Chapter 4: Introduction to Cell Structure and Function

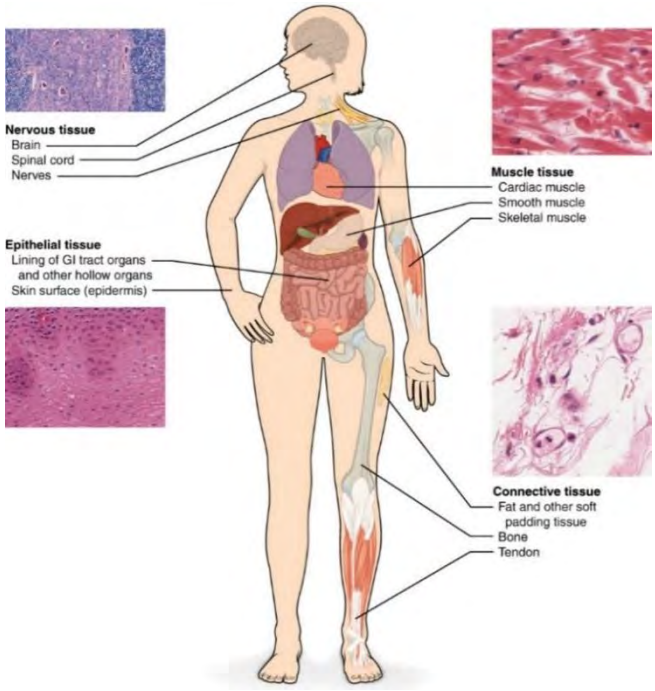

Figure 4.1 The body is made up of cells organized into four tissue types. Clockwise from from top left: nervous tissue, muscle tissue, connective tissue, and epithelial tissue LM × 872, LM × 282, LM × 460, LM × 800. (Micrographs provided by the Regents of University of Michigan Medical School © 2012 / Anatomy and Physiology OpenStax)

Close your eyes and picture a brick wall. What is the basic building block of that wall? Most would answer, it is a single brick. Like a brick wall, multicellular organisms are composed of basic building blocks, called cells. In multicellular organisms, several cells of one particular kind interconnect with each other and perform shared functions to form tissues. For example, the muscle tissue in animals or mesophyll tissue in plants. Several tissues combine to form an organ (for example, stomach, heart, or brain), and several organs make up an organ system (such as the digestive system, circulatory system, or nervous system). Several systems functioning together form an organism (such as an elephant).

An average human is thought to have 37.2 trillion cells. All cells that make up your body are classified as eukaryotic animal cells. However, the cells of the body are not uniform. Each population of cells is specialized for a specific purpose. For example, epithelial cells protect the surface of the body and line internal organs and body cavities (Figure 4.1). These cells are very flat and fried egg-shaped. Muscle cells help physically move the body from one location to the next and allow movement of materials within the body. These cells are very long and cylindrical. Each of these cell types plays a vital role during the growth, development, and day-to-day maintenance of the body.

Despite the enormous variations, all cells share certain fundamental characteristics. In this chapter you will learn about the similarities and differences amongst cell types.

4.1 How Microorganisms Are Studied

Learning objectives

By the end of this section, you will be able to:

- *Describe the roles of cells in organisms*
- *Understand the importance of the microscope*
- *Summarize the cell theory*

Microorganisms, as the name implies, are tiny in size and often cannot be seen without some magnification. They differ from each other not only in size but also in structure, habitat, metabolism, and many other characteristics.

The **cell** is the smallest unit of life that makes up a living organism. Cells are found in each of the three domains of life: Bacteria, Archaea, and Eukarya. Cells within the domains Bacteria and Archaea are all **prokaryotes**; their cells lack a nucleus. Cells in the domain Eukarya are classified as **eukaryotes**; their cells do contain a nucleus. It is important to mention that there are other microorganisms besides cells, such as viruses, that do not fall within the domains of life. We will briefly discuss viruses, before focusing our attention on cells.

Viruses are acellular, meaning they are not composed of cells. Essentially, a virus consists of proteins and genetic material. The genetic material can be either DNA or RNA. Viruses are inactive outside of a host organism. Therefore, they do not grow and develop, nor can they reproduce on their own. However, by incorporating themselves into a host cell, viruses can utilize the host's cellular mechanisms to multiply and infect other hosts. Viruses can infect all types of cells, from human eukaryotic cells (Figure 4.2) to the cells of other microorganisms, including prokaryotic bacteria. A key take-away message is that viruses are dependent on the host cells. Viruses themselves do not display all the properties of life.

