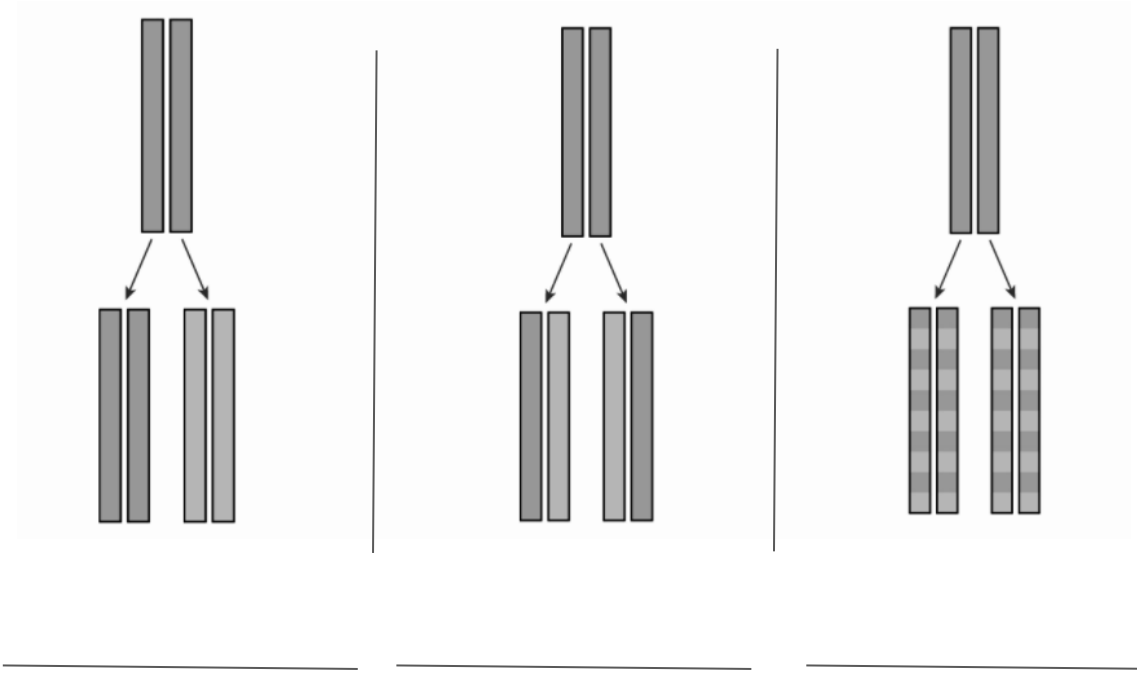
DNA Replication

DNA replicates during the _____ phase of the cell cycle.

How does DNA replicate?

Models of DNA Replication

There were 3 alternative models for DNA replication

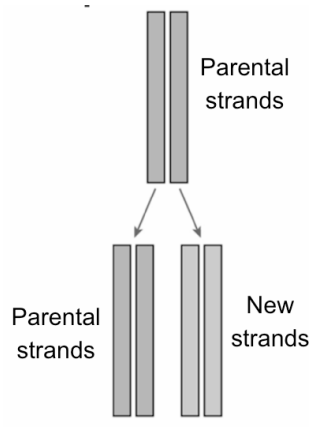


➔Questions?
➔Textbook chapters/pages to review

Models of DNA Replication

1. _____

The _____ strands direct synthesis of:

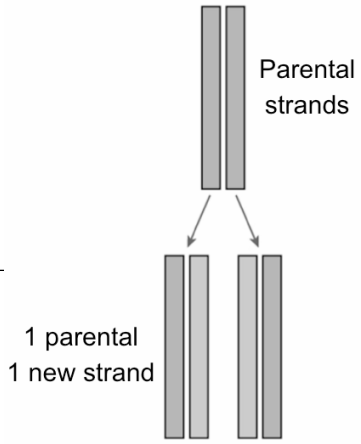


The parental strands are fully _____.

2. _____

The two parental strands:

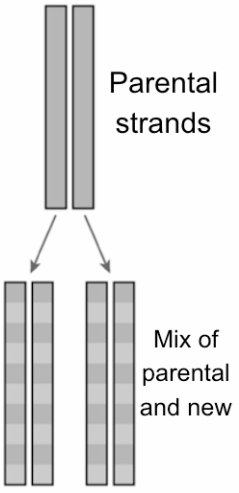
After one round of replication, the two _____ molecules each have one _____ and one _____ strand.



3. _____

The material in the two parental strands is dispersed _____ between the two _____ molecules.

After one round of replication, the _____ molecules contain a _____ _____ of parental and new DNA.



➔Questions?
➔Textbook chapters/pages to review

Which Model Is Correct?

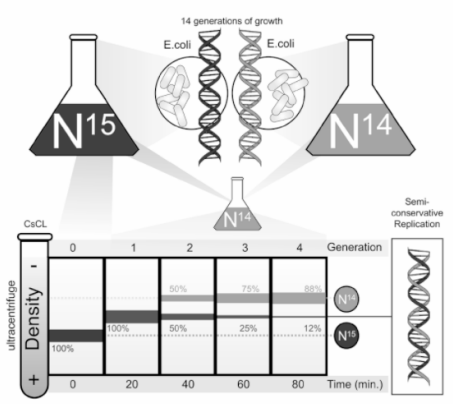
In 1954 _____ and _____ performed an experiment using bacteria.

