

Microbiology let 2

دراسة تاييم

Cell membrane

Composition of plasma membrane

Bacterial structure: intracytoplasmic structures ✓ - Cell wall ✓ - structure outside the cell wall.

Thin, fragile membrane located just inside the cell wall [Essential].

Phospholipid bilayer + Protein + (No sterols)
An exception is *Mycoplasma* which have sterols

- Intracytoplasmic structures:**
- 1) Nucleoid
 - 2) Ribosomes
 - 3) Inclusion granules (inclusion bodies)
 - 4) Cell membrane
 - 5) Plasmid

Function of the cell membrane

1) A. Selective transport (Passive)
[Extracellular concentration is higher than intracellular concentration, so molecules get into the cell.]

1) B. Selective transport (Active)
[Extracellular concentration is lower than intracellular concentration, so molecules need energy to get into the cell.]

2) Mesosomes
Respiration enzyme (Making energy) (Like Mitochondria).
They contain respiration enzymes which are responsible of making energy (They resemble the mitochondria in eukaryotes).

Cell division - Separate DNA - Septal mesosomes.

3) Biosynthesis of cell wall
Cell membrane synthesizes the building blocks "precursors" of the cell wall

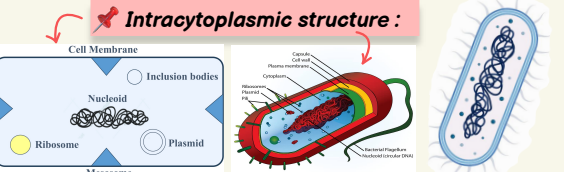
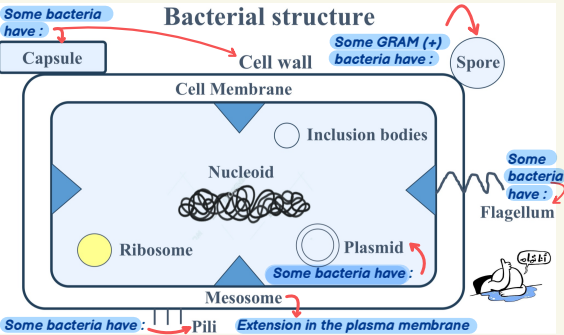
4) Excretion of extracellular enzymes (Hydrolytic enzymes)
[Large food → enzymes digest → can penetrate cell membrane].

5) Excretion of extracellular enzymes (Penicillinase)
Some bacteria excrete these enzymes (such as Penicillinase) to defend themselves against some antibiotics (such as Penicillin, cephalosporins)

6) Chemotactic system For bacteria that has flagella
The cell membrane has receptors for certain materials.
When they detect a beneficial substance, they signal the flagella to propel the bacteria toward it.
Conversely, if a harmful substance is sensed, they signal the flagella to move the bacteria away.

Plasmid

EXTRA circular chromosomal dsDNA Not essential
Why isn't plasmid considered a part of the bacterial chromosome?
1) Replicate autonomously (Independent of bacterial chromosome).
2) Its genetic function is toxin production for drug resistance.
Recall that bacterial chromosome's function is survival & growth



Nucleoid

- 1) Single chromosome
- 2) Circular
- 3) dsDNA (ds = double strand)
- 4) 1mm in length
- 5) supercoiled
- 6) Carry genetic information for growth & survival
- 7) Essential = all bacteria have it

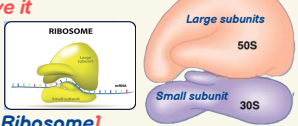
→ It is what distinguishes bacteria from eukaryotes.
→ Bacteria doesn't have a nuclear membrane, so the nucleoid exists in the cytoplasm.
Bacteria's length is measured by microns, and [1mm is 1000 microns!] So, DNA must be supercoiled to fit inside the bacteria.

Ribosomes

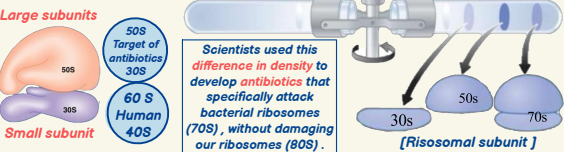
[Ribo=RNA - Some=body]
[Site of Protein synthesis]
[Protein synthesis = mRNA + Ribosome]
[Essential]

[Bacterial ribosomes (70S)] the type of the ribosomes is 70S = [Sedberg unit]

The unit "Svedberg" is named according to the scientist "Svedberg" and it measures the density of them.

