

"Introduction to Microbiology / Host- Microbe Relationships"

**Microbio. & Immuno. M./ 1st Year Class
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Learning Objective

- Define of Medical Microbiology. Distinguish Between Types of Microbes.
- Recognize The Different Causes of Diseases. Define Risk Factors of The Microbial Infection.
- Define Host And Microbe. Describe The Host Microbe Relationships.
- Mechanism of Pathogenesis Adhesion/ Colonization / Virulence And Toxigenicity.
- Host Response Against Microbe.

Introduction to Microbiology

Microbiology (from Greek μῆκος, mīkros, "small"; βίος, bios, "life"; and -λογία, -logia) is the study of microscopic organisms, those being unicellular (single cell), multicellular (cell colony), or acellular (lacking cells). Microbiology encompasses numerous sub-disciplines including virology, mycology, parasitology, and bacteriology.

Taxonomic arrangement

- Bacteriology: The study of bacteria.
- Mycology: The study of fungi.
- Protozoology: The study of protozoa.
- Parasitology: The study of parasites.
- Immunology: The study of the immune system.
- Virology: The study of viruses.
- Microbial physiology: The study of how the microbial cell functions biochemically. Includes the study of microbial growth, microbial metabolism and microbial cell structure.

- Historians are unsure who made the first observations of microorganisms. In 1676, Anton van Leeuwenhoek observed bacteria and other microorganisms, using a single-lens microscope of his own design.
- Following on from this, in 1857 Louis Pasteur also designed vaccines against several diseases such as anthrax, followed cholera and rabies as well as pasteurization for food preservation.
- In 1867 Joseph Lister is considered to be the father of antiseptic surgery. By sterilizing the instruments with diluted carbolic acid and using it to clean wounds, post-operative infections were reduced, making surgery safer for patients.
- In the years between 1876 - 1884 Robert Koch provided much insight into infectious diseases. He was one of the first scientists to focus on the isolation of bacteria in pure culture. This gave rise to the germ theory. He developed a series of criteria around this that have become known as the Koch's postulates.
- A major milestone in medical microbiology is the Gram stain. In 1884 Hans Christian Gram developed the method of staining bacteria to make them more visible and differentiated under a microscope. This technique is widely used today.

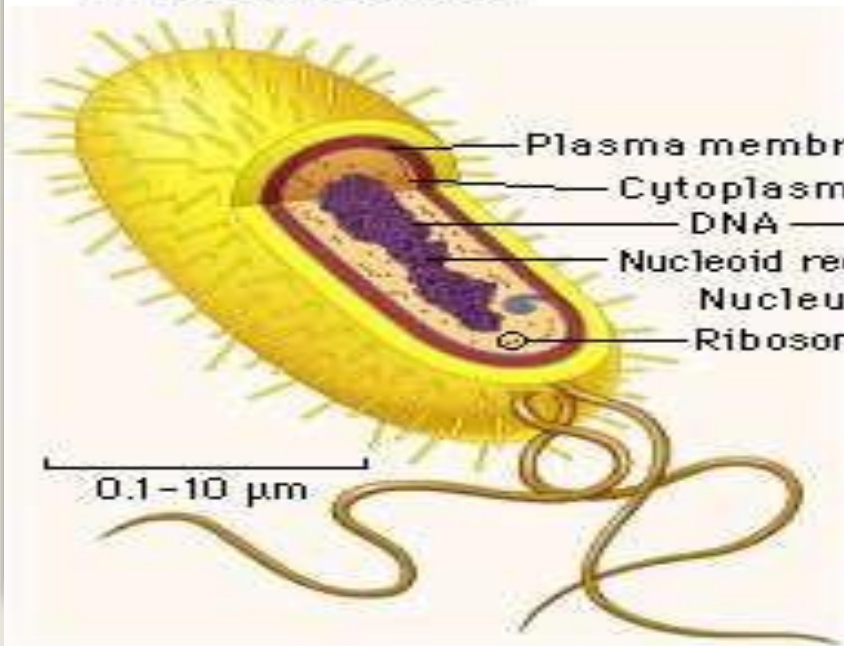
- Majority of them contribute to the quality of our life: such as maintaining the balance of chemical elements in the nature (include breaking down the remains of all dead organisms, and recycling carbon, nitrogen, sulfur, phosphorus, and other elements in the nature).
- Most M.Os. are harmless and even beneficial: M.O.s could be applied to assist in production of some processed foods and food products such as bread, cheese, yoghurt, vinegar, alcohol, ..etc. In addition to that M.O.s also assist in production of drugs such as antibiotics (e.g., penicillin) and immunosuppressive drugs (e.g., cyclosporine).

