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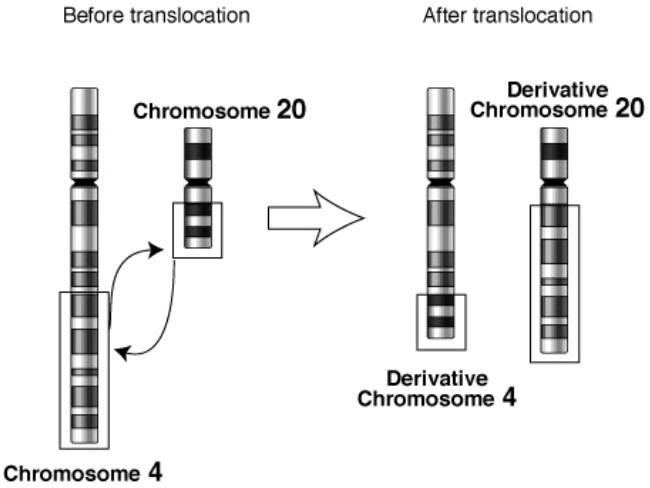
LG #13: How Does a DNA Sequence Become a Physical Feature?
"What's the Point?"
Worksheet

"What's the Point?" --- Point, Frameshift, Inversion, & Deletion Mutations



http://members.cox.net/amgough/mutation_chromosome_translocation.gif

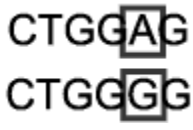
Introduction:

In biology, **mutations** are changes to the **base pair sequence** of the genetic material of an organism. Mutations can be caused by copying errors in the genetic material during cell division, by exposure to ultraviolet or ionizing radiation, chemical mutagens, or viruses. In multicellular organisms, mutations can be subdivided into **germ line mutations**, which can be passed on to descendants, and **somatic mutations**, which cannot be transmitted to descendants in animals.

Proteins are made of **amino acids** that are strung together in a chain. Each three-letter DNA sequence, or **codon**, encodes a **specific amino acid**. If a change in the DNA sequence occurs, the **instructions for making the proteins will be changed** producing a mutation.

Types of Mutations:

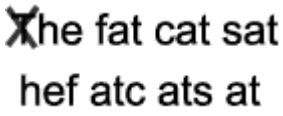
1. **Substitution Mutation:**
   A substitution is a mutation that **exchanges one base for another** (i.e., a change in a single "chemical letter" such as switching an A to a G).



2. **Insertion Mutation:**
   Insertions are mutations in which **extra base pairs are inserted** into a new place in the DNA.

3. **Deletion Mutation:**
   Deletions are mutations in which a **section of DNA is lost**, or deleted.

4. **Frameshift Mutation:**
   Since protein-coding DNA is divided into codons three bases long, **insertions and deletions can alter** a gene so that its message is no longer correctly read and translated. These changes are called frameshifts.



Objective:

Students will use DNA sequences and corresponding paper templates of mRNA strands to show various mutations and the effect that changing these genes has on the construction of the amino acid sequence of proteins.

Materials:

- DNA strand template
- mRNA strand template
- Scissors
- Tape
- Crayons or colored pencils
- Small paper clips
- Computer with Internet Access

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Procedure – DNA Sequence & Proteins:

Gene 1 (DNA) – Color RED

DNA	T	A	C	G	G	C	A	A	T	C	T	G	T	T	T	
mRNA																

Gene 2 (DNA) – Color BLUE

DNA	G	G	G	C	C	C	T	A	T	T	A	A	G	C	A	
mRNA																

Gene 3 (DNA) – Color GREEN

DNA	A	C	G	G	A	C	T	A	G	C	T	G	G	A	T	
mRNA																

Gene 4 (DNA) – Color YELLOW

DNA	T	T	C	C	G	C	G	G	T	T	G	A	G	G	T	
mRAN																

Gene 5 (DNA) – Color VIOLET

DNA	C	T	G	C	A	T	C	G	G	C	G	C	A	T	T	
mRNA																

1. Color code the five genes on Template 1 as follows: Gene 1 – red, Gene 2 – blue, Gene 3 – green, Gene 4 – yellow, and Gene 5 – violet.

2. Cut out the 5 genes and tape them together in order, 1 – 5, to assemble a chromosome with its DNA base sequence. This is your **DNA template.**

3. Record the sequence of the DNA bases for each gene in Table 1.

Table 1: DNA, mRNA, and Protein Code

Gene 1

DNA Template															
mRNA Strand															
Protein Code															

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Gene 2

DNA Template															
mRNA Strand															
Protein Code															

Gene 3

DNA Template															
mRNA Strand															
Protein Code															

Gene 4

DNA Template															
mRNA Strand															
Protein Code															

Gene 5

DNA Template															
mRNA Strand															
Protein Code															

After each base is written on the mRNA genes, color code them as you did for the DNA genes; Gene 1 – red, Gene 2 – blue, Gene 3 – green, Gene 4 – yellow, and Gene 5 – violet.

*****C-G A-T NO T**hymine **in mRNA, use U**racil **instead…A-U*****

4. Do **NOT** tape these 5 mRNA genes together. Instead, join them together in the correct order (1 – 5) with **small paper clips** so mutations can be made. This is your **mRNA template**.

