

Classification and Morphology of Microorganisms and Molecular structures of Microorganism

By:

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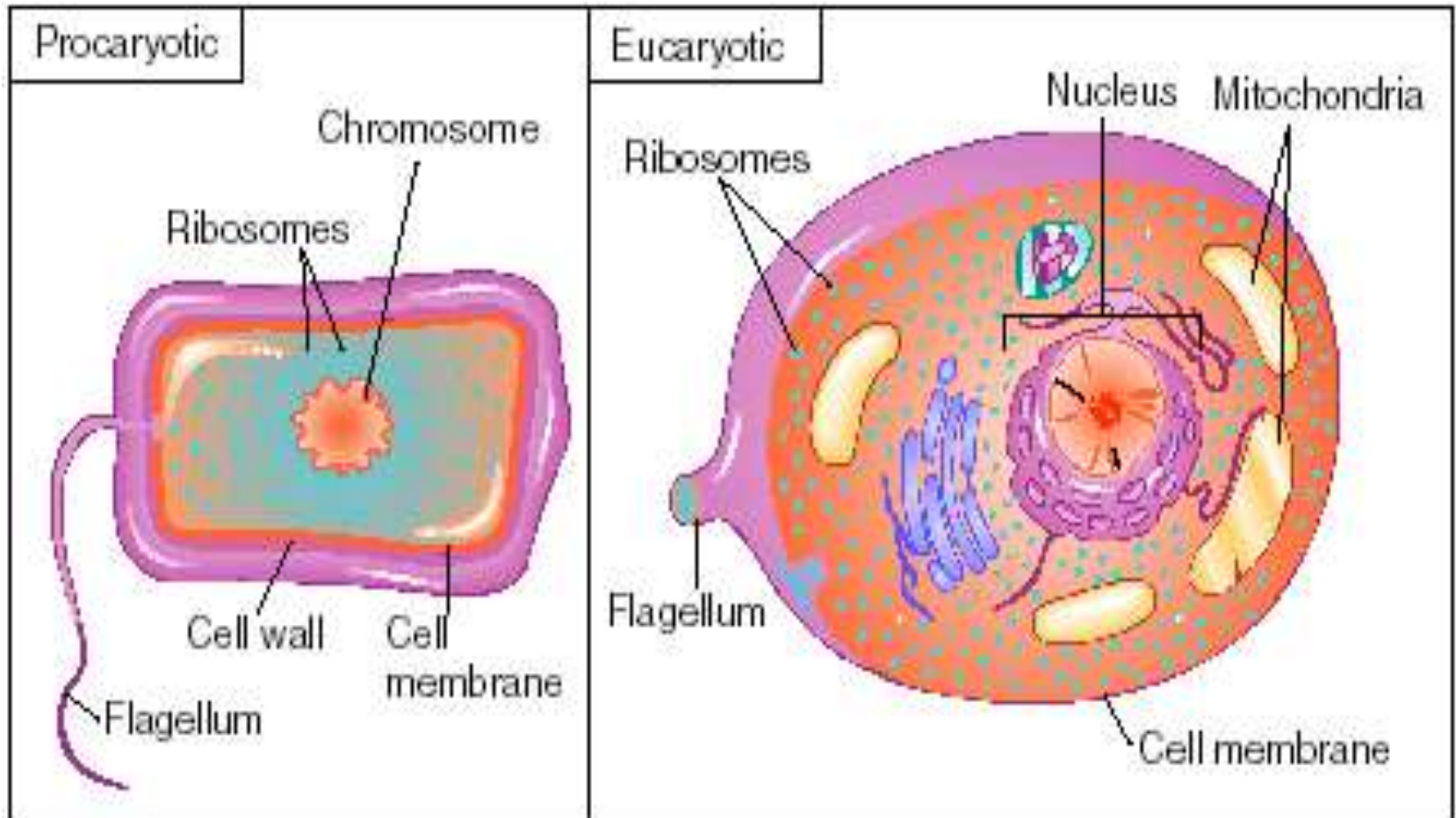
- There is a classification for the major groups of microorganisms which can be distinguished on the bases of their structure and the complex of their organization and **biochemistry**.
 - **A- Prokaryotes:** which included Bacteria and blue green algae.
- *Characteristics of prokaryotes:
- 1- Very small in size.
 - 2- Lack of nuclear membrane
 - 3- Lack of mitochondria.

