MICROBIOLOGY

بسم الله الرحمن الرحيم

MID – Lecture 3

Bacterial Structure (Pt.2)

﴿ وَإِن تَتَوَلَّوْا يَسْتَبْدِلْ قَوْمًا غَيْرَكُمْ ثُمَّ لَا يَكُونُوا أَمْثَالَكُم ﴾

اللهم استعملنا ولا تستبدلنا

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Objectives

Structures outside the cell wall

1) Capsule

2) Flagella

3) Pili

4) Spore formation

Capsule - Definition

Glyco → **carbohydrate**

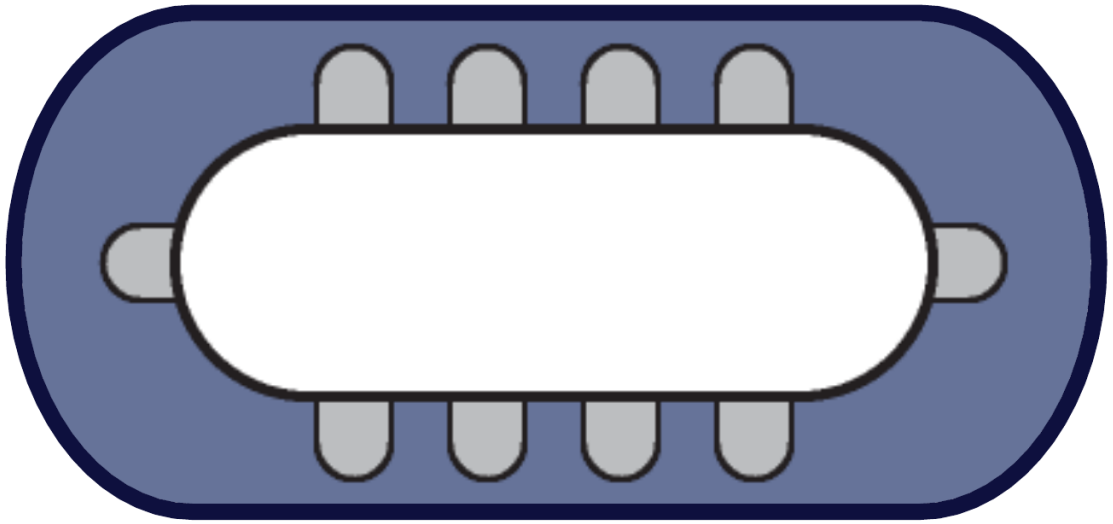
calyx → **enveloped**

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

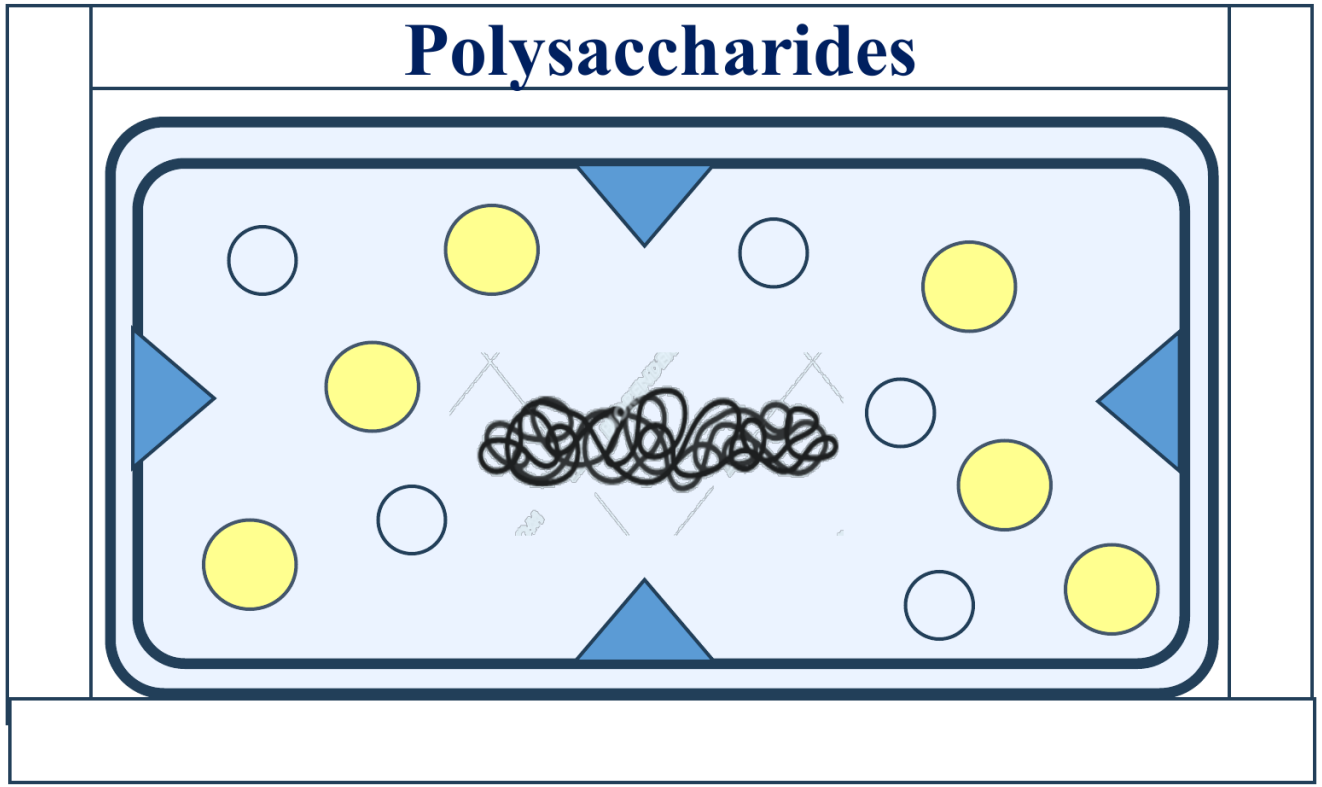
Capsule - Composition

Usually Polysaccharides

EXCEPT

Polypeptides

(*B. anthracis*)



Capsule - Composition

Variation of Capsule

Caused by different

(Arrangement of Polysaccharides)

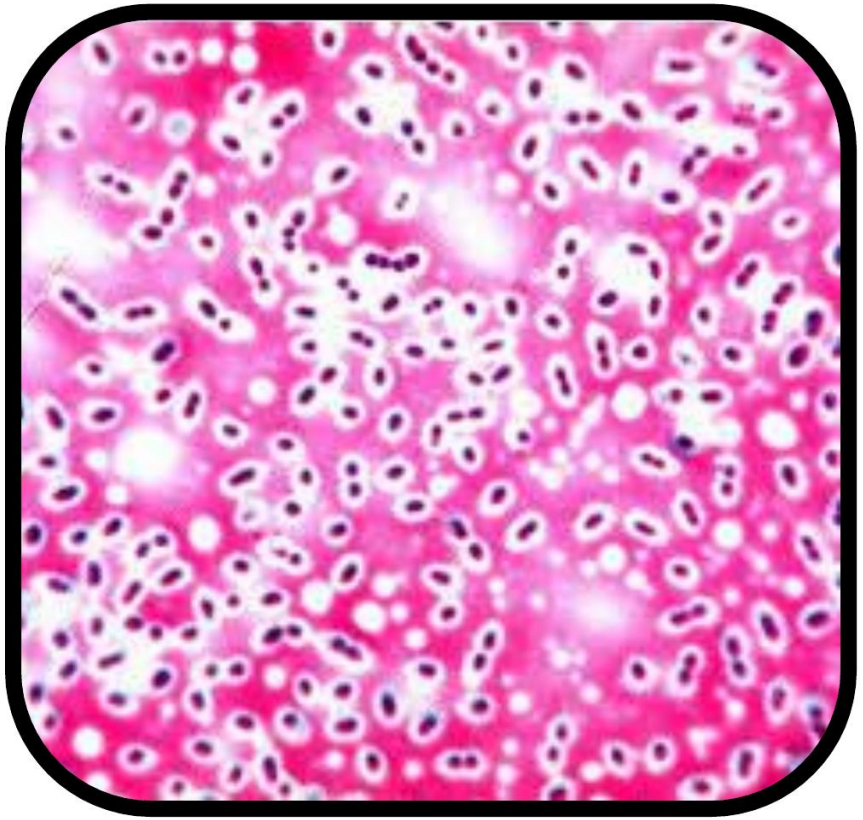
Sucrose	Mannose	Lactose
Mannose	Sucrose	Mannose
Lactose	Sucrose	Mannose

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

Capsule - Composition

Do Not stained by

Gram stain

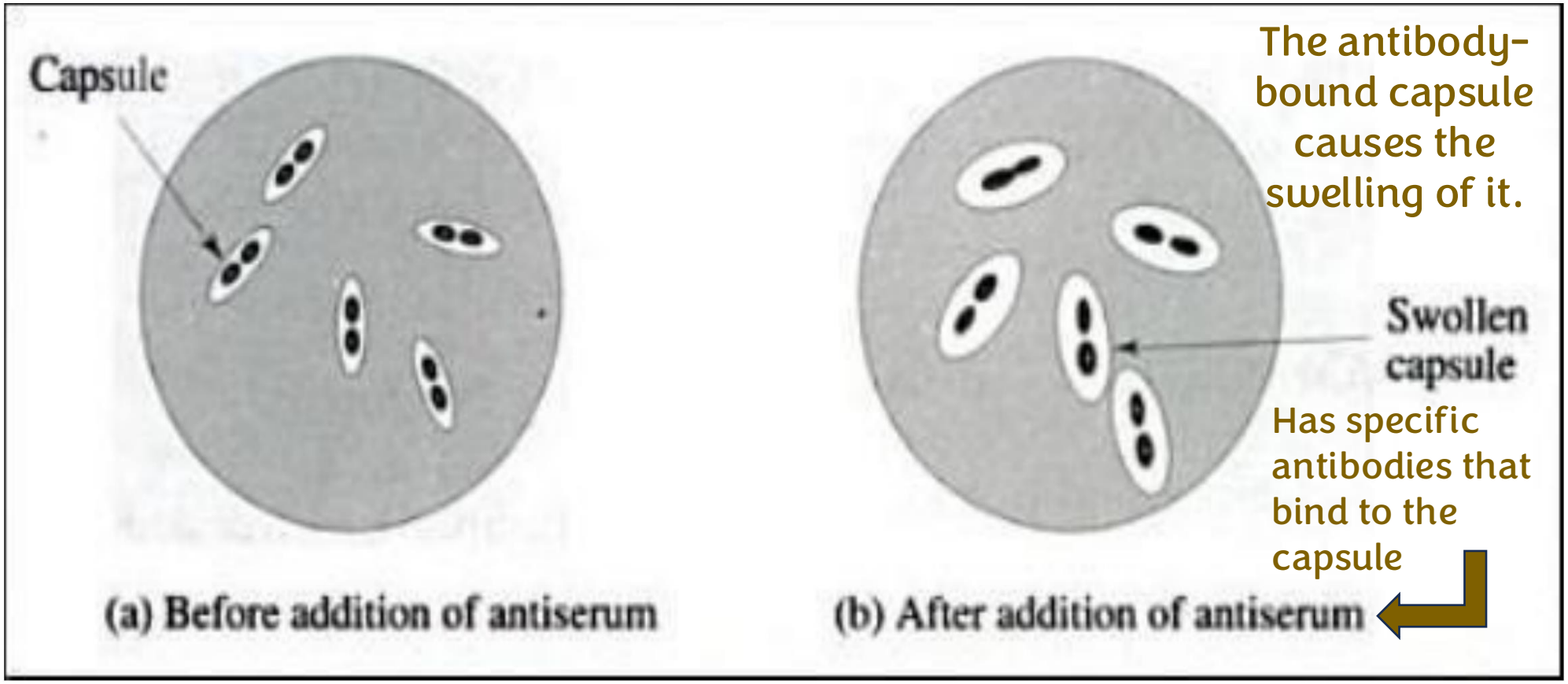


That is why we see **Unstained halo around the organism**

Capsule - Composition

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

Quellung reaction (swelling)



The antibody-bound capsule causes the swelling of it.

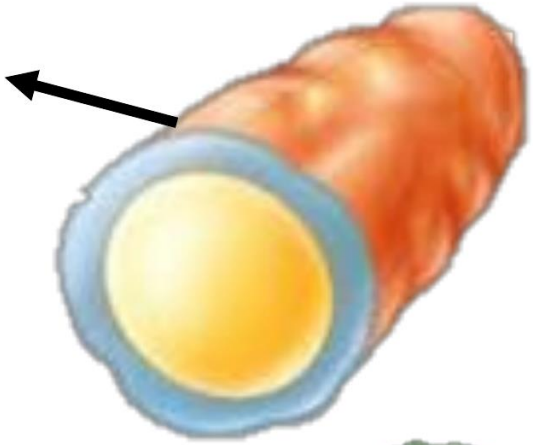
Swollen capsule

Has specific antibodies that bind to the capsule

Capsule - Composition

Capsule

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

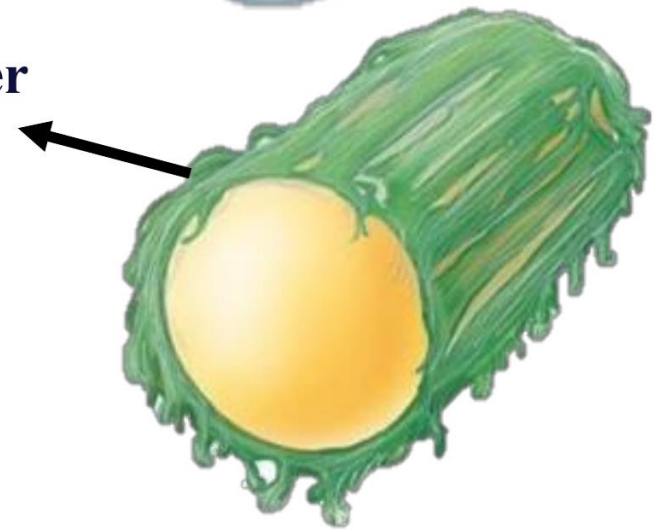


Glycocalyx

Has fibril extensions help it adhere

Slime layer

These components are similar in their loose, unorganized attachment



Capsule - Composition

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

Capsule

Tightly, organized bound around all cell wall

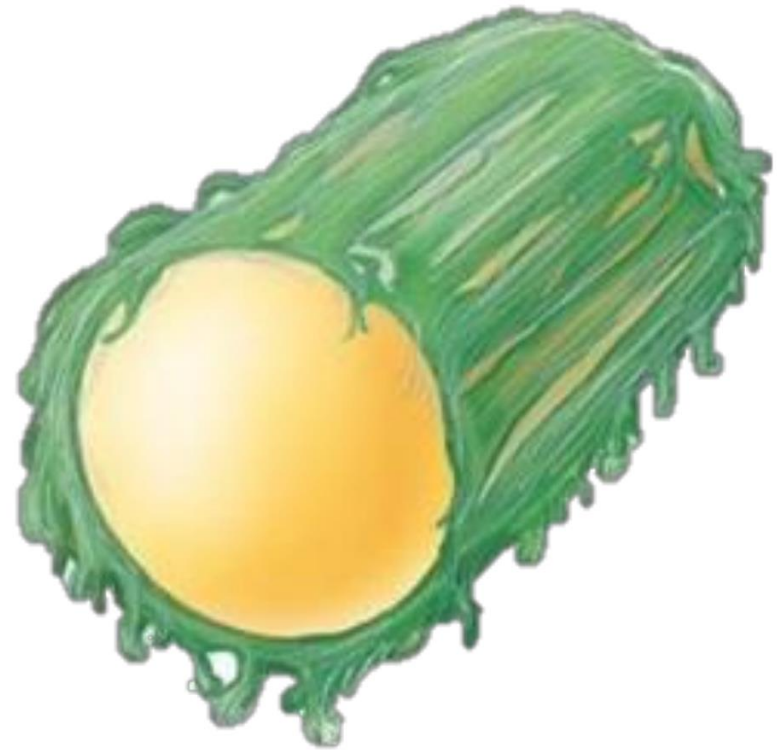
Firmly adherence to surface organism

Capsule - Composition

Glycocalyx

(Slime layer)

