



بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ
الَّذِي عَلَّمَ بِالْقَلَمِ ۖ عَلَّمَ الْإِنْسَانَ مَا لَمْ يَعْلَمْ ۝



MICROBIOLOGY

MID | Lecture 4

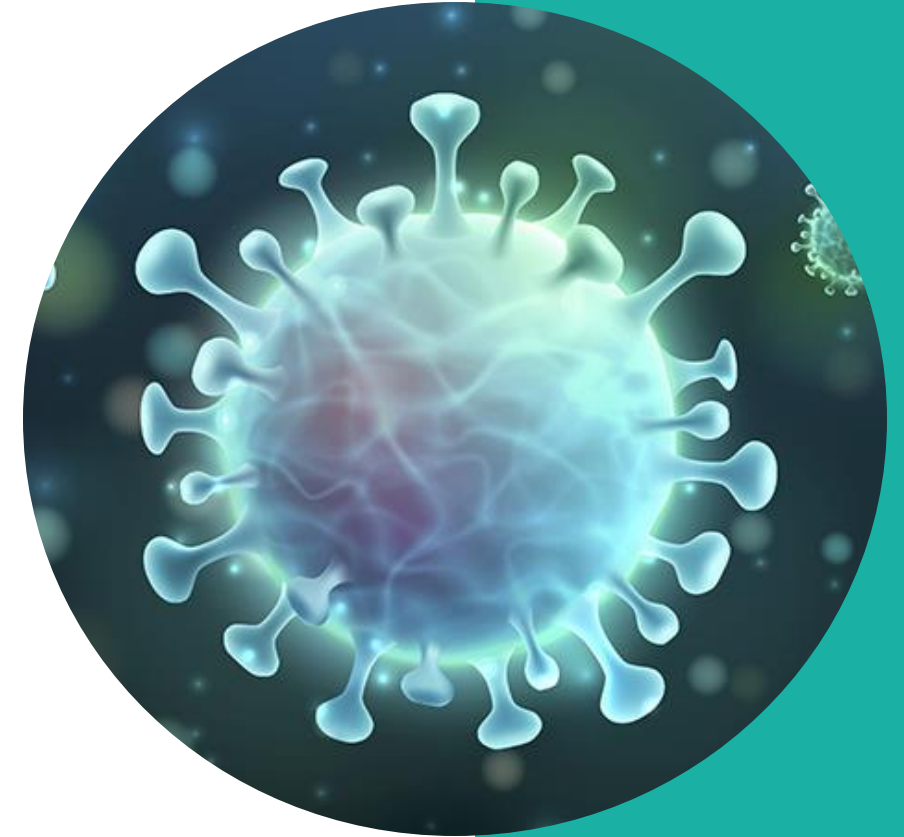
Bacterial Structure Pt.2

Written by :

NST

Reviewed by

MST



Color coding used in the modified:



Black: the original slides



Teal: the doctor's explanation/words



Gray: additional information and explanation

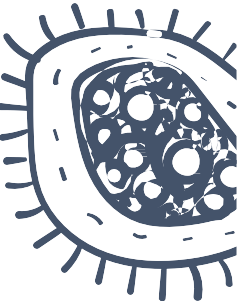


Red: important information

Cell Wall Deficient

**Bacteria without
cell wall**

**Cell
membrane**

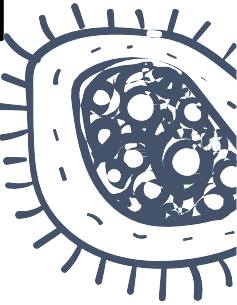


Cell wall Deficient

1) Naturally

**Mycoplasma
(Sterol)**

2) Induced



Cell wall inhibitors
Lysozyme

Like some
antibiotics

Produced by immune
system to break the bacterial
cell wall down

2) Induced

Completely

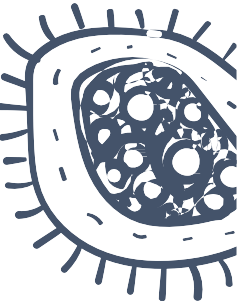
Cell membrane

**Protoplast (+ve)
Spheroplast (-ve)**

Partially

Cell membrane

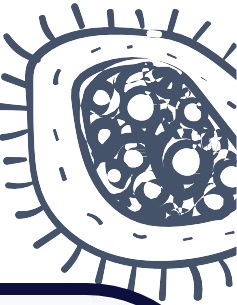
L-form bacteria



L-form & Mycoplasma

Resist to Penicillin & Cephalosporines

Penicillin and cephalosporins are ineffective against cell wall-deficient bacteria because they target the cell wall. Instead, antibiotics that act on other structures, such as ribosome-targeting antibiotics, can be used.



Objectives

Structures outside the cell wall

1) Capsule

2) Flagella

3) Pili

4) Spore formation

Capsule - Definition

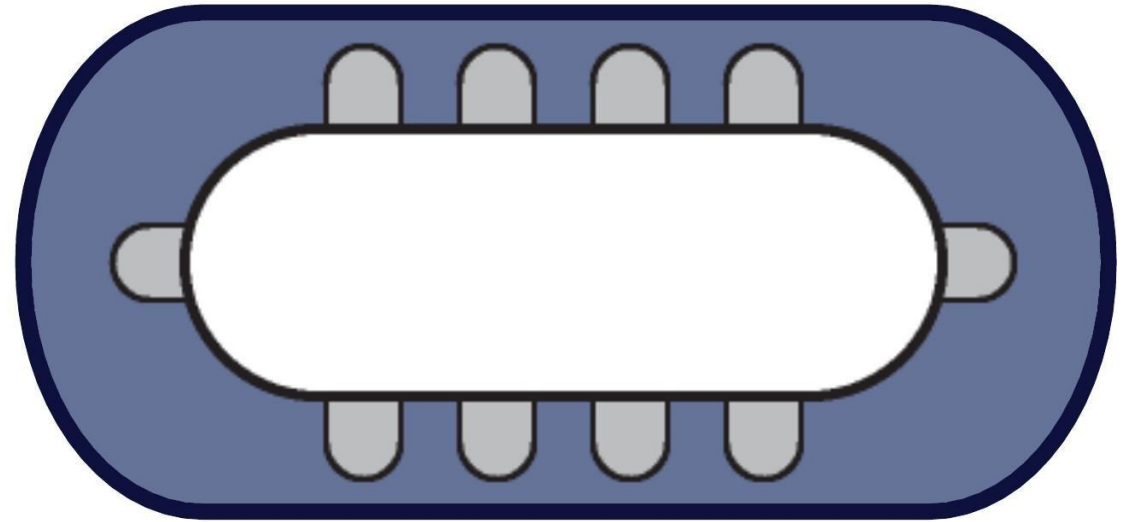
Glyco **calyx**
↓ ↓
carbohydrate **enveloped**

A capsule is a wall made of carbohydrates that surrounds the cell wall.

Capsule - Definition

The capsule is an extra layer since it is NOT present in ALL bacteria.

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



Extra layer

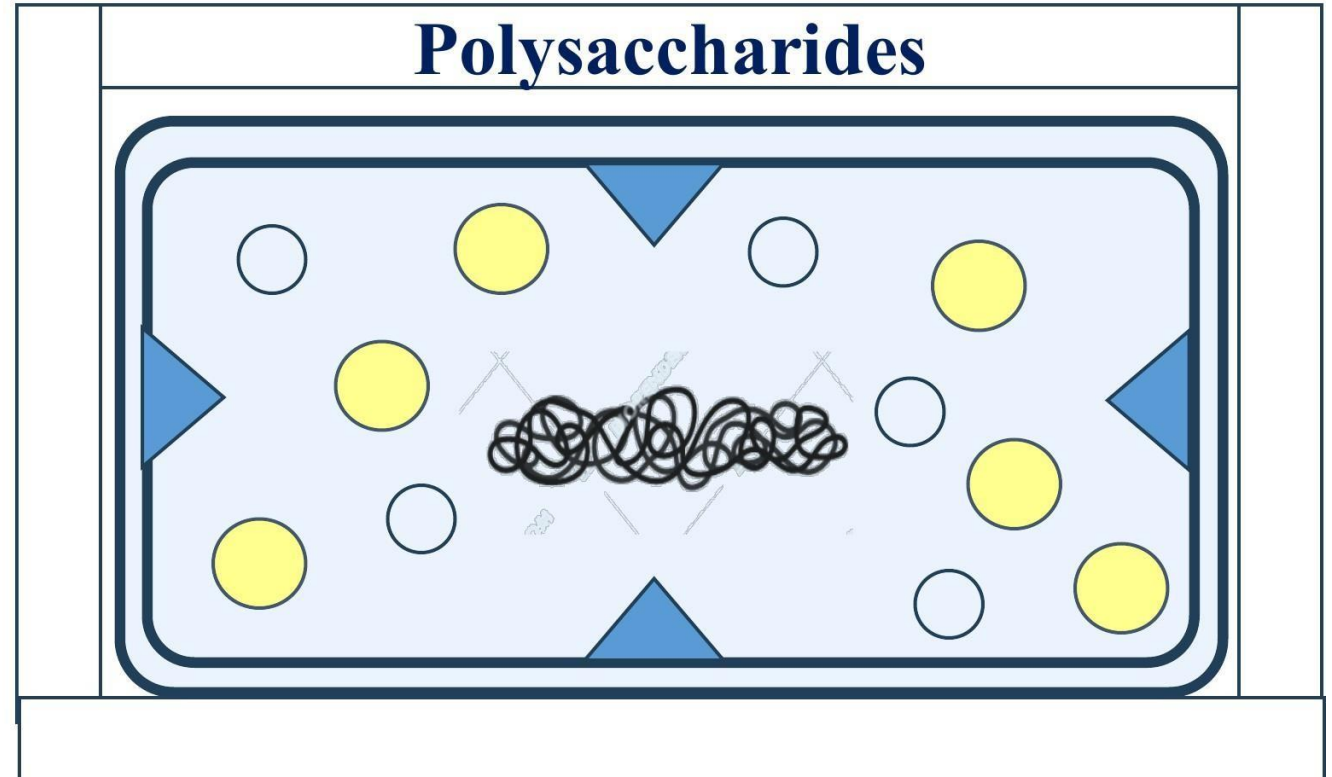
Capsule - Composition

Usually Polysaccharides

EXCEPT

Polypeptides

(*B. anthracis*)



Capsule - Composition

Variation of Capsule



Caused by different

(Arrangement of
Polysaccharides)

Sucrose	Mannose	Lactose
Mannose	Sucrose	Mannose
Lactose	Sucrose	Mannose

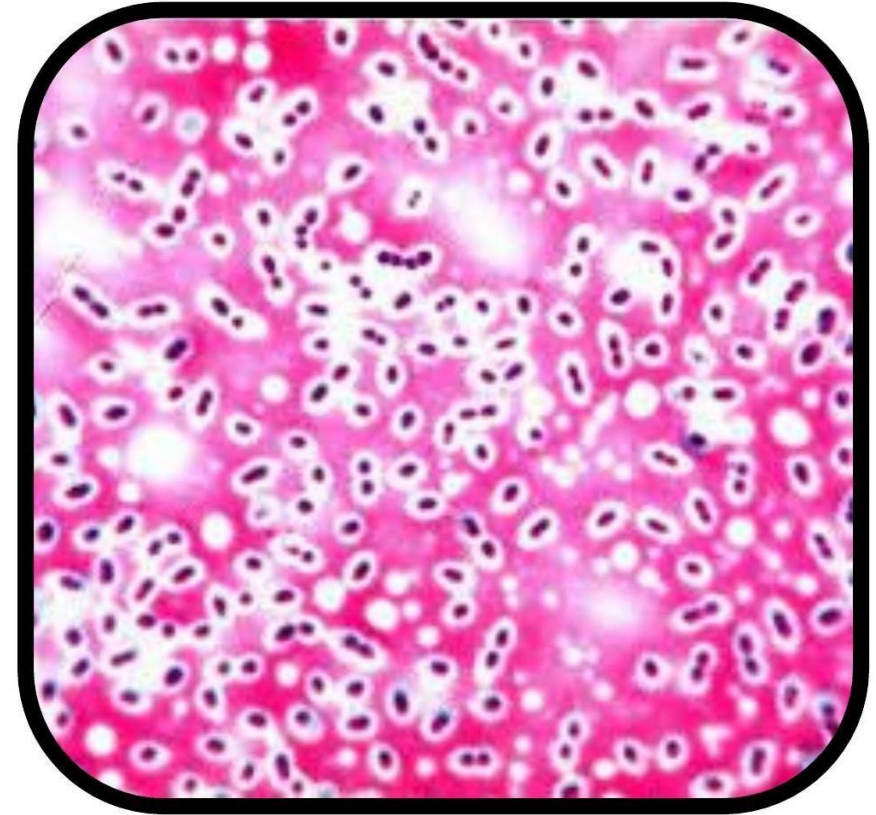
e.g. 91 types of

Str. pneumoniae

Due to different polysaccharides arrangement

Capsule - Composition

**Do Not stained by
Gram stain**

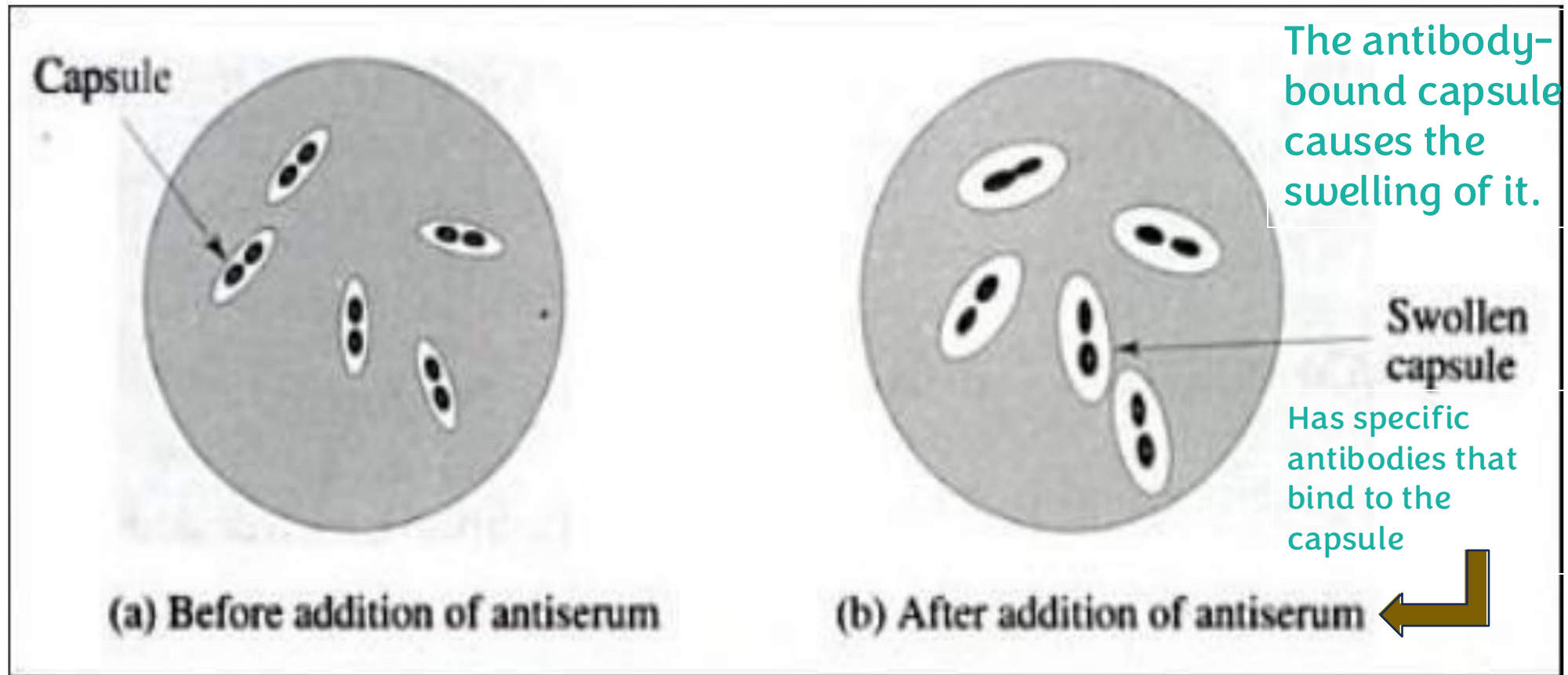


That is why we see **Unstained halo around the
organism**

Capsule - Composition

This is one of the mechanisms used to identify bacteria that has capsules.

