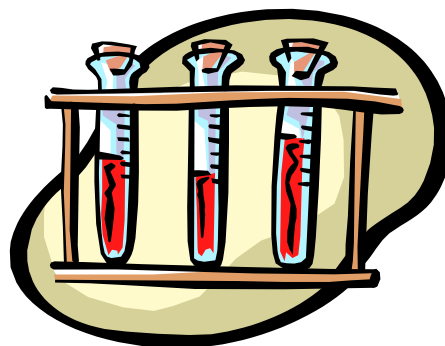


# General Bacteriology



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2012

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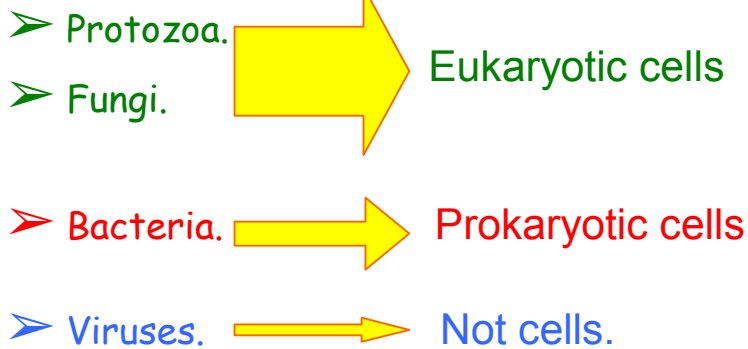


# INTRODUCTION

## ★ Microbiology:

The study of living organisms of microscopic size.

### ⇒ The microorganisms of medical importance:



## Classification of bacteria

### THE OLD SYSTEM:

#### (I) ACCORDING TO MORPHOLOGY:

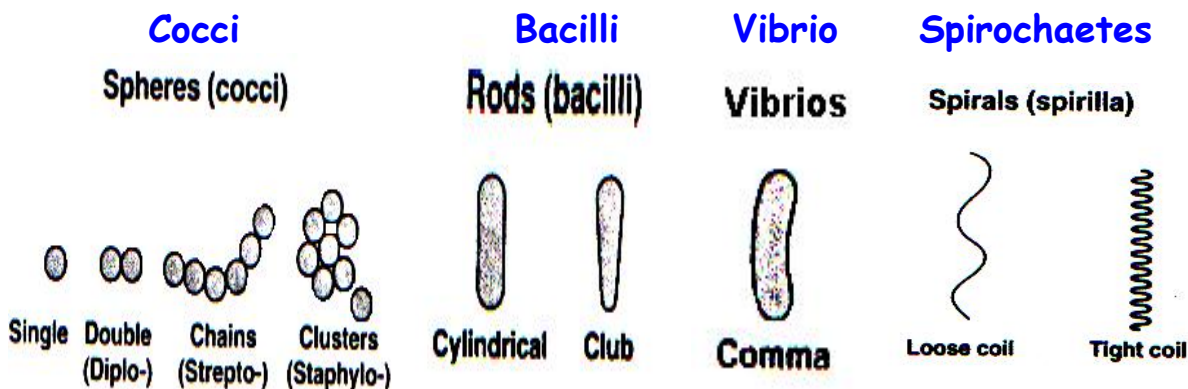
##### Higher bacteria

**Actinomyces**  
(Filamentous branching organism)

**Leptothrices**  
(Filamentous non branching organism)

##### Lower bacteria

(Simple unicellular organisms)





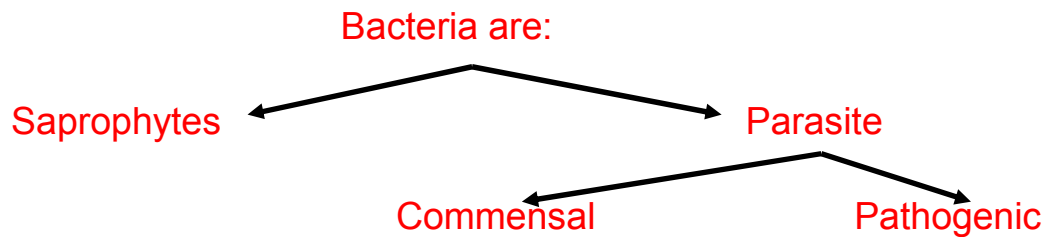
(2) REACTION TO GRAM STAIN.

(3) METHOD OF ENERGY PRODUCTION:

➤ Respiration.

➤ Glycolysis.

(4) PATHOGENICITY:



(5) ACCORDING TO NUTRITIONAL REQUIREMENT.

