Chapter 2 The Structure of Life

Key Terms

Biology
Cells
Cell membrane
Centrosome
CHONS elements
Cytoplasm
Entropy
Nuclear membrane
Nucleoli
Nucleolus
Nucleus
Mitochondria
Mitosis
Organelles
Organic compounds
Ribosomes

Learning Objectives

After completing this chapter, you should be able to:

- Understand the difference between the terms *organic* and *inorganic*.
- What is the first rule of biology?
- Identify the inner parts of a cell.
- Describe how living cells grow and divide.

THE MIRACLE OF LIFE

Everything in the universe has a natural tendency to lose energy and become more disordered. This loss of energy is referred to as **entropy** (EN-troh-pee). Entropy is what happens to your bedroom if you don't make an effort to keep it clean. Entropy is also the reason your lunch spoils if you forget to put it in the refrigerator. Decay is the natural state of matter and entropy is the force that drives it.

In a universe ruled by entropy and constantly drawn toward greater disorder, the beauty and mystery of life is its ability to create an organized form from formlessness. Life organizes matter. The magic of life is its ability to draw order from a sea of disorder. All living organisms have the gift of creating order on themselves, which permits them to escape the force of entropy.

Although scientists can observe the birth of simple organic molecules, they cannot generate life from nonliving matter. George Washington Carver created more than 300 different products from peanuts but was unable to change even one of them back into a peanut.

Biology is the science of the study of living things. The word combines "bio" which means life and "ology" which means the study of. The study of biology is essential for hairstylists because it relates to hair and skin. The first rule of biology is that all forms of life need the element carbon to exist. This is true for everything that has ever lived. All plants, animals, and bacteria are made of carbon. Without this element, life as we know it would not exist. Carbon is the backbone of nature.

Carbon is only one of ninety different elements that are found in nature. Hydrogen is the lightest element and uranium is the heaviest.

Our bodies contain many other elements, but the most important is carbon. Hydrogen, oxygen, and nitrogen together account for over 78 percent of the human body. In the body, they combine with carbon (or each other) to form compounds. When elements combine to form compounds, they become molecules. Carbon combines with oxygen, hydrogen, and nitrogen to make an unlimited number of different compounds.

Chemists use shorthand abbreviations to show what elements are in a molecule. Carbon is represented by a capital C, *H* stands for Hydrogen, O represents Oxygen, *N* is for Nitrogen, and *S* is for Sulfur. Since these are the elements which make skin, nails, and hair, it is important to remember them and their symbols. It is easy to remember these elements of life if you arrange the symbols into a word. They become the **CHONS elements.** These elements make up more than 99 percent of the body.

Compounds that contain carbon are called **organic compounds.** Since anything that lives must contain carbon, all living things are *organic*. Skin and hair are organic matter. They are made from many large molecules of the CHONS elements. When millions of these large molecules group together into microscopic communities, they are called **cells.** Now you can see why carbon, along with other elements, are the building blocks of nature. The way these elements combine is the basis for all living things

This topic is discussed in further detail in chapter 8.

IT'S ORGANIC

One of the most misused words in the beauty industry is *organic*. Advertisers realize that the public has a misconception of this term. They have promoted its use to sell everything from vitamins to shampoo.

Most people believe that organic means that the product is healthy, safe, or natural. To some it means no artificial ingredients or preservatives are used. Still others think organic products are good for the preservation of our environment.

In truth, this word has little real meaning for the average consumer. Organic means a substance contains the element carbon in its chemical structure. Almost all artificial ingredients in foods and cosmetics are organic. Pesticides and preservatives are commonly made of organic compounds. Even smog and cigarette smoke are organic. The famous philosopher Socrates was forced by his enemies to drink hemlock, a poisonous, organic herb.

Cow manure and crude oil are organic, but most people would not want them as an ingredient in shampoo or skin cream. *Don't be fooled!* If you buy products simply because they are organic, you're probably getting less than you bargained for!

CELLS

In 1665, the English scientist Robert Hooke tried a new, more powerful type of microscope. When he looked at thin slices of cork he saw many small boxlike structures. He called them cells, from the Latin word for "chamber." The cells he saw were dead and empty. It would not be known for another two hundred years that all living things were made of cells. This word is still used today as the name for the smallest piece of organized living matter.

