Lecture-2

Principles of Microbiology (Part-1)

Principles of Microbiology Content

1.1 Microbiology and Microorganisms

- The importance of microorganisms

1.2 Microbial Cells

- Cell chemistry and key structure
- Characteristics of living systems
- Cell functions: coding and metabolism.

1.3 Microorganisms and Their Environments

- Microbial interaction

1.4 The Impact of Microorganisms on Humans

- Microorganisms as disease agents
- Microorganisms and agriculture
- Microorganisms and food
- Microorganisms, energy and there environment
- Microorganisms and their genetic resources
- Microbiology as a career

Introduction

- Microbiology is the study of microscopic organisms, such as bacteria, viruses, archaea, fungi and protozoa. This discipline includes fundamental research on the biochemistry, physiology, cell biology, ecology, evolution and clinical aspects of microorganisms, including the host response to these agents. (https://www.nature.com/subjects/microbiology)

- **What is Microbiology about?**
  - Microbiology is about microbial cells and how they work .
  - Microbiology is about diversity and evolution of microbial cells.
  - It is about what microorganisms do in the world , soil , water , human body , animal , plant ..etc.

- Microorganisms can affect and support all other forms of life, and considered the most fundamental of the biological sciences.

Microbiology and Microorganisms

The science of microbiology revolves around two themes:

1. Understanding basic life processes of microscopic organisms (**basic biological science**).
   - Microbes are excellent experimental systems for understanding cellular processes in unicellular and multicellular organisms.
2. Applying that knowledge to the benefit of humans, animals and plant (**applied biological science)**
   - Microbes play important roles in medicine, agriculture, and industry.

Microbiology and Microorganisms

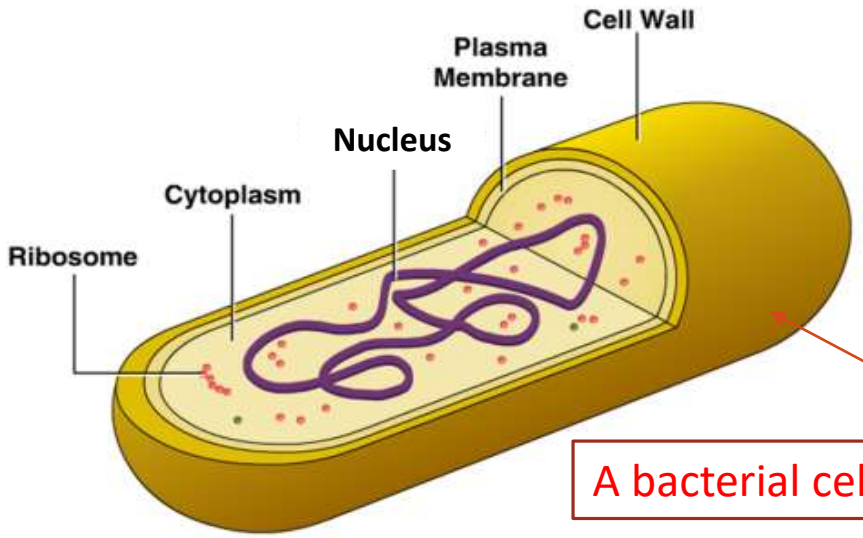
The importance of microorganisms

- Oldest and smallest form of life
- Largest mass of living material on Earth
- Carry out major processes for biogeochemical cycles
- Can live in places unsuitable for other organisms
- Other life forms require microbes to survive

