Bacteriology

Basic features of bacteria

Bacteria form a large group of parasitic, saprophytic, and free-living microorganism

1. Bacterial cell wall (protects against osmotic damage)

Bacterial cell is prokaryotic. Contains high concentration of inorganic ions and requires as strong cell wall to prevent fluid being drawn into and lysing the cell. The cell wall is strengthen by mucopeptide polymer **(peptidoglycan**)

Chemically: the rigid part of cell wall is peptidoglycan: this is a mucopeptide composed of a strand of alternating N-acetylglucosamine and N-acetylmucramic acid molecules

- Protects the cell from mechanical disruption
- Osmotic protection
- Provides a barrier against certain toxic chemical and biological agent
- Being rigid responsible for the shape of the cell
- Antigenic determinant of the cell surface

A century ago by the Danish microbiologist **Hans Christian Gram,** * gram stain

Differences in the composition of bacterial cell walls, lead to differences in the staining of bacteria. The most important staining procedure is the gram staining, by this the organism is classified as gram positive (purple in color) or gram negative (red in color) depending on whether they retain the stain crystal violet (**gram positive**) or are decolorized and take up the red counter stain (**gram negative**).

He main differences between the cell walls of gram positive and gram-negative bacteria are as follows

	Gram positive bacteria (G+)	Gram negative bacteria (G-)
Cell wall	Large amount of **peptidoglycan** and **teichoic** acid	Small amount of peptidoglycan
	Additional carbohydrate and proteins according to species	Outer layer of cell wall contains lipo-polysaccharide molecules (endotoxine) (LPS) and phospholipids

Gram negative

Highly complex, multilayer structure. The cytoplasm membrane (called **inner membrane**) in gram negative bacteria is surrounded by single planner sheet of peptidoglycan to which h is anchored a complex layer called **outer membrane**

The space between the inner and outer is called **periplasmic space;** the membrane of the gram-negative bacteria is rich in lipids.

The outer-membrane of the gram-negative cell wall is anchored to underlying peptidoglycan Braun's lipoprotein. The membrane is bilayered structure consisting mainly of phospholipids, proteins and lipopolysacharides; the lipopolysacharieds has toxic properties and is known as endotoxines. It is occurs in outer layer of membrane and its composed three covalently linked parts

A. Lipid A firmly embedded in the membrane
B. Core polysaccharides located at the membrane surface
C. antigen extend like whiskers from the membrane

2. protoplast, spheroplast, L-form

- protoplast

  a bacterium is referred to as a protoplast when it is without cell wall. The cell wall is lost due to the action of lysozome enzymes that destroy peptidoglycan or blocking the synthesis of peptidoglycan with an antibiotic such as Penicillin.

- Spheroplast

  Bacteria with damaged cell wall. The damage is cause by the action of toxic chemical or an antibiotic such as Penicillin can changed to there regular fore if grown on a culture media

- L-form

  Mutant bacteria without cell wall

3. Bacterial capsule

Many bacteria secrete around themselves a polysaccharide substances often referred to as slim layer.
*India ink preparation
* Pathogenicity (not phagocyte and destroyed by host cell)

4. flagella and pili

Flagella are third like structure composed of proteins

- they are the organ of locomotion
- made up of proteins (flageline)
- they are highly antigenic (H antigen)

Three types of arrangement

- monotrichous: single polar flagellum
- lophotrichous multiple polar flagellum
- peritrichous flagella distributed over the entire cell

Pili (fimbriae) (short hair like structure)

many gram-negative bacteria possess rigid surface called pili, they are shorter and fine than flagella like flagella composed of structural proteins subunits know as pilins
Enable the organism to adhere to host tissues and to one another
Virulence factors
certain enteric bacteria are able to form a specialized pili called F pili (Sex pili) which enable DNA material to be transferred from one bacterium to another (conjugation), *antibiotic resistance

F pili also possess receptors to which viruses become attached (bacteriphage) to transfer genetic characteristic from one bacterial strain to another b means of bacteriophage.

