



LECTURE 2

Bacterial structure

- Intracytoplasmic structure
- Cell wall
- Structures outside the cell wall

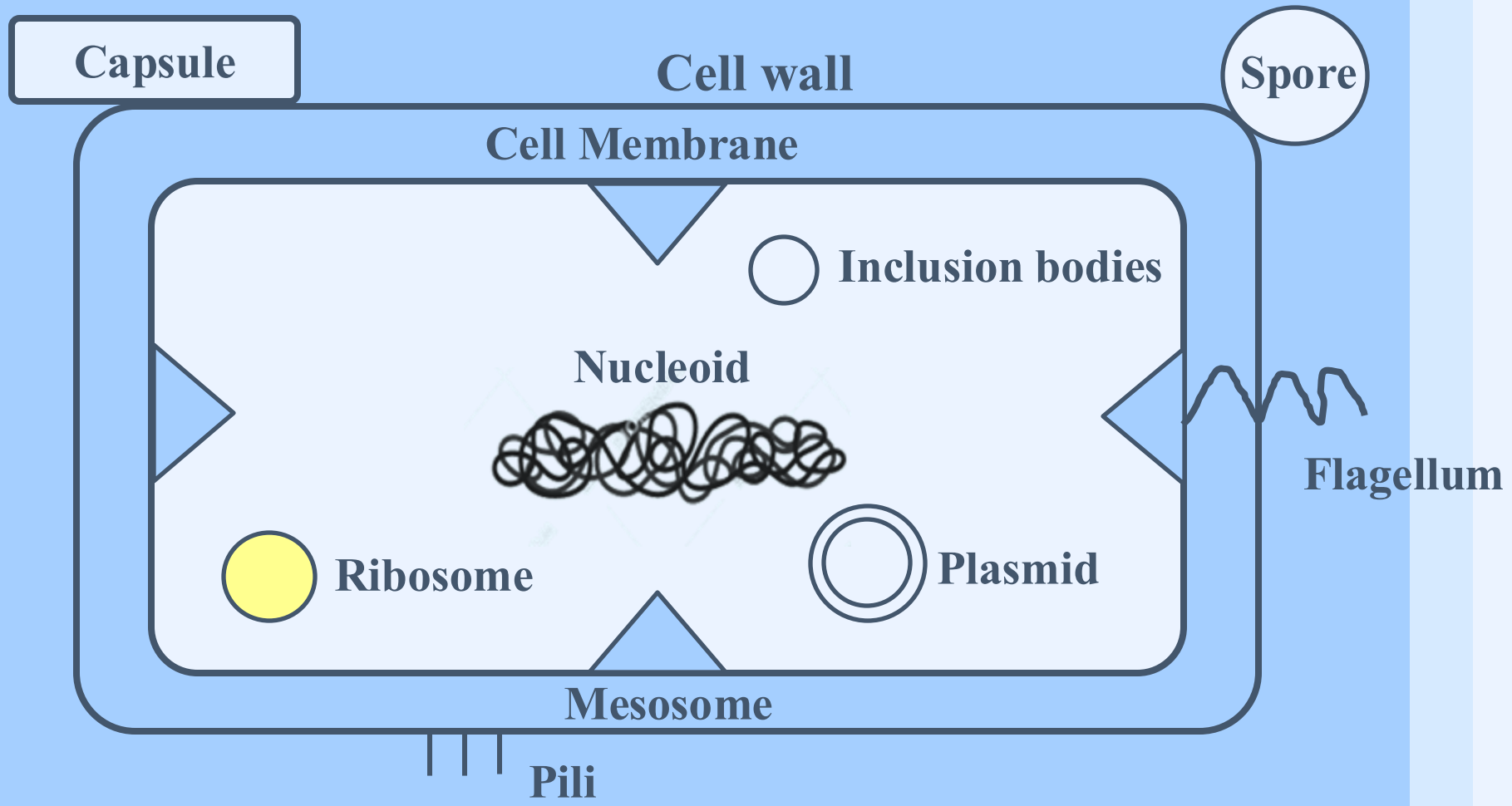


Objectives

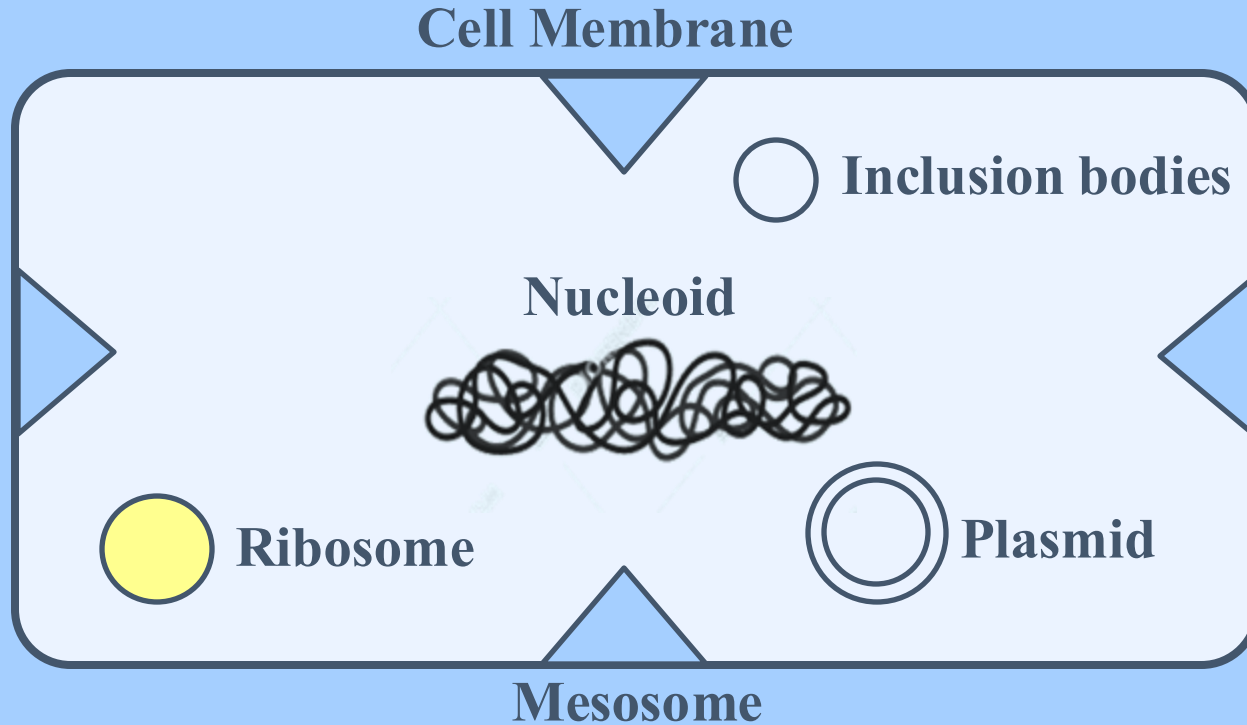
Intracytoplasmic structure

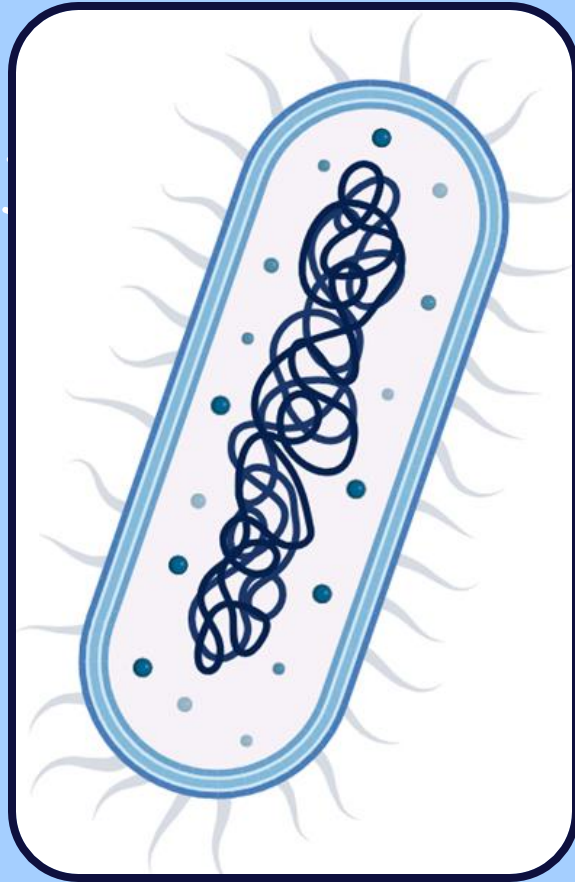
- 1) Nucleoid
- 2) Ribosome
- 3) Inclusion granules
- 4) Cell membrane
- 5) Plasmid

Bacterial structure



Intracytoplasmic structure





1) Nucleoid

1

Single chromosome

2

Circular

3

dsDNA

4

1mm in length

5

supercoiled

6

**Carry genetic information for growth
& survival**

Essential

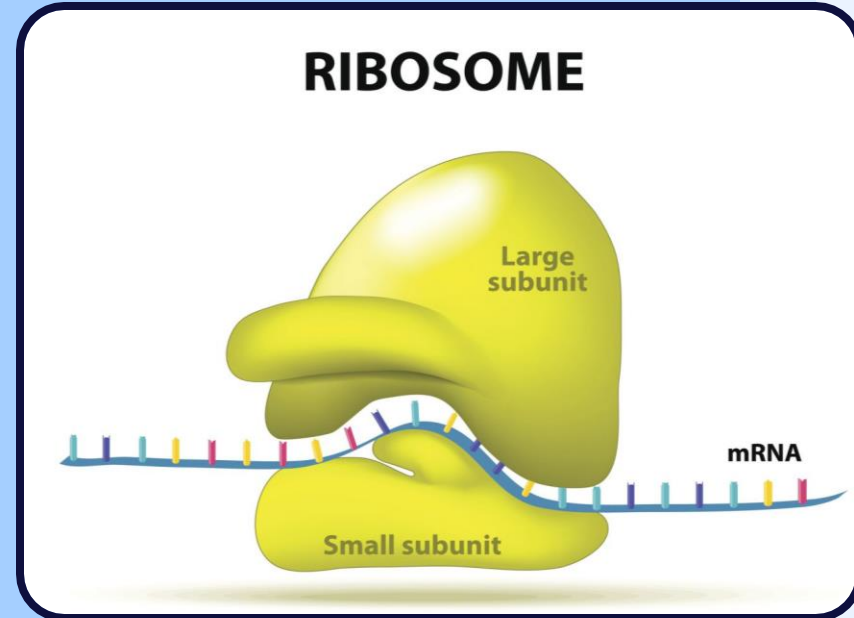
2) Ribosome

1 Ribo=RNA

2 Some=body

3 Site of Protein synthesis

Essential



2) Ribosome

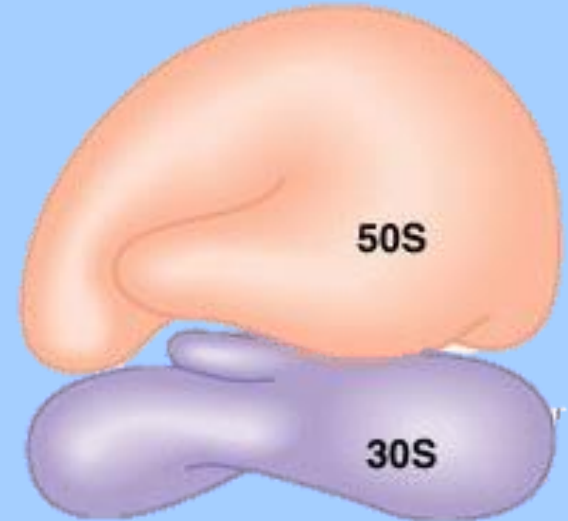
Bacterial ribosomes



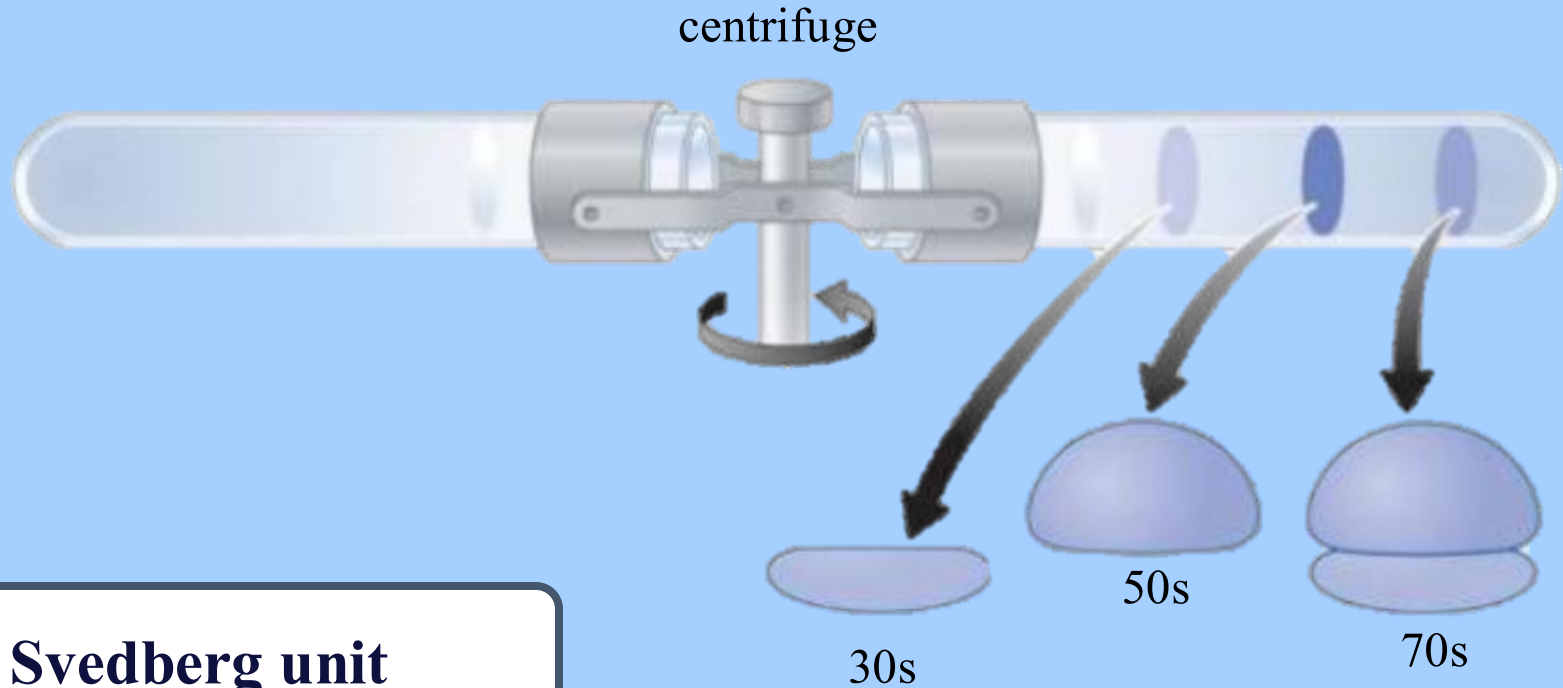
(70S)



Svedberg unit



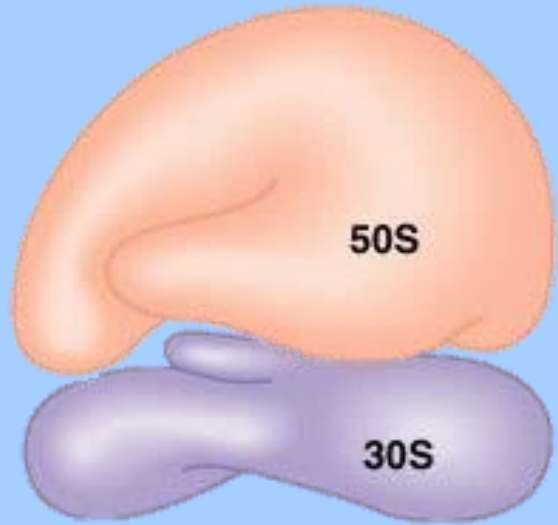
2) Ribosome



Svedberg unit

Ribosomal subunits

2) Ribosome



2) Ribosome



50S

60S

Target of antibiotics

Human



30S

40S

3) Inclusion granules

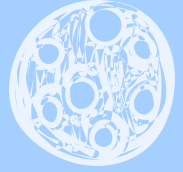
Store of nutrient

Glycogen

Starch

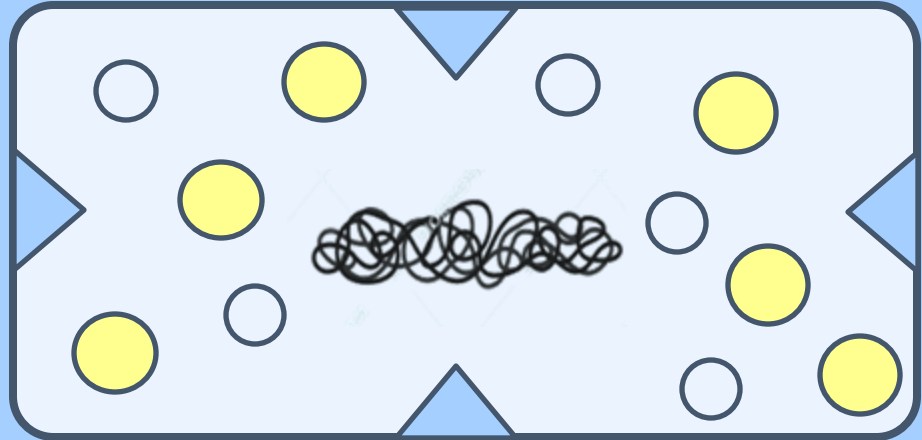
Phosphate

**Volutin granule
(Metachromatic
granules)**



Definition of the cell membrane

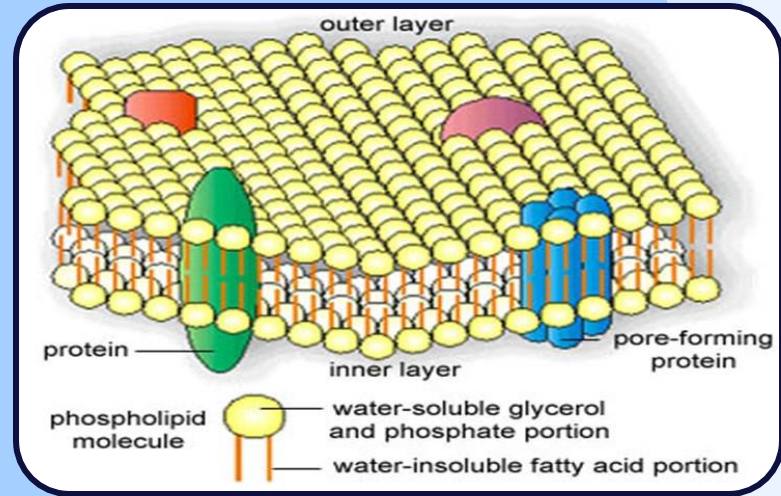
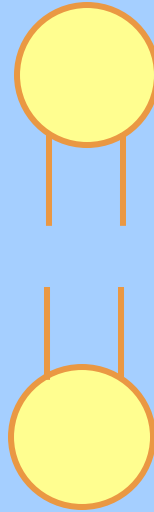
**Thin, fragile membrane
located just
inside the cell wall**



