LECTURE 2

Bacterial structure

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

Objectives

Intracytoplasmic structure

1) Nucleoid

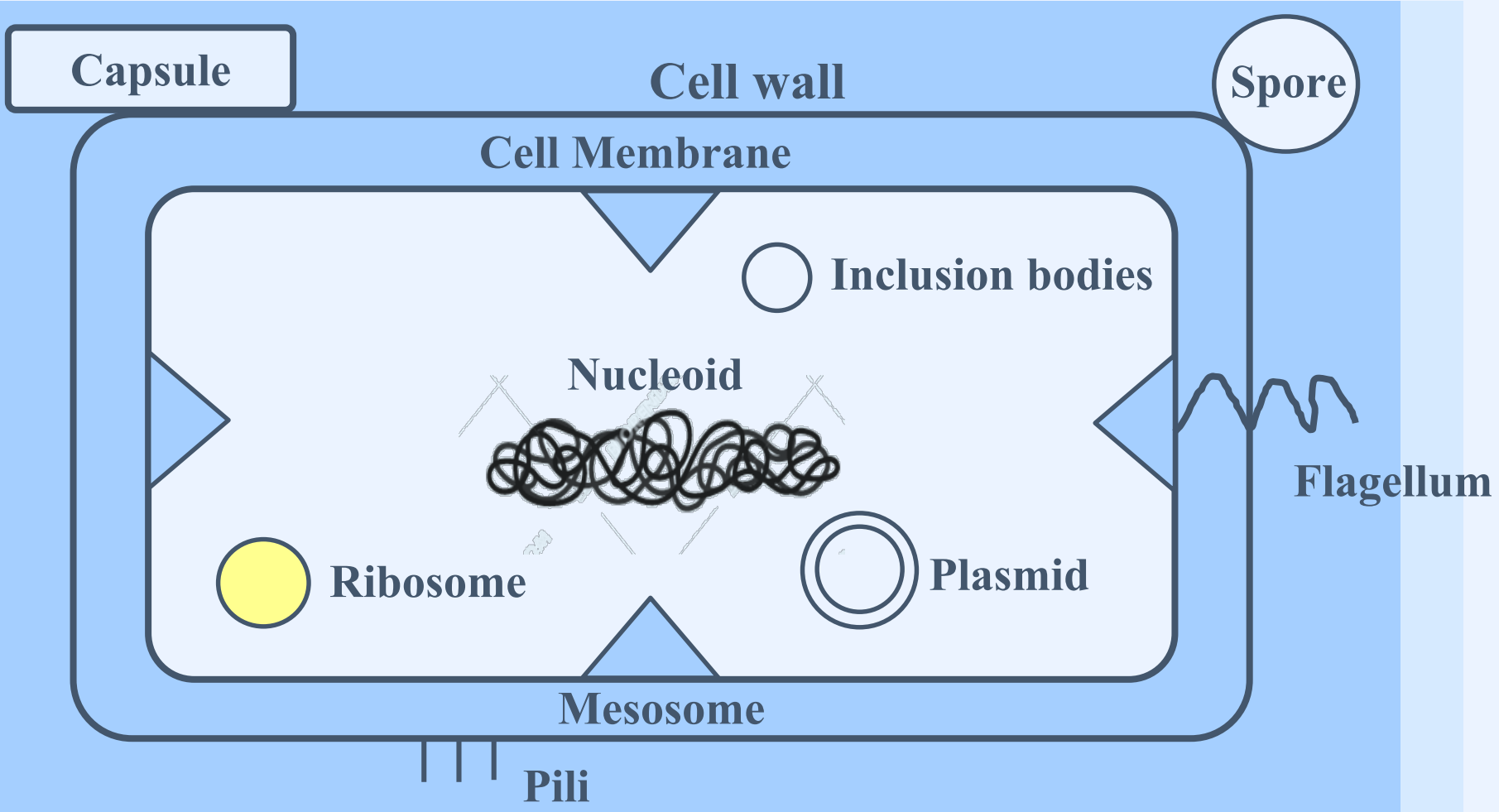
2) Ribosome

3) Inclusion granules

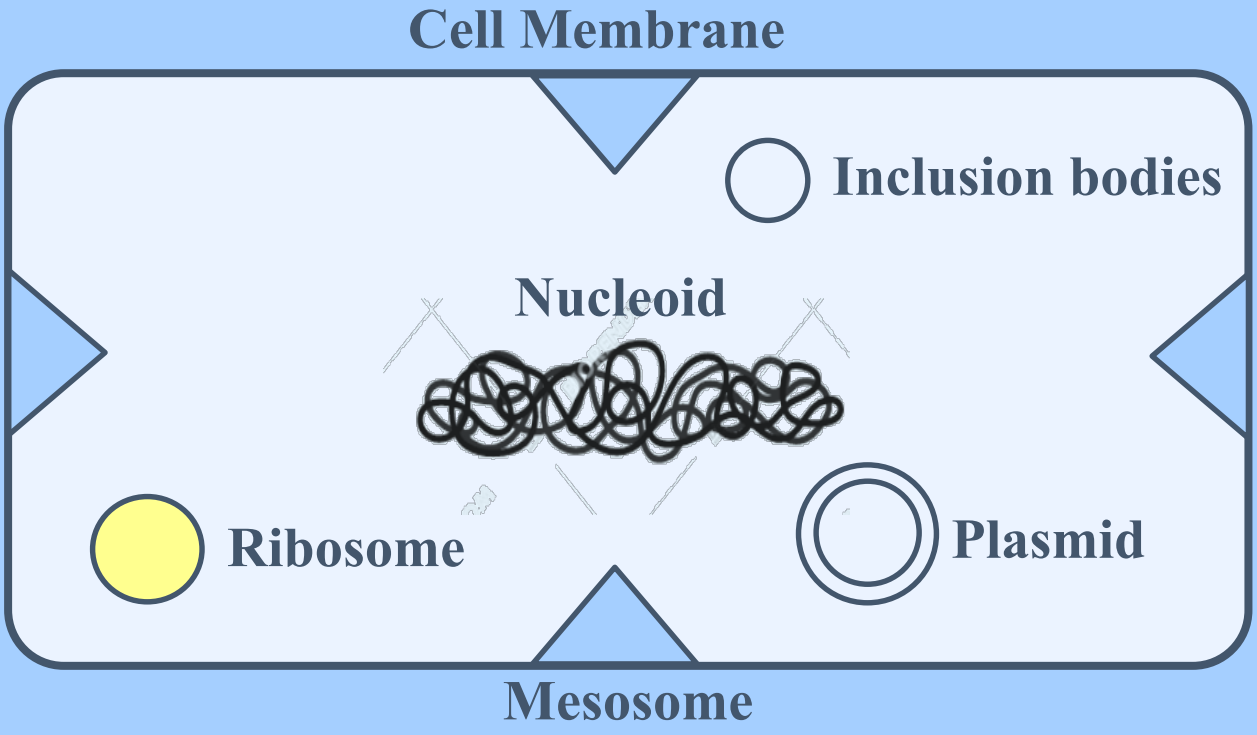
4) Cell membrane

5) Plasmid

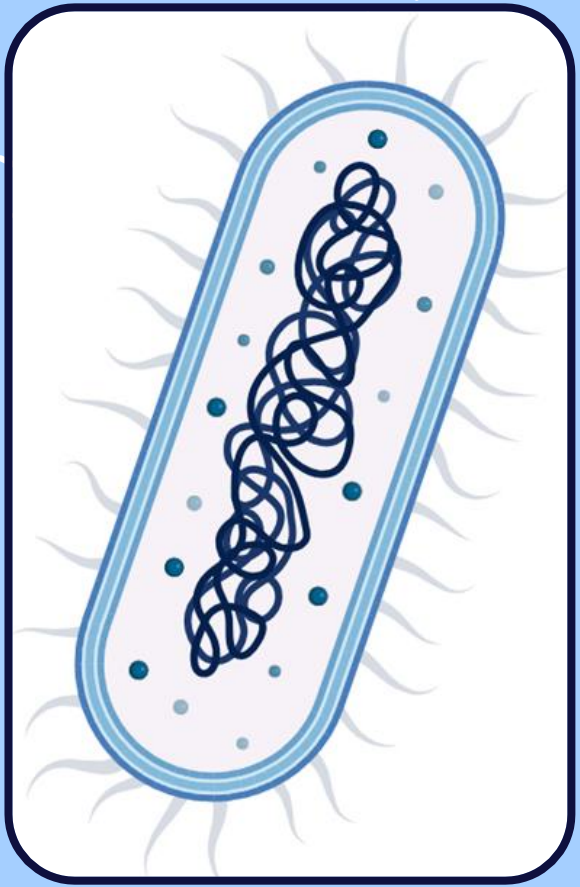
Bacterial structure



Intracytoplasmic structure



1) Nucleoid



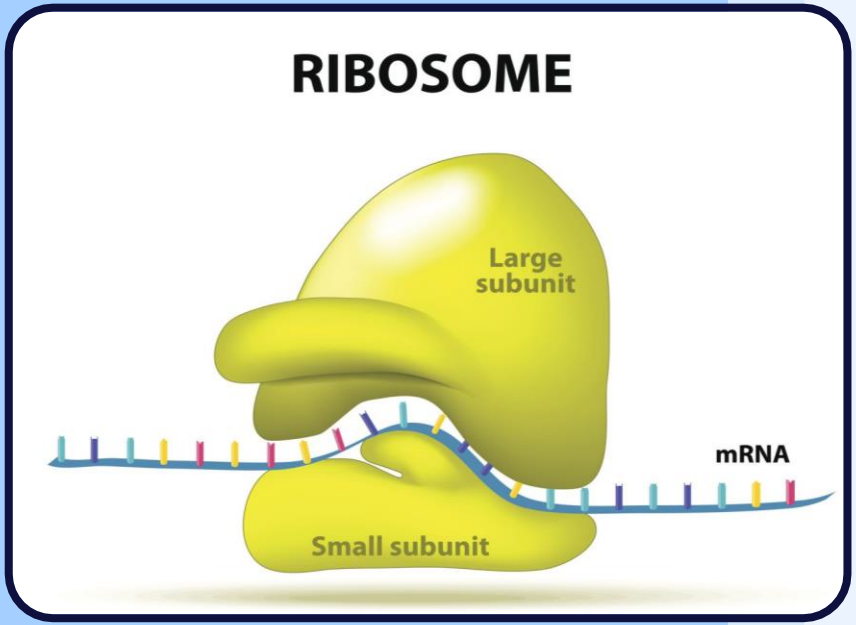
1. Single chromosome
2. Circular
3. dsDNA
4. 1mm in length
5. supercoiled
6. Carry genetic information for growth & survival

Essential

2) Ribosome

1. Ribo=RNA
2. Some=body
3. Site of Protein synthesis

Essential



2) Ribosome

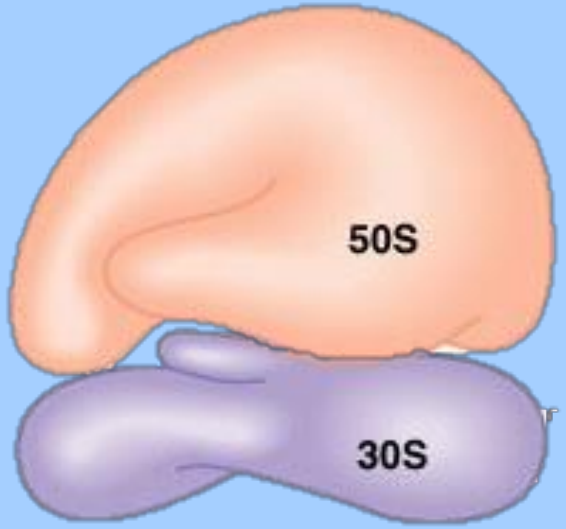
Bacterial ribosomes

↓

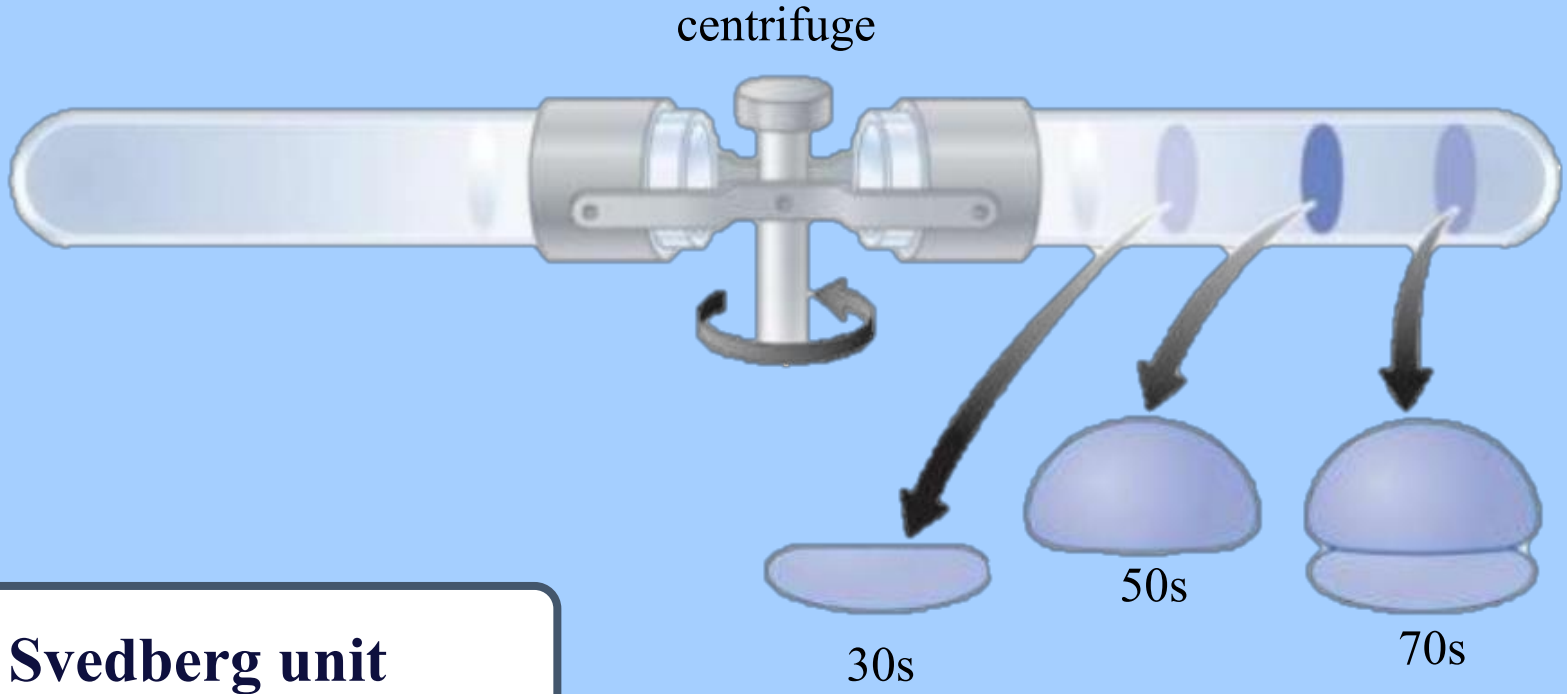
(70S)

↓

Svedberg unit

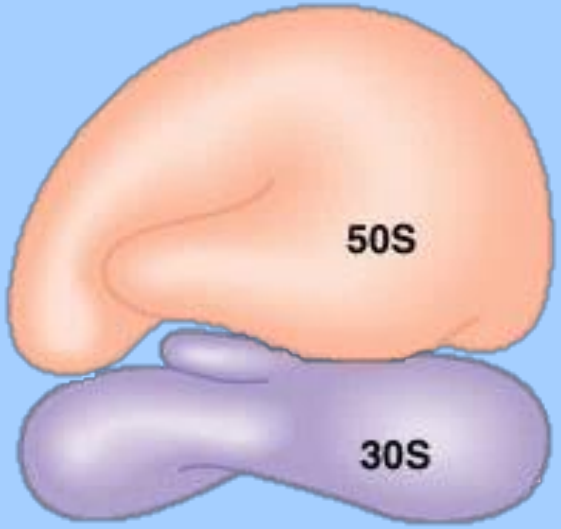


2) Ribosome

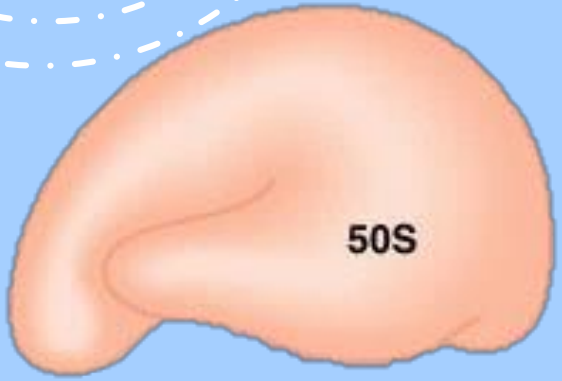


Svedberg unit

2) Ribosome



2) Ribosome



50S

60S

Target of antibiotics

Human

30S

40S

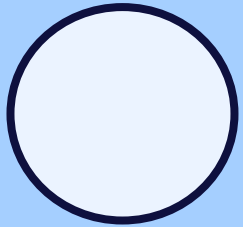
3) Inclusion granules

Store of nutrient

Glycogen

Starch

Phosphate



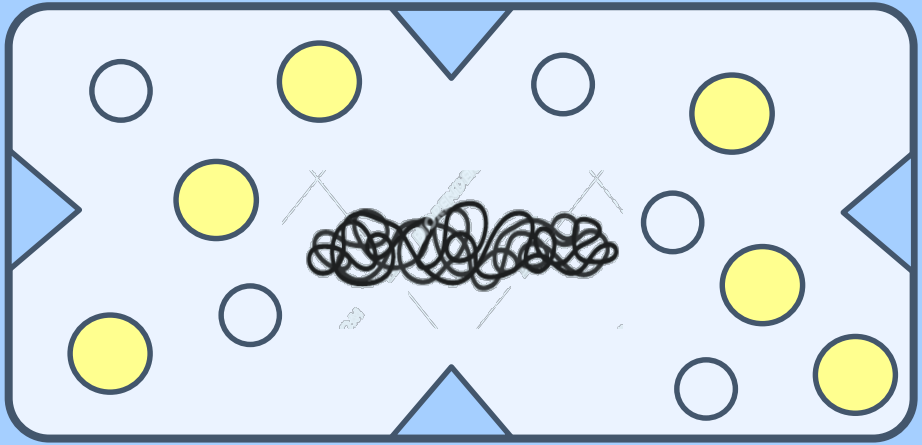
Volutin granule (Metachromatic granules)