Loosely & unorganized attached



Capsule - Composition

Glycocalyx

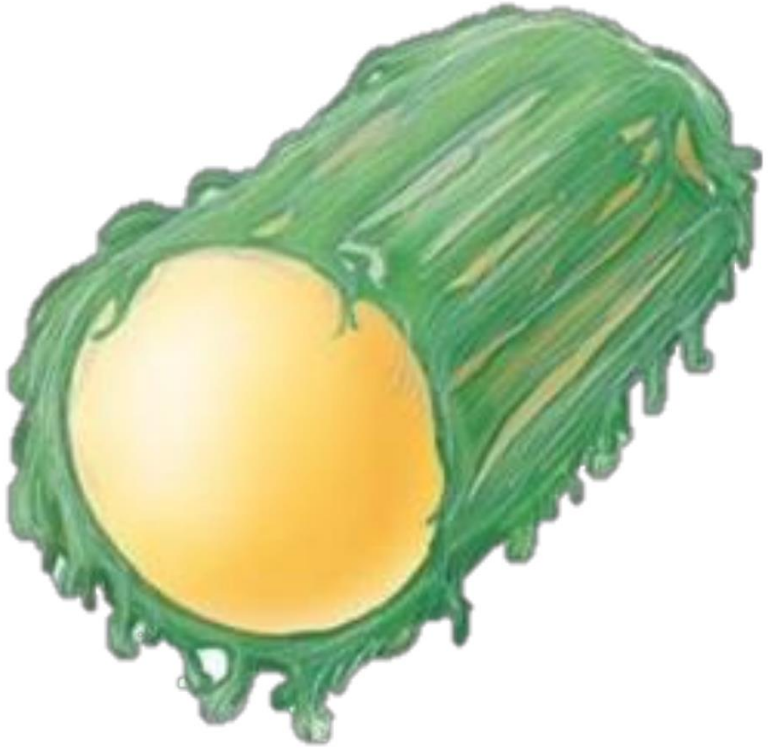
Fibrils extending

Make it

It adhere firmly to skin, heart, etc

e.g. *Strept. mutans*

It adheres to the host cell
NOT the bacterial capsule

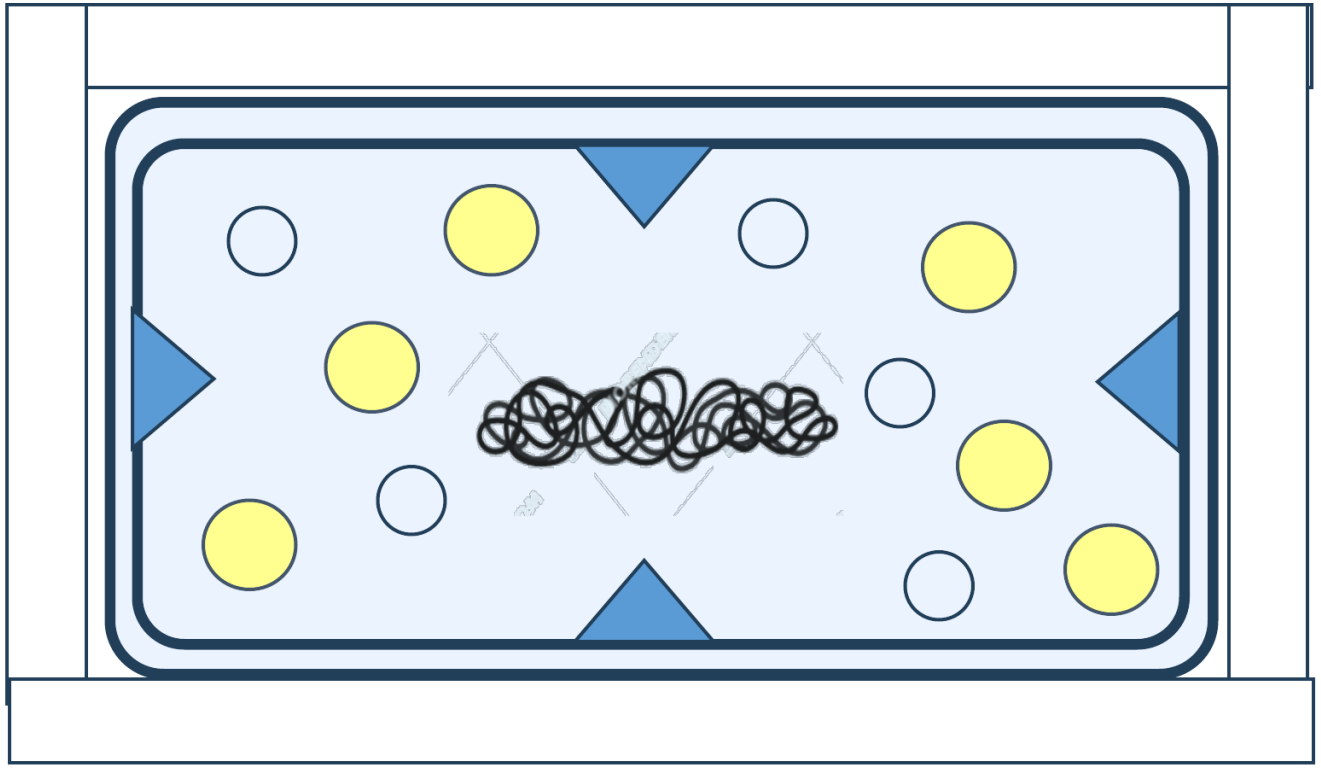


Loosely & unorganized attached

Capsule - Function

A

Protect Cell wall



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.

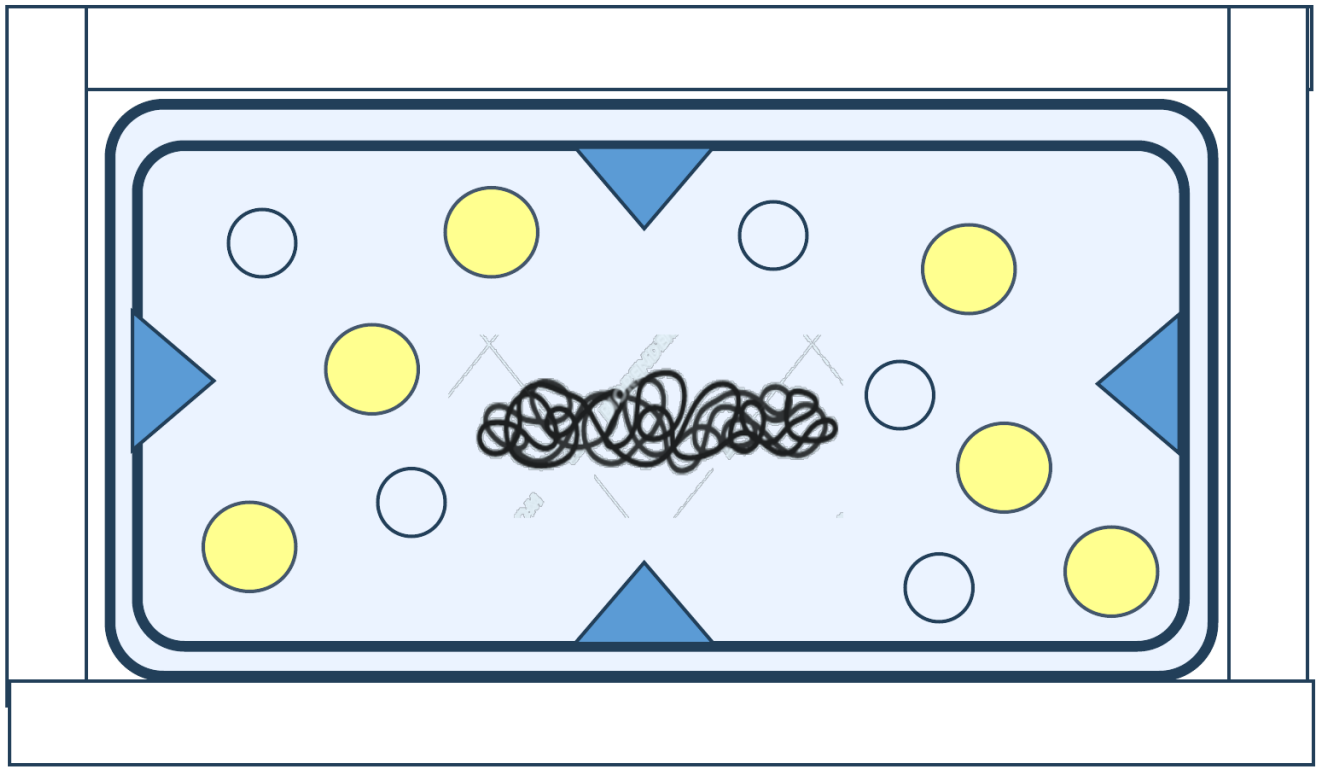
Capsule - Function

A

Protect Cell wall

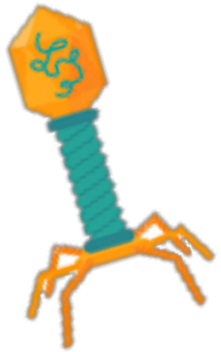
From Complements (in immunology)

(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 also resulting in no infection.

