Tutorial session 1: Diversity of the Microbial World

I. Introduction

Microorganisms are very small organisms that require a light or electron microscope to be observed. They are found everywhere in our environment. They can be categorized into:

- **Useful microorganisms** for nature and humans, such as:
  - **Decomposers**: They act on plant debris, animal waste, and dead bodies.
  - **Microorganisms used in the food industry**: For the production of yogurt, cheese, and bread.
  - **Microorganisms used in medicine**: For the production of antibiotics.
- **Pathogenic (harmful) microorganisms** that cause infectious diseases, such as:
  - ***Entamoeba histolytica***: Causes amoebic dysentery.
  - ***Tetanus bacillus***: Causes tetanus.
  - **HIV**: Causes AIDS.

II. Main groups of microorganisms

II.1. Protozoa

They are unicellular eukaryotes. Each cell functions as an independent organism capable of performing various vital functions. They inhabit diverse environments, including water, moist soils, and the bodies of other organisms. Some protozoa are pathogenic. Examples include:

- ***Paramecium***:

Paramecium species, like *Paramecium caudatum*, live in freshwater and move using cilia. Some cilia surround a funnel-shaped opening that directs food (e.g., bacteria) into the cell for digestion in a digestive vacuole. They have a macronucleus for cell functions and asexual reproduction, and micronuclei for sexual reproduction.

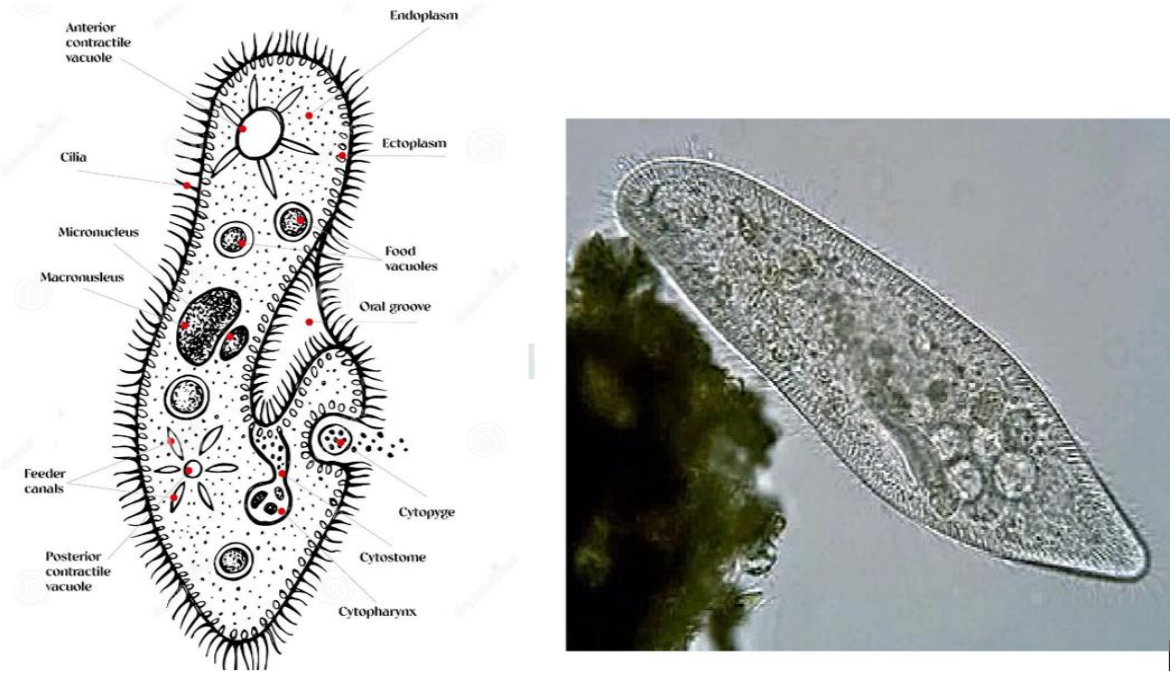

Figure 1: *Paramecium caudatum*

- **Trypanosomes**

Trypanosomes are parasites responsible for African trypanosomiasis, commonly known as sleeping sickness. The parasite is transmitted to humans through the bite of the tsetse fly (*Glossina* spp.), which becomes infected by feeding on the blood of an infected host, either human or animal.

