

MICROBIOLOGY

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



MID – Lecture 3

Bacterial Structure (Pt.2)

﴿ وَإِن تَتَوَلَّوْا يَسْتَبَدِلْ قَوْمًا غَيْرَكُمْ ثُمَّ لَا يَكُونُوا أَمْثَلَكُمْ ﴾

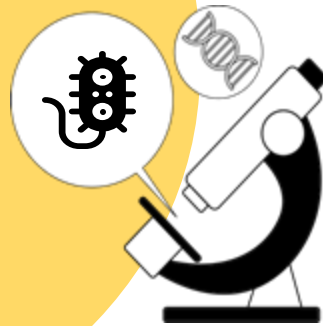
اللهم استعملنا ولا تستبدلنا

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Objectives

Structures outside the cell wall

1) Capsule

2) Flagella

3) Pili

4) Spore formation

Capsule - Definition

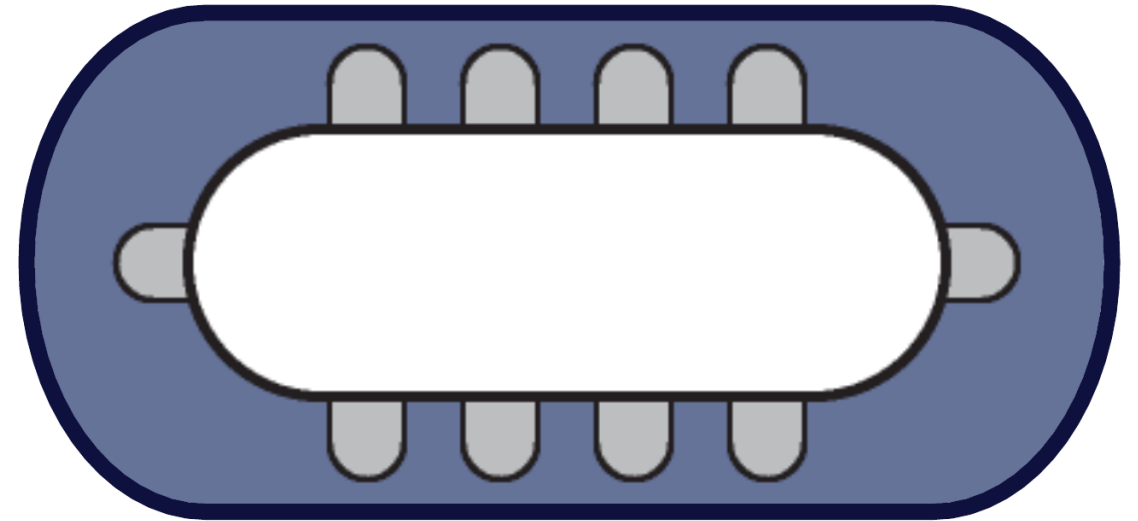
Glyco **calyx**
↓ ↓
carbohydrate **enveloped**

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

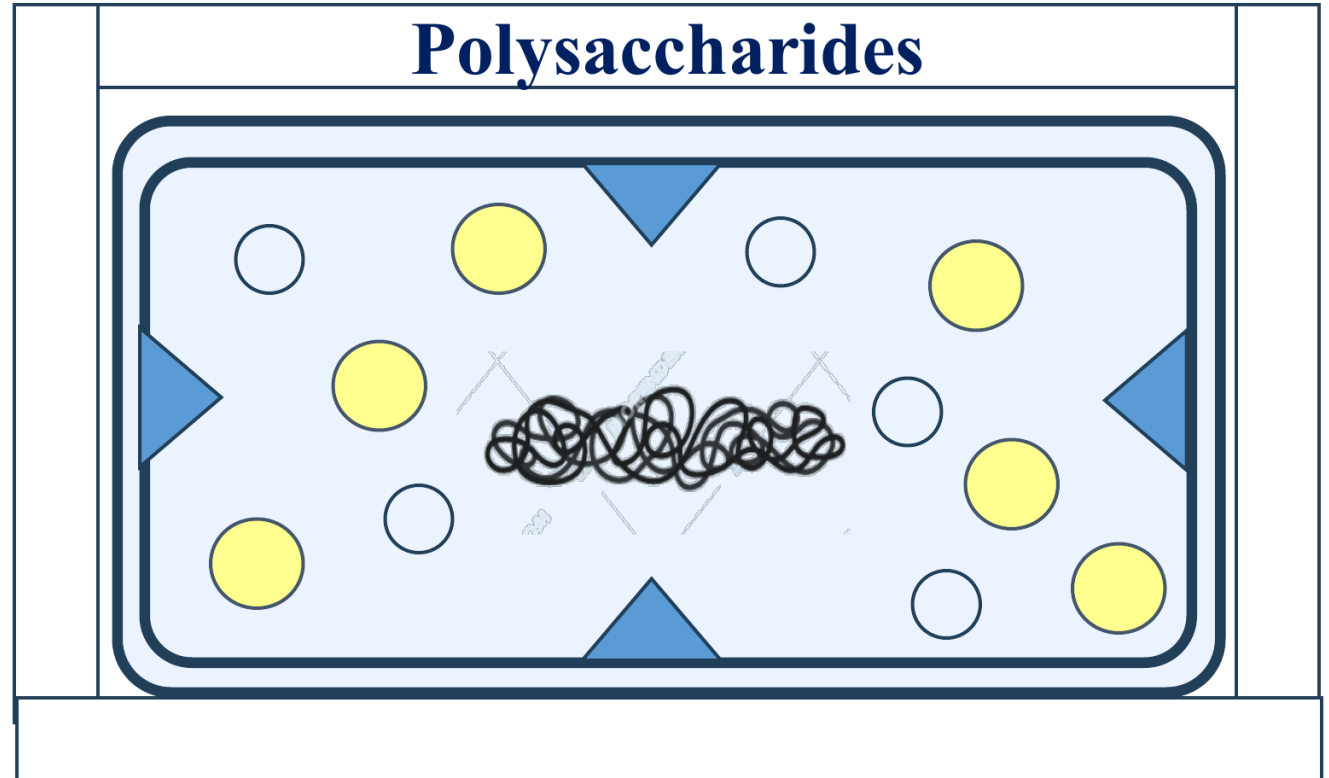
Capsule - Composition

Usually Polysaccharides

EXCEPT

Polypeptides

(B. anthracis)



Capsule - Composition

Variation of Capsule



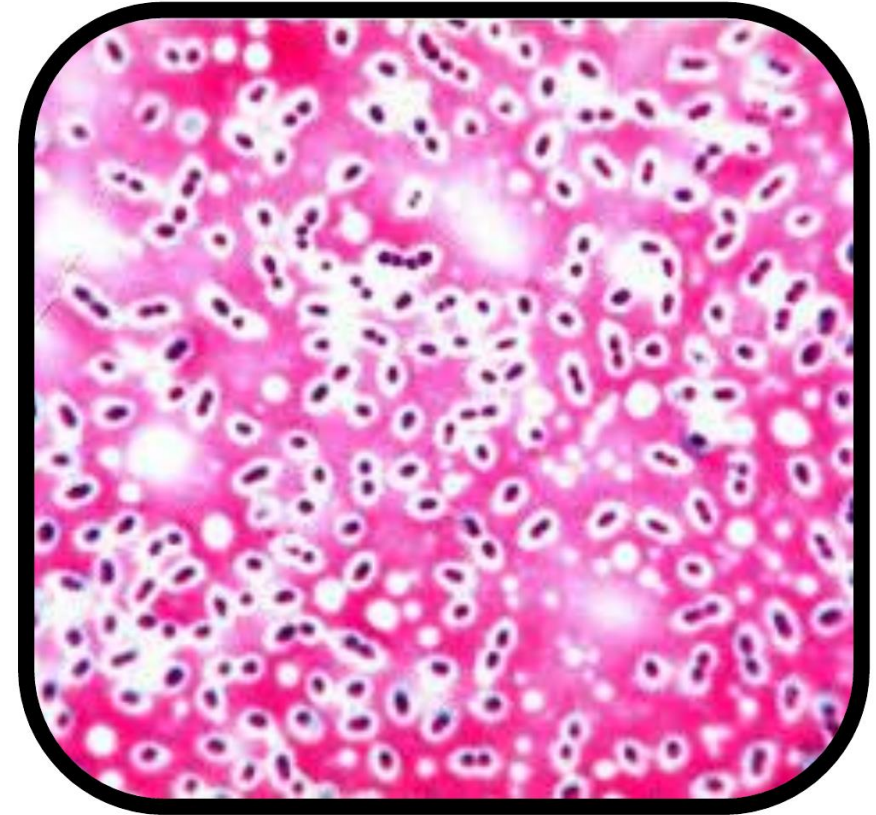
Caused by different
(Arrangement of
Polysaccharides)

Sucrose	Mannose	Lactose
Mannose	Sucrose	Mannose
Lactose	Sucrose	Mannose

e.g. 91 types of
Str. pneumoniae

Capsule - Composition

**Do Not stained by
Gram stain**

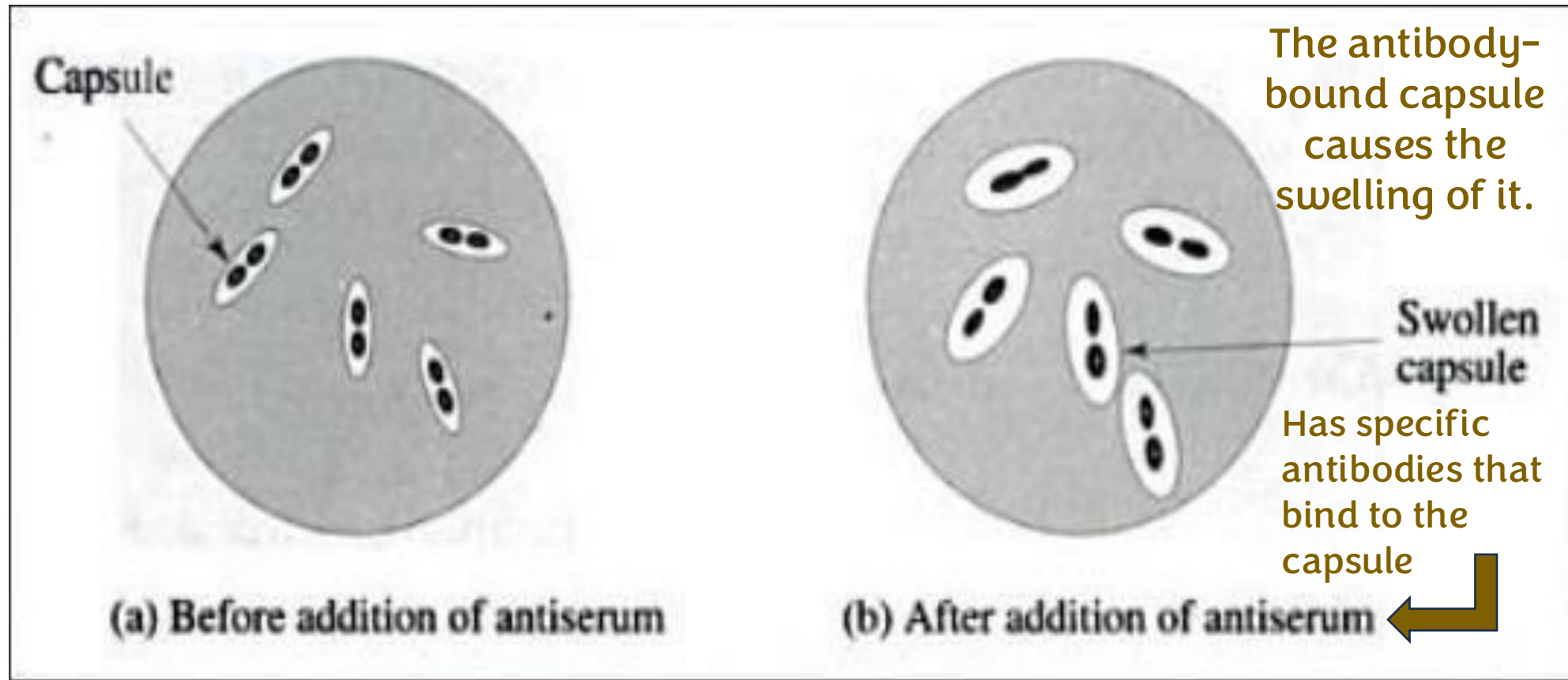


➔ That is why we see **Unstained halo around the
organism**

Capsule - Composition

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

Quellung reaction (swelling)

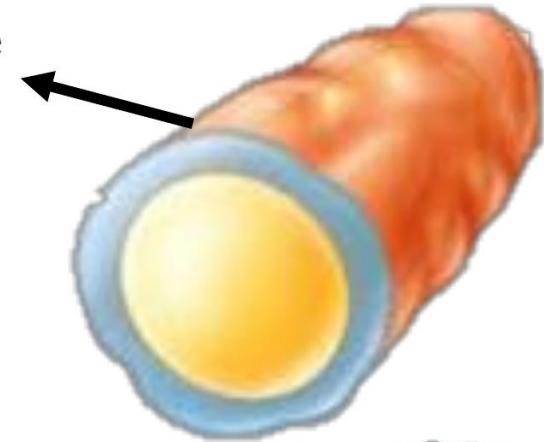


Capsule - Composition

Capsule

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

Capsule



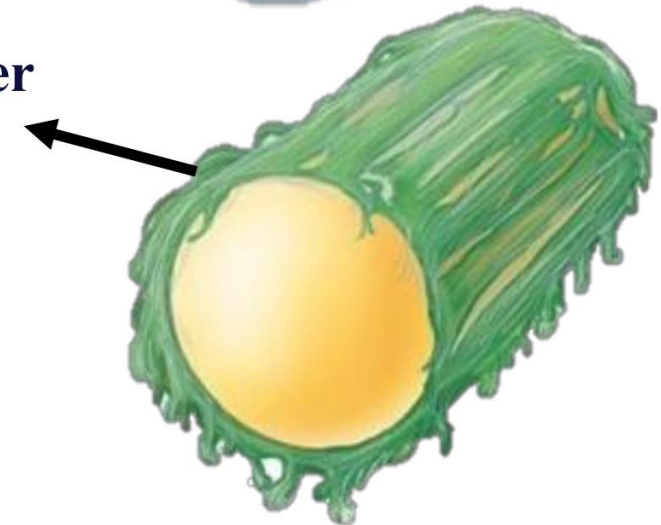
Glycocalyx

Has fibril extensions help it adhere

Slime layer

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**

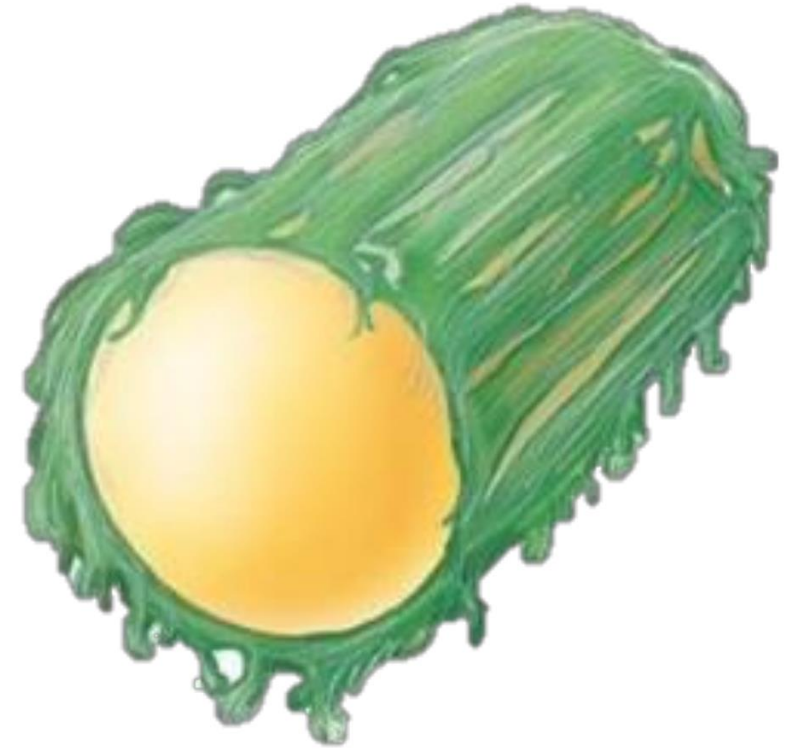


Capsule - Composition

Glycocalyx

(Slime layer)

Loosely & unorganized attached



Capsule - Composition

Glycocalyx

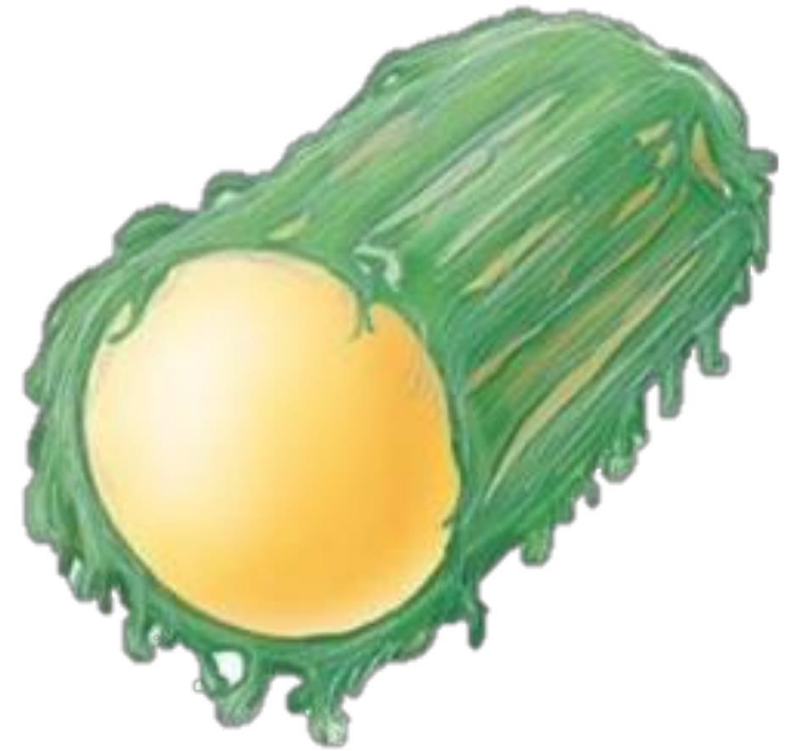
Fibrils extending

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

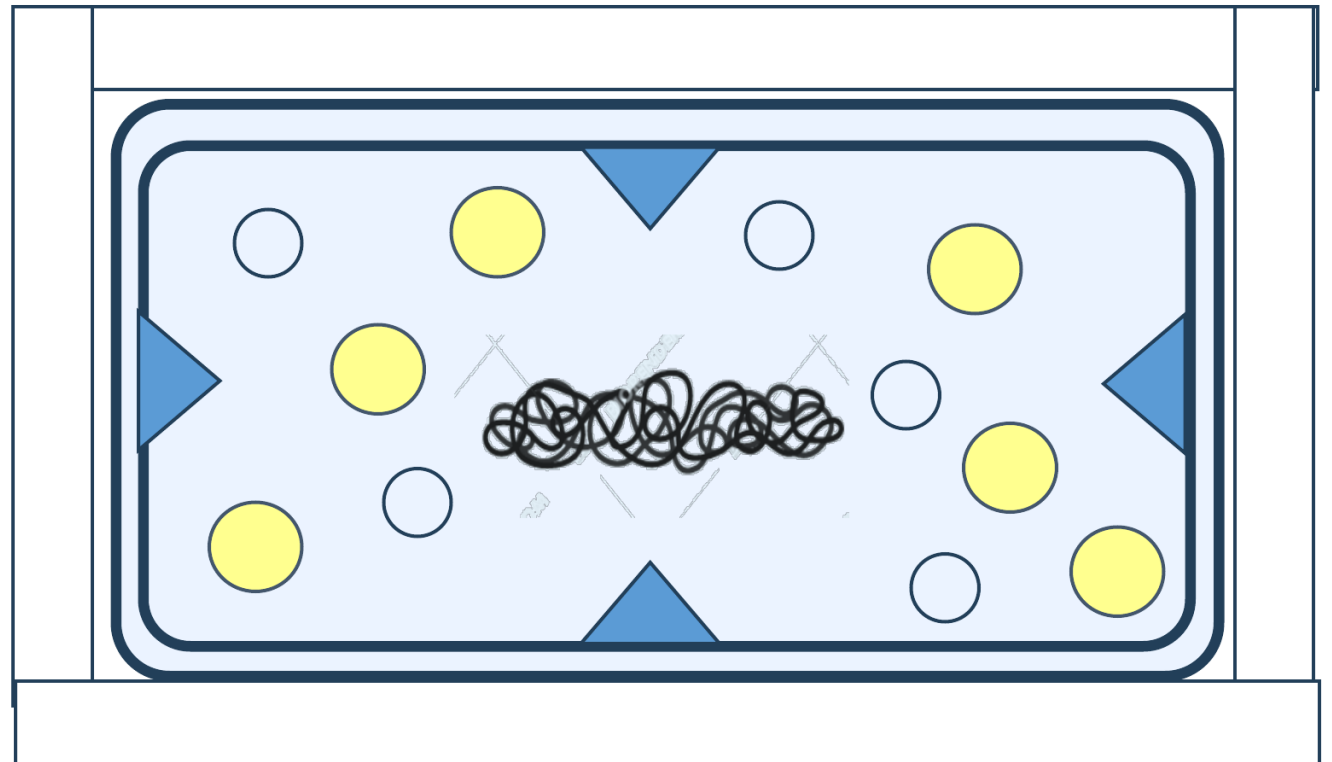
Capsule - Function

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.

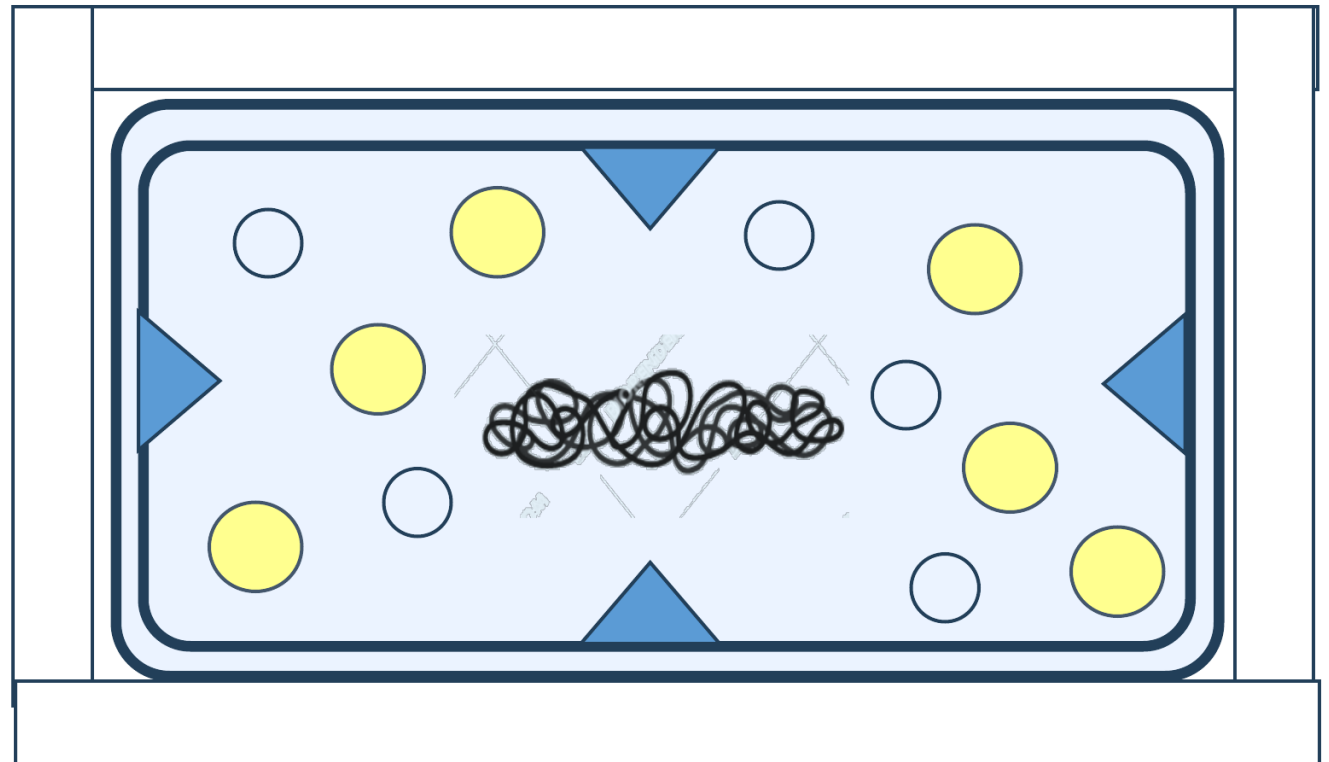


Capsule - Function

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 resulting in more infection.



Capsule - Function

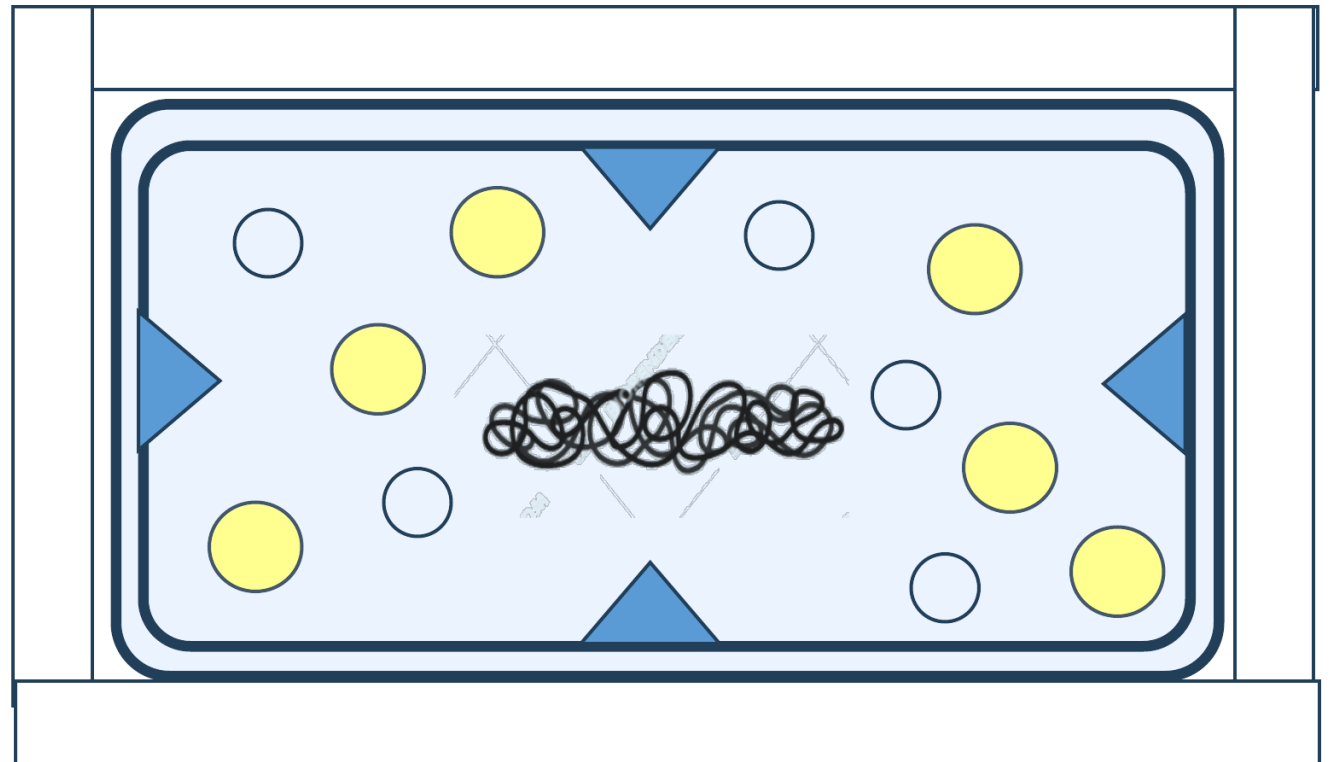
A



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.

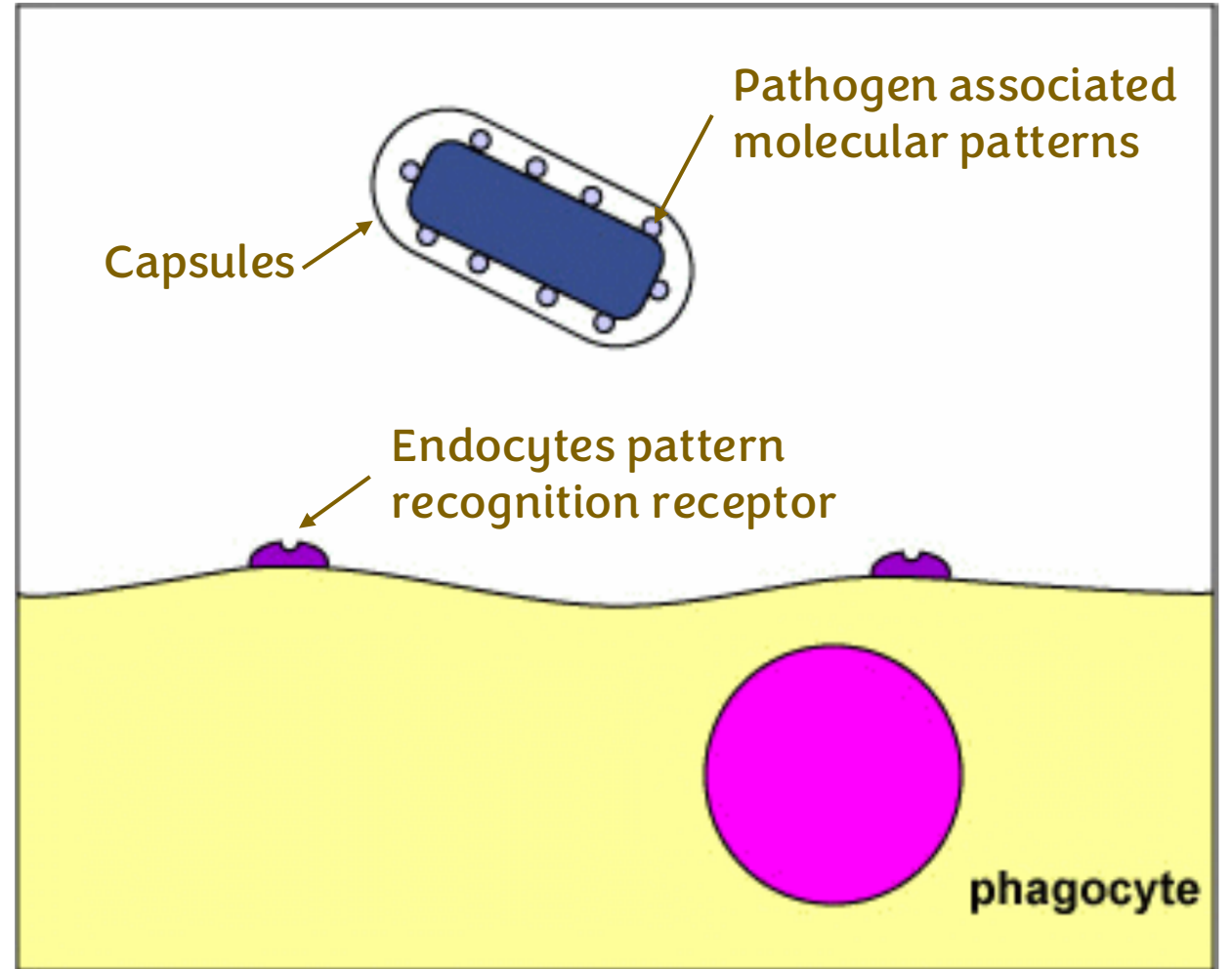


Prevent phagocytosis

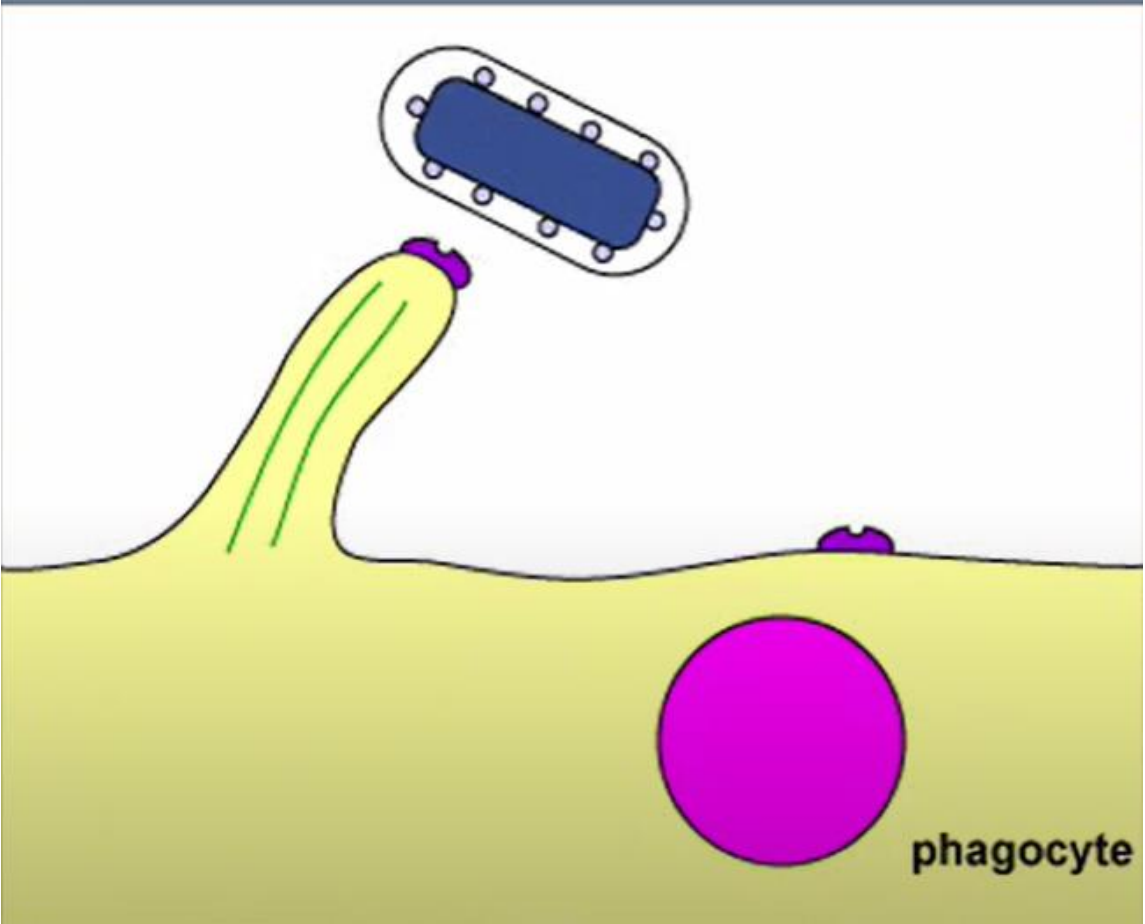
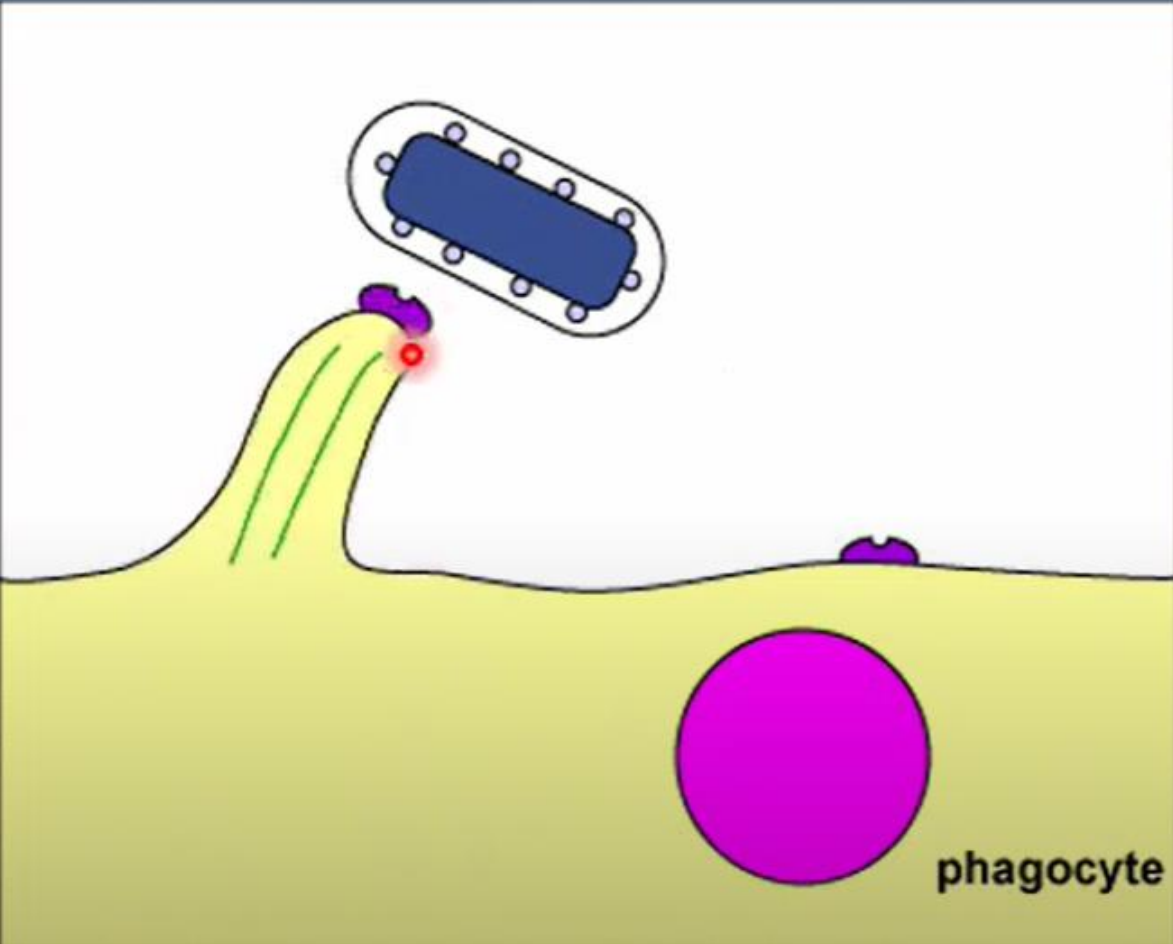
It's a virulence factor

(Virulence)

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



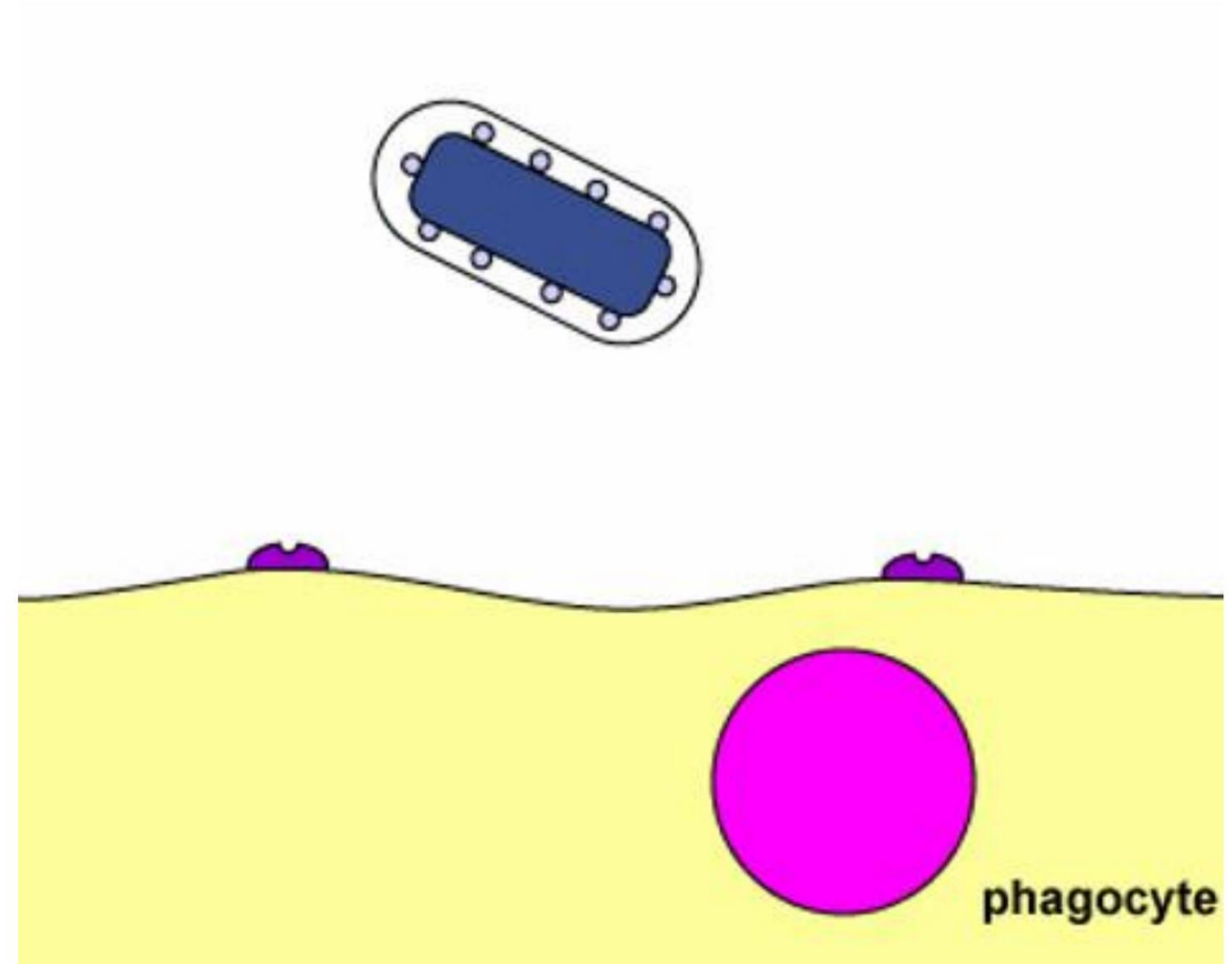
Phagocytosis Prevention by the bacteria



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.

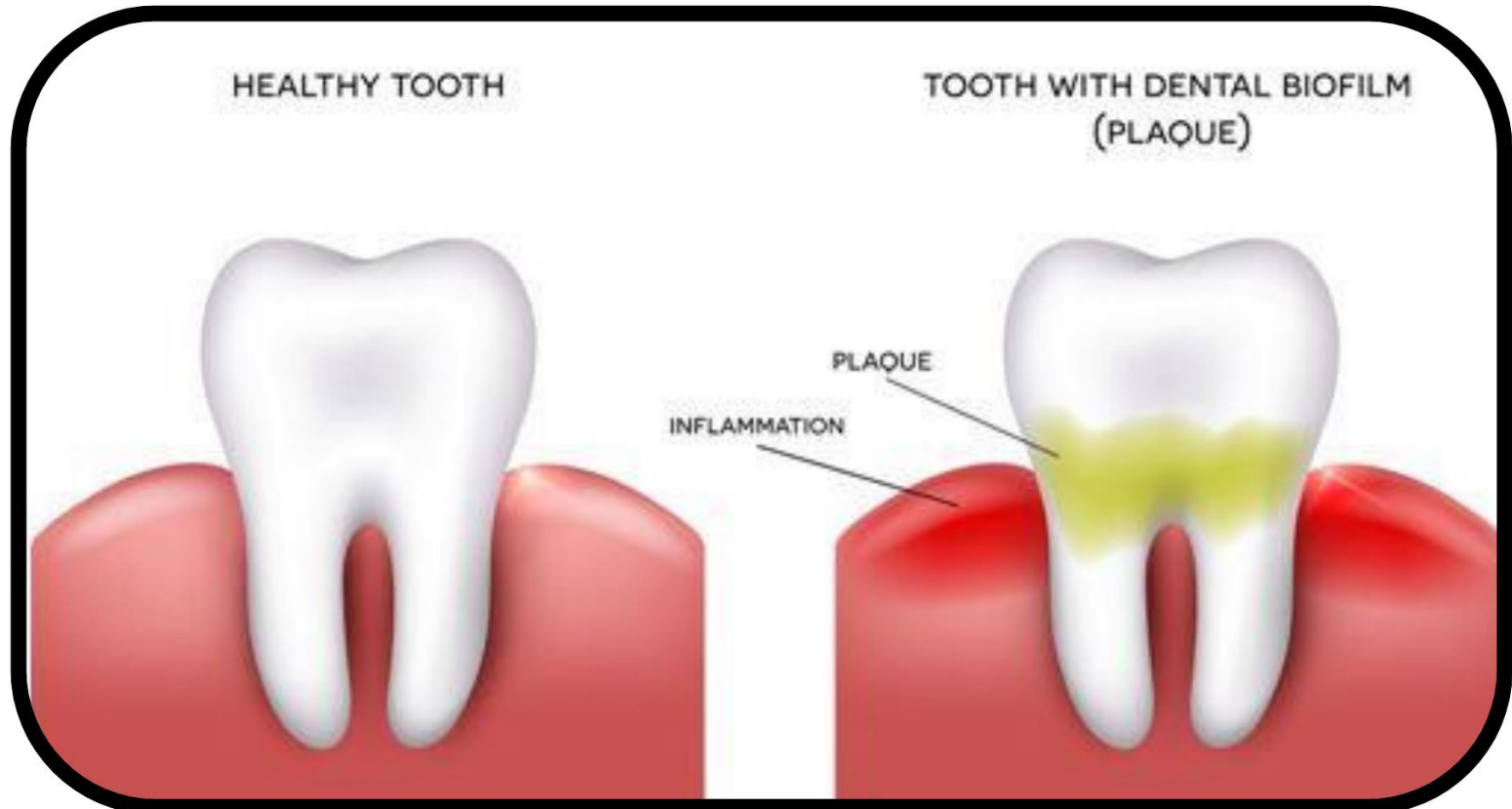
Attachment

(Glycocalyx)

تسوس الأسنان

Dental caries

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



Capsule - Function



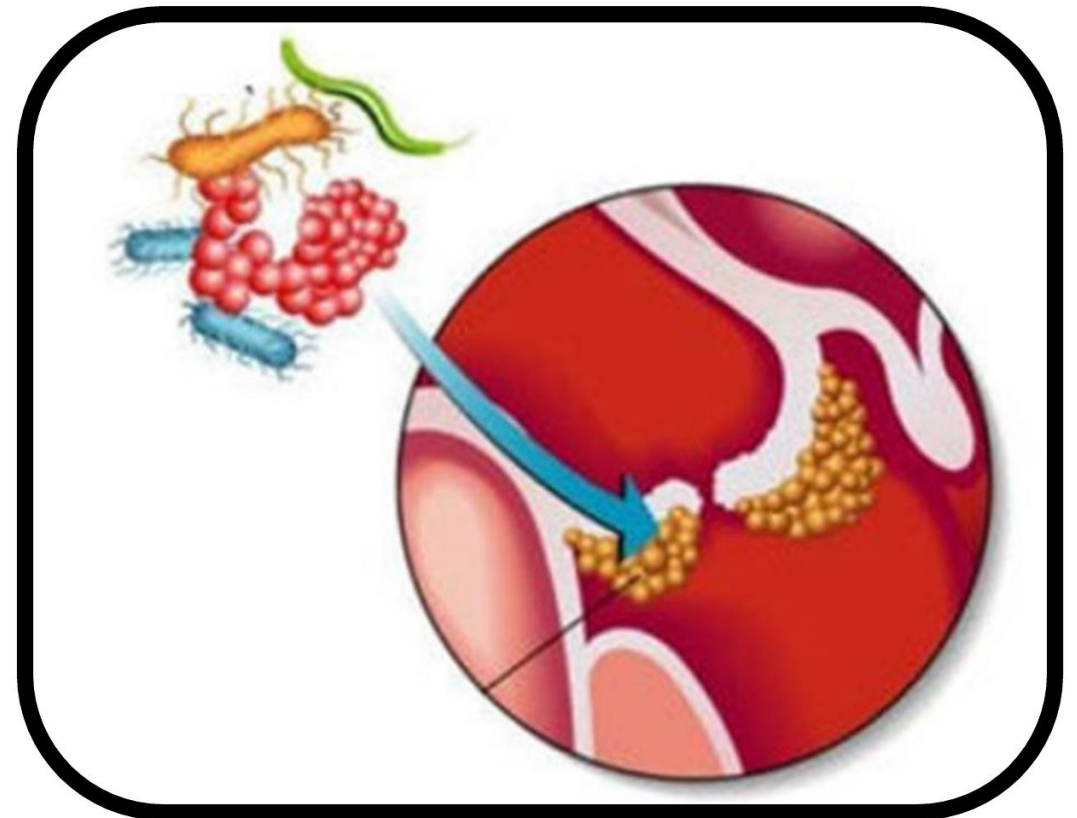
Attachment

(Glycocalyx)

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



Prosthetic heart valves

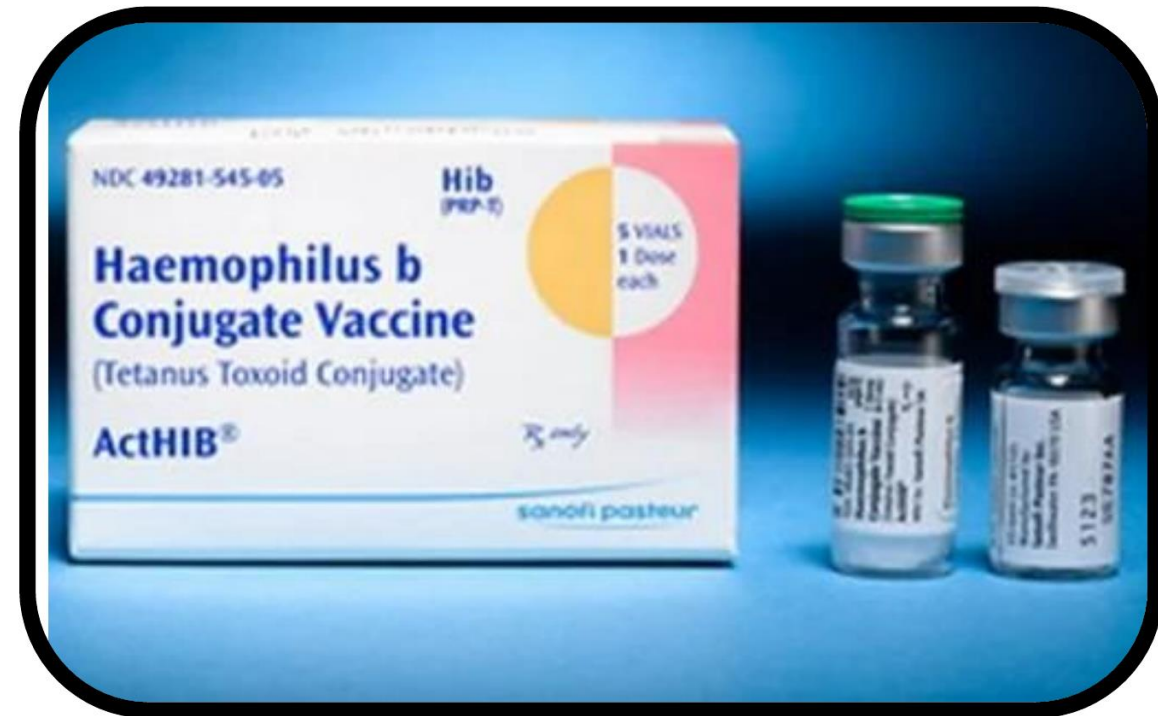


Capsule - Function

D

Development of vaccine

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

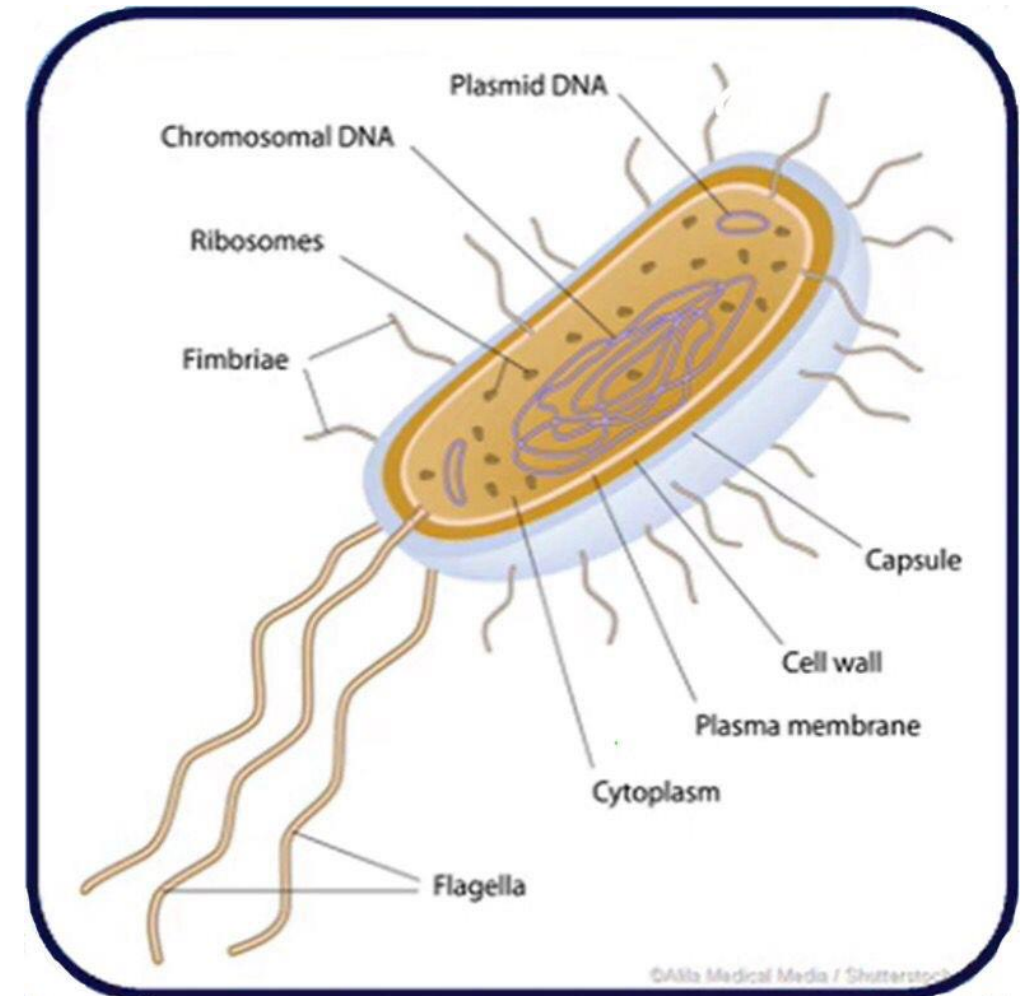


Flagella - Definition

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

(H Ag)

Every flagella present in any bacteria is
symbolized by



Flagella - Definition

Seen by EM

(20nm)

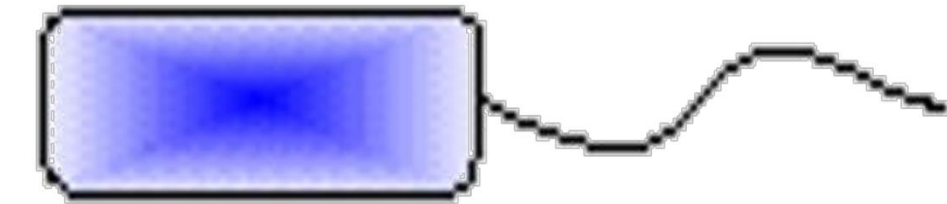
Very small in size



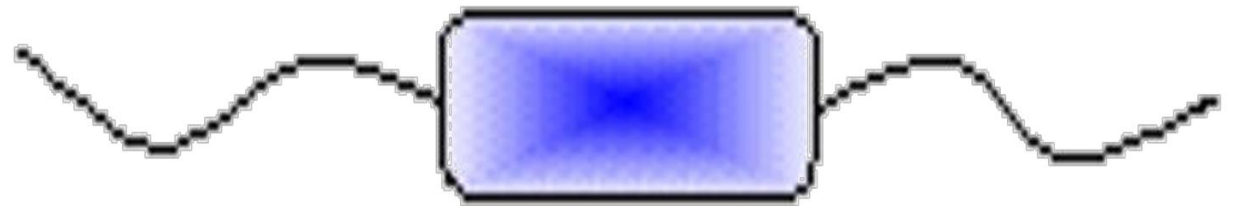
Flagella - Definition

Polar

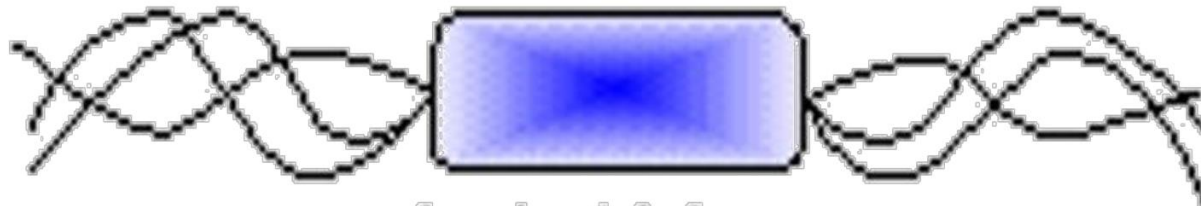
Spiral



monotrichous



amphitrichous



lophotrichous

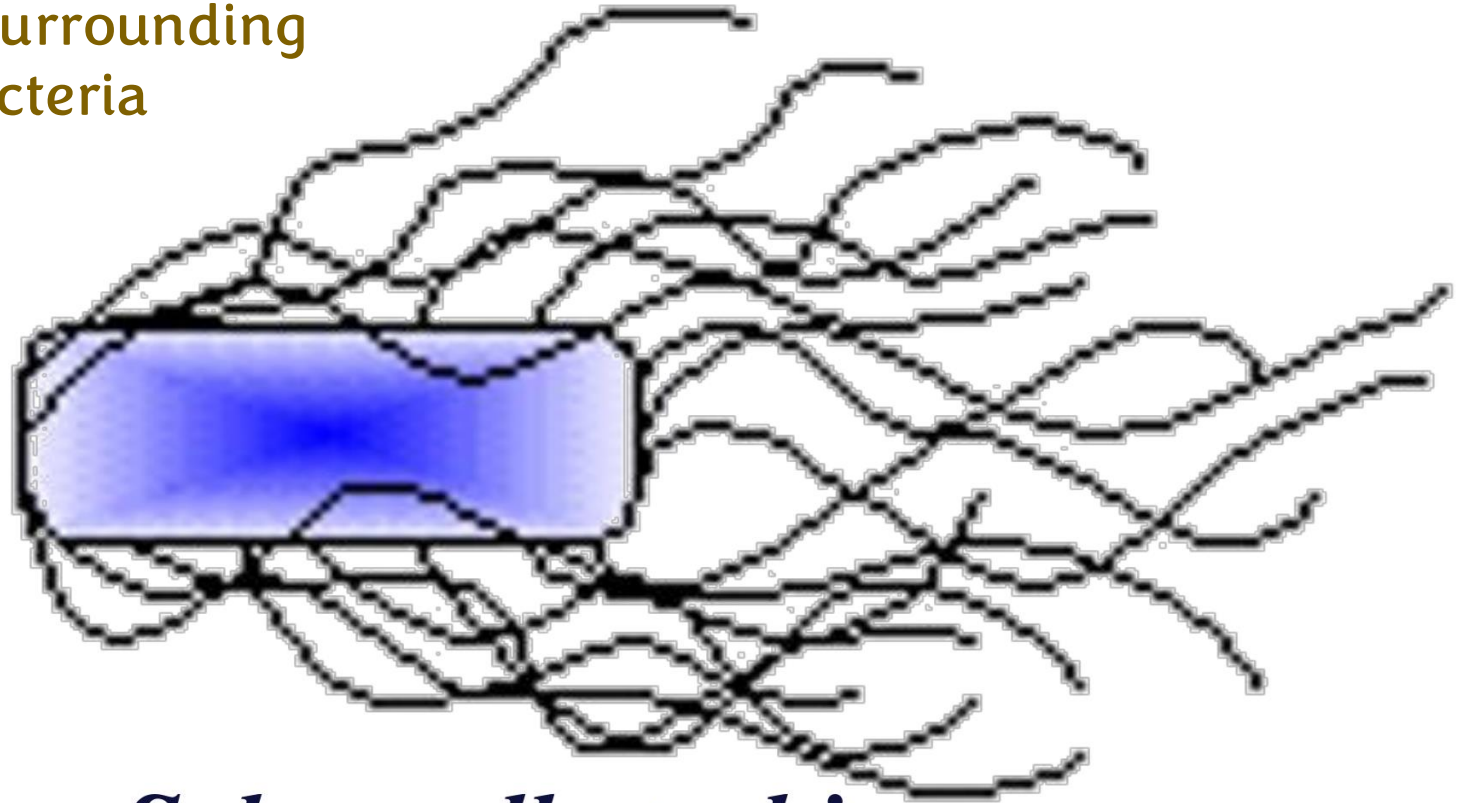
Flagella - Definition

Peri/trichous

Flagella surrounding
all the bacteria

around

peritrichous

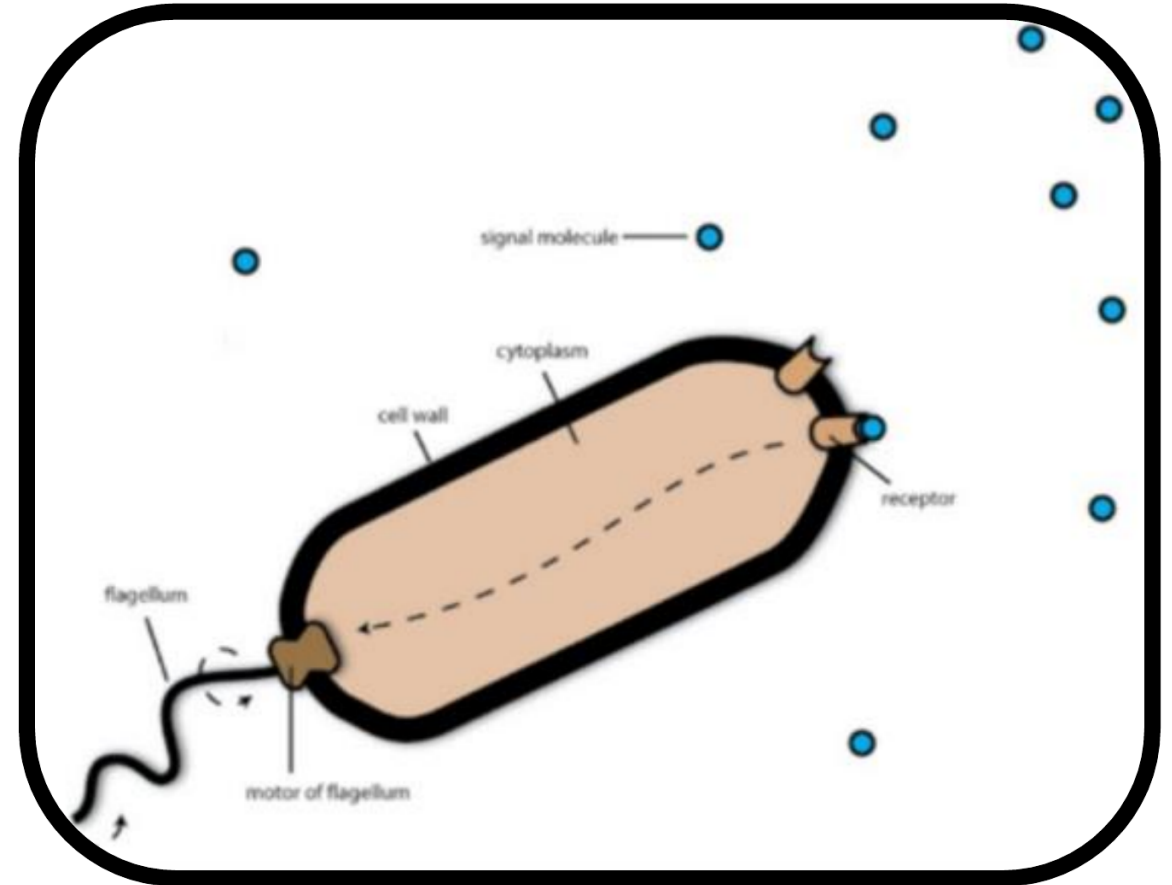


Salmonella typhi

Flagella - Function

The main function of the flagella is

**The organs of
motility**

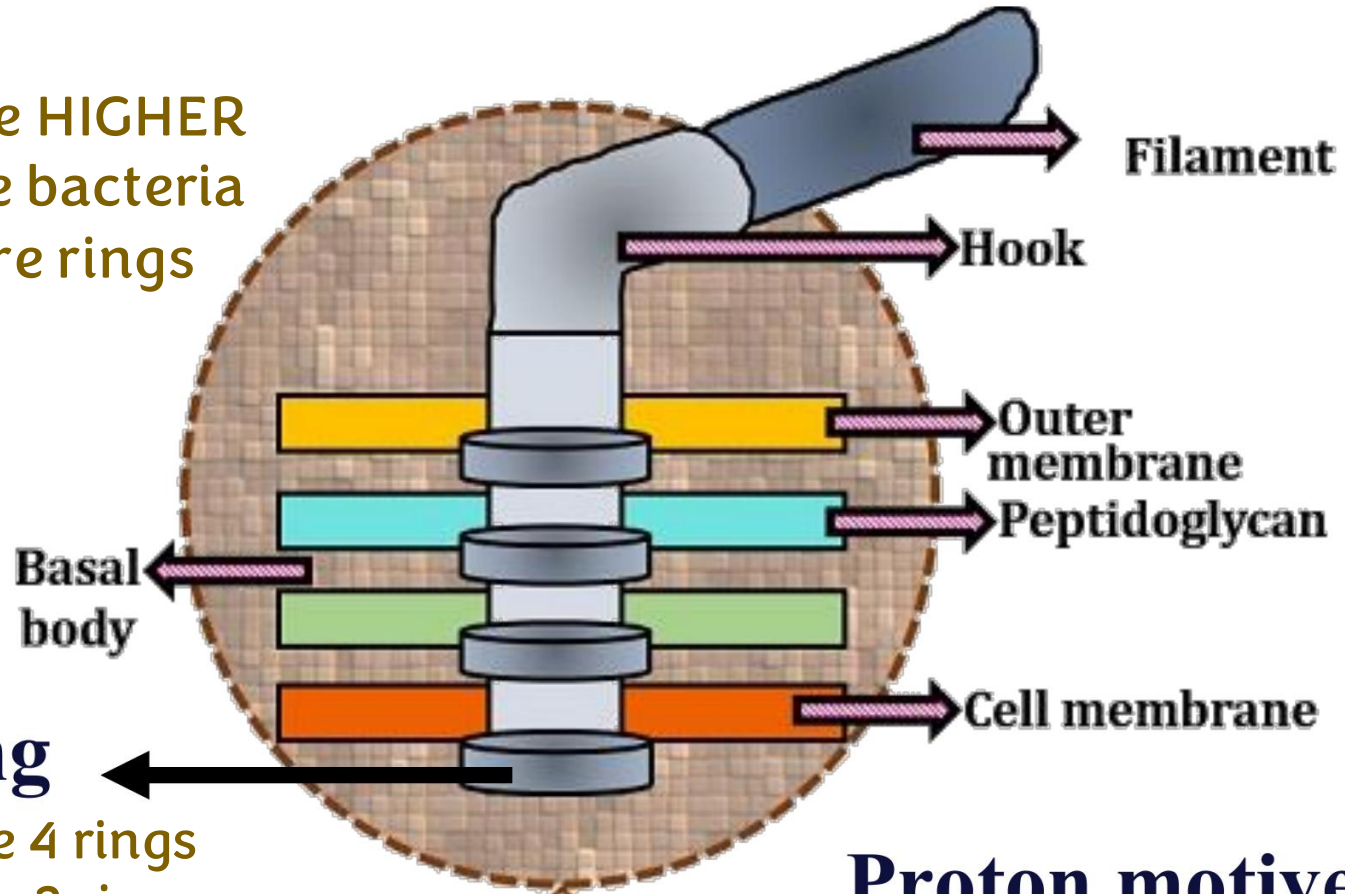


Flagella - Function

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.



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

Proton motive force

This force makes the ring move

STRUCTURE OF FLAGELLA

Flagella - Function

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

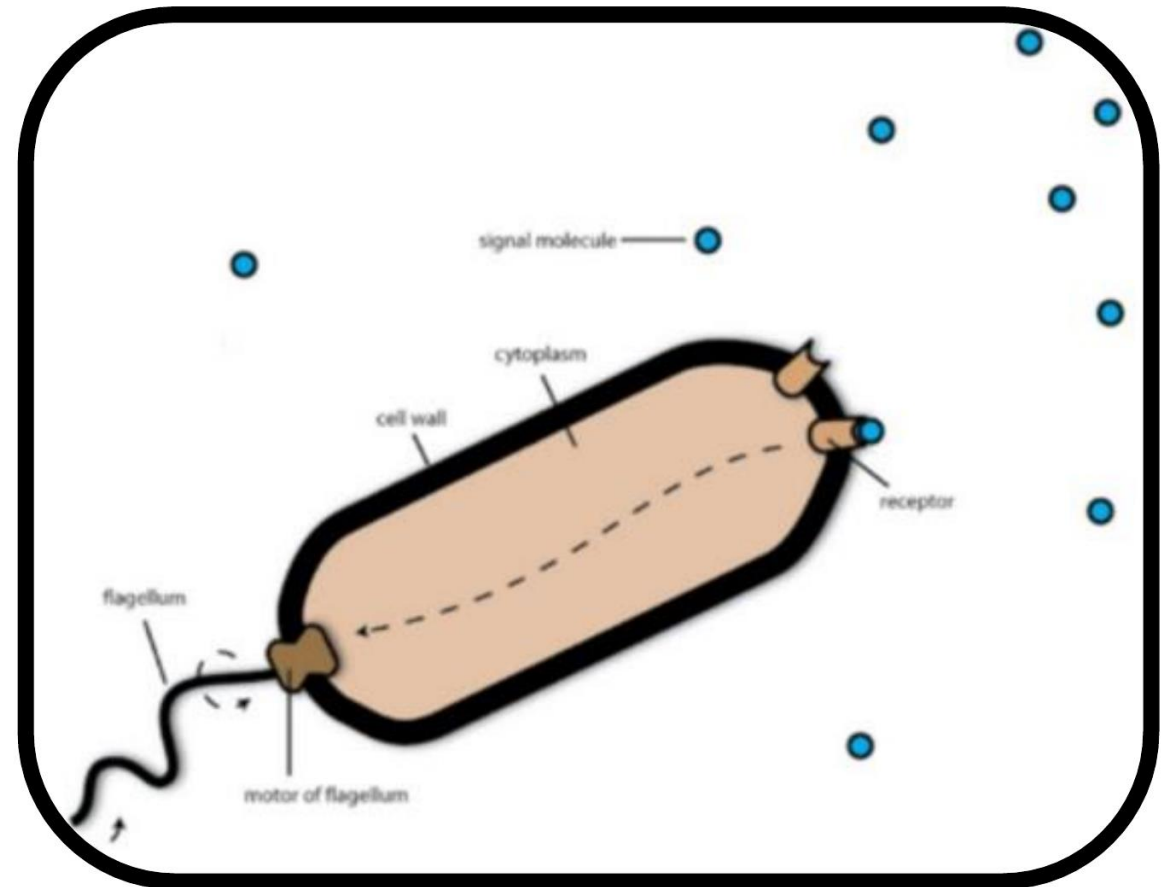
Tactic response (Taxis)

(Stimulus)

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

from stimulating agent)

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



Flagella - Function

Tactic response (Taxis)

Stimulating agent

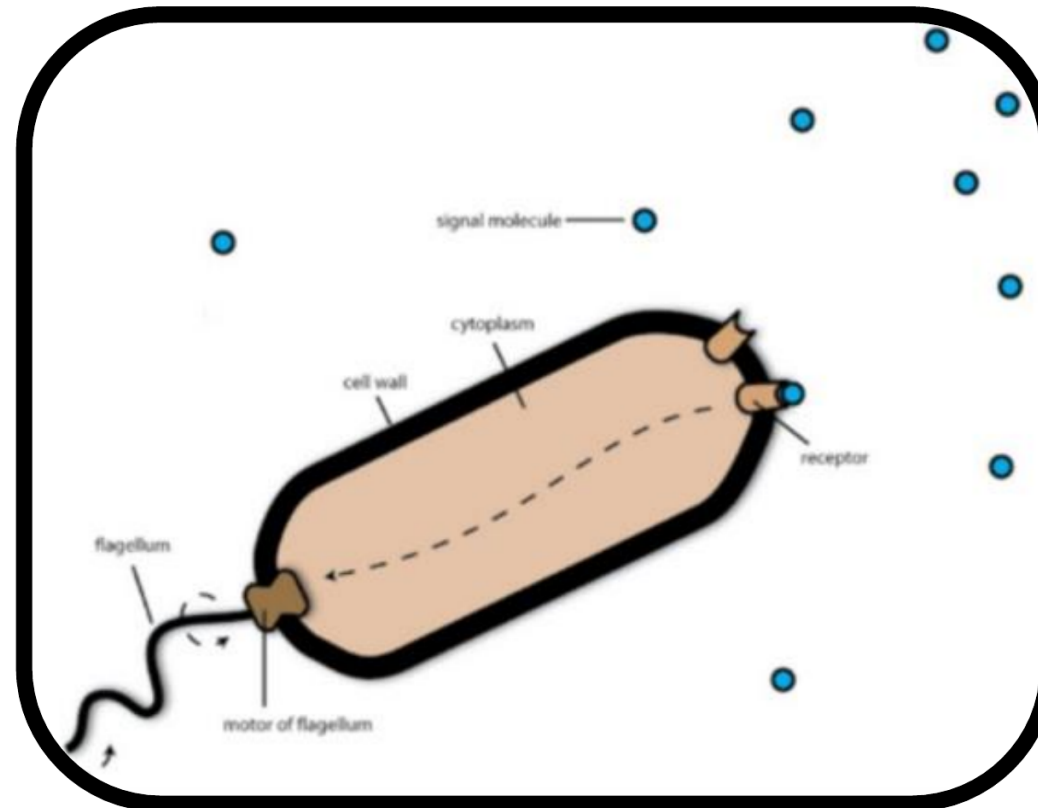
Two types of tactic response

Chemo Taxis

If the stimulus is chemical

Photo Taxis

If the stimulus is light



Chemical

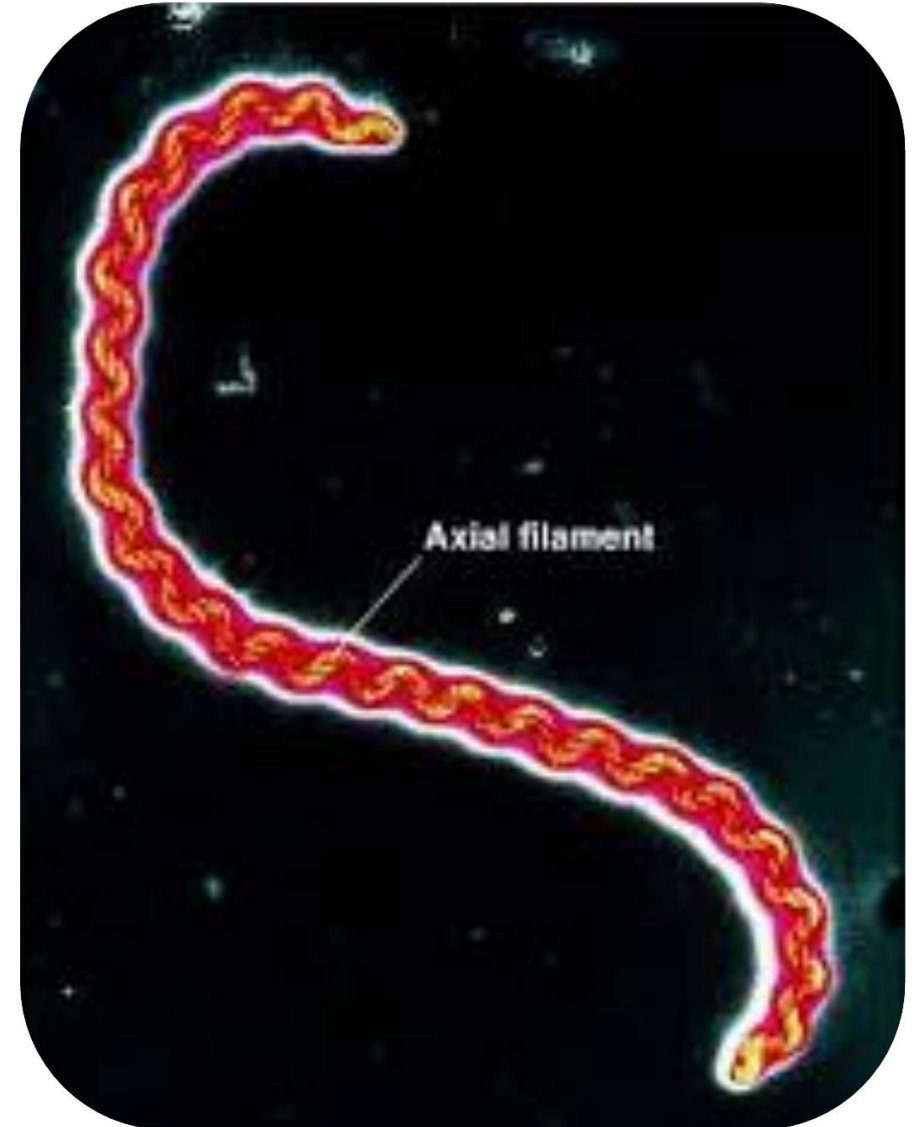
Light

Axial Filaments

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

Endoflagella

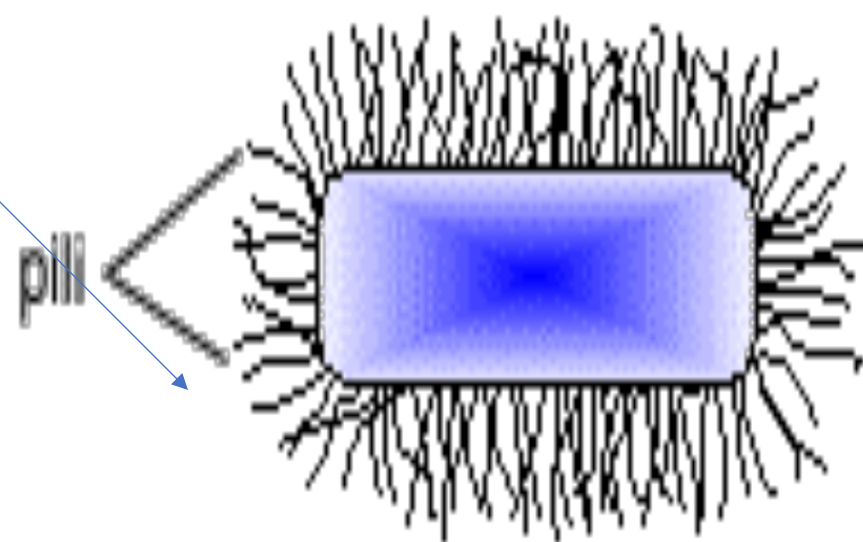
In spirochetes { Example }



Pili (Fimbriae)

Short and thin
Hair like formed from
protein

(Pilin) Name of protein



Pili

Seen by EM

Only

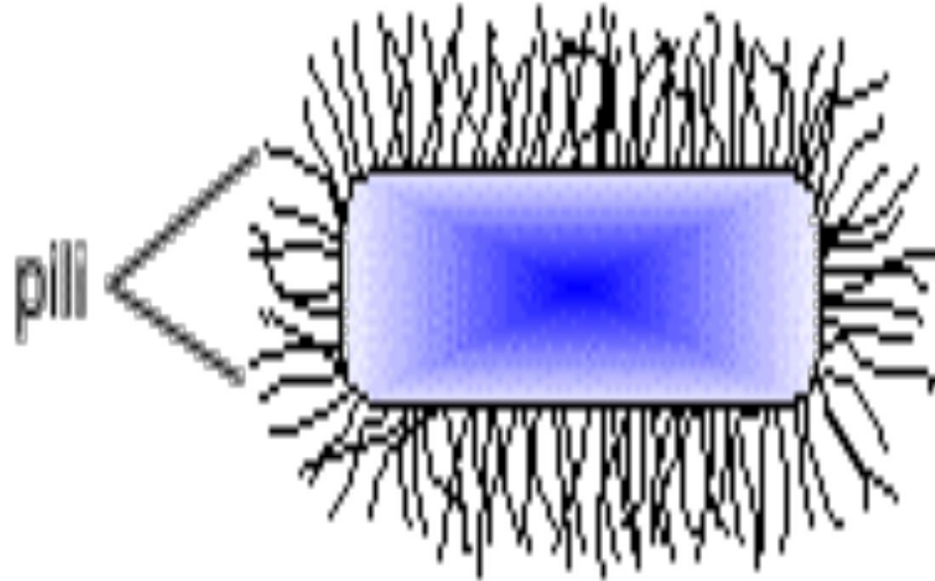


Pili

Two types of pili :

**A) Ordinary pili
(Attachment)**

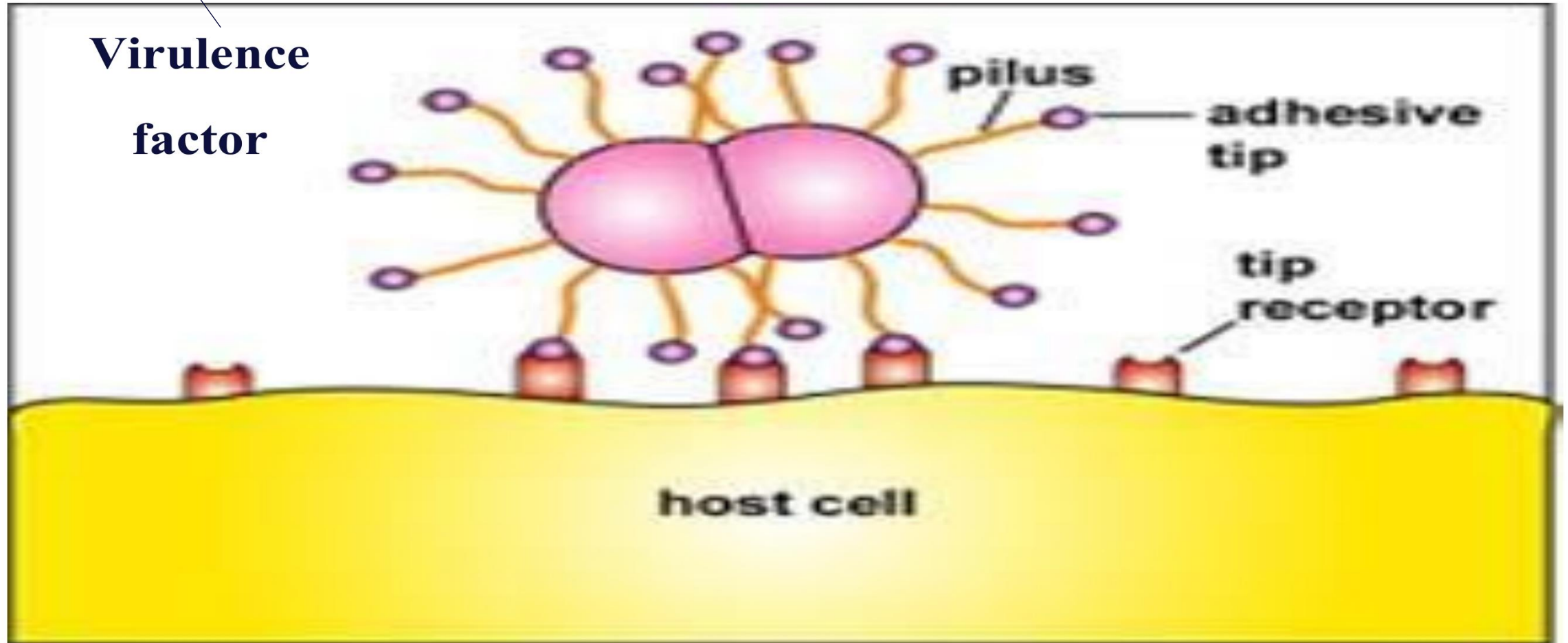
**B) Sex pili
(Genetic transfer)**



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).

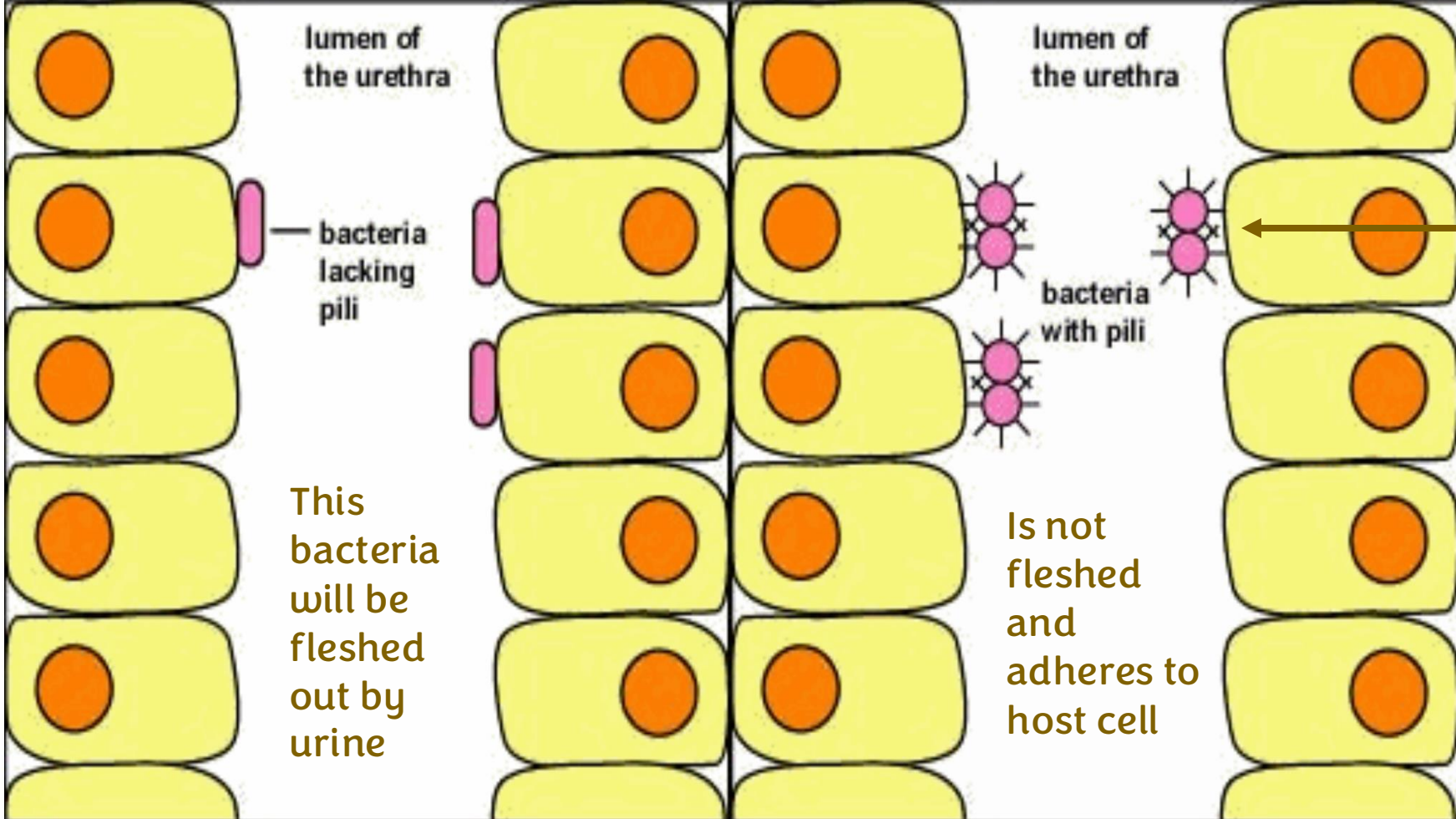
Ordinary Pili

**Virulence
factor**



This photo
from urethra

Ordinary Pili



This bacteria will be fleshed out by urine

Is not fleshed and adheres to host cell

Bacteria can resist the fleshing of the urine

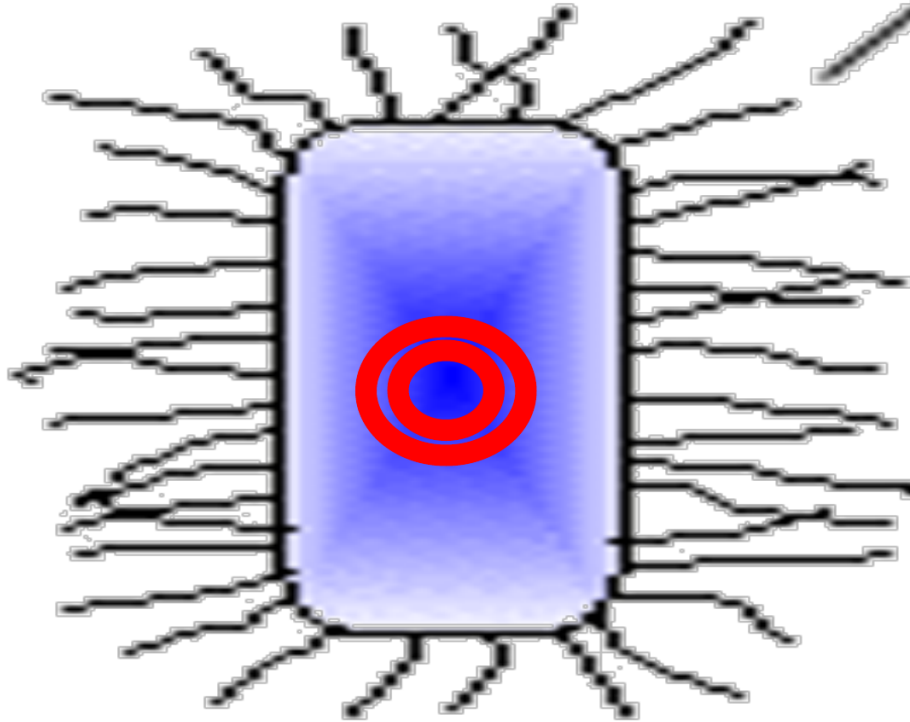
Sex Pili

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)

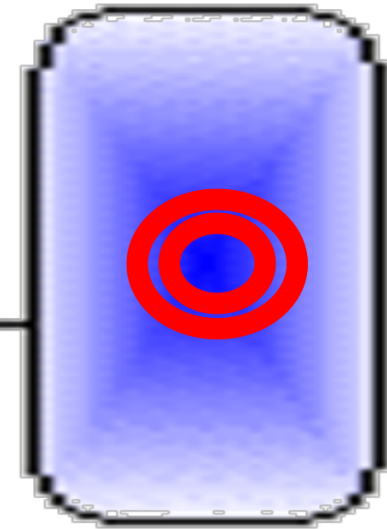
pili

Is characterized by:
Long pili

Sex pili!!



Male



Female

nonprecise



Nonprecise name ←

F+ :fertile

mostprecise ←

Donor

Another name :

Conjugation

F- :nonfertile

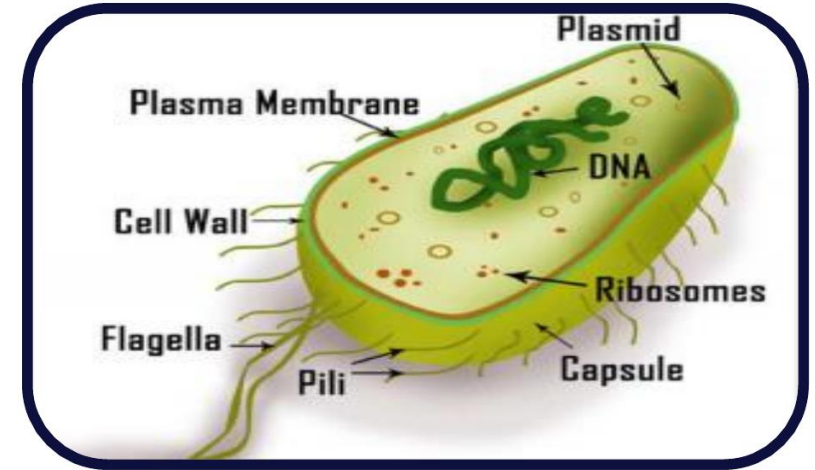
→most precise

Recipient

Spore formation

Vegetative bacteria

:bacteria that divide and replicate **INSIDE THE HOST CELL**



Unsuitable condition

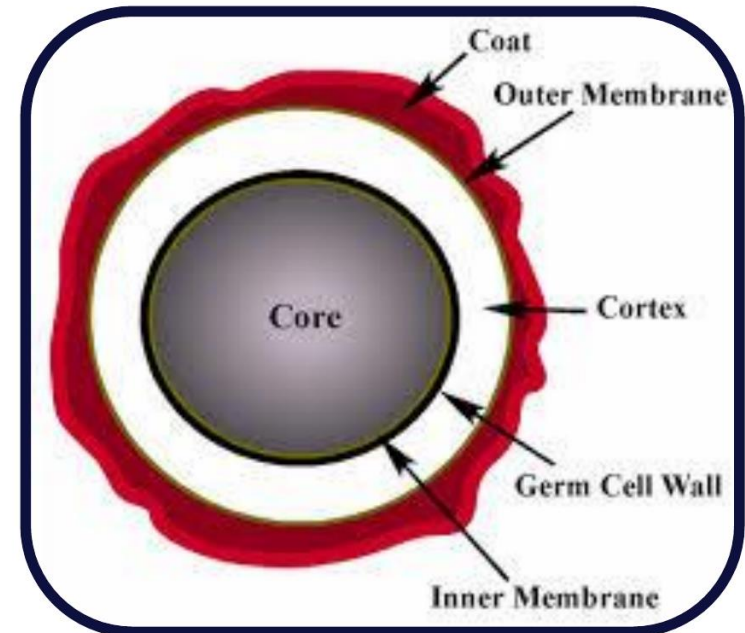
this lead to :

البوغ
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

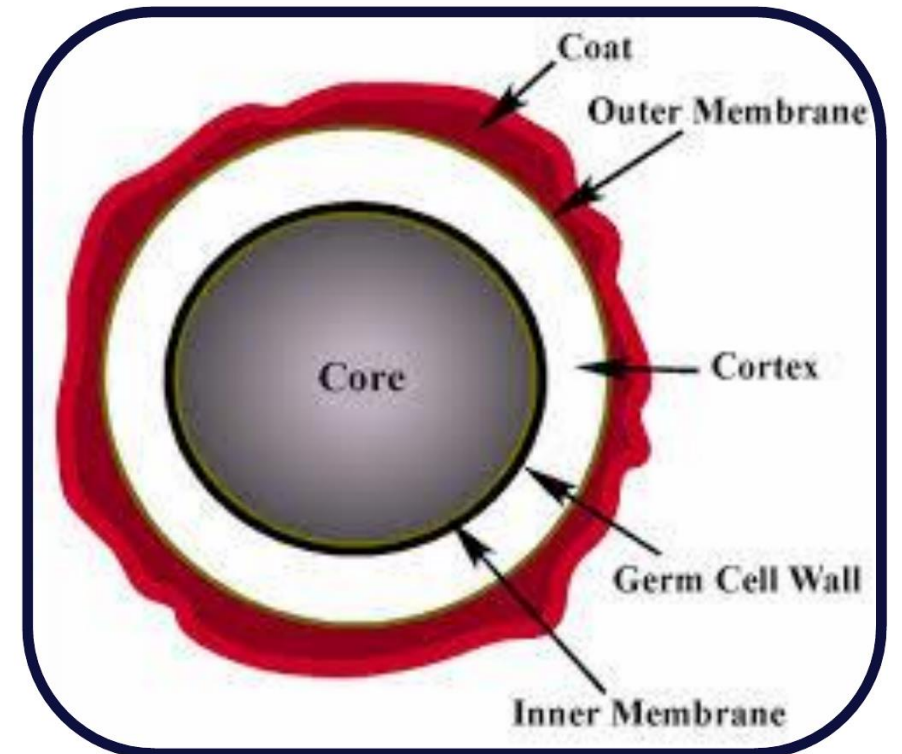
Only 2 types of bacteria can form spores :

Bacillus

Clostridium

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

↓
OUTSIDE THE
HOST CELL



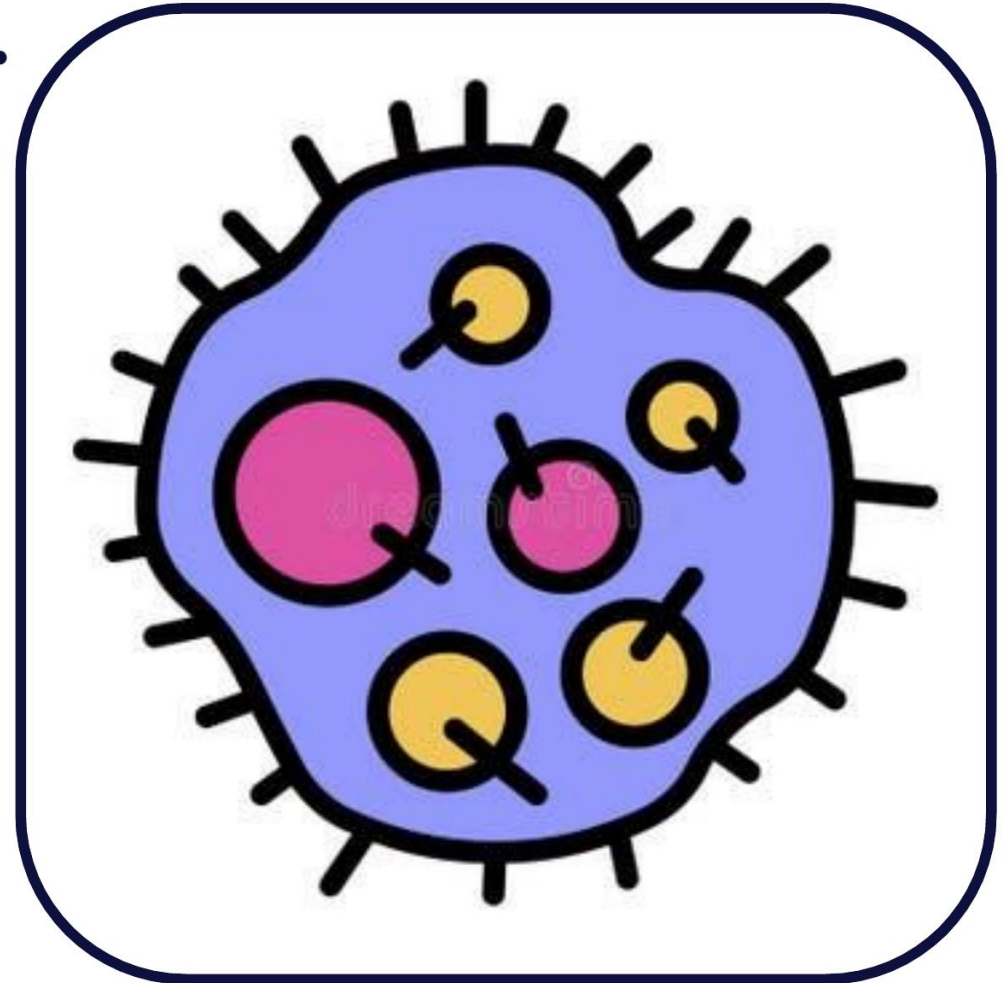
Spore formation

Occur to unfavorable conditions e.g.

High temp.

Drying

Depletion of
nutrition

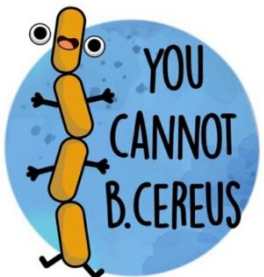


Spore formation

Formed outside the body (in VITRO)

Can not stained by ordinary stain

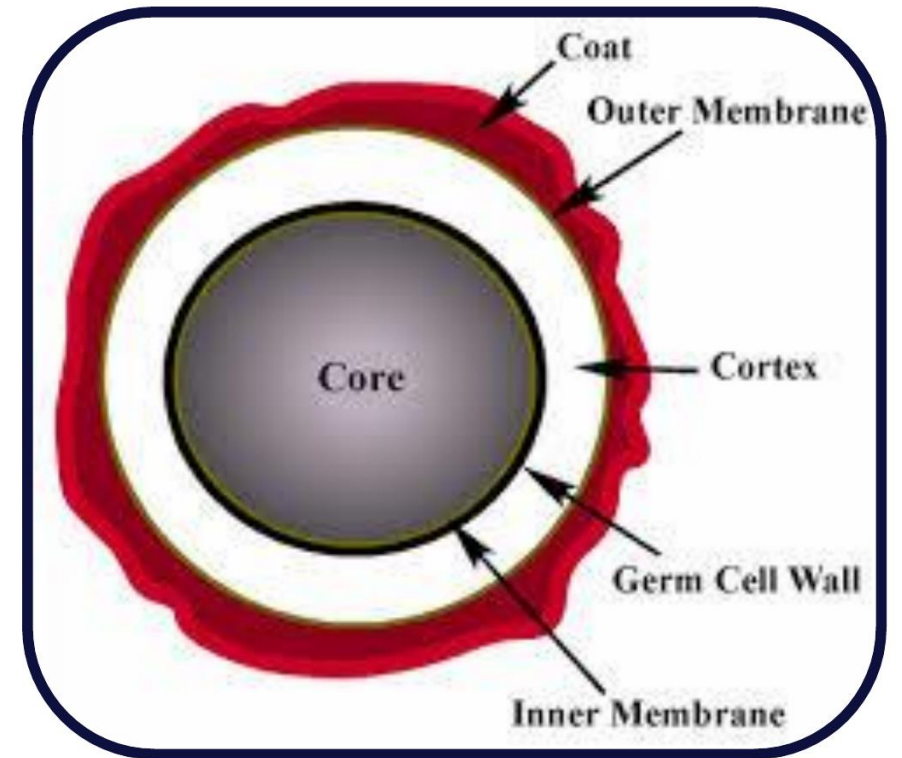
Instead they
have specific
stains



Spore formation

Spores are :

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



Spore formation

Inside host cell and divide

Outside host cell + dormant

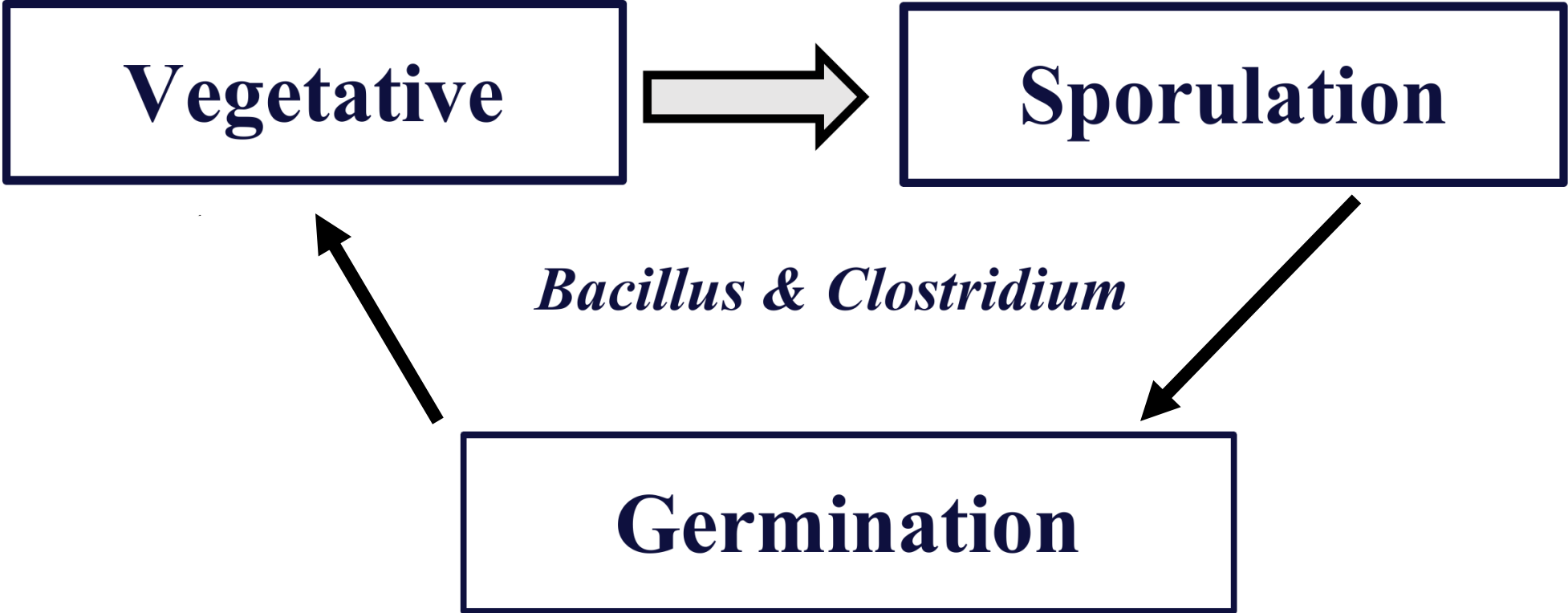
Vegetative



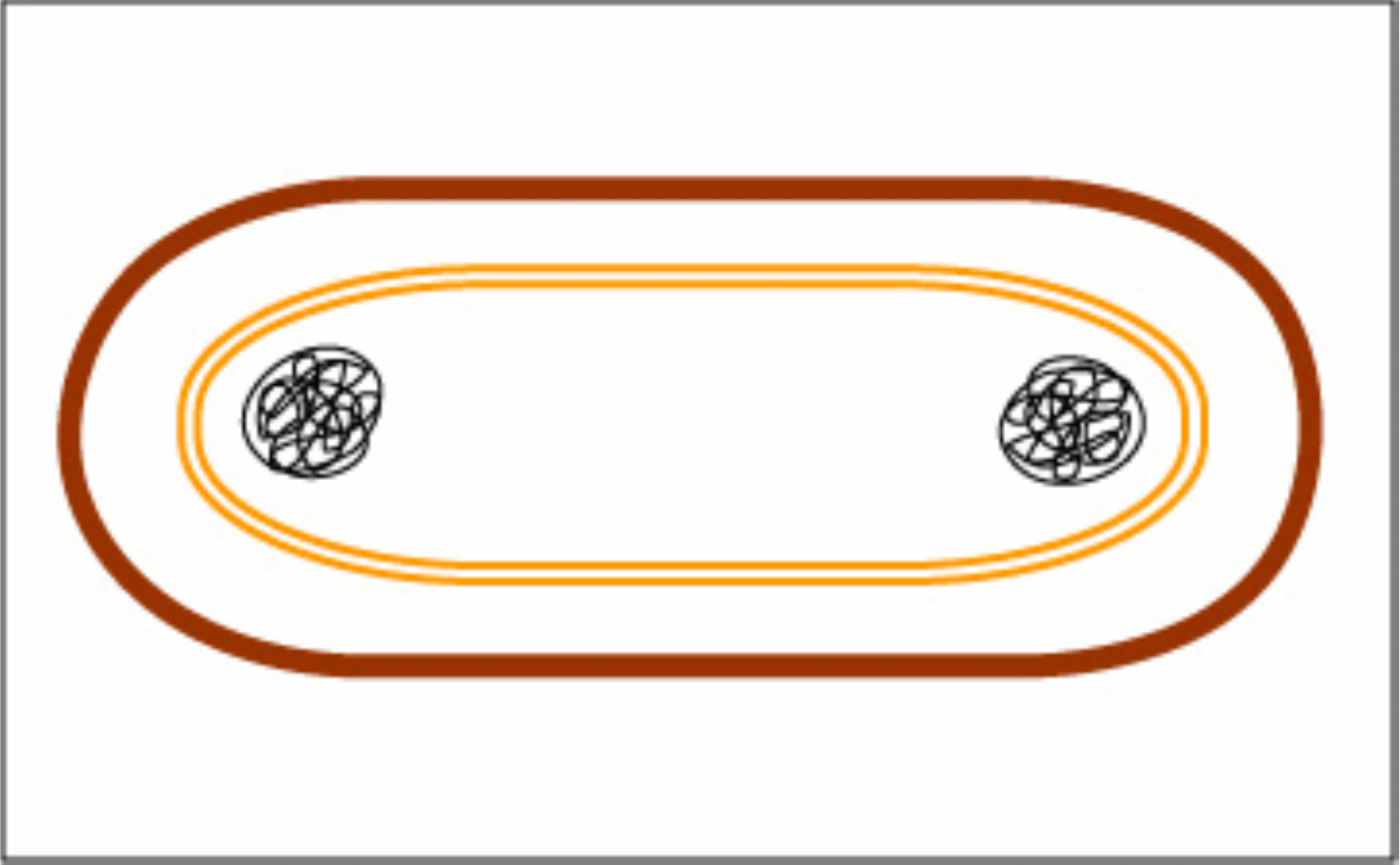
Sporulation

Bacillus & Clostridium

Germination



Spore formation



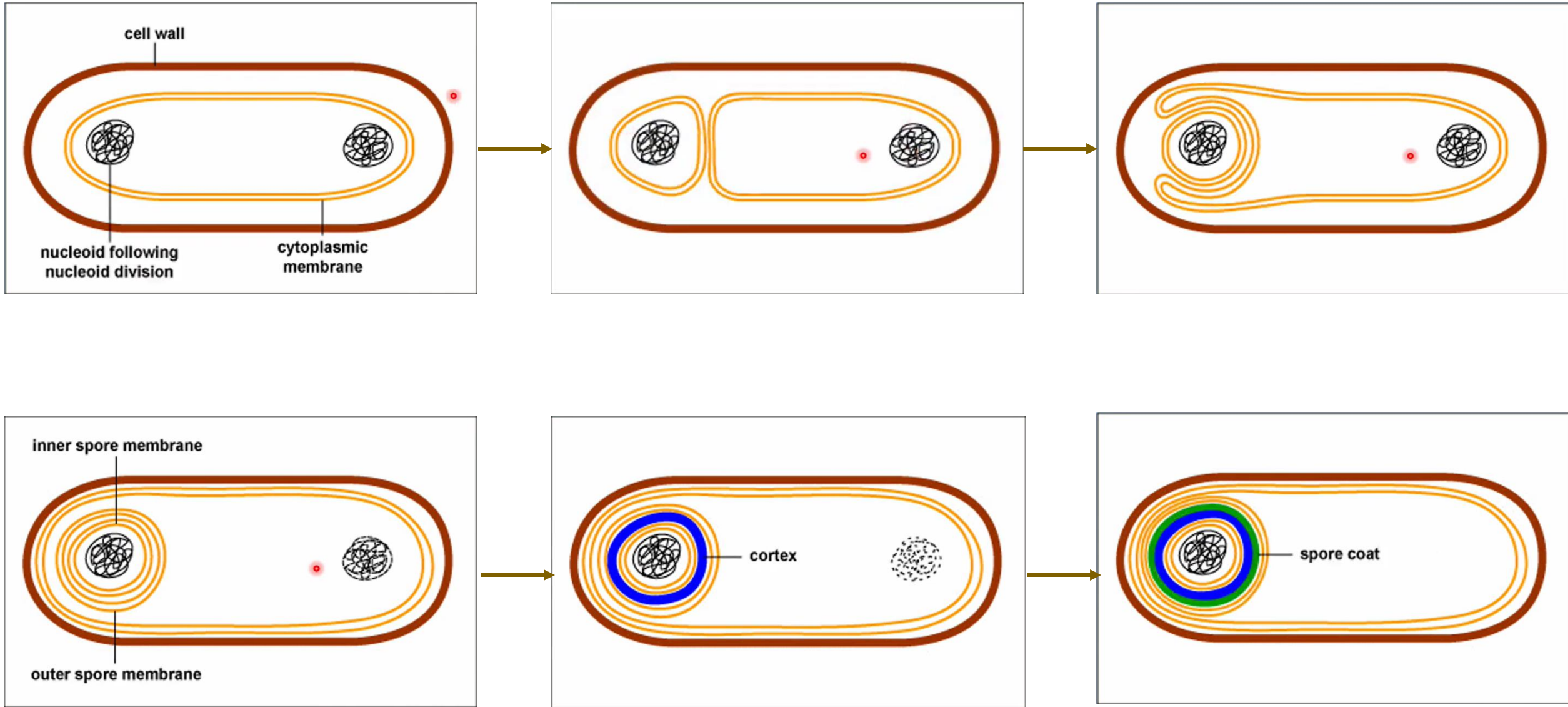
Ca⁺² &

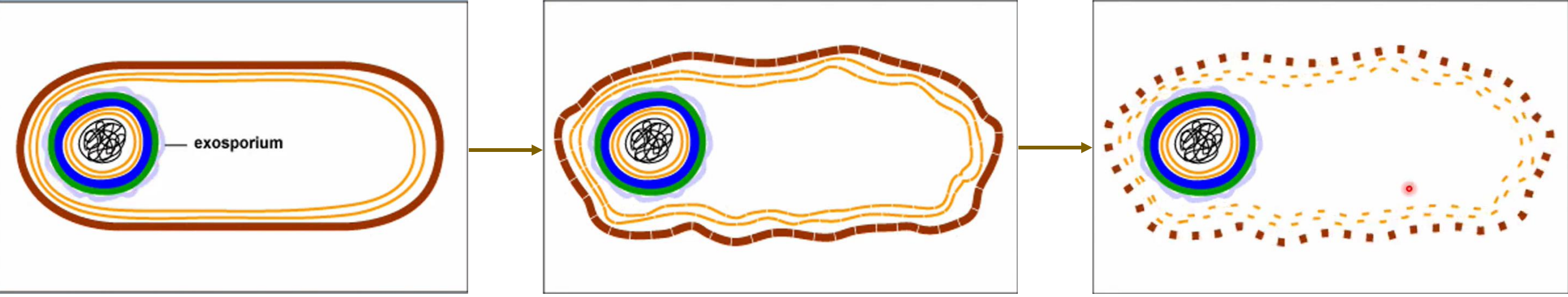
Diploic acid

Explained in
next slide

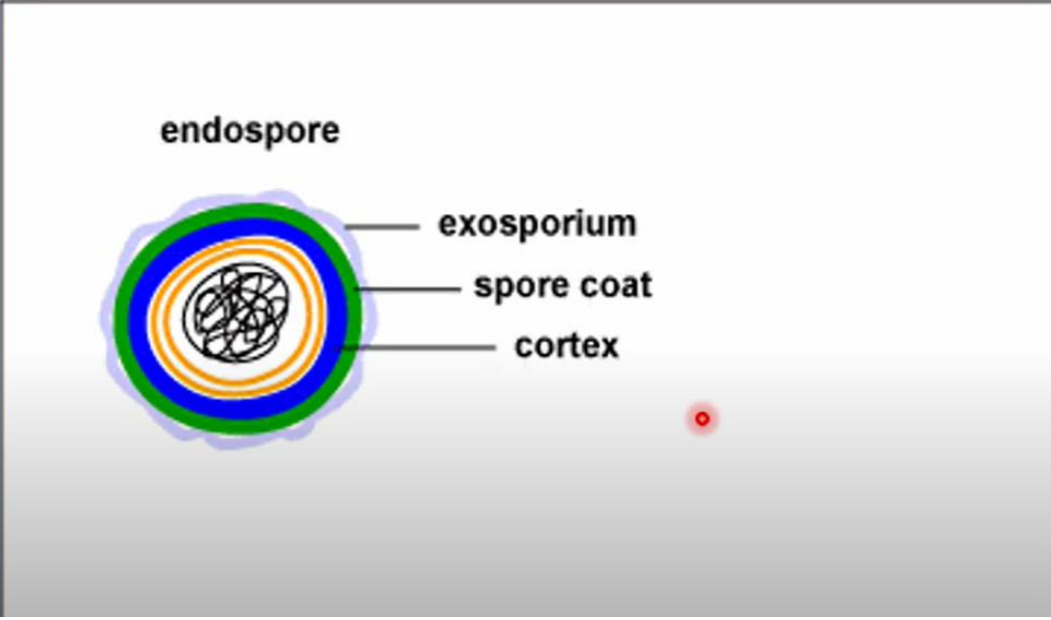
Multiple membranes

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



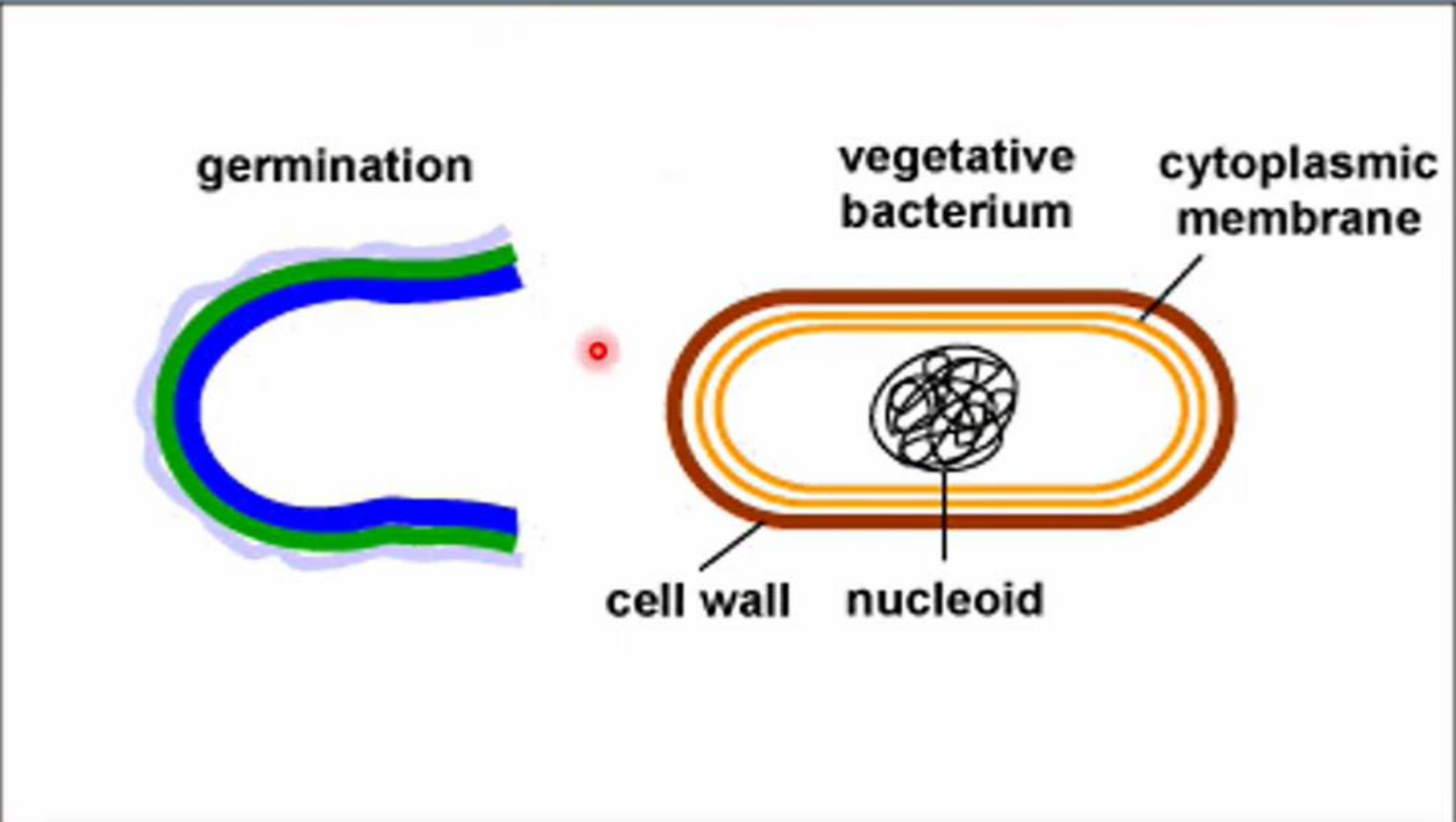
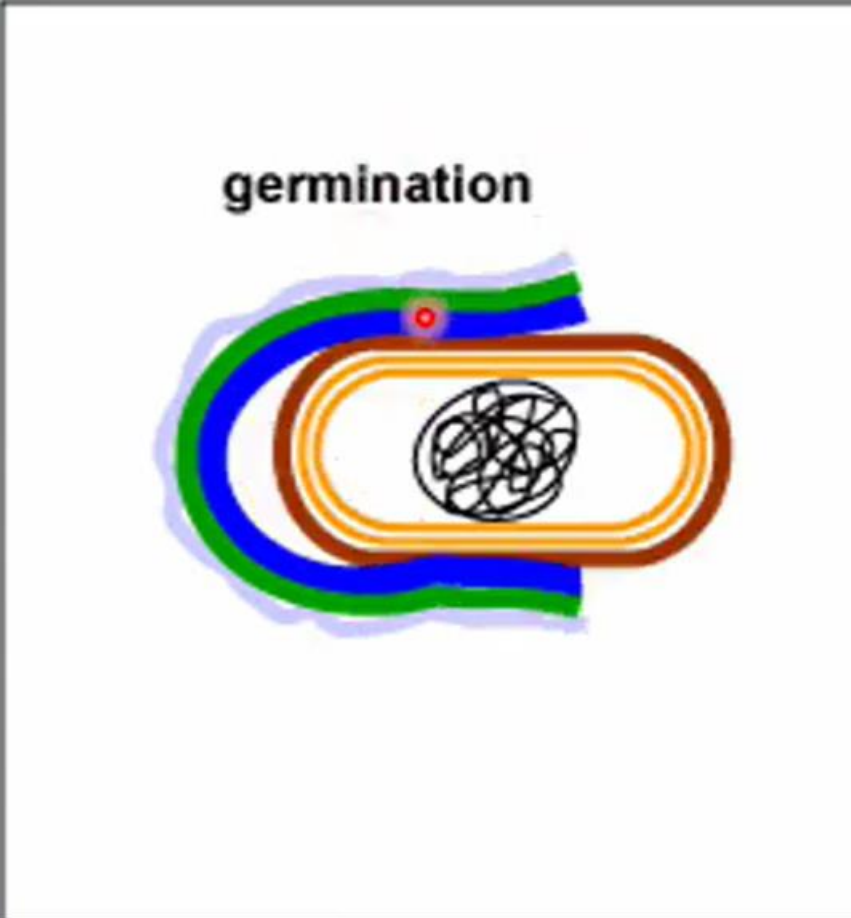
Germination

التبرعم



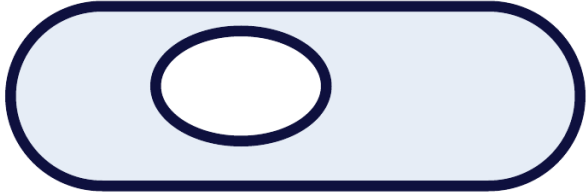
Germination of spores occurs when the bacteria find suitable conditions like availability of water . In germination, bacteria will break down all the layers (cortex , spore coat , exosporium) and return to become vegetative bacteria and begin their activities inside the host cell

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	Slide #14 Slide #20	...resulting in no infection This is NOT a virulence factor	...resulting in more infection This is a virulence factor
V1 → V2			

Additional Resources:

رسالة من الفريق العلمي:

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