

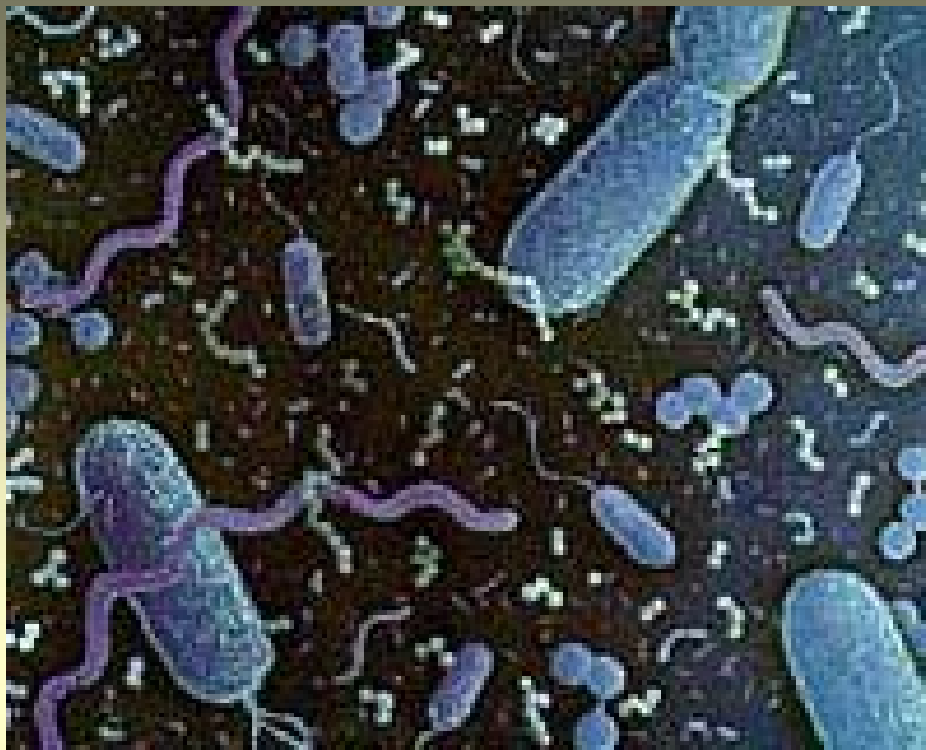
Foundations in Microbiology

Fifth Edition

Talaro

Chapter

4



Prokaryotic Profiles: the Bacteria and the Archaea

Chapter 4

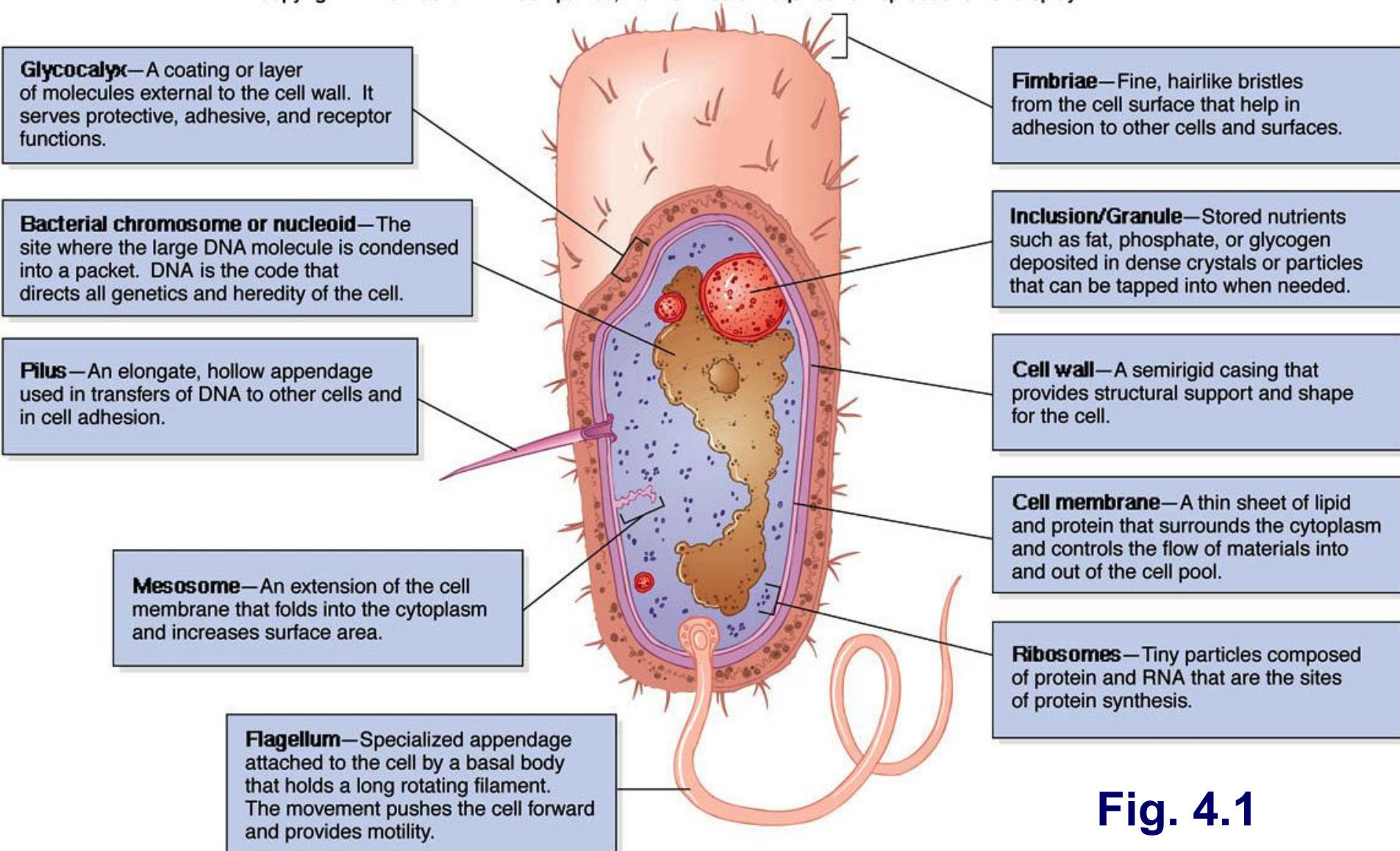


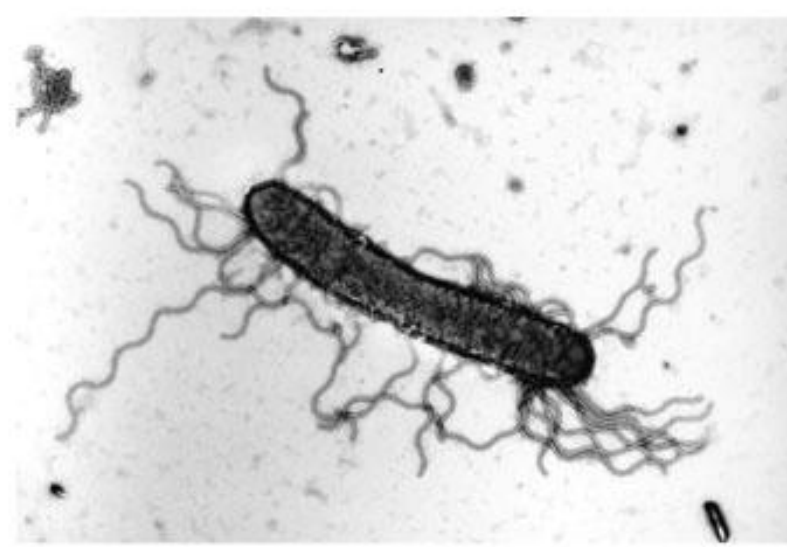
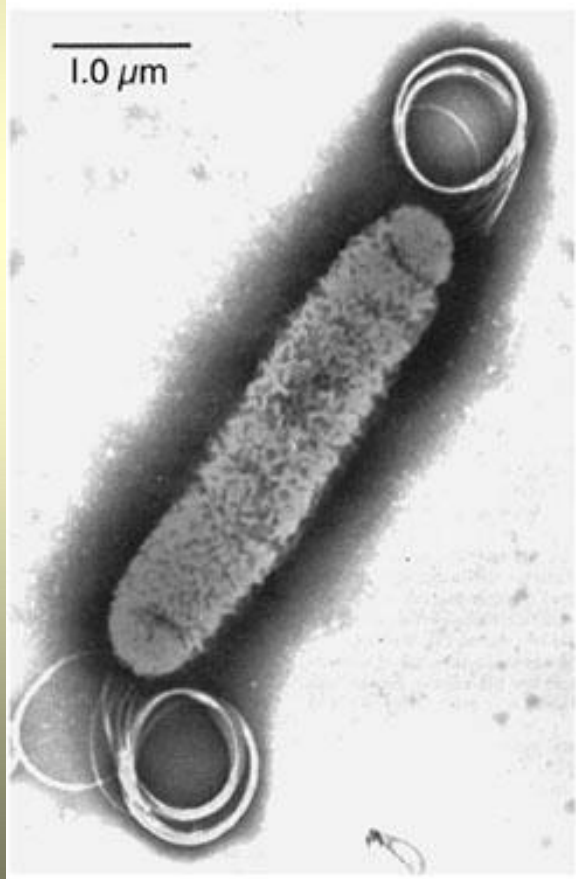
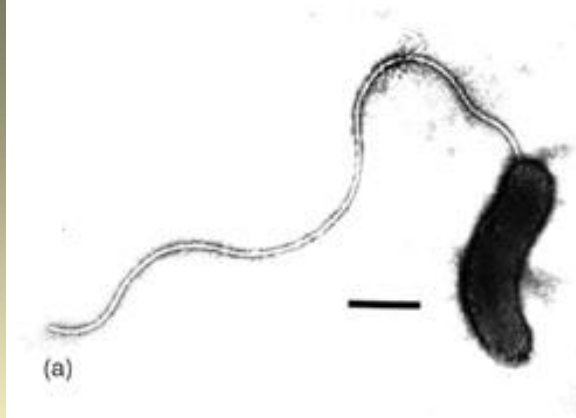
Fig. 4.1

