Biochemistry Of Macromolecules (BCH417)

Bacterial Cell Wall

Learning Objectives For Today

1. Define macromolecules

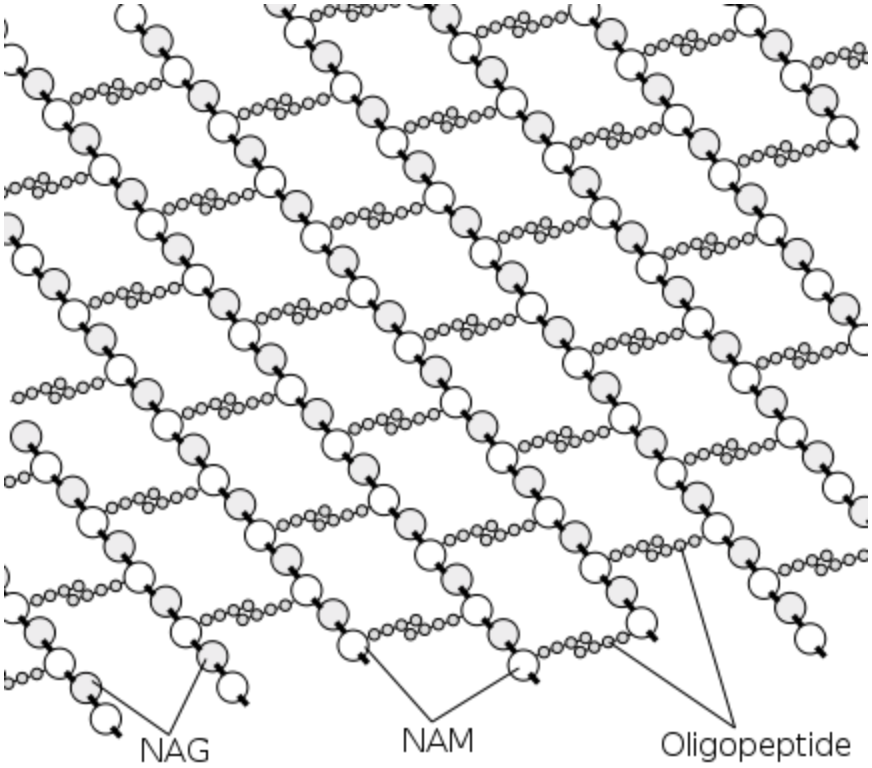
2. Describe how polymers are assembled from monomers and how polymers can be disassembled back to monomers

3. Identify the four major classes of biological macromolecules

Peptidoglycan (pep-tid-o-gly-can) is a molecule found only in the cell walls of bacteria. The rigid structure of peptidoglycan gives the bacterial cell shape, surrounds the plasma membrane and provides prokaryotes with protection from the environment.

Peptidoglycan is a huge organic polymer of interlocking chains composed of similar monomers. The backbone of the peptidoglycan molecule is composed of two derivatives of the sugar glucose: NAG & NAM.

Strands of NAG (N-acetylglucosamine) and NAM (N- acetylmuramic acid) are connected by interpeptide bridges.



Bonding Structure of peptidoglycan in bacterial cell wall, with strings of sugars (NAG and NAM) held together with oligopeptide bridges.