1.2 Microbial cell

A cell

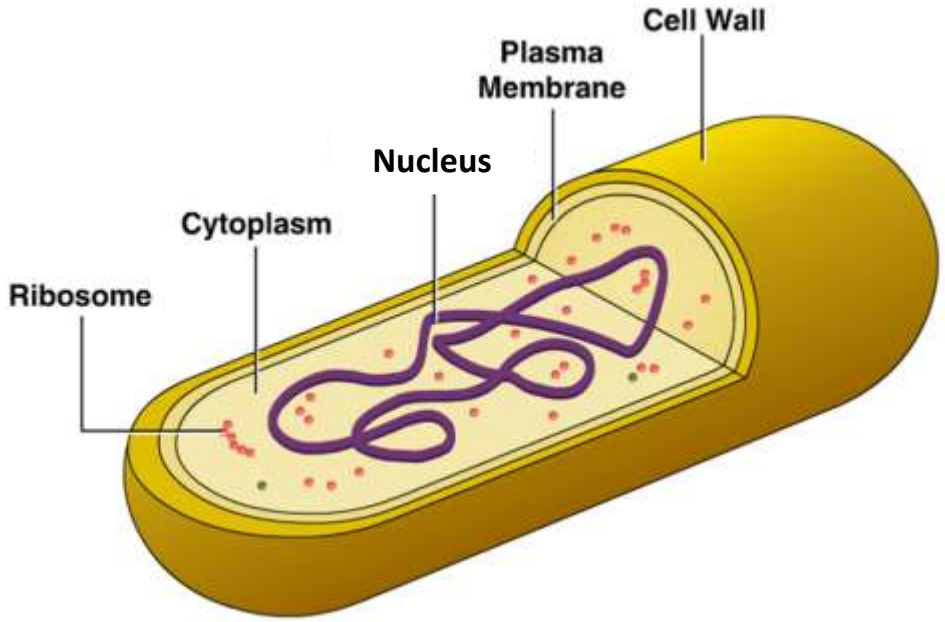
- The cell is a dynamic entity that forms the fundamental unit of life
- Contains 4 chemical components, form 95% of dry weight of the cell:
  1. Proteins
  2. Nucleic acids
  3. Lipids
  4. Polysaccharides



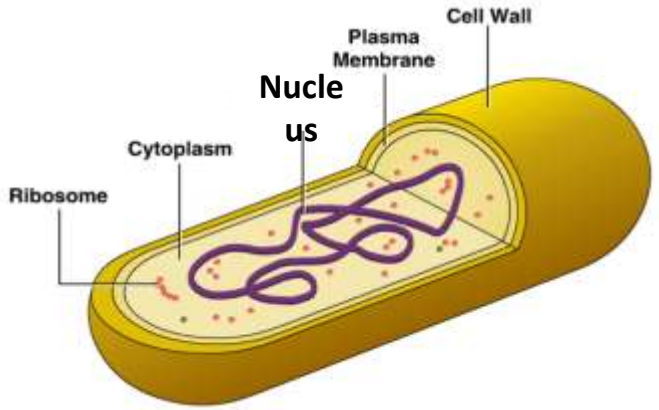
A bacterial cell as example of microbial cell

1.2 Microbial cell

- Cell wall
  - Present in some types of microbial cells confers structural strength and prevents the cell from osmotic bursting.
- Cytoplasmic (cell) membrane ((or inner membrane)
  - Barrier that separates the inside of the cell from the outside environment.

