



**number**

2

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## ***Micobiology : Lecture 2***

○ كيف منفرق خلايا البكتيريا عن باقي الأجسام الخلوية؟

The major difference between the two is that bacterial cells are prokaryotic cells, the rest are eukaryotic cells.

○ الخاصية الرئيسية للخلايا غير حقيقية النواة:

Looking at its name we can conclude that there is no true nucleus which basically means that there is DNA in the nucleoid but there isn't a nuclear membrane surrounding this DNA.

### **➔ In bacteria:**

- Real nucleus is absent while still having the nucleoid that contains the chromosome.
- This chromosome isn't like any other. In bacteria, there is only one chromosome represented as a circular molecule of loosely organized DNA(double stranded DNA).

يعني :

The bacterial chromosome is circular in shape, and the DNA molecule it contains is double stranded as the DNA in any other organism (Double helix)

DNA molecule of bacteria is loosely organized:

بكون متداخل مع بعضه و مضغوط

Some microorganisms (most commonly bacteria) have extrachromosomal DNA in plasmids. A plasmid is a circular and a double-stranded DNA molecule (just like bacterial DNA) outside the nuclear region (outside the nucleus). However, it is much smaller in size than bacterial DNA and it is absent in human cells.

Plasmid is important in conjugation and in resisting antibiotics, but it has no connection with major metabolic activities like division.

\*Bacterial conjugation is the transfer of genetic material between bacterial cells.

البلازميدات رح تحكي عنهم الدكتوراة بالتفصيل ل قدام ، رح  
تحكي عن:

## **GENETICS OF BACTERIA:**

### ***Transcription process:***

Unlike in eukaryotes, bacterial transcription and translation can occur simultaneously in the cytoplasm. This is basically because bacteria don't have a nuclear membrane.

○ لانو ما في غلاف نووي ما في نقل من النواة الى السيتوبلازم،  
يعني :

Once the transcription process is done(DNA to mRNA), mRNA is translated into proteins.

Ribosomes, which are located in the cytoplasm are the site of protein synthesis.

## **RIBOSOMES IN BACTERIA VS RIBOSOMES IN EUKARYOTIC CELLS(HUMANS)**

**Ribosomes function:** protein synthesis in cytosol and in ER.

\*Ribosomes of humans are different from those of bacteria.

What's the benefit of knowing the difference in ribosomes between bacterial and human cells? Antibiotics that affect bacterial ribosomes won't affect human ones.

-> Ribosomes of bacteria are composed of 2 subunits with larger and smaller sedimentation rates: The larger one is 50S and the smaller one is 30S.

-> S(Svedberg Unit) is the sedimentation coefficient. When we do ultracentrifugation, these 2 ribosomes will separate, the smaller (faster) 30S subunit and the larger (slower) 50S subunit.

Eukaryotic cells have different ribosomes which are actually made of proteins: 1) ribosomal proteins, 2) ribosomal RNA. **Human ribosomes 80S are larger in size and they will separate in centrifuging differently. (60S and 40S) from bacterial ones (70S)**

السبب الي عمل هادا الفرق انو في عنا بروتينات مختلفة وهاي البروتينات هي الي بتكون الرايبوسومات.

***How do bacteria produce energy even though it does not have mitochondria?***

➔ Bacteria have enzymes which bind to the cell membrane, making invaginations which are needed for energy production instead of mitochondria.

***In addition, we have photosynthetic bacteria that do not have plastids so how does this bacteria do photosynthesis?***

➔ It has invaginations which can do photosynthesis .

