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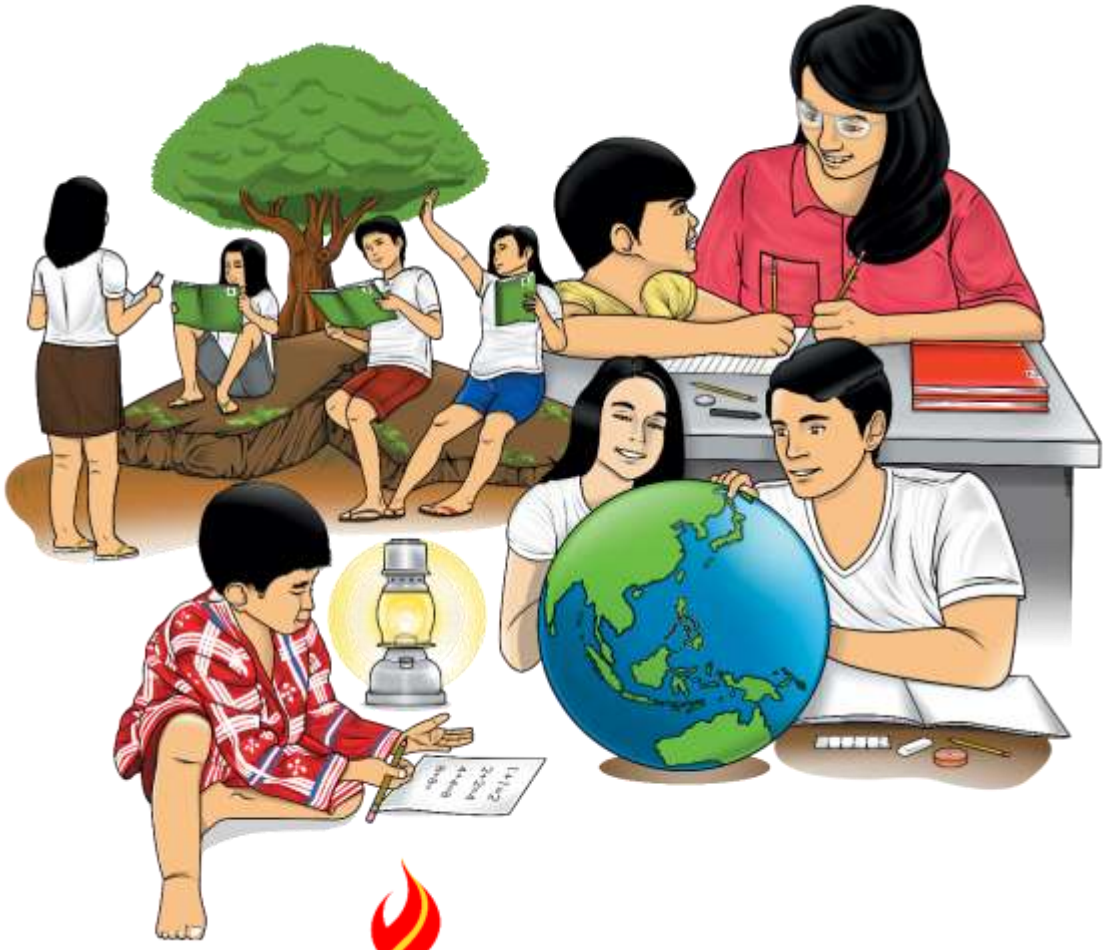
Science

Quarter 3 – Module 5:
Mutation



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Science

Quarter 3 – Module 5:
Mutation

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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

What I Need to Know

DNA or deoxyribonucleic acid is a genetic material made of nucleotides. In the previous lesson, we learned how proteins were created through transcription (DNA codes are copied into mRNA) and translation (mRNA into linked amino acids). However, in this module we want to learn how those processes can "go wrong" and create mutations. In this module, you will investigate a gene mutation in which there is a change in one nucleotide. You will determine how these changes affect the way the message is transcribed into mRNA and translated to protein.

This module will introduce you to the effects of gene mutations. So, stay tuned and have fun learning the following:

1. Explain how mutations may cause changes in the structure and function of a protein **(S10LTIIIe-38).**

Going through this module can be a meaningful learning experience. All you need to do is make use of your time and resources efficiently. To do this, here are some tips for you:

1. **Take the pretest** before reading the rest of the module.
2. **Take time** in reading and understanding the lesson. Follow instructions carefully. Do all activities diligently. This module is designed for independent or self-paced study. It is better to be slow but sure than to hurry and miss the concepts you are supposed to learn.
3. Use a **clean sheet of paper** for your answers in each activity/ assessment. **Don't forget to write your name**. Label it properly.
4. Try to **recall and connect the ideas** about Life Science that you had in the lower years. Use the concept discussed in the lesson to explain the results of activities or performance task. You may answer in English or a combination of your vernacular and English.
5. **Be honest.** When doing the activities, record only what you have really observed. Take the self-assessments after each activity, but do not turn to the Answer Key page unless you are done with the entire module.
6. **Don't hesitate to ask.** If you need to clarify something, approach or contact your teacher or any knowledgeable person available to help you. You may also look into other references for further information. There is a list of reference at the back part of this module.
7. **Take the posttest** prepared at the end of the module, so you can assess how much you have learned from this module.
8. You can **check your answers** in the activities, self-assessments, and posttest after you finished the entire module to know how much you have gained from the lesson and the activities.

What I Know

Directions: Read each question carefully. Choose the letter of the correct answer. Use a separate sheet of paper for your answers.

