Name Date Class

Section 11.2

From DNA to Protein

North Carolina Objectives **Objective 3.01** Analyze the molecular basis of heredity including: Protein synthesis (transcription, translation); Gene regulation

Before You Read

Have you ever seen a computer code? Computers understand a language called binary language. It is made up of only two options—zero and one. 000011001001100101010000 is an example of a computer code. From simple games to Web browsers, complex software is built by stringing together zeros and ones into long computer codes. Think about this as you read this section.

Read to Learn

STUDY COACH

Mark the Text **Identify Main Ideas** Highlight the main point under each head. State each main point in your own words.

Reading Check

1. What are the three types of RNA?

_____

_____

_____

Genes and Proteins

DNA contains information used to make proteins. Proteins have many uses. Some proteins become structures and some control cell functions. Since DNA has the information for making proteins, DNA controls cells. Remember that all this information is based on the sequence of nucleotides in the DNA molecule.

RNA

What is the role of RNA in a cell? Think of a car factory and an assembly line. A car is a complicated piece of machinery. But cars are built by following simple steps. Engineers tell workers how to make the cars, and workers follow the directions to build the cars on the assembly line. Suppliers bring parts to the assembly line so they can be used to build the cars. This is similar to the role of DNA and RNA in a cell. DNA gives the instructions to make proteins. Workers build proteins. Other workers bring the parts, in this case, amino acids, to the assembly line. In our example the workers are the RNA.

Just as in a typical factory, workers have specific tasks. So does RNA. There are three different kinds of RNA. One type is **messenger RNA** (mRNA). It brings instructions from DNA to the cytoplasm. A second type of RNA is called the ribosome, or **ribosomal RNA** (rRNA). It binds to the mRNA and uses the instructions to assemble the amino acids in the right order. The third type of RNA is **transfer RNA** (tRNA). It delivers amino acids to the ribosome to be made into a protein.

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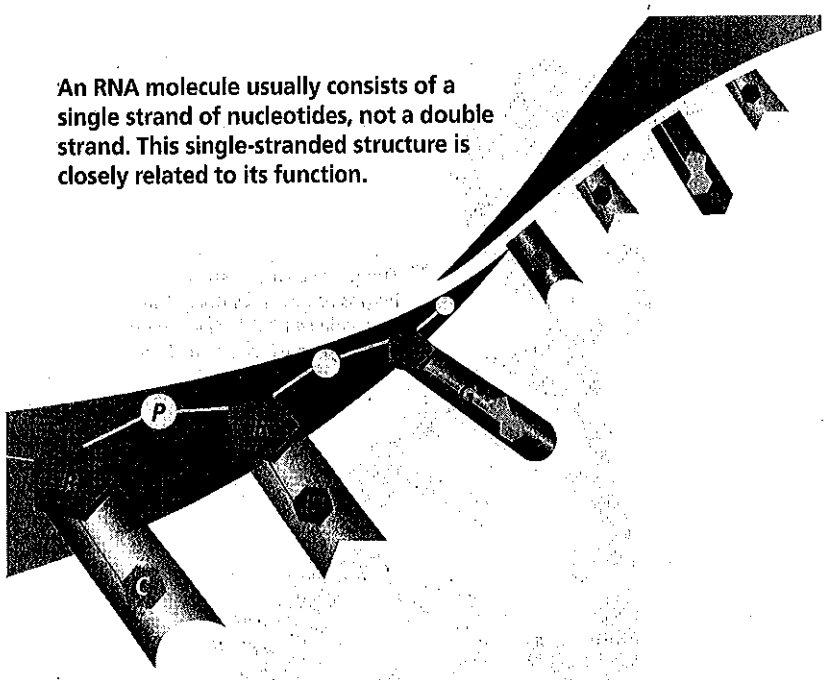
What does RNA look like?

RNA, like DNA, is a nucleic acid. But the structure of RNA is quite different. RNA is a single strand. It looks like one half of a zipper. DNA is a double strand. The sugar in RNA is different than the sugar in DNA. Finally, both RNA and DNA have four nitrogenous bases, but instead of thymine, RNA has uracil. Remember that in DNA, guanine binds with cytosine, and thymine binds with adenine. In RNA uracil (U) binds with adenine. The structure of RNA helps it do all the work of building proteins.



An RNA molecule usually consists of a single strand of nucleotides, not a double strand. This single-stranded structure is closely related to its function.