Quellung reaction (swelling)



Capsule - Composition

Capsule

The name differs depending on the binding of the substance to the cell wall.

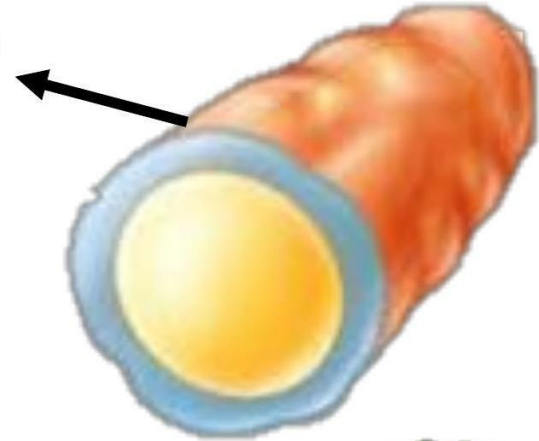
Glycocalyx

Has fibril extensions help it adhere

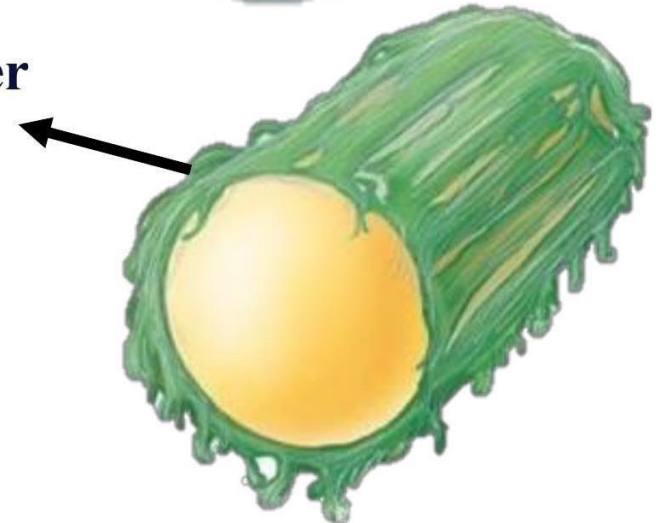
Slime layer

These components are similar in their loose, unorganized attachment

Capsule



Slime layer



Capsule - Composition

If the substance is highly attached to the cell wall, we call it a capsule

Capsule

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

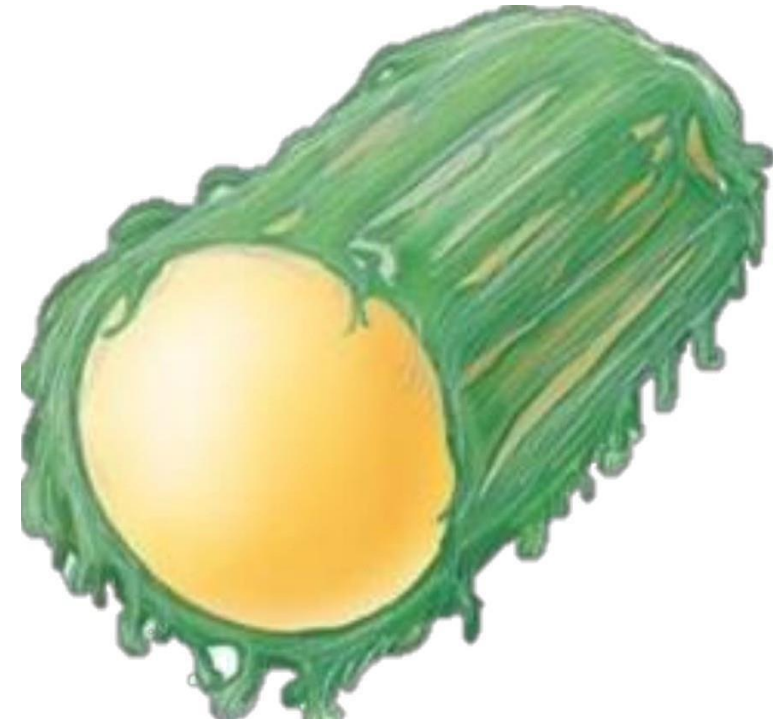
**Firmly adherence to
surface organism**



Capsule - Composition

Glycocalyx
(Slime layer)

Loosely & unorganized attached



Capsule - Composition

Glycocalyx

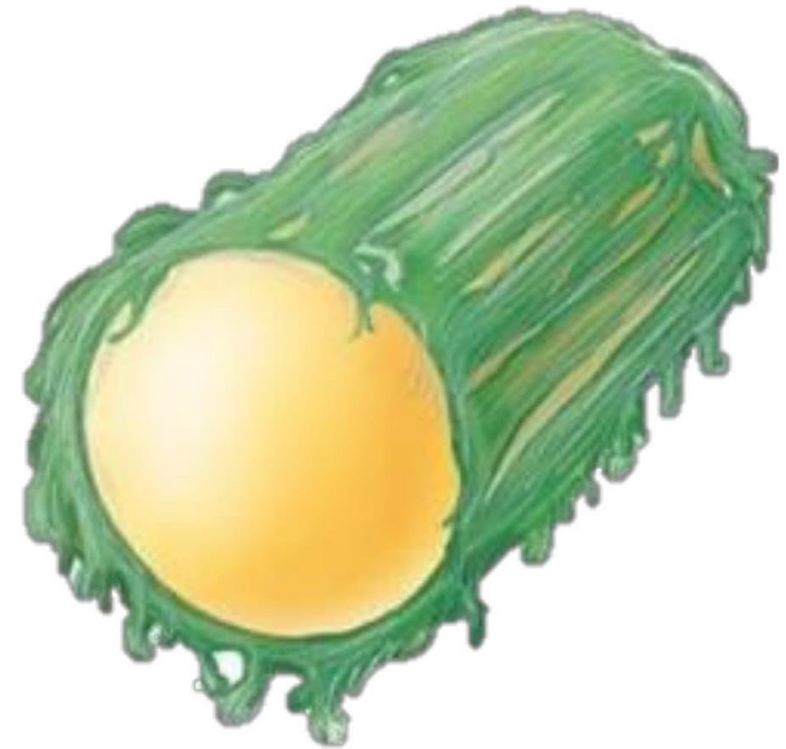
Fibrils extending

Make it

It adhere firmly to skin, heart, etc

e.g. *Strept. mutans*

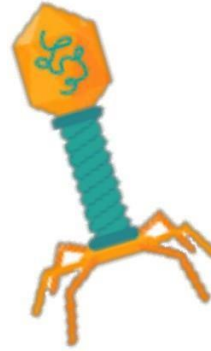
It adheres to the host cell
NOT the bacterial capsule



Loosely & unorganized attached

Capsule - Function

A

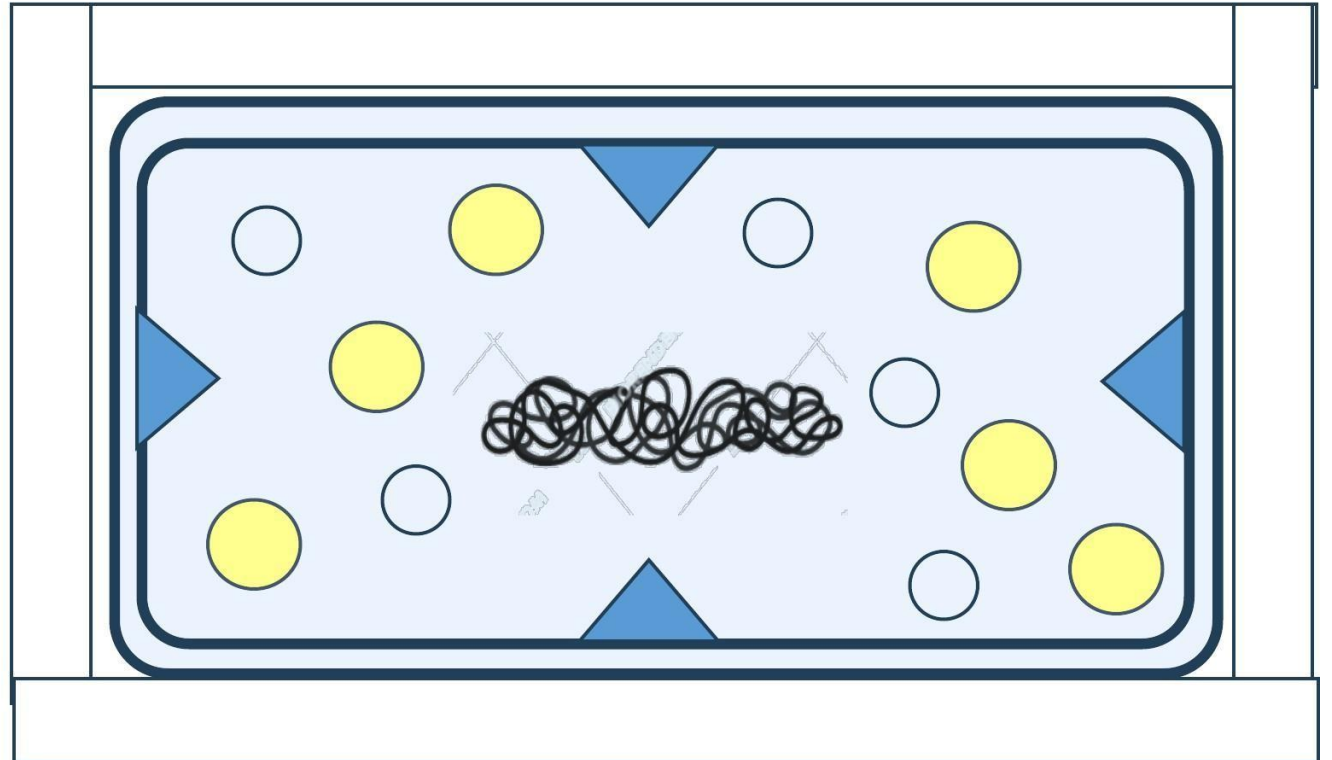


Protect Cell wall

From

Bacteriophage

Infective virus that has specific receptors on the bacterial wall. When the cell wall is surrounded by capsules, it prevents bacteriophages from binding to the bacteria resulting in no infection.

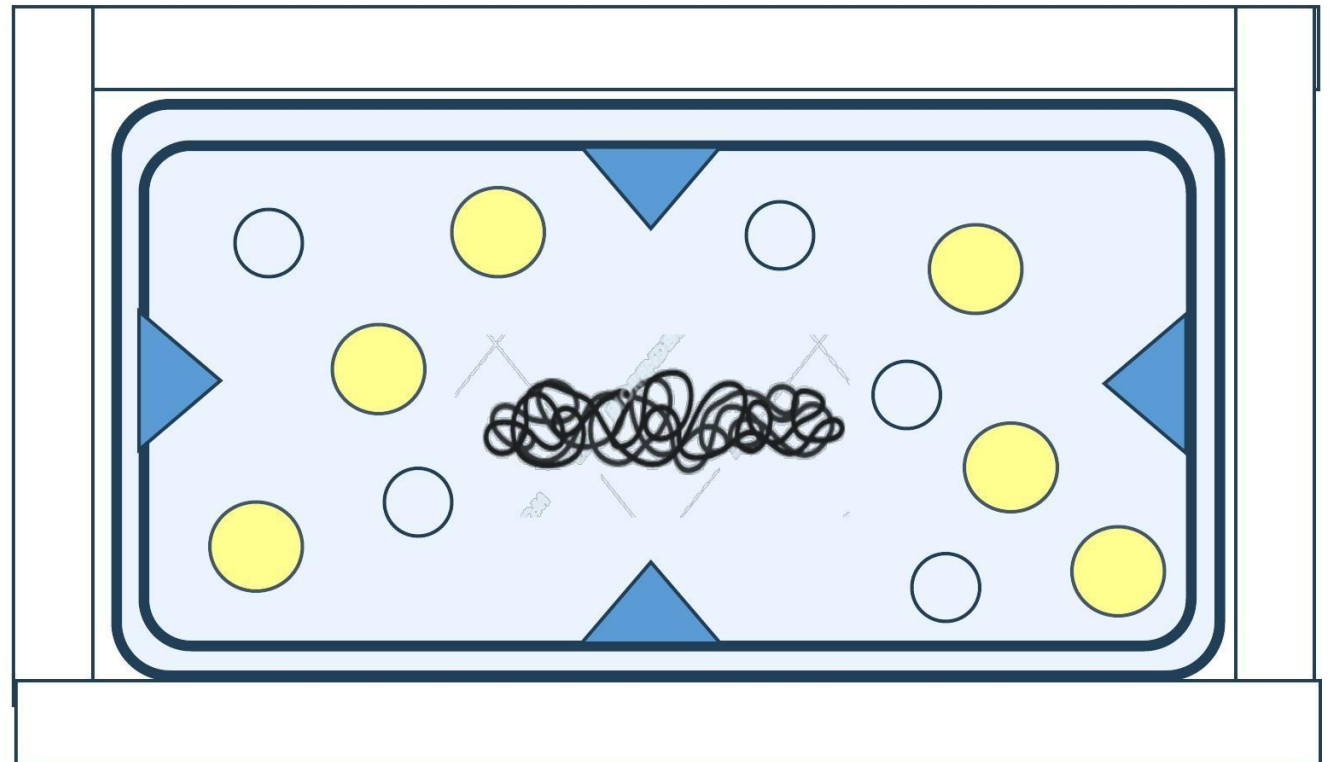
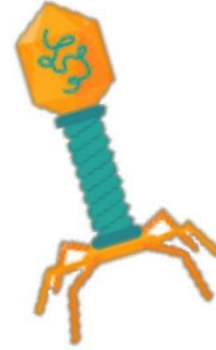


Capsule - Function

A

Protect Cell wall From Complements (in immunology)

(e.g lectin & alternative pathway)
The complement system must adhere to parts of the bacterial cell wall to start working. The capsule prevents the complement from binding resulting in more infection.



Capsule - Function

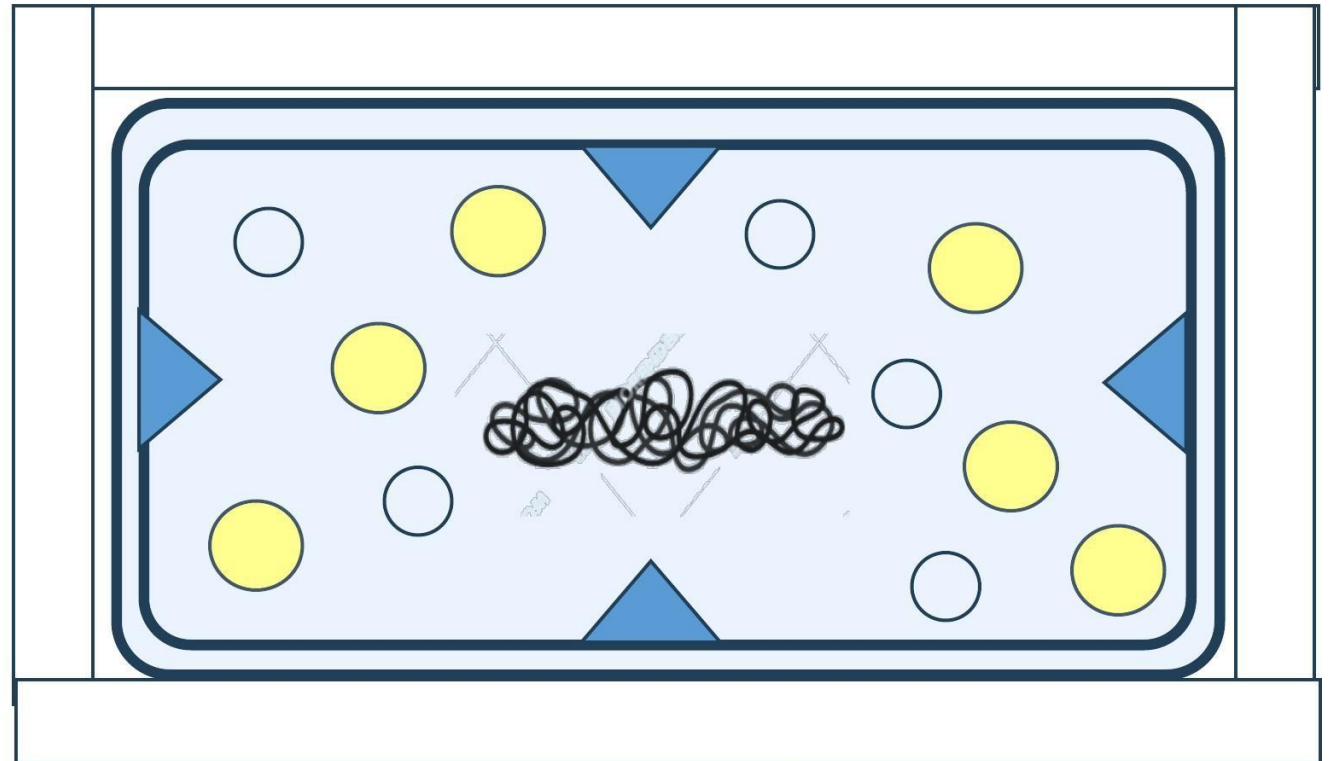
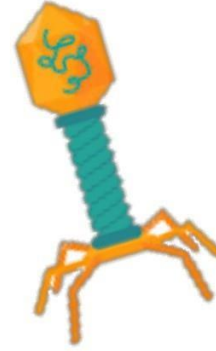
A

Protect Cell wall

From Lysozymes

=Enzymes that degrade bacterial cell wall.