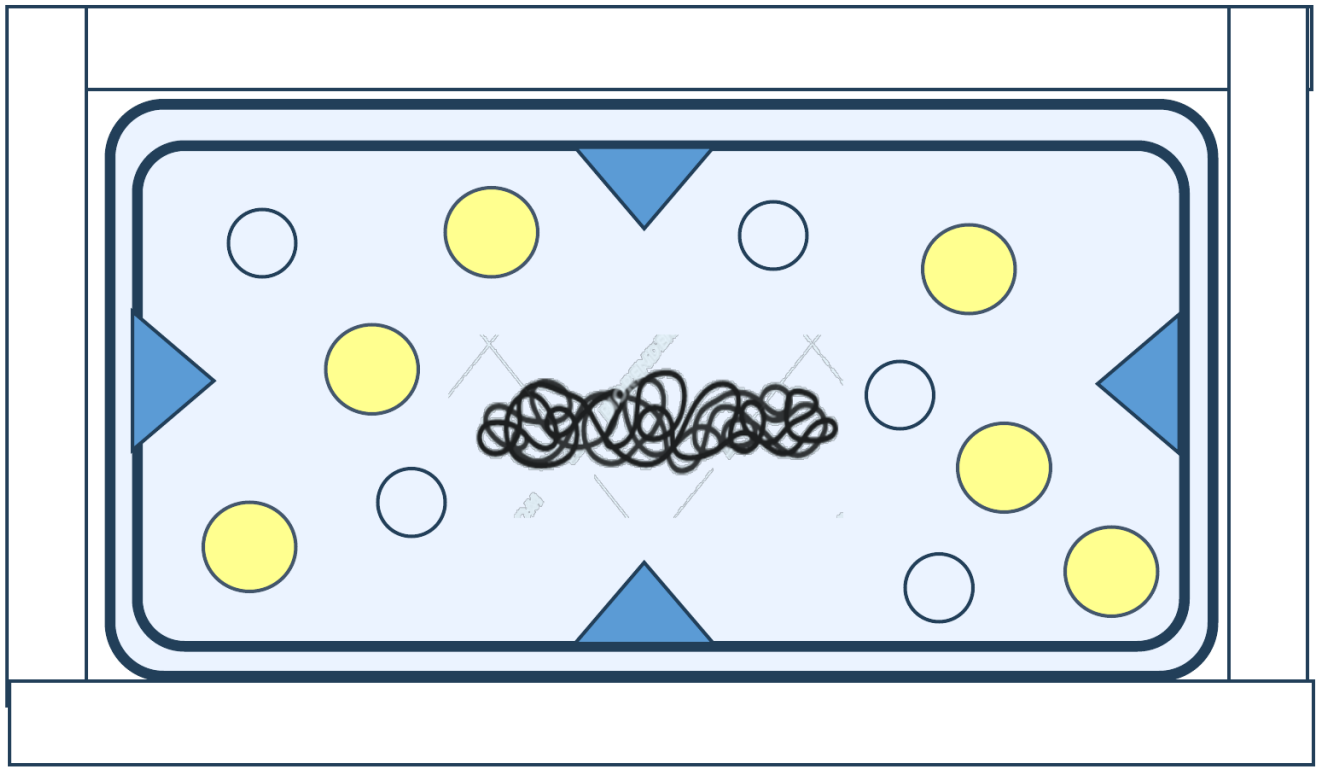


Capsule - Function

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

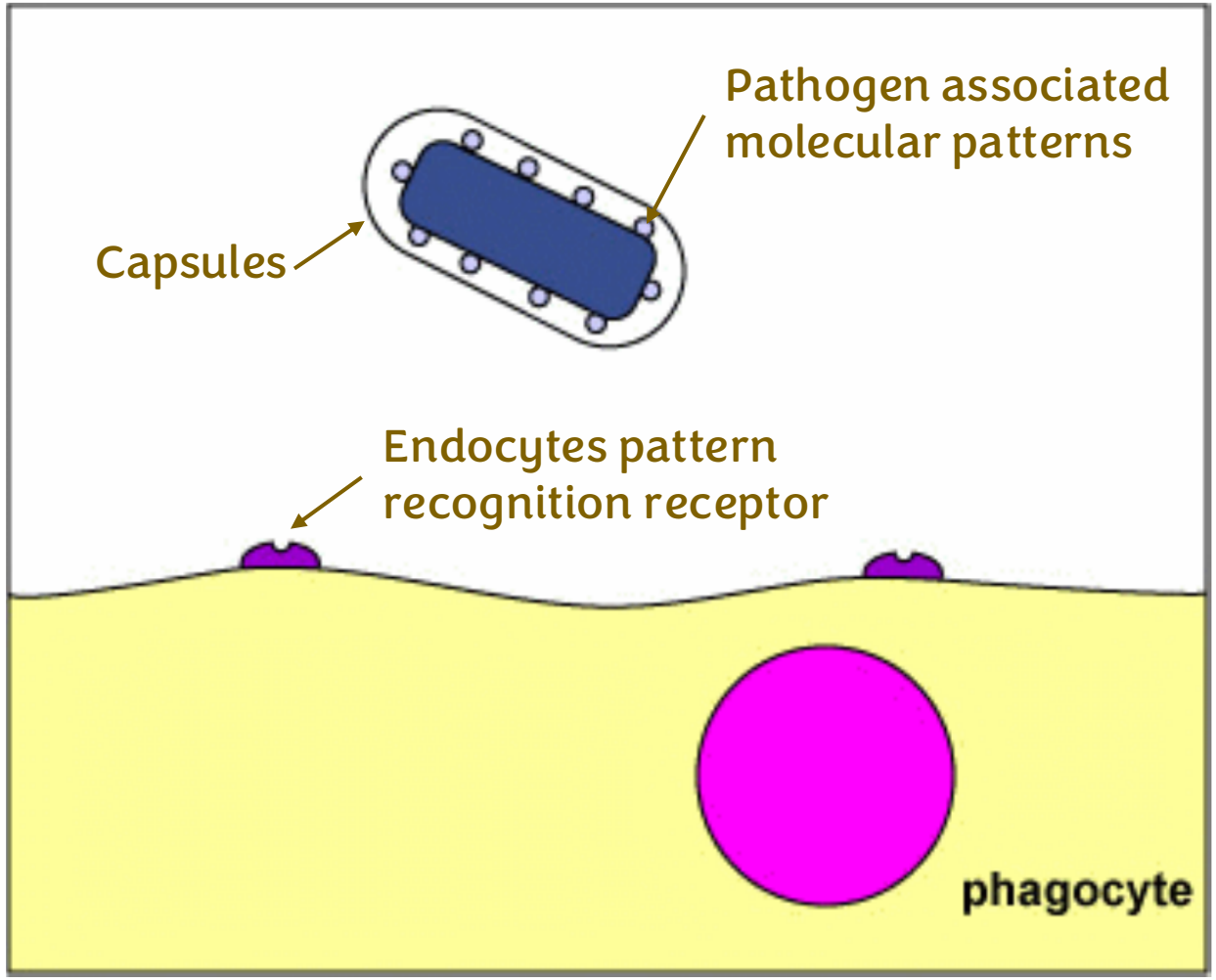
B

Prevent phagocytosis

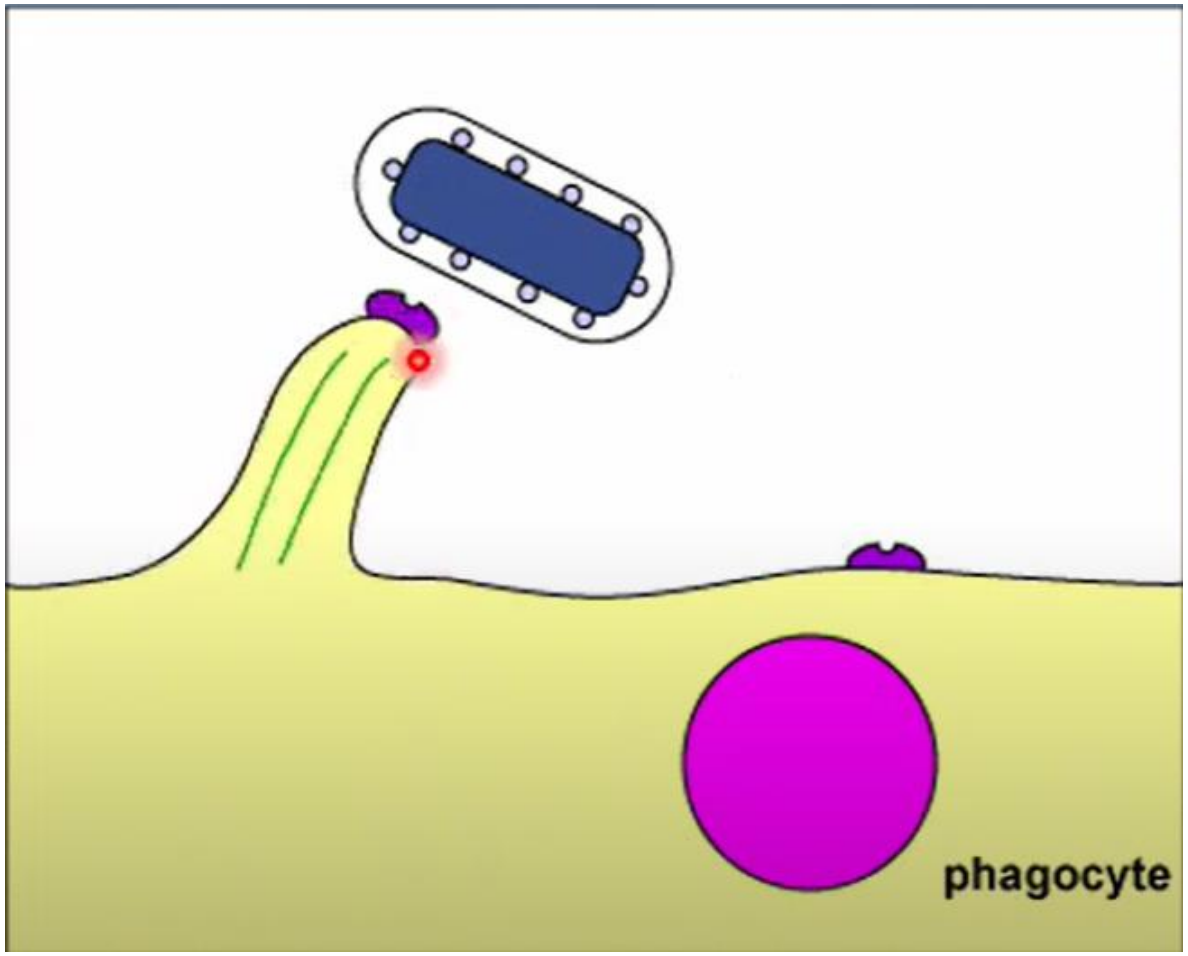
It's a virulence factor (سلاح دفاع)

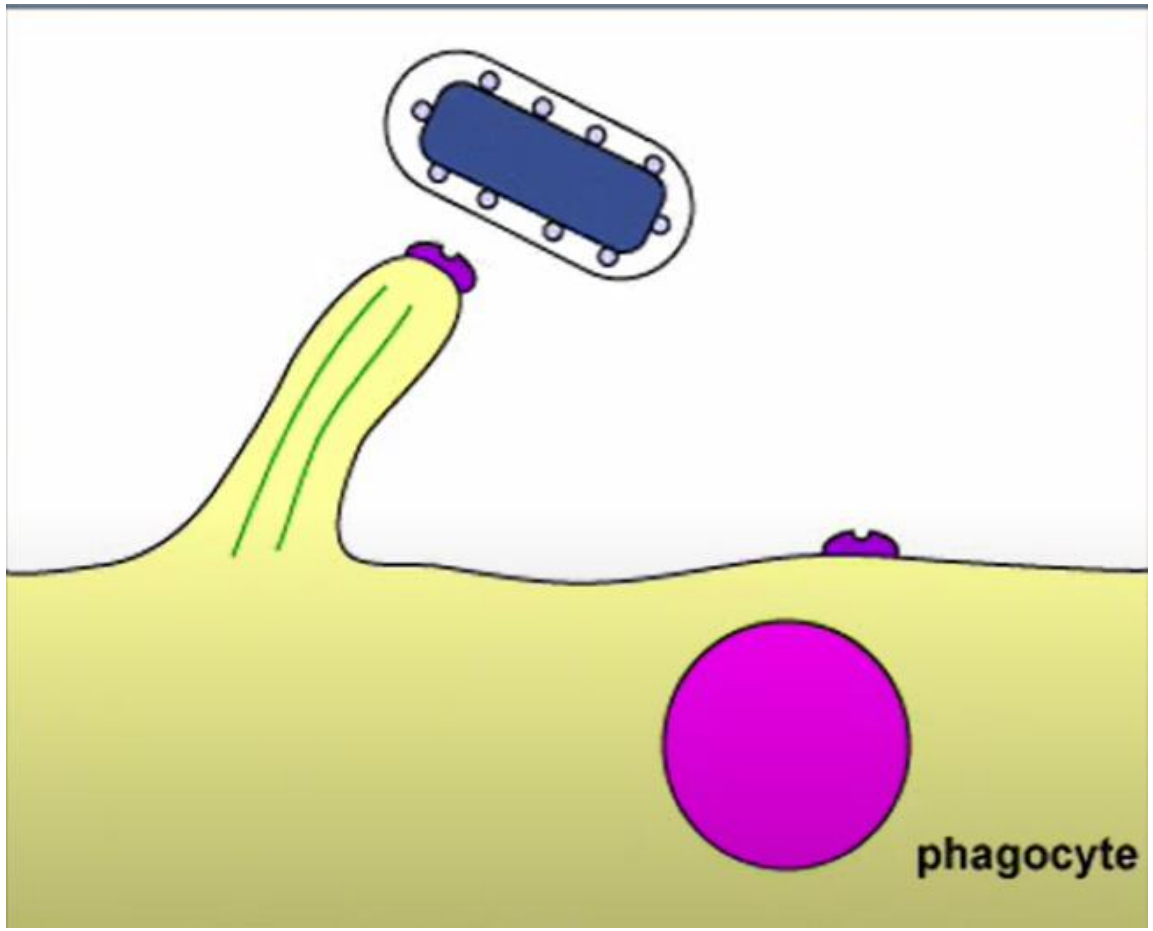
(Virulence)

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



Phagocytosis Prevention by the bacteria



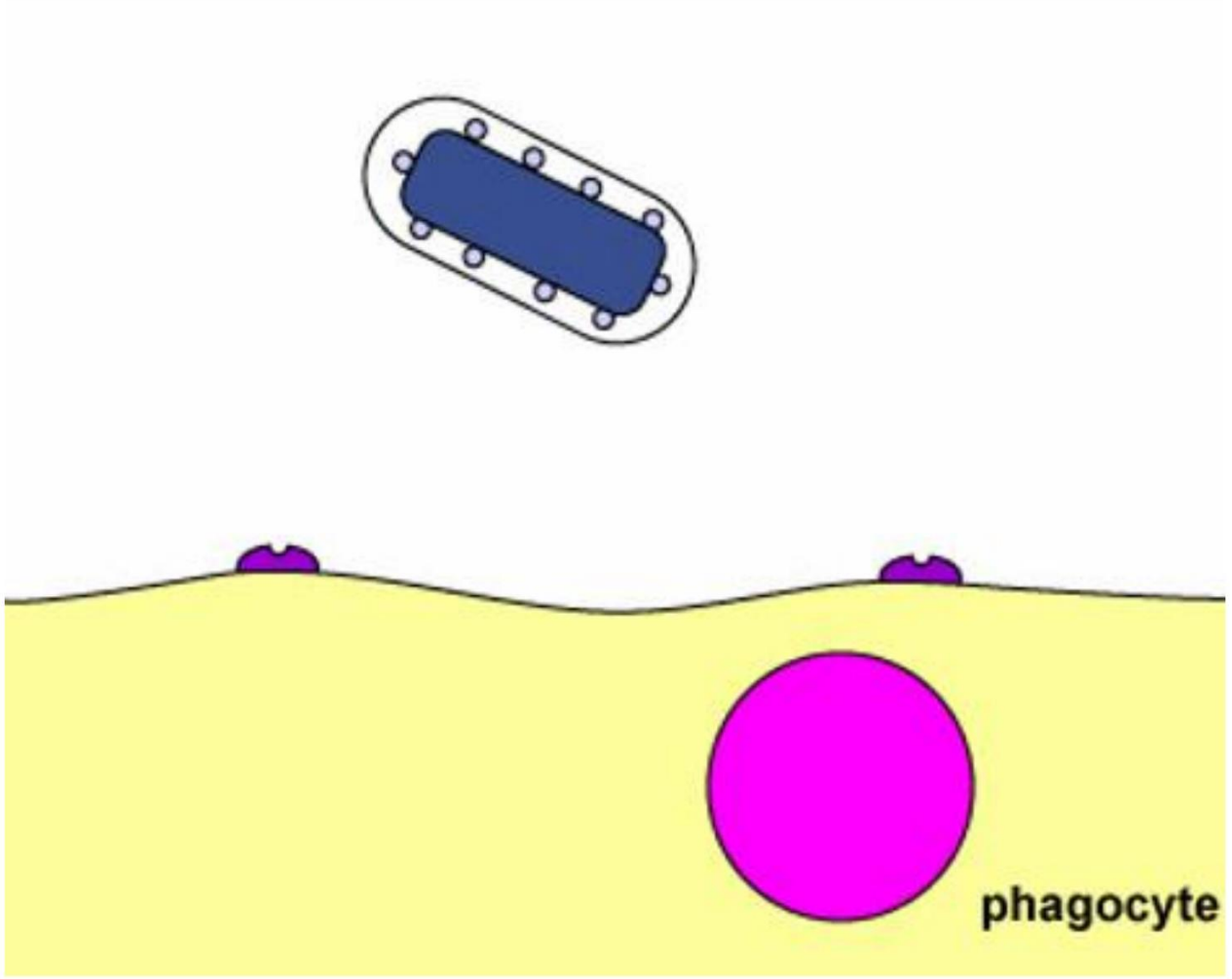


Capsule - Function

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

C

Attachment

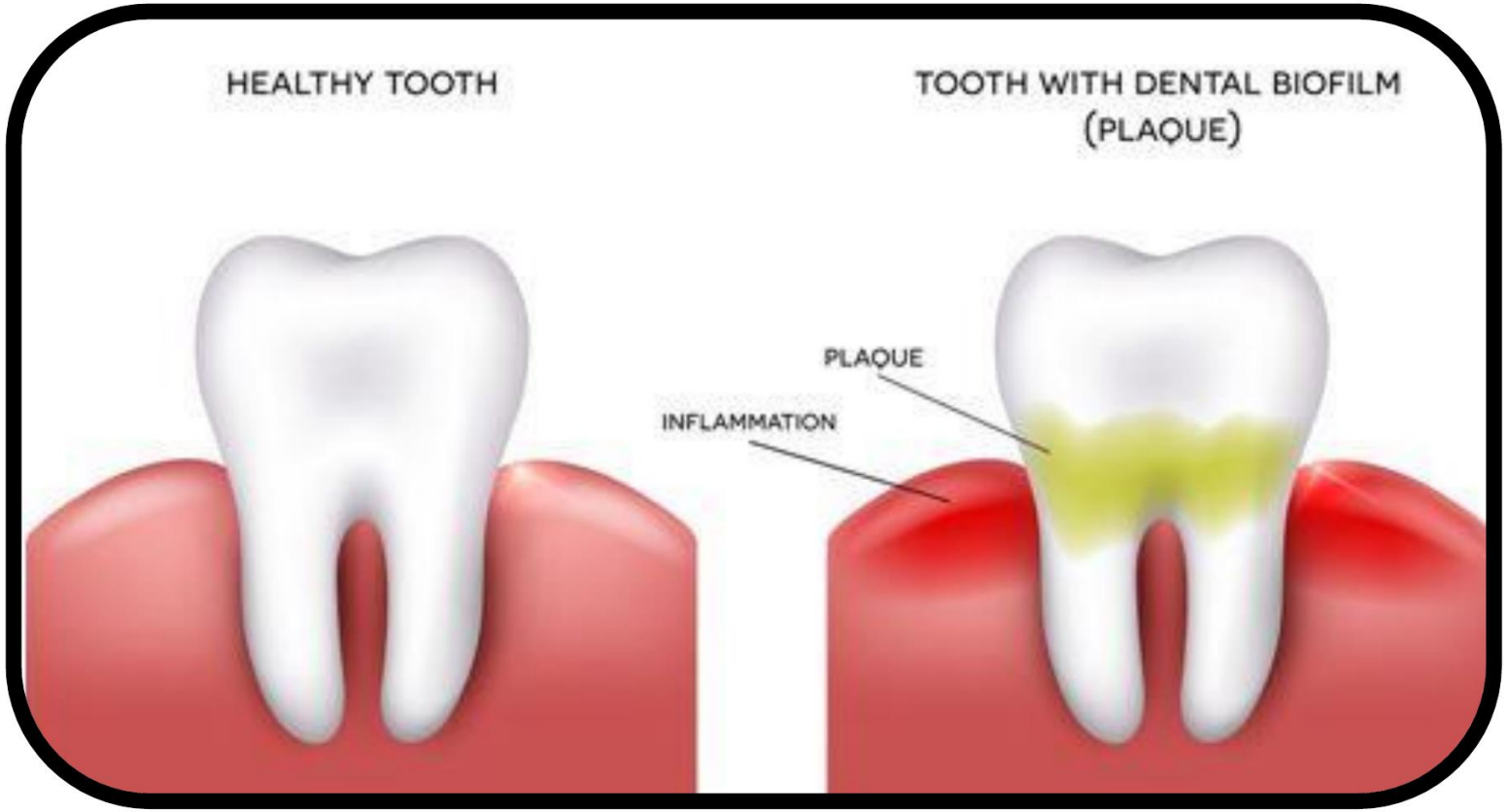
(Glycocalyx)

تسوس الأسنان

Dental caries

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

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



Capsule - Function

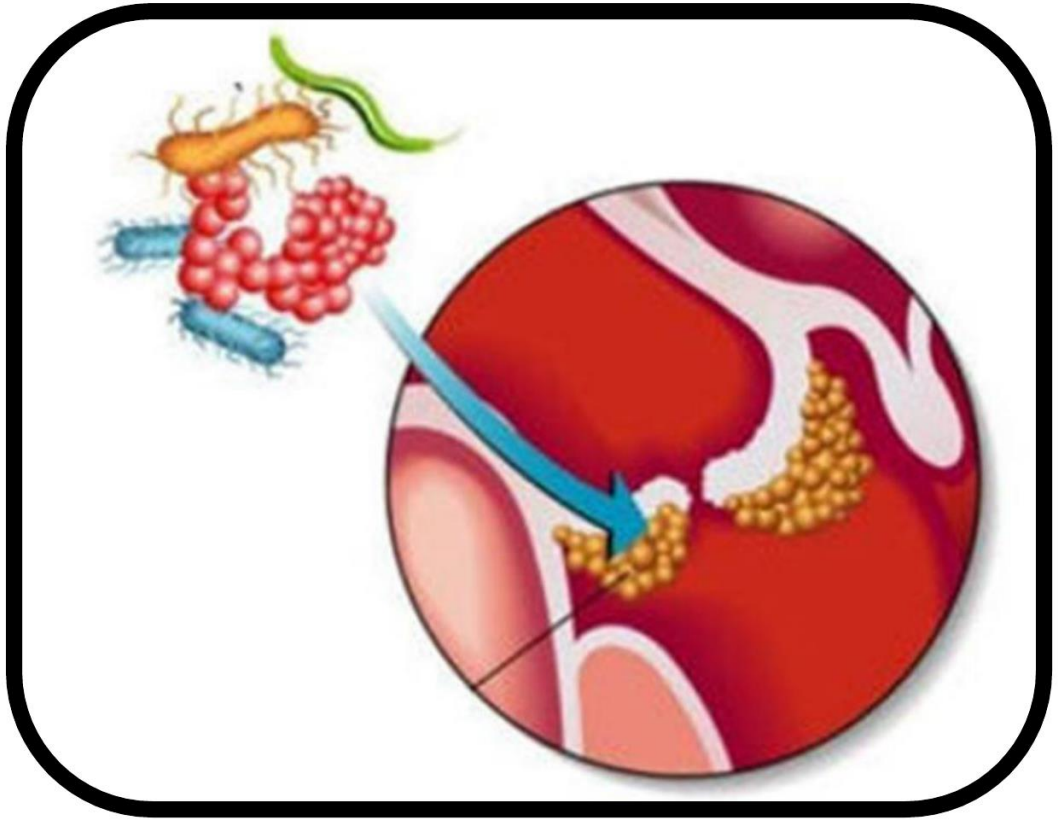
C

Attachment

(Glycocalyx)

This is NOT a virulence factor since the glycocalyx high adherence (in this case to the heart) leads to diseases.

