2 Characteristics of Life

2.0 CHAPTER PREVIEW

In this chapter we will:

- Investigate the meaning of "organism."
- Define the properties that all living things share.
- Discuss the common things that almost all organisms on earth require to live.

2.1 OVERVIEW

It may seem silly, but when one studies life science, one must know which things are alive and which things are not. You can often tell what is alive and what is not by looking at the object. You know that a rock is not alive, but that a tree, a tiger, or a robin is alive. What about yeast (they are living organisms) and viruses (they are not living organisms)? What about the structure in figure 2.1.1? In order to study "life", one must know what is and is not alive. There are common properties of all life forms, whether they are single-cell organisms, such as bacteria and yeasts, or multicellular organisms such as trees and human beings. All life forms have the following properties in common.

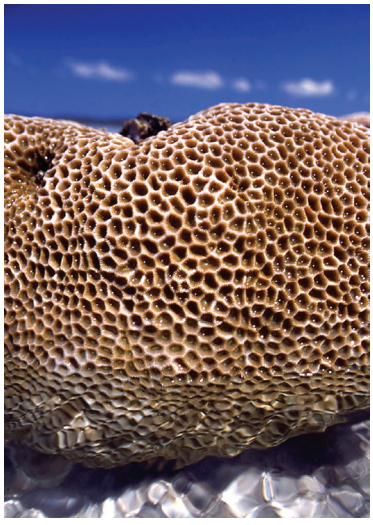


Figure 2.1.1

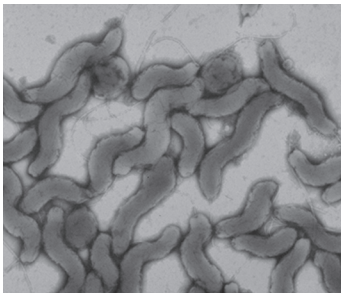
Is it Alive?
It is usually easy to tell if an organism is alive just by looking at it. We can also usually tell by looking at a dead organism that it once was alive. But there are some organisms that are impossible to know if they are alive or dead by looking at them. Coral, right, is one of these organisms. It looks a lot like a rock, but it is not. Coral is an animal that lives in the ocean. Because of organisms like coral, life scientists have determined common properties that all living things have.

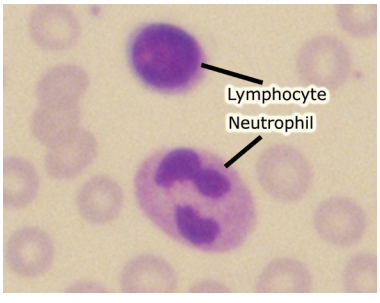
2.2 PROPERTIES OF LIFE: CELLS

All life forms are made up of one or more cells. Therefore, the cell is the basic functional unit of all of life. Some organisms are made up of only one cell (**unicellular**). Almost all single-cell organisms are too small to be seen unless they are viewed with a microscope. Other organisms are made up of many cells (**multicellular**). Almost all multicellular organisms are large enough to be seen with the naked eye. Bacteria are the most numerous organisms on earth. They are unicellular. A human being is made up of about one trillion cells (that is one thousand billion!). Larger organisms, such as the sperm whale, are made of several trillion cells. We will discuss the structure and function of a cell in a couple of chapters.

Figure 2.2.1

Basic Cell Graphic and a Bacterial Cell
The cells below on the left are bacteria. They are enlarged about 7000x with an electron microscope. Bacteria are all single-celled organisms. This means that each cell is an individual, functioning organism. There are more bacteria living in your mouth than the number of people who have ever inhabited the earth. The picture on the right is a sample of human blood as seen through a light microscope. This is enlarged about 1000x. Blood is made up of a watery substance in which cells are suspended. The smaller cells are red blood cells. They carry oxygen to our tissues and organs. The larger cells are white blood cells, and each specific cell is labeled. White blood cells fight infections—lymphocytes fight viruses and neutrophils kill bacteria. All multicellular organisms are made up of many individual cells, which function together for the good of the organism.





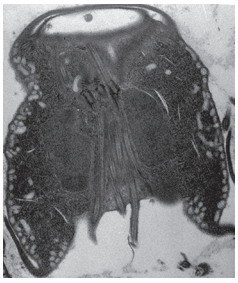


Figure 2.2.2

Giardia lamblia
SEM view of an organism called *Giardia lamblia*. It is a unicellular organism that infects people's intestines and causes diarrhea.