Essential

Composition of cell membrane

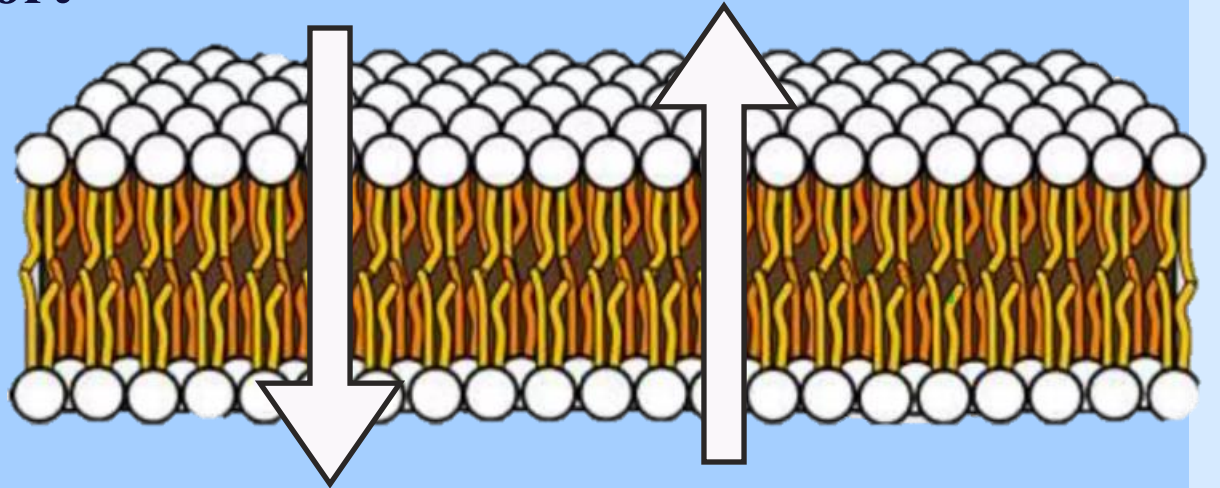
Phospholipid bilayer + Protein
(No sterols)



Function of the cell membrane

1

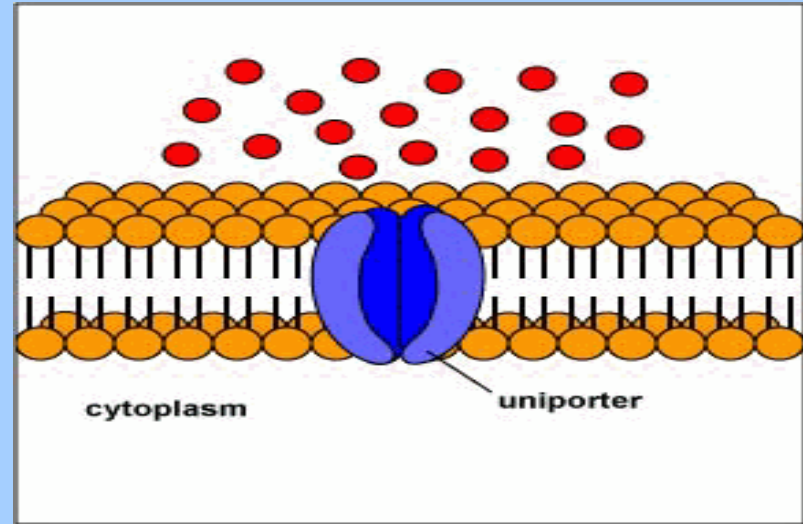
Selective transport
(Passive)



Function of the cell membrane

1

Selective transport (Active)



Function of the cell membrane

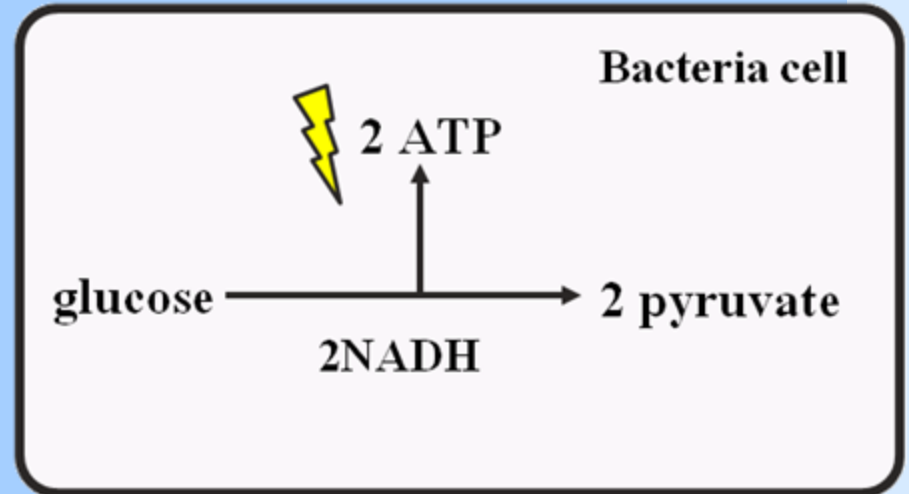
2

Mesosomes

Respiration enzyme

(Making energy)

(Like Mitochondria)



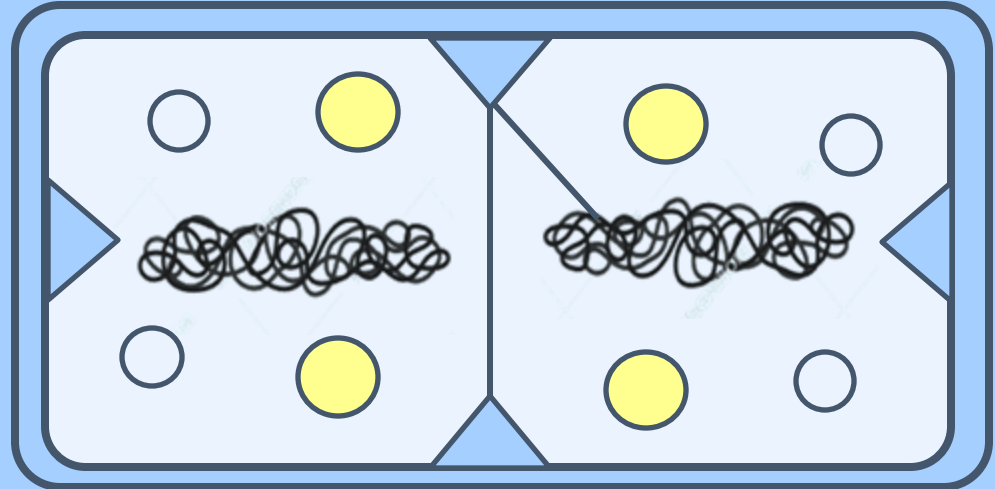
Function of the cell membrane

2

Cell division

Separate DNA

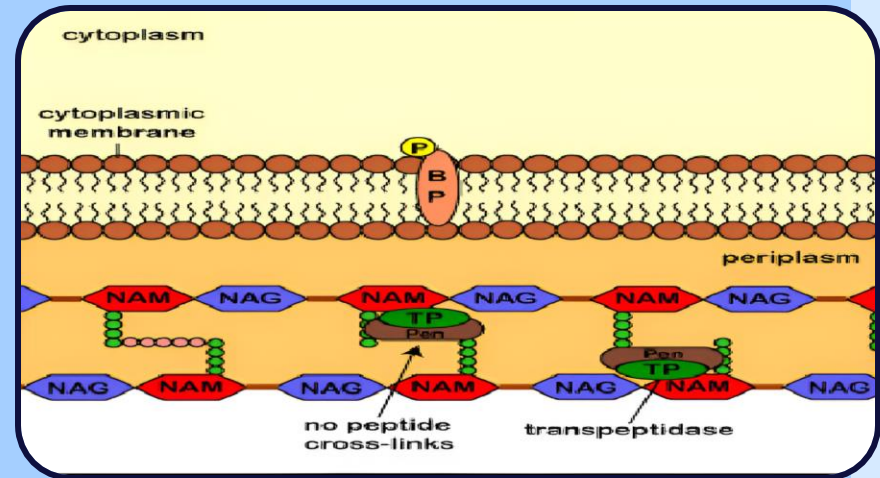
Septal mesosome



Function of the cell membrane

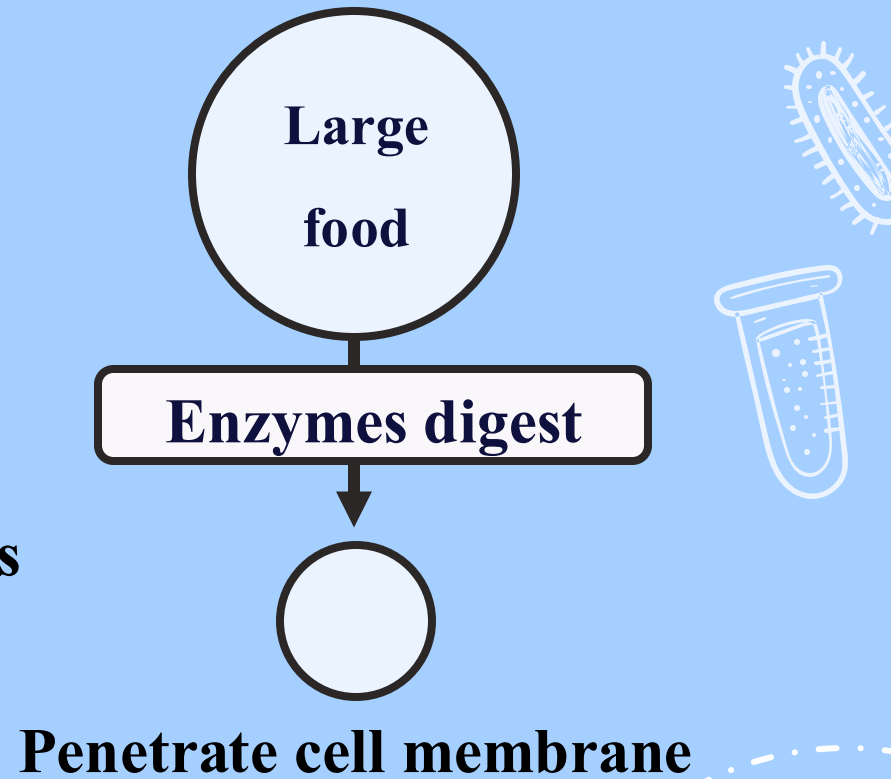
3

Biosynthesis of cell wall



4

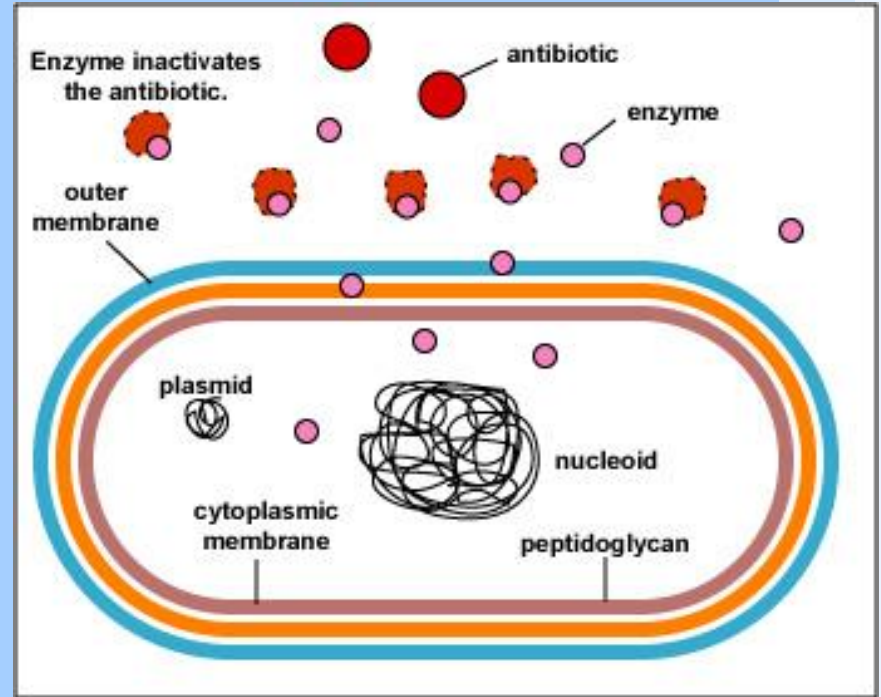
**Excretion of extracellular enzymes
(Hydrolytic enzymes)**



Function of the cell membrane

5

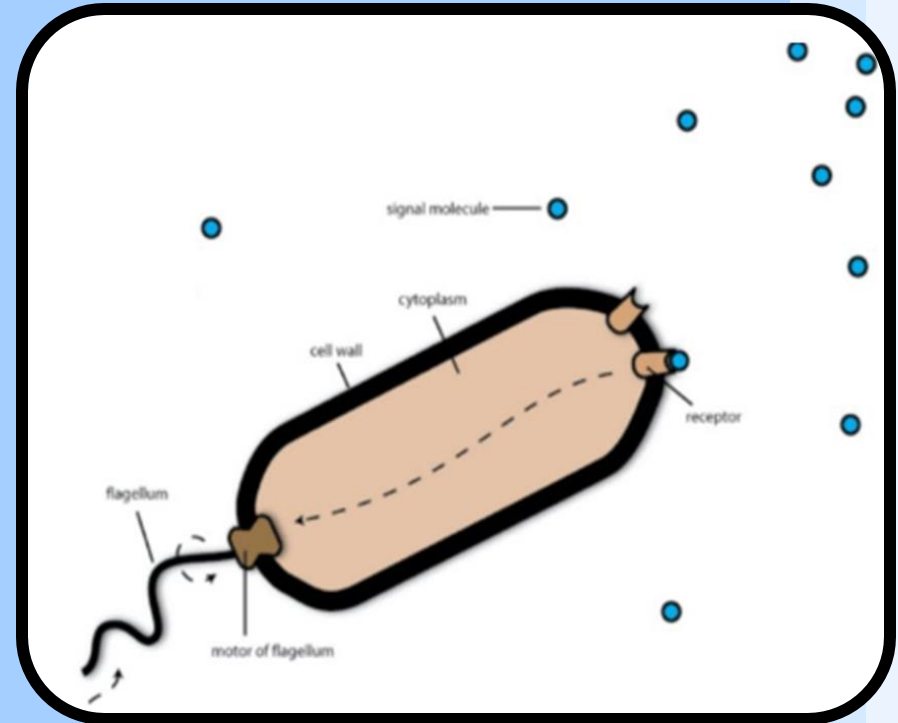
Excretion of extracellular enzymes (Penicillinase)



Function of the cell membrane

6

Chemotactic system



Plasmid

EXTRA chromosomal dsDNA

1 Replicate autonomously (Independent of bacterial chromosome)

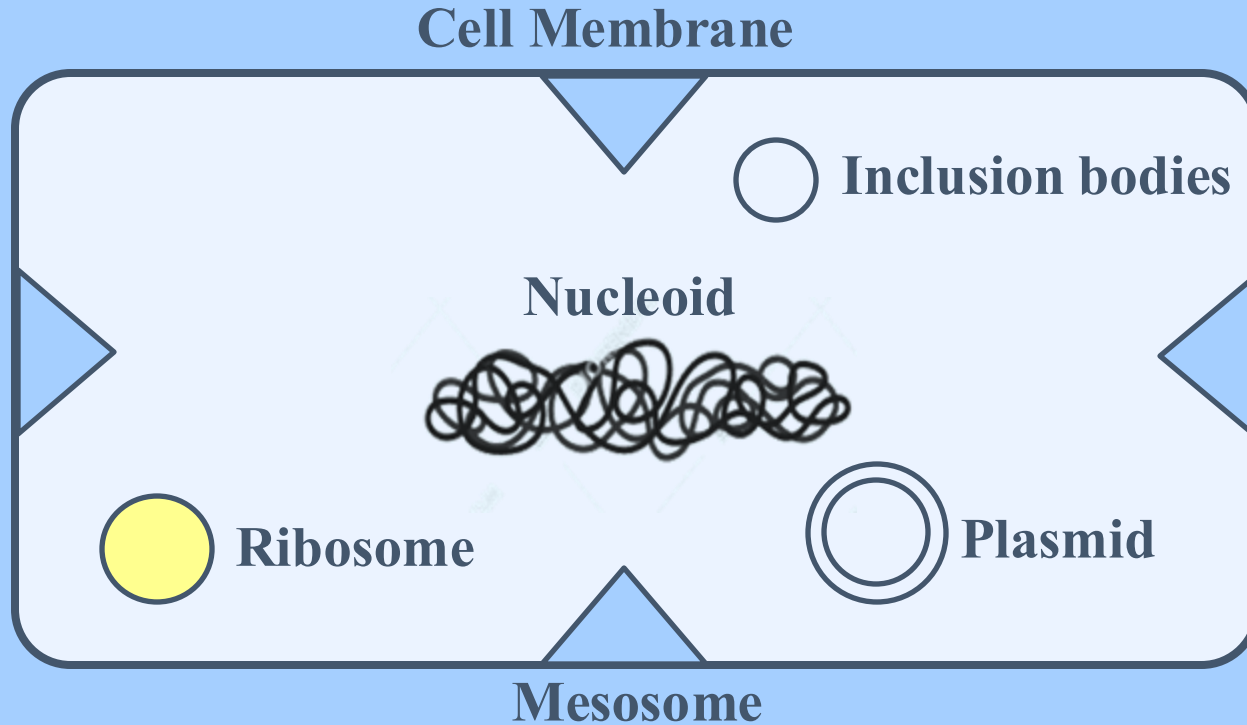
2 Toxin production Drug resistance

Not essential



Plasmid

Intracytoplasmic structure



Objectives

Cell wall

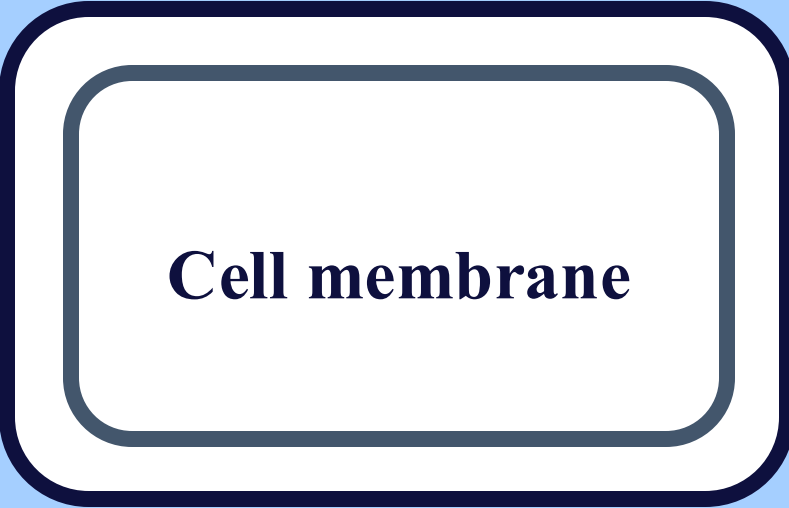
- 1) Definition
- 2) Composition
- 3) Synthesis
- 4) Function
- 5) Cell wall Deficient

Definition of cell wall

Outermost layer!!!

