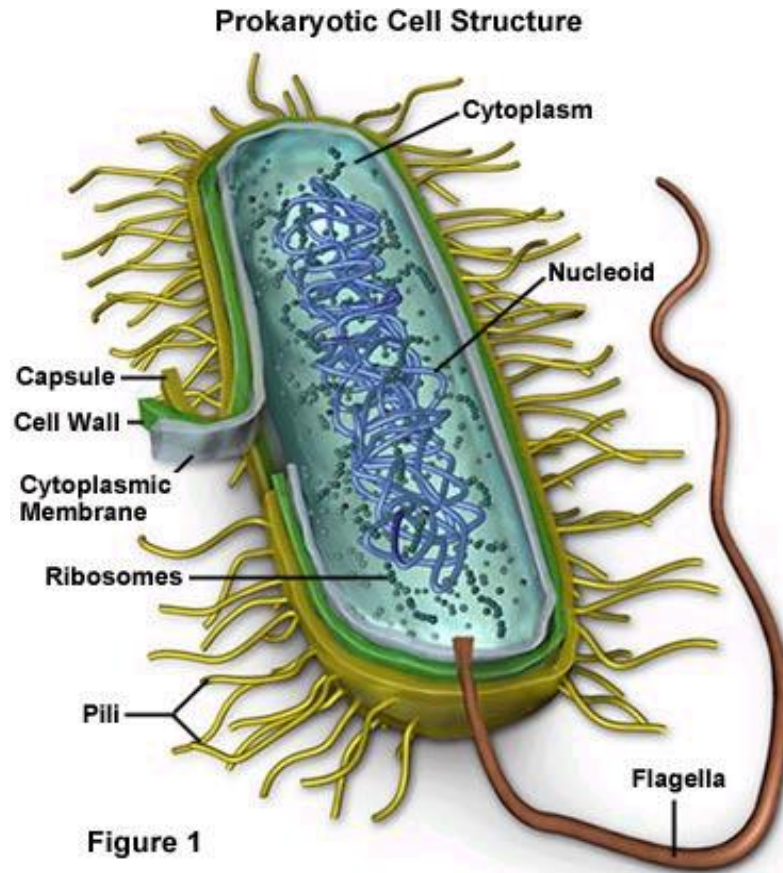


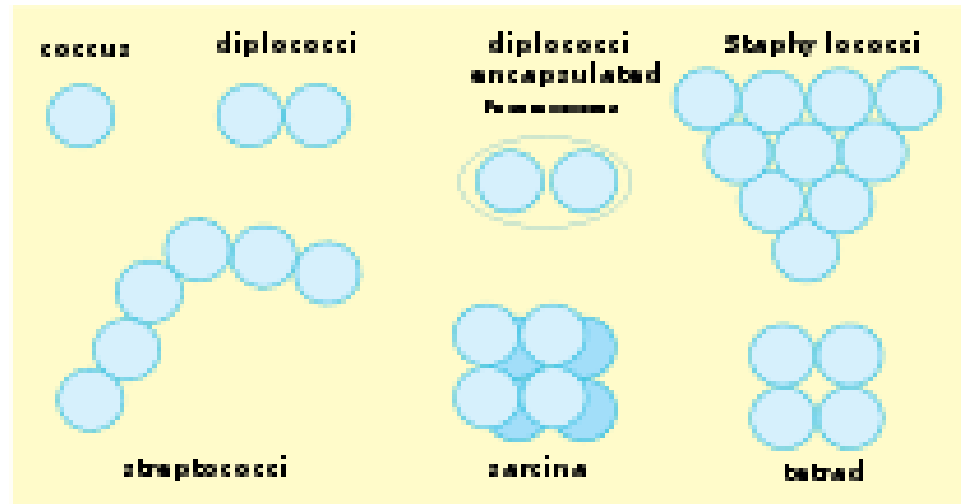
Prokaryotic Cell Structure



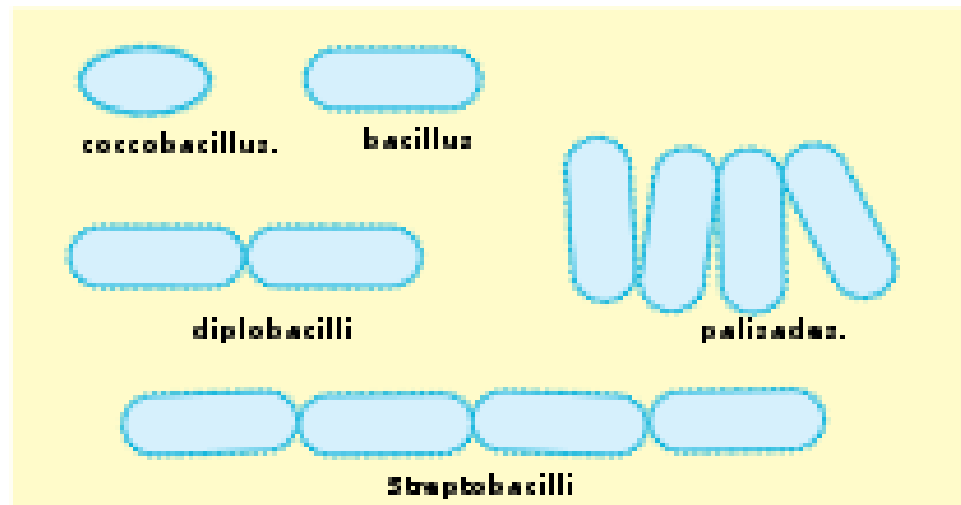
Bacteria – shape and size

- Bacteria are believed to be the first cell to evolve – have no clear membrane bound nucleus or organelles
- Bacteria vary in size and shape
- **Coccus**
- In pairs diplococcus. eg. *Neisseria*.sp.
- Long chains – *Streptococcus* sp.
- Irregular grape like clumps - *Staphylococcus* sp.
- Tetrads eg. *Micrococcus* sp.

