

Bacterial Structure & Genetics

***Important**

***Further explanations**



LECTURE ONE

OBJECTIVES:

Define the cellular organization of bacteria and know the differences between Eukaryotes and Prokaryotes. ○

Know major structures of bacteria and its functions. ○

Know the structure of cell wall of bacteria including ; chemical structure , the differences between Gram positive and Gram negative bacteria and main functions. ○

Know short encounter on the bacteria with defective cell wall. ○

Know the external structures of bacteria with and functions (flagella, pill and capsule). ○

Know the cytosol and internal structures of bacteria including ; cytoplasmic membrane ,nucleoid, ribosomes and cytoplasmic inclusions ○

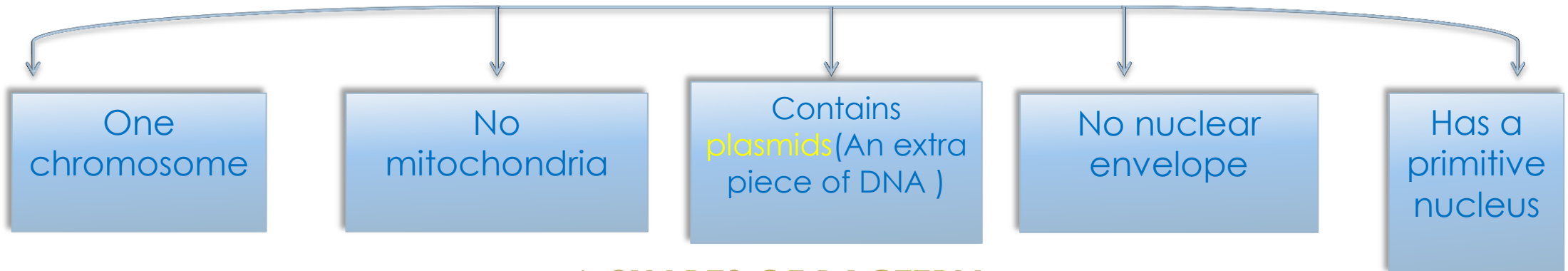
Describe bacterial spores , its chemical structure, function, types and its application in the practice of medicine. ○

OBJECTIVES:

- Know basic information about bacterial genetics and the meaning of different terminologies. ○
- Know the types of bacterial DNA . ○
- Know brief information about replication of bacteria and bacterial cell division. ○
- Define plasmids, its origin , types and importance ○
- Recalls genetics variations, including ; mutation and types of gene transfer. ○
- Application on bacterial resistance to antimicrobial agents. ○

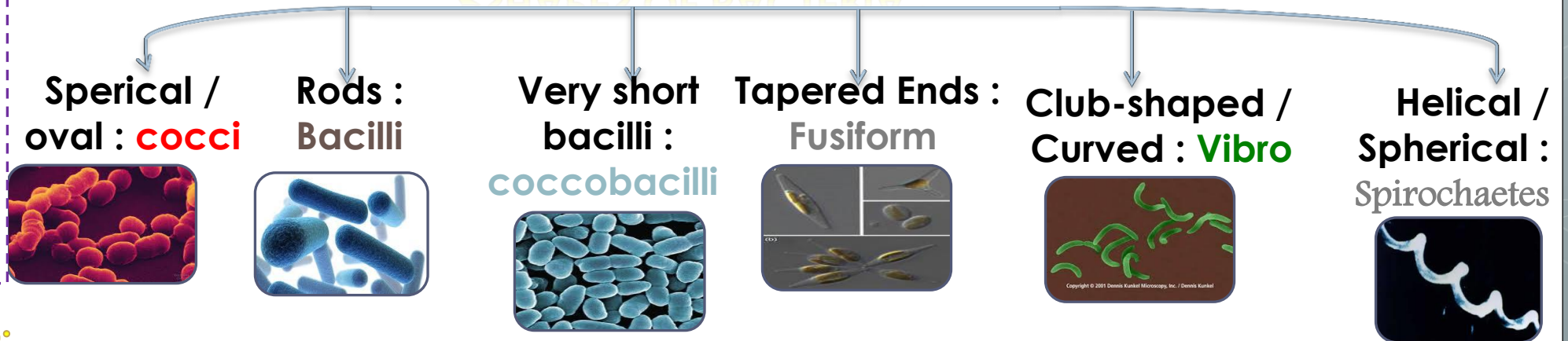
- ▶ Bacteria : Cells that have a well-defined nucleus are called **EUKARYOTES** , whereas cells that **LACK** a nucleus are called **PROKARYOTES** . **ALL BACTERIA ARE PROKARYOTES** .