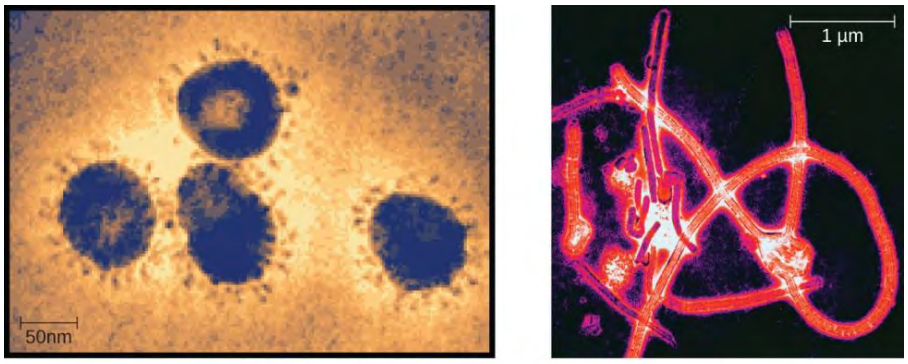

Figure 4.2 (a) Members of the Coronavirus family can cause respiratory infections like the COVID-19, common cold, severe acute respiratory syndrome (SARS), and Middle East respiratory syndrome (MERS). (b) Ebolavirus, a member of the Filovirus family. (credit a: modification of work by Centers for Disease Control and Prevention; credit b: modification of work by Thomas W. Geisbert / Microbiology OpenStax)

Microscopy

We will now turn our attention to how cells are studied. Cells vary in size, and with few exceptions, cannot be seen with the naked eye (Figure 4.3). In order to study cells, scientists use microscopes (micro- = "small"; -scope = "to look at"). A **microscope** is an instrument that magnifies an object.

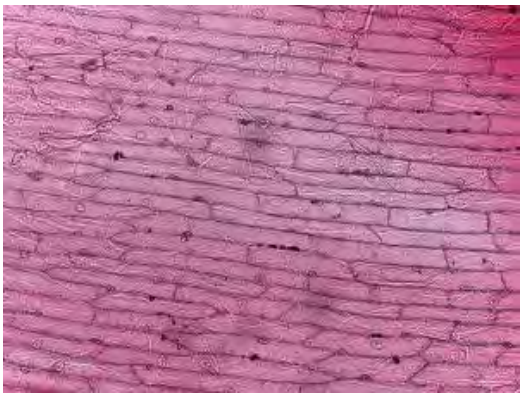

Figure 4.3 Onion cells (eukaryotic plant cells) stained to show the cell walls and nuclei. (credit: Elizabeth O'Grady)

Light Microscopes

In the lab, you will become proficient using a compound light microscope (Figure 4.4a). Visible light passes and bends through the lens system, which enables the user to see the specimen. Light microscopes are advantageous for viewing living organisms. However, since individual cells are generally transparent, their components are not distinguishable unless they are colored with special stains. Staining, however, usually kills the cells. In the lab, you will learn how to stain specimens and make slides.

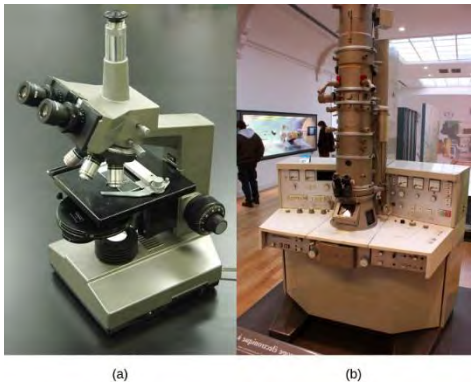

Figure 4.4 (a) A standard light microscope. (b) An electron microscope provides significantly more magnification than a light microscope. (credit a: modification of work by "GcG"/Wikimedia Commons; credit b: modification of work by Evan Bench / Biology 2E OpenStax)

Cell Theory

In a 1665 publication called *Micrographia*, written by Robert Hooke, the term "cell" (from the Latin *cella*, meaning "small room") was used to describe the box-like structures he observed when viewing cork tissue through a lens. In the 1670s, Antonie van Leeuwenhoek discovered bacteria and protozoa. Later advances in lenses and microscope construction enabled other scientists to see different components within cells.

By the late 1830s, botanist Matthias Schleiden and zoologist Theodor Schwann were studying tissues and proposed that all living things are composed of one or more cells. They also suggested that the cell is the smallest and most basic unit of life and that all new cells arise from existing cells. Many scientists, including Louis Pasteur, famous for his discovery of the process of pasteurization, confirmed these same conclusions through their experimentation. Their work, along with many others, is why these principles still stand today and are considered the **cell theory**.