Surrounds the cell membrane

Rigid



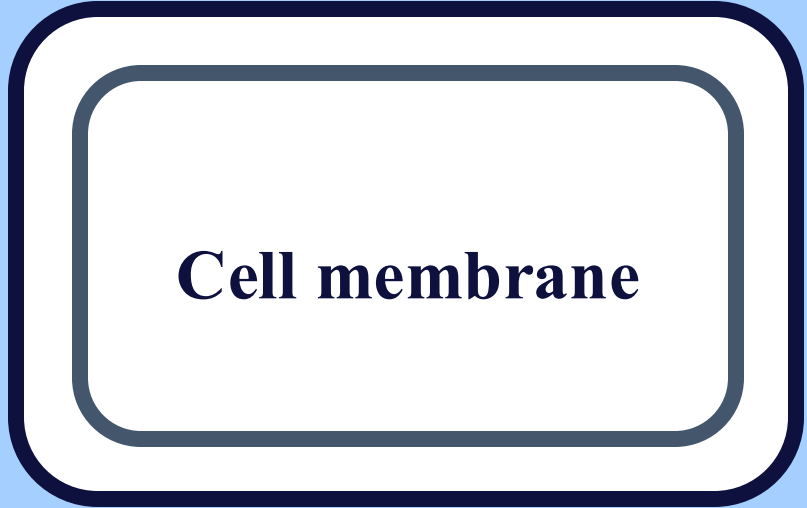
The diagram illustrates the structure of a cell. It features a large, light blue rounded rectangle representing the cell wall. Inside this rectangle is a smaller, white rounded rectangle representing the cell membrane. The text 'Cell membrane' is written in bold, dark blue font inside the white rectangle. In the top left corner of the slide, there are decorative dashed white lines forming a partial arc.

Cell membrane



Composition of cell wall

**Rigidity
(Peptidoglycan)**



Cell membrane

Composition

N-acetylmuramic acid

Glycans

NAM

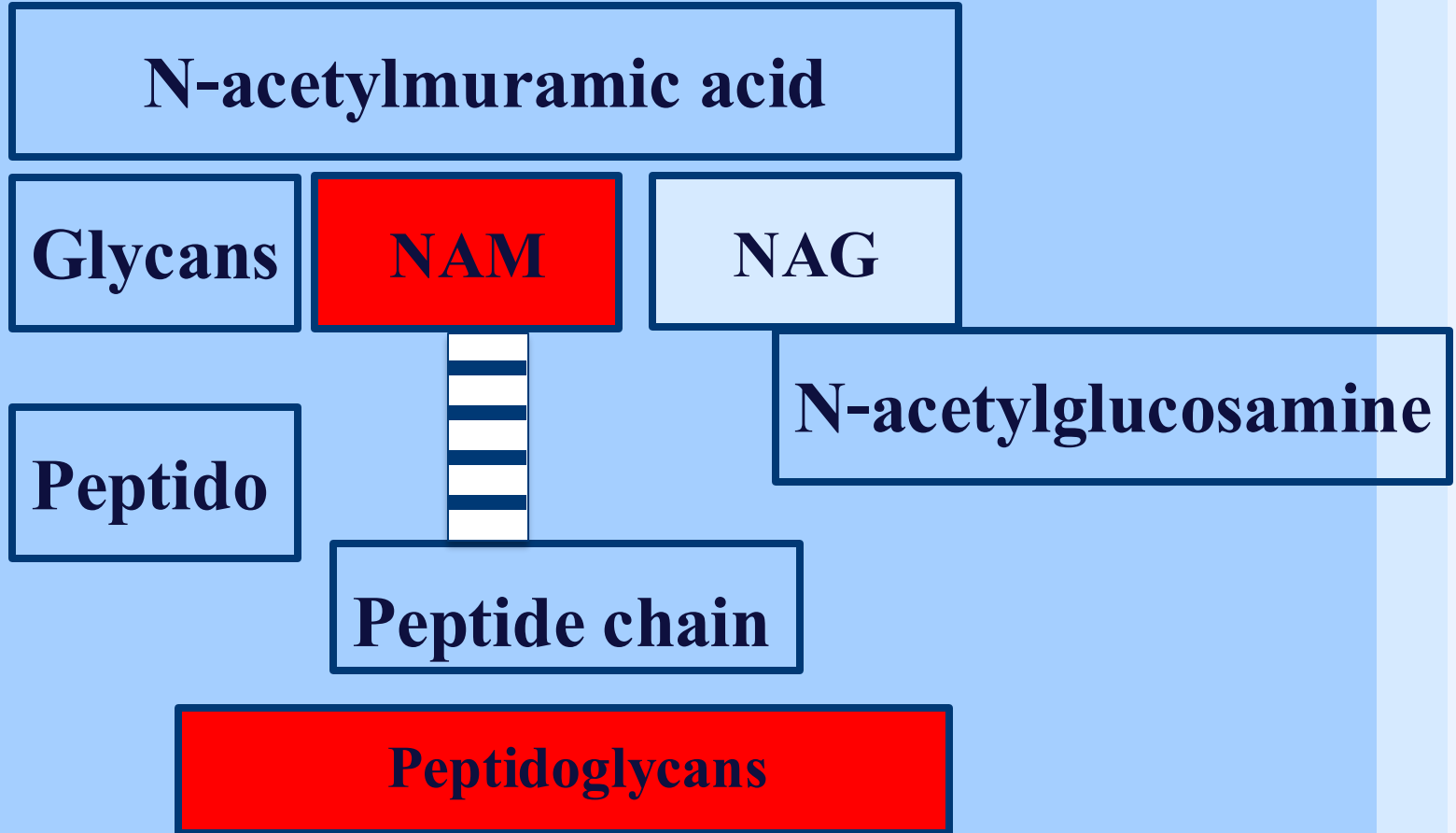
NAG

N-acetylglucosamine

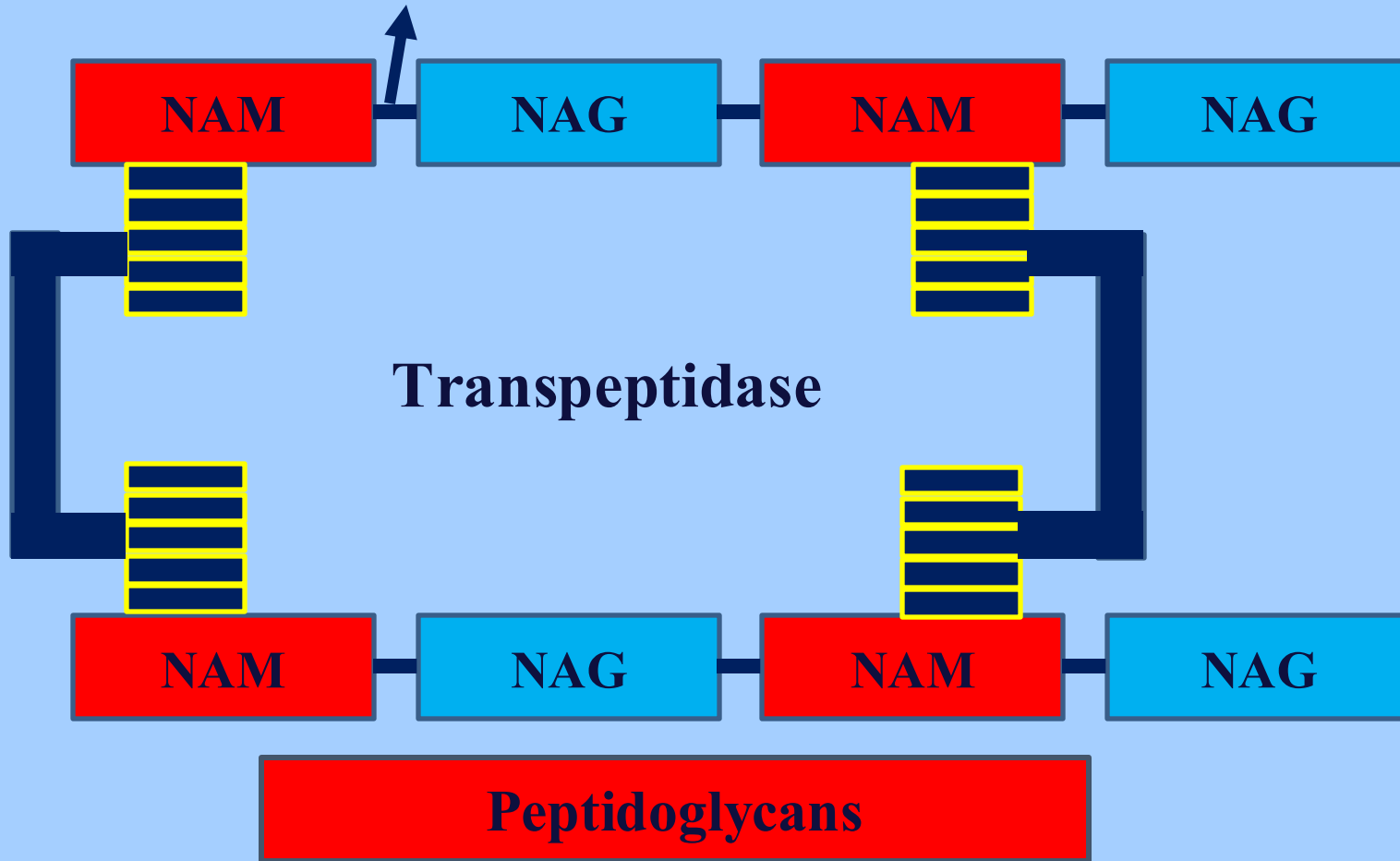
Peptido

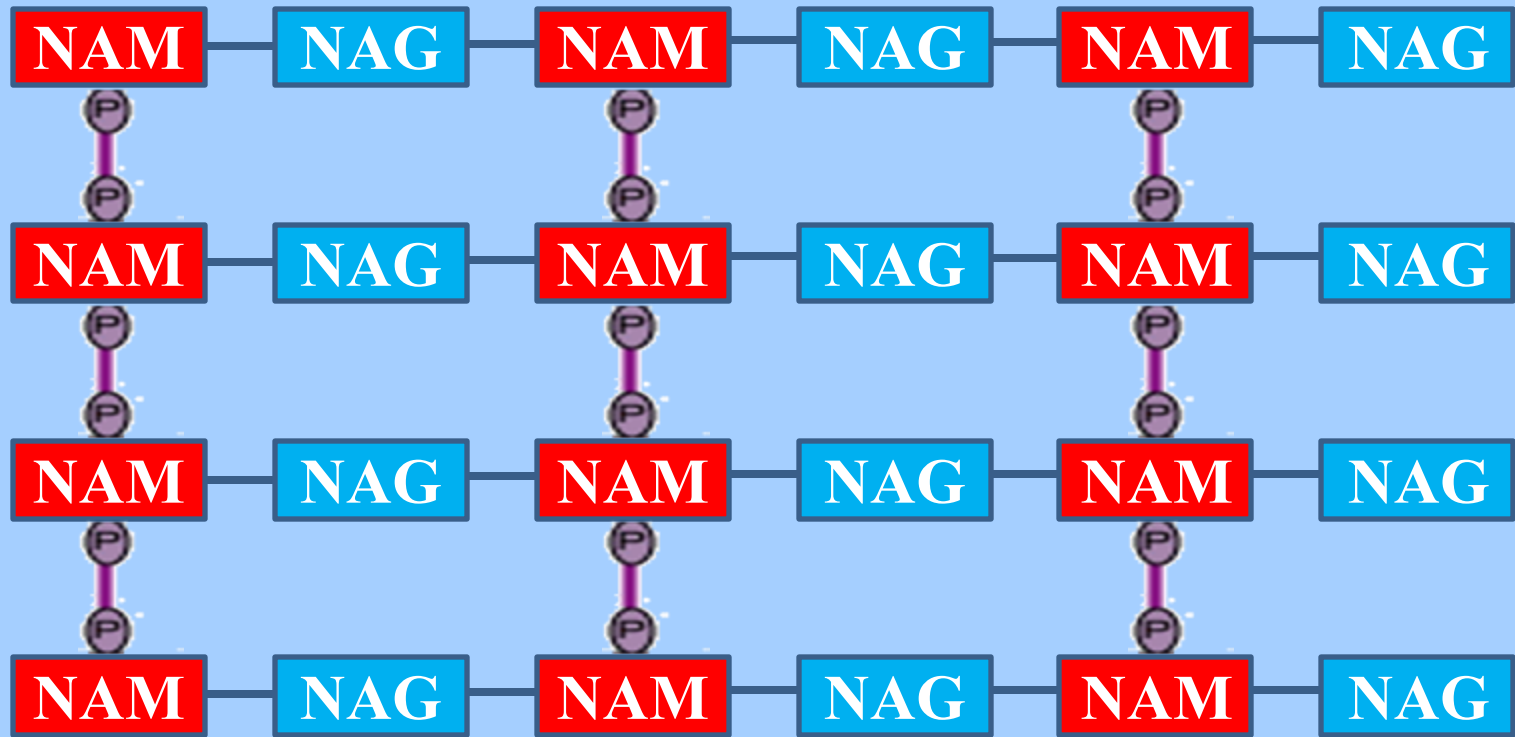
Peptide chain

Peptidoglycans

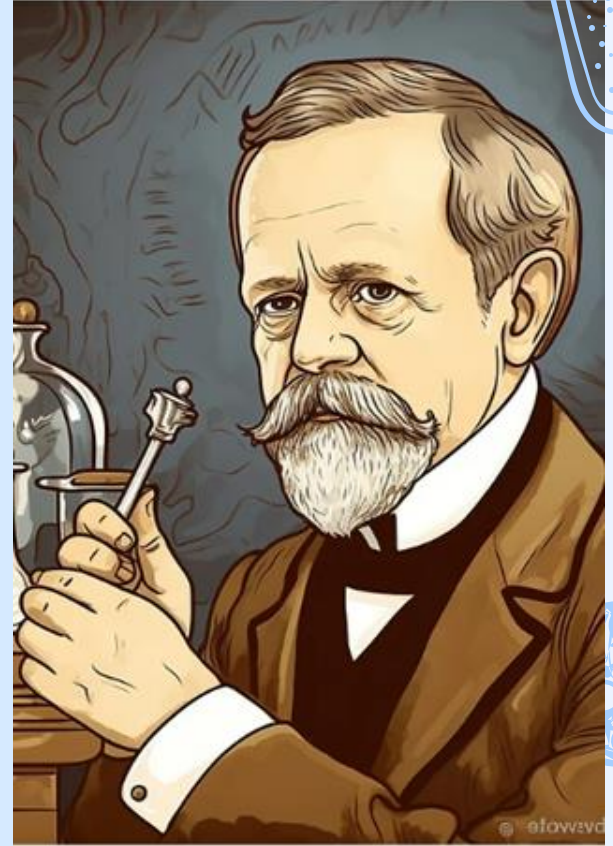
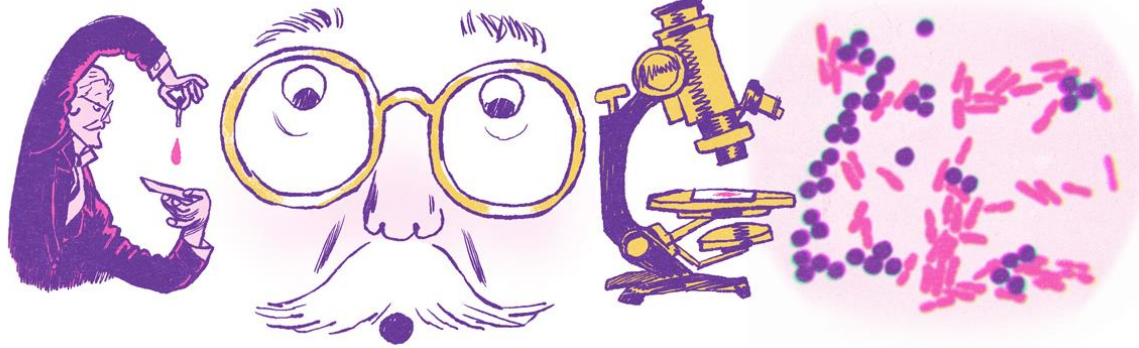


