General microbiology
Lecture-9

Microbial cell structure
Prokaryotes-2

Microbial cell structure

- Domains of living cells
- Principles of microbial cell structure
  - Elements of Microbial cell Structure
  - Eukaryotes
  - **Prokaryotes & chemistry of cellular components**

Prokaryotes, cell structure

All cells have the following in common:

- Cell wall and cytoplasmic membrane
- **Cytoplasm**
- Ribosomes
- Genetic materials

Prokaryotes, cell structure
Cytoplasm

Cytoplasm

- semifluid substance inside the cell membrane.
- 4/5 of the cytoplasm is water. The remaining 1/5 substances dissolved or suspended in the water (e.g. enzymes, proteins, carbohydrate, lipids and inorganic ions)
- Many chemical reactions occur in the cytoplasm
- Cytoplasm is thick, aqueous, semitransparent and elastic .
- The major structures in the cytoplasm of prokaryotes are nucleoid and ribosomes.
- Prokaryotic cytoplasm lacks certain features of eukaryotic cytoplasm such as cytoskeleton .

Prokaryotes, cell structure
Ribosomes

All cells have the following in common:

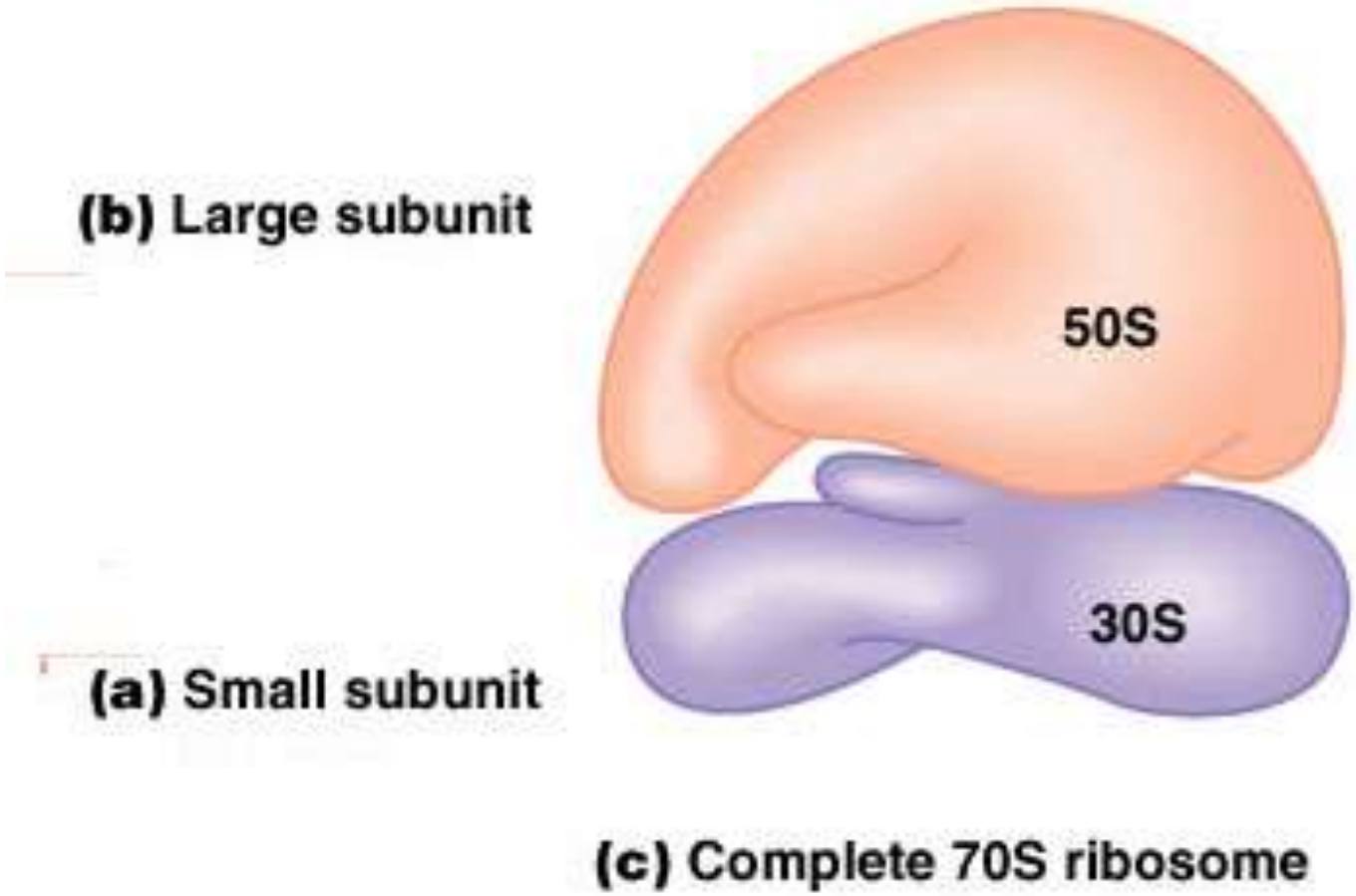
- Cell wall and cytoplasmic membrane
- Cytoplasm
- **Ribosomes**
- Genetic materials

Prokaryotes, cell structure
Ribosomes

Ribosoms

Ribosomes:

- Consist of RNA and Protein.
- Abundant in the cytoplasm of prokaryotes.
- Polyribosomes= chains of ribosomes in one cell
- Nearly spherical, stain densely.
- It contains a large subunit and small subunit.
- Site for protein synthesis.
- The size is determine by measuring their **sedimentation rates**
- Expressed in terms of Svedberg unit (S) unit.



