

Structure, Function and Classification Bacteria (Prokaryotes) General

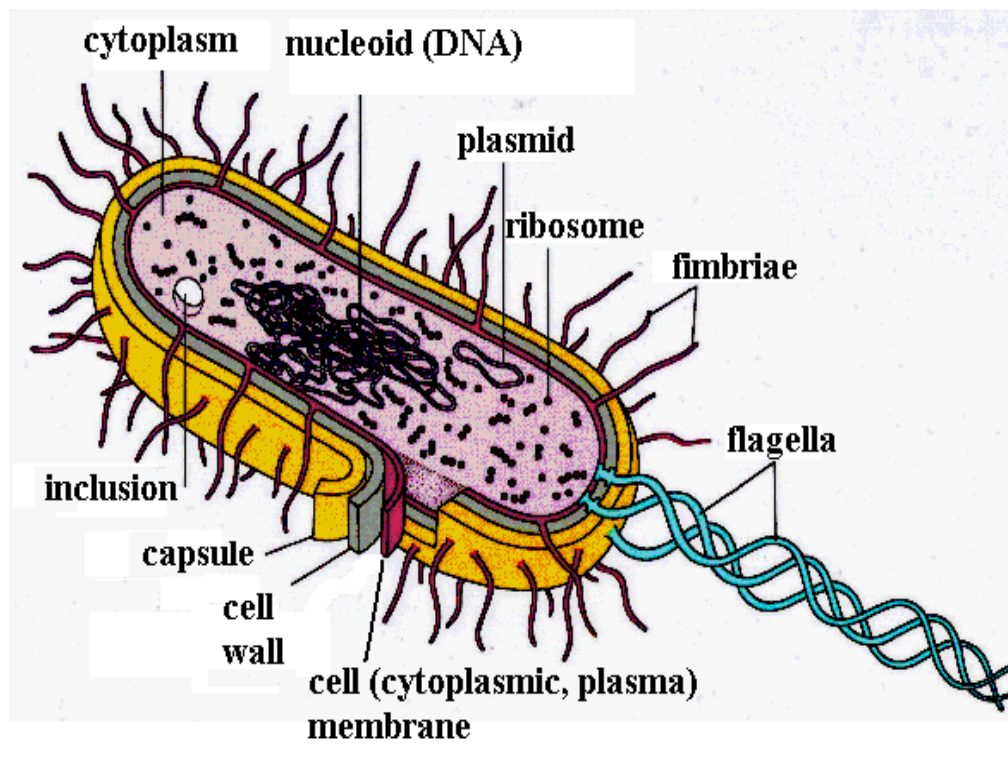
Bacteria all are prokaryotes (prokaryote = “before nucleus”) smallest, simplest, oldest cells on earth simple structure; not much internal structure no organelles.

Microscopic Structure of Bacteria

Most individual bacterial cells are too small to be seen without a microscope.

All bacteria are **prokaryotes: (Before nucleus)**

- 1- no nucleus
- 2- small cells, simple structure
- 3- usually no organelles
- 4- much **less efficient** design



I- Extracellular structure

1- Cell Wall

2- Cell membrane (Cytoplasmic or Plasma membrane)

Cell envelope composed from (cell wall & cell membrane)