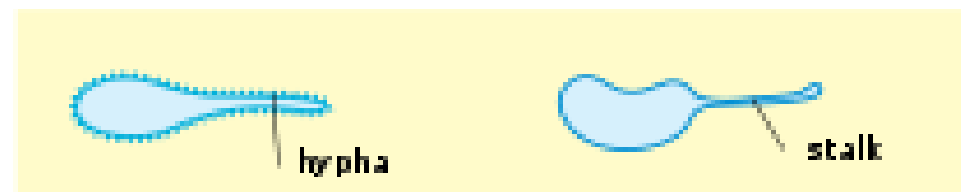
Cocci



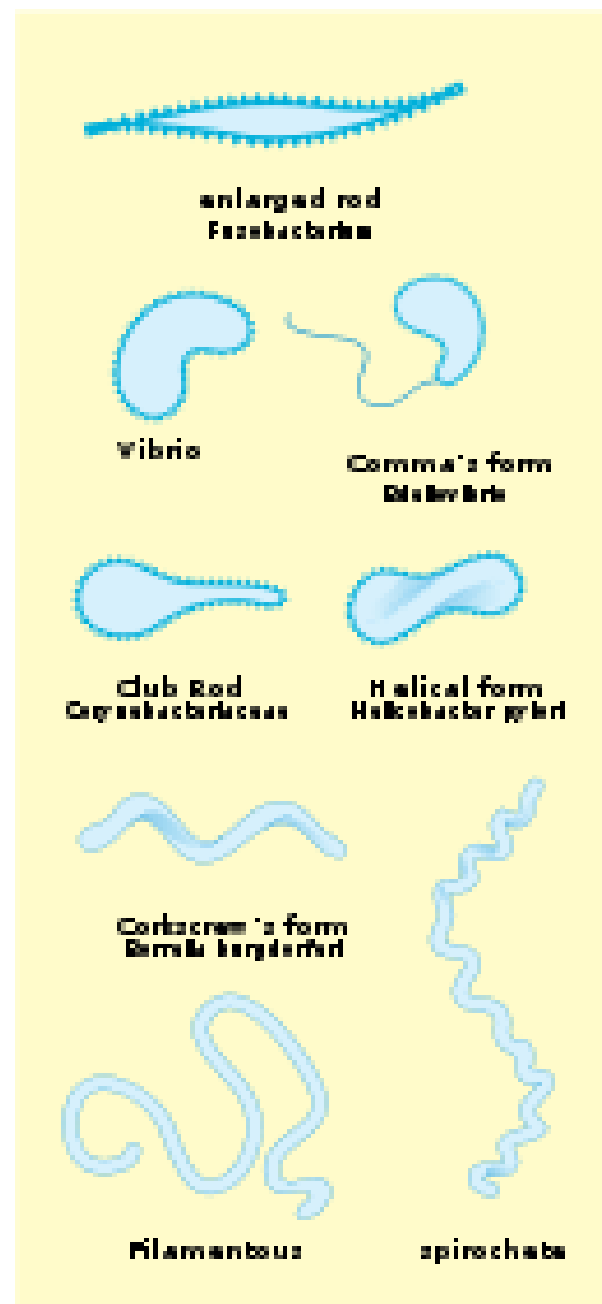
Bacilli



Budding and appendaged bacteria



Others





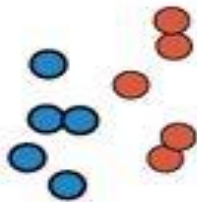
Coccus sphere



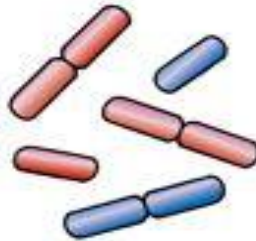
Bacillus (rod)



