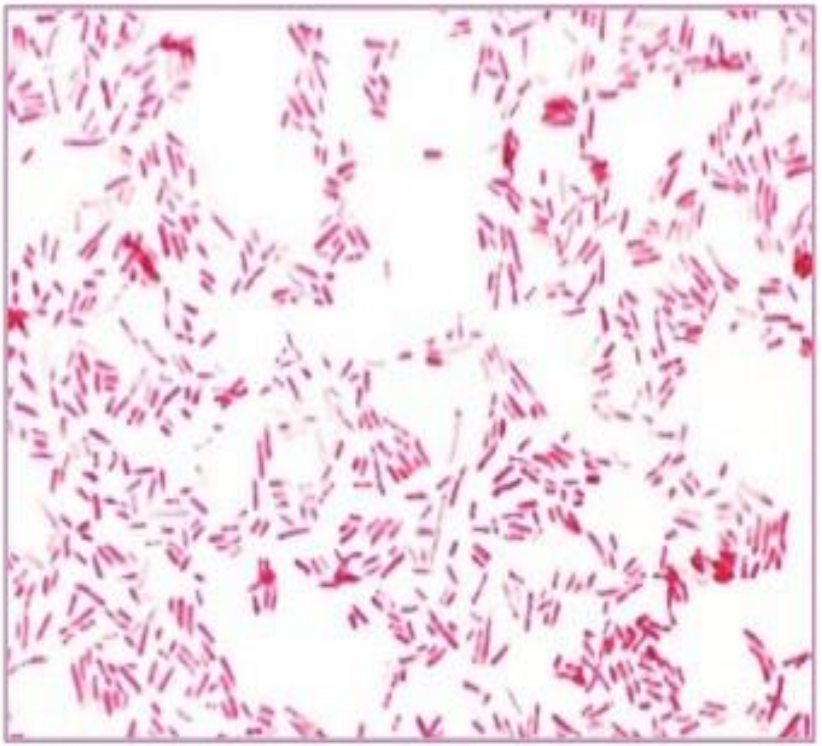
- **Peptidoglycan** is a polymer consisting of sugars and amino acids that forms a mesh-like layer outside the plasma membrane.

- **Binary fission** ("division in half") is a kind of **asexual** reproduction.

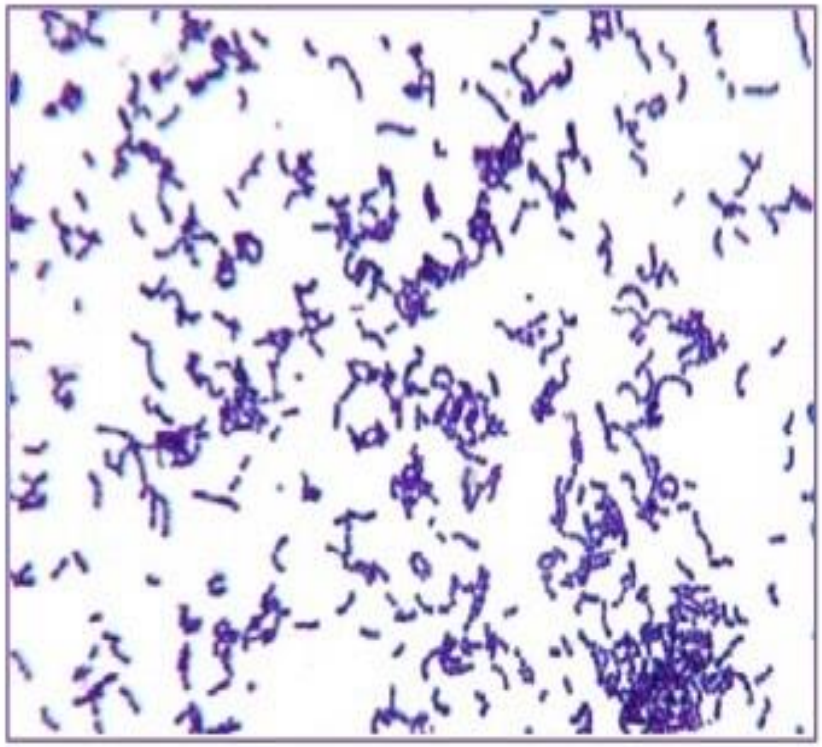
Difference in cell wall structure:

- The **difference in cell wall structure** is a major feature used in **classifying** bacteria.