Glycosidic bond (Transglycosidase) Alternating repeating unit





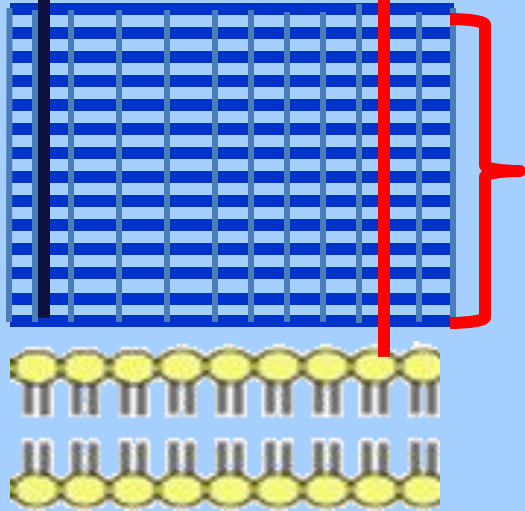
Gram scientist



Gram positive/negative bacteria

Teichoic acid

Lipoteichoic acid

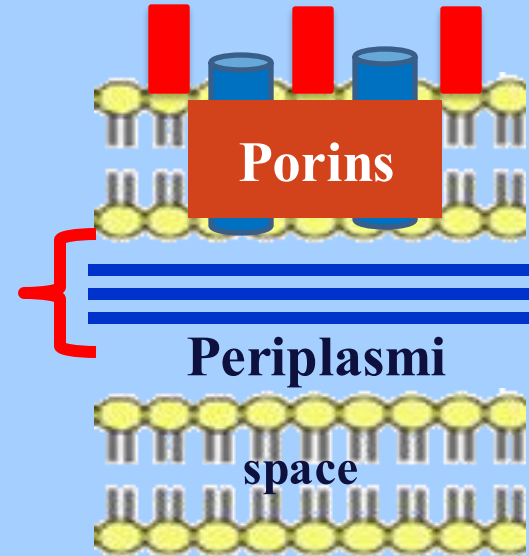


Peptidoglycan

G+ve

Outer membrane

(Lipopolysaccharides)



Porins

Periplasmic

space

G-ve

Gram positive bacteria

1) Peptidoglycan

(50%)

NAM-NAG

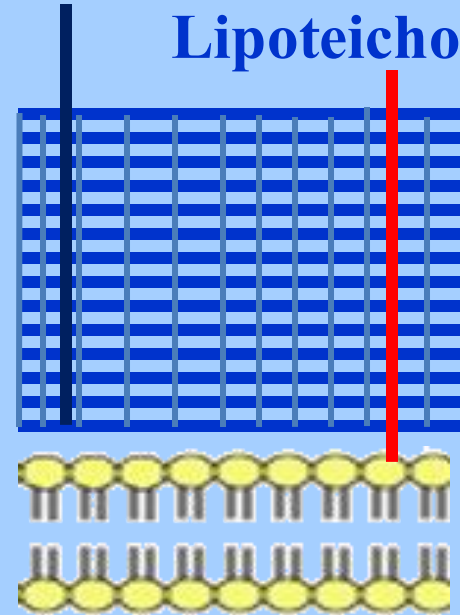


Peptide

Porous

Teichoic acid

Lipoteichoic acid



G+ve

Composition of Gram positive

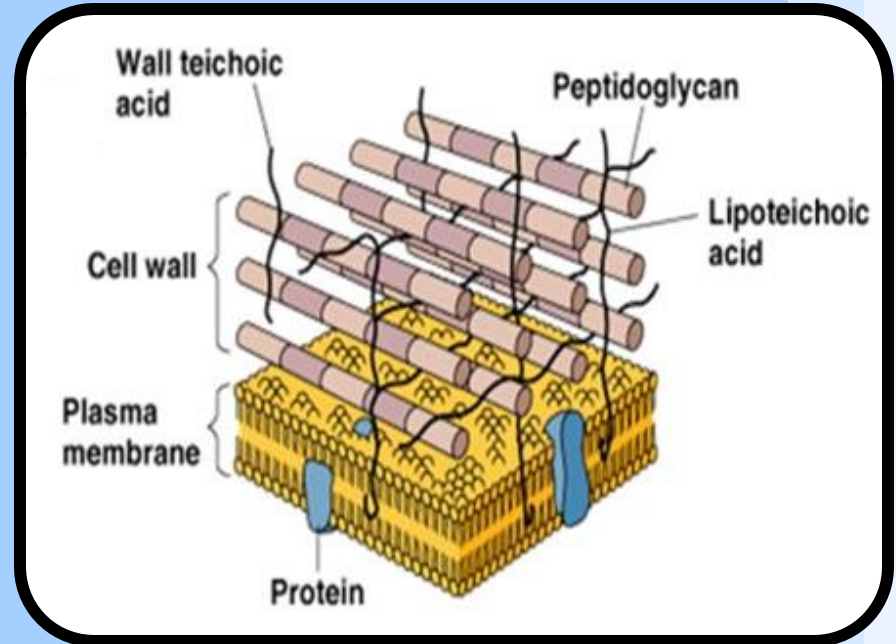
Polymers of glycerol or

Rbitol

Lipoteichoic acid
(Cell membrane)

Teichoic acid
(Cell wall)

2) Teichoic acid



Composition of Gram positive

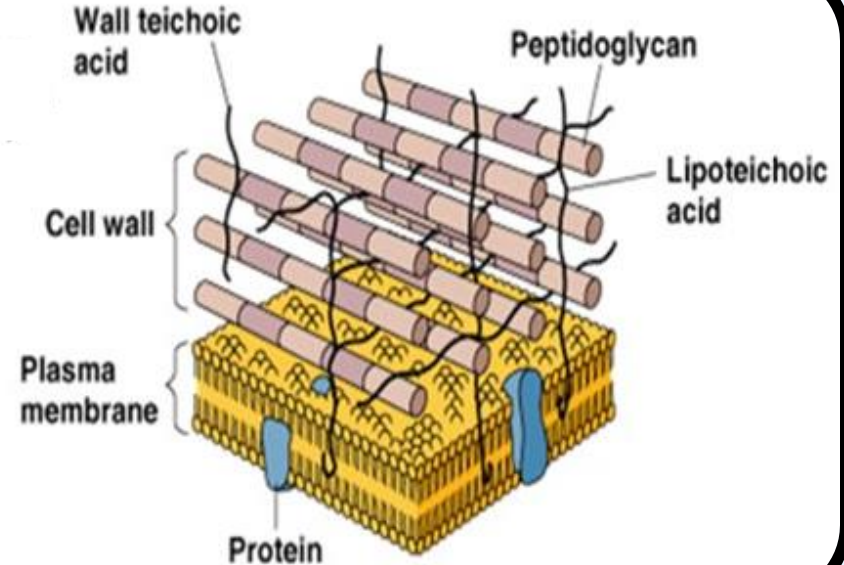
Major surface Ag of G+ve

Highly
immunogenic

TNF- α

IL-1

2) Teichoic acid



Composition of Gram positive

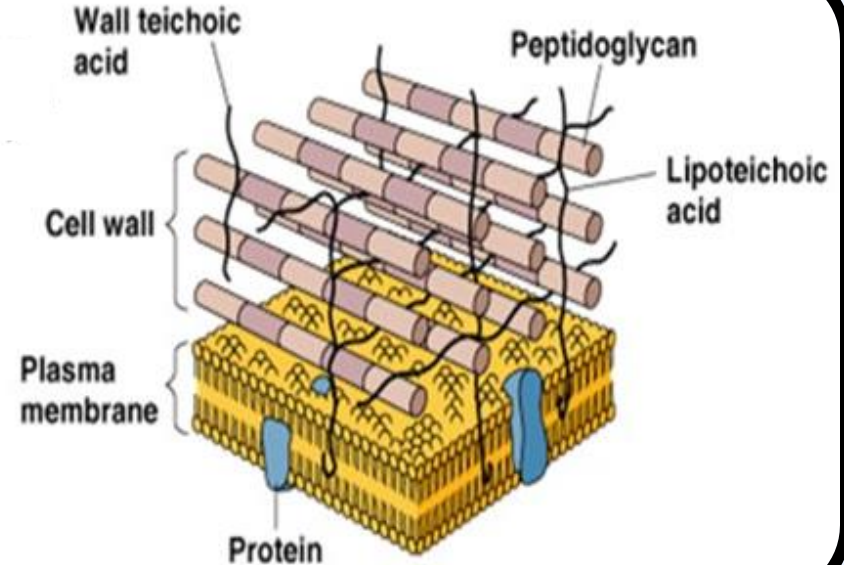
Major surface Ag of G+ve

Highly
immunogenic

TNF- α

IL-1

2) Teichoic acid



Composition of Gram Negative

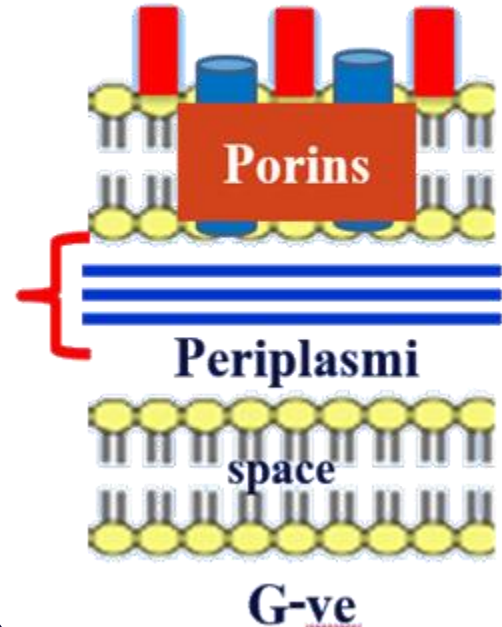
1) Peptidoglycan

A thin layer (5%)

2 sheets of
(NAM & NAG)

Peptides

Outer membrane
(Lipopolysaccharides)



Outer membrane

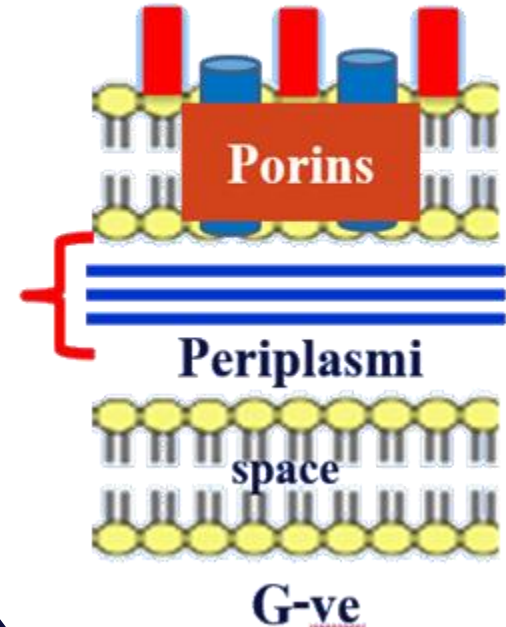
A) Bilayer phospholipids

B) Lipopolysaccharides

Lipid A
(Endotoxin)

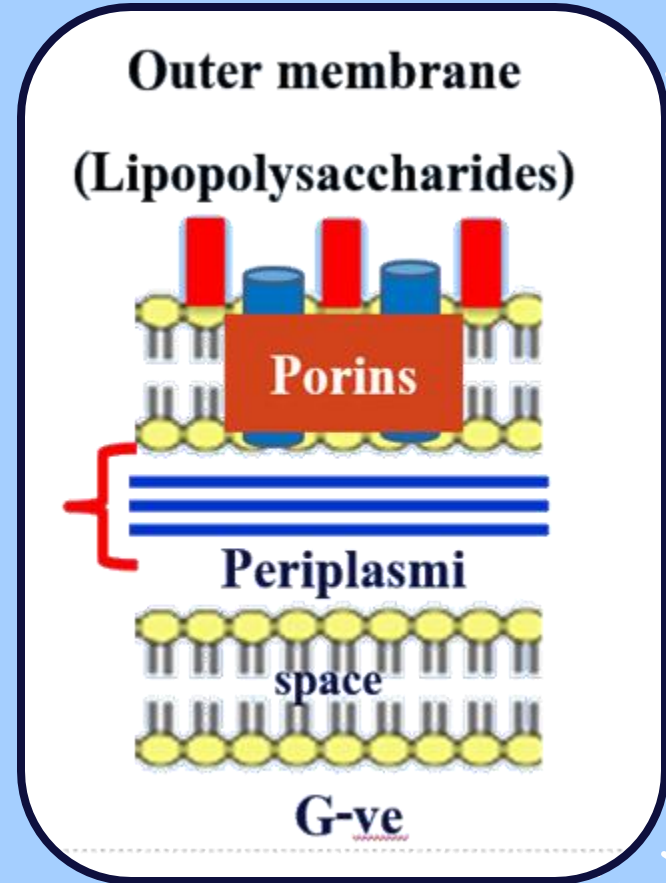
Polysaccharides
(somatic O Ag)

Outer membrane
(Lipopolysaccharides)



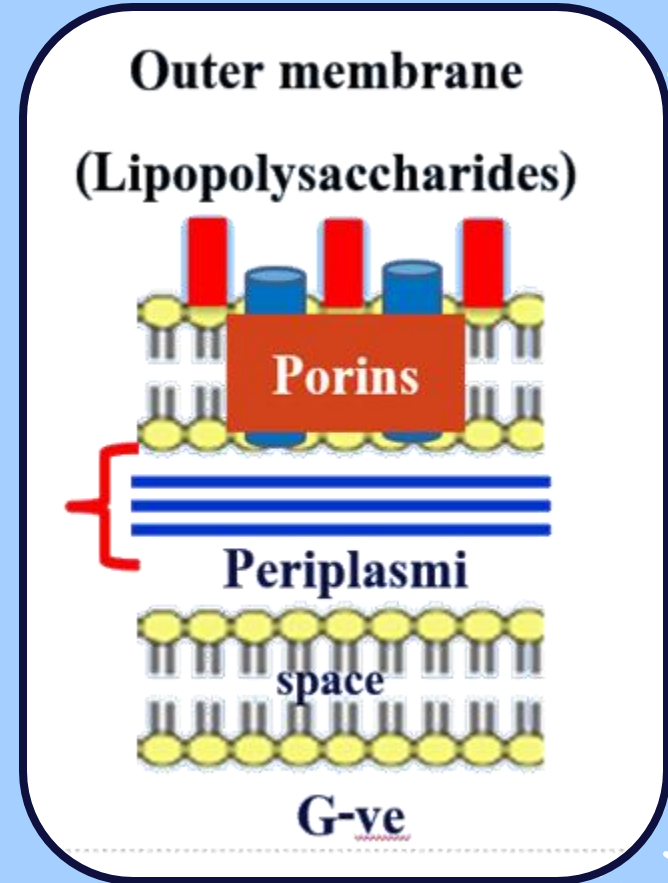
Outer membrane

C) Porins
(hydrophilic Protein)
in the outer membrane
(Transportation)

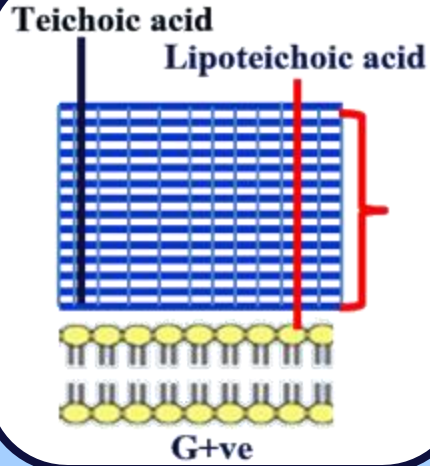


Periplasmic space

Space between cytoplasmic &
outer membrane
Peptidoglycan layer &
gel-like protein



Gram positive/Negative bacteria



1) Peptidoglycan

Thick

2) Teichoic acid/

Lipoteichoic acid

Yes

3) Outer membrane

No

1) Peptidoglycan

Thin

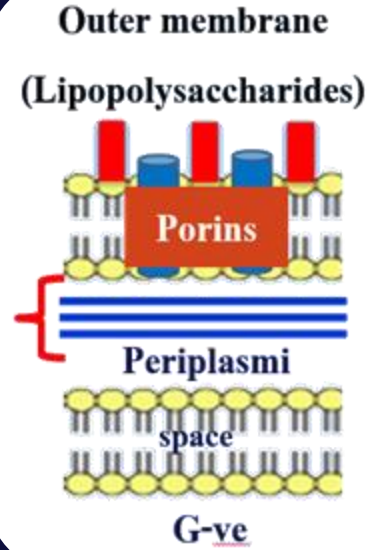
2) Teichoic acid/

Lipoteichoic acid

No

3) Outer membrane

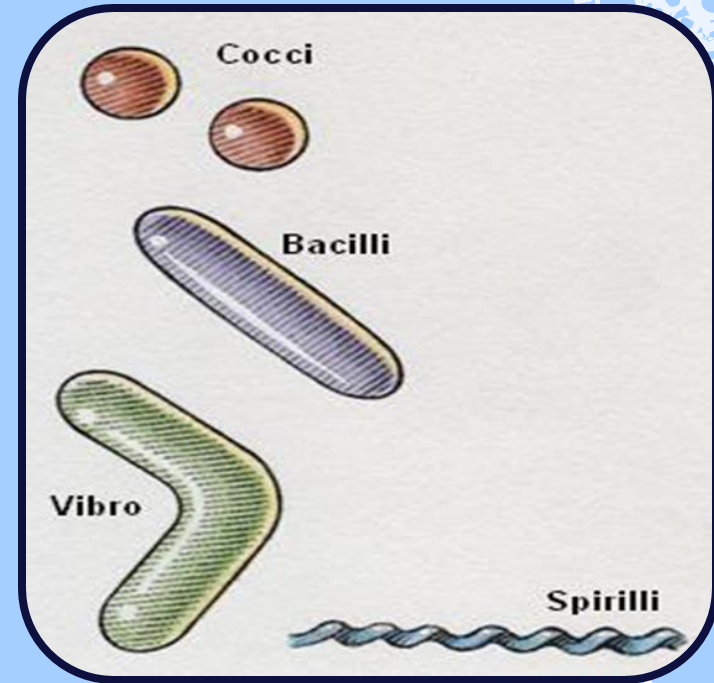
Yes



Function of cell wall

1

**Maintenance of the
shape (Rigid)**

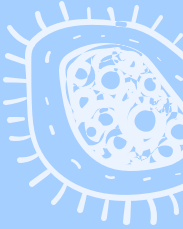


Function of cell wall

1

Deficient of cell wall

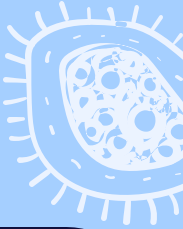
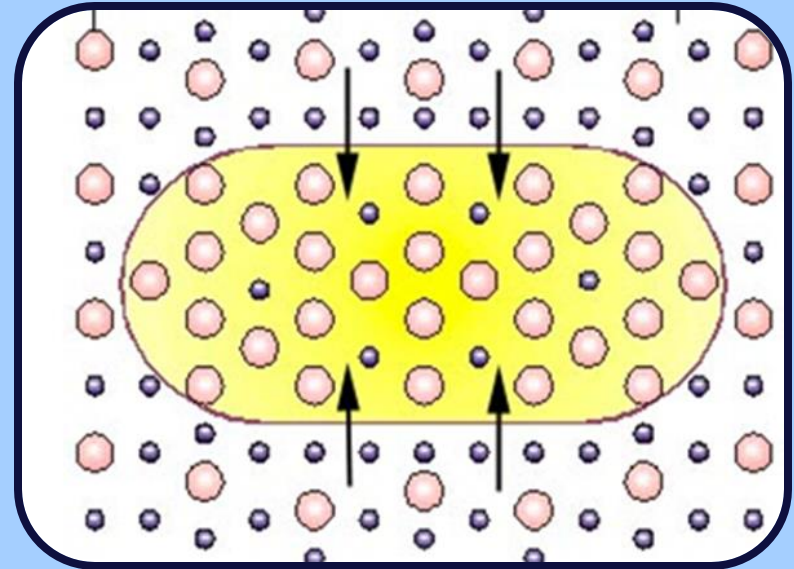
Polymorphic



