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Département de Biologie**

Microbiology Control Quality
Master 2

**Structure and Function of
Bacterial Cell Walls**

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Bacterial Cell Walls

The cell wall is a fairly rigid layer that lies just outside the cytoplasmic membrane.

This layer confers the characteristic shape of the microorganism in addition to protecting against osmotic lysis.



Several components contribute to the integrity and function of the cell wall thus affecting the penetrability of the cell

The shape and strength of the cell wall is mostly a result of the large polymer peptidoglycan (PG) also known as murein (Figure 1).

Gram -

Gram +

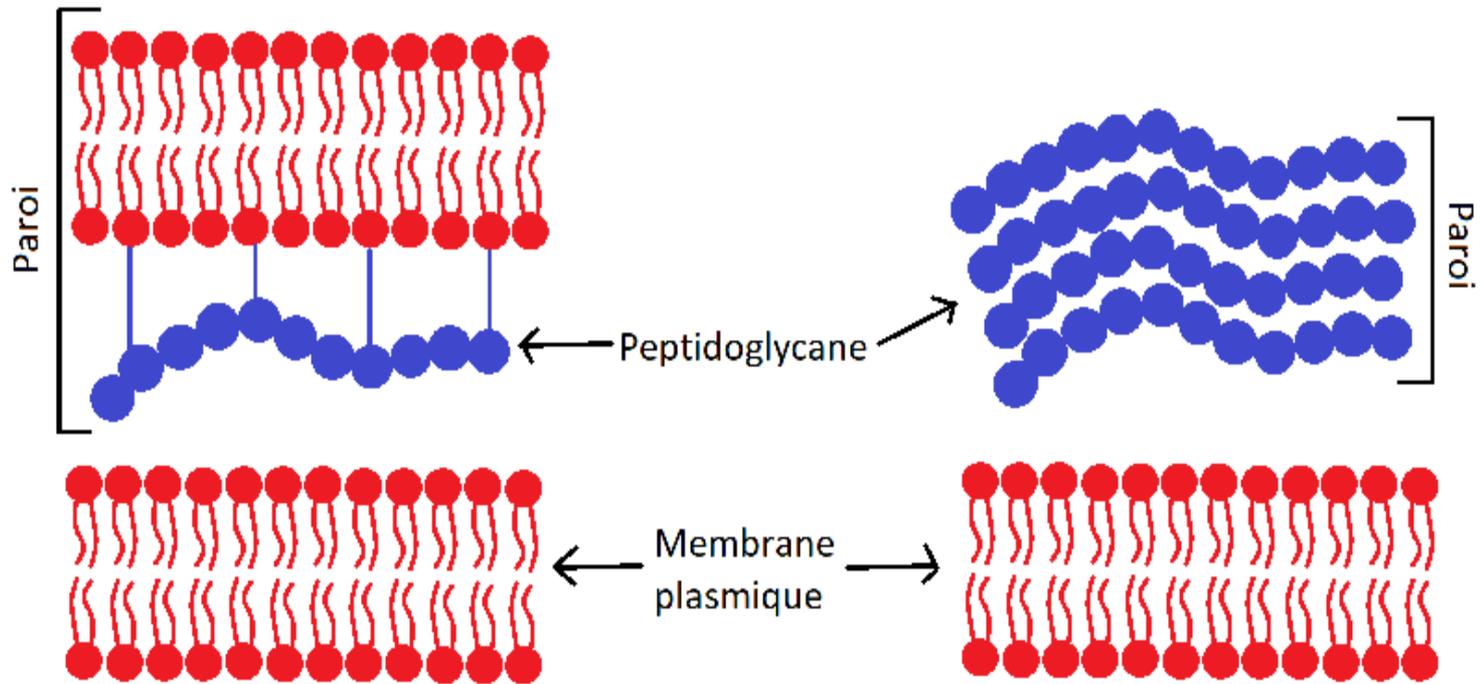
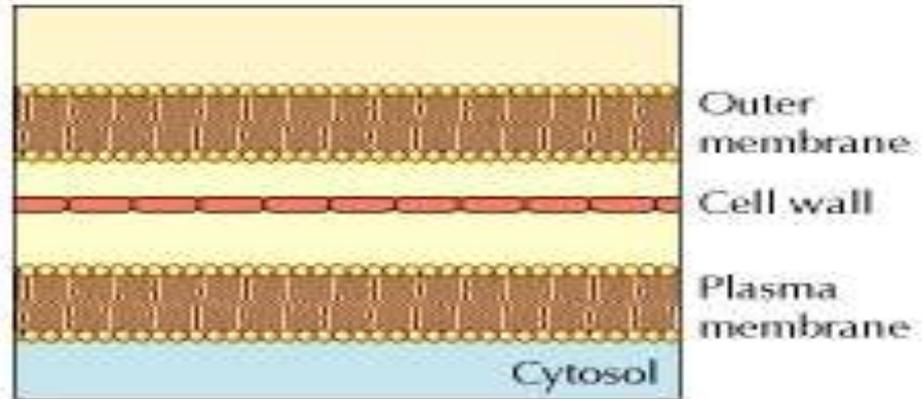


