Introduction and historical

Microbiology is the study of microorganisms' biological entities too small to be seen with the unaided eye. Most major advances in microbiology have occurred within the past 150 years, and several important sub disciplines of microbiology have developed during this time, including microbial ecology, molecular biology, immunology, industrial microbiology and biotechnology. Microorganisms of various types exist in all three domains of life (the Bacteria, Archaea and Eukarya). Microscopic biological agents include bacteria, archaea, protists (protozoa and algae), fungi, parasitic worms (helminths) and viruses. Although a small percentage of microorganisms are harmful to certain plants and animals and may cause serious disease in humans, the vast majority of microorganisms provide beneficial services, such as assisting in water purification and the production of certain foods, and many are essential for the proper functioning of Earth's ecosystems. Microbiology considers all aspects of microbial cells, including their structure, metabolism, diversity, genetics and evolution, ecology and roles in infectious diseases.

The discovery of microorganisms

- The English naturalist Robert Hooke (1635–1703) was an early microscopist and published the first book devoted entirely to microscopic observations of microorganisms. Hooke prepared detailed and quite accurate drawings of moulds (fungi) and many other microbes, and these were the first known description of microorganisms.

Figure1:Robert Hooke

- The first person to see bacteria, which are typically much smaller than moulds, was the Dutch amateur microscopist Antoni van Leeuwenhoek (1632 1723). Van Leeuwenhoek constructed simple microscopes that contained a single lens and used them

to examine various natural substances. These microscopes were crude by today's standards, but by careful manipulation and focusing, van Leeuwenhoek was able to see a wide variety of microorganisms, including bacteria. His communications revealed a previously hidden microbial world that existed in water, nutrient solutions, the oral cavity and virtually anywhere one could imagine.

Figure2: Van Leeuwenhoek

- Pasteur initiated studies on the mechanism of the alcoholic fermentation, which in the mid-nineteenth century was assumed to be a strictly chemical process. Through microscopic observations and other rigorous experiments, Pasteur showed that the fermentation was actually caused by the metabolic activities of yeast cells. Pasteur then used these insights to design a series of classic experiments to disprove the theory of spontaneous generation, the widely held belief at the time that living organisms could arise from nonliving matter. Pasteur's work on spontaneous generation forced him to develop effective sterilization procedures, many of which have remained mainstays in microbiology and clinical medicine to this day.

Figure3: louis pasteur

Classification and Characteristics of Microorganisms

Microorganisms encompass an enormous diversity of microscopic life forms, each with distinct characteristics. On the basis of their genotypic (genetic) and phenotypic (observed) properties, all organisms are classified into one of three domains – the *Bacteria*, *Archaea* or *Eukarya* – and numerous examples of microorganisms are found in all three (**digram1)**. The comparison of ribosomal ribonucleic acid (rRNA) gene sequences has been especially important in determining the evolutionary, or phylogenetic, relationships of organisms. An overview discussion of microbiology must also include a consideration of viruses, even though they are not cellular and thus are not included in the three-domain tree of life.

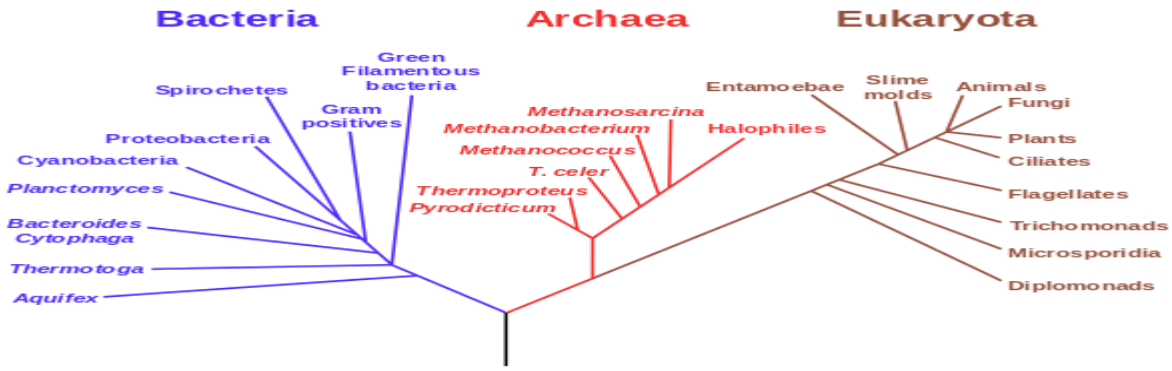


Diagram1: phylogenetic tree

1) The *Bacteria* and *Archaea*

The *Bacteria* and *Archaea* are vast groups of microorganisms consisting of potentially hundreds of thousands to millions of species, most of which remain uncharacterized. These microbes are ubiquitous, inhabiting and subsist in nearly every imaginable environment on Earth. Various species thrive on or within every plant and animal, within and underneath massive glaciers, in hypersaline waters of the Great Salt Lake and the Dead Sea, and even in boiling hot springs and deep sea volcanic (hydrothermal) vents. *Bacteria* and *Archaea* are classified based on

a. Phylogenetic distinctions

b. Structural and morphological characteristics, such as cell shape, size and arrangement.

c. Biochemical and physiological traits, such as growth factor requirements, range of carbon and energy sources and products of metabolism.

