CLASS SESSION: BIOEVOLUTION - HETEROTROPH HYPOTHESIS

A. Origin of Life (description) - the concepts surrounding the theories on the origin of life on earth may be considered both tentative and speculative; it is believed that before there could have been organic evolution (that of living organisms), there must have occurred a chemical evolution

1. heterotroph hypothesis (definition) - the hypothesis accounts for the evolution of life forms which are distinguished by their form of nutrition and their energy processes

a. basic nutrition forms (heterotroph vs autotroph) -

b. basic energy processes (anaerobic vs aerobic) -

B. Heterotroph Hypothesis Summary:

1. primitive conditions (first stage)(description) -

2. organic compounds (second stage)(description) -

3. aggregation (third stage)(description) -

4. anaerobic heterotrophs (description) -

a. fermentation (evolution of process) -

1. carbon dioxide (new product) -

5. anaerobic autotrophs (description) -

a. photosynthesis (evolution of process) -

1. oxygen (new product) -

6. aerobic heterotrophs and autotrophs (description) -

a. respiration (evolution of process) -

Note: Organisms today may be considered evolved from the basic groups outlined by the heterotroph hypothesis. Anaerobic heterotrophs include groups of bacteria, protists and fungi. Anaerobic autotrophs include groups of bacteria and protists. Aerobic heterotrophs include groups of bacteria, protists, fungi, and animals. The aerobic autotrophs include groups of bacteria and protists, and complex green plants.

CLASS SESSION: INTRODUCTION TO CELL STRUCTURES

A. Cell Doctrine (definition) - the cell doctrine states that cells form from existing cells and that the cell is the basic unit of structure and function in organisms; refers to the cell as a basic building block making up organisms and refers to the cell as the site or location at which life functions are performed

1. eukaryotes (description) -

2. prokaryotes (description) -

B. Eukaryotic Cell (generalized) - refers to typical plant or animal cells that are not modified for any particular function; general cells display typical structures of nucleus and organelles; serve as a "model" of typical cell structure

1. nucleus (description) - organelle that contains protoplasm known as nucleoplasm and surrounded by a double layer nuclear envelope; includes the chromatin material and nucleolus

a. function of the nucleus -

b. chromatin material (definition) -

c. nucleolus (description) -

2. organelles (definition) - may be defined as the sub-cellular structures of the cell found in the cytoplasm; each organelle is surrounded by membranes and each organelle is designed as a site within the cell associated with a particular function

a. cytoplasm (definition) -

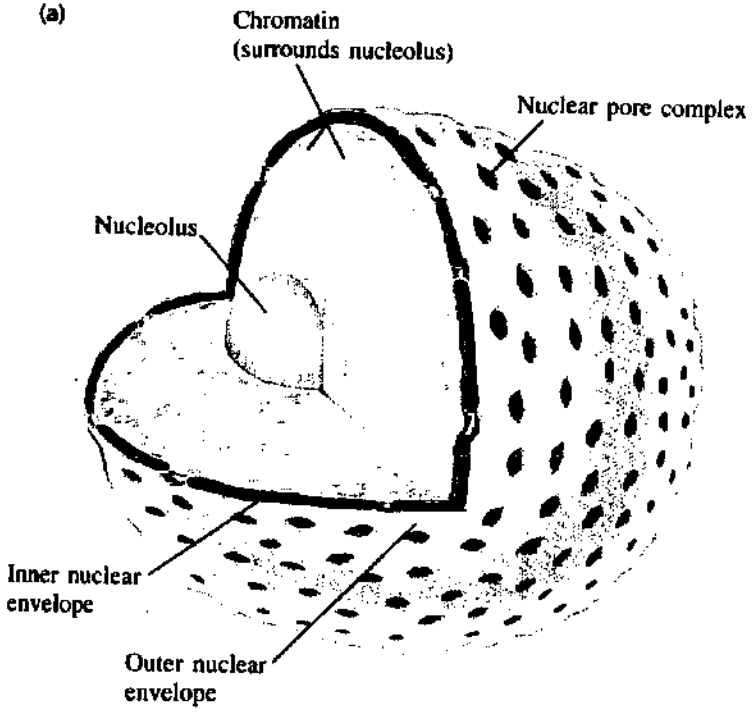
C. Eukaryotic Cell Organelles (description) - found and function in typical eukaryotic cells; there are some basic differences in organelles to be noted between a general animal cell and a general plant cell

1. plasma membrane (description) - organelle of typical cells that defines and surrounds the cell as the cell membrane; composed of protein and lipid (fat); openings in the membrane are described as pores

a. function of plasma membrane -

b. fluid mosaic model (description) -

Diagram of Cell Membrane (Fluid Mosaic Model):



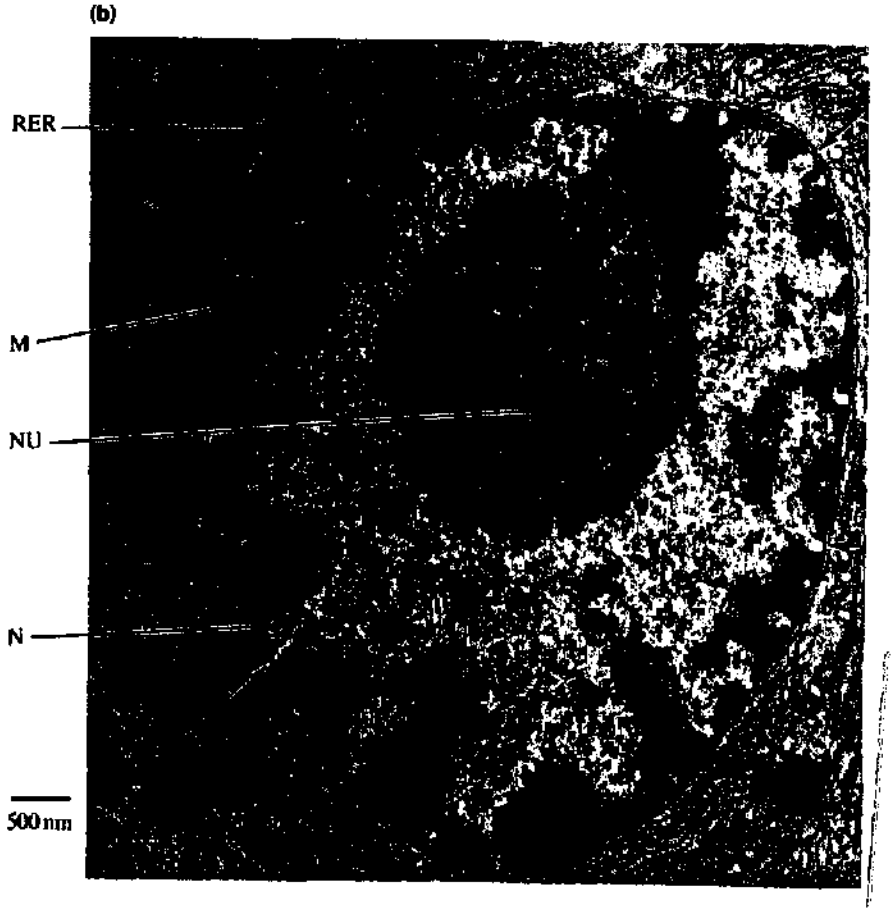


Figure 1·9
Nucleus of a eukaryotic cell. (a) Diagram. (Illustrator: Lisa Shoemaker.) (b) Transmission electron micrograph of a cross-sectional view of a nucleus in a rat pancreas cell. The arrows point to nuclear pore complexes. Also labeled are the rough endoplasmic reticulum (RER), mitochondrion (M), nucleus (N), and nucleolus (NU). The integrated activities of these and other organelles allow synthesis and transport of materials throughout the cell. (Courtesy of Stephen L. Wolfe.)