flagella

- 3 parts
 - filament – long, thin, helical structure composed of proteins
 - hook- curved sheath
 - basal body – stack of rings firmly anchored in cell wall
- rotates 360°
- 1-2 or many distributed over entire cell
- functions in motility

Flagellar arrangements

1. monotrichous – single flagellum at one end
2. lophotrichous – small bunches arising from one end of cell
3. amphitrichous – flagella at both ends of cell
4. peritrichous – flagella dispersed over surface of cell, slowest



axial filaments

- periplasmic, internal flagella, enclosed between cell wall and cell membrane of spirochetes
- motility

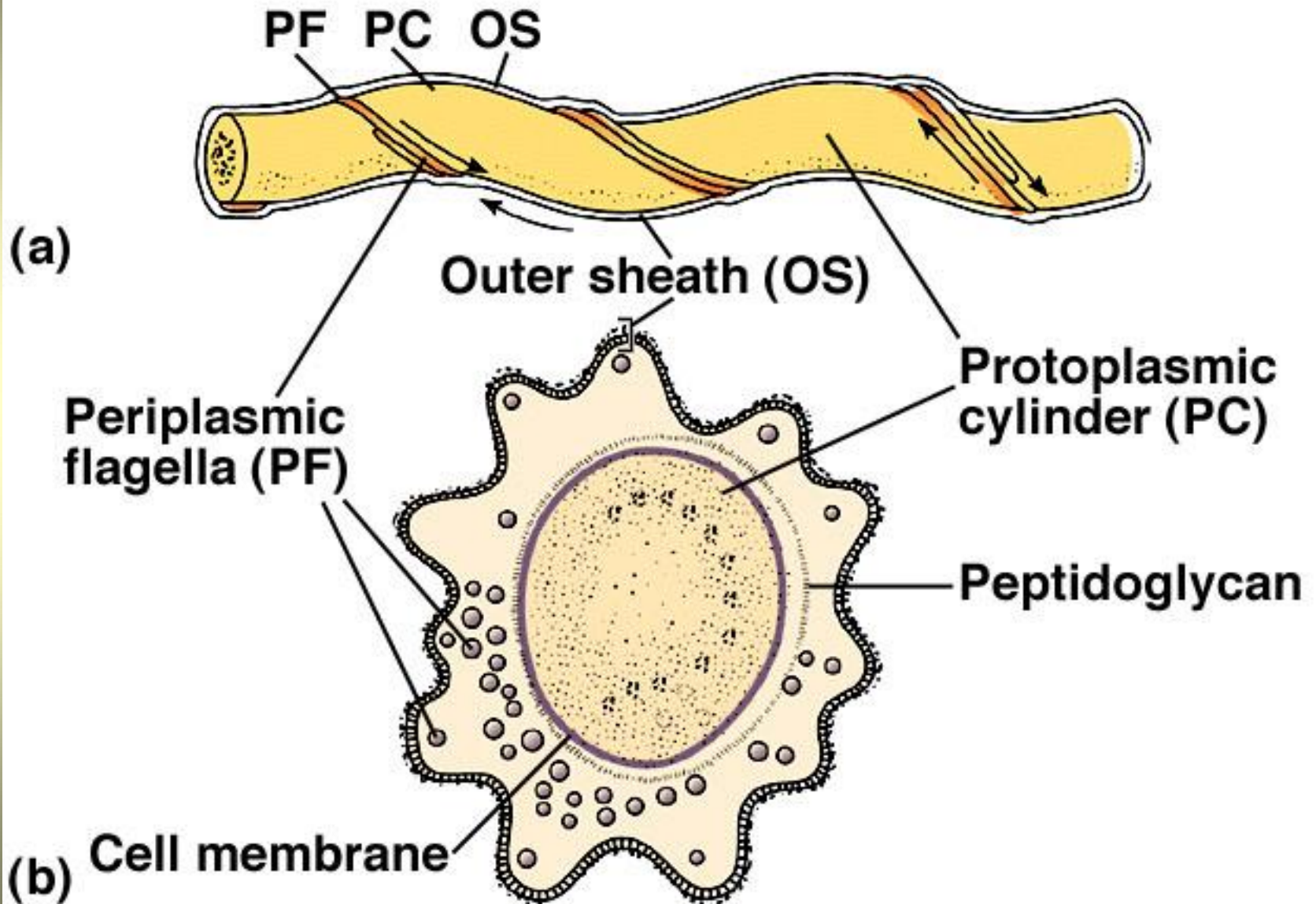
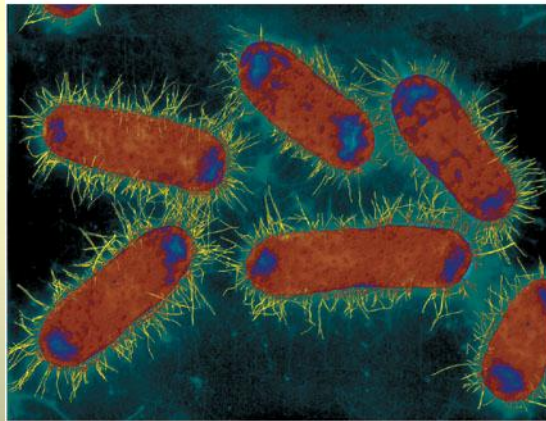


Fig 4.7a b

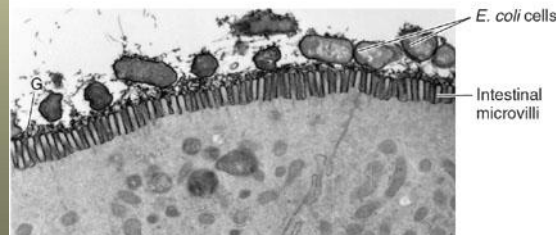
fimbrae

- fine hairlike bristles from the cell surface
- function in adhesion to other cells and surfaces

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(a)



(b)

