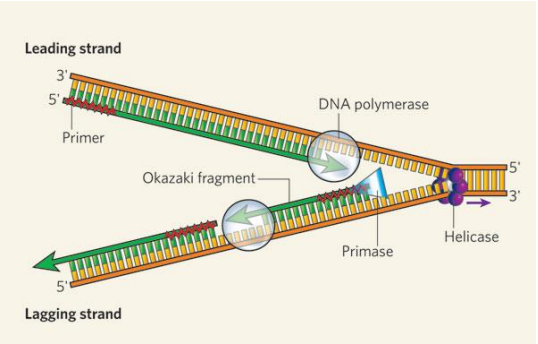
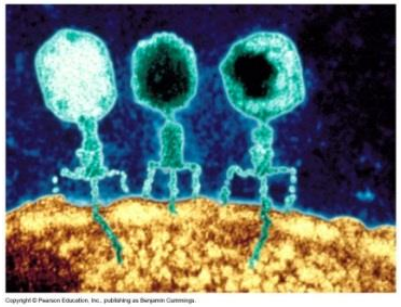
Friday, April 17th



UNIT 6
MOLECULAR GENETICS



Crash Course:

DNA, Transcription and Translation

Today I will…

1. ***Review*** the component parts of a DNA molecule.
2. ***Describe*** the process of transformation.
3. ***Explain*** what is meant by anti-parallel.

Monday/Tuesday, April 20-21st

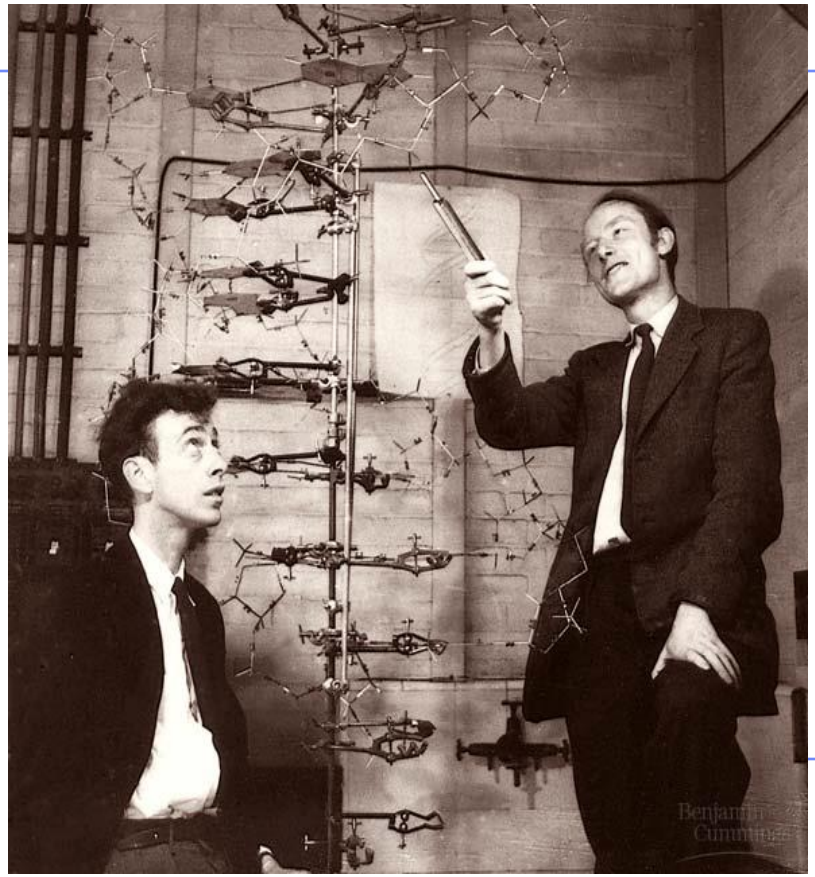
Happy Tuesday! Please pick up the 2 sheets off the front counter. One will serve as a bellwork "log" for the next few weeks. Complete today's after you pick up your sheet.

QUESTION TO PONDER

Today I will…

1. Review the structure of DNA.
2. List various scientists involved in the discovery of DNA.
3. Explain transformation.
4. Describe the process of DNA replication. Compare prokaryotic and eukaryotic replication mechanisms.