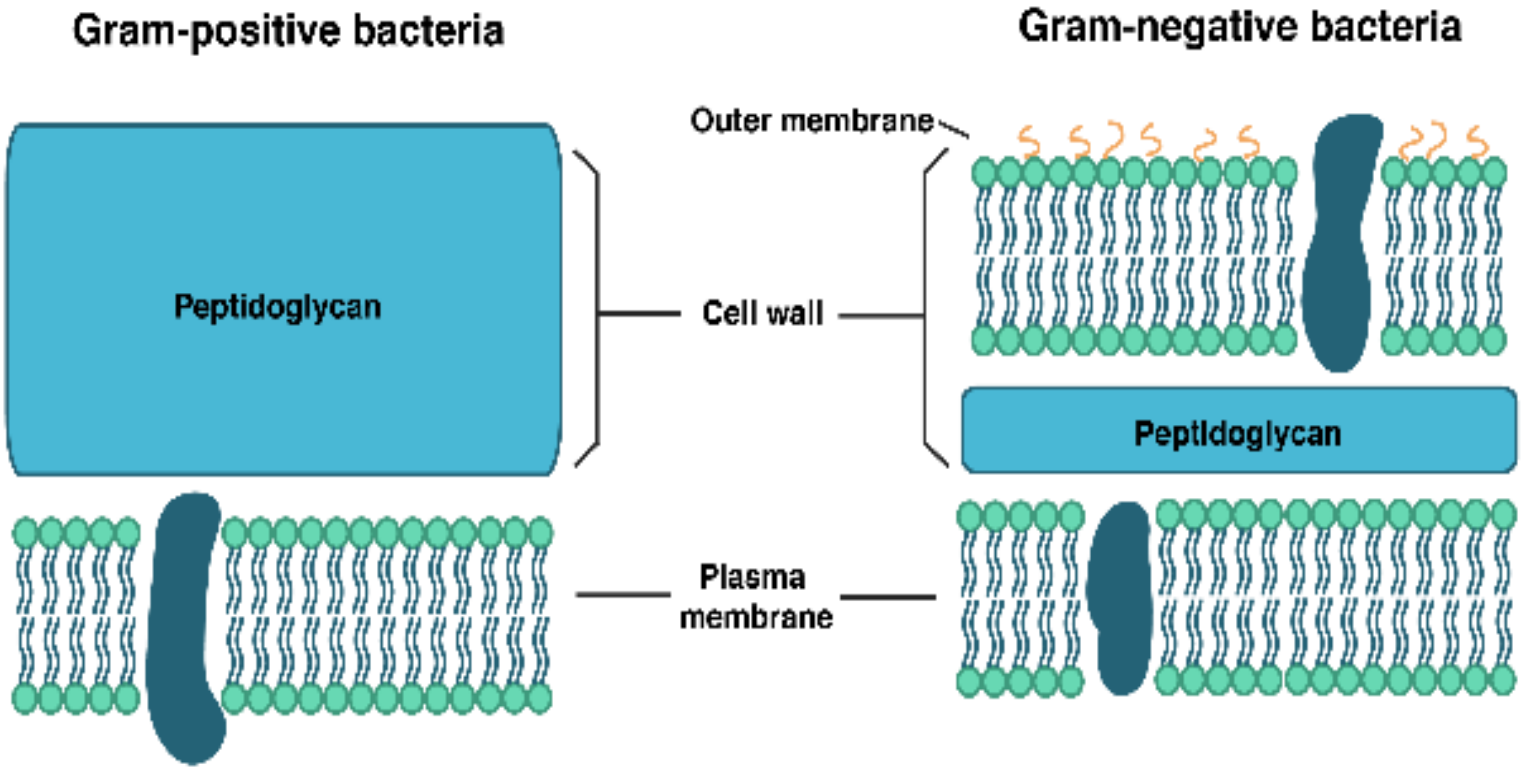
- According to the way their cell wall structure stains, bacteria can be classified as either **Gram-positive** or **Gram-negative** when using the Gram staining.



Gram-Negative Bacteria



Gram-Positive Bacteria


Gram-positive bacteria
Gram-negative bacteria
Outer membrane
Peptidoglycan
Cell wall
Peptidoglycan
Plasma membrane

Difference in oxygen tolerance:

Bacteria can be further divided into the following groups based on their **response to gaseous oxygen** :

- **aerobic** (living in the presence of oxygen)
- **anaerobic** (living without oxygen)
- **facultative anaerobes** (can live in both environments)

Difference in energy sources:

According to the way they **obtain energy**, bacteria are classified as **heterotrophs** or **autotrophs**.

- **Autotrophs** make their own food by using the energy of sunlight. If they get energy from chemical reactions, they are called **chemoautotrophs**.

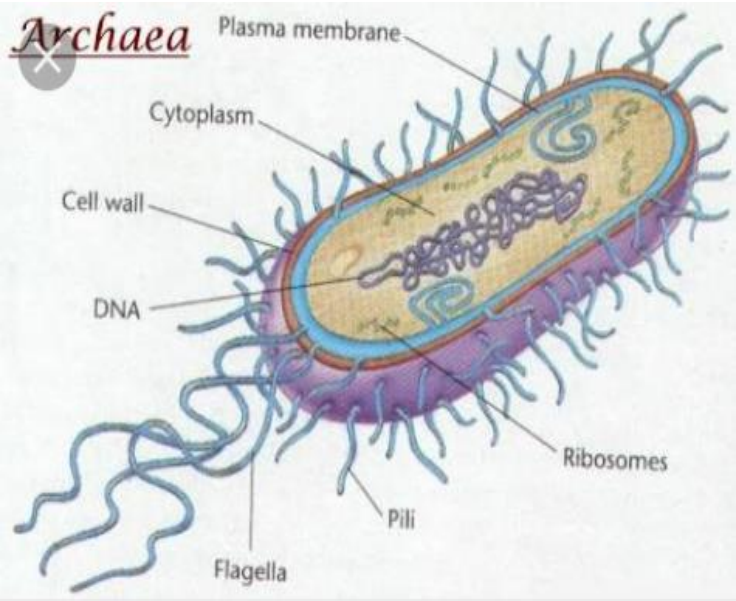
- A **heterotroph** is an organism that cannot manufacture its own food by carbon fixation and therefore derives its intake of nutrition from other sources of organic carbon, mainly plant or animal matter.