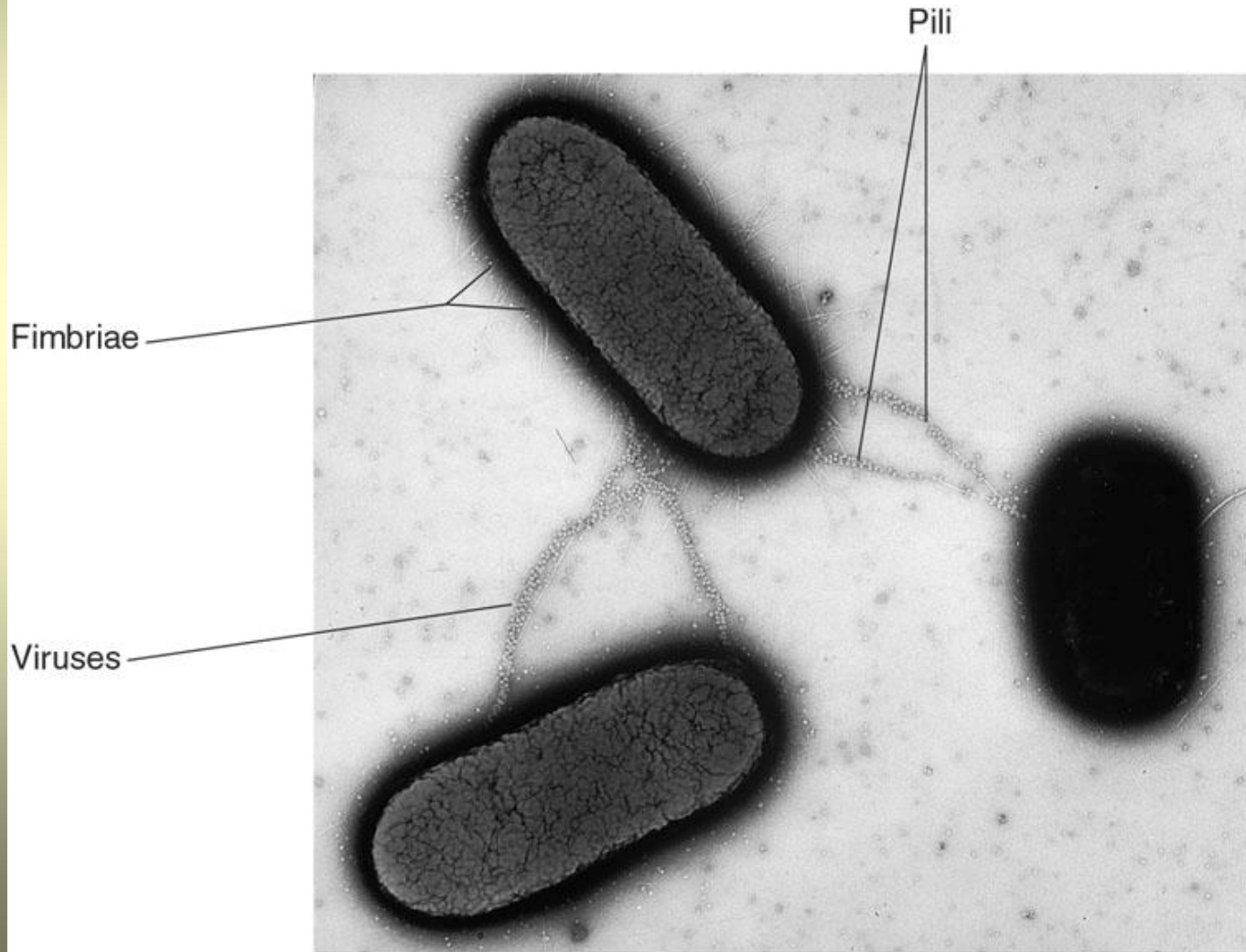
pili

- rigid tubular structure made of pilin protein
- found only in Gram negative cells

- Functions
 - joins bacterial cells for DNA transfer (conjugation)
 - adhesion

Conjugation

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glycocalyx

- Coating of molecules external to the cell wall, made of sugars and/or proteins
- 2 types
 1. capsule - highly organized, tightly attached
 2. slime layer - loosely organized and attached
- functions
 - attachment
 - inhibits killing by white blood cells
 - receptor

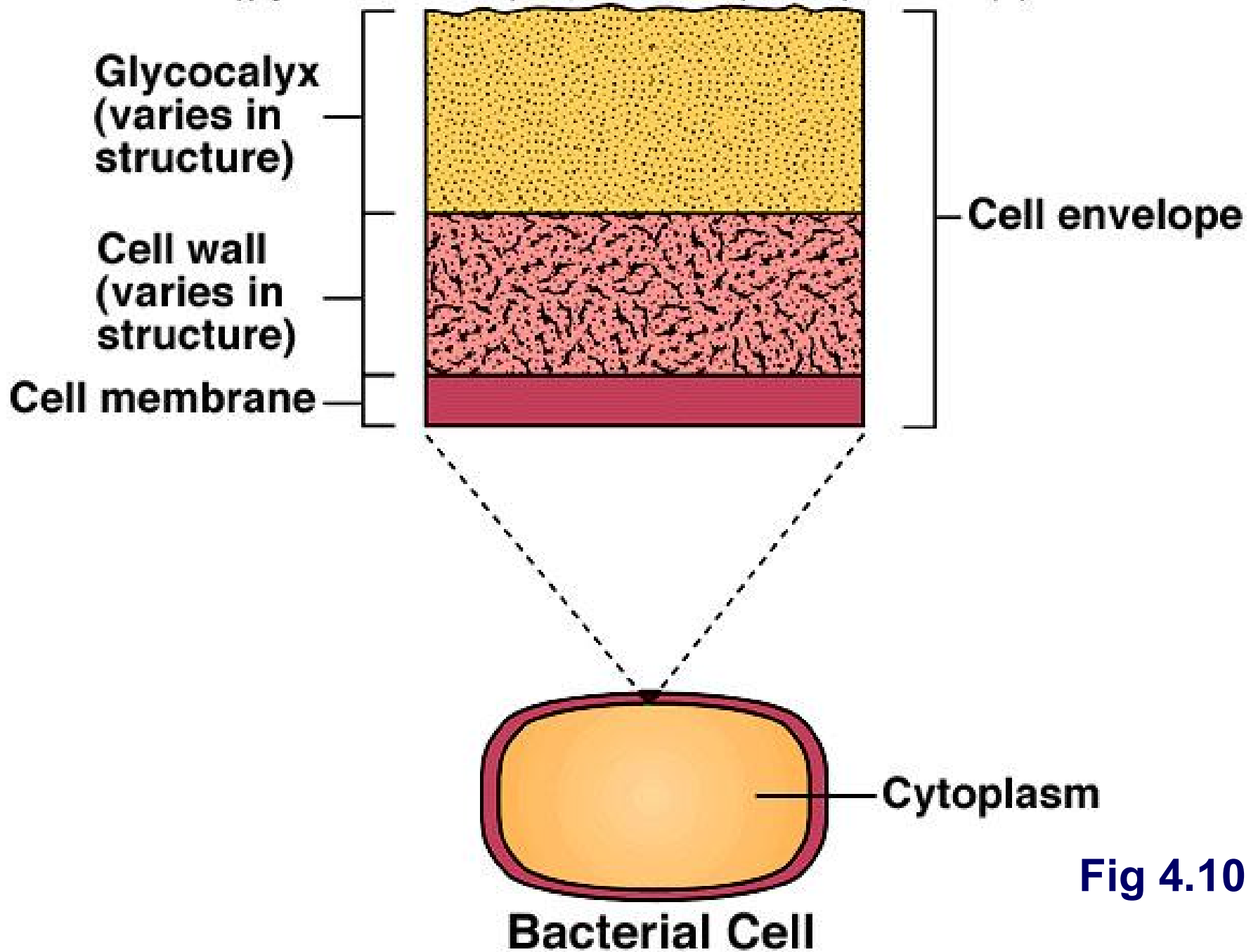
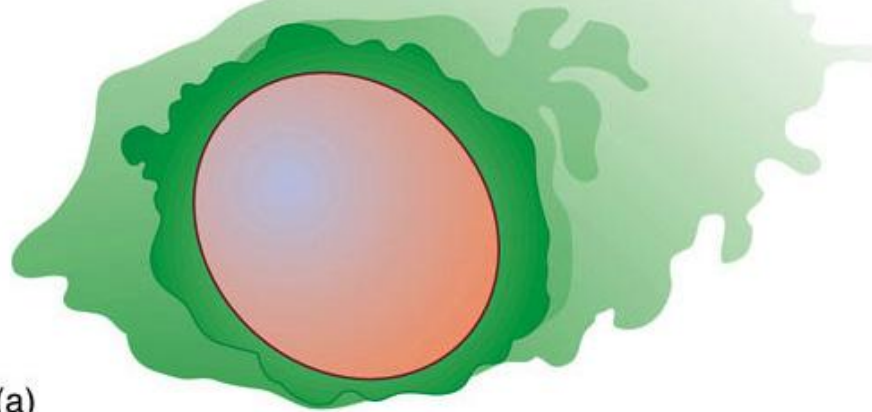