Presence of the capsule prevents the breakdown of the cell wall by lysozymes.



Capsule - Function

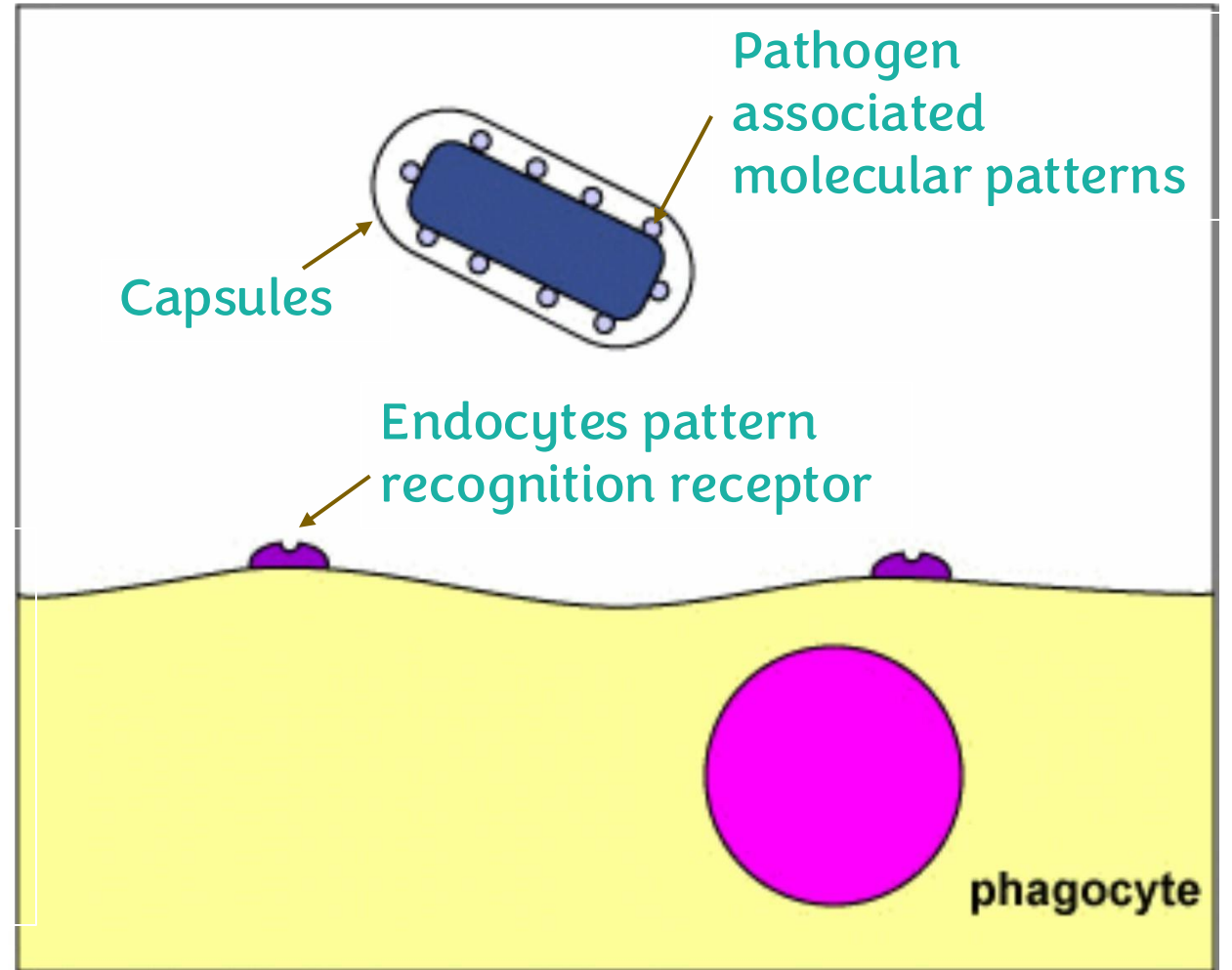
Virulence factor: the ability of a pathogen to cause the disease.



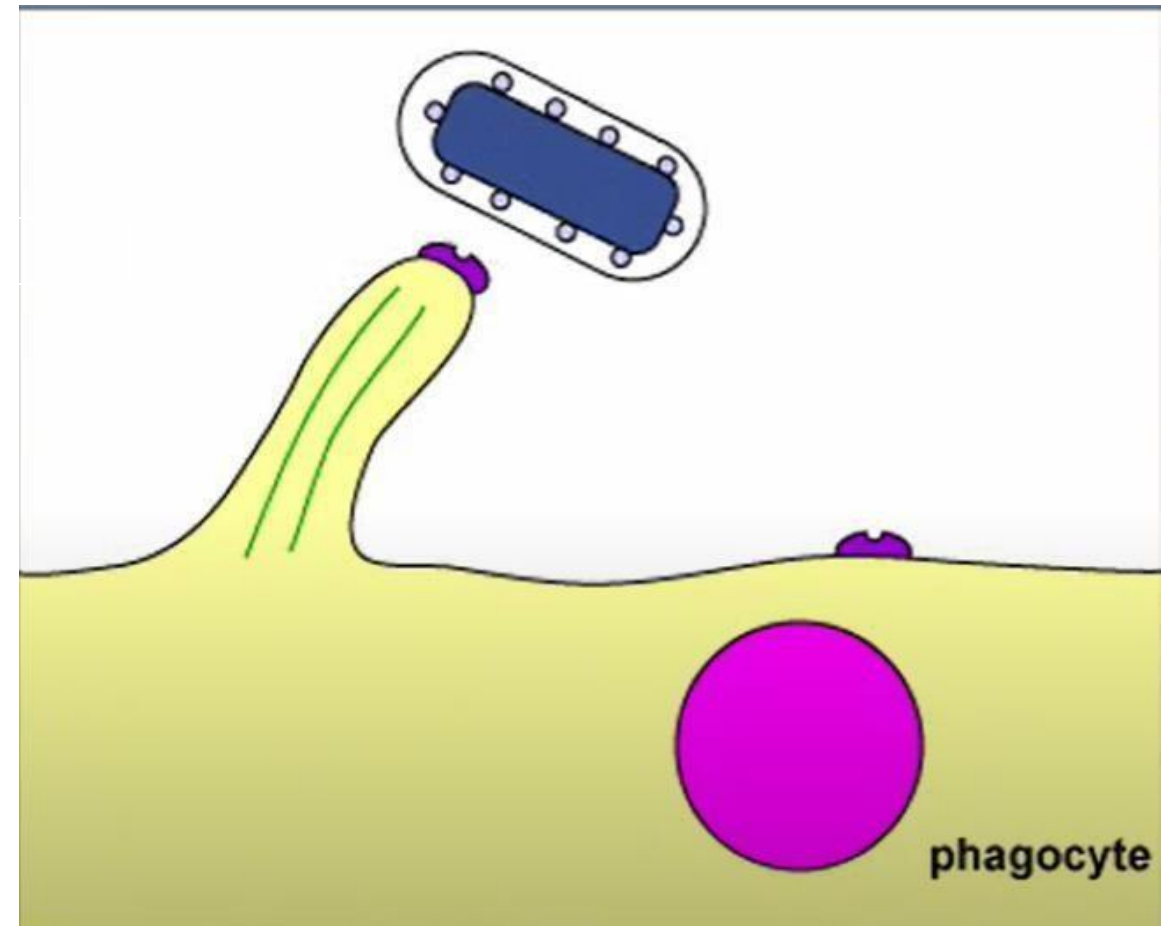
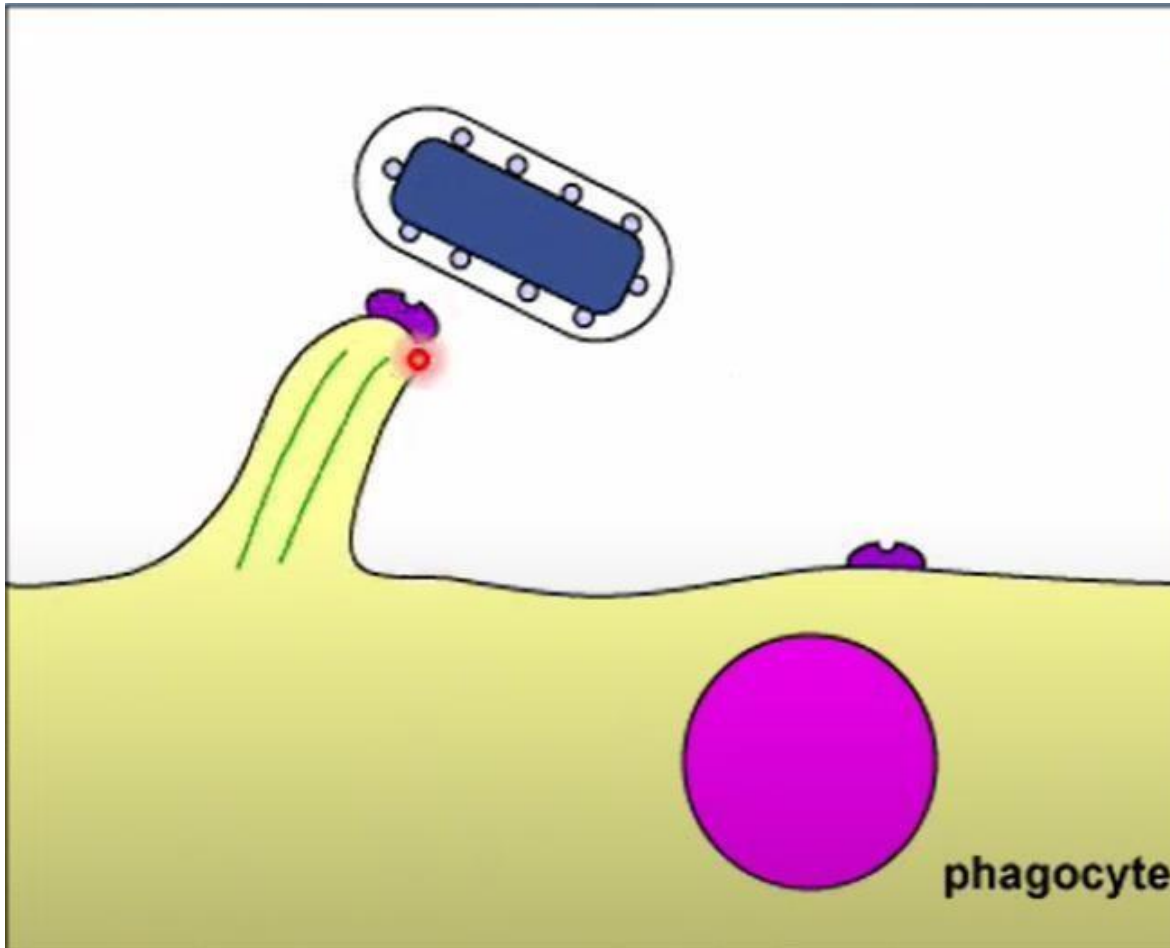
Prevent phagocytosis

Capsule is a virulence factor
(Virulence)

The capsule protects the cell wall from phagocytosis to protect itself. (by "running away" from the phagocyte)



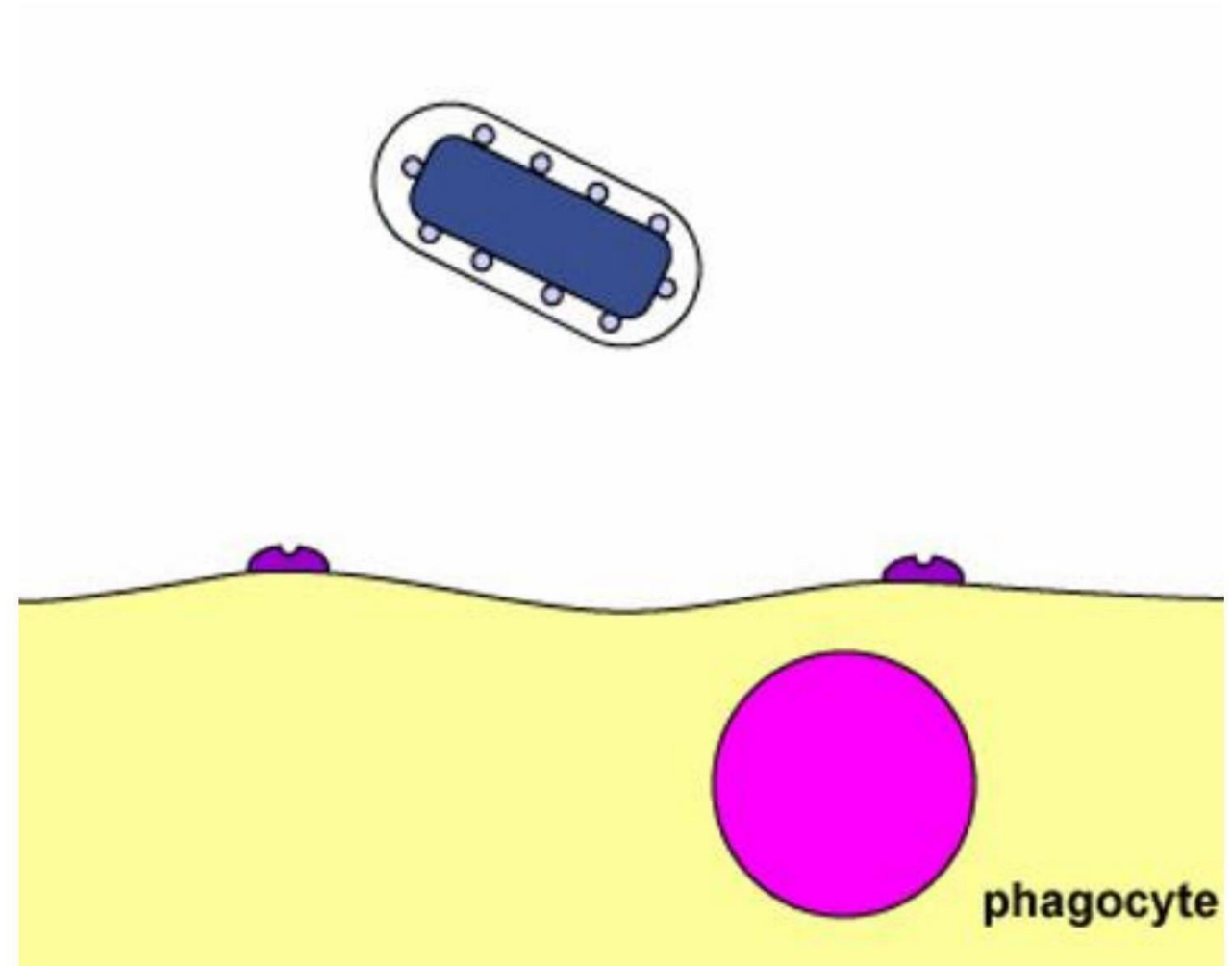
Phagocytosis Prevention by the bacteria



Capsule - Function

Capsules are formed in VIVO ONLY

When the bacteria enter the host cell, they start forming the capsule by producing the components inside and secreting them to the outer surface of the bacterial cell wall.