➢ **Prosthetic heart valves**

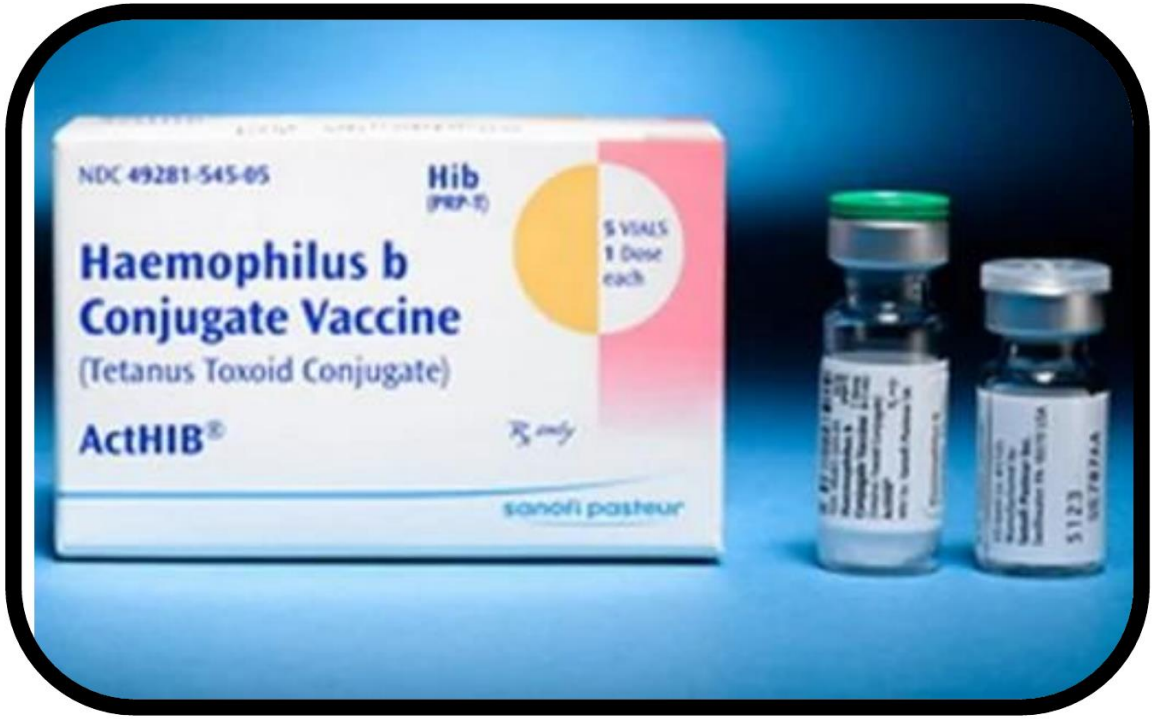


Capsule - Function

D

Development of vaccine

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



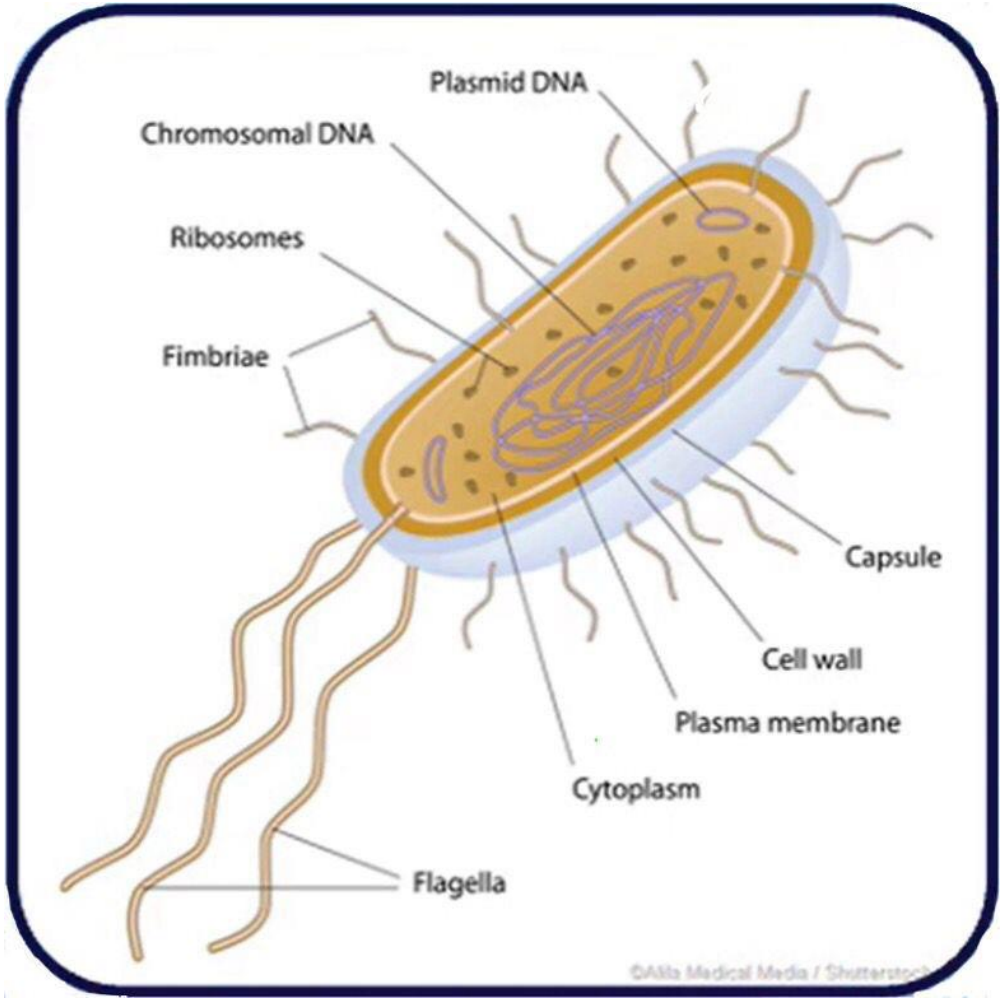
Flagella - Definition

Long thick threads like (filamentous),

formed from protein (flagellin)

(H Ag)

Every flagella present in any bacteria is symbolized by



Flagella - Definition

Seen by EM

(20nm)