Definition of the cell membrane

Thin, fragile membrane

located just

inside the cell wall

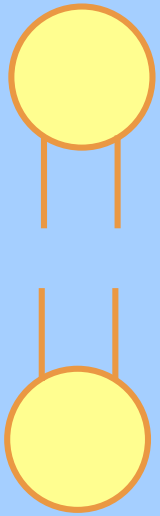


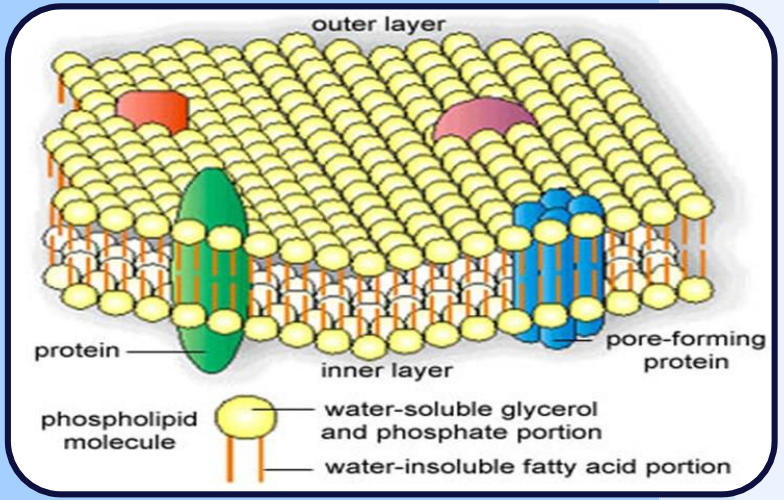
Essential

Composition of cell membrane

Phospholipid bilayer + Protein

(No sterols)



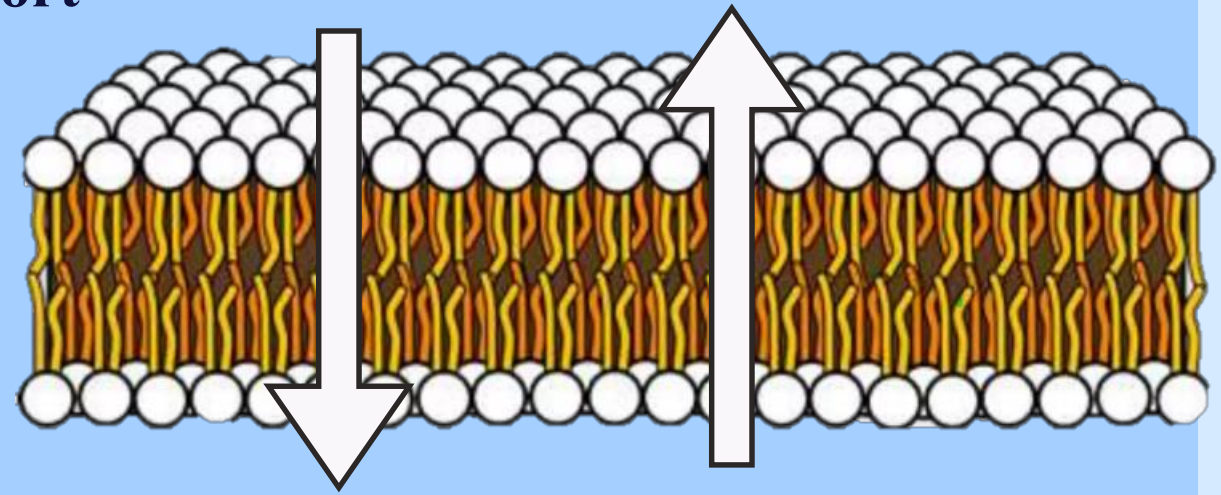


Function of the cell membrane

1

Selective transport

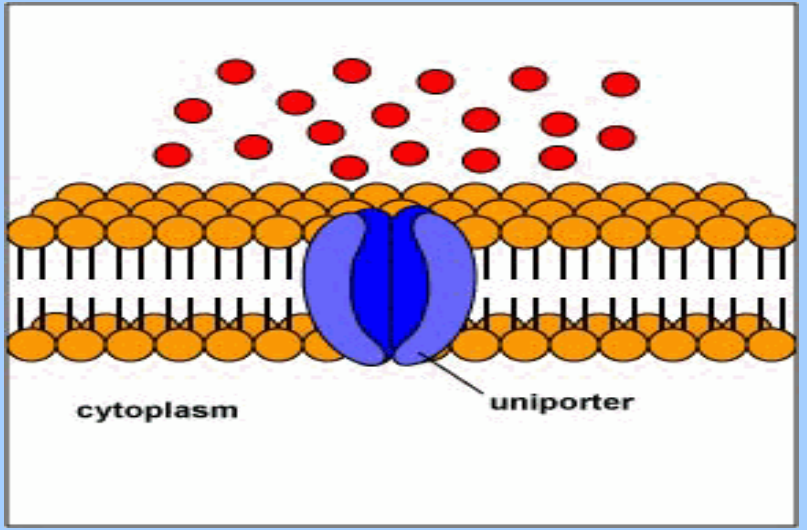
(Passive)



Function of the cell membrane

1

Selective transport (Active)



Function of the cell membrane

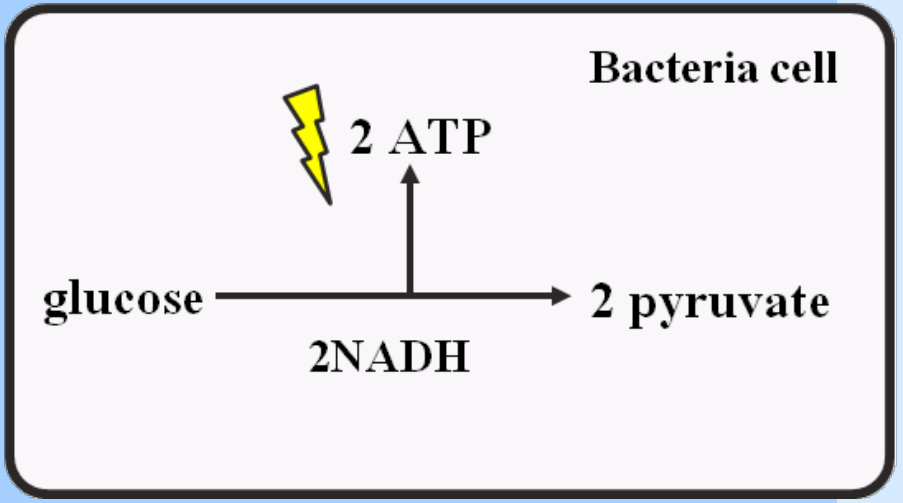
2

Mesosomes

Respiration enzyme

(Making energy)

(Like Mitochondria)



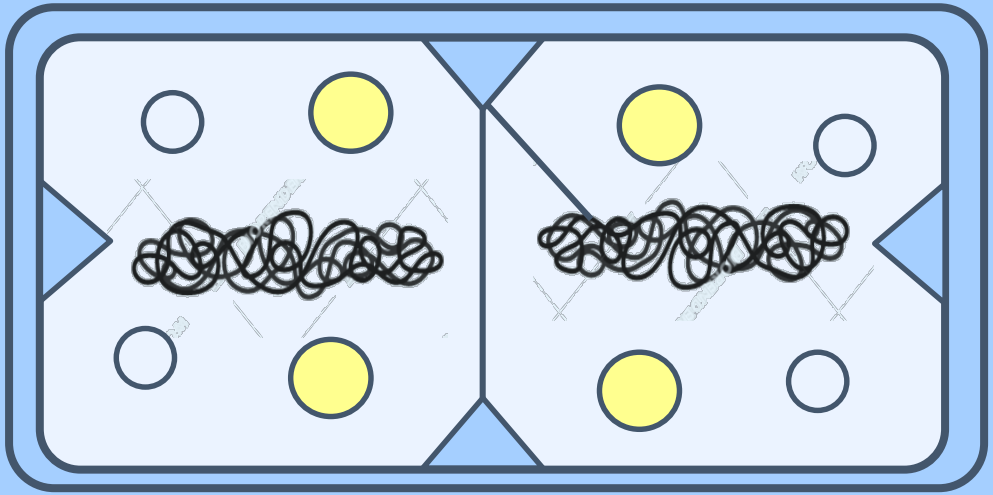
Function of the cell membrane

2

Cell division

Separate DNA

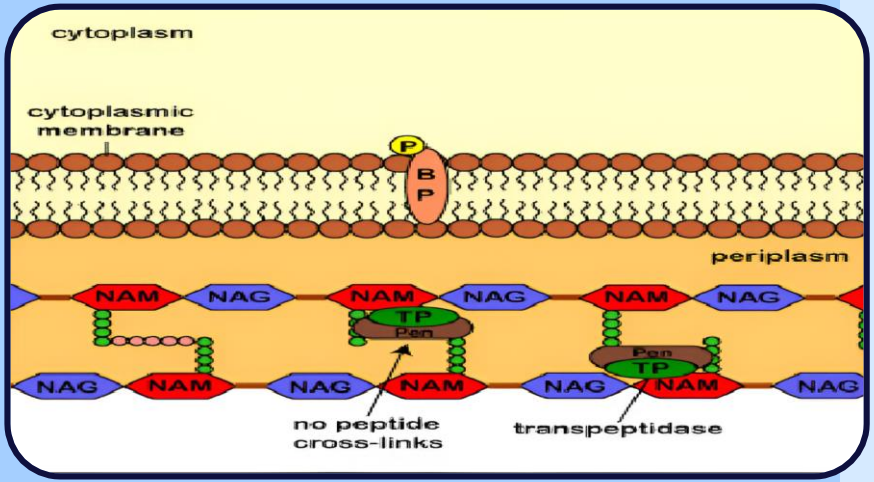
Septal mesosome



Function of the cell membrane

3

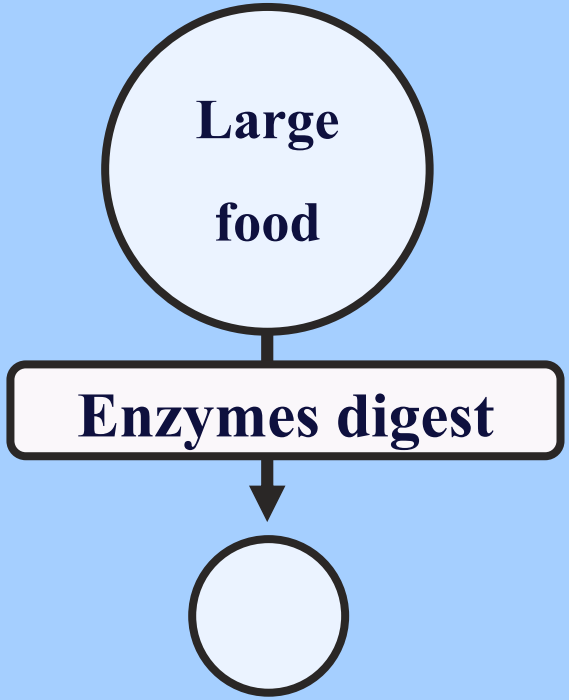
Biosynthesis of cell wall



4

Excretion of extracellular enzymes

(Hydrolytic enzymes)



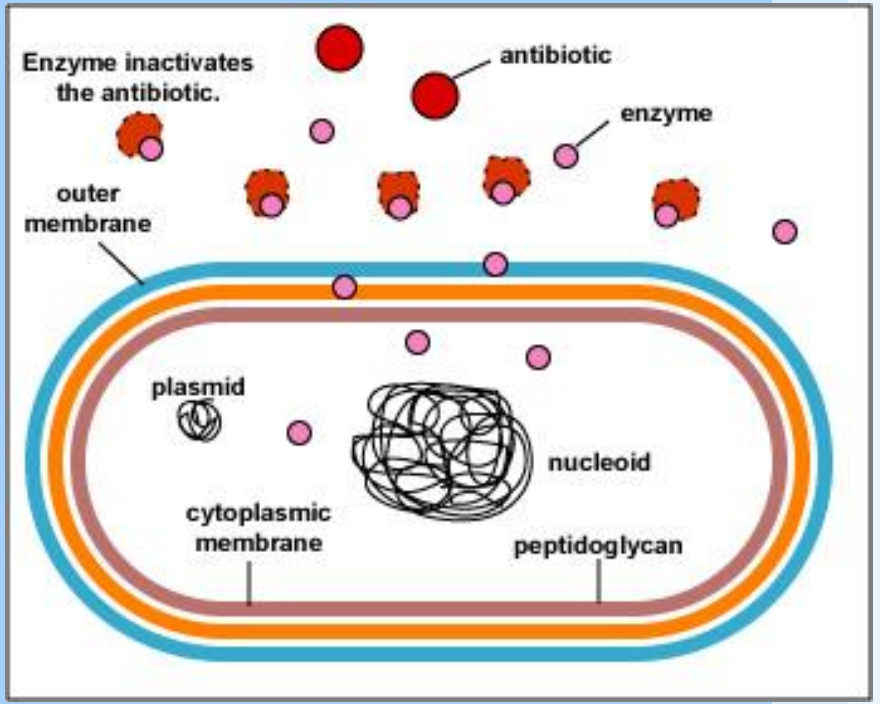
Penetrate cell membrane

Function of the cell membrane

5

Excretion of extracellular enzymes

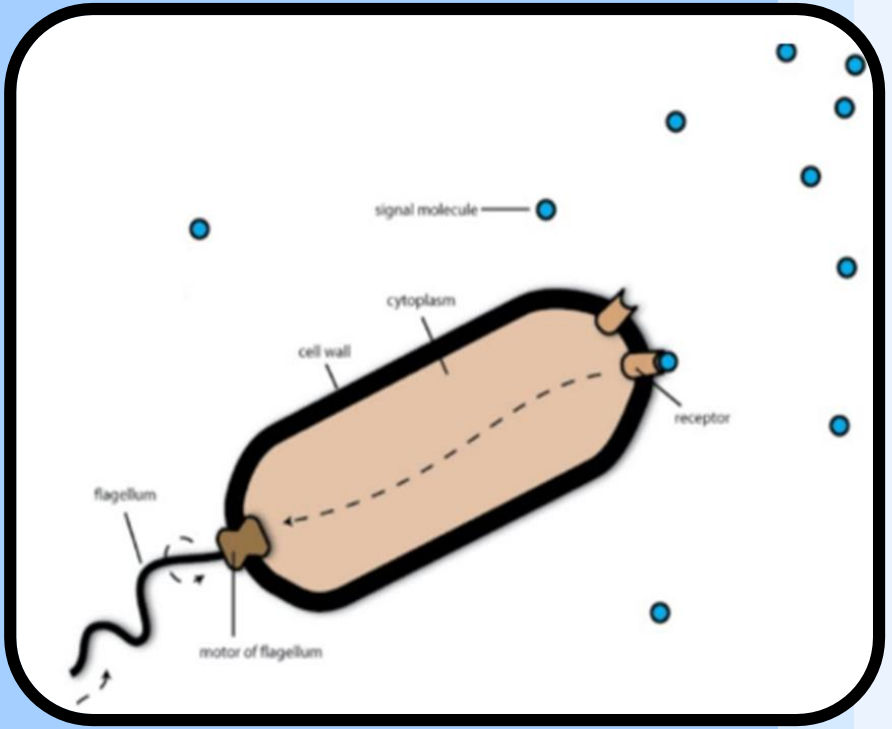
(Penicillinase)



Function of the cell membrane

6

Chemotactic system



Plasmid

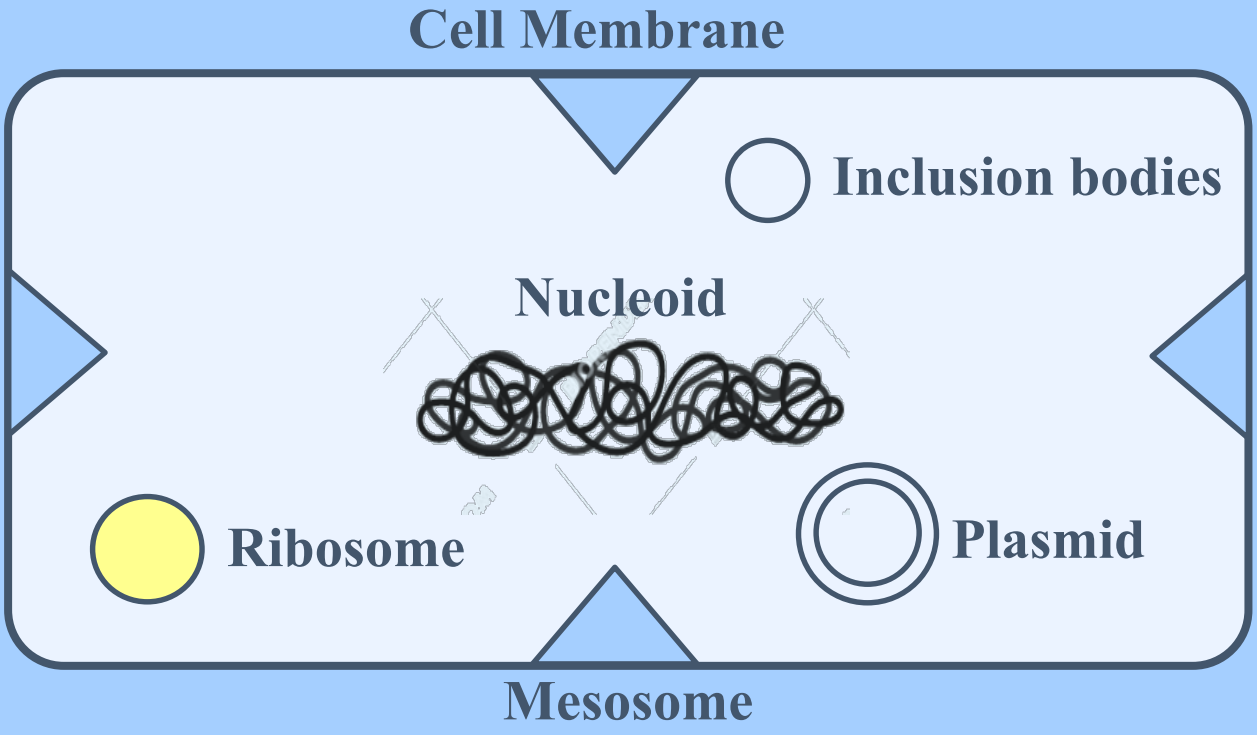
EXTRA chromosomal dsDNA

1. Replicate autonomously (Independent of bacterial chromosome)
2. Toxin production Drug resistance

Not essential

Plasmid

Intracytoplasmic structure



Objectives

Cell wall

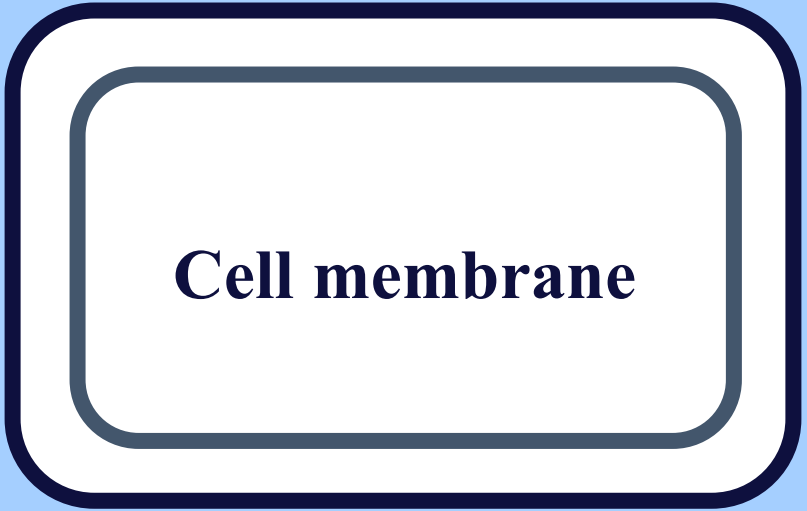
1) Definition
2) Composition
3) Synthesis
4) Function
5) Cell wall Deficient

Definition of cell wall

Outermost layer!!!

