**B-4.1 Compare DNA and RNA in terms of structure, nucleotides, and base pairs.**

**It is essential for students to understand** that *\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_* are organic molecules that serve as the blueprint for proteins and, through the action of proteins, for all cellular activity.

• There are \_\_\_\_\_\_\_\_ types of nucleic acids.

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_ ( )

2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_ ( )

• Both \_\_\_\_\_\_ and \_\_\_\_\_\_ are composed of small units called *nucleotides.* The nucleotides that compose nucleic acids have ***three*** parts:

1. A *nitrogenous base*

♦ \_\_\_\_\_\_\_ (C)

♦ \_\_\_\_\_\_\_ (G)

♦ \_\_\_\_\_\_\_ (A)

♦ \_\_\_\_\_\_\_ (T) (DNA only)

♦ \_\_\_\_\_\_\_ (U) (RNA only)

○2. A simple (pentose) *sugar*

♦ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (DNA only)

♦ \_\_\_\_\_\_\_\_\_\_ (RNA only)

3. A *\_\_\_\_\_\_\_\_\_\_\_\_ group*

The basic structure of the two molecules is different.

• \_\_\_\_\_\_\_\_\_ consists of two single chains which spiral around an imaginary axis to form a double helix with nitrogenous bases from each strand of DNA chemically bonded through the axis of the helix.

○ Bases that bond are called *complementary bases.*

♦ Guanine (G) - Cytosine (C).

♦ Thymine (T) - Adenine (A).

• RNA consists of a single chain of nucleotides with nitrogenous bases exposed along the side.

♦ Guanine (G) - Cytosine (C).

♦ Uracil (U) - Adenine (A).

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| **DNA**  | **RNA**  |
| Type of base composing nucleotides  | Cytosine (C) Adenine (A) Guanine (G) Thymine(T)  | Cytosine(C) Adenine (A) Guanine (G) Uracil (U)  |
| Type of sugar composing nucleotides  | deoxyribose  | ribose  |
| Molecule structure and shape  | Double helix  | Single chain  |

**Summarize the relationship among DNA, genes, and chromosomes.**

**It is essential for students to understand** that DNA, genes, and chromosomes compose the molecular basis of heredity.

• A *\_\_\_\_\_\_\_\_\_\_\_\_* is a structure in the nucleus of a cell consisting essentially of one long thread of DNA that is tightly coiled.

• *\_\_\_\_\_\_\_*, composed of nucleotides, provides the blueprint for the synthesis of proteins by the arrangement of nitrogenous bases.

○ The code for a particular amino acid (the base unit of proteins) is determined by a sequence of three base pairs on the DNA molecule.

• A *\_\_\_\_\_\_* is a specific location on a chromosome, consisting of a segment of DNA, that codes for a particular protein.

○ The particular proteins coded by the DNA on the genes determine the characteristics of an organism.

○ Each chromosome consists of hundreds of genes determining the many proteins for an individual organism.

**B-4.3 Explain how DNA functions as the code of life and the blueprint for proteins.**

 **DNA**, which comprises the organism’s chromosomes, is considered the “code of \_\_\_\_\_” (*genetic code*) because it contains the code for each protein.

○ A gene is a segment of DNA that codes for one particular \_\_\_\_\_\_\_\_\_\_.

• Each cell in an organism’s body contains a complete set of chromosomes.

○ The \_\_\_\_\_\_\_ of chromosomes varies with the type of organism. For example, humans have \_\_\_ pairs of chromosomes; dogs have 39 pairs; potatoes have 24 pairs.

○ One pair of chromosomes in an organism determines the sex (male, female) of the organism; these are known as *\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_* All other chromosomes are known as *\_\_\_\_\_\_\_\_\_\_\_\_*.

○ Cells (except for sex cells) contain one pair of each type of chromosome.

♦ Each pair consists of two chromosomes that have genes for the same proteins.

• Each chromosome consists of thousands of \_\_\_\_\_\_\_\_. This is because there are so many unique proteins that each organism needs to produce in order to live and survive.