Function of cell wall

2

Protection
(Osmosis insensitive)



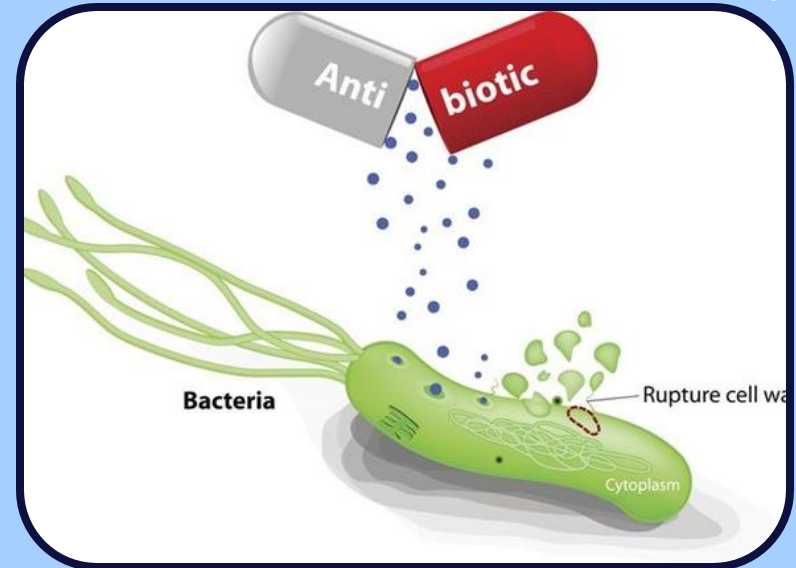
Function of cell wall

3

Target site for antibiotics

Penicillin

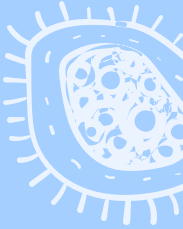
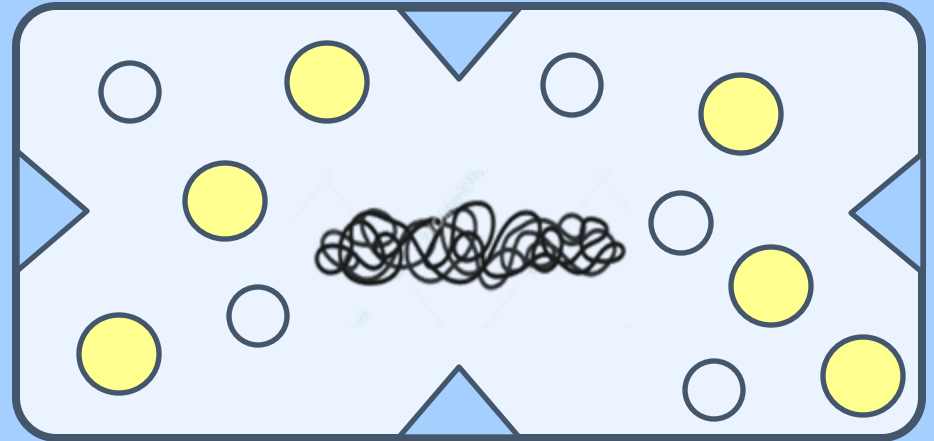
Cephalosporines



Function of cell wall

4

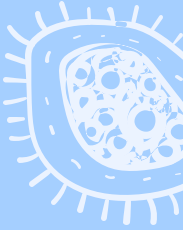
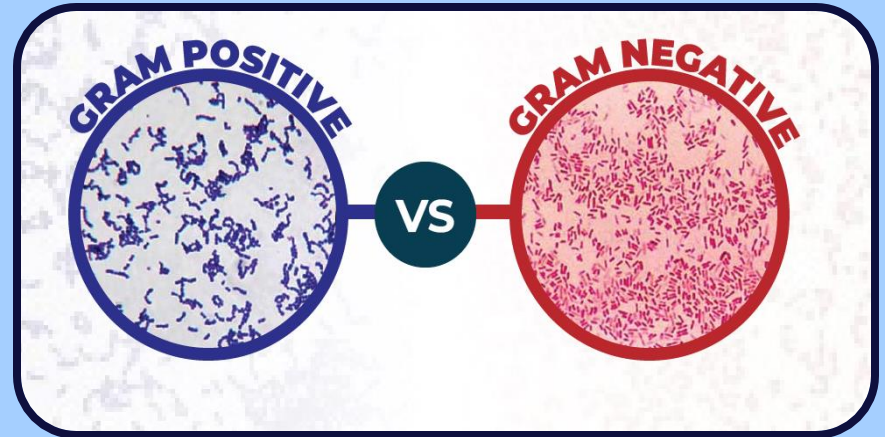
Role in cell division



Function of cell wall

5

Responsible
for staining



Function of cell wall

Responsible for staining

G+ve



Fixation



G-ve



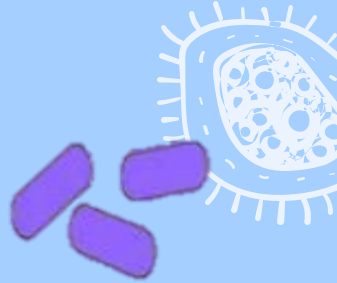
Crystal
violet



Iodine



Acetone

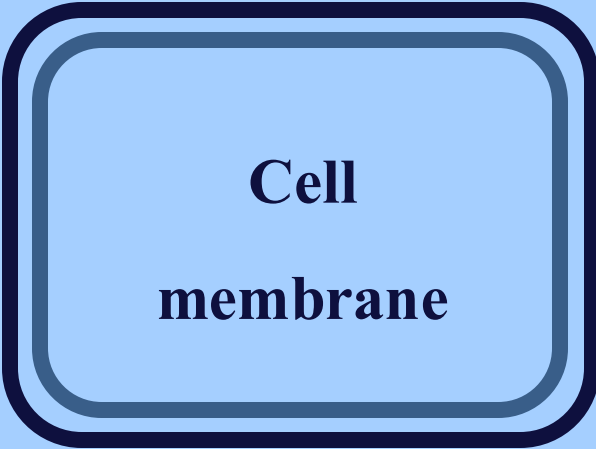


Counter
stain



Cell wall Deficient

**Bacteria without cell
wall**



**Cell
membrane**

The diagram shows a bacterium with a cell wall deficiency. It is represented by a rounded rectangle with a thick, dark blue border. Inside this border is a lighter blue rounded rectangle. The text 'Cell membrane' is centered within the lighter blue area. To the right of the main diagram is a small, stylized illustration of a bacterium with a cell wall, showing internal organelles and a fuzzy outer surface. At the bottom right, there are some faint, dashed white lines.

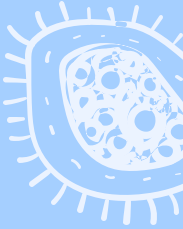
Cell wall Deficient

1) Naturally

**Mycoplasma
(Sterol)**

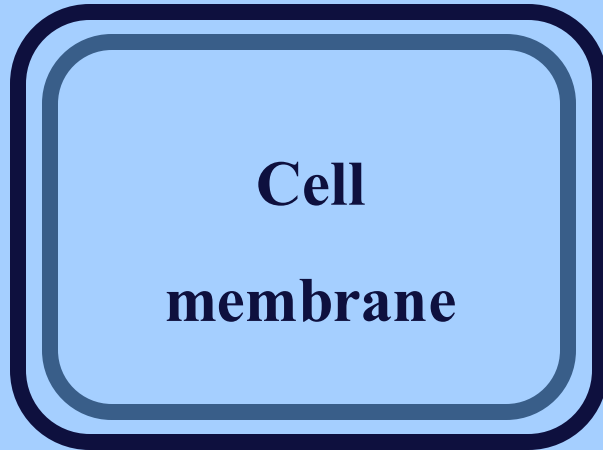
2) Induced

**Cell wall inhibitors
Lysozyme**



2) Induced

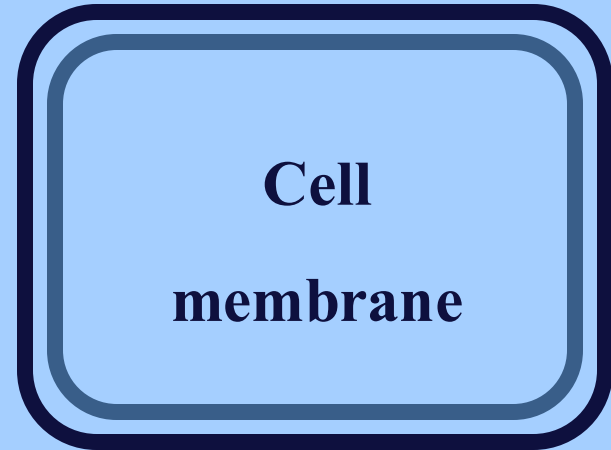
Completely



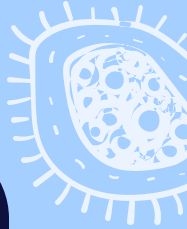
Protoplast (+ve)

Spheroplast (-ve)

Partially

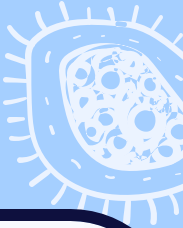


L-form bacteria



L-form & Mycoplasma

**Resist to Penicillin &
Cephalosporines**



Objectives

Structures outside the cell wall

1) Capsule

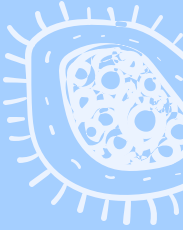
2) Flagella

3) Pili

4) Spore formation

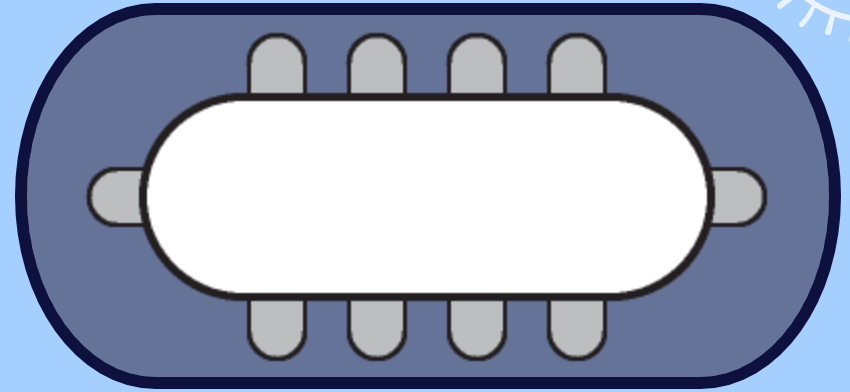
Capsule - Definition

Glyco **calyx**
↓ ↓
carbohydrate **enveloped**



Capsule - Definition

**Gelatinous (Viscous) layer
covering cell wall of some
bacteria**

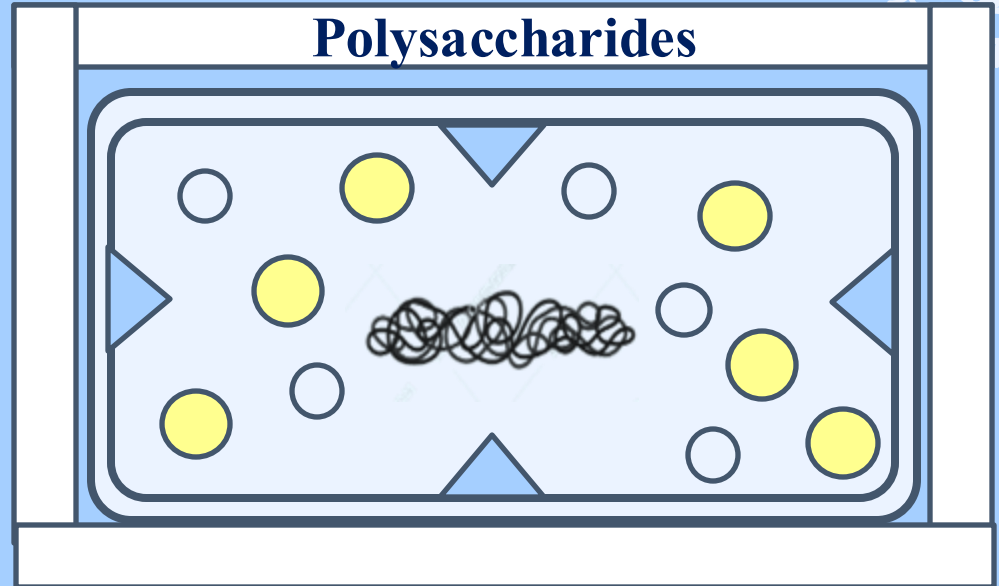


Extra layer

Capsule - Composition

Usually Polysaccharides

Polypeptides
(*B. anthracis*)



Capsule - Composition

Variation of Capsule

**(Arrangement of
Polysaccharides)**

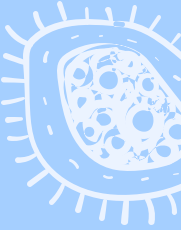
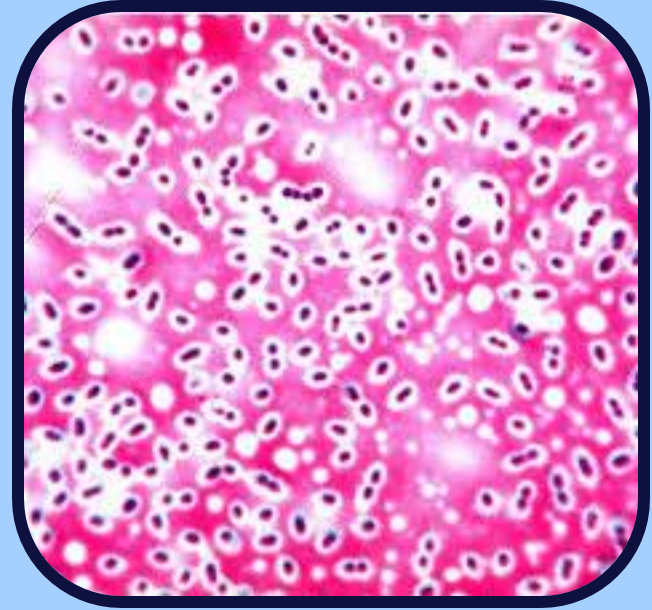
Sucrose	Mannose	Lactose
Mannose	Sucrose	Mannose
Lactose	Sucrose	Mannose

e.g. 91 types of

Str. pneumoniae

Capsule - Composition

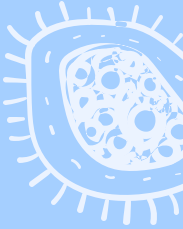
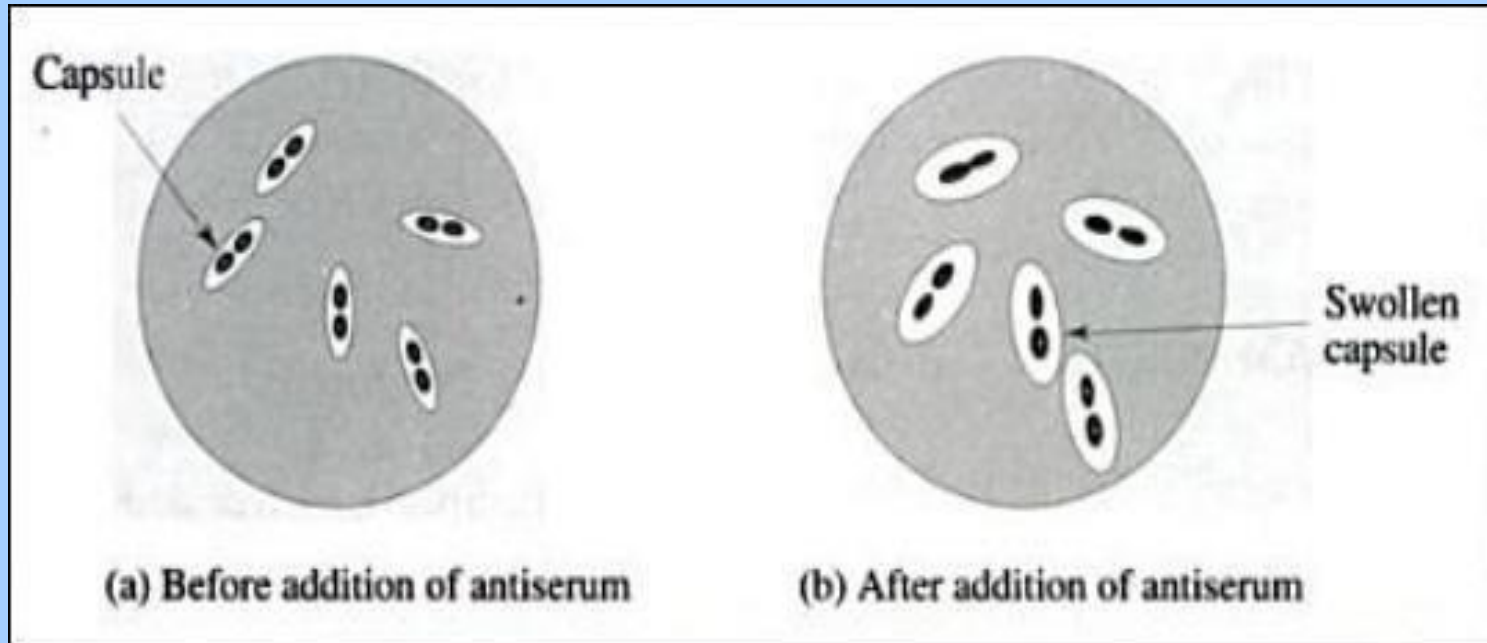
**Do Not stained by
Gram stain**