Surrounds the cell membrane

Rigid

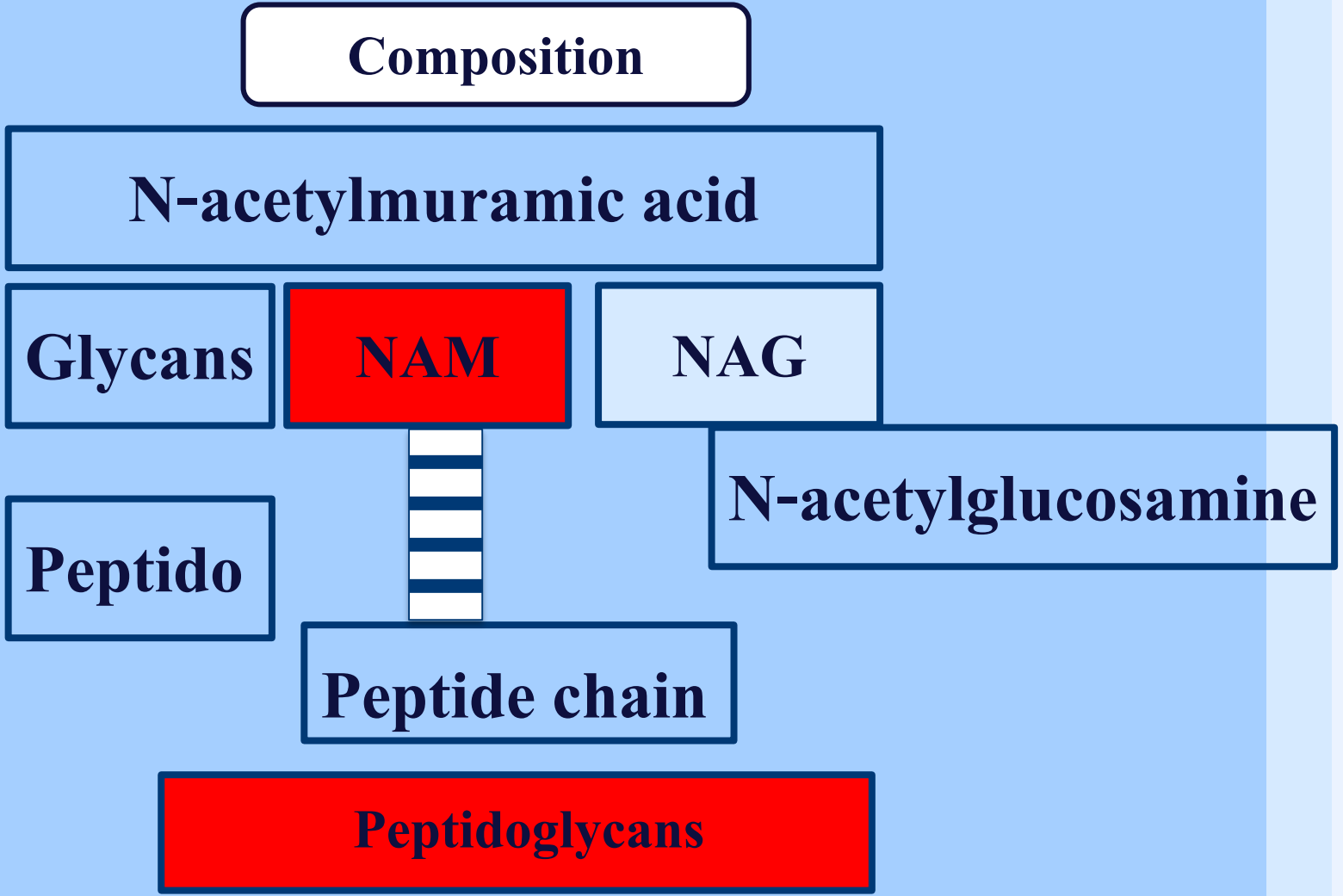


Composition of cell wall

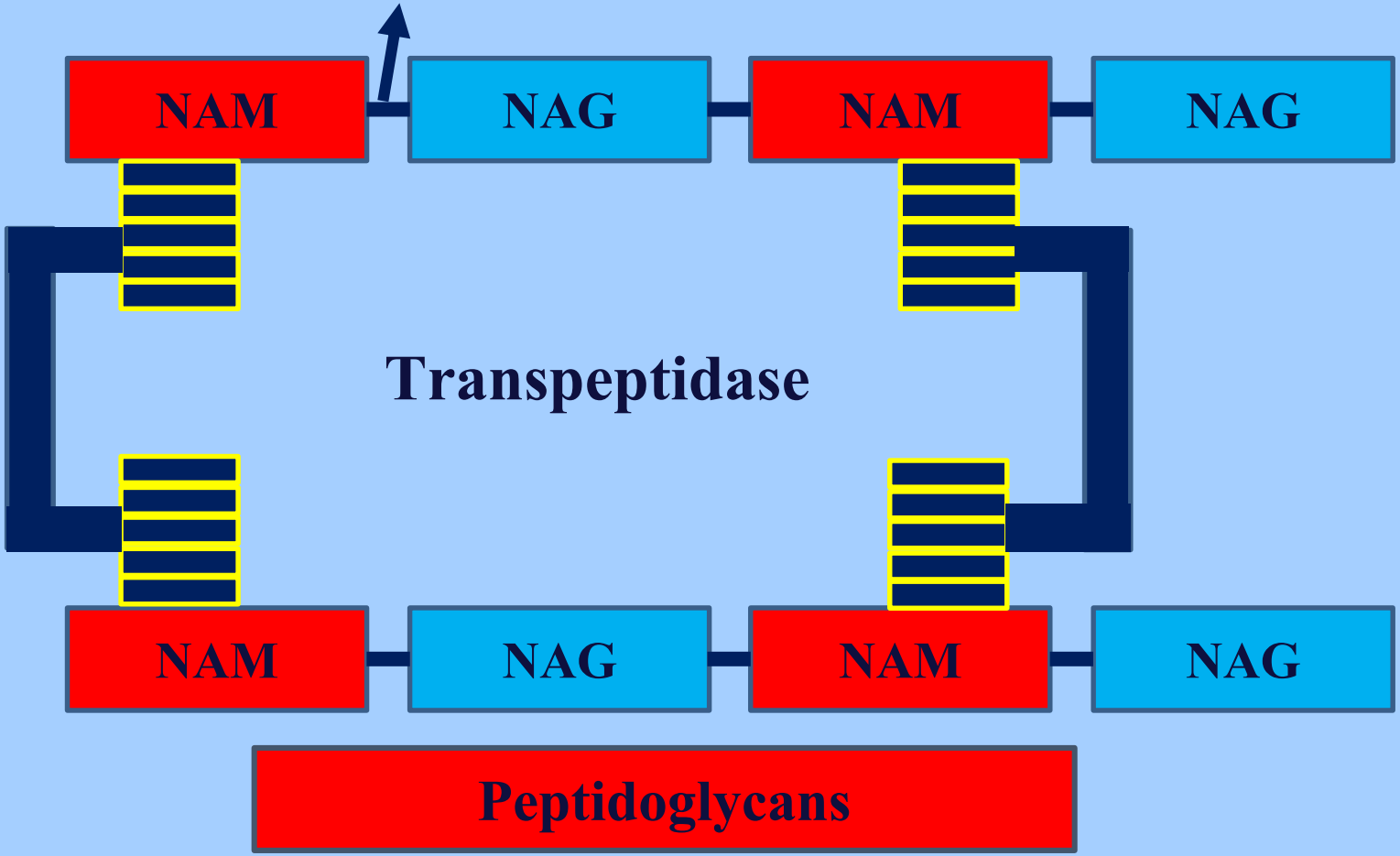
Rigidity

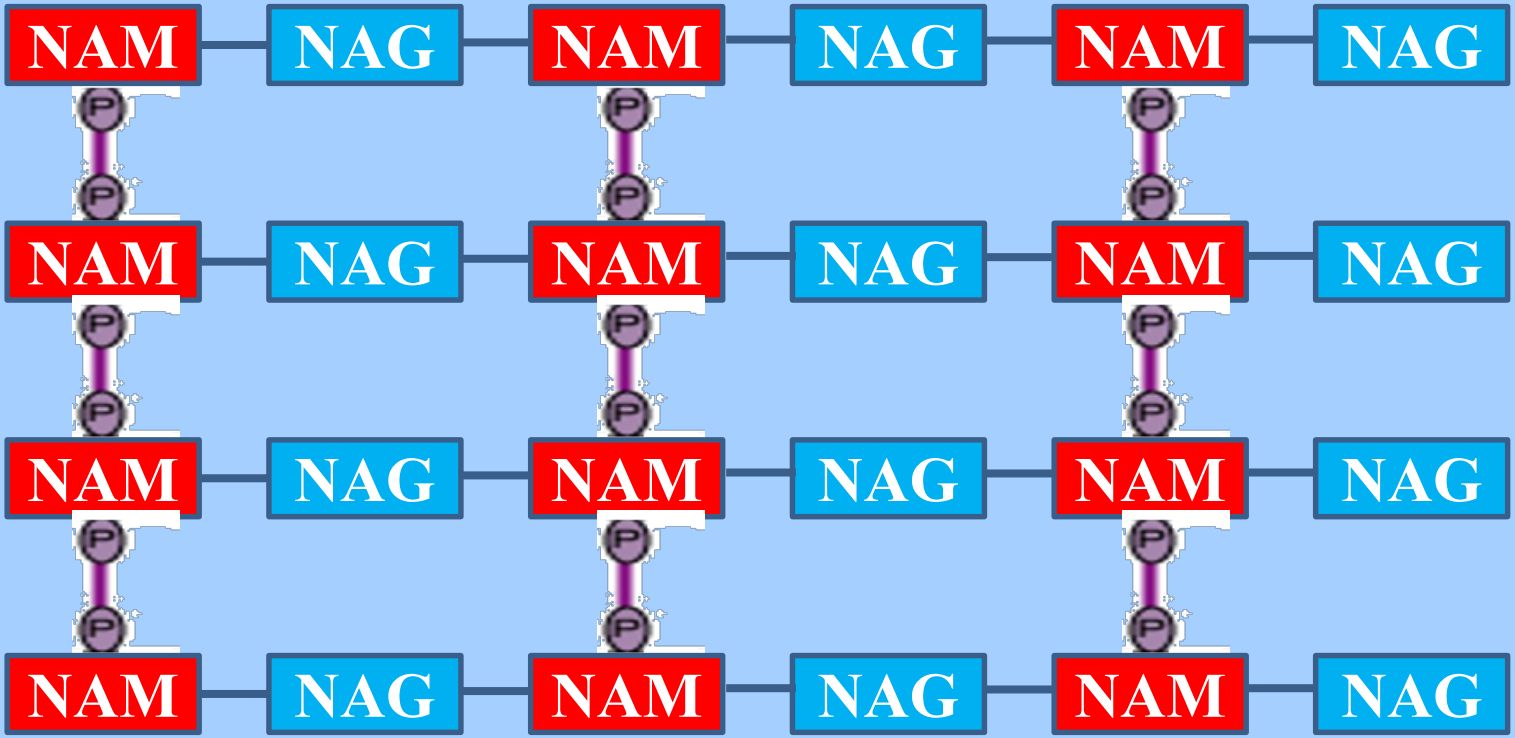
(Peptidoglycan)

Cell membrane

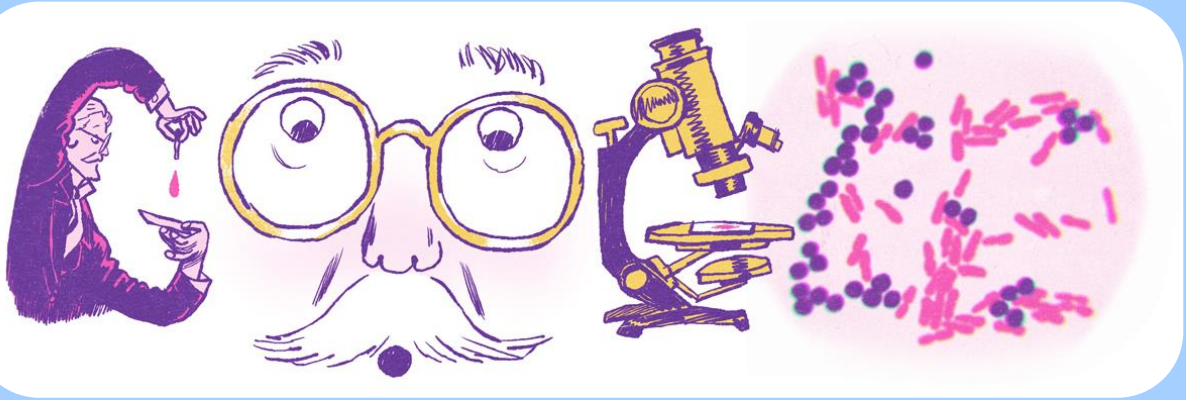

Composition
N-acetylmuramic acid
Glycans
NAM
NAG
N-acetylglucosamine
Peptido
Peptide chain
Peptidoglycans

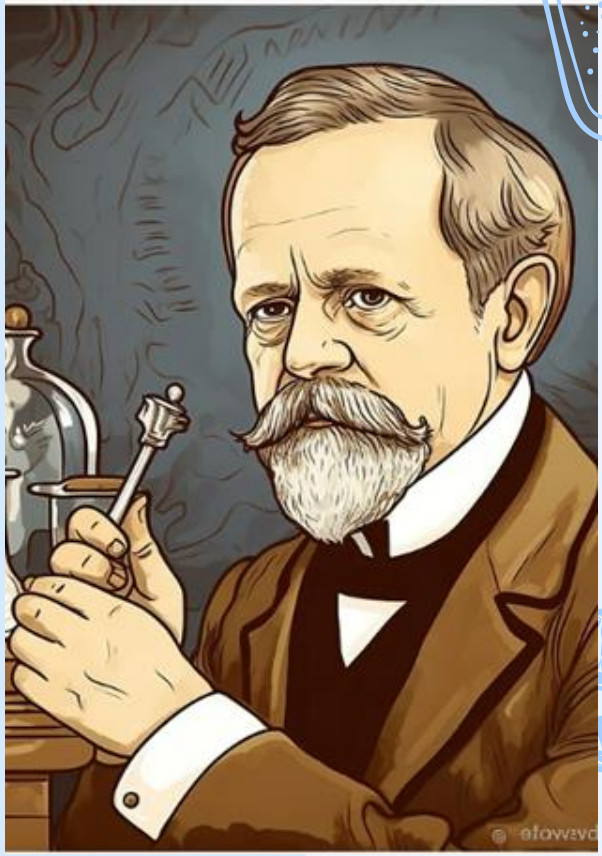
Glycosidic bond (Transglycosidase) Alternating repeating unit



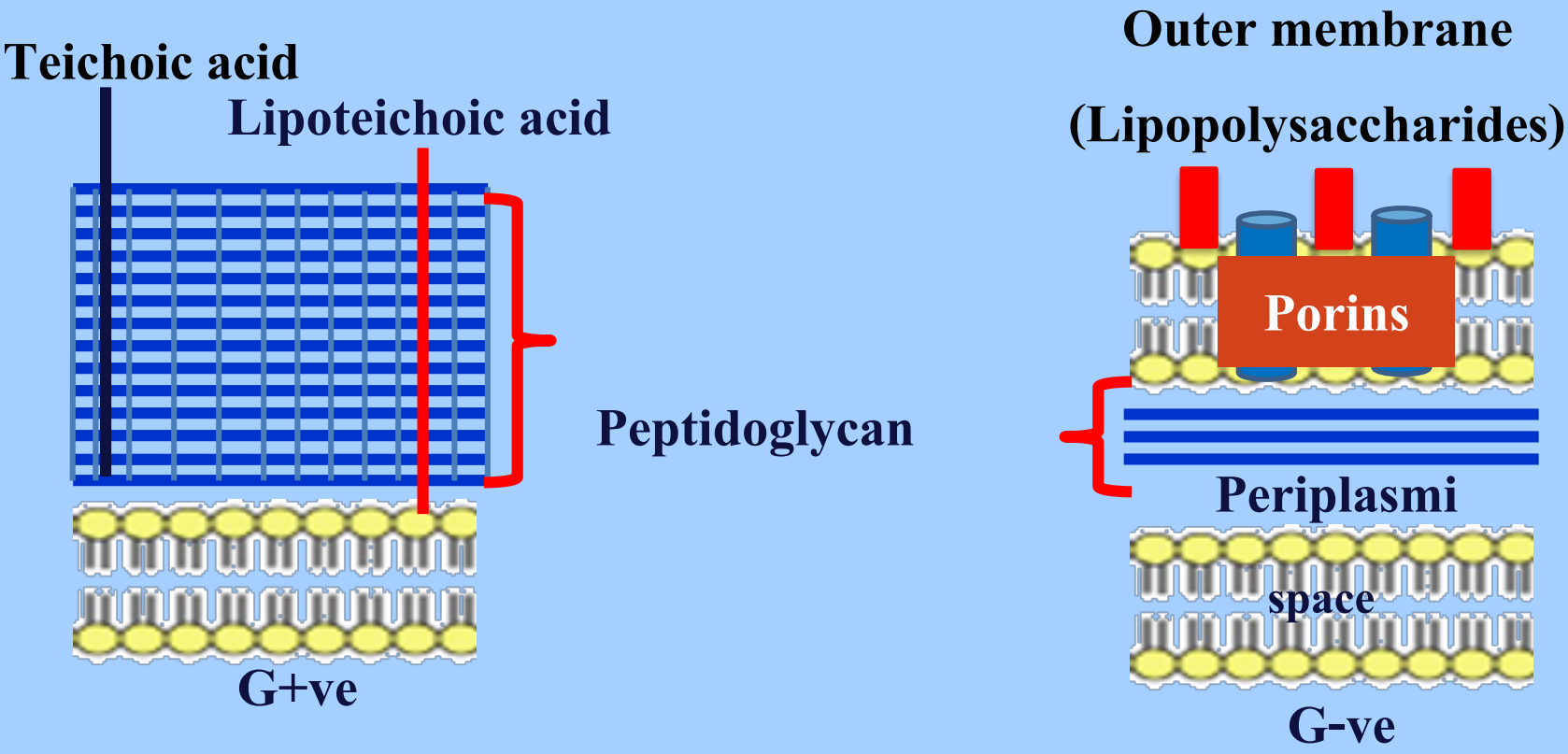

NAM
NAG
NAM
NAG
NAM
NAG
P
P
NAM
NAG
NAM
NAG
NAM
NAG
P
P
NAM
NAG
NAM
NAG
NAM
NAG
P
P
NAM
NAG
NAM
NAG
NAM
NAG

Gram scientist





Gram positive/negative bacteria



Gram positive bacteria

1) Peptidoglycan

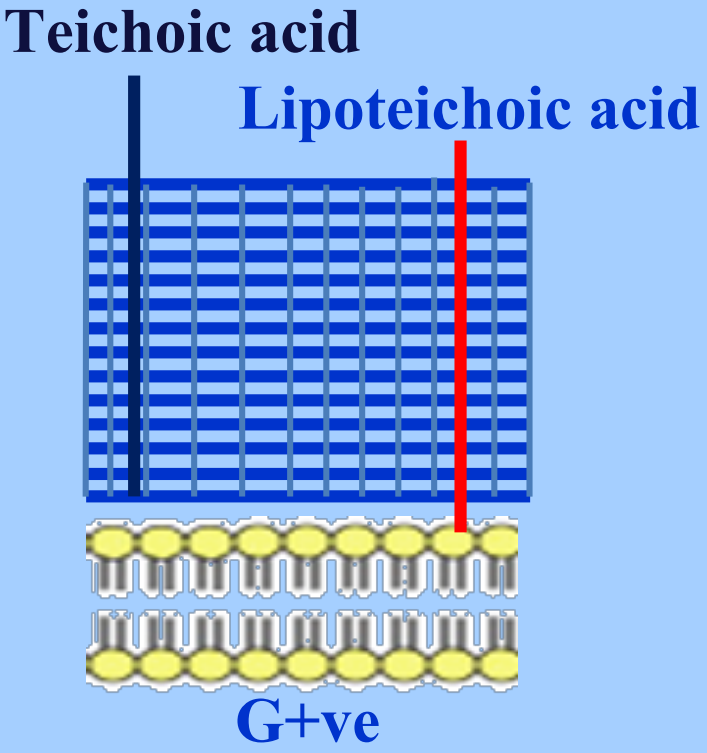
(50%)