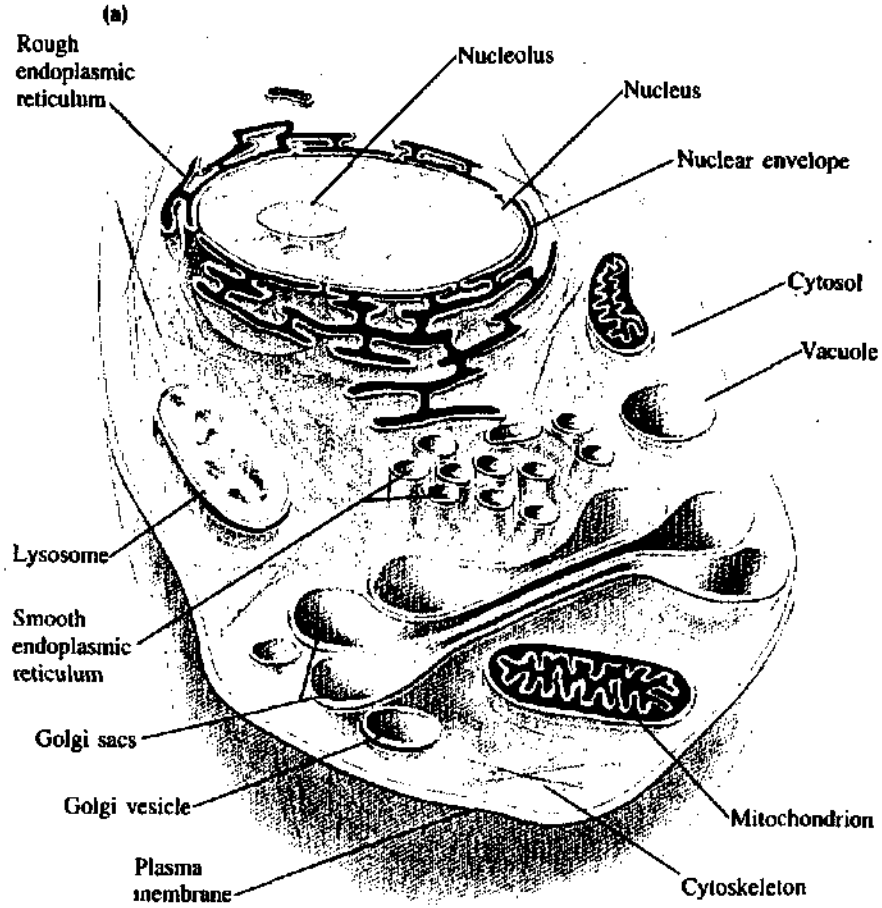
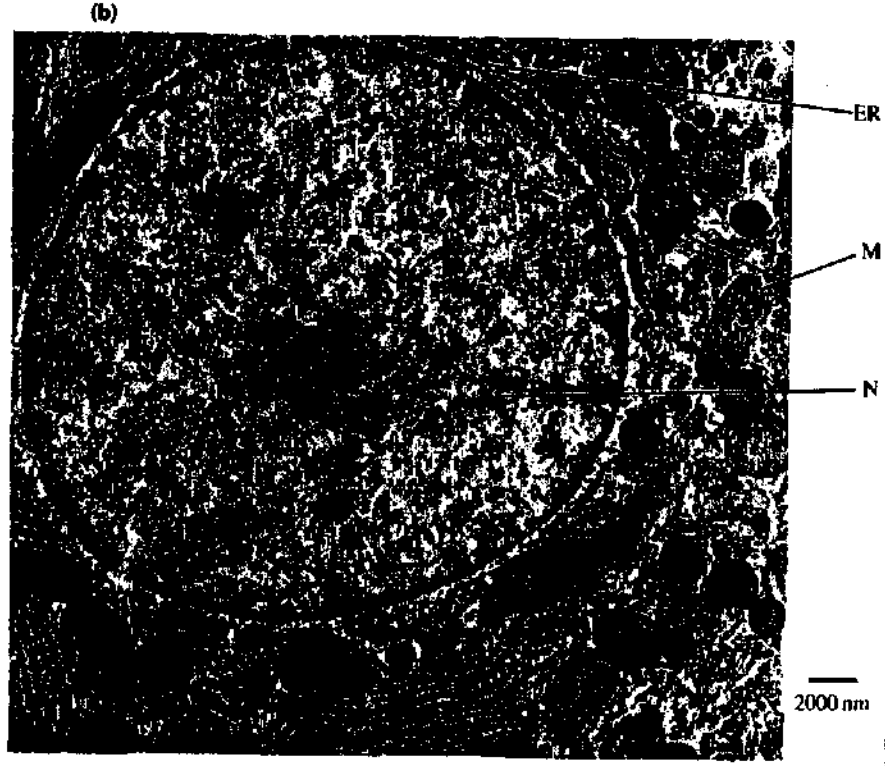


Figure 1·8
Eukaryotic cell. (a) Illustration. Eukaryotic cells are much larger and much more complex than prokaryotic cells. The primary components shown here are described in this chapter. (Illustrator: Lisa Shoemaker.) (b) Transmission electron micrograph of a rat liver cell. The major ultrastructural features shown are: nucleus (N), mitochondria (M), and endoplasmic reticulum (ER). (Courtesy of Keith R. Porter.)



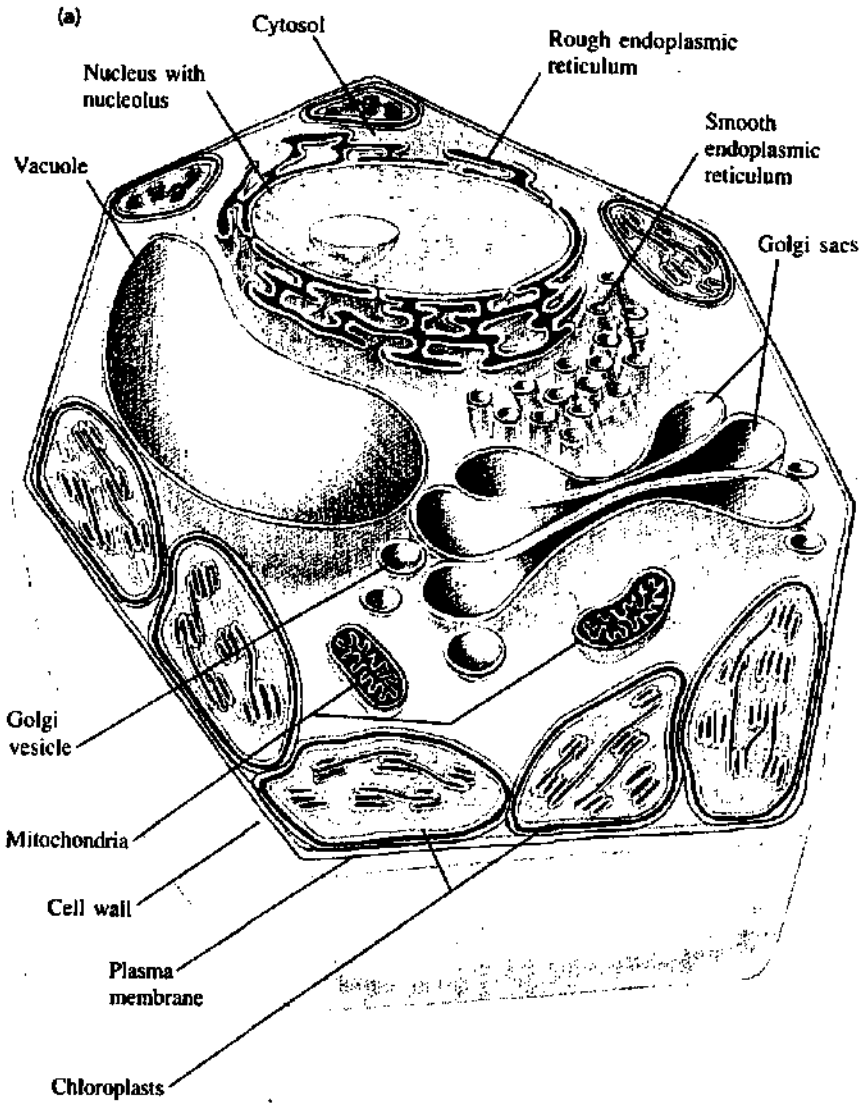
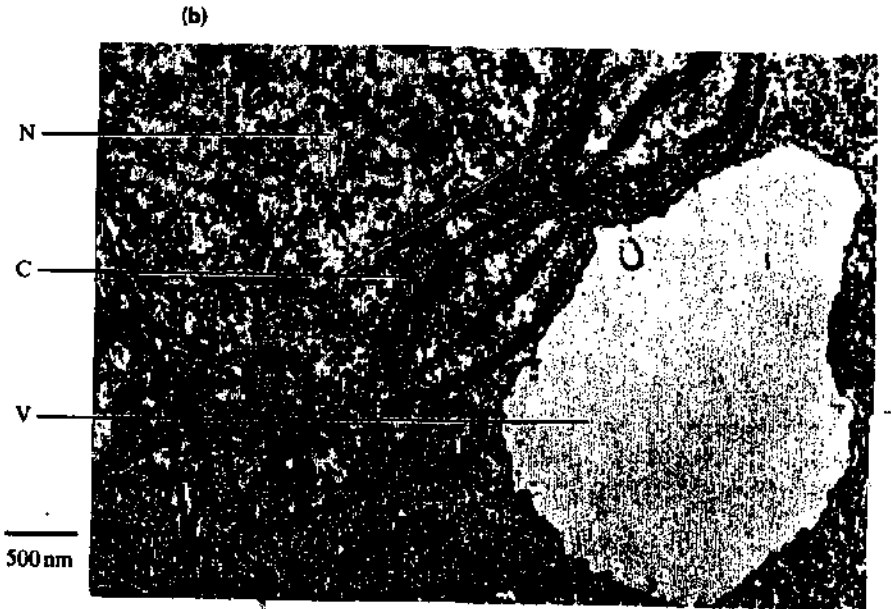


Figure 1·15
Plant cell. Unique features of plant cells include chloroplasts, the sites where photosynthesis occurs; rigid cell walls composed of cellulose; and vacuoles, large, seemingly empty spaces containing solutes and cellular wastes. These and other components of plant cells are described in this chapter. (a) Diagram. (Illustrator: Lisa Shoemaker.) (b) Transmission electron micrograph of a cell from the root tip of *Spirodela* (duckweed). Note the vacuole (V), chloroplasts (C), and nucleus (N). (Courtesy of Keith R. Porter.)