**Unstained halo around the
organism**

Capsule - Composition

Quellung reaction (swelling)



Capsule - Composition

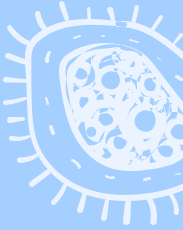
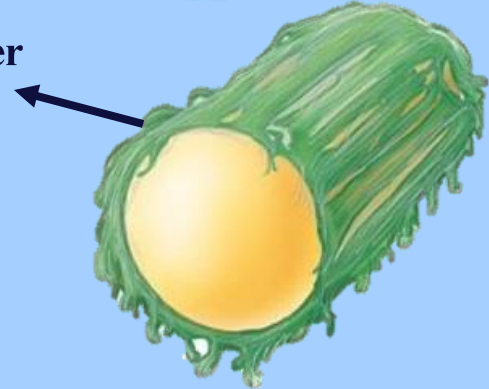
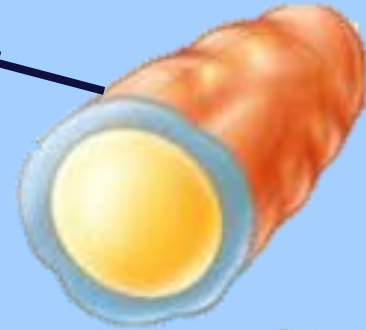
Capsule

Glycocalyx

Slime layer

Capsule

Slime layer

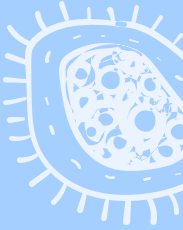


Capsule - Composition

Capsule

**Tightly, organized bound
around all cell wall**

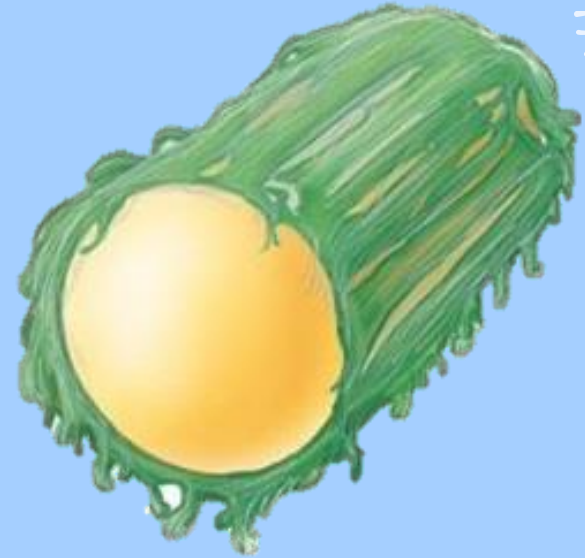
**Firmly adherence to
surface organism**



Capsule - Composition

Glycocalyx
(Slime layer)

Loosely & unorganized attached



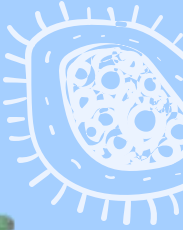
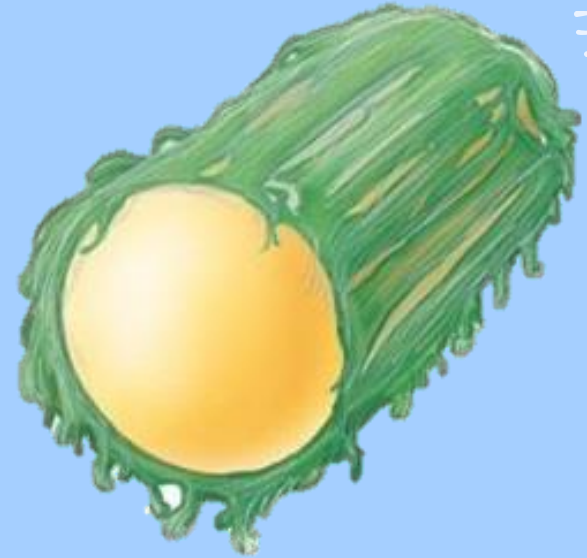
Capsule - Composition

Glycocalyx

Fibrils extending

It adhere firmly to skin, heart, etc

e.g. *Strept. mutans*



Loosely & unorganized attached

Capsule - Function

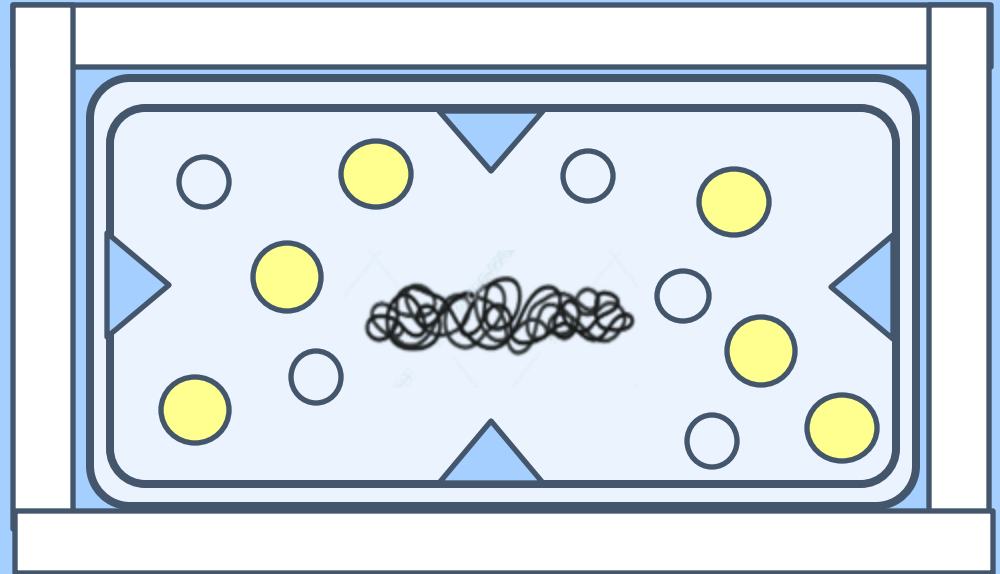
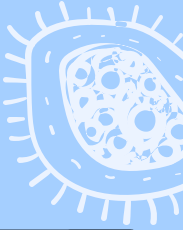
A

Protect Cell wall

Bacteriophage

Complement

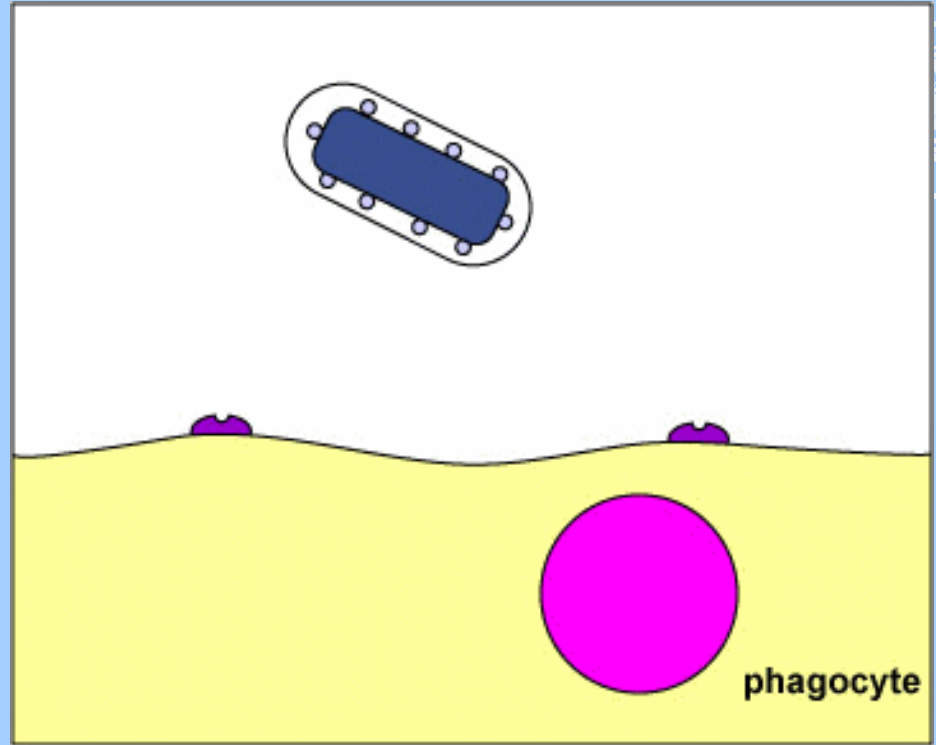
lysozyme



Capsule - Function

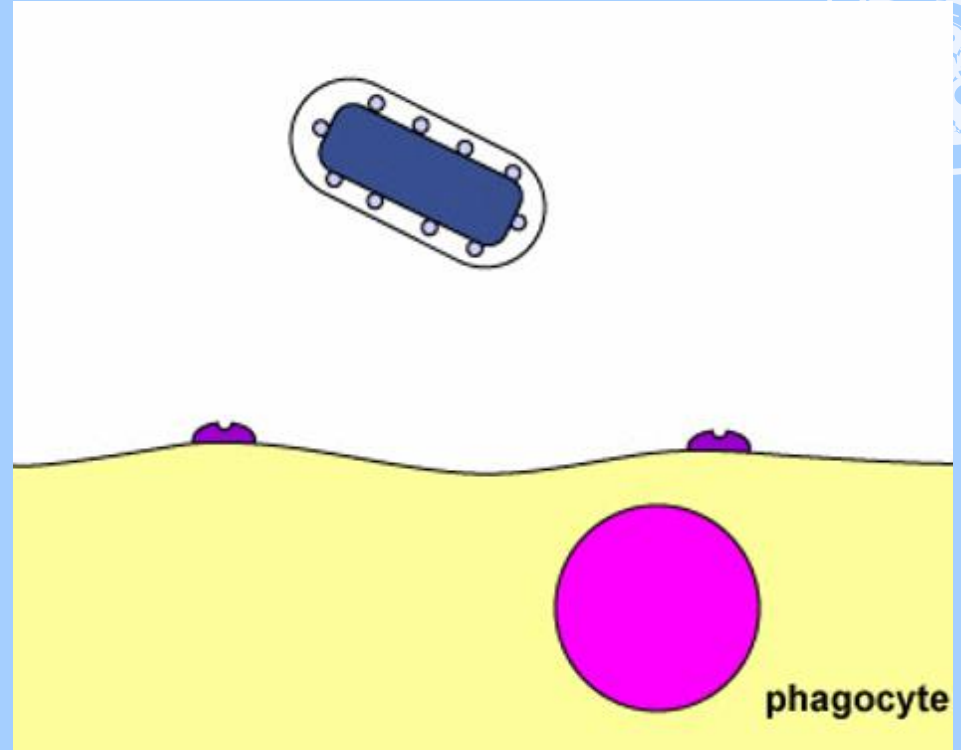
B

**Prevent phagocytosis
(Virulence)**



Capsule - Function

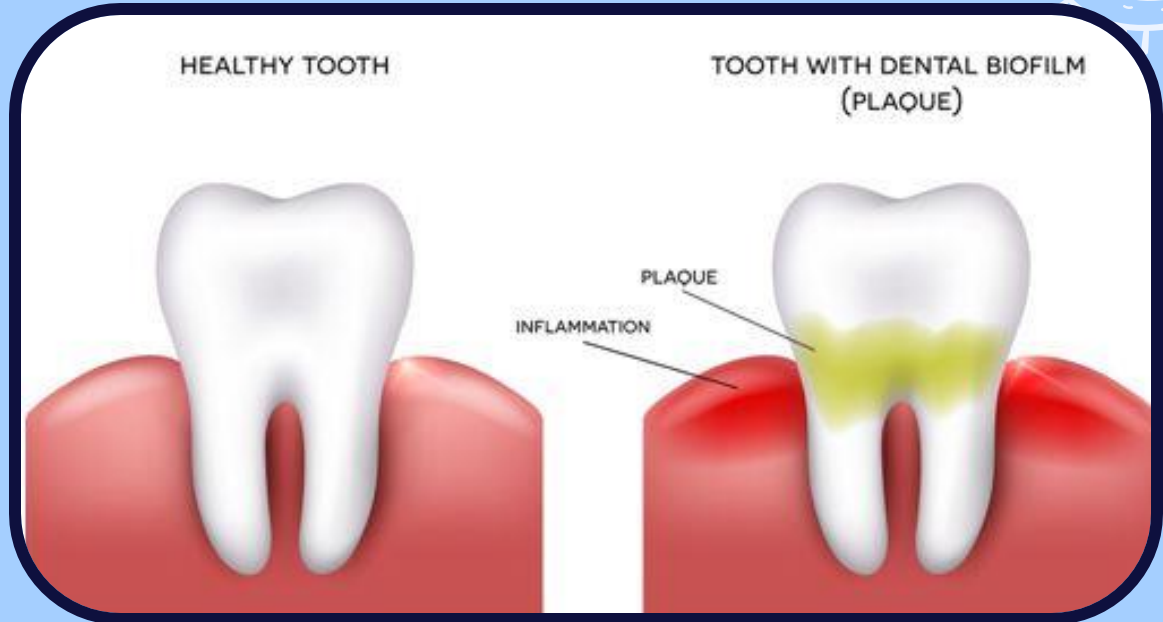
**Capsules are formed
in VIVO ONLY**



Capsule - Function



Attachment
(Glycocalyx)
Dental caries



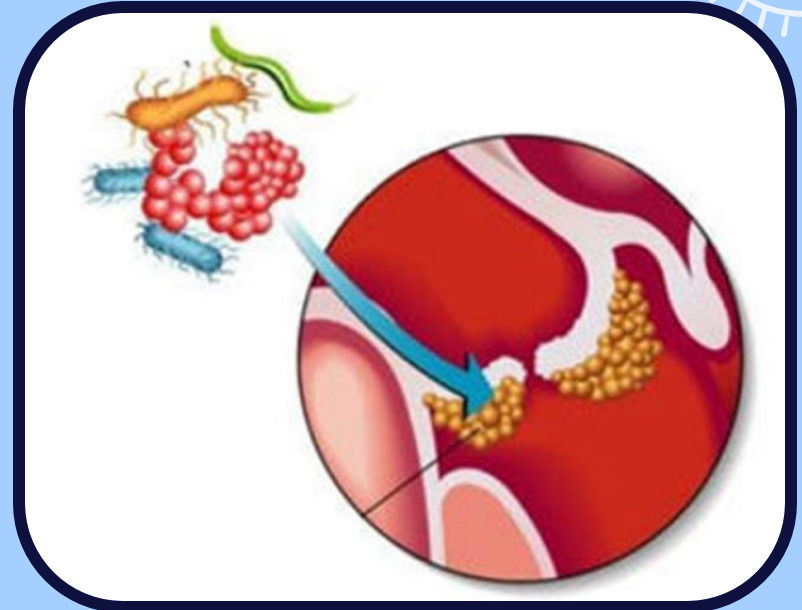
Capsule - Function



**Attachment
(Glycocalyx)**



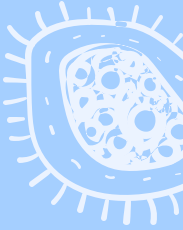
**Prosthetic heart
valves**



Capsule - Function

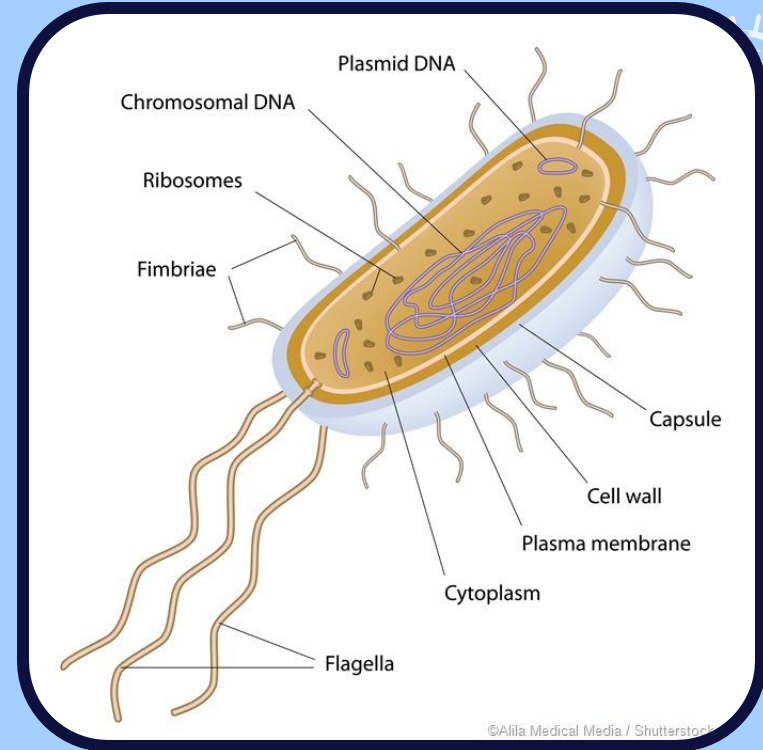
D

Development of vaccine



Flagella - Definition

**Long thick threads like (filamentous),
formed from protein (flagellin)
(H Ag)**



Flagella - Definition

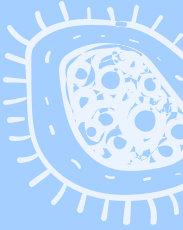
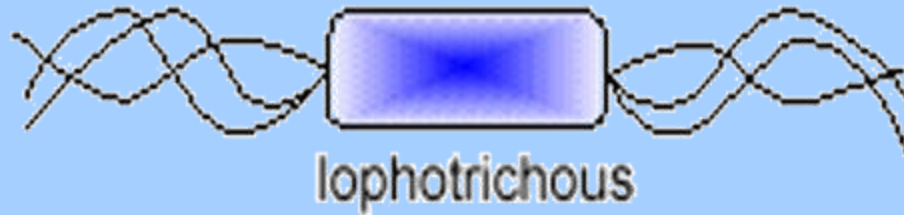
Seen by EM
(20nm)



