

DNA Mutation Worksheet

A mutation is a permanent change of the nucleotide sequence of the genome of an organism, virus, or extra chromosomal DNA or other genetic elements. Only gamete cells (sperm & eggs) will pass on mutations. Mutations are a common natural process occurring in DNA sequences.

Think of mutations as “typos” in the DNA code. These “typos” happen about every 100,000 nucleotides. When a human cell is copied and transmitted the exact same sequence of 3 billion nucleotides to its daughter cells. This means there are about 120,000 errors in an average human cell each time it divides.

Three ways DNA can be altered when a mutation (change in DNA sequence) occurs.

1. Point Mutation or Substitution — mutation causing replacement of a single base nucleotide with another nucleotide of the genetic material, DNA or RNA. In other words, one base-pair is replaced by another.

- If a substitution changes the amino acid, it's called a **missense** mutation.
- If a substitution does not change the amino acid, it's called a **SILENT** mutation.
- If a substitution changes the amino acid to a “stop,” it's called a **NONSENSE** mutation.

G → C or A → G CGTC

2. Insertion — One or more base pairs is added to a sequence.

DNA: CGA TGG → CGA **ATG** G

mRNA: GCT ACC → GCT **TAC** C

3. Deletion — one or more base pairs is lost from a sequence

DNA: CGA TGG → CAT GG

mRNA: GCT ACC → GTA CC

There are five possible results

1. Silent mutations — When a base pair is substituted but the change still codes for the same amino acid in the sequence.

TCT and TCC both code for the same amino acid, Serine

2. Substitution — When a base is substituted and the new codon codes for a different amino acid.

TCT codes for Serine and CCT codes for Proline

3. Premature Stop — When a substitution results in the formation of a STOP codon before all of the codons have been read and translated by the ribosome.

DNA: GTG GTC CGA AAC ACC → GTG GTC **TGA** AAC ACC

mRNA: GUG GUC CGA AAC ACC → GUG GUC **UGA** AAC ACC

Val-Val-Pro-Asn-Thr → Val-Val-**STOP**

4. Codon Deletion or Insertion — When a whole new amino acid is added or one is missing from the mutant protein.

DNA: GTG GTC CGA AAC ACC → GTG GTC **TGC** CGA AAC ACC

mRNA: GUG GUC CGA AAC ACC → GUG GUC **UGC** CGA AAC ACC

Val-Val-Pro-Asn-Thr → Val-Val-**Cys**-Pro-Asn-Thr

5. Frame Shift — When a deletion or insertion results in a different base pair being the beginning of the next codon, shifting it over, changing the whole sequence of amino acids. Meaning the reading “frame” changes, changing the amino acid sequence.

DNA: GTG GTC CGA AAC ACC → GTG GTC **GAA ACA CCT**

mRNA: GUG GUC CGA AAC ACC → GUG GUC **GAA ACA CCT**

Val-Val-Pro-Asn-Thr → Val-Val-**Glu-Thr-Pro**

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DNA Mutations Practice

Adapted from Jennifer Bush, Deer Creek High School

Directions: Transcribe and translate the original DNA sequence. Then, do the same for each mutated DNA sequence. Then, determine the consequence, if any, for each mutation, by circling your choice for each question. **You will need a Genetic Code Chart.**

Original DNA sequence:	TAC	ACC	TTG	GCG	ACG	ACT
mRNA transcript:						
amino acids:						

Mutated DNA Sequence #1:	TAC	ATC	TTG	GCG	ACG	ACT
mRNA transcript: (Circle any changes)						
amino acids:						

Type of mutation (Circle one.)	Point ⇒ Substitution			Frameshift ⇒ Insertion or Deletion		
How did the mutation affect the amino acid sequence (protein)? (Circle one.)	No change	1 amino acid changed	Premature stop signal	No stop signal	1 amino acid added/ deleted	All the amino acids changed after the point of mutation

Mutated DNA Sequence #2:	TAC	GAC	CTT	GGC	GAC	GAC	T
mRNA transcript: (Circle any changes)							
amino acids:							

Type of mutation (Circle one.)	Point ⇒ Substitution			Frameshift ⇒ Insertion or Deletion		
How did the mutation affect the amino acid sequence (protein)? (Circle one.)	No change	1 amino acid changed	Premature stop signal	No stop signal	1 amino acid added/ deleted	All the amino acids changed after the point of mutation

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Mutated DNA Sequence #3:	TAC	ACC	TTA	GCG	ACG	ACT
mRNA transcript: (Circle any changes)						
amino acids:						

Type of mutation (Circle one.)	Point ⇒	Substitution		Frameshift ⇒	Insertion	or	Deletion
How did the mutation affect the amino acid sequence (protein)? (Circle one.)	No change	1 amino acid changed	Premature stop signal	No stop signal	1 amino acid added/ deleted	All the amino acids changed after the point of mutation	

Mutated DNA sequence #4:	TAC	ACC	TTG	GCG	ACT	ACT
mRNA transcript: (Circle any changes)						
amino acids:						

Type of mutation (Circle one.)	Point ⇒	Substitution		Frameshift ⇒	Insertion	or	Deletion
How did the mutation affect the amino acid sequence (protein)? (Circle one.)	No change	1 amino acid changed	Premature stop signal	No stop signal	1 amino acid added/ deleted	All the amino acids changed after the point of mutation	

Mutated DNA sequence #5:	TAC	ACC	TTG	GGA	CGA	CT
mRNA transcript: (Circle any changes)						
amino acids:						

Type of mutation (Circle one.)	Point ⇒	Substitution		Frameshift ⇒	Insertion	or	Deletion
How did the mutation affect the amino acid sequence (protein)? (Circle one.)	No change	1 amino acid changed	Premature stop signal	No stop signal	1 amino acid added/ deleted	All the amino acids changed after the point of mutation	

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Conclusions

1. Which type of mutation is responsible for new variations (alleles) of a trait?
2. Which type of mutation results in abnormal amino acid sequence?
3. Which type of mutation stops the translation of the mRNA?
2. A geneticist found that a particular mutation had no effect on the protein coded by a gene. What do you think is the most likely type of mutation in this gene? Why?
4. Examine your genetic code chart. Name one amino acid that has more than one codon. Name an amino acid that has only one codon.
5. Look at the following sequence: THE FAT CAT ATE THE RAT. Delete the first H and regroup the letters in groups of three- write out the new groups of three. Does the sentence still make sense? What type of mutation is this an example of?
6. Given the following three mRNA sequences, determine which two code for the same protein. Circle them.

	mRNA #1	mRNA #2	mRNA #3
Transcript	AGU UUA GCA ACG AGA UCA	UCG CUA GCG ACC AGU UCA	AGC CUC GCC ACU CGU AGU
Translate			

Bonus: You have a DNA sequence that codes for a protein and is 105 nucleotides long. A frameshift mutation occurs at the 85th base - how many amino acids will be correct in this protein? **Show your work.**