- 4- Multiplication is by binary fission.
 - 5- Has a single piece of genetic material known as **plasmid**.
 - **B- Eukaryotes:** which included Fungi and **protozoa**.
- *Characteristics of eukaryotes:
- 1- Large size.
 - 2- Lack of plasmid.
 - 3- Posses mitochondria.
 - 4- Multiply by sexual multiplication and others (mitosis).
 - 5- Posses nuclear membrane.

- The agents of human infectious belong to five major groups of microorganisms; bacteria, fungi, viruses, protozoa and helminthes.
- Based upon cell characteristic, living organism are recognized as having Eukaryotic or prokaryotic cell type.
- Bacteria belong to Prokaryotic, fungi and protozoa are Eukaryotic cell type. Viruses are classified by some scientist as kingdom viruses they are acellular (non-cellular).

- **Differences between Eukaryotes and Prokaryotes:**

	Eukaryotes	Prokaryotes
Size	Larger	Relatively small
Structure of cell	Complex	Primitive
DNA content	Nucleus	Nucleoid
Nuclear membrane	Present	Absent
Mitochondria	Present	Absent
Multiplication	Mitotic	Binary fission
Enzyme system	Complex	Simple
Golgi bodies	Present	Absent
Respiration	Via Mitochondria	Cytoplasmic membrane



Microbial cells are of the small, relatively simple procaryotic variety (left) or the larger, more complex eucaryotic type (right).

- * The kingdom Prokaryote is further divided into division classes orders families genera species strain (subspecies).
- Practically, only the name of genus and species are used.
- The generic (genus) name is always given a capital letter. The specific (species) name is given a small letter e.g. *Staphylococcus aureus*.
- The generic and specific name are italicised (*Staphylococcus aureus*), or, if this is not possible, underlined (Staphylococcus aureus).

Bacteriology

Bacterial size

- The major characteristics of Bacteria are based on their size, shape and arrangements.

1. Size

The unit of measurement used in bacteriology is the micron (micrometer).

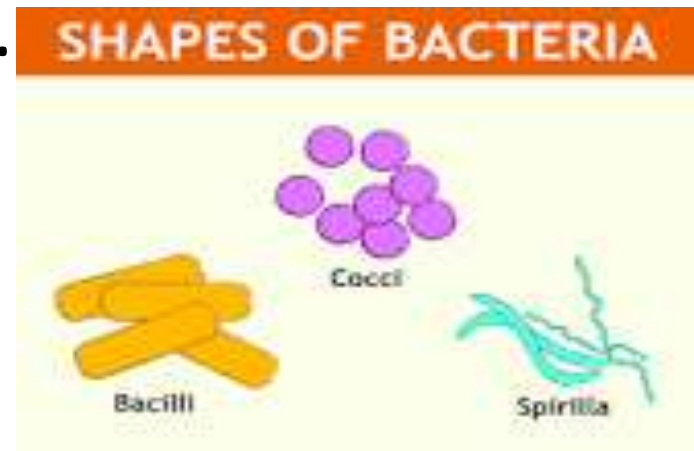
1 micron (μ) or micrometer (μm) – **one thousandth** of millimeter.

- The limit of resolution with the unaided eye is about 200 microns. Bacteria are smaller which can be visualized only under magnification. Bacteria of medical importance generally measure **0.2 – 2.0** μm in diameter and about **3-5** μm in length.

Morphology of microorganisms

2. Shape and arrangement:

- **1- Cocci:** round or spherical in shape, singular known as Coccus. It's diameter ranges between **0.5-1** micron. When microorganisms occurs as single it is known as Micrococcus, Monococcus= single cell.



- *When it occurs in pairs, it is known as Diplococci e.g. Meningococci which cause meningitis.
- *When it occurs in chain which can be short or long, it is known as streptococci e.g. *Streptococcus pyogenes* which cause throat inflammation.

- *When it occur in cluster (grape like) it is known as *Staphylococcus* e.g. *Staphylococcus aureus*.
- These arrangements are determined by the orientation and degree of attachment of the bacteria at the time of cell division.

