

Microbiology 2 - Prokaryotic Cell Walls

Why would bacterial cells need to employ cell walls?

- ① to combat high osmotic pressure inside cell and prevent cell lysis
- ② to provide shape and rigidity to cell

Gram positive and gram negative bacteria differ in their cell wall composition.

→ uniform monolayer
(10-20 layers thick)
PG

↓
consist of at least two layers
(1-3 layers thick)
PG

Peptidoglycan

- composed of two sugar derivatives - N-acetylglucosamine & N-acetylmuramic acid + a few amino acids - lysine, alanine, glutamic acid.
(Glycan tetrapeptide)
- Rigidity in X-direction - glycosidic bonds connecting sugar
Rigidity in Y-direction - cross-linking between amino acids
- destroyed by lysozyme - breakage of β -1,4-glycosidic bonds

How is the peptidoglycan so variable?

Due to organisms adapting to different² microniches → different necessity

Biosynthesis of Peptidoglycan

Cytoplasm

Fructose-6-phosphate

↓ hexosamine pathway

Uridine diphosphate N-acetylglucosamine (UDP-GlcNAc)
(1st precursor)

MurNAc-(pentapeptide)-pyrophosphoryl-undecaprenol
[Lipid I]

Cytoplasmic memb. leaflet

Enzyme: UDP-N-acetylglucosamine-3-enolpyrenyl transferase
[MurA]

GlcNAc added to Lipid I

Lipid II → GlcNAc- β -(1,4)-MurNAc-(pentapeptide)-
pyrophosphoryl-undecaprenol

Lipid II is then transported across cytoplasmic membrane
via MurJ (flippase) to the periplasm or exterior

↳ Candidate: FtsW & RodA (member of SEDS family)

Penicillin-binding-proteins (PBP) necessary for biosynthesis
RodA & FtsW - polymerises into peptidoglycan in correlation
with PBPs

Why is crosslinking an important target for antibiotics?

because earlier products are also utilised in other biochemical pathways

Autolysin

- repair and growth of peptidoglycan layer (esp. during cell division)
- hydrolyses β -1,4-glycosidic bond of peptidoglycan
- autolysins trim the exposed parts of the PGs from the cell wall, which would otherwise trigger an immune response

PGs are hidden by layers of proteins and glycopolymers in Gram- $+$ ve, and by an outer-membrane in gram- $-$ ve bacteria.

They are recognised by PAMPs & trigger immune response

- also helps in repair of damaged peptidoglycan

Bactoprenol

- hydrophobic C_{55} alcohol

- binds to peptidoglycan precursors
- transports them from cytoplasm through hydrophobic memb. and then to externally situated site of incorporation of growing PG
- once in periplasm, bactoprenin interacts with glycosylases that insert cell wall precursors into the growing pt. of the cell wall & catalyse glycosidic bond formation