Transcription

In order to get the information to the cytoplasm, first messenger RNA has to be made. In this process, called **transcription** (trans KRIHP shun), RNA is made from part of a DNA strand. Use the illustration on page 120 to help you understand the process after you read the following description.

First, a portion of the DNA molecule unzips. Free RNA nucleotides pair with the nucleotides on the DNA strand. The mRNA strand is complete when the RNA nucleotides form a strand by bonding together. The mRNA strand breaks away and the DNA strands rejoin. The mRNA strand leaves the nucleus and enters the cytoplasm. You can see that transcription is similar to replication with one important difference—a single strand RNA molecule is created rather than a double strand DNA molecule. You can also see from the illustration that mRNA pairs guanine with cytosine, but pairs uracil with adenine.

RNA Processing

Not all of a DNA strand carries information to make proteins. There are long sequences of noncoding nucleotides on DNA strands. Enzymes cut out any noncoding sequences that may have been transcribed. In this way, the mRNA carries only information it needs to make protein.

STUDY COACH

Mark the Text **Identify Details**
Circle the parts of the diagram on page 120 that illustrate each part of the transcription process.

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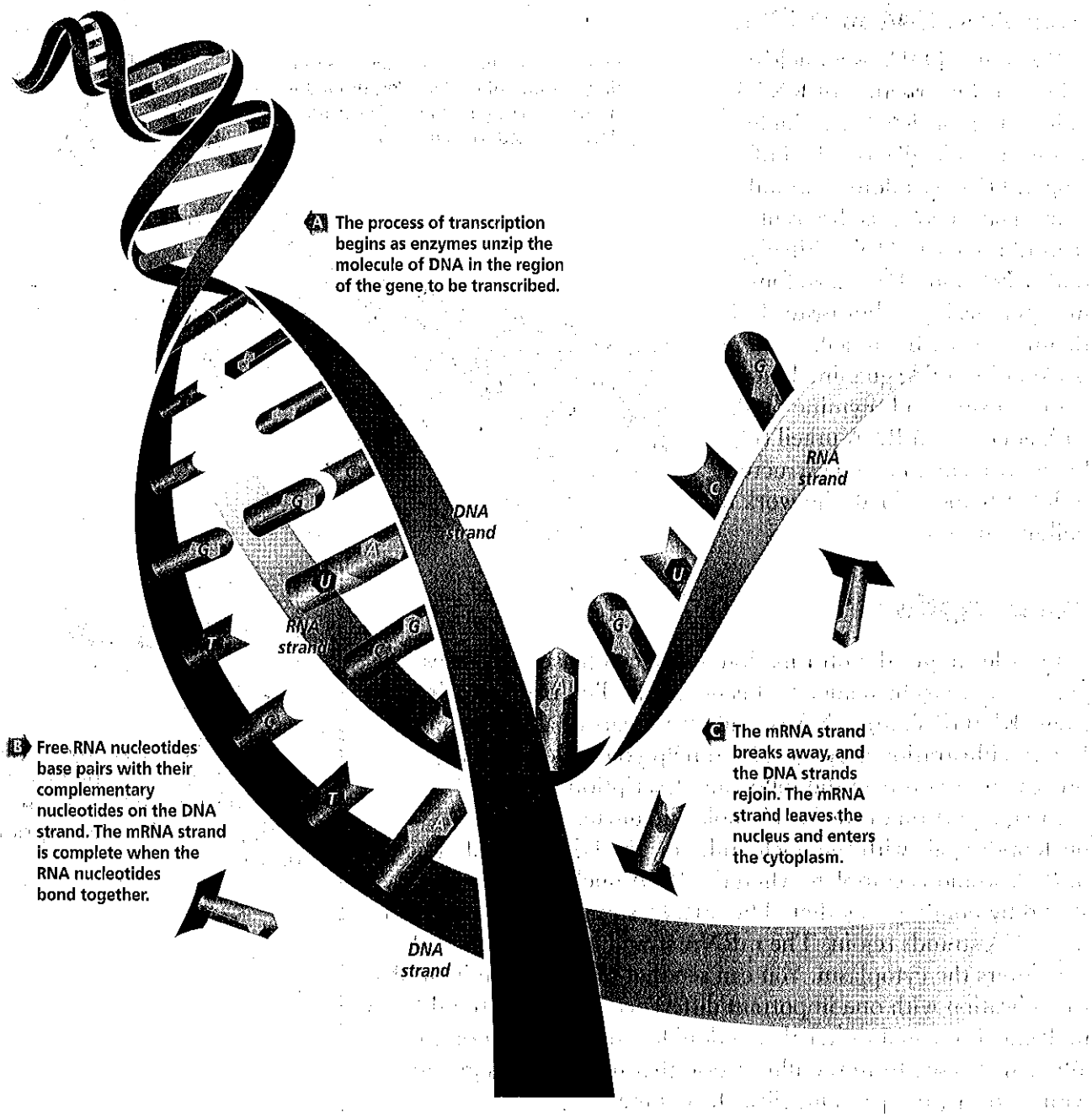