Arrangements of Cells

Monads



Diplococci



Staphylococci



Streptococci



Tetrad



Tetrad

- **2-Rods:** in Latin are known as **Bacilli**, Rod=Bacillus; it has a stick like shape and the end may be round cut or square cut (Value of identification).
- When rod is single; it is known as bacillus or may be chain known as streptobacillus.
- Sometimes the rods may occur in chains but branching e.g. Actinomyces. some have the shape of Chinese letters and is known as club shaped e.g. *Corynebacterium diphtheriae* which causes diphtheria.

Arrangements of Bacilli



coccobacillus.



bacilli



diplobacilli



palisades.



Streptobacilli

- **3- Vibrios:** it has a comma or curved shape.
- It is known as Vibrio and e.g. *Vibrio cholerae* which causes cholera.



- **4- Spirillum and Spirochetes:**
- Have the shape of spiral e.g. *Treponema palidum* which causes syphilis.



Coccus



Coccobacillus



Vibrio



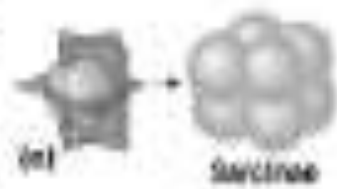
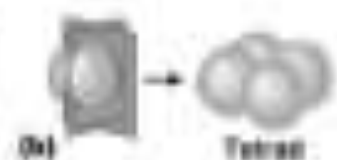
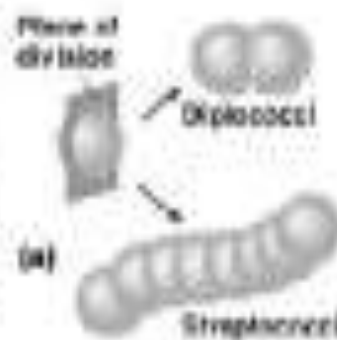
Bacillus



Spirillum



Spirochete



<http://www.Medicalofem.com>

Bacteria in the nature:

- Microorganism are highly distributed in the nature, almost every where, in the air, in our bodies (Normal Flora) in the eyes, the skin, the mouth, etc. Also we can find them in the polar ice, also in the hot spring. So it is very difficult to study.

- **Hans Christian Gram** made study on two different cell types of bacteria which are the **rod** and **cocci** in two groups and he added a stain of **crystal violet** and leaves it to react for 1 minute, after wards washed with tap water which found after to be violet colour. Then he added a solution of **iodine** and left it to react for 1 minte and then washed it with water. He found that one of the groups is deep violet and the other remained as it is. Then he added **ethanol** and left it for 10 seconds and washed with water. The deep violet remained as it is and the other group **was decolouized**. Then he added **safranin** and left it to react for 2 minutes, and then washed with water.

- The first group was violet and the decolourized group by alcohol was red (pink).
- Then he called them G+ve and G-ve and that was 1884 and the technique named Gram's staining technique.
- The differences that happened between G+ve and G-ve is due to cell wall.
- The bacteria are classified according to this technique into G+ve and G-ve bacteria (act as identification criteria).

Molecular structure of Bacteria

1. Cell Membrane

- It is very important structure in the bacterial cell, also called cytoplasmic membrane or sometimes protoplasmic membrane. Chemically cytoplasmic membrane is composed of bilayers of phospholipids.
- Basic functions of cell membrane are:-
 - 1/to control the movement of substances.
 - 2/ to secrete hydrolytic enzymes.
 - 3/ responsible for secretion of transport protein and protein involved in cell wall synthesis.

2. **Cytoplasm:** which contains

- 1. **Genetic Material:** a single piece of DNA without nuclear membrane.
 - 2. **Ribosomes:** which are known as protein making organelle.
 - 3. **Mesosomes:** which are attached to the cell membrane and is thought that is associated in cell division (binary fission).
- ## 3. **Cell wall:** is another component of bacterial cell which is outside the cell, it is a rigid organelle and also it gives the bacteria its shape and also prevents expansion of cell membrane (protects the cell against **osmotic pressure**).