2. endoplasmic reticulum (ER)(description) - organelle of typical cells described as a network of membraneous sacs, channels and tubes that are continuous with the plasma membrane and form a system of channels throughout the cytoplasm; also continuous with the outer membrane of the nuclear envelope that surrounds the nucleus

a. function of endoplasmic reticulum -

3. ribosomes (description) - organelles of typical cells described as small rounded organelles surrounded by membrane that are often located along the membrane channels of the endoplasmic reticulum

a. function of ribosomes -

Note: The endoplasmic reticulum is referred to as Rough ER when the ribosomes are located along its membrane channels. When the ribosomes are not found associated with the endoplasmic reticulum, then it is referred to as Smooth ER. The distribution of ribosomes in the typical cell is related to the utilization of newly synthesized proteins. When proteins are synthesized for the cell's own use the ribosomes are distributed throughout the cytoplasm, and in cell's that export protein products many ribosomes are found attached to the ER.

4. vacuoles (description) - organelle of typical cells that varies in shape and form in animal and plant cells; immature plant cells typically have many small vacuoles but mature plant cells have a single large central fluid-filled vacuole

a. function of vacuoles -

b. vesicles (description) -

5. Golgi complex (description) - organelle of typical cells described as a stack of membraneous sacs surrounded by tubules and vesicles usually near the cell's nucleus

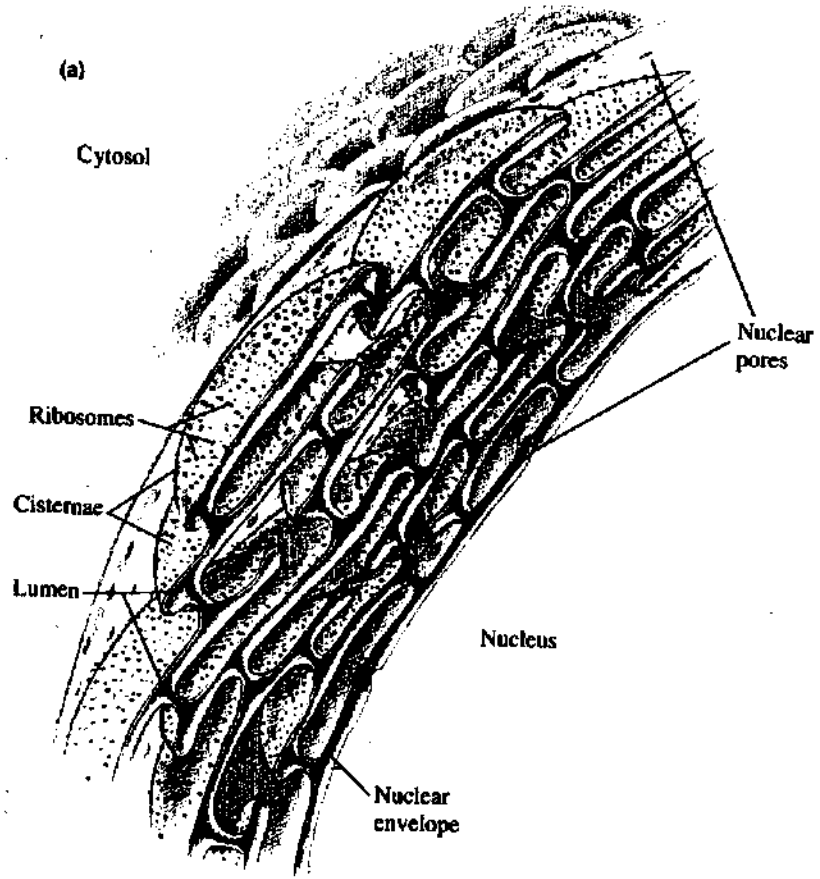


Figure 1·11
Rough endoplasmic reticulum. Ribosomes bound to the *surface* of the cisternae of the rough ER carry out protein synthesis and inject these products into the lumen where they are packaged and exported. Rough ER merges with the outer membrane of the nuclear envelope. **(a)** Diagram. (Illustrator: Lisa Shoemaker.) **(b)** Transmission electron micrograph of rough ER in a rat liver cell. The dark, electron-dense regions are ribosomes (R) attached to the outer membrane of the cisternae. Note also the less electron-dense areas of the lumen (L). A Golgi complex (G) is also identified. (Courtesy of Keith R. Porter.)

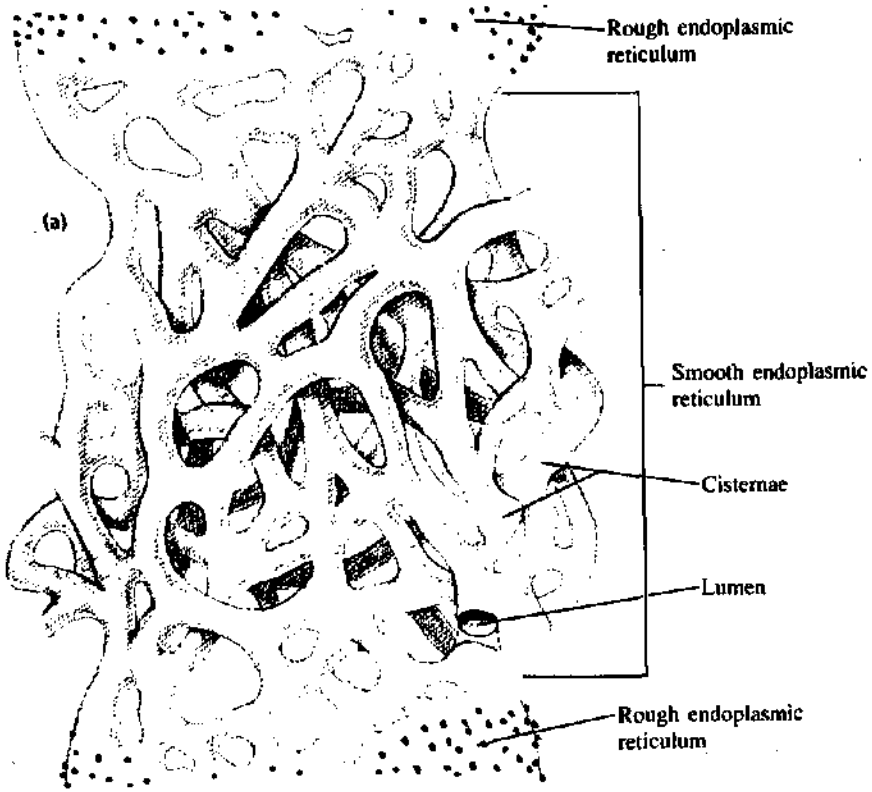
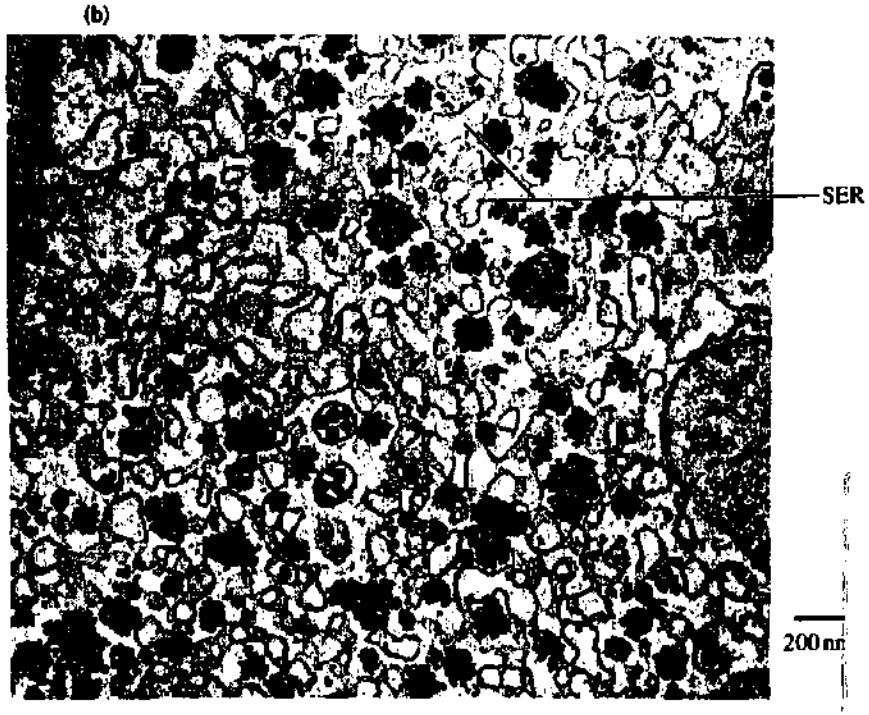