Prokaryotic ribosomes are 70S ribosomes ,and the subunits are 30S and 50S.

Prokaryotes ribosome.

Prokaryotes, cell structure
Genetic materials (Nuclear region and plasmids)

All cells have the following in common:

- Cell wall and cytoplasmic membrane
- Cytoplasm
- Ribosomes
- **Genetic materials**

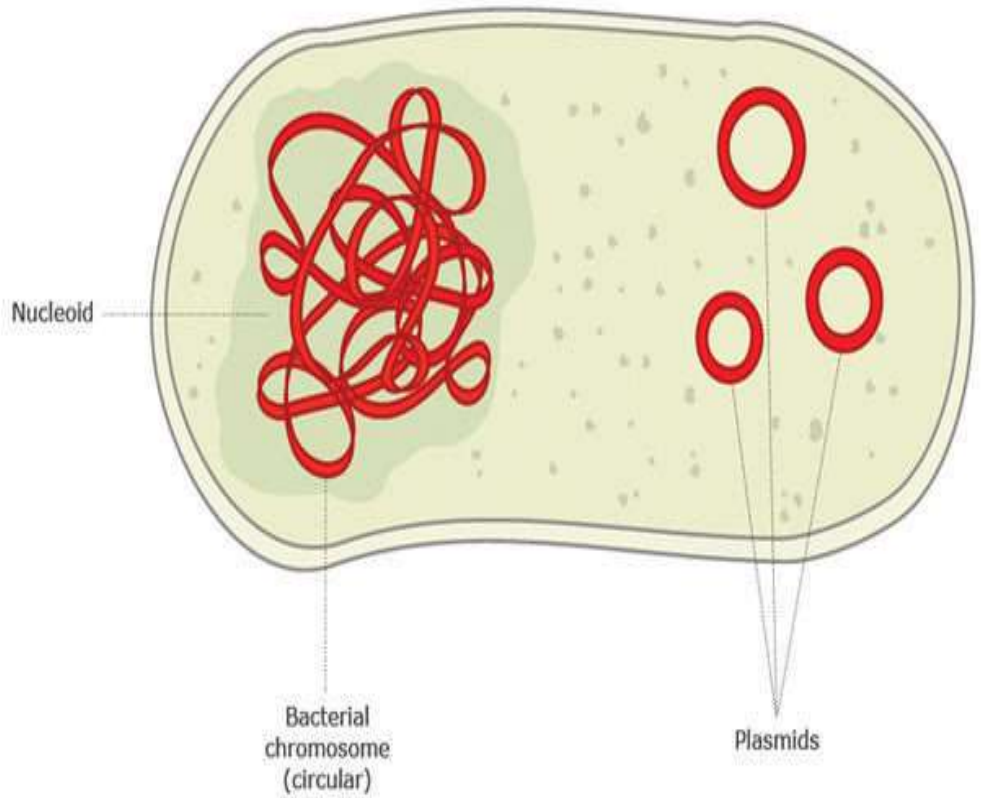
Nuclear region.

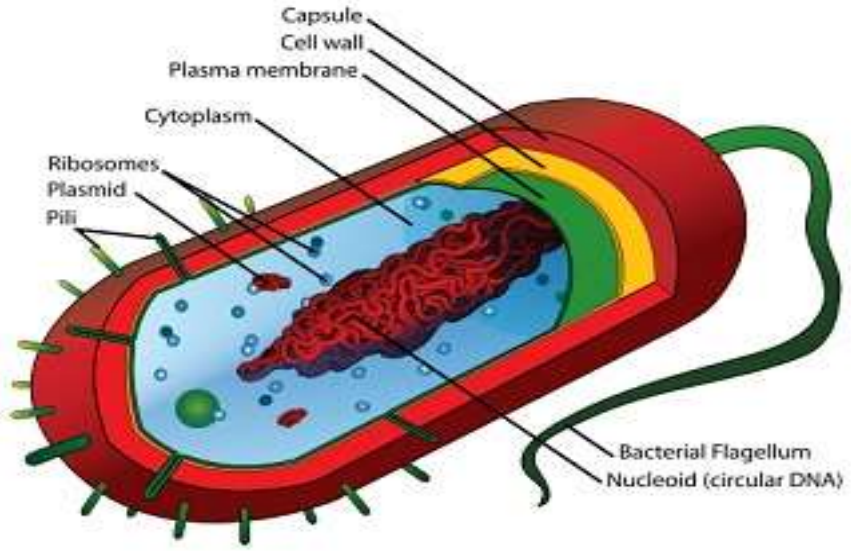
- Nucleoid of nuclear region consists of DNA, has some RNA and protein associated with it. 1
- The dsDNA is single one circular chromosome. However, some bacteria contain two circular chromosomes (e.g. *Rhodobacter sphaeriodes* and *Vibrio cholerae*).

Plasmids

- are small circular molecules of dsDNA. Extrachromosomal genetic elements.
- Often, the genes carried in plasmids provide bacteria with genetic advantages, such as antibiotic resistance.
- They are not essential for the bacterium.