Capsule - Function



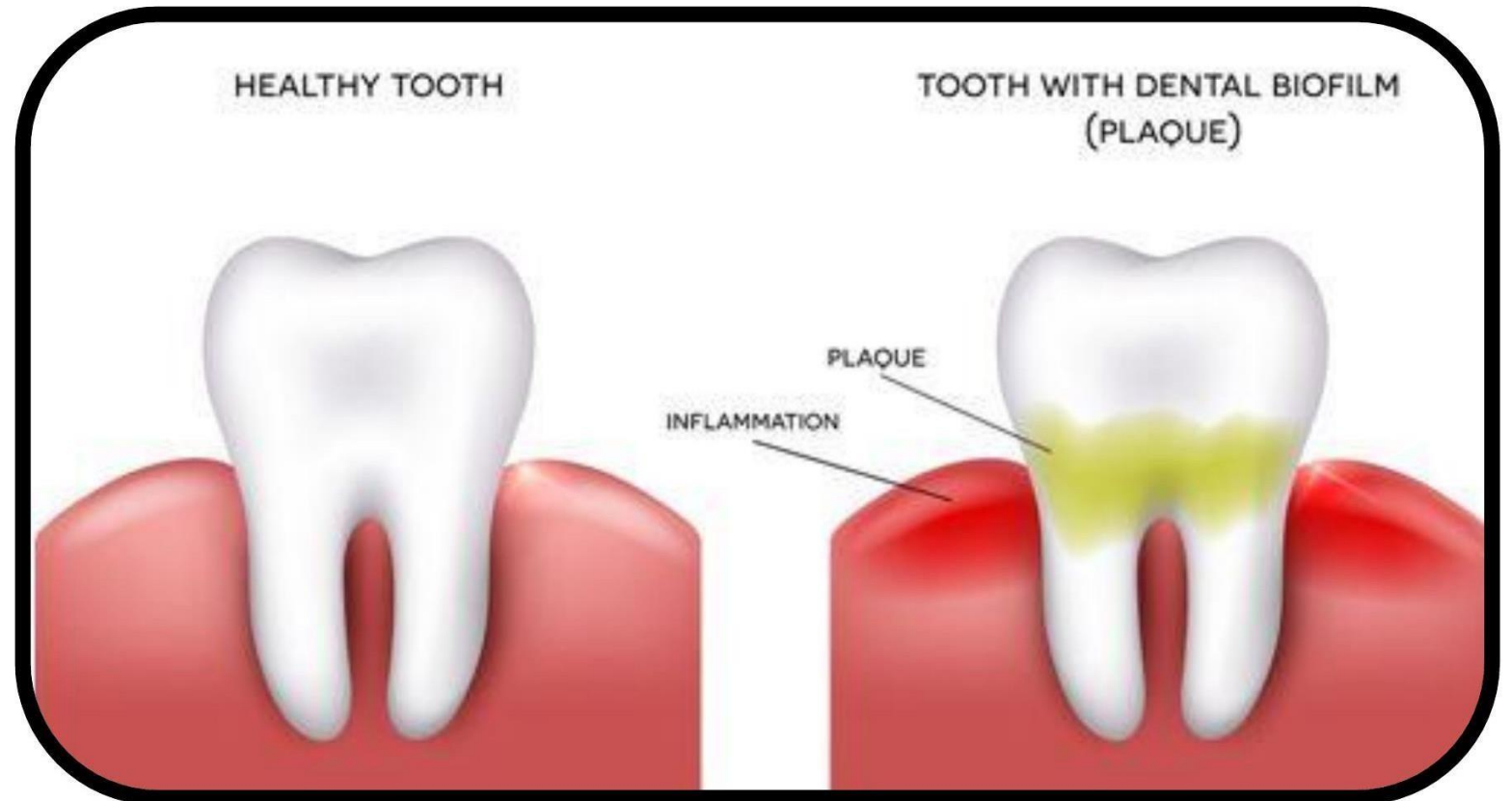
The sugars in the bacteria undergo fermentation and end up releasing acids that result in formation of dental caries.

Attachment

(Glycocalyx)

Dental caries

The fibril extensions bind to any medical device (like implants, prosthetics..) in this case they adhere to the tooth enamel



Capsule - Function



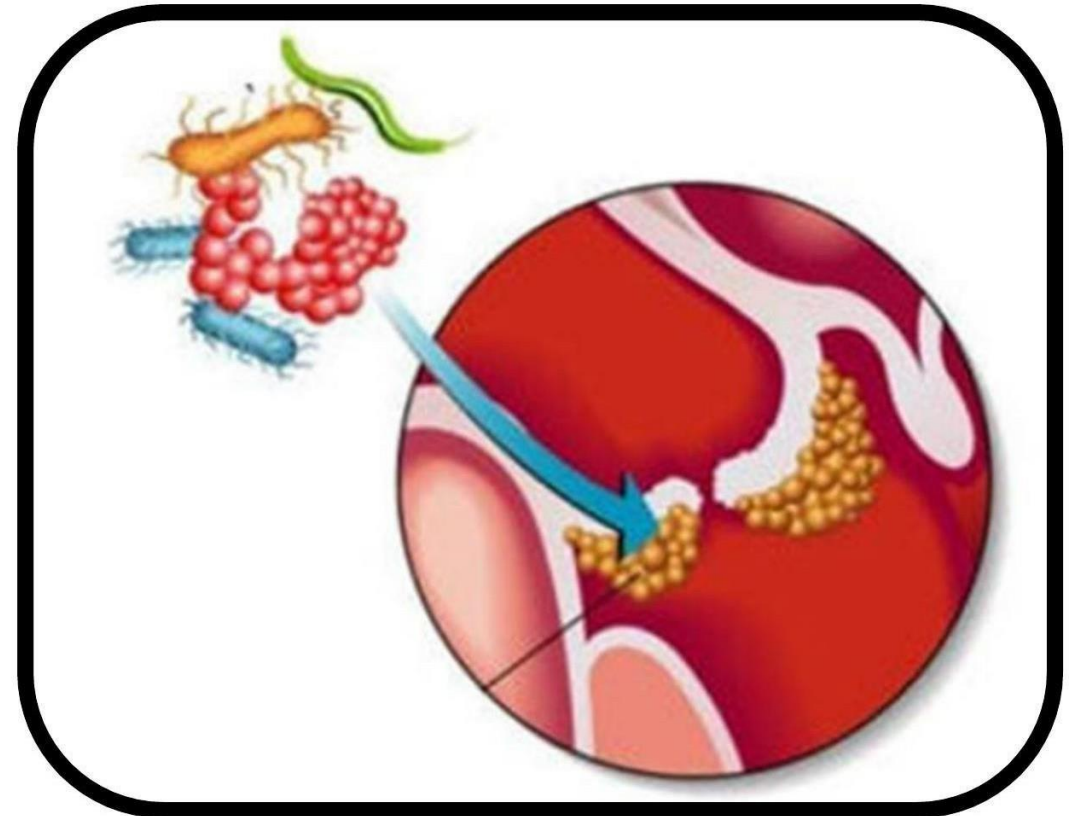
Attachment

(Glycocalyx)

This is a virulence factor since the glycocalyx high adherence (in this case to the heart) leads to diseases.



**Prosthetic heart
valves**

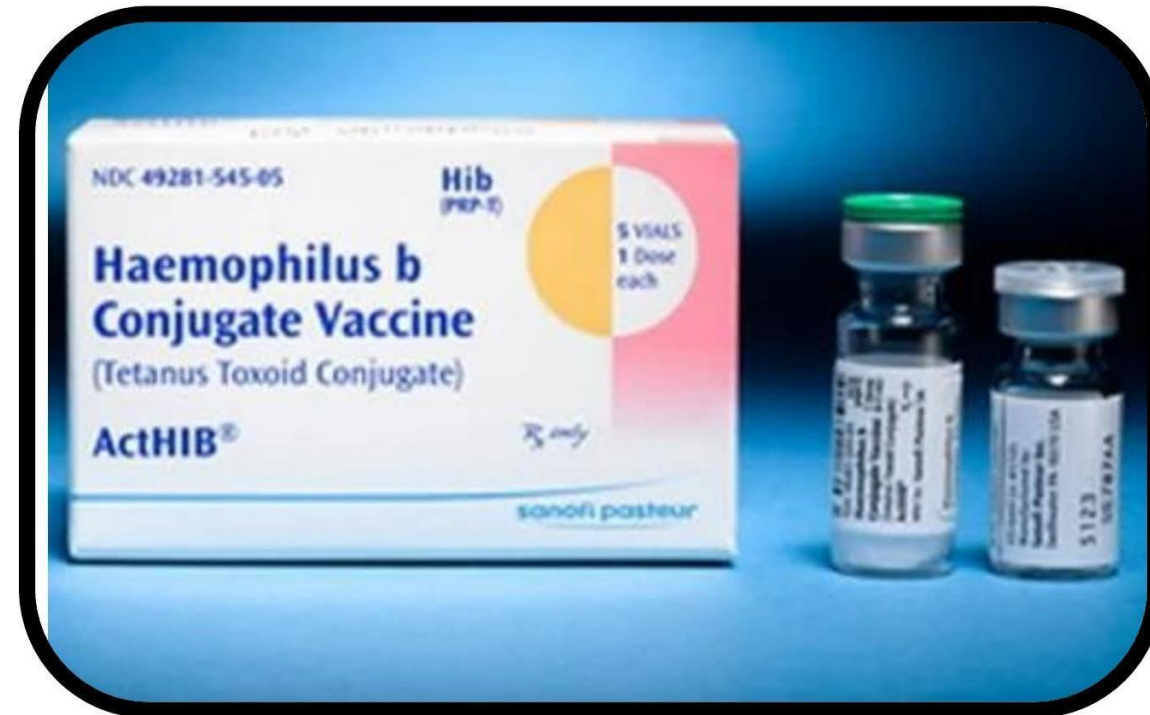


Capsule - Function

D

Development of vaccine

This is performed by extracting the capsule of “Haemophilus Influenzae b” bacteria and binding it to a protein.

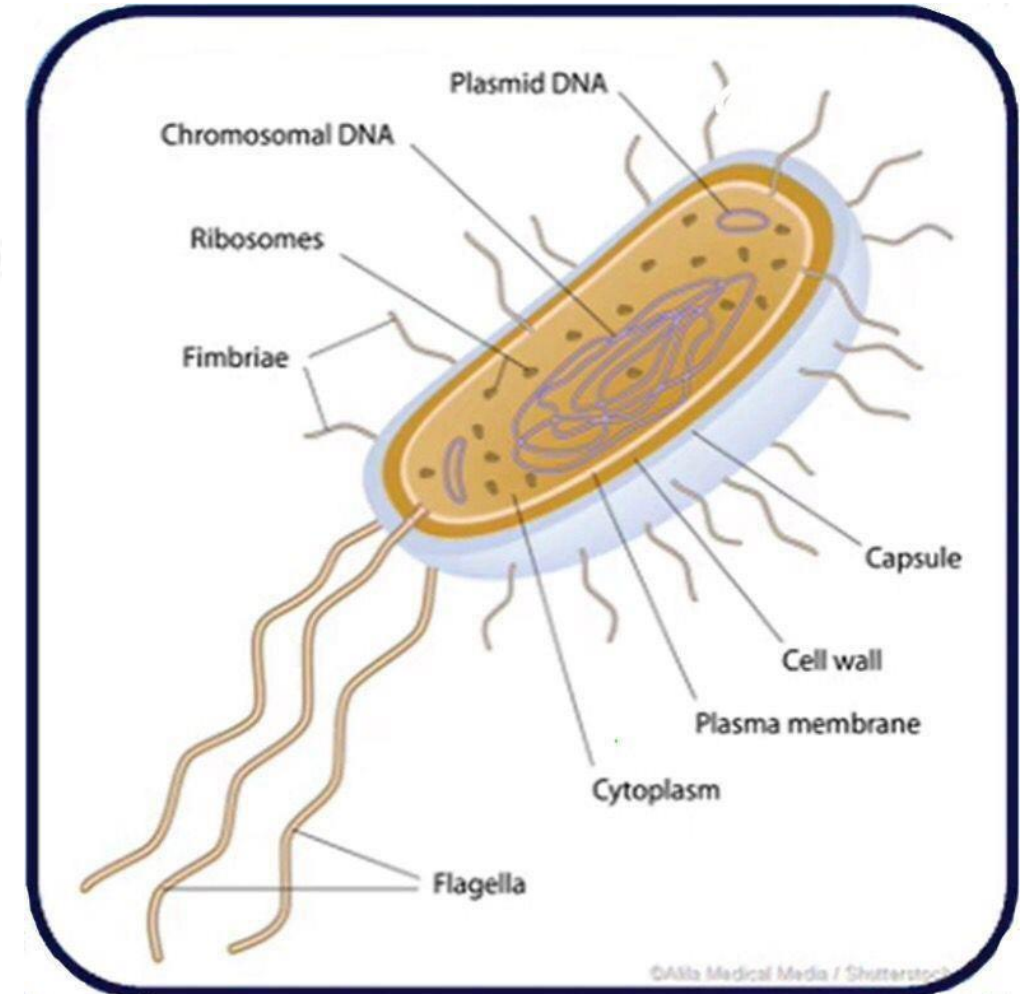


Flagella - Definition

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

(H Ag)

Every flagella present in any bacteria is
symbolized by (H Ag)



Flagella - Definition

Seen by EM

(20nm)