Cytoplasmic membrane
It is also called? *
Structure
It has composed of phospholibids and proteins, the membrane of prokaryotes distinguished from eukaryotes bye the absence of sterols

1. Mesosomes

There are two types

- ❖ Spetal mesosomes which involve in the cell division (forming cross wall)
- ❖ Lateral mesosomes the (bacterial DA is attached to spetal mesosomes)
- ❖ Amino acid and number of granules

2. Single piece of double stranded DNA
3. Ribosome’s
4. Water
5. Inorganic ions
6. Mitochondrial granules
7. Certain bacteria contains the plasmid (extra pieces of chromosome material DNA that can exchange between bacterial cells through the specializes sex pili

This is one of the antibiotic resistances*

Function of the cell membrane

1. Selective permeability and transports of solutes
2. Electron transports and oxidative phosphorylation in aerobic species
3. Excretion of hydrolytic exoenzymes
4. Bearing the enzymes and carrier molecules that function in the biosynthesis of DNA, cell polymers and membrane lipids
5. Bearing the receptors and other proteins of the chemtactic and other sensor transduction system

Spores formation
When conditions for vegetative growth are not favorable, especially when carbon and nitrogen become unavailable,
e.g. *Bacillus* and *Clostridium*

sproulation:
the sporulation process begin when neutritonal conditions become unfavorable
sporulation process beings with formation of an axial filament, the process continues with an enfolding of the membrane to produce a double membrane structure
the grow pints move progressively toward the pole of the cell so as to engulf the developing spore
the two spores membrane now engage in the active synthesis of special layer that will form the cell envlope the spore wall and the cortex, lying between the facing membrane And the coat and exosporium lying outside the facing membrane

properties of endospores

- Core spore protplast it contains a complete nucleus (chromosome)
- Spore wall inner most layer surrounding inner spore membrane
- Cortex the thicker layer of the spore envelope
- Coat compose of a keratin like protein
- Exosporium is lipoprotein membrane containing some carbohydrate

- Germination process occurs in three stages

- activation
  - most endospore cannot germinate immediately after they formed after several days can germinator activated by using rich medium

- Initiation
  - Once activated spore will germinate if environmental conditions are favorable

- outgrowth
  - degradation of the cortex and outer layer resulting in the emergence of new vegetative cell consisting of the spore protoplast with its surrounding wall