1. What are the DNA complementary bases of the following: ATC-GTG-CCC**?**
    a. AUG-CAC-GGG
    b. AUG-TAT-GGG
    c. TAG-CAC-GGG
    d. TAG-TAT-GGG

2. What do you call the change in a gene due to damage or being copied incorrectly?
    a. evolution
    b. meiosis
    c. mutation
    d. segregation

3. What is the collective term for “agents of mutations”?
    a. GMO’s
    b. mutagens
    c. mutants
    d. transgenic

4. Which of the following is **NOT** a mutagen?
    a. alcohol and drugs
    b. cigarette smoke
    c. radiation
    d. vitamins

5. The original strand of DNA looks like this ACGTCTCGA, the mutated strand looks like this ACGTCTACGA. What type of mutation is this?
    a. deletion
    b. frameshift mutation
    c. insertion
    d. nonsense mutation

6. What do you call the point mutation that changes a codon specifying an amino acid into a stop codon?
    a. deletion mutation
    b. frameshift mutation
    c. missense mutation
    d. nonsense mutation

7. Changing the codon from AGC to AGA represents a ____ mutation.
   a. deletion
   b. frameshift
   c. missense
   d. nonsense

8. Which of the following describes a frameshift mutation?
   a. It introduces a section of amino acids not normally found.
   b. It joins two different proteins.
   c. It removes part of the protein.
   d. It replaces one amino acid with another.

9. Gene mutation occurs at the time of _____.
   a. cell division
   b. DNA repair
   c. DNA replication
   d. RNA transcription

10. Point mutation involves _____.
   a. change in single base pair
   b. deletion
   c. duplication
   d. insertion

11. What type of point mutation results in a frameshift mutation?
   a. deletion
   b. insertion
   c. substitution
   d. Both A and B

12. Which is **NOT** a type of substitution mutation?
   a. conservation
   b. missense
   c. nonsense
   d. silent

13. Which is a stop codon?
   a. UAG
   b. UCC
   c. UUC
   d. All of the above

14. Sickle cell anemia is a disease that affects red blood cells. This is the result of a mutation called _____.
   a. deletion
   b. insertion
   c. nonsense mutation
   d. substitution

15. Cystic Fibrosis (CF) is a recessive inherited disorder that is associated with thick, sticky mucus in the lungs and trouble breathing, salty sweat, infertility in certain individuals, and a shortened life expectancy. This is the result of a mutation called _____.

a. deletion
b. insertion
c. nonsense mutation
d. substitution

Answer Key on Page 19

How did you find the pre-test? What was your score? If you got 15 items correctly, you may skip the module. But if your score is 14 and below, you must proceed with the module.

Lesson 5 Mutation

What's In

The DNA is used to complete the process of protein synthesis. Protein synthesis has two stages which are called transcription and translation. During protein synthesis at the ribosome, messenger RNA sequences are read and translated into amino acids. These amino acids will form proteins.

These amino acids are specified by codons carried by mRNA. If the mRNA is copied incorrectly during transcription stage, there will be an anomaly in the genes. This is called mutation. A mutation is a change that occurs in our DNA sequence, either due to mistakes when the DNA is copied or as the result of environmental factors such as UV light and cigarette smoke. Mutation occurs during DNA replication, thus transcription into mRNA is anomalous.

Let's explore the different types of mutation in the next activity. Are you ready?

What's New
Genomazing Challenge!

What you need:

- ✓ *work sheet*
- ✓ *sheet of paper*
- ✓ *ball pen*

What you have to do:

1. Study Figure 1 (amino acid chart) and the DNA sequences carefully, and read the captions very well. Get a sheet of paper for your answers and observation. Do not copy the questions, just write down your answer or observations. 2. Study the following DNA strand:

Transcribe and Translate the original DNA strand:

DNA: A T G C C C G G C G A G

mRNA: _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

tRNA: _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

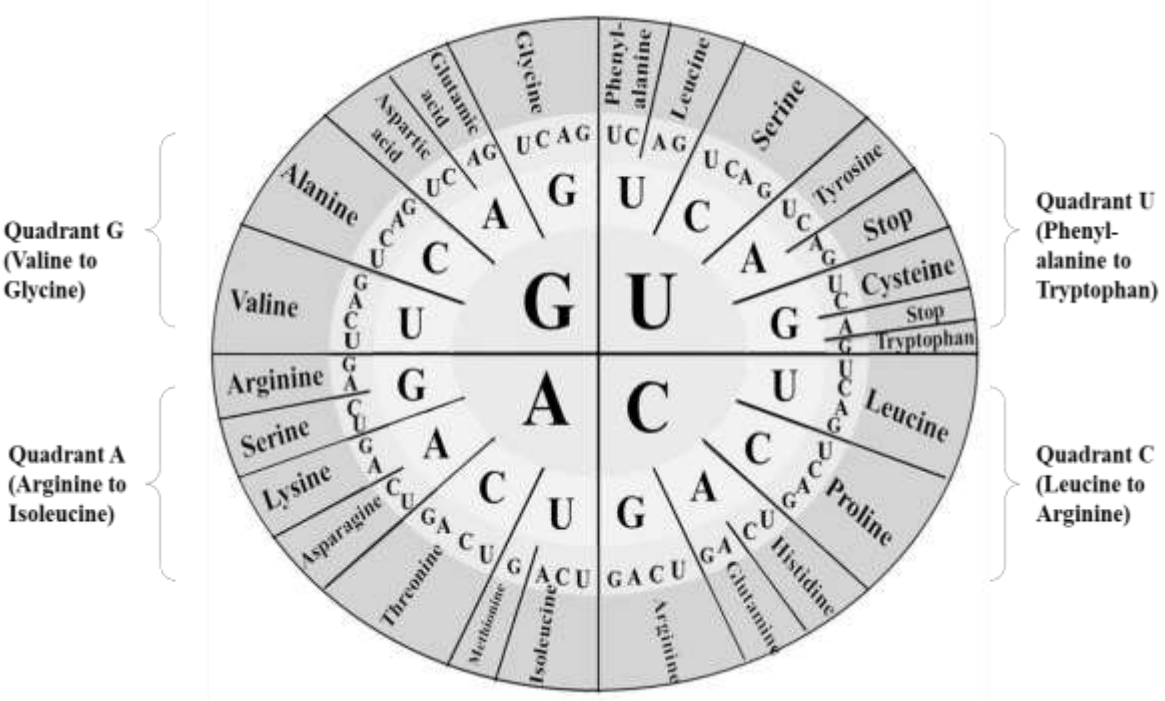
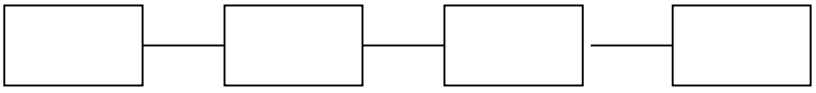


