

Bacteria and oral diseases

و.رنا مشعل

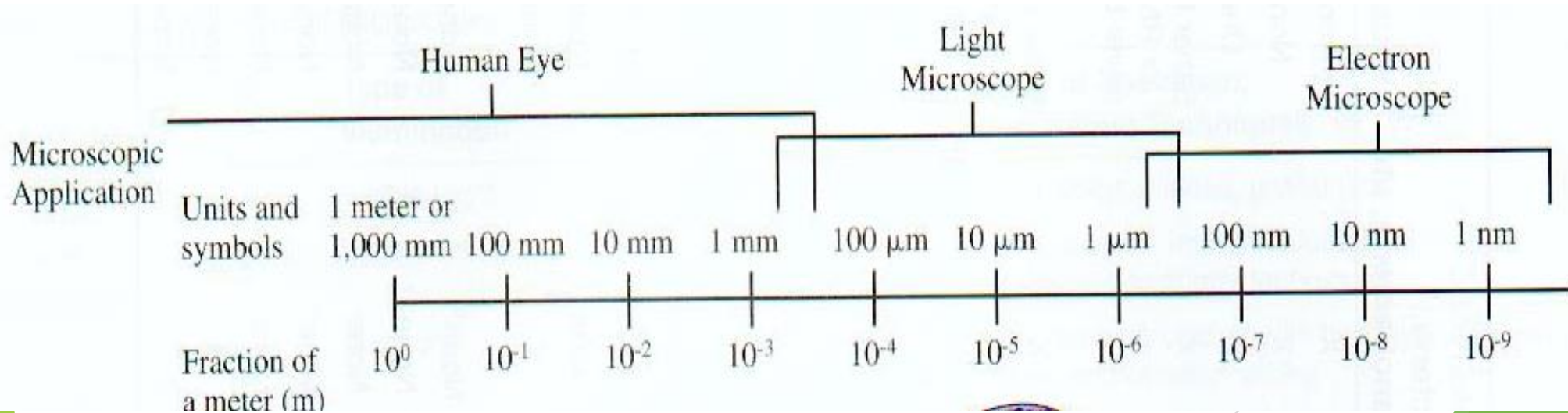
SIZE OF BACTERIA

► Unit for measurement :

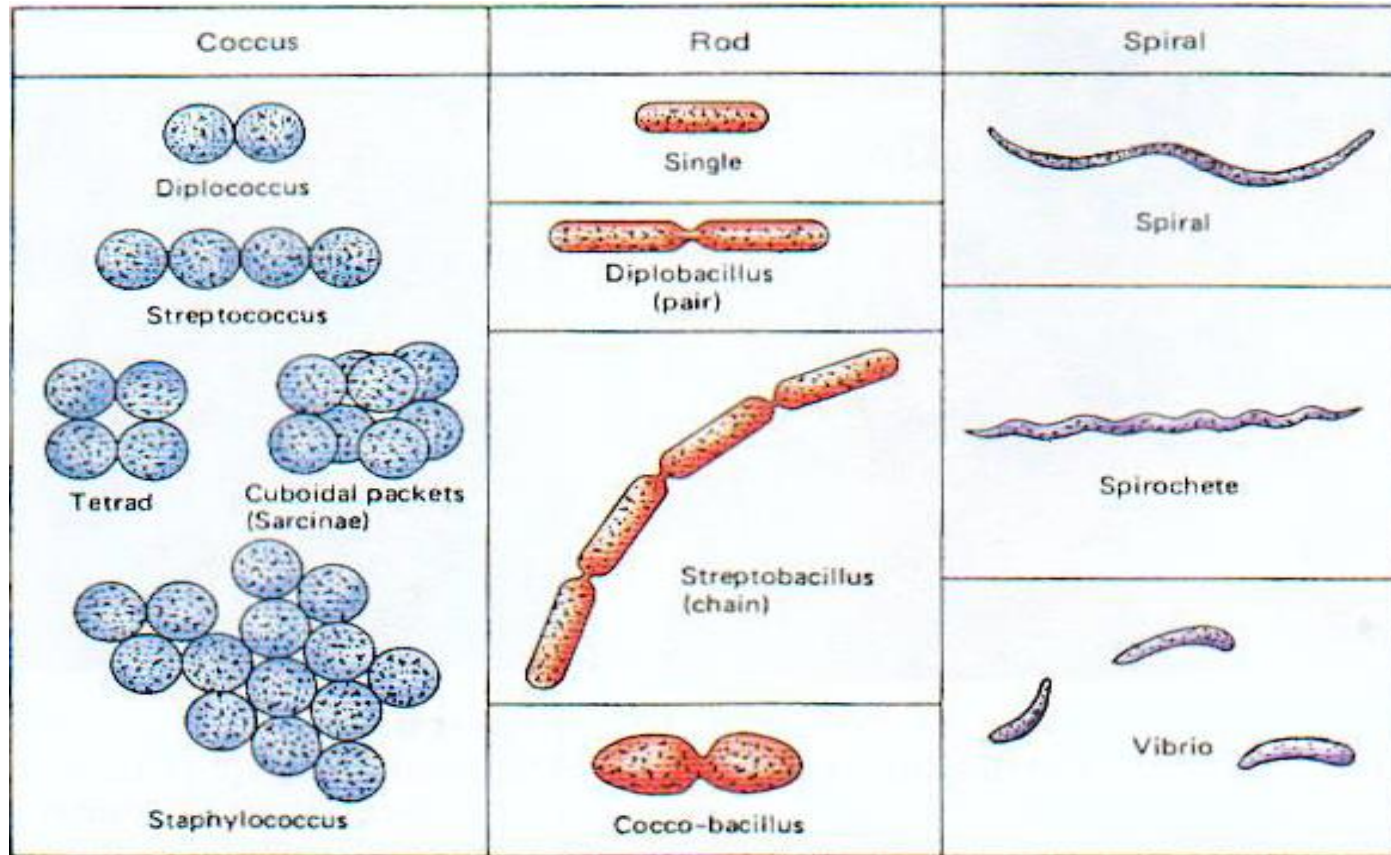
Micron or micrometer, μm : $1\mu\text{m}=10^{-3}\text{mm}$