Process:

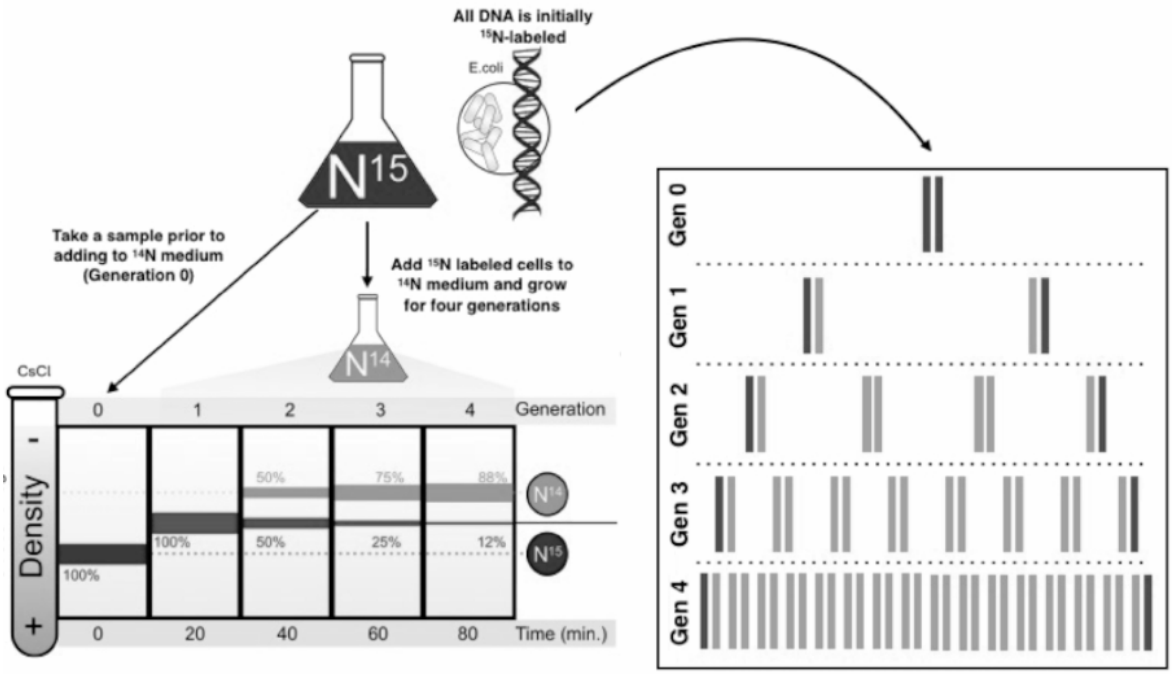
1.

2.

3.



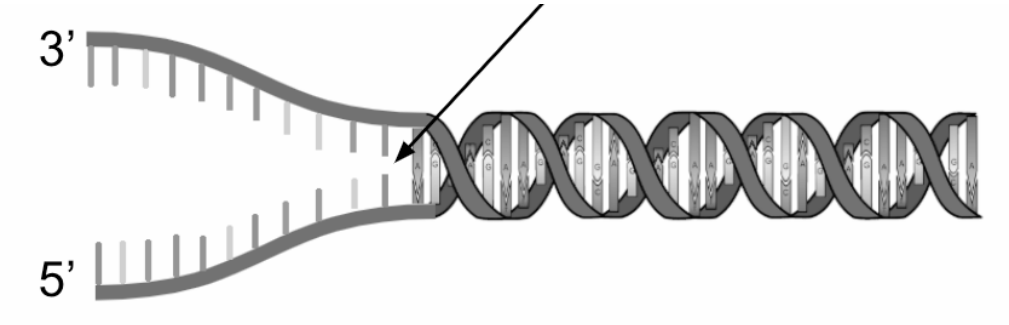
By analyzing samples of DNA after each _____, it was found that the parental strands were following the _____ model.



➔Questions?
➔Textbook chapters/pages to review

Steps in DNA Replication

1. DNA replication begins at sites called _____

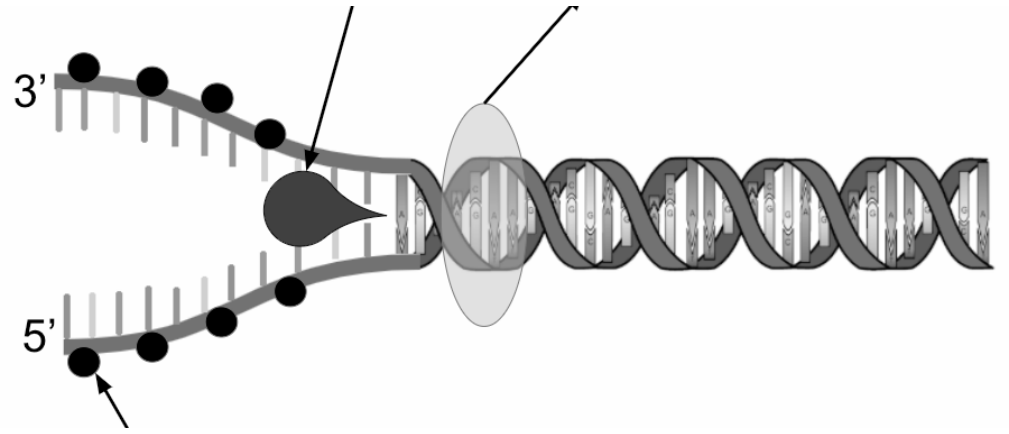


2. _____ will unwind the DNA strands at each _____ _____

To keep the DNA from re-bonding with itself:

_____ will help prevent _____

ahead of the replication fork by relaxing _____.