Figure 1: peptidoglycan (PG)

Gram-negative



Gram-positive

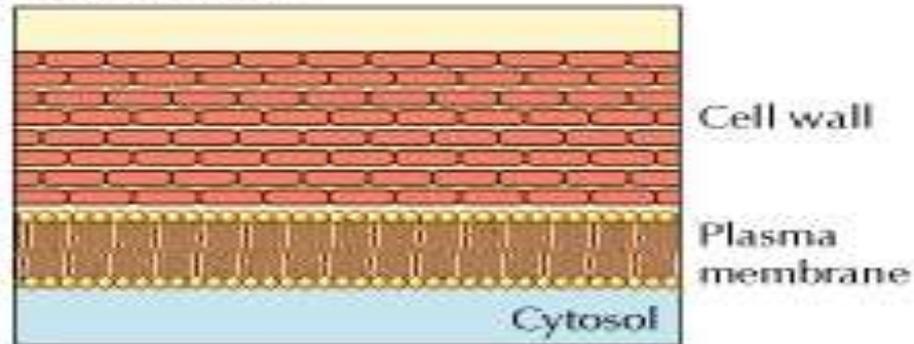


Figure 2: The plasma membrane of Gram-negative bacteria is surrounded by a thin cell wall beneath the outer membrane. Gram-positive bacteria lack outer membranes and have thick cell walls.



Indeed, PG isolated from a cell retains the shape of the bacterium from which it was derived.

Peptidoglycan contains two sugar derivatives, N-acetylglucosamine (NAG) and N-acetylmuramic acid (NAM), as well as four of five possible amino acids; L-alanine, D-alanine, D-glutamic acid, L-lysine and diaminopimelic acid (DAP).



PG is a very large macromolecule and is in fact somewhat unique among biological macromolecules.

Unlike nucleic acids, proteins or polysaccharides, PG is neither linear nor branched-linear but instead forms two and three-dimensional networks.

Gram-positive cell walls

The gram-positive cell wall is made up mostly of a thick homogenous peptidoglycan layer which can range from 20 – 80nm in thickness (Figure 2).