- ***In eukaryotes, the mitochondria which has DNA, also (may) also have singular invaginations.***
- ***Prokaryotes have haploid chromosome but eukaryotes have diploid ones.***
- ***In eukaryotes, chromosomes usually have histone proteins which are important for regulation but in bacteria there is no histone proteins and there is no introns(no intergenic sequences).***
- ***All DNA is usually expressed or translated into proteins/enzymes***

***BUT in eukaryotes there are intergenic sequences.***

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## **METHODS OF CLASSIFICATION OF BACTERIAL CELLS:**

- 1) Structure
- 2) Shape
- 3) Arrangement
- 4) Pathogenesis
- 5) Oxygen requirement (aerobic and anaerobic)
- 6) Nutrition
- 7) PH
- 8) Motility
- 9) Temperature
- 10) Cell wall

### **\*Mycobacterium tuberculosis:**

- 1) Rigid cell wall
- 2) Rich in lipids

**\*Bacteria are:** 1) Pathogenic 2) Non-pathogenic

**\*Microorganism:** a very small organism.

**\*Pathogen:** a microorganism which has the ability to cause disease.

➔ Example: There is a special type of bacteria which is normal flora. This bacteria is found in the body normally like on the surface, in the GIS and in the colon.

**\*GIS(gastrointestinal system) bacteria are:** 1) normal flora 2) non-pathogenic

3) produces vitamin k and helps in digestion

\* Non-pathogenic opportunistic: becomes pathogenic in some cases, for example:

1) using drugs 2)Thermotherapy 3) Chemotherapy  
[Which changes from non-pathogenic into pathogenic]

**\* Oxygen requirement:**

1) Aerobic            2) Anaerobic            3) Obligatory Aerobic

**\*Spores:** are structures formed in response to environmental conditions like very little amounts of nutrition. They are formed by the conversion of bacterial cells from being actively metabolic to being inactively metabolic. Not all bacteria have the ability to



make spores. The condition in which spores are made is when we have a LACK of nutrients (starvation).

-> *Staph aureus and Staph epidermidis are non-spore forming bacteria.*

-> *All the staph coccus bacteria are gram positive.*

### **NAMING OF BACTERIA:**

The name of a bacteria consists of two sections, the family and the species.

- ➔ ***Protozoa*** are simple, unicellular and can have flagella and cilia.
- ➔ ***Appendages:*** flagella and cilia (in animal cells).
- ➔ ***Fungi:*** have complex cells with organelles and a complex cell wall.

### **\*Classification according to reproduction:**

**Bacteria:** binary fission

**Human cells:** mitosis and meiosis

○ البكتيريا زيها زي أي اشي تاني عندها أشكال مختلفة:

**1) Spherical (cocci):**

**a) diplococci:** 2 cells together

**b) streptococci:** رباعية يعني

**c) clusters:** زي قطف العنب (staphylococci)

\*مرات بكون في عنا ديبلوكوكساي بس شكلها مثل ال:

*Kidney*

\*شكل البكتيريا تحت المجهر كثير مهم ل النا عشان نقدر نكشف عنها  
وفي كمان اشي مهم كمان منعتمد عليه وهو:

*Gram stain*

**2) Rod shaped (عصوي):** we call them bacilli. The arrangement of the bacilli will not help us very much but they may be large rods with square ends, short fat rods and many different shapes of rods.

### 3) Spiral shaped (لولبي): زي الكوليرا

والتروبينيما

#### Note:

في اشي اسمو كوكوباسيلاري (coccobacillary) همي بيشبهو الكوكساي تحت المجهر بس همي مش كوكساي بكون عصوي.

#### BACTERIAL STRUCTURE:

في البيولوجي لازم دايما نربط التركيب مع الوظيفة لانو مهم.

#### General components of bacteria:-

1-Capsule

2-Cell wall

3-Cell membrane

4-Cytoplasm

**1- Cell wall (جدار الخلية):** is located outside of the cell membrane and consists of peptidoglycan(peptides + polysaccharides).

➔ The majority of bacterial cells each have a cell wall except for "Mycoplasma" which doesn't have a cell

wall. Medical indication: we need to use other specific antibiotics to treat them. Identification and diagnosis: we cannot use usual staining for mycoplasma (need other mechanisms).

→ **Functions of the cell wall:**

1. Giving the shape of the cells.
2. Resisting the osmotic pressure which protects the cell from lyses if we have high osmotic pressure.

\*عشان هيك اذا تكسر هادا الجدار او انو صار سلايتلي رح بصير لايسيز للخلية وكان في كثير ضغط جواها.