NAM-NAG

|

Peptide

Porous



Composition of Gram positive

Polymers of glycerol or

Rbitol

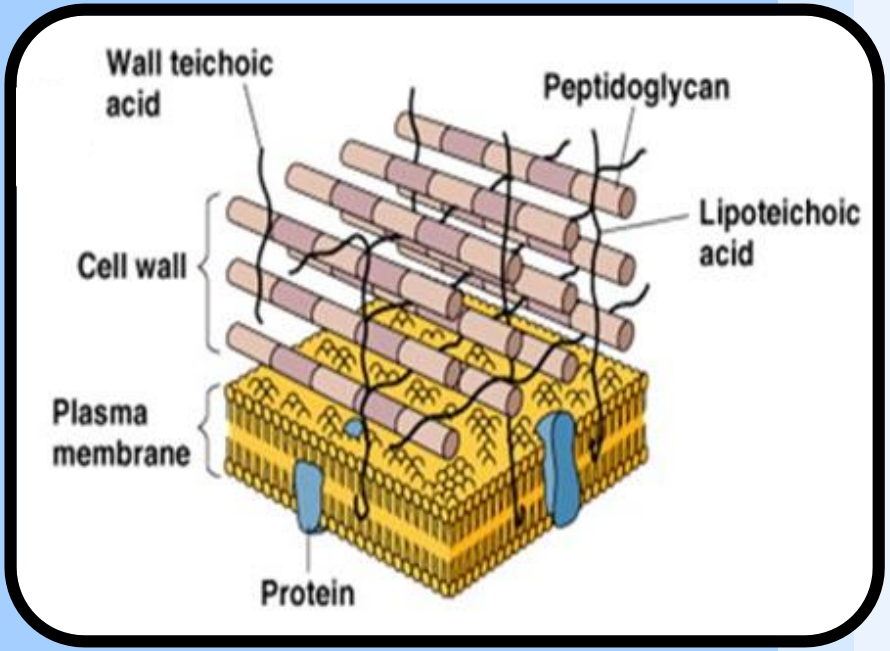
Lipoteichoic acid

(Cell membrane)

Teichoic acid

(Cell wall)

2) Teichoic acid



Composition of Gram positive

Major surface Ag of G+ve

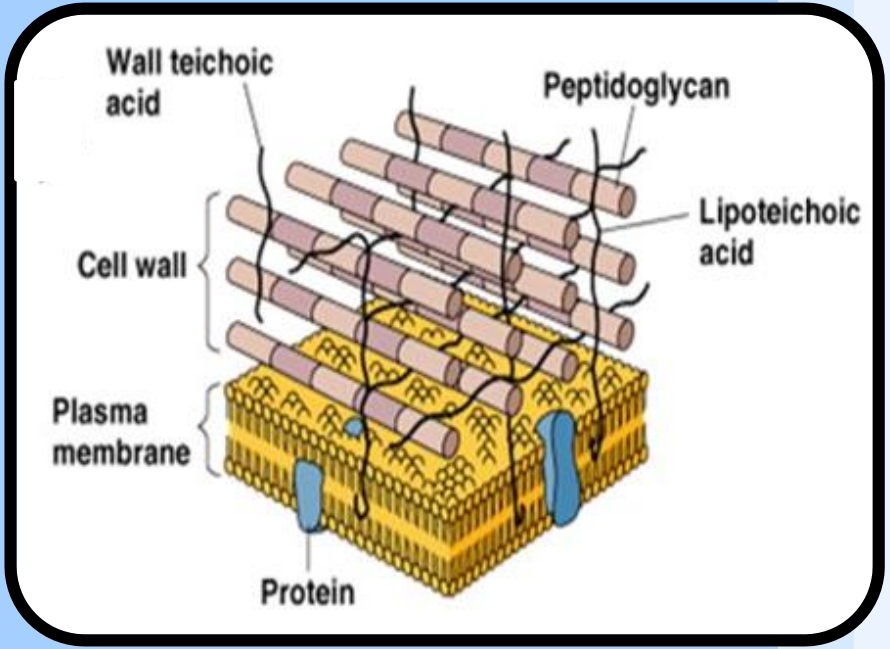
Highly

immunogenic

TNF-α

IL-1

2) Teichoic acid



Composition of Gram positive

Major surface Ag of G+ve

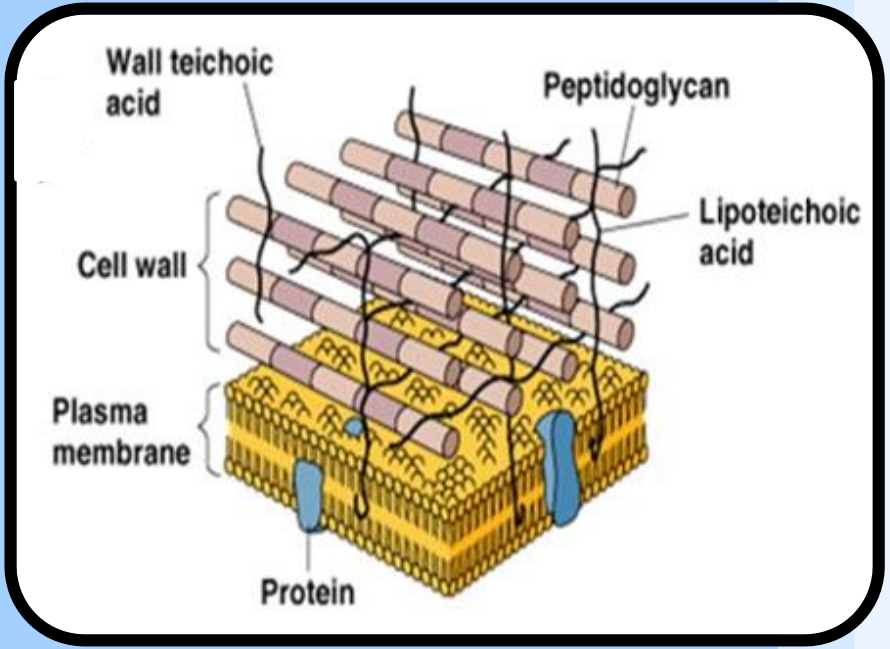
Highly

immunogenic

TNF-α

IL-1

2) Teichoic acid



Composition of Gram Negative

1) Peptidoglycan

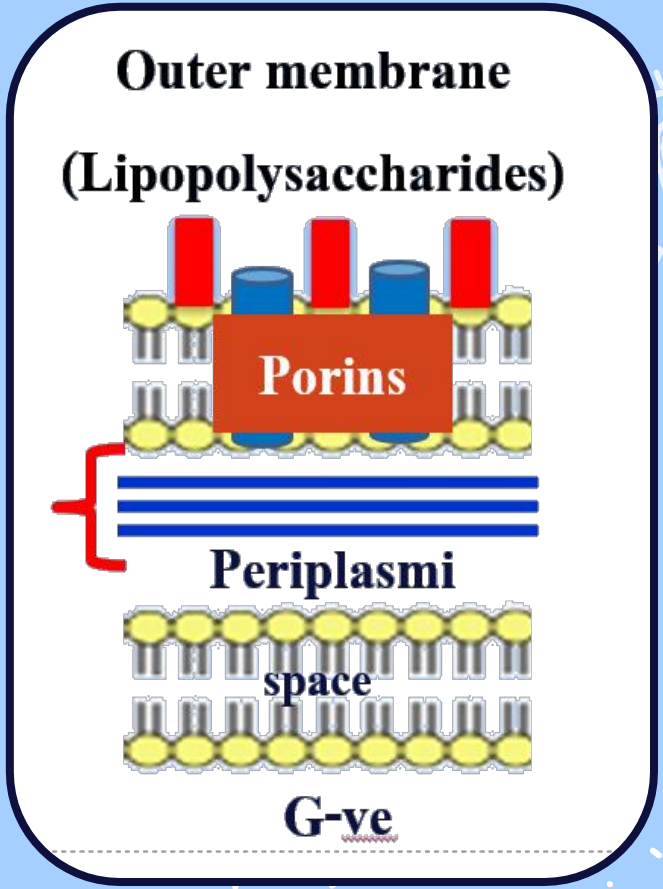
A thin layer (5%)

2 sheets of

(NAM & NAG)

|

Peptides

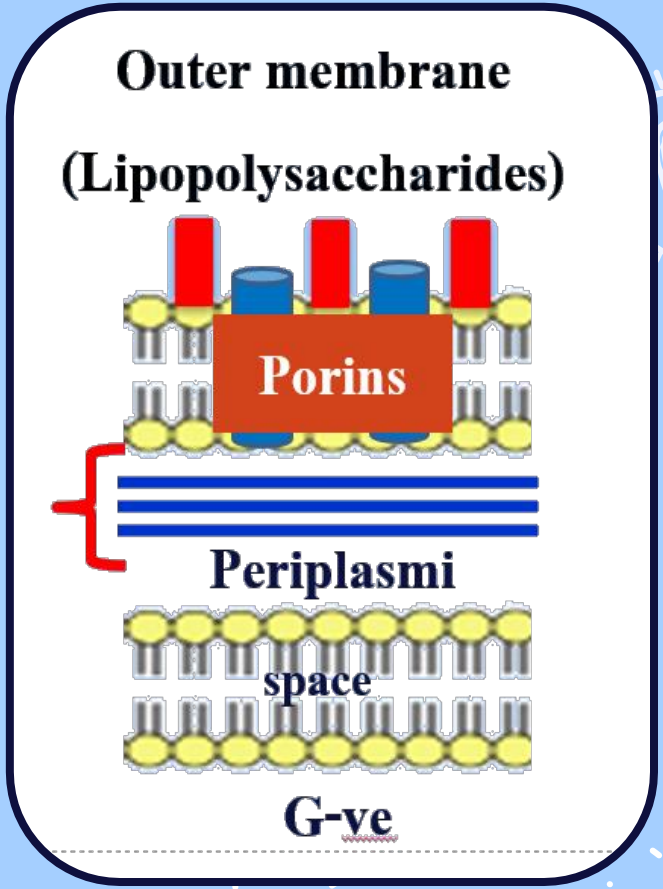


Outer membrane

A) Bilayer phospholipids

B) Lipopolysaccharides

- **Lipid A (Endotoxin)**
- **Polysaccharides (somatic O Ag)**



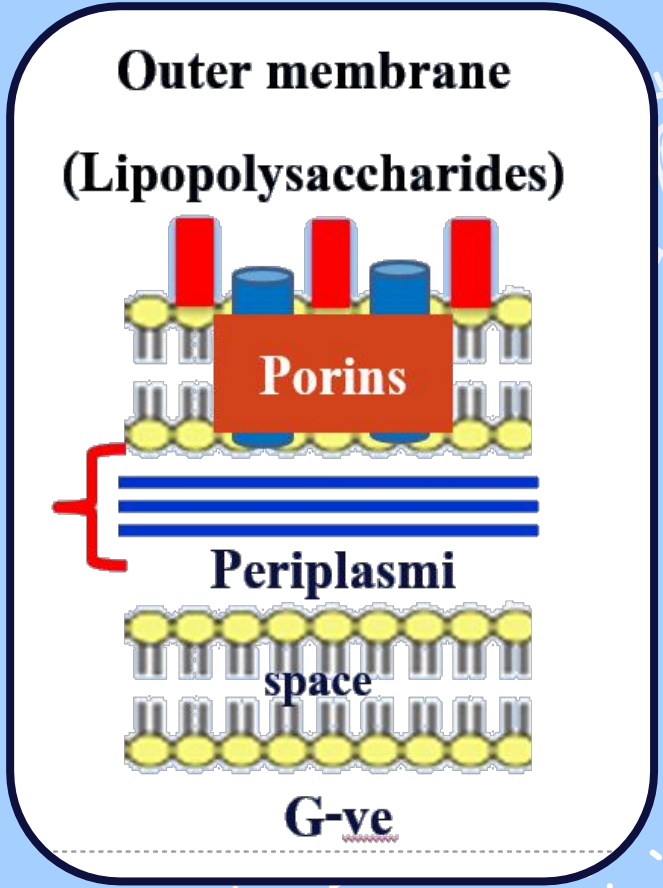
Outer membrane

C) Porins

(hydrophilic Protein)

in the outer membrane

(Transportation)



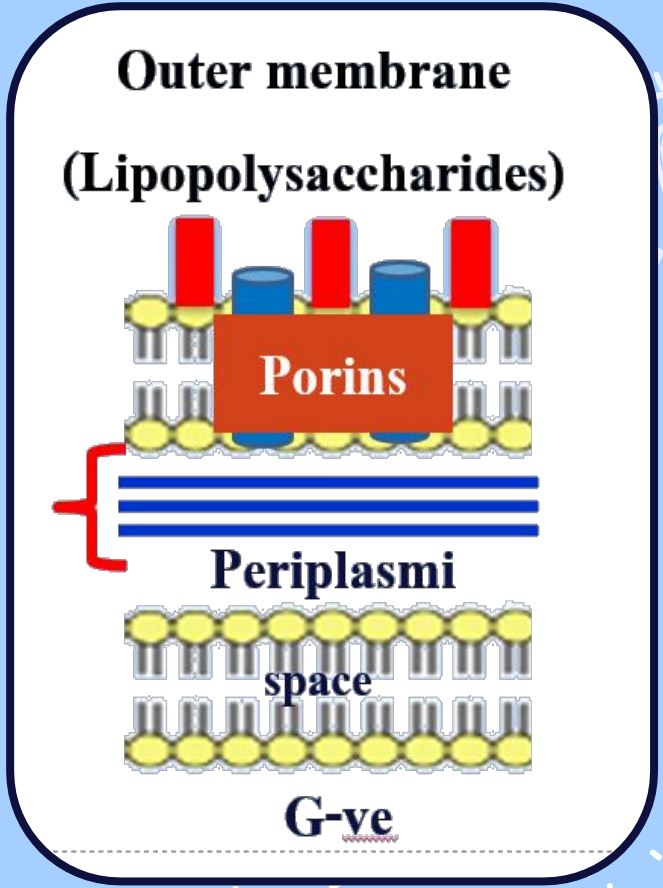
Periplasmic space

Space between cytoplasmic &

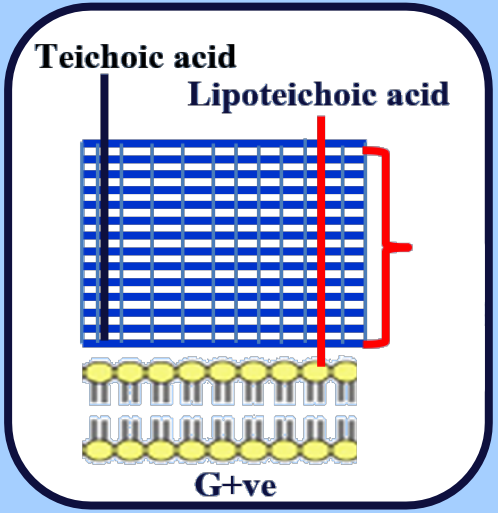
outer membrane

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

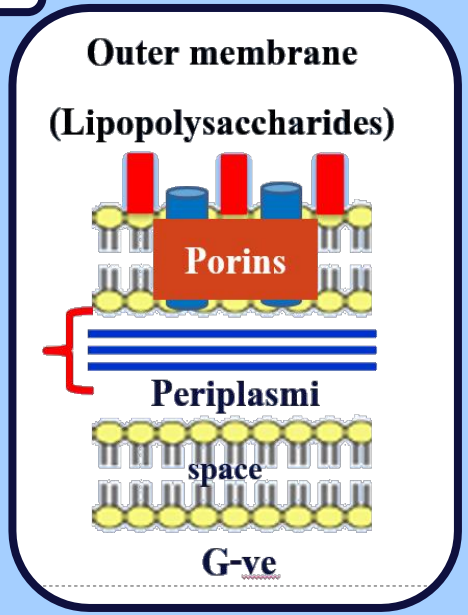
2) Teichoic acid/

Lipoteichoic acid

No

3) Outer membrane

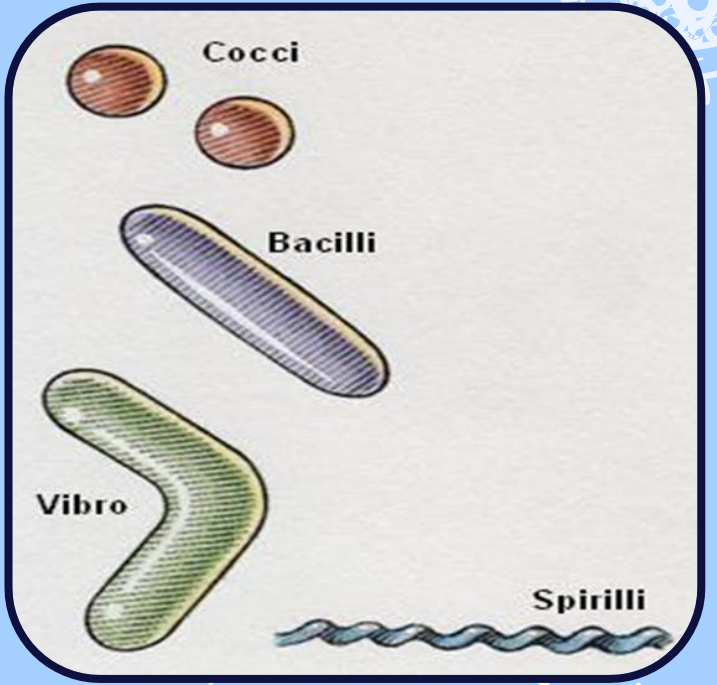
Yes



Function of cell wall

1

Maintenance of the shape (Rigid)