Classification of Microorganisms

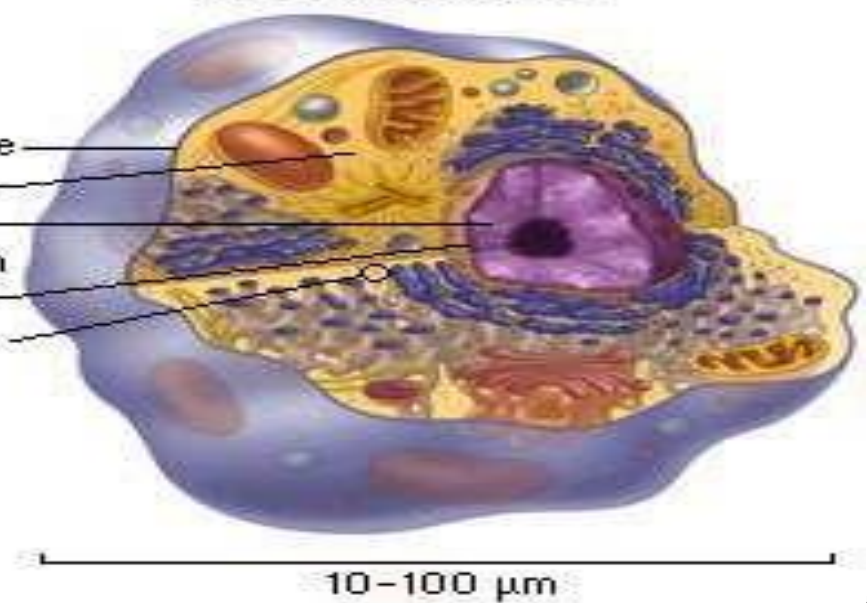
Prokaryotes and Eucaryotes

Cellular organisms are broadly classified as **prokaryotic (without a nucleus)** or **eukaryotic (with a nucleus)**. Prokaryotic organisms are divided into two major groups: the **eubacteria**, which include all bacteria of medical importance, and the **archaea**, a collection of evolutionarily distinct organisms. Eukaryotic organisms include fungi, protozoa, and helminths as well as humans.

Prokaryotic cell



Eukaryotic cell



1. Bacteria: Bacterial cells divide by binary fission. However, many bacteria exchange genetic information carried on plasmids (small, specialized genetic elements capable of self-replication) including the information necessary for development and expression of antibiotic resistance.

A. Typical bacteria: Most bacteria have shapes that can be described as a rod, sphere, or bacilli. Prokaryotic cells are smaller than eukaryotic cells. Nearly all bacteria, with the exception of the Mycoplasmas, have a rigid cell wall surrounding the cell membrane that determines the shape of the organism. and it's also determines whether the bacterium is classified as gram positive or gram negative. External to the cell wall may be flagella, pili, and/or a capsule.

B. Atypical bacteria: Atypical bacteria include groups of organisms such as Mycoplasma, Chlamydia, and Rickettsia that although prokaryotic **lack** significant characteristic structural components or metabolic capabilities that separate them from the larger group of typical bacteria.

2. Eucarya: This domain includes **all life forms having cells possessing a nucleus**. The **plant kingdoms** and **animal kingdoms** are all **eukaryotic life forms**.

This domain also includes different kinds of M.O.s (some of them are pathogenic, they are:

A. FUNGI

Fungi are non photosynthetic, generally saprophytic, eukaryotic organisms. Some fungi are filamentous and are commonly called molds, whereas others (i.e, the yeasts) are unicellular. Fungal reproduction may be asexual, sexual, or both, and all fungi produce spores. Pathogenic fungi can cause diseases, ranging from skin infections (superficial mycoses) to serious, systemic infections (deep mycoses).

B. PROTOZOA

Protozoa are single-celled, non photosynthetic, eukaryotic organisms that come in various shapes and sizes. Many protozoa are free living, and others are among the most clinically important parasites of humans.

C. HELMINTHS

Helminths are groups of worms that live as parasites. They are multicellular, eukaryotic organisms with complex body organization. They are divided into three main groups: tapeworms (cestodes), flukes (trematodes), and roundworms (nematodes). Helminths are parasitic, receiving nutrients by ingesting or absorbing digestive contents or ingesting or absorbing body fluids or tissues.

