

**Prokaryotes “ monera ” :**

**Bacteria and archaeobacteria .**

**Bacteria, rickettsia , chlamydia , and mycoplasma.**

**I. Bacterial characteristics .**

**II. Bacterial shapes and size .**

**III. Bacterial structures .**

**IV. Bacterial growth and reproduction .**

**V. Domains of organisms .**

**VI. Classification of Bacteria according to :**

**1. Bacterial shapes .**

**2. Position of Bacterial flagella .**

**3. Spore forming ( sporulation).**

**4. Nutrition of Bacteria .**

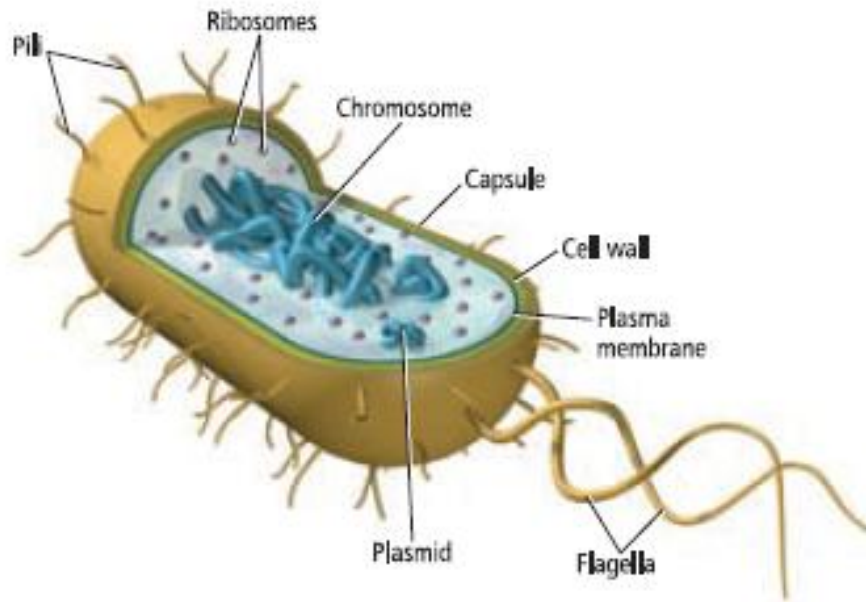
**5. Gram staining .**

**The domains of organisms :**

Living organisms are grouped into three general categories called “domains” one of them is eukarya ( eukaryotic ), which is divided into four kingdoms protists , fungi , plants, and animals . the second domain is bacteria ( true bacteria or eubacteria ) and third domain is archaea ( archae bacteria ).

**Comparison between the domains of life**

Features	Bacteria	Archaea	Eukarya
<b>Nuclear envelope</b>	Absent	Absent	Present
<b>Membrane-enclosed organelles</b>	Absent	Absent	Present
<b>Peptidoglycan in cell wall</b>	Present	Absent	Absent
<b>RNA polymerase</b>	One kind	Several kinds	Several kinds
<b>Introns in genes</b>	Very rare	Present in some genes	Present
<b>Response to the antibiotics (streptomycin and chloramphenicol)</b>	Growth inhibited	Growth not inhibited	Growth not inhibited
<b>Histones associated with DNA</b>	Absent	Present in some species	Present
<b>Circular chromosome</b>	Present	Present	Absent
<b>Growth at a temperatures &gt;100c</b>	No	Some species	No
<b>Size of ribosomes</b>	70s	80s	80s

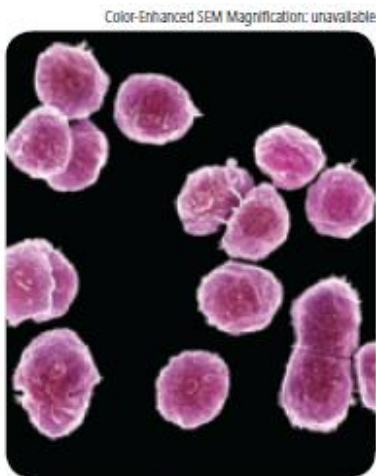


### Prokaryotic diversity :

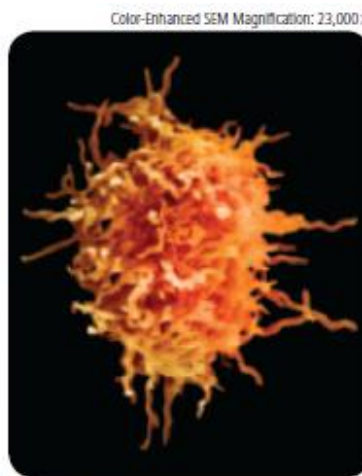
Prokaryotes are not easily classified according to their forms .