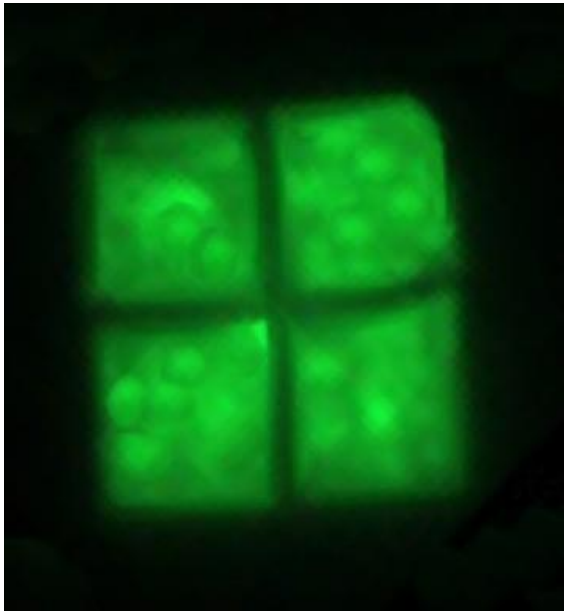
- Bacteria that use decaying life forms as a source of energy are called **saprophytes**.

Archaea

Archaea or **Archaebacteria** differ from true bacteria in their cell wall structure and **lack of peptidoglycan**.

Some of them can occur in unique shapes such as **square or almost flat.**





They are **prokaryotic cells** with liking for **extreme environmental conditions**.

Based on their **habitat**, all **Archaeas** can be divided into the following groups:

- **methanogens** (methane-producing organisms)
- **halophiles** (live in salty environments)
- **thermophiles** (live at extremely hot temperatures)
- **psychrophiles** (live at cold-temperature)

- Archaea use different energy sources like **hydrogen gas, carbon dioxide, and sulphur.**

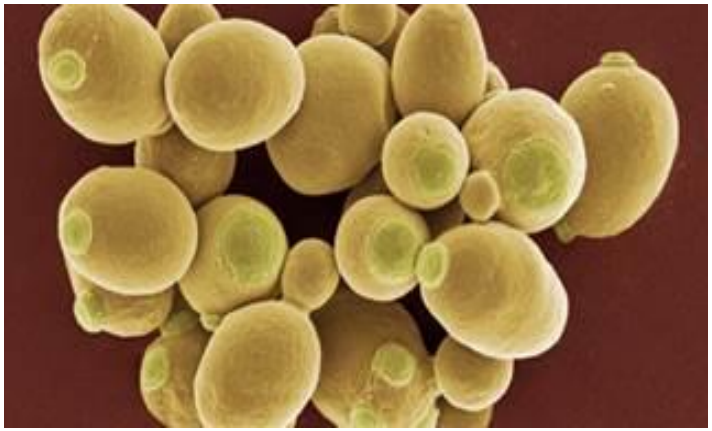
- Some of them use **sunlight** to make energy, but not the same way as plants do by photosynthesis.

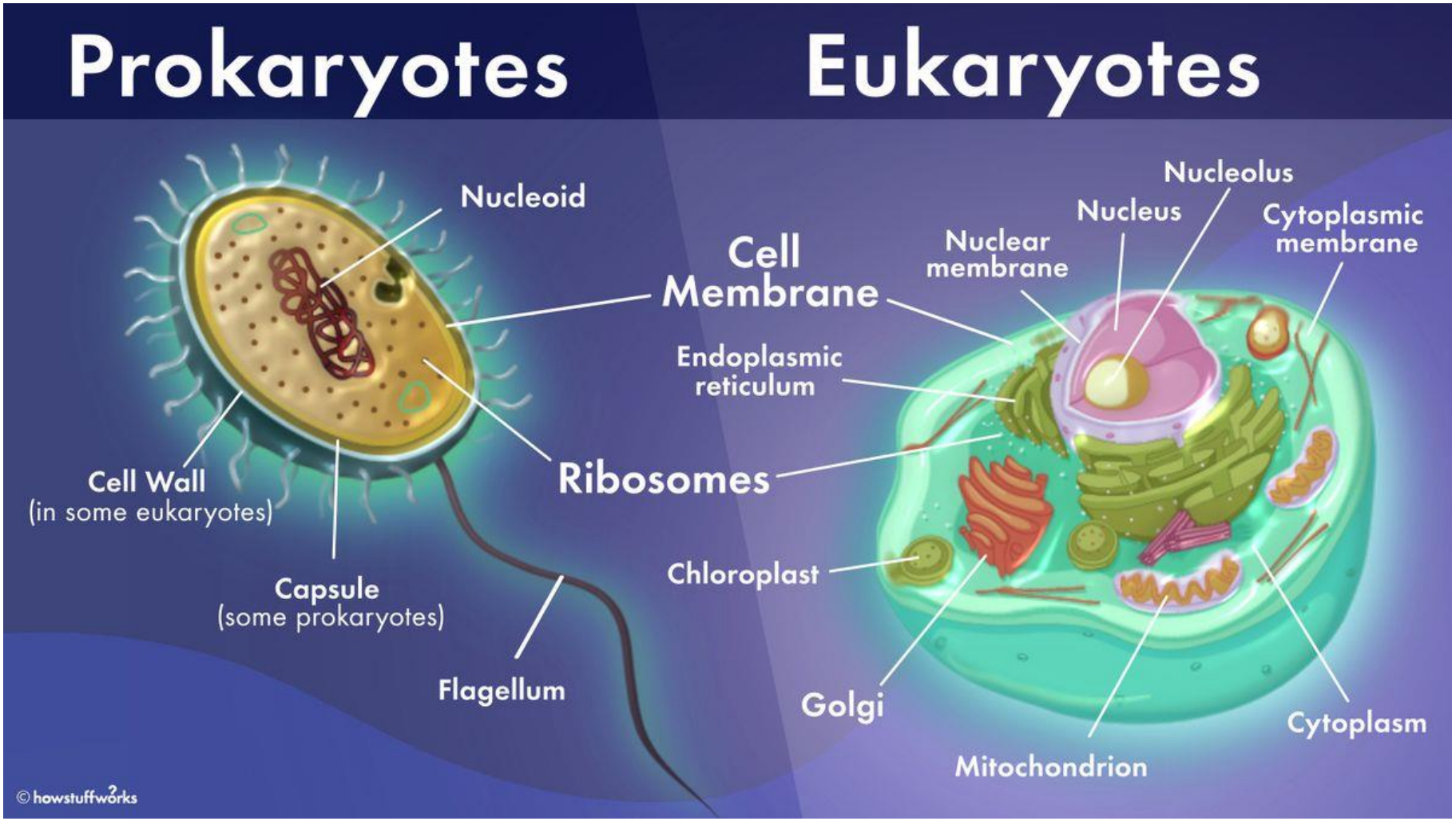
- They absorb sunlight using their membrane pigment, **bacteriorhodopsin**.