➤ CHARACTERISTICS OF BACTERIA :



➤ SHAPES OF BACTERIA :

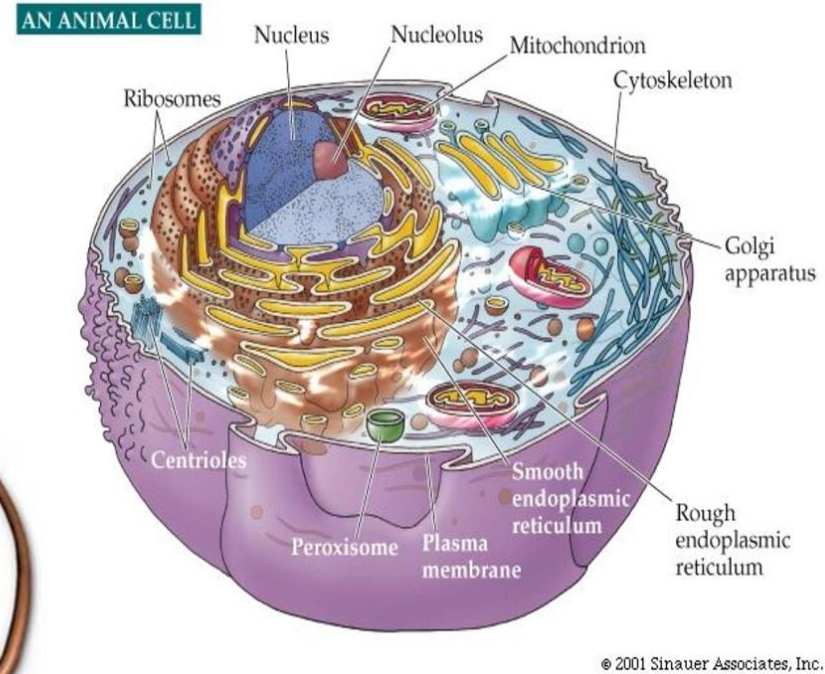
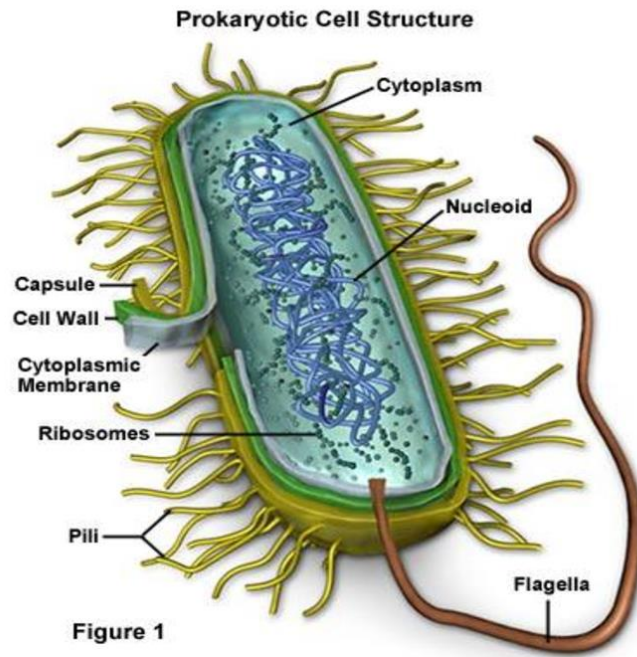
We use those Latin names when we're describing the bacteria under the microscope.



VIDEO:

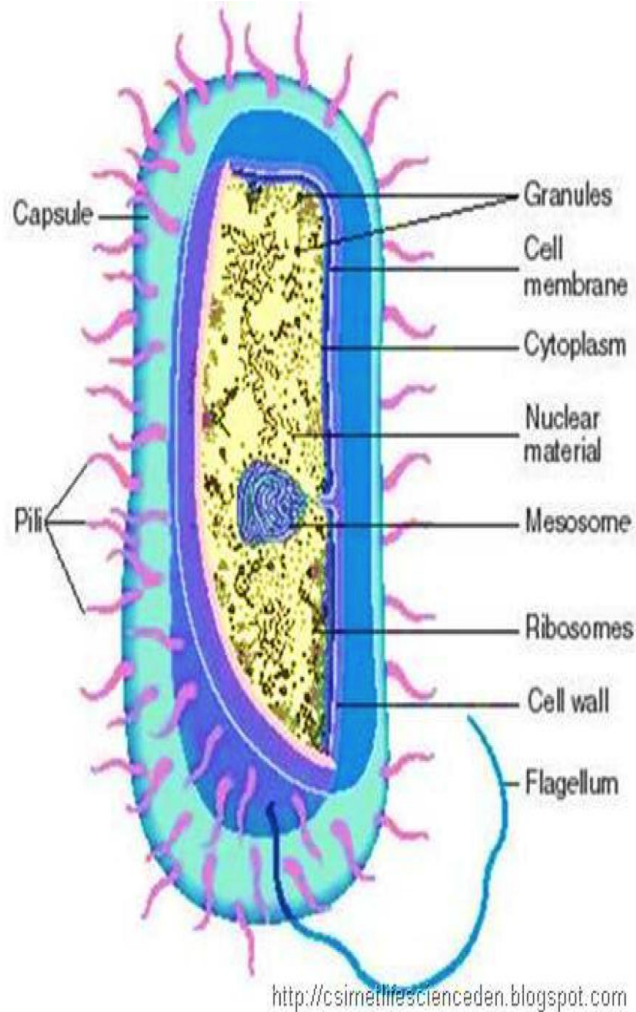
http://www.youtube.com/watch?v=fzIKJpcfXfo&list=UUesNt4_Z-Pm41RzpAClfVcg

