Bacterial Structure and Function

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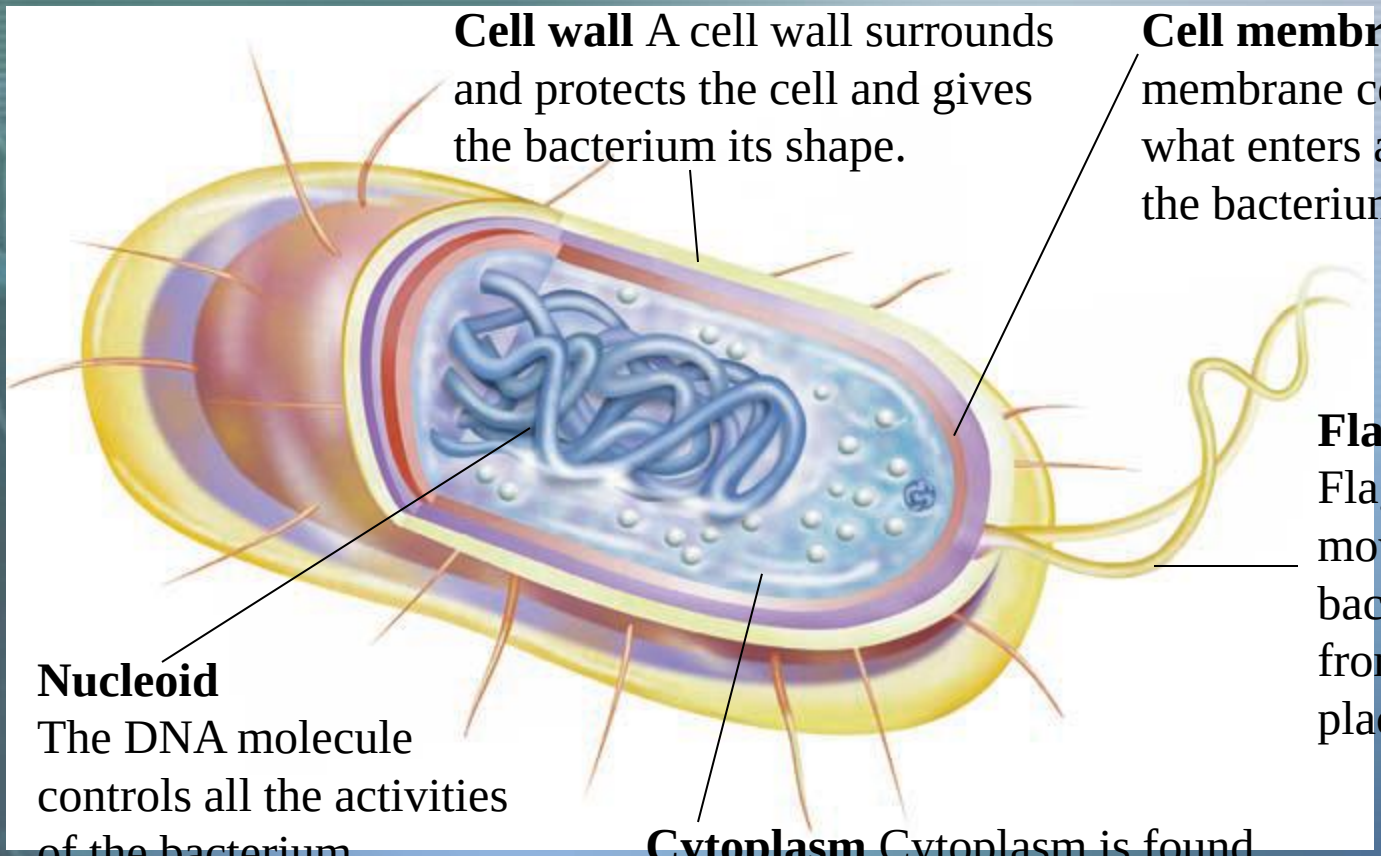
Structure of Bacteria

The cells of bacteria are prokaryotic cells. Because bacteria are cells, they have some of the same structures discussed and associated with eukaryotes in our previous meetings. As you read this section, locate each structure in the **Figure below.**

Structures of a Typical Gram-Negative Bacterium



Cell wall A cell wall surrounds and protects the cell and gives the bacterium its shape.