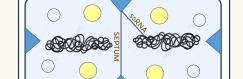
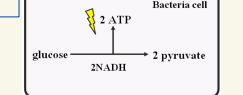
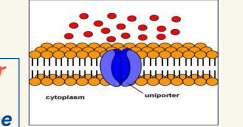
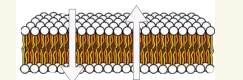
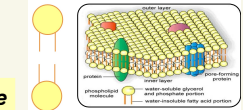


Small subunit's density is 30s
Large subunit's density is 50s
Their density when together is 70s
By Centrifugation - Small & large subunits binds together when they are attached to the mRNA

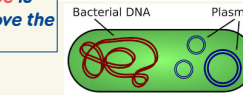
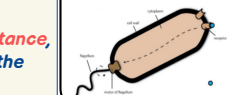
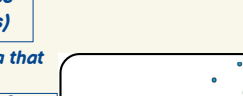
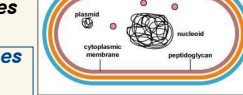
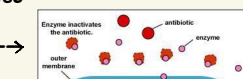
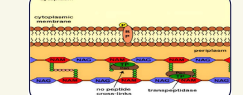


Inclusion granules - It's Maine fiction (storing of nutrients) [Glycogen - starch - phosphate].

Some type of bacteria mainly stores phosphate in its inclusion bodies, that's why it granules called: Volutin granule (Metachromatic granules).



ssRNA = single stranded RNA It helps in DNA separation into 2 copies





cell wall :



Definition of cell wall :

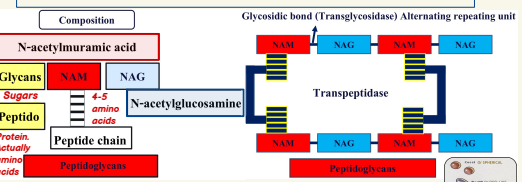
Some bacteria have **capsules** that are external to the cell wall!

Outermost layer
A more precise definition:
Surrounds the cell membrane
Rigid

Due to its composition and the presence of **peptidoglycans (glycan + peptido)**

composition of cell wall :

Peptidoglycans
1) **Glycans = Sugars**
Alternating repeating unit (sugars) of :
NAG (N-acetylglucosamine)
NAM (N-acetylmuramic acid)
that are linked together by **Glycosidic bond** by an Enzyme called (**Transglycosidase**)
2) **Peptido = Protein**
A Chain (tetra \ penta) amino acids
The peptide chain **ALWAYS** connected to **NAM**
The Enzyme that made the peptide bonds Between the peptide called (**Transpeptidase**)



function of cell wall :

- Maintenance of the shape (Rigid)** Different shapes for bacteria depending on the **CELL WALL**
Deficient (**lack**) of cell wall example [**MYCOPLASMA**] Takes many shapes (no certain shape) **Polymorphic**
- Protection (Osmosis insensitive)**
Protects the cell membrane which is Osmosis **Sensitive**
the **tonicity concept** : If the cell is :
in a **hypertonic solution** → it **shrinks**
in a **hypotonic solution** → it **lyses (bursts)**
This effect is countered by the **present of the cell wall**
- Target site for antibiotics** [**Penicillin, Cephalosporines**] they attack the cell wall of bacteria
- Role in cell division**
- Responsible for staining**
the colors very well and distinguish between them

Function of cell wall

Cell wall deficiency

1) **Naturally**: [**Mycoplasma (Sterol)**] in the cell membrane give some **protection** because this type lacks a cell wall.
2) **Induced**: Some **antibiotics - Cell wall inhibitors** [**Lysozyme**] From our bodies
Completely : [**Protoplast (G+ve)**] [**Spheroplast (G-ve)**]
Partially Named after **Leister city in England** [**L-form bacteria**]

GRAM stain procedure (4 stains):

- 1. Crystal Violet** (The primary stain)
- 2. Iodine** (For fixation)
- 3. Acetone** Or alcohol (95%) (For decolorization)
- 4. Counter Stain** (Safranin)

Critical step: It must be performed quickly and accurately. Little to no effect on GRAM (-) in this step.

