Al- Mustaqbal University
College of Science
Medical Physics Department
First Stage

General biology

Lecture : 8

The Bacteria

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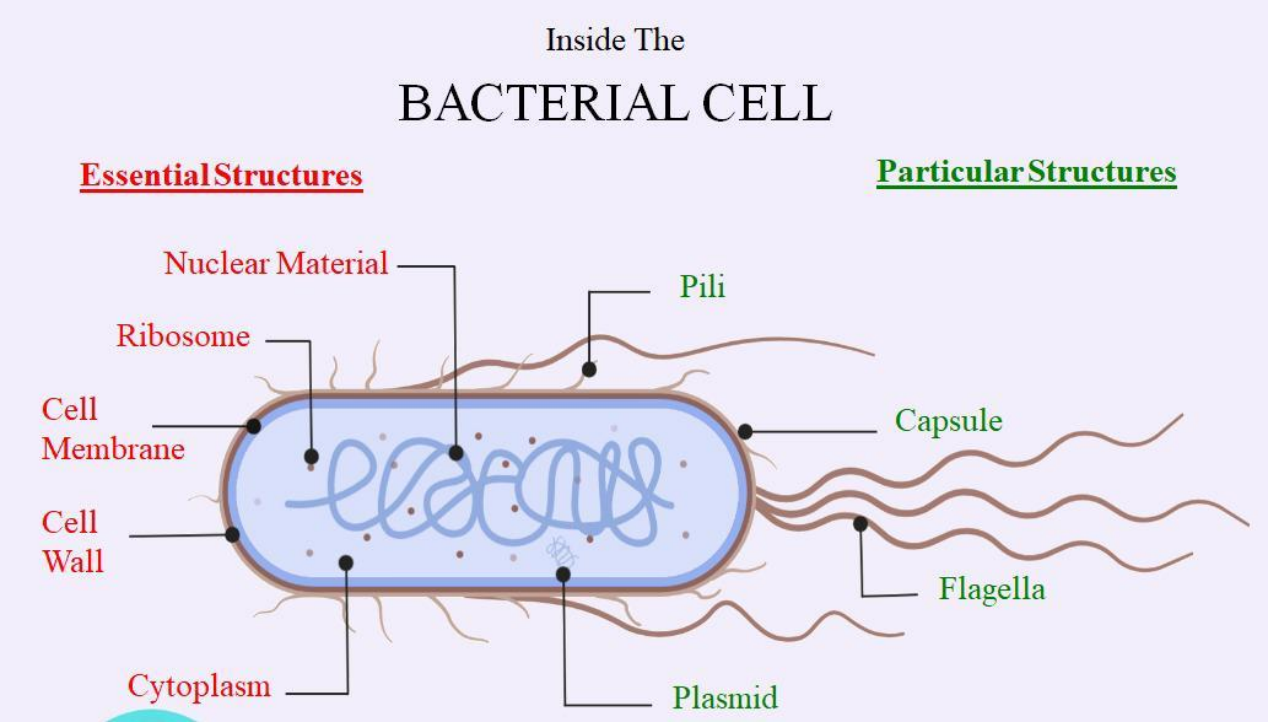
Introduction to Bacteria

Bacteria are among the earliest forms of life on Earth. They are unicellular organisms that lack a true nucleus, placing them in the prokaryotic domain. Their versatility and adaptability have allowed them to inhabit virtually every environment, from deep ocean vents to the human gut.

Despite their microscopic size, bacteria play a profound role in ecological balance, industrial processes, and human health. Understanding their nature is essential in various fields such as microbiology, biotechnology, and medicine.



Figar (1) Bacterial Cell

Bacterial Cell Structure

The structure of a bacterial cell is simple compared to eukaryotic cells but highly efficient. Each component contributes to the survival, replication, and interaction of the bacterium with its environment.

Key structures include:

1- Cell wall – provides structural integrity and protection; primarily composed of peptidoglycan in most bacteria.

2- Plasma membrane – regulates the movement of substances in and out of the cell.

3- Cytoplasm – the gel-like substance inside the cell where cellular processes occur.

4- Ribosomes – responsible for protein synthesis; smaller than eukaryotic ribosomes (70S).

5- Nucleoid – region containing circular DNA; not membrane-bound.

6- Plasmids – small, circular DNA molecules that often carry antibiotic resistance genes.

7- Capsule – a gelatinous outer layer that aids in adhesion and protection against host defenses.

8- Flagella – long, whip-like appendages used for motility.

9- Pili and fimbriae – hair-like structures involved in attachment and conjugation.

10- Endospores – dormant, highly resistant structures formed under stress (e.g., Bacillus, Clostridium).