Figure 1. Amino Acid Chart

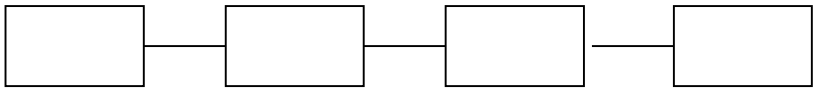
Illustrated by Jayson A. De Guzman

2.1. Refer to your answer in item number 2. When protein synthesis is completed, write the sequence of amino acid. Refer to Figure 1: Amino acid chart



2.2. Edit the DNA strand in #2 by changing the second and third bases of ATG to A. What will be the new amino acid chain created by the modified DNA? Refer to Figure 1: Amino acid chart.

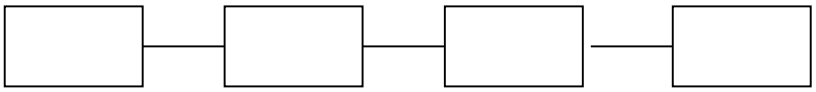
DNA: _____
mRNA: _____
tRNA: _____

Amino acid: 

2.3. Return the DNA to its original state (A T G C C C G G C G A G). This time, write an additional A after ATG, the DNA strand will be _____.

What will be the new amino acid chain created by the DNA? Refer to Figure 1: Amino acid chart.

DNA: _____
mRNA: _____
tRNA: _____

Amino acid: 

2.4. Return the DNA to its original state (A T G C C C G G C G A G). Write CCA instead of CCC.
What will be the new peptide created by the DNA? Refer to Figure 1: Amino acid chart.

DNA: _____
mRNA: _____
tRNA: _____

What Is It

Mutations are changes to a DNA sequence. Just like the information in DNA as a group of sentences, mutations are mistakes in spelling of the words that form those sentences.

Mutagens are agents that cause alteration in the DNA and can lead to permanent mutations in the DNA sequence depending on the ability of an organism to repair the damage. Examples of mutagens are radioactive substances, x-rays, ultraviolet radiation, and certain chemicals or drugs.

There are different types of mutations that you have explored in the previous activity. These are POINT mutation and FRAMESHIFT mutation. First, you made a **POINT** mutation in the original DNA. The second mutation you explored is a **FRAMESHIFT** mutation. Lastly, the third mutation you determined is a special type of point mutation called a **SILENT** mutation.

Let's take a look on the definitions and descriptions about the types of mutation.

First gene mutation is the **point mutation.** It is the type mutation in DNA or RNA wherein one single nucleotide base is deleted, added or altered. This can lead to substitution mutation. There are three types of substitution mutation. These are nonsense, missense and silent mutation.

1) Nonsense mutation results in the formation of a stop codon due to the substitution of one nitrogenous base. Remember, stop codons are special nitrogenous bases that stop the translation stage in protein synthesis. These are **ATC**, **ATT**, or **ACT** in DNA, and UAG, UAA, or UGA in mRNA. They are usually located at the end of messenger RNA nucleotide base sequence. However, when a substitution mutation causes it to appear in another place, it will suddenly stop the translation process to amino acid and will fail to produce the correct protein.

Example:

Original DNA Code for Amino Acid Sequence

DNA:	**AGG**	**AAG**	**AAC**	**ACG**	**CAG**	**AGC**	**ATG**
mRNA:	**UCC**	**UUC**	**UUG**	**UGC**	**GUC**	**UCG**	**UAC**
tRNA:	**AGG**	**AAG**	**AAC**	**ACG**	**CAG**	**AGC**	**AUG**
amino acid:	**Ser -**	**Phe-**	**Leu-**	**Cys-**	**Val -**	**Ser-**	**Tyr**

Replacement of a single nucleotide

Mutated DNA CODE

DNA:	**AGG**	**AAG**	**AAC**	**ACT**	**CAG**	**AGC**	**ATG**
mRNA:	**UCC**	**UUC**	**UUG**	**UGA**	**GUC**	**UCG**	**UAC**
tRNA:	**AGG**	**AAG**	**AAC**	**ACG**	**CAG**	**AGC**	**AUG**
amino acid:	**Ser-**	**Phe-**	**Leu-**	**STOP**			

incorrect sequence causes shortening of protein

2) When one nitrogenous base of the DNA is replaced and the result is an altered codon but **does not form a stop codon**, it is classified as **missense mutation.**

This will create a different amino acid in protein synthesis.