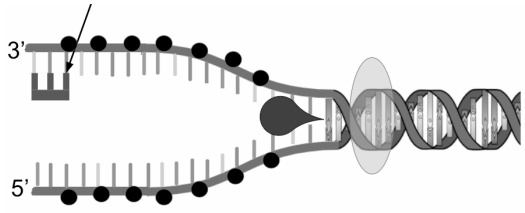
➔Questions?
➔Textbook chapters/pages to review

Steps in DNA Replication

3. The enzyme _____ initiates replication by adding short segments of _____, called _____, to the parental DNA strand.

   The enzymes that synthesize DNA can only attach new DNA nucleotides to:

   Primers serve as the:



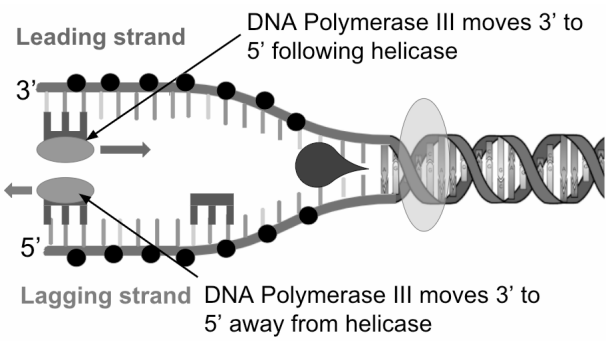
4. Antiparallel elongation

   DNA Polymerase III (DNAP III):

   As it moves, it adds:

   The DNAP III that follows helicase is known as the _____ and it only requires _____ _____.

   The DNAP III on the other parental strand that moves away from helicase is known as the _____ _____ and requires _____ primers.

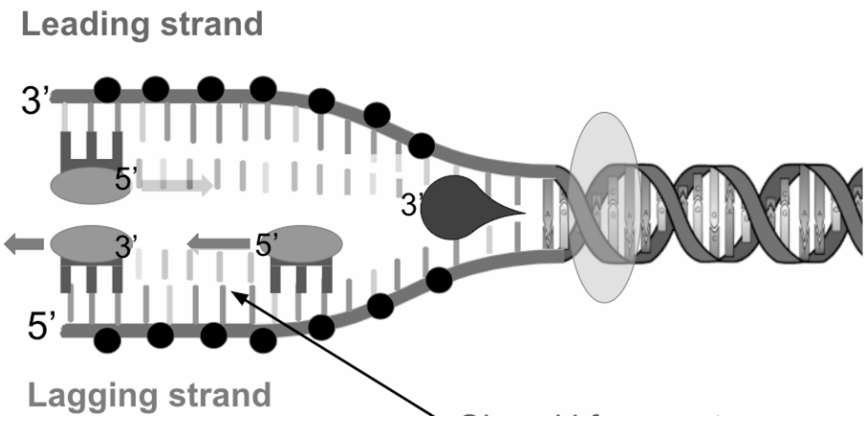


➔Questions?
➔Textbook chapters/pages to review

Steps in DNA Replication

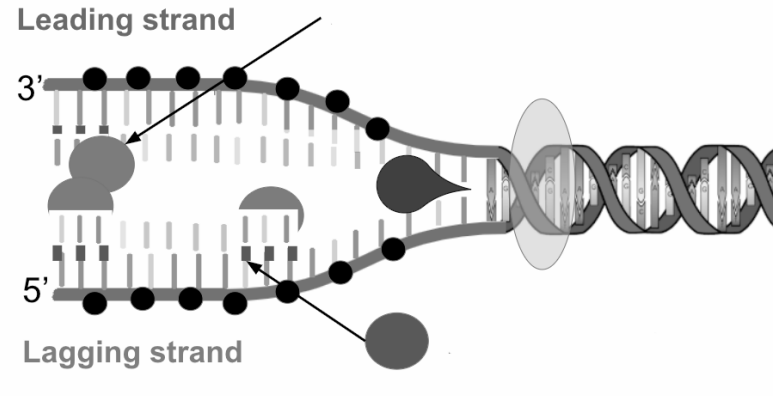
5. The _____ strand is synthesized in one continuous segment, but since the _____ strand moves away from the _____ _____ it is synthesized in chunks.

Okazaki fragments:



6. After _____ forms an _____ fragment, _____ replaces _____ nucleotides with _____ nucleotides.

DNA ligase:



➔Questions?
➔Textbook chapters/pages to review

Problems at the 5' End

Since DNAP III can only add nucleotides to a 3' end, there is no way to finish replication on the 5' end of a _____ strand.

Over many replications this would mean:

How are the genes on DNA protected from this?

Telomeres:

Proofreading and Repair

As _____ adds nucleotides to the new DNA strand, it proofreads the bases added.

If errors still occur:

If segments of DNA are damaged:

Quick Review

1. If a parental DNA strand read: 5'- ACGTAC- 3' what would a newly synthesized complementary strand read?

2. Summarize the role of helicase, topoisomerase, and DNA Polymerase III.

3. What direction does DNAP III move along the parental strand?

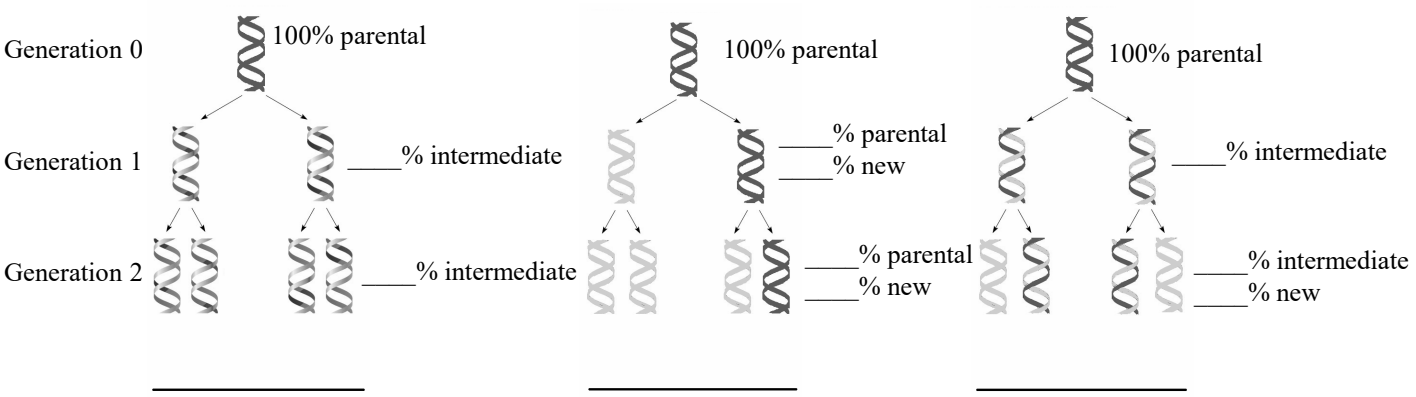
4. Why do Okazaki fragments occur on the lagging strand.