Not required





1

Genetic materials = Genome

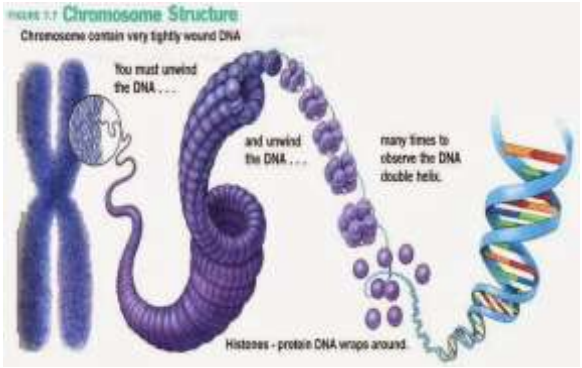
A cell's full complement of genes

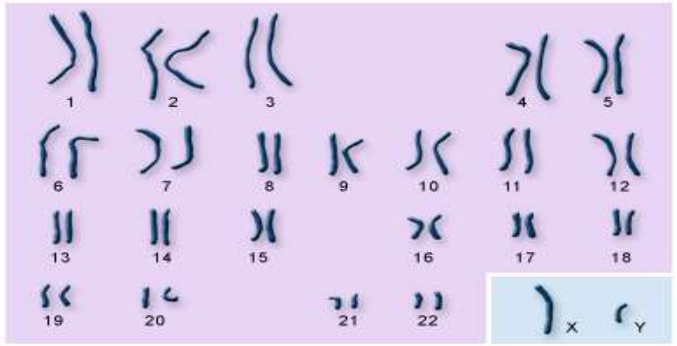
Eukaryotic

DNA is linear and found within the nucleus

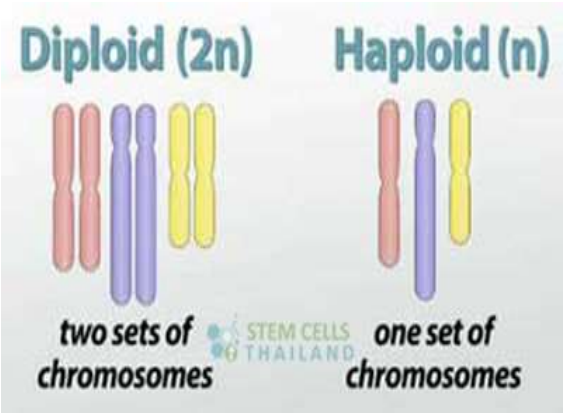
- Associated with proteins that help in folding of the DNA
- Usually more than one chromosome
- Typically two copies of each chromosome
- During cell division, nucleus divides by mitosis
- During sexual reproduction, the genome is halved by meiosis

These three photos are not required





U.S. National Library of Medicine



Prokaryotes, cell structure

NOTE:

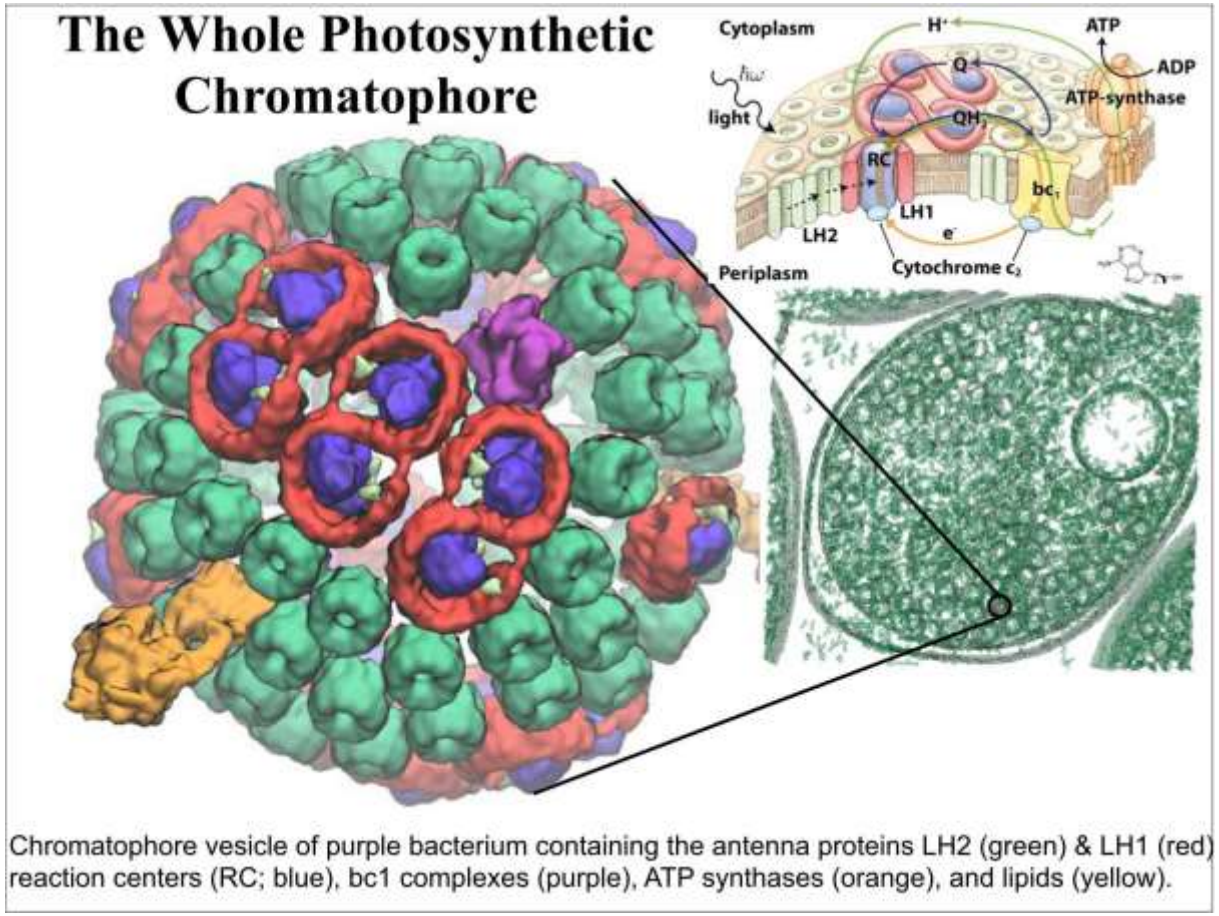
Other internal and external structures may exist