- The other name of the cell wall is known as peptidoglycan which is composed of polysaccharides: the main polysaccharide which are found in the composition are:
- -N-acetyl glucose amine.
- - N-acetyl muramic acid.
- And this peptidoglycan is only found in the cell wall of bacteria. It is a target for antibiotics to act on. Some antibiotics act on the cell wall e.g. penicillins and cephalosporins. This is known as **selective toxicity**.

- Differences between G+ve and G-ve bacteria:

	G+ve	G-ve
1-	Cell wall is thick	Cell wall is thin
2-	Cell wall is compact	Cell wall is less compact
3-	Cell wall almost is peptidoglycan which includes 90%	Only 10% peptidoglycan
4-	Contains a component of teichoic acid	No teichoic acid
5-	Presence of lipoteichoic acid	No lipoteichoic acid
6-	Cell wall contains no lipopolysaccharide	Cell wall contains lipopolysaccharide
7-	The surface is made of protein	The surface is made of lipopolysaccharide, lipoprotein, phospholipid

- Defect or obstruction of the cell wall will give:
- 1- Protoplast
- 2-Spheroplast
- 3- L-forms

***1- Protoplast**

- Is a G+ve bacteria with defective cell wall which is killed by lysozymes or antibiotic (penicillin).

***2-Spheroplast**

- Is a G-ve bacteria which lost it's cell wall completely or partially due to the action of lysozymes or antibiotic (penicillin).

***3-L form**

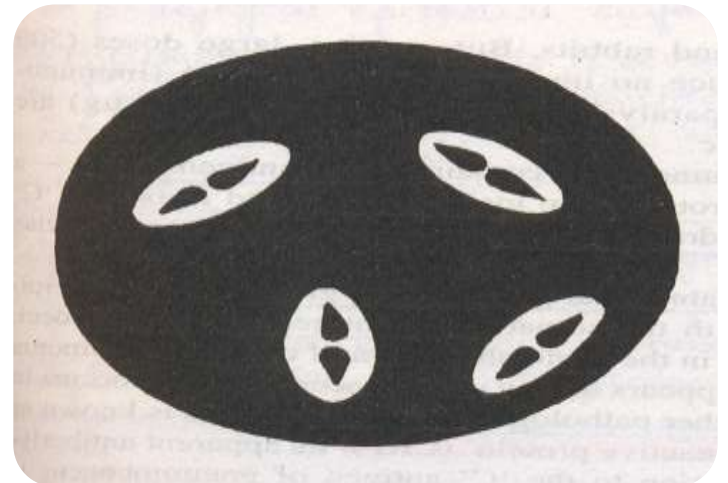
- It may be G+ve or G-ve bacteria loss their cell wall due to mutation. They are able to grow and divide or multiply and this is possible in hypertonic or concentrated media or isotonic in order to retain its contents and do not release them. In this medium shrinking may happened but it does not affect. But in hypotonic media it will expand and then explode.

- Specialized products outside the cell wall:

1- Capsule

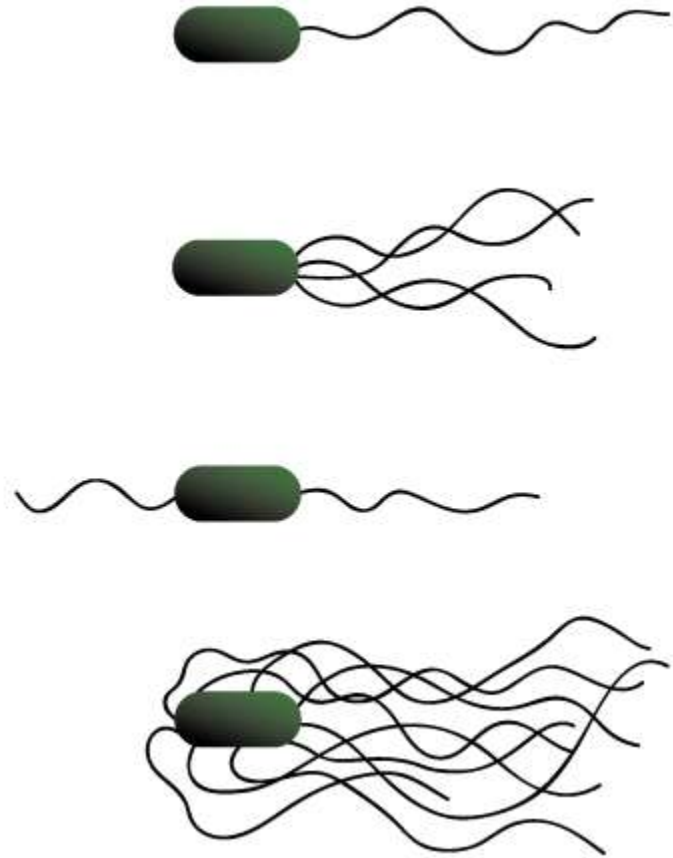
- This is a layer of loose slime material which surrounds some bacterial cells. The capsules are composed of mainly of polysaccharides or peptides. They resist phagocytosis and so their presence on a bacterium is associated with virulence. They are identified by **negative staining** due to their low affinity for simple staining.