➔Use this space to reflect on Topic 2
➔Textbook chapters/pages to review

DNA Replication: An Overview

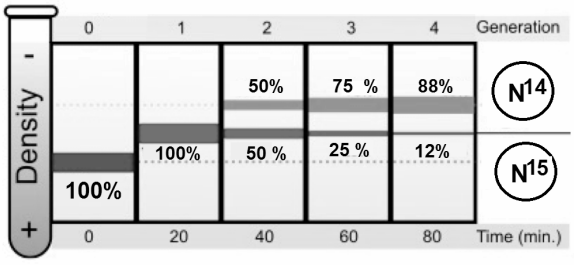
1. What is the purpose of DNA replication?

2. Examine the models of DNA replication below. Label each picture with the correct model (conservative, semiconservative, or dispersive). Then, label each generation with the appropriate percentages of DNA.



3. Describe each of the DNA replication models (conservative, semiconservative, and dispersive).

4. The Meselson and Stahl experiment sought to determine the correct model of DNA replication. The results from their experiment are shown below. Which model does their data support? Justify why the data supports this model.

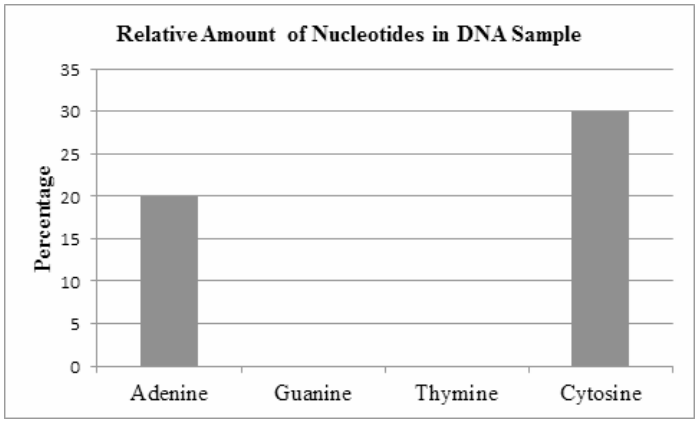


5. In DNA, adenine bonds with _____ and cytosine bonds with _____.

6. DNA strands are _____, meaning one strand runs 3' to 5', while the other strand runs 5' to 3'.

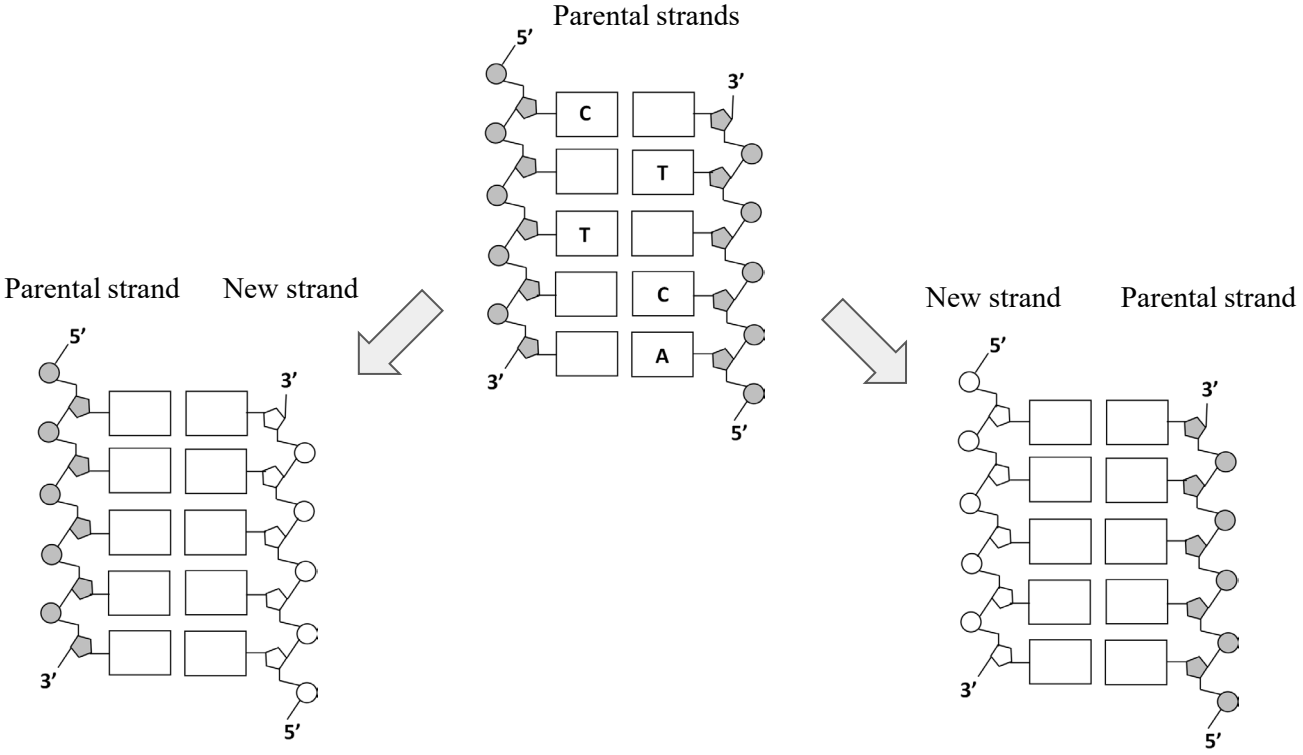
7. The sugar phosphate backbone of DNA has directionality. The 5' end has a _____ group, while the 3' end has a _____ group.