Deoxyribonucleic Acid



- ***The Molecular Basis of Inheritance***

Who are these guys?

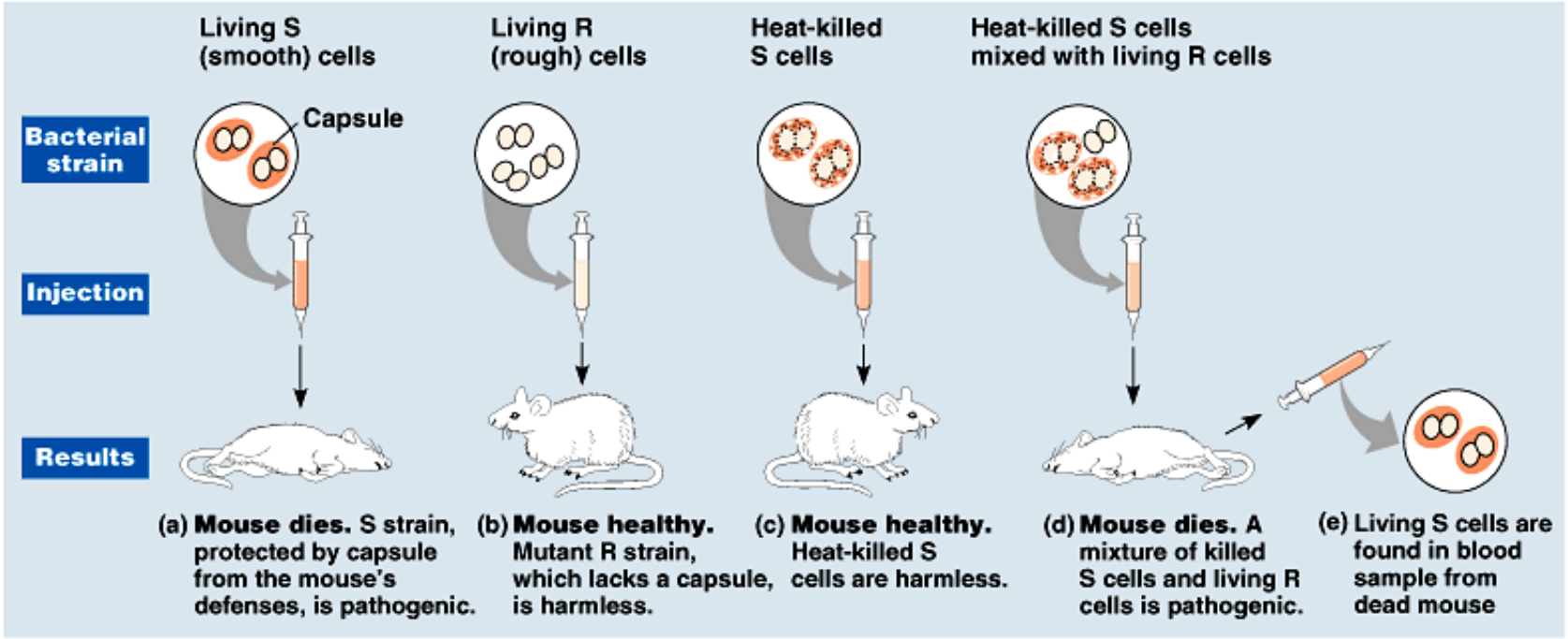
What is DNA?

- Primary source of genetic information
  - RNA can be used in some cases
- **Eukaryotic cells** – multiple, linear chromosomes, found in nucleus
- **Prokaryotic cells** – circular chromosomes, found in cytosol

