

LESSON 2: INTRODUCTION TO MICROBIOLOGY

Learning Objectives:

By the end of this lesson, the learners should be able to:

1. Define: Microbiology and Microbe/ microorganism
2. Explain the importance of studying microbiology
3. Name and give characteristics of various microorganisms
4. Describe the essential structure of a bacterium cell
5. Differentiate between prokaryotes and eukaryotes

What is Microbiology?

Microbiology is the study of microorganisms such as Bacteria, Fungus, Parasites, Viruses. Most can only be seen with the microscope while medical microbiology is the study of microorganism the cause disease or are of medical importance in one way or the other.

What is a Microbe/ Microorganism?

Organisms Smaller than 0.1mm. Includes bugs, things, germs, viruses, protozoan, bacteria, animalcules, small suckers the occur in all environments. They have many beneficial aspects related to life processes (food web, nutrient cycling). Only a minority cause disease. Most of our problems are caused by microbes

Microorganisms are studied in health training institutions, clinical hospital laboratories, reference laboratories, and research facilities. Medical Microbiology studies are usually performed on human blood and body fluids. Medical Laboratory Technicians and Medical Laboratory Technologists perform the studies. Medical Microbiology comprises and integrates the fields of;

- Virology
- Mycology
- Parasitology
- Bacteriology
- Immunology



Each of which has seen considerable independent development in the past few decades. The common bond between them is the focus on the causes of infectious diseases and on the reactions of the host to the pathogens.

Assignment: Look out for the definitions of the various fields of microbiology

Why do we study Microbiology?

Microorganisms are ubiquitous, but why are they worth learning about? Yes, because microorganisms are involved in;

- Nutrient production & energy flow
- Decomposition (bioremediation)
- Production of foods

Medical microbiology is to instill a broad based knowledge of organisms causing disease mechanisms leading to clinical manifestation of infections into medical practitioners. This knowledge is a necessary prerequisite for:

- Disease diagnosis, Microorganisms cause disease (microorganisms have killed more people than have ever been killed in war).
- Therapy, find a drug, usually an antibiotic, to inhibit the microorganism.
- Production of drugs & vaccines
- Genetic Engineering-Scientists have started to use viruses to benefit people. They are an important tool in genetic engineering. They are used to carry new genes into the DNA of the cells of other organisms.
- Prevention of infectious diseases
- Microbiologists continue to study the microorganisms through research to determine new antibiotics.

A microbiologist is a specialist in microbiology.

Characteristics of Microorganisms

Microorganisms are either of Prokaryotic (Eubacteria), Eukaryotic (Fungi, Protozoans), Sub-cellular biological entities (viruses and prions) or small animals (majorly parasite worms)

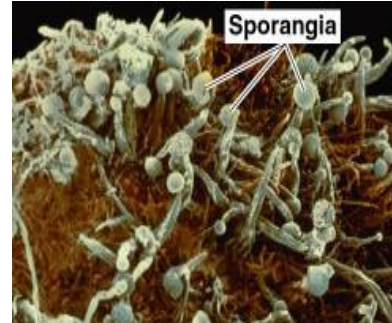
Fungi

Fungi are called microorganisms but some can easily be seen with the naked eye. Mushrooms, toadstools and bread mould are all types of fungi. Individual fungus cells have a nucleus, cell wall and structures like mitochondria can be seen in their cytoplasm. They can join together to form long tubes, called hyphae, that grow as a network of fibres in the material the fungus is feeding on. Fungi play a vital role in decomposing dead material and recycling the nutrients to make them available for the growth of other plants. Brewers' and bakers' yeast are types of fungi that grow as individual cells. They have been used for many centuries in the production of beer, wine and bread.

The fungus *Penicillium notatum* helps to save lives by producing the antibiotic penicillin.

Characteristics of fungi

- Are eukaryotes
- Their cell wall contain chitin
- Use organic chemicals for energy
- Molds and mushrooms are multicellular consisting of masses of mycelia, which are composed of filaments called hyphae



Yeast is a type of single celled fungus which we use to make bread and beer. Yeasts can also cause disease. Yeast cells are smaller than plant and animal cells. They are around 0.01mm in diameter. They reproduce asexually by budding. There are different types of yeast but their cells all have some components in common:

Nucleus: contains the genetic material which controls the cell activities and reproduction

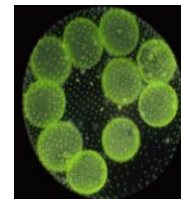
Cytoplasm: liquid gel in which many of the chemical reactions of the cell take place

Cell wall: maintains the shape of the cell

Bud: new yeast cell forming by asexual reproduction

Protists (Algae)

- Cell walls contains cellulose
- Use photosynthesis for energy
- Produce molecular oxygen and organic compounds



Protozoa

Protozoa are microorganisms in various sizes and forms that may be free-living or parasitic. Many parasitic protozoa are transmitted by arthropods, whereby multiplication and transformation into the infectious stage take place in the vector. Protozoa cause a number of human diseases. The best known is malaria, but they also cause one form of dysentery and also sleeping sickness among others. They:

- Are eukaryotes
- Typically, unicellular microorganisms
- Absorb or ingest organic chemicals
- May be motile via pseudopods, cilia, or flagella

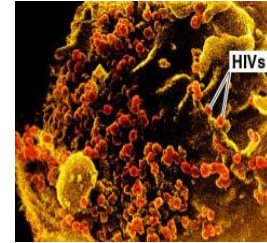


Viruses

Viruses are very tiny (Ultramicroscopic) – they are much smaller than bacteria or fungi, and are obligate intracellular organism that:

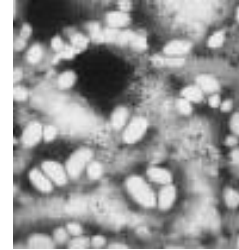
- Contain only one type of nucleic acid, either DNA or RNA,
- possess no enzymatic energy-producing system and no protein-synthesizing apparatus, and
- Force infected host cells to synthesize virus particles.

- Possess both living and nonliving characteristics, they are considered neither prokaryotic nor eukaryotic.
- Core is surrounded by a protein coat
- Coat may be enclosed in a lipid envelope
- Viruses are replicated only when they are in a living host cell
- Viruses can attack all different types of living organisms – they invade animal, plant and even bacterial cells.



Archaea:

- Their cell walls lack peptidoglycan
- Live in extreme environments (high or low temperatures, saline env't etc)
- Include: Methanogens, Extreme halophiles and Extreme thermophile



Chlamydiae

These are obligate intracellular organisms that are able to reproduce in certain human cells only and are found in two stages: the infectious, non-reproductive particles called elementary bodies (0.3µm) and the noninfectious, intracytoplasmic, reproductive forms known as initial (or reticulate) bodies.

Rickettsiae.

These are obligate intracellular organism, rod shaped to coccoid, that reproduce by binary transverse fission. The diameter of the individual cell is from 0.3–1 µm.

Mycoplasmas.

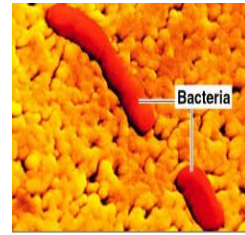
Mycoplasmas are bacteria without rigid cell walls. They are found in a wide variety of forms, the most common being the coccoid cell (0.3–0.8 µm). Threadlike forms also occur in various lengths.

Prions

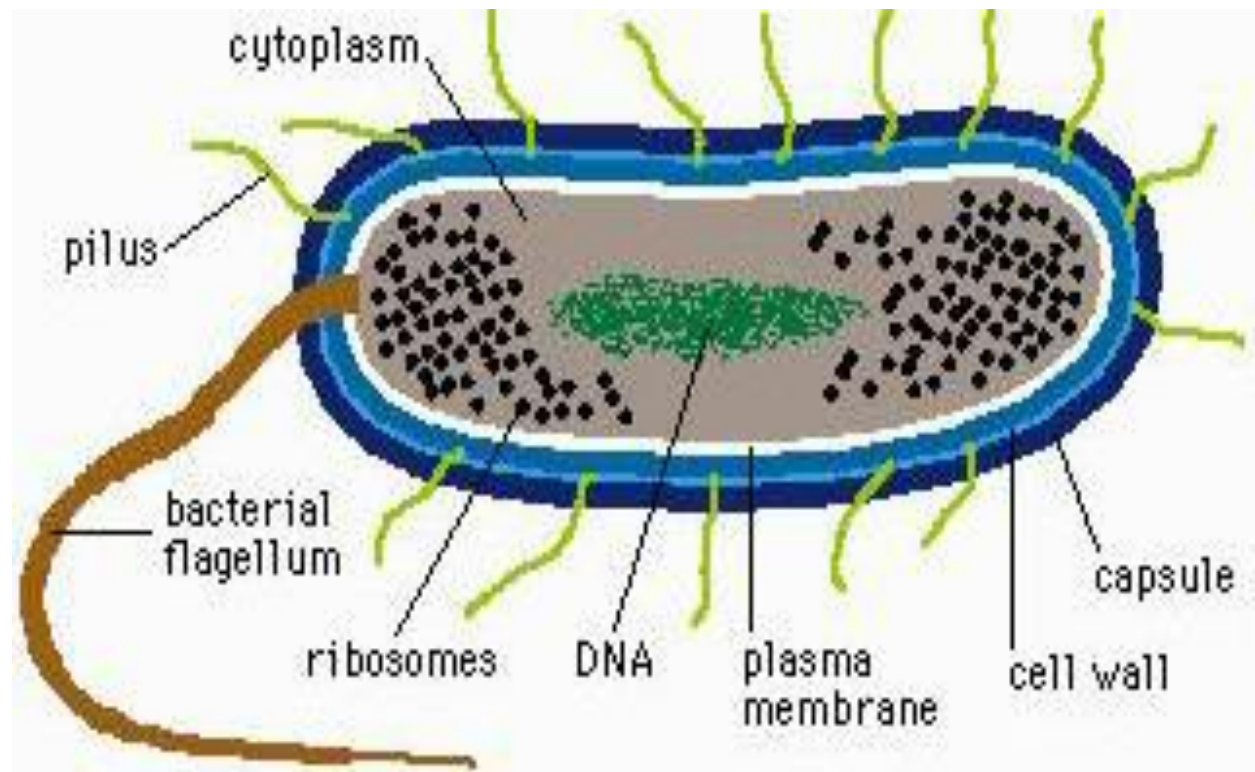
Prions are proteinaceous infectious particles. The evidence indicates that prions are protein molecules that cause degenerative central nervous system (CNS) diseases such as Creutzfeldt-Jakob disease, scrapie in sheep, and bovine spongiform encephalopathy (BSE) (general term: transmissible spongiform encephalopathies [TSE]).