8. Examine the graph below that represents the relative percentage of nucleotides found in a sample of DNA. Draw bars that would represent the amount of guanine and thymine.

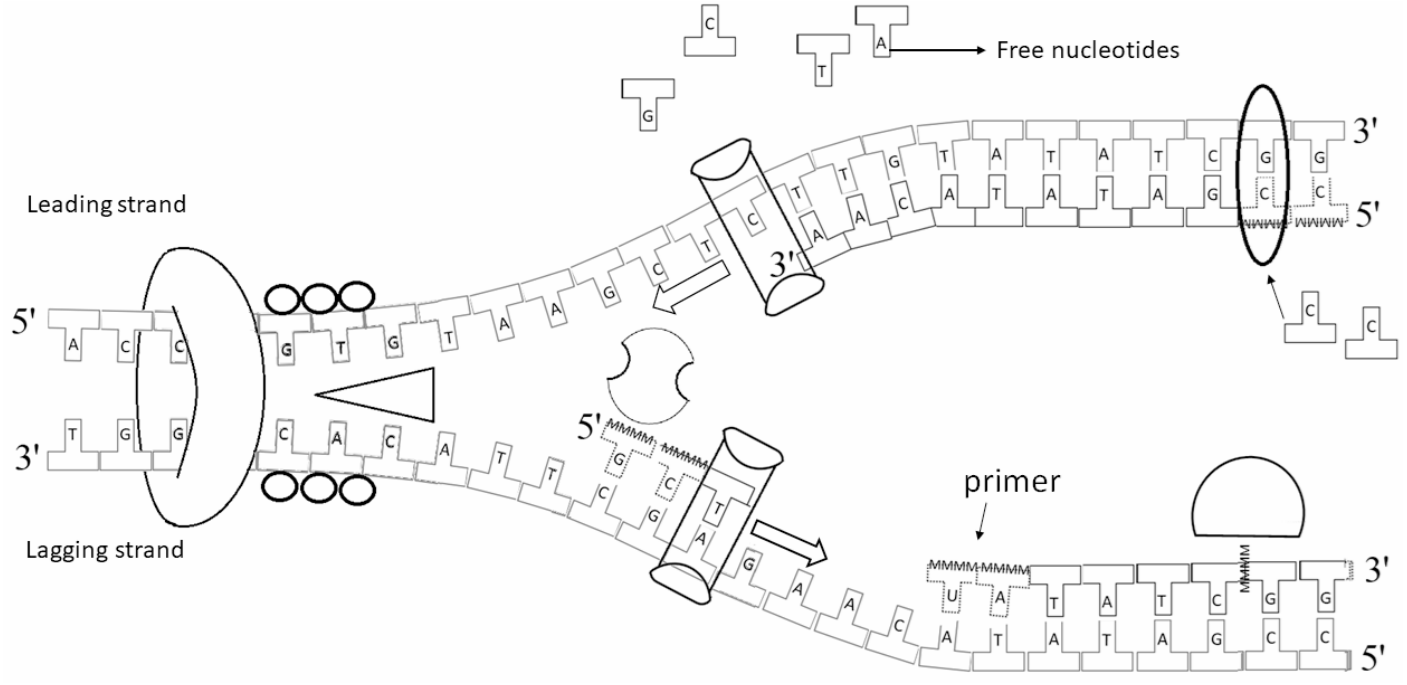


9. A section of DNA reads as follows: 5'- ACT GAC GTT ACG- 3'. What would the complementary strand read? Hint: don't forget- strands are antiparallel!

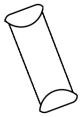
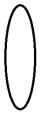
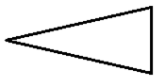
10. Examine the DNA that has been replicated below. First, fill in the missing nucleotides on the parental strand. Then, determine the nucleotides of the replicated strands



DNA Replication: Key Players

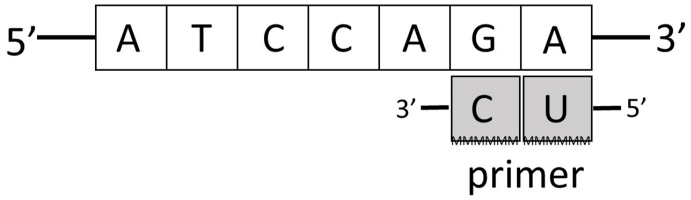


Examine the image above, which gives an overview of DNA replication. Identify the "key players" involved in replication, then summarize their function in the table below

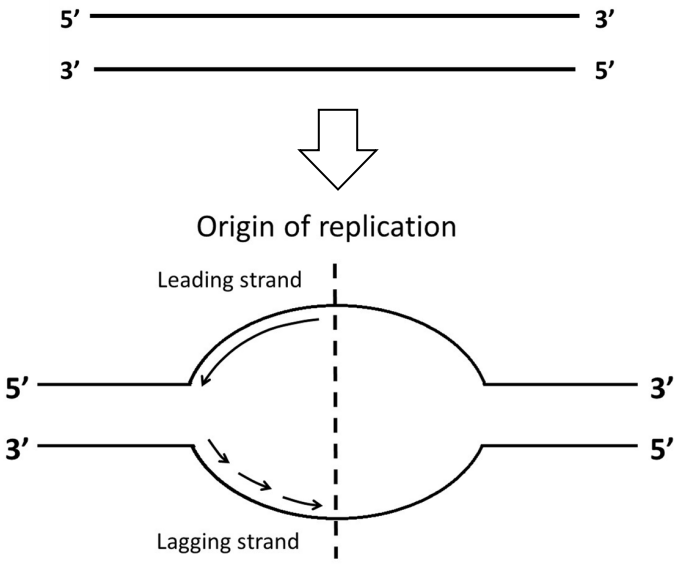
Topoisomerase 		RNA primase 	
DNA polymerase III 		DNA polymerase I 	
Single strand binding proteins 		Leading strand	
Helicase 		Lagging strand	
DNA ligase 		Okazaki fragments	