- This **reacts with light**, leading to the formation of the energy molecule **adenosine triphosphate (ATP).**

Fungi

Fungi (mushroom, molds, and yeasts) are **eukaryotic cells (with a true nucleus).**




Prokaryotes
Eukaryotes
Nucleoid
Cell Membrane
Cell Wall
(in some eukaryotes)
Ribosomes
Capsule
(some prokaryotes)
Flagellum
Nucleolus
Nucleus
Cytoplasmic membrane
Nuclear membrane
Endoplasmic reticulum
Chloroplast
Golgi
Cytoplasm
Mitochondrion
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- Most fungi are **multicellular** and their cell wall is **composed of chitin,** which is a fibrous substance consisting of polysaccharides**.**

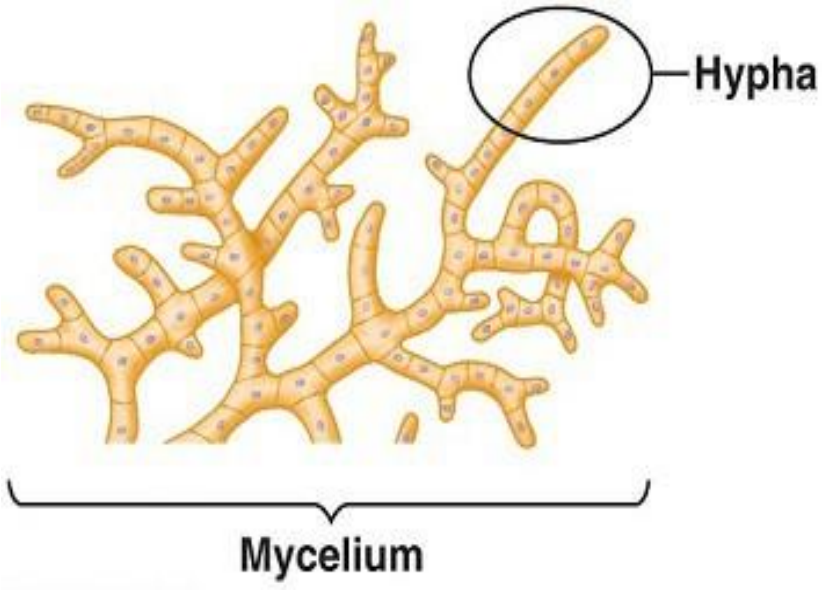
- They obtain nutrients by:

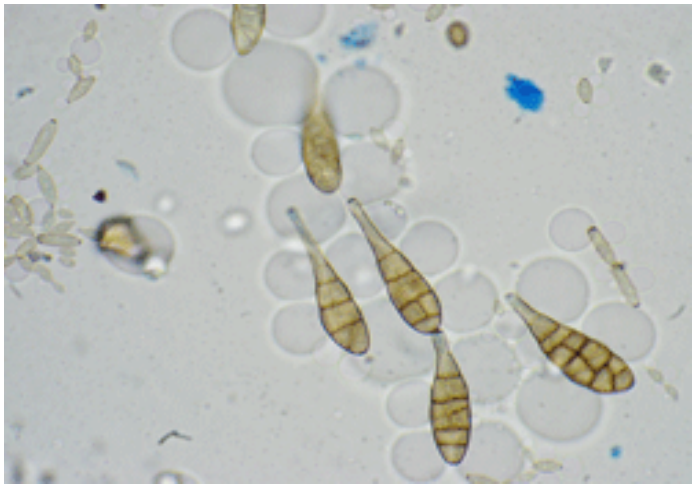
  -- **absorbing organic material** from their environment

  -- **through symbiotic relationships with plants**

  -- **harmful relationships with a host (parasites)**

- They form characteristic filamentous tubes called **hyphae** that help absorb nutritious materials.
- The collection of hyphae is called **mycelium**.
- Fungi generally reproduce by releasing **spores**.





