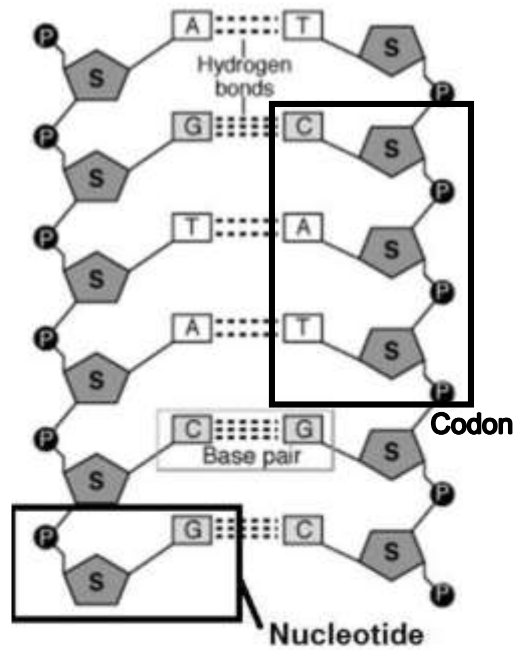
DNA & Proteins Unit Storyline

The world is home to a seemingly endless variety of life. Each organism has a unique combination of genes in their DNA. These genes code for the assembly of proteins. Proteins are primarily responsible for cell function and create the unique characteristics of each species and organism.

Structure & Function of DNA

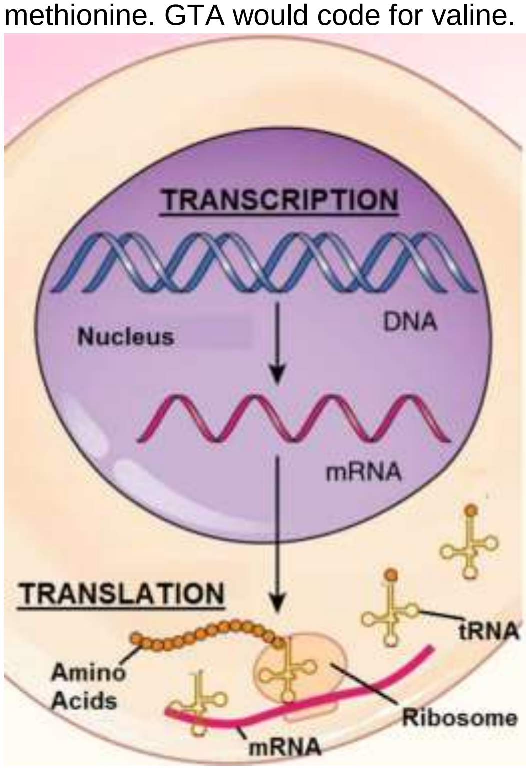
All species depend on DNA to provide the instructions for assembling their proteins. DNA in every species is made from the same three key molecules - a *phosphate*, a *sugar*, and a *base*. The phosphate and sugar molecules provide structure to DNA; the bases are what store the information needed to assemble proteins. A *nucleotide* is the basic building block of DNA and consists of a phosphate, sugar, and base molecule.



There are four kinds of bases in DNA - A, C, G, and T. Due to differences in size and bonding sites, there are only two possible combinations of these bases: A always binds to T, and G always binds to C. These are known as *complementary base pairs*. If an A is on one side of double-stranded DNA, a T is on the other side. If G is on one side, C is on the other. If one side of DNA has AGTACG, the other side of DNA would have TCATGC.

This makes it easy for a cell to duplicate its DNA. A cell splits the double-stranded DNA into two single strands using a protein called *helicase*; another protein, called *DNA polymerase*, then fills in the remaining sides to create two identical strands of DNA.

The order of bases in DNA determines the order of amino acids in a protein. All proteins are made from the same 20 amino acids. The order in which amino acids are assembled determines the type of protein created. Every combination of three bases (a *codon*) codes for a specific amino acid. For example, ATG codes for the amino acid methionine. GTA would code for valine.



Transcription & Translation

DNA must be protected in the nucleus of the cell. However, proteins are assembled outside of the nucleus in the cell's *ribosomes*. Cells use *RNA* to get the information in DNA to where the proteins are assembled. RNA is very similar to DNA. However, unlike DNA, RNA is 1) single stranded, 2) uses Uracil (U) instead of Thymine (T), and 3) has a slightly different sugar molecule.

RNA is central to two key processes: transcription and translation. *Transcription* is the process of producing an RNA copy of a gene. *Translation* when a protein is assembled using information from the RNA copy.

During transcription, the cell produces a copy of DNA called *mRNA* (or *messenger RNA*). RNA polymerase is the protein that produces this mRNA copy. A cell produces the mRNA copy in a similar manner as it would produce a DNA copy. If RNA polymerase sees GCG, it will add CGC to the mRNA. If RNA polymerase sees ATG, it will add UAC (*remember: what would be a T in DNA is a U in RNA*).