Example: DNA: C**A**T to mRNA : GUA to tRNA CAU (**Valine**)

CA**T** is changed into CC**T** to mRNA: GGA to tRNA: CCU (**Glycine**)

Original DNA Code for Amino Acids

DNA:	**GCA**	**ATG**	**CAT**	**CAT**	**CGT**	**CGC**	**CAA**
mRNA:	**CGU**	**UAC**	**GUA**	**GUA**	**GCA**	**GCG**	**GUU**
tRNA:	**GCA**	**ATG**	**CAU**	**CAU**	**CGU**	**CGC**	**CAA**
amino acid:	**ARG-**	**TYR**	**VAL-**	**VAL -**	**ALA-**	**ALA-**	**VAL**

Mutated DNA CODE

Replacement of a single nucleotide

DNA:	**GCA**	**ATG**	**CAT**	**CCT**	**CGT**	**CGC**	**CAA**
mRNA:	**CGU**	**UAC**	**GUA**	**GGA**	**GCA**	**GCG**	**GUU**
tRNA:	**GCA**	**ATG**	**CAU**	**CCU**	**CGU**	**CGC**	**CAA**
amino acid:	**ARG**	**TYR**	**VAL**	**GLY**	**ALA**	**ALA**	**VAL**

This is an incorrect amino acid which may produce a malfunctioning protein

Missense mutation can be classified into conservative and non-conservative.
Conservative mutation: When the new amino acid formed has the same properties of the one that was supposed to be produced.
Non-conservative: When the new amino acid formed has different properties of the one that was supposed to be produced.

3) Silent mutation happens when a nitrogenous base is altered but the same amino acid is produced. Remember, many codons can code for the same amino acid. Example: GGC and GGU can both code for glycine. If C is changed to an U, the same amino acid will be produced and therefore, the amino acid will not be changed.

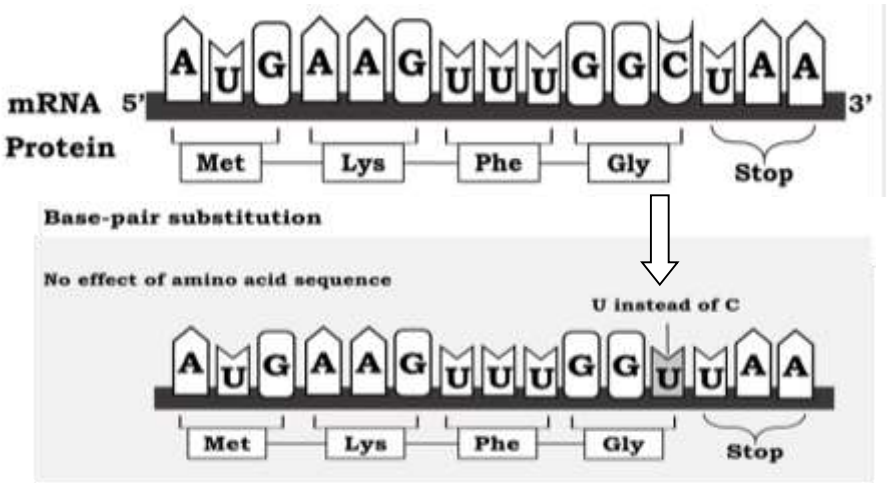


Figure 2. Silent Mutation
Illustrated by Jayson A. De Guzman

Table 1 shows the different kinds of substitution point mutations. It shows the DNA template, messenger RNA codon, anticodon, and the amino acid produced.
Take note: Amino Acids are based on mRNA

No mutation		Point mutations			
		Silent	Nonsense	Missense	
				Conservative	Non-conservative
DNA level	TTC	TT**T**	**ATC**	**TCC**	T**G**C
mRNA level	AAG	AA**A**	**UAG**	**AGG**	A**C**G
tRNA level	UUC	UU**U**	**AUC**	**UCC**	U**G**C
Protein level	**LYSINE**	**LYSINE**	STOP	**ARGININE**	**Threonine**

Table 1: Types of Point Mutations

Second gene mutation is the **frameshift mutation.** Frameshift mutation happens when the normal sequence of codons is disorganized by the insertion or deletion of one or more nitrogenous bases, given that the number of nitrogenous bases added or deleted is not a multiple of three. For example, if just one nucleotide is deleted, then all of the codons after the mutation will have an altered reading frame. This can lead to the possible change of many amino acids that may affect the amino acid chain produced incorporation of many changes in amino acids into the protein. In contrary, when three nitrogenous bases are deleted or inserted, there will be no shift in the codon reading frame but, there will be either an extra or a missing amino acid in the protein. Therefore, frameshift mutations lead to the abnormal protein with an improper amino acid sequence that can be either longer or shorter than the normal protein.

The following are kinds of chromosomal mutations:

1. Deletion- happens when a base is deleted from the nitrogen base **sequence.**

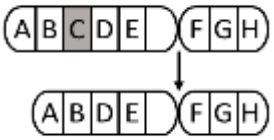


Figure 3. Deletion

2. Duplication – occurs when a part of a chromosome is copied (duplicated) too many times. This type of chromosomal change results in extra copies of genetic material from the duplicated segment.

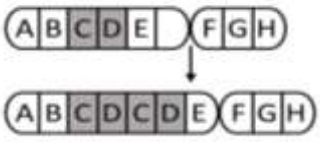


Figure 4. Duplication

3. Inversion - when a segment of a chromosome is reversed end to end.

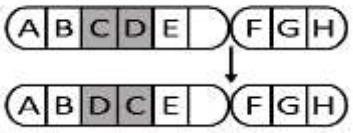


Figure 5: Inversion

4. Insertion- the addition of one or more nucleotide base pairs into a DNA sequence.

Figure 6: Insertion

5. Translocation- segments of two chromosomes are exchanged.

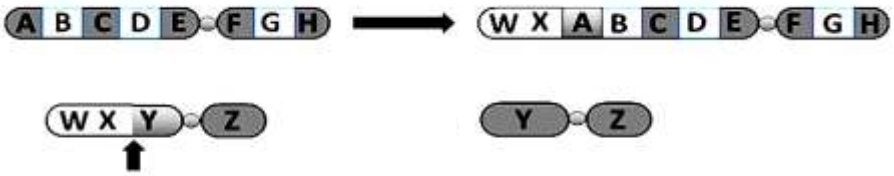


Figure 7: Transloaction

What happens when a person has mutated genes?

