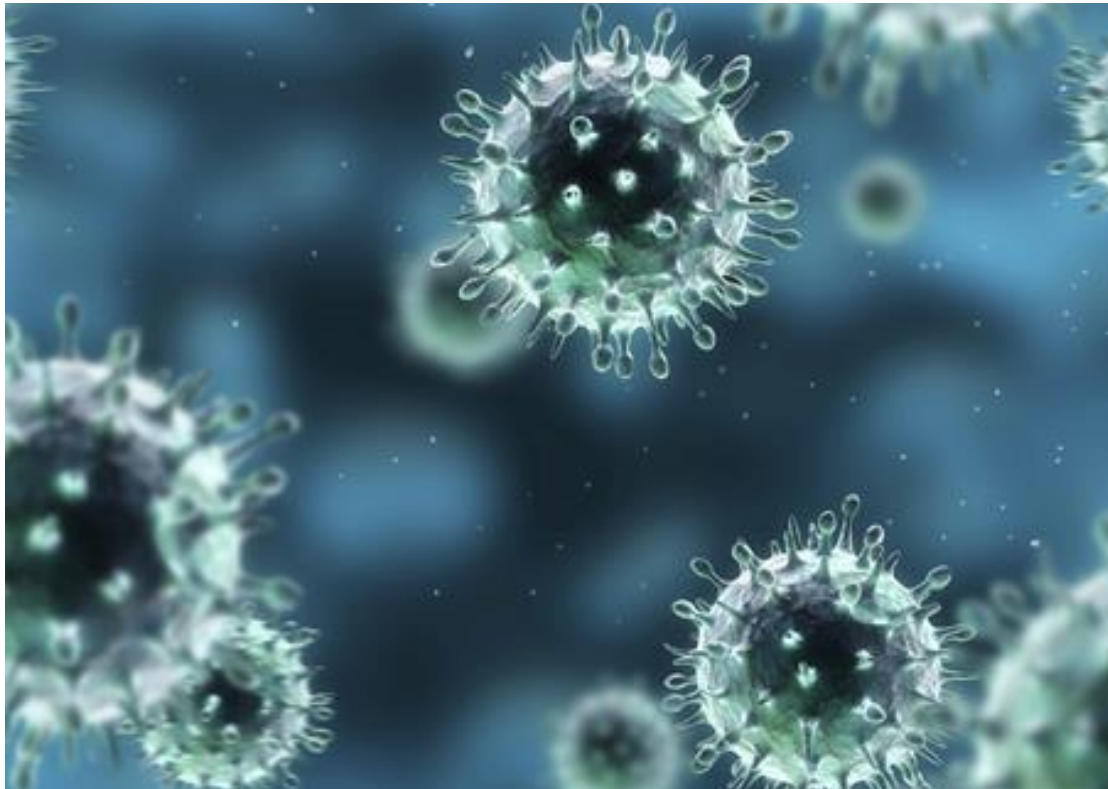


An Introduction to General Microbiology



Microbiology is a subject which deals with living organisms that are individually too small to be seen with the naked eye. It considers the microscopic forms of life and deals about their reproduction, physiology, and participation in the process of nature, helpful and harmful relationship with other living things, and significance in science and industry.

Subdivision of microbiology

- Bacteriology deals about bacteria.
- Mycology deals about fungi.
- Virology deals about viruses.

Microbes, an introduction.

The scale of the “invisible world”; There are a thousand millimetres in a metre. There are a thousand microns (micrometres) in a millimetre, an *E. coli* bacterium is about a micron long – so a million of them lined up form a line a metre long, a cell of bakers yeast (a fungus) is about 10-15 microns in diameter. Some microscopic pond life is invisible to the naked eye, some are “just” visible.

Viruses are very tiny, only a fraction of a micron (say 20 - 100 nanometres - billionths of a metre).

Bacteria, fungi, and protozoa can be seen in a light microscope, but except for the larger protozoans, not with much internal detail. Viruses cannot be seen using a light microscope. Viruses can easily be seen using a transmission electron microscope, extensive details of cells can be analysed with an electron microscope.

The “Branches” of microbiology;

Bacteriologists - study bacteria, there are medical, agricultural, biotechnological specializations.

Mycologists - study fungi, there are medical, agricultural, biotechnological specializations.