خاصة اذا حطينا الخلية في مي، فش أملاح عن طريق الاوسموزيس رح تدخل المي ل جوا وما كان في جدار للخلية رح يصير لايسيز.

Peptidoglycan is made of many stacks with polysaccharides as a back bone. Polysaccharides are made up of 2 amino sugars (glucose molecule and another molecule): N-acetyl glucose amine & N-acetyl muramic acid.

هادا الباك بون مقوى ب سلسلة بيتايد.

***Tetrapeptide chain -> side chains***

There are also crosslinks, there are peptide bonds between the amino acids which give more strength to the peptidoglycan.

-> ***The cell wall of the bacteria is unique.***

\*الانتي بيوتيك زي البنسلين بتضعّف هاي الروابط ف بتقضي على البكتيريا.

\*الانتي بيوتيك زي البنسلين والسيفلوسبورين بيعملو Inhibition ف بصير لايسيز للخلية.

➔ **Function of the cell membrane:**

Permeability and transport.

\*The capsule is not found in all bacterial cells.

\*Mycoplasma has a rigid cell membrane instead of a cell wall.

\*Capsules are made of polysaccharides.

\*Rigid cell wall -> gram positive

\*كمان اشي مهم وهو:

Lysosomes: eukaryotes produce lysosomes which produce enzymes that break the bond between these 2 sugar amines.

- Lysosomes are in our body fluids(saliva, sweat)

### GRAM STAIN:

○ ليش لما نعمل صبغة غرام بيطلع بكتيريا موجية وسالبة ؟؟؟

الموجبة لونها أزرق والسالبة لونها أحمر.  
بس الفرق الرئيسي بينهم هو جدار الخلية...

Gram positive and gram negative bacteria both have a cell membrane. The structure of the cell membrane in any organism is: a phospholipid bilayer embedded with proteins which are very important in transport from/to the cell.

Above the cell membrane in gram positive bacteria there are many thick stacks of peptidoglycan. However, in negative bacteria, it is very thin.

○ في اشي موجود عند البكتيريا السالبة ومش موجود عند الموجبة والي هو:

The phospholipids bilayer of gram negative bacteria contains a very unique structure called lipopolysaccharides(LPS).

○ \*بما انو في عنا: Inner membrane , outer membrane  
معناها في فراغ بينهم:

This space is called periplasmic space. The periplasmic space contains enzymes that make beta lactamases -> resistance of antibiotics (degradation of penicillin's and other  $\beta$ -lactam drugs).

### **COMPARISON BETWEEN CELLS AND VIRAL PARTICLES:**

- 1) Bacterial cells are extracellular but viral particles are intracellular. Bacterial cells can survive intracellularly and extracellularly(they grow better inside the cell). Viral particles are obligatory intracellular survivals .
- 2) Presence of cell wall and cell membrane in bacteria. Absence of both in viral particles.

3) Viral: contains either DNA or RNA while bacteria contains both DNA and RNA.

4) Bacteria divides into 2 identical cells. Viral particles use enzymes and sources of other cells to duplicate its nucleic material ( DNA or RNA) and proteins.

**TABLE 1-2 Comparison of Medically Important Organisms**

Characteristic	Viruses	Bacteria	Fungi	Protozoa and Helminths
Cells	No	Yes	Yes	Yes
Approximate diameter ( $\mu\text{m}$ ) <sup>1</sup>	0.02–0.2	1–5	3–10 (yeasts)	15–25 (trophozoites)
Nucleic acid	Either DNA or RNA	Both DNA and RNA	Both DNA and RNA	Both DNA and RNA
Type of nucleus	None	Prokaryotic	Eukaryotic	Eukaryotic
Ribosomes	Absent	70S	80S	80S
Mitochondria	Absent	Absent	Present	Present
Nature of outer surface	Protein capsid and lipoprotein envelope	Rigid wall containing peptidoglycan	Rigid wall containing chitin	Flexible membrane
Motility	None	Some	None	Most
Method of replication	Not binary fission	Binary fission	Budding or mitosis <sup>2</sup>	Mitosis <sup>3</sup>