(6) ABILITY TO FORM SPORE.

### **THE RECENT SYSTEM:**

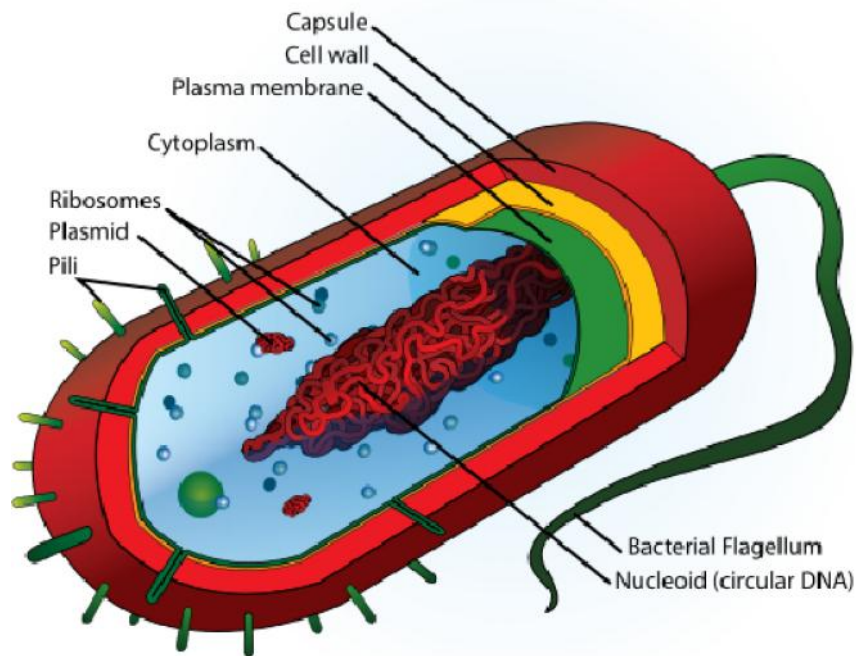
**Depends on Genotypic criteria of bacteria by different techniques of molecular biology and molecular genetics.**

- (1) Nucleotide base composition: for example (G + C) bases.
- (2) Nucleic base homology.
- (3) Genome sequencing: this technique based on base sequences homologies in ribosomal RNA.





# ANATOMY OF THE BACTERIAL CELL



## Essential component:

- ☞ Cell wall.
- ☞ Cytoplasmic Membrane.
- ☞ Cytoplasm of bacteria.
- ☞ Nucleus.

## Non Essential component:

- ☞ Capsule.
- ☞ Pili. "Fimbria"
- ☞ Flagella.

## A. Essential component:

### The nuclear body:

- ✓ No outer nuclear membrane, No nucleolus.
- ✓ Not bounded to proteins "no histones".



## Cell wall:

- ✓ The outer most component.
- ✓ Lies immediately external to the cytoplasmic membrane.
- ✓ It is 10-25 nm thick.
- ✓ Strong and relatively rigid, with some elasticity.
- ✓ It is porous; allow free exchange with the surrounding media.  
"Osmotically insensitive"

### ★ Composition of the cell wall:

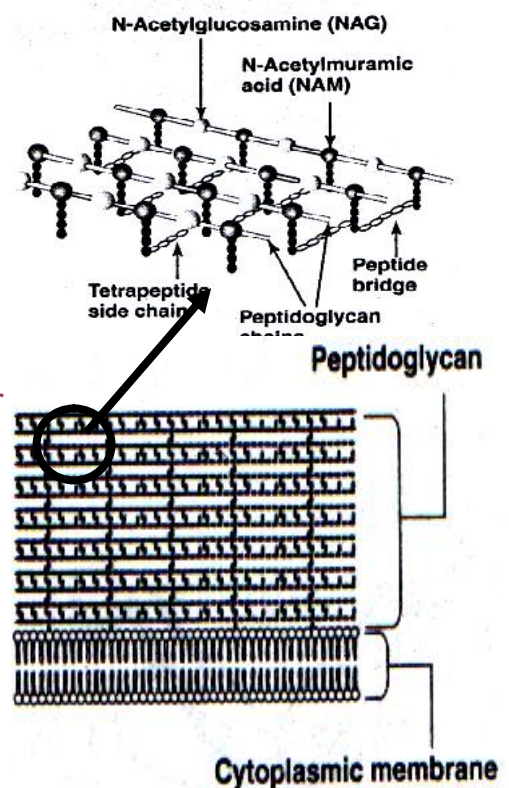
#### 😊 G +ve bacteria:

##### 1) PEPTIDOGLYCAN LAYER:

- Thick, about 50% of the thickness.
- Composed of a cross linked mesh.
- This mesh consists of 40 sheets of alternating N-acetylglucosamine and N-acetylmuramic acid joined together by a short chain of four aminoacids (L-alanine or glycine, D- glutamic acid, lysine and D-alanine)
- It is responsible for rigidity of the cell wall

##### 2) TEICHOIC ACID LAYER:

- It's a thin layer cover the Peptidoglycan.
- Complex molecule formed of polymers of ribitol or glycerol phosphate.
- It's antigenic layer.



