

فسيولوجيا الأحياء الدقيقة

Microbial Physiology

د. تركي محمد الداود
مكتب ٢ ب ٤٥

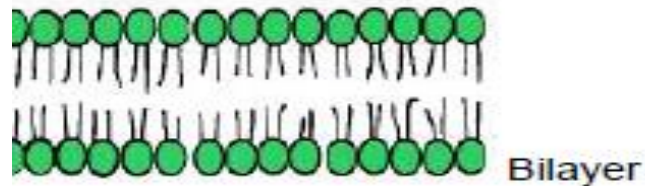
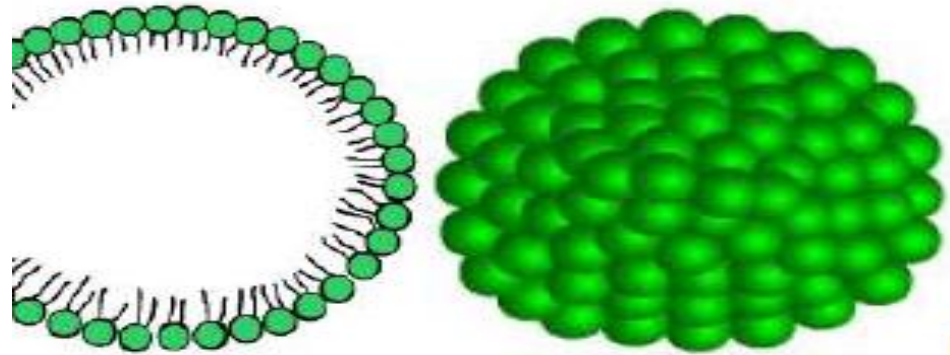
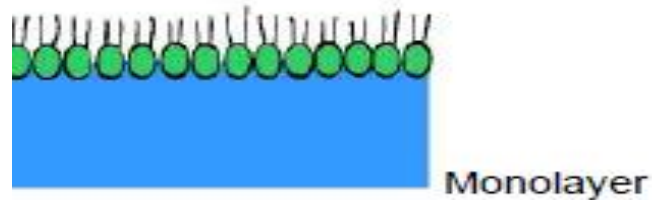
مقدمة

Introduction-L4

Lipids

• Lipids:

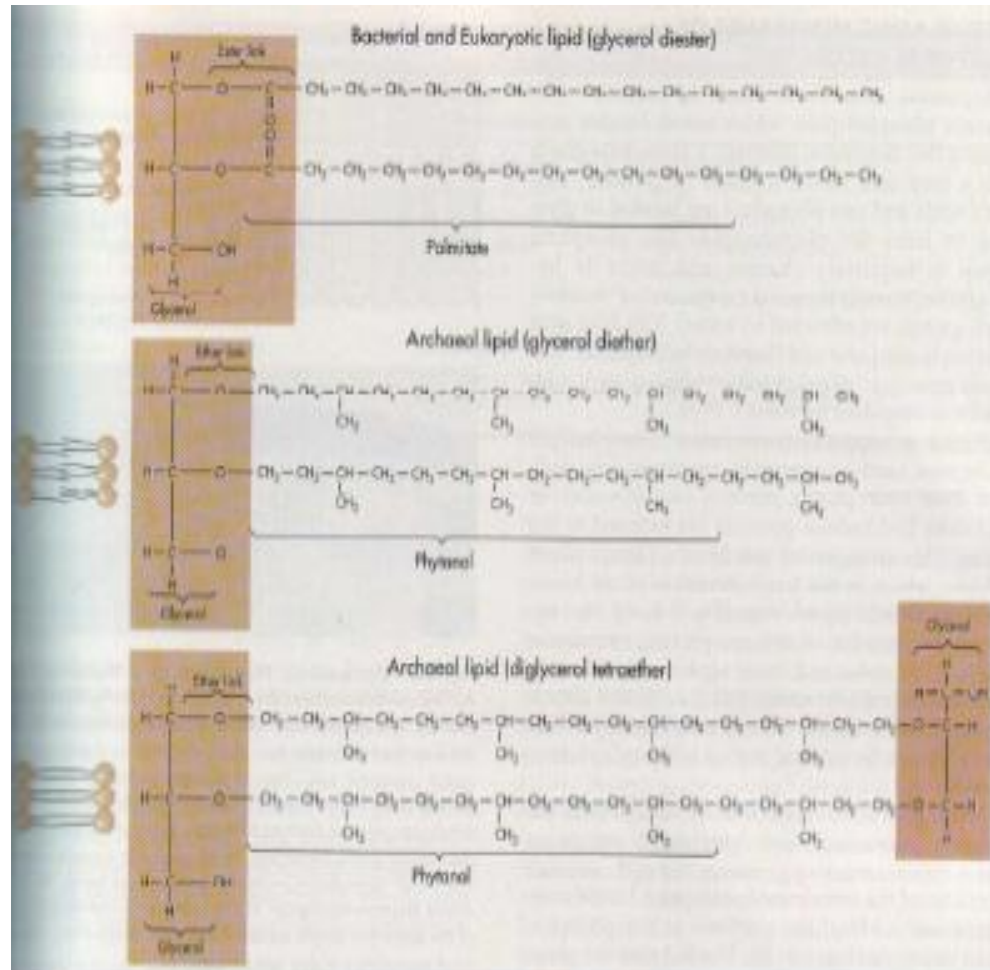
- ❖ Lipids tends to be formed in 3 structures:
 - **Monolayer** is formed on an aqueous surface.
 - **Micelles** are formed in solutions with polar heads on the outside and hydrophobic tails to the centre.
 - **Bilayers** are formed under the increased concentration of lipids. It forms the membranes of all cells.