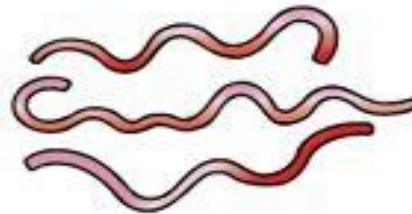
Spirochete



Pairs and singles



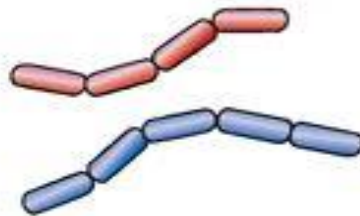
Pairs and singles



Borrelia



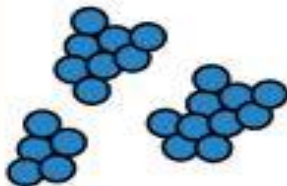
Chains



Chains



Treponema



Clusters

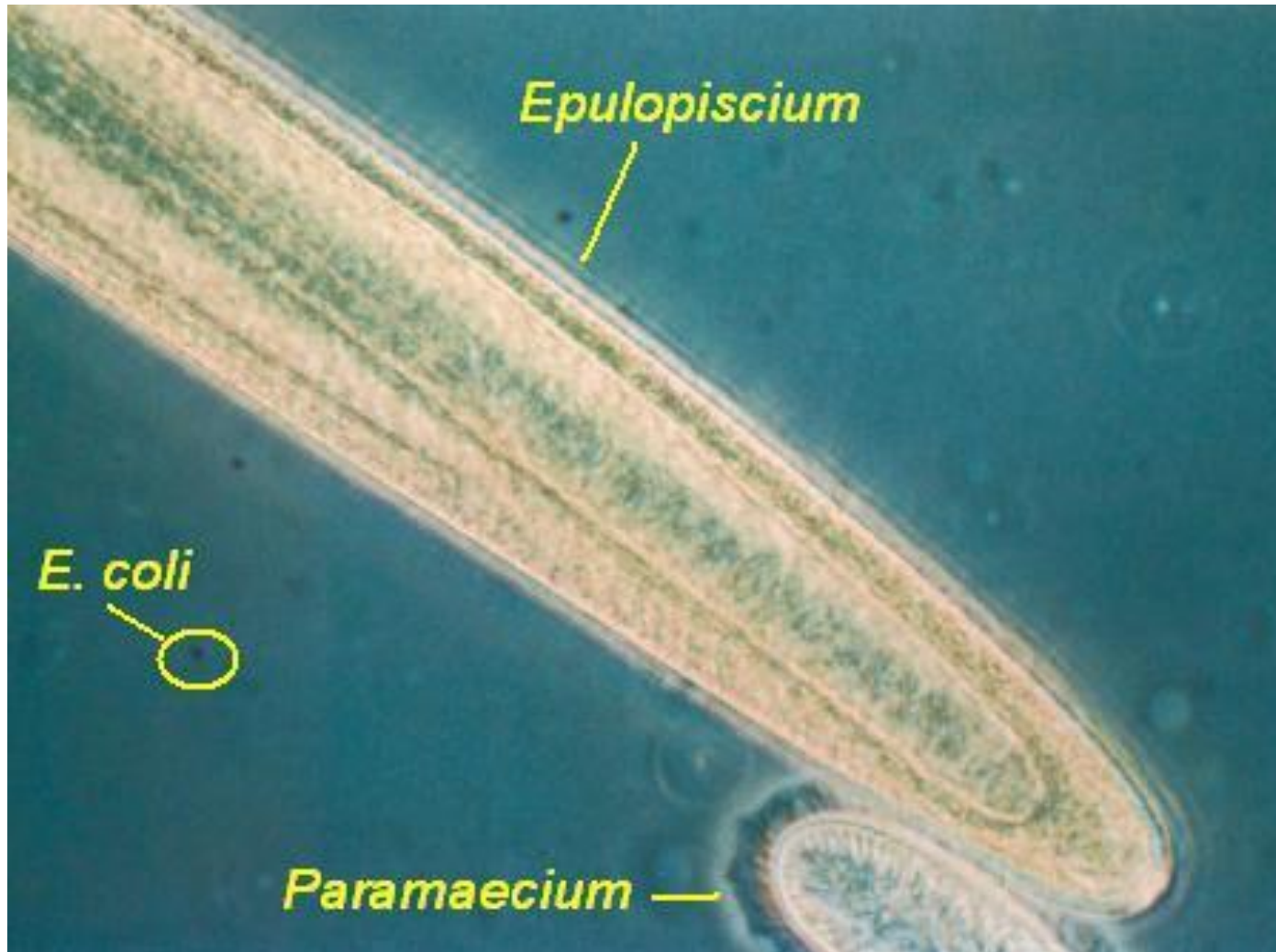


Flagellated bacilli



Spirilla

Epulopiscium fishelsoni grows as large as 600 μm by 800 μm , a little smaller than a printed hyphen. Exceptionally large bacteris



- **Bacillus:** rod shape eg. *Bacillus* spp.
 - Coccobacilli
 - The shape of the rod's end often varies
 - Some bacteria form long multinucleate filaments – eg. *Actinomyces*
- **Spirillum:** long rods twisted into spirals or helix
 - spirilla (rigid) spirochetes (if flexible)
- **Size:**
 - Mycoplasma are only 100 - 200 nm in diameter
 - *E. coli* is 1.1 to 1.5 µm wide by 2.0 to 6.0 µm. long,
 - Spirochetes - size reaches 500 µm in length

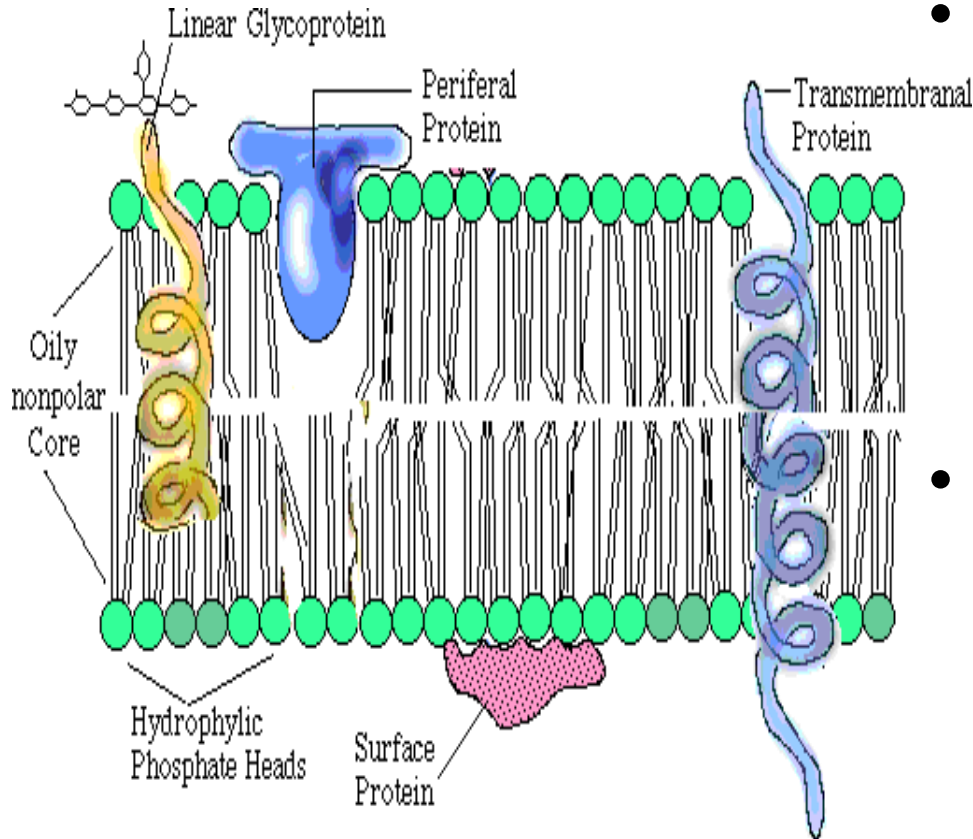
Structure and function of prokaryotes

- **Membrane systems**
- prokaryotic and eukaryotic membranes are similar in structure
- Membranes of eukaryotic microorganisms serve to compartmentalize cell contents into organelles
- Prokaryotic organisms contain only a single membranous structure, **cytoplasmic membrane or plasma membrane**
- measures 4 – 5 nm thick

- permeability barrier of the cell
- involve in complex biochemical processes
respiration
- membranes are formed of a **lipid bilayer**, made of phospholipids
- fatty acid portion hydrophobic, glycerol phosphate part hydrophilic
- hydrophilic parts are exposed to the aqueous external environment