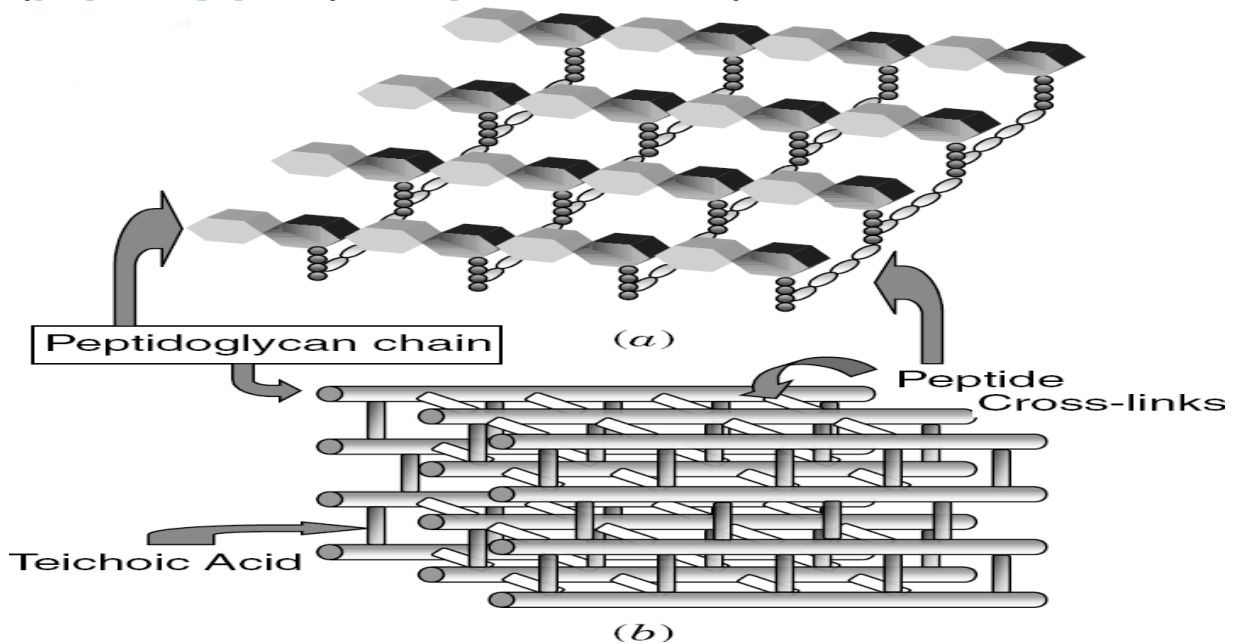
Functions of cell wall:

- 1- Protects the bacteria.
- 2- Allows them to live in "extreme" environments.
- 3- Give it their external shape.

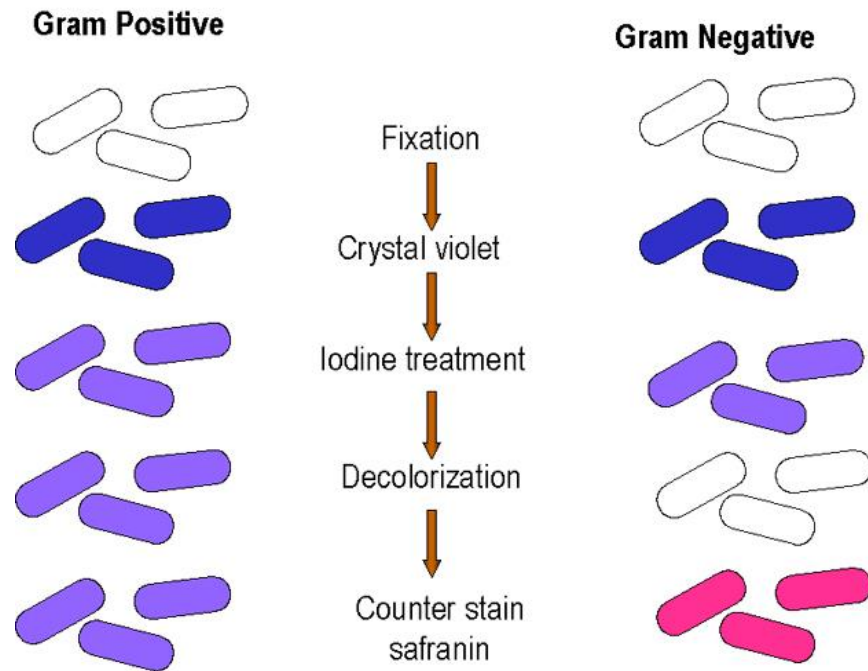
The function of cell membrane:

- 1- uptake of nutrients
- 2- excretion of waste products
- 3- secretes the enzymes