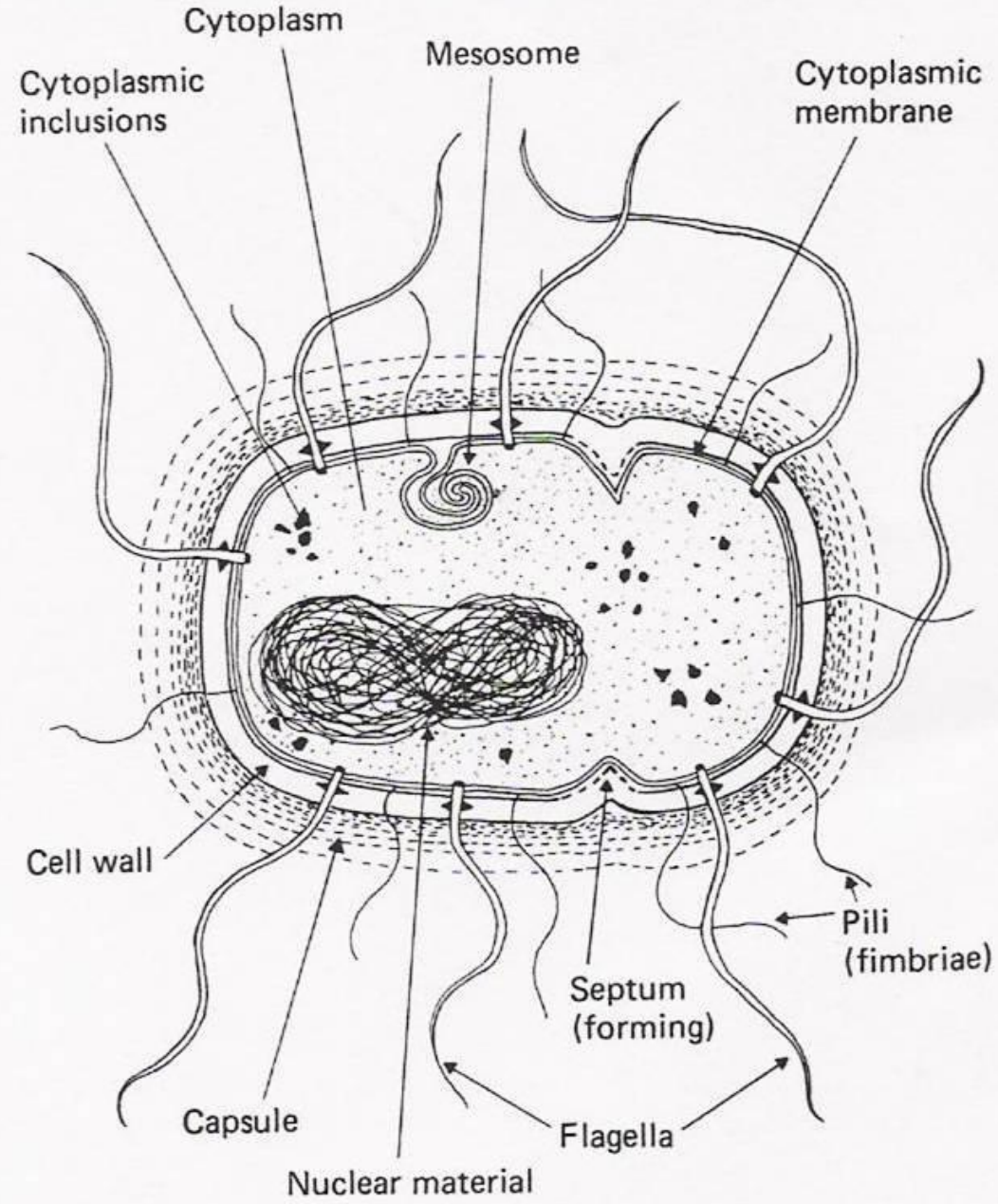

Fig. 32.1 Diagram of a typical but composite bacterial cell.

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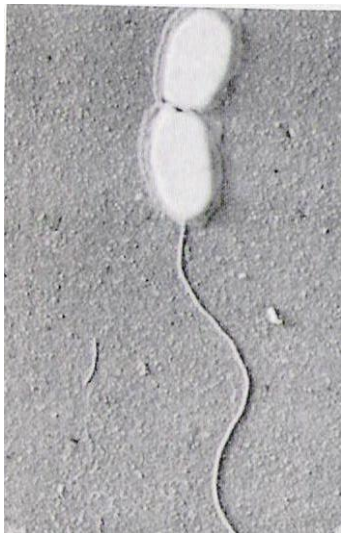