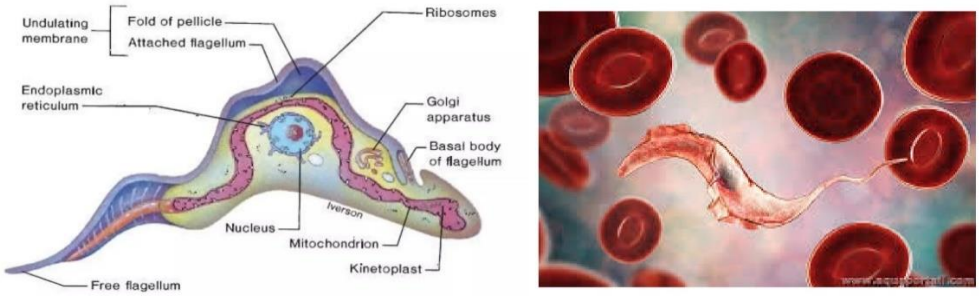

Figure 2: *Trypanosoma brucei*, the causative agent of sleeping sickness

- **The dysentery amoeba**

The dysentery amoeba (*Entamoeba histolytica*) is the causative agent of amoebic dysentery, a single-celled protozoan. Amoebas move and capture prey using pseudopods, which are temporary extensions of their cytoplasm. When environmental conditions become unfavorable, the amoeba can form a protective cyst, allowing it to survive outside a host.

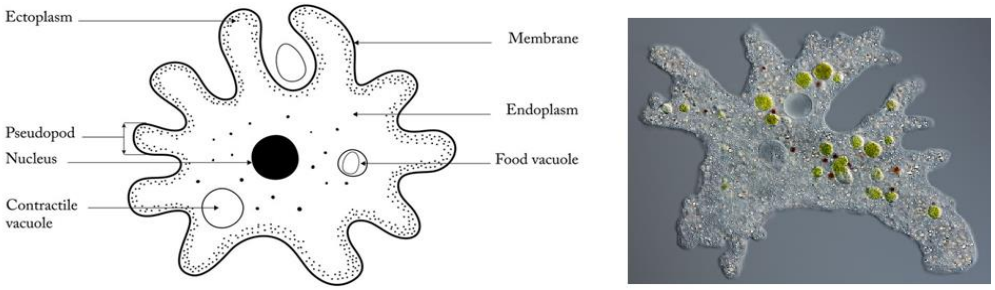

Figure 3: Structure of amoeba

II.2. Fungi

Only microscopic fungi are classified as microorganisms, and they are part of the eukaryotes. They can be categorized into:

- **Unicellular fungi (yeasts):** These are single-celled microorganisms with shapes that vary by species, often oval. Humans have used them since ancient times for producing alcoholic beverages and leavened dough, such as bread. Today, they are extensively utilized in biomedical research and biotechnology.

Example: Baker's yeast (*Saccharomyces cerevisiae*) consists of isolated oval-shaped cells. Under favorable conditions (presence of water and nutrients like glucose), it reproduces by forming small buds (budding) that detach from the mother cell and grow until they reach normal size.

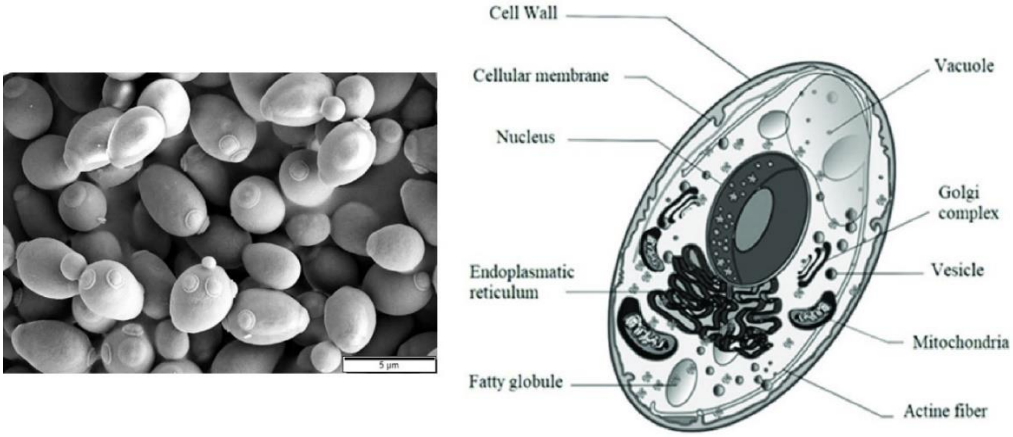

Figure 4: *Saccharomyces cerevisiae* cell and organelles description.