Figure 1·12
Smooth endoplasmic reticulum. The smooth ER constitutes part of a cell's extensive membrane transport system. (a) Diagram. (Illustrator: Lisa Shoemaker.) (b) Transmission electron micrograph of smooth ER (SER) in a rat liver cell. (Courtesy of G. E. Palade.)



a. function of Golgi complex - function as sites for carbohydrate synthesis and as a packaging center for secretions by receiving vesicles from the ER and modifying the contents to incorporate finished products into transport vesicles that deliver them to the cell surface and around the cell; also associated with production of lysosomes; also processes, packages, and distributes lipids and proteins to form glycoproteins and glycolipids needed for membranes of the organelles and the cell

6. lysosomes (description) - organelle of typical cells described as rounded and relatively large vesicle surrounded by protective membrane and contain digestive enzymes

a. function of lysosomes - function in the digestion of food inside the cell (intracellular); also function for defense and for breakdown of old organelles; nicknamed "suicide sac" because of digestive enzyme content

7. peroxisomes (description) - organelle described as another type of relatively large vesicle that contains lytic enzymes

a. function of peroxisomes - function in the breakdown of nitrogen bases known as purines and several other compounds; in plants also serve as the site for the breakdown of toxic hydrogen peroxide, which forms during reactions in sunlight, to water and oxygen

8. mitochondrion (description) - organelle of typical cells described as oval or "football-shaped" structure surrounded by a double membrane

a. function of mitochondria - function as sites for cellular respiration which involves the processes of energy production in the form of ATP molecules from basic fuels such as glucose

9. cytoskeleton (description) - refers to internal protein filaments within the cytoplasm that maintain cell shape, allow for cell movement, anchor organelles, and direct the flow of cytoplasmic streaming; includes microtubules and actin filaments

a. actin filaments (microfilaments) (description) - sub-cellular components described as thread-like protein fibrils through the cytoplasm; each filament consists of many globular actin molecules linked in a helical chain structure; function to facilitate intracellular movement to include cyclosis or streaming

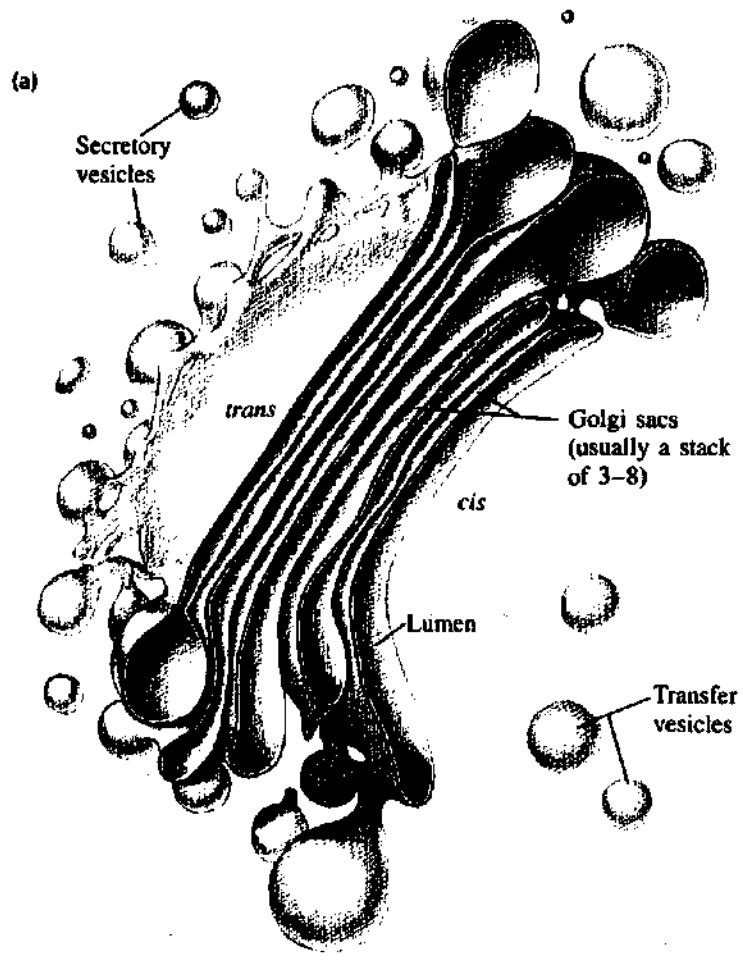
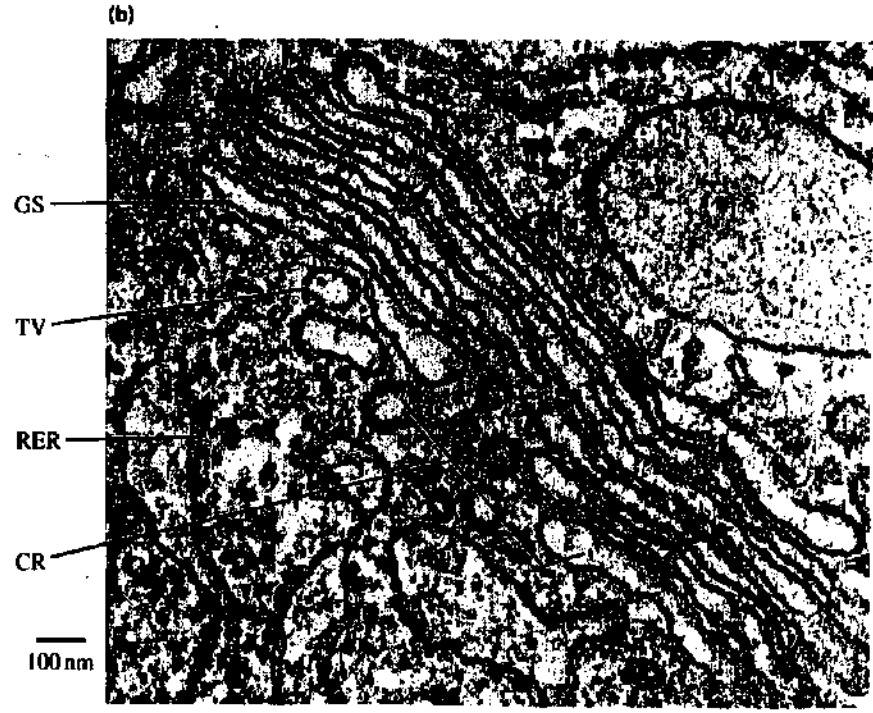


Figure 1-13
Golgi complex. Closely associated with the ER, Golgi complexes store, modify, and transport carbohydrate and lipid precursors. (a) Diagram. (Illustrator: Lisa Shoemaker.) (b) Transmission electron micrograph of plasma cell of a rat. Note the rough ER (RER) adjacent to the apparent *cis* region (CR) of the Golgi complex. Putative transfer vesicles (TV) from the rough ER fuse with the Golgi sacs (GS). (Courtesy of Keith R. Porter.)



b. microtubules (description) - sub-cellular components described as tube-like protein bundles in the cytoplasm; formed from globular tubulin proteins; function as part of the internal skeleton of the cell; important in cell division and cellular locomotion by forming the structural basis for centrioles, cilia and flagella

10. cilia and flagella (structure and function) - described as hair-like or whip-like structures embedded in the surface of some eukaryotic cells for locomotion, feeding, or transport of materials along the cell surface; internal structure formed by nine pairs of fused microtubules surrounding a central pair of non-fused microtubules

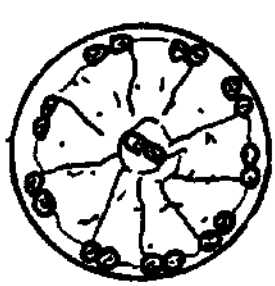
a. cilia or flagella in eukaryotes (examples) - include cilia for locomotion in protists such as paramecia and other ciliates; cilia lines trachea of vertebrates to filter material; cilia lines oviduct of mammals to facilitate egg transport; flagella for locomotion and feeding in protists such as euglena

b. basal body (description) - described as an organelle of some protist and animal cells that have cilia or flagella; underlies cilium and flagellum and anchors them to cell surface; internal structure has nine triplets of microtubules around the periphery with no central microtubule; may transmit ATP and nutrients to cilia and flagella

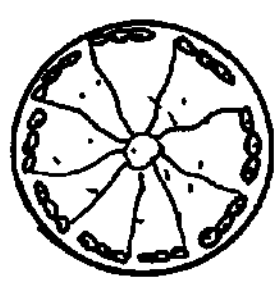
1. centrioles (structure and function) - described as bundles of microtubules similar to those in cilia and flagella, but identical in arrangement to those of the basal body; absent in flowering plants, but found in animals and protists; function to form the spindle fibers associated with separation of chromosomes during cell division; typical cells contain two centrioles arranged at right angles to eachother; formerly described as part of a single organelle found only in typical animal cells located outside of the nucleus known as the centrosome

