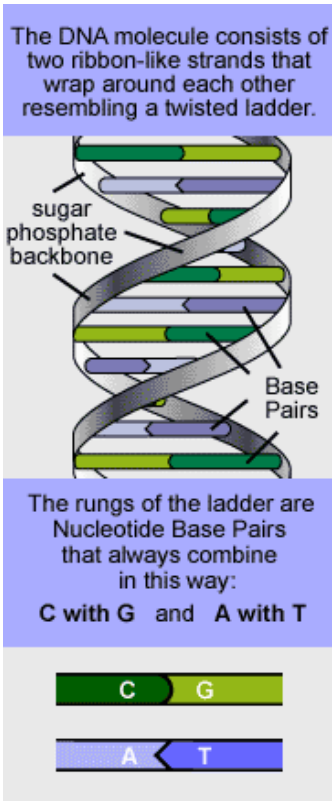
DNA Structure & Function Lab



In today's lab you will study the two functions of DNA, replication and protein synthesis (expression). Replication of DNA occurs during the S phase of interphase and is required before cells can undergo either mitosis or meiosis. The processes of mitosis and meiosis can be modeled to illustrate the behavior of DNA (chromosomes) during cell division. The process of mitosis, which occurs during growth and repair of tissues results in the production of daughter cells that are diploid and identical the parent cell. The process of meiosis occurs in the gonads (ovaries & testes) exclusively for the production of gametes (eggs & sperm) and results in cells that are haploid and not identical to the parent cell.

The primary day-to-day function of DNA in our cells is to code for the production of the proteins that cells need to function. Proteins, in turn, do all the work in the cell. This includes catalyzing the synthesis of the other macromolecules needed by the cell, the carbohydrates, lipids and even the nucleic acids. The ability of DNA molecules to function in this way is a direct result of their structure and propensity towards complimentary base-pairing. In today's lab, we will observe the structure of DNA and model protein synthesis.

The Structure of DNA

The phenotype of each person is directed by the DNA they inherit from their parents. DNA is a double-stranded molecule resembling a twisted ladder. Each strand is composed of a long chain of molecules called nucleotides. Each nucleotide has three parts: A five carbon sugar (deoxyribose in DNA & ribose in RNA), a phosphate group and a nitrogenous base. The bases are: Adenine, Guanine, Cytosine, Thymine (in DNA only) and Uracil (in RNA only).

Each side of the ladder consists of a chain of phosphate and sugar molecules, and the rungs are made of two bases held together by hydrogen bonds. The bases are always paired in a complimentary fashion. A-T and C-G.

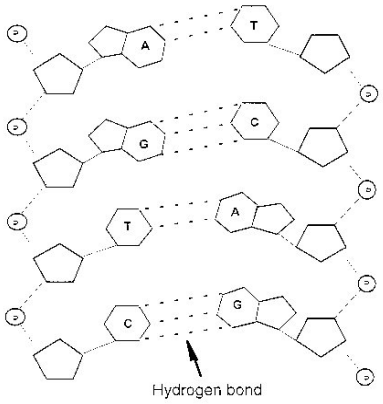
1. Observe the models of the DNA double helix. Familiarize yourself with the complimentary nature of the base-pairing.

2. Consider a single strand of DNA with the bases in the following order: TACCTGATCGTGGGTACGTAT

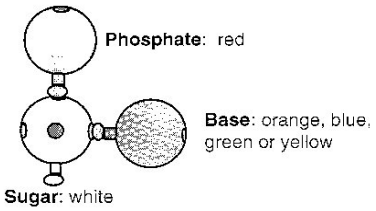
3. Draw a diagram of this strand using the example below as a guide. Used colored pencils to color your strand as directed in the example below.

Sugar (deoxyribose):	**white**	**P**hosphate:	**red**
Adenine:	**orange**	**T**hymine:	**yellow**
Cytosine:	**blue**	**G**uanine:	**green**

DNA Molecule



DNA Nucleotide



Create your drawing here:

Questions:

1. What is meant by complimentary base pairing?

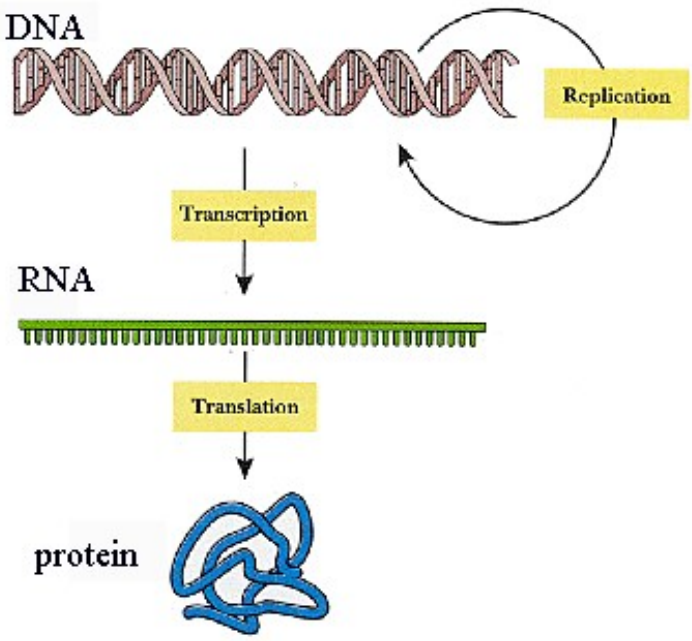
2. What is a gene?

3. Each cell in a living organism contains the same DNA. Using yourself as an example, explain how this happens.

4. If an error occurred during DNA replication in one of your cells, could your child inherit this error? How? Explain.

5. What is a mutation? A mutagen? Why is it said that mutation is the source of all diversity? Explain.

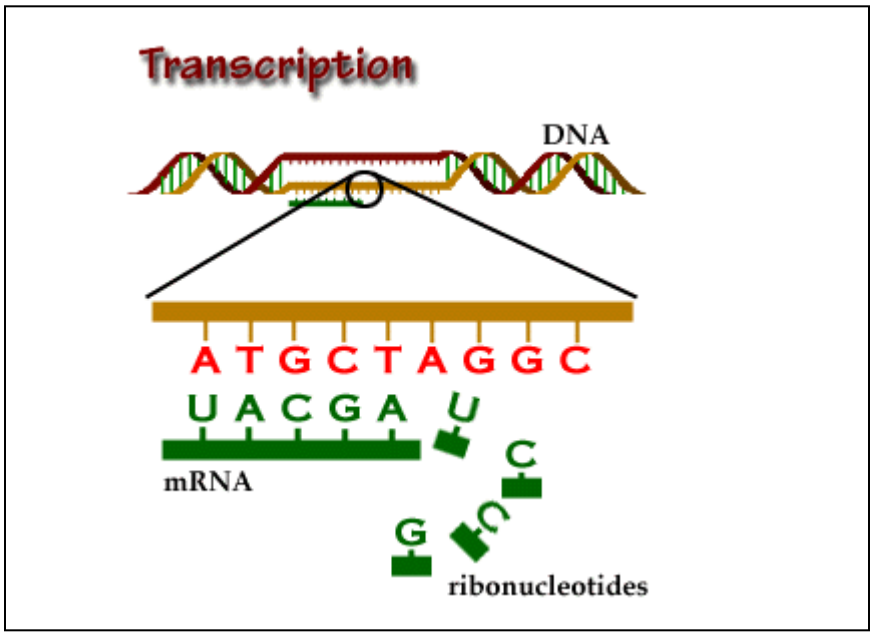
Gene Expression



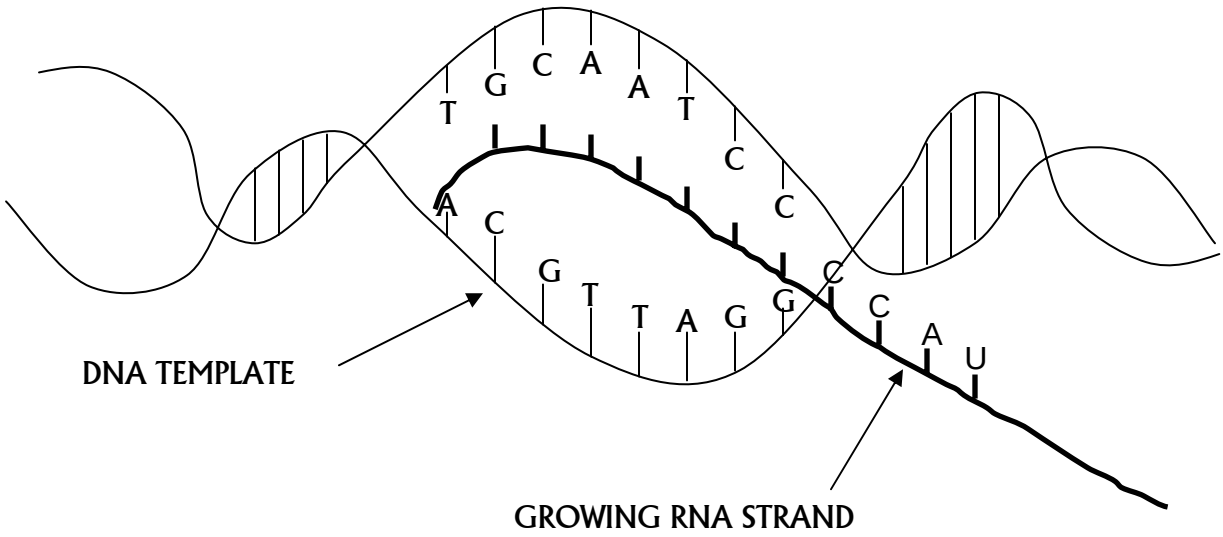
Gene Expression can be summarized as transcription and translation.