Prokaryotic vs Eukaryotic Cells



Kathleen Park Talaro and Arthur Talaro, *Foundations in Microbiology*, 3e Copyright © 1999 The McGraw-Hill Companies, Inc. All rights reserved.

Bacterial shapes and arrangements



<p>Coccus</p>		<p>Rod, or Bacillus</p>		<p>Curved forms: Spirillum/Spirochete</p>
<p>Diplococci (cocci in pairs)</p>	<p>Neisseriae (coffee-bean shape in pairs)</p>	<p>Coccobacilli</p>		<p>Vibrios (curved rods)</p>
<p>Tetrads (cocci in packets of 4)</p>	<p>Sarcinae (cocci in packets of 8, 16, 32 cells)</p>	<p>Mycobacteria</p>	<p>Corynebacteria (palisades arrangement)</p>	<p>Spirilla</p>
<p>Streptococci (cocci in chains)</p>	<p>Micrococci and staphylococci (large cocci in irregular clusters)</p>	<p>Spore-forming rods</p>	<p>Streptomycetes (moldlike, filamentous bacteria)</p>	<p>Spirochetes</p>

STRUCTURES OF BACTERIA :

*CELL WALL :

- The cell wall is the most important part of Bacteria and is mostly

Made-up of : **PEPTIDOGLYCAN**

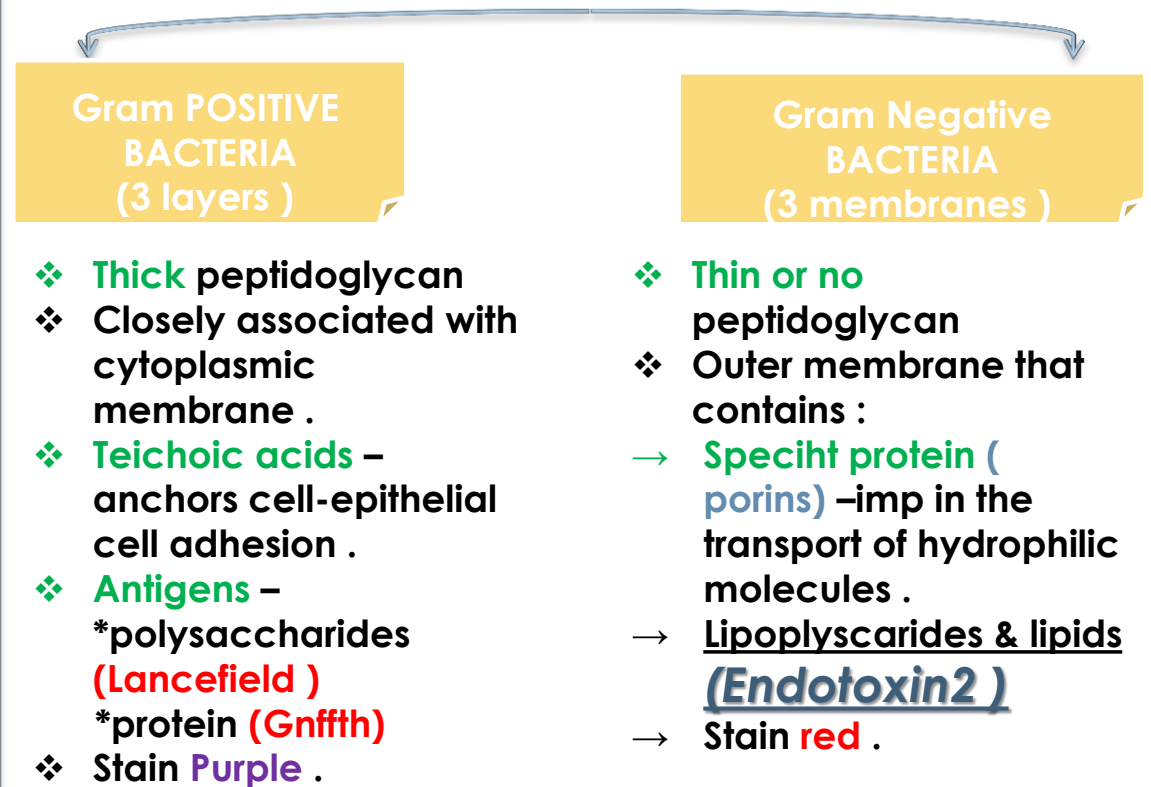
The most important chemical structure of bacteria.