Lipids structural difference

- **Bacterial and eukaryotic lipids VS Archaeal lipids:**

- ❖ Bacteria and eukaryotes
Lipids = **Ester-links**
between tails and polar heads.
- ❖ Archaeal lipids =
Ether-links between
tails and polar heads.

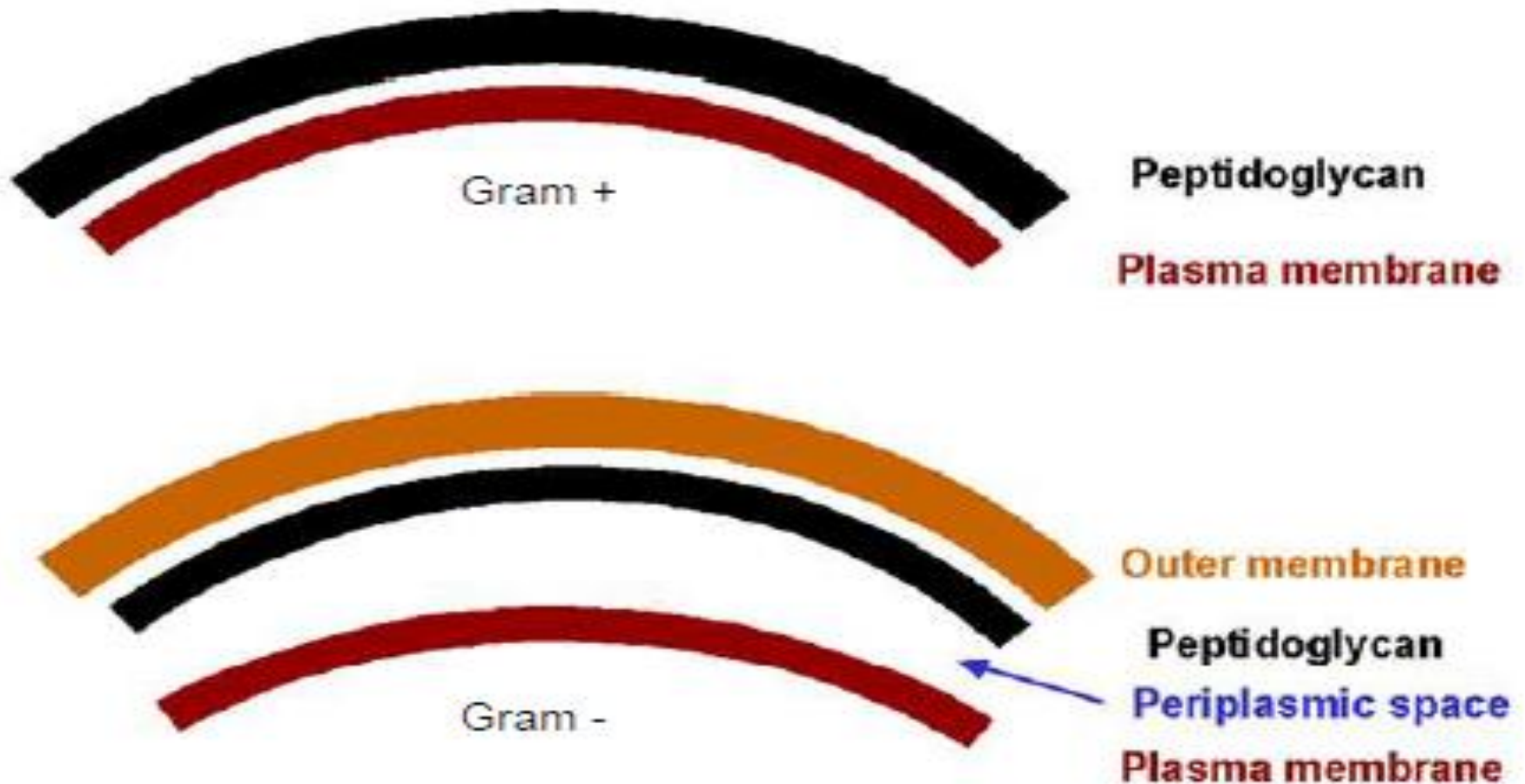


Lipids structural difference

- **In bacteria:**

- Over 200 associated proteins in the cell membrane fluid structure.
- Involved with the synthesis and maintenance of the cell wall and membrane.
- Others are involved in the degradation of macromolecules and transport.

Bacterial cell membrane structures



Gram Positive Cell Wall Synthesis

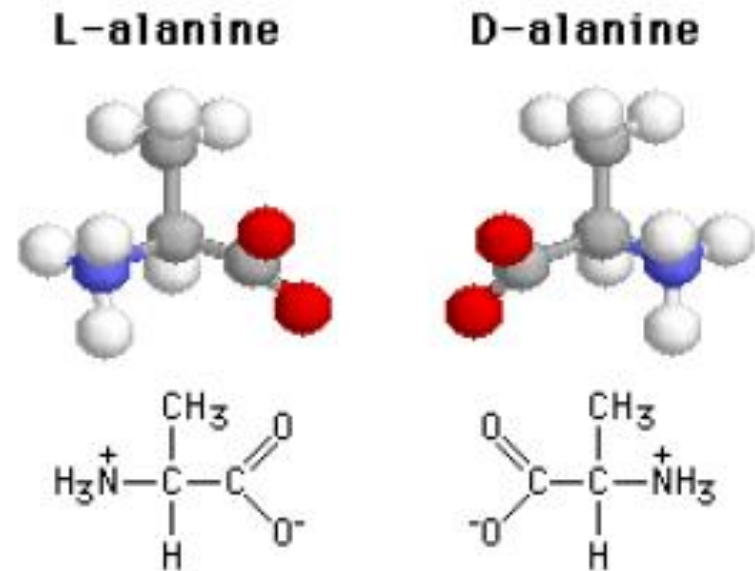
• Cell Wall:

- Made up of a thick many-layered peptidoglycan.
- An alternating sugar unit motif connected by inter-peptide bridges.
 - N-acetyl-glucosamine (NAG).
 - N-acetyl-muramic acid (NAM).
- The peptidoglycan is a layer of the cell wall that interacts with the environment.

Gram Positive Cell Wall Synthesis

- **Peptidoglycan formation:**

- An alternating sugar unit motif (design) connected by inter-peptide bridges.
- The two alternating sugar residues are N-acetylglucosamine and N-acetylmuramic acid.
- The Penta-peptide bridge is added to N-acetylmuramic acid.
- The inter-peptide bridge contains naturally occurring D-forms of amino acids.



Gram Positive Cell Wall Synthesis

▪ Peptidoglycan formation:

❖ Three stages:

• Stage 1

- Occurs in the cytoplasm.
- N-acetylglucosamine (NAM) is converted to N-acetylmuramic acid (NAM).
