Doodle Sheet – DNA Synthesis & Mutations

(DNA Replication, Mutations)

Learning Target: How is DNA copied? Name _____

Box A

(1,2,3) What are the three parts of a DNA nucleotide?

_____

_____

_____

(4,5,6,7) List the four nitrogen bases found in DNA.

_____ & _____

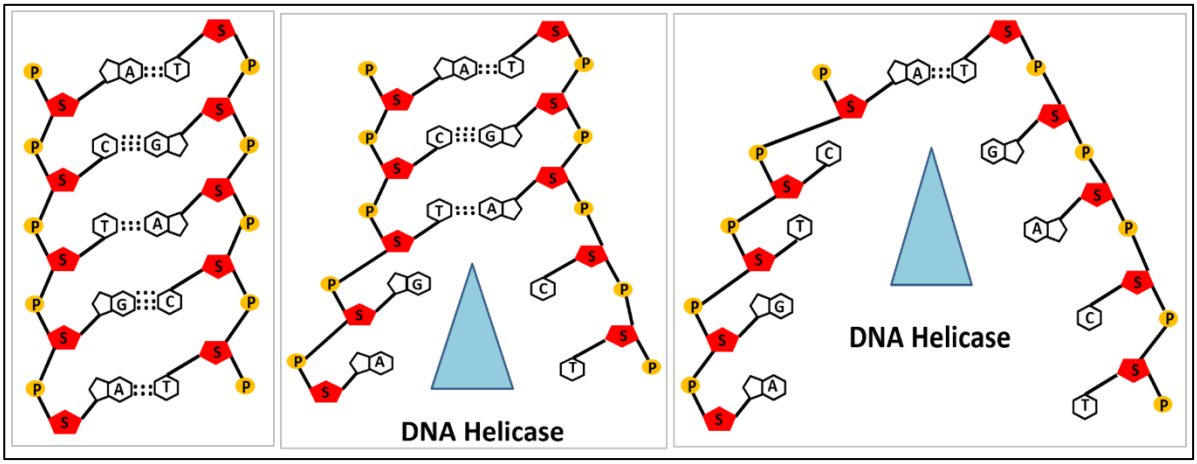
_____ & _____

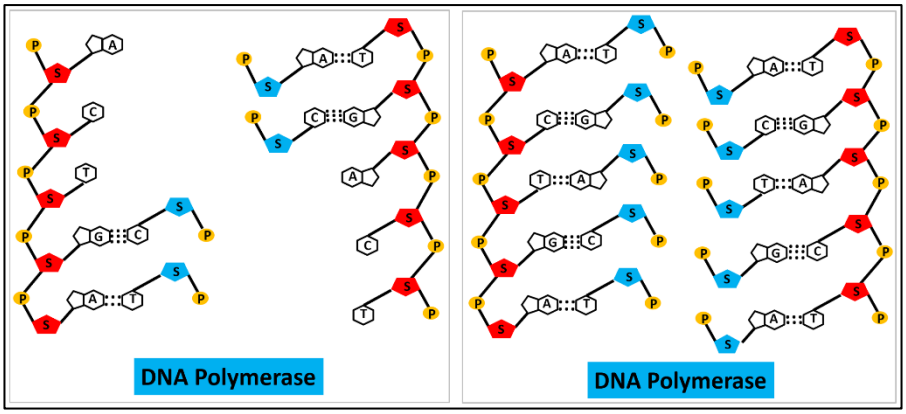
(8,9) What makes up the backbone of the DNA strand?