Function of cell wall

1

Deficient of cell wall

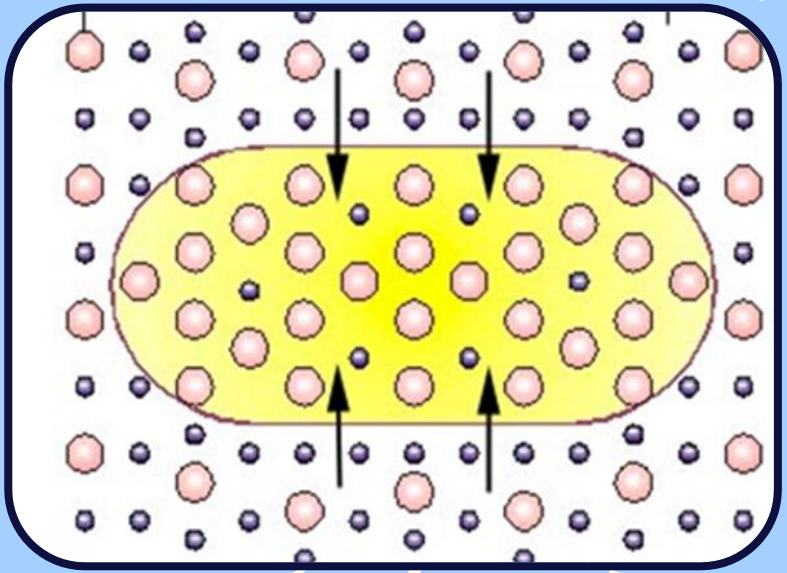
Polymorphic

Function of cell wall

2

Protection

(Osmosis insensitive)



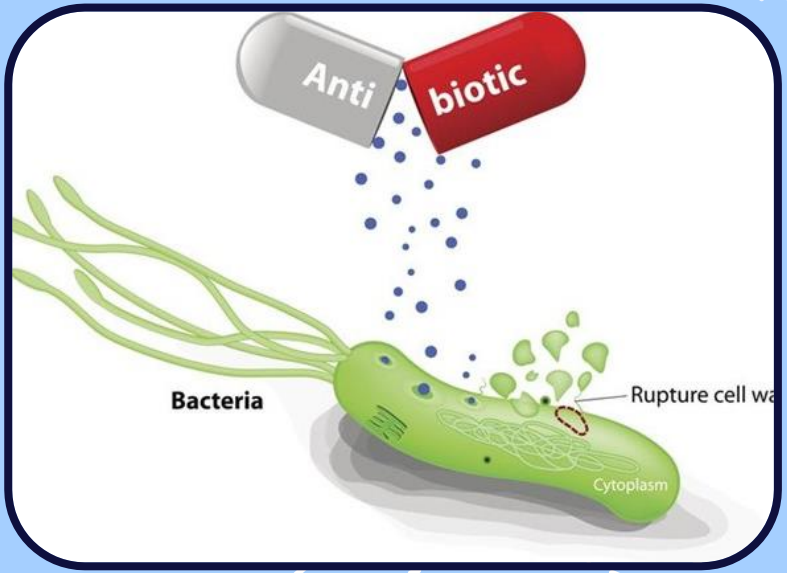
Function of cell wall

3

Target site for antibiotics

Penicillin

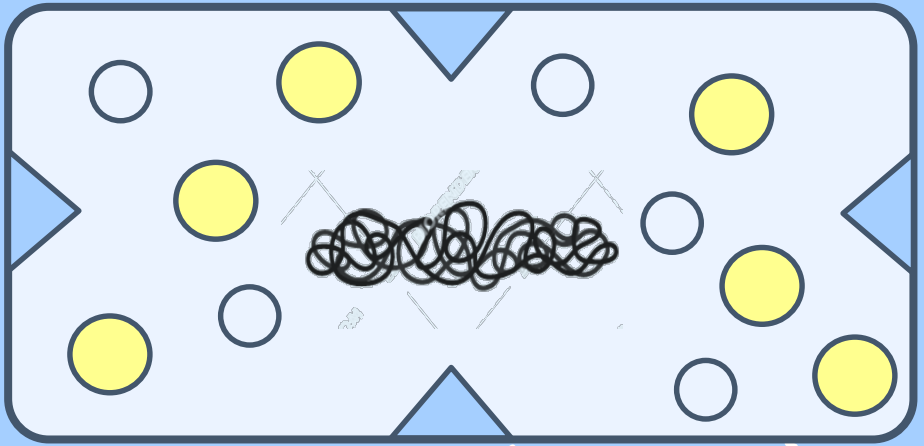
Cephalosporines



Function of cell wall

4

Role in cell division

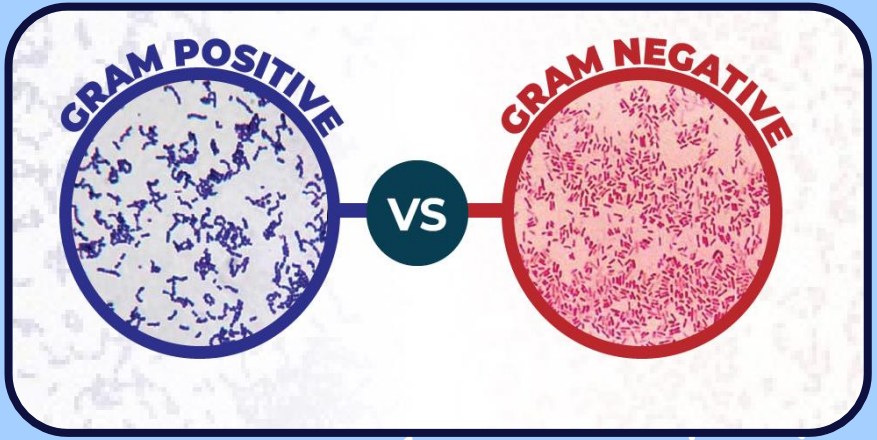


Function of cell wall

5

Responsible

for staining



Function of cell wall

Responsible for staining

G+ve

Fixation

Crystal violet

Iodine

Acetone

Counter stain

G-ve

Cell wall Deficient

Bacteria without cell wall

Cell membrane

Cell wall Deficient

1) Naturally

Mycoplasma

(Sterol)

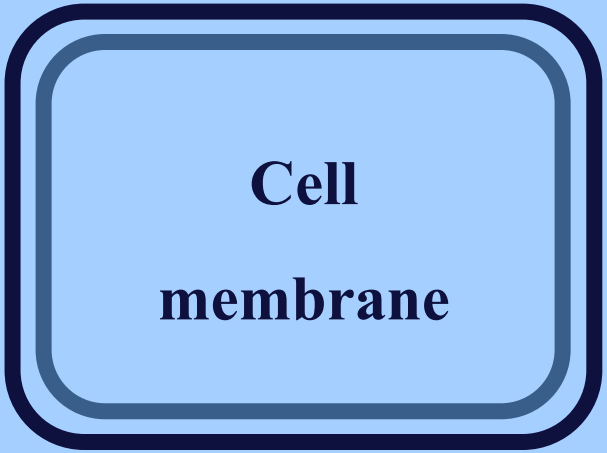
2) Induced

Cell wall inhibitors

Lysozyme

2) Induced

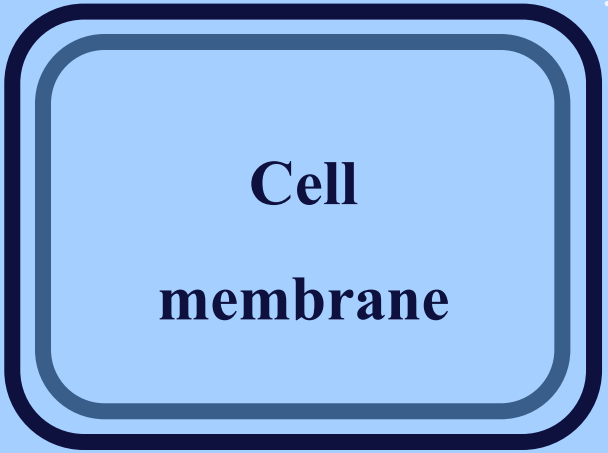
Completely



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

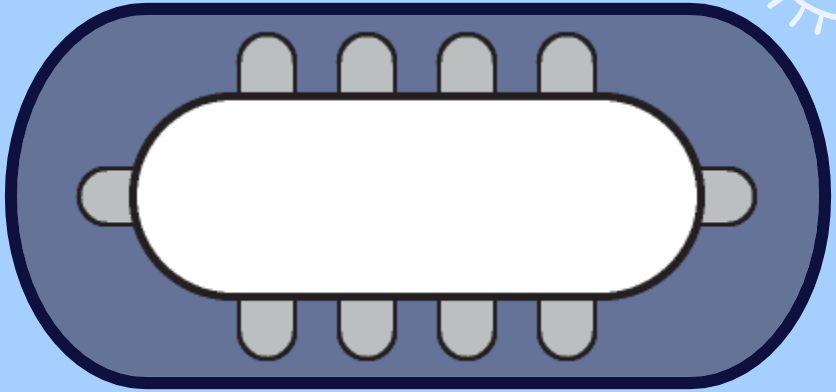
Capsule - Definition

Glyco → **carbohydrate**

calyx → **enveloped**

Capsule - Definition

Gelatinous (Viscous) layer covering cell wall of some bacteria



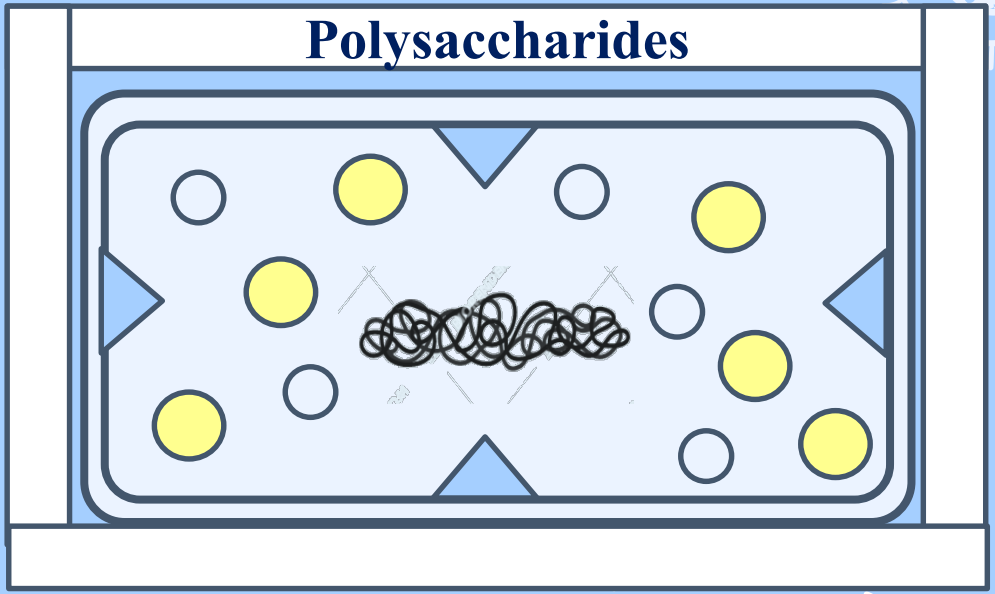
Extra layer

Capsule - Composition

Usually Polysaccharides

Polypeptides

(*B. anthracis*)



Capsule - Composition

Variation of Capsule

(Arrangement of Polysaccharides)

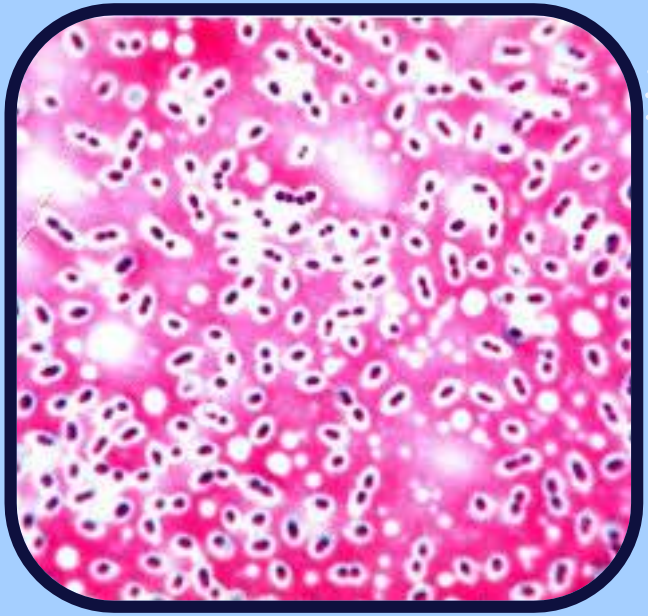
Sucrose	**Mannose**	**Lactose**
Mannose	**Sucrose**	**Mannose**
Lactose	**Sucrose**	**Mannose**

e.g. 91 types of *Str. pneumoniae*

Capsule - Composition

Do Not stained by

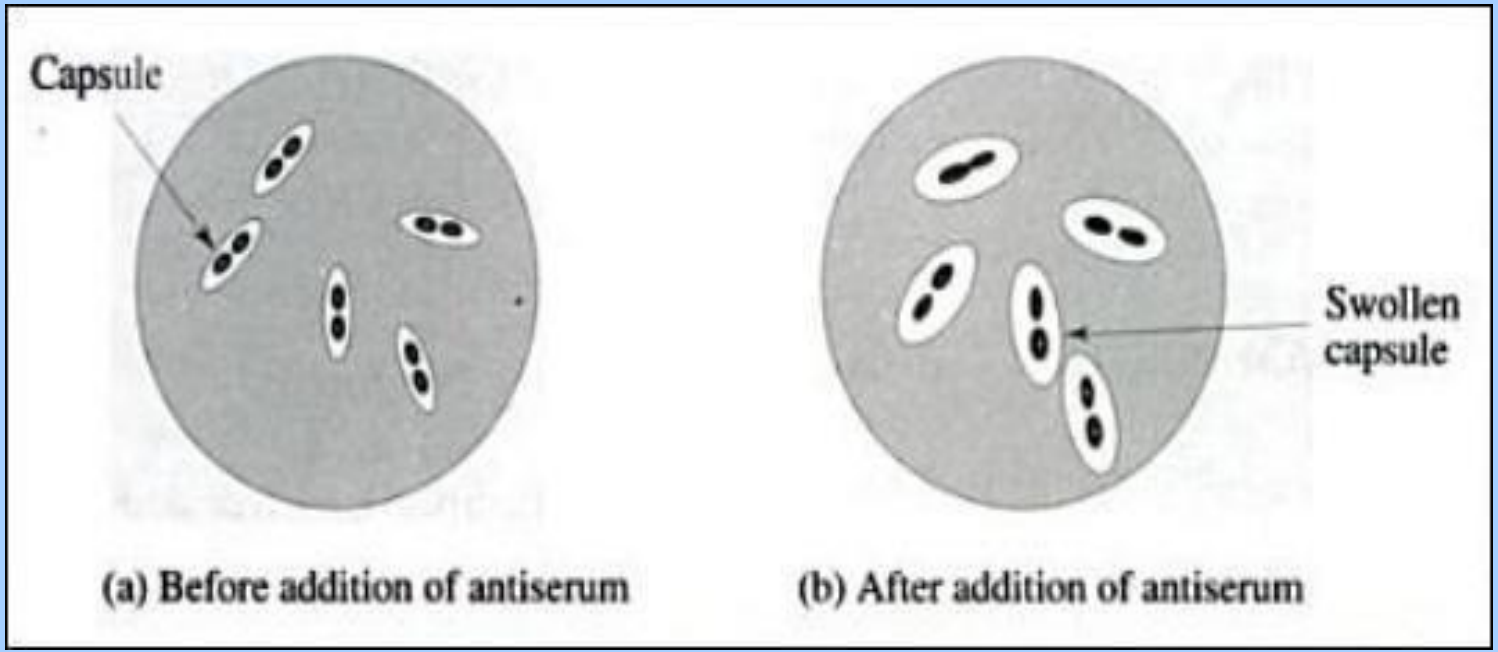
Gram stain



Unstained halo around the organism

Capsule - Composition

Quellung reaction (swelling)

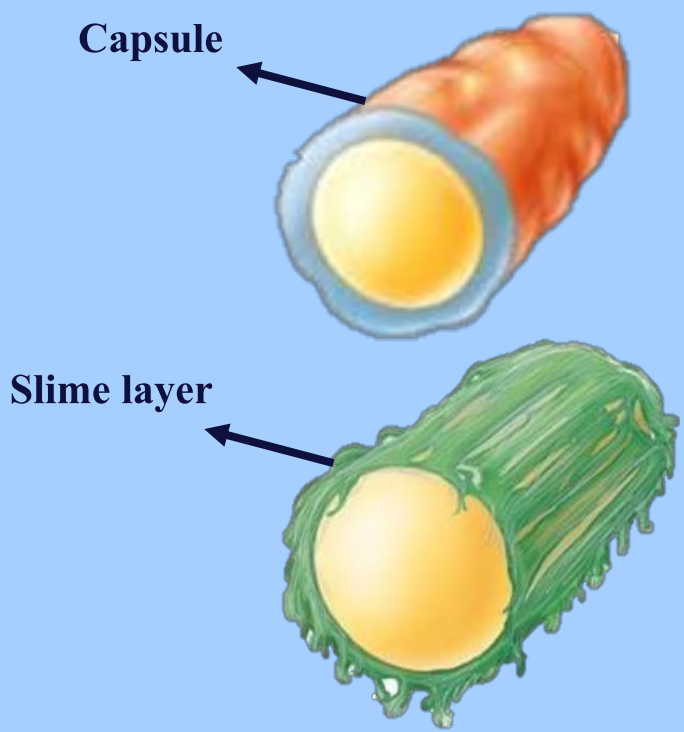


Capsule - Composition

Capsule

Glycocalyx

Slime layer



Capsule - Composition

Capsule

Tightly, organized bound around all cell wall

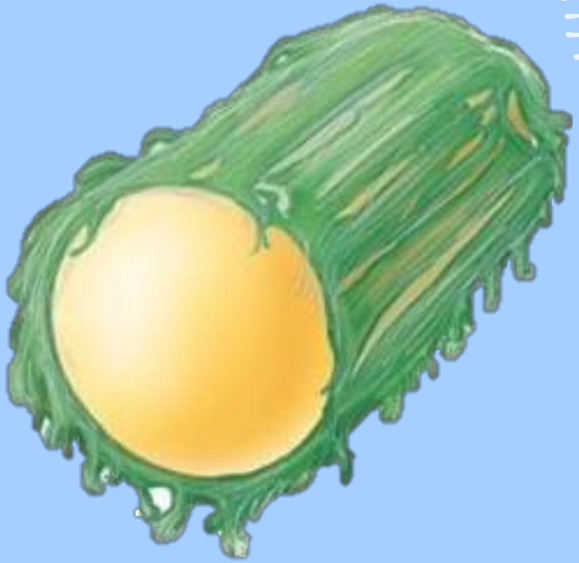
Firmly adherence to surface organism

Capsule - Composition

Glycocalyx

(Slime layer)