Diagram: Microtubule Arrangements/Cross Section

cilia and flagella



basal body and centrioles



11. chloroplast (plastid) (description) - organelles found only in typical plant cells and other photosynthetic cells described as rounded to oval shaped structures containing the photopigment chlorophyll arranged in membrane stacks; functions as the site for photosynthesis or synthesis of carbohydrate (glucose)

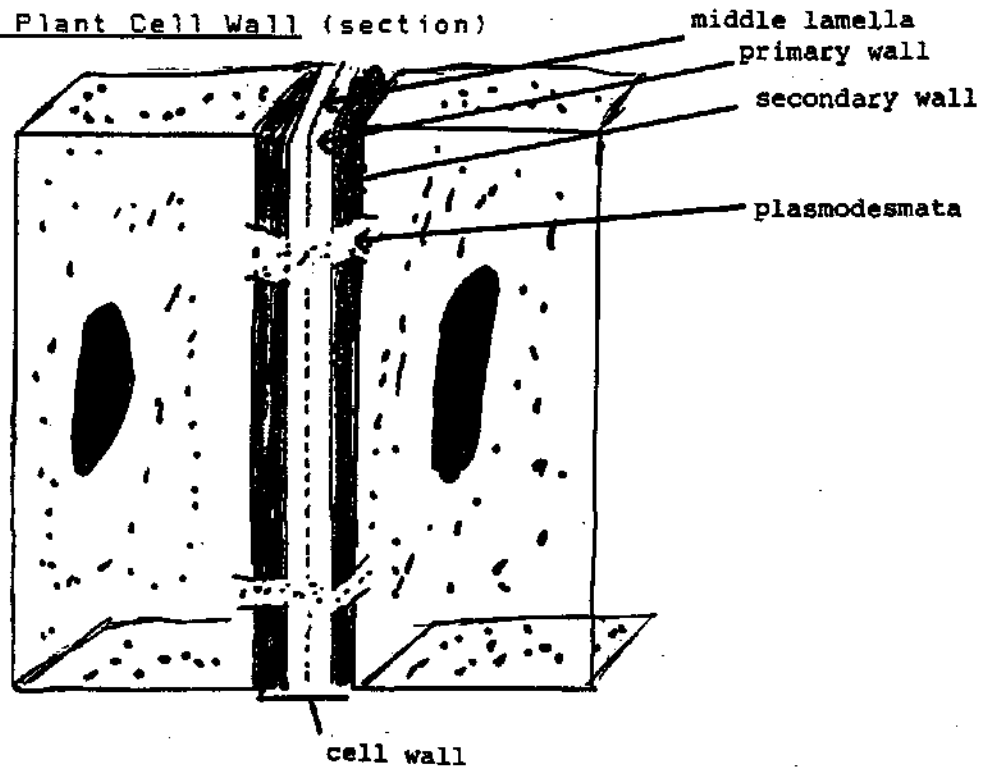
Note: There are other types of plastids found in plant cells other than chloroplasts. There are chromoplasts which contain red, yellow, or orange photopigments. There are also leucoplasts which lack photopigments and serve as storage sites.

12. cell wall (description) - organelle found only in plant cells and situated outside the plasma membrane; adjacent cell walls are held in place at a middle lamella composed of pectins and other polysaccharides; on each side of the middle lamella there is a primary cell wall composed of cellulose; the primary wall is capable of expansion as the cell grows through elongation; non-expanding secondary walls may be constructed as the plant cell matures and may contain lignin

a. function of cell wall - functions to provide protection, rigidity, and shape for the plant cell; does not have a regulation function

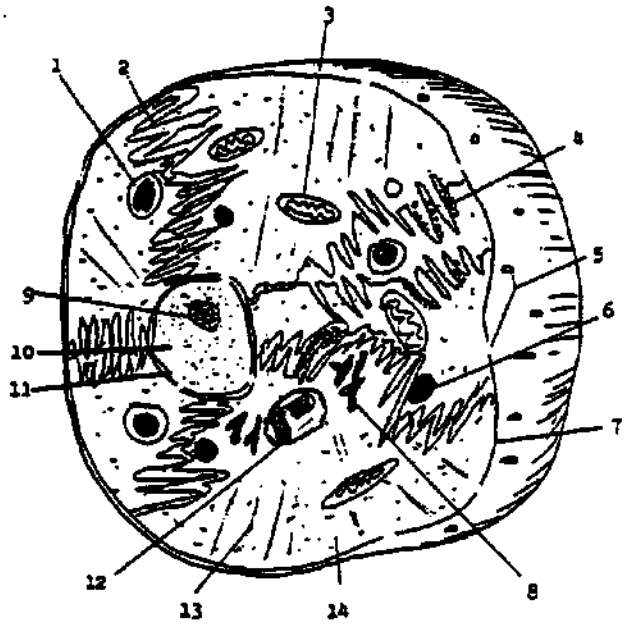
b. plasmodesmata (description) - refers to cytoplasmic strands that extend through channels or pores that cross through the cell walls and lamella to connect the cytoplasm of adjacent plant cells

Diagram: Plant Cell Wall (section)



Diagrams;

General Animal Cell



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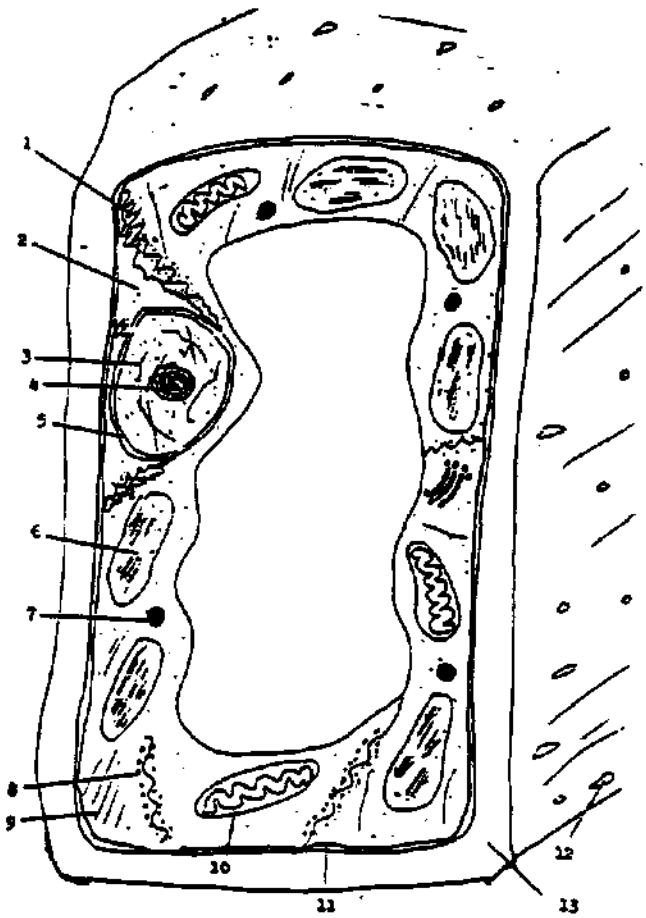
12. _____
13. _____
14. _____

General Plant Cell



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D. Prokaryotic Cell (generalized) - refers to typical moneran cell type that lacks a nucleus surrounded by a nuclear envelope and lacks typical organelles found in eukaryotic cells; may be viewed as more "primitive" cell types.

1. nucleoid (description) -

2. cytoplasm (description) -

a. cell membrane (description) -

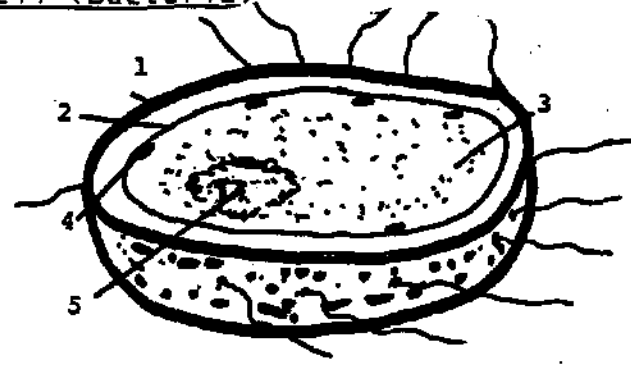
b. cell wall (description) -

c. flagella (description) -

Note: The "flagella" of prokaryotes differs in structure from the flagella and cilia of typical eukaryotic cells. In addition, prokaryotic cells also display pili which are rigid, rod-like cylindrical structures formed from the protein pilin that extend from the cell; these serve to attach bacteria to a food source, or to oxygen-rich liquids, or to eachother during some forms of reproduction (eg. conjugation).