Fungal spores

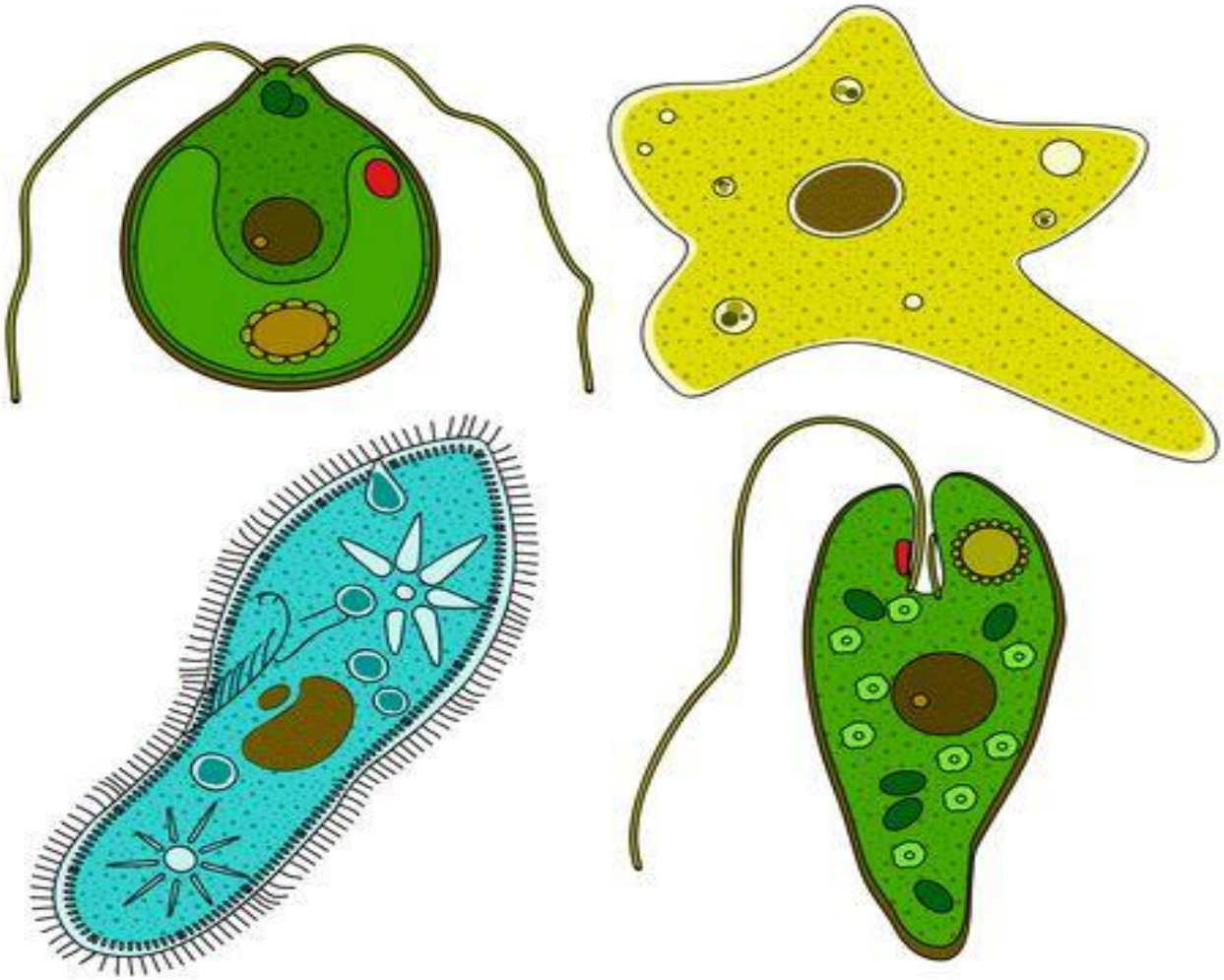
Protozoa

- Protozoa are **unicellular aerobic eukaryotes**.
- They have a **nucleus, complex organelles**, and obtain nourishment by absorption or ingestion through **specialized structures.**
- They make up the **largest group of organisms in the world** in terms of numbers, biomass, and diversity.
- Their cell walls are made up of **cellulose.** Cellulose is also found in plants; it helps plants to remain stiff and upright.

Protozoa have been traditionally divided based on their **mode of locomotion:**

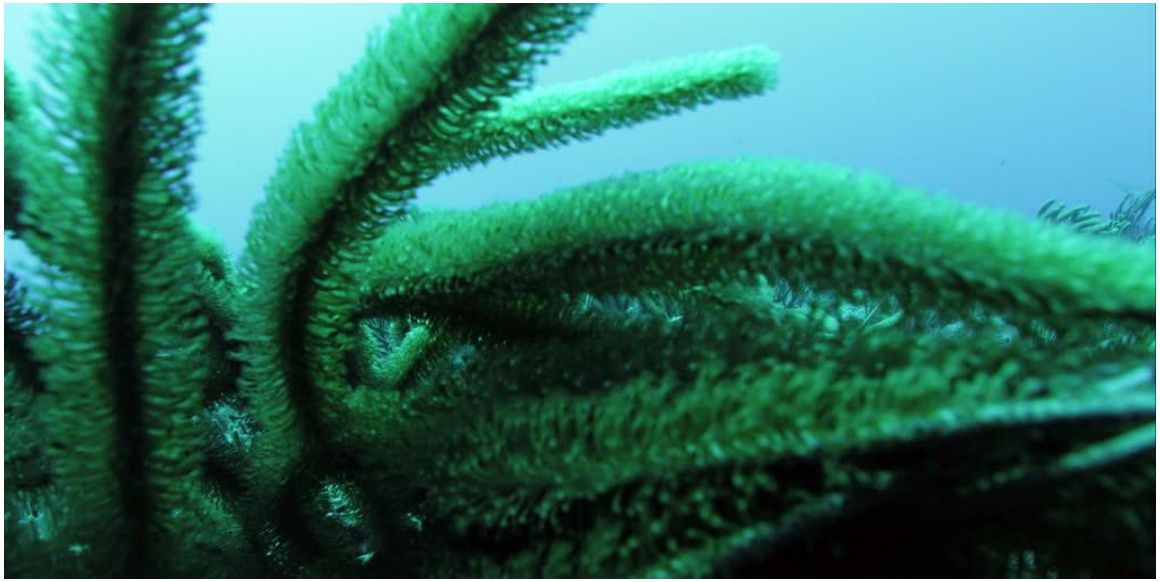
- **flagellates** use their whip-like structure to propel forward
- **ciliates** have tiny hair that beat to produce movement
- **amoeboids** have false feet (pseudopodia) used for feeding and locomotion
- **sporozoans** are non-motile.

