**Chapter 8.4 How Proteins are Made**

|  |  |
| --- | --- |
| Objectives | Vocabulary |
| * **Compare** the structure of RNA with that of DNA.
* **Summarize** the process of transcription.
* **Relate** the role of codons to the sequence of amino acids that results after translation.
* **Outline** the major steps of translation.
* **Discuss** the evolutionary significance of the genetic code.
 | Ribonucleic acid (RNA)UracilTranscriptionTranslationGene expressionRNA polymeraseMessenger RNA  | CodonGenetic codeTransfer RNAAnticodonRibosomal RNADecoding the Information in DNARibonucleic Acid |

**Decoding the Information in DNA**

* Traits, such as eye color, are determined by \_\_\_\_\_\_\_\_\_\_\_\_\_ that are built according to instructions \_\_\_\_\_\_\_\_ in DNA.
* The instructions for making each protein are contained in small segments of our DNA called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* A single molecule of DNA has thousands of genes lined up like \_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_.
* Proteins, however, are not built directly from DNA…ribonucleic acid or \_\_\_\_\_\_\_ is also involved.
* Like DNA, **RNA** is a nucleic acid—a molecule made of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ linked together.
* RNA differs from DNA in \_\_\_\_\_\_ ways
	1. RNA consists of a \_\_\_\_\_\_\_\_\_\_\_\_ strand of nucleotides
	2. In place of thymine, RNA contains the nitrogenous base \_\_\_\_\_\_\_\_\_\_\_\_\_
	3. In place of deoxyribose, RNA nucleotides contain the five-carbon sugar \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_The only difference between the two sugars is that deoxyribose contains one less \_\_\_\_\_\_\_\_\_\_\_
		+ So, deoxyribose is said to be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 

**Types of RNA**

* Additionally, there are three types of RNA
	1. Messenger RNA (\_\_\_\_\_\_\_\_\_)
	2. Transfer RNA (\_\_\_\_\_\_\_\_\_)
	3. Ribosomal RNA (\_\_\_\_\_\_\_\_\_\_)

**Messenger RNA**



* mRNA is a \_\_\_\_\_\_\_\_\_ strand of RNA nucleotides that is used to acquire DNA’s genetic code
* In a eukaryotic cell, mRNA carries the code \_\_\_\_\_\_ of the nucleus in order to make a protein
* Why might it be important for DNA to stay inside of a eukaryotic cell’s nucleus?



**Transfer RNA**

* tRNA loops up on itself to take on a \_\_\_\_\_\_\_\_\_ leaf shape
* This shape is held together by \_\_\_\_\_\_\_\_\_\_\_\_\_ bonds
* It is used to \_\_\_\_\_\_\_\_\_\_\_ amino acids

**Ribosomal RNA**



* rRNA joins with \_\_\_\_\_\_\_\_\_\_\_\_\_\_ to make a structure called a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Free ribosomes are the \_\_\_\_\_\_\_\_\_\_ or location of protein synthesis
* The instructions for making a protein are \_\_\_\_\_\_\_\_\_\_\_ from a gene in DNA to an RNA molecule in a process called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Cells then read the instructions on the RNA molecule to put together the sequence of \_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_ that make up the protein in a process called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The entire process by which proteins are made based on the information encoded in DNA is called **gene \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_,** or protein \_\_\_\_\_\_\_\_\_\_\_\_\_.



**Transcription occurs in three steps**

Step 1

 \_\_\_\_\_\_ polymerase, an enzyme that adds complementary RNA nucleotides, binds to a gene’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ site. This site on DNA promotes or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the start of transcription

Step 2

RNA polymerase\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the DNA strands

Step 3

As it moves along DNA, RNA polymerase adds \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ RNA nucleotides in order to form \_\_\_\_\_\_\_\_\_\_. Notice that only \_\_\_\_\_\_\_\_\_\_ strand of DNA is used to make RNA…this strand is called the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. As it moves along DNA, RNA polymerase adds \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ RNA nucleotides in order to form \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Notice that only \_\_\_\_\_\_\_ strand of DNA is used to make RNA…this strand is called the \_\_\_\_\_\_\_\_\_\_\_\_\_

* So let’s practice transcribing a strand of mRNA

make complementary mRNA base pairs with the DNA strand below…***Remember…RNA does NOT have thymine!***

DNA 🡪 G C A T A C G T A

RNA 🡪

* In eukaryotic cells, there are typically about \_\_\_\_\_\_ RNA polymerase molecules working on one gene
* The mRNA being transcribed fans out to give the DNA a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ appearance
* Also in a eukaryotic cell, the mRNA has to leave the nucleus and enter the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in order to find a free \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, which is where a protein will be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* How does mRNA get out of the nucleus?
* In prokaryotic cells, transcription occurs in the cytoplasm, and not in a nucleus…why?
1. Compare the structure of RNA with that of DNA
2. Summarize the process of transcription.