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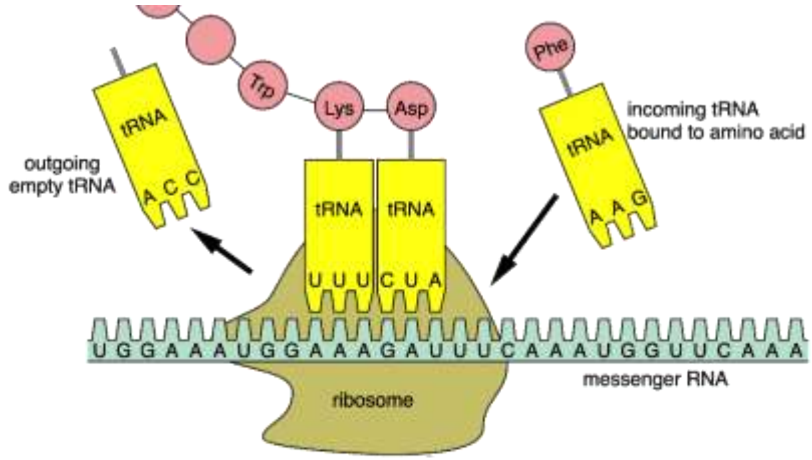
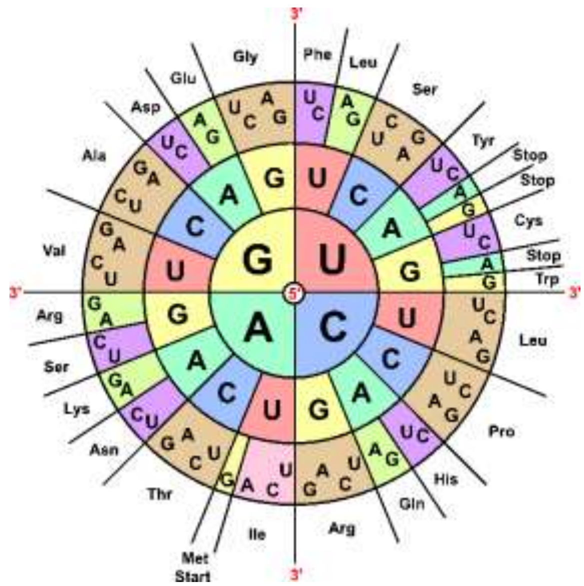
During translation, the mRNA copy leaves the nucleus and moves to a ribosome (where proteins are assembled). The mRNA copy moves through the ribosome one codon (3 bases) at a time. *tRNA* (or *transfer RNA*) delivers amino acids to the ribosome based on the information copied in mRNA.



Each codon in mRNA codes for a specific amino acid. This is shown in the circular table below. The tRNA carrying the needed amino acid will have a codon that is complementary to the codon in mRNA. For example, if the next codon in mRNA is CCC, the only tRNA that can bind to it is one with the codon GGG. This tRNA will deliver the next amino acid needed to assemble the protein. This ensures that amino acids are assembled in the correct order to make the protein.



Summary

In summary, transcription is the process of making the mRNA copy of a gene. Translation is the process of assembling a protein using the mRNA copy. Transcription and translation are sort of like using a recipe. Transcription is like making a copy of a cherished family recipe (to avoid damage to the original recipe, you need to use a copy). Translation is equivalent to using the copied recipe to combine ingredients in the correct order.

<u>Unit Vocabulary</u>:

<u>Base</u>: a part of a nucleotide that stores information; there are four bases in DNA: A, T, C, and G.
<u>Codon</u>: a group of three bases in DNA that codes for a specific amino acid.
<u>Complementary Base Pairs</u>: the only possible combinations of DNA bases. A pairs with T; G pairs with C.
<u>DNA Polymerase</u>: the protein that makes duplicate copies of DNA.
<u>DNA</u>: a macromolecule made from nucleotides that stores information about how to assemble proteins.
<u>Helicase</u>: the protein that separates the two DNA strands prior to making a duplicate copy of DNA.
<u>mRNA</u>: acts as a copy of a gene and delivers information to a ribosome needed for protein assembly; short for *messenger RNA.*
<u>Nucleotide</u>: the molecules used to make DNA and RNA; consists of a phosphate, sugar, and base molecule.
<u>Phosphate</u>: a part of a nucleotide that provides structure to DNA by holding sugar molecules in place.
<u>Ribosomes</u>: molecular structures that assemble proteins from amino acids; made from *ribosomal RNA* (rRNA).
<u>RNA polymerase</u>: the enzyme that creates the mRNA copy.
<u>RNA</u>: a single-stranded macromolecule made from nucleotides that serves as a link between the information stored in DNA and the assembly of proteins.
<u>Sugar (deoxyribose in DNA; ribose in RNA)</u>: a part of a nucleotide that holds bases in place.
<u>Transcription</u>: the process of producing a mRNA copy of a gene in the DNA.
<u>Translation</u>: process of assembling a protein from amino acids delivered to the ribosomes by tRNA based on the information in the mRNA copy.
<u>tRNA</u>: delivers amino acids to the ribosome based on info in mRNA; short for *transfer RNA.*

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