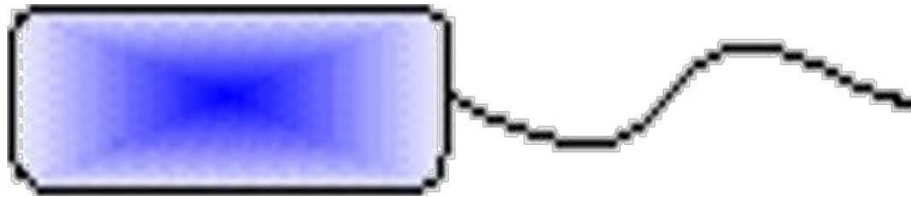
Very small in size



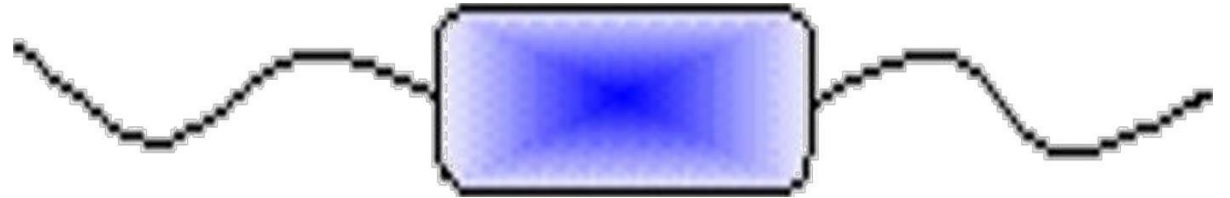
Flagella - Definition

Polar

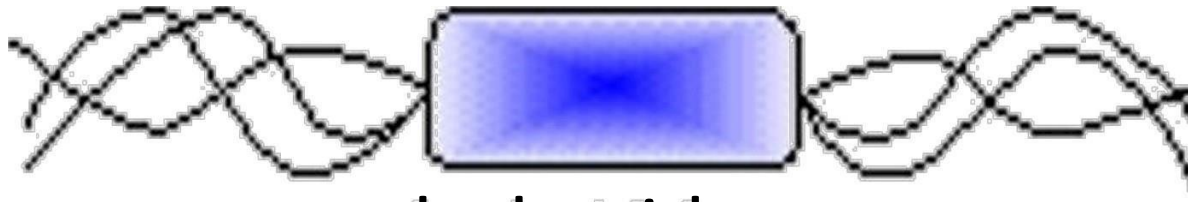
Spiral



monotrichous



Amphotrichous



lophotrichous

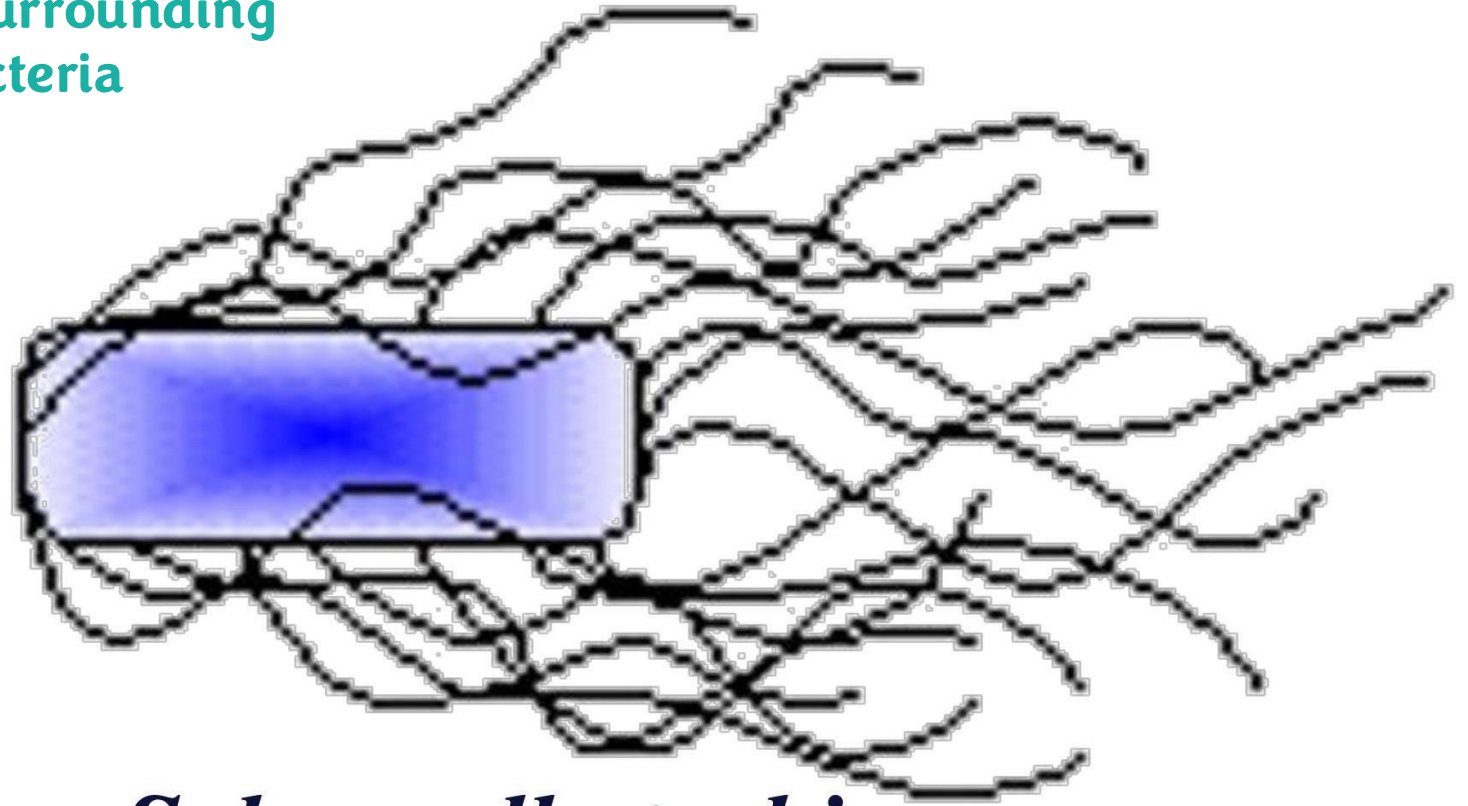
Flagella - Definition

Peri/trichous

Flagella surrounding
all the bacteria

around

peritrichous

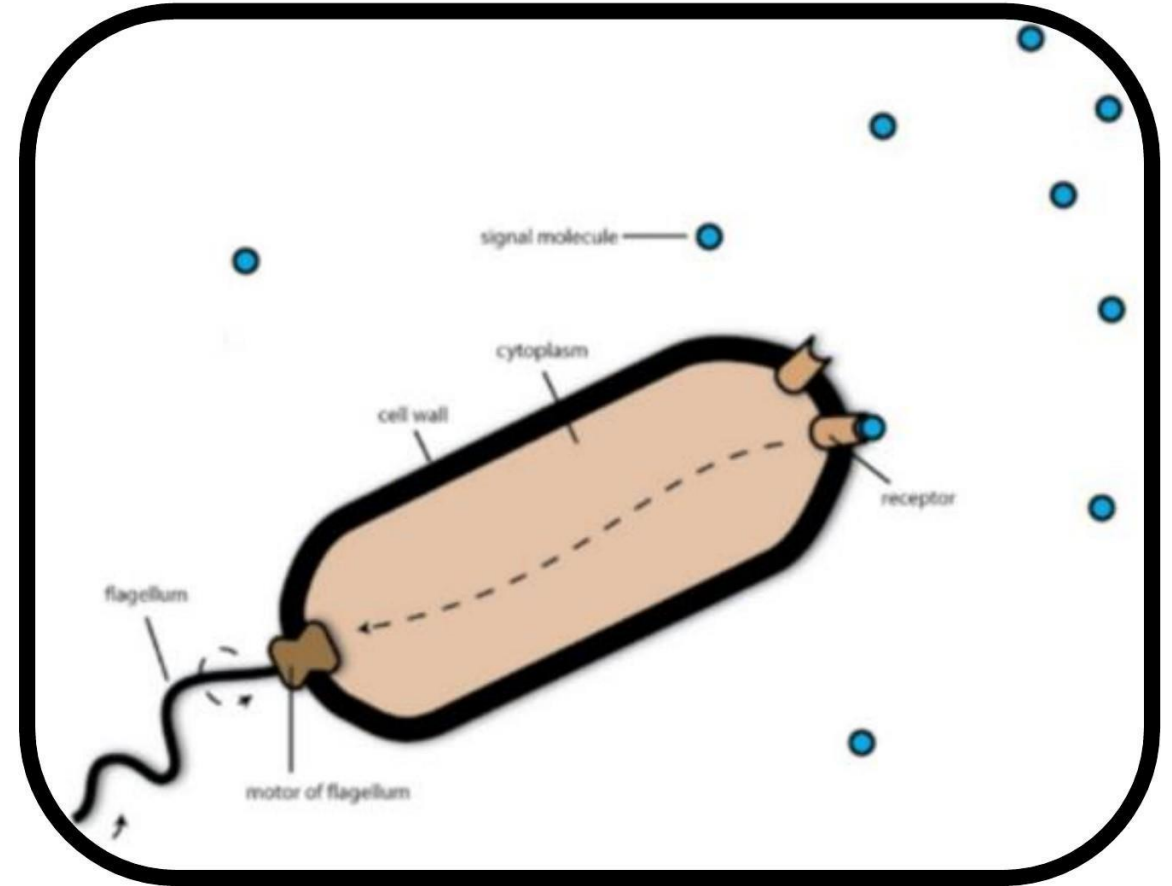


Salmonella typhi

Flagella - Function

The main function of the flagella is

**The organ of
motility**

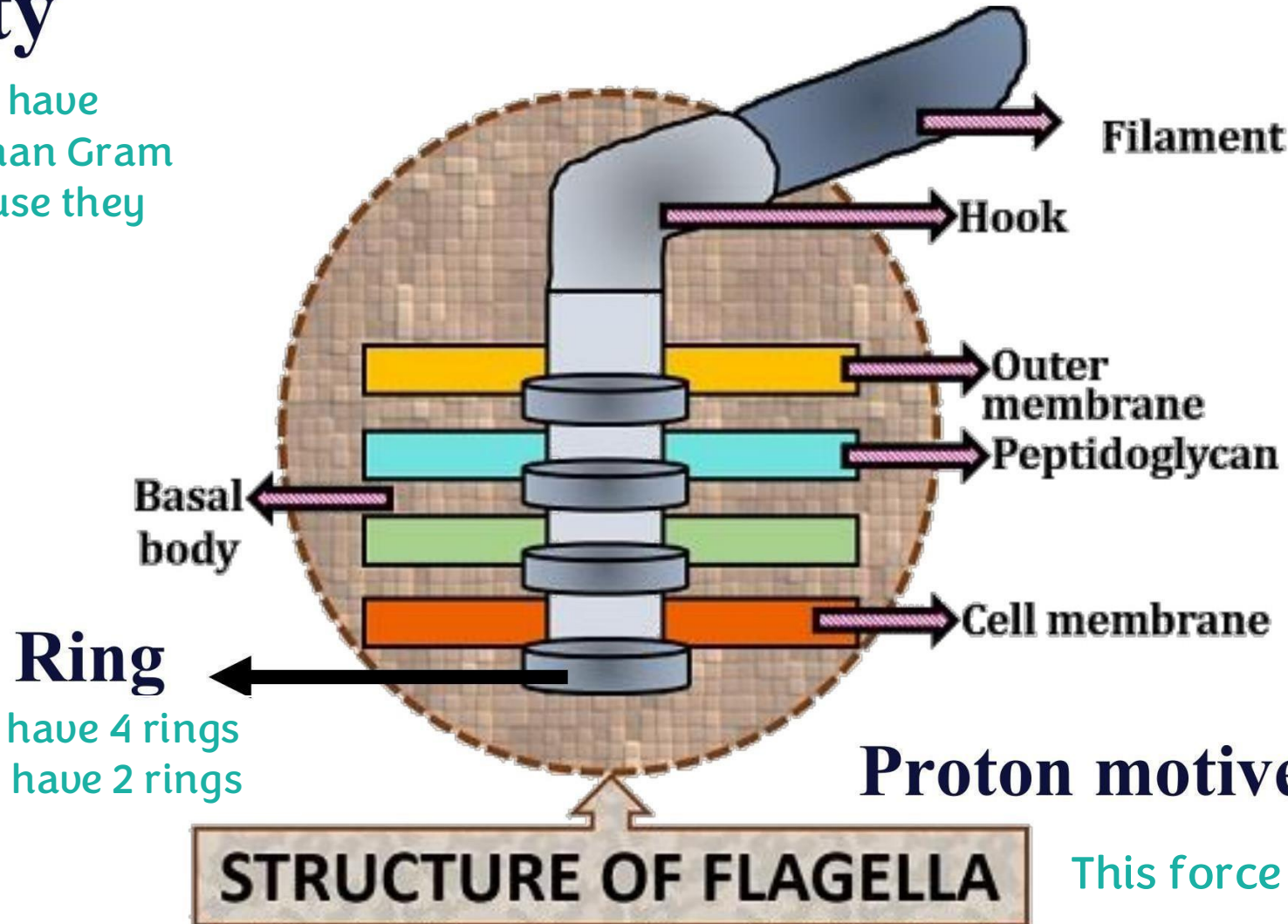


Flagella - Function

Motility

Gram -ve bacteria have HIGHER motility than Gram +ve bacteria because they have more rings.

For the filament to move, the rings must move, this causes the flagella to move as well as the bacteria.



Gram -ve bacteria have 4 rings
Gram +ve bacteria have 2 rings

Proton motive force

This force makes the ring move

Flagella - Function

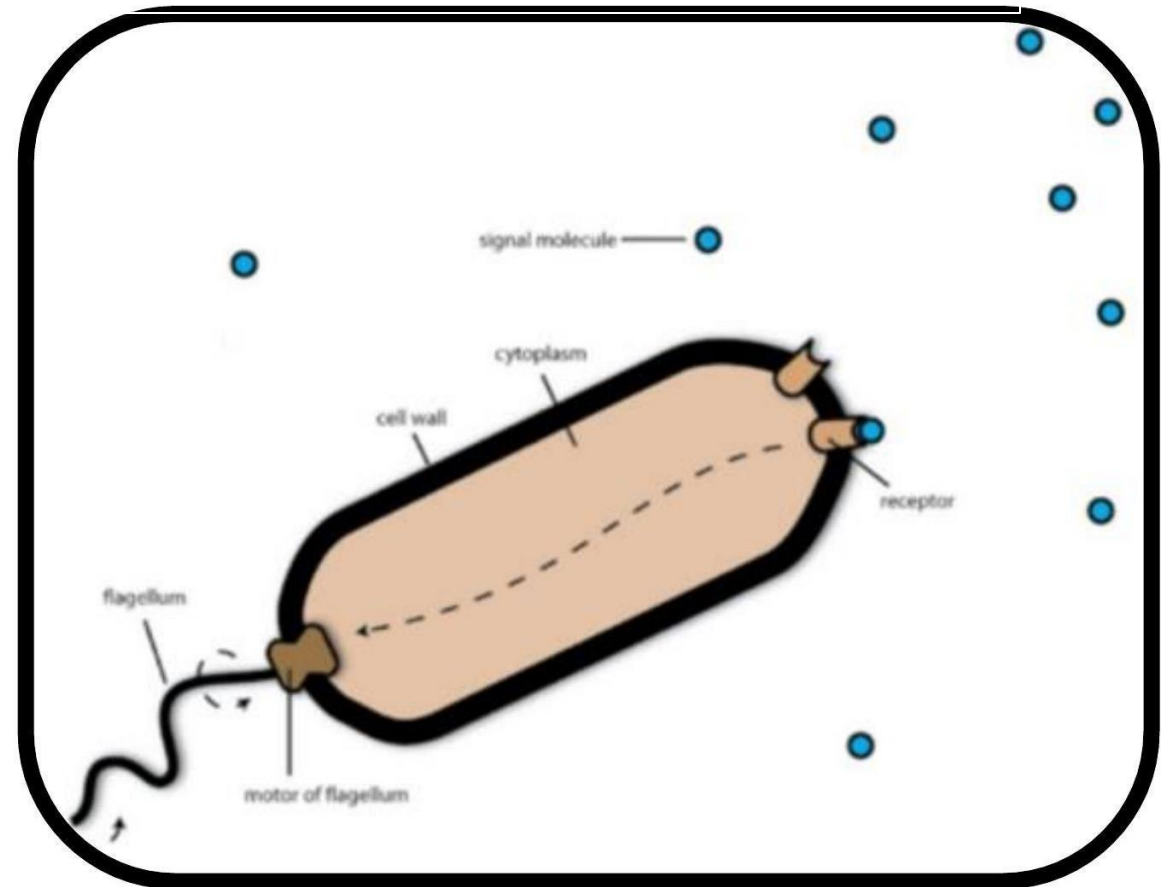
Tactic response (Taxis)

(Stimulus)

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

Positive chemotactic response - >toward material
Negative chemotactic response - >away from material.

This response is due to the cell's chemotactic system where cell membrane sends signals to direct flagella toward beneficial materials and away from harmful ones.