Cell membrane A cell membrane controls what enters and leaves the bacterium.

Flagellum Flagella move the bacterium from place to place.

Nucleoid The DNA molecule controls all the activities of the bacterium.

Cytoplasm Cytoplasm is found inside the cell membrane and contains the bacterium's ribosomes.

SOURCE: https://www.mheonline.com/contemporary/assets/ConBiologySE_p126_129.pdf

1. CELL WALL:

The outer wall of most bacteria is the cell wall. The cell wall is rigid and tough, and it protects the bacterial cell and determines its shape.

2. CELL MEMBRANE

Inside the cell wall is the cell membrane. The cell membrane controls what substances enter and leave the bacterial cell.

3. CYTOPLASM

Inside the cell membrane is the jelly-like cytoplasm that contains all the other structures found in a bacterial cell.

4. NUCLEOID

DNA, the bacterial cell's genetic material, is the rope-like tangle in the cytoplasm. Because bacteria are prokaryotes, their DNA is not enclosed in a nucleus. However, the DNA still controls the activities of the cells. The production of proteins is carried out by the ribosomes found throughout the cytoplasm.

5. FLAGELLUM

Another structure found on some bacteria is the flagellum. **Flagella** are whiplike structures that extend outward from the cell membrane into the bacterial cell's environment and move the cell through that environment. Bacteria without flagella must depend on air or water currents or other living organisms to move from one place to another.

BACTERIAL CELL SHAPE AND ARRANGEMENT

Gram Staining for demonstration of Cell Shape and Arrangement

Hans Christian Gram described bacteria as being either Gram positive (G+) or Gram negative (G-). Gram staining is an important way to characterize bacteria. When a bacterial smear is Gram stained, G+ cells will appear purple, while G- cells will appear pink. Gram stain character is based on the structure of their cell walls. Gram positive cell walls consist of many thick layers of peptidoglycan (cross-linked by teichoic acid and lipoteichoic acid). Gram negative cell walls have thin layers of peptidoglycan, surrounded by a lipid-based outer membrane.

Gram Stain Method

1. Clean a microscope slide with Bon Ami cleanser, rinse (H_2O) and soak for 1 min in isopropyl alcohol.
2. Dry the slide with paper towels.
3. Make a bacterial smear.

a. **From an agar stock culture**, put a SMALL drop of water on the slide and smear a SMALL amount of cells into the water.

b. **From a broth stock culture**, smear several (6 to 8) loop-fulls of broth onto the slide.

4. Allow the slide to air dry (so that there is no visible moisture on the slide).
5. Heat fix the slide by passing it (cell side up) three times through the cool (upper) part of the flame of a Bunsen burner **OR** hold directly above the opening of a Bacticinerator for 45 seconds.

Gram Staining Method

6. Flood the slide with Gram's Crystal Violet for 1 min. Rinse with distilled water.
7. Flood the slide with Gram's Iodine for 1 min. Rinse with distilled water.
8. Flood the slide with Acetone-Alcohol for **exactly** 5 seconds. Rinse with distilled water.
9. Flood the slide with Safranin for 2 min. Rinse with distilled water.
10. Blot dry with bibulous paper.
11. View under 4x, 10x, 40x, and oil immersion (100x). **A Gram-stain can only be validly evaluated using immersion oil and the oil immersion lens (1000x total magnification)!**