Additional internal and external structures

2

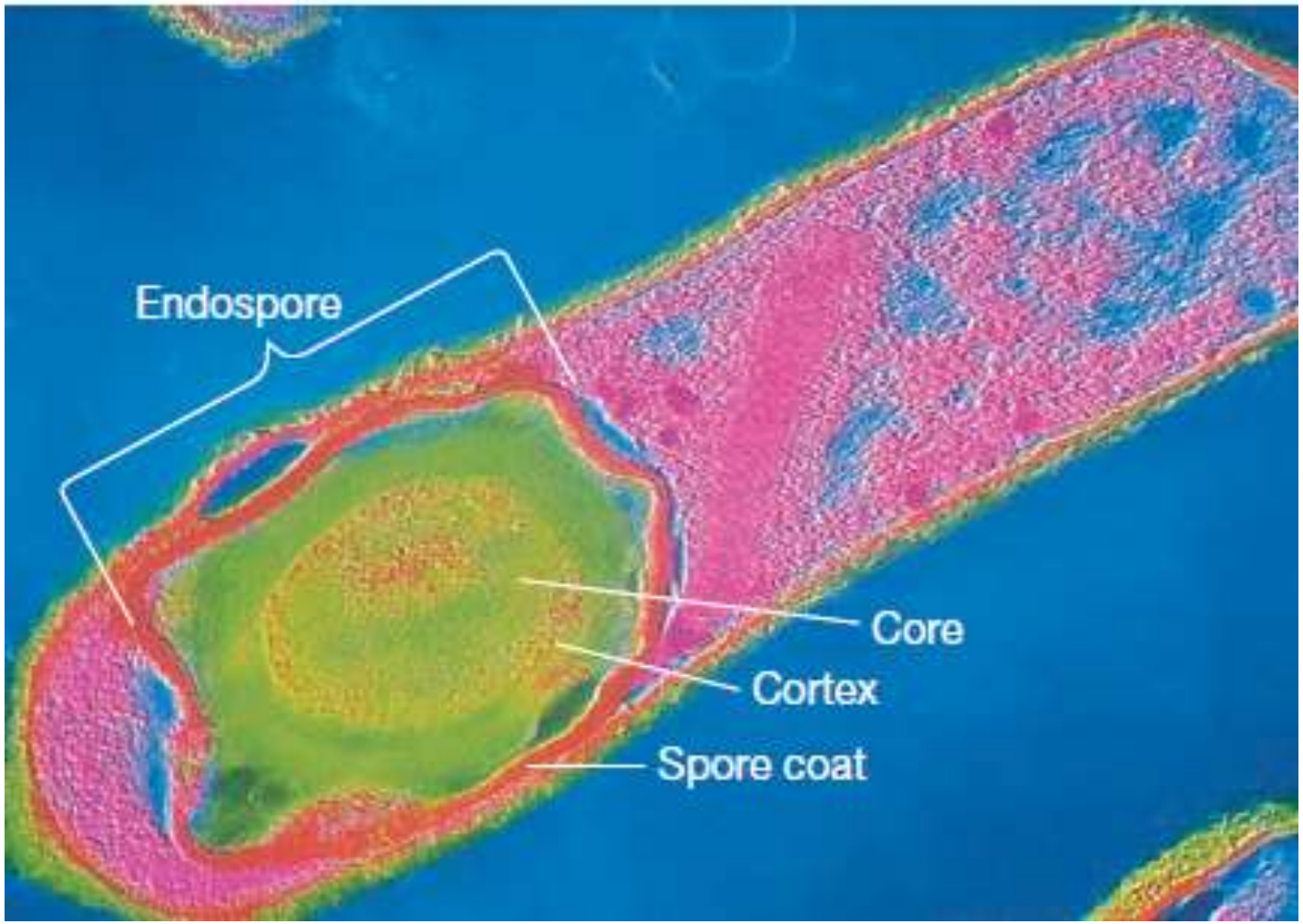
1. **Chromatophores.** In photosynthetic bacteria, contain the pigments used in photosynthesis.
2. **Cell Inclusions:** such as **Granules** (contain glycogen or polyphosphate), **Vesicles** (gas-filled vacuoles)
3. **Endospores:** vegetative cells of some bacteria produce resting stages called endospores. Examples are *Bacillus* and *Clostridium.* ***Bacteria produce one endospore while fungi produce high number of spores (usually external).***
4. **Flagella:** The primary function of a flagellum is that of locomotion
5. **Capsule**: it enhances the ability of bacteria to cause disease (e.g. prevents phagocytosis).
6. **Fimbriae:** is used to attach the bacterium to a surface.
7. **A pilus** (plural: pili) is a hair-like appendage found on the surface of many bacteria and archaea. Conjugative pili allow for the transfer of DNA between bacteria.

Not required



Chromatophore vesicle of purple bacterium containing the antenna proteins LH2 (green) & LH1 (red) reaction centers (RC; blue), bc1 complexes (purple), ATP synthases (orange), and lipids (yellow).