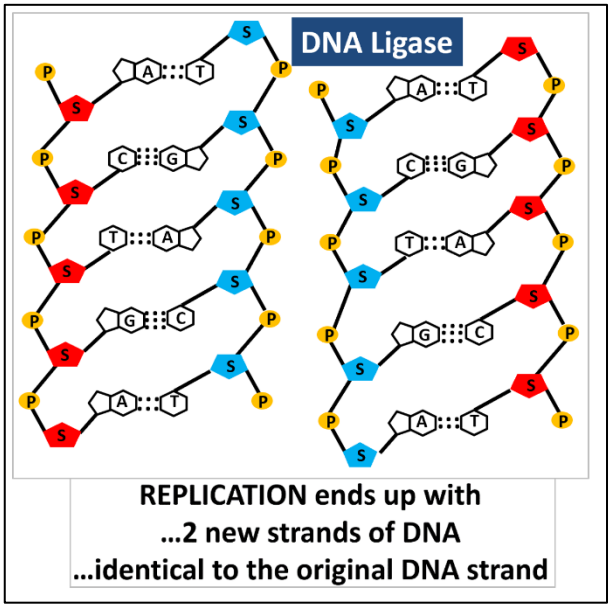
_____ & _____

(10) The structure of DNA can be described as a…

_____



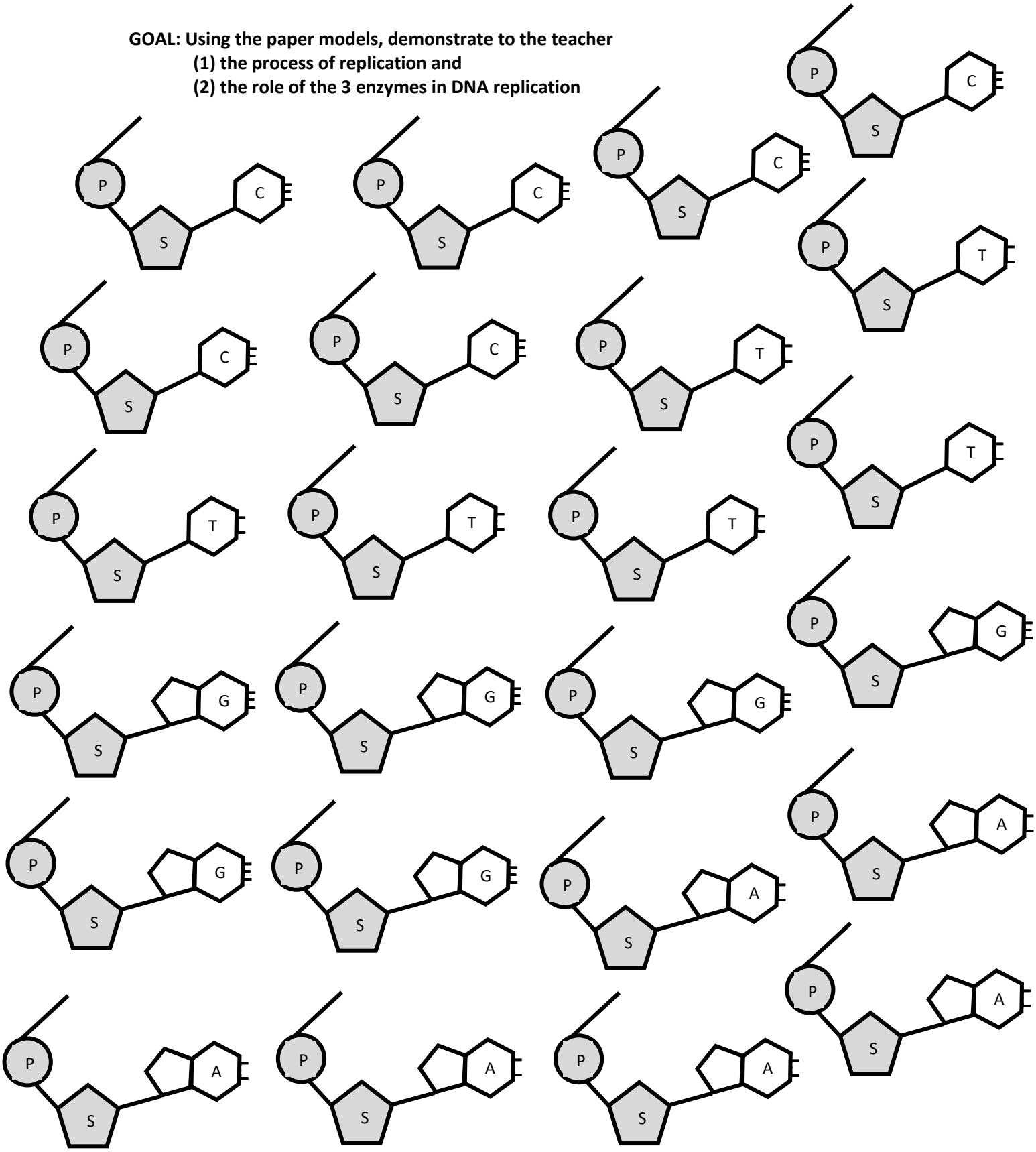




- **Students use the DNA Replication Presentation and DNA Replication Reading on the website.**
  https://sciencemathhelpcenter.weebly.com/unit-8---dna-synthesis--mutations.html