	Gram-negative Bacteria	Gram-positive Bacteria
Gram reaction	Can be decolourized to accept counter stain (Safranin or Fuchsine); stain red or pink, they don't retain the Gram stain when washed with absolute alcohol and acetone.	Retain crystal violet dye and stain dark violet or purple, they remain coloured blue or purple with gram stain when washed with absolute alcohol and water.
Peptidoglycan layer	Thin (single-layered)	Thick (multilayered)
Teichoic acids	Absent	Present in many
Periplasmic space	present	Absent
Outer membrane	Present	Absent
Lipopolysaccharide (LPS) content	High	Virtually none
Lipid and lipoprotein content	High (due to presence of outer membrane)	Low (acid-fast bacteria have lipids linked to peptidoglycan)
Flagellar structure	4 rings in basal body	2 rings in basal body
Toxins produced	Primarily Endotoxins	Primarily Exotoxins
Resistance to physical disruption	Low	High
Inhibition by basic dyes	Low	High
Susceptibility to anionic detergents	Low	High
Resistance to sodium azide	Low	High
Resistance to drying	Low	High
Cell wall composition	The cell wall is 70-120 Armstrong thick two layered.The lipid content is 20-30% (High), whereas Murein content is 10-20% (Low).	The cell wall is 100-120 Armstrong thick, single layered. The Lipid content of the cell wall is low , whereas Murein content is 70-80% (Higher).
Mesosome	Mesosome is less prominent.	Mesosome is more prominent.

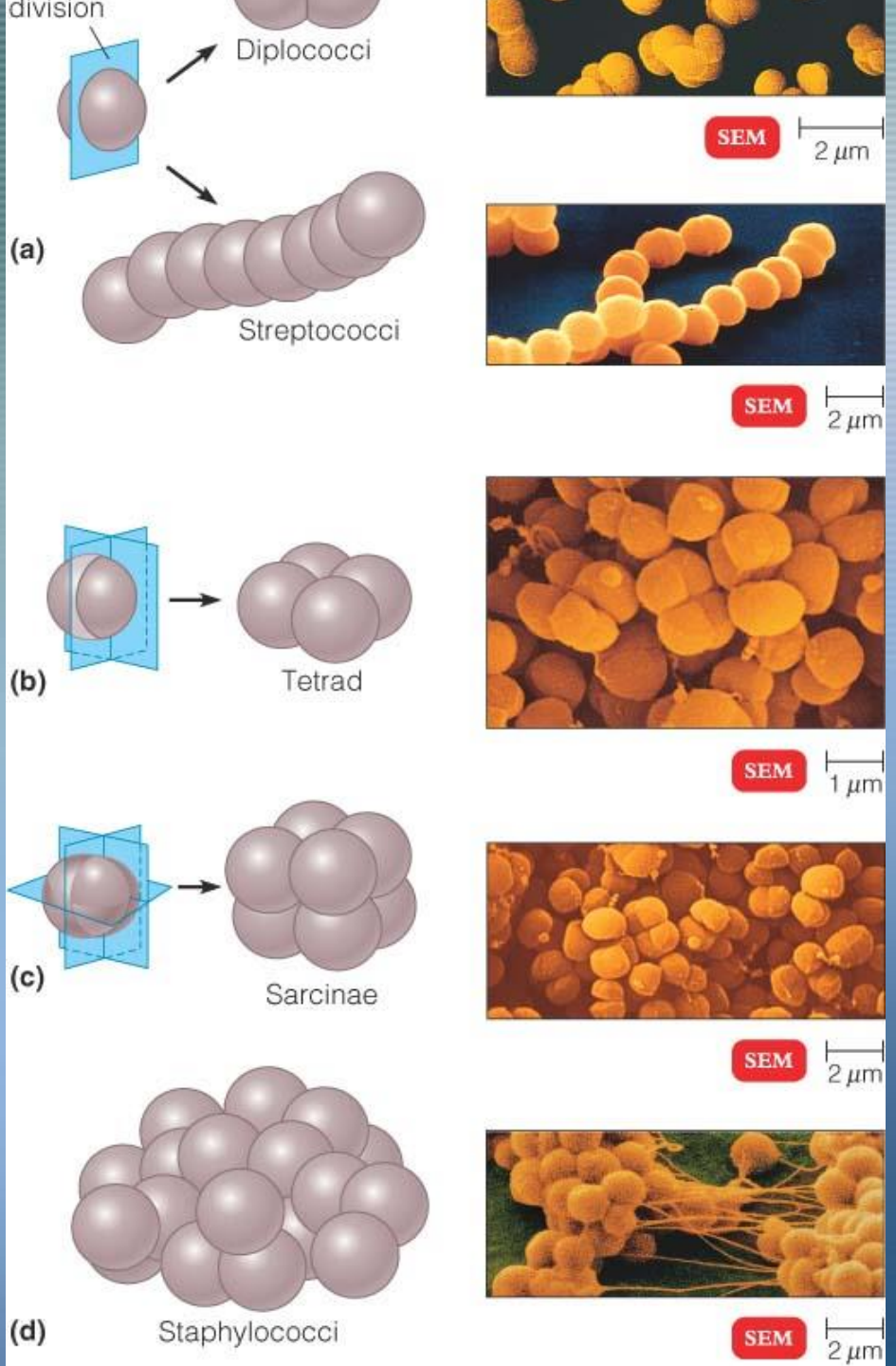
SIZE, SHAPE AND ARRANGEMENT OF BACTERIAL CELLS