- D-forms amino acids, the pentapeptide (PP), are added to NAM.

• Stage 2

- Occurs in the membrane.
- After the addition of PP, NAM is bound to the carrier lipid undecaprenyl phosphate (UDCP).
- NAM is then bound to the NAM pentapeptide.
- They are released on the other side of the membrane.

Gram Positive Cell Wall Synthesis

- **Peptidoglycan formation:**

- **Stage 3**

- Occurs at extracellular side of membrane.
 - The individual peptidoglycan residues are then polymerized into the glycan chain.
 - Trans-peptide bridges are formed resulting in the releases of the last D-ala residue.

Gram Positive Cell Wall Synthesis

- **How does penicillin affect peptidoglycan synthesis?**
 - The antibiotic of choice for use against gram positive bacteria are the β -lactams (penicillin). The enzymes involved in the final steps of transpeptidation, glycan chain formation, and undecaprenyl phosphate recycling are inhibited by penicillin.
 - They are known as Penicillin Binding Proteins (PBP's).
 - Found outside the inner membrane enabling penicillin to act on them.

Gram Positive Cell Wall Synthesis

▪ Teichoic acids:

- A characteristic wall bound acid.
- Wall bound (**wall teichoic acids**).
- Formed by the polymerization of:
 - Ribitol phosphate or
 - Glycerol phosphate molecules.
 - Joined by a phosphodiester links.
- Membrane/wall bound (**Lipoteichoic acids**).
 - Generally 16-40 phosphodiester linked glycerophosphate residues bound to a membrane anchor (glycolipid or glycophospholipid).