- **Students will create a physical model of DNA that consists of 12 model pieces (6 base pairs)**
- **Students will use the DNA model and simulate DNA Replication.**

GOAL: Using the paper models, demonstrate to the teacher
(1) the process of replication and
(2) the role of the 3 enzymes in DNA replication



Learning Target: How is DNA copied?

Box B

(1,2) During which steps in the Cell Cycle do cells make proteins?

_____ and _____

(3) During which step in the Cell Cycle does the DNA replicate?

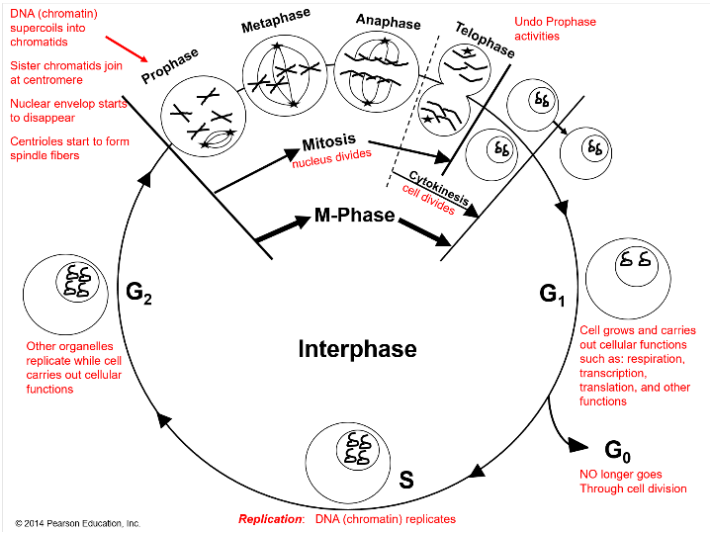
_____

(4) What enzyme (protein) splits the DNA double helix (breaks hydrogen bonds)?

_____

(5) What enzyme (protein) attaches new nucleotides to the original DNA strand and forms new hydrogen bonds?

_____



(6) What enzyme (protein) finishes connecting the new DNA strand together?

_____

(7) Where do the extra nucleotides come from that are used in Replication? _____

(8) Where in the cell does Replication take place? _____

(9) Is the DNA supercoiled during Replication? Why/Why Not?

_____

(10) What is the DNA called during the process of Replication? _____

(11) What are the differences between purines vs. pyrimidines?

_____

(12) What is the end result of Replication?

_____

(13) Why does Replication need to occur?

_____

(14) What is the monomer of DNA? _____

(15) What does DNA stand for? _____

Learning Target: How is DNA copied?

Box C

Success Criteria – Teacher & Self-Assessment

Learning Target:

Replication

1) What is Replication?

2) During which part of the cell cycle does Replication take place?

3) Where in the cell does Replication take place?

4) Which enzyme(s) are used in the process of Replication?

5) If you start with the following DNA molecule…

A – T – G – G – T – G - C – A – A - T – C – G – T – G

T – A – C – C – A – C - G – T – T - A – G – C – A – C

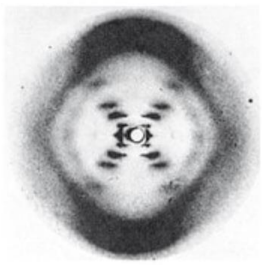
…draw a diagram of the final product of Replication.