|  |
| --- |
| Objectives |
| * **Relate** the role of codons to the sequence of amino acids that results after translation.
* **Outline** the major steps of translation.
* **Discuss** the evolutionary significance of the genetic code.
 |

**The Genetic Code: Three-Nucleotide “Words”**

* In order for a protein to be made, the code stored in mRNA must be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* The code is stored in a series of \_\_\_\_\_\_\_\_ nucleotide sequences on mRNA called **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
* Each codon codes for a specific \_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_ that will be placed in a protein

**Codes in mRNA**

To determine which amino acid is coded for, find the area on the chart where all three of the nucleotides in a codon \_\_\_\_\_\_\_



* Practice…What does AUG code for?
* So AUG is a \_\_\_\_\_\_\_\_ codon, that signals the beginning of translation
	+ It codes for the amino acid \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, abbreviated \_\_\_\_\_
	+ It is found at the beginning of most proteins, but is often \_\_\_\_\_\_\_\_\_\_\_ after translation
* What does CCC code for?
* What does GGU code for?
* What does UAU code for?
* What does UGA code for?
	+ UGA is a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ codon that terminates protein synthesis
* What are the other two stop codons?
* \_\_\_\_\_ codons signal for the \_\_\_\_\_ amino acids found in proteins

 Why are there so many codons?

* If codons only contained a combination of \_\_\_\_ nucleotides, mathematically there would not be \_\_\_\_\_\_\_\_\_\_\_\_ codons to signal for twenty different amino acids. To determine the amount of nucleotide combinations, you must know how many bases are \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and how many bases will be in a \_\_\_\_\_
* So, how many RNA bases are there?
* If there was only \_\_\_\_ base in a codon, you would raise the number of \_\_\_\_\_\_\_\_\_\_\_\_\_\_ bases to the 1st power

 41 =

* If there are \_\_\_\_ bases in a codon, you raise the number of available bases to the \_\_\_\_\_\_\_\_ power

 42 or 4 x 4 =

* How many different codons are possible if they contain three bases?

* So several different codons code for the \_\_\_\_\_\_\_ amino acid, but each codon only codes for \_\_\_\_\_ specific amino acid

**Translation**

* Translation occurs when the three types of RNA work \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to assemble a protein
* Recall that a ribosome consists of \_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. It also consists of \_\_\_\_\_subunits



* The ribosome will read the codons in \_\_\_\_\_\_ as it passes between the

 two subunits

* The ribosome also contains two different\_\_\_\_\_\_\_, labeled \_\_\_\_and \_\_\_\_

 which hold\_\_\_\_\_\_\_\_\_\_\_\_ RNA molecules

* **Recall that tRNA** molecules are single strands of RNA that \_\_\_\_\_\_\_



up on themselves

* One side of tRNA has an \_\_\_\_\_\_\_\_\_\_\_\_\_\_ site that temporarily

carries a specific \_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_

* The other end contains an \_\_\_\_\_\_\_\_\_\_\_\_\_, which is

a series of three nucleotides that will base pair with codons on \_\_\_\_\_\_\_

**Steps of Translation**

****

**Step 4** The tRNA in the P site \_\_\_\_\_\_\_\_\_\_\_ and leaves its amino acid behind. Scientists have recently discovered that there is an additional site, the \_\_\_ site or \_\_\_\_\_\_\_ site, from which the tRNA molecules actually leave

**Step 5** The tRNA in the A site \_\_\_\_\_\_ to the P site and a \_\_\_\_\_\_\_ tRNA molecule brings in another amino acid. If the new codon in the A site reads CAG, what amino acid will it code for?

What tRNA anticodon will bind with it?

**Step 6** Another peptide \_\_\_\_\_\_\_ is formed between the two amino acids, and the tRNA in the \_\_\_\_\_ site detaches and leaves its amino acid behind.

**Step 7** The process is repeated until a \_\_\_\_\_\_\_\_ codon is reached. The ribosome complex falls \_\_\_\_\_\_\_\_\_\_ and the newly made protein is \_\_\_\_\_\_\_\_\_\_\_\_.

* With few exceptions, the genetic code is the \_\_\_\_\_\_\_ in all organisms
	+ For example, the codon GUC codes for the amino acid \_\_\_\_\_\_\_\_\_\_\_ in bacteria, birds, plants, and humans
	+ For this reason, the genetic code is often said to be \_\_\_\_\_\_\_\_\_\_\_\_\_\_
	+ From an evolutionary standpoint, it appears that all organisms share a \_\_\_\_\_\_\_\_\_\_\_\_\_ ancestor with a \_\_\_\_\_\_\_\_\_\_ genetic code
1. **Relate** the role of codons to the sequence of amino acids that results after translation.
2. **Outline** the major steps of translation.
3. **Discuss** the evolutionary significance of the genetic code.