FIGURE 2.2.3

Multicellularity
All of the organisms that you can see here—grass, deer, and bushes—are multicellular. All of the cells function together for the common good of the organism.

2.3 PROPERTIES OF LIFE: DEOXYRIBONUCLEIC ACID (DNA)

All life forms contain **DNA**, or **deoxyribonucleic acid**. DNA is a complex molecule carrying the information for the development of every trait, or characteristic, of an organism. DNA is contained in every cell of every living organism. DNA is passed from parent to offspring so that the offspring have the information they need to function properly. DNA is said to contain the genetic information. Genetics refers to the passage of traits from parents to offspring. A short segment of DNA that contains the information for the development of a certain trait is called a **gene**. Therefore, when DNA is passed from parent to offspring, genes are passed from parent to offspring. The passage of genes and traits from parent to offspring is called **inheritance** or heredity.

Practically, this means that DNA contains all of the information that causes an organism to be an organism. DNA contains the information for a cow to grow into a cow and a fire maple tree to grow into a fire maple tree. Any trait of a cow that you can think of is controlled by the DNA. A certain cow looks the way it does in terms of size, coloring, hoof size, etc., because these traits develop based on the information contained in DNA.

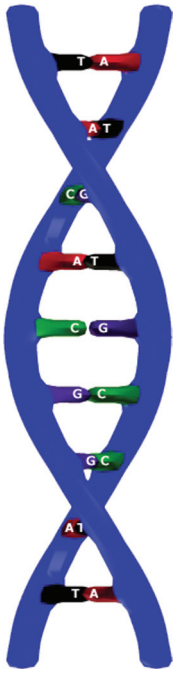


Figure 2.3.1

DNA
DNA stands for deoxyribonucleic acid. It is called the blueprint of life because DNA contains the information that determines everything about an organism. Hair color, height, how fast you digest your food, how long you sleep, and millions of other characteristics of every organism on earth are all controlled by DNA. The graphic on the left reveals the structure of a molecule of DNA. It took researchers many years to determine this structure. The structure on the right—called a chromosome—is what an actual molecule of DNA looks like when it is inside a cell. DNA in this form is called a chromosome. DNA is like a slinky. Sometimes the DNA is spread out, like a slinky is if you stretch it out as far as it can go. A chromosome is DNA wound tightly, like a slinky when it is sitting there.

Figure 2.3.2

DNA Controls Traits
Every trait, or characteristic, of an organism is controlled by the information contained in DNA. The striped coloration of the zebra is controlled by DNA. The lighter-looking zebra's coloration is also controlled by DNA. The reason the two zebras look different is because their DNA is different and contains slightly different genes. The lighter zebra's genes contain information that makes it look light instead of the normal appearance that the striped zebra's genes instruct it to be. The pansy flower develops on the pansy plant because the information contained in the DNA of all of the pansy plant cells contains information that directs the flower to grow and look the way it does. DNA also causes the flower to grow to a certain size and to have a certain coloration pattern. Why does a pansy flower look different than a rose? Because the DNA of a pansy plant is different than the DNA contained in a rose plant. The information contained in the pansy's genes causes the flower to grow to look like a pansy flower, and the information contained in the rose DNA causes the flower to grow to look like a rose.

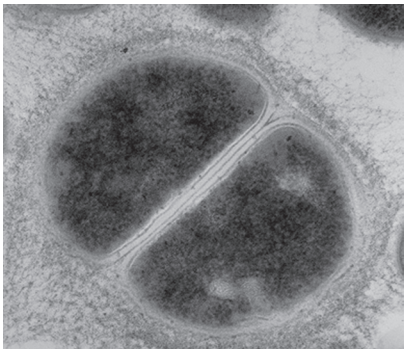
2.4 PROPERTIES OF LIFE: REPRODUCTION

All life forms make more of themselves, or **reproduce**, for the purpose of generating more organisms that look and function just like the original. This assures the survival of that life form. No non-living things reproduce. There are two kinds of reproduction—**sexual** and **asexual**.

Asexual reproduction is the formation of a new cell or organism without the exchange of genetic material. It is accomplished by a single cell splitting into one or more cells exactly like it. Organisms and cells that are produced from asexual reproduction all contain the same DNA information. Asexual reproduction is similar to making photocopies in that all of the copies (offspring) are identical to the original (parent).