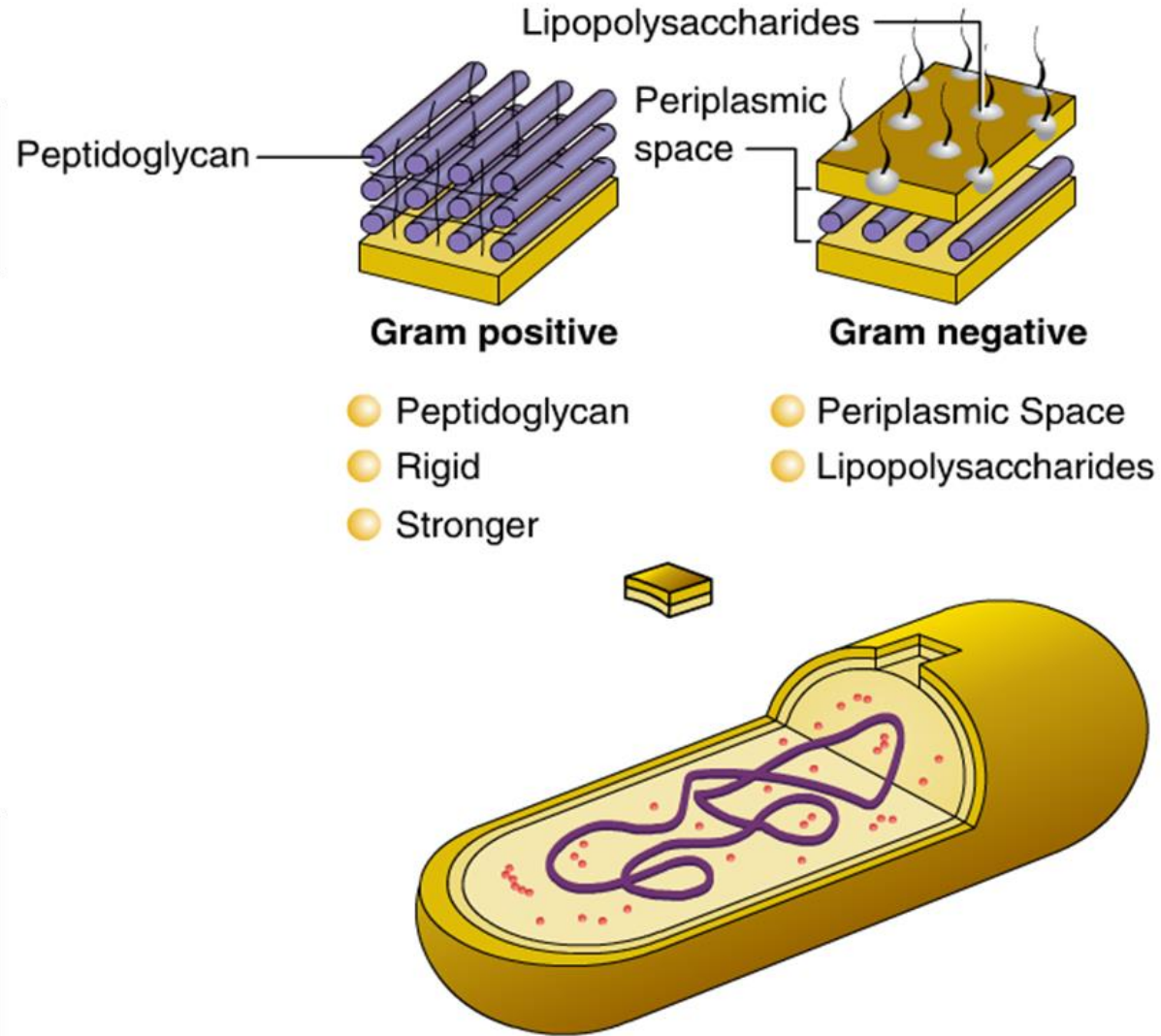
- The functions of cell wall are :

1. Rigidity .
2. Gives the bacteria its shape .
3. Protection .
4. Cell division .
5. Porous (**preamble to low molecular weight molecules**) .
6. Antigenic¹ determinants .