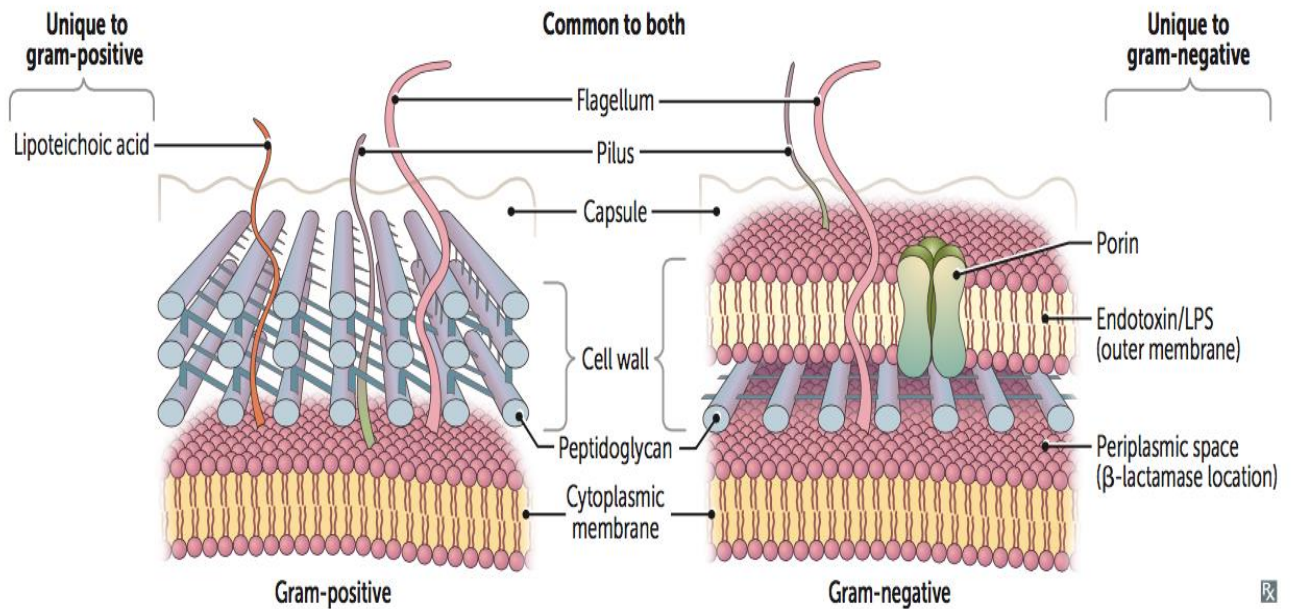
- In most bacteria the cell wall is made of **bacterial starch** (**peptidoglycan**) and (**Teichoic acid**)



Note: Remove cell wall and all bacteria turn into spheres



Gram stain= a different stain procedure + different results (Gram +ve) or (Gram -ve)... Based on the differences in Cell wall and outer envelope

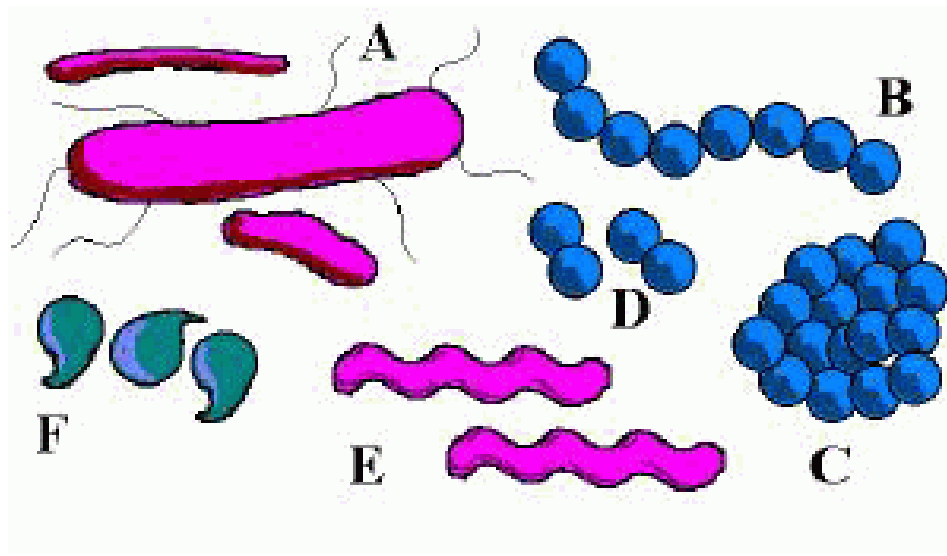


Main shapes of bacteria are:

1- Cocci 2- Bacilli (Rod) 3- Spiral (spirocheates)

Arrangement of bacteria:

Diplo, staphylo, strepto, etc



- Bacterial cell “shapes” A=bacillus or pl. bacilli B= round, coccus, cocci pl., in chains “Streptococcus) C. Staphylococcus – clusters D= diplococcus E=Spirillum, spirilla pl. (spirochete is a corkscrew shape – not shown) F= vibrio, more comma shaped