1. During DNA replication, what direction does DNA polymerase III move along the template strand? In what direction does it synthesize new DNA by adding DNA nucleotides to the new strand?

2. Examine the image below. Why must RNA primase lay down a primer before DNA polymerase can begin adding DNA nucleotides to the new strand?



3. Below is an image of DNA that is about to go through replication. Notice that the replication of DNA begins at particular sequences of nucleotides, called **origins of replication**. When the DNA opens up, it forms a **replication bubble**. At each end of the bubble is a **replication fork**, a Y-shaped region where the parental DNA is being unwound by helicase. On the replication bubble, draw and label the leading and lagging strands. One side has been done for you.

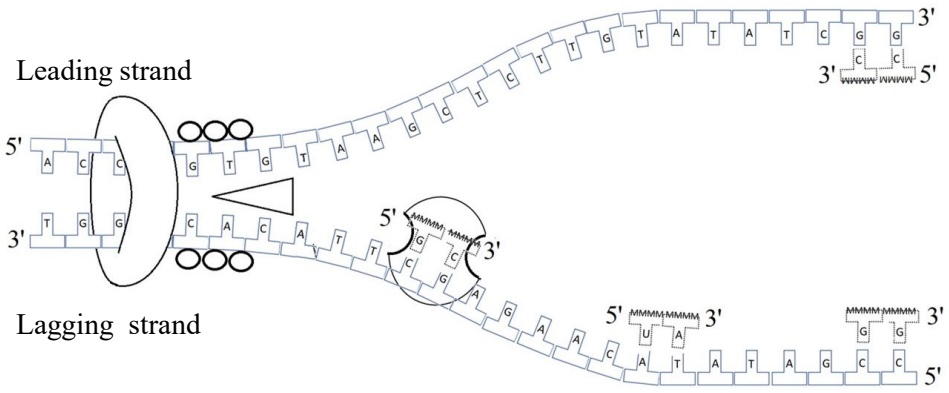


4. Imagine a cell had a mutation that prevented the production of DNA ligase. What effect would it have on the process of replication?

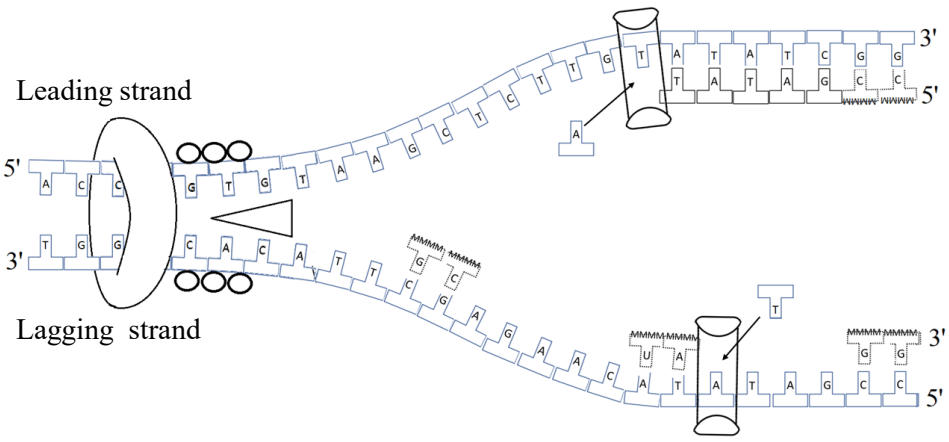
5. Human DNA contains approximately 3 billion base pairs, which reside in the 23 pairs of chromosomes. DNA polymerase III can elongate the new DNA strand at about 50 nucleotides per second. Knowing this, how is it possible that DNA replication only takes about 8 hours for a typical human cell?

Lagging Strand: A Closer Look

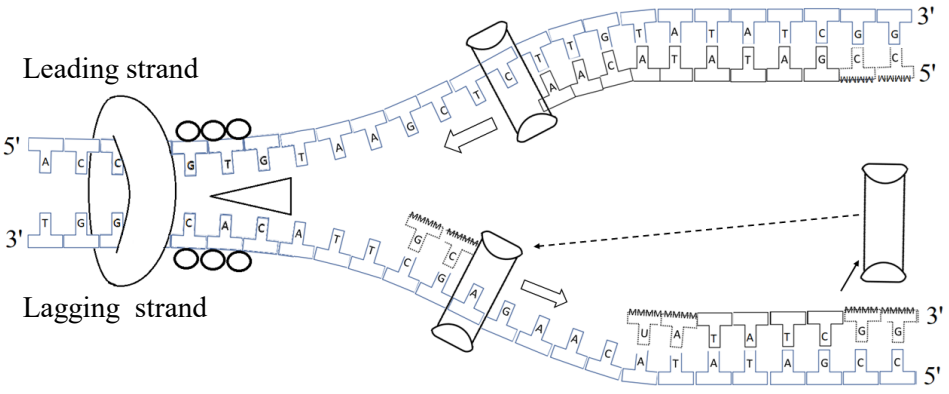
Replication of the lagging strand is more complex than replication of the leading strand. Why? Well, DNA polymerase III moves in the 3' to 5' direction on both parental strands. For the leading strand, this is simple because that means DNA polymerase III follows helicase and adds nucleotides to the new DNA continuously. However, due to the antiparallel nature of DNA, that means DNA polymerase III will move away from helicase on the lagging strand, so it has to synthesize DNA in segments known as Okazaki fragments. Let's take a closer, step-by-step look at the lagging strand. Fill in the blanks with the appropriate proteins or enzymes involved (refer to the "DNA Key Players" worksheet if you get stuck). Please note, the process of replication is also being shown for the leading strand, but you are only answering questions about the lagging strand.