This can lead to inherited disorders. One of the most common disorders is the **sickle cell anemia.** This type of anemia is caused by a recessive disorder through a single **substitution** mutation in the gene that is responsible for hemoglobin production. Hemoglobin is known for carrying oxygen in the blood. In a normal gene, glutamic acid is formed in the chain. But when the amino acid **valine substitutes glutamic acid**, this leads to the production of sickle-shaped blood cells. These cells cannot properly carry oxygen. Sickle cell anemia's symptoms are anemia, pain crises and frequent infections. It can be managed with prescription drugs, folic acid, bone marrow transplants, and blood transfusions.

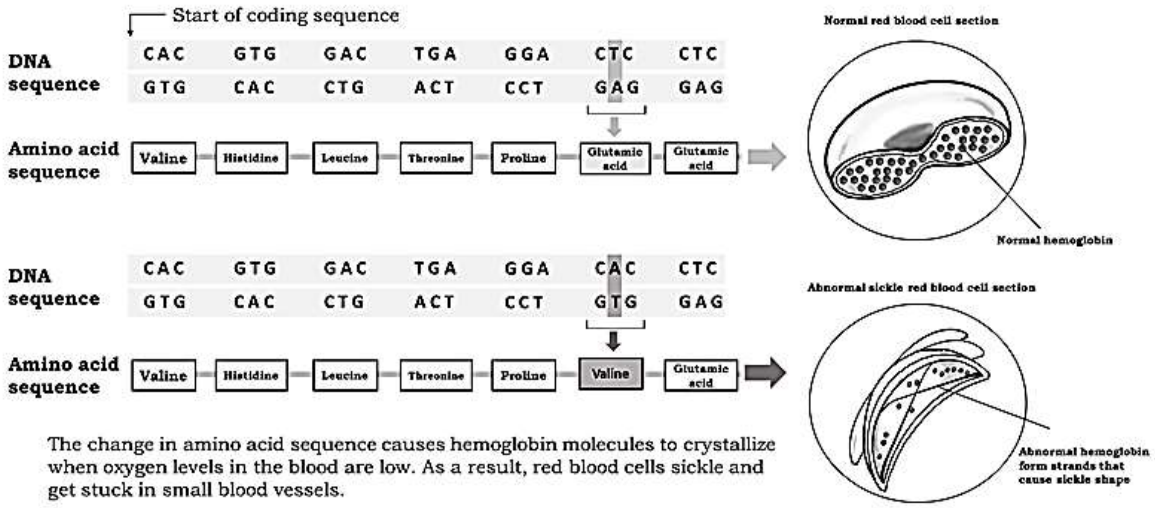


Figure 8. DNA sequence of Sickle Cell Anemia

Illustrated by Jayson A. De Guzman

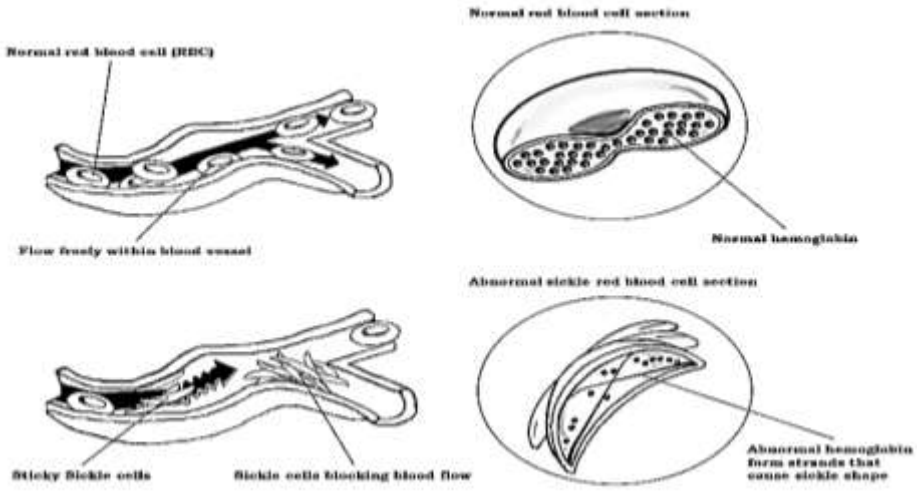


Figure 9. Sickle cells
Illustrated by Jayson A. De Guzman

Likewise, **deletion** mutation can lead to albinism. **Albinism** (specifically type I oculocutaneous albinism) is an autosomal recessive disorder in which the formation of melanin is reduced or absent in skin, hair, and eyes due to the lack of activity of tyrosinase. This is caused by the deletion of the **tyrosinase gene.**

Another is the **Cystic Fibrosis** (CF). It is a recessive inherited disorder. Although there are many different mutations that can cause cystic fibrosis, **deletion** mutation is the most common cause. It affects the cystic fibrosis transmembrane conductance regulator (CFTR) gene that leads to the deletion of the amino acid phenylalanine. This causes an incorrect protein.

Furthermore, is the **Down syndrome** or **Trisomy 21**. It is related with slight retardation of cognitive ability. It is also characterized with impairment of physical growth, body and facial features. Down syndrome is caused by a **translocation** during meiosis that transfers most of **chromosome 21** (showing three chromosomes) onto chromosome 14 (see Figure 11).