#### 😊 G -ve bacteria:

##### 1) PEPTIDOGLYCAN LAYER:

- Thin layer, constitute up to 5-10% of the cell wall.

##### 2) OUTER MEMBRANE:

- Formed of 2 parts:
- The inner part:

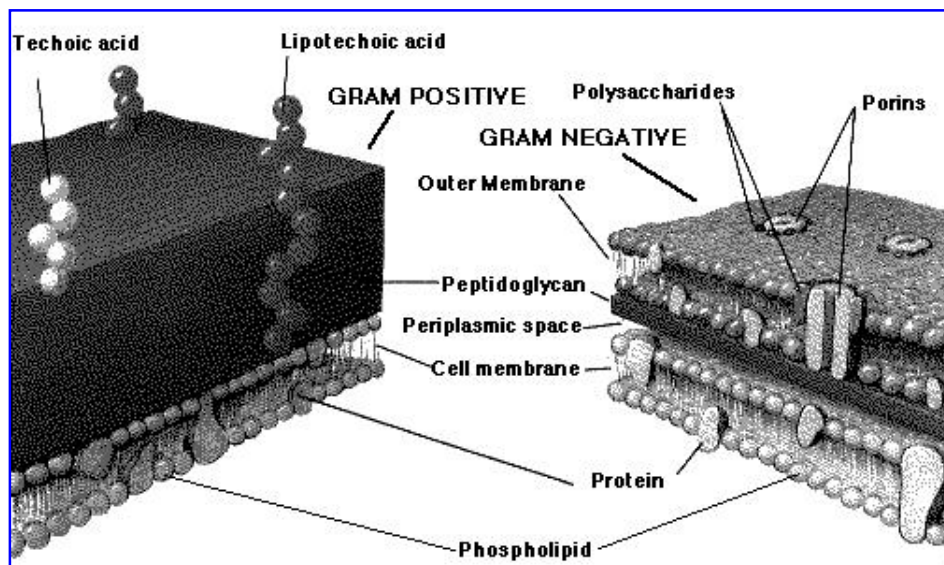
Formed of phospholipids bilayer like the cell membrane.



- The outer part: contains lipopolysaccharide (LPS).
- The **LIPOLYPSACCHARIDE** (LPS) Consists of 3 parts:
  - a- Inner lipid A forms endotoxin.
  - b- Middle polysaccharide core.
  - c- Outer polysaccharide side-chains "O-somatic antigen".
- Also it has special channels, protein in nature called "porins"; allow passive diffusion of low molecular weight compounds.

### 3) PERIPLASMIC SPACE:

- It is the space between the inner Cytoplasmic membrane and outer membrane.
- It contains 1-2 sheets of Peptidoglycan layer and gel-like solution of protein.



### ★ Functions of bacterial cell wall:

- ① Maintains the integrity and the shape of the cell.
- ② Supports the cytoplasmic membrane.
- ③ Determines the staining reaction of Gram stain.
- ④ Protects the bacteria.
- ⑤ Responsible for the antigenicity.
- ⑥ Cell division.





## ★ **Cell wall Deficient Bacteria:**

Weakening, removal or defective formation of the cell wall produce abnormal forms, it may be:

### **(1) NATURALLY:**

#### **Mycoplasma:**

- ☞ Originally bacteria without cell wall.
- ☞ It's cytoplasmic membrane contain sterol.
- ☞ Can cause acute diseases.
- ☞ Can't be reverted.
- ☞ It is resistant to cell wall inhibitors antibiotics.

### **(2) INDUCED:**

- ☞ Removal of cell wall by lysozymes or blocking biosynthesis of Peptidoglycan by antibiotics.
- ☞ It may be:

#### **① Protoplasts:**

- ☒ Produced from G +ve " **P**ositive "
- ☒ Due to removal of the cell wall.
- ☒ By the action of lysozymes. " ! "

#### **② Spheroplasts:**

- ☒ Produced from G –ve.
- ☒ Weakened or damaged cell wall.
- ☒ Due to the action of penicillins "or beta lactam antibiotics"

#### **③ L - Form:**

- ☒ May rise spontaneously.
- ☒ Or by inducer "penicillins more than lysozymes"
- ☒ Can revert to the normal form on removal of the inhibitor.
- ☒ They can multiply and replicate.
- ☒ They produce chronic infection.
- ☒ They are resistant to antibiotics "especially penicillins".