Loosely & unorganized attached



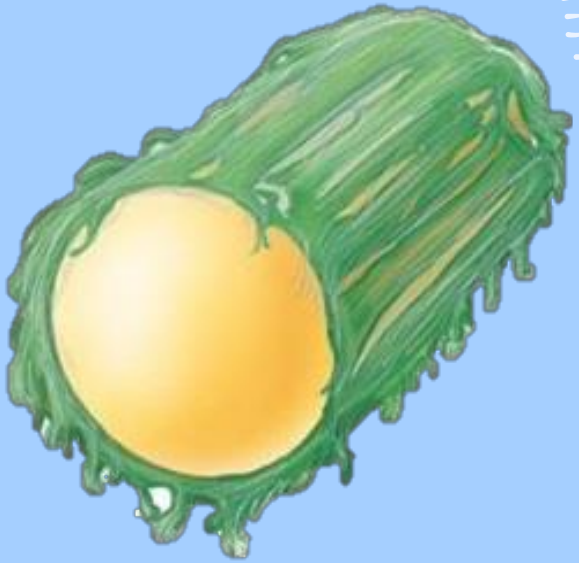
Capsule - Composition

Glycocalyx

Fibrils extending

It adhere firmly to skin, heart, etc

e.g. *Strept. mutans*

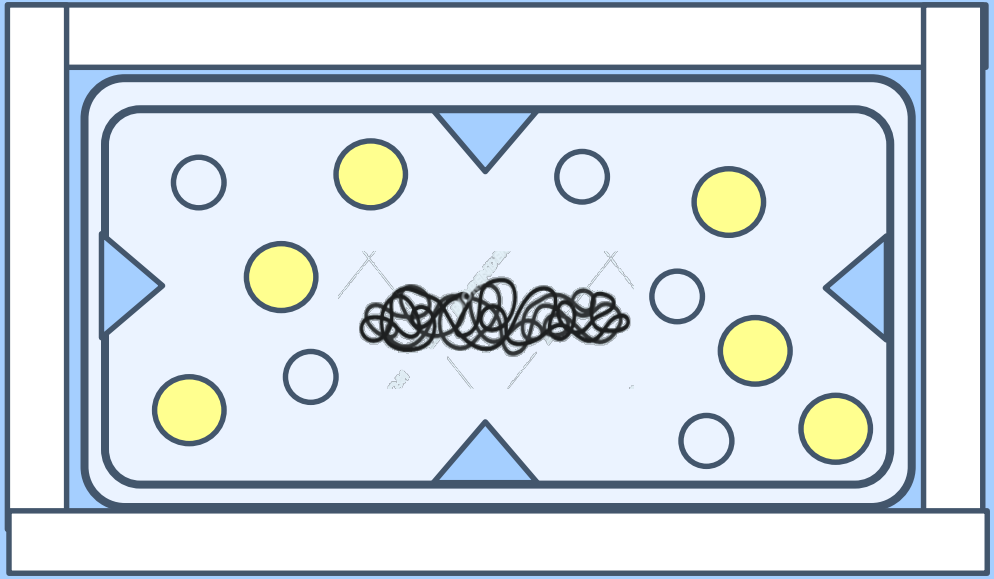


Loosely & unorganized attached

Capsule - Function

A

Protect Cell wall



Bacteriophage

Complement

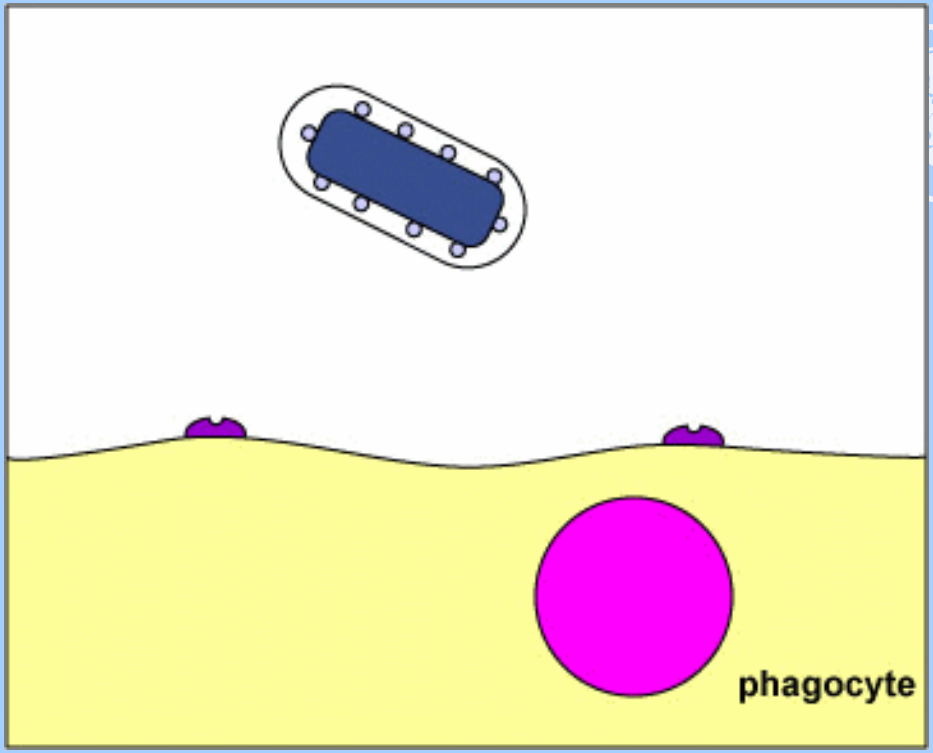
lysozyme

Capsule - Function

B

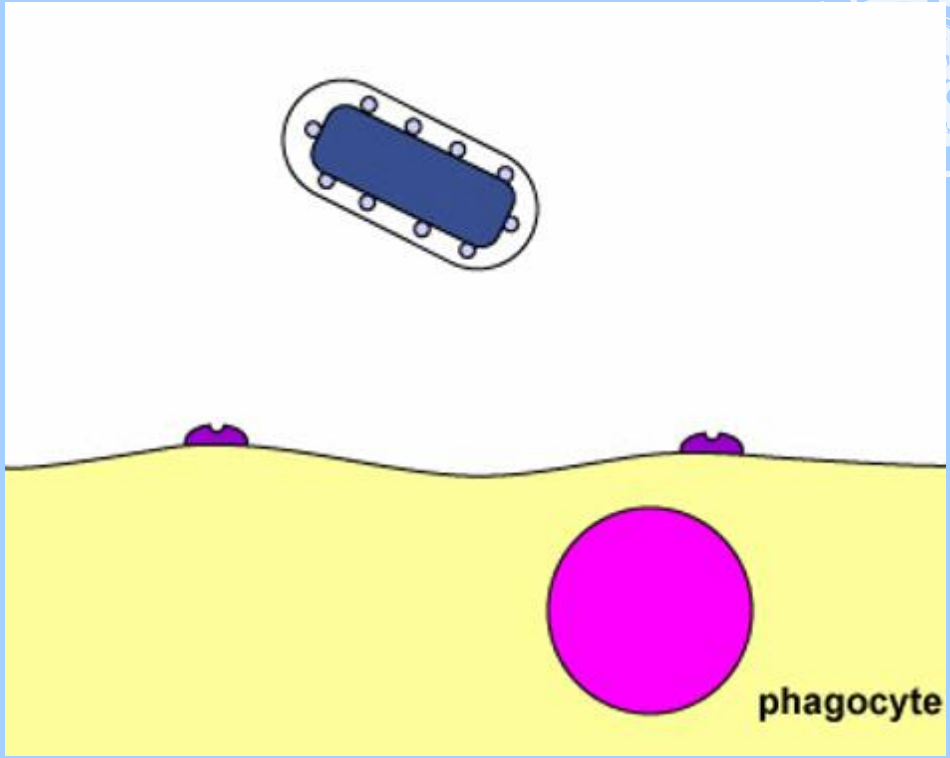
Prevent phagocytosis

(Virulence)



Capsule - Function

Capsules are formed in VIVO ONLY



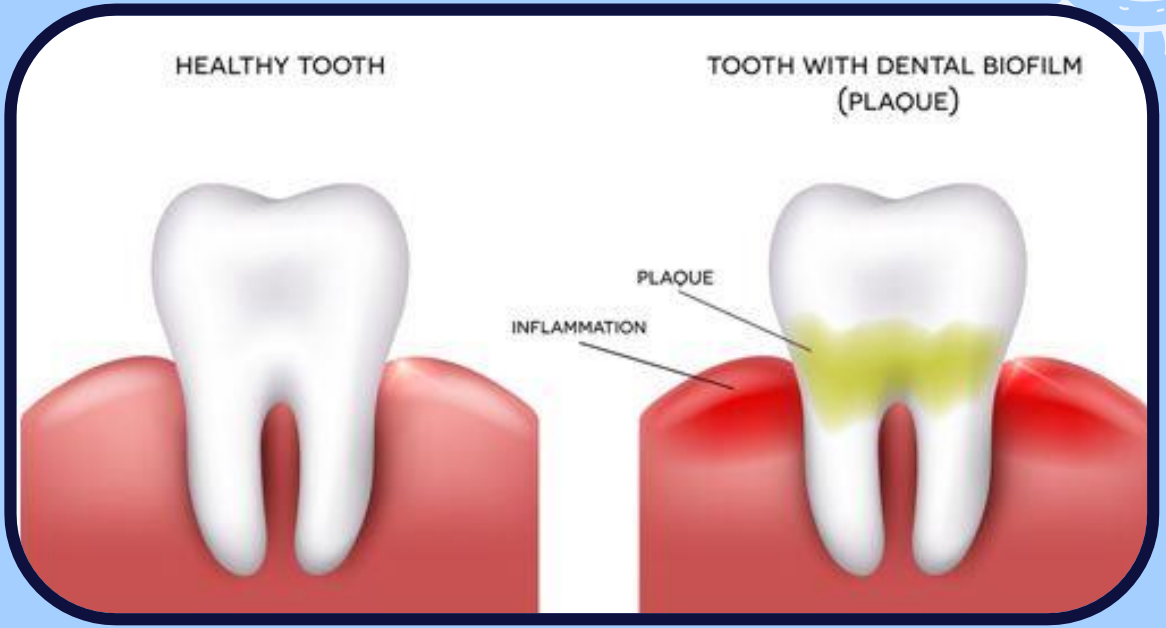
Capsule - Function

C

Attachment

(Glycocalyx)

Dental caries



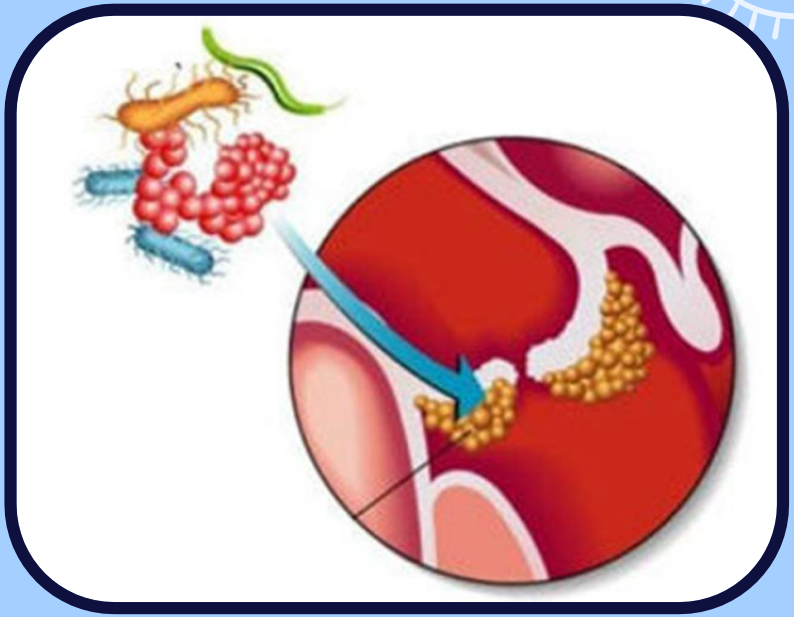
Capsule - Function

C

Attachment

(Glycocalyx)

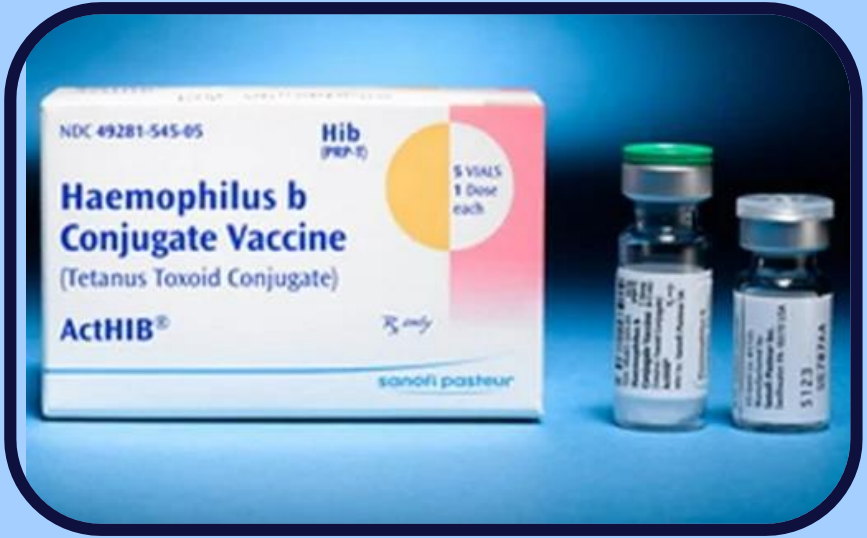
- **Prosthetic heart valves**



Capsule - Function

D

Development of vaccine



Flagella - Definition

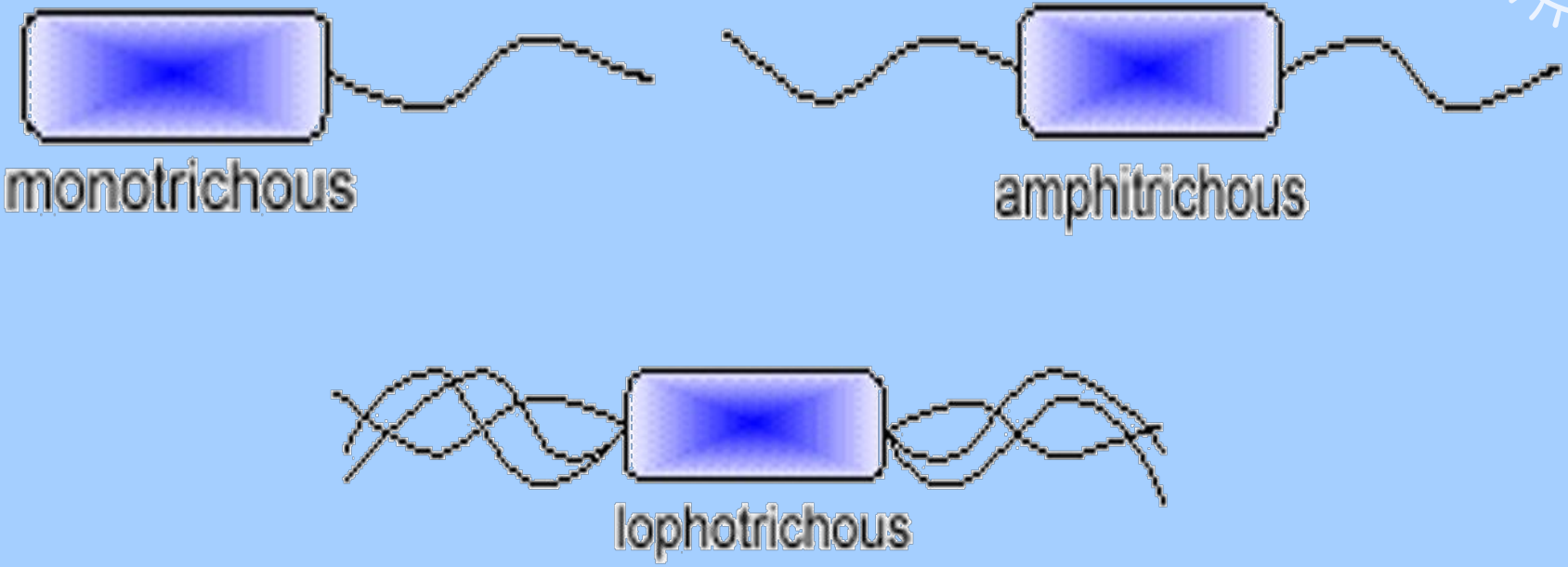
Seen by EM

(20nm)