*CHEMICAL STRUCTURE OF CELL WALL IN BACTERIA:

Based on its reaction to **Gram Stain** it is divided into two groups :





STRUCTURES OF BACTERIA :

BACTERIA WITH DEFECTIVE CELL WALL:

Mycoplasma: natural , stable, NO peptidoglycan.
Some species of *Mycoplasma* are pathogenic .

EXTERNAL STRUCTURE OF BACTERIA :

These structures are extended from the cell into the environment .

1- Flagella¹ :

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

- Peritrichous - - - - - Around all the bacteria
- Monotrichous . - - - - - Only one
- Lophotrichous - - - - - Few at one pore

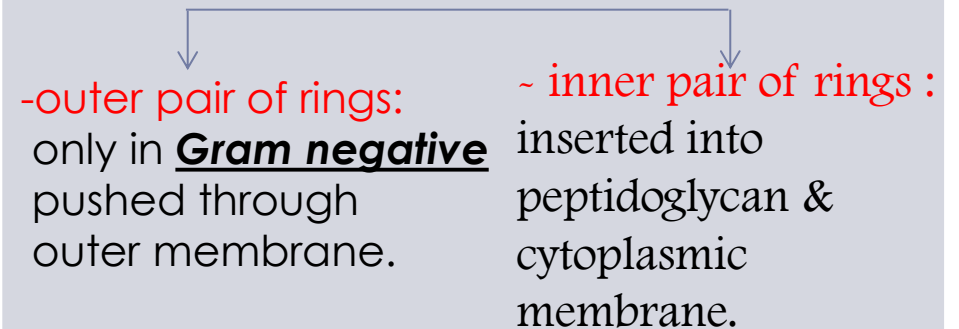
Function of Flagella:

- 1- Motility.
- 2- Chemotaxis

No cell wall can't be stained

Structure of Flagella

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



Hook : bent structure -act as joint

Long Filament : Flegellin protein

STRUCTURES OF BACTERIA :

EXTERNAL STRUCTURE OF BACTERIA :

2 – Philli :

- ❑ Fine short filaments extruding from cytoplasmic membrane.
- ❑ Found on the surface of many Gram negative & Gram positive bacteria.
- ❑ Composed of protein **Pilin**.

1/ **Common pili (fimbriae):**

- covers the surface
- responsible for: **adhesion & colonization**

2/ **Sex pili :**

- in some bacteria only
- responsible for **conjugation.**

STRUCTURES OF BACTERIA :

EXTERNAL STRUCTURE OF BACTERIA :

3 – Capsule¹ : → Without a clearly defined shape

- ❖ Amorphous material surrounds bacteria.
- ❖ Usually polysaccharide .
- ❖ Occasionally protein .

Capsule differ from bacteria to another. Some have thick capsule others have thin.

- Cytoplasmic membrane (cell membrane) :
 - Double layered structure composed of phospholipid & protein .
 - Act as semi- permeable membrane (passive diffusion) .
 - Site of numerous enzymes .

Functions of Capsule :