#### **N.B:**

- ☒ Protoplasts & Spheroplasts are osmotically sensitive, so they vary in size.
- ☒ Protoplasts do n't multiply while spheroplast can when kept in suitable conditions.



## Cytoplasmic Membrane:

- ✓ Lies just inside the Peptidoglycan layer.
- ✓ Consists mainly of phospholipids bilayer.
- ✓ Impermeable to most hydrophilic molecules.
- ✓ Does not contain cholesterol except **Mycoplasma**.

### ★ Functions of cytoplasmic membrane:

- ① Selectively permeability.
- ② Excretion of toxins and extracellular enzymes "Pathogenicity".
- ③ Excretion of hydrolytic enzymes to digest large food particles.
- ④ Respiration: the Cytochrome enzymes responsible for ATP generation.
- ⑤ Cell division by septal Mesosomes.
- ⑥ Chemotactic systems: specific receptors that binds to attractants and repellents.

## Mesosomes:

These are invaginations of the cytoplasmic membrane.

★ **Types:** Septal & lateral.

★ **Function:**

- ✓ Site of attachment of DNA during cell division "Septal mesosomes.
- ✓ Site of respiratory enzymes. " ! "
- ✓ Increase the surface area of the cytoplasmic membrane  $\Psi$  increasing the efficiency of active transport.

## Cytoplasm:

- ✓ It is a viscous watery solution or soft gel.
- ✓ It contains nuclear body and:

## (1) Ribosomes:

- ☒ The site of protein synthesis.
- ☒ They have a sedimentation constant of **70 S**.
- ☒ Composed of **30 S** and **50 S** subunits.





- ☒ The two subunits are separated except in protein synthesis they aggregate to form **polyribosome 70 S**.
- ☒ Site of action of some antibiotics.

### **N.B.:**

The human ribosome is **80 S**, Composed of **40 S** and **60 S** subunits. " ! "

## **(2) Inclusion granules:**

- ☒ Round granules are observed in the cytoplasm.
- ☒ Not permanent or essential structures "may be absent".
- ☒ They are aggregated substances concerned with the cell metabolism. E.g. excess metabolites stored as nutrient reserve
- ☒ E.g.: volutin granules in *C. Diphtheria*.

## **(3) Plasmids:**

Extrachromosomal double stranded circular DNA molecules smaller.

★ **Characters & Function:** Will be mentioned later.

## **B. Non Essential component:**

### **Capsule:**

- ✓ The outermost layer in the capsulated bacteria.
- ✓ Lies outside and immediately in contact with the cell wall.
- ✓ Firm gelatinous material, formed of:
  - \* **Polysaccharides** as in: pneumococcal capsule.
  - \* **Polypeptides** as in: *Bacillus anthracis* capsule.
  - \* **Hyaluronic acid** as in: streptococcal capsule.
- ✓ Formed inside host tissue "In vivo".
- ✓ Appears as unstained halo in gram stain.

### ★ **Importance of bacterial capsules:**

- ① It protects the cell wall of bacteria.
- ② Protect against the phagocytic action of the host cells.
- ③ Its **antigenic**, helps in:
  - ☒ Typing of certain species of bacteria.
  - ☒ Identification by capsule swelling test (Quellung test).
  - ☒ Vaccine production, which is known as "Subunit vaccine".

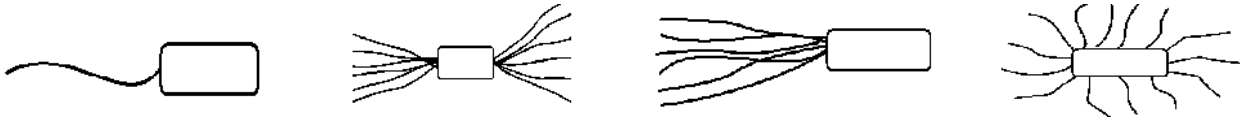


- ④ It plays a role in attachment of the organism to the m.m.
- ⑤ Stained by special stain, so helps in identification.

## Flagella:

Filamentous appendages which act as organs of locomotion (Motility).