Most bacteria are 0.2 um in diameter and 2-8 um in length (average 1.0um).

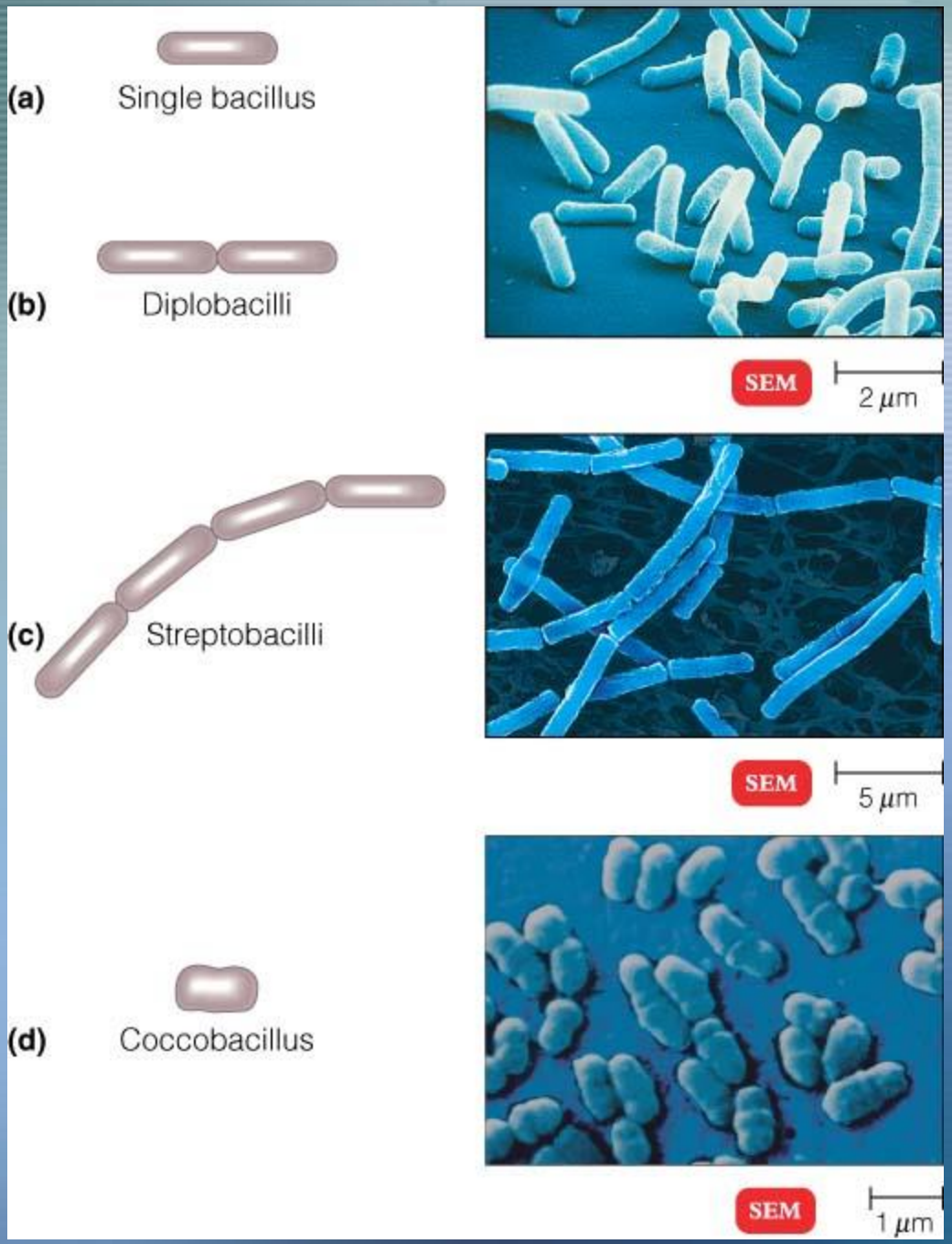
The three basic bacterial shapes are

- coccus (spherical),
- bacillus (rod-shaped),
- and spiral (twisted),
- however pleomorphic bacteria can assume several shapes.