Bacteria are found in three basic shapes which are:

A- rod (bacillus, pl., bacilli)

B- round or spherical (coccus, pl., cocci)

C- spiral or helical-shaped (spirillum, pl., spirilla).

a. Bacilli in pairs b. Cocci in chains c. A spirillum with flagella

There are many characteristics have been used to classify bacteria which are:

1- presence of endospores.
2- Metabolism
3- Growth
4- nutritional

Bacteria and Humans

A. Beneficial roles:

- Normal flora – bacteria in the human gut aid digestion and synthesize vitamins.
- Biotechnology – production of insulin, antibiotics, and enzymes using genetically engineered bacteria.
- Food industry – fermentation processes (e.g., yogurt, cheese, vinegar).
- Environmental – bioremediation of pollutants and sewage treatment.

B. Pathogenic roles:

- Cause of diseases such as tuberculosis, pneumonia, cholera, and food poisoning.
- Virulence factors include toxins, capsules, and enzyme secretion.
- Antibiotic resistance poses a growing global health challenge.

Intracellular structures:

The bacterial cell is surrounded by a cell membrane, which is made primarily of phospholipids. This membrane encloses the contents of the cell and acts as a barrier to hold nutrients, proteins and other essential components of the cytoplasm within the cell. Unlike eukaryotic cells, bacteria usually lack large membrane-bound structures in their cytoplasm such as a nucleus, mitochondria, chloroplasts and the other organelles present in eukaryotic cells. However, some bacteria have protein- bound organelles in the cytoplasm which compartmentalize aspects of bacterial metabolism, such as the carboxysome. Additionally, bacteria have a multi- component cytoskeleton to control the localisation of proteins and nucleic acids within the cell, and to manage the process of cell division.

Q/ Bacteria form endospore? why

When faced with unfavorable environmental conditions, some bacteria, such as anthrax bacteria form endospores.

Q/ Talking about endospore formation in bacteria?

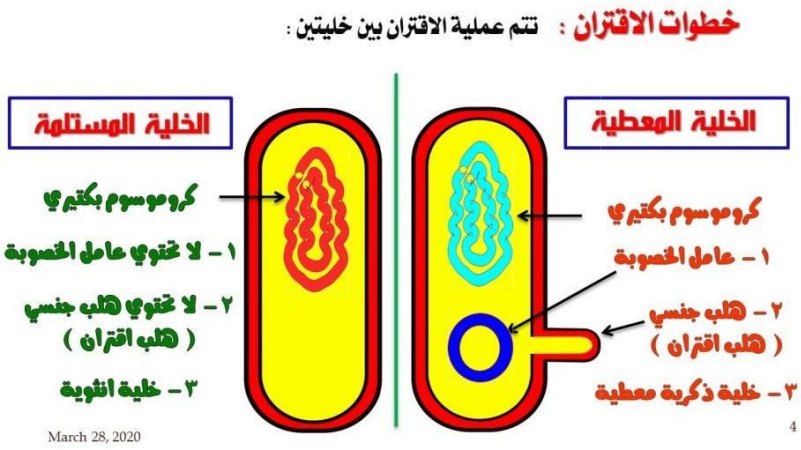
1- A portion of the cytoplasm and a copy of the chromosome dehydrate and are then encased by three heavy, protective spore coats.

2- The rest of the bacterial cell deteriorates, and the endospore is released.

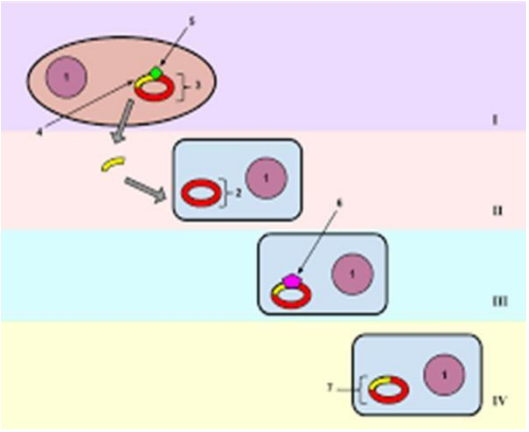
3- When environmental conditions are again suitable for growth, the endospore absorbs water and grows out of the spore coats.

genetic recombination in bacteria:

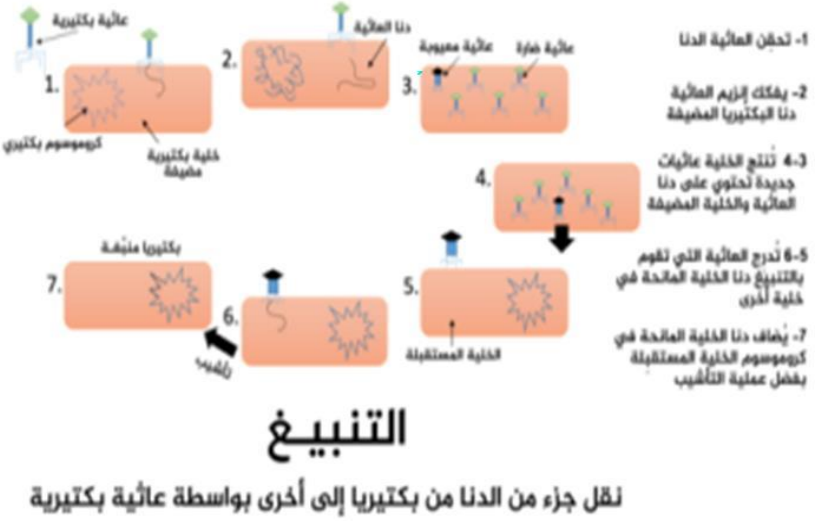
a- ***Conjugation****:* takes place when the so-called male cell passes DNA to the female cell by way of a sex pilus.