- the inner and outer sides of the cytoplasmic membrane have different properties
- property of '*sidedness*' is of great importance
- overall structure of a membrane is maintained by hydrogen bonds and hydrophobic interactions
- (Mg^{2+} , Ca^{2+}) help to stabilize the structure
- Eucaryotic membranes differentiated from those of prokaryotes with *sterols*
- Mycoplasmas, contain sterols

Plasma Membrane



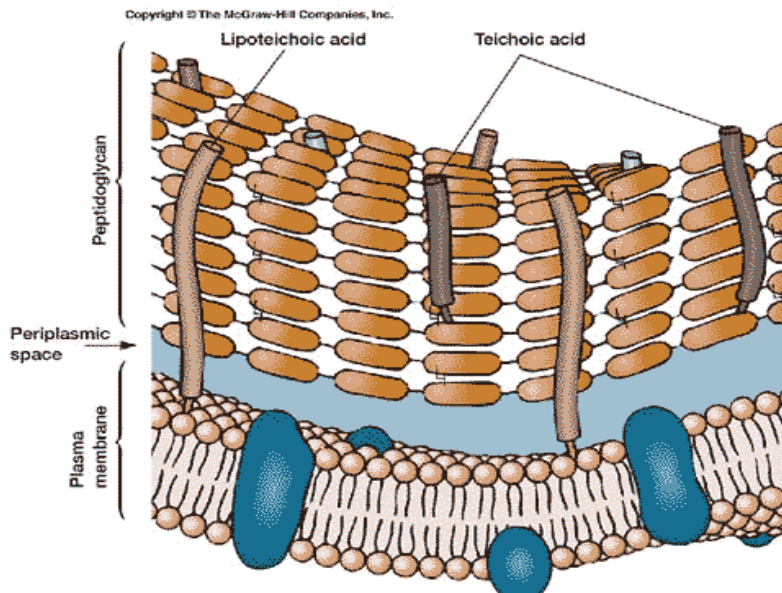
- Layer of phospho-lipids and proteins that separates cytoplasm from external environment.
- Regulates flow of material in and out of cell.

Cell walls

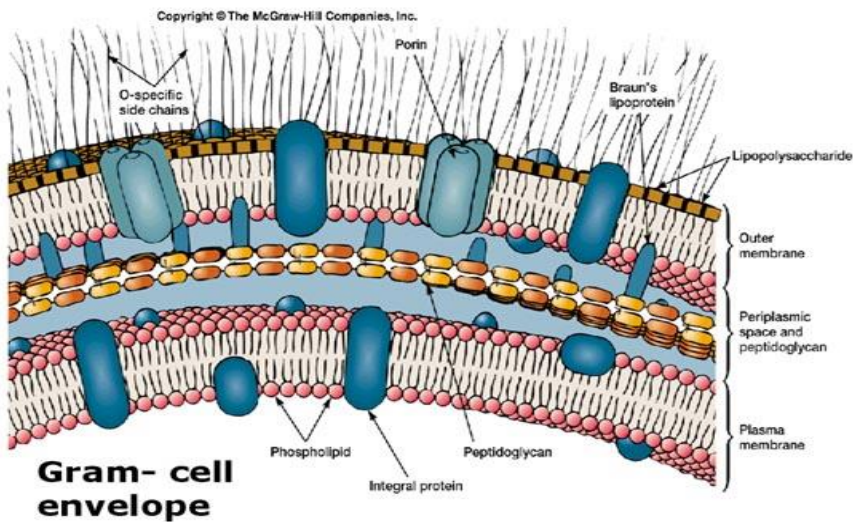
- Bacterial cell wall is unique two broad categories, Gram positive and gram negative
- Gram positive bacteria have a thick, single layered wall. Gram negative - complex multilayered wall thin
- Peptidoglycan layer is present in the cell walls
- In Gram positive bacteria, bulk of the wall is peptidoglycan Gram-negative it accounts for only the innermost layer

- Peptidoglycan consists N-acetylmuramic acid (NAM) and N-acetylglucosamine (NAG) linked by bonds described as β 1-4 linkages
- Gram positive cell walls contain another polymer called *teichoic acid*
- *Mycobacterium*, *Corynebacterium* contain waxy esters of mycolic acids

Cell Wall



- Rigid peptidoglycan - polysaccharide coat that gives the cell shape and surround the cytoplasmic membrane. Offers protection from environment.

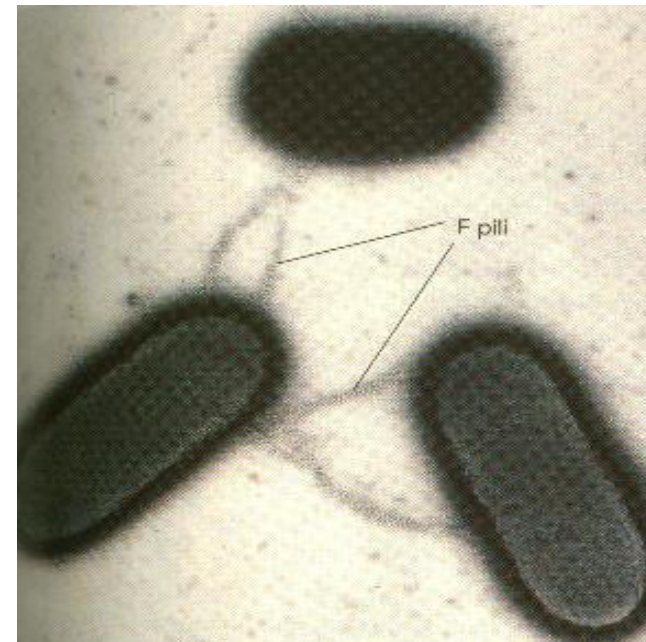


Bacterial cell surface (Fimbriae and Pili)