Key characteristics used in classifying prokaryotes are :

1. Photosynthetic or non- photosynthetic.
2. Biochemical tests .
3. Motile or non-motile .
4. Unicellular or colony-forming or filamentous .
5. Formation of spores (sporulation ) or division by transverse binary fission (spore or non-spore forming simple binary fission ).
6. Cell structure table . 2-1
7. Cell wall gram-positive and gram negative .



Archaeobacteria



Eubacteria



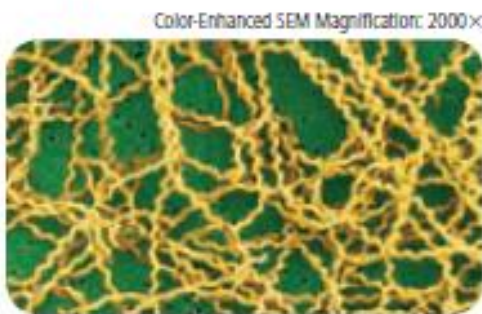
Photosynthetic eubacteria



Cocci

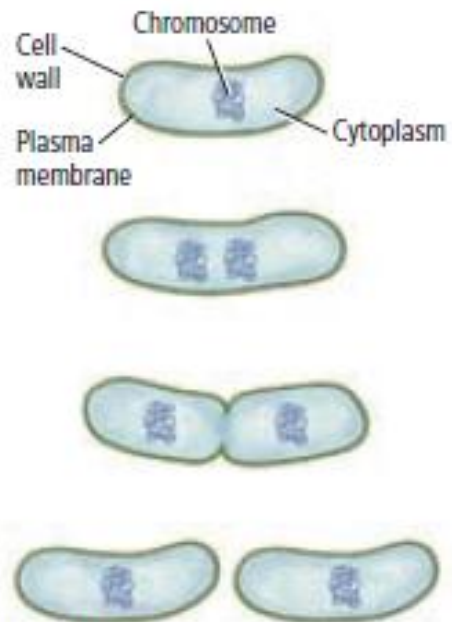


Bacilli



Spirochetes

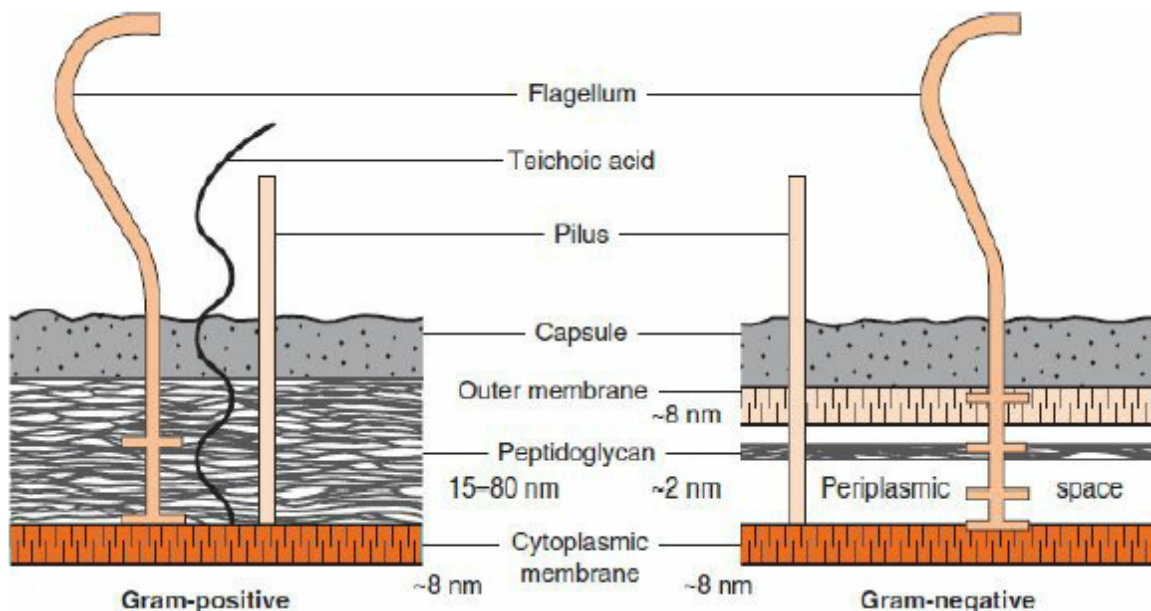
There are three shapes of prokaryotes: cocci, bacilli, and spirochetes.