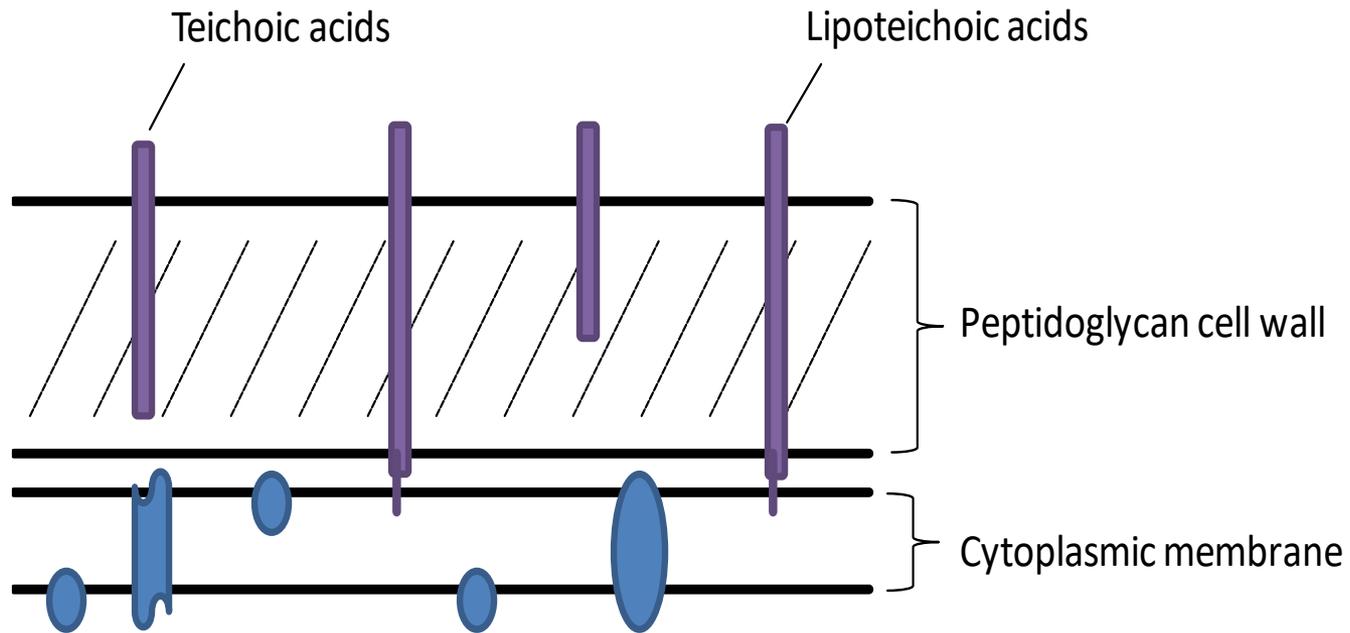


Figure 2: Structure of the gram-positive cell wall, depicting the thick peptidoglycan layer also containing wall-associated teichoic acids and membrane-associated lipoteichoic acids.

Gram-negative cell walls

it is clear the cell wall of gram-negative species is far more complicated than that of gram-positive organisms.

In contrast with the thick gram positive cell wall composed mainly of PG, gram negative bacteria have only a thin 1-3nm PG layer, often comprised of only a couple sheets of PG.



Another distinct difference between the two PG layers is the open molecular structure of gram-negative PG.

As mentioned before, PG offers rigidity and protection; however the thinness of the gram negative cell wall offers greater flexibility.



The defining feature of the gram-negative cell envelope is the lipopolysaccharide (LPS) containing outer membrane.

This outer barrier, often referred to as a ‘molecular sieve’, is responsible for regulating the flux of molecules into and out of the periplasmic space