- e.g. of capsulated bacteria:
 - Klebsiella pneumoniae* (polysaccharide)
 - Bacillus anthracis* (poly-D-glutamic acid)
- * The capsule is used for rapid and accurate diagnosis where agglutination reaction happens between the antibodies and the antigen (capsular antigen).

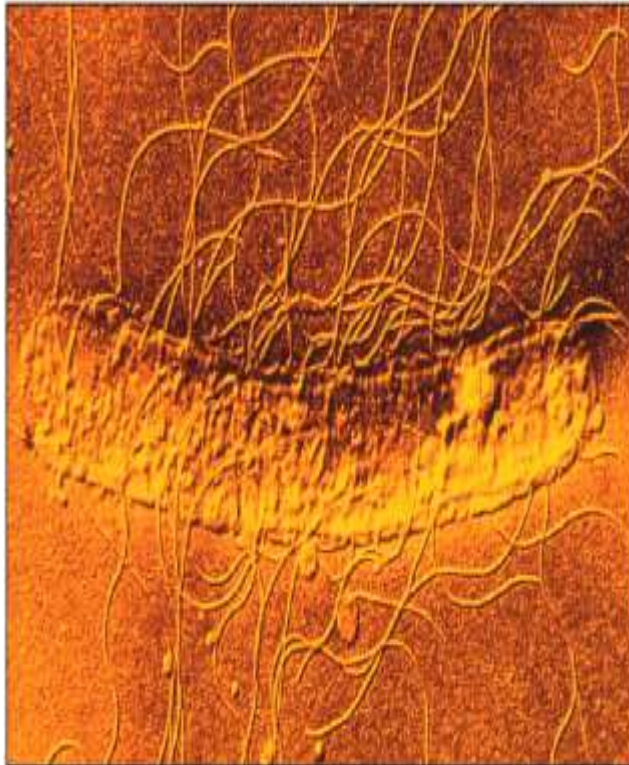


2- Flagella

- These are filaments that originate from the cytoplasm. They function as organs of motility. They are therefore seen only in organisms that are motile. They are made of protein (**Flagellin**). They have characteristics patterns of arrangement on the bacterial cell:
 - A) Monotrichate: one flagella at one pole.
 - B) Lophotrichate: tuft flagella at one poles.
 - C) Amphitrichate: single or tuft on both sides.
 - D) Peritrichate: flagella completely surrounding the bacterial cell.