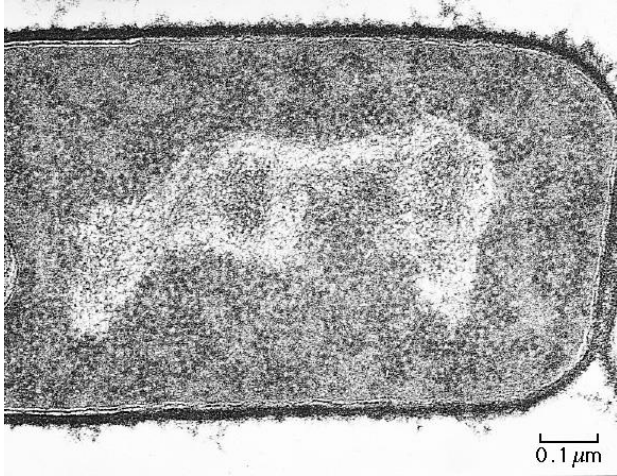
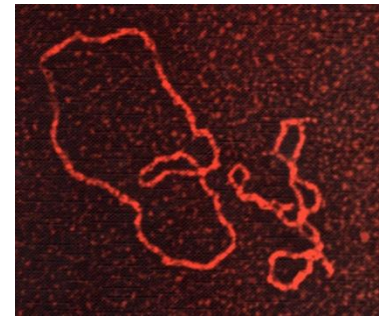
- Some bacteria possess additional hair like structures called fimbriae
- shorter than flagella but numerous
- to stick to a surface
- Pili – specialised pili - conjugation process
- **Glycocalyx (Slime / capsule)**
 - Glycocalyx consists of polysaccharides, with glycoprotein
 - Hinders the engulfing (phagocytosis)
 - Also prevents desiccation.

PILI

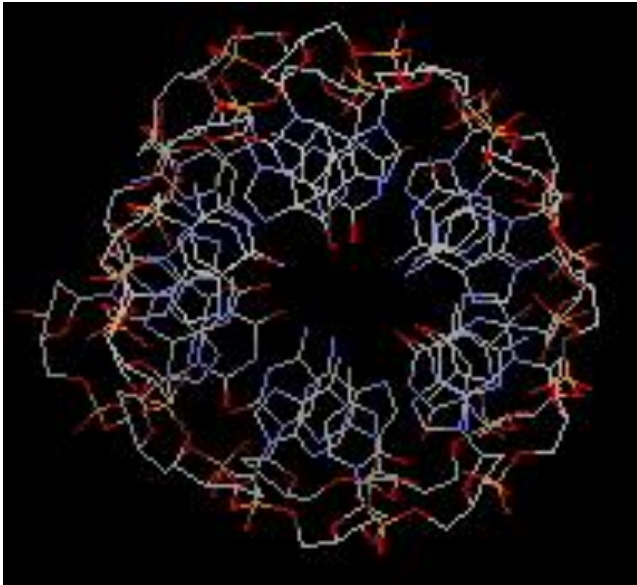
- Short protein appendages
- Smaller than flagella
- Adhere bacteria to surfaces
- Used in conjugation for Exchange of genetic information
- Aid Flotation by increasing buoyancy



Nucleoid



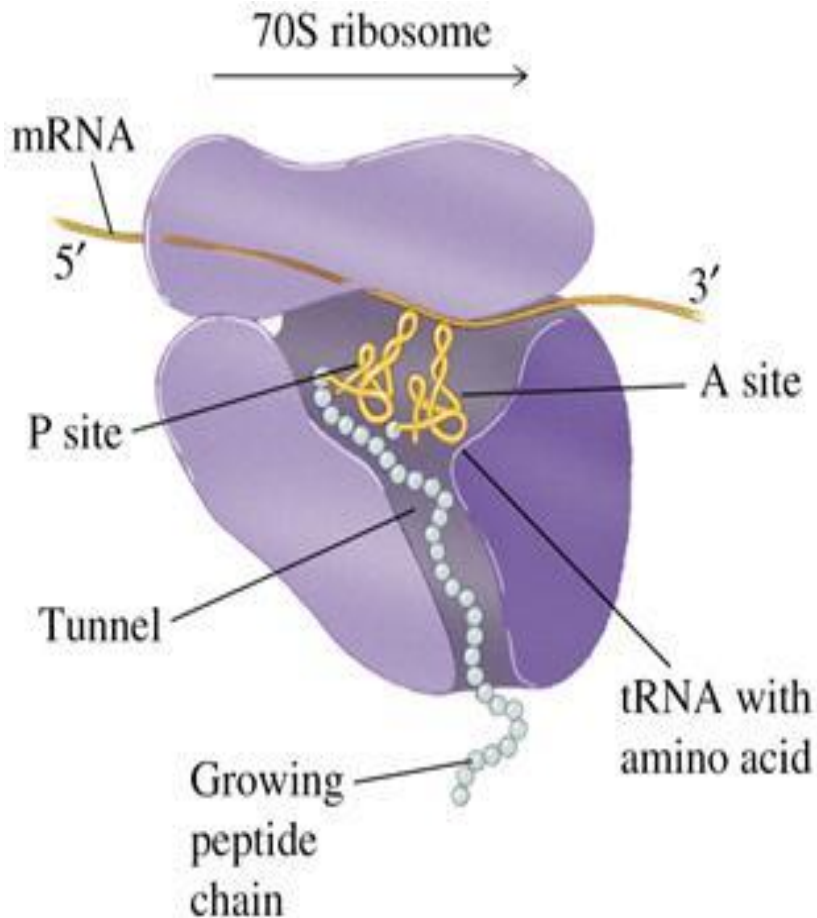
- Region of the cytoplasm where chromosomal DNA is located. Usually a singular, circular chromosome.
- Smaller circles of DNA called plasmids (extra chromosomal DNA) are also located in cytoplasm.