b- ***Transformation****:* occurs when a bacterium binds to and then takes up DNA released into the medium by dead bacteria.



c- ***transduction:*** bacteriophages carry portions of DNA from one bacterium to another.



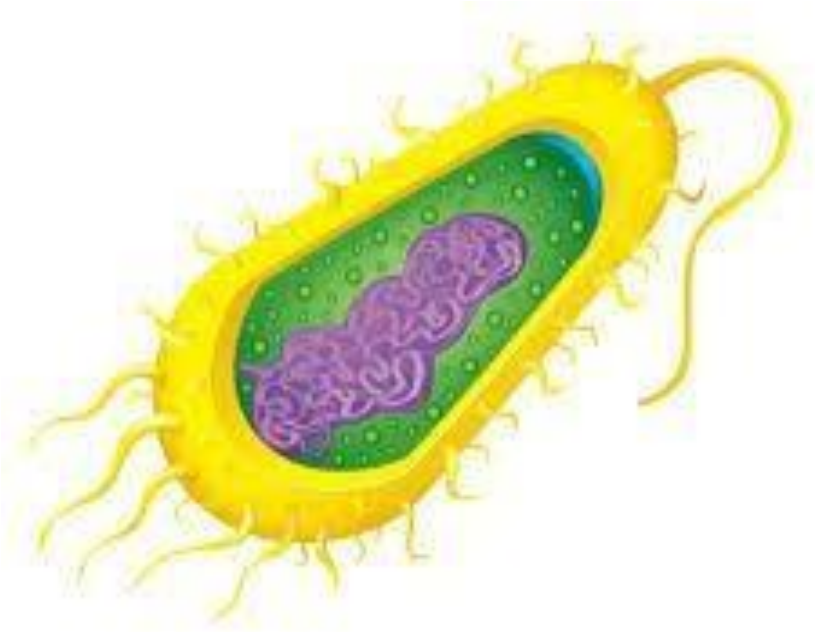
Bacterial motility

Many bacteria are motile (able to move themselves) and do so using a variety of mechanisms. The best studied of these are flagella, long filaments that are turned by a motor at the base to generate propeller-like movement. The bacterial flagellum is made of about 20 proteins, with approximately another 30 proteins required for its regulation and assembly. The flagellum is a rotating structure driven by a reversible motor at the base that uses the electrochemical gradient across the membrane for power.

The different arrangements of bacterial flagella: A-Monotrichous; B- Lophotrichous; C-Amphitrichous; D-Peritrichous

Bacteria can use flagella in different ways to generate different kinds of movement. Many bacteria (such as E. coli) have two distinct modes of movement: forward movement (swimming) and tumbling. The tumbling allows them to reorient and

makes their movement a three-dimensional random walk. Bacterial species differ in the number and arrangement of flagella on their surface; some have a single flagellum (monotrichous), a flagellum at each end (amphitrichous), clusters of flagella at the poles of the cell (lophotrichous), while others have flagella distributed over the entire surface of the cell (peritrichous). The flagella of a unique group of bacteria, the spirochaetes, are found between two membranes in the periplasmic space. They have a distinctive helical body that twists about as it moves.



Transmission electron micrograph of Desulfovibrio vulgaris showing a single flagellum at one end of the cell. Scale bar is 0.5 micrometers long.

Two other types of bacterial motion are called twitching motility that relies on a structure called the type IV pilus, and gliding motility, that uses other mechanisms. In twitching motility, the rod-like pilus extends out from the cell, binds some substrate, and then retracts, pulling the cell forward.

Motile bacteria are attracted or repelled by certain stimuli in behaviours called taxes: these include chemotaxis, phototaxis, energy taxis, and magnetotaxis. In one peculiar group, the myxobacteria, individual bacteria move together to form waves of cells that then differentiate to form fruiting bodies containing spores.The myxobacteria move only when on solid surfaces, unlike E. coli, which is motile in liquid or solid media.

Several Listeria and Shigella species move inside host cells by usurping the cytoskeleton, which is normally used to move organelles inside the cell. By promoting actin polymerisation at one pole of their cells, they can form a kind of tail that pushes them through the host cell's cytoplasm.

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