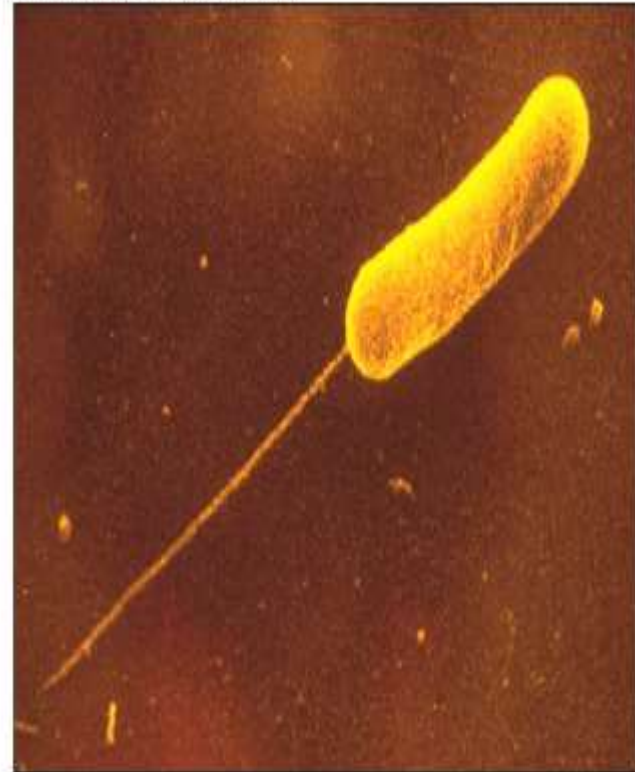


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(a)

1 μm



(b)

1 μm

- The flagella are too thin to be seen in ordinary stained preparation, but become visible only in silver impregnated preparation or in electron microscopy.
- The functions of flagella are:
 - 1- motility (mainly)
 - 2-attachment to site of infection e.g. stomach.
 - 3-Diversity of antigens, this is used for diagnosis and this is mainly in *Salmonella typhi* (the causative agent of typhoid fever).

4- Invasion

5- Colonization (form colony)

3.Pili

- Hair –like, extended from cytoplasmic membrane, they are shorter and finer filaments than the flagella. They are made of protein (pilin).
- Pili are divided into two groups:

1- Sex pili

- Referred to as sex pili because of their role during conjugation when genes are transferred from one cell (donor) to another cell (recipient).

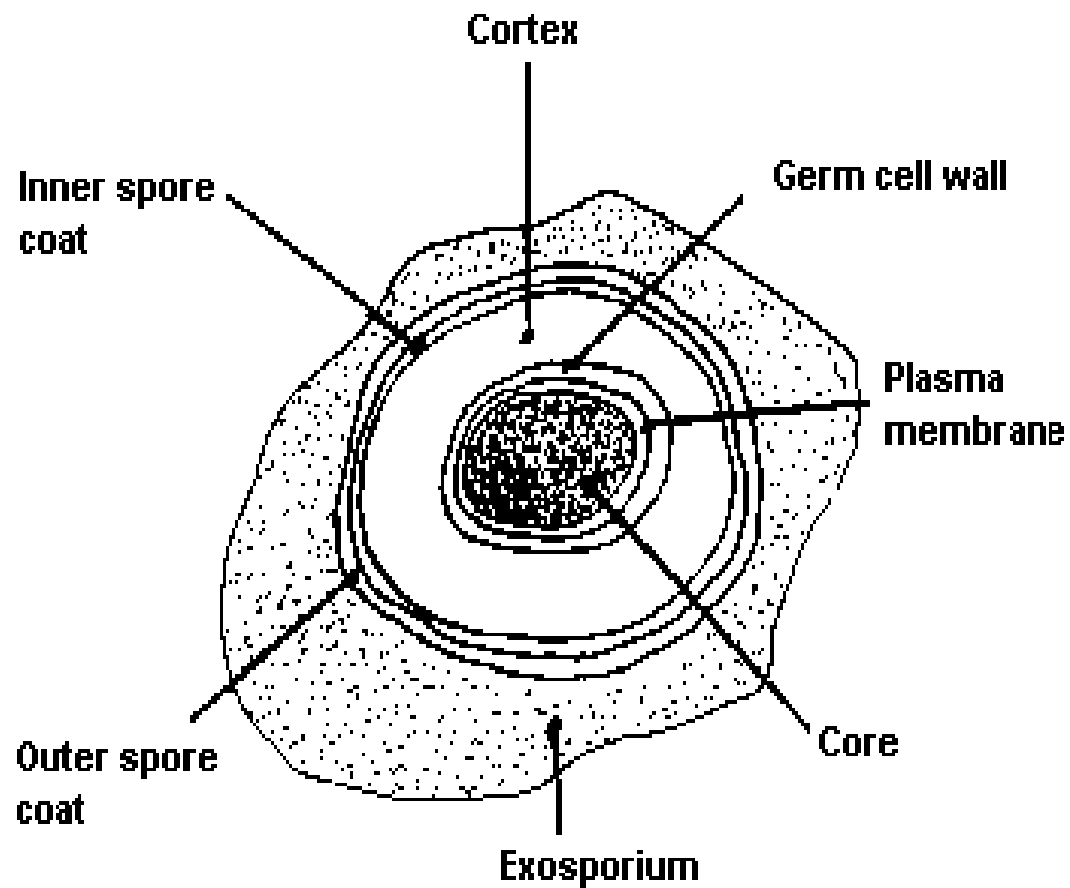
2- Common pili, or Fimbriae:

- These are thought to be the organs of adhesion that help bacteria to attach to the host cells (Virulence Factor).