Flagella - Definition

Polar

Spiral

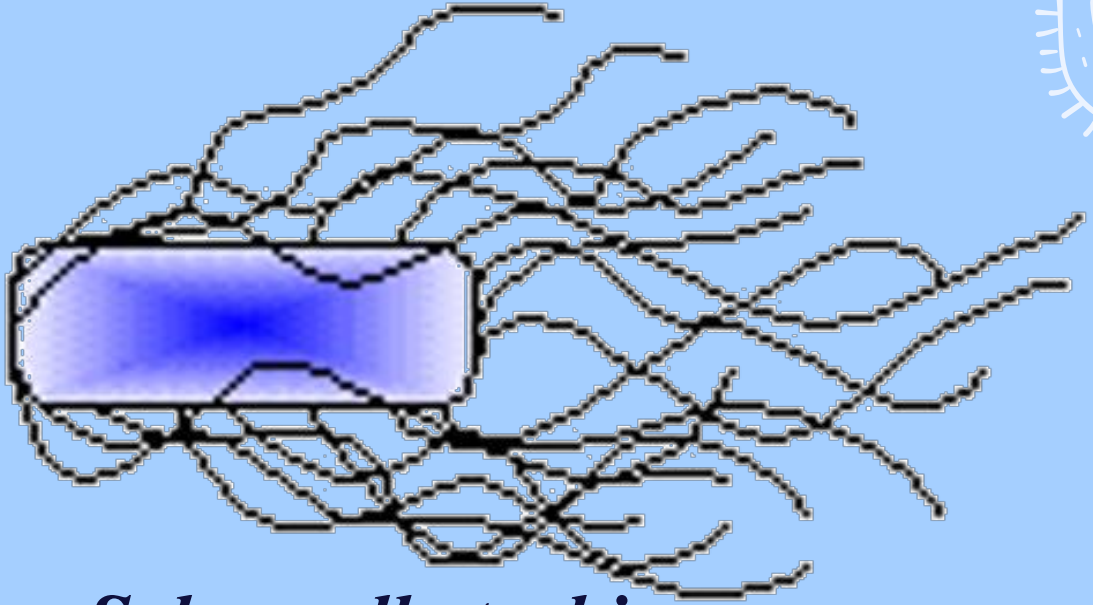


Flagella - Definition

Peri/trichous

around

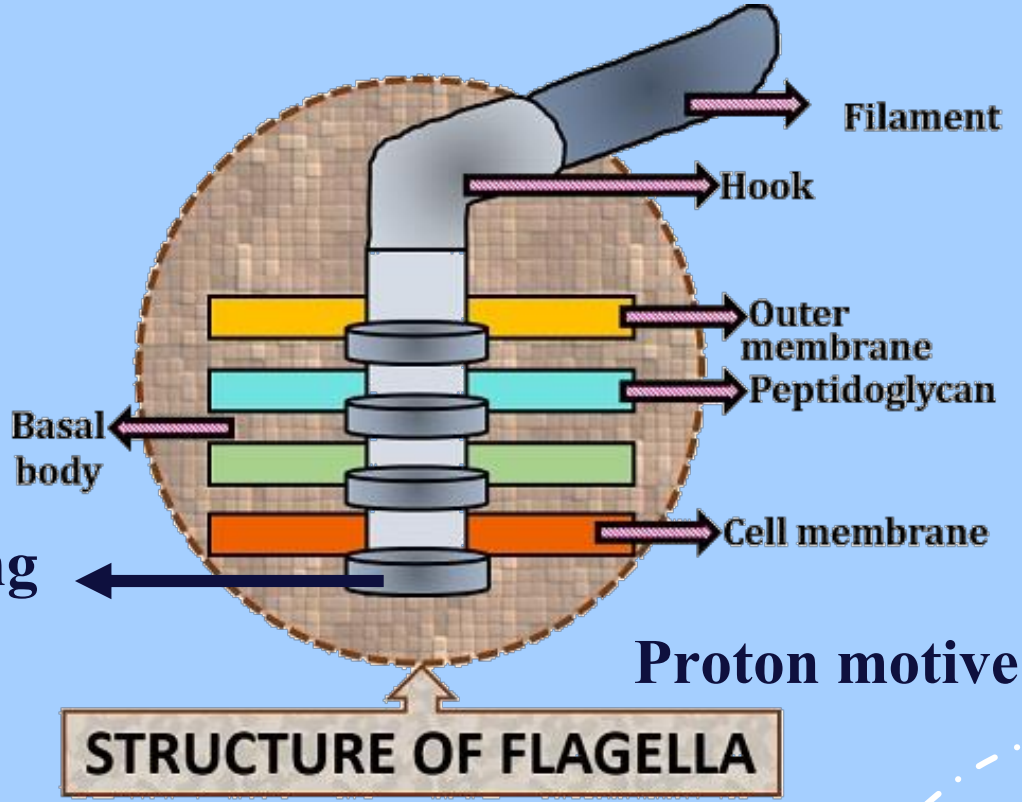
peritrichous



Salmonella typhi

Flagella - Function

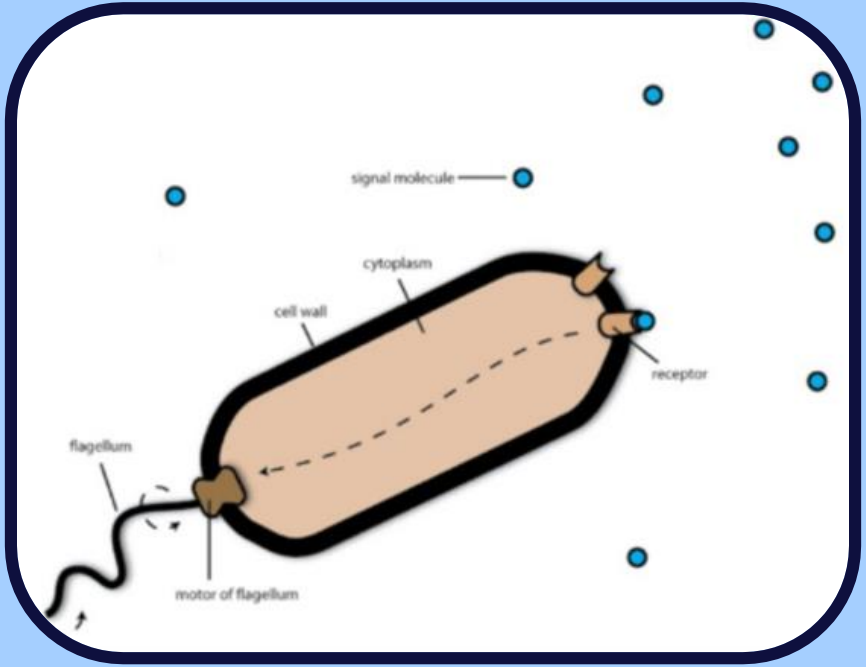
Motility



Proton motive force

Flagella - Function

The organs of motility

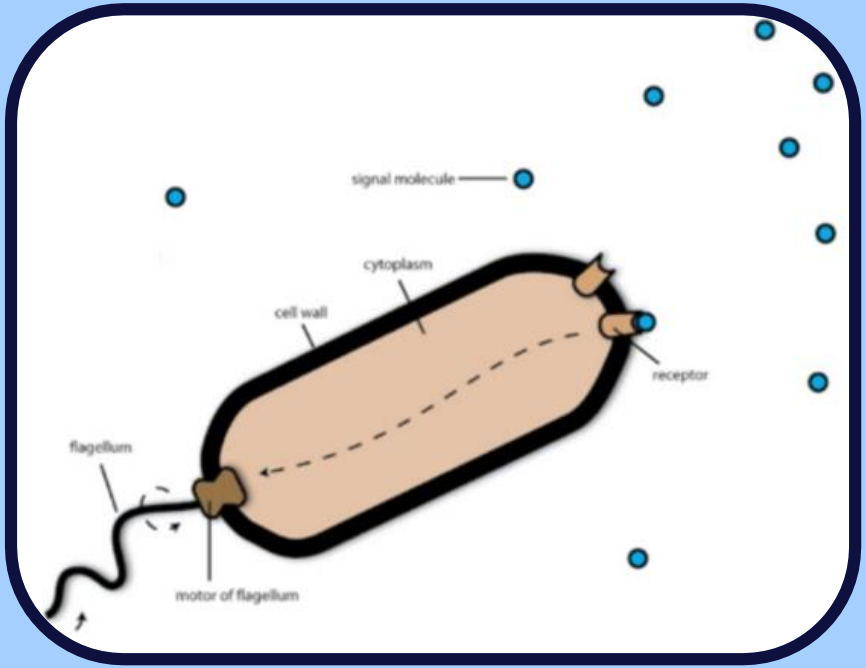


Flagella - Function

Tactic response (Taxis)

(Stimulus)

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



Flagella - Function

Tactic response (Taxis)

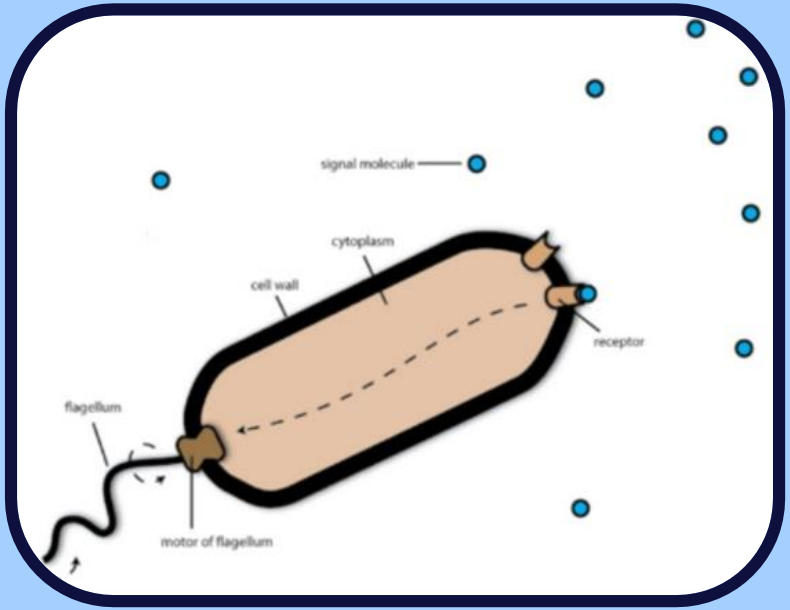
Stimulating agent

Chemo

Light

Photo

Chemical



Axial Filaments

Endoflagella

In spirochetes

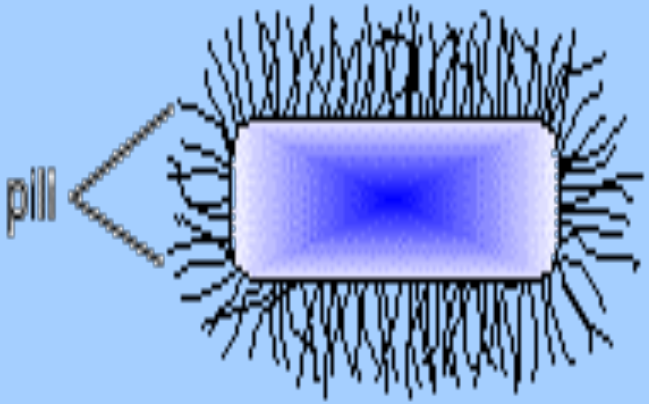
Pili (Fimbriae)

Short and thin

Hair like formed from

protein

(Pilin)



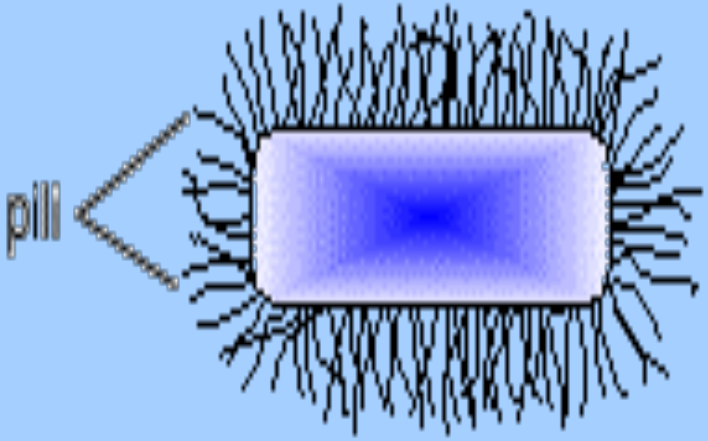
Pili

Seen by EM

Pili

A) Ordinary pili

(Attachment)

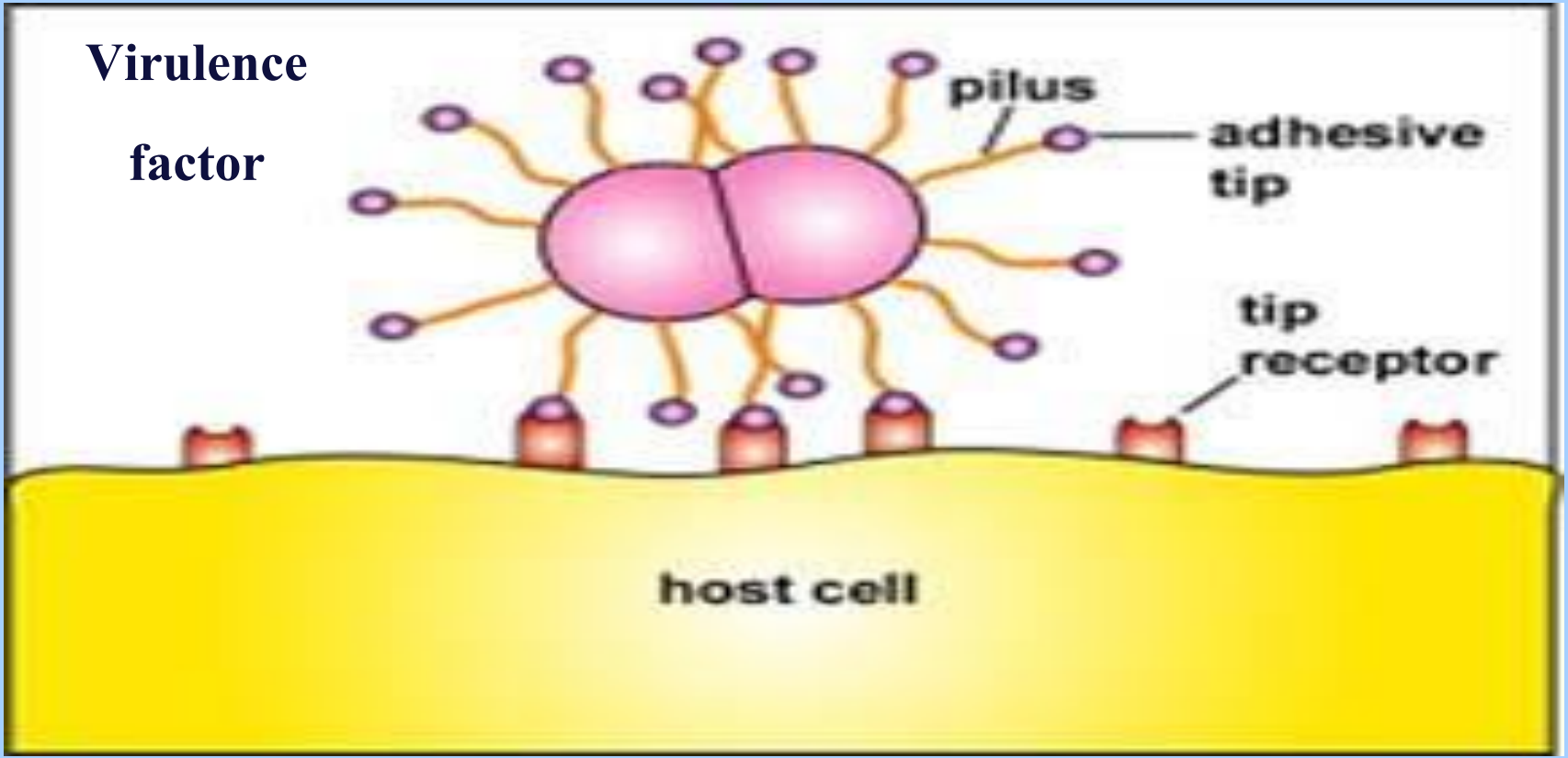


B) Sex pili

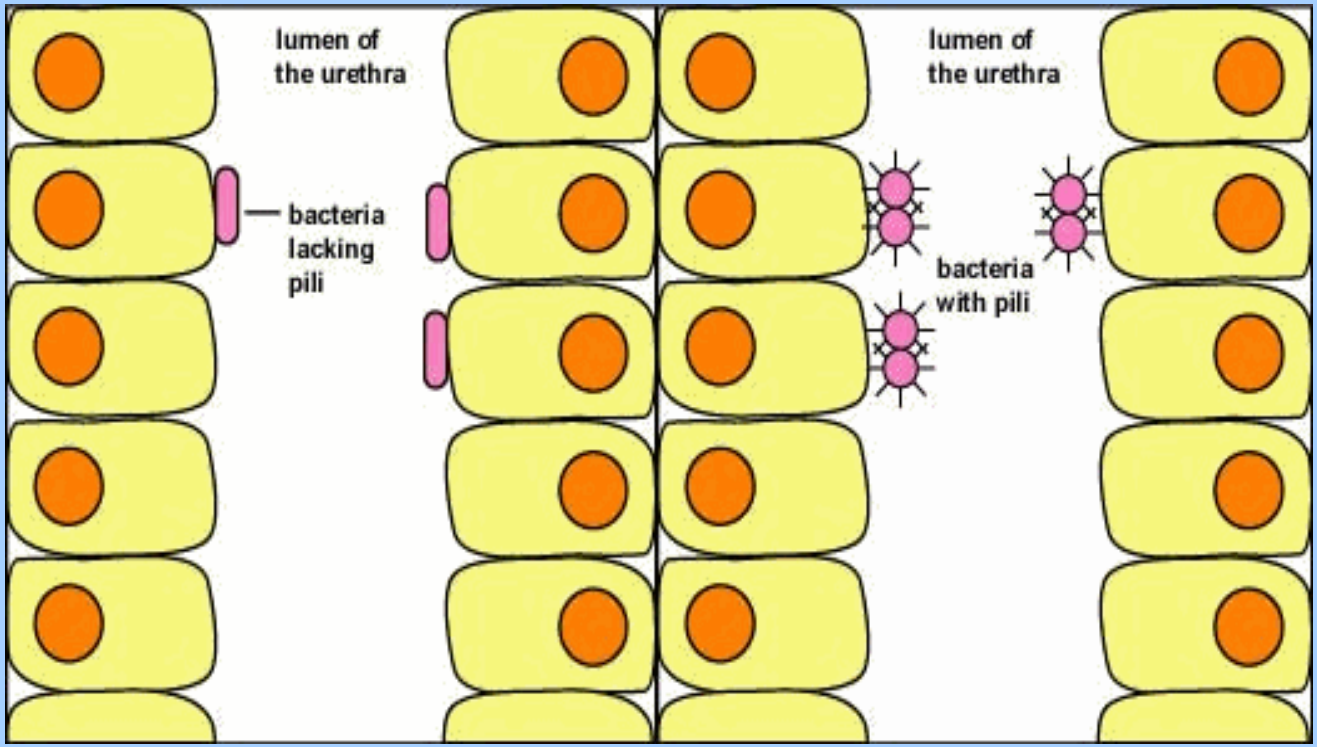
(Genetic transfer)