Very small in size

Flagella - Definition

Polar

Spiral

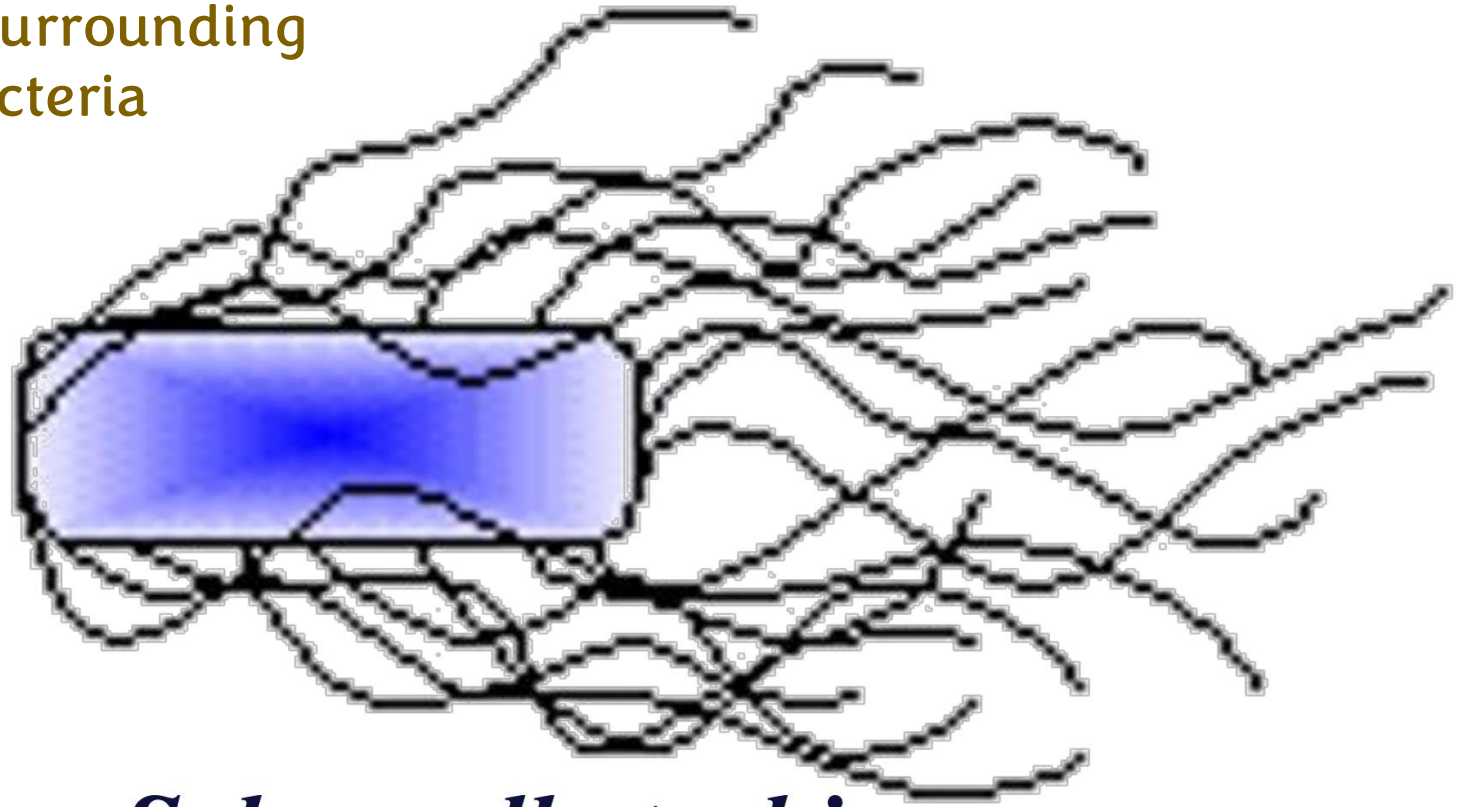
Flagella - Definition

Peri/trichous

Flagella surrounding
all the bacteria

around

peritrichous

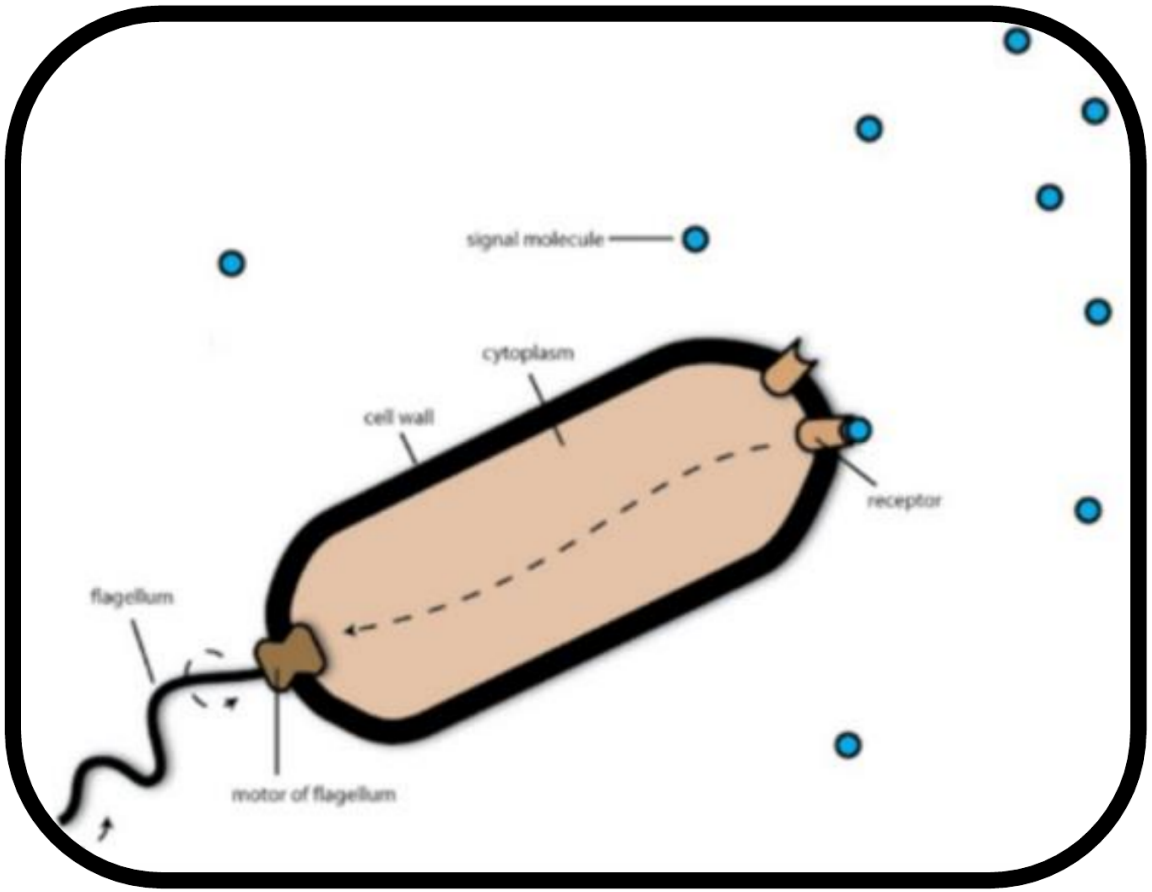


Salmonella typhi

Flagella - Function

The main function of the flagella is

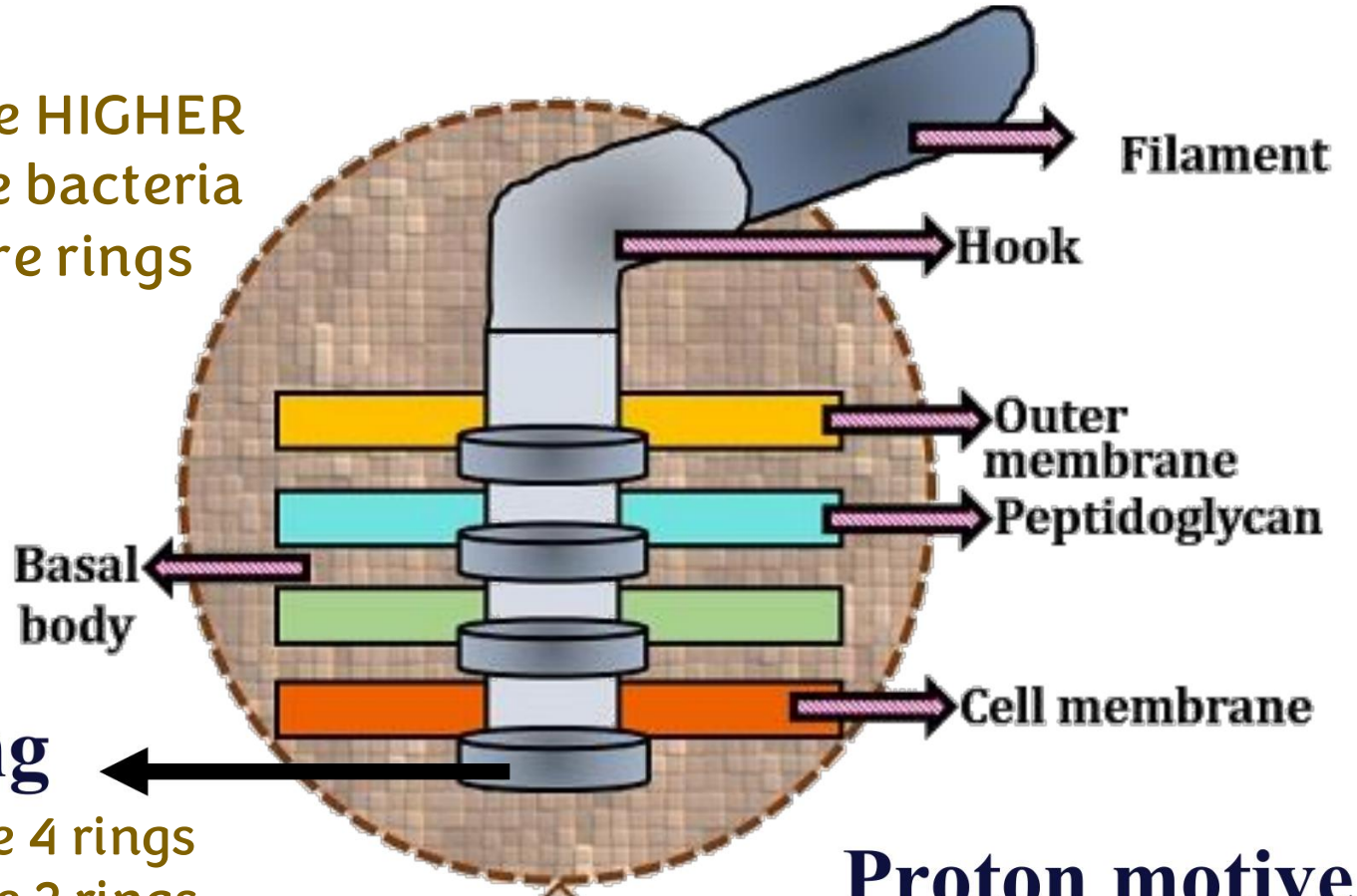
The organs of motility



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.

Ring

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

Proton motive force

This force makes the ring move

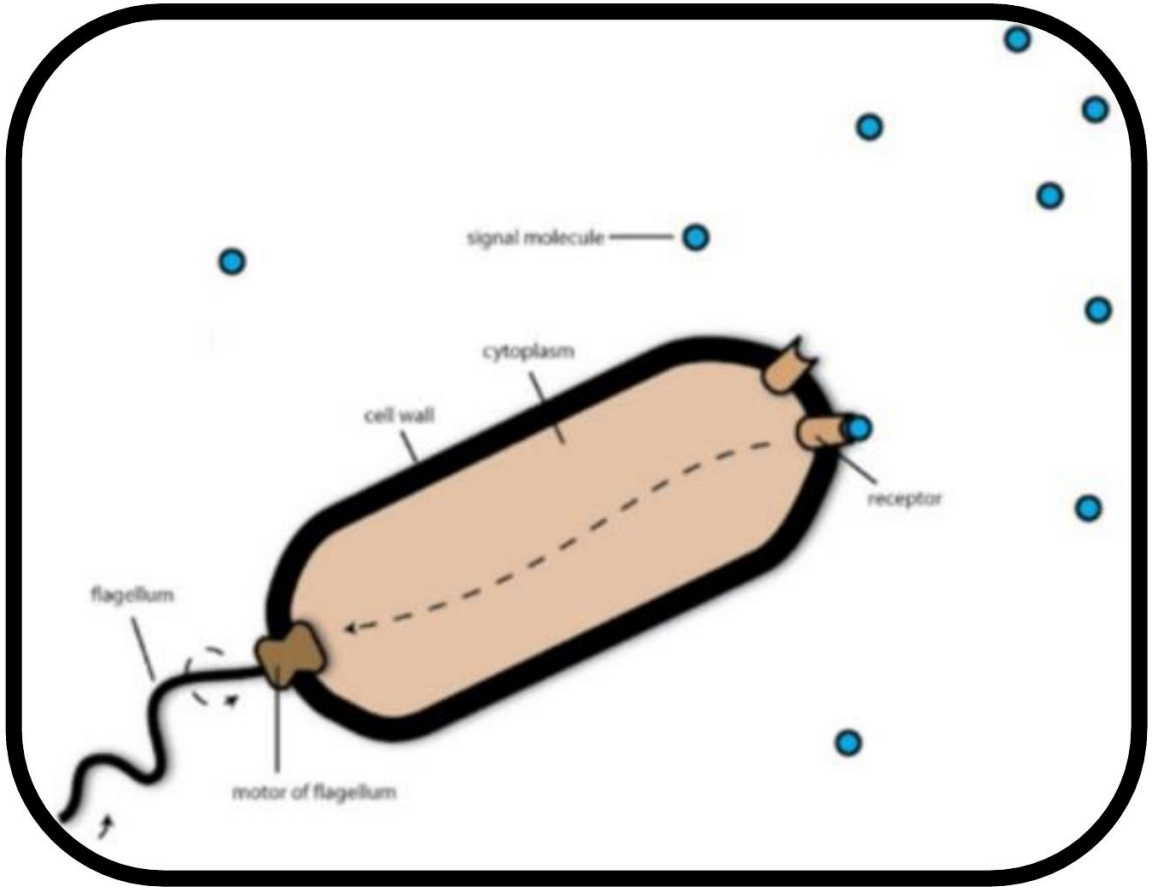
Flagella - Function

Tactic response (Taxis)

(Stimulus)

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

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



Positive chemotactic res -> toward material
Negative chemotactic res -> away from material

Flagella - Function

Tactic response (Taxis)

Stimulating agent

Two types of tactic response

Chemo Taxis

↓

If the stimulus is chemical

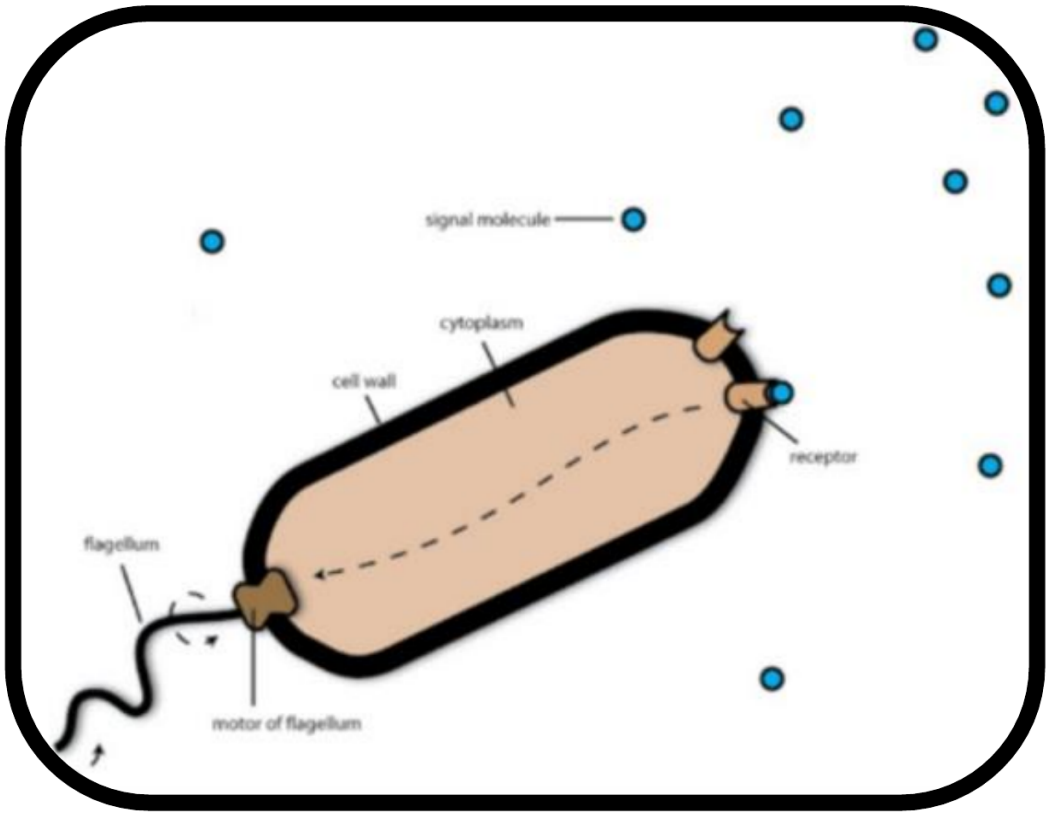
Chemical

Photo Taxis

↓

If the stimulus is light

Light

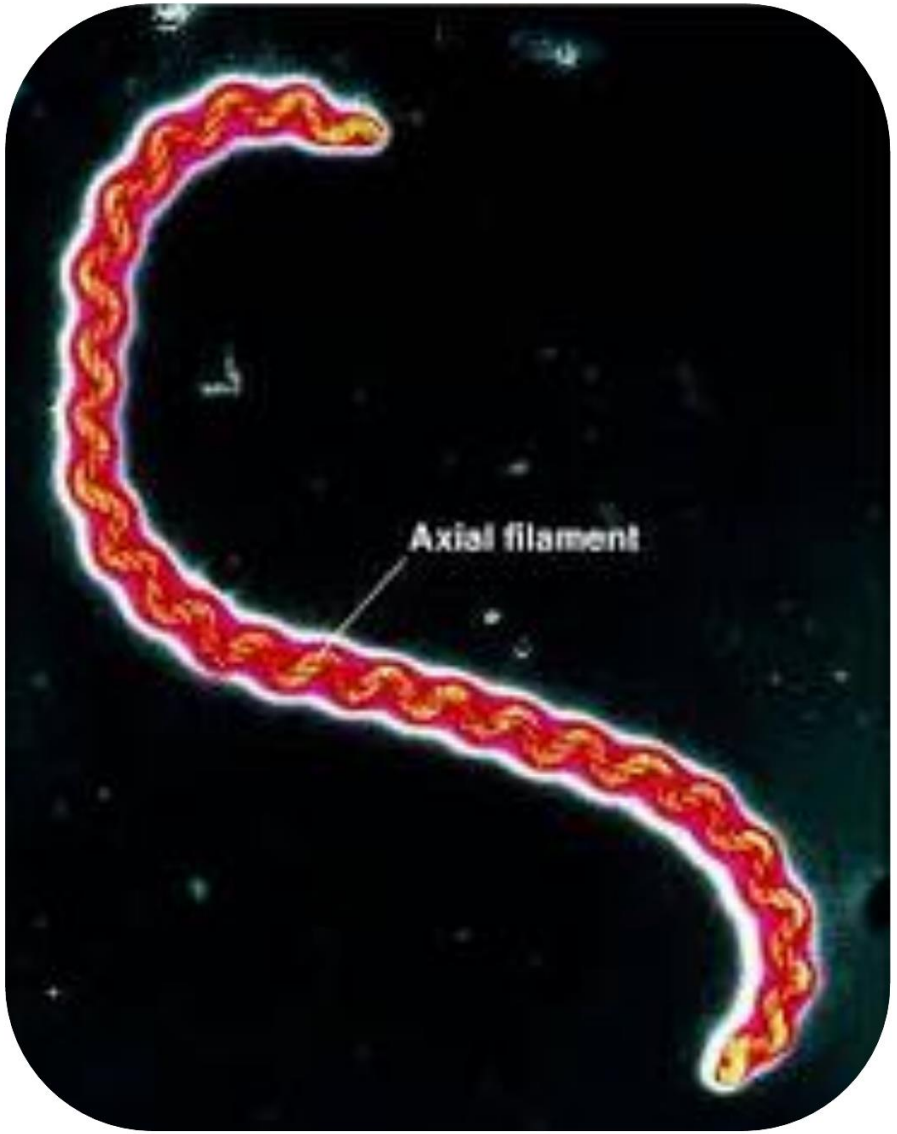


Axial Filaments

Some bacteria posses internal flagella instead of outside the bacteria
This is known as endoflagella also referred as axial filaments
These bacteria has wave like movements

Endoflagella

In spirochetes { Example}

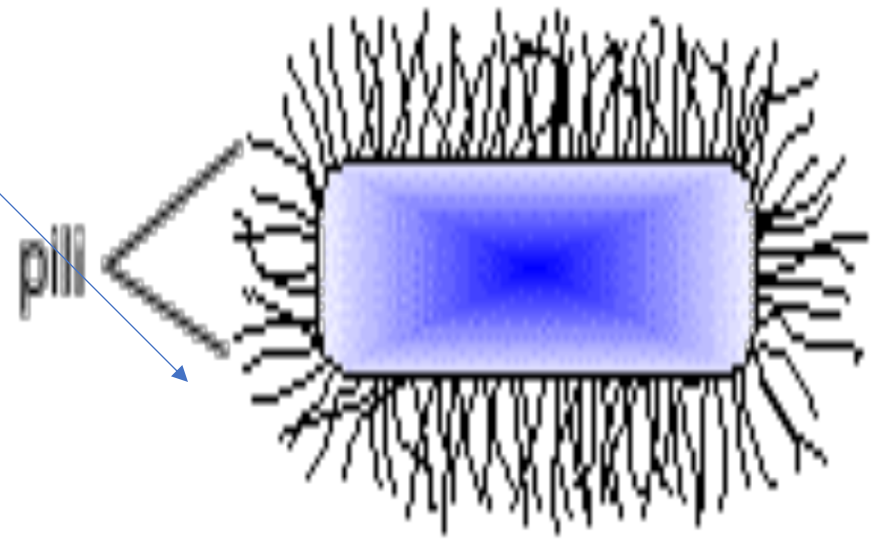


Pili (Fimbriae)

Short and thin

Hair like formed from protein

(Pilin) Name of protein



Pili

Seen by EM

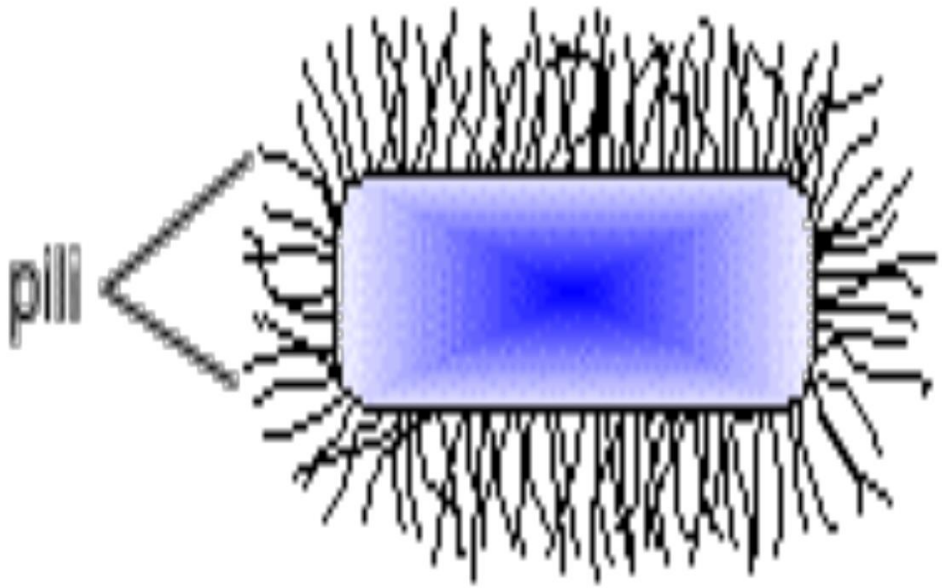
Only

Pili

Two types of pili :

