Chapter 1 : The Microbial World

1- History :

Before the discovery of microorganisms, all living beings were classified within the animal and plant kingdoms. Scientific principles dictate that animal organisms derive their energy from the oxidation of organic materials, accumulate reserve substances in the form of fats or glycogen, are photosynthetic, use light as a source of energy, synthesize starch as a nutritional reserve, lack movement, and possess a cell wall. It was during the 17th century that Antony Van Leeuwenhoek (1632-1723) revealed to the scientific world the prodigious diversity of microorganisms and the incredible richness of natural environments, such as water, in protozoa, algae, yeast, and bacteria. However, it was not until the 19th century and the experiments of Louis Pasteur that this microbial world was explored.

In 1866, the German zoologist Ernst Haeckel proposed to the scientific world the creation of a third kingdom, which he called the Protista kingdom, encompassing algae, protozoa, fungi, and bacteria.

Plants and animals are multicellular organisms and exhibit extremely advanced cellular differentiation : renal cells, neuronal cells, etc. Protists, on the other hand, are primarily characterized by a rudimentary biological organization, being unicellular or multicellular. They always present the same type of undifferentiated cells. The bacterial cell is a complete, independent organism, endowed with autonomous reproductive power. The contemporary classification is as follows:

- Plants : Vascular plants and Bryophytes.
- Animals or Metazoans.
- Protists : Higher protists and lower protists.
- Viruses, non-cellular organisms.

Protists are traditionally divided into two major classes :

- Higher Protists or Eukaryotes :
    - Algae (except blue-green algae)

- Protozoa
- Fungi

❖ Lower Protists or Prokaryotes :

- Blue-green algae or Cyanobacteria or Schizophyceae
- Bacteria or Schizomycetes

Very recently, organisms that do not belong to any of these fundamental categories have been discovered. They resemble bacteria externally, but phylogenetically, they are neither prokaryotic nor eukaryotic. They are called Archaebacteria and constitute a third class of Protists.

The eukaryotic cell, characteristic of plants, animals, and higher protists, contains a "true" nucleus, surrounded by a nuclear envelope, containing two similar sets of chromosomes (homologous) : diploid. The prokaryotic cell does not have a "true" nucleus but a diffuse nuclear apparatus, not isolated by a membrane, with a single chromosome carrying the vast majority of the cell's genetic information : haploid.

2- General Characteristics of Eukaryotic and Prokaryotic Cells

2.1- Nuclear Apparatus and Genophores

	Eukaryote	**Prokaryote**
1. Nuclear Apparatus-Structure		
- Nuclear Membrane	**+**	**-**
- DNA-Histone Association	**+**	**-**
- Chromosome	2n	**Unique**
2. Genetic Information		
- Nuclear Genophores	+	**+**
- Mitochondrial Genophores	+	**-**
- Chloroplastic Genophores	**d***	-
- Plasmid Genophores	-	+
3. Divisions	**Mitosis**	**Amitose**
4. Genetic Recombination	**Total → Zygote**	**Partial → Merozygote**

2.2- Cytoplasm and Cellular Elements

	Eukaryote	Prokaryote
Common Elements		
- Ribosome	+ (80S)	+ (70S)
- Inclusion Granules-Reserve	+	+
- Gas Vacuoles	+	d
Unknown Elements		
- Mitochondria	+	-
- Chloroplasts	d	-
- Endoplasmic Reticulum	+	-
- Golgi Apparatus	+	-
- Lysosomes	+	-
- Microbodies	+	-
- Microtubules	+	-

2.3- Diversity of Membrane Systems

	Eukaryote	Prokaryote
1. Presence and Diversity		
- Plasma Membrane	+	+
- Nuclear Membrane	+	-
- Mitochondria	+	-
- Chloroplasts	+	-
- Endoplasmic Reticulum	+	-
- Golgi Apparatus	+	-
- Lysosomes	+	-
- Microbodies	+	-
2. Chemical Composition		
- Sterols	+	- +
3. Regulation of Exchanges		
- Passive Transport	+	+

- Active Transport	+	+
- Endo-Exocytosis	+	-
4. Respiration		
- Mitochondrial Membranes	+	-
- Cytoplasmic Membranes	-	+
5. Photosynthesis		
- Chloroplasts	-	-++
- Plasma Membranes	-	-+++

+- Present in small quantities in Cyanophyceae and in Mycoplasmas cultured on serum.

++- In Cyanophyceae, presence of a membrane system analogous to that of chloroplasts.

+++- Except in photosynthetic purple bacteria.

3- General Characteristics of Eukaryotic Protists :

3.1. Algae : Their dimensions vary from microscopic cellular forms to filamentous forms reaching one meter in length. Algae are aquatic organisms found in the fresh waters of lakes, rivers, ponds, and in the saline waters of seas and oceans. They are all photosynthetic and accumulate their reserves in the form of starch.

3.2. Protozoa : As their name indicates, they are the first and least evolved animal forms. They are generally studied within the framework of zoology. They are extremely diverse in their morphology and dimensions. Their distribution is widespread in nature. The most numerous forms are aquatic. They produce organic substances in elaborated and organized solutions like bacteria. They are divided according to the absence or presence of a locomotor apparatus and its nature.

3.3. Fungi : They are recognized for a biological organization distinctly different from that of algae and protozoa. They lack chlorophyll pigments (non-photosynthetic) and derive their energy from the oxidation of chemical compound. They are characterized by a mycelial structure and a coenocytic organization as they consist of filamentous elements: hyphae, and they are divided according to their mode of reproduction:

- **Phycomycetes :** Primitive
- **Ascomycetes :** Ascospores
- **Basidiomycetes :** Basidiospores
- **Deuteromycetes :** Imperfect fungi

4- General Characteristics of Prokaryotic Protists :

4.1. Blue-Green Algae : They have a spherical shape and are photosynthetic. They reproduce by fission or by hormogonia, which detach from the free end of the filament. The most well-known are *Beggiatoa* and *Hiothrix*.

4.2. Myxobacteria : They move by gliding on solid surfaces, are non-photosynthetic, and are widely distributed in nature, soil, and water. They participate in the mineralization of organic matter thanks to their active and specialized enzymes. The most well-known are *Myxococcus*, *Cytophaga*, and *Porocytophaga*.

4.3. Spirochetes : They have a helical shape due to their axial filament, which gives them great mobility. The most well-known are *Treponema*, *Leptospira*, and *Borrelia*.

4.4. Eubacteria :

- **Photosynthetic Eubacteria :** *Rhodomicrobium*
- **Non-Photosynthetic Eubacteria**
- **Stalked Eubacteria :** *Caulobacter*
- **Filamentous Eubacteria :** *Sphaerotilus*, *Gallionella*
- **Mycelial Eubacteria (Actinomycetes) :** *Actinomyces*, *Nocardia*

4.5. Rickettsiae : They are obligate intracellular parasites as they are incapable of reproducing outside the animal. They are smaller than bacteria and parasitize lice : *Rickettsia prowazekii*.

4.6. Chlamydiae : They resemble Rickettsiae but only infect vertebrate hosts.

4.7. Mycoplasmas : They lack a rigid cell wall and can therefore take on various forms depending on the environment that hosts them: *Mycoplasma*.

4.8. Archaebacteria : They may constitute a separate kingdom due to the following:

- They possess various types of cell walls based on muramic acid.
- Their membrane lipids are not composed of linear fatty acids and glycerol but of branched fatty acids (phytanol) linked by ester bonds.
- They possess RNA polymerase subunits different from those of bacteria.
- Their transfer RNA contains pseudouridine.