Nucleoid

- Prokaryotic DNA is in circular form
- lack a nuclear envelope
- Bacterial DNA not associated with proteins
- The DNA is highly coiled
- Plasmids
- extrachromosomal circular DNA

Ribosomes



- Translate the genetic code into proteins.
- Free-standing and distributed throughout the cytoplasm.
- Bacterial ribosomes have two sub units 50S and 30S

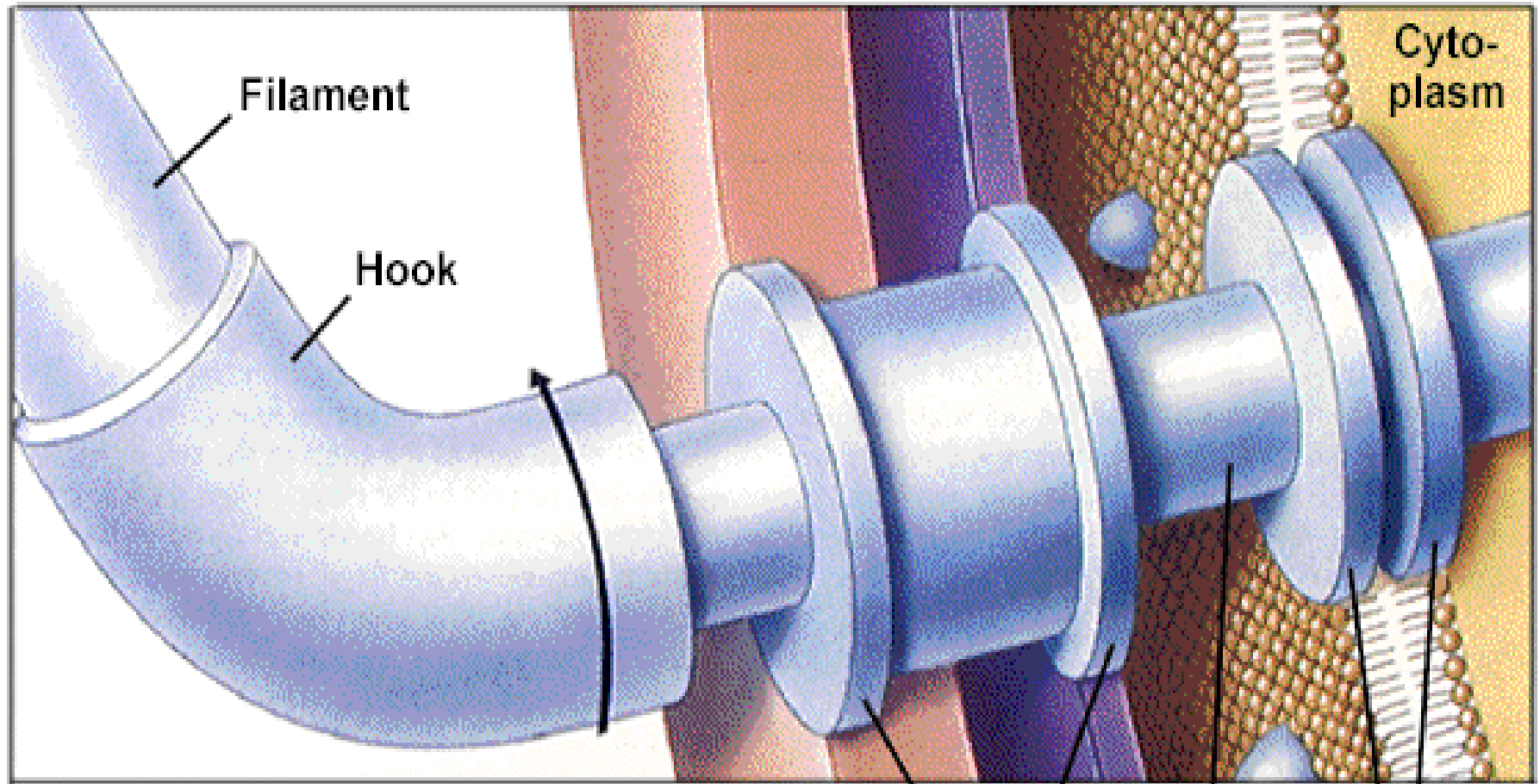
Flagella

- hair-like structures called flagella
- (14 – 20 nm diameter) rotate like a ship's propeller
- protein called Flagellin, flagellar subunits
- basal body rotates the flagellum to cause movement of the cell

Arrangement of flagella

- Monotrichous: Eg. *Vibrio cholerae*
- Amphitrichous : Eg. *Spirillum volutans*
- Lophotrichous: Eg. *Alcaligenes faecalis*
- Peritrichous: Eg. *E.coli*

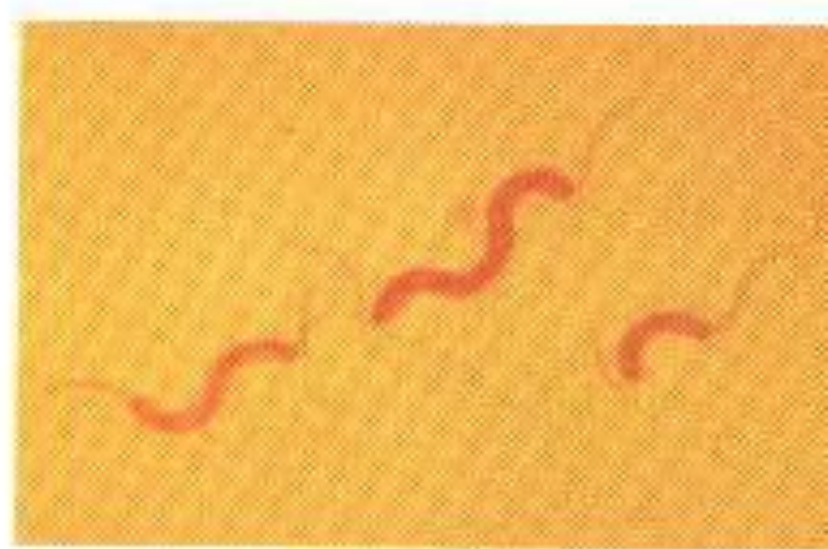
Cell wall
Outer membrane Peptidoglycan Cell membrane