2



Endospore

A colorized electron microscopy graph of an endospore within a *Clostridium perfringens* cell

Overview of prokaryotic

1. The DNA is not enclosed within a membrane and usually a singular circularly arranged chromosomes.
2. The DNA is not associated with histones
3. The lack membrane- enclosed organelles
4. The cell wall contain complex polysaccharide peptidoglycan
5. They dived by binary fission.

Prokaryotes

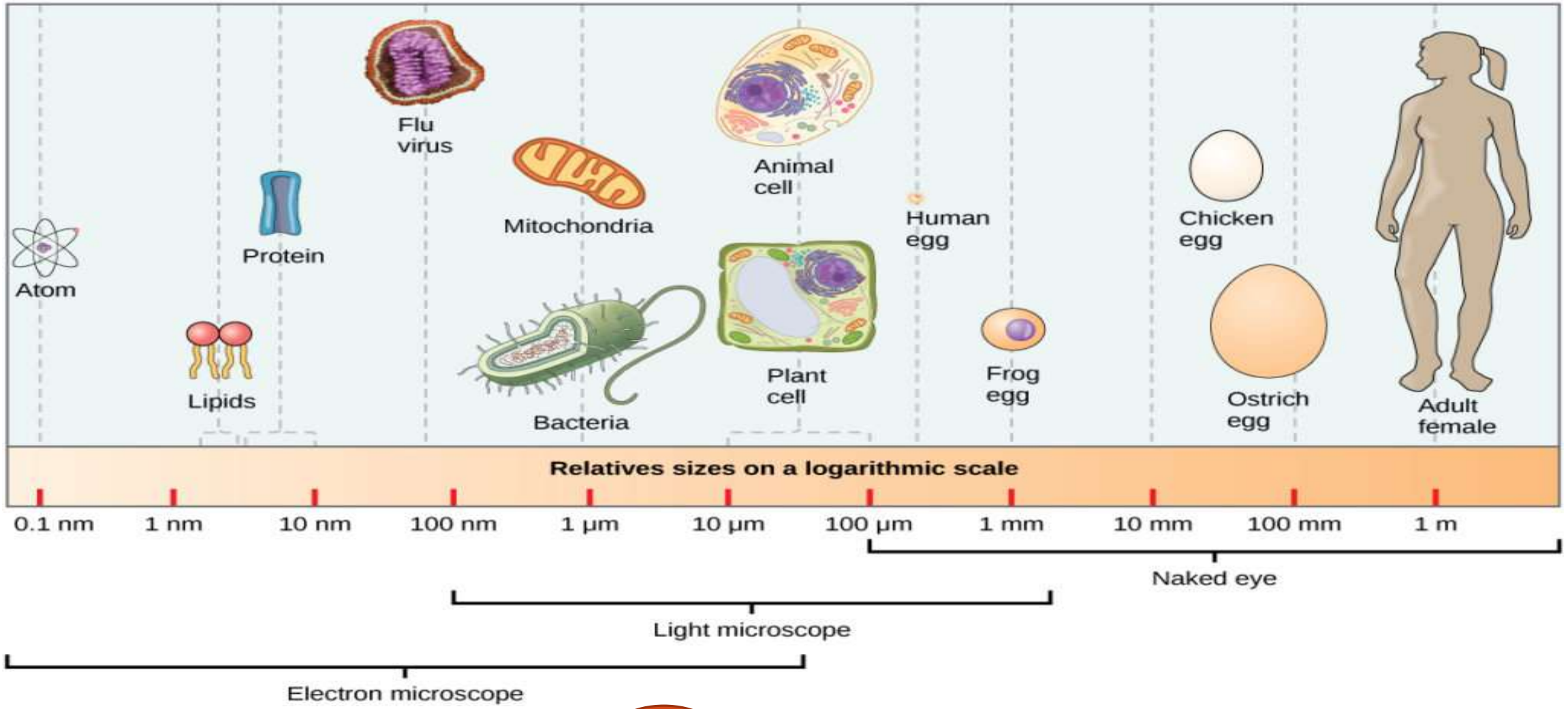
SIZE, SHAPE AND ARRANGEMENT

Prokaryotes
Size, shape and arrangement

SIZE

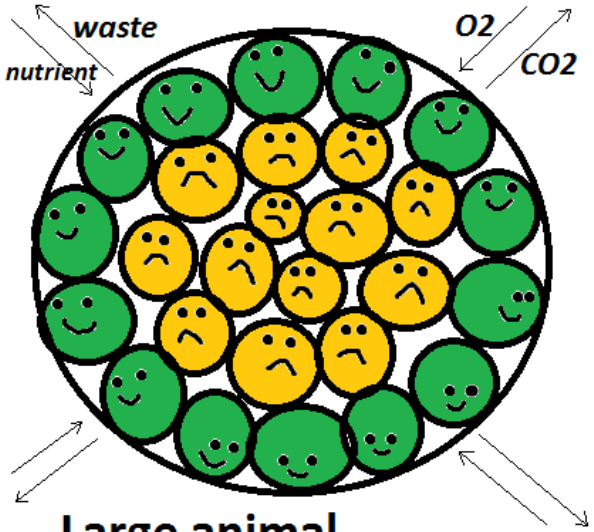
- Prokaryotes are among the smallest of all organisms.
- Range from 0.5-2.0 µm in diameter. 3
- HOWEVER, Bacteria have a large (surface : volume) ratio. e.g. spherical bacteria with a diameter of 2µm have a surface area of ~ 12µm^2 and a volume of ~ 4µm^3 4