- ✓ The flagellum is a long thin filament.
- ✓ Formed of a protein called flagellin.
- ✓ It originates in the bacterial protoplasm and is extended through the cell wall several times the length of bacterial cell.
- ✓ It is **antigenic** (H or flagellar antigen).
- ✓ Can be seen only with the electron microscope.
- ✓ Stained with a special stain.
- ✓ Flagella are arranged around the bacterial cell as follows:



Monotrichate

Amphitrichate

Lophotrichate

Peritrichate

## Fimbria (Pili):

They are hair like filaments, extend from the bacterial surface.

- ✓ Peritrichous, much shorter, thinner and more than Flagella.
- ✓ Formed of a protein called pillin.
- ✓ They are of two types:

	Common Fimbriae	Sex pili
* <b>Shape:</b>	Short, thin, numerous.	Long one pilus.
* <b>Expression:</b>	Under chromosomal control.	Under control of plasmid.
* <b>Function:</b>	Organs of adhesion to host cell.	Mediate conjugation.



## Spore:

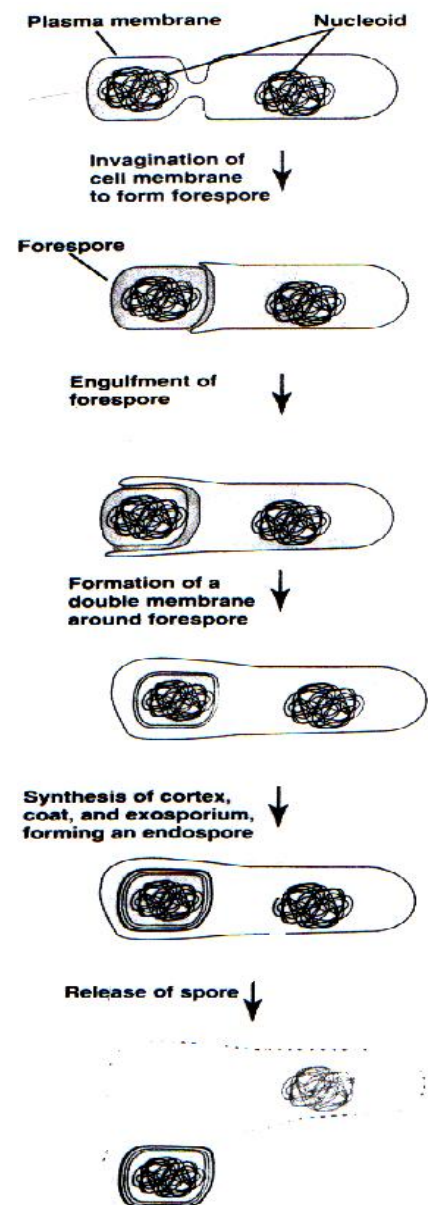
Some species develop a **highly resistant resting phase**.

- ✓ It is the dormant state of bacteria.
- ✓ It is formed in response to unfavorable conditions" long period of starvation, dryness, unsuitable temp...etc"
- ✓ Spores are virulence factor formed outside the host "!".
- ✓ Appear as empty space by Gram stain. "Need special stain"

### ★ Formation:

- \* The cell membrane invaginate to include the essential selected components.
- Acquires a thick covering protective layer (the cortex).

- ✓ Site of the spore:





## ★ Comparison between Prokaryotic & Eukaryotic cells

	<i>Prokaryotic</i>	<i>Eukaryotic</i>
★ <b>Definition:</b>	Cells in which DNA not physically separated from cytoplasm.	Cells contains membrane bound nucleus.
★ <b>Example:</b>	Bacterial cell.	Fungi - plant - human cell.
★ <b>Cell Wall:</b>	Present Exp.: Mycoplasma.	Absent in animal cells In fungi "chitin"
★ <b>Cytoplasmic membrane:</b>	No sterol Exp.: Mycoplasma	Contain sterol
★ <b>Cytoplasm:</b>		
☞ <b>Ribosomes:</b>	70 S. 2 subunits: 50 S , 30 S.	80 S 2 subunits: 60 S , 40 S.
☞ <b>Mitochondria:</b>	Absent.	Present.
☞ <b>Mesosomes:</b>	Present.	Absent.
☞ <b>Plasmid:</b>	Present.	Absent.
★ <b>Nucleus:</b>		
☞ <b>Nuclear membrane:</b>	Absent.	Present.
☞ <b>Nucleolus:</b>	Absent.	Present.
☞ <b>No. of chromosomes:</b>	Single.	Multiple.
☞ <b>Histones:</b>	Absent.	Present.
★ <b>Division:</b>	Simple binary fission.	Miosis, budding in fungi.