- **Filamentous fungi (molds):** These are multicellular microscopic fungi that reproduce via spores. In nature, molds act as natural decomposers. They can be either beneficial or harmful to humans. Molds can cause food spoilage and may also be pathogenic, responsible for certain diseases.

Example:

- ***Mucor*** grows on food left at room temperature in humid environments (e.g., fruits, vegetables, bread, etc.). It spreads through a mycelium made up of filaments and produces sporangia containing spores. These lightweight spores are dispersed through the air and, under favorable conditions, give rise to new mycelia.

Figure 5 : Structure of Mucor mold

- **Penicillium** are molds that commonly grow on damp bread and leftover jam. Their spores are arranged in brush-like structures at the ends of certain filament branches.
  - ✓ ***Penicillium notatum*** is a species cultivated for the production of an antibiotic: penicillin.

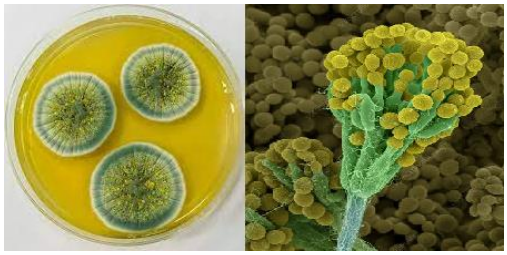

Figure 6: *Penicillium notatum*

  - ✓ ***Penicillium roqueforti*** is a species used in the production of certain cheeses, such as Roquefort and Danish blue cheese.

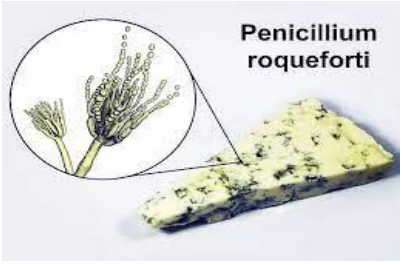

Figure 7: *Penicillium roqueforti*

  - ✓ ***Penicillium camemberti*** is a species used in the production of other cheeses, such as Camembert.

Figure 8: *Penicillium camemberti*

Other examples of pathogenic fungi

- **Trichophyton**, the causative agent of ringworm, is a mold that partially destroys hair. Its mycelium, composed of filaments, grows within the hair and produces spores that facilitate the fungus's spread.

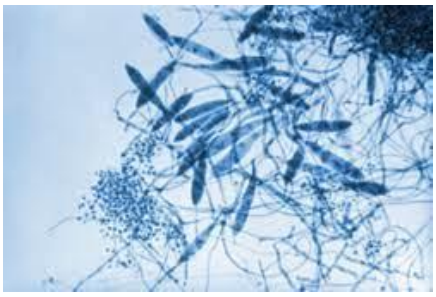

Figure 9: Trichophyton

- ***Plasmopara viticola*** is a fungus responsible for a grapevine disease called "downy mildew." It develops on all green parts of the plant (branches, leaves, clusters, etc.).

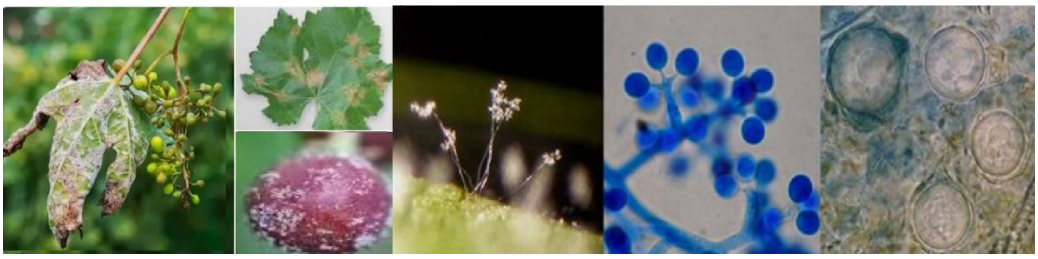

Figure 10: *Plasmopara viticola*

II.3 Bacteria

They are microscopic, single-celled living organisms. Their size typically does not exceed 2 micrometers. Bacteria are prokaryotic cells characterized by:

- A rigid cell wall beneath which lies a cytoplasmic membrane.
- A cytoplasm rich in cytoplasmic inclusions.
- A simple nucleus not surrounded by a nuclear membrane.

Bacteria reproduce through binary fission (simple cell division resulting in cells identical to the parent cell), which is a form of asexual reproduction.

Bacteria can have various shapes: spherical (cocci), elongated (rod-shaped, called bacilli), or spiral-shaped (referred to as spirilla).