Ordinary Pili

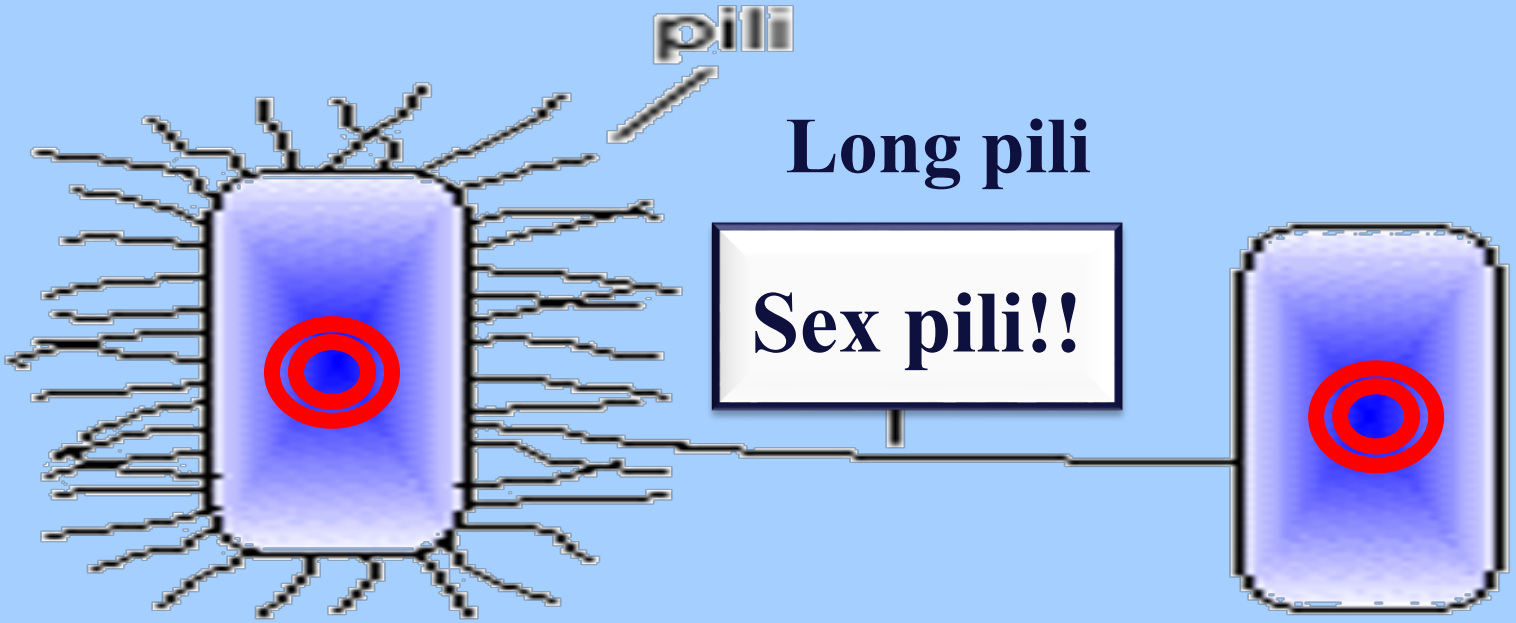
Virulence factor



Ordinary Pili



Sex Pili



F+

Donor

Conjugation

F-

Recipient

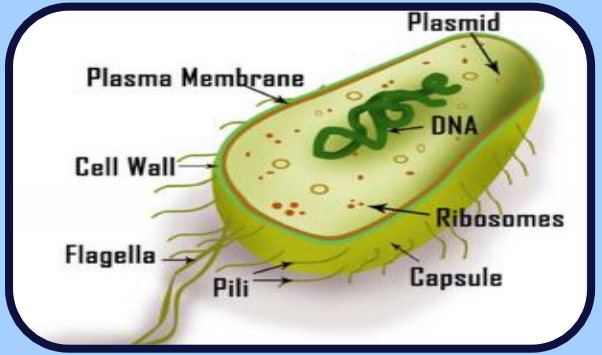
Spore formation

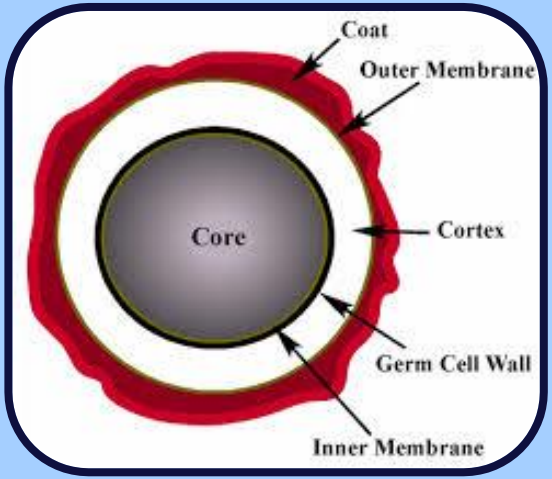
Vegetative bacteria

Unsuitable condition

Spore formation

(Outside)



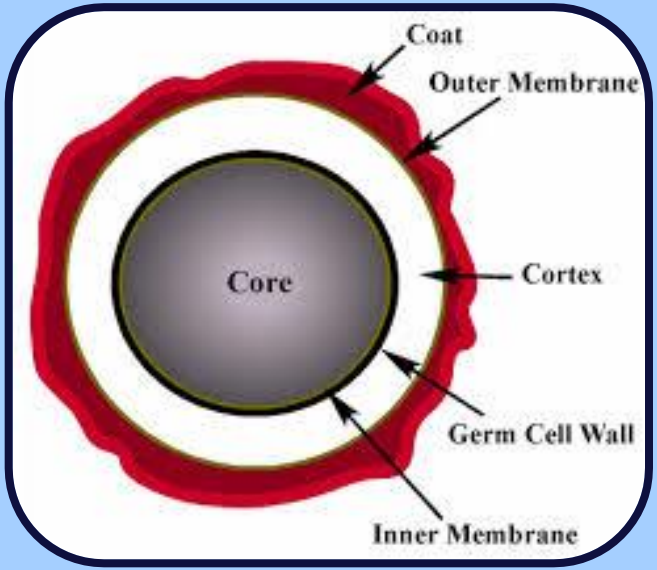


Spore formation

Forming highly resistant resting phase (Endospores) in VITRO

Bacillus

Clostridium



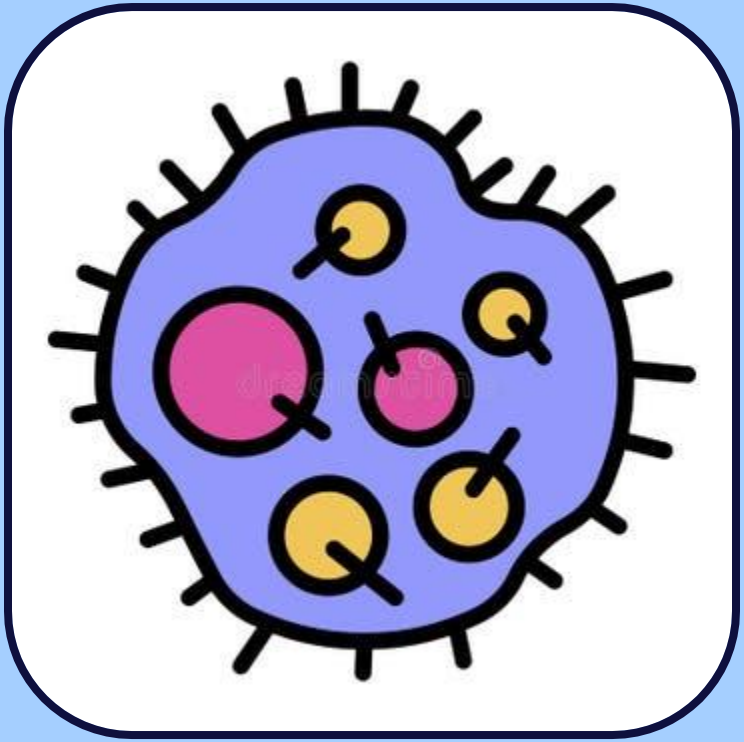
Spore formation

Occur to unfavorable conditions e.g.

High temp.

Drying

Depletion of nutrition



Spore formation

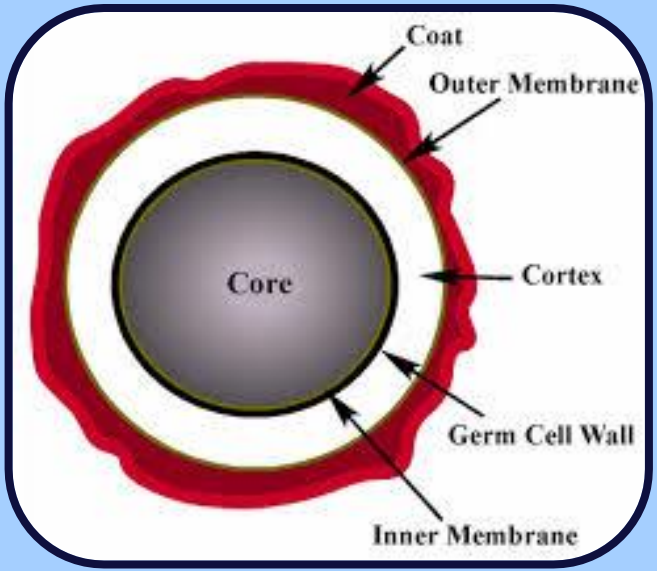
Formed outside the body (in VITRO)

Can not stained by ordinary stain

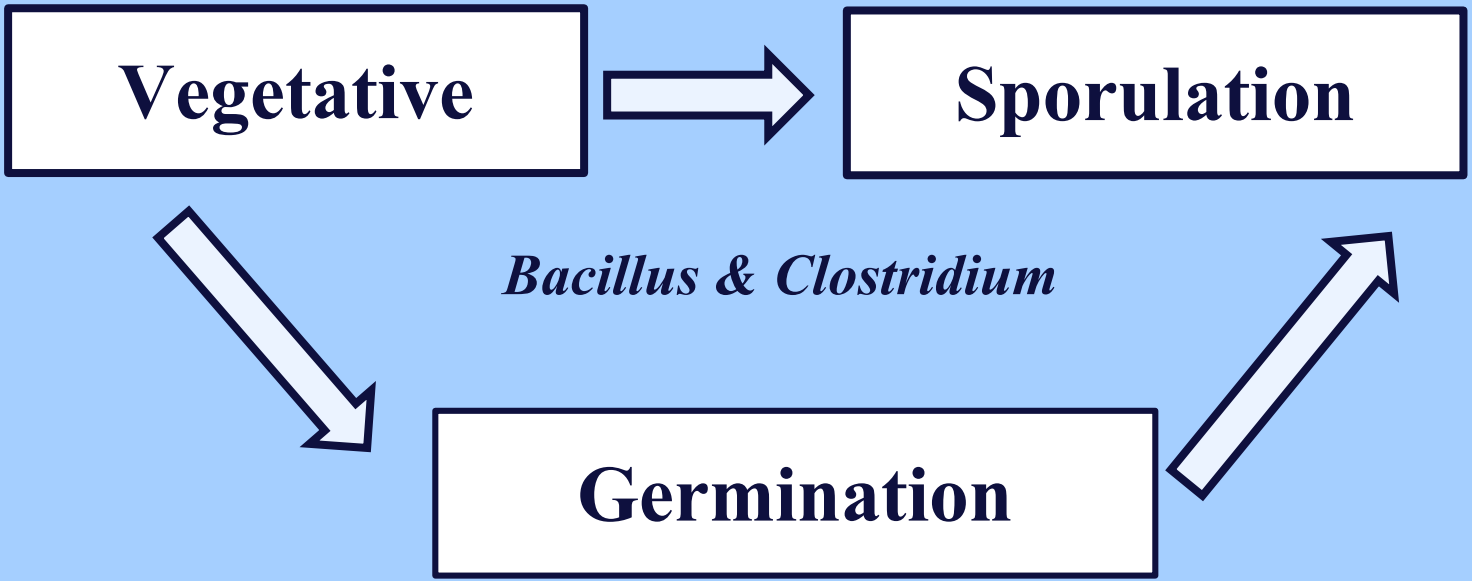
Spore formation

Highly resistant to dryness,

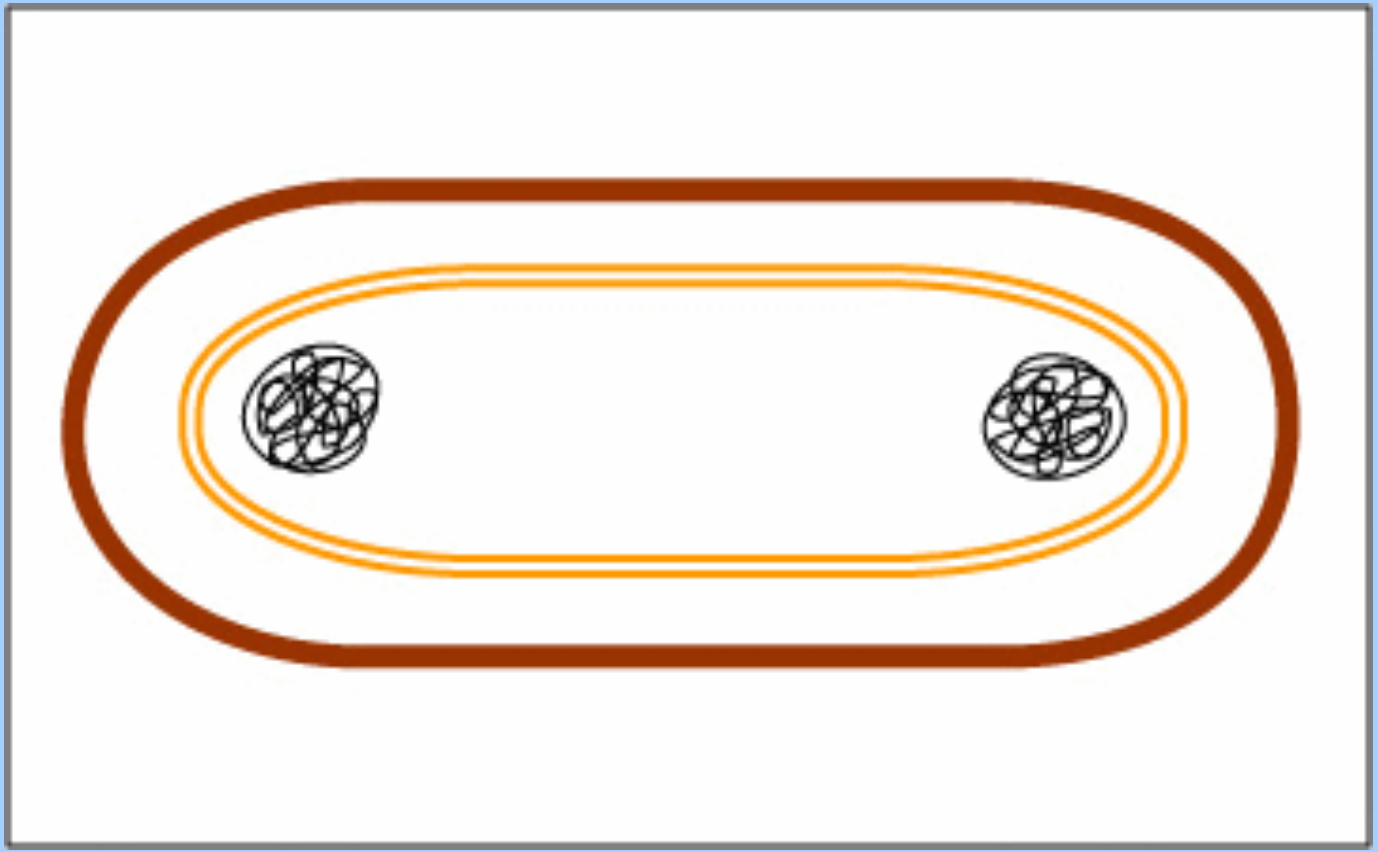
heat & Disinfectant



Spore formation



Spore formation

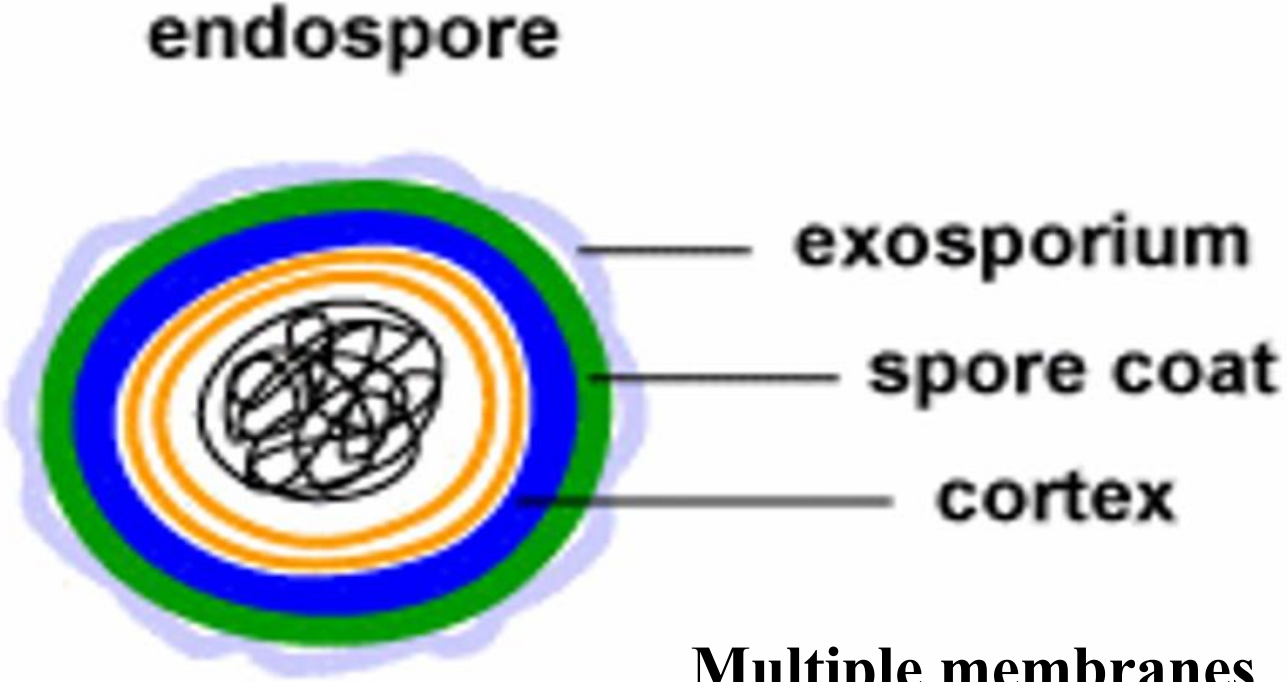


Ca+2 &

Diplconic acid

Multiple membranes

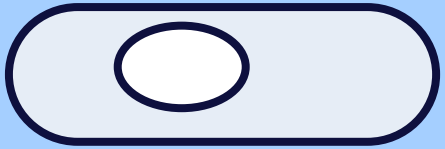
Spore formation



Multiple membranes

Germination

Position of spores



B. anthracis

Central & Oval

Cl. perfringens

Sub-terminal & Oval

Cl. Tetani

Terminal & Spherical