The Genetic Code

The nucleotide sequence transcribed from DNA to a strand of messenger RNA is a genetic message that has all the information needed to build a protein. The message is in a special language that uses nitrogenous bases as the alphabet. Remember that proteins are made up of amino acid chains. There are 20 different amino acids. These amino acids are made from only four

nitrogenous bases. Scientists wondered how four nitrogenous bases could make a code for 20 amino acids.

Scientists were able to crack the genetic code when they discovered that it takes a group of three nitrogenous bases in mRNA to code for one amino acid. Each group of three nitrogenous bases is known as a **codon.** For example, the codon for the amino acid alanine is G-C-U. The codon for lysine is A-A-A. Every amino acid has a three-letter codon, each letter representing one of the four nitrogenous bases. That is how four nitrogenous bases can code for 20 amino acids. There is even a codon that tells the mRNA that this is the start of the amino acid chain and another codon that says this is the end. To simplify, those codons are called *start* and *stop.*

Translation: From mRNA to Protein

Remember the factory example? Messenger RNA is the worker that brings the instructions for making protein to the cytoplasm. It takes two more kinds of RNA to actually make the protein. The process of changing the information in mRNA into an amino acid chain in protein is called **translation.**

Here is how it works.

1. The mRNA moves to the cytoplasm.
2. A ribosome (rRNA) attaches itself to the start codon, A-U-G, on the mRNA.
3. Transfer RNA (tRNA) molecules, carrying amino acids, approach the ribosome. The nitrogenous base sequence that is the complement to the mRNA sequence is the anticodon. If the mRNA codon is G-C-C, the tRNA anticodon is C-G-G. For every codon on mRNA there is an anticodon on tRNA.
4. The ribosome attaches the anticodon to the codon and the amino acids bond. The ribosome then slides to the next codon.
5. Again the ribosome attaches the anticodon to the codon, amino acids bond, and the ribosome slides over.
6. This translation process continues until the stop codon is reached. At this point the amino acids have formed a chain and when the stop codon is reached, the chain is released.

You can see from the illustration of the translation process on page 122 that the tRNA does not stay attached during the whole process. As soon as the amino acid bonds to the amino acid next to it, the tRNA that brought it moves away to bring another amino acid.

