

Chapter 4

Topic: Cell structure

Main concepts:

- Cells were first discovered in 1665 by naturalist Robert Hooke. He thought the little “boxes” in a thin slice of cork, seen under the microscope, resembled monk’s cells. He did not know what the cells were for, but noted that they were “full of juices” in living plant tissue. Anton van Leeuwenhoek, a cloth merchant, made lenses and studied cells in the 1670’s, making the first discoveries of bacteria, protozoans, and other microorganisms.
 - All cells share some things in common. All:
 - have plasma (cell) membranes
 - have DNA as a hereditary material
 - contain cytoplasm
 - obtain energy and nutrients from their environment.
 - The size of cells is limited. Materials must diffuse into and out of the cell, and a cell that is too large will not be able to move materials efficiently enough. Cells must maintain an ideal surface-to-volume ratio.
 - Prokaryotic organisms are those that lack a membrane-bound nucleus and organelles. They do have DNA and ribosomes.
 - Prokaryotic organisms (Domains Bacteria and Archaea) are all very small, usually only a few microns long. Their cell membranes are surrounded by a wall, which itself may be surrounded by a capsule or slime layer. Prokaryotic organisms have very few structures inside.
 - Eukaryotic organisms are organisms whose cells have a membrane-bound nucleus and organelles. Eukaryotic organisms (Domain Eukarya) may be single-celled or multi-cellular.
 - Eukaryotic cells have multiple membrane-bound organelles to enclose and contain many of their life processes.
 - Organelles are membrane-bound structures that carry out particular functions in the cell.
 - The nucleus contains DNA, which contains codes (“genes”) for all of the proteins needed by the body. The nucleus controls the functions of the cell by activating certain genes when the protein they code for is needed.
 - The nucleolus is found inside the nucleus. It is where ribosomes are assembled.
 - The endoplasmic reticulum (endos = inside, reticulos = net), or “ER,” is a network of tubes composed of membranes. The rough ER is studded with ribosomes, which “read” RNA transcriptions of DNA genes and assemble proteins according to the encoded instructions. The smooth ER is the site of lipid synthesis. The ER is also a system of channels that move the materials from the site of manufacture to the delivery system.
 - The Golgi complex (also called the Golgi apparatus or the Golgi body) is a stack of flat membrane bags, where proteins and lipids are finished, packaged, and sent for delivery to parts of the cell or outside the cell. Vesicles bud off of the Golgi complex and move to the site where the products need to be delivered.
 - Lysosomes are small bags of digestive enzymes. They pick up and digest waste products within the cell. They can also cause cell death if ruptured. One-celled organisms used lysosomes to digest food that is inside of food vacuoles.
 - Plant cells have a large central vacuole for water regulation, support, and storage of materials.
 - Mitochondria convert sugars and other food molecules into a usable form of chemical energy, ATP. Mitochondria have their own unique DNA and have bacteria-like membranes. Cell biologists now describe them as symbiotic organisms. All eukaryotic cells have mitochondria.
 - Chloroplasts are found only in photosynthetic eukaryotes. Like mitochondria, they appear to be symbiotic organisms. Chloroplasts harvest light energy and use it to assemble inorganic carbon sources (such as carbon dioxide) into organic molecules (such as sugar), which plants use for energy and for making polymers.
 - The cytoskeleton supports the cell and gives different cells their unique shapes.
 - Cilia and flagella are used by some cells to move. A system of protein tubules sliding past one another creates the motion.
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Common misconceptions:

- Many students have difficulty thinking about the microscopic scale, and may have a sense that all things “microscopic” are about the same size. In fact, eukaryotic cells are much larger than prokaryotic cells, and both are much larger than the biomolecules.
- Students may use the terms “cell,” “molecule,” and “atom” interchangeably, thinking they are all pretty much the same thing.
- Most students are unfamiliar with the parts of the cell, so learning all of this material from scratch can be difficult. It helps to organize the information in a table or chart.
- Because prokaryotic cells have no nucleus, students often believe they have no DNA.
- Students may believe that all one-celled organisms are “simple” and must be prokaryotic.
- Students often believe that plants have chloroplasts instead of mitochondria, when in fact plants have both. The chloroplasts are needed to harvest light energy and make energy-rich molecules, while the mitochondria are necessary to convert that energy into a usable form.
- Students may believe that plants have a cell wall instead of a cell membrane, when in fact plants have both.

Chapter study guide:

- List the main discoveries of Hooke, Leeuwenhoek, Schwann, and Schleiden. (Scientific Inquiry section)
- Describe the difference between a light microscope and an electron microscope. (Scientific Inquiry section)
- List Rudolf Virchow’s three statements that make up Cell Theory.
- What is the plasma (cell) membrane and what does it do?
- What is the function of DNA in living cells?
- What is cytoplasm and what does it do?
- Describe why cells cannot be too large.
- Use Figure 4.1 to put the following in order from smallest to largest: eukaryotic cells, bacteria, viruses, mitochondria, proteins, frog embryo.
- Describe the differences between eukaryotic and prokaryotic cells.
- Create a table and list the following structures down the side: cell wall, plasma (cell) membrane, nucleus, nucleolus (note the spelling on both of those), ribosomes, rough ER, smooth ER, Golgi complex, lysosomes, central vacuole, chloroplasts, mitochondria, cytoskeleton. Then state the functions of each of the structures, and whether the structure is found in plants, animals, or both. Use Table 4-1 as a guide.
- Sketch a picture of a generalized plant cell and a generalized animal cell. Label the parts.
- If a cell needed to make a particular protein to deliver to another cell (such as the hormone insulin), describe how it would do that, and what path the protein would take. Be sure to include the nucleus, the rough ER, ribosomes, the Golgi complex, and vesicles.
- Describe several functions that vacuoles carry out in different cells. How is a contractile vacuole like a primitive kidney?
- Describe how the motion of protein tubules in cilia and flagella causes the distinctive swimming motions.
- Read the case study and describe how cell culture is being used to regenerate tissues. Consider some of the ethical dilemmas that this technology creates.
- Read the Links to Life section and describe how tooth plaque forms in the mouth.

Useful websites:

- “CellsAlive!” <http://www.cellsalive.com/index.htm> has many excellent resources for cell study, including interactive cell models and a “How Big” animation showing relative sizes of microscopic structures.
 - “Cell Structure” http://www.wiley.com/legacy/college/boyer/0470003790/animations/cell_structure/cell_structure.htm features interactive cell models and an activity that allows you to “build” various cells from a list of parts.
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