Transcription:

DNA serves as a template for making RNA. RNA carries the instructions fro making a protein. DNA cannot leave the nucleus of a cell, but RNA can and does. RNA must leave the nucleus and go into the cytoplasm of the cell because that is where the ribosomes are present so that protein synthesis can take place.



RNA is somewhat different from DNA in structure. The sugar in RNA's backbone is ribose, the base Thymine is replaced by Uracil and RNA molecules are single-stranded. Otherwise they are similar to DNA. The nucleotide bases in mRNA are complimentary to the nucleotide bases in DNA. In mRNA sequences of 3 nucleotide bases serve as codes for single amino acids and are called codons. The strands of mRNA are formed by a process called transcription. The mRNA then leaves the cell nucleus and enters the cell cytoplasm in order to complete the process of translation. Complete the following drawing of transcription by writing the correct letters in the newly created RNA strand.



Questions:

1. What is a codon? What is an anticodon? For each describe what is it's purpose, structure and where it is found.

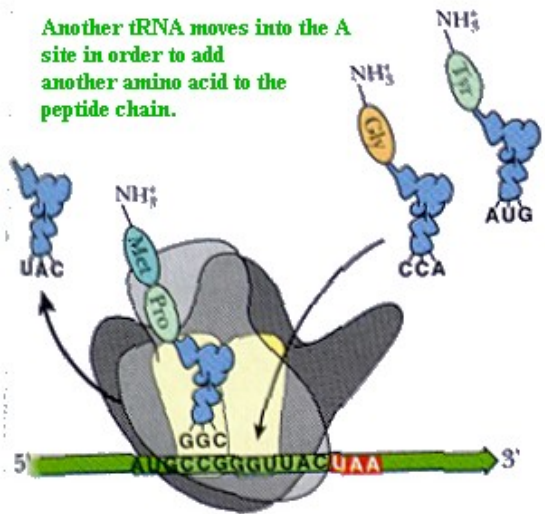
2. Explain how DNA and RNA are different in the following ways:

a. Physically (structure) -

b. Purpose/functionality-

Translation:

RNA exists in three different forms: messenger RNA (mRNA), ribosomal RNA (rRNA) and transfer RNA (tRNA). These three types of RNA work together to synthesize proteins. This process is called translation.



When an mRNA strand leaves the nucleus and enters the cytoplasm, it will become attached to a ribosome (either on the rough ER or free-floating in the cytoplasm). This forms a "landing-site" for the tRNA molecules to begin bringing amino acids to the site of protein synthesis. The tRNA molecules have

sequences called anti-codons which are complimentary to the codons of the mRNA strands. These match up so that the correct amino acids are placed in order in the growing protein. The amino acids are bound to each other and the protein grows until a stop codon is reached.

Questions:

1. What is an amino acid?

2. What are the three types of RNA and what are their functions?

3. Based on what you've learned previously in biology class, explain how the process of transcription and translation must be different in prokaryotes vs. eukaryotes.

Gene Expression Exercise

1. Use the card provided by your instructor to construct a DNA strand out of pop-beads according to the color scheme on page 2. This will be your "gene" and will represent coding strand of a double-stranded segment of DNA.

Write down the sequence and number on your card below:

Card #_____
Sequence on card_____

2. Give YOUR ORIGINAL STRAND to the lab group to your right. You will receive a **DNA strand** from the lab group to your left.