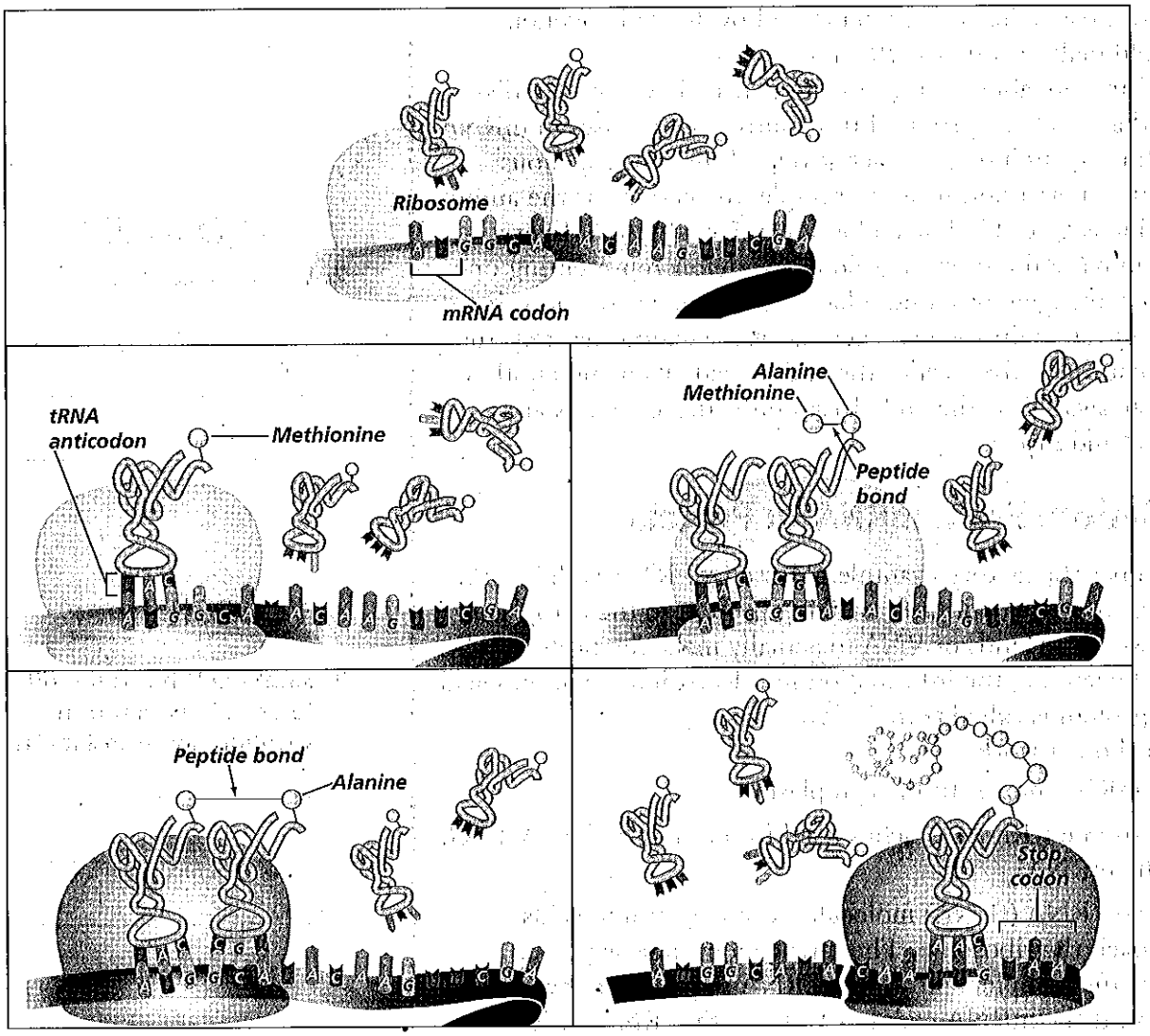
Reading Check

2. What is a codon?

Think it Over

3. Analyze What is the difference between transcription and translation?

Section 11.2 From DNA to Protein, *continued*



Amino acid chains become proteins when they are freed from the ribosome. The amino acid chains twist and curl into complex three-dimensional shapes. Each protein chain forms the same shape every time it is produced. These proteins become enzymes and cell structures.

What is the central dogma?

If you were to summarize the process of replication, transcription, translation, and protein formation you might say simply that the pathway of information flows from DNA to mRNA to protein. This process is called the central dogma of biology. This means that the same process occurs in every living thing, from the simplest bacteria to the most complex animal.

Think it Over

4. **Sequence** The pathway of information flows from (Circle your choice.)
   a. DNA to mRNA to protein.
   b. mRNA to DNA to protein.
   c. protein to mRNA to DNA.

After You Read

Mini Glossary

codon: group of three nitrogenous bases in mRNA that code for one amino acid

messenger RNA: RNA that carries information from DNA in the nucleus to the cell's cytoplasm

ribosomal RNA: RNA that makes up the ribosomes; binds to mRNA and uses its information to assemble amino acids in the right order

transcription (trans KRIHP shun): process in the cell nucleus where a copy of RNA is made from part of a DNA strand

transfer RNA: RNA that delivers amino acids to the ribosomes to be assembled into proteins

translation: process of changing the information in mRNA into an amino acid chain in a protein

1. Read the key terms and definitions in the Mini Glossary above. Then on the lines, write a definition of **transcription** and **translation** using your own words.

2. Under each type of RNA, write the words or phrases that tell something about it.

mRNA →	rRNA →	tRNA

codon
moves along mRNA
anticodon
transcription
translation
connects codon to anticodon
brings instructions
brings amino acid
uses instructions to assemble amino acids

Visit the Glencoe Science Web site at **science.glencoe.com** to find your biology book and learn more about DNA to protein.