There are nearly ten trillion cells in your body, and every one of them came from only two original cells, a female egg cell and a male sperm cell. Cells die and are replaced at the fantastic rate of fifty million each second. In our body, cells carry food and oxygen. They also fight bacteria. Without cells we could not see, hear, or taste. Cells digest our food as well as store our thoughts and memories (Fig. 2.1).

There are three main parts to a cell.

1. The **cell membrane** (MEM-brayn) or **wall** encloses a single cell and separates it from other cells. It allows food in and lets waste pass out of the cell.
2. The **nucleus** (NOO-klee-us) is the control center of the cell. The nucleus directs the cell's activity, organizes its work, and stores reproductive genes.
3. The **cytoplasm** (SY-toh-plaz-em) is a clear jellylike substance that fills the cell membrane. The nucleus and other smaller bodies float in this thick fluid.

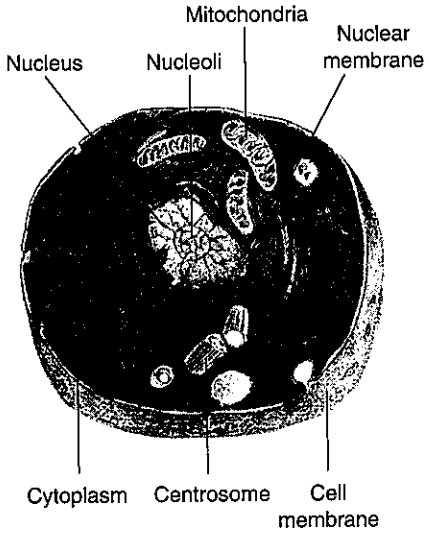

Figure 2-1 *Diagram of a typical cell.*
(Courtesy: N. Richardson)

Suspended in the cytoplasm are small bodies that the nucleus uses to perform the cell's work. These bodies are called **organelles** or little organs. Just as we have organs in our body to breathe and digest food, the same is true for cells. Cells are much like little cities.

A city needs a lot of power to run, and so do cells. One very important organelle is the **mitochondria** (migh-to-KON-dree-uh). These are the powerhouses of the cell. They provide the energy that cells need to do work. A cell in the muscle, for instance, may have hundreds of tiny power plants.

Nucleoli (new-KLEE-oh-lye) are located in a region within the nucleus. Most cells have two or more nucleoli. The nucleolus (singular) is the site of ribosomal RNA synthesis and consists of ribosomal RNA and ribosomal protein. After the ribosomes are manufactured in the nucleoli, they move through the pores in the nuclear membrane and pass into the cytoplasm.

The **nuclear membrane** is the outer boundary of the nucleus. Openings called nuclear pores are located at various spots on its surface and serve as passageways for molecules entering and leaving the nucleus.

The **centrosome** (SEN-tro-sohm) is a spherical region in the cytoplasm with no apparent structure. It may vary in size from one cell type to another, and although it is generally free of organelles, it may contain ribosomes and mitochondria.

Ribosomes (RY-bo-sohms) are the small spherical structures where proteins are manufactured.

Skin cells die quickly. Normal abrasion, sunlight, and defending against invaders are just a few reasons for quick cell turnover. Old cells that die are replaced

