

GHSGT Review: Biology (Day 3)

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OBJECTIVE: Explains the structure of DNA and RNA and their role in protein synthesis

DNA

DNA is the genetic material of living things. It is contained in the nucleus of most organisms. DNA stands for **DeoxyriboNucleic Acid**. DNA contains three parts - nitrogen bases, a five carbon sugar, and a phosphate group. The nitrogen bases are called adenine, guanine, thymine, and cytosine. Each of these bases are attached to a sugar - deoxyribose, and a phosphate group. Each unit that includes a base, sugar, and phosphate is called a nucleotide.

DNA is shaped in a double-helix. A double-helix looks like a spiral staircase or a twisted ladder. The sides of the helix are the phosphate groups and sugar molecules and the rungs on the helix are the nitrogen-carrying bases. The bases pair up in a specific pattern. Adenine always pairs with thymine and guanine always pairs with cytosine.

To give you an idea of size, all 46 of the human chromosomes are composed of more than 5 billion nucleotides.

The pairs of nucleotides that appear on the helix can appear in any order. **The sequence of the nucleotides is the code that controls the production of all the proteins of an organism.** A gene is a sequence of nucleotides that controls the production of a polypeptide (large protein) or an RNA molecule.

RNA

If DNA is located in the nucleus and the synthesis of proteins takes place in the ribosomes located in the cytoplasm, then there must be a way for DNA to instruct the ribosomes in protein production without leaving the nucleus. RNA acts as a messenger between DNA and the ribosomes. RNA stands for **RiboNucleic Acid**.

RNA is similar to DNA in many respects, but differs in three important ways. The sugar in RNA is ribose, not deoxyribose. Also, uracil replaces thymine as a nitrogen base in RNA. Finally, RNA is usually a single strand unlike DNA's double-helix.

There are three types of RNA. Messenger RNA (mRNA) carries the sequence of nucleotides from the DNA in the nucleus to the ribosomes. Transfer RNA (tRNA) picks up individual amino acids and brings them to the ribosome. The amino acids are then joined together in proper order to form a protein. Ribosomal RNA (rRNA) is contained in the ribosome and helps to bind mRNA and tRNA together in one step of protein synthesis.

REPLICATION

Replication is the process in which DNA duplicates itself. Remember that each new cell gets a copy of the genetic code. DNA replicates before cell division. During replication several steps take place.

- a. Unzips - First, the chemical bonds between the nucleotides in the double-helix break and the double-helix splits into single strands.
- b. Attachment - Special enzymes bring the correct nitrogen base to pair with the complementary base on the strand. Other enzymes link the new nucleotides into one long strand. Each thymine pairs with an adenine. Also, each guanine pairs with cytosine.

Each completed DNA molecule contains one old strand and one new strand. ATP and the action of the enzymes power the entire process.

PROTEIN SYNTHESIS

Protein Synthesis is the process whereby DNA encodes for the production of amino acids and proteins. It consists of two steps: transcription and translation.

Transcription

Transcription is the process whereby mRNA is copied from DNA molecules. This process transfers the DNA code to molecules of mRNA. Several steps occur.

- a. Unzips - The DNA double-helix separates, exposing the two strands. One of these strands will serve as a template for mRNA.
- b. Attachment - mRNA nucleotides bind to their complementary pairs on the DNA. The DNA strand determines the sequence of mRNA pairs. The sequence of bases on the mRNA is a code for amino acids.
- c. Removal - Once the mRNA is made, it detaches from the DNA and the DNA reattaches to the other DNA strand to become a double-helix again.

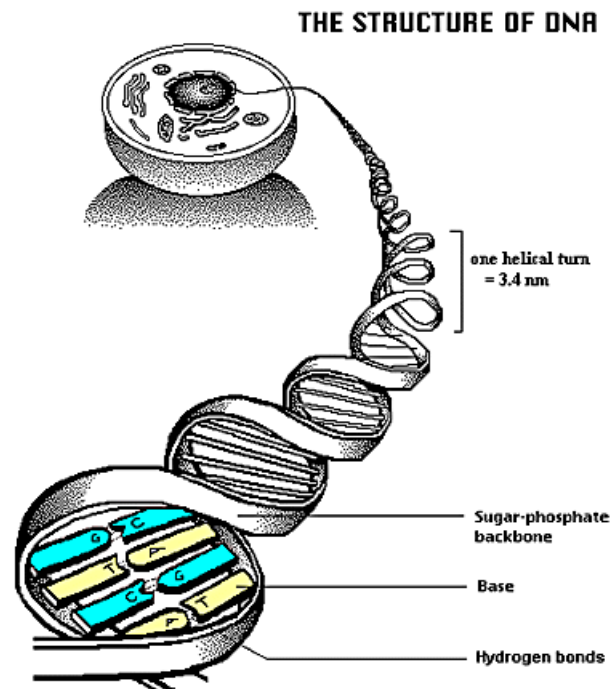
The code in the mRNA allows it to collect the right amino acids and assemble them in the correct sequence to synthesize a particular protein. Each code is a three letter word with a base standing as a letter. Each three letter code is called a codon.

Translation

The mRNA carries the codon information to the ribosome in the cytoplasm. Translation is the process where the ribosome attaches to mRNA and carries out the formation of a protein. Several ribosomes are involved in translation thus allowing one mRNA molecule to repeatedly produce a specific protein molecule.

The ribosome is made up of two parts. The smaller part attaches to the mRNA. The larger part contains an enzyme that helps to link amino acids together to form a protein. The tRNA brings specific amino acids to the ribosome to be joined to a forming protein strand. Each tRNA has an amino acid attached and an anticodon. The anticodon pairs with a codon on the mRNA and thus amino acids are added in proper sequence

OBJECTIVE: Describes the double-helix model.



The structure of DNA is illustrated by a right handed double helix, with about 10 nucleotide pairs per helical turn. Each spiral strand, composed of a sugar phosphate backbone and attached bases, is connected to a complementary strand by hydrogen bonding (non-covalent) between paired bases, adenine (A) with thymine (T) and guanine (G) with cytosine (C).

Adenine and thymine are connected by two hydrogen bonds (non-covalent) while guanine and cytosine are connected by three.

This structure was first described by James Watson and Francis Crick in 1953.

Practice Questions

1. A DNA nucleotide does not include a (A) five carbon sugar (B) phosphate group (C) double helix (D) nitrogen base
2. James Watson and Francis Crick (A) built a structural model of DNA (B) discovered DNA replication (C) used X-ray diffraction (D) discovered DNA
3. If the sequence of nucleotides on one strand of a DNA molecule is GCCATTG, the sequence on the complementary strand is (A) GGGTAAG (B) CCCTAAC (C) CGGTAAC (D) GCCATTC
4. RNA differs from DNA in that RNA (A) has the sugar deoxyribose (B) has the nitrogen base uracil (C) has a phosphate group (D) has nucleotides
5. The making of RNA based on the sequence of nucleotides in DNA is called (A) DNA replication (B) translation (C) transcription (D) gene regulation
6. A short chain of DNA has the nucleotide sequence ATA CCG. Its complementary mRNA nucleotide sequence is (A) TAT GCC (B) UAU GCC (C) TUT GCC (D) UAU GGC
7. The making of proteins from the information carried by the mRNA is called (A) DNA replication (B) translation (C) transcription (D) gene regulation

Answers:

1. C, 2. A, 3. C, 4. B, 5. C, 6. D, 7. B