► Size:

Varies with kinds of bacteria, and also related to their age and external environment.



Shape of Bacteria



- ▶ Cocci: sphere, 1 μ m
- ▶ Bacilli: rods , 0.5-1 μ m in width -3 μ m in length
- ▶ Spiral : 1~3 μ m in length and 0.3-0.6 μ m in width

Structure of Bacteria

Essential structures

cell wall
cell membrane
Cytoplasm
nuclear material

Particular structures

capsule
flagella
pili
spore

Bacterial structure

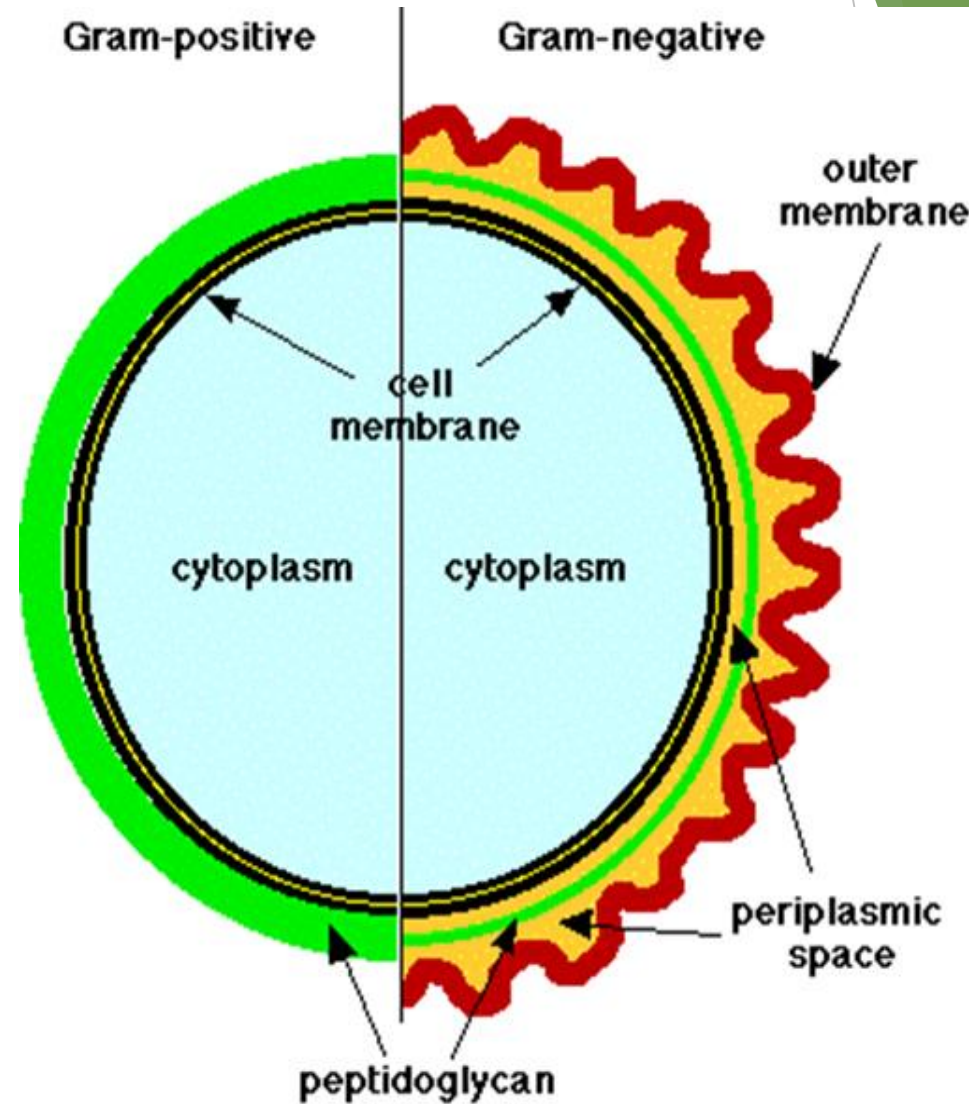
The Bacterial Cell wall:

Gram -ve bacteria, it is composed of:

- 1) Outer membrane
- 2) Periplasmic space
- 3) Cytoplasmic membrane.

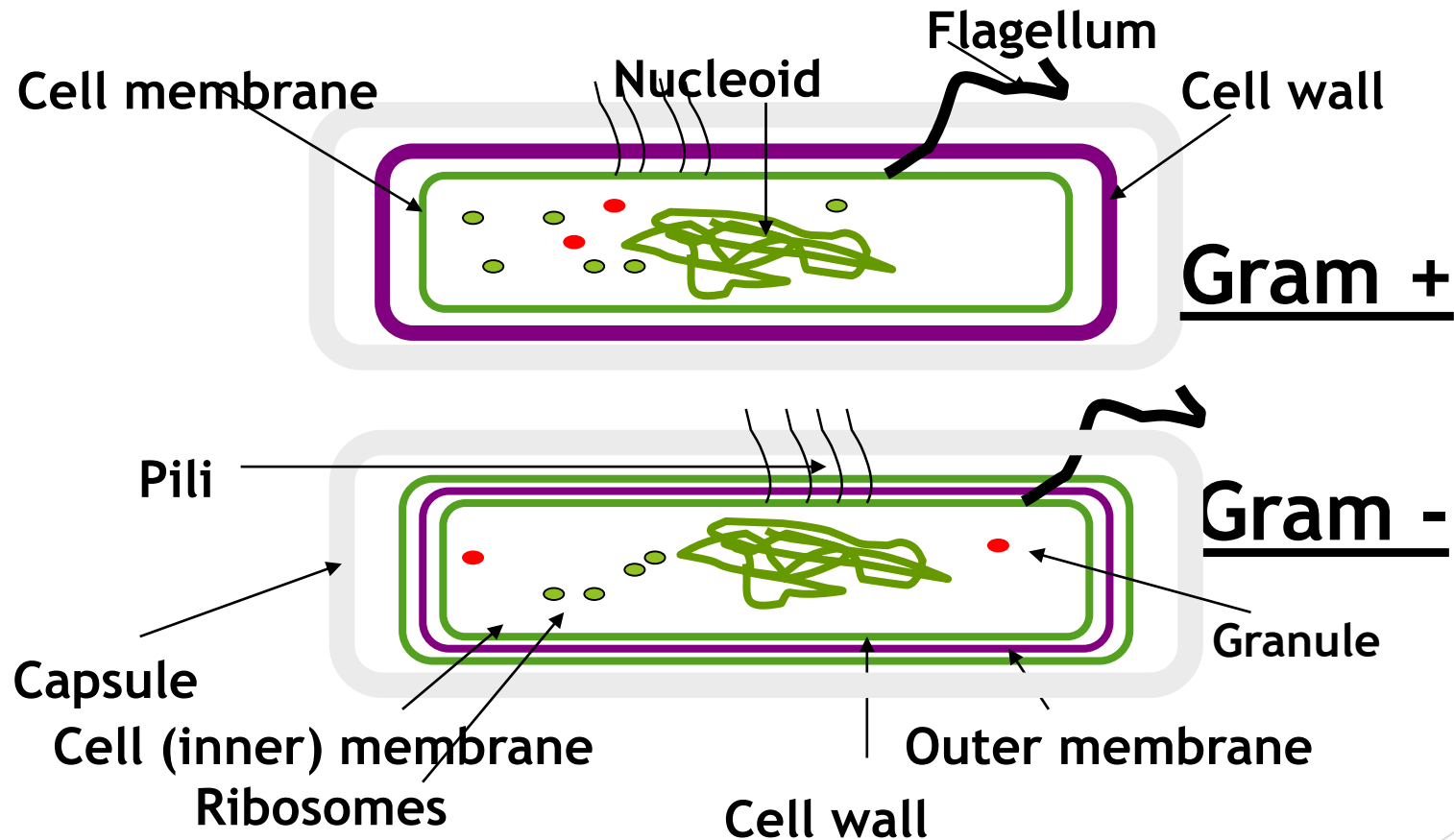
Gram +ve bacteria:

- 1) Thick compact peptidoglycan layer
- 2) No Outer membrane layer
- 3) No periplasmic space,
- 4) Cytoplasmic membrane.a



1884: Christian Gram: First publication for the Gram stain method)

Editor's note: I would like to testify that I have found the Gram method to be one of the best and for many cases the best method which I have ever used for staining Schizomycetes.



Functions of Cell Wall

- ▶ Maintaining the cell's characteristic shape- the rigid wall compensates for the flexibility of the **phospholipid membrane**.
- ▶ Countering the effects of osmotic pressure.
- ▶ Providing attachment sites for bacteriophages.
- ▶ Providing a rigid platform for surface appendages- **flagella**, **fimbriae**, and **pili** all anchored to the wall and extend beyond it
- ▶ Play an essential role in cell division.
- ▶ Be the sites of major antigenic determinants of the cell surface.

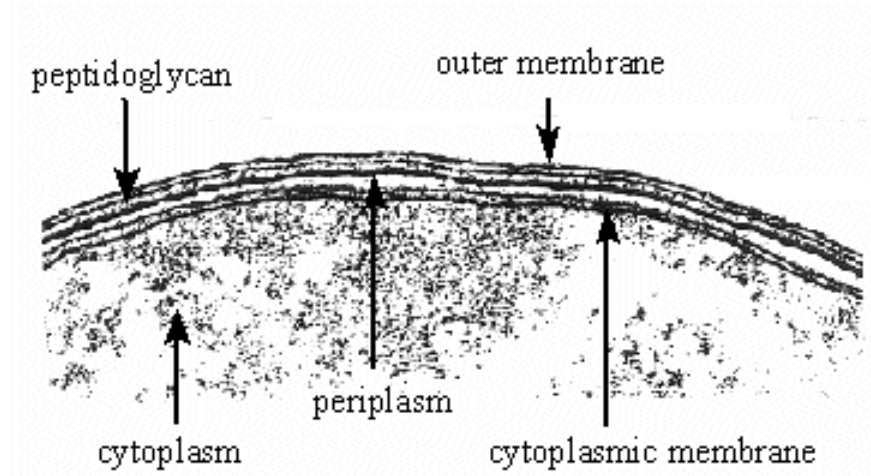
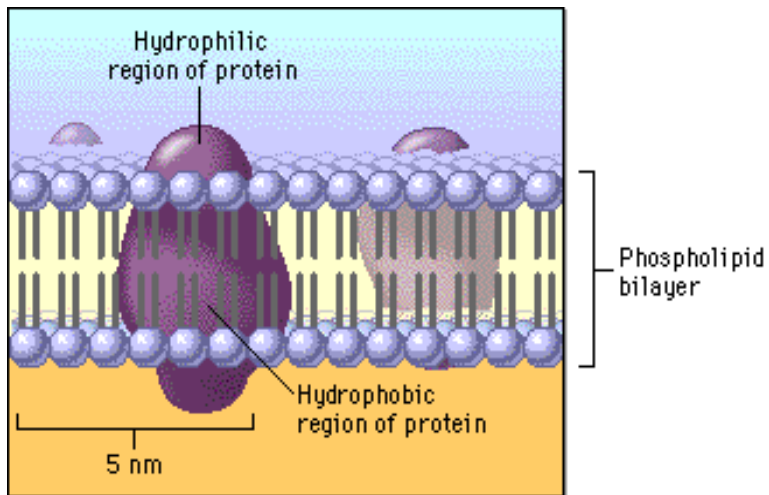
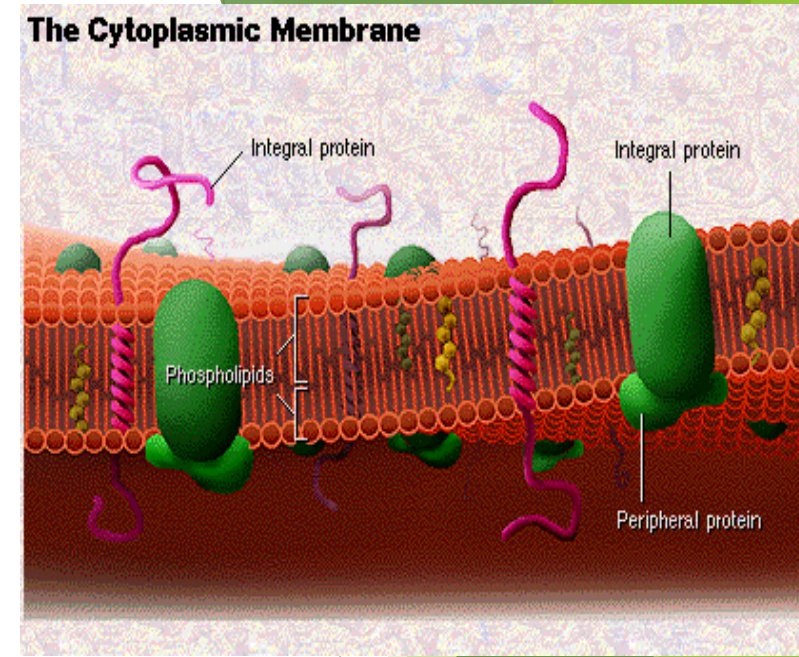
Cytoplasmic membrane

phospholipid bilayer, no steroids (except mycoplasma).