Protozoologists, study small “animal - like” single celled organisms such as amoeba, and various disease causing parasites.

Phycologists study algae. The study of lichens can also be regarded as a sub discipline of microbiology

Parasitologists- a term generally used to describe those who study small animals as agents of disease (like some microscopic worms for instance) but also used to describe those who study protozoan pathogens.

Immunology is often taught and researched in microbiology faculties.



KEYWORD single **CELLS**
(OR cell clusters)

Characteristics that Microorganisms have that;

1. **CELL MEMBRANE** –barrier that separates the inside of the cell from the outside
2. **NUCLEUS OR NUCLEIOD** – location of genetic information (DNA)
3. **CYTOPLASM** –location of the machinery for cell growth and function
4. **MACROMOLECULES** – proteins, nucleic acids, lipids, polysaccharides

What organisms are considered to be microbial cells and studied in microbiology

1. **BACTERIA**
2. **FUNGI**
3. **ALGAE**
4. **PROTOZOA**
5. **Viruses**(although not a cellular entity but an intracellular pathogen)
6. **Prions** (a biochemical anomaly—misfolded proteins)
7. **Helminths Worms** (multicellular)

Taxonomy

The study of **phylogenetic** relationships between organisms
(*The sorting of all living things based on their related or differentiating features*)

KINDOM the highest level in classification

PHYLUM related classes

CLASS related orders

ORDER related families

FAMILY related genera

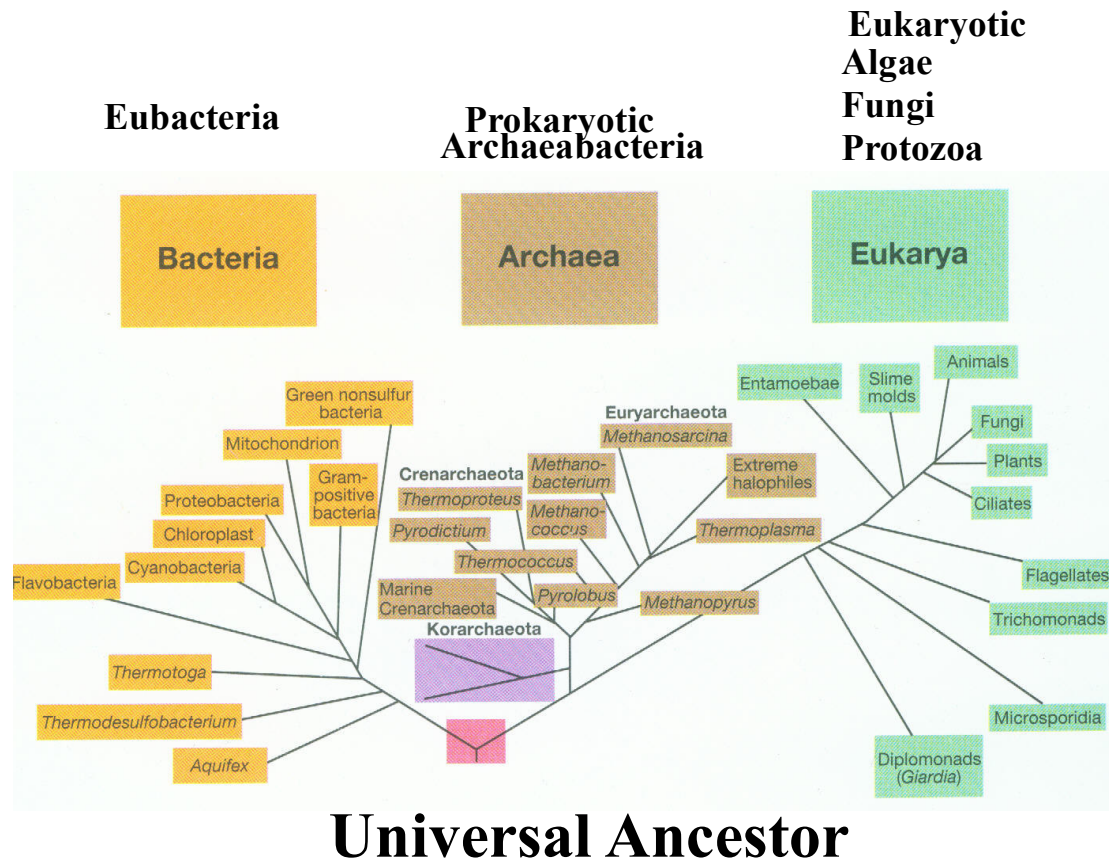
GENUS closely related species

SPECIES organisms sharing a set of biological traits and reproducing only with their exact kind