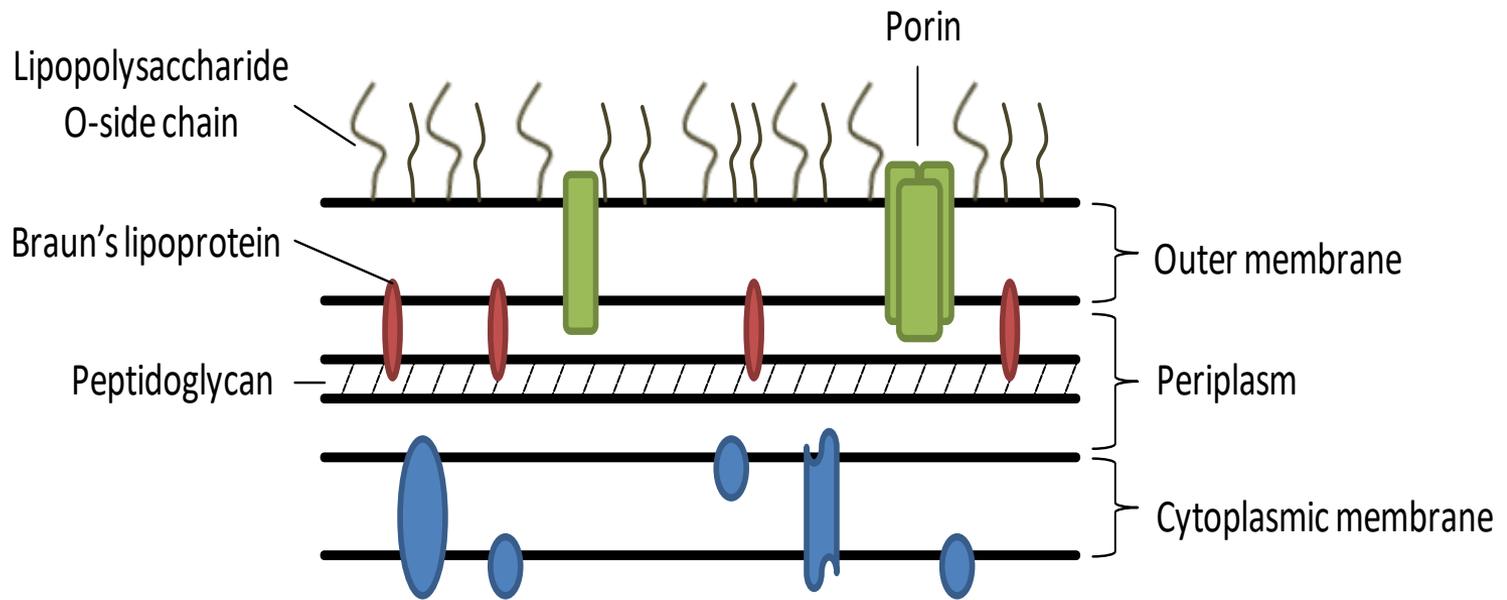
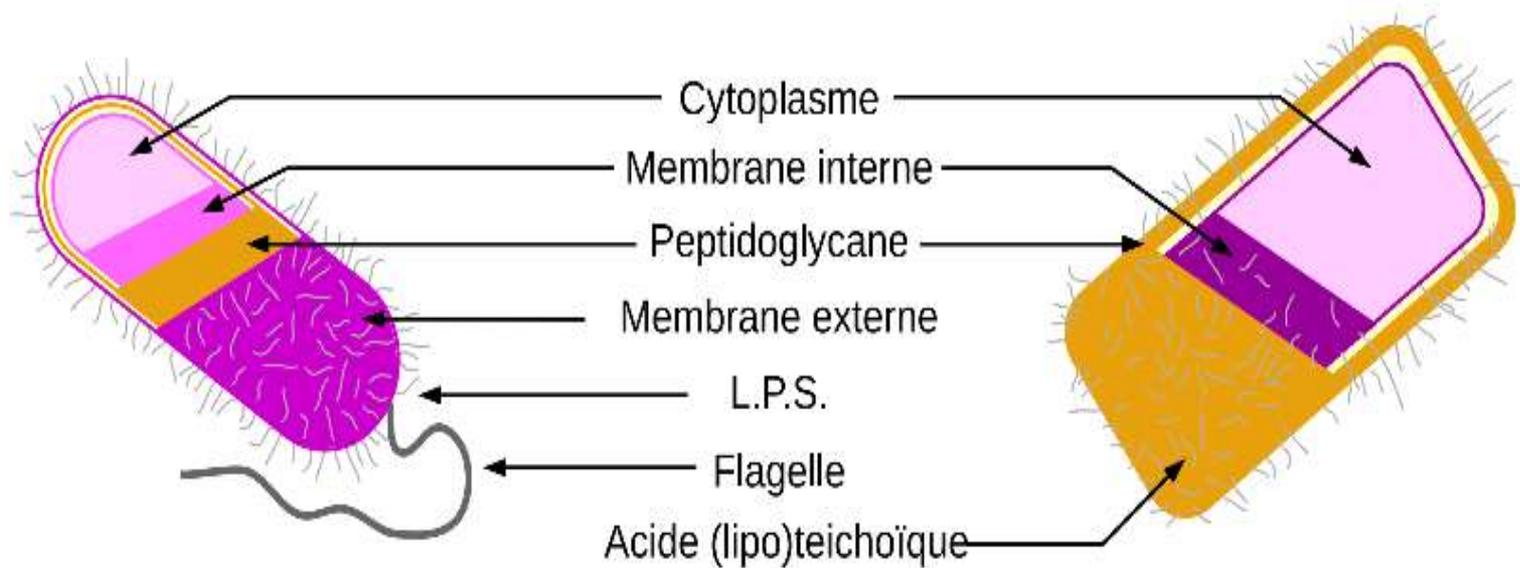


Figure 3: Structure of the gram-negative cell wall including the peptidoglycan layer, periplasmic space and outer membrane. The external leaflet of the outer membrane is predominately lipopolysaccharides. The outer membrane and peptidoglycan are linked together by Braun's lipoprotein.

Paroi Gram négative

Paroi Gram positive



Le peptidoglycane est présent à la fois chez les bactéries à paroi Gram négative et positive.

L.P.S. = lipopolysaccharide



While LPS contributes structurally by stabilizing the outer membrane, it is also classified as an endotoxin due to the toxic lipid A portion of the molecule.



Lipid A is the only part of LPS

recognizable by the innate immune

response, is highly immune

stimulatory and may illicit a response

even at low concentration

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Thank you