Rate your level of Understanding:

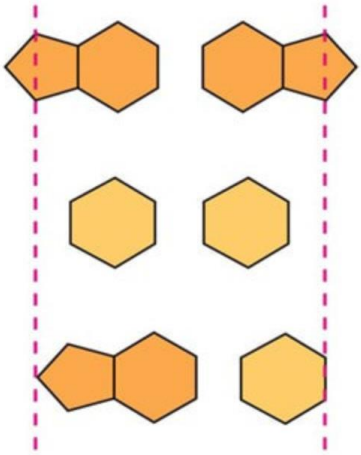
3 = Mastery/Expert 2 = Good Understanding 1 = Partial Understanding 0 = Very Little/No Understanding

Franklin produced a picture of the DNA molecule using this technique

(a) Rosalind Franklin



(b) Franklin's X-ray diffraction photograph of DNA



Purine + Purine: too wide

Pyrimidine + Pyrimidine: too narrow

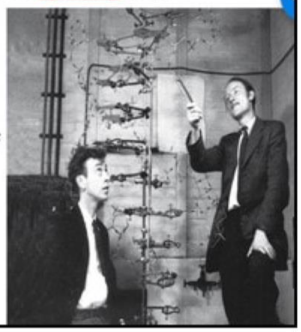
Purine + Pyrimidine: width consistent with X-ray data

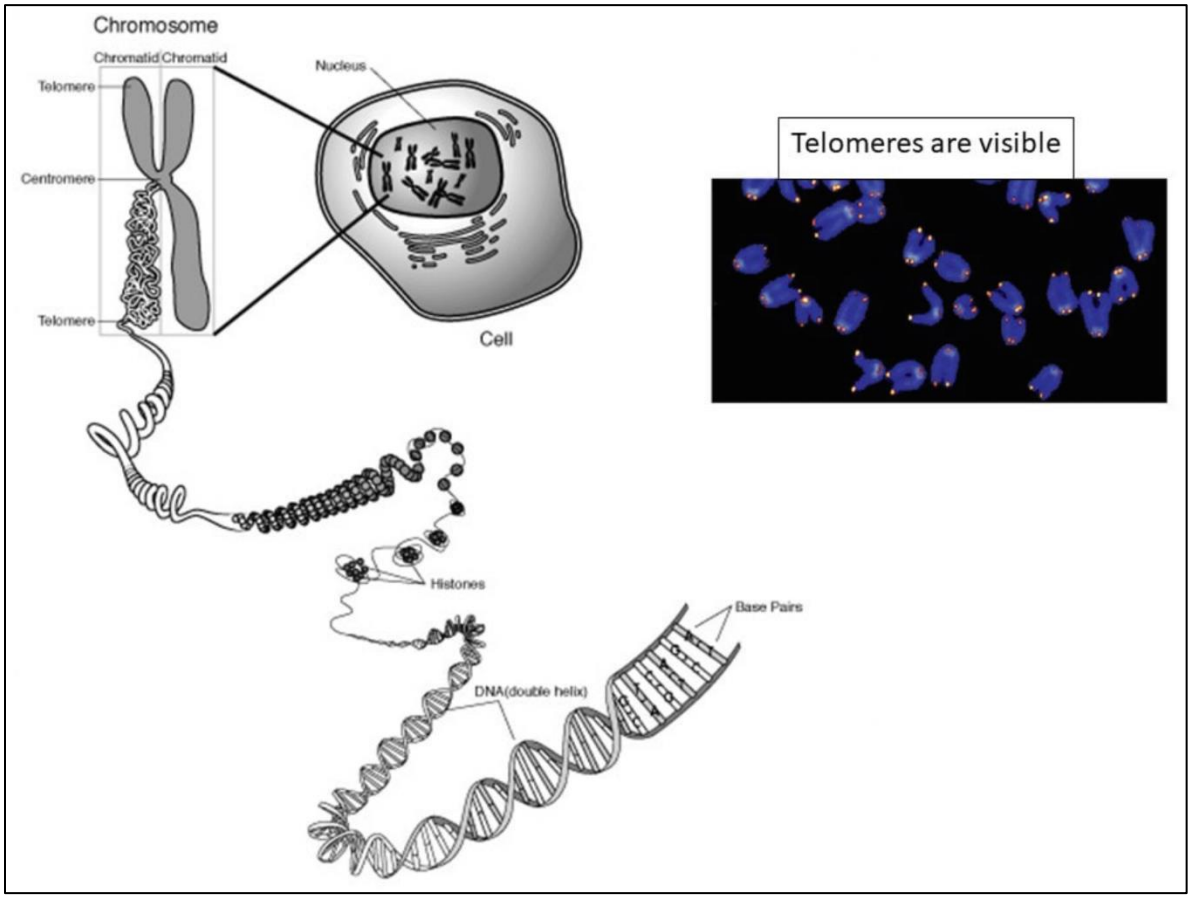
1952, Rosalind Franklin

1953, James Watson and Francis Crick

Franklin's X-ray crystallographic images of DNA enabled Watson and Crick to deduce that