Further classifications especially with bacteria:

Strain—organisms within a species varying in a given quality

Type—organisms within a species varying immunologically



Phylogenetic classification of micro-organisms;

EUBACTERIA most abundant of the bacteria
found in soil, water and animal digestive tracts

ARCHAEACTERIA live in **extreme conditions** (temperature, pH etc)
mostly **anaerobic** (unable to live in the presence of oxygen)

EUKARYOTES **algae**: live in soil and water, contains chlorophyll for photosynthesis, has a cell wall
fungi: yeast, molds. Lack chlorophyll and obtains energy from organic compounds in soil and water, has a cell wall
protozoa: colorless, lacks a cell wall, ingests other organisms or organic particles

Major Differences between prokaryotic and eukaryotic micro-organisms

Prokaryotes

1. Nonmembrane bound nucleoid region
2. DNA-one circular molecule one chromosome
3. Haploid-One copy of a gene
4. Plasma membrane does not contain sterols
5. Reproduction—simple binary fission

Eukaryotes

1. Membrane bound nucleus containing DNA
2. DNA-linear molecules arranged to form several chromosomes
3. Diploid-Two copies of a gene
4. Plasma membrane contains sterols
5. Reproduction—meiosis and mitosis
6. Presence of membrane bound organelles such as chloroplasts and mitochondria.

Why study Microbiology ?

Microbiology as a BASIC Science

Bacteria and yeast are useful in studying molecular biology, biochemistry and genetics

- reproduce rapidly
- are genetically (DNA) and biochemically more simple than higher order organisms
- working with bacteria and yeast for understanding life processes has no ethical ramifications.

Microbiology as an APPLIED Science

Medicine— Vaccine development, production of antibiotics, production of important biological enzymes (insulin)

Industry— Production of beer, wine, cheeses and yogurt

Agriculture— maintenance of soil fertility/digestion in cattle

Ecology— **Bioremediation**— microorganisms that degrade toxic waste materials

Key figures in the history of microbiology

Robert Hooke (1635 - 1703) was a “polymath” he made many scientific discoveries in the 17th century, including making one of the first microscopes and also using a copy of one of Leeuwenhoek’s microscopes to see and draw details of the structure of plant cells and some microbes.

Antony van Leeuwenhoek (1632-1723) made the first useful microscopes in the 17th century, they were fiendishly difficult to make and use, they were essentially a lens held in a metal clip, the lens was made from a tiny drop of molten glass, and he used such a microscope to see the first microscopic cells.

Ilya Metchnikoff (1845-1916) was the first to realize that animals such as us had a defence system against infection, what we now call the immune system

Paul Ehrlich (1854-1915), searched for the “magic bullet” against infectious disease, he synthesized the first successful (but very toxic) drug against a disease – syphilis, it was an arsenic derivative he called salvarsan.

Gerhardt Domagk (1895-1964) developed the first useful drug against a variety of bacterial infections, the first sulfa drug –prontosil. Ironically, he died of an infection!

Sir Alexander Fleming (1881-1955) and **Selman Waksman** (1888-1973) discovered the first relatively safe and effective antibiotics (of natural origin) – isolated from microorganisms. Fleming discovered penicillin, Waksman discovered streptomycin and a number of other antibiotics.

Louis Pasteur (1822-1895) was a chemist, he made many great discoveries, and he performed a crucial experiment using a swan necked flask that proved that new life did not just spontaneously arise from substances like rotting meat. For centuries before Pasteur, many people believed in Spontaneous Generation- the belief that life is generated spontaneously from dead organic matter. **Robert Koch** (1843-1910) and his colleagues made many important discoveries in microbiology, Koch initiated the use of the seaweed polysaccharide gel called agar as a stable material for the formation of a gel on which separated and pure (single species) colonies of bacteria and fungi could be grown (actually it was the wife of a colleague of his who suggested it), this was a critical advance, and he also stated and used his Koch’s postulates (discussed later) required to prove that a given organism caused a given disease.