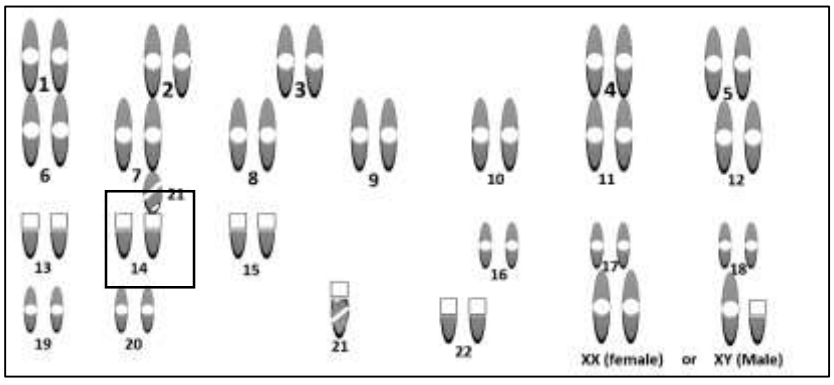


Figure 10. Karyotype of Trisomy 21
Illustrated by Jayson A. De Guzman

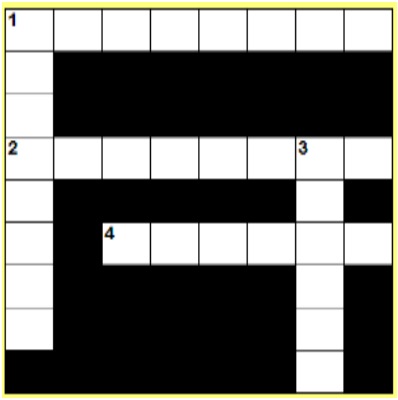
Figure 11. Down syndrome
Illustrated by Jayson A. De Guzman

What's More

Since you have accepted and conquered the "Genomazing challenge" a while ago, here are some enrichment activities for you to work on to strengthen the basic concepts you have learned from our mini-lesson and to validate your observations in the activity part.

Activity 1: Crossword Puzzle

Directions: Complete the crossword by filling out the boxes a word that fits each clue.



Across:
1. The term used for describing the "alterations/errors" in DNA sequence.
2. This is an autosomal recessive disorder in which the formation of melanin is reduced or absent in skin, hair and eyes.
4. _____ cell anemia is caused by the substitution mutation for haemoglobin gene.

Down:
1. These are the agents of mutation.
3. This happens when a nitrogen base is altered but the same amino acid is produced.

Assessment 1: Word Hunt

Directions: Look for the words pertaining to our lesson about mutations. There are five clues listed below and you will look for the corresponding terms inside the table of letters below. Use separate sheet for your answers.

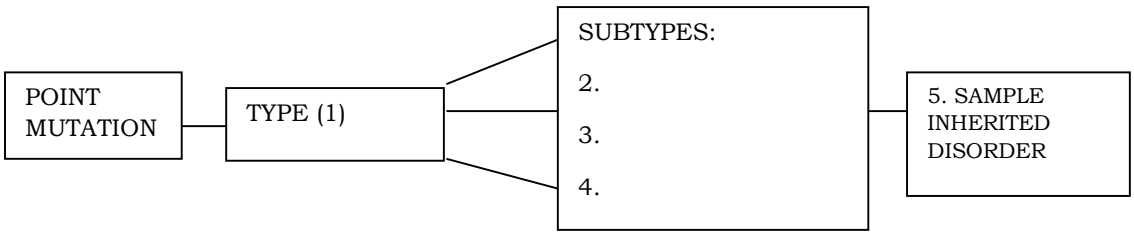
M	S	I	L	E	N	T	D	D	I	P	G	L	C	Y
I	H	O	S	P	H	O	L	I	P	O	D	A	H	B
S	A	G	L	Y	P	O	R	T	E	I	T	U	A	C
S	B	S	F	G	H	J	K	L	L	N	R	T	N	D
E	L	Y	C	O	P	R	O	T	E	T	N	S	N	E
N	L	A	G	L	Y	P	O	R	T	E	R	T	E	F
S	Y	P	A	A	L	D	A	S	X	D	S	A	L	G
E	F	R	A	M	E	S	H	I	F	T	S	S	S	G
H	P	T	B	C	H	A	L	Y	D	S	S	A	A	J
H	R	R	N	D	G	A	S	D	S	S	A	S	G	S
M	O	T	M	W	C	F	S	F	S	S	S	A	O	D
I	T	E	S	O	H	S	D	F	G	H	J	K	L	T
S	B	D	C	C	D	A	S	F	G	S	F	G	J	D
Y	N	O	N	S	E	N	S	E	P	O	T	E	R	D

1. This result when one single nucleotide base is deleted, added or altered.
2. This results in the formation of a stop codon due to the substitution of one nitrogen base.

3. This results in an altered codon formation but does not form a stop codon.
4. This happens when a nitrogen base is altered, but the same amino acid is produced.
5. These mutations happen when the normal sequence of codons is disorganized by the insertion or deletion of one or more nitrogen bases.

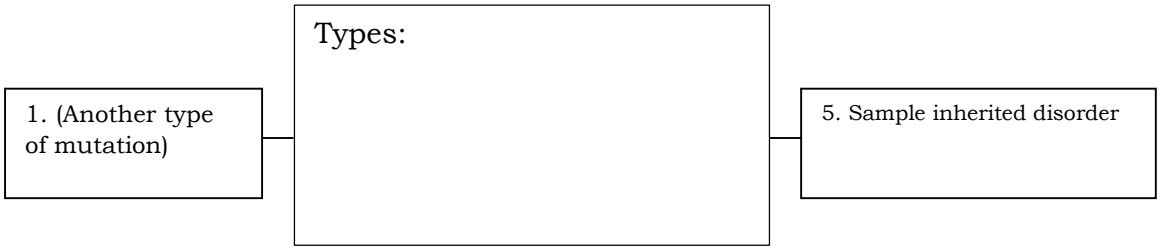
Activity 2: What's the point?

Directions: Fill out the corresponding boxes with the correct word/s to compete the diagram. Use another sheet for your answer.



Assessment 2: Frameshift it

Directions: Fill out the corresponding boxes with the correct word/s to compete the diagram. Use another sheet for your answer.