Not required

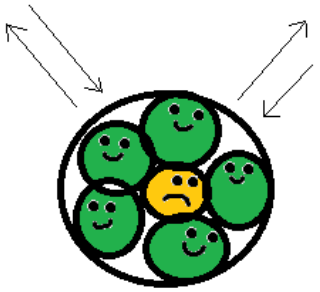


3

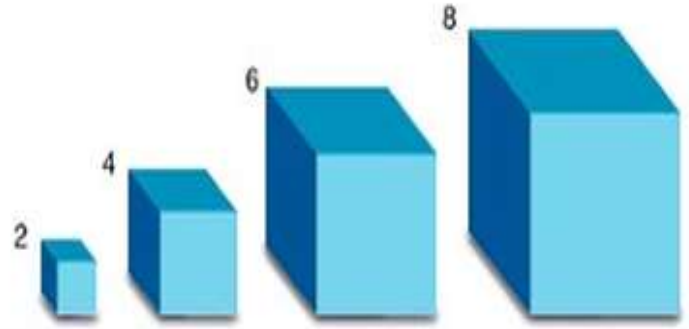
Not required



Large animal
-low total surface area exposed compared to the volume



Small animal
-high TSA exposed compared to the volume



Surface area (cm^2)	24	96	216	384
Volume (cm^3)	8	64	216	512
Surface area / Volume	3.0	1.5	1.0	0.75

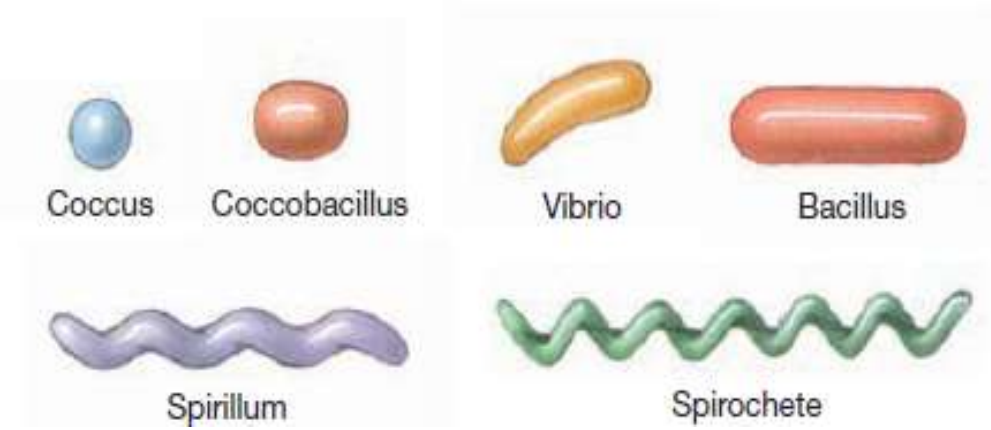
4

Prokaryotes
Size, shape and arrangement

SHAPES

- **Bacteria:** come in 3 basic shapes: 5

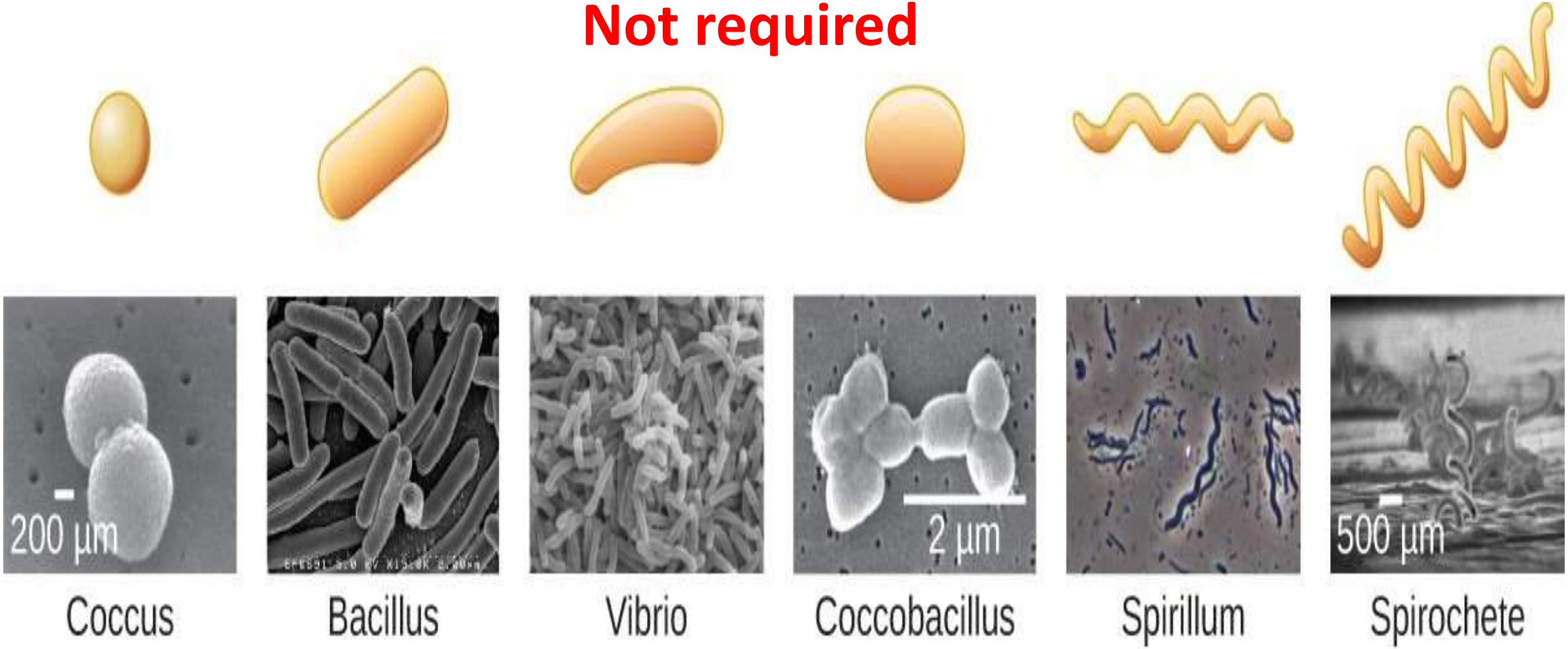
1. **Spherical**: called Coccus (plural:cocci)
2. **Rod like**: called Bacillus (plural: Bacilli)
    - Some bacteria called **coccobacilli**
1. **Spiral**: variety of curved shapes.
    - Vibrio: a curved-rod (comma) shape
    - Spirillum: rigid wavey shape
    - Spirochete: corkscrew-shape