Diagram: Typical Prokaryotic Cell (Bacteria)

1. _____
2. _____
3. _____
4. _____
5. _____



E. Comparison: Prokaryotic and Eukaryotic Cells

Structure:	Prokaryotic Cell Types	Eukaryotic Animal Cells	Eukaryotic Plant Cells
cell membrane:			
cell wall:			
nuclear envelope:			
chromosomes:			
ribosomes:			
endo. retic.(ER):			
mitochondria:			
Golgi complex:			
lysosomes:			
peroxisomes:			
vacuoles:			
plastids:			
centrioles:			
cilia/flagella: (microtubules)			

F. Endosymbiotic Theory (description) -

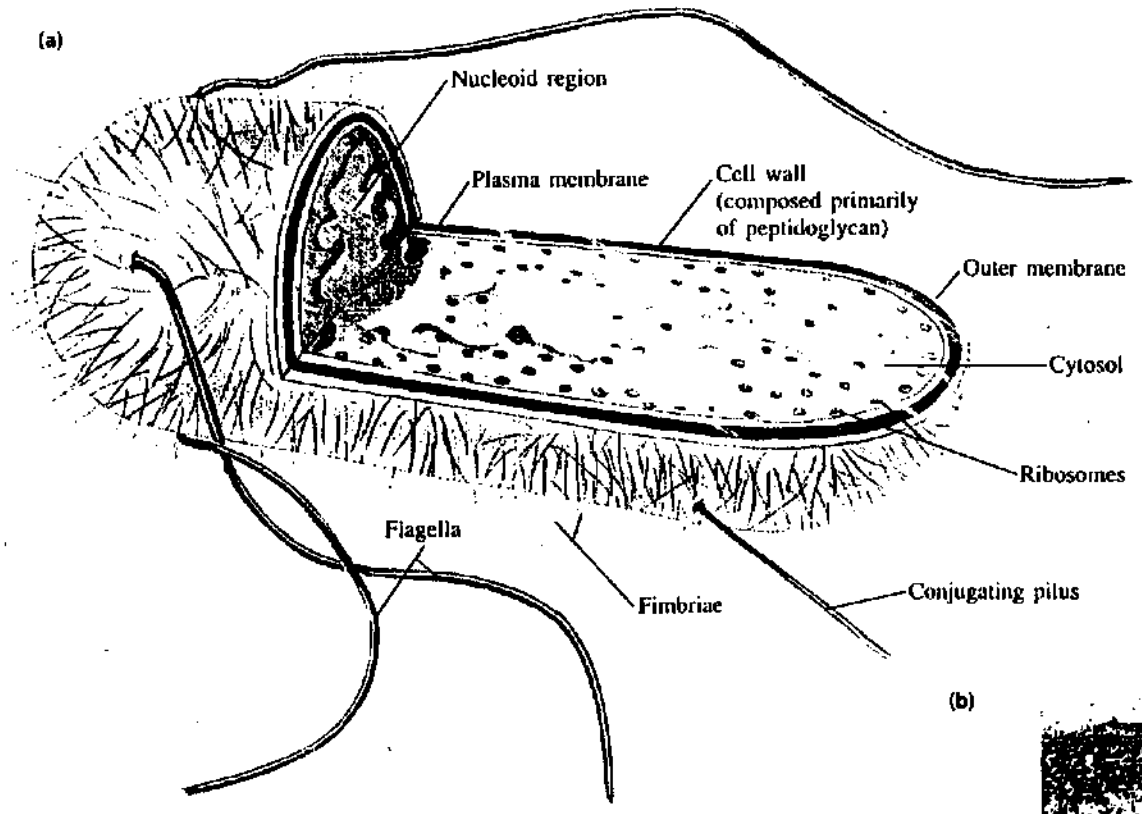
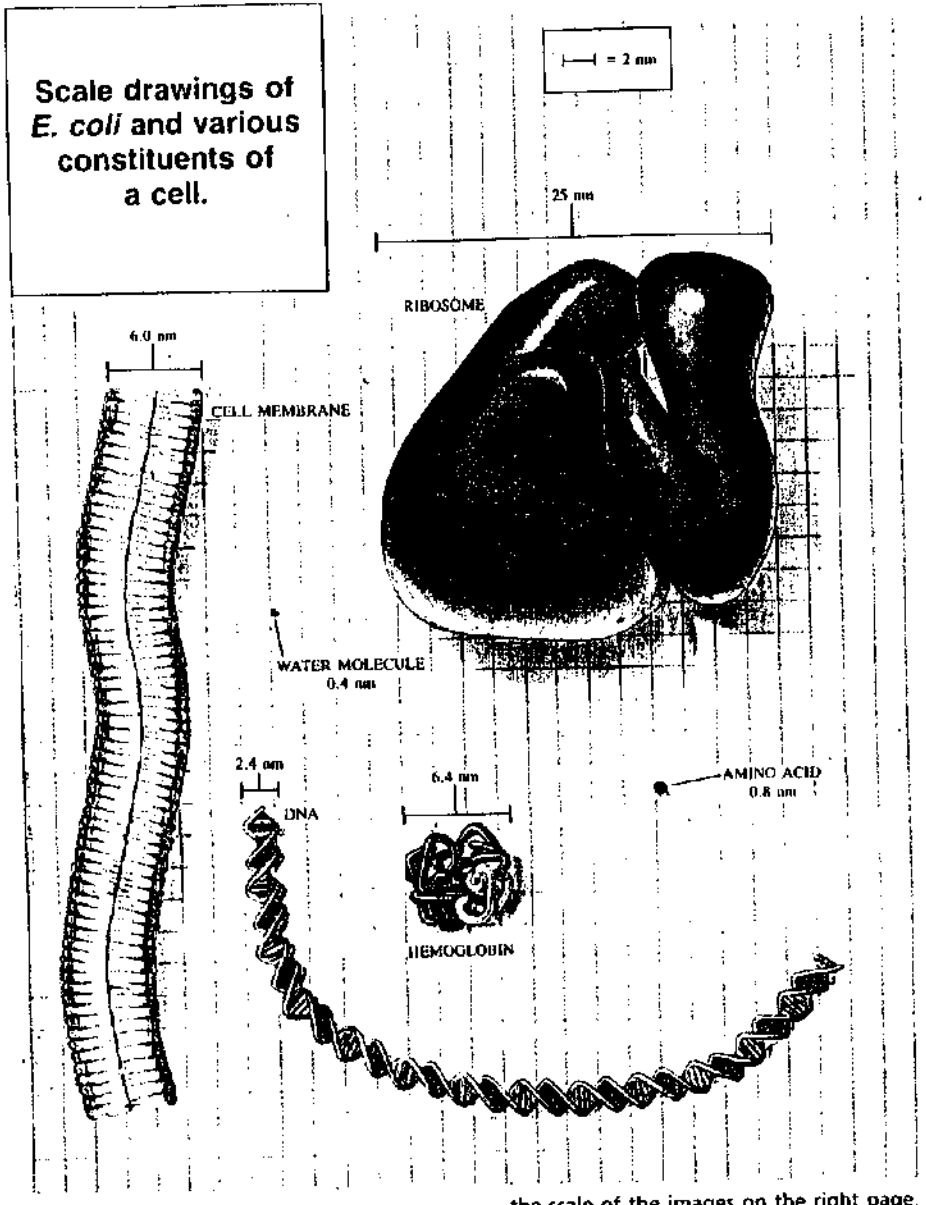


Figure 1·4
Ultrastructure of an *E. coli* cell. Whereas a human is a multicellular organism composed of over 200 different types of eukaryotic cells that have a wide range of sizes and shapes, bacteria such as *E. coli* are unicellular and prokaryotic. (a) Illustration. Primary components of a prokaryotic cell are shown. These and other components are described in this chapter. (Illustrator: Lisa Shoemaker.) (b) Transmission electron micrograph. Primary ultrastructural components include an outer membrane (OM), plasma membrane (PM), and nucleoid (N). (Courtesy of W. van Iterson.)

Scale drawings of *E. coli* and various constituents of a cell.



