

Advisement Teacher & Room # _____

Student Name _____ Tutor: _____

Biology Tutorial #15

Biology Teacher's Name _____ Period _____

CA State Standard 4c - Students know how mutations in the DNA sequence of a gene may or may not affect the expression of the gene or the sequence of amino acids in the encoded protein.

A mutation is any permanent change to the sequence of nucleotides in an organism's DNA. Some mutations can cause changes in a protein. Other mutations do not affect the amino acid sequence in a protein.

Types of Mutations

The DNA sequence can be changed in many different ways, from single nucleotide substitutions to large movements of parts of chromosomes.

- **Point mutations** are caused when one nucleotide is substituted for another. When these mutations occur during DNA replication, they are usually caught and corrected by DNA polymerase. If they are not caught, the daughter cells and the daughter cells of those cells, and so on will inherit the mutation.
- **Frameshift mutations** are caused by insertions or deletions of nucleotides in DNA. The mutation shifts the sequence of codons that follows by one or more nucleotides.
- **Gene duplication** is a chromosomal mutation caused by errors in crossing over during meiosis. If homologous chromosomes do not align with each other, crossing over may exchange segments of unequal length. When this happens, one chromosome will have duplicate copies of the same gene and the other will not have the gene.
- **Translocation** is a chromosomal mutation caused when two non-homologous chromosomes exchange segments of DNA during meiosis. Each chromosome gets a set of genes that did not previously exist on that chromosome.

Effects of Mutations

Many mutations within a gene do not affect an organism's phenotype because most amino acids are **represented by more than one specific codon**. For example, four different codons (GUU, GUC, GUA, GUG) all code for the amino acid valine. Suppose the genetic code for a protein included the sequence GUC, and a mutation changed the C to A (GUA). Even though the genetic code is changed, the amino acid sequence of the protein it produces is the same, because both GUC and GUA code for the same amino acid.

Not all nucleotide sequences in a gene code for amino acids in proteins; mutations in these areas will not change the amino acids in a protein. However, some of these non-coding sequences are important for regulating gene expression. So mutations could cause changes in amounts of protein being made or affect whether a gene is or is not transcribed.

Mutations can sometimes improve a protein's function (these are beneficial mutations), but this is not often the case. Mutations can also decrease or destroy a protein's function (these are harmful mutations). Human diseases such as sickle cell anemia and Tay-Sachs disease are the result of harmful mutations.

In which cells can Mutations occur?

Mutations can occur in the DNA of any cell. Mutations are only **passed to offspring if they occur in the organism's gametes**. These mutations are the underlying source of genetic variation among organisms. However, mutations **in body cells affect only that organism**. They can lead to cellular changes and in some cases may give rise to cancer.

Fill-in-the-blanks:

1. _____ are caused when one nucleotide is substituted for another.
2. _____ is a chromosomal mutation caused when two non-homologous chromosomes exchange segments of DNA during meiosis

- _____ is a chromosomal mutation caused by errors in crossing over during meiosis.
- _____ are caused by insertions or deletions of nucleotides in DNA.
- A dairy cow is exposed to radiation that changes the DNA sequence for a milk protein in her milk-producing cells. It is not possible for the cow to
 - continue to make a milk protein.
 - produce milk for its offspring.
 - make a milk protein that functions better than the normal version.
 - pass these mutations on to offspring through its gametes.
- Suppose a gene in a plant leaf cell undergoes a mutation. In the original gene, the nucleotide sequence was GCCTATCCA, The mutated sequence is GCCATCCA. This new sequence will *most* likely
 - cause the production of an incorrect protein.
 - give the plant an advantage over other plants in its environment.
 - be passed on to its offspring.
 - kill the plant before the mutation is passed on to its offspring.
- Suppose a particular gene has four codons. If one of the bases in the sequence is replaced by a different one, how many codons will be affected by this mutation?
 - one
 - two
 - three
 - four
- Why do some mutations not affect the amino acid sequence of a protein?
 - Many amino acids are coded for by more than one codon.
 - Many ribosomes will recognize mutations and not translate them.
 - Many cells can produce the correct proteins out of habit.
 - Many mutations are ignored during translation.

USE THE CHART OF GENETIC CODES TO ANSWER THE FOLLOWING:

9. Original sequence: **AUG AGA CGC UAC**

What would the amino acid sequence of the protein be?

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10. Substitution 1: **AUG AGG CGC UAC**

What would the NEW amino acid sequence of the protein be? How does this sequence differ from the original?

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11. Substitution 2: **AUG AGC CGC UAC**

What would the NEW amino acid sequence of the protein be? How does this sequence differ from the original?

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		Second base letter				
		U	C	A	G	
First base letter	U	Phe Phe Leu Leu	Ser Ser Ser Ser	Tyr Tyr Stop Stop	Cys Cys Stop Trp	U C A G
	C	Leu Leu Leu Leu	Pro Pro Pro Pro	His His Gin Gin	Arg Arg Arg Arg	U C A G
	A	Ile Ile Ile Met	Thr Thr Thr Thr	Asn Asn Lys Lys	Ser Ser Arg Arg	U C A G
	G	Val Val Val Val	Ala Ala Ala Ala	Asp Asp Glu Glu	Gly Gly Gly Gly	U C A G
						Third base letter