Flagella - Function

Tactic response (Taxis)

Stimulating agent

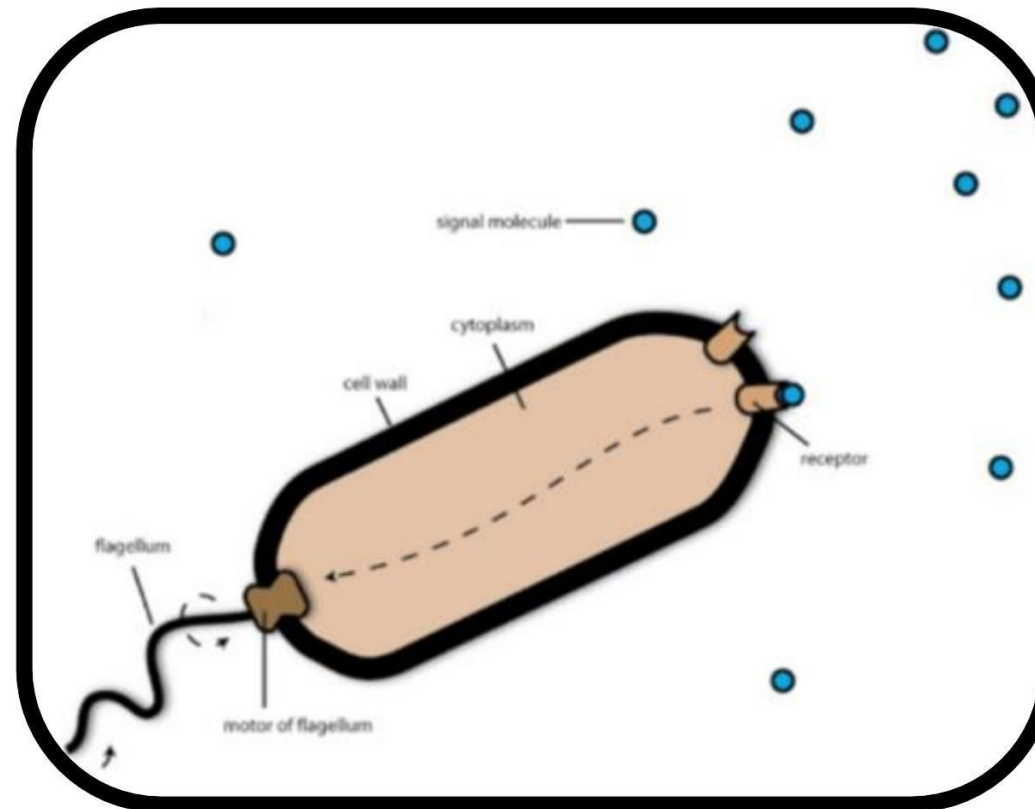
Two types of tactic response

Chemo Taxis

↓
If the stimulus is chemical
Taxis

Photo

↓
If the stimulus is light



Chemical

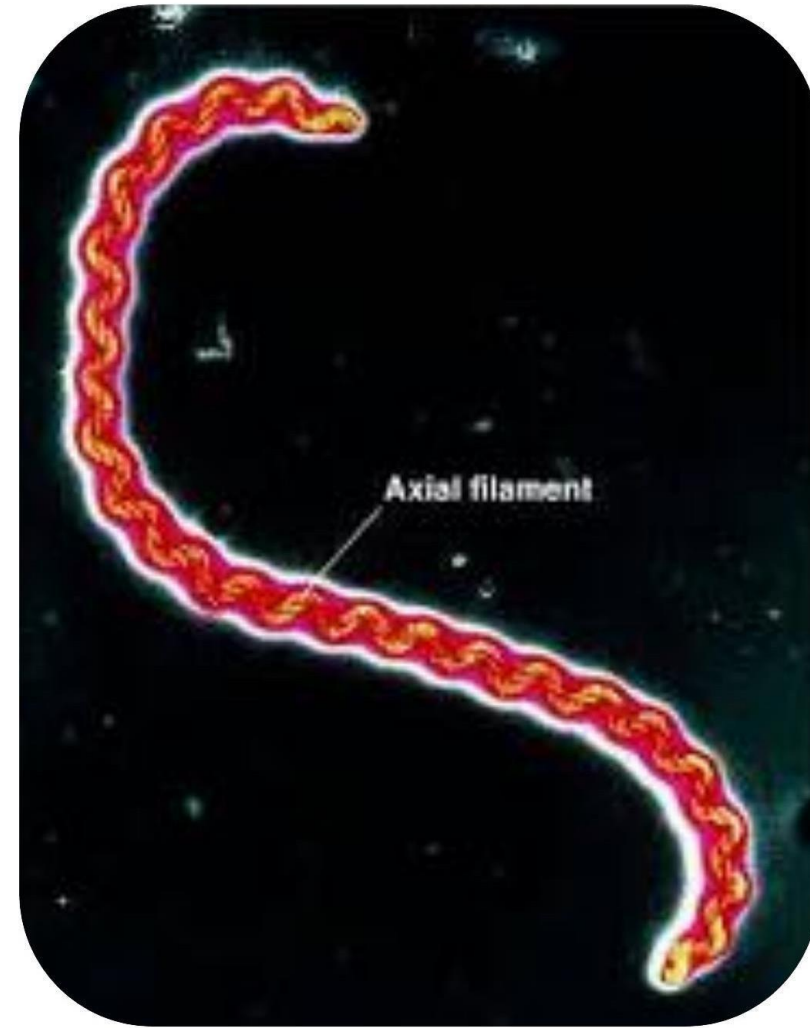
Light

Axial Filaments

Endoflagella

In spirochetes {Example}

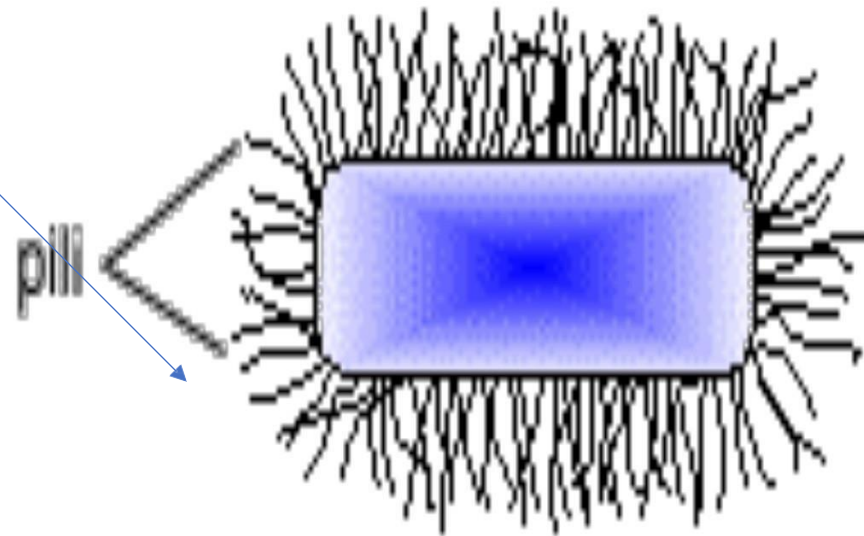
- Some bacteria possess internal flagella instead of outside the bacteria.
- This is known as endoflagella also referred as axial filaments.
- These bacteria have wave-like movements.



Pili (Fimbriae)

Short and thin
Hair like formed from
protein

(Pilin) Name of protein



Pili

Only Seen by EM

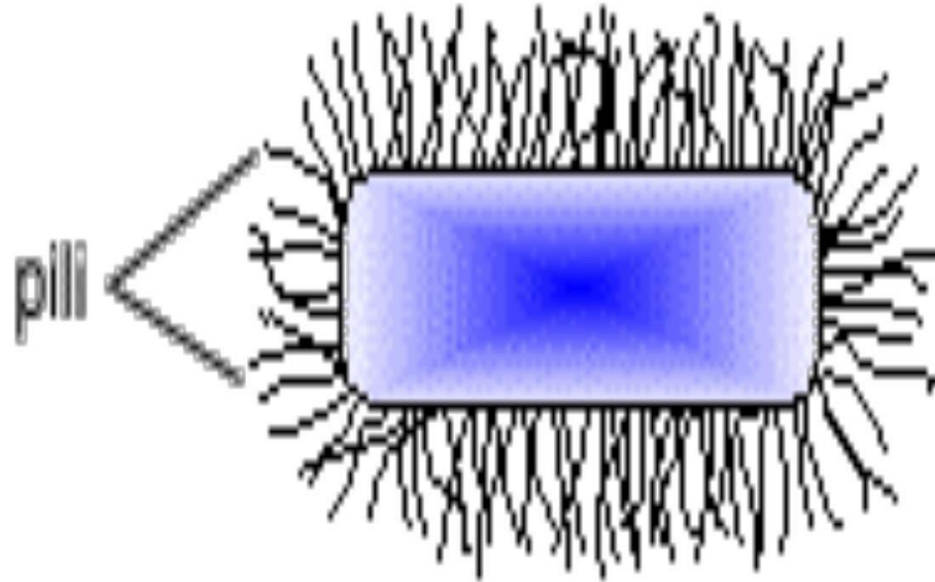


Pili

Two types of pili :

A) Ordinary pili
(Attachment)

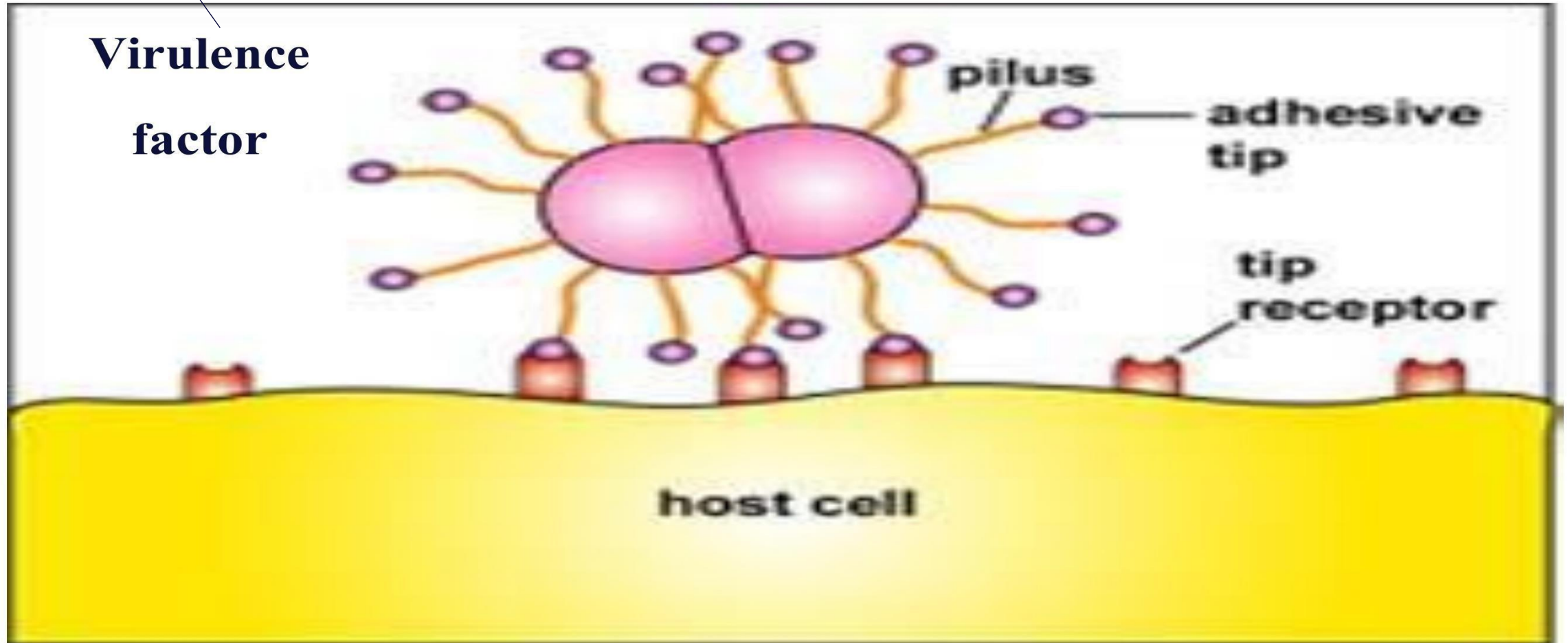
B) Sex pili
(Genetic transfer)



Because this pili act as
defending weapon and help
in adhering of bacteria to the
host cell in the first step of
infection (establishing
a disease).

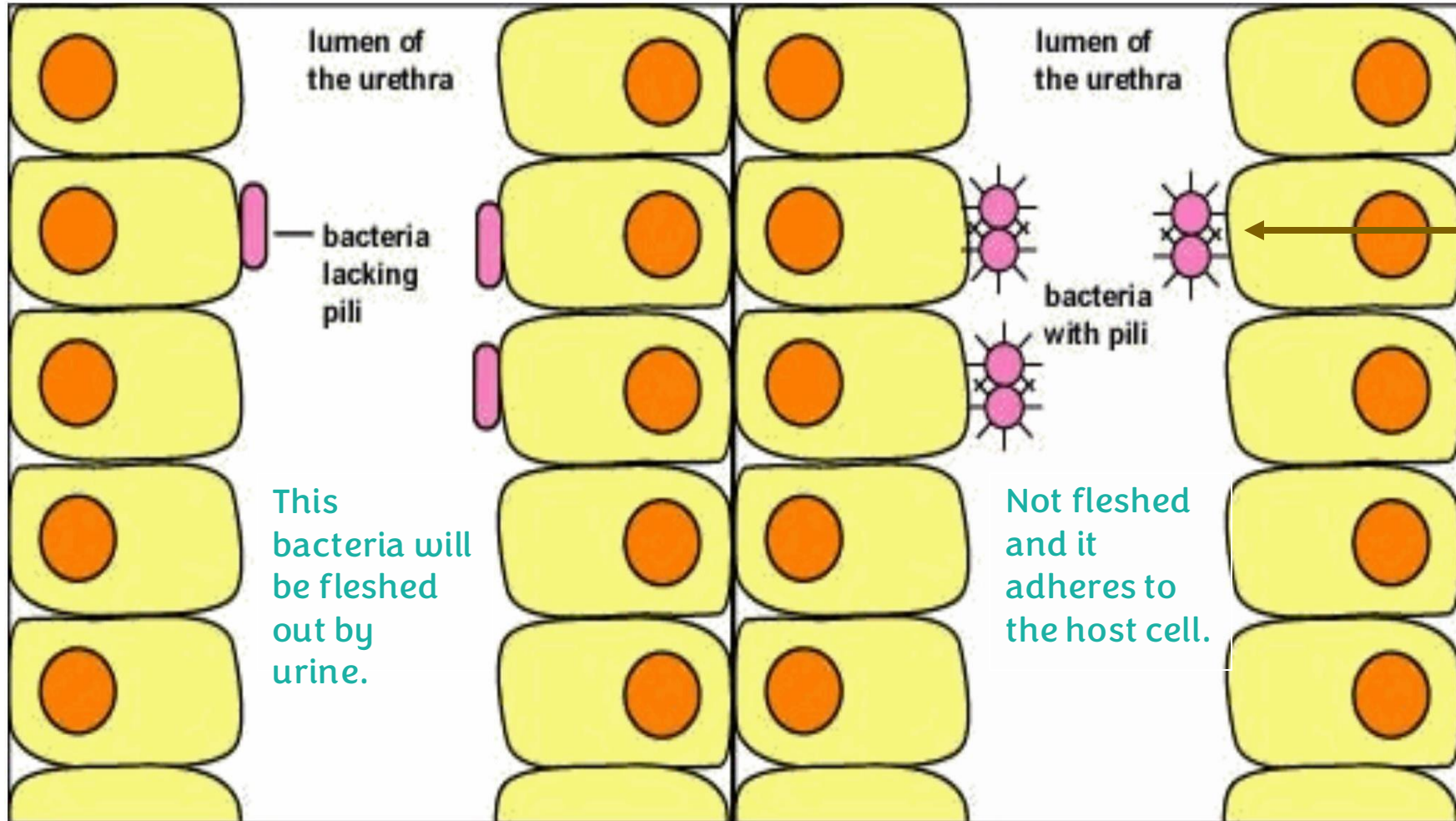
Ordinary Pili

**Virulence
factor**



Ordinary Pili

This photo
from urethra



Bacteria can
resist the
fleshing of the
urine.

Sex Pili

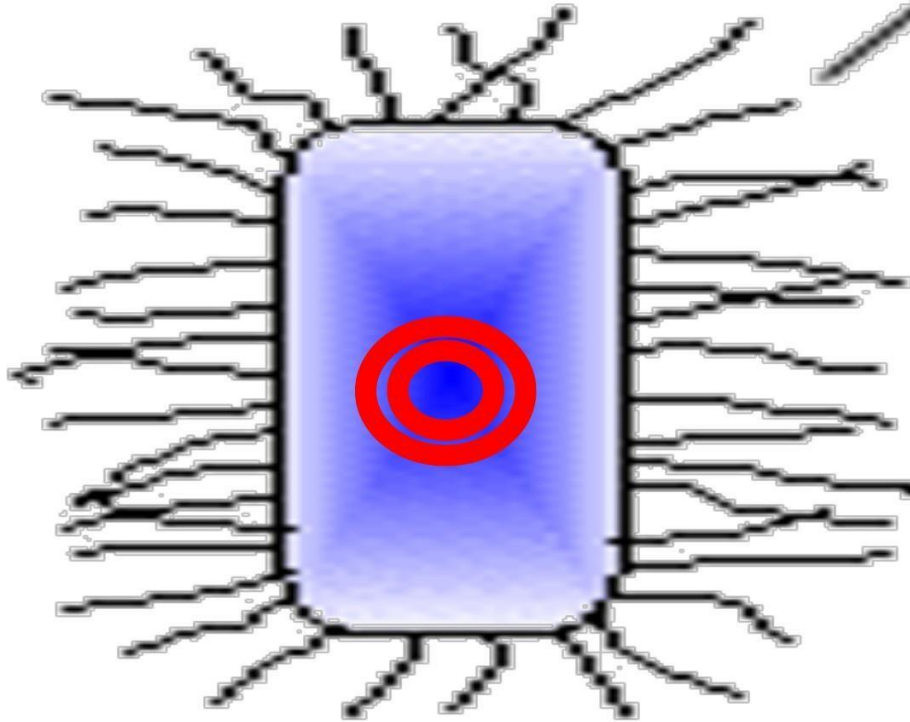
pili

Is characterized by :

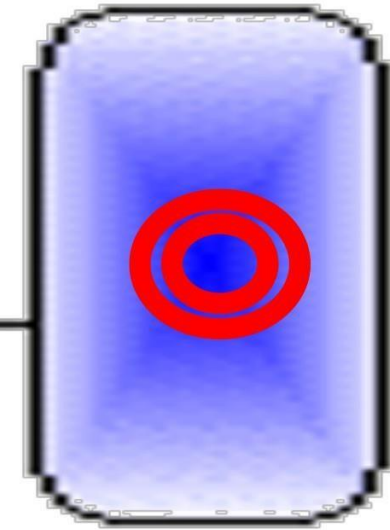
Long pili

Sex pili!!