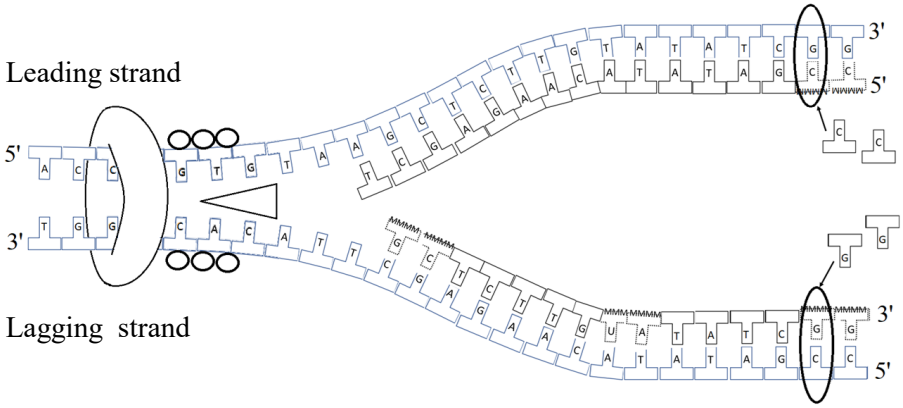
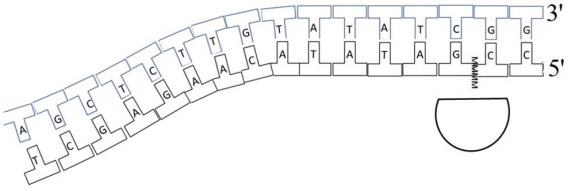
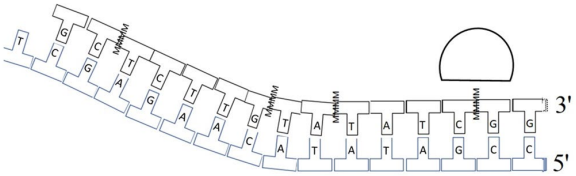
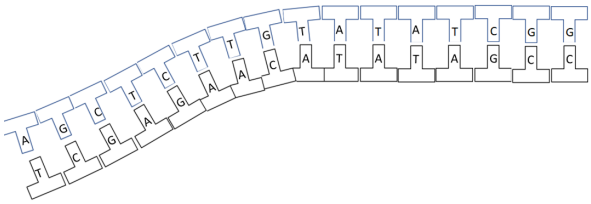
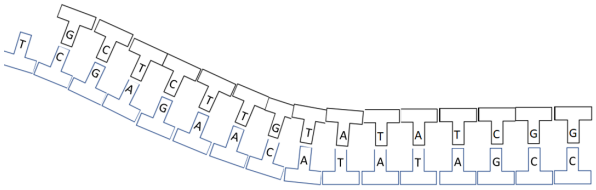
To initiate replication of the lagging strand _____ adds RNA nucleotides to the parental strand. These nucleotides are necessary because _____ can only add DNA nucleotides to a free _____ end.



Since the new strand, made of short segments of RNA nucleotides, has a free 3' end, _____can attach and add _____ nucleotides forming short segments of newly synthesized DNA. These segments are known as _____ _____.



When _____ reaches the next _____, it detaches and moves to the next section of DNA that is primed. It continues moving in a _____ to _____ direction and repeats this pattern of detaching and moving to a newly primed section of DNA.

Leading strand  Lagging strand	Next, _____ comes in to replace the _____ nucleotides with _____ nucleotides.
Leading strand   Lagging strand	Lastly, _____ forms a bond between the_____ end of DNA fragments and the _____ end of another fragment.
Leading strand  Lagging strand 	This forms one continuous strand of newly synthesized _____.

In your own words, summarize the process of DNA replication, and make sure to highlight the differences between the leading and lagging strand.

Topic 3 Notes: Transcription and RNA Processing

Proteins

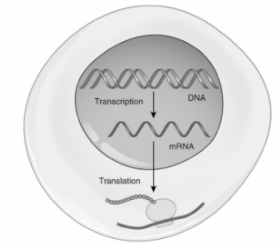
Proteins are _____ made up of _____ _____.

Amino acids are linked by:

Gene expression:

Includes two stages:

Transcription and Translation



Transcription:

Allows for:

Occurs in:

Translation:

➔Questions?
➔Textbook chapters/pages to review

Types of RNA

As we go through transcription and translation there will be three key RNA molecules.

1.

2.

3.

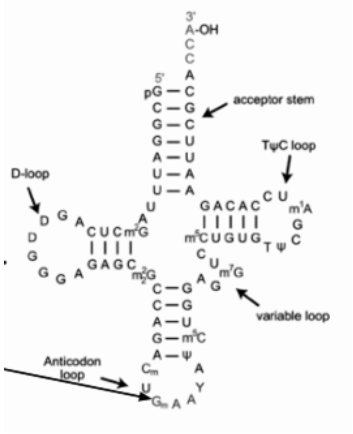
Messenger RNA

Messenger RNA is synthesized during _____ using a _____ template.

mRNA carries information from the _____ (at the _____) to the

_____ in the _____.

Transfer RNA



Transfer RNA molecules are important in the process of _____.