- ***Plasmids*** = separate extra-piece of circular DNA

Griffith's Transformation Experiment - 1928

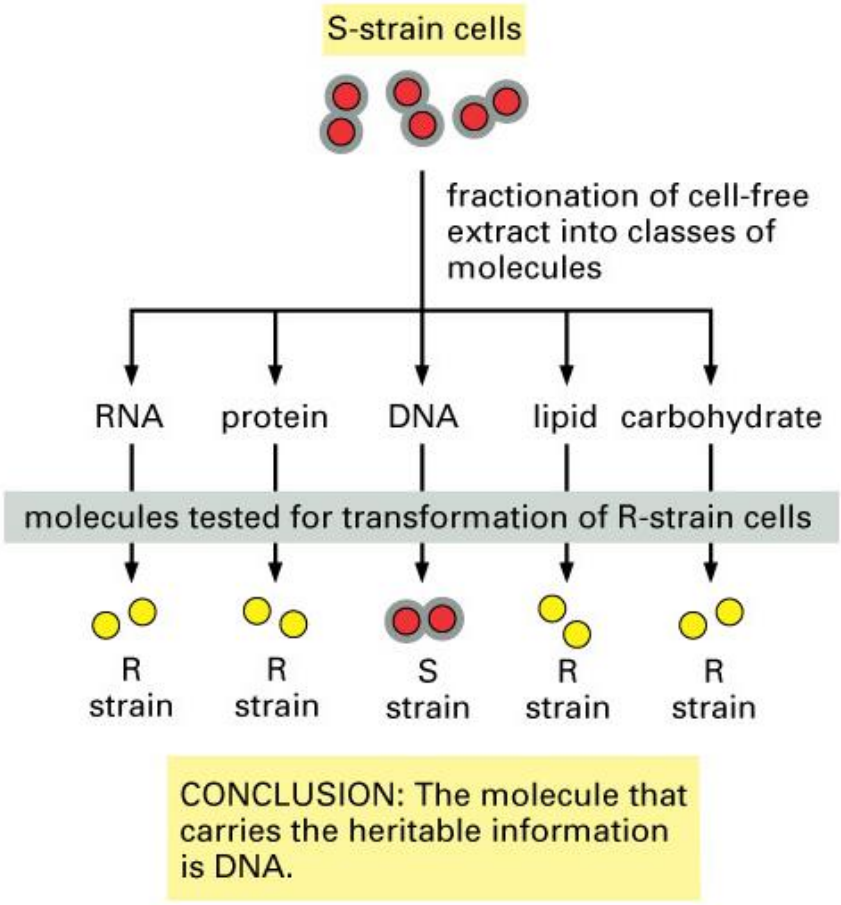
- Bacteria could get traits from other bacteria "transforming" their traits.



AP

Avery, McCarty and MacLeod - 1944

- Refined Griffith's experiment
- Proved transforming agent was nucleic acid.

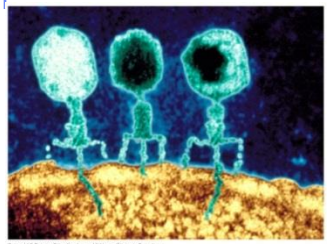


ll Biology, 2/e. (© 2004 Garland Science)

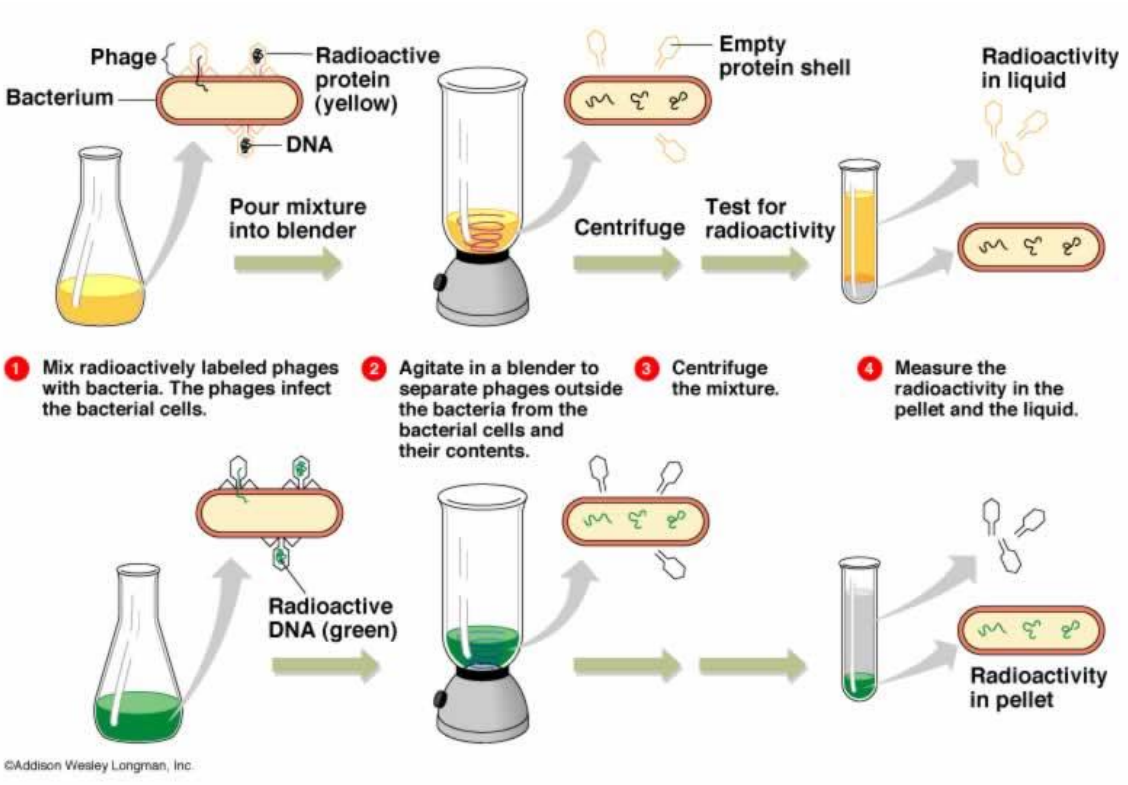
Hershey and Chase – *"Blender Experiment "* 1952