1. DNA was helical
2. the width of the helix and the spacing of the nitrogenous bases
3. The pattern in the photo suggested that the DNA molecule was made up of two strands, forming a **double helix**





Telomeres are visible

Learning Target: How is DNA copied?

Box D

DNA Extraction from Wheat Germ

1. Place 1 level plastic teaspoon (1 g) of raw wheat germ in a test tube or a 50 ml beaker.
2. Fill beaker up to the 25 ml mark (about half way) with hot water (50-60ºC).
3. Mix constantly for 3 minutes.
4. Add 1/4 teaspoon (1 ml) of (HE laundry) detergent to beaker.
5. Mix for 30 seconds, let rest for 30 seconds. Repeat mixing and resting for 5 minutes.

   DO NOT MAKE FOAM OR BUBBLES WHEN MIXING
6. Remove any foam that exists.
7. Add 15 ml (1 Tablespoon) of alcohol to mixture by pouring the alcohol down the side of the beaker. You should use a syringe or eye dropper to add the alcohol. You are trying to create a layer of alcohol on top of the existing water/wheat germ/detergent solution.
8. Let the beaker rest a few minutes.
9. Using the bent paperclip, lift the top of the lower wheat germ layer into the upper alcohol layer. You will see the DNA precipitating. The DNA looks like slimy, snotty looking substance.

QUESTIONS - Please use complete sentences, be concise and to the point, and please write neatly.

1. Give two reasons why the water temperature is so important.

   a)

   b)

2. What is the purpose of the detergent?

3. What is the purpose of the alcohol?

See next page for extra information

NOTES ON THE DNA Extraction from Wheat Germ PROCEDURE

Raw Wheat germ: The procedure will only work with raw wheat germ, which can be purchased at a health food store; toasted wheat germ does not work.

Water temperature: Do not use water hotter than 50-60ºC. The water will become cooler during the extraction procedure, but this does not matter. Test your tap water - it may be hot enough right from the tap. The heat softens the phospholipids in the cell membrane. It also denatures the deoxyribonuclease enzymes (DNase) which, if present, would cut the DNA into such small fragments that it would not be visible. Enzymes denature at 60ºC and DNA denatures at 80ºC.

Detergent: I have used both Woolite and Lemon Fresh Joy detergents with equal success. The detergent contains sodium laurel sulfate (SLS) which breaks down the cell and nuclear membranes in wheat germ, releasing the DNA. The detergent emulsifies the lipids and proteins in the membranes by disrupting the polar interactions that hold them together. The detergent forms complexes with these lipids and proteins, causing them to precipitate out of the solution.

Alcohol: Use close to 99% Isopropyl or Ethyl alcohol. The alcohol should be poured carefully to form a layer on top of the wheat germ/soapy water layer.

As an extension experiment, students could bring other detergents from home and compare the amount of DNA extracted with different detergents. One way to compare amounts of DNA is to dry the DNA on pre-weighed filter paper pieces, weigh the filter paper again with the DNA, and calculate the DNA weight.

Learning Target: How can mutations affect DNA and Proteins?

Students need to respond to every "?" for the following problems.

** indicates the DNA template you should use for Transcription.

Box E Original DNA Strand

A C T G A C G T A C G T A C G T A C G T T G C A T G C A T C T
T G A C T G C A T G C A T G C A T G C A A C G T A C G T A G A

? Replicated DNA Strands (Find the Point Mutation – Substitution)

(1) **A C T G A C G T A C G T A C G T A C G T T G C A T G C A T C T**
T G A C T G C A T G C A T G C A T G C A A C G T A C G T A G A

(2) A C T G A C G C A C G T A C G T A C G T T G C A T G C A T C T
T G A C T G C A T G C A T G C A T G C A A C G T A C G T A G A

