7.2 Gene Expression

REMEMBER: Proteins are polymers of amino acids (Section 2.9). The DNA in a body cell contains enough information to rebuild the individual (6.1). Information is encoded in the sequence of nucleotide bases in a DNA strand (6.2).

You learned in Chapter 6 that chromosomes are like a set of books that provide instructions for building and operating an individual. You already know the alphabet used to write those books: the four letters A, T, G, and C, for the four nucleotides in DNA—adenine, thymine, guanine, and cytosine. In this chapter, we investigate "words" that can be made from those letters, and "sentences" that can be made from the words.

The nature of information represented by the sequence of nucleotides in a DNA molecule occurs in hundreds or thousands of units called genes. The DNA sequence of a **gene** encodes (contains instructions for building) an RNA or protein product. Converting the information encoded by a gene into a product starts with RNA synthesis, which is called transcription. During **transcription**, enzymes use a strand of DNA as a template to assemble a strand of RNA.

Most of the RNA inside cells occurs in single strands that are similar in structure to single strands of DNA (Figure 7.2). For example, both are chains of four kinds of nucleotides. Like a DNA nucleotide, an RNA nucleotide has three phosphate groups, a sugar, and one of four bases. However, the sugar in an RNA nucleotide (ribose) is slightly different from the sugar in a DNA nucleotide (deoxyribose). Three bases (adenine, cytosine, and guanine) occur in both RNA and DNA nucleotides, but the fourth base differs between the two molecules. In DNA, the fourth base is thymine (T); in RNA, it is uracil (U). These small differences in structure give rise to very different functions. DNA's important but only role is to store a cell's genetic information. By contrast, a cell makes several kinds of RNAs on an ongoing basis, and the different types have different functions. **Messenger RNA** (**mRNA**) was named for its function as the "messenger" between DNA and protein. By the process of **translation**, the protein-building information in an mRNA is decoded (translated) into a sequence of amino acids. The result is a polypeptide that twists and folds into a protein.

Transcription and translation are both part of **gene expression**, the multistep process by which information in a gene guides the assembly of an RNA or protein product. Expression of a gene that encodes an RNA product (such as an mRNA) involves transcription. Expression of a gene that encodes a protein product involves both transcription and translation:

DNA —*transcription*→ mRNA —*translation*→ protein

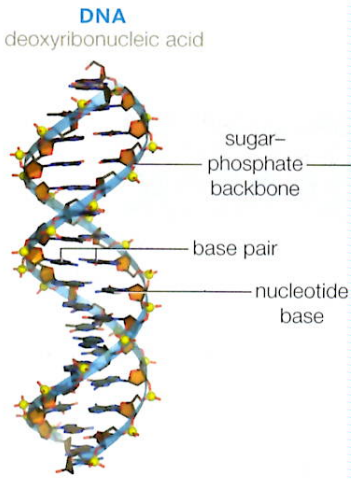

Figure 7.2 Comparing DNA and RNA. DNA permanently stores a cell's genetic Cells continually make different types of have various functions.

Take-Home Message 7.2

What is the nature of the information carried by DNA?

- Information in a DNA sequence occurs in units that are called genes.
- A cell uses the information encoded by a gene to make an RNA or protein product, a process called gene expression.
- Transcription converts information in a gene to RNA; translation converts information in an mRNA to protein.

gene A part of a chromosome that en or protein product in its DNA sequence

gene expression Process by which th tion in a gene guides assembly of an R product. Includes transcription and tra

messenger RNA (mRNA) RNA that ha building message.

transcription Process by which enzyn an RNA using a strand of DNA as a ten

translation Process by which the prot instructions in an mRNA guide the ass polypeptide.