Hershey and Chase experiment

- **Further proved that DNA, not protein, is the hereditary material**



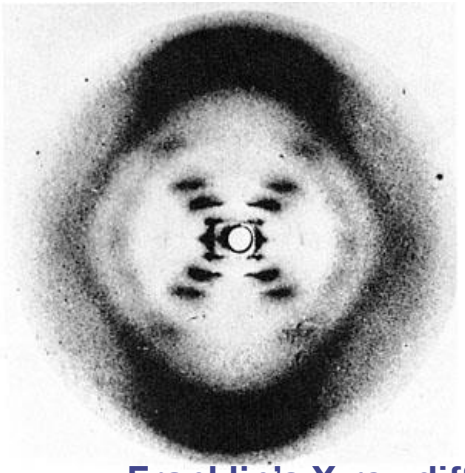
Bacteriophages!
Viruses that infect bacteria



- **Maurice Wilkins and Rosalind Franklin**
  - Were using a technique called X-ray crystallography to study molecular structure
- **Rosalind Franklin**
  - Produced a picture of the DNA molecule using this technique

Why was this an important discovery?

(a) Rosalind Franklin



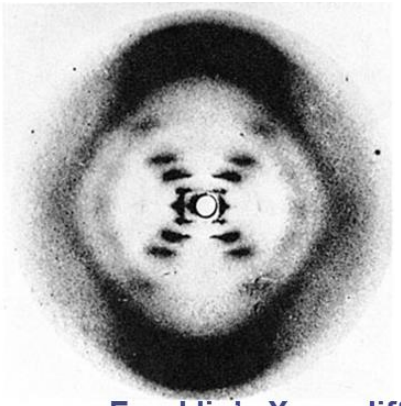
(b) Franklin's X-ray diffraction Photograph of DNA

Figure 16.6 a, b

Watson and Crick – 1953

- Discovered the structure of DNA
- Nobel prize in 1962 (with Wilkins)
- Deduced that DNA was a double helix
  - Through observations of the X-ray crystallographic images of DNA from Rosalind Franklin