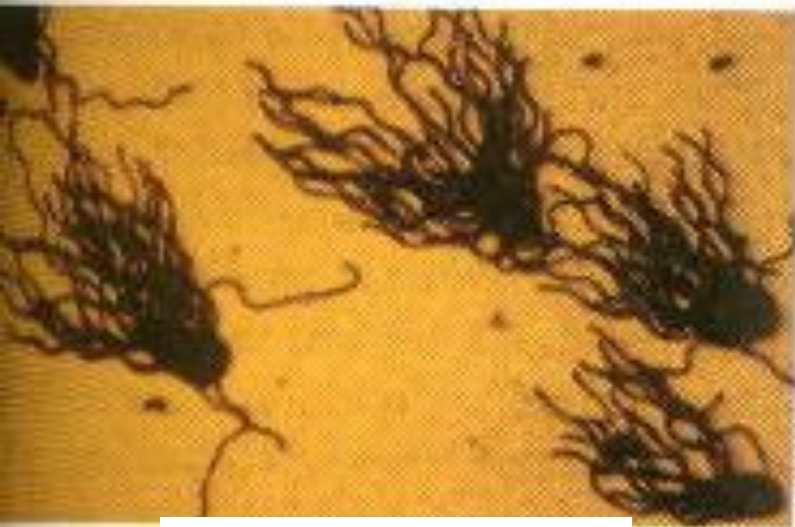
Outer rings Rod Inner rings
Basal body



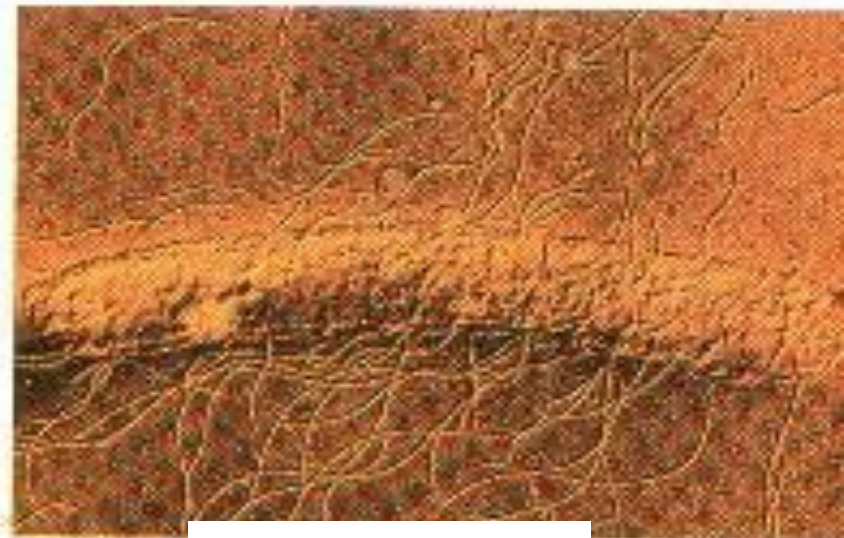
Monotrichous



Lophotrichous



Amphitrichous

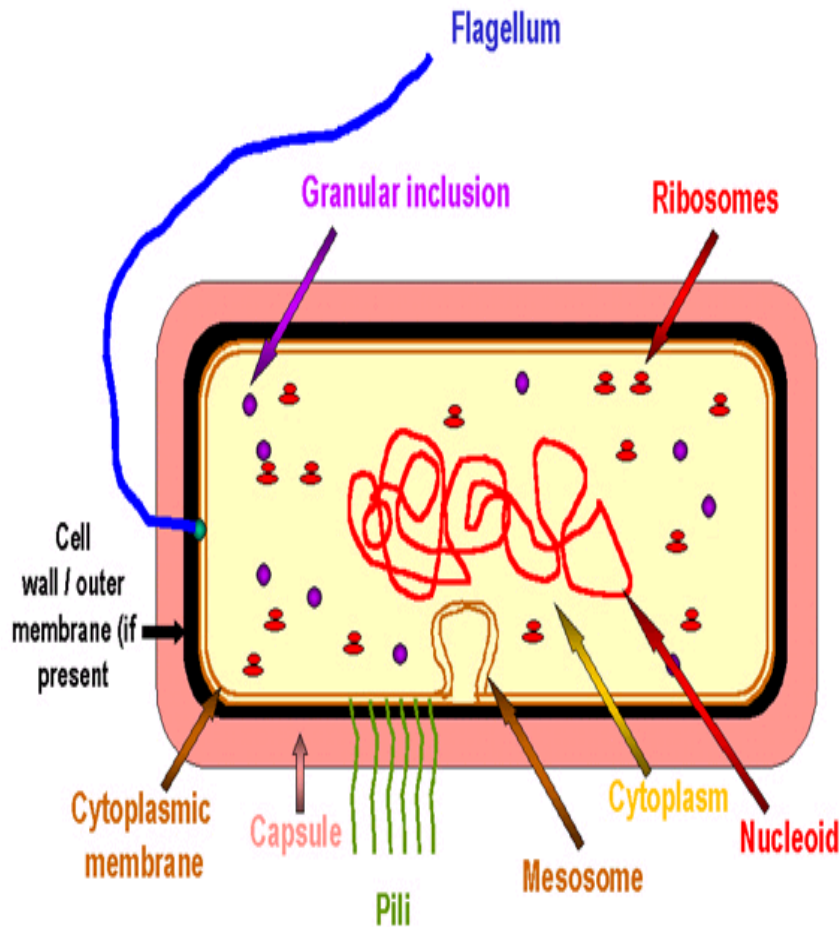


Peritrichous

Chemotaxis and Motility

- Chemotaxis is the movement of an organism towards or away from a chemical
- **Positive chemotaxis** movement towards a chemical (attractant); **negative chemotaxis** movement away from a chemical (repellent)
- Bacterial movement is characterized by runs and tumbles
- when an attractant present it is marked by larger runs and less frequent tumbles

Mesosome



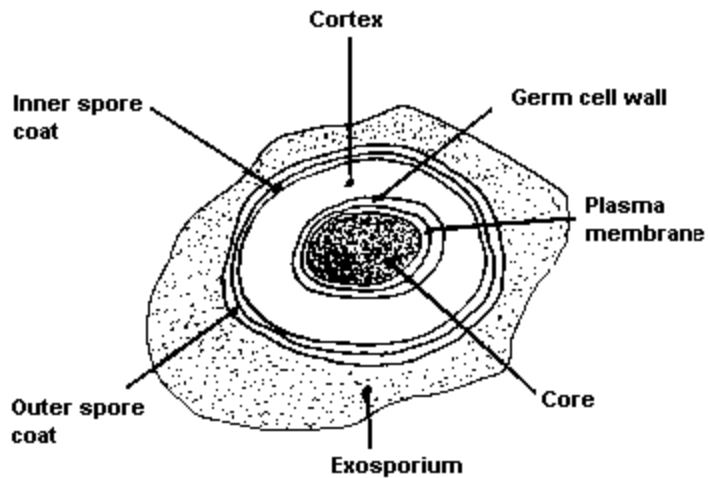
- Infolding of cell membrane.
- Possible role in cell division.
- Increases surface area.
- Photosynthetic pigments or respiratory chains here.