Activity 3: Complete me please

Directions: Complete the table by filling out what is needed or being asked in each item. Refer to the **amino acid chart on the next page** to indicate what amino acids are being coded for by the base sequences listed for **mRNA.**

Normal DNA	TAT	CAT	CCT	AAG	GTA	
Protein	Iso	Val	Gly	Phe	His	
1. (Type of Mutation)	TAT	CAT	C**G**T	AAG	GTA	
Protein	Tyr	His	Arg	Lys	Val	
2. (Type of Mutation)	TAT	CAT	CGC	TAA	**GGT**	**A**
Protein	Tyr	His	Arg	Stop	Gly	

3. (Type of Mutation)	TAT	**C_TC**	CTA	AGG	TA	
Protein	Iso	Glu	**4.** _____	**5.** _____	X	

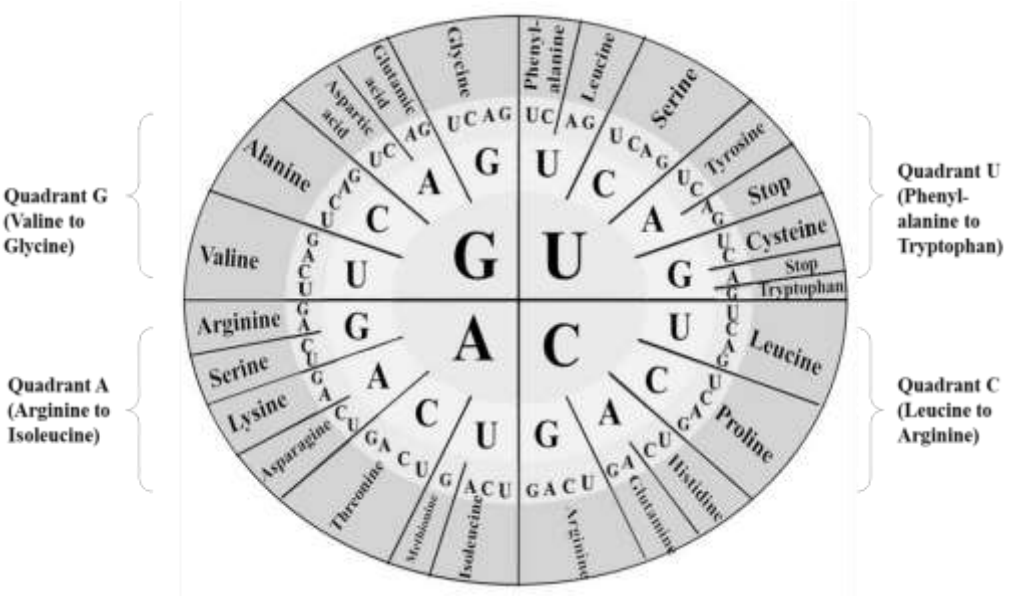


Figure 12. Amino Acid Chart
Illustrated by Jayson A. De Guzman

Assessment 3:

Directions: Complete the sequence by filling out what is needed or being asked in each item. Refer to the **amino acid chart above** to indicate what amino acids are being coded.

Original DNA code –C-A-G-C-A-G-C-A-G-C-A-G-C-A-G-C-A-G

Mutated DNA gene- C-A-G-C-A-G-C-A-G-_-A-G-C-A-G-C-A-G

Amino Acid: **Val--- Val** ---1____- --- 2_____- 3_____

Mutated base or nucleotide 4 _____

Type of mutation: 5 _____

What I Have Learned

Great job! You are almost done with this module. Let's summarize what you have learned from the lesson and activities by choosing the correct word inside the parentheses. Use a separate sheet of paper for your answer.

1. (*Mutations, Mutagens*) are changes to a DNA sequence.

2. (*Mutations, Mutagens*) are agents that cause alteration in the DNA.
3. The type mutation in DNA or RNA wherein one single nucleotide base is deleted, added or altered is called (*point, frameshift*) mutation.
4. Point mutation can lead to (*substitution, frameshift*) mutation.
5. (*Nonsense, Missense*) mutation results in the formation of a stop codon due to the substitution of one nitrogen base.
6. When one nitrogen base of the DNA is replaced, and the result is an altered codon formation but does not form a stop codon, it is classified as (*nonsense, missense*) mutation.
7. (*Missense, Silent*) mutation can be classified into conservative and non-conservative.
8. (*Conservative, Non-conservative*) mutation happens when the same properties of amino acid were formed to the one that was supposed to be produced.
9. (*Conservative, Non-conservative*) happens when amino acid has produced different properties of protein)
10. (*Missense, Silent*) mutation happens when a nitrogen base is altered, but the same amino acid is produced. Remember, many codons can code for the same amino acid.
11. (*Point, Frameshift*) mutation happens when the normal sequence of codons is disorganized by the insertion or deletion of one or more nitrogen bases, given that the number of nitrogen bases added or deleted is not a multiple of three.
12. (*Cystic Fibrosis, Albinism*) is a recessive inherited disorder caused by the deletion of the amino acid phenylalanine.
13. (*Cystic Fibrosis, Sickle cell anemia*) is caused by a recessive disorder through a single substitution mutation in the gene that is responsible for hemoglobin production.
14-15. (*Cystic Fibrosis, Down syndrome*) is related with slight retardation of cognitive ability. It is also characterized with impairment of physical growth, body and facial features. It is caused by a (*substitution, translocation*) during meiosis that transfers most of chromosome 21 onto chromosome 14.

What I Can Do

Directions: For the following activities, <u>choose only one</u> that you prefer to accomplish. Use another sheet for your answer.

1. For example you are given a chance to be one of the representatives in the "Down Syndrome Awareness Month Forum". The activity is to write an inspirational letter to your fellow youth and friends who are parents or relatives of a person with Down syndrome. What are the words of inspiration that you can give to them? You may use English or vernacular. (50-100 words).