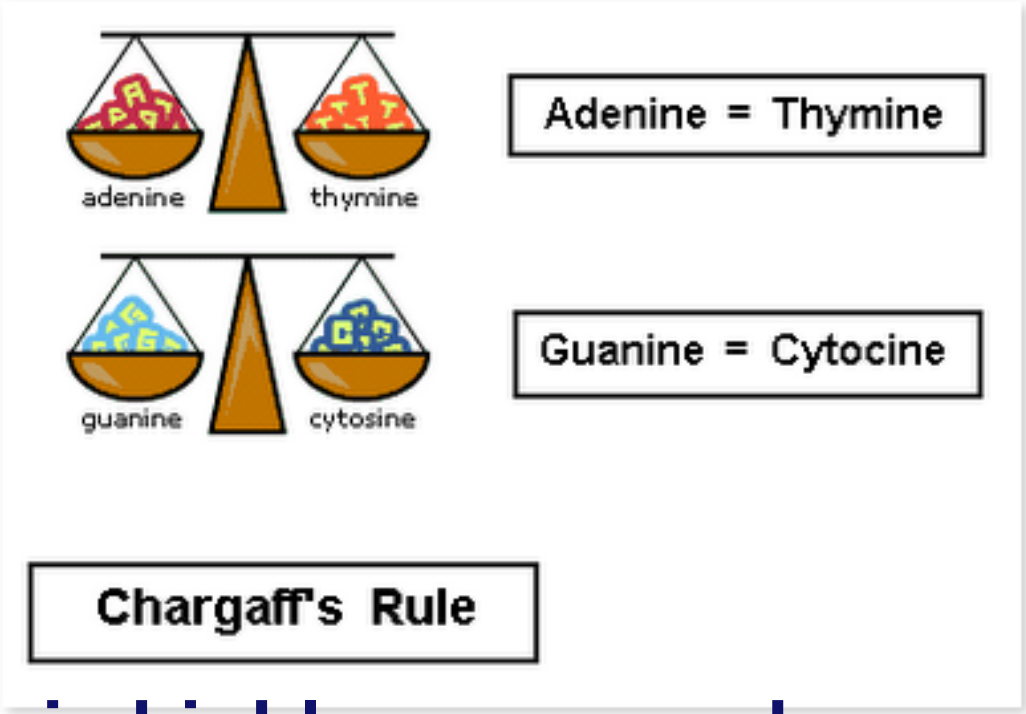
(a) Rosalind Franklin



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

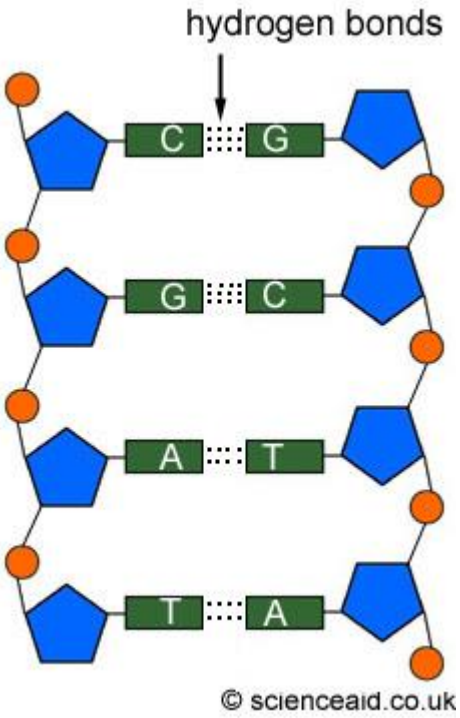
Erwin Chargaff – 1950's

- All organisms have the same bases just in different amounts.
- In any DNA:

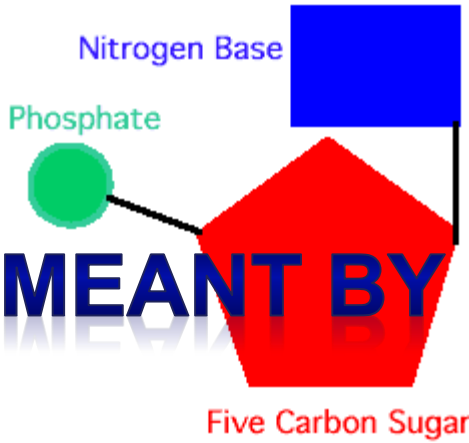


- Base pairing is highly conserved through evolution

DNA Structure



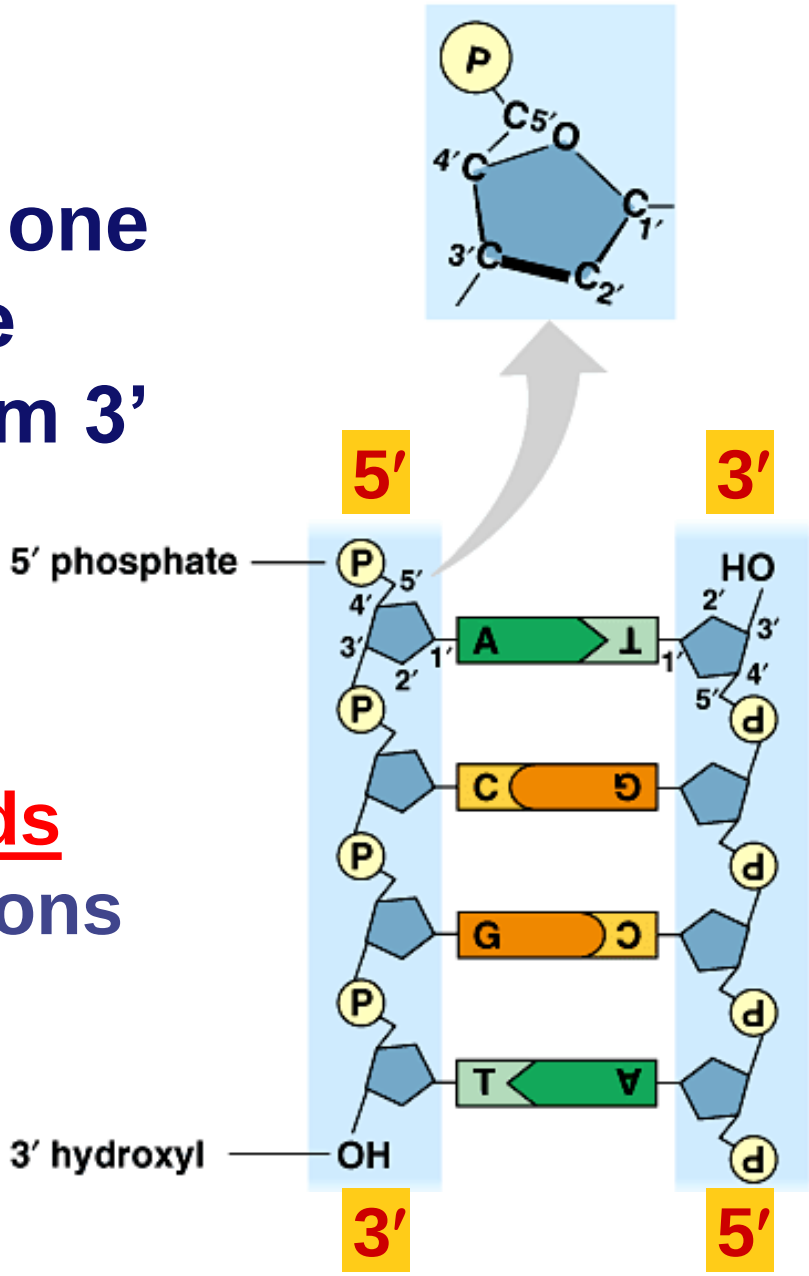
- Monomers = nucleotides
- Nucleotide structure:
  - Phosphate
  - Sugar (deoxyribose)
  - Nitrogen base
    - Adenine, guanine, thymine, cytosine



WHAT IS MEANT BY 5' AND 3'?

Anti-parallel strands

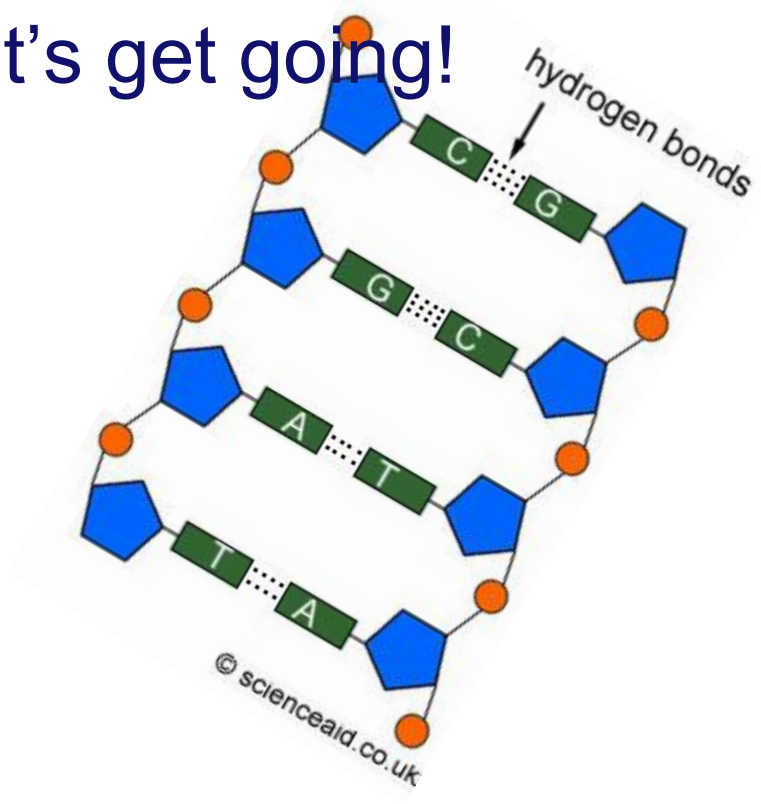
- Nucleotides in DNA on one side run 5’ to 3’ and the opposing side runs from 3’ to 5’
  - This gives the DNA molecule “direction”
  - Complementary strands run in opposite directions