Fig 4.10

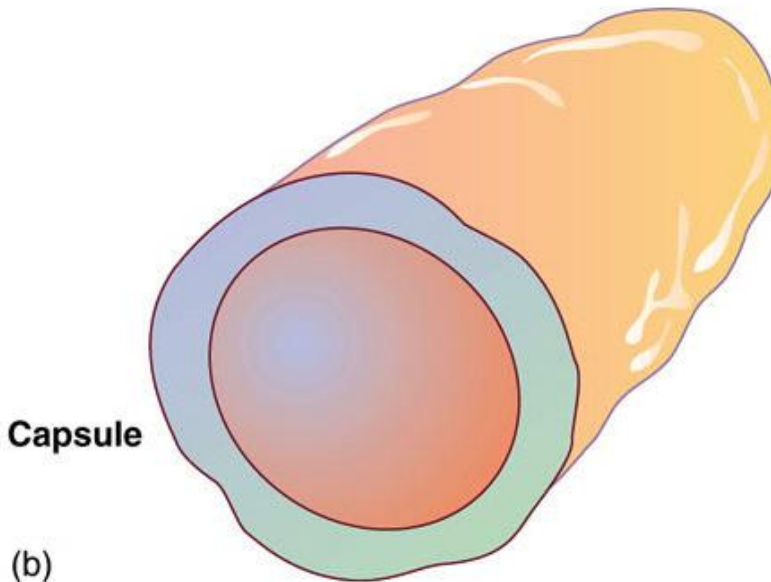
2 Types of Glycocalyx

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Slime Layer

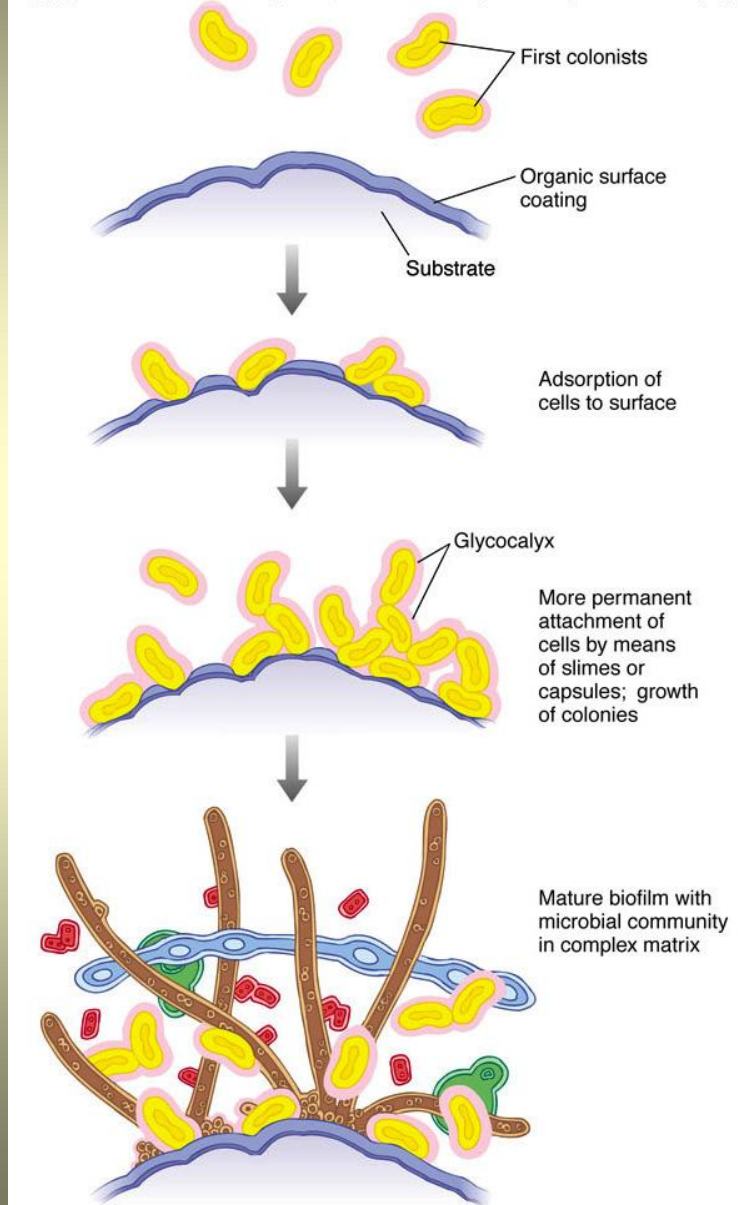


Capsule



Biofilms

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DOCTOR FUN

7 Feb 2002



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Dental caries adventure tours

Peptidoglycan

- unique macromolecule composed of a repeating framework of long glycan chains cross-linked by short peptide fragments
- provides strong, flexible support to keep bacteria from bursting or collapsing because of changes in osmotic pressure

Peptidoglycan

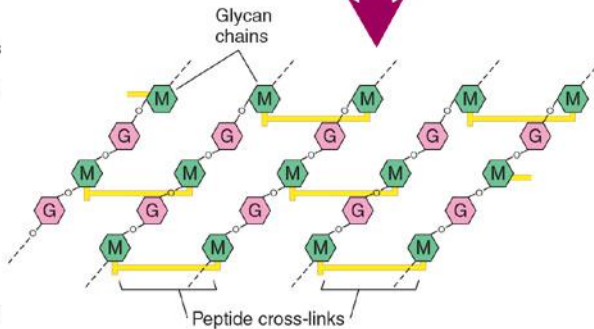
Cell Wall Video

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(a) The peptidoglycan of a cell wall can be presented as a crisscross network pattern similar to a chain-link fence, forming a single massive molecule that molds the outer structure of the cell into a tight box.

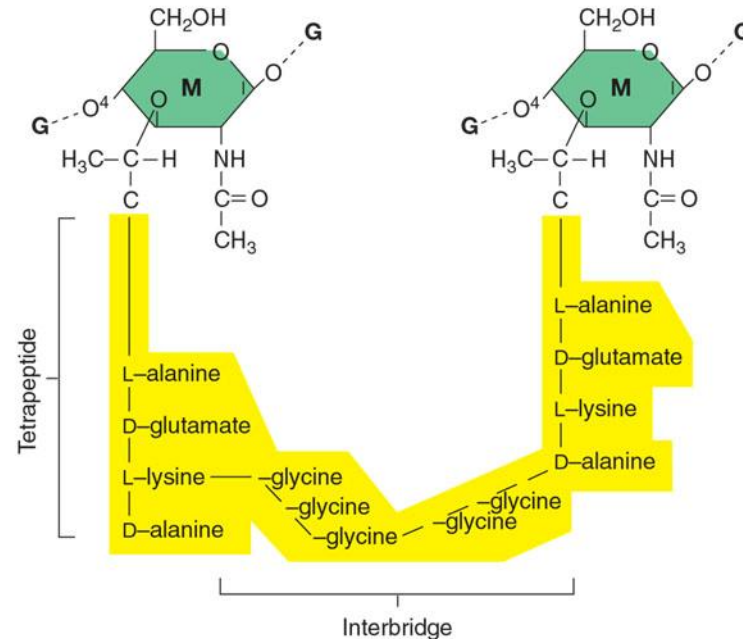


(b) An idealized view of the molecular pattern of peptidoglycan. It contains alternating glycans (G and M) bound together in long strands. The G stands for *N*-acetyl glucosamine, and the M stands for *N*-acetyl muramic acid. A muramic acid molecule binds to an adjoining muramic acid on a parallel chain by means of a cross-linkage of peptides.



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(c) A detailed view of the links between the muramic acids. Tetrapeptide chains branching off the muramic acids connect by interbridges also composed of amino acids. The types of amino acids in the interbridge can vary and it may be lacking entirely (gram-negative cells). It is this linkage that provides rigid yet flexible support to the cell and that may be targeted by drugs like penicillin.