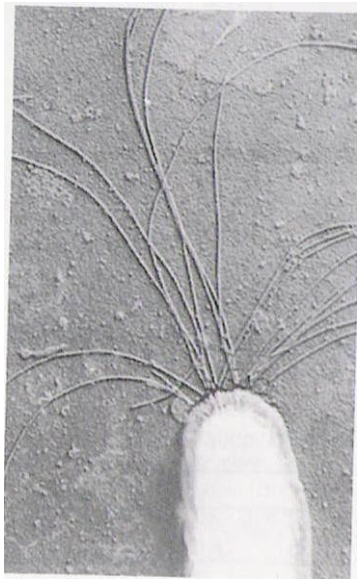

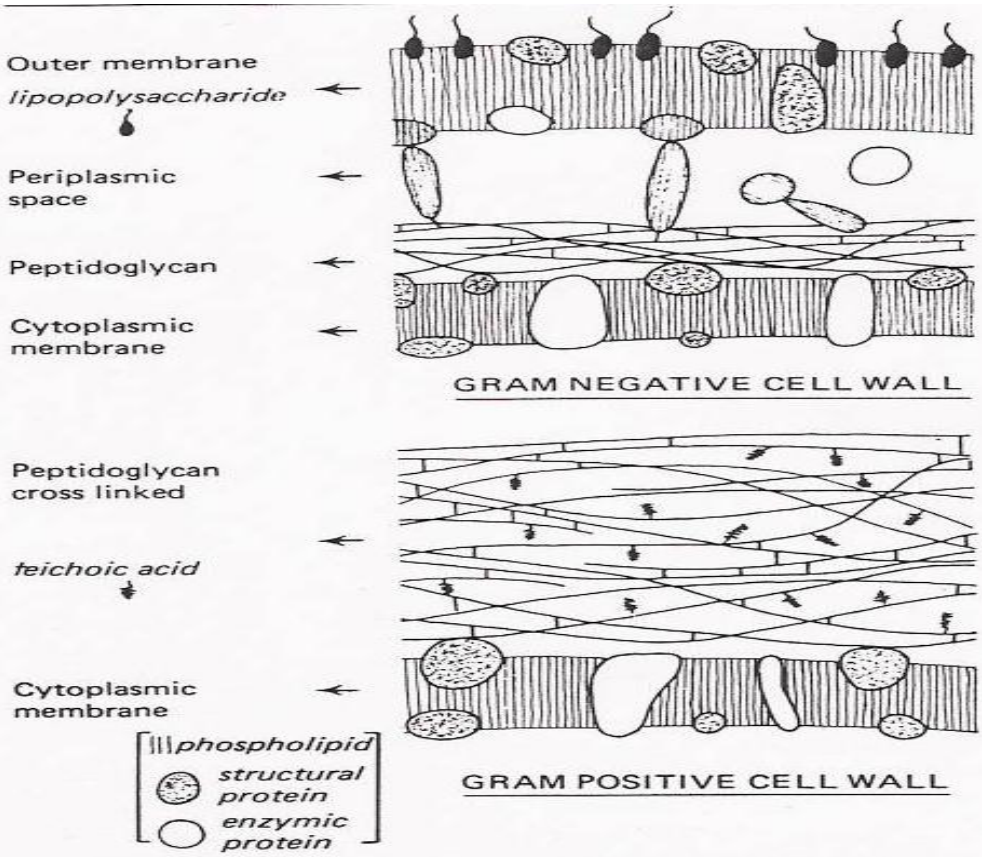

Fig. 32.2 Diagram to show the structure of Gram positive and Gram negative bacteria.
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Aerobic and anaerobic bacteria

Many bacteria obtain there energy from oxidation or fermentation of simple carbohydrates. These metabolic reaction are brought about by the different enzyme systems found in bacterial cells
Depending on the atmospheric requirements, an organism can be described as:

- Obligatory (strict) aerobe: e.g. *Pseudomonas aeruginosa*
- Microaerophilic organism: e.g. *Compylobacter jejuni*
- Obligatory (strict) anaerobic: *Clostridium tetani*
-
- Facultative anaerobe: e.g. *Streptococcus pyogenes*
- Carboxyphilic e.g. *Neisseria meningitidis*

Reproduction of fungi
Bacteria multiply by simple cell division know as binary fission (splitting into two). the single piece of double strand DNA reproduces its self exactly.
Mutation: transmissible variation through changes in morphology and physiology of bacteria (temporary).

Taxonomy and classification

1. Classification: the division of organism into ordered groups
2. Nomenclature : the labeling of the groups and of individual members within groups or is naming the organism by international rules according to its characteristic

Identification refers to practical use of classification

- isolate and distinguish desirable organism
- verifying special properties
- isolate and identify the causative agent of a disease

3. Antigenic differentiation

   The arrangement of organisms into taxonomic group (taxa) based on similarities or relationship

Criteria for classification of bacteria

- Cell shape
- Presence or absence of specialized structures
- Staining procedures Gram staining
- Production of some pigments
- Certain enzymes (extra cellular)….haemolysis
- Immunological cross-reaction

Molecular biology*

Genetic instability* e.g. antibiotic resistance

Ewing classification

Depends on phenotypic properties and classified into eight trips seven of them are humming beings the rest are plant pathogen. Those formed of different genre which as some biochemical and diagnostic criteria

Berge's manual system

Based on DNA relation, classified into fourteen genre and there are 6 additional

CDC central disease control

Based on DNA classification and phenotypic characteristic

Description of the major categories and groups of bacteria

There are two different groups

Eubacteria

Archaebacteria

Eubacteria contains the more common bacteria

The other doesn't produce the peptidoglycan , and they live in extreme environment and carry unusual metabolic reaction

3. Antigenic differentiation

- serotypes a single bacterial strains or type, defined by antigenic structure
- sero-groupe a group of serologically related organism

Classification according to morphological characteristic

- Cocci ,,,,coccus
- Rods bacilli,,,, bacillus
- Vibrios ,,,vibrio
- Spirilla,,, spirillum
- Spirochaetes

Cocci :

Round oval bacteria measuring about 0.5-1 um in diameter, when multiply they form pairs, chains, or groups

- Cocci in pairs called diplococci.g. *Meningococcal*
- Cocci in chain called streptococci for e.g. *Staphylococcus pyogenes*
- Cocci in irregular group (clusters) called staphylococci e.g. *staphylococcus aureus*

Gram reaction staphylococci and streptococci are gram positive, where diplococcic are can be gram negative or positive