Bacteria

These organisms reproduce asexually by binary transverse fission. They do not possess the nucleus typical of prokaryote. The cell walls of these organisms are rigid (with some exceptions, e.g., the mycoplasma). cell wall is made of peptidoglycan. For energy, bacteria use organic chemicals, inorganic chemicals, or photosynthesis



Structure of a typical bacteria



Essential structure of a bacterial cell

Cell wall

This offers the bacteria its shape and also protects the cytoplasmic membrane. The cell wall is a complicated lattice structure of lipoprotein, lipopolysaccharide and peptidoglycan. The cell wall of certain bacteria e.g. bacillus (bacillus anthracis) species are covered with capsules. In many cases possession of a capsule is associated with virulence. Capsule also helps in adherence of bacteria to surface in its environment

Cytoplasmic membrane

This consists of a layer of lipoprotein and is 5-10nm thick. It encloses the cytoplasm and lying within the cytoplasm is the bacterial chromosome- usually a single closed ring of double

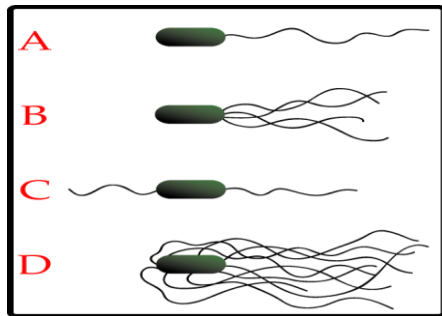
stranded DNA. During cell division (binary fission), a duplicate copy of the chromosome is passed to the daughter cell and this ensures uniformity among the offspring of a single cell. Many bacterial cells contain smaller circles of DNA, called plasmids which often carry genes that confer antibiotic resistance on the cells carrying them. These plasmids may be transferred between cells of different types during a mating process (conjugation) that involves the sex pili.

Pili (fimbriae)

These are often on bacterial cells. They may be important in the attachment of pathogens to the host tissue cells

Flagella

Motile organisms possess flagella, which are thread-like appendages composed of protein called flagellin and are about 20nm thick. The flagella enable the bacteria to move (at speed of 50um/Sec). Some organisms possess one flagellum other more than one.



A. Monotrichate- One flagellum at one pole

B. Lopotrichate- Tuft of flagella at one or both poles

C. Amphitrichate- One flagellum at each pole

D. Peritrichate- Flagella completely surrounding the bacterial body

Multicellular Animal Parasites

Helminths. Parasitic worms belong to the animal kingdom. These are metazoan organisms with highly differentiated structures. Medically significant groups include the trematodes (flukes or flatworms), cestodes (tapeworms), and nematodes (roundworms).



Arthropods. These animals are characterized by an external chitin skeleton, segmented bodies, jointed legs, special mouthparts, and other specific features. Their role as direct causative agents of diseases is a minor one (mites, for instance, cause scabies) as compared to their role as vectors transmitting viruses, bacteria, protozoa, and helminths.

Assignment: Compare and contrast the cellular structures of Prokaryote and Eukaryotes

Characteristic	Prokaryotes (bacteria)	Eukaryotes (fungi, protozoans)
Nuclear structure	Circular DNA molecule not covered with proteins	Complex of DNA and basic Proteins
Localization of nuclear structure	Dense tangle of DNA in cytoplasm; no nuclear membrane	In nucleus, surrounded by nuclear membrane
DNA	Nucleoid and plasmids	In nucleus and in mitochondria
Cytoplasm	No mitochondria and no endoplasmic reticulum, 70S ribosomes	Mitochondria and endoplasmic reticulum, 80S ribosomes
Cell wall	Usually rigid wall with murein layer; exception: mycoplasmas	Present only in fungi: with glucans, chitin, cellulose
Reproduction	Asexual, by binary transverse fission	In most cases sexual, possibly asexual

Questions are welcome, otherwise eyalama for participating

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