D. VIRUSES

Viruses are obligate intracellular parasites that do not have a cellular structure. Rather, a virus consists of molecule(s) of DNA or RNA, but not both, surrounded by a protein coat. A virus may also have an envelope derived from the membrane of the host cell from which the virus is released. The fate of the host cell following viral infection ranges from rapid lysis and release of many progeny virions to gradual, prolonged release of viral particles.

- Table: Comparison of Prokaryotic and Eukaryotic Cell**

Characteristic	Prokaryote	Eukaryote
Typical size	0.4-2 μm in diameter	10-100 μm in diameter
Nucleus	No nuclear membrane; nucleoid region of them cytosol	Classic membrane-bound nucleus
Chromosomal DNA	Circular; complexed with RNA	Linear; complexed with basic histones and other proteins
extrachromosomal circular DNA	Plasmids, most commonly found in gram-negative bacteria; each carries genes for its own replication; can confer resistance to antibiotics	In mitochondria and chloroplasts
Reproduction	Asexual (binary fission)	Sexual and asexual
Membrane-bound organelles	Absent	All
Golgi bodies	Absent in all	Present in some
Lysosomes	Absent in all	Present in some

Characteristic	Prokaryote	Eukaryote
Endoplasmic reticulum	Absent in all	Present in all; lipid synthesis, transport
Mitochondria	Absent in all	Present in most
Nucleus	Absent in all	Present in all
Ribosomes Size	70S in size, consisting of 50S and 30S subunits	80 S in size, consisting of 60 S and 40 S subunits
Sterols in cytoplasmic membrane	Absent except in <i>Mycoplasma</i> spp.	Present
Plasma membrane	Lacks carbohydrates	Also contains glycolipids and glycoproteins
Cell wall, if present	Peptidoglycan in most bacteria	chitin (fungi), other glycans (algae)
Cilia	Absent	Present
Pili and fimbriae	Present	Absent
Flagella, if present	Simple flagella	Complex flagella

- **Infection:** Multiplication of an infectious agent (pathogenic bacteria but not normal flora) within the body even if the person is asymptomatic.

Infectious agents cause disease by either **toxin production** or **invasion and inflammation** .

- **Host:** is a larger organism that harbours a smaller organism; whether a parasitic, a mutualistic, or a commensalist guest.
- **Microbes** are tiny living things that are found all around us and are too small to be seen by the naked eye. They live in water, soil, and air. The human body is home to millions of these microbes too, also called microorganisms.
- **Invasion:** The process whereby bacteria, animal parasites, fungi, and viruses enter host cells or tissues and spread in the body.
- **Toxigenicity:** The ability of a microorganism to produce a toxin that contributes to the development of disease.
- **Carrier:** a person or animal with asymptomatic infection that can be transmitted to another susceptible persons or animals.

Infectious disease: is illness resulting from an infection, also known as transmissible disease or communicable disease.

- **Pathogen**: A microorganism capable of causing disease especially in immunocompetent people.
- **Pathogenesis**: is the mechanisms of origination and development of signs and symptoms of disease.
- **Pathogenicity** :The ability of an infectious agent to cause disease .
- **Virulence**: The quantitative ability of an agent to cause disease when introduced into the host in small numbers. Virulence involves adherence, persistence, invasion, and toxigenicity.
- **Host Susceptibility to a pathogen**: is the ability of a pathogen to cause infection in a host. This ability depends on the physiologic and immunologic conditions of the host and on the virulence of the pathogen.
- **Drug-Resistant organisms**: Microbes that have the ability to develop resistance to drugs created to destroy them.

Types of infection :

1. **Primary infection:** initial infection with an organism in a host.
2. **Reinfection :** subsequent infection with the same organism in the same host.
3. **Secondary infection:** infection with new organism in a host whose body resistance is already lowered by a pre-existing infectious disease.
4. **Cross infection:** infection with a new organism from another host or another external source in a patient who is already suffering from a disease.
5. **Nosocomial infection:** cross-infection acquired in hospital.
6. **Subclinical infection:** in apparent **clinical infection** (which has a number of outcomes covering the spectrum between death and complete recovery) .
7. **Latent infection :** hidden stage of microorganism in a host and subsequent multiplication to produce clinical disease when host resistance is lowered .
8. **Chronic infection :** situation where a person continues to harbor a pathogenic organism but suffer no ill-effects themselves (asymptomatic).

Thank
you