Rods (bacilli)

theses are stick like bacteria with rounds tapered (fusiform) square or swollen ends they measures 1-0 um in length , the short roads with rounded ends called coccobacilli , when multiply they don't attach to each other

- chain e.g. streptobacillus species
- Branching chain e.g. lactobacilli
- Mass together. *Mycobacterium leprae*
- remain attached at various angles resemble Chinese letters e.g. *Corynebacteriaum diphtheriae*

Bacillus genus and clostridium are able to form resistant spores

Many roads having flagella

Gram reaction

Many roads are gram negative such as large group of *enterobacteracae*

Gram-positive roads include clostridium, *Corynebacterium*

And *bacillus* sp, *Lesteria moncytogenes*

Coccobacilli such as *yersinia*

Vibrios

Curved roads measuring 3 -4 um in width

Most of vibrio is motile with a single flagellum at one end

Showing darting motility e.g. *vibrio chol*era

Gram reaction vibrio is gram negative

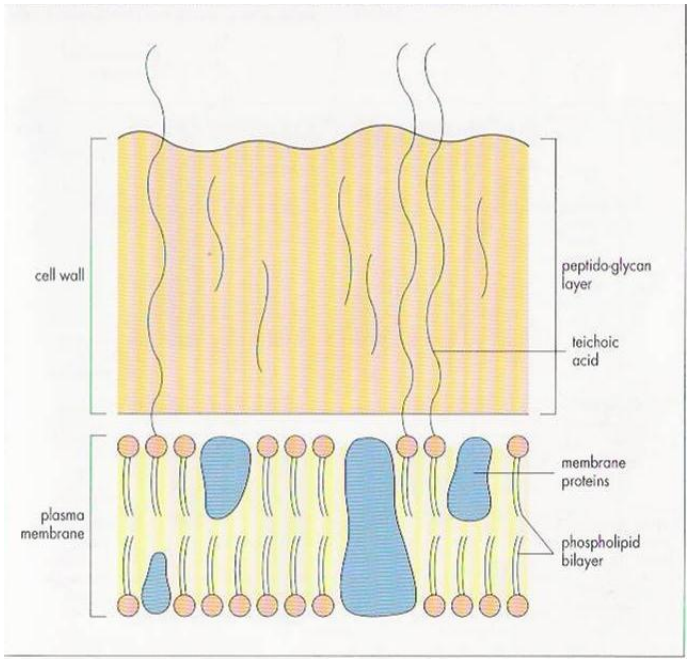
Spirilla

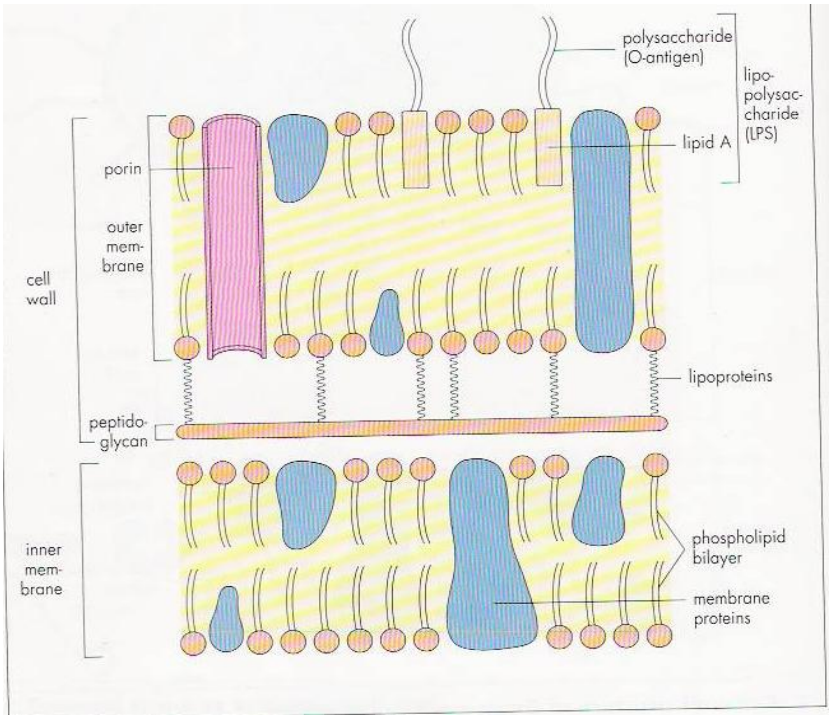
These are small regularly coiled, rigid organism measuring about 3-4 um in length each coil measuring about 1 um
Spirilla are motile with groups of flagella at both ends e.g. spirillum minus
Gram reaction spirilla are gram negative