3. Use the first spaces below to write down the DNA template sequence you received.

4. Complete the activity by "reading" the DNA sequence and then complete **transcription** by writing down the mRNA sequence on the line below. Complete **translation** of your mRNA sequence by writing the amino acid sequence on the lines below. When you have a finished protein (a.a. sequence) come up to the front desk and find your protein. If you do not find a match, you have a mutation…go back and try again!!!

Protein #1

DNA Template

_____/_____/_____/_____/_____/_____

mRNA Strand

_____/_____/_____/_____/_____/_____

Amino Acid Sequence

_____-_____-_____-_____-_____-_____

Protein #2

DNA Template

_____/_____/_____/_____/_____/_____

mRNA Strand

_____/_____/_____/_____/_____/_____

Amino Acid Sequence

_____-_____-_____-_____-_____-_____

Protein #3

DNA Template

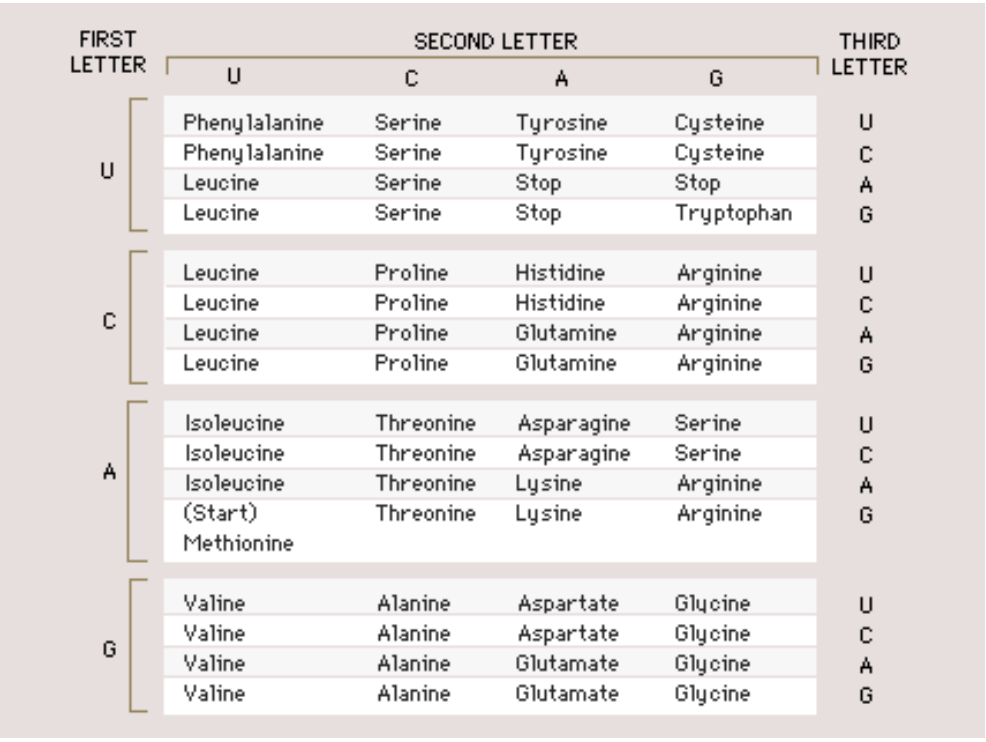
_____/_____/_____/_____/_____/_____

mRNA Strand

_____/_____/_____/_____/_____/_____

Amino Acid Sequence

_____-_____-_____-_____-_____-_____



FIRST LETTER	SECOND LETTER U	SECOND LETTER C	SECOND LETTER A	SECOND LETTER G	THIRD LETTER
U	Phenylalanine	Serine	Tyrosine	Cysteine	U
	Phenylalanine	Serine	Tyrosine	Cysteine	C
	Leucine	Serine	Stop	Stop	A
	Leucine	Serine	Stop	Tryptophan	G
C	Leucine	Proline	Histidine	Arginine	U
	Leucine	Proline	Histidine	Arginine	C
	Leucine	Proline	Glutamine	Arginine	A
	Leucine	Proline	Glutamine	Arginine	G
A	Isoleucine	Threonine	Asparagine	Serine	U
	Isoleucine	Threonine	Asparagine	Serine	C
	Isoleucine	Threonine	Lysine	Arginine	A
	(Start) Methionine	Threonine	Lysine	Arginine	G
G	Valine	Alanine	Aspartate	Glycine	U
	Valine	Alanine	Aspartate	Glycine	C
	Valine	Alanine	Glutamate	Glycine	A
	Valine	Alanine	Glutamate	Glycine	G