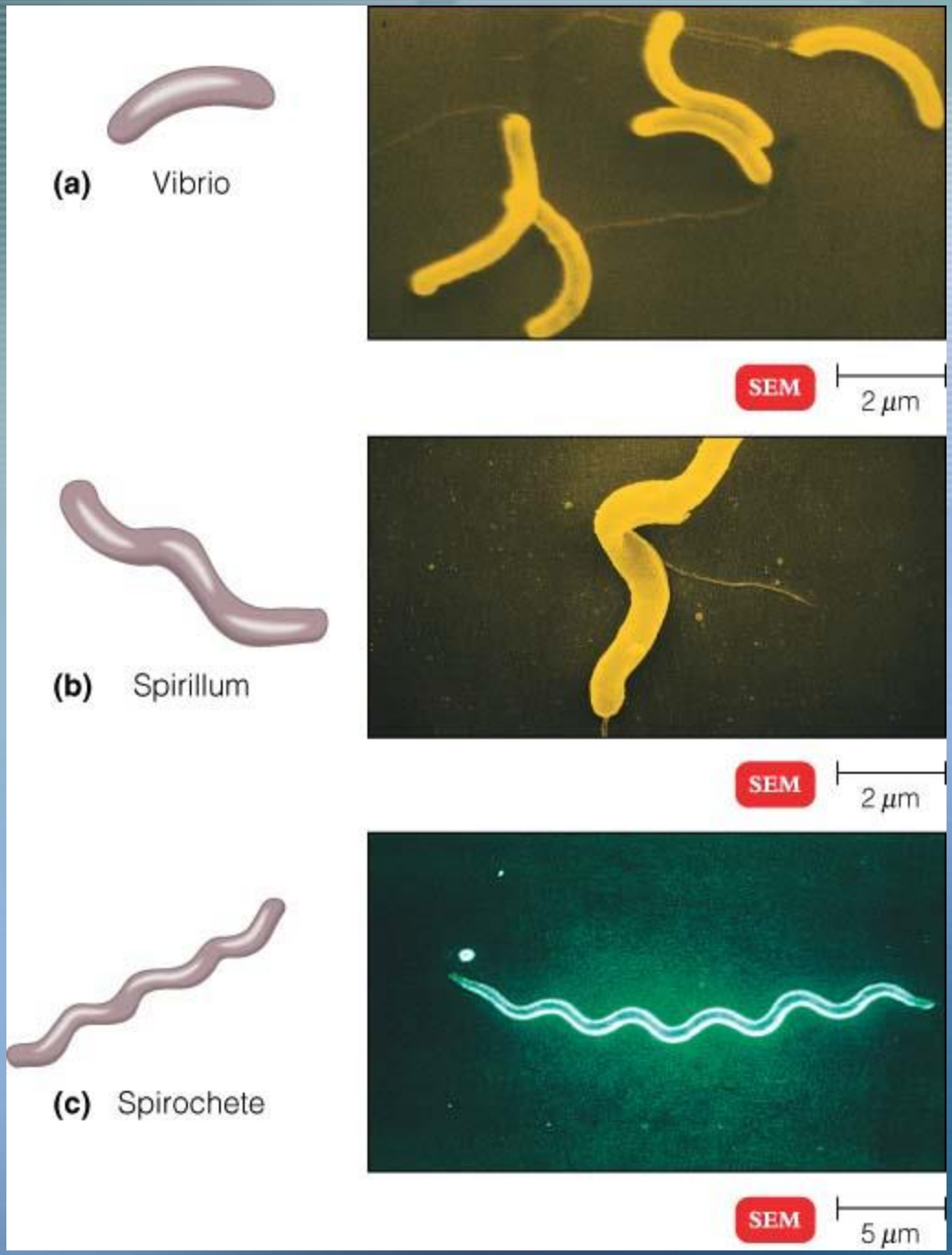
Arrangement of cocci



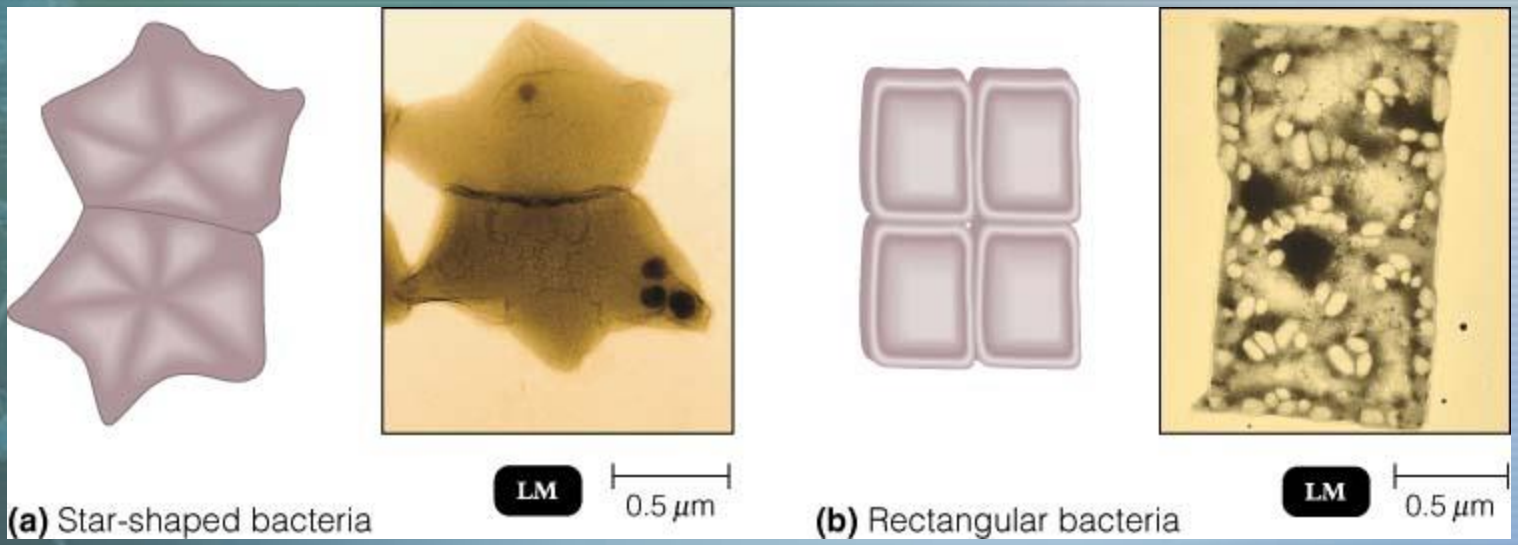
Arrangement of bacilli



Arrangement of spiral bacteria



Other shapes of prokaryotes



Stella are star-shaped.

Haloarcula, a genus of halophilic archaea, are rectangular.