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# ACTIVITY 19-2. RNA AND PROTEIN SYNTHESIS

In the replication of DNA, existing strands serve as templates for the synthesis of new complementary strands of DNA. Strands of DNA also serve as templates for the synthesis of a type of RNA called *messenger RNA*, or *mRNA*. The mRNA then serves as a template for the assembling of amino acids, which bond together to form polypeptides and proteins. Thus, the sequence of nucleotides in the DNA determines the sequence of nucleotides in the mRNA, which in turn determines the sequence of amino acids in proteins. Two other types of RNA are involved in protein synthesis. These are ribosomal RNA (rRNA) and transfer RNA (tRNA).

**structure of RNA**

Like DNA, RNA is composed of nucleotide subunits. Unlike DNA, RNA is single-stranded, and the sugar it contains is ribose instead of deoxyribose. Also, instead of the thymine that is present in DNA, RNA contains the pyrimidine uracil, which is complementary to adenine.

## Question

How does the structure of RNA differ from that of DNA?

**synthesis of messenger RNA**

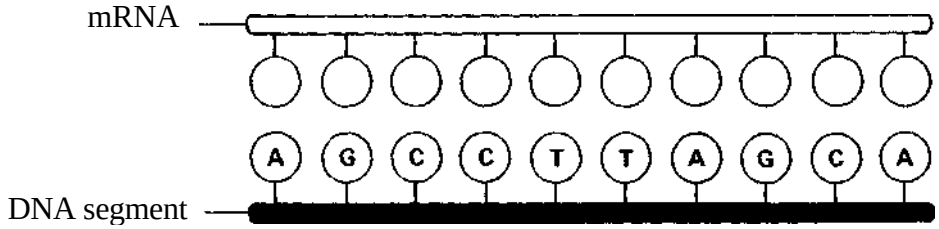
Like the replication of DNA, the synthesis of mRNA involves a complex series of enzyme-catalyzed reactions. It begins with the attachment of a particular enzyme to a special site on the DNA molecule. This causes the two strands of DNA to unwind in that area. It is thought that only one of the two strands of DNA serves as a template for RNA synthesis. The RNA nucleotides (ribonucleotides) align along the DNA strand, forming a complementary strand of mRNA. The process by which the hereditary information of the DNA is copied into the mRNA is called *transcription.* The pairing of bases in mRNA synthesis is the same as in DNA replication except that where there is an adenine on the DNA, there is a uracil on the mRNA. Messenger RNA is a short-lived intermediate in protein synthesis. It can be synthesized very rapidly and broken down just as rapidly. From the nucleus where it is synthesized, the mRNA passes into the cytoplasm and becomes attached to ribosomes.

## Questions

1. In what part of the cell does the synthesis of mRNA occur? _____
2. What determines the sequence of bases in mRNA?

3. Messenger RNA migrates from its site of synthesis and becomes attached to _____.

4. The diagram below shows the sequence of bases in a segment of DNA. Fill in the bases for a complementary segment of mRNA.




## ribosomal and transfer RNA

Ribosomal RNA, along with some protein, makes up the ribosomes. Transfer RNA, found in the cell cytoplasm, picks up amino acids and carries them to the ribosomes. Both rRNA and tRNA are stable components of the cell. They are not continually synthesized and broken down as is mRNA. Like mRNA, tRNA and rRNA are synthesized by transcription of the DNA template.

Questions

1. The three types of RNA found in the cell are_____ , _____ _, and_____
2. Ribosomes are made up of_____ and _____.
3. Amino acids are carried to the ribosomes by_____

## the genetic code and protein synthesis

The genetic information is encoded in the sequence of nucleotides in the molecules of DNA. The same information is encoded in the nucleotide sequence of messenger RNA. The code itself consists of specific sequences of three nucleotides. Each such triplet, or *codon*, codes for a particular amino acid. Some amino acids are coded for by more than one triplet. For example, the codes for the amino acid lysine are AAA and AAG.

Protein synthesis takes place at the ribosomes. Here, the mRNA from the nucleus acts as a template for the assembly of amino acids. The sequence of bases of the mRNA determines the sequence of amino acids. Each kind of amino acid (there are about twenty) is picked up by a specific transfer RNA and carried to the ribosome. The tRNA has a triplet of exposed nitrogenous bases that are complementary to a triplet of bases (codon) on the mRNA at the ribosome. This triplet of bases on the tRNA is called the *anticodon* because it is complementary to the codon of the mRNA. The tRNA carrying its amino acid becomes temporarily attached to the complementary triplet of the mRNA at the ribosome. In this way, a specific series of amino acids lines up at the ribosome. The order in which the amino acids are arranged is determined by the base sequence (triplets) of the mRNA, and ultimately by the base sequence of the cell DNA.

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The amino acids at the ribosome are joined together by dehydration synthesis to form proteins. This is accomplished with energy from ATP and in the presence of specific enzymes. When the protein is complete, it separates from the tRNA, and the tRNA separates from the mRNA.

# Questions

1. Where does protein synthesis occur in the cell?

2. What determines the sequence of amino acids in a given protein?

3. Why does a particular tRNA become temporarily attached only to a specific triplet of mRNA?

4. What is a codon?

5. The type of reaction by which amino acids bond together to form proteins is _____ _____.

6. Using the reference list below, determine the sequence of amino acids coded for by the mRNA shown below. (Start from the top of the mRNA.)

**mRNA**

C
G
U
A
A
A
U
G
G
A
G
G
G
U
A
G
A
A
U
U
C
A
A
G

**AMINO ACID SEQUENCE**

1, _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

Reference List:

| AMINO ACID | RNA TRIPLET CODE |
|---|---|
| valine | GUA,GUG,GUC,GUU |
| arginine | AGA, AGG, CGA, AGA, CGC, CGU |
| lysine | AAA,AAG |
| tryptophan | UGG |
| glutamic acid | GAG,GAA |
| phenylalanine | UUU,UUC |