A) Ordinary pili

(Attachment)

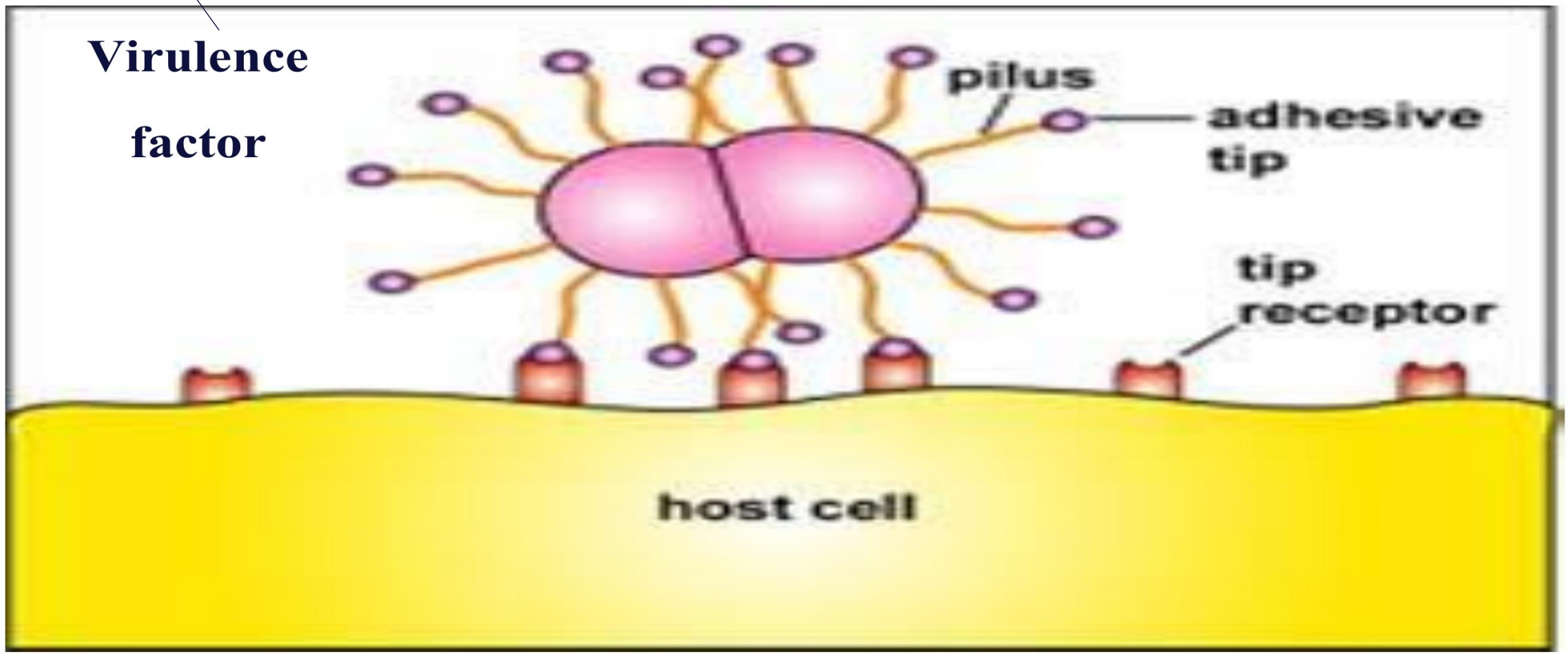


B) Sex pili

(Genetic transfer)

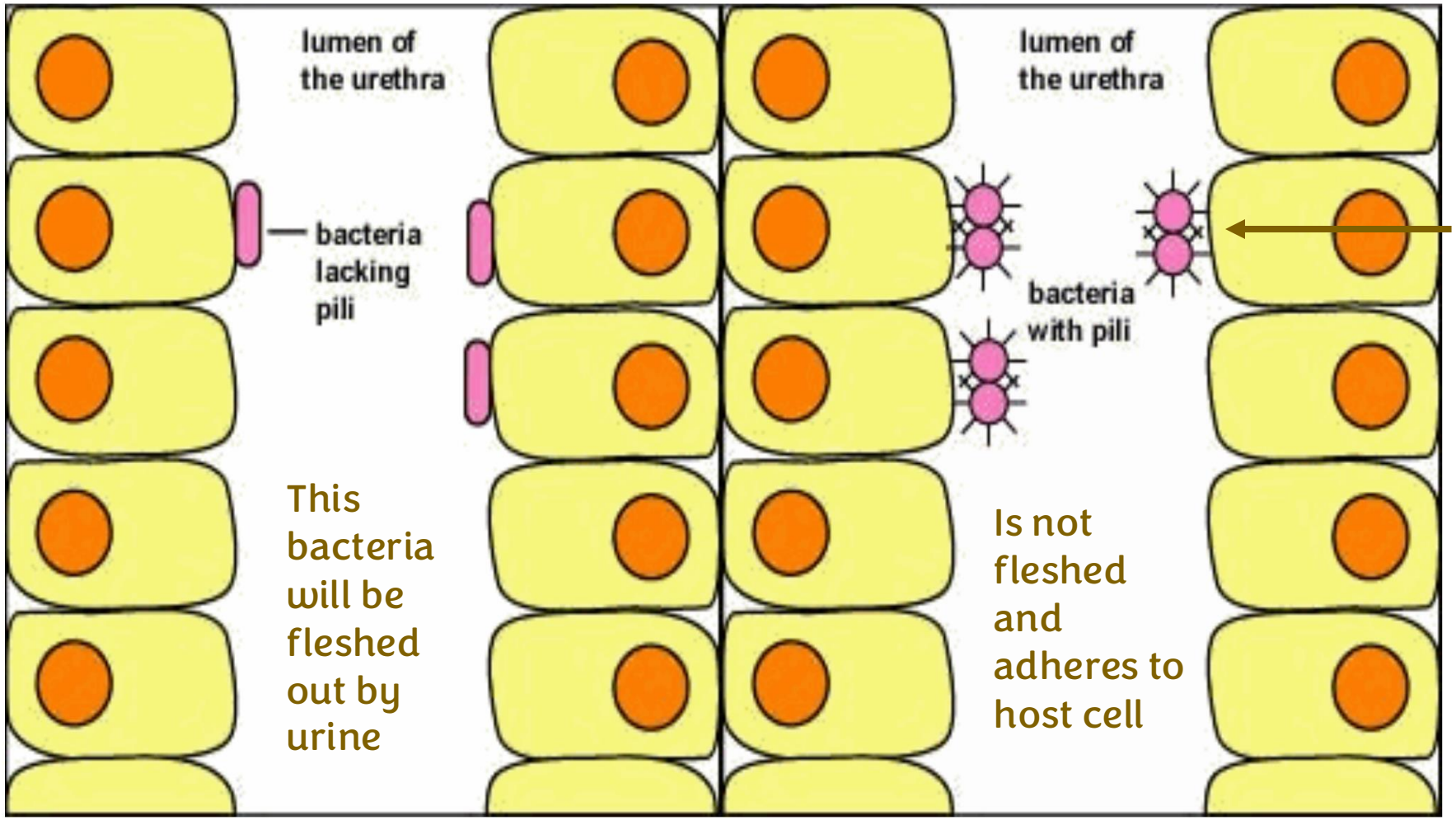
Because this pili act as defending weapon and help in adhering of bacteria to the host cell in the first step of infection (establishing a disease).

Ordinary Pili



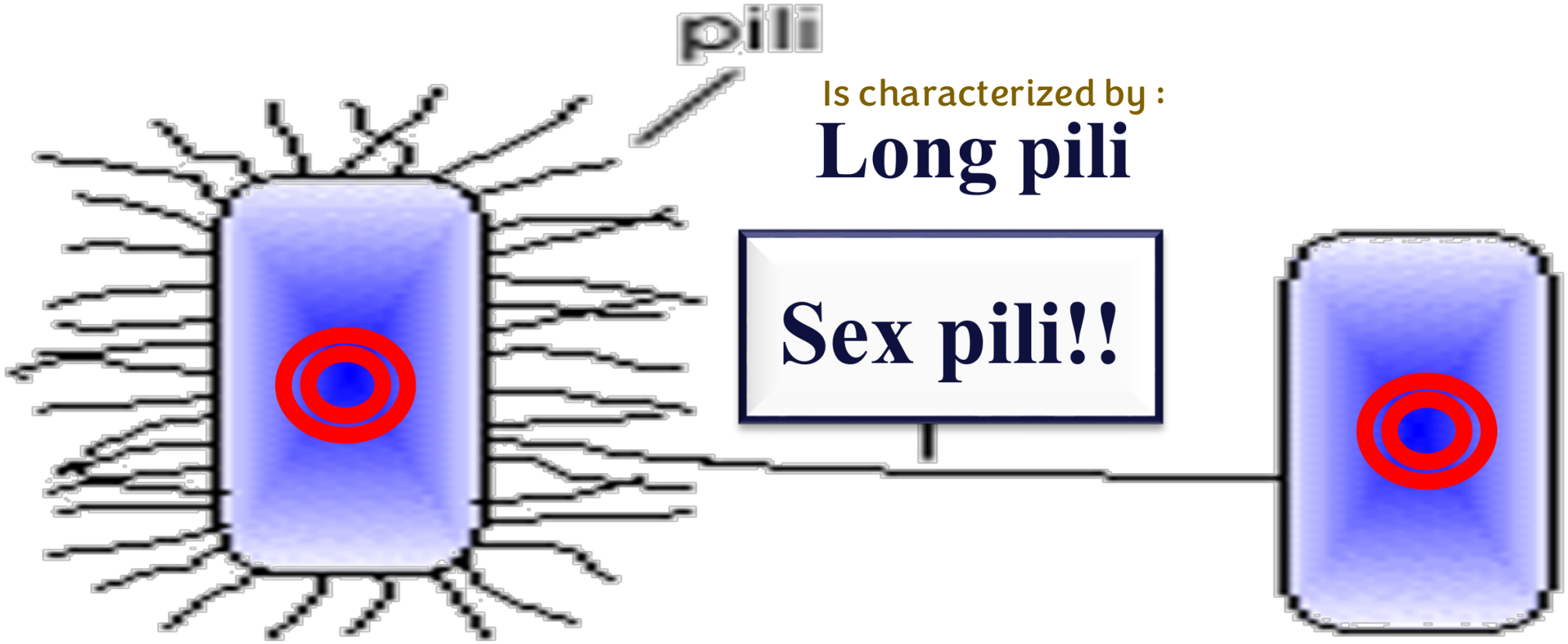
This photo from urethra

Ordinary Pili



Bacteria can resist the fleshing of the urine

Sex 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

Nonprecise name ←

F+ :fertile

mostprecise ←

Donor

Another name :

Conjugation

Female

nonprecise ↗

F- :nonfertile

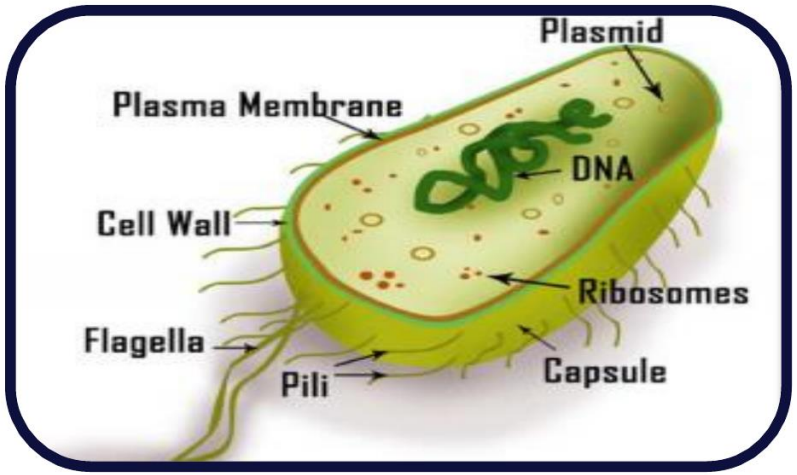
Recipient

→most precise

Spore formation

Vegetative bacteria

:bacteria that divide and replicate INSIDE THE HOST CEIL



Unsuitable condition

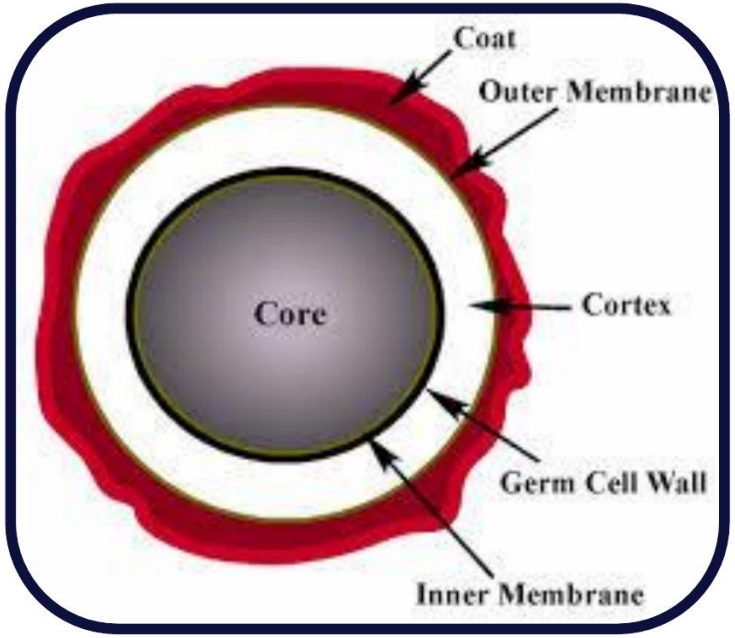
this lead to :

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

Spore formation البوغ

(Outside)

Outside the host cell



Spore formation

Forming highly resistant resting phase (Endospores) in VITRO

↓

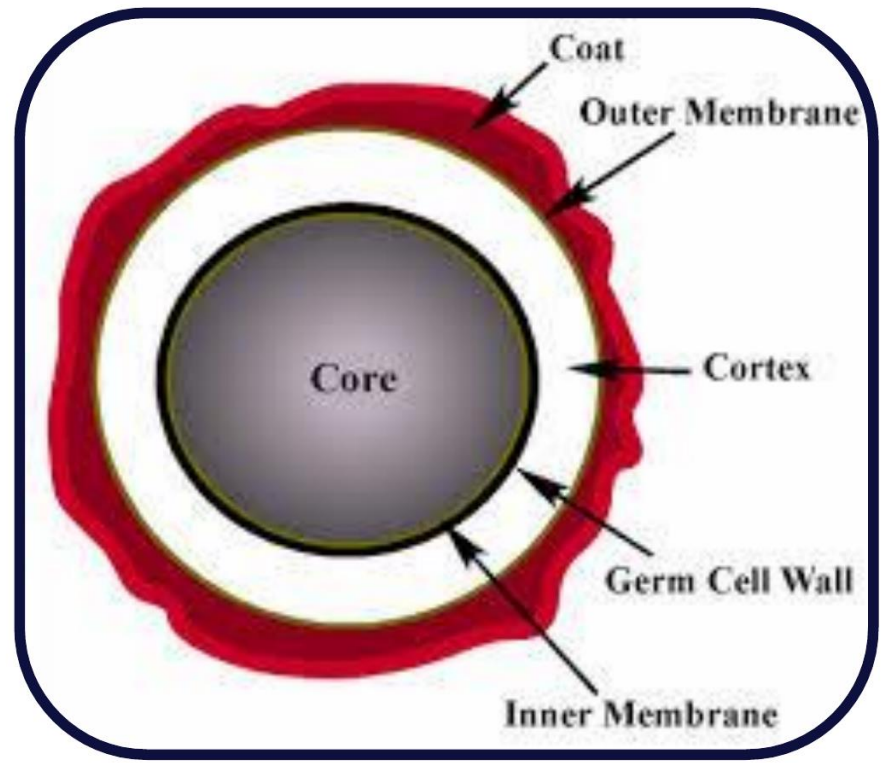
OUTSIDE THE HOST CELL

Only 2 types of bacteria can form spores :

