

Lecture 4

Bacteria and their Structure

Introduction of bacteria

Bacteria are single celled prokaryotic unicellular microorganisms, usually a few micrometers in length that normally exist together in millions. The cell wall of bacteria usually contains peptidoglycan and multiplies by binary fission. The cell structure is simpler than that of other organisms as there is no nucleus or membrane bound organelles. Instead their control Centre containing the genetic information is contained in a single loop of DNA. Some bacteria have an extra circle of genetic material called a plasmid. The plasmid often contains genes that give the bacterium some advantage over other bacteria. For example it may contain a gene that makes the bacterium resistant to a certain antibiotic.

Shapes of bacteria

Most bacteria are 0.2 μm in diameter and 2-8 μm in length. The three basic bacterial shapes are coccus (spherical), bacillus (rod-shaped), and spiral (vibrio twisted), however pleomorphic bacteria can assume several shapes.



Characteristic Groups

These bacteria can give themselves higher Level structural organizations such as

Cocci

Cocci may be oval, elongated, or flattened on one side. Cocci may remain attached after cell division. These group characteristics are often used to help identify certain cocci.

- 1) Cocci that remain in pairs after dividing are called diplococci.
- 2) Cocci that remain in chains after dividing are called streptococci.
- 3) Cocci that divide in two planes and remain in groups of four are called tetrads.

4) Cocci that divide in three planes and remain in groups cube like groups of eight are called sarcinae.

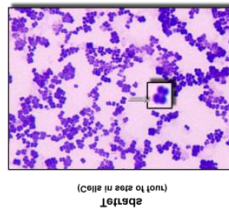
5) Cocci that divide in multiple planes and form grape like clusters or sheets are called staphylococci.



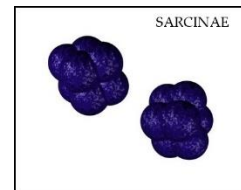
Diplococci



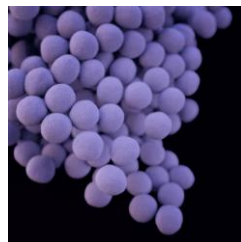
Streptococci



Tetrads



Sarcinae



Staphylococci

Bacilli

Bacilli only divide across their short axis there are fewer groupings. Bacillus is a shape (rod shaped) but there is also a genus of bacteria with the name *Bacillus*.

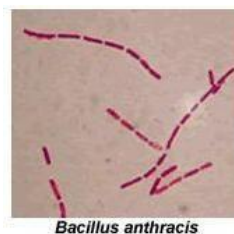
1) Most bacilli appear as single rods. Diplobacilli appear in pairs after division.

2) Streptobacilli appear in chains after division.

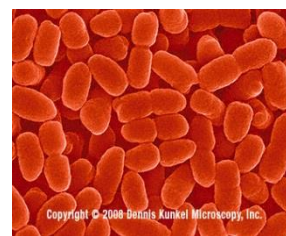
3) Some bacilli are so short and fat that they look like cocci and are referred to as coccobacilli.



Diplobacilli



Streptobacilli



Coccobacilli

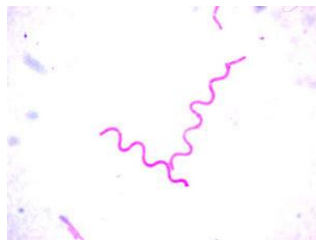
Spiral bacteria

Spiral bacteria have one or more twists.

- 1) Vibrios look like curved rods.
- 2) Spirilla have a helical shape and fairly rigid bodies.
- 3) Spirochetes have a helical shape and flexible bodies. Spirochetes move by means of axial filaments, which look like flagella contained beneath a flexible external sheath.



Vibrio's



Spirillum



Spirochetes

Structure of bacteria

The bacterial structure is composed of following components. These are

- | | | |
|--------------|--------------------|--------------|
| 1) Cell wall | 2) Plasma membrane | 3) Cytoplasm |
| 4) Ribosomes | 5) Plasmid | 6) Flagella |
| 7) Pili | 8) Capsule | |

1) Cell wall

Cell walls of bacteria are made up of glycoprotein murein. The main function of cell wall is it helps in providing support, mechanical strength and rigidity to cell. It protects cell from bursting in a hypotonic medium.

Two distinct structural types of cell wall known as:

















- Gram-negatives
- Gram-positives

Gram negative cell wall

Gram-negative cell walls are thin and unlike the gram-positive cell walls, they contain a thin peptidoglycan layer adjacent to the cytoplasmic membrane. Gram-negative bacteria are stained as pink colour. The chemical structure of the outer membrane's lipopolysaccharides is often unique to specific bacterial sub-species and is responsible for many of the antigenic properties of these strains.

Gram positive cell wall

Gram-positive cell walls are thick and the peptidoglycan (also known as *murein*) layer constitutes almost 95% of the cell wall in some gram-positive bacteria and as little as 5-10% of the cell wall in gram-negative bacteria. The gram-positive bacteria take up the crystal violet dye and are stained purple.

Step	Microscopic Appearance of Cell		Chemical Reaction in Cell Wall (very magnified view)	
	Gram (+)	Gram (-)	Gram (+)	Gram (-)
1. Crystal violet				
			Both cell walls affix the dye	
2. Gram's iodine				
			Dye crystals trapped in wall	No effect of iodine
3. Alcohol				
			Crystals remain in cell wall	Cell wall partially dissolved, loses dye
4. Safranin (red dye)				
			Red dye has no effect	Red dye stains the colorless cell

2) Plasma membrane

It is also known as cytoplasmic membrane (or) cell membrane. It is composed of phospholipids, proteins and carbohydrates, forming a fluid-mosaic. It helps in transportation of substances including removal of wastes from the body. It helps in providing a mechanical barrier to the cell. Plasma membrane acts as a semi permeable membrane, which allows only selected material to move inside and outside of the cell.

3) Cytoplasm

Helps in cellular growth, metabolism and replication. Cytoplasm is the store houses of all the chemicals and components that are used to sustain the life of a bacterium.

4) Ribosome

A tiny granule made up of RNA and proteins. They are the site of protein synthesis. They are freely floating structures that help in transferring the genetic code.

5) Plasmid

Plasmids are small circle of DNA. Bacterial cells have many plasmids. Plasmids are used to exchange DNA between the bacterial cells.

6) Flagella

This is a rigid rotating tail. It helps the cell to move in clockwise and anticlockwise, forward and also helps the cell to spin. The rotation is powered by H⁺ gradient across the cell membrane. Common forms include:

- **Polar *Monotrichous***
A single flagellum at one or both ends of the cell
- ***Amphitrichous***
Two or several flagella at one or both ends of the cell
- **Bipolar**
One flagellum arises predominantly from the both pole of the cell
- ***Monotrichous***
One flagellum from the each of the cellular pole
- **Peritrichous**
Random, haphazard arrangement of flagella scattered around the bacterial cell

7) Pili

Pili are protein tubes that extend out from the outer membrane in many members of the *Proteobacteria*. They are generally short in length and present in high numbers about the entire bacterial cell surface. Fimbriae usually function to facilitate the attachment of a bacterium to a surface (e.g. to form a biofilm) or to other cells (e.g. animal cells during pathogenesis).

8) Capsule

Capsule is a kind of slime layer, which covers the outside of the cell wall. They are composed of a thick polysaccharide. It is used to stick cells together and works as a food reserve. It protects the cell from dryness and from chemicals.