Spirochaetes

These are flexible, coiled, motile organism they progress by rapid body movement most are not easily stained by gram method
Spirocheates divided into three main groups

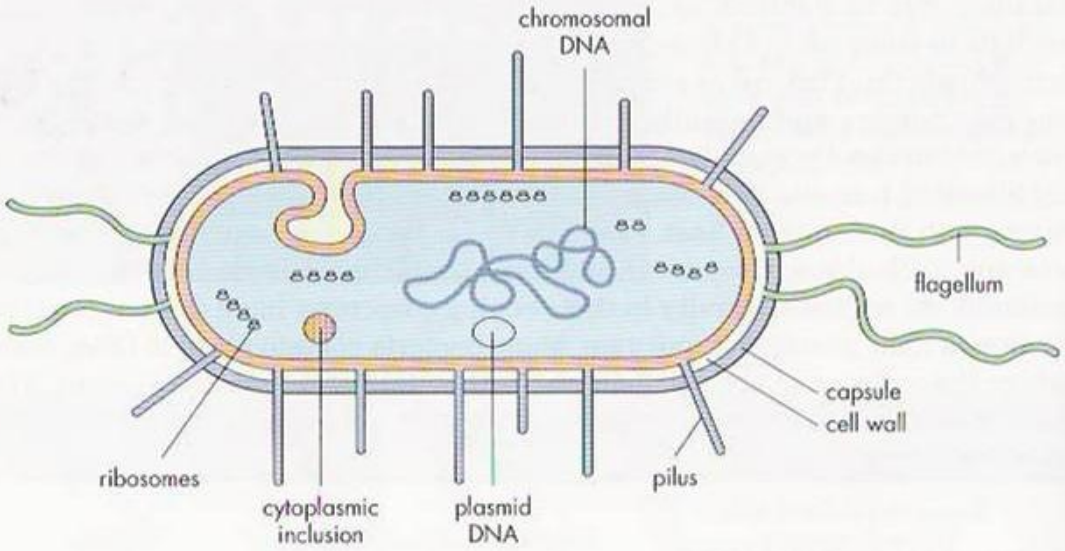
- Treponems, thin delicate spirocheates with regular tight coils e.g. Treponema pallidum
- Borreliae, large spirochetes irregular open coils m e.g. Borrelia duttoni
- Leptospires thin spitocheates many tightly packed coils that are difficult to distinguish


cell wall
peptido-glycan layer
teichoic acid
membrane proteins
plasma membrane
phospholipid bilayer

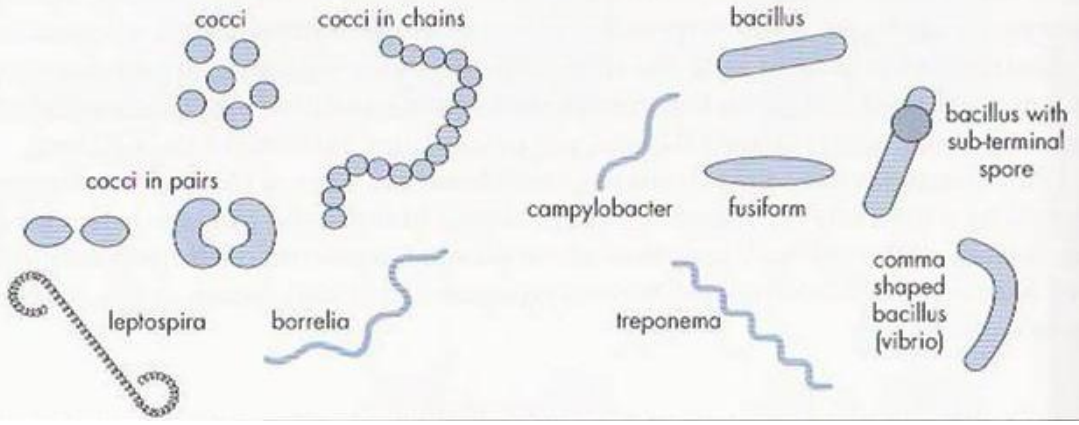

polysaccharide (O-antigen)
lipo-polysac-charide (LPS)
lipid A
porin
outer mem-brane
cell wall
lipoproteins
peptido-glycan
inner mem-brane
phospholipid bilayer
membrane proteins