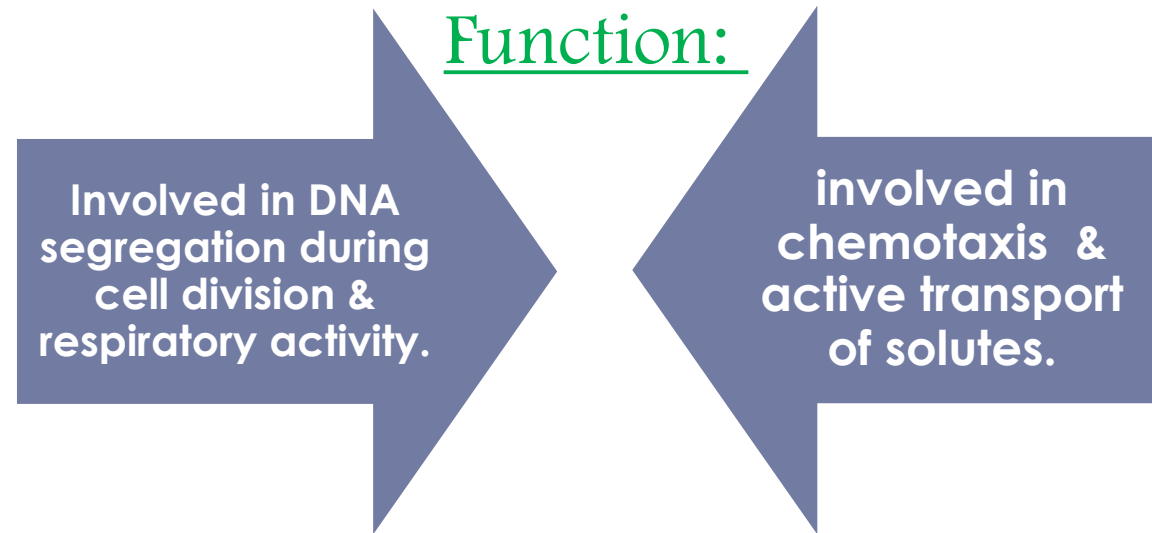
Inhibits phagocytosis

Acts as Virulence factor in some bacteria by assessing attachment to the surfaces.

STRUCTURES OF BACTERIA :

INTERNAL STRUCTURE OF BACTERIA :

1 -Mesosomes : convoluted invaginations of cytoplasmic membrane.



2- Core :

- Composed of :
- **1- Cytoplasmic inclusions:** (Nutritional storage granules) eg:
 - Volutin
 - Lipid
 - Starch / or Glycogen

3-Nucleoid .

4-Ribosome .

STRUCTURES OF BACTERIA :

INTERNAL STRUCTURE OF BACTERIA :

Ribosomes are scattered inside the bacteria as there is no ER

3 Ribosomes

- Distributed throughout the cytoplasm.
- Site of protein synthesis.
- Composed of RNA and protein .

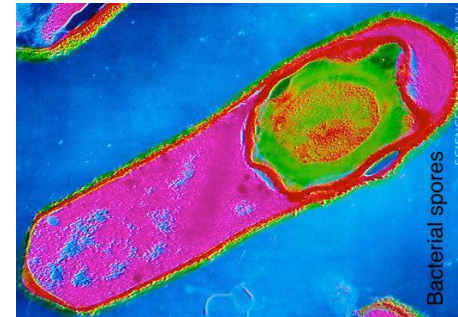
4 Nucleoid (nuclear body)

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

STRUCTURES OF BACTERIA :

INTERNAL STRUCTURE OF BACTERIA :

5- Spores¹ Not All Bacteria Has Them.



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

Enables the bacteria to survive adverse environmental conditions.

Contain high con. of **Calcium** .

Resistant to heat (over 100C) , dissection & disinfectants.

Often remain associated with the cell wall.

Described as :

1-
Terminal
spores

2- Sub-
terminal
spores

3-
Central
spores

BACTERIAL GENETICS

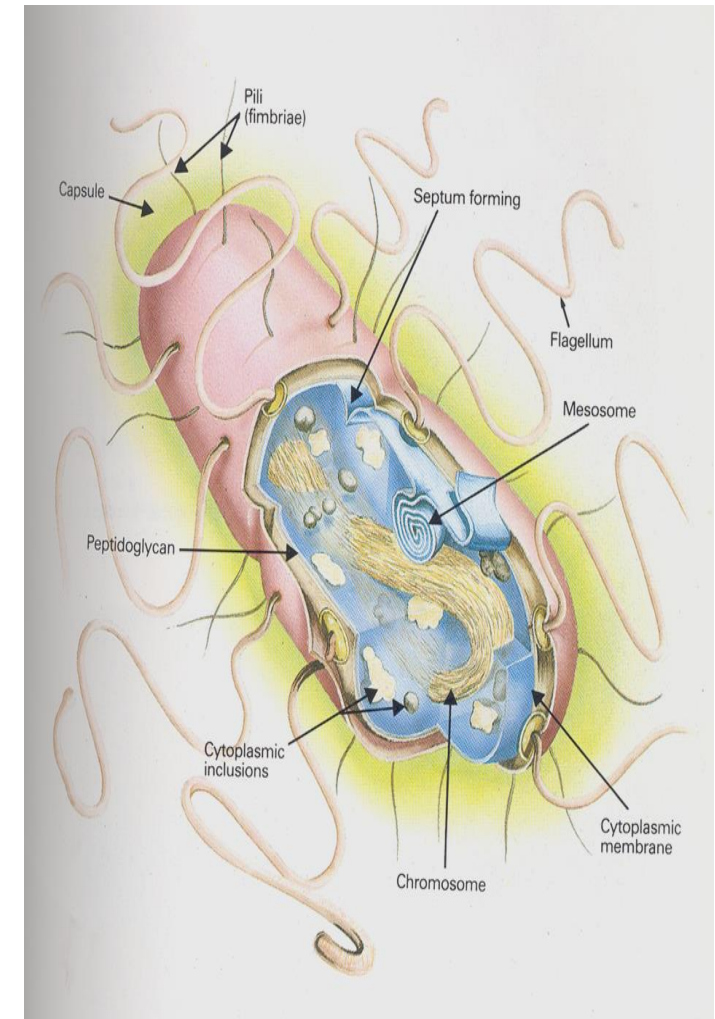
DEFINITIONS :

- Genetics is the study of inheritance and variation.
- Genetic information encoded in DNA.