- All teichoic acids are capable of scavenging to concentrate divalent cations (Mg^{2+}) as ready supply at cell surface.

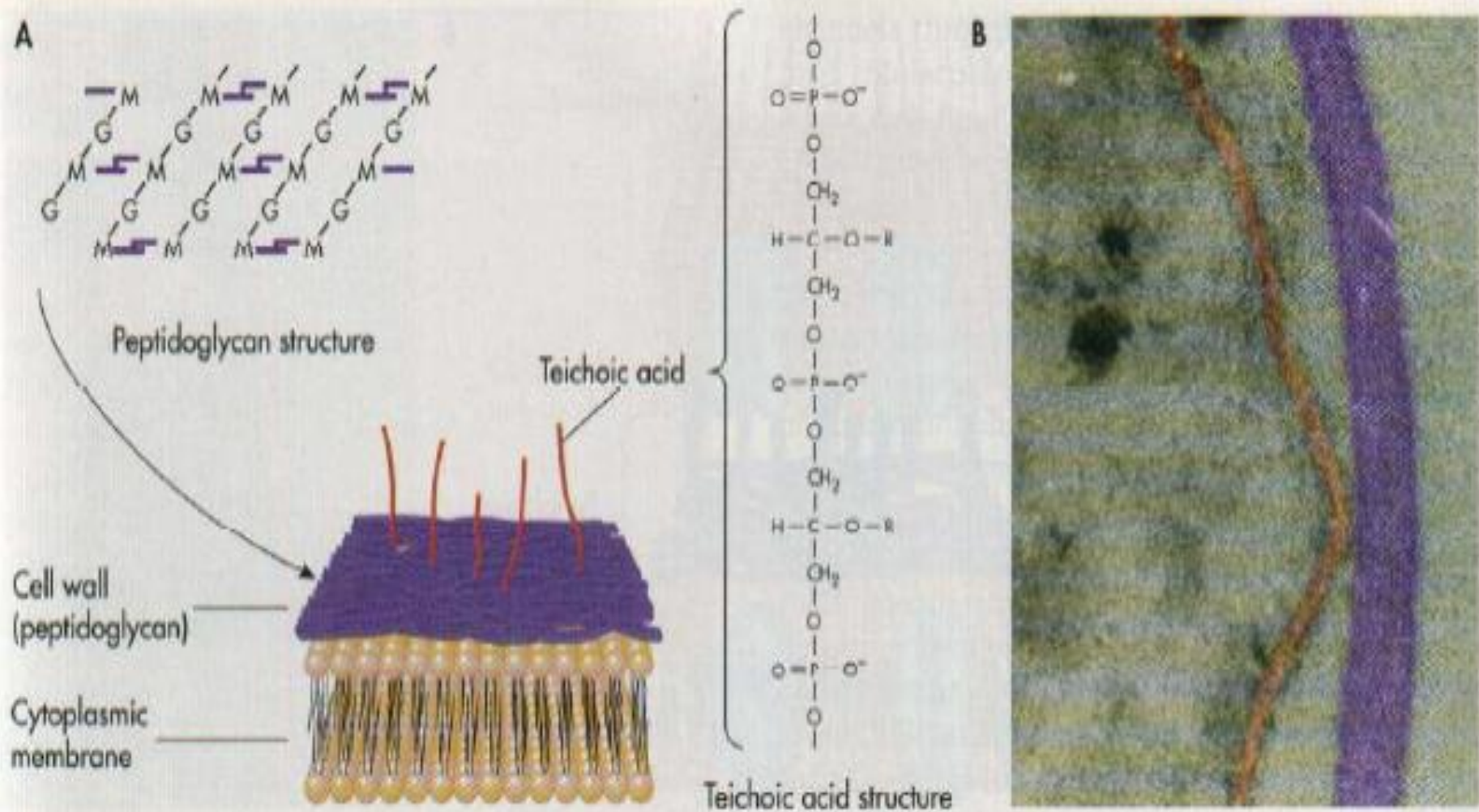


Fig. 3-20 Gram-positive Bacterial Cell Wall. **A**, The Gram-positive cell wall that surrounds and protects the cytoplasmic membrane has a relatively thick peptidoglycan layer. It also has teichoic acids, which are polymers of glycerol or ribitol phosphate. The teichoic acid structure shown here is the glycerol type, and *R* may be *D*-alanine or glucose. **B**, Colorized micrograph of the cell wall of the Gram-positive bacterium *Bacillus subtilis* shows the thick peptidoglycan layer (purple). This cell wall completely surrounds and protects the cytoplasmic membrane.

QUESTIONS??