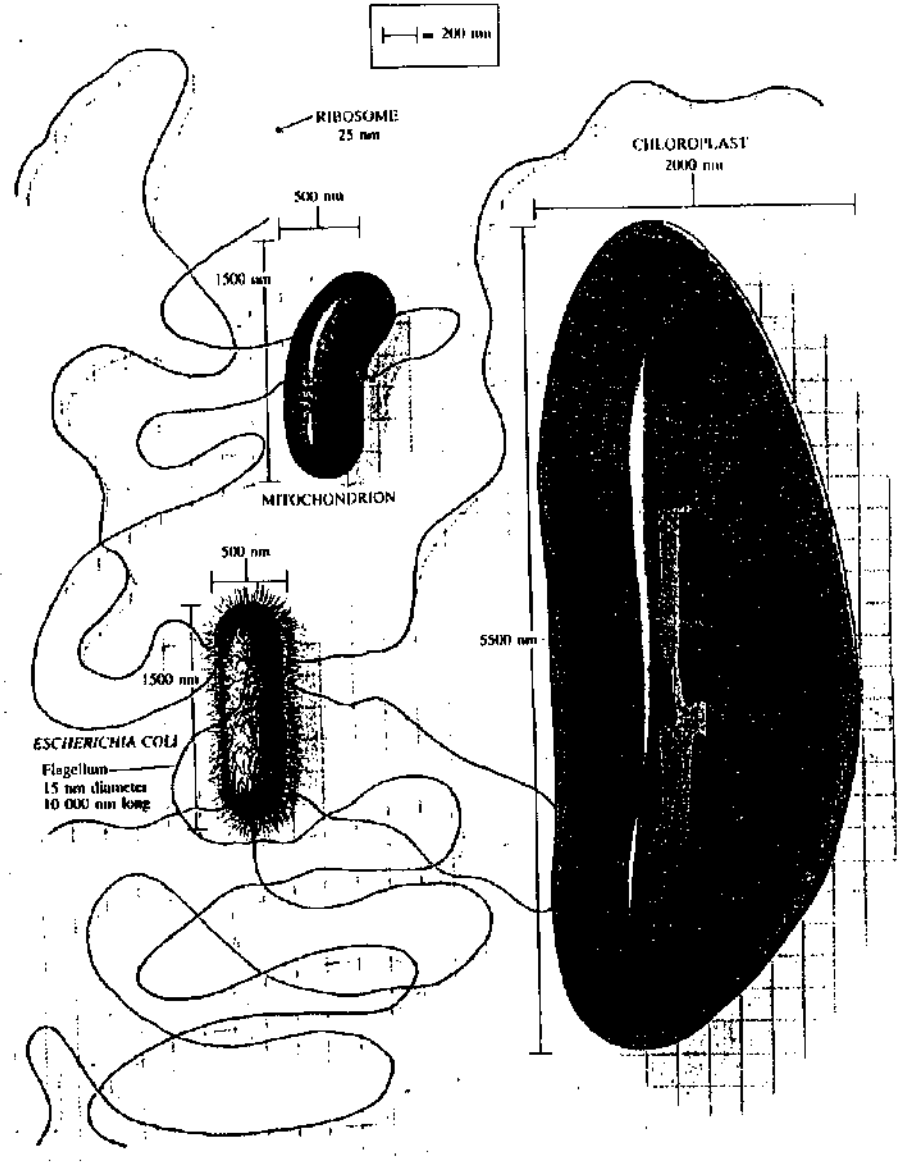


Figure 1·18
Scale drawings of *E. coli* and various constituents of a cell. The scale of the images on the left page is 100 times larger than the scale of the images on the right page. A ribosome has been included on both pages as a frame of reference. Note the width of the cell membrane relative to the width of the ribosome on the left page. Then note the width of the ribosome on the right page and imagine the much thinner cell membrane in relation to structures such as the mitochondrion and chloroplast which it surrounds. (illustrator: Lisa Shoemaker.)

EXERCISE: PROKARYOTIC ORGANISMS - Bacteria (Eubacteria)

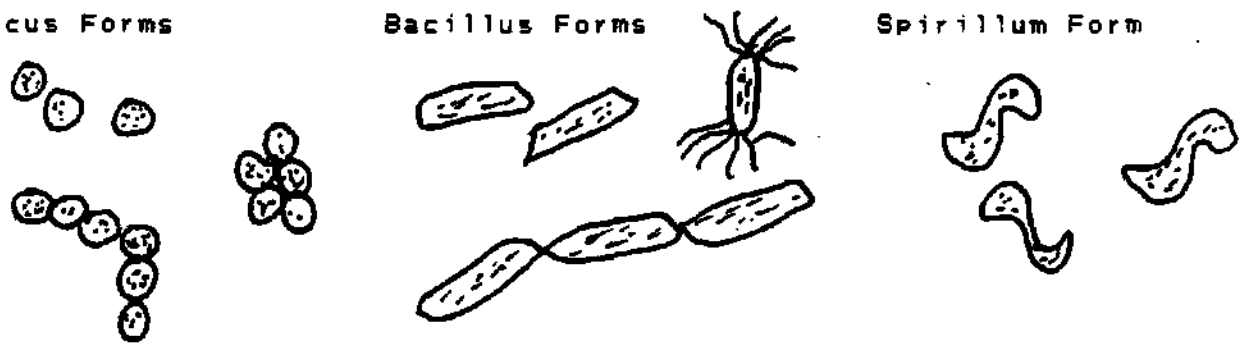
Materials: compound microscope; prepared slides of bacterial types; prepared slides of Escherichia coli; prepared slides of Nostoc and Oscillatoria (or other blue-green bacteria).

Bacteria: Background Information

The bacteria are representative of the Kingdom Monera. The bacteria are grouped into the archaebacteria, which are associated with extreme environments (salt-tolerant, acidity or hot temperature conditions), and the eubacteria, which include most of the known heterotrophic and autotrophic forms. The shapes of bacterial cells are distinctive and include at least three major forms that are sphere-shaped or globular (coccus), cylindrical or rod-shaped (bacillus), and corkscrew or spiral-shaped (spirillum). Some bacteria are unicellular, but others form colonies that may be described as "clusters" or "chains". The prefix "strepto" describes chains of bacteria (eg. streptococci, streptobacilli), and "staphylo" describes clustered forms (eg. staphylococci).

Note: Colonies, in general, are formed by several to many cells that are attached, but display no or little specialization among themselves. A simple colony may be described as an association of unicellular organisms, in which each cell has the capacity for reproduction. Other, more complex colonies display some cell specialization, but are not defined as true multicellular.

Coccus Forms | Bacillus Forms | Spirillum Form



Bacteria have a typical prokaryotic cell structure. Some cells secrete around the cell wall a "slime" layer, which forms a sheath or capsule for added protection. Many pathogenic bacteria have such a capsule. The DNA material of the cell forms a single circular chromosome that occupies the nuclear area or nucleoid. In addition, bacteria have circular segments of DNA in structures called plasmids (these are especially significant for genetic engineering techniques). The bacillus and spirillum forms may also have flagella (not composed of microtubules) that extend singly or in tufts from the cell surface. When growth conditions are unfavorable, some bacteria form endospores, which are dormant forms consisting of the genetic material and some cytoplasm surrounded by a protective sheath.

Bacterial cells are heterotrophs or autotrophs. The heterotrophic forms are typically parasitic or saprophytic, and the autotrophic forms are photosynthetic or chemosynthetic. Energy metabolism includes forms that are obligate aerobes (must have oxygen for cellular respiration), obligate anaerobes (cannot live in the presence of oxygen and only use fermentation), or facultative aerobes (use respiration or fermentation depending on availability of oxygen).

Reproduction in bacteria is asexual by binary fission. Prior to cell division, the single circular chromosome attaches to the cell membrane and replicates. A cell wall then forms between the chromosome and its copy to divide the cell into two equal daughter cells, each with a copy of the single chromosome. There are mechanisms by which bacterial cells can exchange or recombine genetic material despite the lack of "sexual" reproduction. In some bacteria, one cell can transfer some of its DNA (eg. plasmids) to another cell through temporary cytoplasmic bridges in a process described as conjugation. Some DNA segments released from bacterial cells that have died and ruptured can be taken into and incorporated into the DNA of other live bacteria by the process of transformation. Finally, some bacteria receive and incorporate new DNA segments carried by an invading bacteriophage (virus) through the process of transduction.

Bacteria are often associated with diseases. Such pathogenic bacteria include coccus, bacillus, and spirillum forms. Some pathogenic cocci forms cause strep throat, scarlet fever, gonorrhea, meningitis, and pneumonia. Cholera and syphilis are caused by spirilli types of bacteria. Pathogenic bacilli cause tetanus, typhoid fever, botulism, anthrax, plague, and diphtheria.

1. Examination of Bacteria: Observe prepared slides of E. coli and other bacteria forms and note the forms and shapes of these prokaryotic cells. Using the highest magnification, DRAW representative E. coli cells and at least two other bacterial forms and LABEL cell wall, flagella (if present) and note coccus, bacillus, or spirillum forms.