	U		C		A		G		
U	UUU	Phenylalanine	UCU	Serine	UAU	Tyrosine	UGU	Cysteine	U
	UUC	Phenylalanine	UCC	Serine	UAC	Tyrosine	UGC	Cysteine	C
	UUA	Leucine	UCA	Serine	UAA	Stop	UGA	Stop	A
	UUG	Leucine	UCG	Serine	UAG	Stop	UGG	Tryptophan	G
C	CUU	Leucine	CCU	Proline	CAU	Histidine	CGU	Arginine	U
	CUC	Leucine	CCC	Proline	CAC	Histidine	CGC	Arginine	C
	CUA	Leucine	CCA	Proline	CAA	Glutamine	CGA	Arginine	A
	CUG	Leucine	CCG	Proline	CAG	Glutamine	CGG	Arginine	G
A	AUU	Isoleucine	ACU	Threonine	AAU	Asparagine	AGU	Serine	U
	AUC	Isoleucine	ACC	Threonine	AAC	Asparagine	AGC	Serine	C
	AUA	Isoleucine	ACA	Threonine	AAA	Lysine	AGA	Arginine	A
	AUG	Methionine (Start)	ACG	Threonine	AAG	Lysine	AGG	Arginine	G
G	GUU	Valine	GCU	Alanine	GAU	Aspartic Acid	GGU	Glycine	U
	GUC	Valine	GCC	Alanine	GAC	Aspartic Acid	GGC	Glycine	C
	GUA	Valine	GCA	Alanine	GAA	Glutamic Acid	GGA	Glycine	A
	GUG	Valine	GCG	Alanine	GAG	Glutamic Acid	GGG	Glycine	G

Original DNA Strand

A C T G A C G T A C G T A C G T A C G T T G C A T G C A T C T
** T G A C T G C A T G C A T G C A T G C A A C G T A C G T A G A

Transcribed mRNA strand (correct)

A C U G A C G U A C G U A C G U A C G U U G C A U G C A U C

Translated Polypeptide (correct)

Threonine – Aspartic Acid – Valine – Arginine – Threonine – Tyrosine – Valine – Alanine – Cysteine – Isoleucine

Box F

Original DNA Strand

A C T G A C G T A C G T A C G T A C G T T G C A T G C A T C T

** T G A C T G C A T G C A T G C A T G C A A C G T A C G T A G A

? Transcribed mRNA strand Find Point Mutation (Substitution)

A C U G A C G U A C G A A C G U A C G U U G C A U G C A U C

Translated Polypeptide

?

Silent Mutation

Box G

Original DNA Strand

A C T G A C G T A C G T A C G T A C G T T G C A T G C A T C T

** T G A C T G C A T G C A T G C A T G C A A C G T A C G T A G A

? Transcribed mRNA strand Find Point Mutation (Substitution)

A C U G A C G U A C C U A C G U A C G U U G C A U G C A U C

Translated Polypeptide

?

Sickle Cell

Box H

Original DNA Strand

A C T G A C G T A C G T A C G T A C G T T G C A T G C A T C T

** T G A C T G C A T G C A T G C A T G C A A C G T A C G T A G A

Transcribed mRNA strand with Deletion (Frameshift Mutation)

A C U G C G U A C G U A C G U A C G U U G C A U G C A U C U

Translated Polypeptide

?

Gene Mutations	Point mutations	Frameshift mutations
DNA mutations during Replication during S-phase OR RNA mutations during Transcription	Substitutions	Insertions & Deletions

Learning Target: How can mutations affect DNA and Proteins?

Box I Students should review the "**Mutation Reading"** on the website.
https://sciencemathhelpcenter.weebly.com/unit-8---dna-synthesis--mutations.html

