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MICROBIOLOGY BRANCHES AND CELL TYPES

❖ The Science of Microbiology: Introduction

Microbiology is the study of microorganisms, a large group of microscopic organisms that exist as single cells or cell clusters; it also includes viruses, which are microscopic but not cellular. Microorganisms have a tremendous impact on all life and the physical and chemical make-up of our planet. They are responsible for cycling the chemical elements essential for life, including carbon, nitrogen, sulfur, hydrogen, and oxygen; more photosynthesis is carried out by microorganisms than by green plants. It has been estimated that 5×10^{30} microbial cells exist on earth; these cells constitute about 90% of the biomass of the entire biosphere. Humans also have an intimate relationship with microorganisms; more than 90% of the cells in our bodies are microbes.

❖ Branches

The branches of microbiology can be classified into pure and applied sciences. There is overlap between the specific branches of microbiology with each other and with other disciplines.

1. **Bacteriology**: Study of bacteria and their roles in health and disease.
2. **Virology**: Study of viruses and viral infections.
3. **Mycology**: Study of fungi, including yeasts and molds.
4. **Parasitology**: Study of parasites and their interactions with hosts.
5. **Phycology (Algology)**: Study of algae and their environmental significance.

6. **Immunology**: Study of the immune system and its response to pathogens.
7. **Environmental Microbiology**: Study of microorganisms in natural environments and their ecological roles.

❖ **Applied microbiology:**

- **Medical microbiology**: The study of the pathogenic microbes and the role of microbes in human illness. Includes the study of microbial pathogenesis and epidemiology and is related to the study of disease pathology and immunology.

- **Pharmaceutical microbiology**: The study of microorganisms that are related to the production of antibiotics, enzymes, vitamins,vaccines, and other pharmaceutical products .
- **Industrial microbiology:** The exploitation of microbes for use in industrial processes. Examples include industrial fermentation and wastewater treatment.
- **Microbial biotechnology:** The manipulation of microorganisms at the genetic and molecular level to generate useful products.
- **Food microbiology** and Dairy microbiology: The study of microorganisms causing food spoilage and food borne illness. Using microorganisms to produce foods, for example by fermentation.

❖ The General Properties Of Microorganisms:

1. **Ubiquity**: Microorganisms are found everywhere—on land, in water, and in the air, including extreme environments.

2. **Diversity**: Includes a wide range of organisms like bacteria, archaea, fungi, protozoa, algae, and viruses.
3. **Microscopic Size**: Generally too small to be seen with the naked eye, typically ranging from 0.2 micrometers to several millimeters.
4. **Rapid Reproduction**: Can reproduce quickly through processes such as binary fission, budding, or spore formation.
5. **Metabolic Diversity**: Can be autotrophic (producing their own food) or heterotrophic (obtaining nutrients from other organisms).
6. **Genetic Adaptability**: Exhibit high genetic variability and can adapt rapidly through mutations and gene transfer.
7. **Interactions with Other Organisms**: Can form mutualistic, commensalistic, or parasitic relationships with other organisms.
8. **Environmental Impact**: Play key roles in processes like decomposition, bioremediation, and nitrogen fixation.
9. **Structural Adaptations**: Have specialized structures like cell walls, flagella, and capsules to help them survive and thrive.
10. **Resistance Mechanisms**: Can develop resistance to environmental stresses and antibiotics, such as through endospore formation and genetic changes.

A. Eukaryotic cells :

- contain organelles and a nucleus bounded by a nuclear membrane.
- contain complex phospholipids, histones, and sterols.
- lack a cell wall (plant cells and fungi have a cell wall).
- have multiple diploid chromosomes.

- have 80S ribosomes .

Eukaryotic include

Protists

Characteristics: Single-celled or simple multicellular.

Examples: Algae, protozoa, slime molds.

Fungi

Characteristics: Mostly multicellular (yeasts are single-celled), cell walls made of chitin.

Examples: Mushrooms, molds, yeasts.

Plants

Characteristics: Multicellular, cell walls made of cellulose, photosynthetic.

Examples: Mosses, ferns, flowering plants.

Animals

Characteristics: Multicellular, no cell walls, heterotrophic.

Examples: Sponges, insects, mammals.

B. Prokaryotic cells

General Characteristics of Prokaryotes

- No membrane-enclosed nucleus.
- No organelles or histones (rarely complex phospholipids and sterols).
- Have 70S ribosomes.
- Cell wall contains peptidoglycan and muramic acid.
- Haploid with a single chromosome.
- Transcription and translation occur simultaneously.

Typical Bacteria

- Have a peptidoglycan cell wall.

- Can be normal flora or pathogenic.
- Do not have a sexual growth cycle.

Mycoplasmas

- Smallest and simplest self-replicating bacteria.
- Lack a cell wall.
- Only prokaryotes with sterols.

C. Viruses

- Non-Cellular: Not cells and not visible with a light microscope.
- Obligate Intracellular Parasites: Can only reproduce inside host cells.
- Lack Organelles: No organelles or biosynthetic machinery, except for a few enzymes.
- Genetic Material: Contain either RNA or DNA, but not both.
- Bacteriophages: If they infect bacteria, they are called bacterioph
- ages or phages.