Only GRAM (-) are decolorized because the peptidoglycan layer is thin, and the 3rd step is quickly performed, so the thick layer of GRAM (+) keeps the color.
The outer membrane in GRAM (-) is made of lipids, so it is dissolved in alcohol and the alcohol can perform its job then.

L-form & Mycoplasma They resist **Penicillin & Cephalosporines** because their mechanism is attacking the cell wall.

Created the Gram stain :



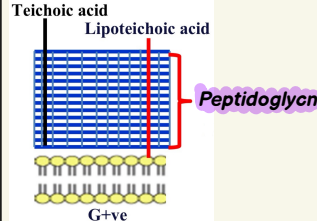
The GRAM stain divides bacteria into two main groups; each has its own characteristics. (Cell wall)

Bacteria are (mainly) either: **There is some exceptions**
GRAM + or GRAM -
2 Colors in this stain:
Purple GRAM + **Pink GRAM -**



Gram +

Cell membrane + **THICK** layer of peptidoglycans
Has **teichoic acid** (peptidoglycan-bound)
Has **lipoteichoic acid** (lipid-bound [to the cell membrane])

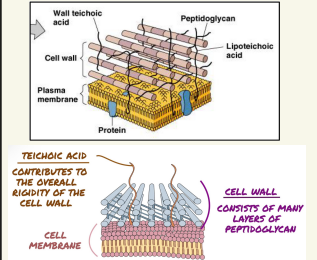


- Peptidoglycan : (50%) thick** [NAM-NAG - Peptide] (Porous) : نقاذ
- Teichoic acid + Lipoteichoic :** **TEICHOIC ACID & LIPOTEICHOIC ACID** are composed of : **Polymers of Glycerol or Ribitol**
Lipoteichoic acid is (Cell membrane-bound) .
Teichoic acid is (Cell wall-bound) .

Teichoic acids that are anchored to the lipid membrane are referred to as **lipoteichoic acids (LTAs)**, whereas teichoic acids that are covalently bound to peptidoglycan are referred to as **wall teichoic acids (WTA)**.

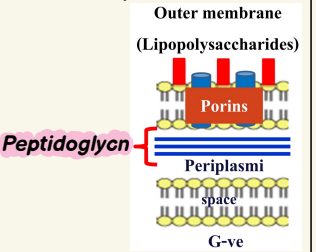
Teichoic acid is the : [function]
1) **Major surface Antigen of G+ve**
Induces an immune response in our bodies because it is perceived as a foreign body
[**Highly immunogenic**]
[**Tumor Necrosis Factor - Alpha**] [**TNF-α**]
[**IL-1**]
Released after detecting the antigen
[**Interleukin - 1**]

2) responsible for the **Toxic Shock Syndrome (TSS)** .

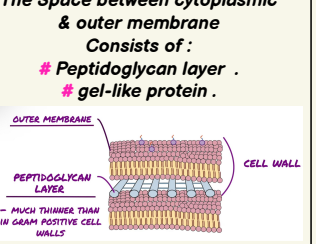


Gram -

Cell membrane + **THIN** layer of peptidoglycans
Has an **outer membrane** (**Lipopolysaccharides**) - **priplasmi** - porins



- Peptidoglycan : A thin layer (5%)**
2 sheets of [NAM & NAG - Peptides]
- Outer membrane composed of :**
A) **Bilayer phospholipids** .
B) **Lipopolysaccharides** .
Lipid A → (**Endotoxin**)
Toxin inside the **GRAM (-)**
Polysaccharides → (somatic Antigen)
C) **Porins : (hydrophilic proteins)** (Transportation) .
- 3) Periplasmic space**
The space between the **2 membranes** :
The Space between cytoplasmic & outer membrane
Consists of :
Peptidoglycan layer .
gel-like protein .



Comparison

Gram positive/Negative bacteria	
Gram positive (+) • Thick • Teichoic acid/ Lipoteichoic acid • Yes • Outer membrane • No	Gram negative (-) • Thin • Teichoic acid/ Lipoteichoic acid • No • Outer membrane • Yes