### Binary fission

Binary fission is an asexual form of reproduction used by some prokaryotes. Conjugation is also an asexual form of reproduction, but it does involve exchange of genetic material.

**Analyze** Which means of reproducing shown here exchanges genetic information?



Cell walls of gram-positive and gram-negative bacteria. Note that the peptidoglycan in gram-positive bacteria is much thicker than in gram-negative bacteria. Note also that only gram-negative bacteria have an outer membrane containing endotoxin (lipopolysaccharide [LPS]) and have a periplasmic space where  $\beta$ -lactamases are found. Several important gram-positive bacteria, such as staphylococci and streptococci, have teichoic acids. (Reproduced with permission from Ingraham JL, Maaloe O, Neidhardt FC. *Growth of the Bacterial Cell*. Sinauer Associates; 1983.)

**Comparison of cell wall for gram-positive and gram negative :**

Component	Gram-positive	Gram-negative
Peptidoglycan	Thicker, multilayer	Thinner, single layer
Teichoic acids	Present (yes)	Absent (no)
Lipopolysaccharide (endotoxin )	Absent (no)	Present (yes)
Periplasmic space	Absent (no)	Present (yes)



**Bacteria** : belong to Monera kingdom (prokaryotes)

1. **Definition** : bacteria are microscopic unicellular , prokaryotic organisms .
2. **Bacteriology** : the study of bacteria is called bacteriology .
3. **Characteristics of bacteria** :
  - 1- They exist everywhere in the water , in soil in the air , on our body (e.g. E. coil, lactobacillus, streptococcus, etc. ).
  - 2- They are unicellular , some exist as colonies .
  - 3- They are prokaryotic .
  - 4- They range in size from 0.5 micron to 3 micron .
  - 5- They are in the form of rods (bacilli), spheres (cocci) , spirals (spirillum), filaments (actinomycetes), vibrio , comma , and spirochaete (spirochete ).
  - 6- The cell is enclosed in a cell envelope made up of a capsule , a cell wall and a plasma membrane ,
  - 7- Nuclear material is represented by a nucleoid without nuclear membrane .
  - 8- An extra chromosomal DNA called plasmid is usually present in the cytoplasm .
  - 9- Cell organelles include 70s ribosomes and mesosomes , other organelles such as mitochondria , lysosomes , Golgi body , endoplasmic reticulum , centrioles , etc. are absent .
  - 10- Appendages like flagella ( flagellum) , Pili (fimbriae) are present .
  - 11- They are either gram-positive or gram-negative .
  - 12- They show absorptive mode of nutrition .

- 13- They multiply by binary fission .
- 14- Some produce endospores .

**Flagella :**

- 1- They are whip like form protein called flagellin .
- 2- They are present in bacilli and spiral bacteria , they are absent from cocci .
- 3- Each flagellum has three parts , namely a basal body a hook and a shaft .
- 4- The flagella are used for locomotion .
- 5- The bacteria maybe motile or non-motile .
- 6- The bacilli and spirilla are motile while the cocci are non-motile .
- 7- There are different types of flagella on bacterial cells .
- 8- Some hair like structures are present on the bacterial cell , they are called pili or fimbriae they are used for attachment , some pili are longer in some bacteria and they are called sex pili .
- 9- The flagellum structure is the following .

**Structure of bacterial cell :** (table 2:1)

- 1- The essential components :
  - 1- Cell wall .
  - 2- Cytoplasmic membrane .
  - 3- Ribosomes .
  - 4- Nucleoid .

- 
- 5- Mesosome .
  - 6- Periplasm .
- 2- Non- essential components :
- 1- Capsule .
  - 2- Pilus or fimbria .
  - 3- Flagellum .
  - 4- Spore .
  - 5- Granule .
  - 6- Glycocalyx .
- 
- 1- Bacterial envelope is protected the bacteria from unfavorable conditions .
  - 2- Envelope consists of capsule, slime layer, cell wall and plasma *membrane* .
  - 3- In some other a slime cover (slime layer) is present instead of a capsule .
  - 4- In some bacterial cells on outer plasma membrane is present between the capsule and the cell wall .
  - 5- Bacteria covered by a capsule are called capsulated bacteria . the bacteria which do not contain a capsule are called non-capsulated (encapsulated) .
  - 6- The envelope or of bacterial cell encloses the cytoplasm , it is mesosomes . the ribosomes are 70s type .



7- Bacterial chromosome is a double stranded DNA . it is not surrounded a nuclear . the nuclear material of bacteria contain an extra chromosomal circular DNA called plasmid .