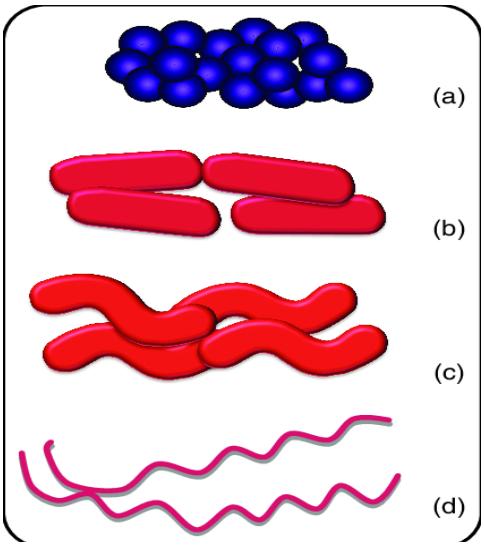
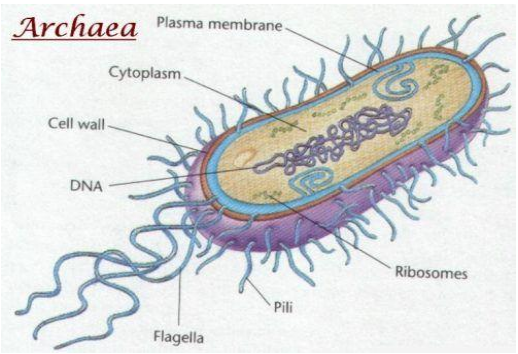


Figure4: Major morphological forms of bacterial cells. (a) coccus (plural, cocci); (b) rod (bacillus; plural, bacilli); (c) spirillum (plural, spirilla) and (d) spirochete.



2) Eukaryotic microorganisms are remarkably diverse, consisting of hundreds of thousands of species of fungi, protozoa and algae, as well as hundreds of species of parasitic worms.

- Fungi are a major component of soil ecosystems. Similar to plants, cells of fungi have rigid cell walls and are non-motile, but unlike plants, they lack chlorophyll and are non-photosynthetic. Instead, fungi subsist by degrading dead plant and animal matter, and therefore, along with bacteria, play a key role in the decomposition and recycling of nutrients. Fungi exist

in two basic forms: molds that consist of filaments called hyphae that can form into masses known as mycelia, and yeasts, which are unicellular and typically oval-shaped. Fungi are capable of sexual reproduction or asexual reproduction, both of which may result in the production of spores that can germinate to form new hyphae. In addition, yeasts often reproduce asexually by budding, a process in which a new daughter cell develops on the surface of a parent cell before eventually breaking away.

- Protozoa are unicellular, mostly non photosynthetic protists that lack cell walls. Some protozoa are large enough to be seen with the unaided eye, although most are microscopic. Many protozoa are capable of reproducing sexually or asexually. Depending on the species, asexual reproduction may occur through any of several mechanisms, including budding, spore formation or mitotic fission. A common mechanism of sexual reproduction in protozoa is conjugation, in which two cells join, exchange genetic material and produce progeny by budding or fission.
- Algae are plant-like protists that are distinguished from fungi and most protozoa by their ability to perform photosynthesis using chlorophyll pigments, and they comprise much of the basis of the food chain in marine and freshwater environments. Algae exhibit a variety of morphological forms, including unicellular, filamentous, colonial and large multicellular aggregates called kelps or 'seaweeds' that can attain lengths of up to 50 m. Somealgae have become increasingly important sources of food or food additives for humans. For example, the red alga *Porphyra*, known as nori, is popular in sushi preparation, and other red algae are the source of agar.
- Viruses are acellular microbes that require living host cells to multiply; thus, they are obligate intracellular parasites. Structurally, viruses are quite simple, often consisting of only DNA or RNA (the viral genome) surrounded by a simple protein coat having either a helical or icosahedral morphology (Figure 5). Viruses that infect bacteria, called bacteriophages, often have a complex morphology in that they exhibit a combination of these two forms (Figure 5). Most viruses are too small to be seen with even the best light microscopes, and because of their tiny size and dependence on host cells, their genomes are typically quite small, in some cases consisting of only two genes.

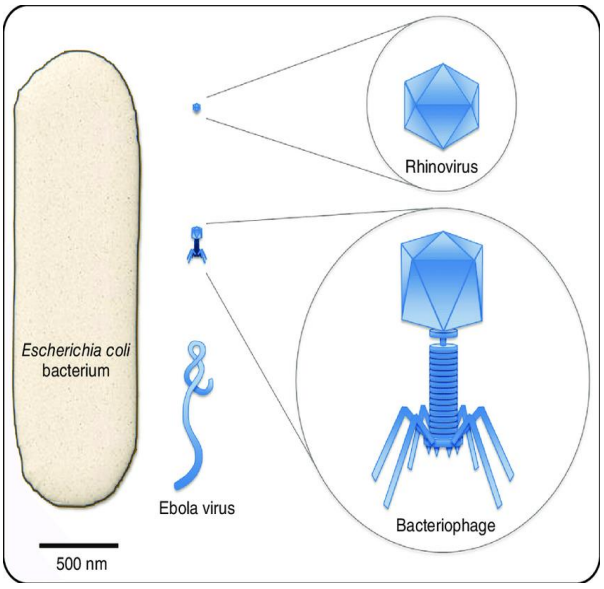


Figure5: Major morphological forms of viruses