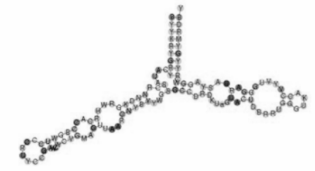
Each tRNA can carry a specific:

Can attach to mRNA via their:

Allow information to be translated into a _____

_____.

Ribosomal RNA



rRNA helps form:

Helps link:

➔Questions?
➔Textbook chapters/pages to review

The Genetic Code

DNA contains the sequence of _____ that codes for _____.

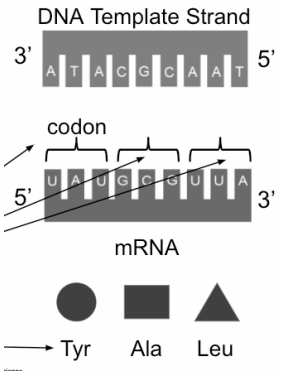
The sequence is read in groups of _____ called the _____ code.

During _____, only one _____ strand is being transcribed.

mRNA molecules formed are _____ and _____ to the DNA nucleotides.

Base pairing:

The mRNA nucleotide triplets are called _____



The Genetic Code

First letter	Second letter: U	Second letter: C	Second letter: A	Second letter: G	Third letter
U	UUU Phe, UUC Phe	UCU Ser, UCC Ser, UCA Ser, UCG Ser	UAU Tyr, UAC Tyr	UGU Cys, UGC Cys	U C A G
	UUA Leu, UUG Leu		UAA Stop, UAG Stop	UGA Stop, UGG Trp	
C	CUU Leu, CUC Leu, CUA Leu, CUG Leu	CCU Pro, CCC Pro, CCA Pro, CCG Pro	CAU His, CAC His	CGU Arg, CGC Arg, CGA Arg, CGG Arg	U C A G
			CAA Gln, CAG Gln		
A	AUU Ile, AUC Ile, AUA Ile	ACU Thr, ACC Thr, ACA Thr, ACG Thr	AAU Asn, AAC Asn	AGU Ser, AGC Ser	U C A G
	AUG Met		AAA Lys, AAG Lys	AGA Arg, AGG Arg	
G	GUU Val, GUC Val, GUA Val, GUG Val	GCU Ala, GCC Ala, GCA Ala, GCG Ala	GAU Asp, GAC Asp	GGU Gly, GGC Gly, GGA Gly, GGG Gly	U C A G
			GAA Glu, GAG Glu		

_____ different codon combinations

_____ code for amino acids

_____ are stop codons

Universal to all _____

➔Questions?
➔Textbook chapters/pages to review

Reading frame:

Example:

If the reading frame shifts even by one letter, it will produce a completely different outcome:

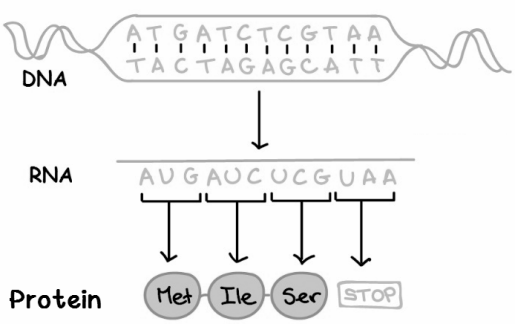
Quick Check:

1. If the DNA template strand reads: 3'-ACGAGA- 5' what will the mRNA transcript read?

2. Using the mRNA transcript from #1, what amino acids will be produced during translation? (Refer to a codon chart.)

Gene Expression: Overview

In biology, the phrase *central dogma* often refers to the flow of information inside of cells. The basic idea of the *central dogma* is represented in the figure to the right. Examine the image and then answer the questions below.



1. Describe the basic flow of information inside of cells.

2. What process takes information from DNA and turns it into RNA? What about from RNA to protein?

3. Referring to question 2, where in a prokaryotic cell does each process take place? What about in a eukaryotic cell?

4. mRNA is read in groups of 3 called _____. What do they code for?

5. Describe how DNA and RNA differ in their nucleotide composition, shape, function, and location.

First letter	Second letter: U	Second letter: C	Second letter: A	Second letter: G	Third letter
U	UUU, UUC: Phe; UUA, UUG: Leu	UCU, UCC, UCA, UCG: Ser	UAU, UAC: Tyr; UAA: Stop; UAG: Stop	UGU, UGC: Cys; UGA: Stop; UGG: Trp	U C A G
C	CUU, CUC, CUA, CUG: Leu	CCU, CCC, CCA, CCG: Pro	CAU, CAC: His; CAA, CAG: Gin	CGU, CGC, CGA, CGG: Arg	U C A G
A	AUU, AUC, AUA: Ile; AUG: Met	ACU, ACC, ACA, ACG: Thr	AAU, AAC: Asn; AAA, AAG: Lys	AGU, AGC: Ser; AGA, AGG: Arg	U C A G
G	GUU, GUC, GUA, GUG: Val	GCU, GCC, GCA, GCG: Ala	GAU, GAC: Asp; GAA, GAG: Glu	GGU, GGC, GGA, GGG: Gly	U C A G

Use the codon chart to the left to answer the questions below.

6. What is the start codon? What amino acid does it code for?

7. What are the three stop codons? Do stop codons code for an amino acid?

8. An mRNA strand reads as follows: 5'- AUG AAU GGC CUA AAG - 3' what sequence of amino acids would this produce?

9. How many codons are there total? How many code for amino acids?

10. How many amino acids are there total? Is it the same as the number of codons? Why or why not?

11. Explain why redundancy is so important for the genetic code.

12. The genetic code has redundancy but no ambiguity. In your own words, what does this mean?