Figure 2.4.1

Asexual Reproduction
All living organisms reproduce. Some organisms reproduce sexually, some reproduce asexually, and some organisms can reproduce both ways. Asexual reproduction results in the generation of a new organism or cell without exchanging genetic material (DNA). Sexual reproduction involves the exchange of genetic information between two organisms. There are many forms of asexual reproduction. Some people who like plants are performing asexual reproduction when they take a plant stem and plant it in dirt or water. The stem then grows into a new plant. That is a form of asexual reproduction. On the right is another type of asexual reproduction. This is a bacterial cell which is splitting into two cells from one cell. After the cells split, each one is a completely functioning new organism.



Sexual reproduction requires a male and a female organism to mate, or to combine their genetic material. DNA from the male combines with DNA from the female, which forms a new cell. This new cell will develop into a new organism and contain some genetic information from the female parent and some from the male. Offspring reproduced asexually always look exactly the same, but offspring produced sexually rarely do.

Some organisms reproduce asexually, some reproduce sexually, and some are able to reproduce both sexually and asexually. The way the cell and the organism reproduce is controlled by the DNA.

2.5 PROPERTIES OF LIFE: COMPLEX AND ORGANIZED

All life forms are **highly organized** and **complex** structures. Even what some biologists may call "simple life forms" are actually complex organisms. This is proven by the utter inability of any scientist to create life from only the basic molecules that make up a living organism. Life is both organized and complex as directed by its DNA. This complexity exists on many levels. For example, all life forms perform many complicated chemical reactions every second. These chemical reactions are highly controlled, so they do not occur when they should not occur. Even the internal structure of a cell is complex and organized.

Multicellular organisms have a higher level of complexity than unicellular organisms. The cells of multicellular organisms are organized into tissues, tissues are organized into organs, and organs are organized into systems.

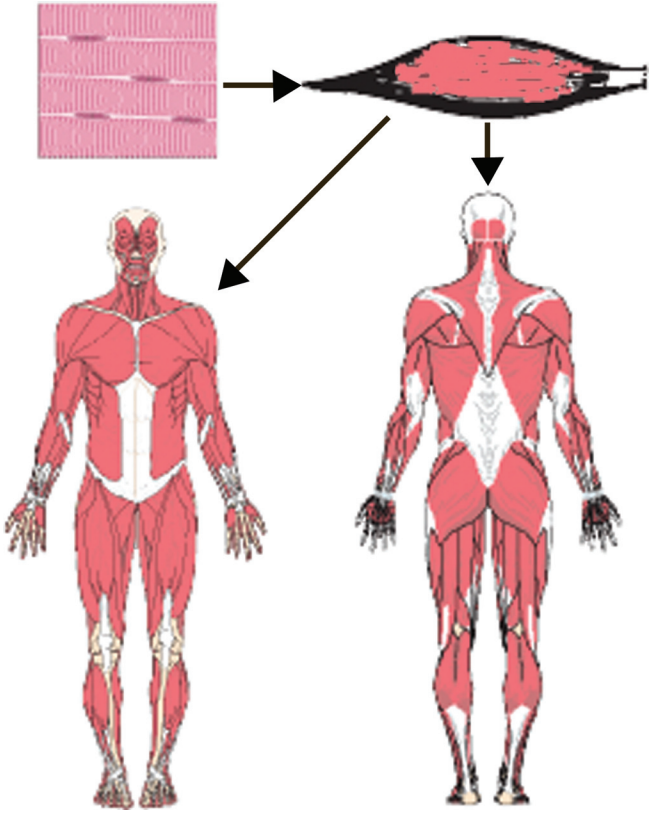


Figure 2.5.1

Organs and Tissues Organization
Multicellular organisms are highly organized. Groups of individual cells that group together and have the same function are called a tissue. For example, an individual cell that can contract and relax is called a muscle cell. Muscle cells are shown in the upper left of the graphic. Groups of muscle cells are called a muscle, which is a tissue. A typical muscle is shown top right. Multicellular organisms are further grouped into organs and systems. All of the muscles in an organism are called the muscular system. The muscles of the human muscular system are shown at the bottom.

2.6 PROPERTIES OF LIFE: RESPONSIVE

All living things are responsive to their surroundings or **environment**. This means that they have various ways to sense changes in their environment and react to those changes. The ability to respond is controlled by different types of **receptors**. Receptors are specialized structures that allow an organism to sense and respond to its environment. These sensing and responsive abilities of an organism help it to locate food, find shelter, and find a mate. The responses almost always result in movement of the organism. Sometimes the movement is on the outside of the organism and can be seen. Other times the movement occurs on the inside of the organism and cannot be seen.