4 groups based on cell wall composition

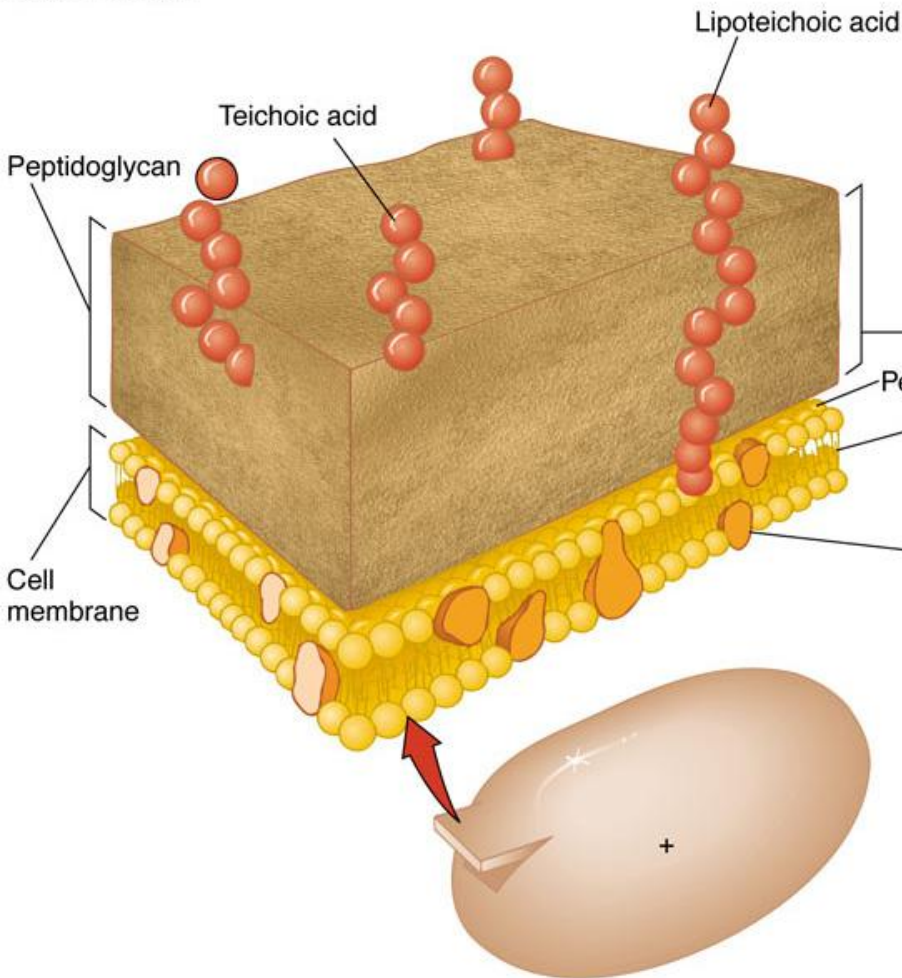
1. Gram positive cells
2. Gram negative cells
3. Bacteria without cell walls
4. Bacteria with chemically unique cell walls

Gram positive

Gram negative

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Gram Positive



Gram Negative

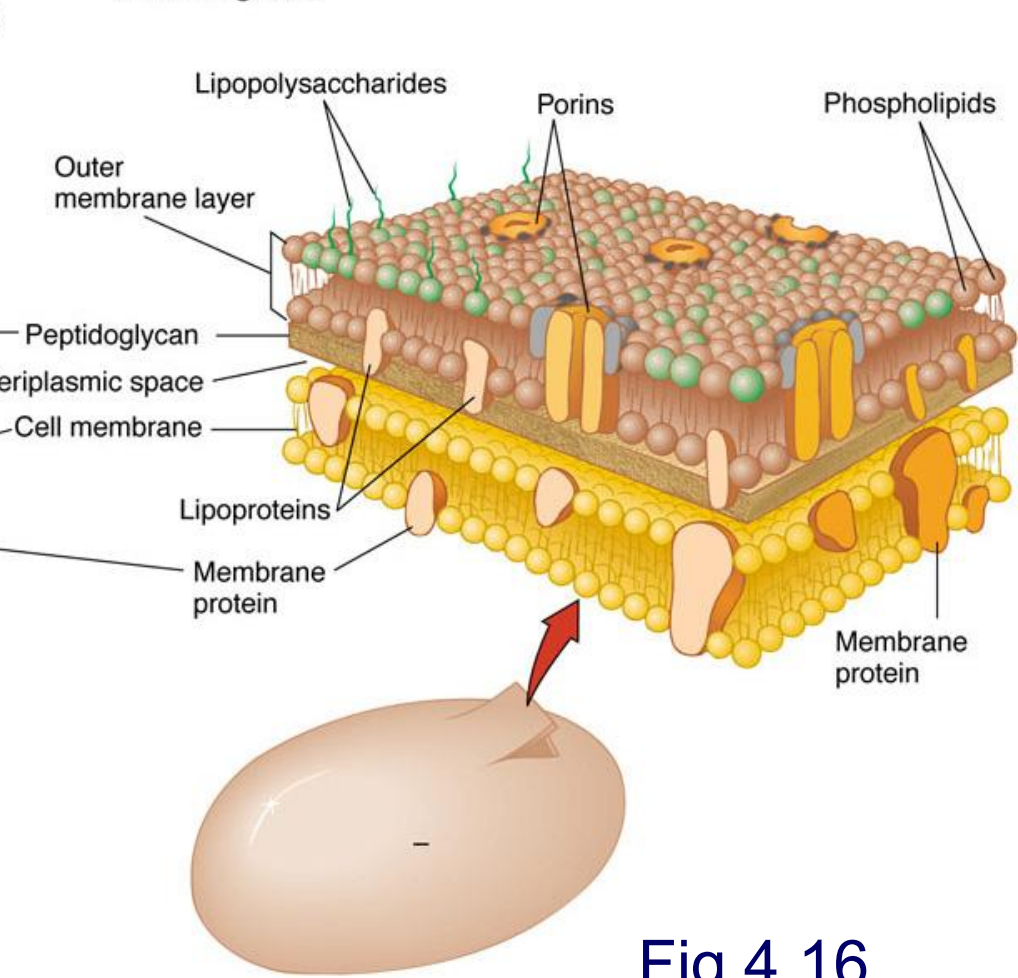


















Fig 4.16

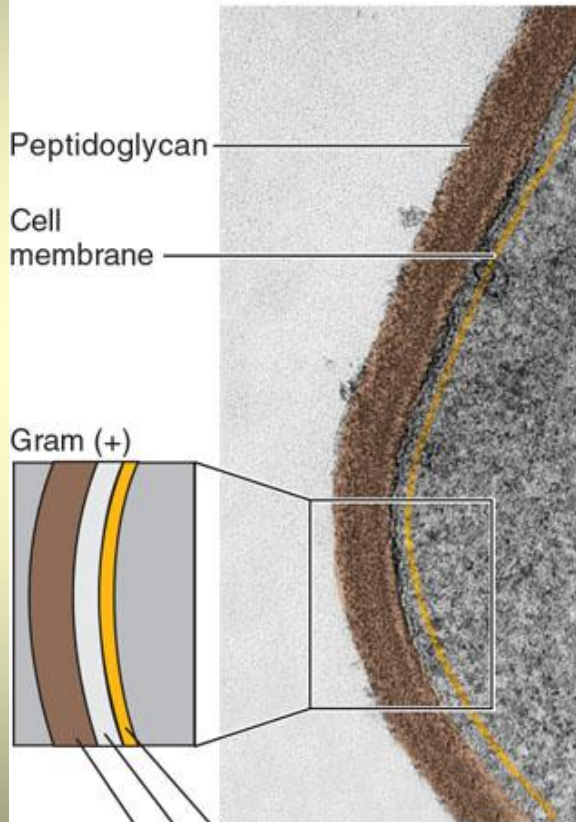
	Microscopic Appearance of Cell		Chemical Reaction in Cell Wall (very magnified view)	
Step	Gram (+)	Gram (-)	Gram (+)	Gram (-)
1. Crystal violet				
			Both cell walls affix the dye	
2. Gram's iodine				
			Dye crystals trapped in wall	
3. Alcohol				
			Crystals remain in cell wall	
4. Safranin (red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

Gram positive cell wall

- Consists of
 - a thick, homogenous sheath of peptidoglycan 20-80 nm thick
 - tightly bound acidic polysaccharides, including teichoic acid and lipoteichoic acid
 - cell membrane
- Retain crystal violet and stain purple