5. Record the sequence of the mRNA bases for each gene in Table 1.

6. **Ribosomes** read the bases on mRNA three at a time (called a **codon**) to assemble **amino acids**. Use the **codon table** to make a list of the correct sequence of amino acids that the ribosome would assemble when it reads the mRNA template strand. Record this amino acid sequence in Table 1.

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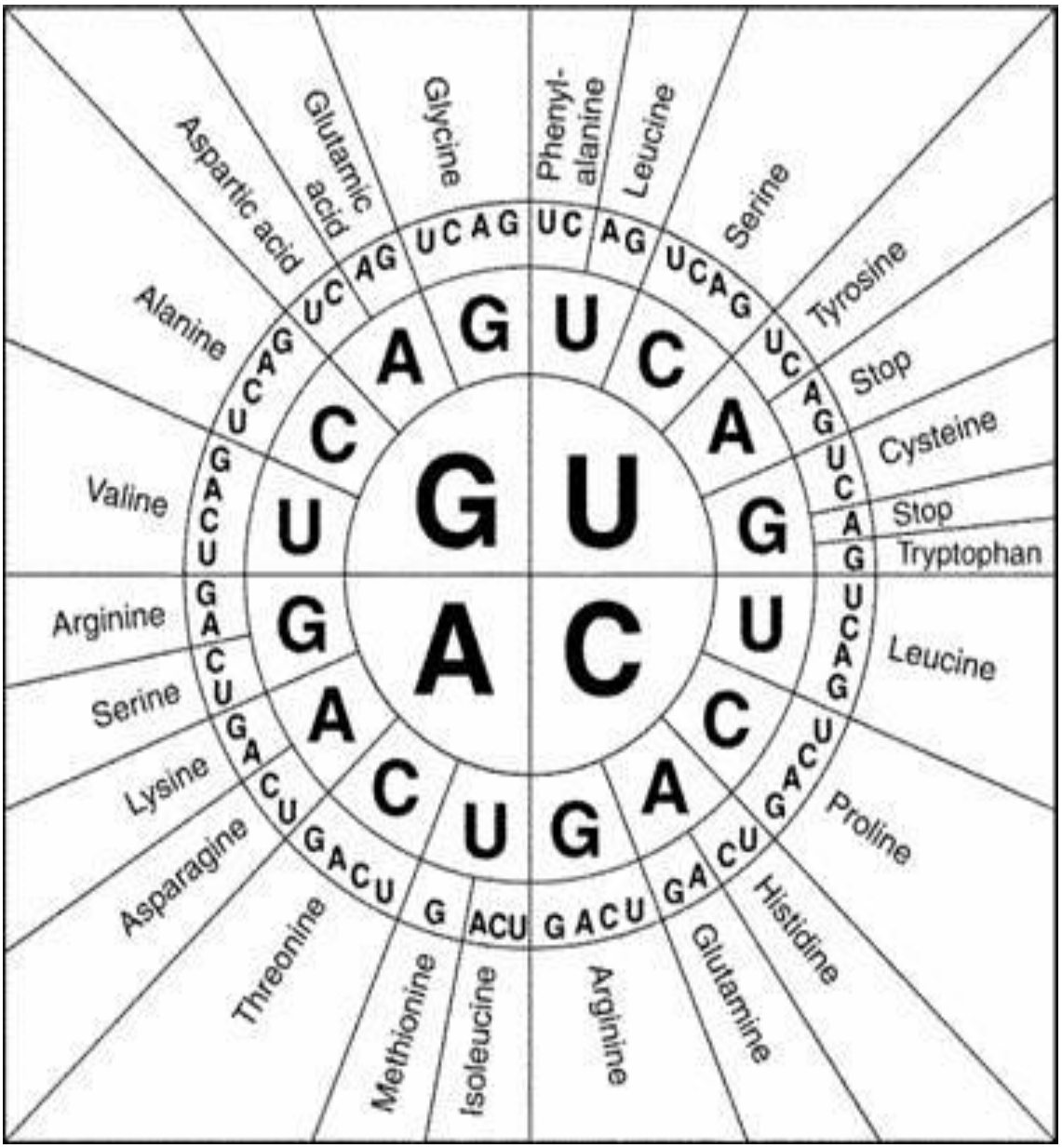
mRNA Codon Table



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Questions:

1. How many genes made up your DNA strand?

2. How many polypeptides would this DNA template code for?

Using the following four codons, answer these questions.

TAC GGT AAC CAT

3. What is the mRNA transcript sequence?

4. What is the complementary DNA strand sequence?

5. If the 3rd DNA base is deleted, what is the new mRNA sequence?

6. If the base adenine is inserted in the 7th position on the DNA strand, what is the new mRNA sequence?

7. What is the amino acid sequence coded for by the original DNA strand?

8. What is the amino acid sequence after the deletion occurred?

9. What is the amino acid sequence after the insertion occurred?

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The nucleotide sequence for the left template strand of human hemoglobin is ---

TAA TGT CGA CCG CTG GTC CAA GTC CTT TGA

10. Write the nucleotide sequence for the complementary DNA strand.

11. What would be the mRNA transcript sequence? What is the amino acid sequence?

12. If the last two codons are inverted (written backwards) on DNA, what is the new mRNA sequence and amino acid sequence?