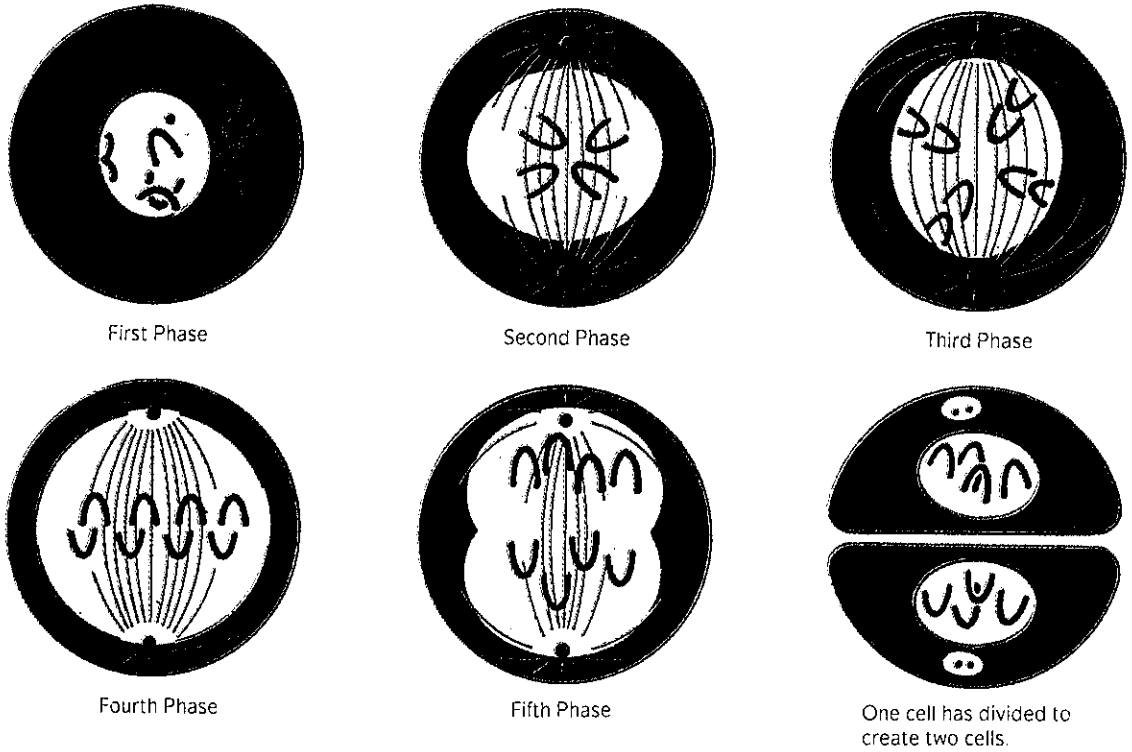

Figure 2-2 *Indirect division of the human cell.*
(Courtesy: CEM)

by new cells that are produced in a process of cell division called **mitosis** (migh-TO-sis). Although it may seem like magic, mitosis is a simple process.

The nucleus stretches and splits in half. A new cell wall forms between the two halves and forms two cells. The cells are identical. When these new cells divide again, their offspring are identical to the original cell. It is by mitosis that hair grows and skin cells are replaced (Fig. 2.2).

The epidermis is in a continual state of renewal as the cells are formed, mature, and die. The epidermis completely renews itself every forty-five to seventy-five days. Keratinocytes are formed by mitosis in the basal layer of the epidermis and move upward through the epidermis as they mature in a process called keratinization. As newly formed keratinocytes mature, they fill with keratin, move upward, flatten out, lose their nucleus and die. The cells in the outer most layer of the stratum corneum flake off and are replaced by new cells from below. It is estimated that a new cell takes twenty-eight days to reach the stratum corneum. Every day the top layer of the stratum corneum is shed, as a new replacement layer is formed, by mitosis, in the stratum granulosum below.

THE BIG PICTURE

Clients have a limited view of the hair and skin. They see only the big picture, the final results. As a hairstylist, you must be concerned with the structure of the hair and the condition of the cells.

Atoms are the basic structure and the building blocks of all matter. Atoms of different elements combine to form compounds (Chapter 8, General Chemistry), and those compounds make up all the cells of the body. The organization and structure of the body begins with its cells. Cells make up tissues, tissues make up organs, and organs make up systems. Every structure of our body can be broken down into cells and understanding those cells allows us to understand ourselves.

REVIEW QUESTIONS

1. Find the name of each element for these chemical symbols: C, H, O, N, S.
2. If a cell in your skin divided by mitosis and both cells divided again and then every cell divided again, how many new cells are formed?
3. What portion of the cell provides the energy for mitosis and other functions?

DISCUSSION QUESTIONS

1. How does the actual definition of "organic" differ from the everyday use of the word? In what way could a misconception like this be dangerous?
2. Why is it important that hairstylists understand the properties of cells?