Gram-positive Cells

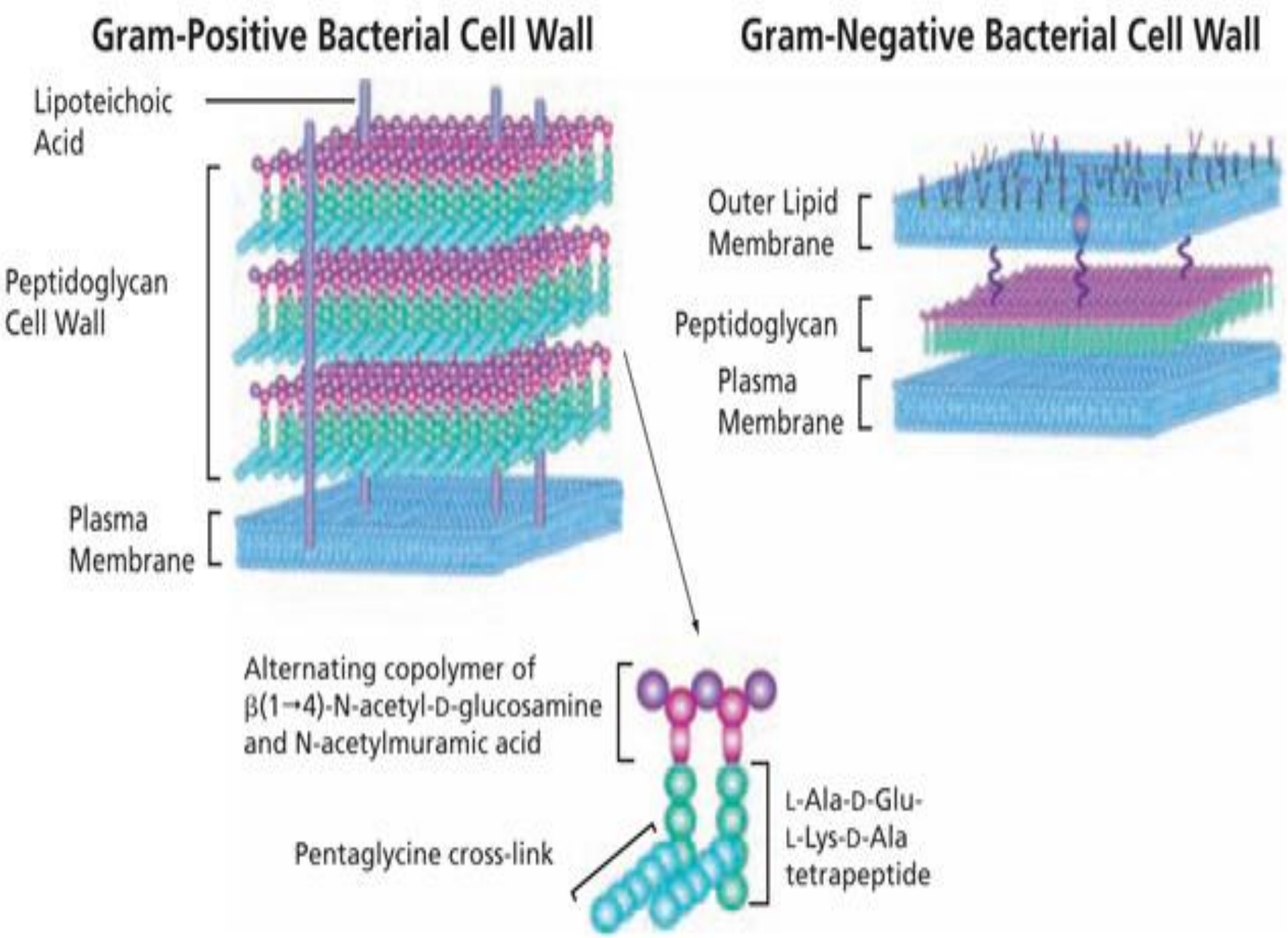
In Gram-positive bacteria, peptidoglycan makes up most (as much as 90%) of the thick cell wall.

Gram-negative Cells

The cell walls of Gram-negative bacteria are more chemically complex, thinner and less compact. Peptidoglycan makes up only 5 – 20% of the cell wall, and is not the outermost layer, but lies between the plasma membrane and an outer membrane.

This outer membrane is similar to the plasma membrane, but is less permeable and composed of lipopolysaccharides (LPS). LPS is a harmful substance classified as an endotoxin.

The space between the cell wall and the plasma membrane is called the periplasm. Periplasm controls molecular traffic entering and leaving the cell.



Source: http://www.sigmaaldrich.com/technical-documents/articles/biology/glycobiology/peptidoglycans.html

Bacterial Cell Structure Summary: *The amount and location of peptidoglycan in the prokaryotic cell wall is what determines whether a bacterium is Gram-positive or Gram-negative.*

Peptidoglycan and Antibiotics

Penicillins and cephalosporin antibiotics interfere with the linking of the interpeptides of peptidoglycan, but because of the LPS membrane, these antimicrobials can't access the peptidoglycan of gram-negative bacteria. Gram-positive bacteria, with no membrane outside the peptidoclycan cell wall, are more susceptible to these antibiotics.

Cell walls without intact peptidoglycan cross-links are structurally weak, and disintegrate when cells divide. This is how penicillins and cephalosporins work to disable bacteria.

Since the eukaryotic cells of humans do not have peptidoglycan cell walls, our cells are not damaged by antibiotics that target peptidoglycan, and microorganisms that do not contain peptidoglycan are also not susceptible to these drugs.

Further Reading

Sources

http://www.sigmaaldrich.com/technical-documents/articles/biology/glycobiology/peptidoglycans.html

http://www.scienceprofonline.com/microbiology/bacterial-cell-wall-structure-gram-positive-negative-2.html

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Park Talaro, K. (2008) *Foundations in Microbiology*, McGraw-Hill.