Gram positive wall

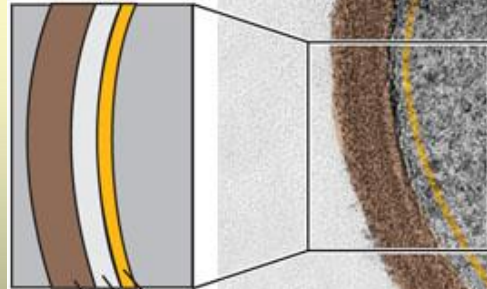
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Peptidoglycan

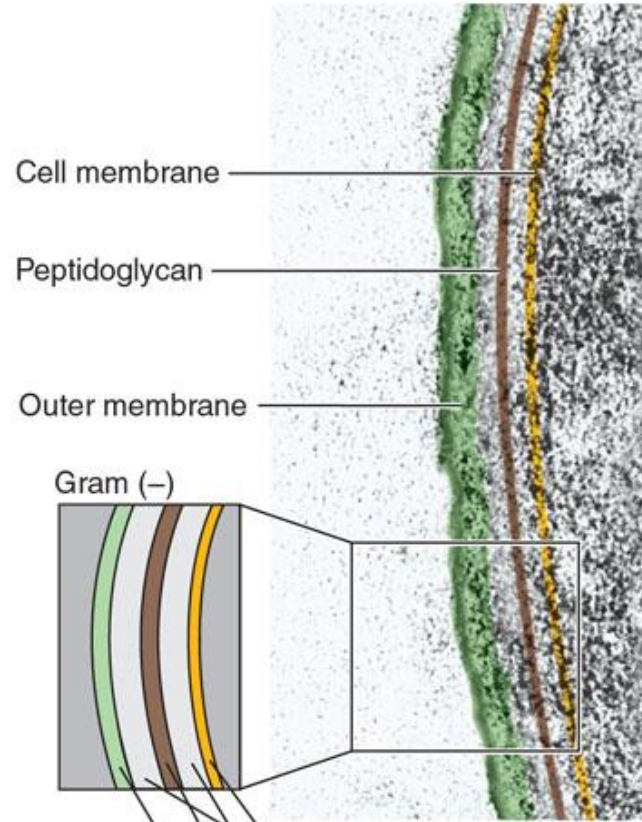
Cell membrane

Gram (+)



Cell membrane
Periplasmic space
Peptidoglycan

(a)

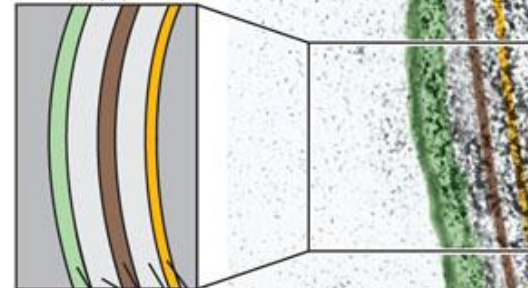


Cell membrane

Peptidoglycan

Outer membrane

Gram (-)



Cell membrane
Periplasmic space
Peptidoglycan
Outer membrane

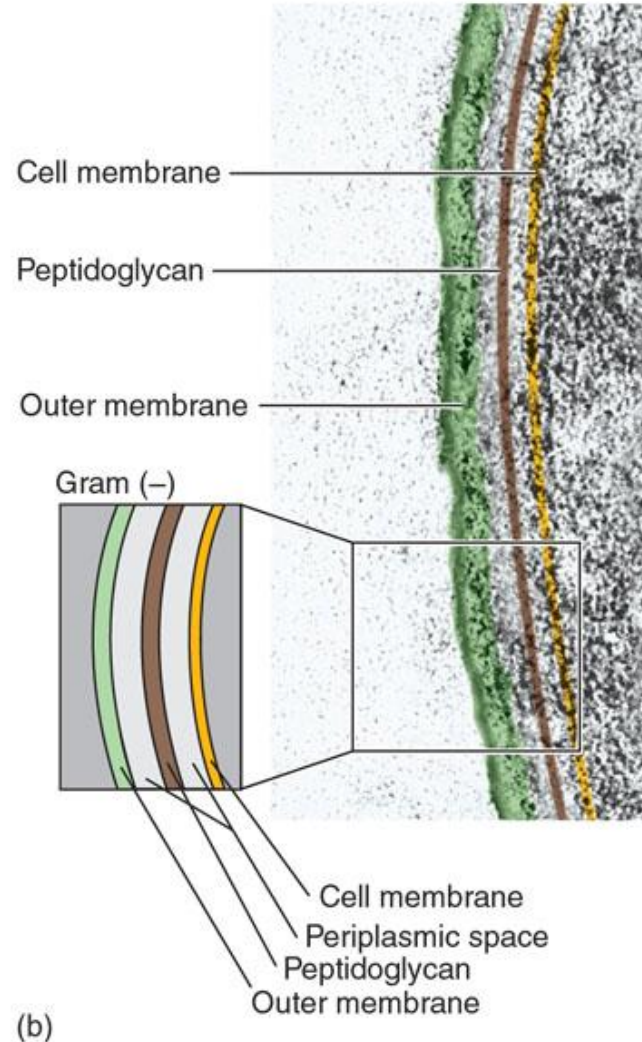
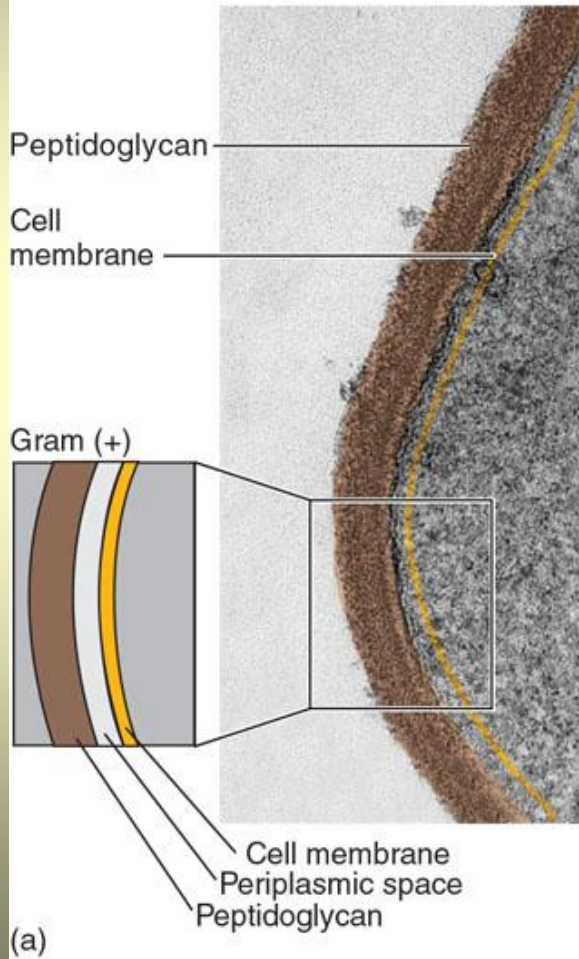
(b)

Gram negative cell wall

- Consists of
 - an outer membrane containing lipopolysaccharide (LPS)
 - thin shell of peptidoglycan
 - periplasmic space
 - inner membrane
- Lose crystal violet and stain red from safranin counterstain

Gram negative cell wall

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Cytoplasm

- dense gelatinous solution of sugars, amino acids, & salts
- 70-80% water
- serves as solvent for materials used in all cell functions

[Cytoplasmic Membrane Video](#)