Figure 11: Common shapes of bacteria

II.4. Archaea (archaebacteria)

They are a group of unicellular microorganisms that, like bacteria, have a prokaryotic morphology (lacking a nucleus and, in general, membrane-bound organelles).

Archaea were previously classified as bacteria, but biochemical differences led to their classification in a separate domain. The main differences include:

- Archaea possess metabolic pathways and several genetic units that are structurally and functionally similar to those of eukaryotes (e.g., enzymes involved in genetic transcription and translation).
- Their cell walls lack peptidoglycan.
- Some archaea live in the human body, but none have been shown to be human **pathogens**.

Like bacteria, archaea are found in nearly every habitat on earth, even extreme environments that are very cold, very hot, very basic, or very acidic.

Archaea reproduce asexually through three methods: budding, binary fission, or fragmentation. Examples of archaea include halobacteria and methanogens.

II.5. Microalgae (Microscopic Algae)

Microalgae make up phytoplankton and form the base of the marine food chain. They float freely in water, and their size varies, depending on the species, from a few micrometers (µm) to several hundred micrometers. They are used in aquaculture as a primary food source for many farmed animals, such as bivalves. Microalgae provide essential vitamins and polyunsaturated fatty acids necessary for their growth, which these animals cannot synthesize on their own.

An example is **Euglenophytes (euglenoids)**, a group of unicellular algae commonly found in freshwater and brackish water. Several species cultivated in laboratories serve as valuable material for research in cellular physiology.

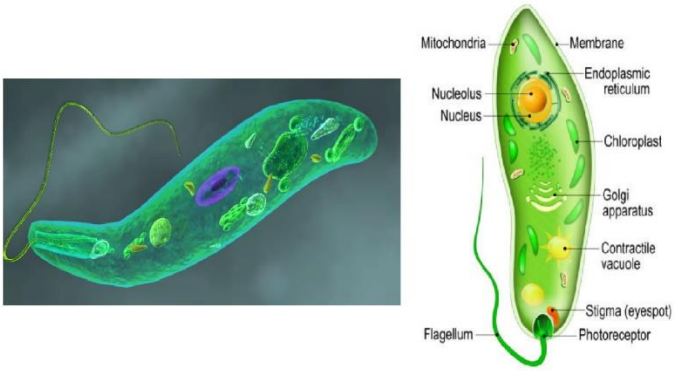

Figure 12: Structure of Euglena

II.6. Viruses

Viruses are particles that are 10 to 100 times smaller than bacteria. They consist of nucleic acid (DNA or RNA, in the case of retroviruses) surrounded by a protein coat. Although viruses are classified as microorganisms, they are not considered living organisms. Viruses cannot reproduce outside of a host cell, nor can they metabolize on their own. They are intracellular parasites, and to multiply, they rely on the enzymatic and energy systems of the host cell they infect.

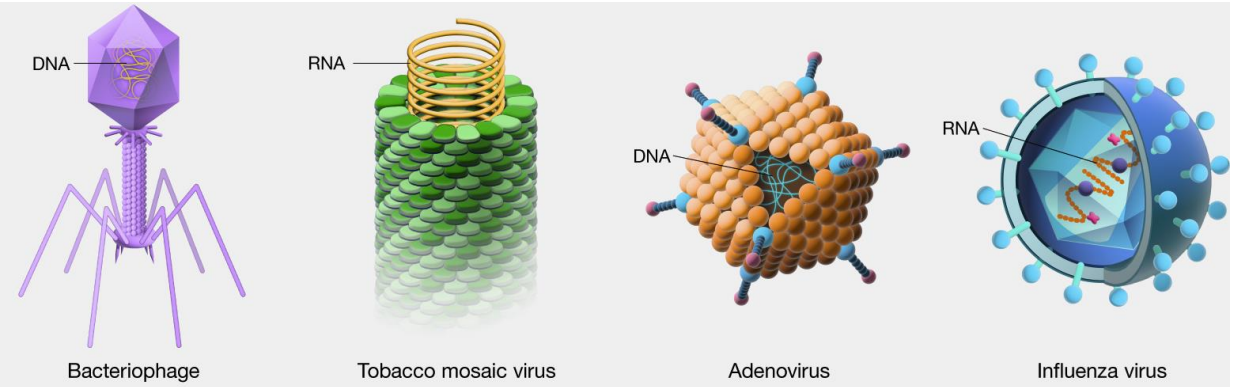

Figure 13: Examples of viruses