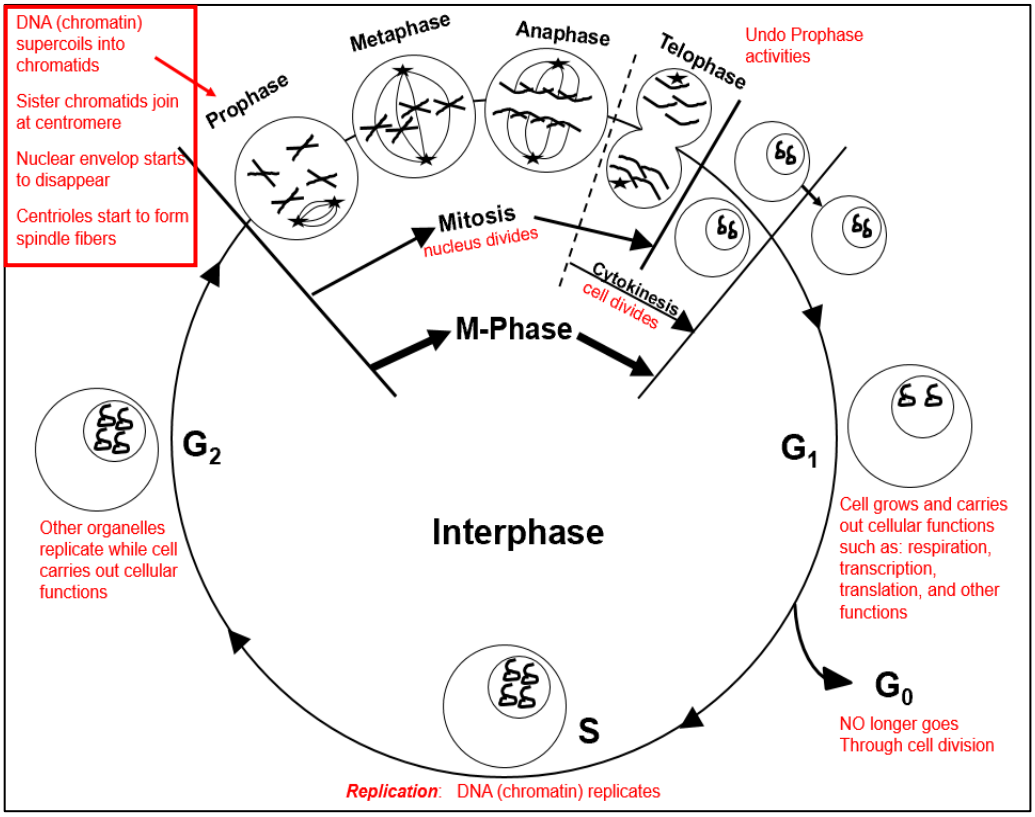
Question: Why are mutations beneficial and important?

The following are links to videos dealing with mutations. These links are also on the class website.
https://sciencemathhelpcenter.weebly.com/unit-8---dna-synthesis--mutations.html

a) A Mutation Story: (4:49)
https://www.pbslearningmedia.org/resource/tdc02.sci.life.gen.mutationstory/a-mutation-story/

b) Mechanisms of DNA Damage and Repair: (11:29)
At the 5:30 mark in video, the mutation discussed relates to a previous question on a worksheet in the previous unit.
https://www.youtube.com/watch?v=sX6LncNjTFU

c) Genetic Mutations - NatGeo: (48:55)
https://www.youtube.com/watch?v=Kk2yHeRoc9w