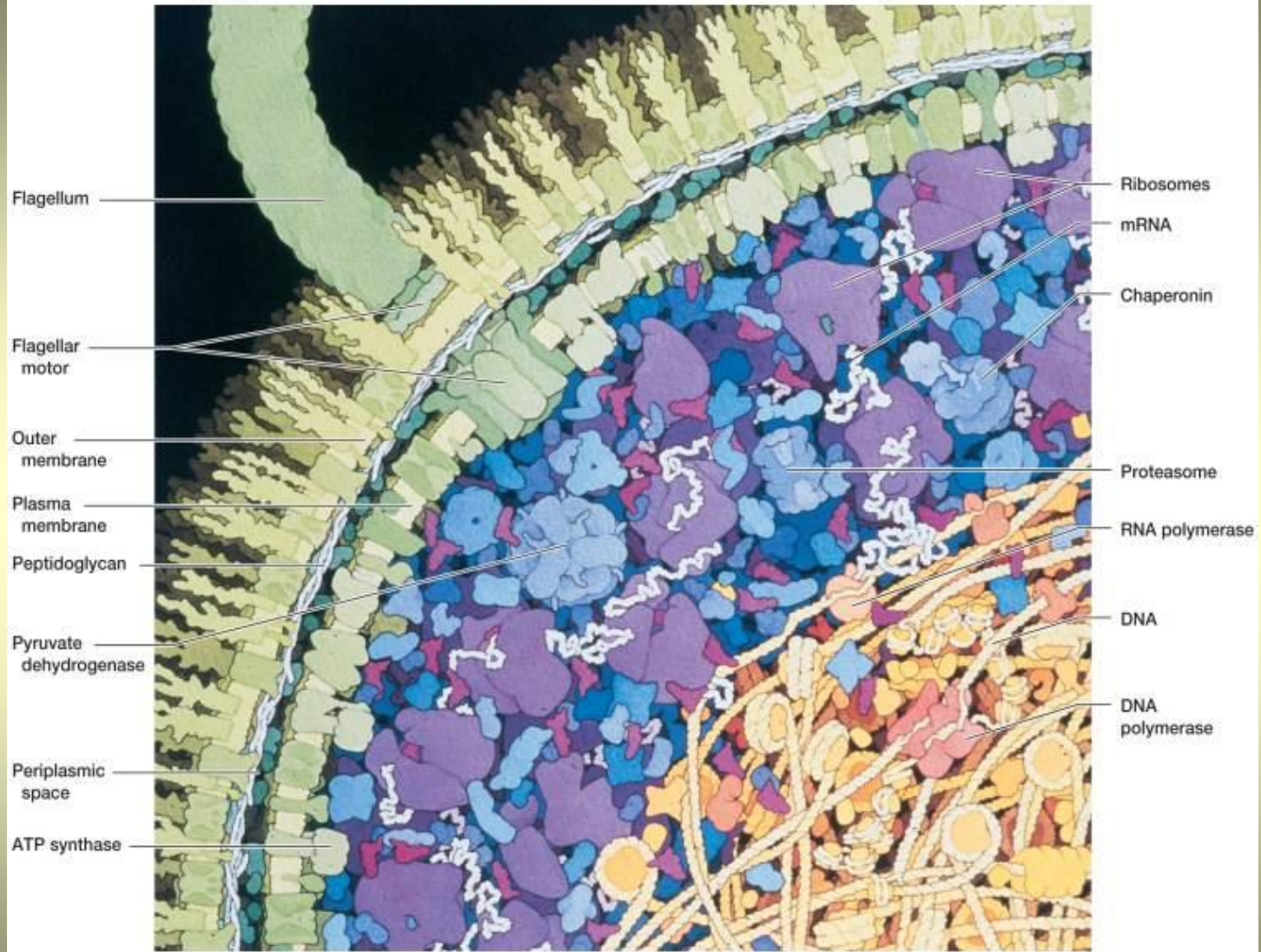


Figure 3.10

Chromosome

- single, circular, double-stranded DNA molecule that contains all the genetic information required by a cell
- DNA is tightly coiled around a protein, aggregated in a dense area called the **nucleoid**

plasmids

- small circular, double-stranded DNA
- free or integrated into the chromosome
- duplicated and passed on to offspring
- not essential to bacterial growth & metabolism
- may encode antibiotic resistance, tolerance to toxic metals, enzymes & toxins
- used in genetic engineering- readily manipulated & transferred from cell to cell

ribosomes

- made of 60% ribosomal RNA & 40% protein
- consist of 2 subunits: large & small
- procaryotic differ from eucaryotic ribosomes in size & number of proteins
- site of protein synthesis
- All cells have ribosomes.

ribosomes

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Ribosome (70S)



Large
subunit
(50S)



Small
subunit
(30S)

Inclusions, granules

- intracellular storage bodies
- vary in size, number & content
- bacterial cell can use them when environmental sources are depleted
- Examples: glycogen, poly- β -hydroxybutyrate, gas vesicles for floating, sulfur and polyphosphate granules

Inclusions

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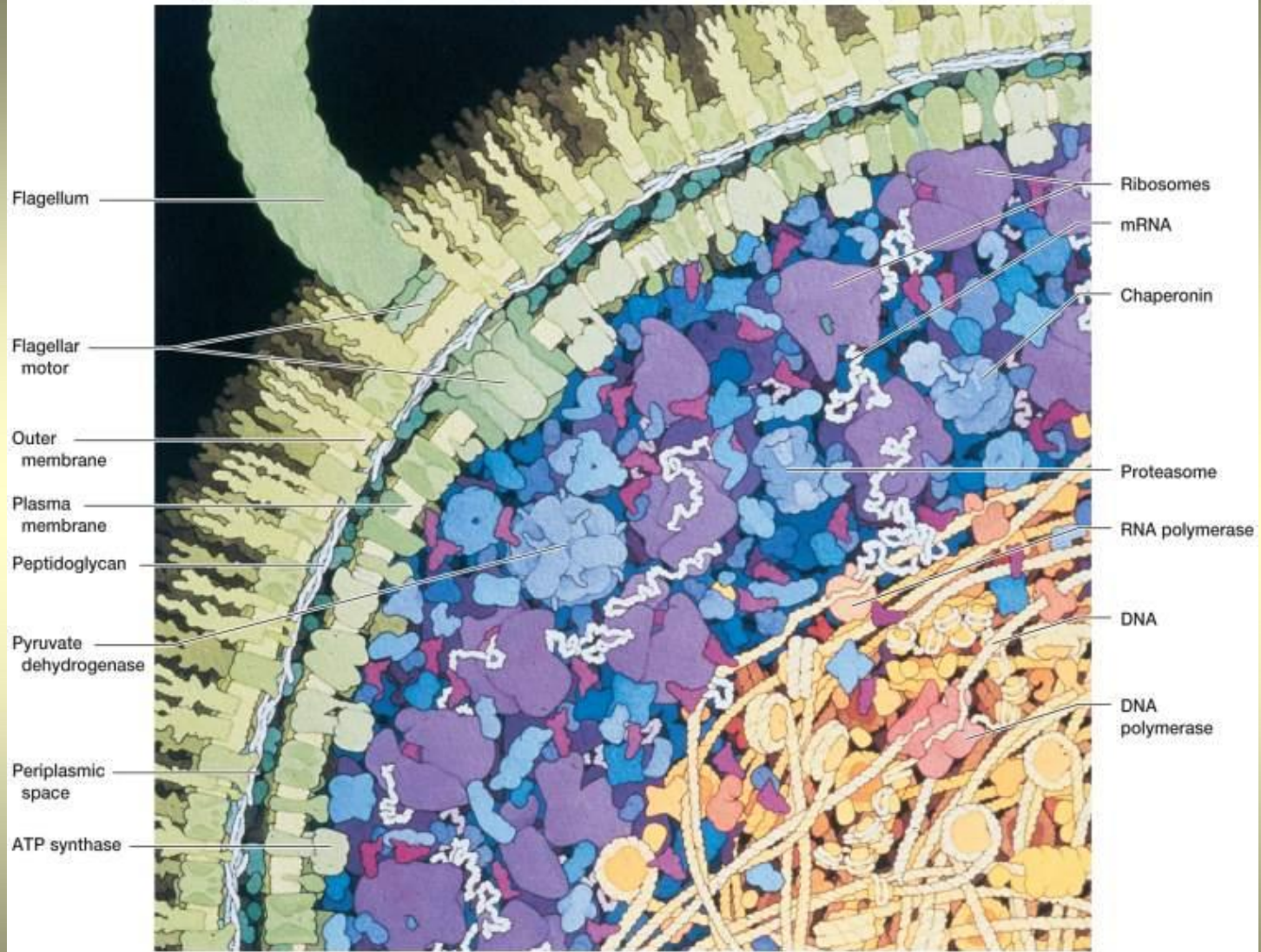