• [Http://www.med.sc.edu:85/fox/protobact.jpg](http://www.med.sc.edu:85/fox/protobact.jpg)

Other structures

- **Inclusion bodies** for storage of materials
- Poly- β – hydroxybutyric acid (PHB), Granules of polyphosphate, volutin granules metachromatic granules generation of ATP and other cell constituents

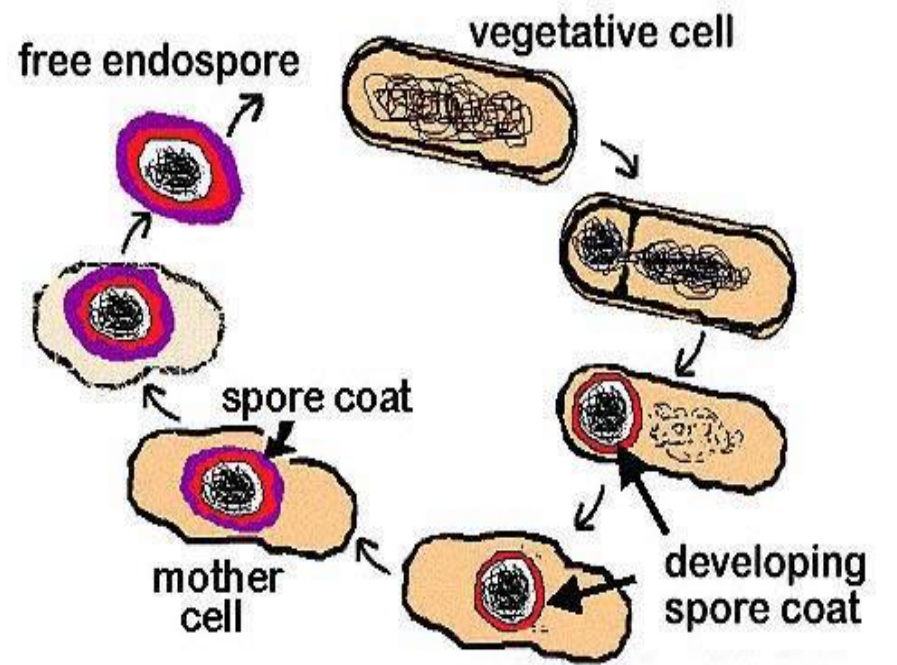
Bacterial endospores



- Bacterial endospore is not a reproductive structure
- Resistant to harsh environmental conditions
- *Bacillus* and *Clostridium* produce endospores
- Endospore is more complex than the vegetative cell
- Dipicolinic acid (DPA)
- Sporulation occurs due to environmental stress

Spore formation

- The sporulation process occurs in four successive stages
- Preparatory stage
- Forespore stage
- Stage of cell wall formation
- Maturation stage

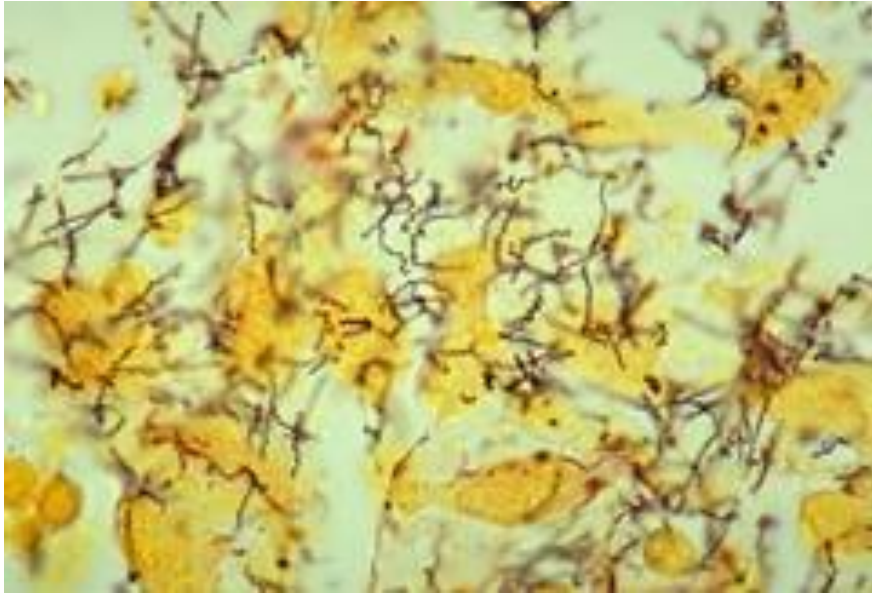


Spirochaetes

- Gram-negative bacteria, long, helically coiled (spiral-shaped) cells.
- Chemoheterotrophic lengths between 5 and 250 μm diameters around 0.1-0.6 μm
- Flagella called axial filaments, cell membrane and outer membrane
- cause a twisting motion which spirochaete will undergo asexual transverse binary fission
- Most spirochaetes are free-living and anaerobic

- **Classification** three families (Brachyspiraceae, Leptospiraceae, Spirochaetaceae),
- Disease-causing members of this phylum *Leptospira* species, *Borrelia burgdorferi*, *Borrelia recurrentis*, *Treponema pallidum*

Spirochaetes



Treponema pallidum
spirochetes