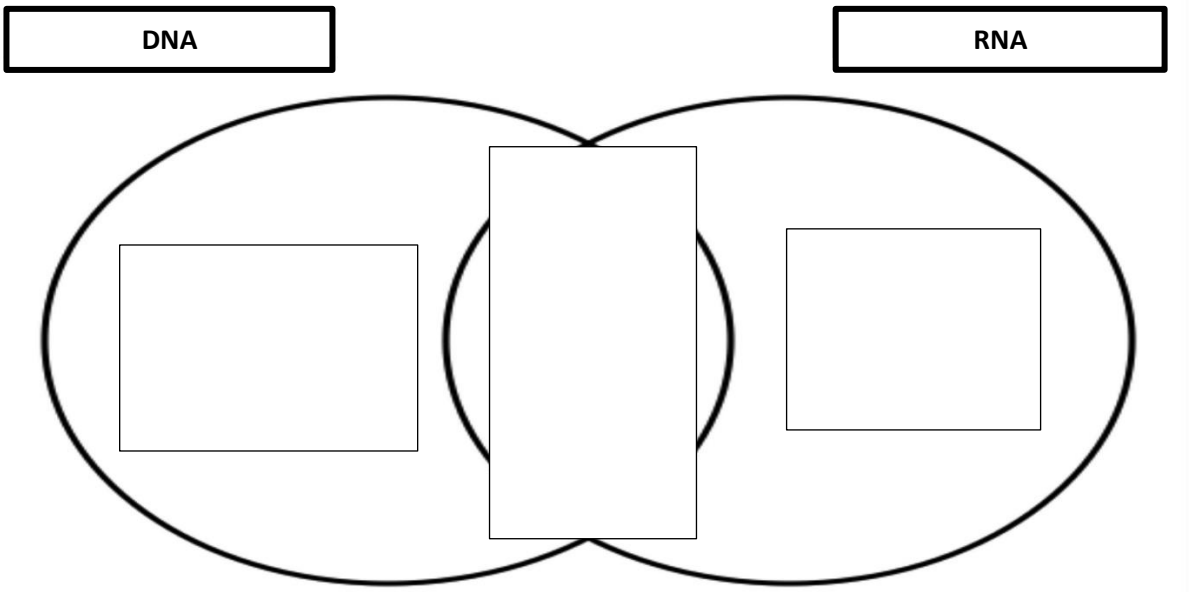


Study Guide

1. Sketch and label the parts of a DNA nucleotide.

2. What are the four nitrogen bases found in DNA?

3. Compare and contrast DNA verses RNA by completing the Venn Diagram.



4. What cell cycle step does DNA replication take place? Also, what part of the cell does replication take place in?

5. What are the three main enzymes that are used in DNA replication? Explain the role of each of these enzymes.

6. Describe a purine and a pyrimidine. Which DNA nitrogen bases are purines and which are pyrimidines?

7. What is the final product of DNA replication?

8. What type of bond holds together adenine and thymine as well as guanine with cytosine?

9. What makes up the backbone of DNA?

10. What is DNA called during the S-phase of Interphase?

11. In DNA replication, if 'TAC' made up the original half of the DNA strand, what is the NEW complementary side of the DNA strand?

12. The mRNA sequence 'GUG' codes for the amino acid 'Valine'. If a mutation occurs and the resulting mRNA sequence is 'GCG', what amino acid will replace 'Leucine'?

	U		C		A		G		
U	UUU	Phenylalanine	UCU	Serine	UAU	Tyrosine	UGU	Cysteine	U
	UUC	Phenylalanine	UCC	Serine	UAC	Tyrosine	UGC	Cysteine	C
	UUA	Leucine	UCA	Serine	UAA	Stop	UGA	Stop	A
	UUG	Leucine	UCG	Serine	UAG	Stop	UGG	Tryptophan	G
C	CUU	Leucine	CCU	Proline	CAU	Histidine	CGU	Arginine	U
	CUC	Leucine	CCC	Proline	CAC	Histidine	CGC	Arginine	C
	CUA	Leucine	CCA	Proline	CAA	Glutamine	CGA	Arginine	A
	CUG	Leucine	CCG	Proline	CAG	Glutamine	CGG	Arginine	G
A	AUU	Isoleucine	ACU	Threonine	AAU	Asparagine	AGU	Serine	U
	AUC	Isoleucine	ACC	Threonine	AAC	Asparagine	AGC	Serine	C
	AUA	Isoleucine	ACA	Threonine	AAA	Lysine	AGA	Arginine	A
	AUG	Methionine (Start)	ACG	Threonine	AAG	Lysine	AGG	Arginine	G
G	GUU	Valine	GCU	Alanine	GAU	Aspartic Acid	GGU	Glycine	U
	GUC	Valine	GCC	Alanine	GAC	Aspartic Acid	GGC	Glycine	C
	GUA	Valine	GCA	Alanine	GAA	Glutamic Acid	GGA	Glycine	A
	GUG	Valine	GCG	Alanine	GAG	Glutamic Acid	GGG	Glycine	G

13) What are the differences between frameshift mutations, silent mutations, and nonsense mutations?

14) Why are mutations beneficial and important?

15) When DNA replication happens, both ends of the new DNA strands gets cut off. These DNA end strands that get cut off do not contain any useful instructions for making a protein. What are these DNA end strands called?

16) What are the roles of Watson, Crick, and Franklin to the discovery of the structure of DNA?