Figure 3.10

endospores

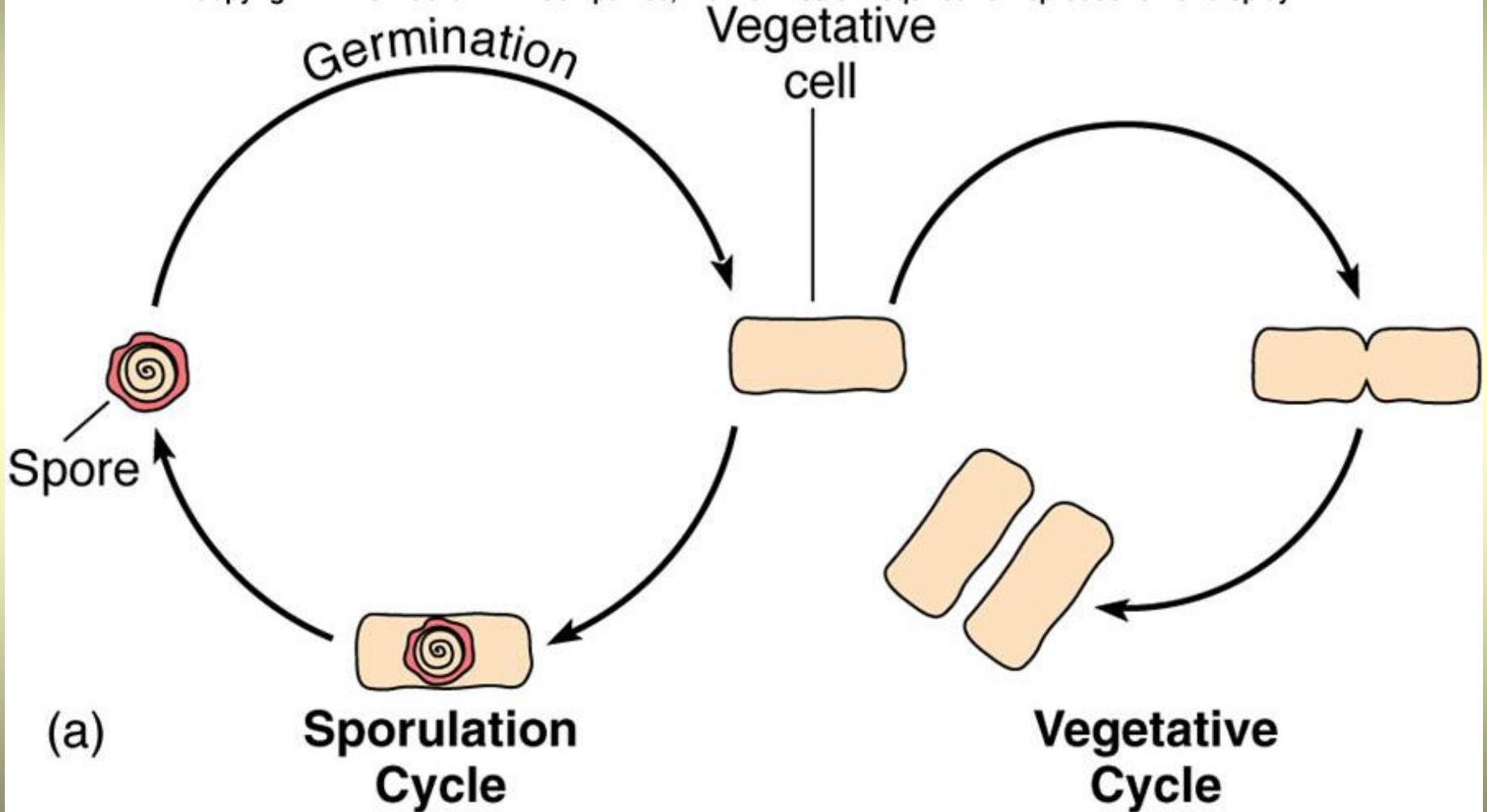
- Resting, dormant cells
- produced by some G⁺ genera: *Clostridium*, *Bacillus* & *Sporosarcina*
- Have a 2-phase life cycle – vegetative cell & an endospore
- **sporulation** -formation of endospores
- **germination**- return to vegetative growth
- hardiest of all life forms
- withstand extremes in heat, drying, freezing, radiation & chemicals not a means of reproduction

endospores

- resistance linked to high levels of calcium & dipicolinic acid
- dehydrated, metabolically inactive
- thick coat
- longevity verges on immortality 25, 250 million years.
- pressurized steam at 120°C for 20-30 minutes will destroy.

endospores

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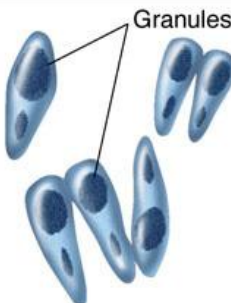








Endospore Formation

[Endospore](#)
[Video Clip](#)

3 shapes of bacteria

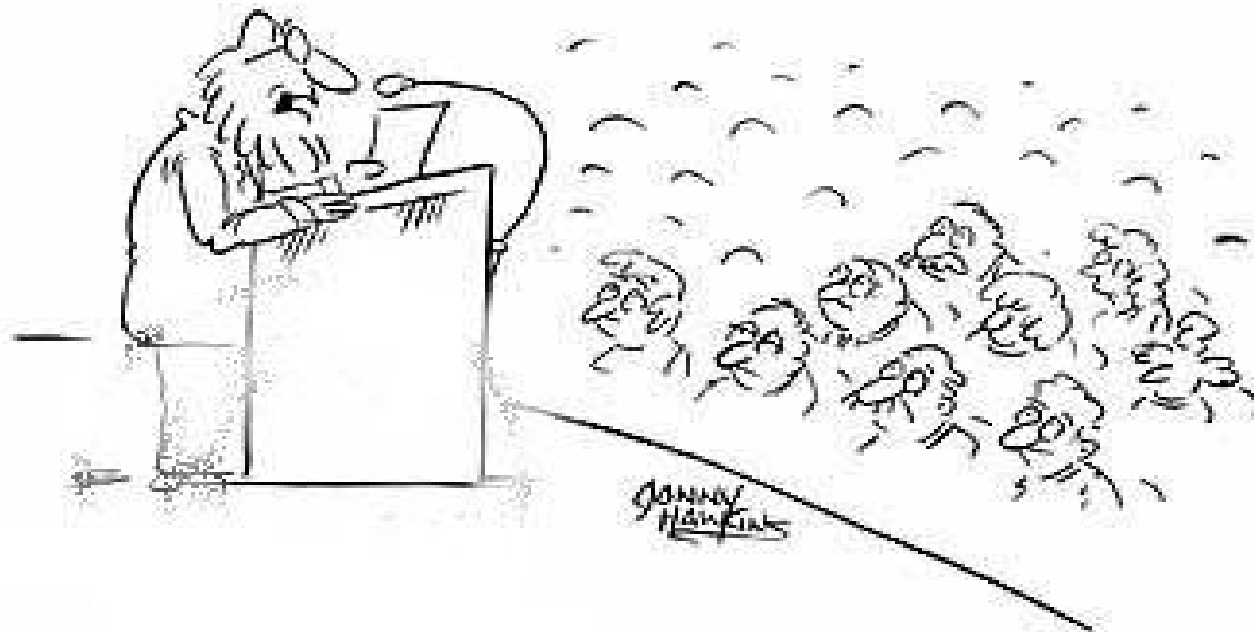
- cocci - spherical
- bacilli - rod
- spiral - helical, comma, twisted rod, spirochete

 <p>Coccus</p>	 <p>Rod, or bacillus</p>	 <p>Curved forms: Spirillum/Spirochete</p>		
 <p>Diplococci (cocci in pairs)</p>	 <p>Neisseriae (coffee-bean shape in pairs)</p>	 <p>Coccobacilli</p>	 <p>Vibrios (curved rods)</p>	
 <p>Tetrads (cocci in packets of 4)</p>	 <p>Sarcinae (cocci in packets of 8, 16, 32 cells)</p>	 <p>Mycobacteria</p>	 <p>Granules Corynebacteria (palisades arrangement)</p>	 <p>Spirilla</p>
 <p>Streptococci (cocci in chains)</p>	 <p>Micrococci and staphylo- cocci (large cocci in irregular clusters)</p>	 <p>Spores Spore-forming rods</p>	 <p>Streptomycetes (moldlike, filamentous bacteria)</p>	 <p>Spirochetes</p>

Archaea: the other procaryotes

- constitute third Domain Archaea
- seem more closely related to Domain Eukarya than to bacteria
- contain unique genetic sequences in their rRNA
- have unique membrane lipids & cell wall construction
- live in the most extreme habitats in nature, extremophiles
- adapted to heat salt acid pH, pressure & atmosphere
- includes: methane producers, hyperthermophiles, extreme halophiles, and sulfur reducers

NOBEL PRIZE AWARDS TODAY



"First of all, I'd like to thank the bacteria..."