Bacillus

Clostridium

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



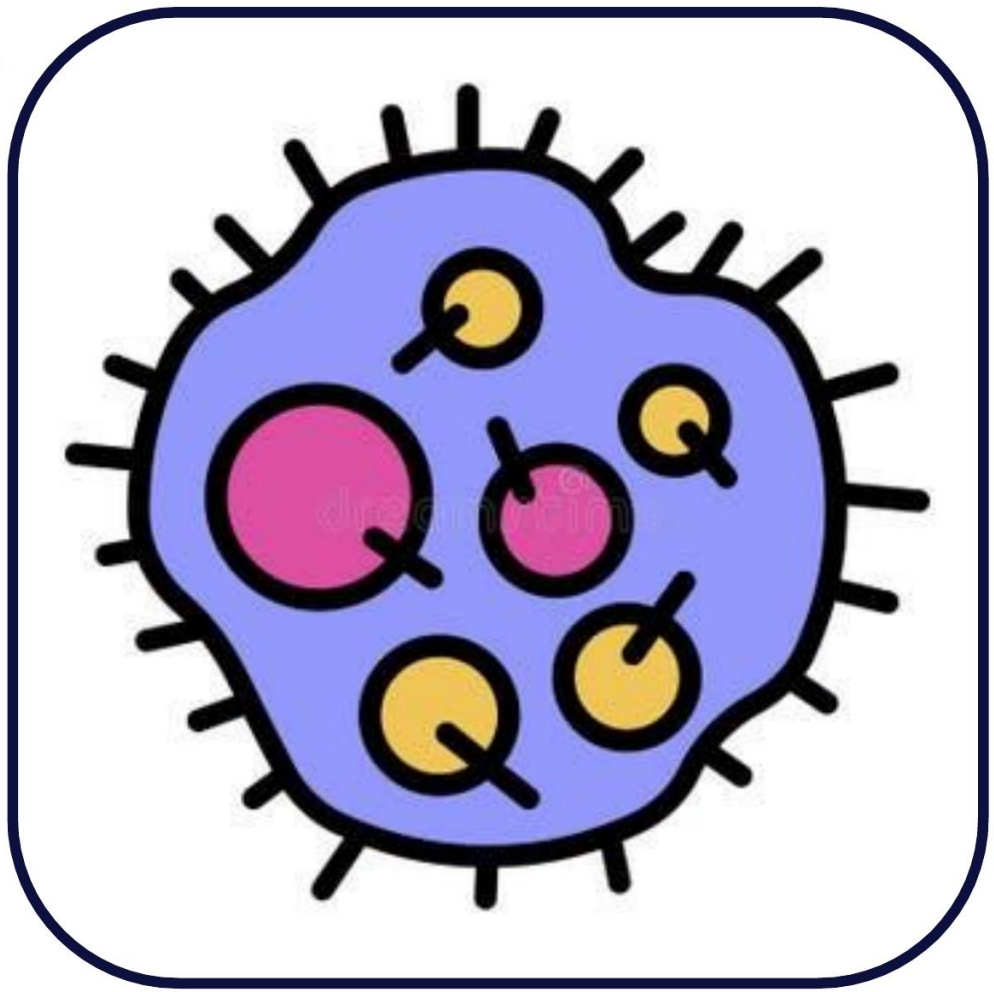
Spore formation

Occur to unfavorable conditions e.g.

High temp.

Drying

Depletion of nutrition

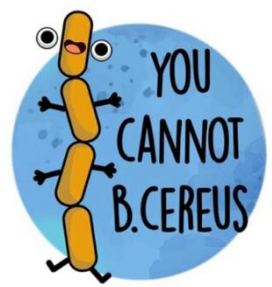


Spore formation

Formed outside the body (in VITRO)

Can not stained by ordinary stain

Instead they have specific stains

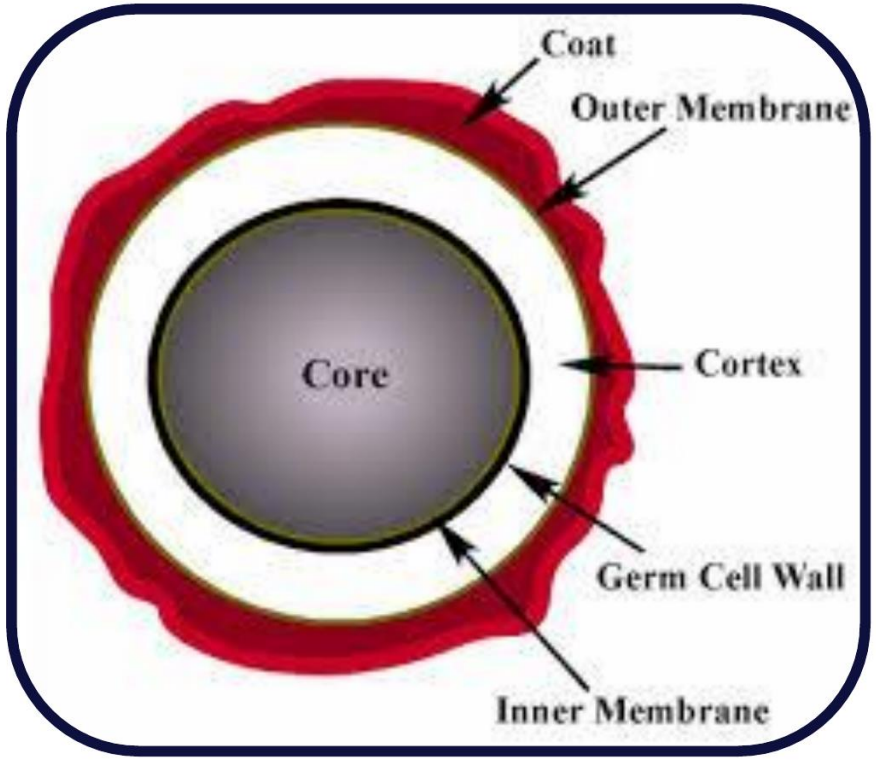


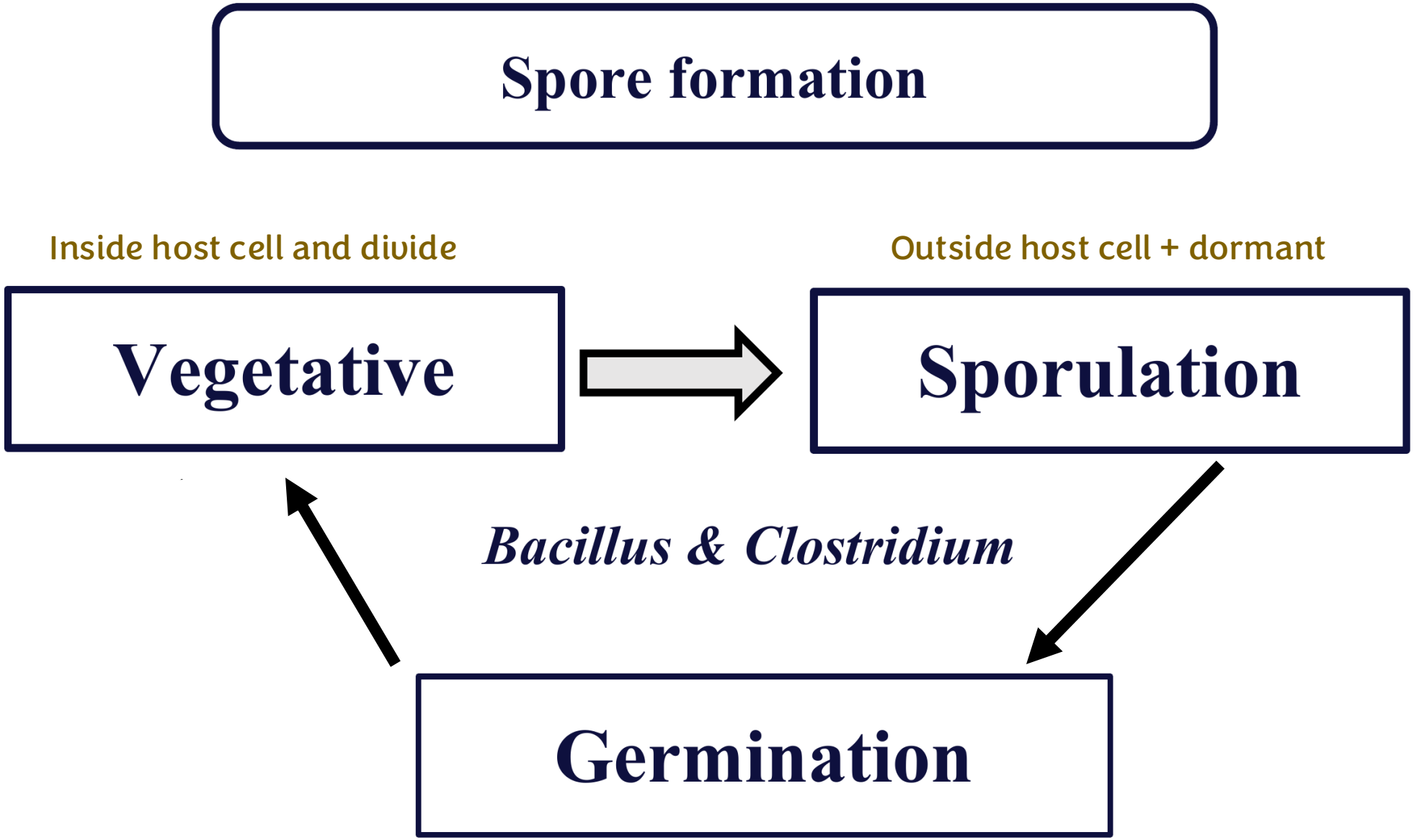
Spore formation

Spores are :

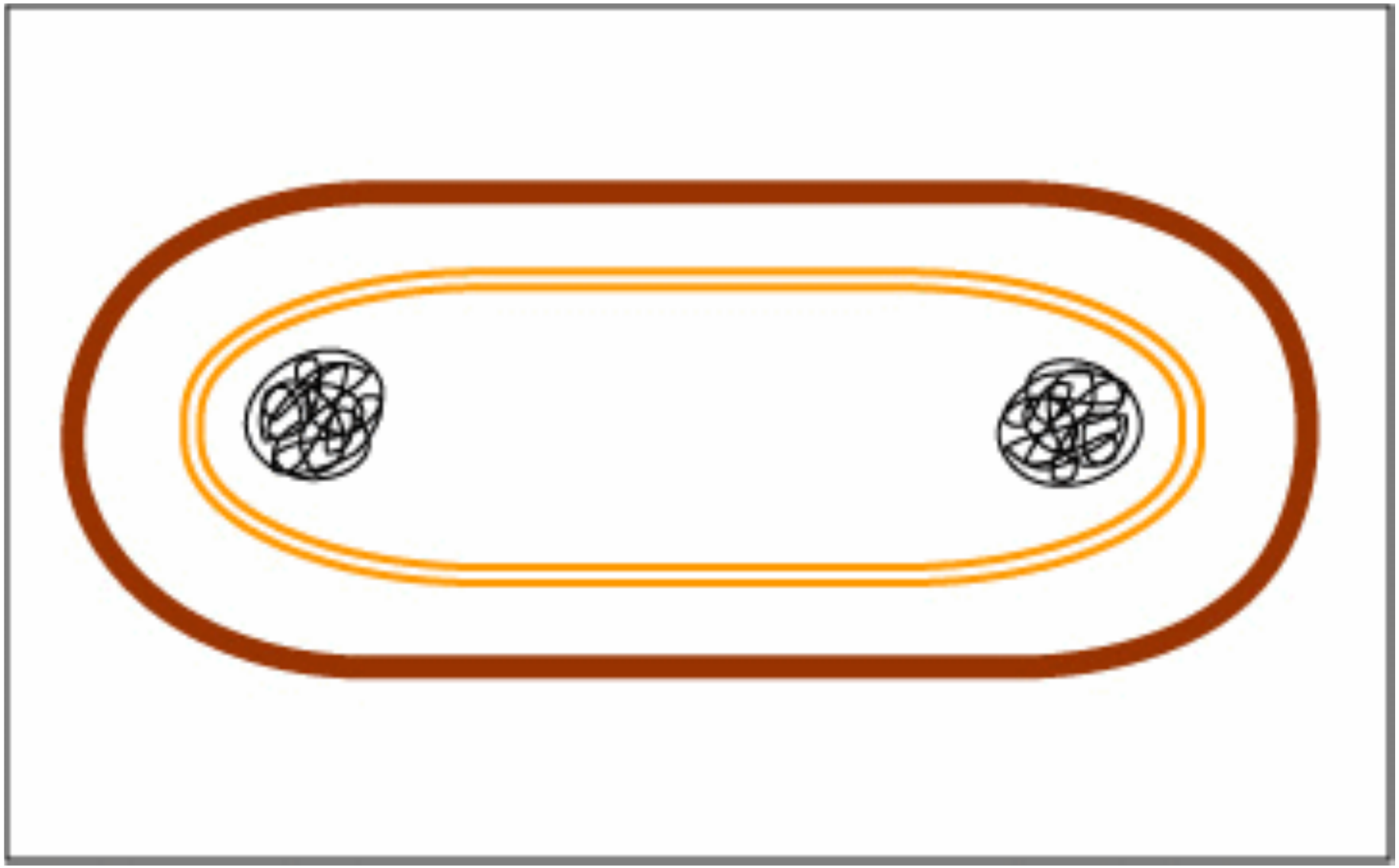
Highly resistant to dryness,

heat & Disinfectant




Spore formation
Inside host cell and divide
Outside host cell + dormant
Vegetative
Sporulation
Bacillus & Clostridium
Germination