Flagella - Definition

Polar

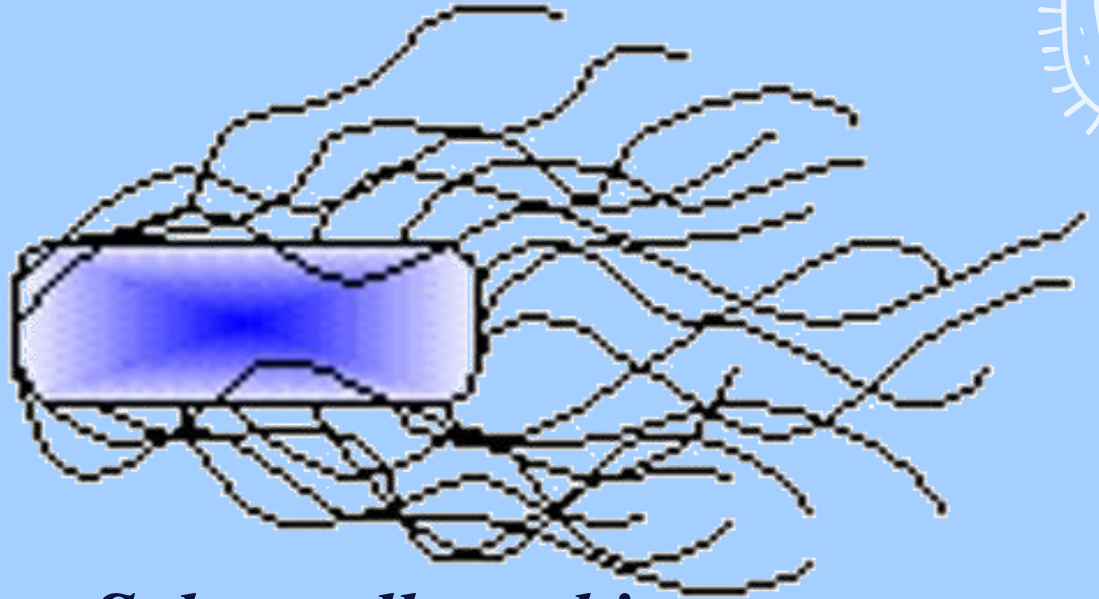
Spiral



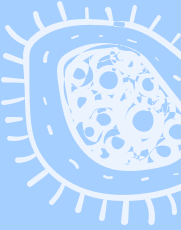
Flagella - Definition

Peri/trichous

around
peritrichous

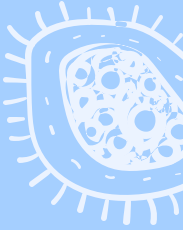
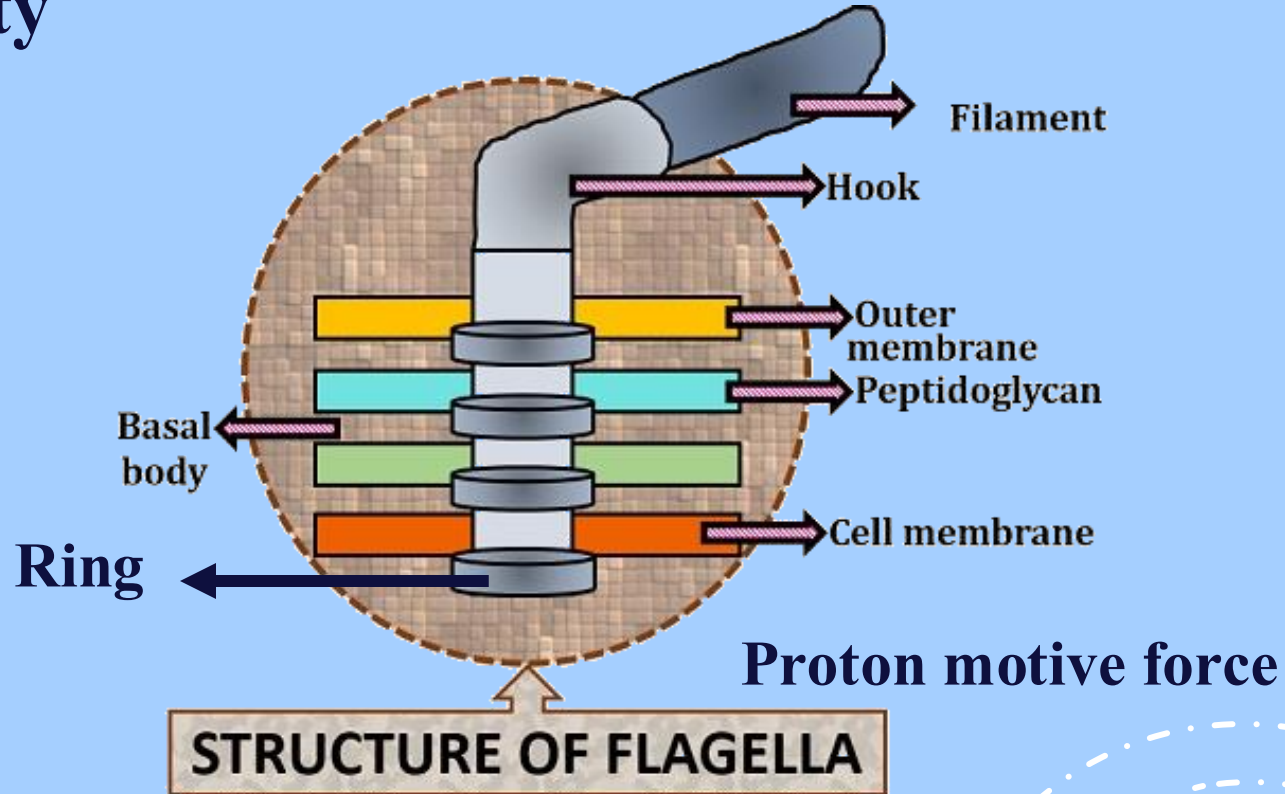


Salmonella typhi



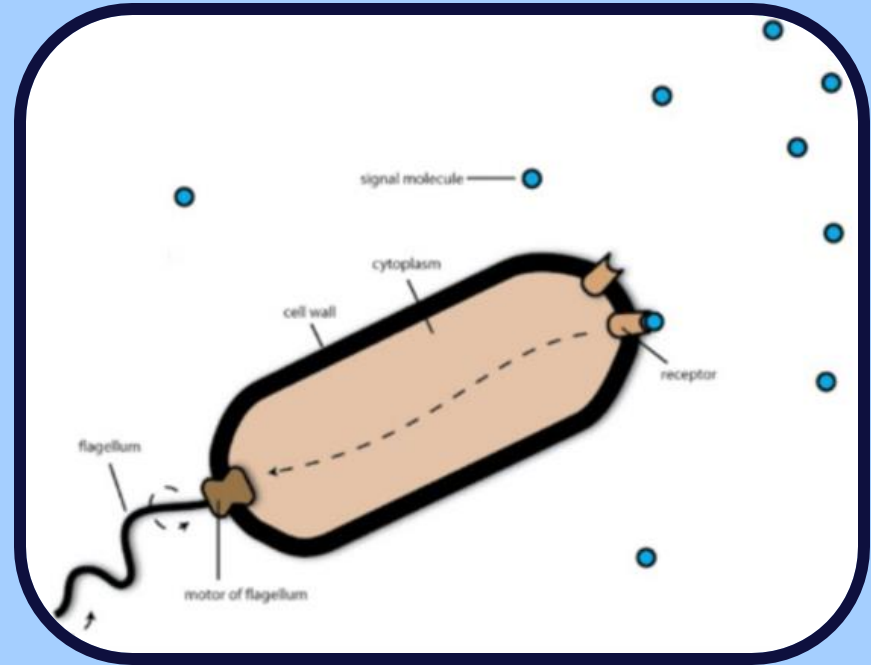
Flagella - Function

Motility



Flagella - Function

The organs of
motility

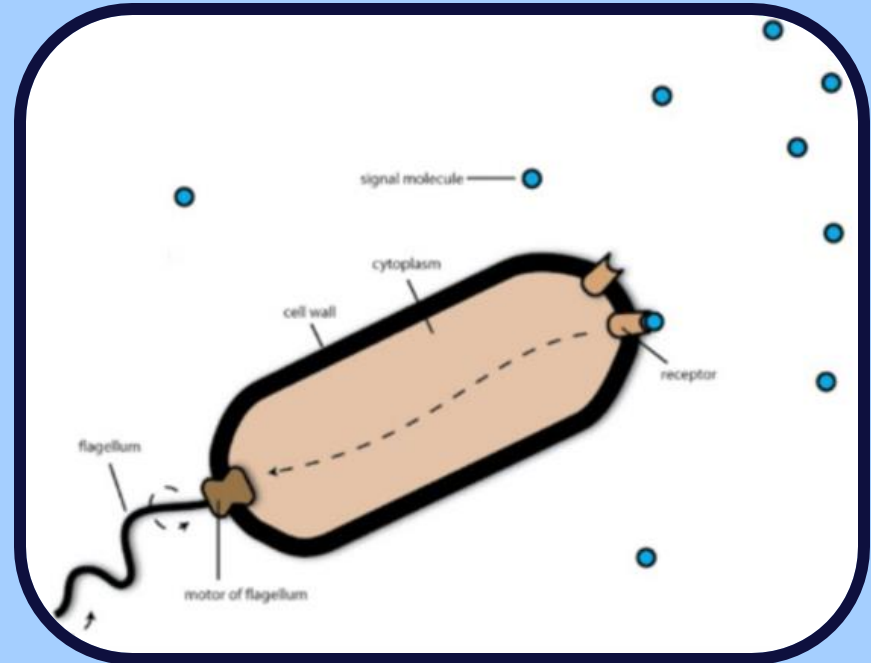


Flagella - Function

Tactic response (Taxis)

(Stimulus)

**(movement of bacteria to
toward (+ve) or away (-ve)
from stimulating agent)**



Flagella - Function

Tactic response (Taxis)

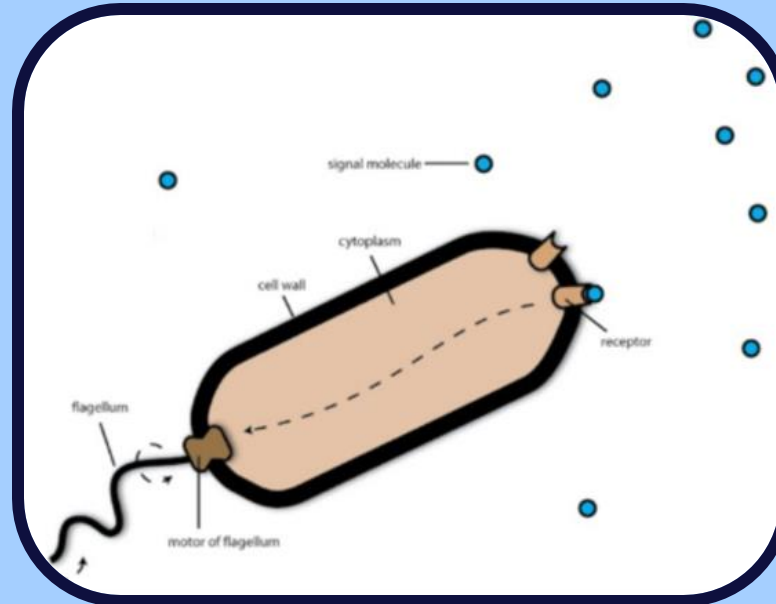
Stimulating agent

ChemoTaxis

Light

PhotoTaxis

Chemical



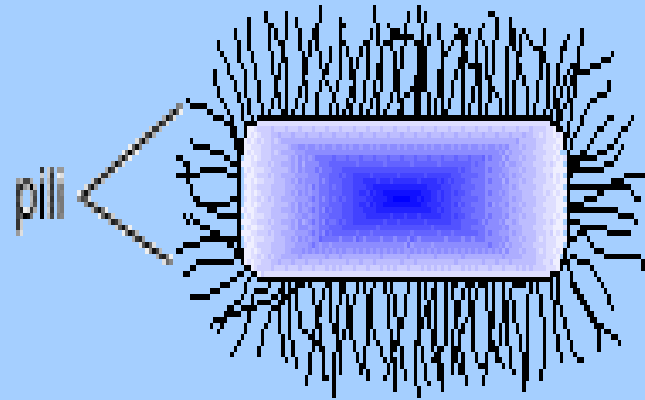
Axial Filaments

Endoflagella
In spirochetes



Pili (Fimbriae)

Short and thin
Hair like formed from
protein
(Pilin)



Pili

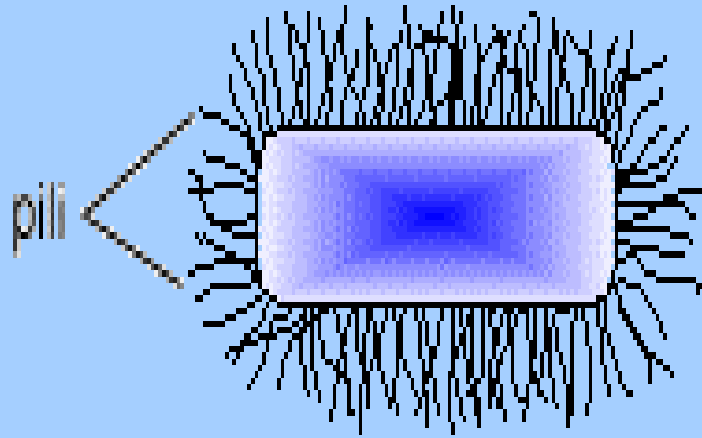
Seen by EM



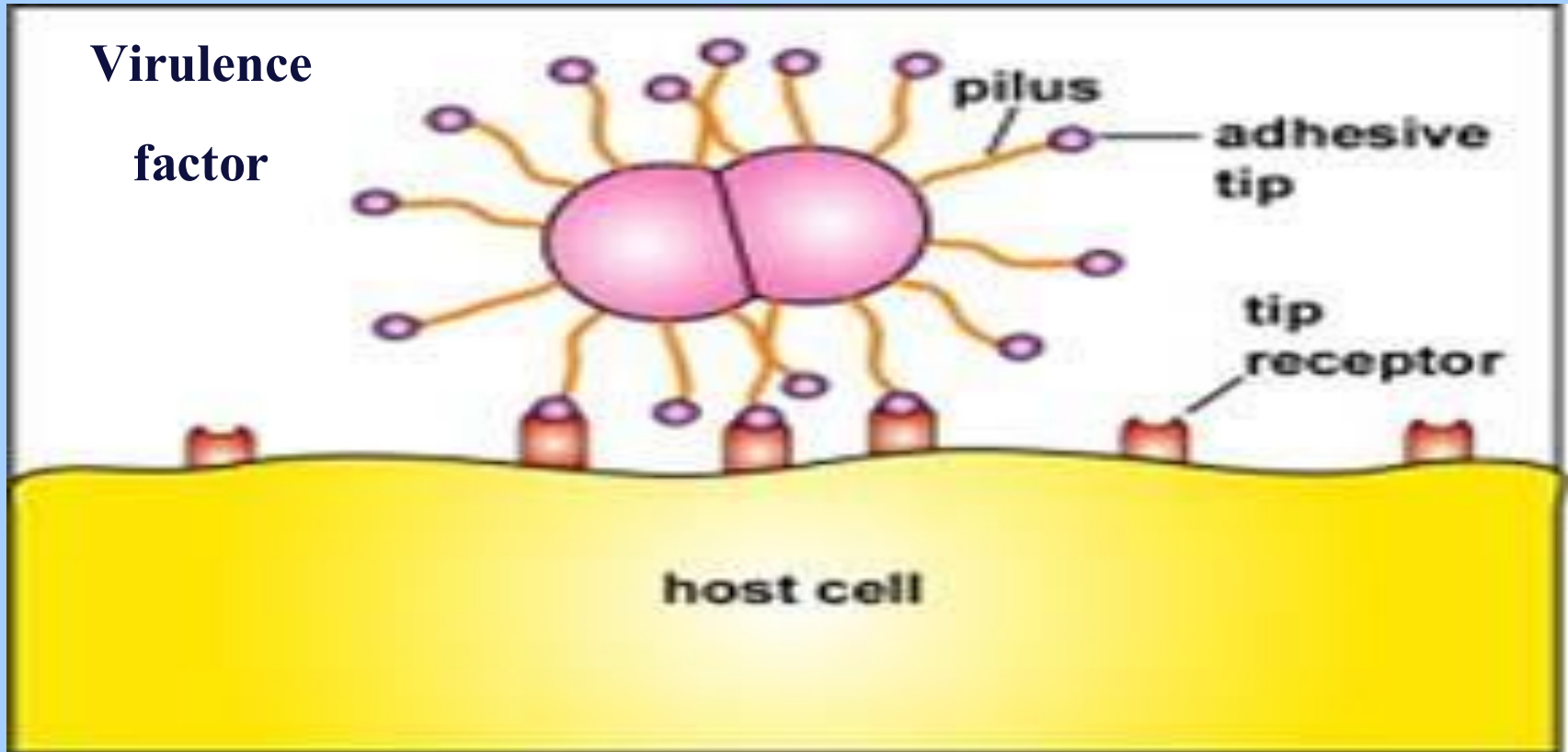
Pili

A) Ordinary pili
(Attachment)