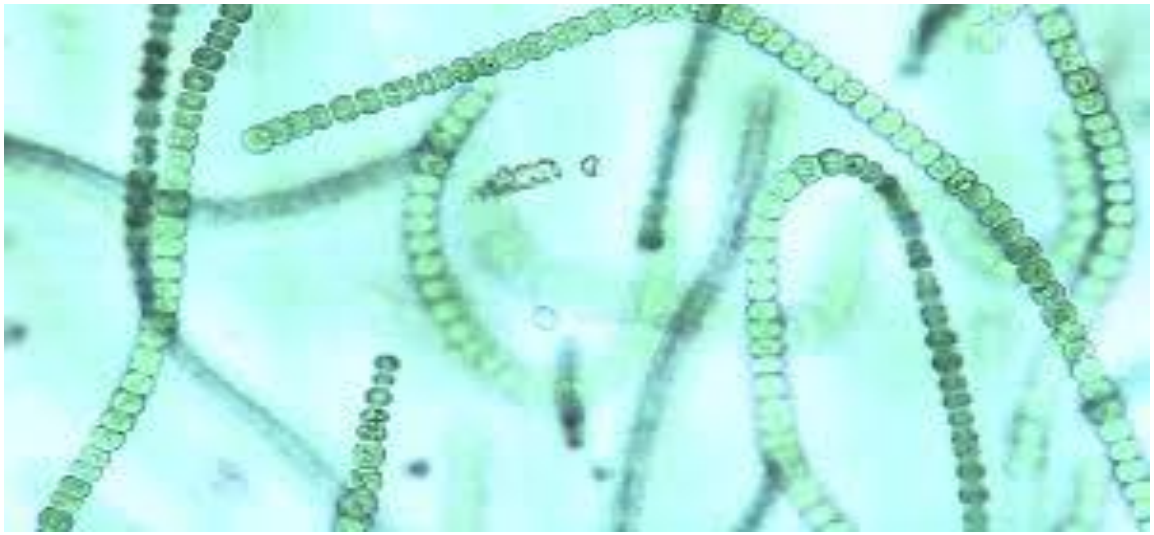
They also have **different means of nutrition**, which groups them as **autotrophs** or **heterotrophs**.



Algae

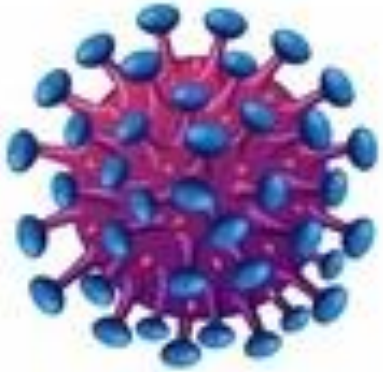
- **Algae** or **green algae** are unicellular or multicellular **eukaryotes** that obtain nourishment by photosynthesis.
- **Cyanobacteria** or **blue-green algae** are **prokaryotes.**
- Algae live in **water, damp soil,** and **rocks** and produce oxygen and carbohydrates which are used by other organisms.
- It is believed that **cyanobacteria** are the origins of **green land plants.**



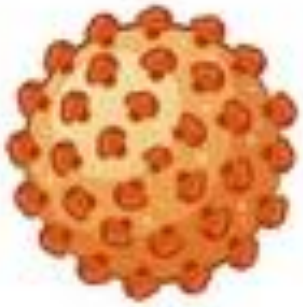


Viruses

- Viruses are **non-cellular entities** that consist of a nucleic acid core (DNA or RNA) surrounded by a protein coat.
- Although viruses are classified as microorganisms, they are **not considered living organisms.**
- Viruses **cannot reproduce outside a host cell** and **cannot metabolize on their own.**
- Viruses often **infect prokaryotic and eukaryotic cells causing diseases.**



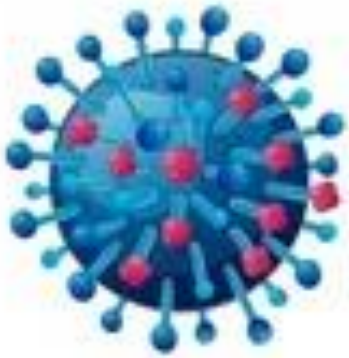
HIV



Hepatitis B

Ebola Virus

Adenovirus



Influenza

Bacteriophage

Multicellular Animal Parasites

- A group of **eukaryotic organisms** consisting of the **flatworms** and **roundworms**, which are collectively referred to as the **helminthes,** are important parasites.