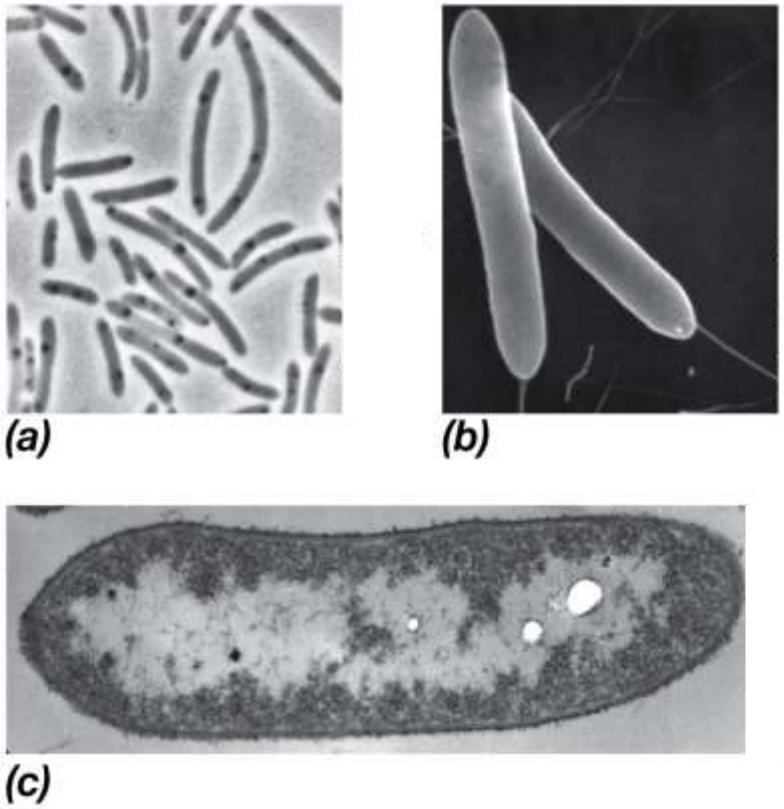


1.2 Microbial cell



- Cytoplasm:
  - The fluid inside the cell contains various structures and chemicals
- **Ribosomes (consisting proteins)**
  - All eukaryotic and prokaryotic cells contain ribosomes, where protein synthesis takes place.
- **Nucleus of a eukaryote and nucleoid of a prokaryote:**
- Nucleus is (the largest structure in the cell, and contains almost all of the cell's hereditary information (DNA). Some DNA is also found in mitochondria and in the chloroplasts of photosynthetic organisms.
- The nucleoid (meaning nucleus-like) contains the DNA of the bacterial chromosome. Bacteria can also contain plasmids, which are circular, extrachromosomal DNA molecules

1.2 Microbial cell



Bacterial cells and some cell structure:

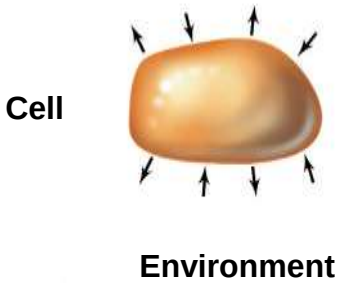
a) Rod-shaped cells bacteria (light microscope)

b) Scanning electron micrograph of the same bacteria

c) Electron micrograph of the same bacteria.

1.2 Microbial cell

Characteristics of living systems



1- Metabolism:

-A cell is a compartment that takes up nutrients from the environment, transforms them into new cell materials, and releases wastes into the environment.

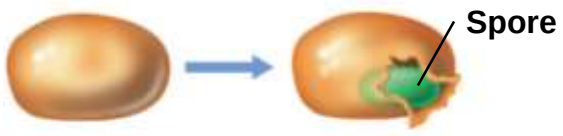
-The cell is thus an *open* system.

2-Growth

Chemicals from the environment and new metabolic products are turned into new cells under the genetic direction of preexisting cells.

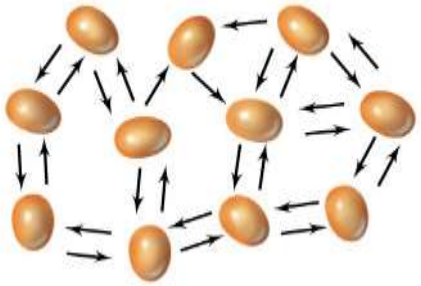
1.2 Microbial cell

Characteristics of living systems



3- Differentiation

Some cells can form new cell structures such as a spore, usually as part of a cellular life cycle to survival.



4- Communication

Many cells *communicate* or *respond* to chemical signals in their environment including those produced by other cells of either the same or different species and, which can trigger new cellular activities.

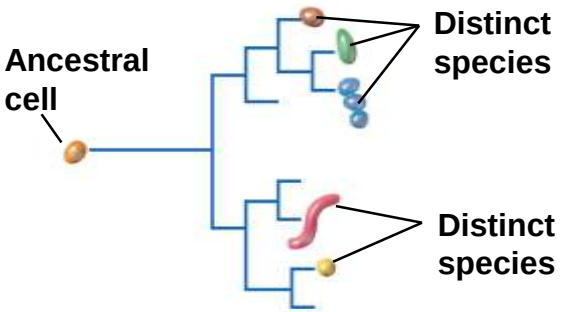
1.2 Microbial cell

Characteristics of living systems

5- Motility

-Some cells are capable of self-propulsion.

- Motility allows cells to move away from danger or unfavorable conditions and to exploit new resources.



6- Evolution

-Cells contain genes and *evolve* to display new biological properties.

-Evolution is typically a slow process but can occur rapidly in microbial cells .

-Phylogenetic trees show the evolutionary relationships between cells.

1.2 Microbial cell

Cells as Catalysts and as Coding Devices

- **The routine activities of cells are is in two ways :**

1- **Catalytic functions** : carrying out the chemical reactions and metabolism

2- **Genetic functions:**

- Cells store and process information that is eventually passed on to offspring during reproduction through DNA and evolution.
- DNA processing include two main events :
  - ***Transcription***: DNA produces RNA (production of RNAs)
  - ***Translation***: RNA makes protein (production of proteins)
- Replication , transcription and translation are the key molecular process in cells.