Some bacteria transfer plasmids that code for drug resistance / toxin through this pili to another bacteria to have these genes(it makes a copy of this genetic information)



Male



Female

Nonprecise name

Nonprecise name



F+ :fertile

Donor

Another name :

Conjugation

F- :nonfertile

Recipient

→more precise

More precise ←

Spore formation

Vegetative bacteria

: bacteria that divide and replicate
INSIDE THE HOST CELL

Unsuitable condition

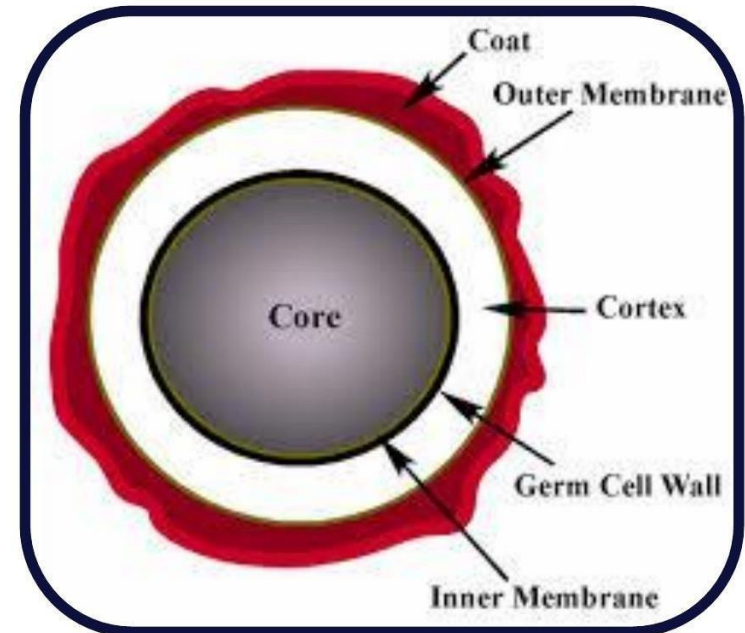
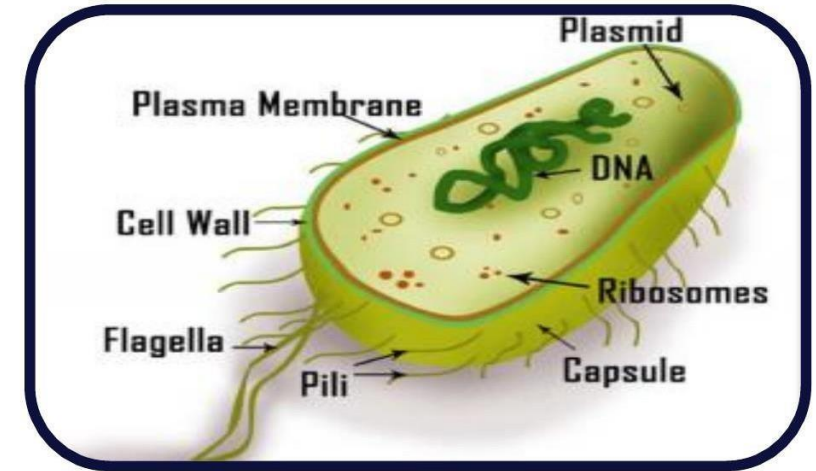


this lead to : **Spore formation**

(Outside)

Outside the host cell

occur when bacterial
leave the host cell and
face harsh conditions like
high temperature,
nutrients deficiency, a
specific disinfectant, etc.



Spore formation

Forming highly resistant resting phase (Endospores) in VITRO

Only 2 types of bacteria can form spores :

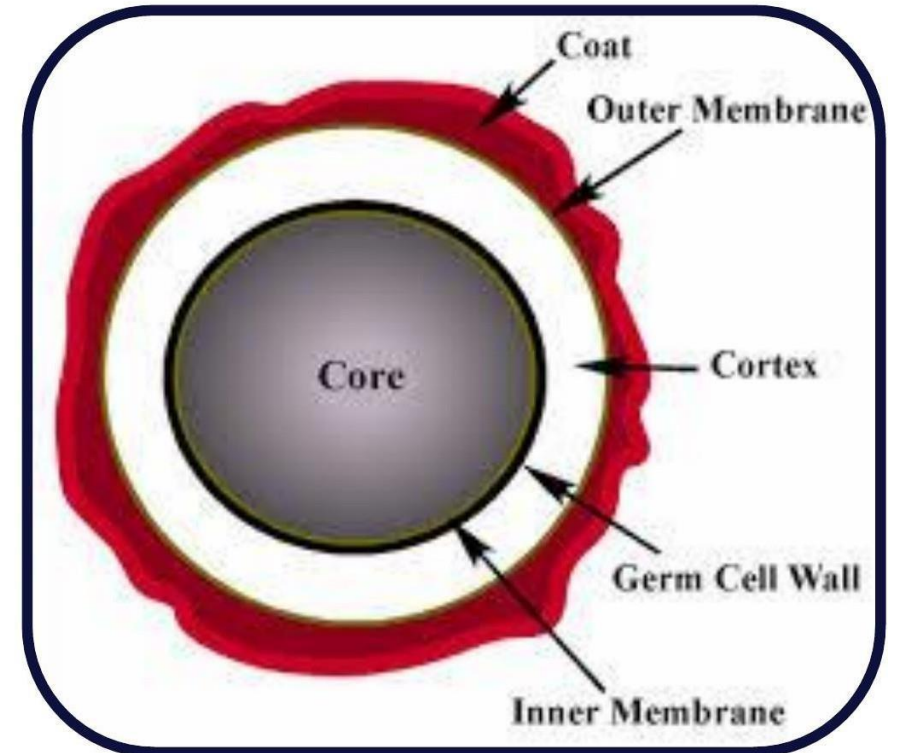
Bacillus

Clostridium

↓ OUTSIDE THE HOSTCELL

Resting phase :

Means in dormant situation (do not perform any divisions or reproduction)



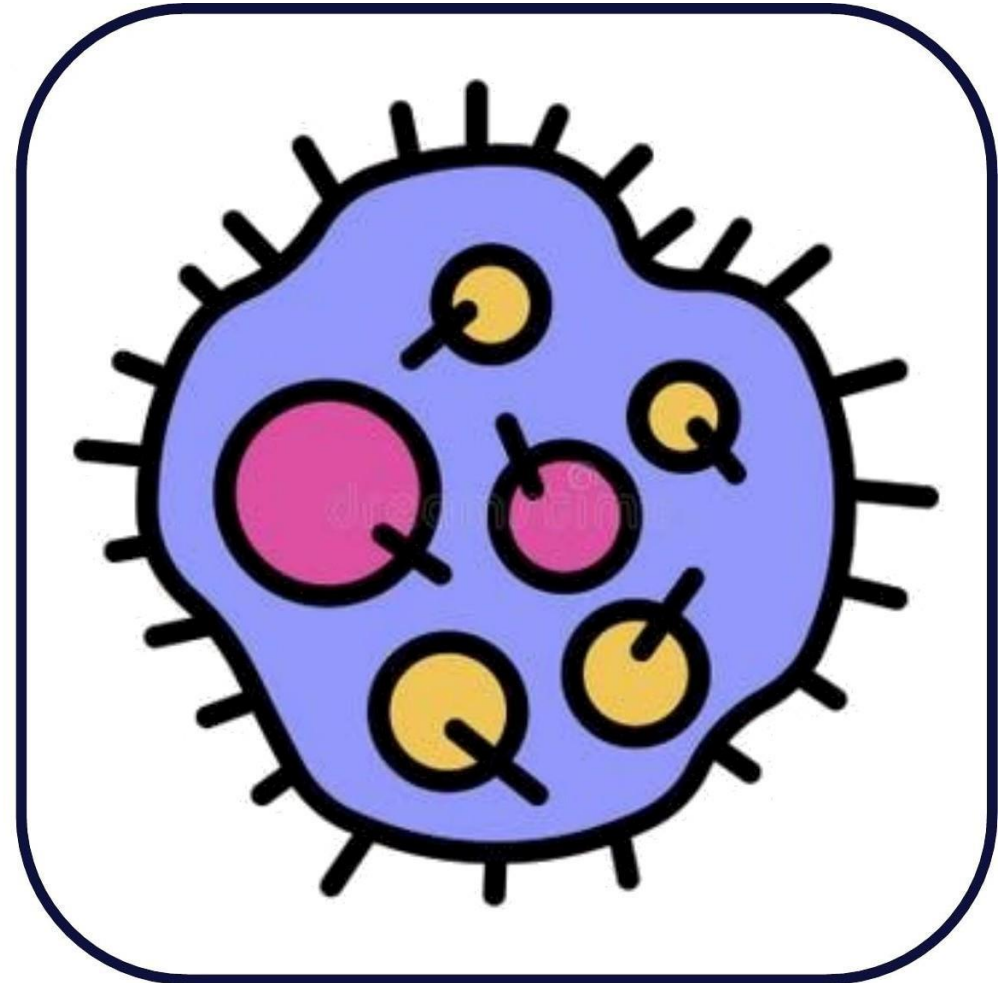
Spore formation

Occur to unfavorable conditions e.g.

High temp.

Drying

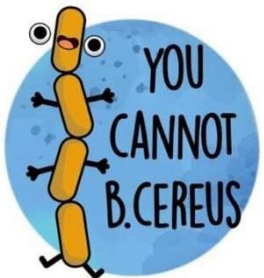
Depletion of nutrition



Spore formation

Formed outside the body (in VITRO)

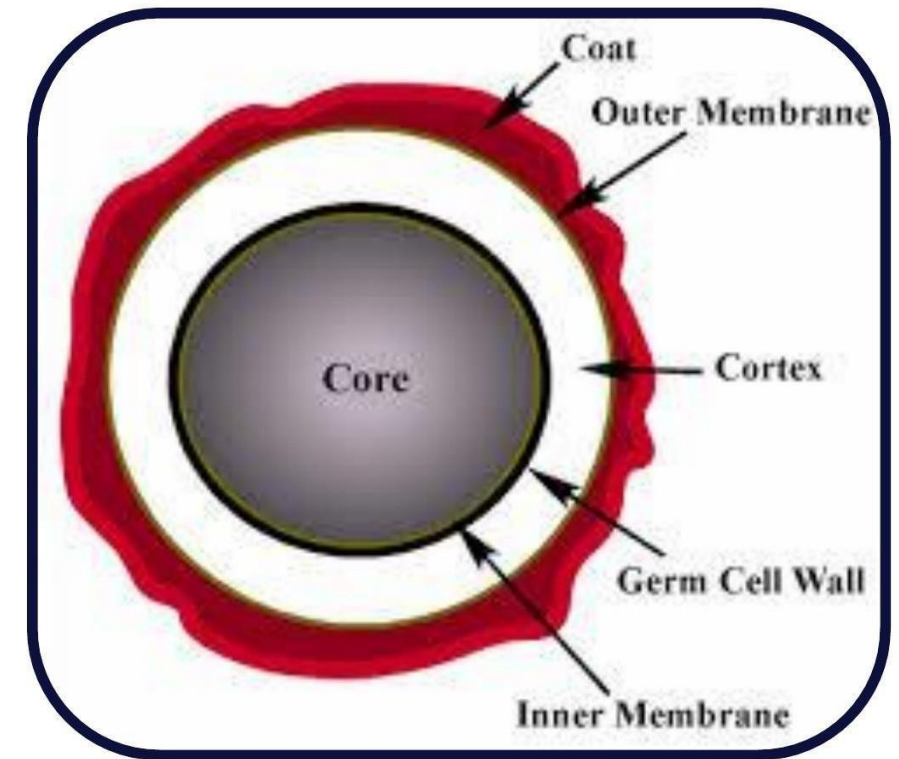
Can not stained by ordinary stain Instead they have specific stains



Spore formation

Spores are :

