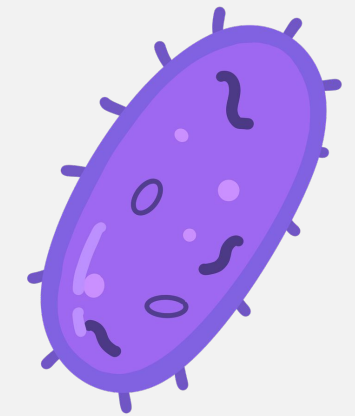
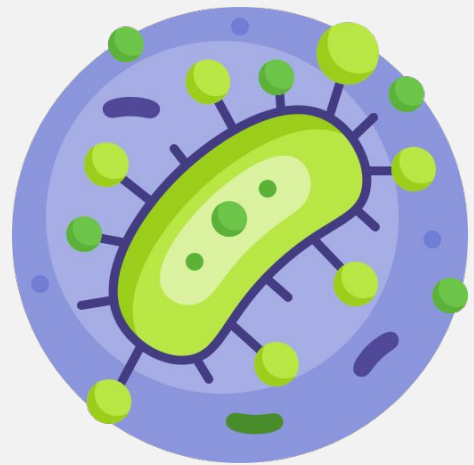


Editing File

Bacteria Structure and Genetics



index:

- Main text.
- **Important.**
- In boys slides only.
- In girls slides only.
- Doctors notes.
- Extra info.

OBJECTIVES



Define the cellular organization of bacteria and recall the differences between Eukaryotes and Prokaryotes



Describe the internal and external structures of bacteria and their functions



Recall major structures of bacteria and its functions



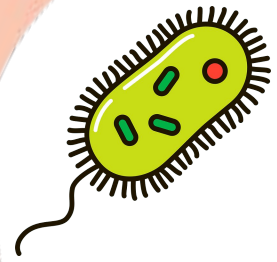
Recall basic information about bacterial genetics and replication of bacteria



Describe the structure of cell wall of bacteria including the differences between Gram positive and Gram negative bacteria and main functions

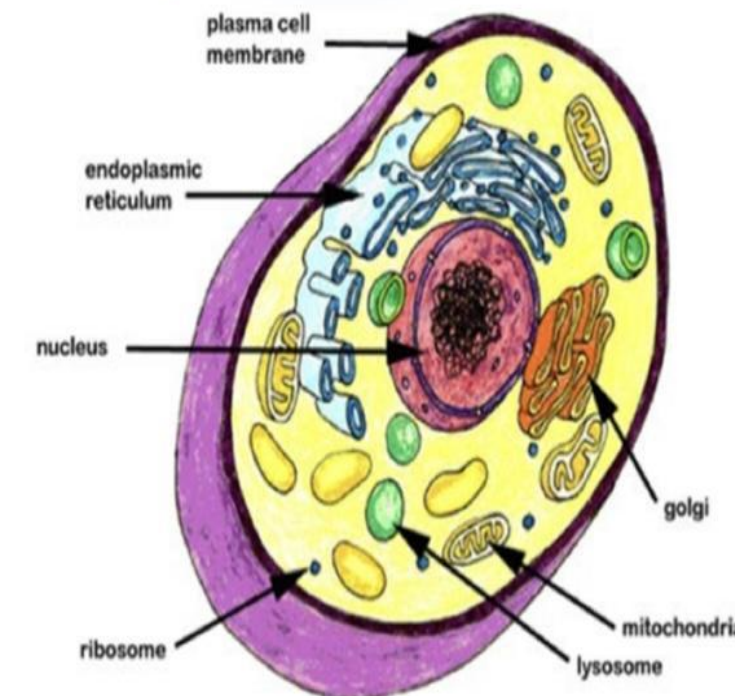
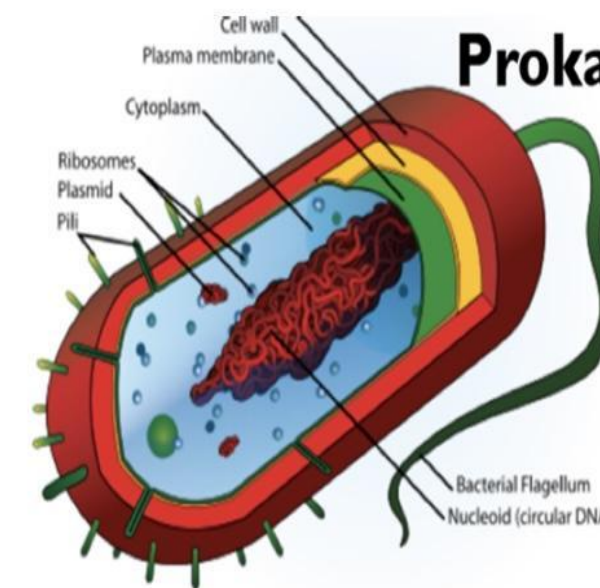
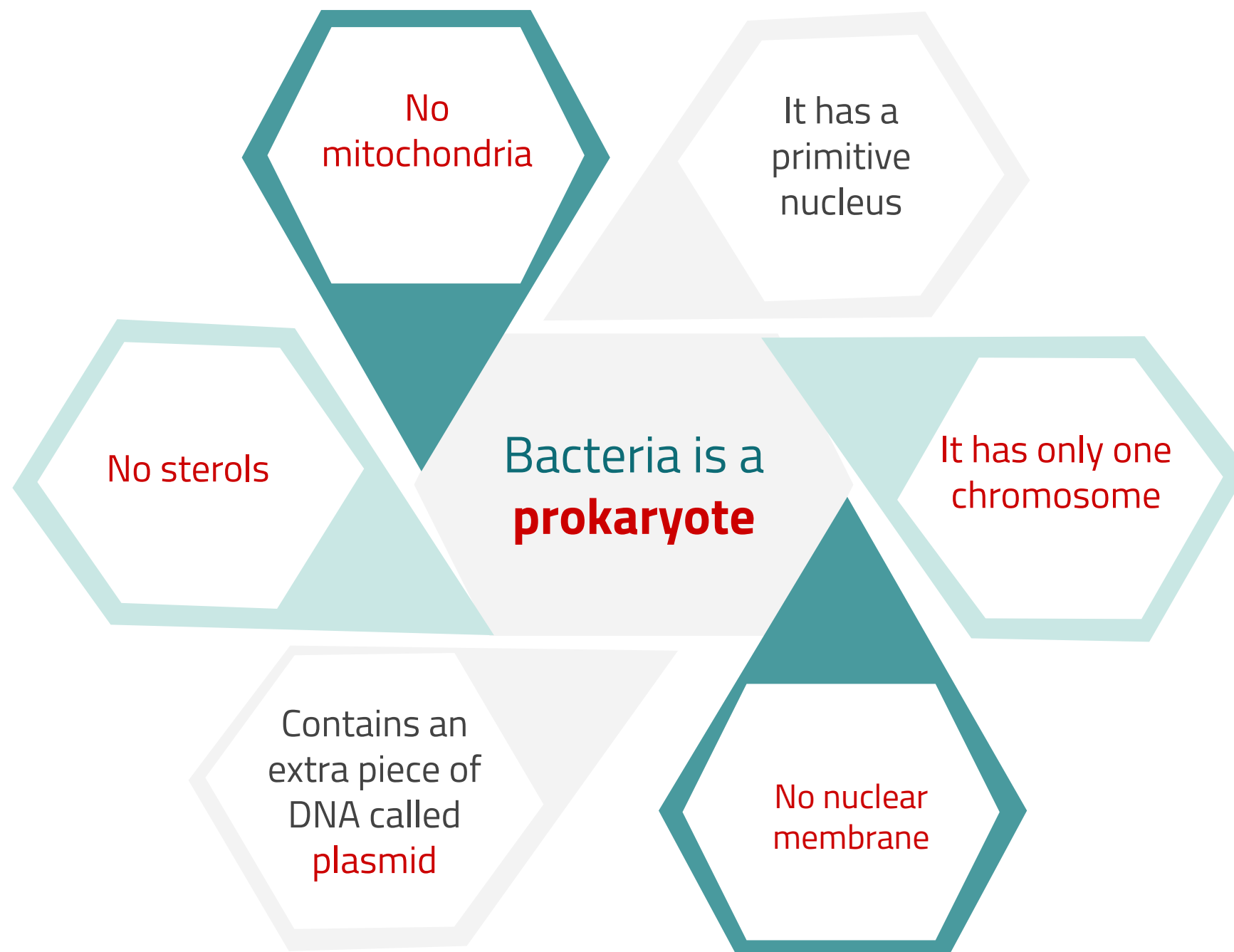


Describe the plasmid origin, types and its importance in medical practice

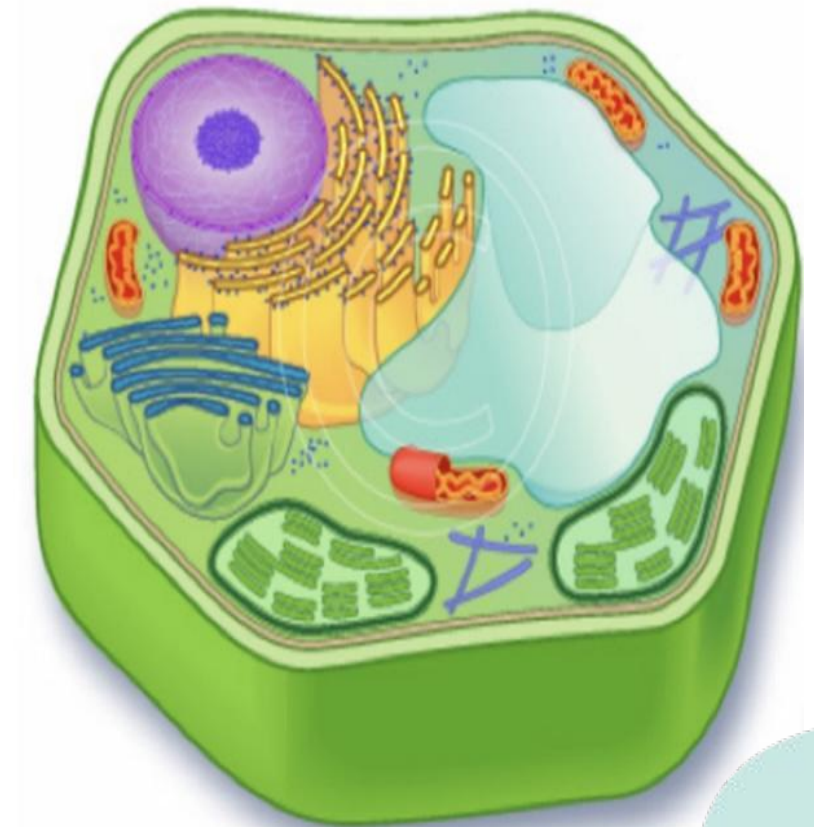


Cellular Organization of Bacteria:

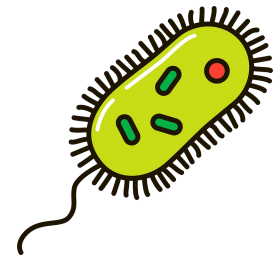
Bacteria is a **heterogeneous (diverse) group of unicellular organisms**, about 1-8 μ m in diameter.



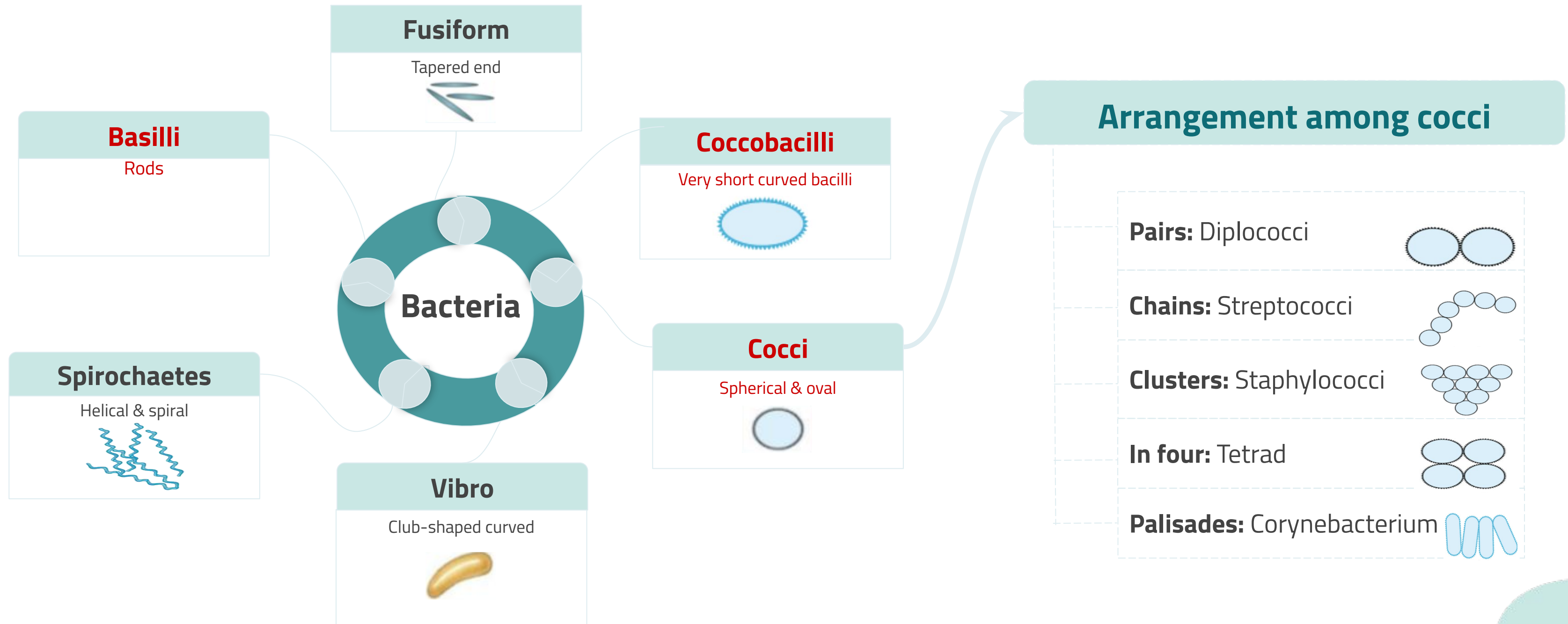
Eukaryotic Cell (Plant)

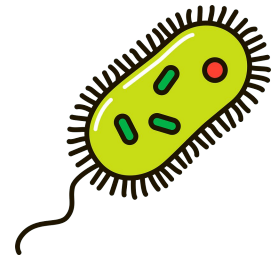


Eukaryotic Cell (Animal)



Shapes and Types of Bacteria:

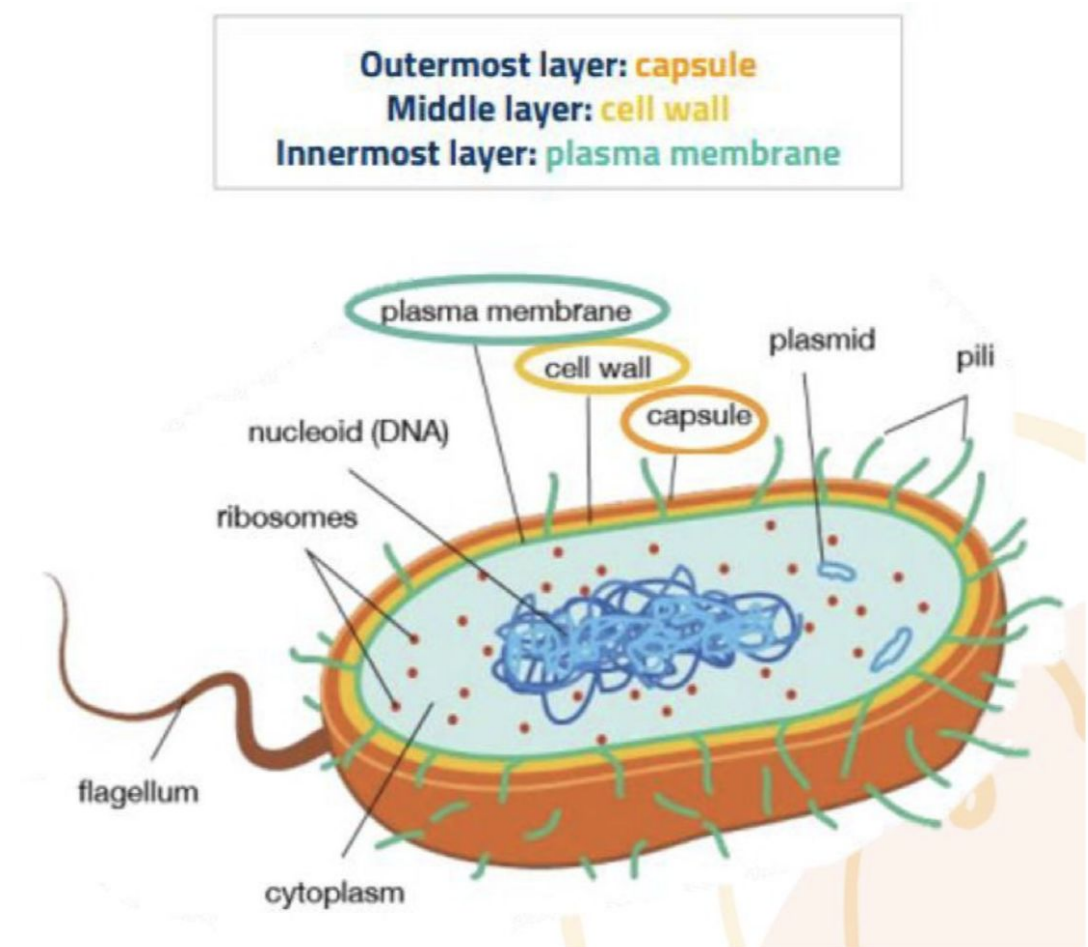
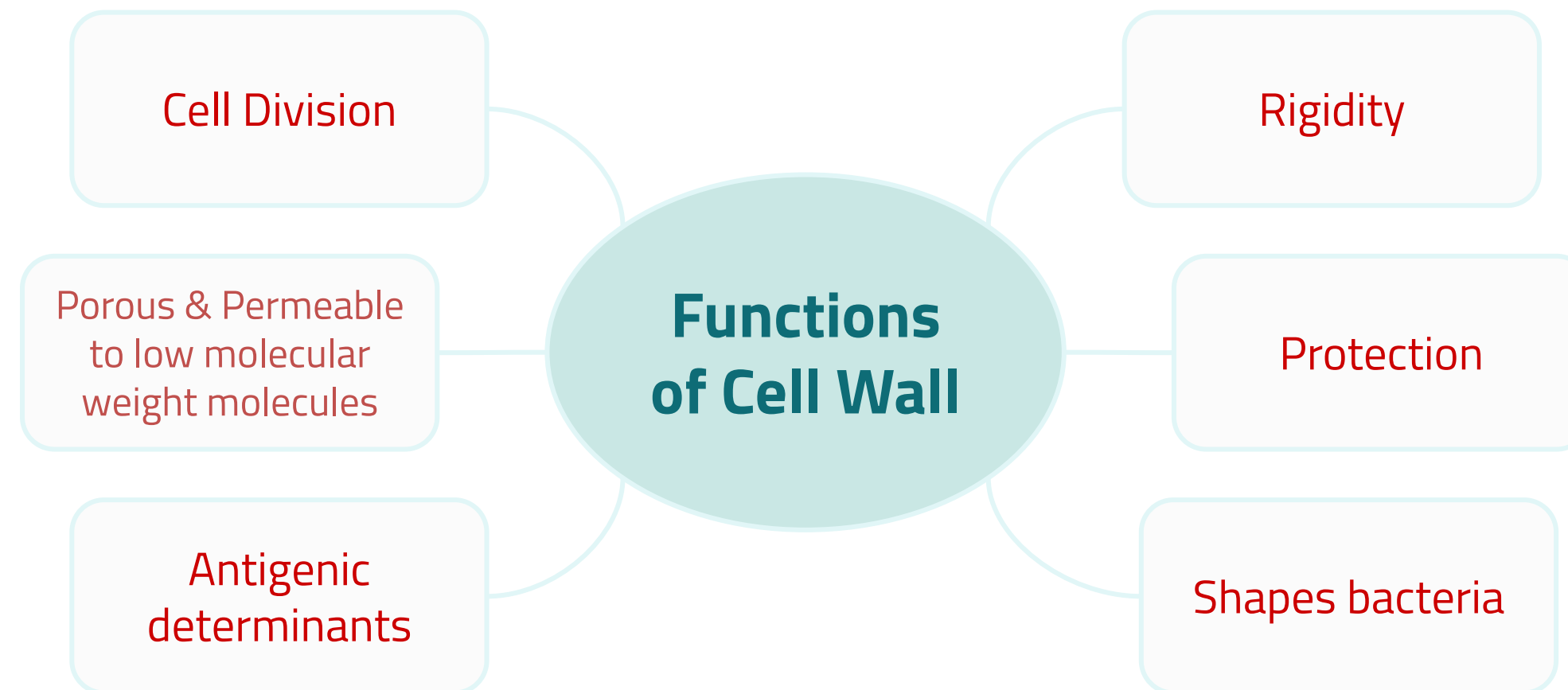


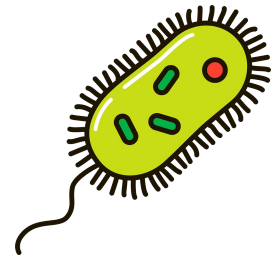


Cell wall of Bacteria :

One of the most important structures is the cell wall

Bacteria are prokaryotic cells with rigid cell walls that surround the cytoplasmic membrane and internal structures.





Cell wall of Bacteria

Bacteria are classified into two groups depending on their reaction to GRAM stain:

Gram Stain

Gram **positive**:
Stain
Blue/purple

Gram **negative**:
Stain
Red

Chemical structure of bacterial cell wall:

Peptidoglycan : Rigid part, mucopeptide composed of alternating strands of **N-acetylmuramic acid** and **N-acetyl glucosamine** cross linked with peptide subunits

Peptidoglycan: Building blocks of cell wall

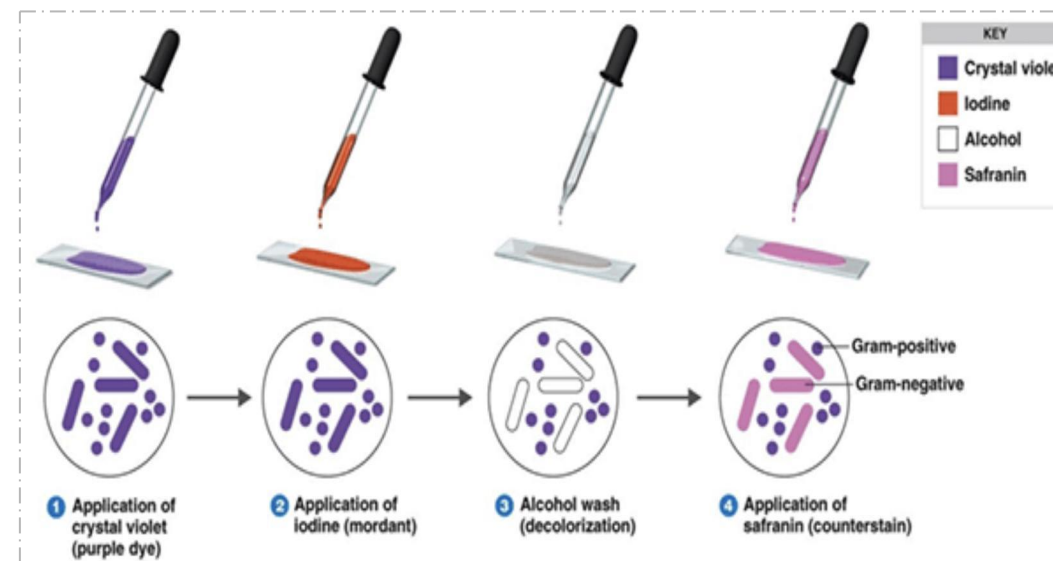
- **Note** : **Mycoplasma** naturally have **no cell wall** (therefore, gram stain are not useful for the diagnosis of this organism)

GRAM-POSITIVE

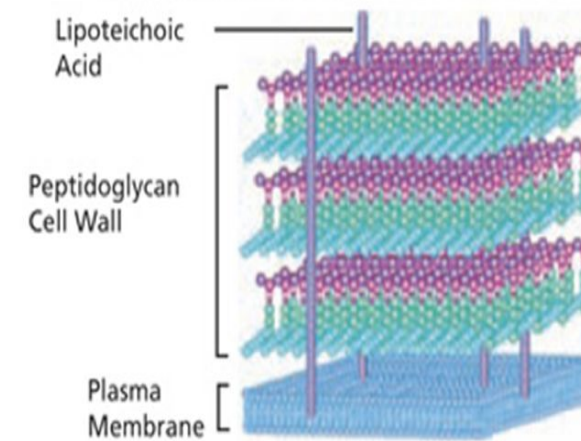
GRAM-NEGATIVE



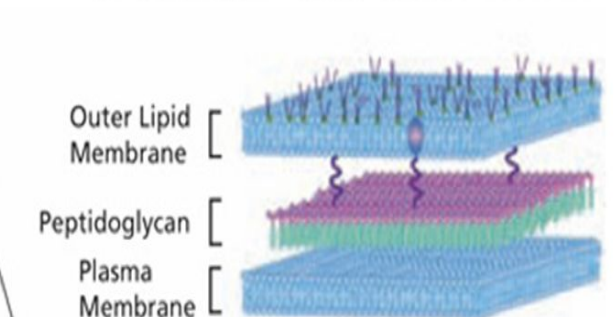
Fixation
↓
Crystal Violet
↓
Iodine Treatment
↓
Decolorisation
↓
Counter stain with Safranin

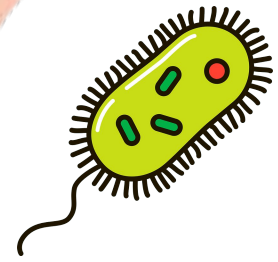


Gram-Positive Bacterial Cell Wall



Gram-Negative Bacterial Cell Wall



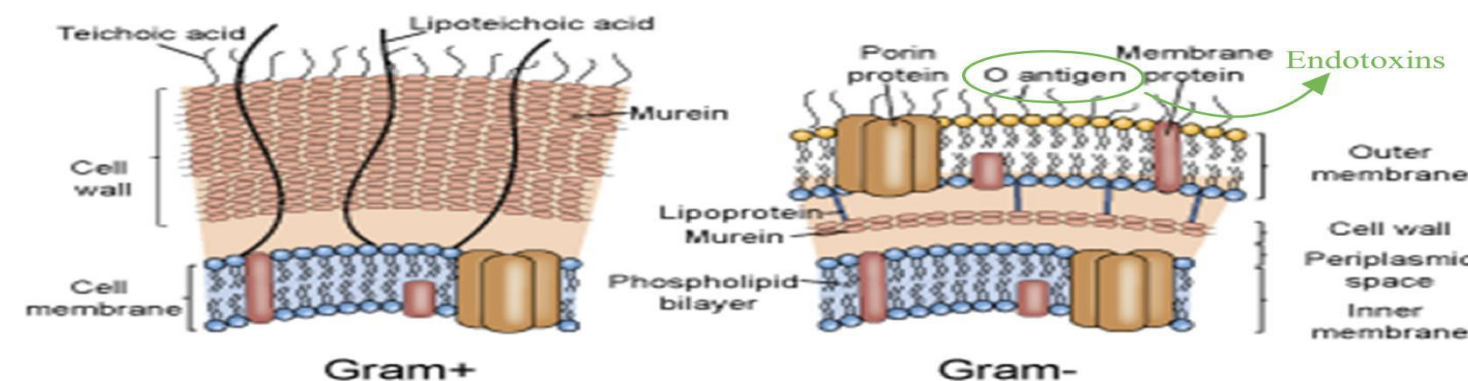


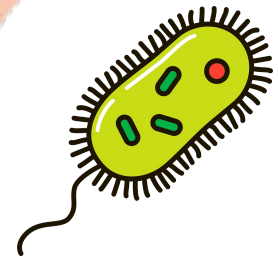
Types of Bacteria (Gram stain) :

Doctor's notes:

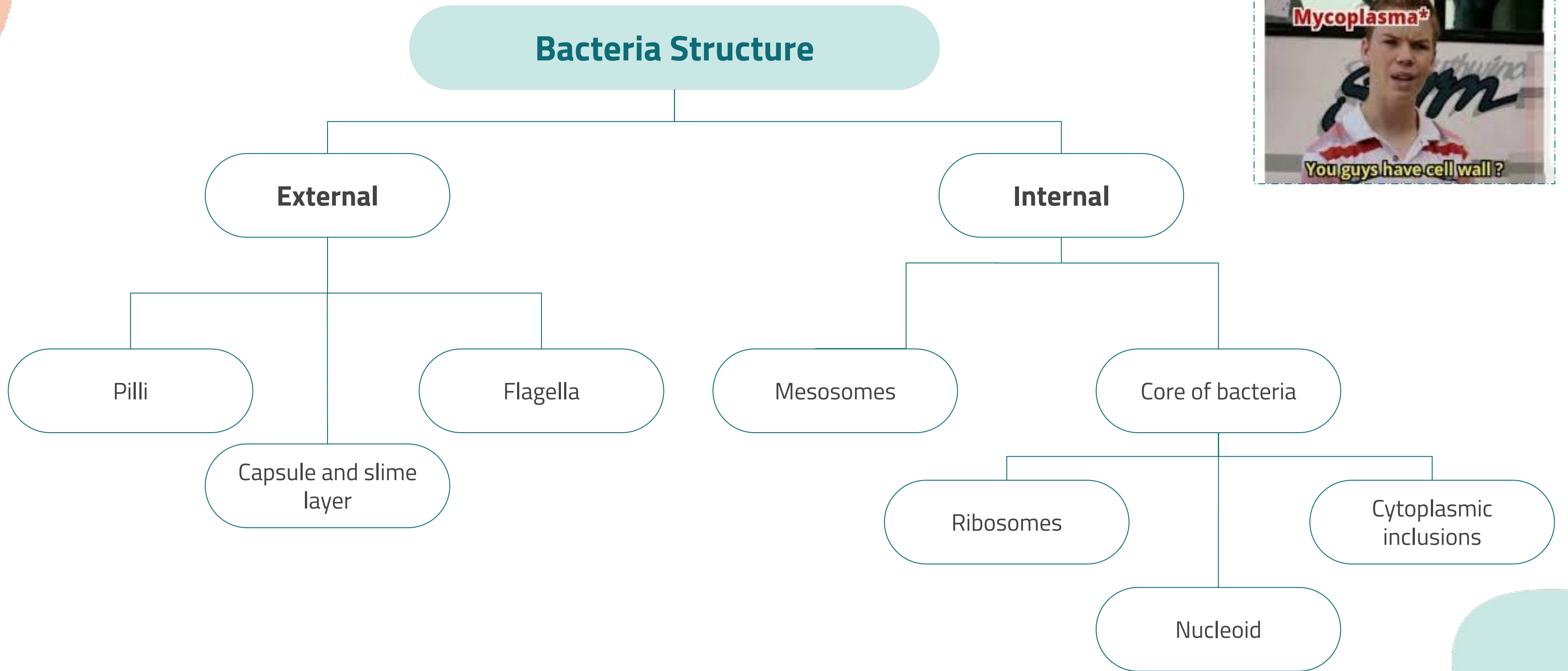
- Due to cell wall thickness, the purple stain will only remain on the thick cell wall (+ve)
- Iodine prevents the easy removal of the crystal violet dye.

Gram-Positive	Gram-Negative
Retains the crystal violet stain. Appears purple under the microscope.	Do not retain the crystal violet stain. Appears pink under the microscope
Closely associated with the cytoplasmic membrane	-
Thick peptidoglycan & multilayered	Thin peptidoglycan & single layered
Outer membrane is absent	Outer membrane is present (Peptidoglycan surround) فوق جدار الخلية
Cell wall contains: - Teichoic acid protein associated with cell wall to anchor it to cell membrane, epithelial cell adhesion. - Antigens: polysaccharides: (Lancefield) protein: (Griffith) (these are used to identify streptococci infection)	Outer membrane contains: - Lipopolysaccharides (Endotoxins): are part of the outer membrane of the cell wall of Gram-negative bacteria. (In the case of infection, cause septic shock) - Specific proteins (porins) important in the transport of hydrophilic molecules



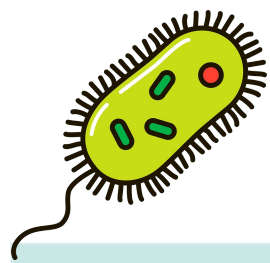


Bacteria Structures :



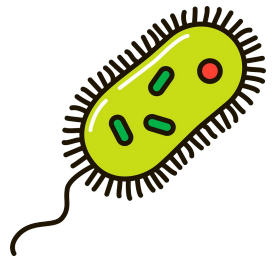
Bacteria discussing about their cell wall properties





External Structure of Bacteria :

	Flagella	Pili	Capsules & slime layer
Shape	Helical filaments	Fine short filaments extruding from cytoplasmic membrane	Structures surrounding the outside of the cell envelope. They can be seen by <u>India ink</u> or some <u>special stains</u> .
Composed of	a protein called FLAGELLIN	a protein called Pilin	usually a polysaccharide , but in some bacteria it is composed of polypeptide (protein)
Found in	both gram positive & gram negative bacteria	the surface of many gram positive & gram negative bacteria	Some strains within species produce capsule while others do not. <u>They are not essential for cell viability</u>
Function	<p>Some bacterias flagella aren't motile motility and chemotaxis.</p> <p>(movement of an organism in response to chemical stimulus)</p>	<p>1- Common pili</p> <p>Also called fimbriae, covers the surface of the bacteria. Responsible for adhesion & colonization</p> <p>2- Sex pili</p> <p>In some bacteria only.</p> <p>Responsible for conjunction (mating)</p>	<ul style="list-style-type: none"> ● Attachment ● Protection from phagocytic engulfment (Antiphagocytic) ● Resistant to dryness ● Reservoir (مخزن) for certain nutrients
Pictures	<p>Distribution:</p> <p>Monotrichous (Single flagellum at one pole)</p> <p>Lophotrichous (Multiple flagella located at the same point)</p> <p>Amphitrichous (Single flagellum on each of two opposite ends)</p> <p>Peritrichous (Multiple flagella all over the cell)</p>	<p>Note 439: Notes:</p> <p>1- sex pili is only found in gram negative bacteria.</p> <p>2- note that there is a difference between conjugation (تزاوج) and reproduction (تكاثر).</p> <p><u>Conjugation</u> is one of the ways bacteria transfer genes to each other, while <u>reproduction</u> is by binary fission.</p>	<p>Plasma Membrane</p> <p>Cell Wall</p> <p>Capsule</p>



Internal Structure :

Cytoplasmic Membrane (plasma membrane)

Mainly for passive diffusion

Double layered structure = phospholipid+protein

Semi-permeable membrane (passive diffusion)

Site of numerous enzymes which are involved in active transport of nutrients and other metabolic processes

Mesosomes

Convolute (folded) invaginations of the plasma membrane

Helps in DNA segregation and cell division and chemotaxis (chemotaxis is moving towards a certain signal)

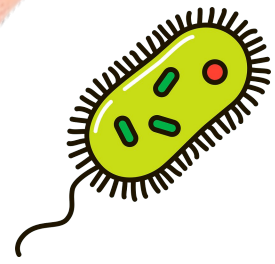
Functions

Coordinates DNA and cytoplasmic segregation during cell division

Contains respiratory enzymes

Contains receptors involved in chemotaxis

Permeability Barrier (active transport of solutes)



Internal Structure of Bacteria:(Core)

Internal Structure

RNA and Protein could be found within it

Cytoplasmic Inclusions

Nutritional Storage Granules store:

Volutin

Lipid

Starch/Glycogen

Ribosomes

Site of protein synthesis

Found throughout the cytoplasm

Composed of 2 subunits (Small+Large)(30s & 50s)

Bacterial Chromosomes

Circular molecule of double stranded DNA (Haploid)

Packed with RNA molecules and proteins to form irregular shaped structure **Nucleoid (Nuclear Body)**

Genetic code in purine and pyrimidine bases of nucleotides that make the DNA strand

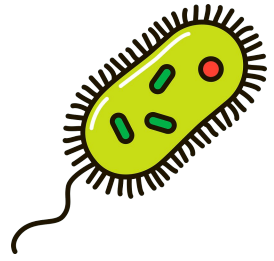
Replication is **Semiconservative** which takes place by **Binary Fission**

Nucleoid

Single circular chromosome

No Nuclear Membrane

DNA undergoes semiconservative replication, bidirectional from a fixed point



Spores of Bacteria :

Only occurs in gram (+ve) bacteria
Spores only form when needed (depends on the environment/situation they are in)
It gives them strength and protection

Spores:

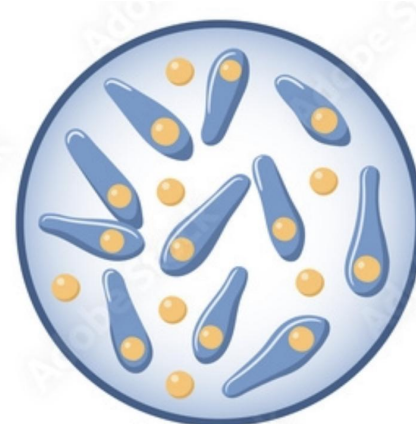
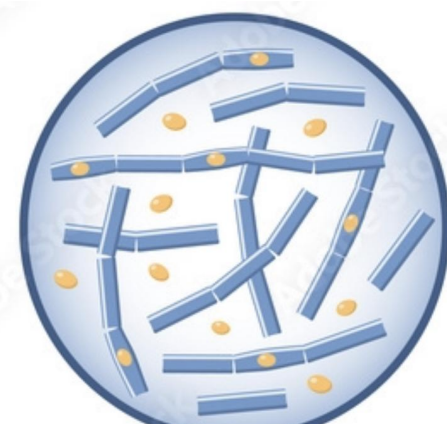
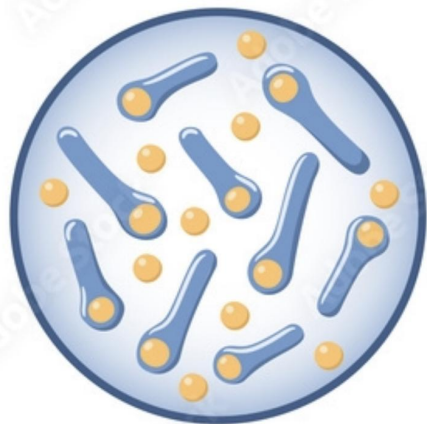
Small dense **metabolically inactive, non-reproductive** structures produced by **Bacillus & Clostridium species**.

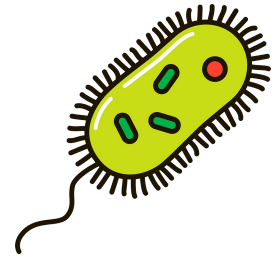
- Enables the bacteria to **survive adverse environmental conditions**
- Contains high concentration of **Calcium dipicolinate** (Which is the reason they can survive harsh environments)
- Resistant to **heat, desiccation & disinfectants**
- Often remains associated with the cell wall
- Spores germinate when growth conditions become favorable to produce vegetative cells
- Application in medical practice: **Spore strips are used for checking the efficacy of Autoclaves** eg: Bacillus subtilis & Bacillus stearothermophilus

Terminal

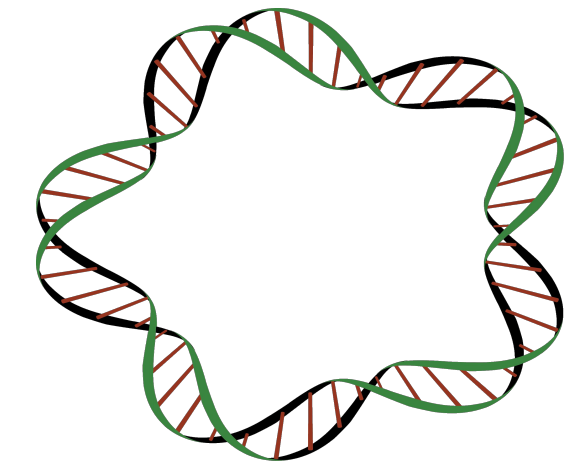
Central

Sub-Terminal





Bacterial Genetics :



Definition:

- **Genetics** is the study of inheritance and variation, how the genetic information is transferred to the offspring or into other bacteria.
- The genetic information is encoded in the DNA
- In bacteria, **genetic variation** is due to:
 1. Gene Transfer
 2. Mutation

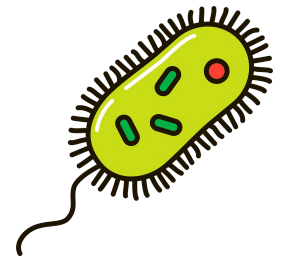
Function of Genetic material

- Replication of the genome
- Expression of DNA to mRNA then to protein (transcription & translation)

Types of DNA in Bacteria:

1. Chromosomal
2. Extra-chromosomal DNA (Plasmid)

Genotype	Complete set of genetic determinants of an organism
Phenotype	Expression of specific genetic material
Wild Type	Reference Strain (Parent) No Mutation No Changes
Mutant	Progeny with Mutation



Mutation:

Mutation

Inheritable changes in the structure of genes (DNA)
Chemical changes in one or more bases of DNA

Mutation Defect

It leads to an alteration in:

- Transcription
- Amino acid sequences
- Function: Bacteria becomes more resistant to Antibiotics

Mutation Classification

Depends on biological sequencing:

Resistance Mutation

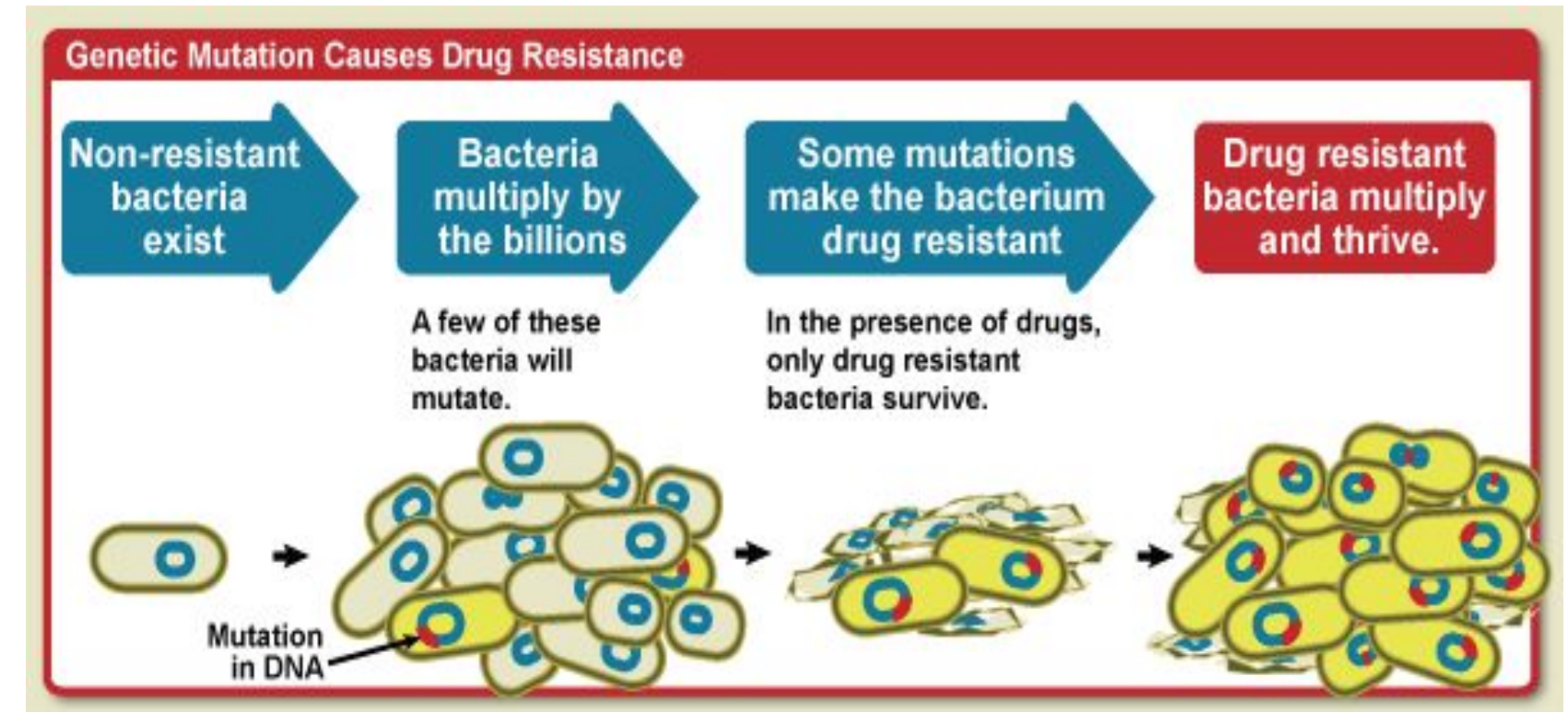
Affects structure of cell protein. Main application in medical practices.
Bacteria become **more resistant to Antibiotics**

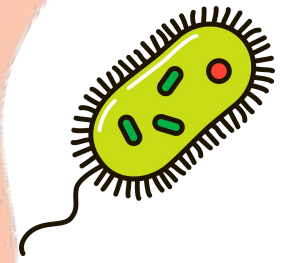
Auxotrophic Mutation

Affects biosynthetic enzyme resulting in a **nutritional requirement** of mutant cell. (Unable to synthesize an essential compound)
Change of nutritional requirements

Lethal Mutation

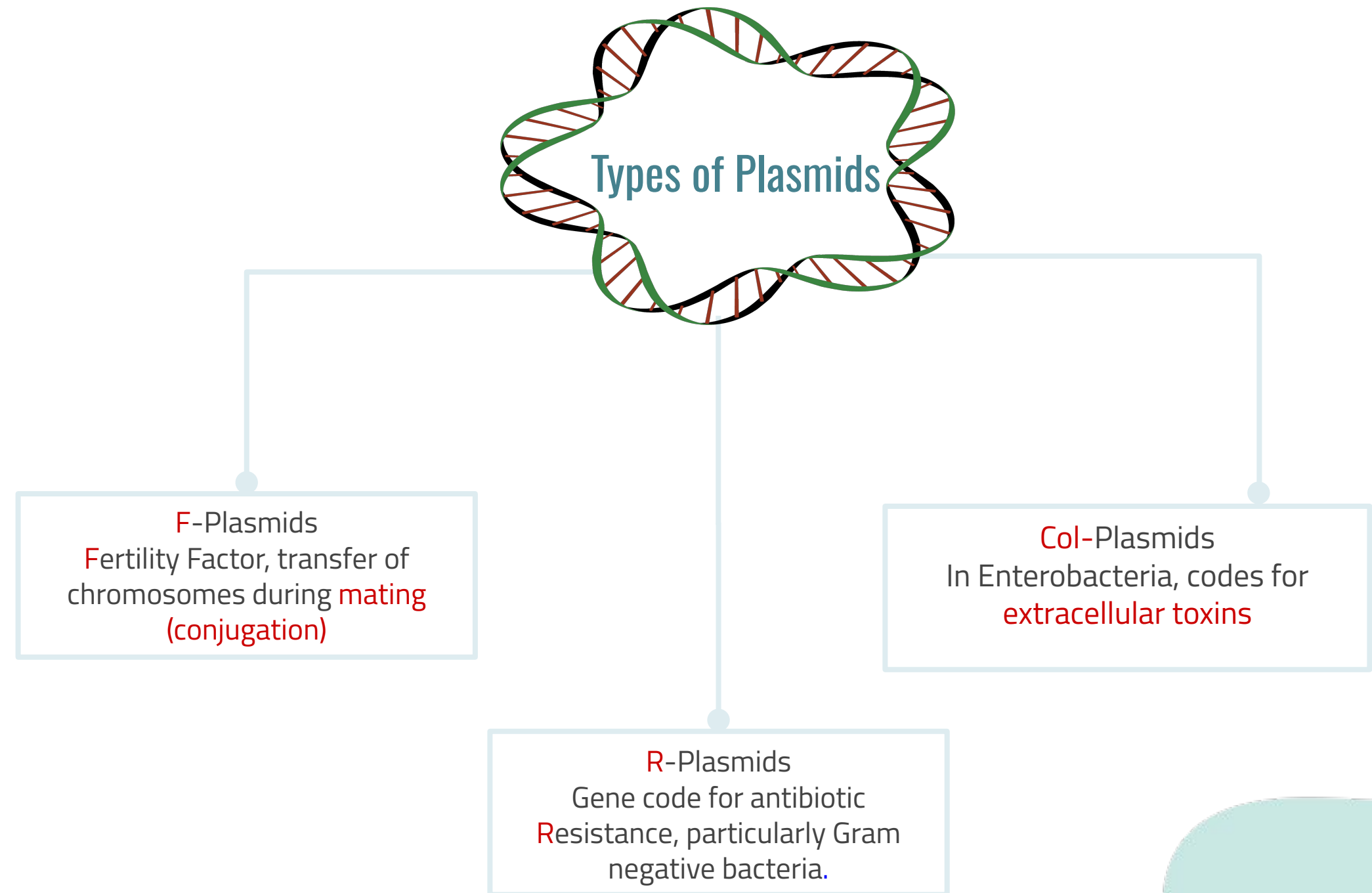
Leads to the death of the Bacteria

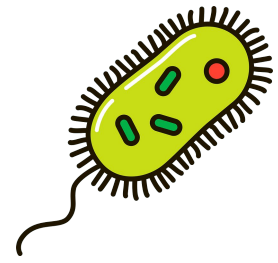




Types of Bacterial DNA:

Chromosomal	Extrachromosomal (Plasmids)
Haploid, circular molecule of double stranded DNA attached to cell membrane	Plasmids are extrachromosomal DNA composed of double stranded DNA
Genetic code in Purine and Pyrimidine bases of nucleotides that makes DNA strand	Found in most species of bacteria, and the origin is unknown
3 bases comprise one code, each triplet codon codes for one amino acid	Govern their own replication Transfer to other bacteria by conjugation
Replication is Semiconservative, takes place by Binary Fission	Application: In genetic exchange, genes amplify Plasmids are not necessary, bacteria can live without them





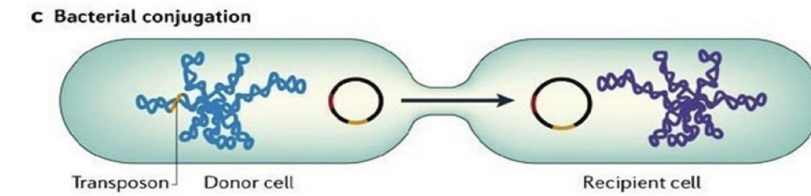
Gene Transfer among Bacteria :



[Transduction](#) and [Conjugation](#) videos for help :)

Ways of gene Transfer among Bacteria

Iodine prevents the easy removal of the crystal violet dye



They transfer through sex pilli

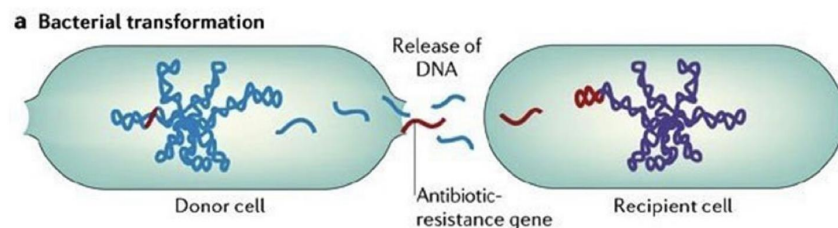
Transformation

Mostly fragments of dead bacteria

A fragment of exogenous **naked bacterial DNA**, are taken up and absorbed into recipient cells

Bacteria becomes resistant to ampicillin

Influenza-Streptococcus-Pneumoniae

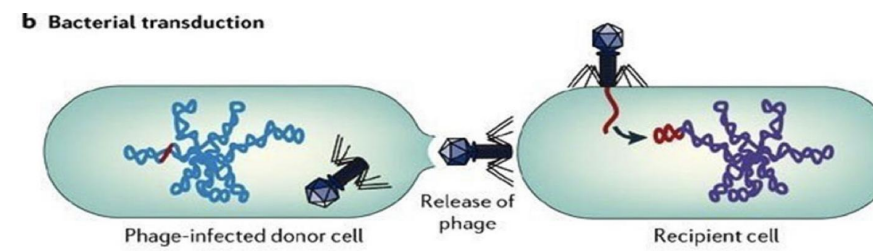


Transduction (phage/virus)

Phage mediated transfer (by virus) of genetic information from donor to recipient cells

Beta-lactamase (enzyme) production in **staphylococcus aureus**: Bacteria becomes resistant to penicillin

Toxin production by **Corynebacterium diphtheria**



Conjugation (Mating)

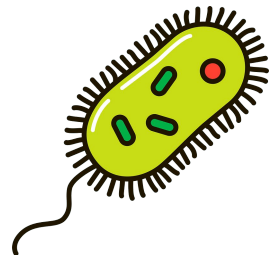
Cell contact is required, and genes reside on plasmid resident within donor cells and transfer to recipient cells (mating)

Common way of transfer of genes resistant to antibiotics among bacteria in hospitals

Plasmids could carry different types of resistance
Plasmids are extrachromosomal DNA

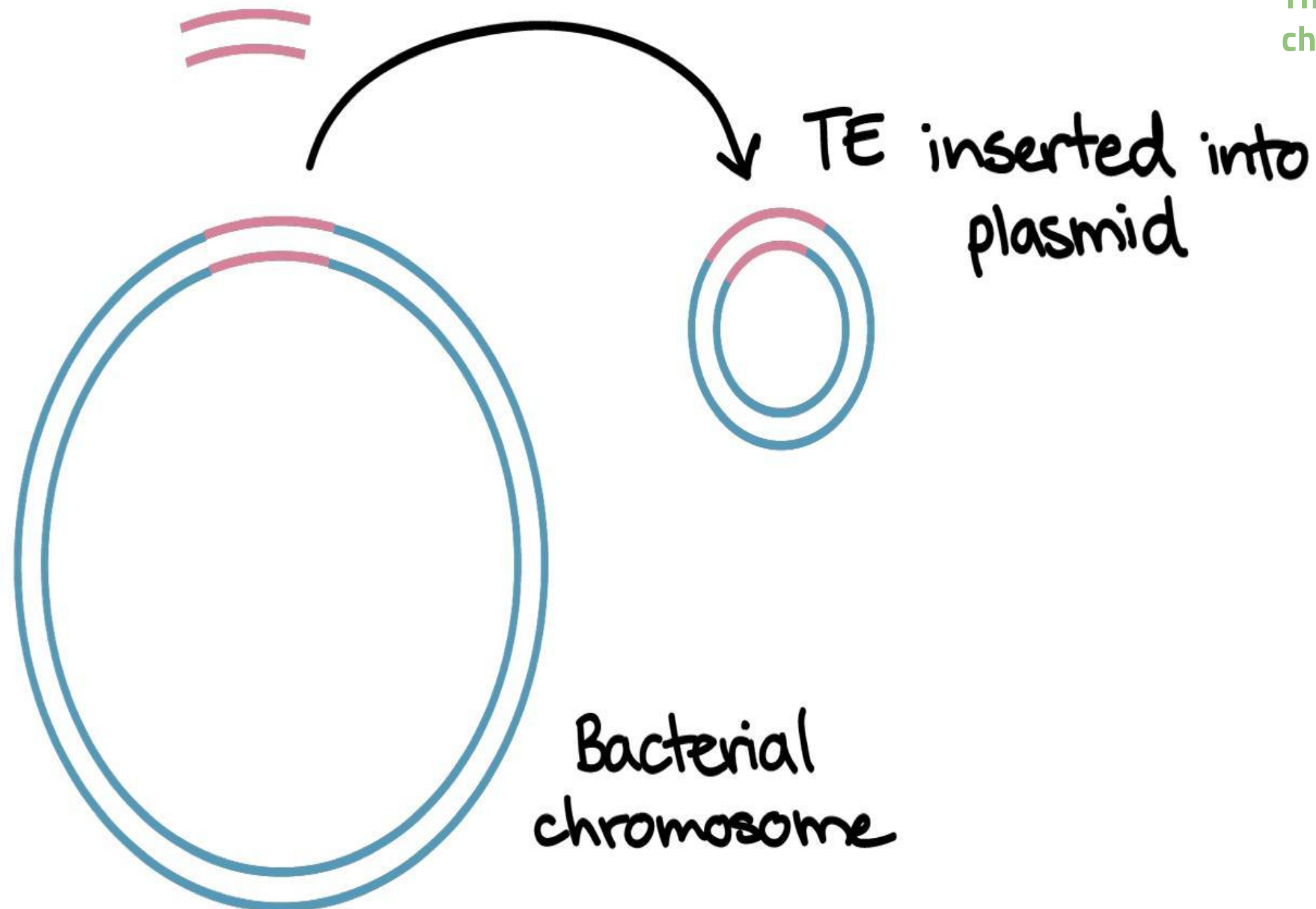
Major way bacteria acquire additional genes

Plasmid mediated F factor



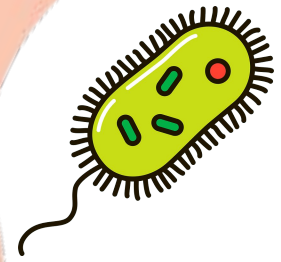
Gene Transfer among Bacteria :

Transposable element (TE)
copied



Transposable Genetic Element
Facilitates transfer

The gene jumps from plasmid to chromosomal and
chromosomal to plasmid



Genetic Recombination :

◆ After Gene transfer there are 3 possible fates:

1 Exogenous **DNA is degraded by nuclease** (enzyme).

2 Stabilized by circularization and becomes plasmid.

3 Forms a particular **Hybrid Chromosome** with segment derived from each source.



Quiz

Q1: Bacterial Spores can survive harsh environmental conditions due to.?

- A Calcium Dipicolinate B Lipoteichoic Acid C Calcium Disodium Edetate D Presence of flagellin protein

Q2: Endotoxins are found in?

- A Outer membrane of gram +ve B Cell wall of gram +ve C Outer membrane of gram -ve D Cell cytoplasm

Q3: What does the gram +ve cell wall contain?

- A Lipid B Porins C Uric acid D Teichoic Acid

Q4: In bacteria, it is the inheritable changes in the structure of genes (DNA)?

- A Inheritable disease B Conjunction C Mutation D Transformation

Q5: Which of the following flagella have a distribution of a tail on both sides ?

- A Monotrichous B Peritrichous C Lophotrichous D Amphitrichous



MEET THE TEAM

Leaders



Members

