INTRODUCTION

The year 1978 marked a major breakthrough in medicine. For the first time ever, scientists were able to induce bacterial cells to make human insulin by inserting human DNA into the cells. This new technology, termed *genetic engineering*, can be used to make products that treat the symptoms of certain genetic diseases.

To carry out genetic engineering, you need good laboratory skills. In this chapter, you'll focus on gaining practice in the use of *micropipettes* (instruments used to transfer small volumes of liquid) and *gel electrophoresis* (a technique for separating and identifying biomolecules)—two critical skills for biotechnology. You will complete two labs, using instruments and supplies that are identical to the ones used in biotechnology research laboratories. These labs are the first step in building the skills you'll need to carry out the subsequent labs and complete your challenge in this program.

CHAPTER 1 GOALS

By the end of this chapter, you will be able to do the following:

- Use micropipettes and the technique of gel electrophoresis correctly
- Explain the importance of micropipettes and gel electrophoresis in genetic engineering
- Describe how gel electrophoresis separates DNA
- Explain how genetic engineering can be used to treat some genetic diseases

WHAT DO YOU ALREADY KNOW?

Discuss the following questions with your partner and write your ideas in your notebook. Be prepared to discuss your responses with the class. Don't worry if you don't know all the answers. Discussing these questions will help you think about what you already know about genetic disease and DNA.

1. What does the term *genetic disease* mean? What examples of genetic diseases do you know about?

2. Adding human DNA to bacteria makes it possible to make human insulin. What do you already know about DNA? Be as detailed as possible and discuss the location of DNA in the cell, DNA structure, the replication of DNA, and the components of DNA.

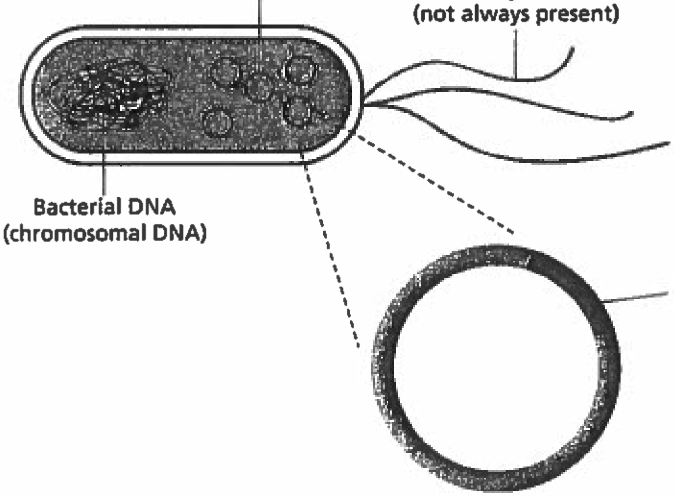
THE GENETIC ENGINEERING PROCESS

Do you know somebody who takes *insulin*, or a *blood clotting factor*, or *human growth hormone*? These substances are all proteins manufactured in certain human cells. If those cells fail to make these particular proteins, the diseases *diabetes*, *hemophilia*, and *growth deficiency* can result. A patient with one of these diseases must be treated with the missing protein.

CONSIDER: Prior to genetic engineering, how could people get missing proteins for a genetic disease?

Before the development of genetic engineering, it was difficult to obtain human proteins to treat people who needed them. Now, bacteria can make these proteins because scientists have figured out a way to change bacterial DNA by adding human DNA. (see Figure 1.3).

Figure 1.3: Bacterial cell with human DNA



What is the relationship between DNA and proteins? Both are *macromolecules*, large molecules made by living cells. When scientists investigated traits in organisms, they found that proteins were responsible for traits. For example, consider a plant that has the trait of red flowers. The flowers' red pigment is produced by the action of an enzyme (one kind of protein). The DNA in that plant contains instructions for making proteins, including that enzyme. The part of a DNA molecule that has the instructions for making a particular protein is called a *gene*.

In the genetic engineering process, a human gene is added to a *plasmid*, a small circular piece of DNA found in many bacteria. The plasmid is taken up by bacterial cells, and the cells make the human protein that is encoded by the human gene along with their own proteins. During this process, biotechnologists use a combination of tools, some human-made and some biological. Among the human-made tools are two that you'll work with in this chapter: micropipettes and gel electrophoresis.

DID YOU KNOW?

The DNA Code

DNA information is encoded by the arrangement of nucleotides, small molecules that join together to form the DNA molecule. A DNA molecule has millions of nucleotides. There are four different kinds of nucleotides, and they are arranged in a specific sequence (order). A specific sequence of nucleotides in the DNA (i.e., a gene) is a code for how to make a specific protein. Think of a sequence of nucleotides as similar to a sequence of written musical notes—the code for how to play music. Just as different sequences of notes encode different songs, different sequences of nucleotides encode different proteins.