- Although they are **not microorganisms by definition**, since they are large enough to be easily seen with the naked eye, they **live a part of their life cycle in microscopic form.**

- Since the parasitic helminths are of **clinical importance**, they are often discussed along with the other groups of microbes.

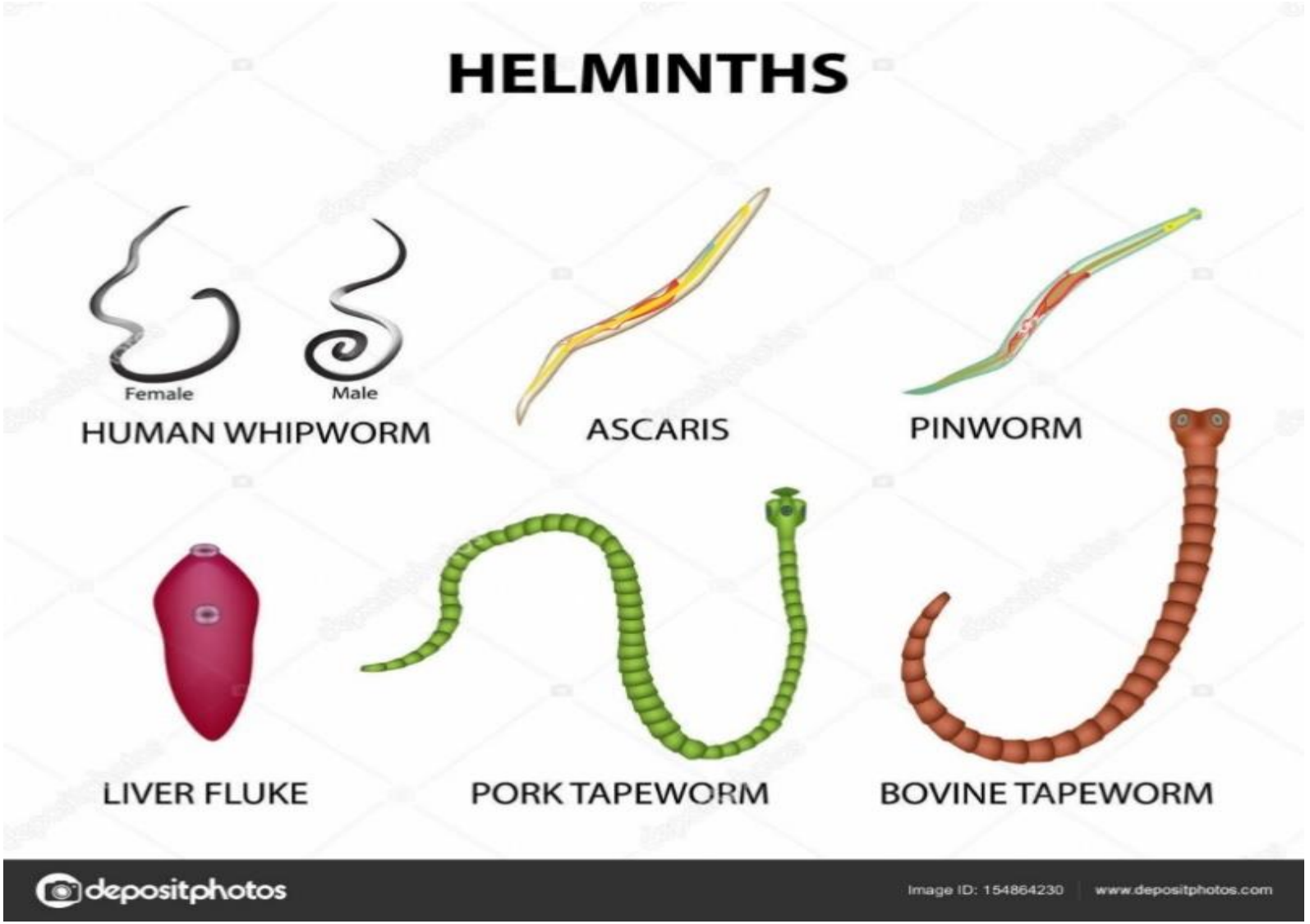

HELMINTHS
Female
Male
HUMAN WHIPWORM
ASCARIS
PINWORM
LIVER FLUKE
PORK TAPEWORM
BOVINE TAPEWORM
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Image ID: 154864230
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Classification of Microorganisms

- Microorganisms are classified into **taxonomic categories** to facilitate research and communication.

- **Taxonomy** is the science of naming, describing and classifying organisms and includes all plants, animals and microorganisms of the world.

- The groups making up the classification hierarchy are called **taxa**.

- Life on Earth is famous for its **diversity**.

- Throughout the world we can find many **millions of different forms of life.**

- By learning to **recognize certain patterns** and **classify them into specific groups**, biologists are better able to understand the relationships that exist among a variety of living forms that inhabit the planet.