○ Organisms that are \_\_\_\_\_\_\_ related may have genes that code for the same proteins that make the organisms similar. Ex. all maple trees have many of the same genes.

DNA can function as the code of life for protein synthesis or the process of DNA replication, which ensures that every new cell has \_\_\_\_\_\_\_\_\_\_\_ DNA.

• *DNA \_\_\_\_\_\_\_\_\_\_\_\_\_* is carried out by a series of enzymes. The first enzyme \_\_\_\_\_\_\_\_ the two strands of DNA that compose the \_\_\_\_\_\_\_\_\_ helix, separating paired bases.

**○ Adenine (A) can only bond to thymine (T)**

**○ Cytosine (C) can only bond to guanine (G)**

• The result is two identical DNA molecules.

**B-4.4 Summarize the basic processes involved in protein synthesis (including transcription and translation).**

**It is essential for students to understand** that when a particular protein is needed, the cell must make the protein through the process of *\_\_\_\_\_\_\_\_\_\_ synthesis.* DNA molecules (which contain the code) do not leave the nucleus of the cell, but protein \_\_\_\_\_\_\_\_\_\_ must occur in the \_\_\_\_\_\_\_\_\_\_\_ which are located outside of the nucleus in the cytoplasm. Therefore, the code must be carried from the nucleus to the cytoplasm.

***Transcription***

*\_\_\_\_\_\_\_\_\_\_\_\_\_\_* is the process by which a portion of the molecule of DNA is copied into a complementary strand of RNA.

• Through a series of chemical signals, the gene for a specific protein is turned on. An enzyme attaches to the exact location on the DNA molecule where the gene is found, causing the two strands of DNA to separate at that location.

|  |  |
| --- | --- |
| DNA nucleotide bases exposed on the separated strand  | RNA nucleotide which bonds  |
| Adenine (A)  | Uracil (U)  |
| Thymine (T)  | Adenine (A)  |
| Cytosine (C)  | Guanine (G)  |
| Guanine (G)  | Cytosine (C)  |

Nucleotides of RNA bond together, forming a single-stranded molecule of RNA that peels away from the DNA strand and the two DNA strands rejoin. This is called *\_\_\_\_\_\_\_\_\_\_\_\_\_ RNA* (*mRNA*).

• The mRNA strand leaves the nucleus and goes through the nuclear membrane into the cytoplasm of the cell.

***Translation***

*\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_* is the process of interpreting the genetic message and building the protein and begins when the mRNA attaches to a ribosome, which contains proteins and \_\_\_\_\_\_\_\_\_\_\_\_\_\_ *RNA (rRNA),* in the cytoplasm.

• Each three-base nucleotide sequence on the mRNA is called a *\_\_\_\_\_\_\_\_*.

o For example, if the DNA sequence was GAC, then the RNA sequence becomes CUG and the amino acid that is coded is Leucine.

• Another type of RNA, *\_\_\_\_\_\_\_\_\_\_\_ RNA (tRNA)*, is vital in assembling amino acids into the correct sequence for the required protein by transferring \_\_\_\_\_\_\_\_ acids to the ribosomes when needed. There are twenty different types of tRNA molecules, one for each amino acid.

○ At one end of each \_\_\_\_\_\_\_\_\_\_ is an *anticodon site*, which has the 3-nucleotide bases complementary to the codon of mRNA.

○ The other end of the tRNA molecule has a specific \_\_\_\_\_\_\_\_\_ acid attached determined by the anticodon.

• The translation process takes place as follows:

○ The tRNA with its attached amino acid pairs to the codon of the mRNA attached to a ribosome.

○ The ribosome forms a *\_\_\_\_\_\_\_\_\_\_ bond* between the amino acids, and an amino acid chain begins to form.

○ The empty tRNA moves off and picks up \_\_\_\_\_\_\_\_\_\_\_ matching amino acid from the cytoplasm in the cell.

○ This sequence is repeated until the ribosome reaches a *\_\_\_\_\_\_ codon* on the mRNA, which signals the end of protein synthesis.