Function of genetic material:

- 1- **Replication** of the genome.
- 2- **Expression** of DNA to mRNA then to protein.

<u>Genotype:</u>	the complete set of genetic determinants of an organism.
<u>Phenotype:</u>	expression of specific genetic material under particular set of growth condition.
<u>Wild type (active) :</u>	The allele that encodes the phenotype most common in a particular natural population , any form of that allele other than wild type is known as Mutant (inactive) type from that allele .



BACTERIAL GENETICS

BACTERIAL DNA 2 TYPES :

- Chromosomal

Extra-chromosomal
(plasmid).

BACTERIAL CHROMOSOME :

Replication is semi-conservative

- Haploid, circular molecule of double strand DNA attached to cell membrane. **No nuclear membrane (prokaryotes).**
- **Replication is semi-conservative.**

PLASMID :

- Extra-chromosomal **DNA** composed of **double stranded DNA**.
- No known **Origin**
- Govern their **own replication**
- Bacteria can **live with out it** only add some functions to certain bacteria (**Accessory**)
- Very useful in medical engineering .

*Plasmid id the same as the DNA, but it's not important as much as the DNA is. Like an accessory. Bacteria can live and function without it.
* Plasmid id very useful for medical engineering.

BACTERIAL GENETICS

TYPES OF PLASMID :

1- R-plasmids:

genes code for antibiotic resistance in Gram negative bacteria.

2-Col-plasmids:

in Enterobacteria, codes for extracellular toxins.

3- F-plasmids:

(fertility) factor
Ex: F^- becomes F^+

GENETIC VARIATION IN BACTERIA :

Mutation

Gene transfer

GENETIC VARIATION IN BACTERIA : MUTATION

- Inheritable changes in the structure of genes (DNA).
- Chemical changes in one or more bases of DNA.
- Result in gene defect.
- Mutation changes the features of the bacteria. That's how we know if there are bacteria or not.

- Inactive mutated form is a **mutant allele versus active wild type allele.**

*Classification of mutations : Depending on biological sequencing:

1- Resistance mutation:

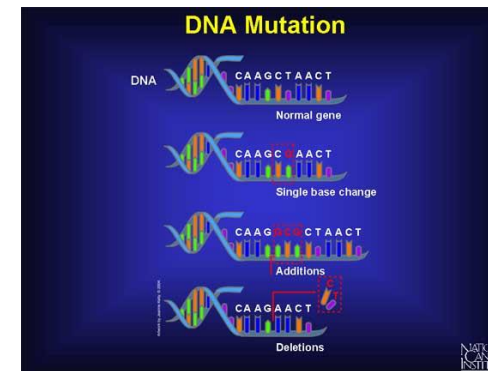
affect structure of cell protein.

2- Auxotrophic mutation:

affect biosynthetic enzyme resulting in a nutritional requirement of mutant cell.

3- Lethal mutation.

It can kills the bacteria



VIDEO :

<http://www.youtube.com/watch?v=qxXRKVompl8>

GENETIC VARIATION IN BACTERIA :

RESULT OF GENE DEFECT :

Could result in alteration of :

- Transcription.
- Amino acid sequence.
- Function e.g.: **Antibiotic resistance** or **Lethal:** undetected mutation.
- **Types :**
- Base substitution(**replacemen**) .
- Deletion
- Insertion
- Inversion
- Duplication (**common**)

GENE EXCHANGE :

Three types:

- **1- Transformation**
- **2- Transduction**
- **3- Conjugation.**

ALL
EXAMPLES OF
THESE ARE
IMPORTANT!!!

TRANSFORMATION :

It is the transfer of genes from one cell to another cell by means of naked DNA .

Common in :

- 1- **Haemophilus influenza**
Streptococcus pneumonia .

GENETIC VARIATION IN BACTERIA :

GENE TRANSFER :

TRANSDUCTION :

Transfer of genes from one cell to another via a **PHAGE¹ FACTOR** (virus) .