**8- Plasmids :**

1. Are small circular DNA ,
  2. Double stranded present inside of bacterial cell .
  3. The plasmids are found in the bacterial cytoplasm .
  4. Plasmids are extra chromosomal genetic elements .
  5. Plasmids are classified into three main types namely :
    1. F plasmids or sex plasmids .
    2. R plasmids .
    3. Col plasmids .
- The F plasmids have the ability to transfer chromosomal genes to other cells, they can also transfer themselves to the cell .
  - The R plasmids has the gene for resistance to one or more anti-biotic.
  - The Col plasmids have the ability to synthesize a toxin called colicins.
  - Some plasmids remain independent , whereas a few get integrated into bacterial DNA .
  - The plasmids integrated to bacterial chromosome is called an episome . the F factor of E. coli is an episome .
  - The plasmids exist in a supercoiled form or open circle or linear duplex .

### **Bacterial nutrition :**

According to their nutrition bacteria are classified into two types namely ;

1- Autotrophs , and 2- heterotrophs .

The autotrophs use the  $\text{CO}_2$  as the source of carbon .

The heterotrophs use organic carbon as the source of carbon .

Many prokaryotes live in symbiotic association with eukaryotes , symbiosis (living together ) between different species that live in direct contact with each other , the kinds (types) of symbiosis are ;

- 1- Mutualism : form of symbiosis in which both organisms are benefited .  
example , nitrogen fixing in plant roots, azotobacter , anabena , cyanobacter, and rhizobium .
- 2- Commensalism : many bacteria inhabit the outer surface of animals and plants without doing damage . example ; normal flora in human and animals E. coli , bacteria receive benefits . while the animal neither benefits nor is harmed .
- 3- Parasitism : is a form of symbiosis in which one member is benefited (bacterium) and the other is harmed (the infected animal or plant).

### **Respiration of bacteria :**

The bacteria may be aerobic or anaerobic or facultative anaerobic :-

- 1- Aerobic bacteria use  $\text{O}_2$  for respiration .
- 2- Anaerobic bacteria use  $\text{CO}_2$  when  $\text{O}_2$  is not available .

**Temperature tolerance :**

Bacteria are classified into three groups namely :

- 1- Mesophilic bacteria / grow well in T° between 25-40 °C .
- 2- Thermophilic bacteria / grow well above 40°C .
- 3- Psychrophilic bacteria / grow well in T° less than 25°C .

**Bacterial growth and reproduction :**

Bacteria reproduce by ;

- 1- Simple binary fission .
- 2- Budding .
- 3- Fragmentation .
- 4- Endospores and conidiospores .

How you calculate the bacterial cells after one hour to growth . if E. coli divide once each 20 minutes , calculate the number of these bacteria after two hours of bacterial growth ?

$$No = 2^n$$

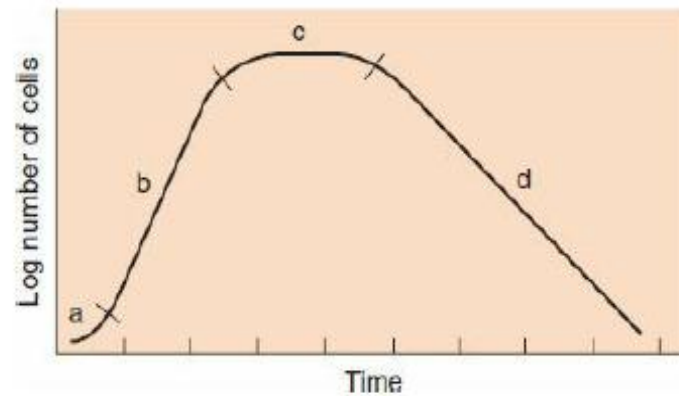
$$\text{Generation time} = 2 \times 60 = 120 \text{ minutes .}$$

$$\frac{120}{20} = 6 \text{ number of generation}$$

$$No^n = 2^6 = 64 \text{ bacterial cells after two hours of bacterial growth .}$$

**Figure :** curve of bacterial growth .

Number of cells	1	2	4	8	16
Exponential	$2^0$	$2^1$	$2^2$	$2^3$	$2^4$



**FIGURE 3–1** Growth curve of bacteria: a, lag phase; b, log phase; c, stationary phase; d, death phase. (Reproduced with permission from Joklik WK et al *Zinsser Microbiology*. 20th ed. Originally published by Appleton & Lange. Copyright 1992 by McGraw-Hill.)

*The End*