2- Cytoplasmic (inner) membrane

- Feature of both Gram-positive and Gram-negative cells
- allows the passage of membrane components through
- has peripheral or integral proteins associated with it

II- Internal structure of bacteria:

- 1- Cytoplasm
- 2- Ribosomes (for protein synthesis)
- 3- Mesosome (contributed with replications)
- 4- Volutin granules (source of energy)

III- Genetic Mterial

- bacterial genes are contained on two kinds of DNA:
 - a. **chromosomal DNA (double strand od DNA)**
 - b. **plasmids (composed of 100 copies of extra-chromosomal DNA)**

Genetic materials have the all genes and coding of bacterial feature and antibiotic resistance.

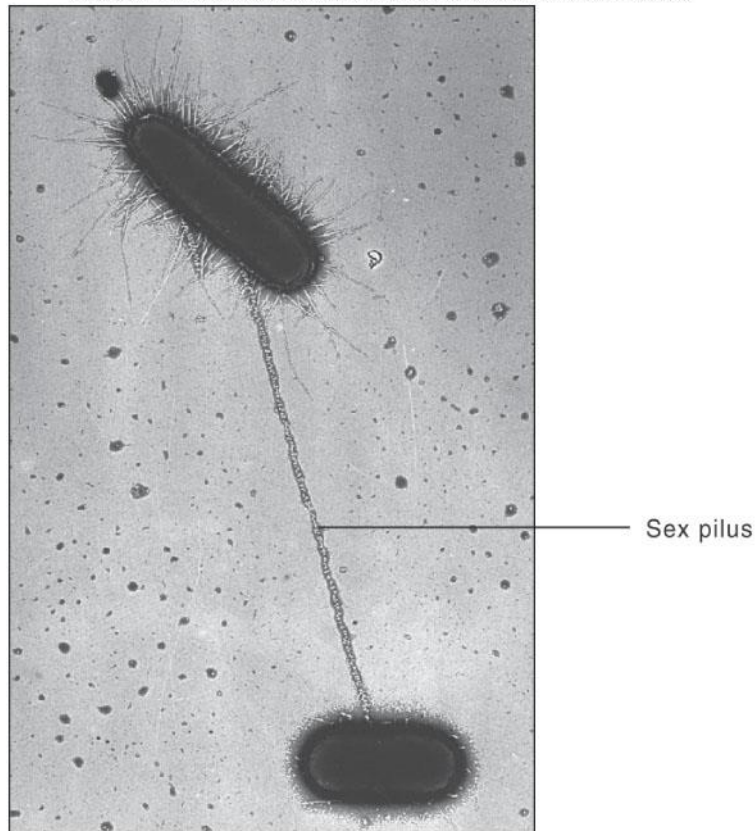
Bacterial appendages: (Special structures)

A- Pilli (fimbriae)

Pilli are short, hair-like, protein: function “adherence” – stick to each other, stick to surfaces.

Specialized “sex” pilus – conjugation

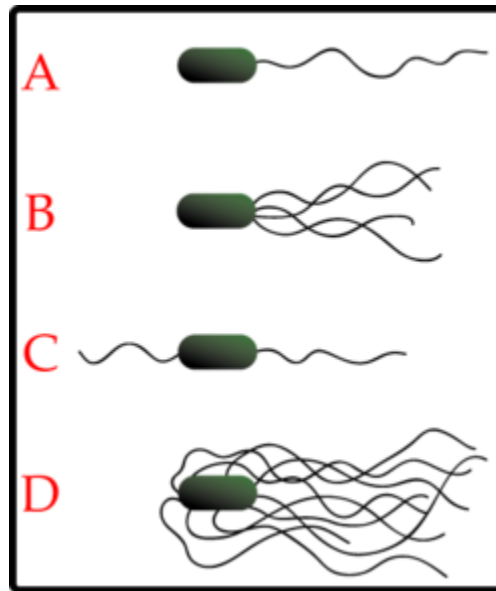
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Flagella:

Organ of motility, a "movement"

A = monotrichous B = amphitrichous C = lophotrichous D = peritrichous



Capsule

Some bacteria produce a **capsule** = a gelatinous, sticky layer that allows bacteria to

- attach to substrates
- make "colonies" together
- also increases pathogenic bacteria's resistance to host's defenses

Slime layer

loosely associated with the bacteria, that is help the bacterial cell to adherence with the surfaces.