- **Beta – lactamase production in *S. aureus*.**
- **Toxin production in *Corynebacterium diphtheriae*.**

CONJUGATION :

COMMON

- The process by which bacteria transfer genes from one cell to another by **Cell to cell contact** *mating*
- Plasmid mediated .
- Differs between **Gram +** and **Gram -** .

Gram + :

- It involves clumping of cells and secretion of **pheromones**.

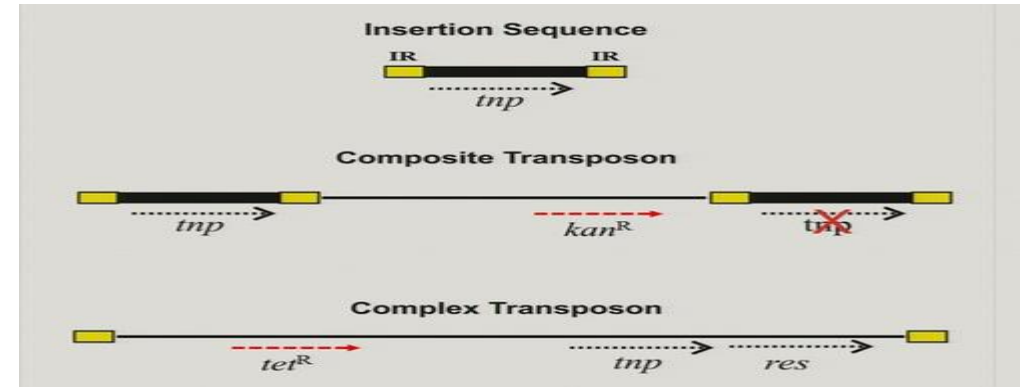
Gram- :

- Mediated by plasmid called **F factor (fertility)**.
- Gene encode changes in surface by producing a **sex pilus**

GENETIC RECOMBINATION:

AFTER GENE TRANSFER THERE ARE 3 FATES :

- 1-Exogenous DNA degraded by nuclease.
- 2-Stabilized by circulation, become plasmid.
- 3- Form a partially hybrid chromosome with segment derived from each source.



TRANSPOSABLE ELEMENTS :

Jumping genes

- IS the DNA sequence that can change its position with in the genome , so sometimes Creating or Reversing **MUTATION** and altering the cells genome size "Jumping Genes".
- **Types:** 1- Transposons.
2- Insertion sequence.

Thank you

قال تعالى: (وَمَا تُنْفِقُوا مِنْ خَيْرٍ
 فَلَا تُفْسِدْهُمُ وَمَا تُنْفِقُونَ إِلَّا ابْتِغَاءَ
 وَجْهِ اللَّهِ وَمَا تُنْفِقُوا مِنْ خَيْرٍ
 يُوَفِّ إِلَيْكُمْ وَأَنْتُمْ لَا تُظْلَمُونَ)

DONE BY:



- Alhanouf AlMohanna



- AlJouhara AlDahsh



- Abudalaziz AlMani



- Amal Afrah



- Aya AlDayel



- Deema AlRajhi



- Dhaherah AlJohani



- Hanan Khoshaim



- Jawaher AlOmran



- Manal AlHamdan



- Nouf AlMasood



- Rawa AlOhali



- Reema Hazazi



- Reema AlHammad



- Wajda AlHathali

MCQ's

Spherical shaped bacteria are called: ○

a) Bacilli b) Vibrio c) Cocci

Fine short filament extruding from cytoplasmic membrane: ○

a) Flagella b) Pili c) Cilia

Sex Pili are responsible for: ○

a) Conjugation b) Motility c) Digestion

Cytoplasmic membrane of bacteria act as membrane: ○

a) Permeable b) Selective c) Semi permeable

Which of the following is involved in DNA segregation and respiratory activity? ○

a) Mesosomes b) Ribosomes c) Spores

MCQ's

The site of protein synthesis: ○

a) Ribosomes b) Cell membrane c) Pilli

..... enables the bacteria to survive adverse environmental conditions: ○

a) Spores b) Nucleoid c) Cytoplasmic inclusion

The complete set of genetic determinants of an organism is its: ○

a) Wild type b) Genotype c) Phenotype

Inactive mutated form is a wild type allele. ○

a) T b)F

Transformation:A fragment of exogenous naked bacterial DNA are taken up and absorbed into recipient cell. ○

a) T b)F

Additional info. And References :

superscripted words are found in the notes down below. ●

Videos ●

<http://www.youtube.com/watch?v=qxXRKVompl8> ●

http://www.youtube.com/watch?v=fzIKJpcfXfo&list=UUesNt4_Z-Pm41RzpAClfVcg ●