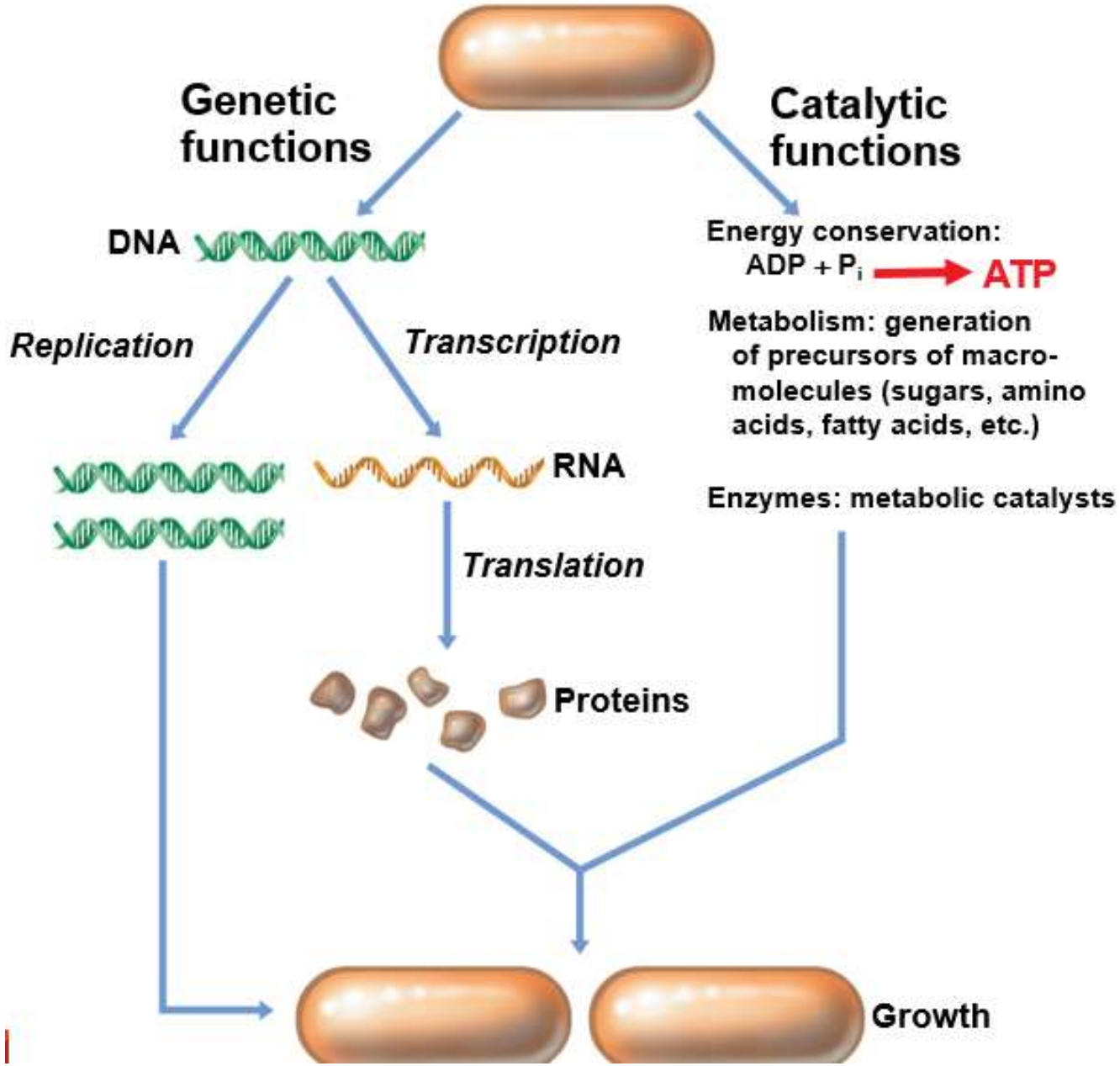
1.2 Microbial cell

Cells as Catalysts and as Coding Devices

- Cells coordinate their catalytic and genetic functions to support **cell growth**.
- In the events that lead up to cell division, all substances and material in the cell are double.

This required:

1. The cell's catalytic machinery
2. ***Enzymes***: protein catalysts of the cell that accelerate chemical reactions
3. Energy conservation
4. Supply precursors for biosynthesis of all cell components.
5. And that its entire **complement** of genes replication



- **The catalytic and genetic functions of the cell.** For a cell to reproduce itself there must be energy and precursors to the synthesis of new macromolecules, the genetic instructions must be replicated and genes must be expressed (transcribed and translated) to produce proteins and other macromolecules.

REMEMBER

You can always ask questions through our discussion board on www.lms.ksu.edu.sa