4-Spores

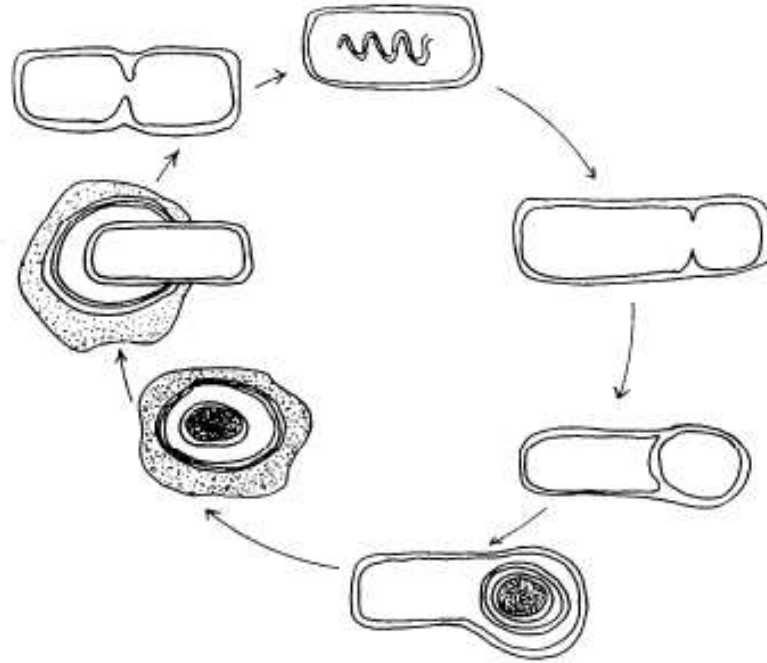
- These are dense structure produced by some bacteria, e.g. the Bacilli and Clostridia groups, that enable them to survive adverse environmental conditions. They develop within and at the expense of vegetative cell. The spore comprises the chromosomal material surrounded by several walls layers.

- Chemically, endospore has a large amount of Calcium , less number of enzymes and less amount of water.
- Spores are resistant to heat, stains, desiccation, chemicals and disinfectants.



- Each spore germinates to produce a vegetative cell during favorable conditions.
- The location and shape of the spore in the cell may be of diagnostic assistance, e.g. the spores of *Clostridium tetani* are terminal, and the diameter is greater than that of the parent cell (bulging), so that they are characteristically of drum stick appearance.

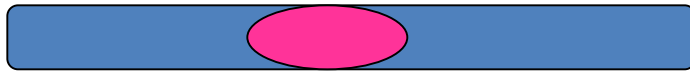
The cycle of spore formation and germination



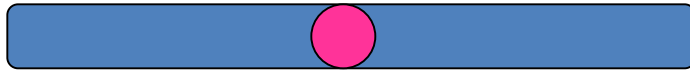
At the beginning of spore formation, a septum forms, separating the nascent spore from the rest of the cell and all of the genetic material of the cell is copied into the newly-forming cell. The spore contents are dehydrated and the protective outer coatings are laid down. Once the spore is matured it is released from the cell. On germination, the spore contents rehydrate and a new bacterium emerges and multiplies.

- The positions of the spores are described as:
 - Terminal
 - Sub terminal
 - Or Central
- The shape of spores are described as:
 - Ovoid (oval)
 - Spherical
 - Cylindrical

Shape & position of bacterial spore



Oval central



Spherical central

Non bulging



Oval sub terminal



Oval sub terminal

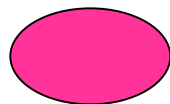


Oval terminal

Bulging



Spherical terminal



Free spore

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- District Laboratory Practice in Tropical Countries volume 2 (Monica).