- ▶ It performs electron transport and energy production (replaces mitochondria).
- ▶ Contains enzymes.
- ▶ Contains transport proteins.
- ▶ Contains ion pumps to maintain membrane potential.
- ▶ Contains actin-like protein filaments: helps determine shape of cell, determine site of septum formation for cell division.

Cell membrane

- Site of biosynthesis of DNA, cell wall polymers and membrane lipids. Selective permeability and transport of solutes into cells
- Electron transport and oxidative phosphorylation



Cytoplasm

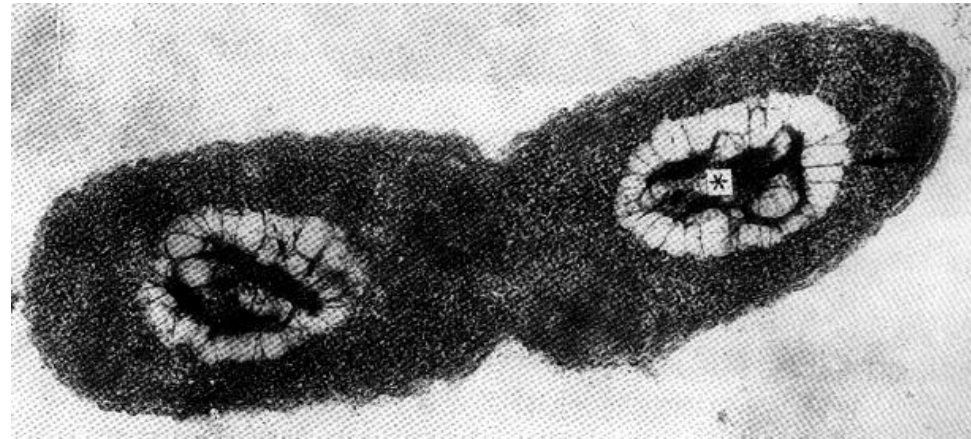
- ▶ Composed largely of water, together with proteins, nucleic acid, lipids and small amount of sugars and salts
- ▶ **Ribosomes**: numerous, 15-20nm in diameter with 70S; Ribosomes are the protein synthesizing factories of the cell.
- ▶ They translate the information in mRNA into protein sequences.
- ▶ distributed throughout the cytoplasm; sensitive to streptomycin and erythromycin site of protein synthesis

Nucleus

- ▶ Lacking nuclear membrane, absence of nucleoli, hence known as nucleic material or nucleoid, one to several per bacterium.