- **NOTES**

1. Some bacteria do not fit in any of the previous categories.
2. Even bacteria of the same kind may vary in size and shape depending on the nutrients and environmental conditions.
3. Some bacteria vary widely in form even within a single culture. Known as **pleomorphism.**

Not required

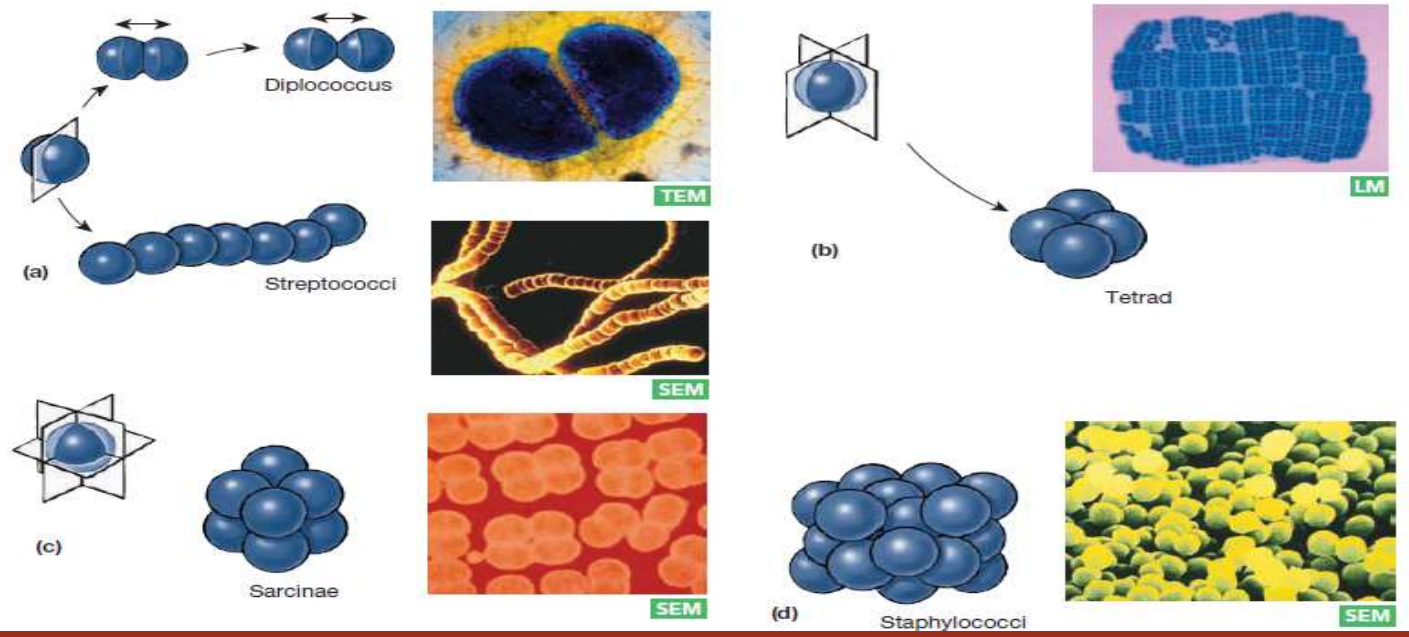


5

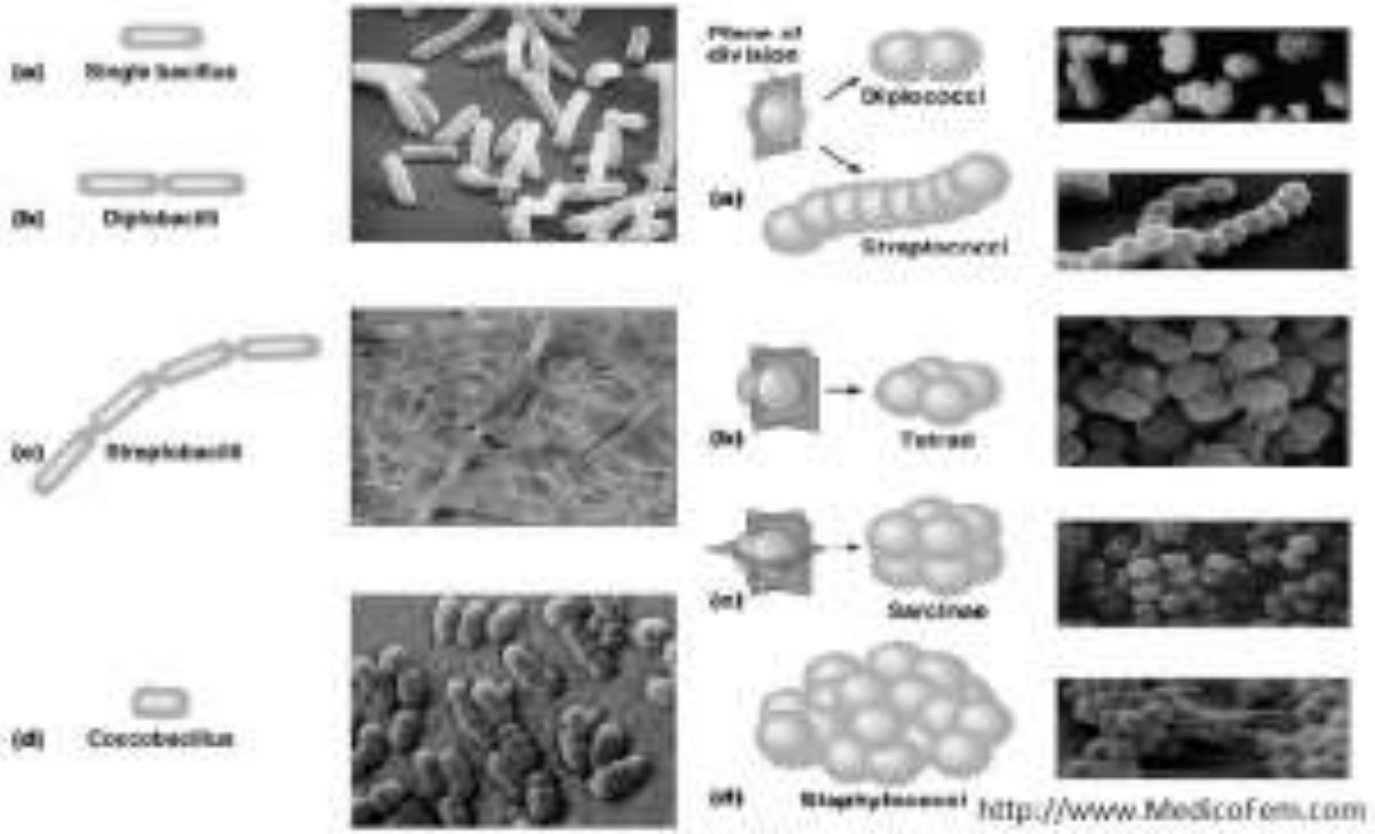
Size, shape and arrangement

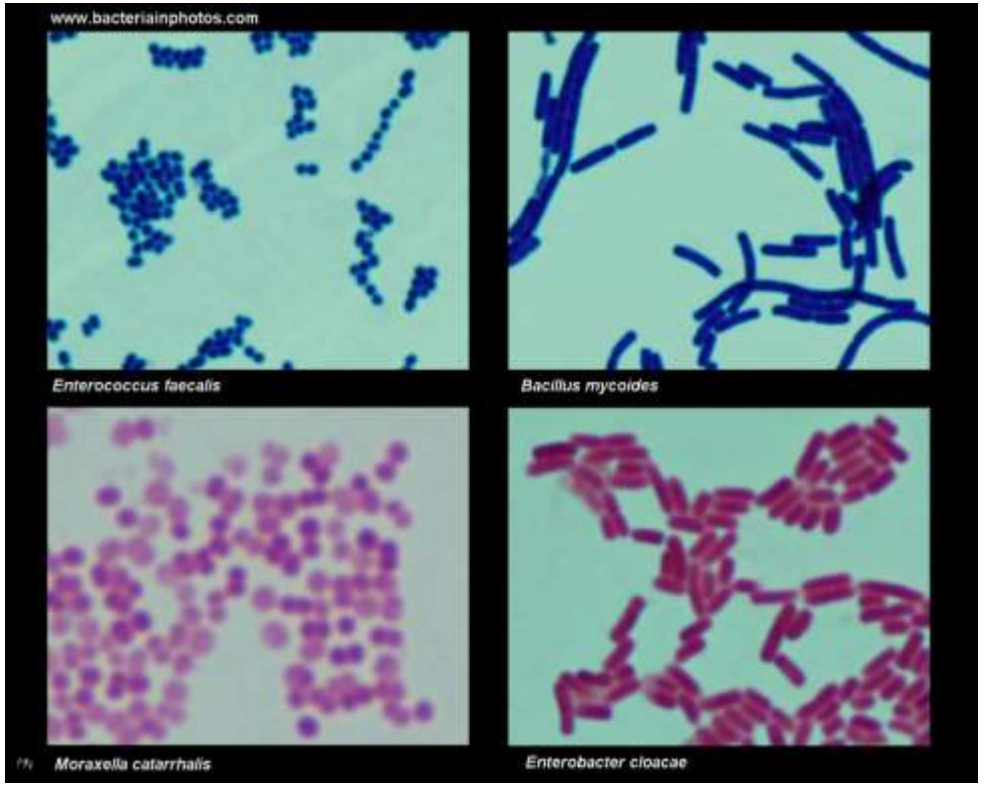
Arrangement

- **Bacterial cells can be found in distinct arrangements.** 5
- In cocci bacteria: Arranged cells divide **without** separating.
  - Division in one plane produces cells in pairs (diplo), or chains (strepto-)
  - Division in random planes produce grapelike clusters (staphylo-).
- Bacilli divide in **only one plane**= can be connected end-to-end
- Spiral bacteria are not generally grouped together.



Not required





5


ANY
QUESTIONS
?