- The **first, largest, and most inclusive group** under which organisms are classified is called a **domain.**

- There are **three** domains:

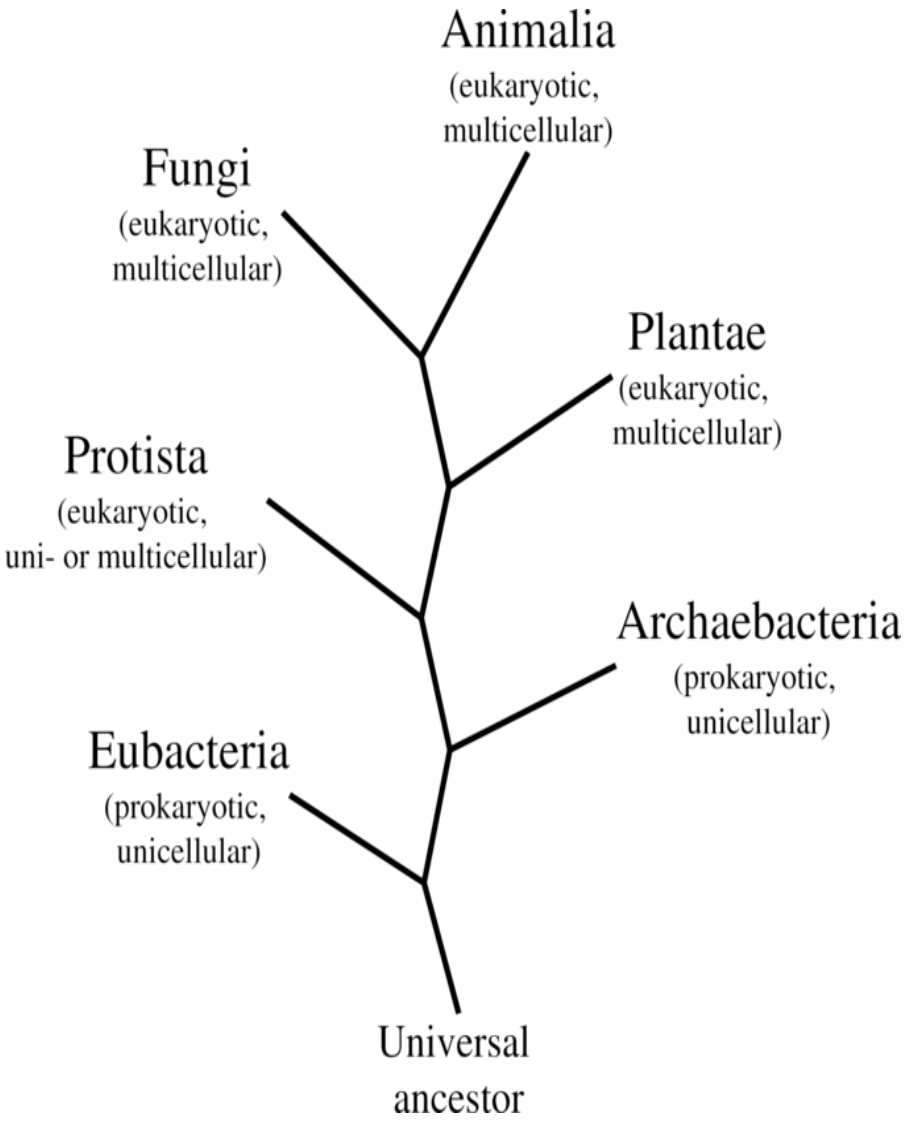
  -- **bacteria**
  -- **archae**
  -- **eukarya**

- The word **"domain"** was proposed by the microbiologist and physicist **Carl Woese in 1978** and is based on **identifying similarities in ribosomal RNA sequences of microorganisms.**

In old system largest group is called a **kingdom**.

Five major kingdoms have been described :

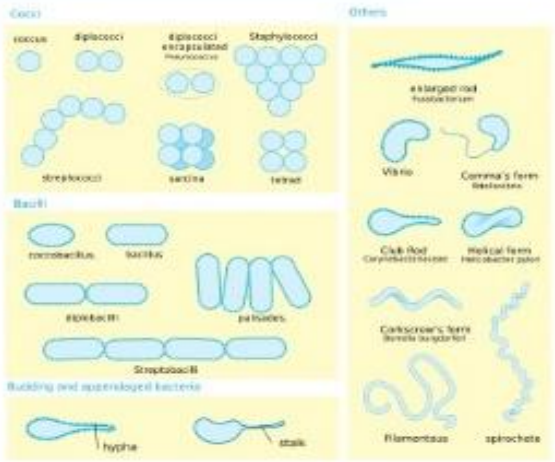
- **prokaryota** (e.g. archae and bacteria)
- **protista** (e.g. protozoa and algae)
- **fungi**
- **plantae**
- **animalia**



A **kingdom** is further split into **phylum or division, class, order, family, genus,** and **species**, which is the **smallest group**.

Classification of Bacteria (Linnaean)

- *Kingdom
- Phylum/Division
- Class
- Order
- Family
- *Genus (1st name)
- *Species (2nd name identifier)



Nomenclature

- Microorganisms are scientifically recognized using a **binomial** (two names) **nomenclature** using two words that refer to the **genus and the species.**

- The names assigned to microorganisms are in **Latin**.

- The **first letter of the genus** name is always **capitalized**.

- All names except for viruses are written in **italics.**

  e.g. *Escherichia coli, Giardia lamblia*

Classification of microorganisms has been largely aided by **studies of fossils** and recently by **DNA sequencing**.

The most widely employed methods for classifying microbes are:

- **morphological characteristics**
- **differential staining**
- **biochemical testing**
- **DNA fingerprinting**
- **polymerase chain reaction**
- **microarrays**


Thank You!