Bacterial chromosome

Single
Circular
Compacted

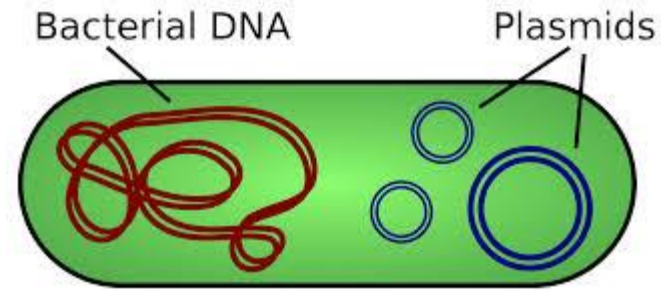


Particular structures

Plasmid

Plasmids are:

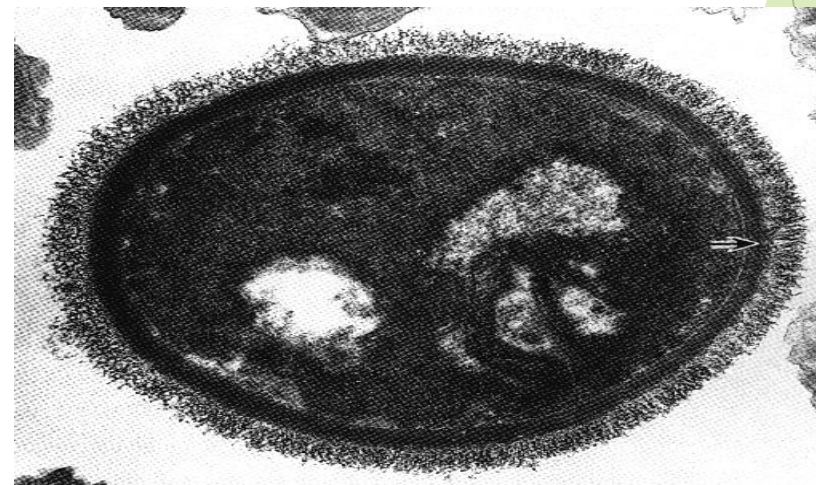
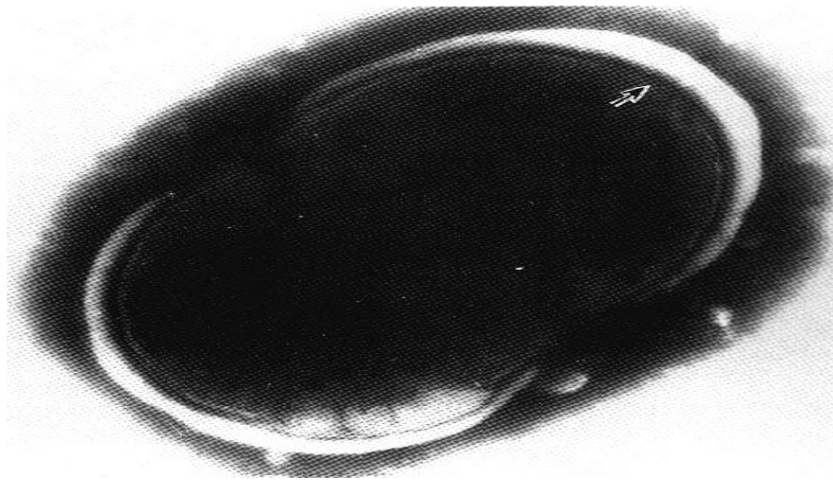
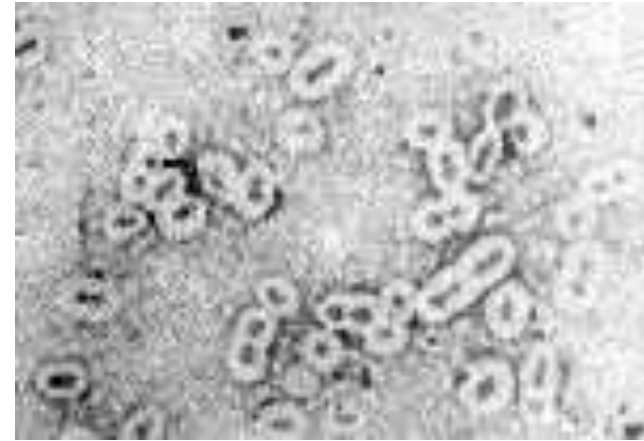
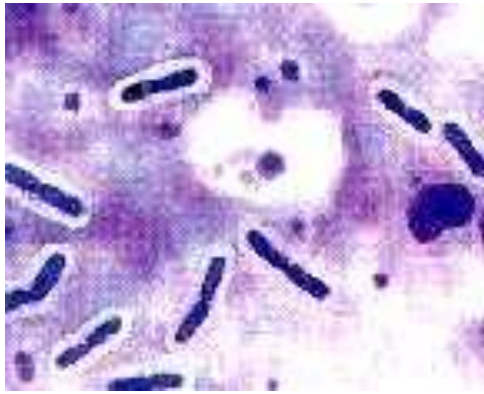
- Small,
- Circular,
- Extrachromosomal,
- They are capable of self-replication and Contain genes that confer some properties, such as antibiotic resistance, virulence factors
- Plasmids are not essential for cellular survival.