Endospores (bacterial spores)

some bacteria can form endospores to survive adverse conditions

- very resistant to destruction
- withstand desiccation and harsh conditions
- **endospore not** for reproduction

Classification of Bacteria:

Based on the following:

- 1- The Shape and arrangement of bacteria.
- 2- Requirement of oxygen.
- 3- Nutritional requirements.
- 4- Biochemical changes

Bacterial Physiology

Bacterial Growth

When we say bacteria “grow” we usually mean they are reproducing, ie. increasing in numbers.

bacterial growth = bacterial reproduction

One of the reasons bacteria are so successful is that most reproduce very rapidly most bacterial reproduction is by **asexual fission (Binary fission)** asexual reproduction is much **faster** than sexual reproduction

Time between divisions = **generation time**

Generation time is typically about 20 o 30 minutes

- **Microbial populations show a characteristic type of growth pattern called exponential growth**

Growth phases:

- 1-Lag phase (adaptation phase)
- 2-Log Phase (increasing or exponential phase)
- 3-Stationary Phase (constant phase)
- 4-Decline phase (death phase)

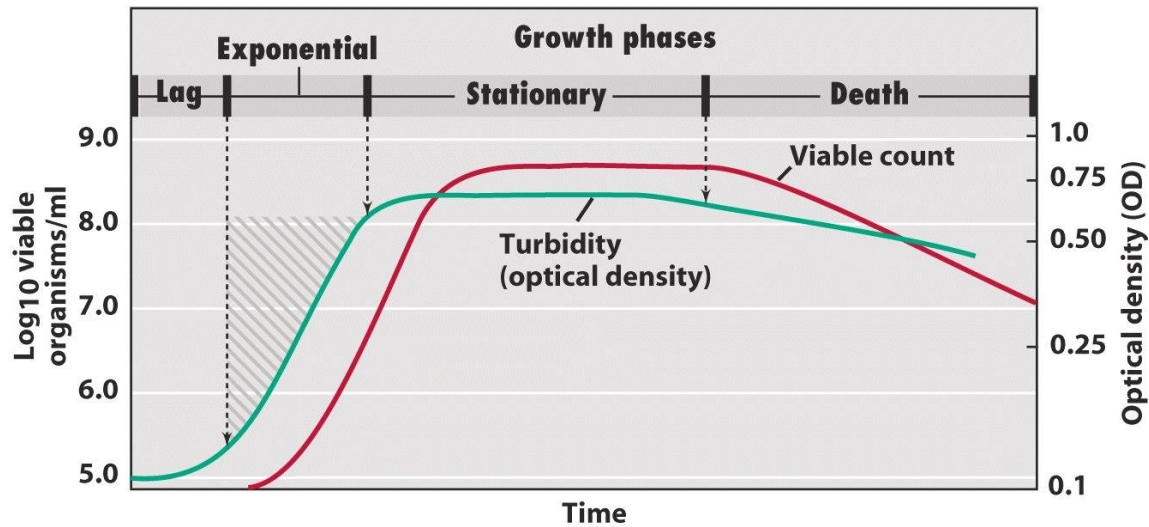


Figure 6-8 Brock Biology of Microorganisms 11/e
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• Bacterial Nutrition

All life requires **food** for survival, in most organisms food must provide 2 main resources:

A. building blocks (nutrients)

As does all life bacteria require sources of **Carbon**, **Hydrogen**, **Oxygen** and **Nitrogen**, **Phosphorus**, etc

As well as several other elements

B. an energy source

Producing energy this way called = **respiration**

Other physical characteristics:

Bacteria are defined by their phenotypes or physical characteristics

– characterized with respect to

Temperature

- Psychrophile: -12 to 20°C
- Mesophile: 14 to 45°C (medical importance)
- Moderate thermophile: 42 to 69°C
- Extreme thermophile: 66 to 105°C

pH

- Acidophile: low pH (eg. 3)
- Neutrophile: ~pH 7 (most bacteria)
- Alkaliphile: high pH (eg. 10)

Oxygen

- Obligate aerobe: require O₂
- Facultative aerobe: O₂ not required but better growth when present
- Microaerophile: low levels of O₂ required
- Aerotolerant: O₂ not required and growth not improved in the presence of O₂
- Obligate anaerobe: O₂ inhibits bacterial growth

Morphological characteristics

- shape
- size
- Gram stain
- sporulating (spore forming)