Escherichia coli	Bacterium sp.	Bacterium sp.
[magnification=___X]	[magnification=___X]	[magnification=___X]

BACTERIAL ULTRASTRUCTURE

FLAGELLUM a

CAPSULE b

CELL WALL c

CELL MEMBRANE d

PILUS e

MESOSOME f

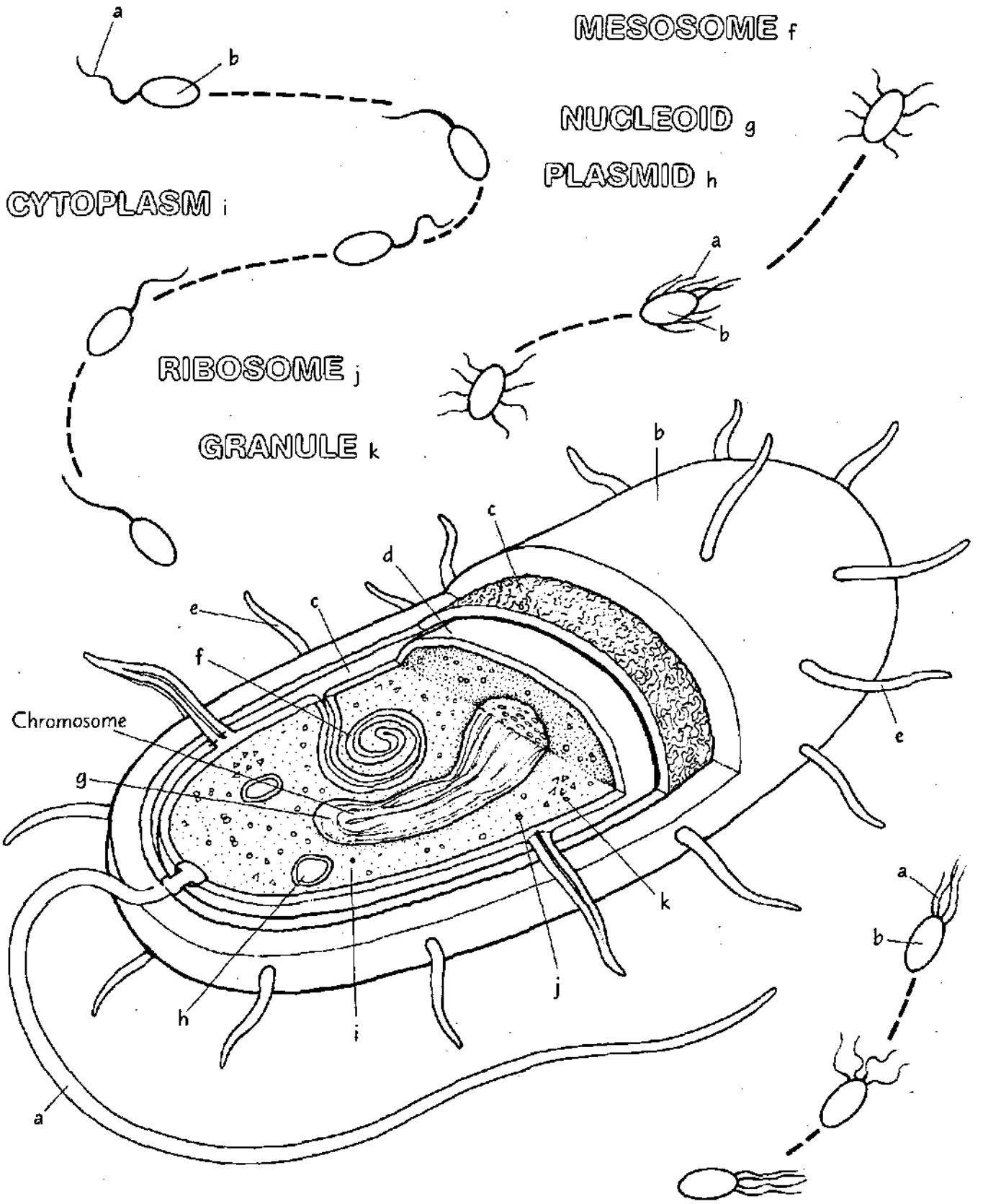
NUCLEOID g

PLASMID h

CYTOPLASM i

RIBOSOME j

GRANULE k



Cyanobacteria; Background Information

The cyanobacteria are monerans that have been previously classified as blue-green algae. These renamed and reclassified blue-green bacteria are now included by some as a major phylum of the eubacteria group. Basically, these cells are prokaryotic and are found as unicellular or in colonies as clusters, "plates", or filaments. Typically, they are found in aquatic habitats, but also in marine environments, on rocks, and in soils (some species are included in the nitrogen-fixing bacteria group associated with roots of legume plants). Some species have symbiotic relationships with fungi to form organisms called lichens.

The blue-green bacteria are photosynthetic and their photopigments are found on membrane folds within the cytoplasm. The blue-green color is due to the presence of green chlorophyll a and a blue pigment, phycocyanin. Additional pigments such as the red pigment, phycoerythrin, give some representatives red colors (as found in the Red Sea). Other blue-green bacteria have pigments that give them yellow, brown, or black coloration.

2. Examination of Cyanobacteria: Observe a prepared slide of Nostoc, a representative blue-green bacterium, under high magnification. Note that the individual Nostoc bacterial cells form a "bead-like" filament. Along the filament, there may be enlarged or "swollen" cells called heterocysts, which are cell sites for nitrogen fixation. DRAW a segment of the Nostoc filament and LABEL the filament, bacterial cell, and heterocyst.

Observe a prepared slide of Oscillatoria, another representative of blue-green bacteria. Note that the bacterial cells of this species also form a filament with an apical cell at the top end of the filament. Along the filament there may be visible some concave cells that appear to "bulge" along their sides; these represent cells where the filament may break by fragmentation to form new filaments as a form of asexual reproduction. DRAW a section of Oscillatoria filament, and LABEL the filament, apical cell, bacterial cell, and concave cell.

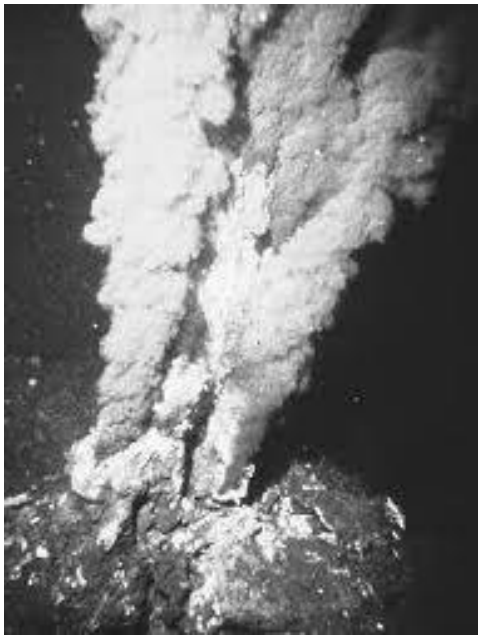
Nostoc (wm):

[magnification= ___X]

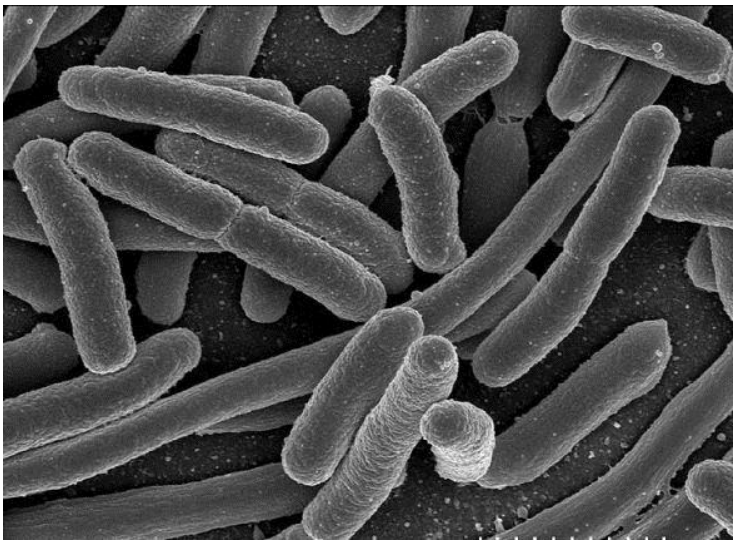
Oscillatoria (wm):

[magnification= ___X]

Bacteria are known to thrive in the ocean's **deep sea vents**. Propose the niche or role of these bacteria in this deep ocean ecosystem. How do these bacteria "relate" or interact with other deep vent species – what big idea(s) and enduring understanding(s) apply to this situation.



Bacteria are an integral part of the "biota" found living within many species of animals. Describe the human bacterial biota or the ruminant bacteria biota (in herbivores), and focus on the **functional relationship** between the bacteria and their respective "host" species. Are there **adaptive functions** and/or **inter/intra species** dependencies and communications involved in the relationships - what big idea(s) and enduring understanding(s) apply to this situation.



CLASS SESSION: CELLULAR ORGANIZATION

A. Unicellular Organisms (definition) - defined as organisms that are individual cells, or independent cells living in close association as colonies or filaments

1. examples of unicellular organisms -

2. multicellular organisms (definition) -

B. Specialized Cells (definition) - defined as cells that are modified for special or specific functions; may display elaboration or loss of organelles; associated with other cells and inter-dependent on other cells in a multicellular organism

1. examples of specialized cells -

C. Tissues (definition) - defined as the functional and structural association of similar or related specialized cells within a multicellular organism

1. examples of tissues -

D. Organs (definition) - defined as the structural association of different tissues that have a related function

1. examples of organs -

D. Systems (definition) - defined as the structural association of related organs that function together

1. examples of systems -