Capsules and slime layers

- ▶ **These are structures surrounding the outside of the cell envelope.**
- ▶ **When more defined, they are referred to as a capsule when less defined as a slime layer.**
- ▶ **They usually consist of polysaccharide; They are not essential to cell viability and some strains within a species will produce a capsule, whilst others do not.**

Capsules and slime layers



Function of Capsules and slime layers(1)

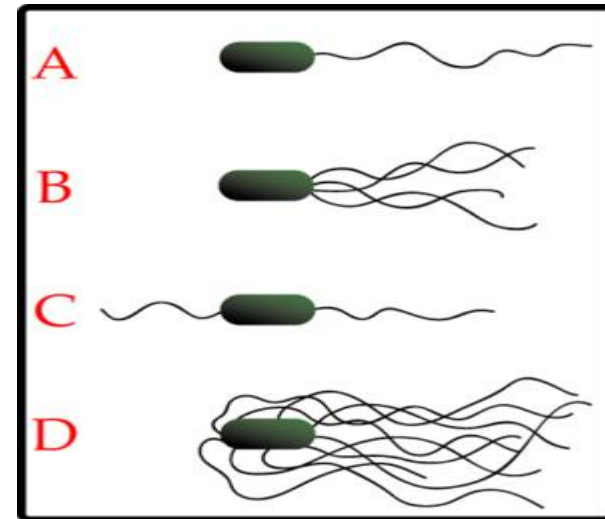
- ▶ **Attachment** :These structures are thought to help cells attach to their target environment.
- ▶ *Streptococcus mutans* produces a slime layer in the presence of sucrose, This results in dental plaque and many bacteria can stick to tooth surfaces and cause decay once *S. mutans* forms a slime layer.
- ▶ *Vibrio cholerae*, the cause of cholera, also produces a glycocalyx which helps it attach to the intestinal villi of the host. Protection from phagocytic engulfment.

Function of Capsules and slime layers(2)

- ▶ ***Streptococcus pneumoniae***, when encapsulated is able to kill 90% of infected animals, when non-encapsulated no animals die.
- ▶ The capsule has been found to protect the bacteria by making it difficult for the phagocyte to engulf the microbe.
- ▶ Resistance to drying. Capsules and slime layers inhibit water from escaping into the environment.
- ▶ Reservoir for certain nutrients.
- ▶ Glycocalyx will bind certain ions and molecules.