Spore formation



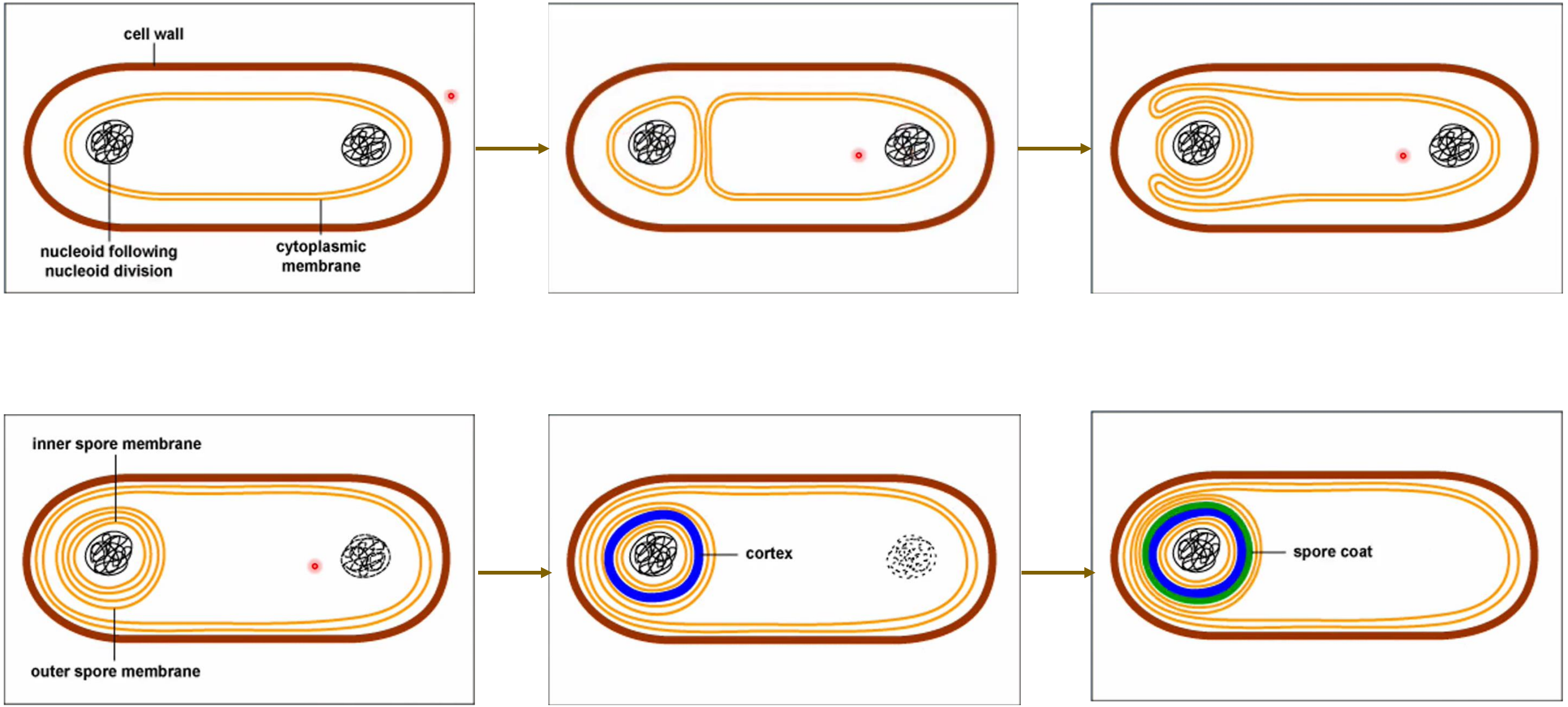
Ca+2 &

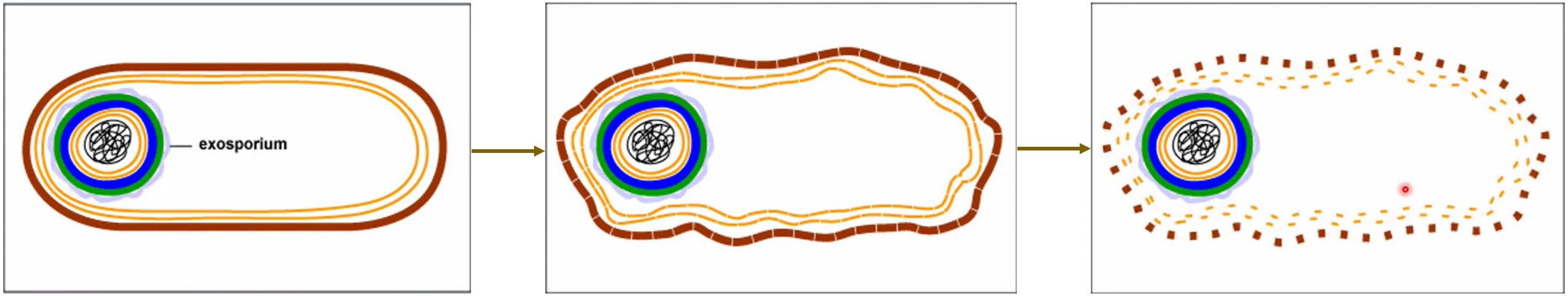
Diplconic acid

Explained in
next slide

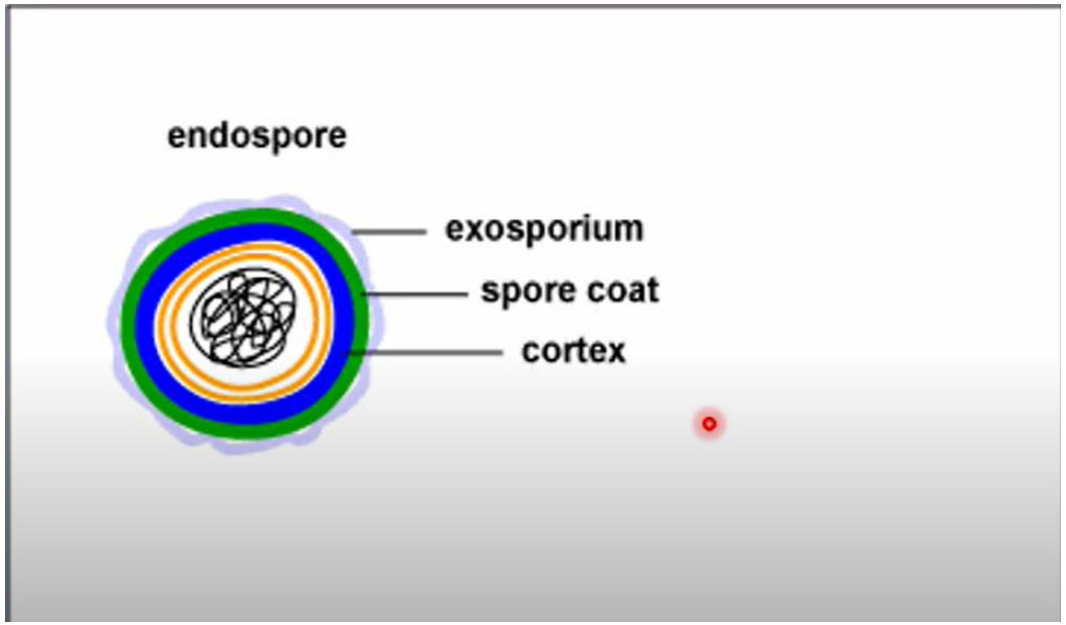
Multiple membranes

The Process of Spore Formation





Formation of Endospore



1) First DNA replication occur, where each copy of the DNA moves to opposite sides of the bacterial cell.

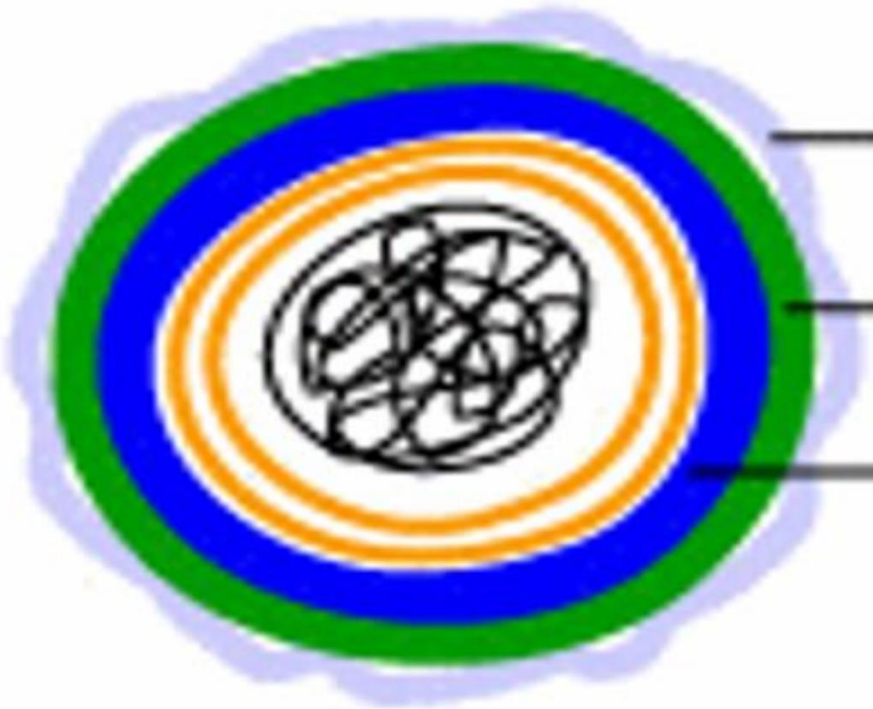
2) Then multiple layers of the cell membrane and peptidoglycan form, producing calcium and dipicolinic acid, both contributing to the tough protective layers.(طبقة جيرية قاسية)

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

↓

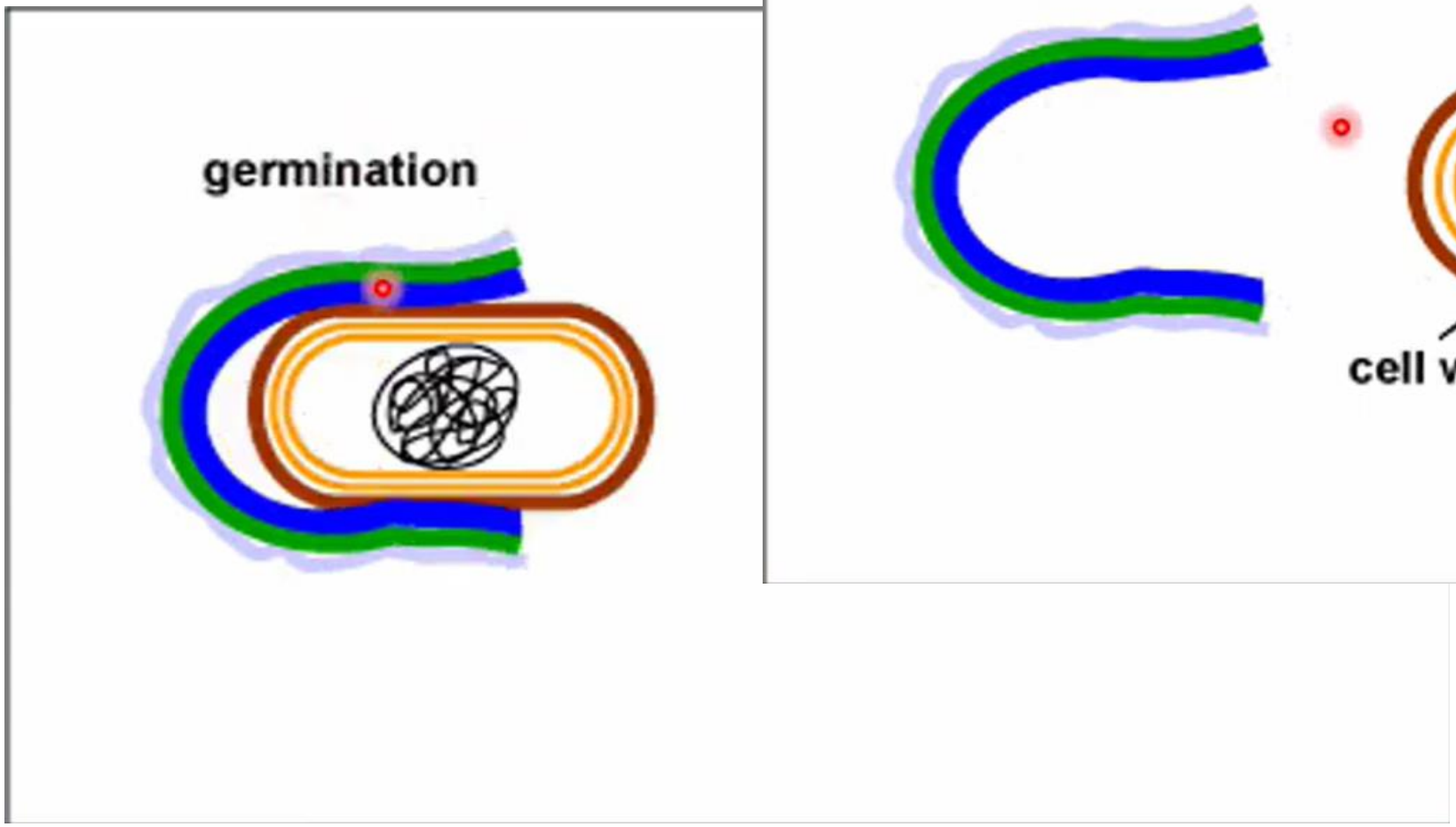
Made from cell membrane + peptidoglycan + ca 2+ + dipicolinic acid

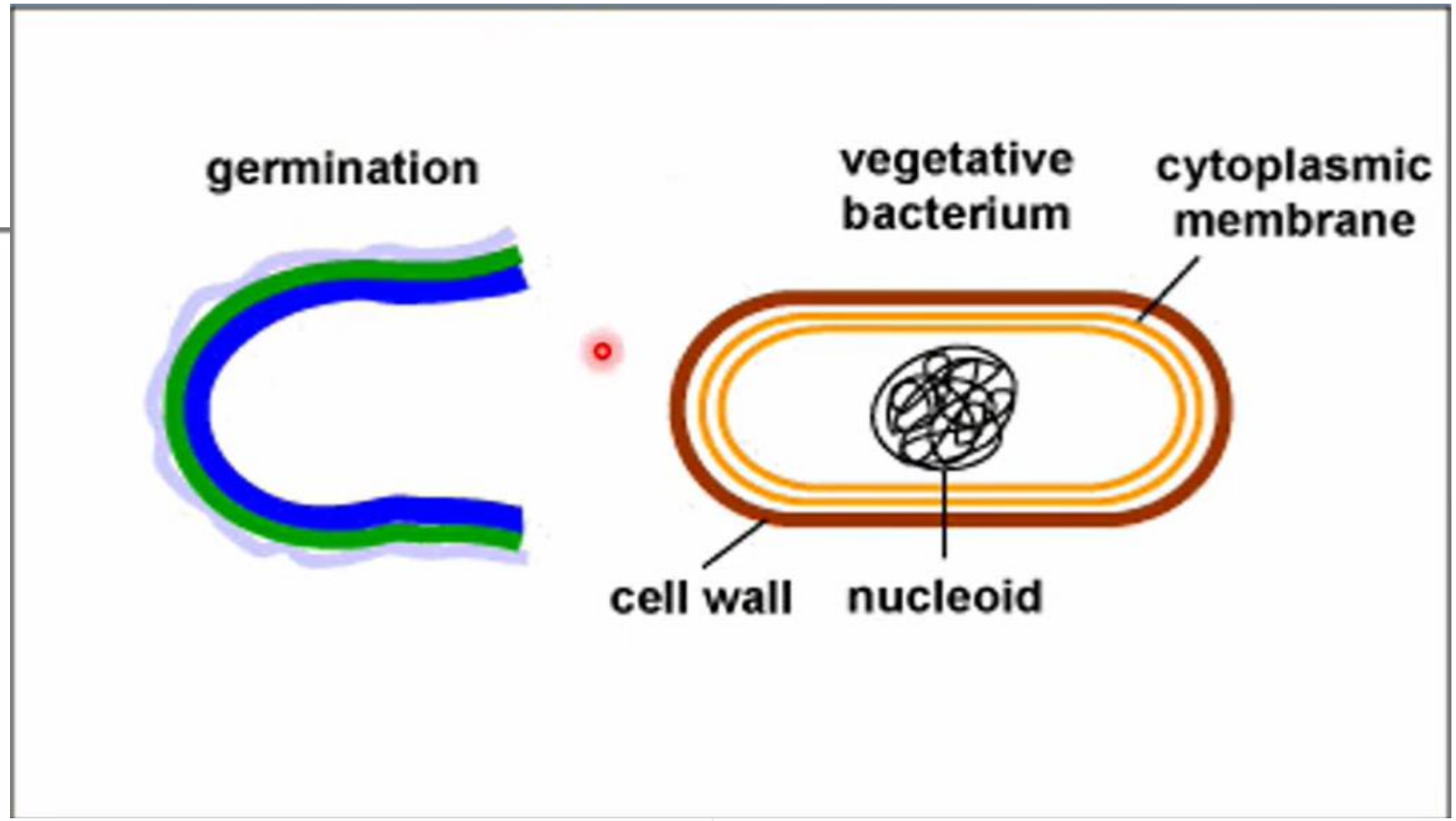
Multiple membranes

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

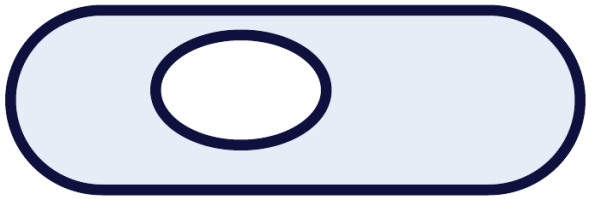
The Process of Germination





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.

Corrections from previous versions:

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

Additional Resources:

رسالة من الفريق العلمي:

اللهم ارزقني فهم النبيين وحفظ المرسلين وإلهام
الملائكة المقربين
اللهم انصر أهل غزة ولبنان والسودان.