Bacterial structure and morphology

Generalised structure of bacterium



Examples of bacterial morphology



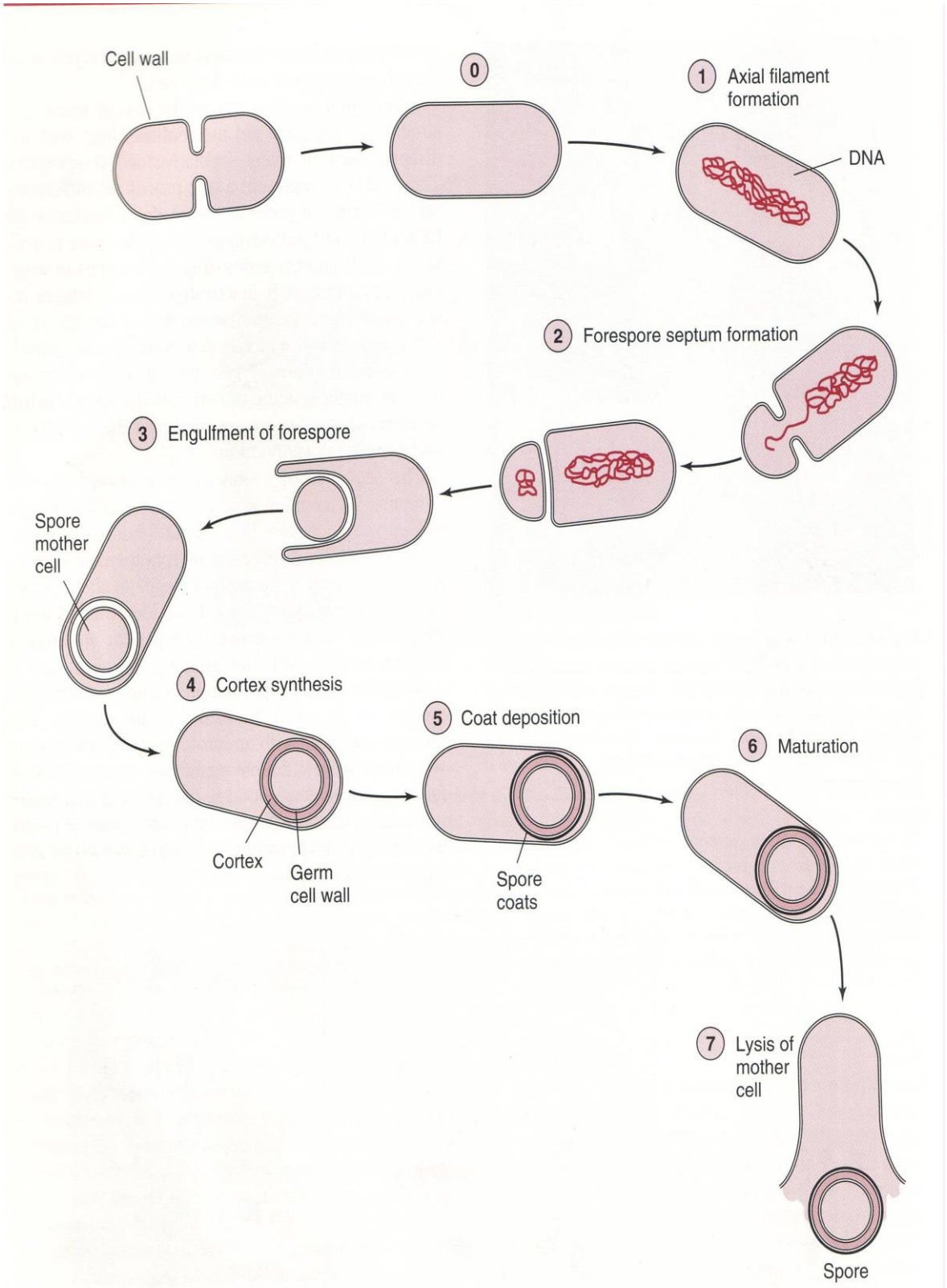


Figure 2–32. The stages of endospore formation. (Reproduced, with permission, from Merrick MJ: Streptomyces. In: Developmental Biology of Procaryotes. Parish JH [editor]. Univ California Press, 1979.)