Flagella

- ▶ Flagella consist of a number of proteins including **flagellin**. The diameter of a flagellum is thin, 20 nm, and long with some having a length 10 times the diameter of cell.
- ▶ Due to their small diameter, flagella cannot be seen in the light microscope unless a special stain is applied.
- ▶ Bacteria can have one or more flagella arranged in clumps or spread all over the cell.
- ▶ Mono/trichous
- ▶ Amphi/trichous
- ▶ Lopho/trichous
- ▶ Peri/trichous
- ▶ Used in Identification of Bacteria
- ▶ Contribute to Pathogenesis
- ▶ Motility of bacteria



Pili

- ▶ Pili are hair-like projections of the cell , They are known to be receptors for certain bacterial viruses.
 - ▶ Chemical nature is pilin
- Sex pili:** longer and coarser, Conjugation, as it is called, is one explanation for the rapid spread of drug resistance in many different species of bacteria.



Spores

- ▶ The mechanisms that account for this include the dehydration of the protoplast and the production of special proteins that protect the spores DNA.

Are capable of detecting their environment and under favorable nutrient conditions germinating and returning to the vegetative state.



Bacteria and oral cavity

- ▶ Bacteria that reside in the oral cavity take a unique and fascinating habitat. The mouth is the only part of the body where hard tissues (the teeth) are naturally exposed to the external environment.
- ▶ a diverse ensemble of bacteria firmly adhere to and grow on the teeth to form a complex biofilm known as dental plaque. Antagonistic interactions, such as acid production by species that inhibit the growth of acid-sensitive organisms or the overt production of antibiotics by certain species in oral biofilms, also help dictate the composition of dental plaque.
- ▶ The complexity of the oral microbial ecology is the mouth also possesses a variety of other surfaces, including the buccal and mucosa, hard palate, tongue, and the floor of the mouth, all of which provide unique habitats for microbial colonization.
- ▶ Finally, the oral tissues are bathed in saliva, which provides physical cleansing as well as host immune defense factors that together have profound for the microbial ecology.

- ▶ The vast majority of oral diseases arise from a perturbation in the homeostatic mechanisms of oral biofilms, generally driven by environmental changes, such as dietary changes or diminished salivary flow from radiation or hyposalivation-inducing drugs.
- ▶ Saliva contains approximately (10^8) bacteria per milliliter. Saliva also contains digestive enzymes and a number of anti-microbial compounds including;
 - ▶ ◦ Secretory IgA
 - ▶ ◦ Lysozyme
 - ▶ ◦ lactoferrin.
- ▶ The presence of oral commensal flora provides protection from overgrowth by pathogens including *Streptococcus pyogenes*, *Streptococcus pneumoniae*, and *Candida albicans*.


- ● pathogenesis is multi-factorial and results from the interaction of the body and its defense mechanisms with products from bacterial plaque.

The mouth is colonized by a characteristic commensal microflora, including bacteria, fungi, viruses and occasionally protazoa.



Change of oral flora by age:

Time during a lifetime	MAJOR COMPONENTS & CHANGES IN ORAL FLORA
Newborn	Oral cavity sterile. Soon colonised by facultative and aerobic organisms; esp <i>S. salivarius</i>
6 months	Flora becomes more complex & includes anaerobic orgs eg. <i>Veillonella sp.</i> & <i>Fusobacteria</i>
Tooth eruption	Increase in complexity. <i>S sanguis</i> , <i>S mutans</i> and <i>A viscosus</i> appear. New habitats include hard surfaces and gingival crevice.
Child to adult	Various anaerobes frequently found inc. Members of the <i>Bacteroidaceae</i> . <i>Spirochaetes</i> isolated more frequently
Loss of teeth	Disappearance of <i>S mutans</i> , <i>S sanguis</i> , <i>spirochaetes</i> and many anaerobes
Dentures etc	Reappearance of bacteria able to grow on hard surfaces

- 
- ▶ many factors affect microbial flora at different sites due to conditions at these sites vary with respect to:
 - ▶ □ Oxygen levels and anaerobiosis.
 - ▶ □ Availability of nutrients
 - ▶ □ Exposure to salivary secretions
 - ▶ □ Mastication forces
 - ▶ □ other variables such as oral hygiene

Oral infections

- ▶ Origin of infection:
- ▶ Oral infection may arise from:
 - ▶ a- Endogenous source involving microorganisms normally found in the mouth such as those associated with the plaque, related conditions of caries and periodontal disease.
 - ▶ b-exogenous source
 - ▶ ● less common than endogenous infections
 - ▶ ● subdivided into:
 - ▶ 1. Primary infections such as herpes simplex or primary syphilis
 - ▶ 2. Secondary manifestations of systemic infections, such as oral tuberculosis and secondary syphilis.