Your sample letter will be rated by your teacher according to the following criteria:

Standards Rubric

Appropriateness of Topic (Down Syndrome Awareness)	10 points
Accuracy of Details and Information (taken from real scenario)	5 points
Techniques (persuasiveness/humor in words/English or vernacular)	5 points
	TOTAL - 20 points

2. Not all mutations are bad. There are naturally occurring genetic mutations that can change the appearance and traits of flowers, fruit or stems of any plant or crops and also, there are laboratory-made mutations. These mutations can be designed by genetic engineers. Suppose you are a genetic engineer, what gene or trait of a plant or crop are you going to design (duplicate, insert, or delete) to help in food production or crop improvement?

Draw a sample of that plant or crop showing the good mutation or trait. (You may label the parts of a crop or plant or write a brief explanation of the use of that gene in that plant).

Standards Rubric

Drawing Quality	10 points
Labels	5 points
Required Information (Title, Short Explanation)	5 points
Total:	**20 points**

Good job! You are now ready to have your posttest. You may want to go over again the lessons and activities to review for the final assessment. God bless you!

Assessment

Directions: Read each question carefully. Choose the letter of the correct answer. Use a separate sheet of paper for your answers.

1. What do you call the change or error in the gene?
    a. genetic engineering
    b. mutagen
    c. mutant
    d. mutation
2. What is the term used to describe the factors that affect error or alterations in base sequence?
    a. genetic engineering
    b. mutagen
    c. mutant
    d. mutation

3. A frame shift mutation is a genetic mutation that is caused by the insertion or deletion of a specific number of nucleotides that shifts the reading frame of the sequence.The insertion or deletion of how many nucleotides would cause a frame shift mutation?
    a.2
    b.3
    c.6
    d.9
4. How do mutations lead to genetic variation?
    a.by changing the organism's appearance
    b.by changing the way that the organism reproduces
    c.by changing the organism's behavior
    d.by producing random changes in an organism's genetic code
5. A piece of each chromosome has broken off and been reattached to the other chromosome, resulting in an exchange.The process that occurs when a section of a chromosome breaks off and reattaches to another chromosome is known as_____.
    a. deletion
    b. inversion
    c. nondisjunction
    d. translocation
6. What do you call the genetic mutation that causes a codon that should code for a specific amino acid to be changed into a stop codon ?
    a. a chromosomal mutation.
    b. a frame shift mutation.
    c. a nonsense mutation.
    d.a silent mutation.
7. A genetic mutation that **does not** result in a change in the amino acid sequence of the resulting protein is called
    a. a chromosomal mutation.
    b. a frame shift mutation.
    c.a nonsense mutation.
    d.a silent mutation.
8. This is a mutation that causes a section of the chromosome to be broken out and reinserted backwards. This is known as
    a. deletion.
    b. insertion.
    c. inversion.
    d. translocation.
9. Persons with Down syndrome usually have _____ copies of chromosome 21.
    a. no
    b. one
    c. two
    d. three
10. If a segment of a chromosome is present several times more than normal due to unequal crossing-over, it is called _____.
    a. a deletion
    b. duplication
    c. an inversion
    d. a translocation

11. What type of mutation is being shown below:

Normal: ABCDEFGH
Mutated gene: ABCBCDEFGH

a. an insertion
b. an inversion
c. a deletion
d. a duplication

12. What type of mutation is being shown below:

Normal gene: ABCDEFGH
Mutated gene: ABCDCEFGH

a. an insertion
b. an inversion
c. a deletion
d. a duplication

13. Children with cystic fibrosis have a thick and viscous fluid in the lungs and digestive tract.
    a. False
    b. True
14. Sickle-cell anemia is a type of anemia caused by a recessive disorder through a single substitution mutation in the gene that is responsible for hemoglobin production.
    a. False
    b. True
15. Albinism is an autosomal recessive disorder in which the formation of melanin is reduced or absent in skin, hair, and eyes due to the lack of activity of tyrosinase.
    a. False
    b. True

Answer Key on Page 19

Answer Key

POST TEST

1. D 9. D
2. B 10. B
3. A 11. D
4. D 12. A
5. D 13. B
6. C 14. B
7. D 15. B
8. C

WHAT I HAVE LEARNED

1. Mutations
2. Mutagens
3. Point
4. Substitution
5. Nonsense
6. Missense
7. Missense
8. Conservative
9. Non-conservative
10. Silent
11. Frameshift
12. Cystic Fibrosis
13. Sickle Cell Anemia
14. Down Syndrome
15. Translocation

ASSESSMENT 2

1. Frameshift
2. Deletion
3. Inversion
4. Insertion
5. Cystic Fibrosis or Down sSndrome or Albinism

ACTIVITY 3

1. Substitution
2. Insertion
3. Deletion
4. Aspartic Acid
5. Serine

ASSESSMENT 3

1. Valine
2. Valine
3. Valine
4. Cytosine or C
5. Deletion

ACTIVITY 2

1. Substitution
2. Nonsense
3. Missense
4. Silent
5. Sick Cell Anemia

ASSESSMENT 1

1. Point
2. Nonsense
3. Missense
4. Silent
5. Frameshift

ACTIVITY 1

1. Mutation
2. Albinism
3. Sickle
4. Mutagens
5. Silent

WHAT'S NEW

1.
2.1 tyrosine-glycine – proline-leucine
2.2 phenylalanine-glycine – proline-leucine
2.3 tyrosine-tryptophan – alanine-alanine
2.4 tyrosine-glycine – proline-leucine
2. DNA: ATG-CCC-GGC-GAG
mRNA: UAC-GGG-CCG-CUC
tRNA: AUG-CCC-GGC-GAG

WHAT I KNOW

1. A 9. C
2. C 10. A
3. B 11. D
4. D 12. A
5. C 13. A
6. D 14. D
7. C 15. A
8. C

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