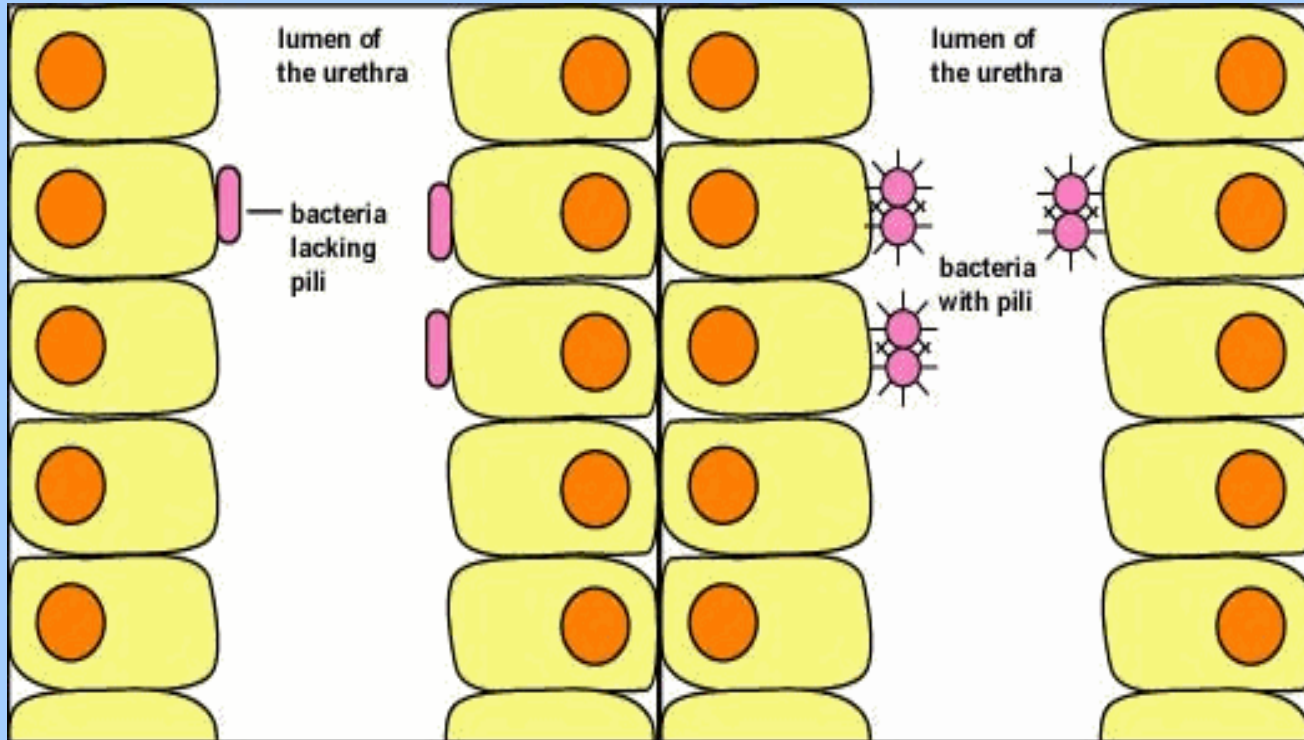
B) Sex pili
(Genetic transfer)



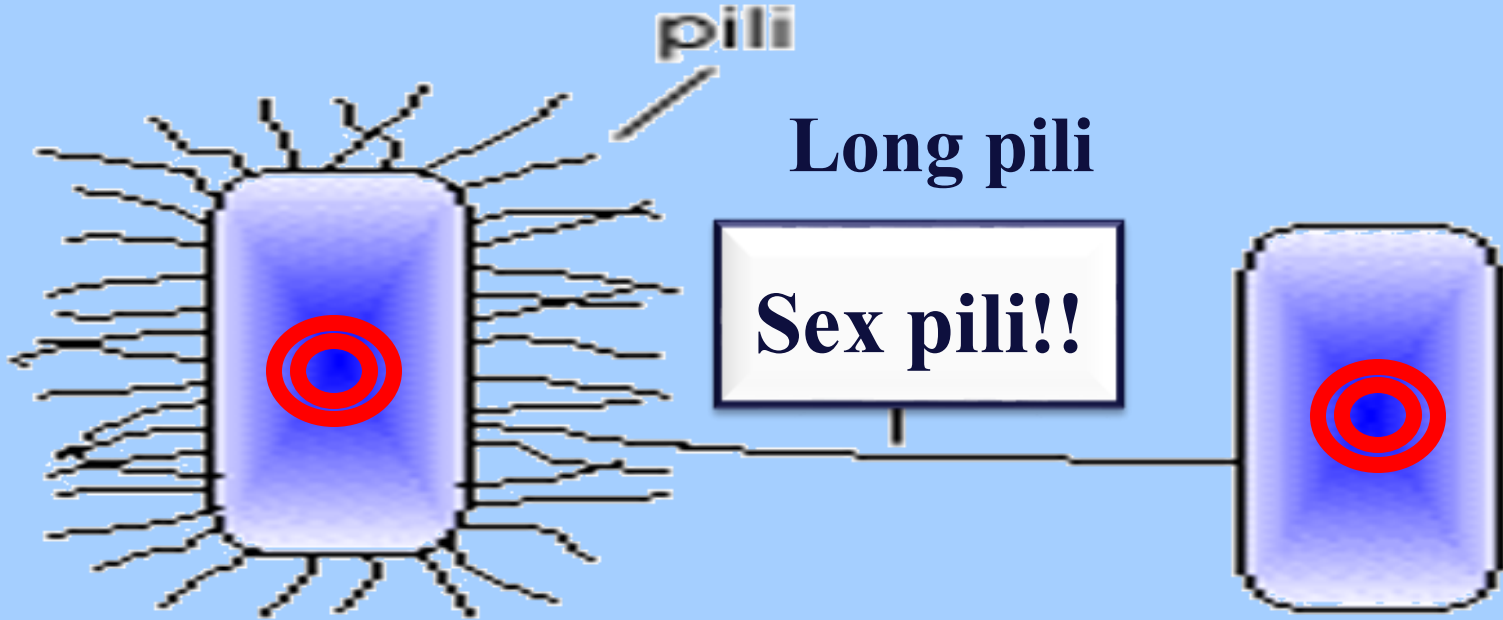
Ordinary Pili



Ordinary Pili



Sex Pili



F+

Donor

Conjugation

F-

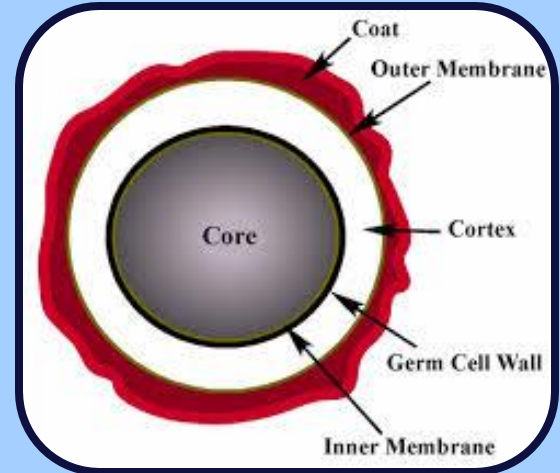
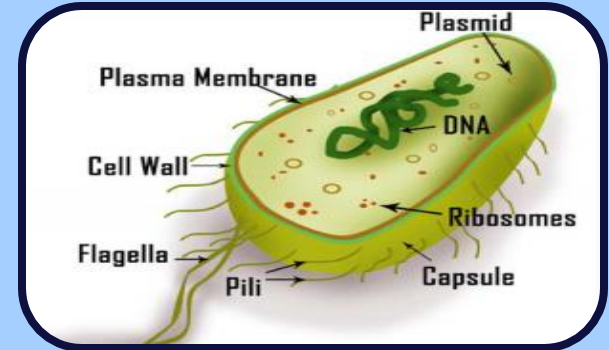
Recipient

Spore formation

Vegetative bacteria

Unsuitable condition

**Spore formation
(Outside)**

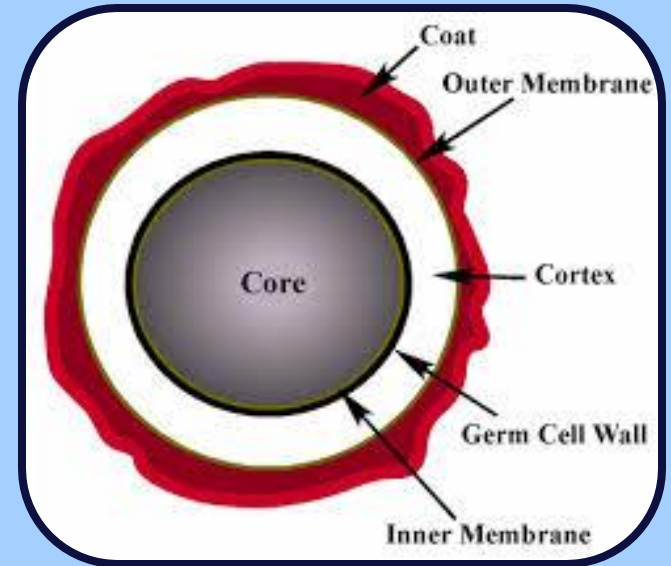


Spore formation

Forming highly resistant resting
phase (Endospores) in VITRO

Bacillus

Clostridium



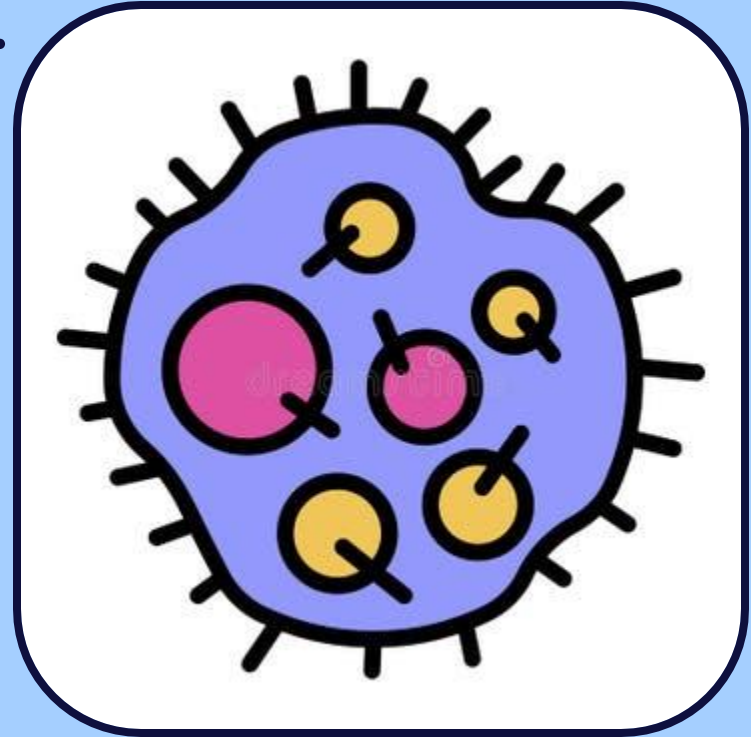
Spore formation

Occur to unfavorable conditions e.g.

High temp.

Drying

Depletion of
nutrition



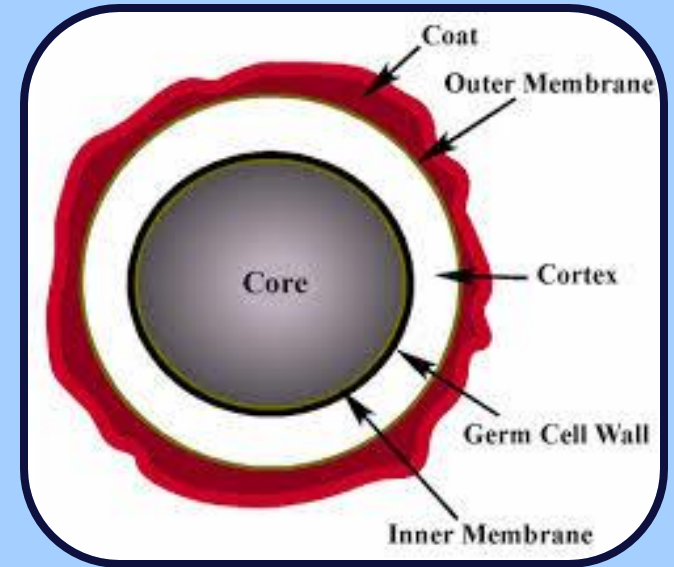
Spore formation

Formed outside the body (in VITRO)

Can not stained by ordinary stain

Spore formation

**Highly resistant to dryness,
heat & Disinfectant**



Spore formation

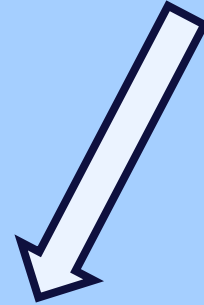
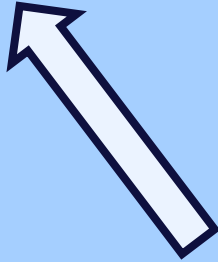
Vegetative



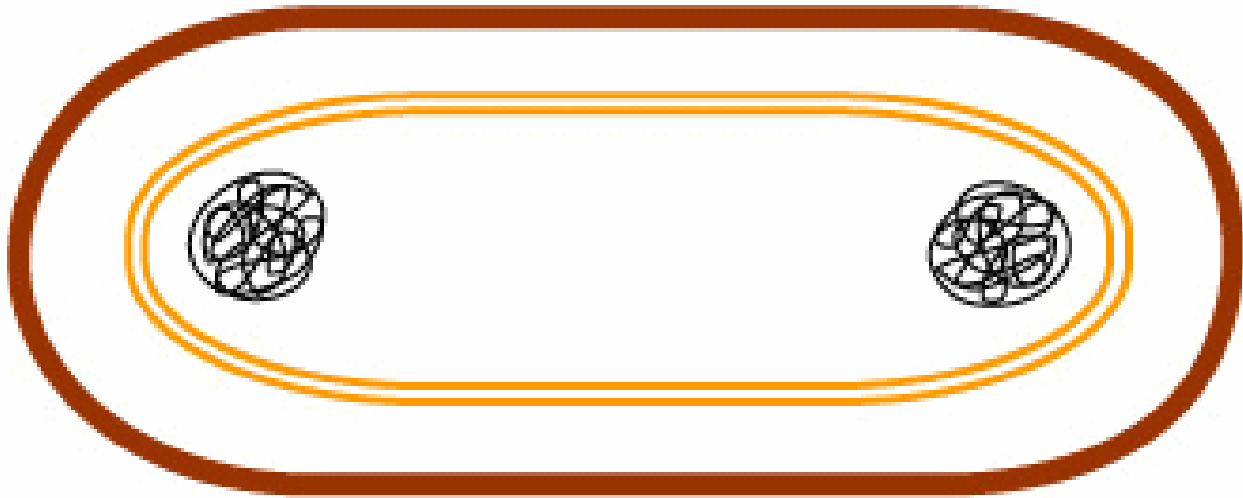
Sporulation

Bacillus & Clostridium

Germination



Spore formation



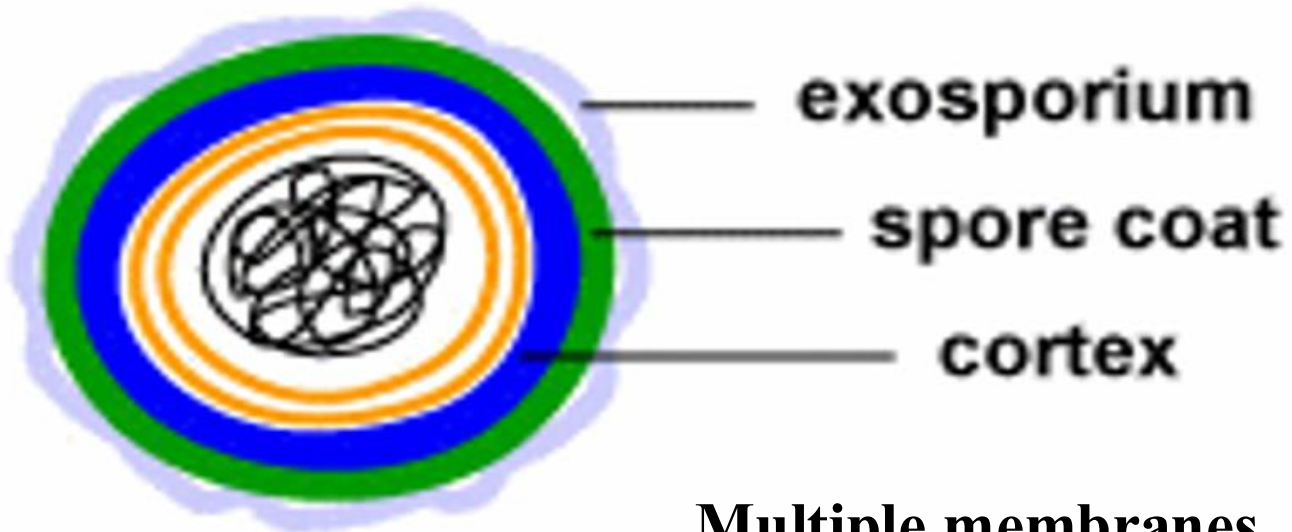
Ca²⁺ &

Dipicolonic acid

Multiple membranes

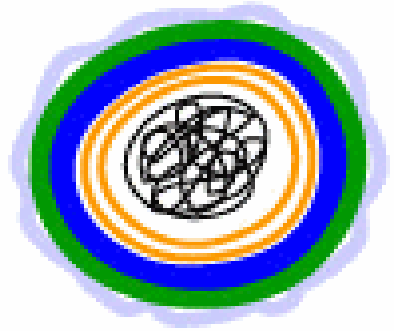
Spore formation

endospore

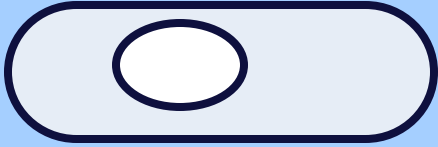


Multiple membranes

Germination



Position of spores



B. anthracis

Central & Oval



Cl. perfringens

Sub-terminal & Oval



Cl. Tetani

Terminal & Spherical