

Course content :

- Definition of microbiology
- Overview of Microbial Life
- Taxonomic classification of microorganisms

Course Objectives

By the end of this course, the student will be able to:

- Identify the fields of study in microbiology.
- Recognize the various organisms that make up microbial diversity.
- Understand the classification system in microbial taxonomy.

1. Definition

Microorganisms constitute a significant and diverse group of microscopic organisms (generally not observable directly to the naked eye), existing as individual cells or in groups, or as non-cellular entities.

Microbiology is the biological science that studies microorganisms. It is a fundamental science because it provides the tools for understanding life processes. It is also an applied science because it allows the study of various issues in medicine, agriculture, industry, etc., to meet human needs.

Microorganisms represent an important element in the balance of ecosystems on the planet. The existence of other higher forms of life, such as animals, plants, and humans, is closely linked to microbial activities and diversity. These interactions can be beneficial, neutral, or harmful.

The microbial world consists of two types of entities: cellular and non-cellular (acellular) :

➤ Cellular Entities: The cell is the fundamental structural and functional unit of living matter. It is the smallest living unit capable of reproducing and maintaining itself autonomously. All cells share identical structural elements and functions. However, they diverge in terms of the level of organization of their internal cellular structures into prokaryotes lacking complex internal cellular organization and eukaryotes having organelles (internal cellular structures delimited by membranes).

Prokaryotic cells share the same chemical characteristics as eukaryotic cells, in that they essentially contain nucleic acids, proteins, lipids, and carbohydrates, and use the same types of chemical reactions to metabolize nutrients, synthesize proteins, and store energy. The difference lies at a structural and functional level. Thus, the unique structure of cell walls and membranes, and the absence of organelle delimitation by membranes, especially for genetic material (DNA), distinguishes prokaryotes distinctly from eukaryotes.

Microorganisms can be prokaryotes (archaea, bacteria) or eukaryotes (molds, yeasts, algae, protozoa). A microorganism can consist of a single cell (bacteria, archaea, yeasts) or an assembly of multiple cells (molds, algae).

➤ Non-Cellular Entities: Other entities lacking the structural and functional properties of living cells make up a significant group of microorganisms. These are primarily viruses, composed of nucleic acid (DNA or RNA) often enclosed in a protein coat (capsid). Prions are another type of non-cellular entities of proteinaceous nature.

2. Systematics in microbiology

Systematics is the branch of biology that aims to describe the diversity of living organisms and classify them based on their similarities, differences, and the relationships that exist among them. Taxonomy and nomenclature are two disciplines within systematics.

Taxonomy is the science that leads to a hierarchical classification of living organisms into groups called taxa. A taxon (or taxonomic unit or taxonomic group) includes different organisms within the whole it constitutes. Each taxon is given a name.

The classification of life utilizes a system of nested and coherent hierarchical taxa that align with the evolutionary history of life.

Nomenclature is a set of rules that allows the clear naming of taxa in accordance with the hierarchical levels of classification. The name of a taxon is chosen according to these rules, is typically Latinized, and is written in *italics* or underlined.

The living world is thus classified into three major domains of life: *Bacteria*, *Archaea*, and *Eukarya*. Each domain is divided into kingdoms, which are further divided into phyla (or phylums), which in turn are divided into classes, which are divided into orders, which are further divided into families that contain genera. Species is the basic taxon in the hierarchical classification of life. The binomial name of a species is written in the form *Genus species*. For example: *Escherichia coli*, *Pyrococcus abyssi*, *Saccharomyces cerevisiae* (Table 1).

Table 1. Examples of Taxonomic Classification of Some Microorganism Species.

Taxon	Example 1	Example 2	Example 3
Domain	<i>Bacteria</i>	<i>Archaea</i>	<i>Eukaria</i>
Kingdom	<i>Bacteria</i>	<i>Archaea</i>	<i>Fungi</i>
Phylum	<i>Proteobacteria</i>	<i>Euryarchaeota</i>	<i>Ascomycota</i>
Class	<i>Gammaproteobacteria</i>	<i>Thermococci</i>	<i>Saccharomycetes</i>
Order	<i>Enterobacteriales</i>	<i>Thermococcales</i>	<i>Saccharomycetales</i>
Family	<i>Enterobacteriaceae</i>	<i>Thermococcaceae</i>	<i>Saccharomycetaceae</i>
Genus	<i>Escherichia</i>	<i>Pyrococcus</i>	<i>Saccharomyces</i>
Species	<i>Escherichia coli</i>	<i>Pyrococcus abyssi</i>	<i>Saccharomyces cerevisiae</i>