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



Spore formation

Inside host cell and divide

Vegetative

Outside host cell + dormant

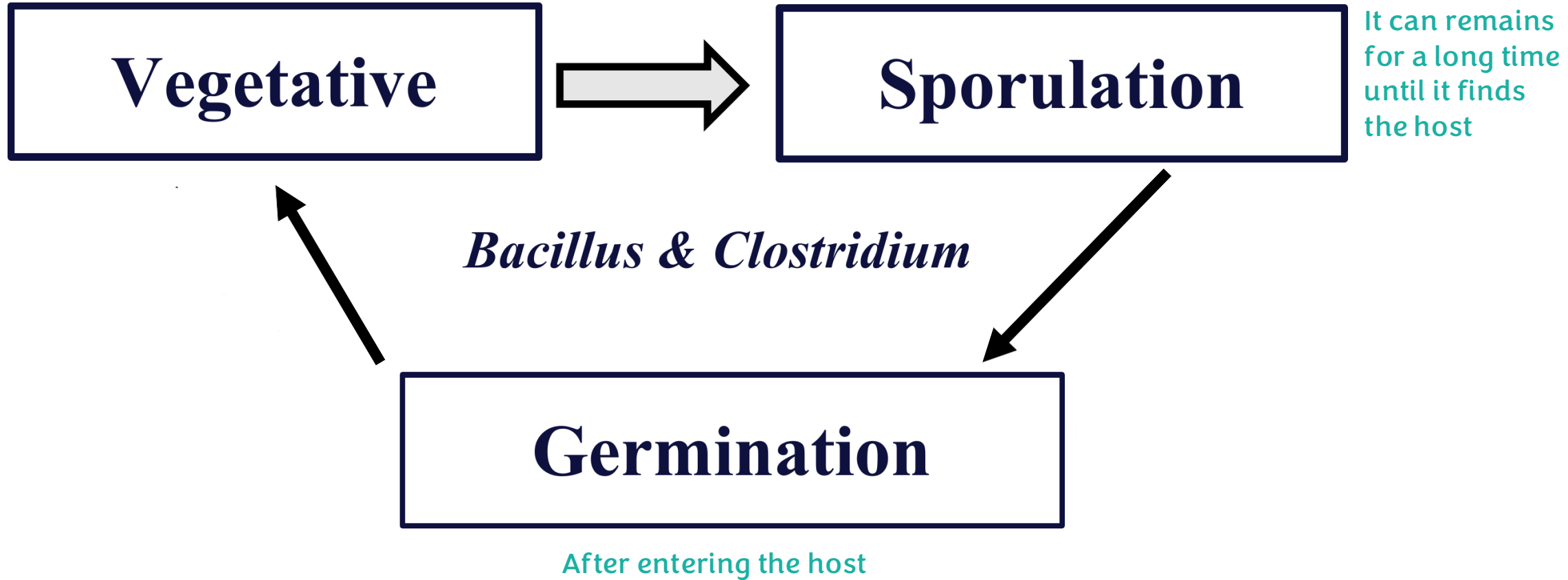
Sporulation

It can remain for a long time until it finds the host

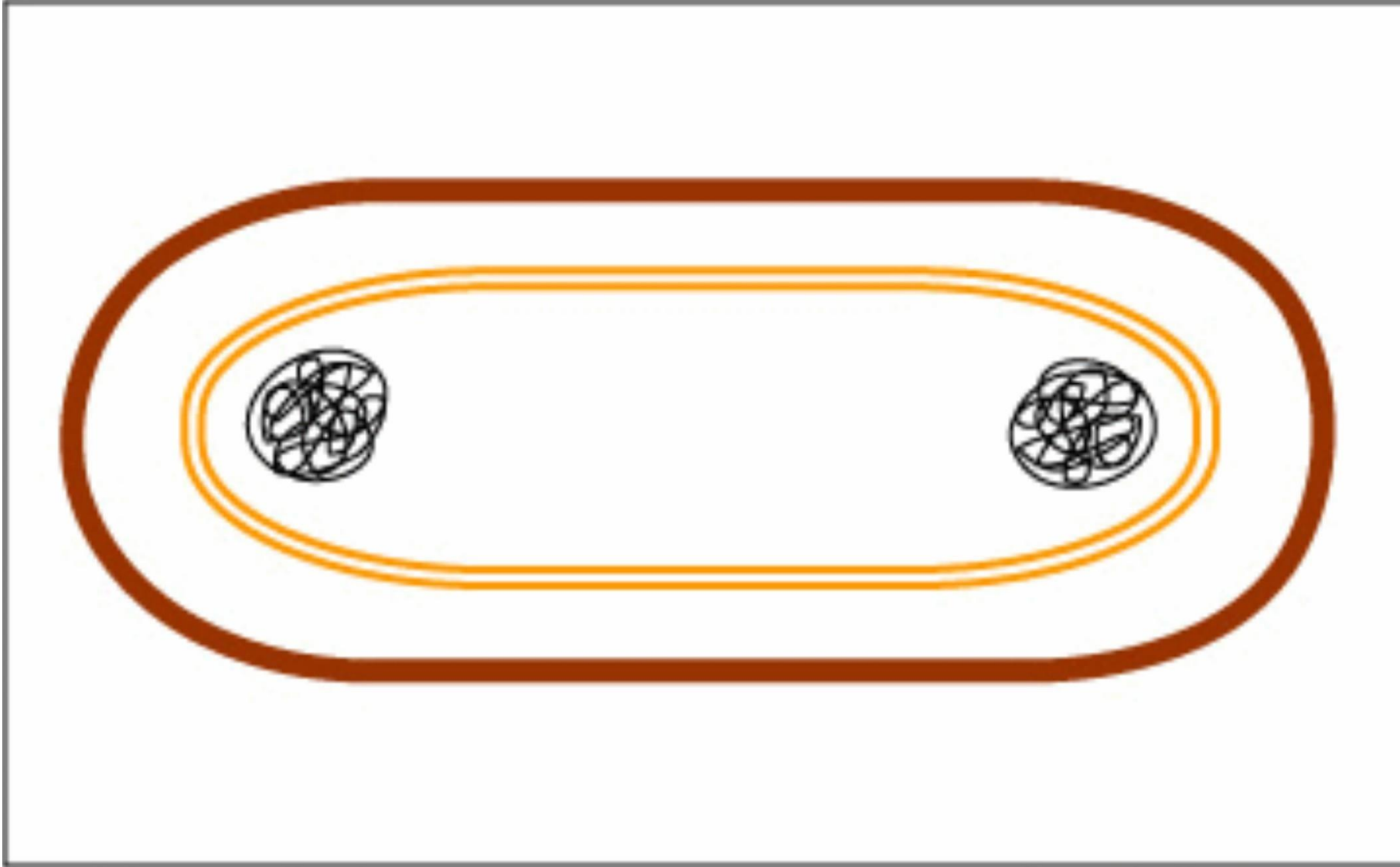
Bacillus & Clostridium

Germination

After entering the host



Spore formation



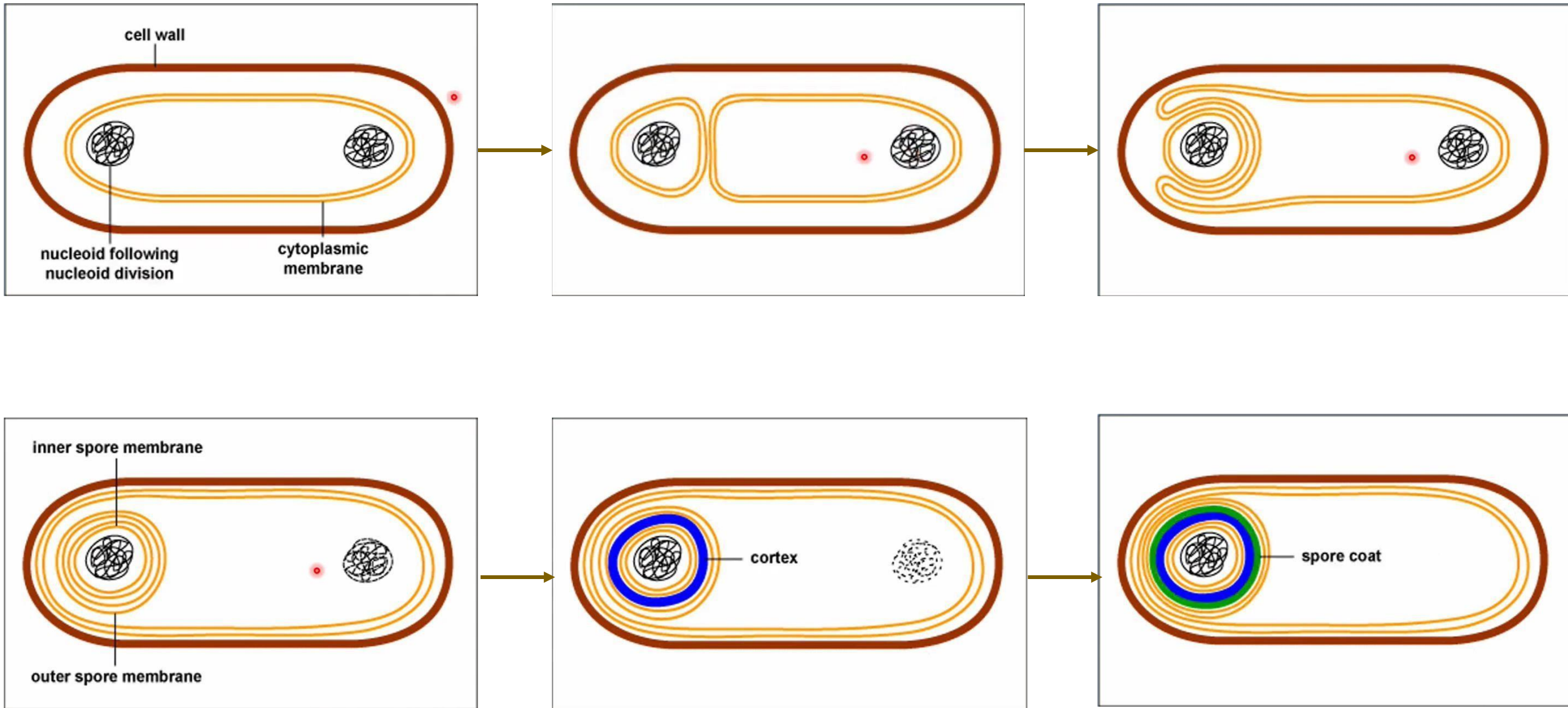
Ca²⁺ &

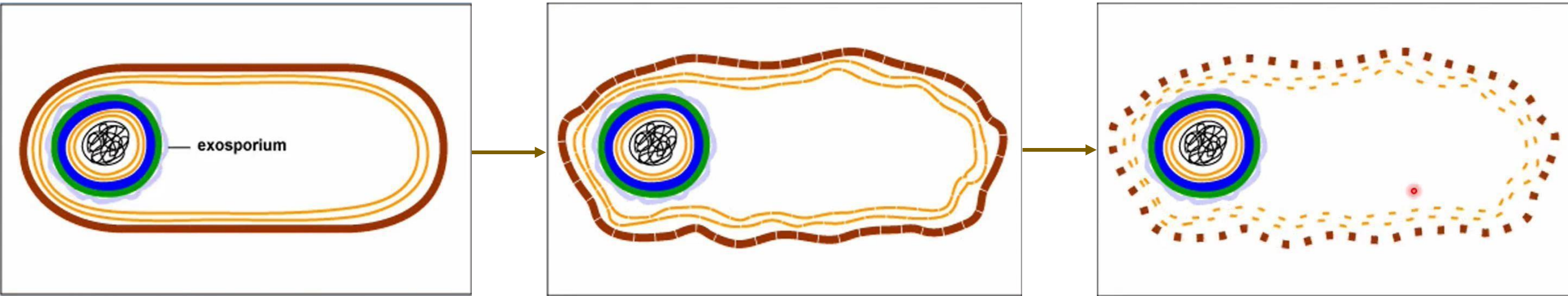
Diploic acid

Explained in next slide

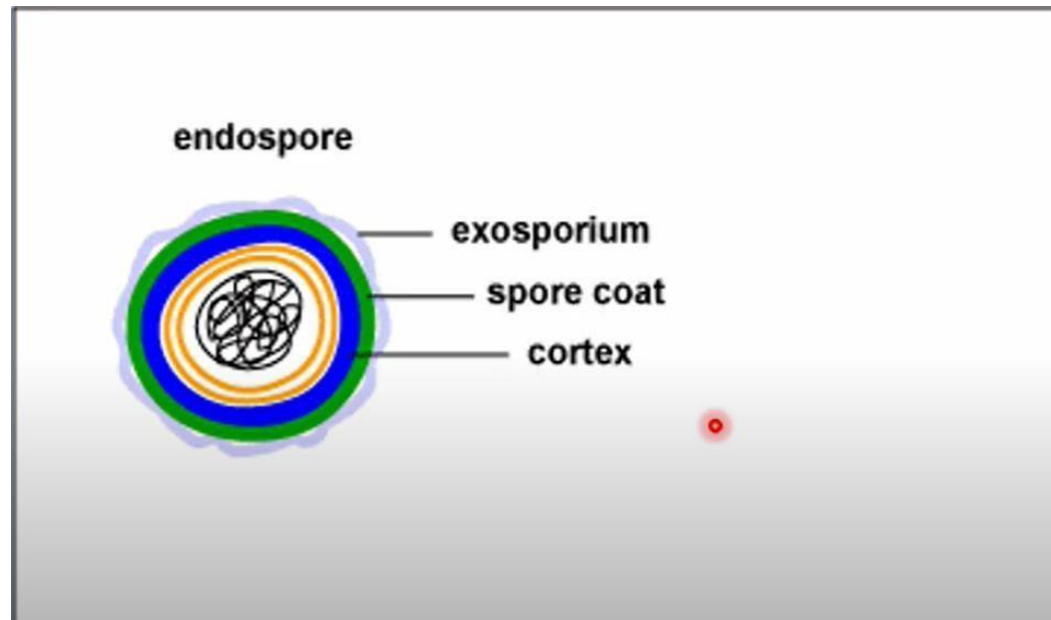
Multiple membranes

The Process of Spore Formation





Formation of Endospore



The Process of Spore Formation

1. First DNA replication occur, where each copy of the DNA moves to opposite sides of the bacterial cell.
2. Then multiple layers of the cell membrane and peptidoglycan form, producing calcium and dipicolinic acid, both contributing to the tough protective layers.(طبقة جيرية قاسية).
3. Next, a cortex forms, followed by the development of a spore coat, which contains over 80 types of proteins. Finally, an exosporium forms around the spore which is a collagen like glycoprotein . Once the spore is fully developed, the bacterium can exit the host cell and remain dormant, potentially surviving for centuries in harsh conditions.

Layers that forms from inside to outside:

Cortex → Spore Coat → Exosporium

Spore formation

endospore

Collagen like protein.



exosporium

spore coat



Made from >80 proteins.

cortex

Made from cell membrane + peptidoglycan
+ Ca^{2+} + dipicolinic acid.

Multiple membranes

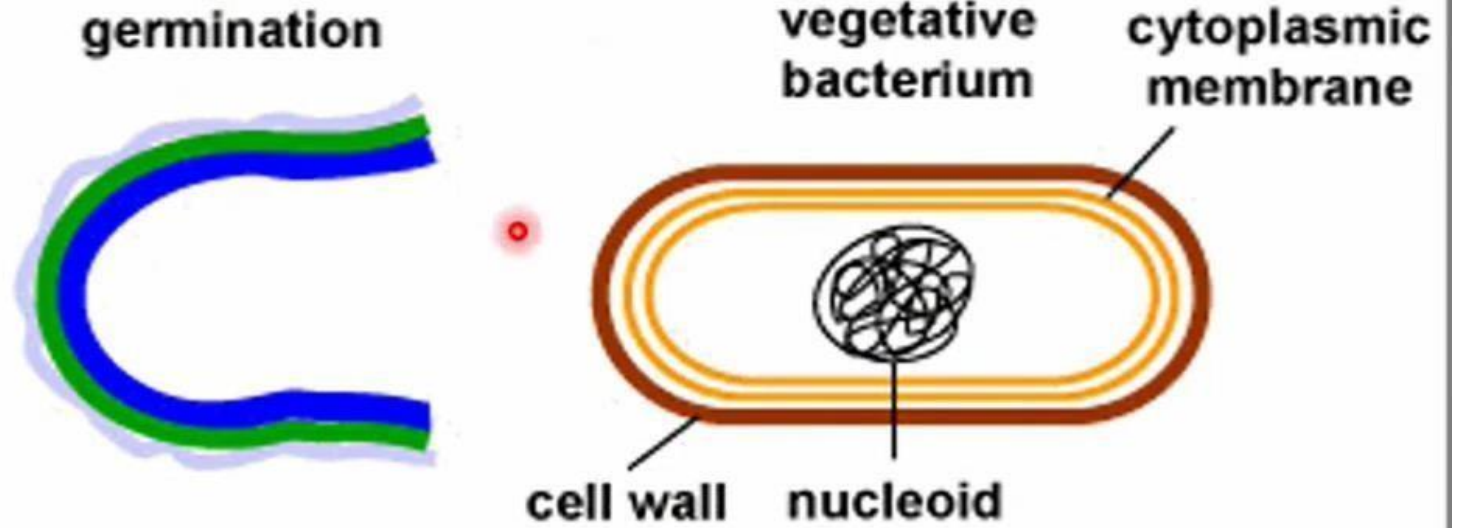
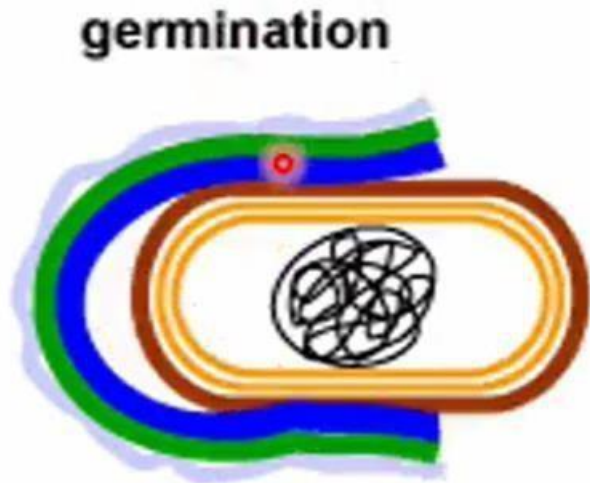


Germination التبرعم



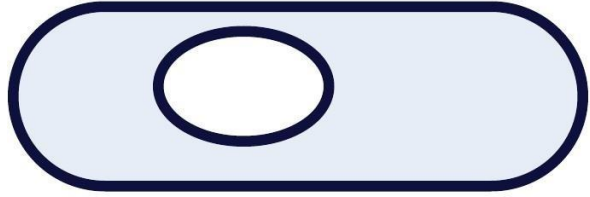
- Germination of spores occurs when the bacteria find suitable conditions like availability of water.
- In germination, bacteria will break down all the layers (cortex , spore coat , exosporium) and return to become vegetative bacteria and begin their activities inside the host cell.

The Process of Germination



Position of spores

Depends on the location of spores.



B. anthracis

Central & Oval



Cl. perfringens

Sub-terminal & Oval



Cl. Tetani

Terminal & Spherical

For any feedback, scan the code or click on it.



Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1			
V1 → V2			

Additional resources:

Reference Used:

Prof Alaa recorded lecture



رسالة من الفريق العلمي: