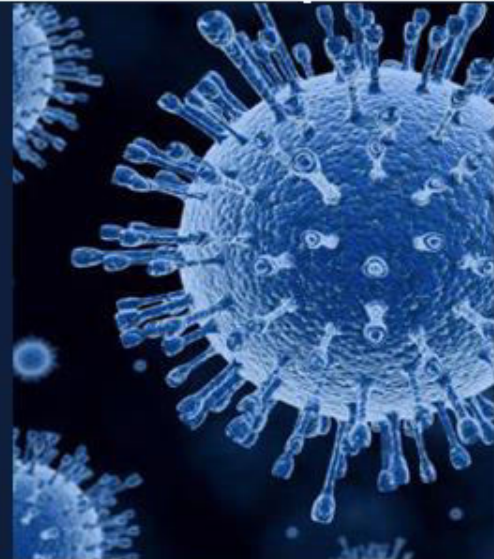
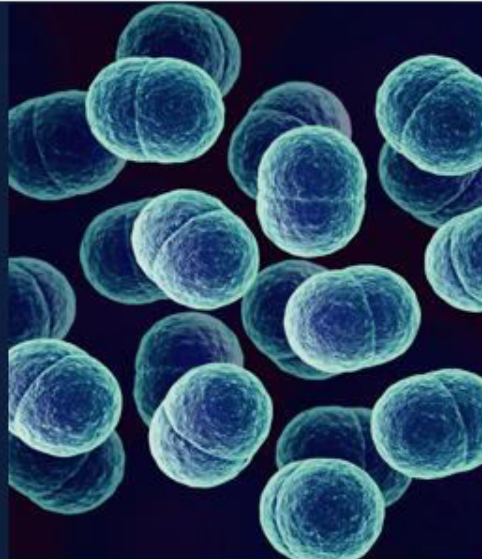
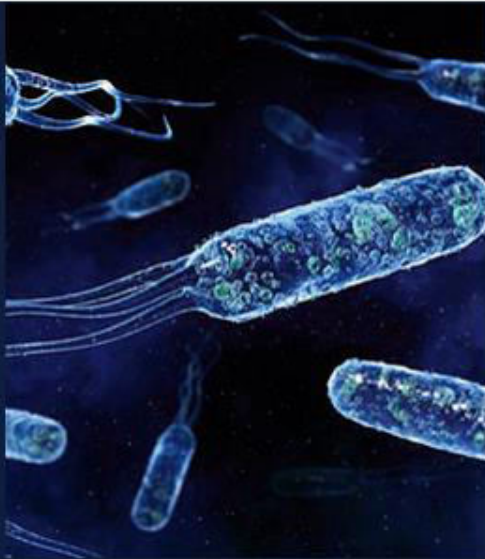


MICRObiology

TEAM 435

هذا العمل لا يغني عن المرجع الأساسي للمذاكرة



Lecture 1

Bacterial Structure and Genetics

● Important

● Term

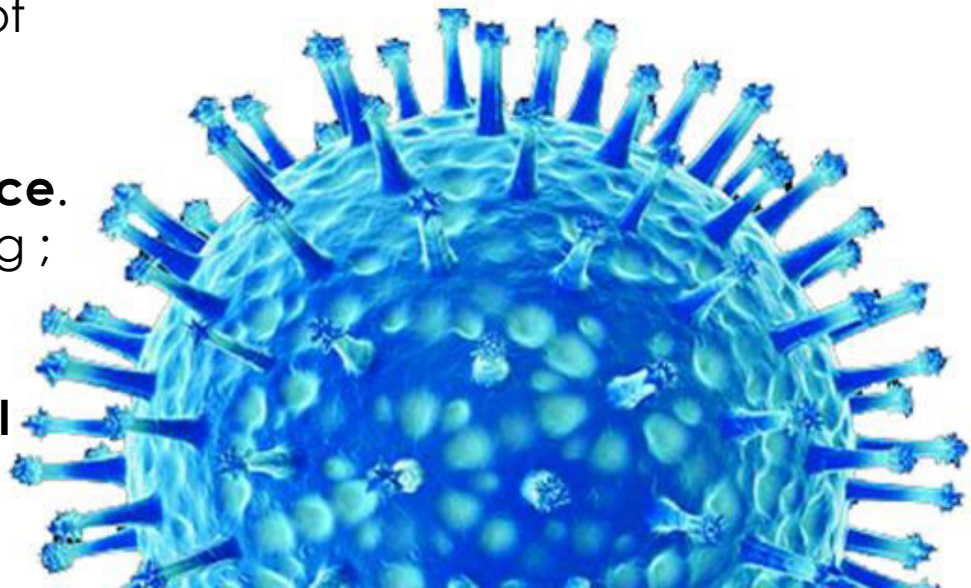
● Extra explanation

● Additional notes

Objectives

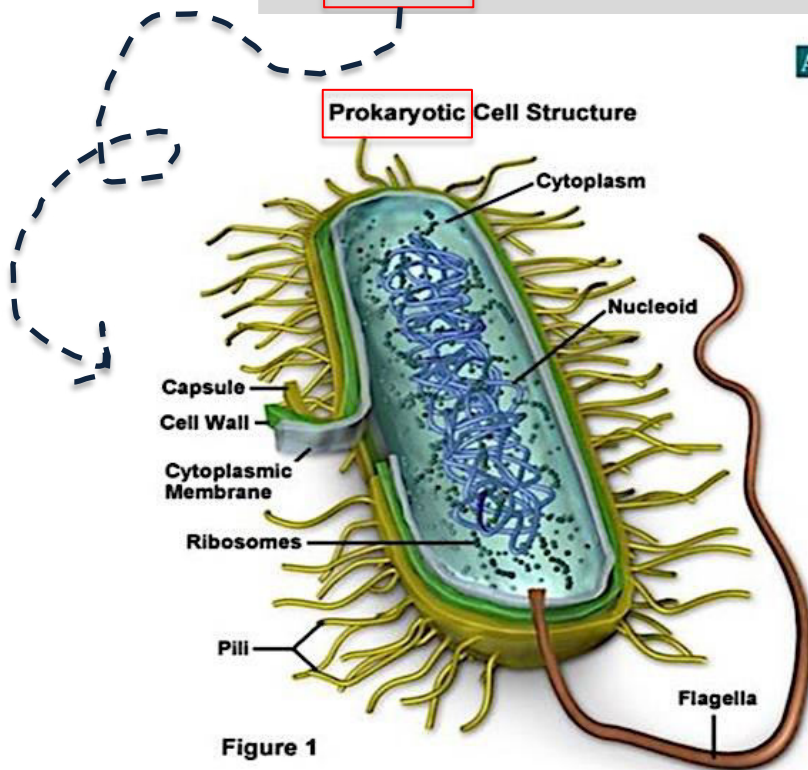


- Define the cellular organization of bacteria and know the **differences between Eukaryotes and Prokaryotes.**
- Know **major structures & functions** of bacteria.
- Know the **structure of cell wall** of bacteria including the **differences between Gram positive and Gram negative bacteria** and main **functions.**
- Know the **external structures** of bacteria with and **functions.**
- Know the **cytosol** and **internal structures** of bacteria .
- Describe **bacterial spores** and its **application in the practice of medicine.**
- Know basic information about **bacterial genetics** and **replication** of bacteria .
- Describe **plasmids** ,its **origin** , **types** and its **importance in clinical practice.**
- Recalls **genetics variations**, including ; **mutation** and mechanisms of **gene transfer** and its implication on bacterial **resistance to antimicrobial agents.**

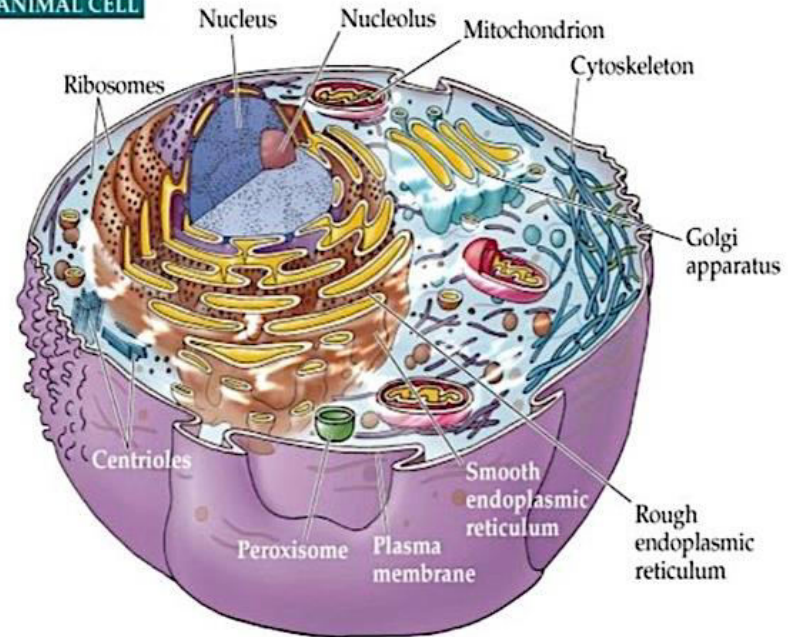


The Difference Between Prokaryote and Eukaryote

Prokaryotic cell	Eukaryotic cell
<p>Size 1-10 μm Always unicellular Has only one chromosome No nucleus Small ribosomes No membranous organelles such as: mitochondria, Golgi apparatus,...etc. Cell wall is present Ex: Bacteria & Archea</p>	<p>Size 10 – 100 μm Often multicellular Has more than > 1 chromosome Central nucleus Larger ribosomes All membranous organelles are Present NO cell wall it is present only in plants Ex: Animals & Plants</p>



AN ANIMAL CELL



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NOTE: This wasn't mentioned in the slides but you should know them because it is written in the objectives.

Characteristics, shapes & arrangements of Bacteria

What is bacteria?

Bacteria is a heterogeneous group of unicellular organisms about 1-8µm in diameter & **ALL BACTERIAS ARE PROKARYOTES**

Characteristics of bacteria

One chromosome

NO mitochondria

NO nuclear membrane

NO sterols

Contains Plasmid (which is an extra piece of DNA)

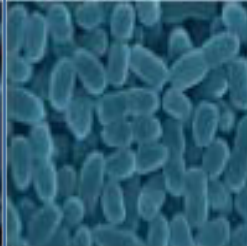
Shapes



Cocci
Spherical /Oval



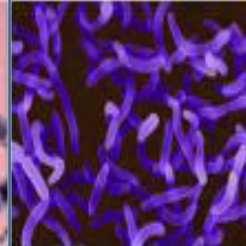
Bacilli
Rods



Coccobacilli
Very short Bacilli



Fusiform
Tapered end



Vibrio
Club-shaped / Curved



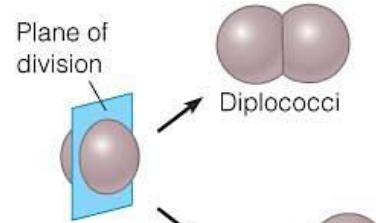
Spirochaetes
Helical / Spiral

Click [HERE](#) for further explanation & pictures about the shapes and arrangements of bacteria

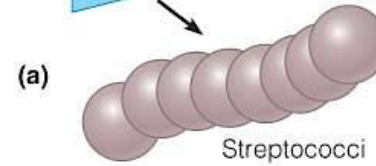
Characteristics, shapes & arrangements of Bacteria

BACTERIAL ARRANGEMENTS

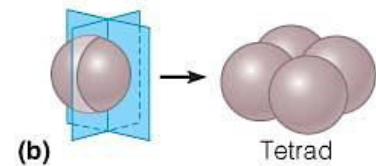
Pairs:
Diplococci



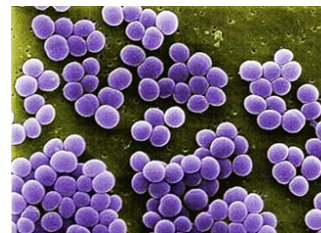
Chains:
Streptococci



In four:
Tetrad



Clusters:
Staphylococci



Palisades :
Corynebacterium



Structures of bacteria

Major Structure: Cell Wall

It's **rigid**, surrounds the **cytoplasmic membrane** and **internal structures**.

the cell wall is made out of peptidoglycan, which gives the cell its **rigidity**.

Not all bacteria have cell walls some are naturally created with **NO** cell walls and they are **pathogenic**.
example: mycoplasma

The Chemical Structure:

Rigid part, mucopeptide composed of alternating strands of **N- acetyl muramic acid** and **N- acetyl glucosamine** linked with **peptide sub units**.

Peptidoglycan

Function

- Rigidity
- Shapes bacteria
- Protection
- Porous / permeable to low molecular weight molecules
- Cell division
- Antigenic determinants

Cell wall

Without the cell wall the bacteria **may die**

peptidoglycan absorbs the **gram stain**

Two groups of bacteria depending on reaction to **GRAM STAIN**.

* عندما تكون سعيد ومرتاح أنت إيجابي + = لون أزرق
* عندما تكون حزين و غضبان أنت سلبي - = لون أحمر
وتنطبق هذه القاعدة على **صيغة حرام**

- **Thin** Peptidoglycan.
- Outer membrane that contains:
 - 1) **Specific proteins (porins)** important in the transport of **hydrophilic molecules**.
 - 2) **Lipopolysaccharide & lipid (ENDOTOXIN)**

endotoxins are only in **gram (-) bacteria**

- Peptidoglycan **thicker** than **Gram negative bacteria**.

- Closely associated with **cytoplasmic membrane**.

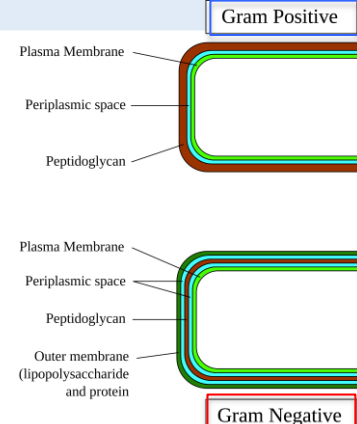
***Teichoic acid** : anchors cell wall to cell membrane , epithelial cell adhesion.

Antigens :

1. **polysaccharides** (Lancefield)
2. **Protein** (Griffith)

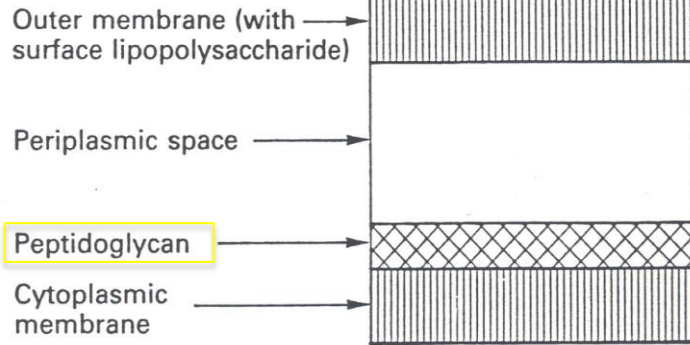
Gram negative - Bacteria
Stain **RED** by Gram stain

Gram Positive + Bacteria
stain **BLUE** by Gram stain



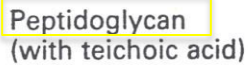
Structures of bacteria

Major Structure: Cell Wall



Gram-negative bacterial cell wall

Thin



Gram-positive bacterial cell wall

Thick

Diagram showing the structure of Gram-negative and Gram-positive bacterial cell walls.

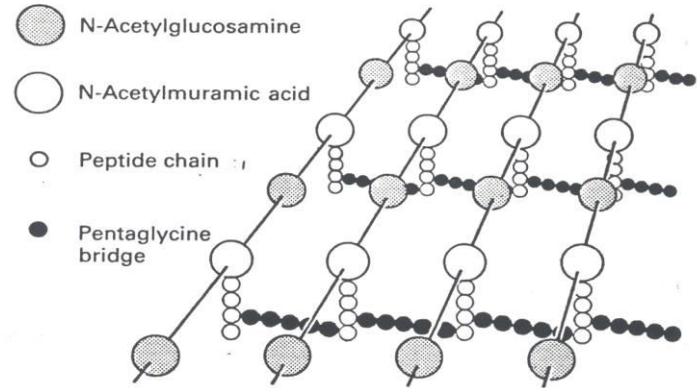
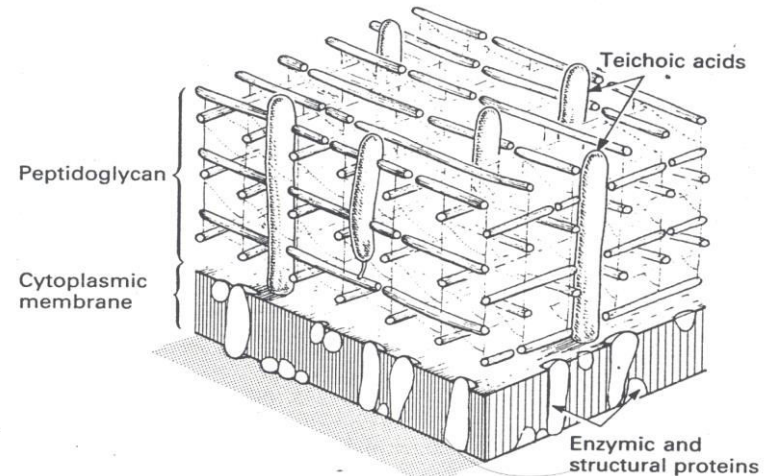


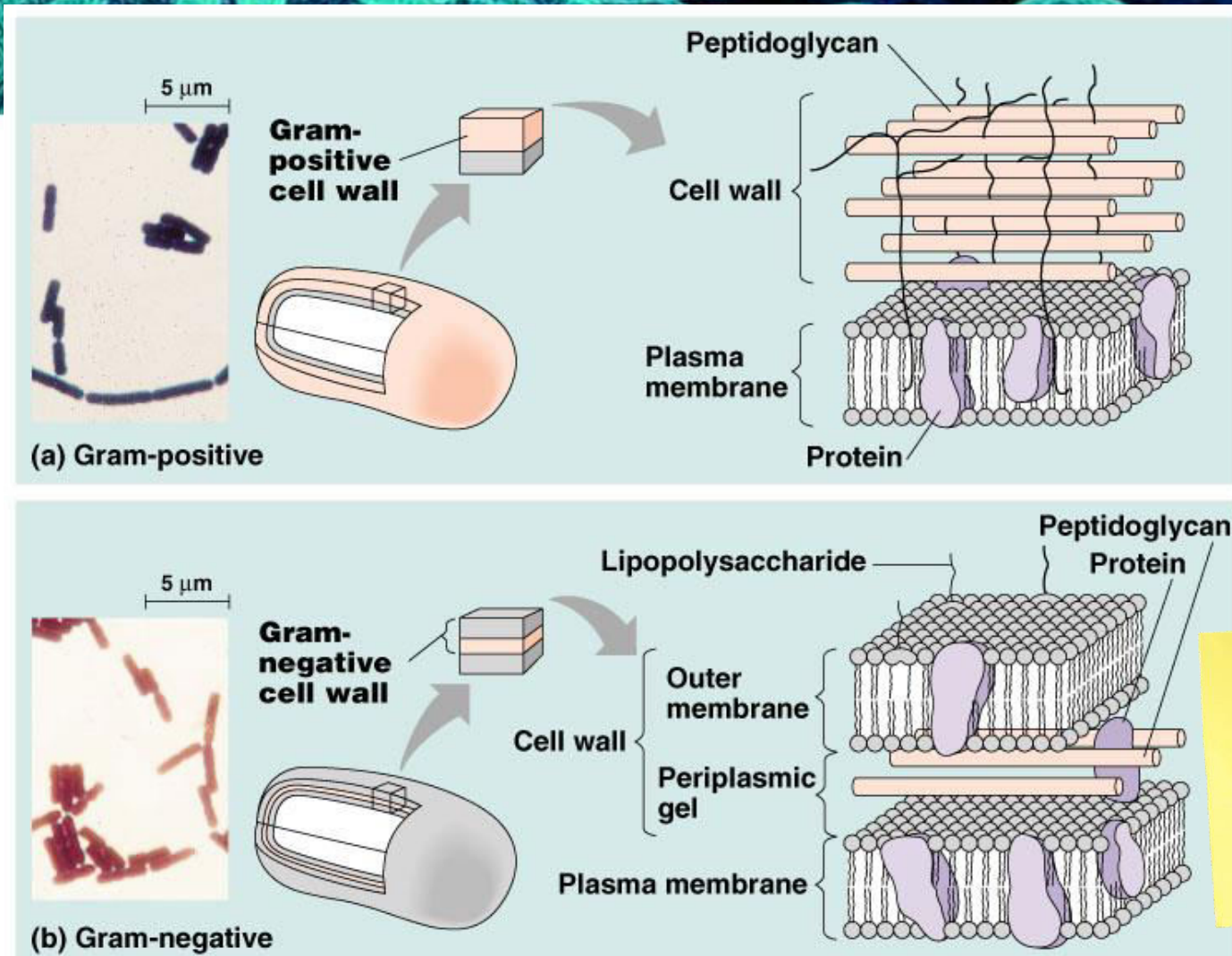
Diagram to show chemical structure of cross-linking in peptidoglycan component of cell walls. From Sharon N The Bacterial Cell Wall. Copyright (C) 1969 by Scientific American Inc. All rights reserved.



Three-dimensional representation of Gram-positive bacterial cell wall.

Structures of bacteria

Major Structure: Cell Wall



Peptidoglycan is 'sandwiched' between the outer and the plasma membranes making the gram-negative bacteria more complex.

Structures of bacteria

External Structure of Bacteria

External protrude from the cell into the environment.:

1) Flagella. 2) Pili 3) Capsule

Distribution:

- Peritrichous
- Monotrichous
- Lophotrichous

- Inhibits **phagocytosis**.
- Acts as **Virulence factor** in some bacteria by assessing **attachment to the surfaces**.

Amorphous material surrounds bacteria.

Usually **polysaccharide**

Occasionally **protein**

3.Capsule

External Structures

1.Flagella

- Composed of protein **FLAGELLIN**.
- **Helical filaments**
- Found in **Gram positive** & **Gram negative** bacteria.

Structure

Basal Body: a **protein** arranged as **rings on central rod** (**4 ring in Gram negative**, **2 ring in Gram positive**).

- **outer pair** of rings: **only in Gram negative**, pushed through **outer membrane**.

- **inner pair of rings**: inserted into peptidoglycan & cytoplasmic membrane.

* **Hook**: bent structure -act as joint

* **Long Filament**: Flagellin protein

* **Function of Flagella**: motility & chemotaxis

Fine short filaments extruding from **cytoplasmic membrane**.

Found on the **surface** of many **Gram negative** & **Gram positive** bacteria.

Composed of **protein Pilin**.

Two classes:

1- **Common pili (fimbriae)**: covers the **surface** responsible for: **adhesion & colonization**

2- **Sex pili**: in some bacteria only, **responsible for conjugation**.

As they adhere or stick to one another, they form colonies.

Cytoplasmic membrane (cell membrane)

Double layered structure composed of **phospholipid & protein**

Act as **semi-permeable** membrane (**passive diffusion**)

Site of numerous enzymes involved in **active transport of nutrients** and **various metabolic processes**

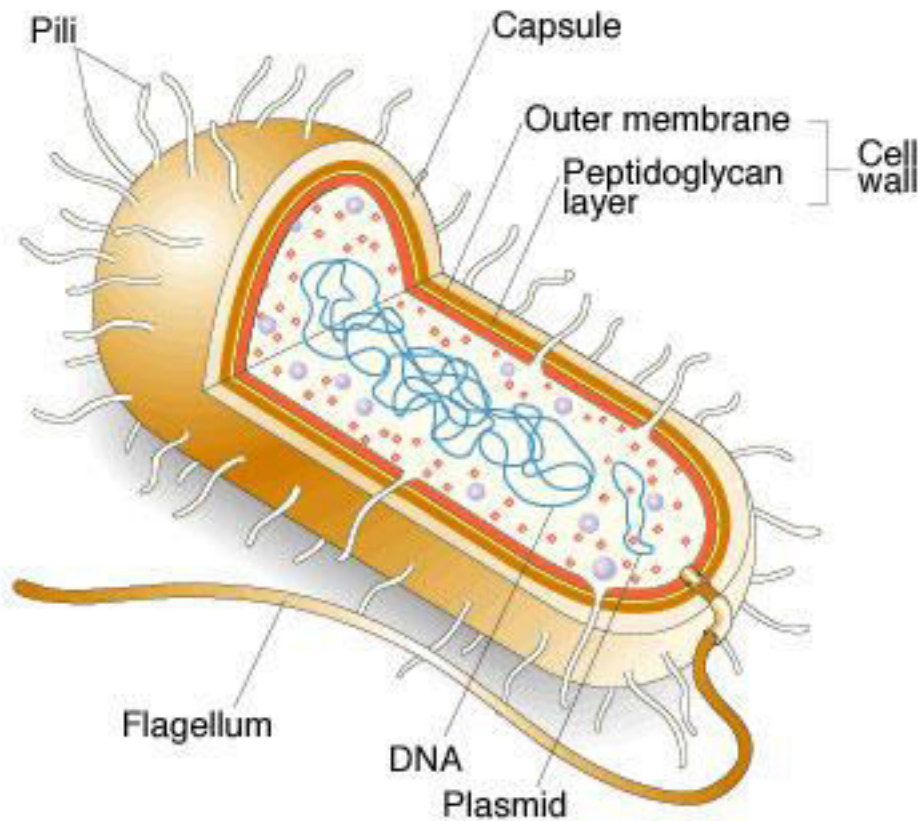
4.Cytoplasmic Membrane

2.Pili

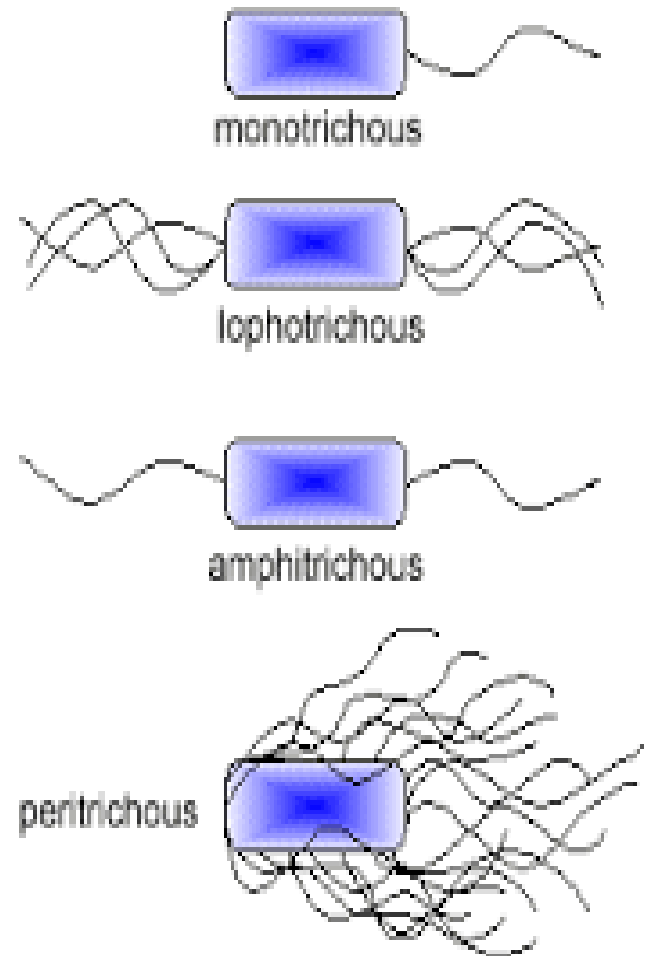
Structures of bacteria

External Structure of Bacteria

Structure of Bacteria



Structure & Distribution of Flagella



Structures of bacteria

Internal Structure of Bacteria

Internal Structures of Bacteria

Mesosomes

convoluted invaginations of cytoplasmic membrane.

Function:

- 1- Involved in **DNA segregation during cell division & respiratory activity**
- 2- Contain **receptors involved in chemotaxis**
- 3- **Permeability barrier** (active transport of solutes).

Cytoplasmic inclusions:

Nutritional storage granules, examples:

- Volutin
- Lipid
- Starch / or Glycogen

Ribosomes

- distributed throughout the cytoplasm
- Site of protein synthesis
- Composed of **RNA and protein**

Core of Bacteria

Nucleoid (Nuclear Body)

- 1- Circular single stranded chromosome (bacteria genome or DNA)
- 2- No nuclear membrane
- 3- DNA undergoes **semi-conservative replication** (bidirectional from a fixed point)

Spores

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

- Enables the bacteria to survive adverse environmental conditions.
- Contain high concentration of **Calcium dipicolonate**.

- **Resistant to heat, dissection & disinfectants**

- Often remain **associated with the cell wall**
- Spores germinate when growth conditions become favorable to produce **vegetative cells**.

Application in medical practice: spore preparations used for checking the efficacy of **Autoclaves**, e.g.. *Bacillus subtilis* & *Bacillus sterothermophilus*

HOW?
By storing genetic material

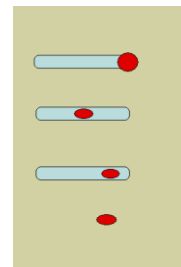
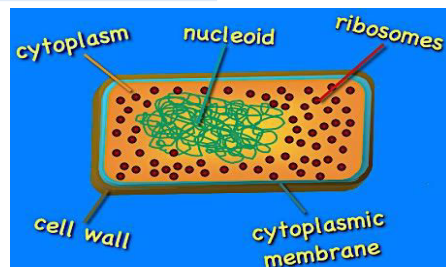
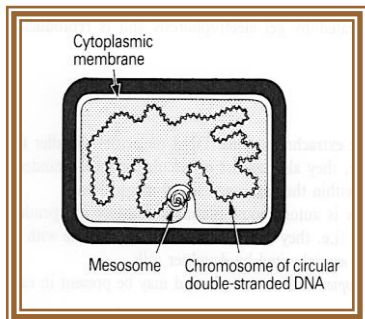
And **Clostridium**

Spores are described as

Terminal spores

Sub-terminal spores

Central spores



Bacterial Genetics

Definitions

What is Genetics? it's the study of inheritance and variation.
Genotype: the complete set of genetic determinants of an organism.

Phenotype: expression of specific genetic material .

Wild type: reference (parent) strain- active.

Mutant: progeny with mutation.

- **Function of genetic material:**
 1. Replication of the genome.
 2. Expression of DNA to mRNA then to protein.
- **Genetic information encoded in DNA.**

Types of DNA in bacteria

Chromosomal

-**Haploid**, circular molecule of double strand DNA attached to cell membrane.

-**No nuclear membrane** (prokaryotes).

-**Replication is semi-conservation.**

-DNA a double helical structure, genetic code in **Purine** and **Pyrimidine** bases of nucleotides that makes > DNA strand.

-bases comprise one code, each triplet codon code for **one** amino acid.

Extra-chromosomal (Plasmid)

-Extra chromosomal DNA **composed of double stranded DNA**.

-Found in **most species** of bacteria.

-**Not known** origin.

-Govern their own replication.

-Transfer by **conjugation**.

-Unrelated plasmids coexist together only.

-**Application** :Genetic exchange, amplify.

R-plasmids

Genes code for antibiotic resistance particularly **Gram negative bacteria**.

Col-plasmids

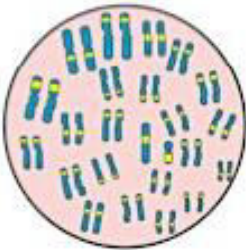
In **Enterobacteria**, codes for extracellular toxins.

F-plasmids

(Fertility) factor, transfer of chromosome during mating.

Bacterial Genetics

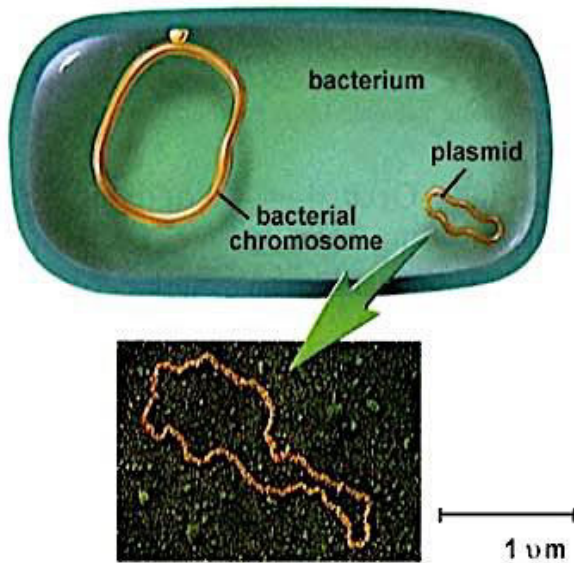
A **genotype** is the genetic makeup of a person



A **phenotype** is the physical manifestation of an inherited trait or disease

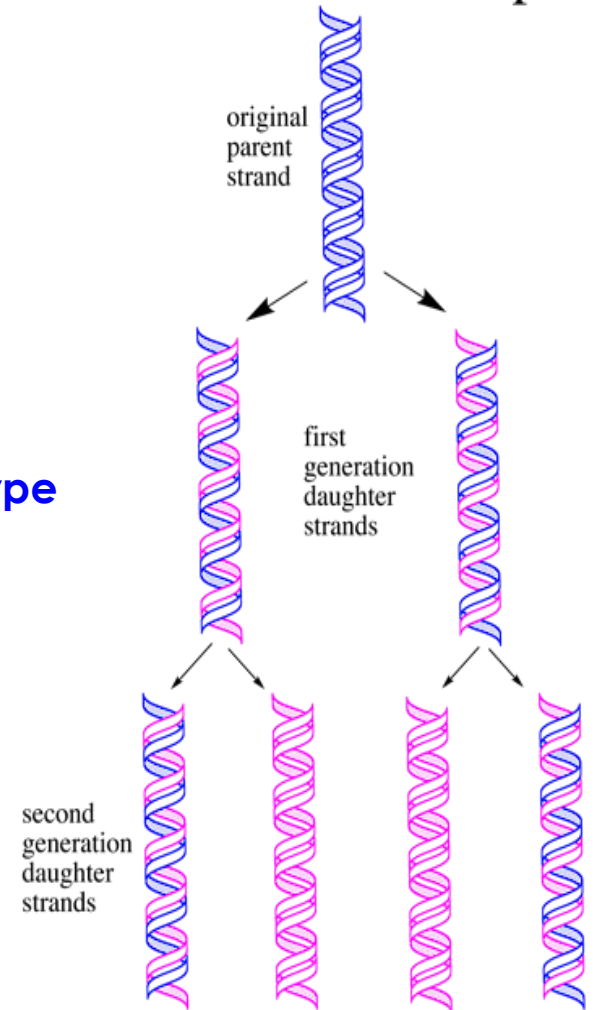


The Difference Between **Genotype & Phenotype**

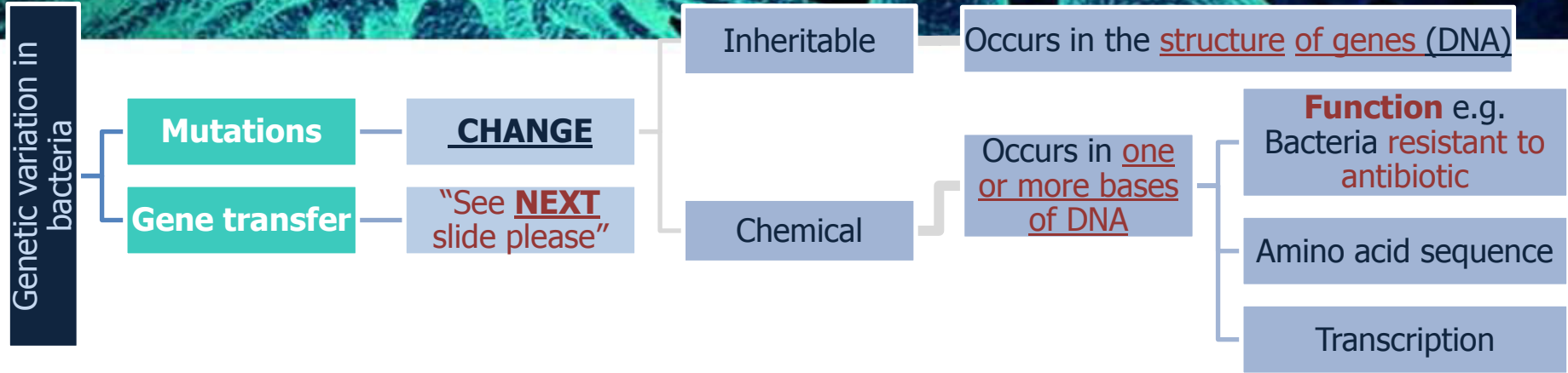


Plasmid

Semiconservative Replication



Genetic Variation



Mutations

Classification of Mutation

Depends on biological sequencing:

1- **Resistance mutation**: affect structure of cell protein. **Main application in medical practice.**

Bacteria become resistant to antibiotics

2- **Auxotrophic mutation**: affect biosynthetic enzyme resulting in a nutritional requirement of mutant cell.

3- **Lethal mutation.**

Gene Transfer

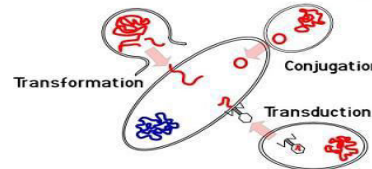
Three mechanisms:

1- **Transformation**

2- **Transduction**

3- **Conjugation.**

Mechanisms of Gene Exchange



Genetic Variation in Bacteria

Genetic Variation

Gene Transfer Among bacteria *THREE* mechanisms:

Transformation

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

Common in

Haemophilus influenzae & *Streptococcus pneumoniae*.

Bacteria become resistant to Ampicillin.

Transduction

Phage mediated transfer of genetic information from donor to recipient cells.

Examples :

Beta – Lactamase production in *Staphylococcus aureus* ; **Bacteria becomes resistant to penicillin.**

Toxin production in *Corynebacterium diphtheriae*.

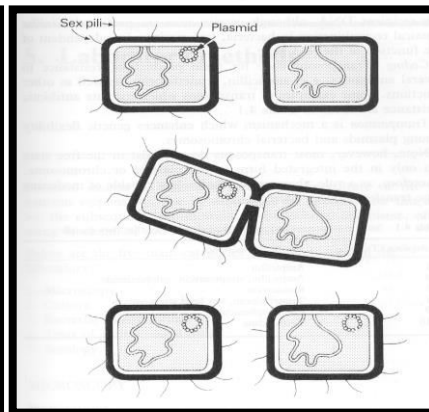
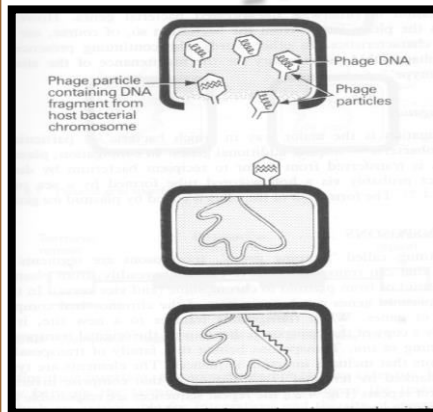
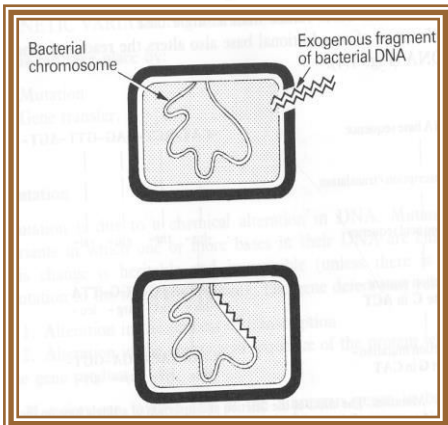
Conjugation

Major way bacteria acquire additional genes; Conjugation is the common way of transfer of genes resistance to antibiotics among bacteria in hospitals.

Plasmid mediated {**F factor** (fertility)};

cell contact required and **genes** reside on plasmid resident within donor cells transfer to recipient cell (**mating**).

Gene encode changes in surface by producing a **sex pilus** .this facilitates capture of F⁻ cells and the formation of a conjugation bridge through which DNA passes from F⁺ into F-cells.



Mutation Causes Antimicrobial Resistance

Genetic Mutation Causes Drug Resistance

Non-resistant
bacteria
exist

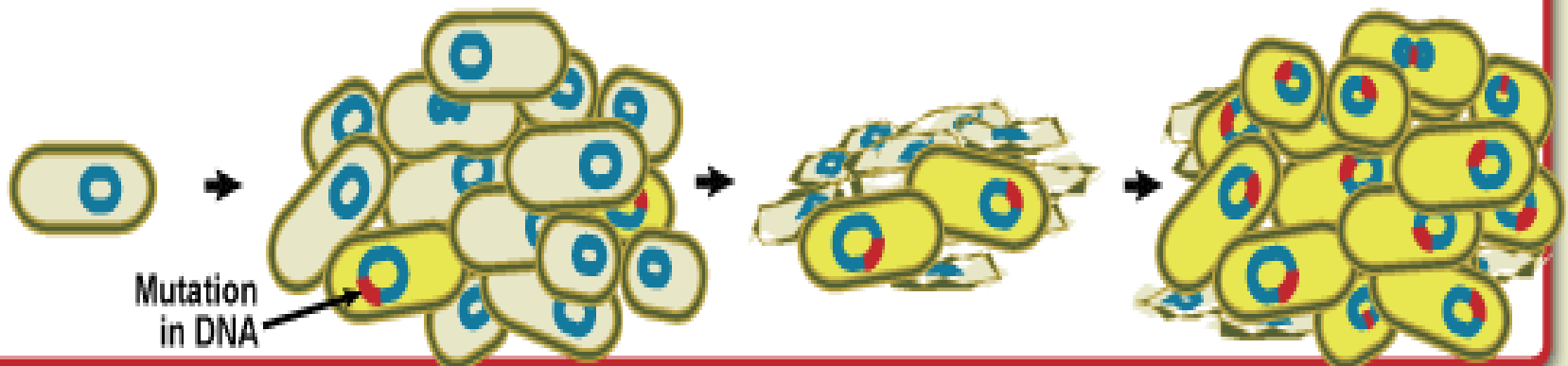
Bacteria
multiply by
the billions

Some mutations
make the bacterium
drug resistant

Drug resistant
bacteria multiply
and thrive.

A few of these
bacteria will
mutate.

In the presence of
drugs,
only drug resistant
bacteria survive.



Genetic Recombination

***After** *gene transfer*, there are

THREE POSSIBLE FATES:

1. Exogenous DNA degraded by nuclease.

2. Stabilized by circulization and become plasmid.

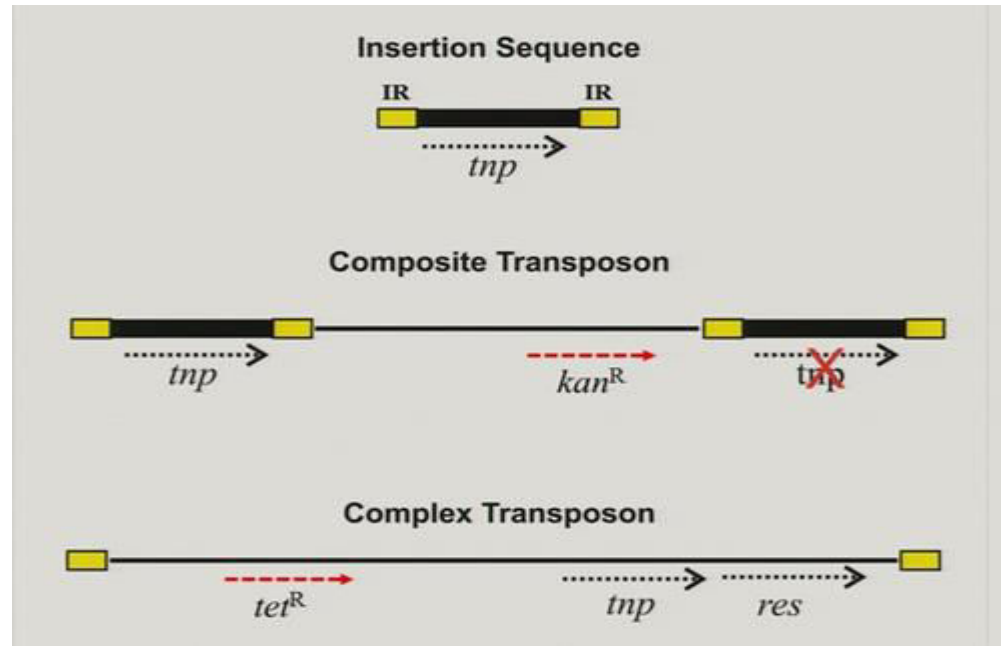
3. Form a partially hybrid chromosome with segment derived from each source.

this is called
“**Genetic Recombination**”

يا ترى الجينات اللي اكتسبتها البكتيريا من الطرق السابقه **إيش مصيرها**؟

1. فيه بجدار الخليه انزيم زي الدفاع للبكتيريا أي حاجه غريبه عنها* ات ول ديقريدها ات* تتخلص منها.
2. ممكن انها هالجين يصير له سيركولاييزيشن ويصير بلازميد* لم يكتشفو من وين جاء البلازميد ويحتمل أن البلازميد جاء من هالشي*!
3. تندمج بالكروموسوم وتكون كروموسوم مهجن اكتسب خواص جينيه من بكتيريا اخرى.

Transposable Elements



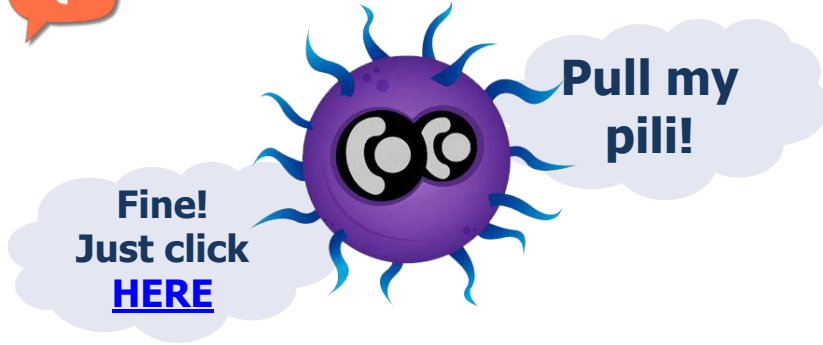
Genetic units capable of mediating own **transfer** from **chromosome to another**, **from location to other on same chromosome** or **between plasmid and chromosome** or **phage DNA**.

Types:

- 1- **Transposons** .
- 2- **Insertion sequence**

*also known as "jumping genes" or transposons, are sequences of DNA that move (or jump) from one location in the genome to another.

Online Quiz



Videos

Bacteria (structure)

<http://youtu.be/fzIKJpcfXfo>

Antibiotics mechanisms of action

<http://youtu.be/IVBCrzjOI40>

Bacteria growth, reproduction classification

<http://youtu.be/7Lh-M-rX86Q>

Books that could help you

- ❖ Microbiology made ridiculously simple
- ❖ Sherris Medical Microbiology



MI**CR**Obiology TEAM 435

We do things better

Boys Team

- Ali Alzahrani
- Khalid Sharahily
- Ahmad Alzahrani
- Zeyad Alsalem
- Muhammad Dossary
- Meshal Alhazmy
- Hamzah Alfiar

Girls Team

- Lamyia Alsaghan
- Nojood Alhaidri
- Monera Alayuni
- Alanoud AlOmair
- Shahad Alenezi
- Amjad Alduhaish
- Aisha Al-Sabbagh
- Bodour Julaidan
- Noura AlTawil
- Deema AlFaris
- Sara Al-Hussein
- Suha Alenezy
- Latifah Alsukait
- Dalal Alhuzaimi
- Reema Allhaidan

Girls power!



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Contact us!