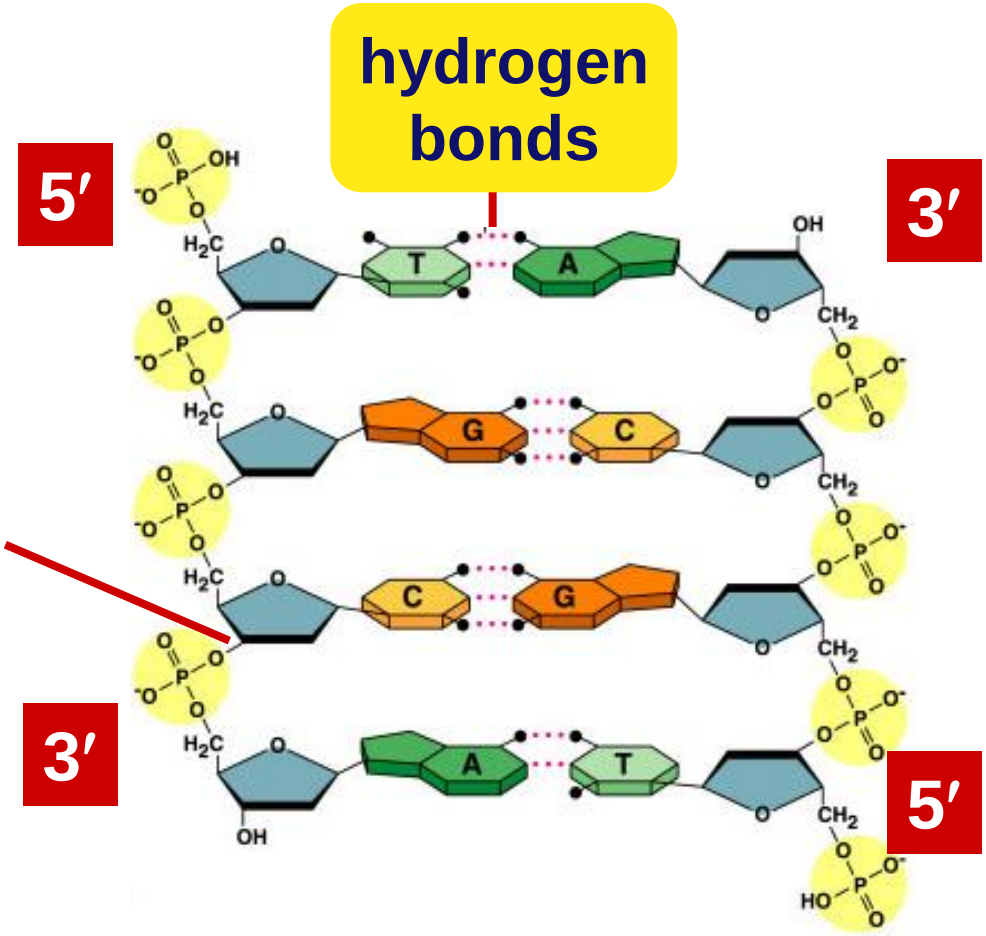
Structure continued…

Yesterday, we discussed the structure of a DNA molecule.

Please take out your **DNA Structure & Replication** wksht and let's get going!



Bonding in DNA

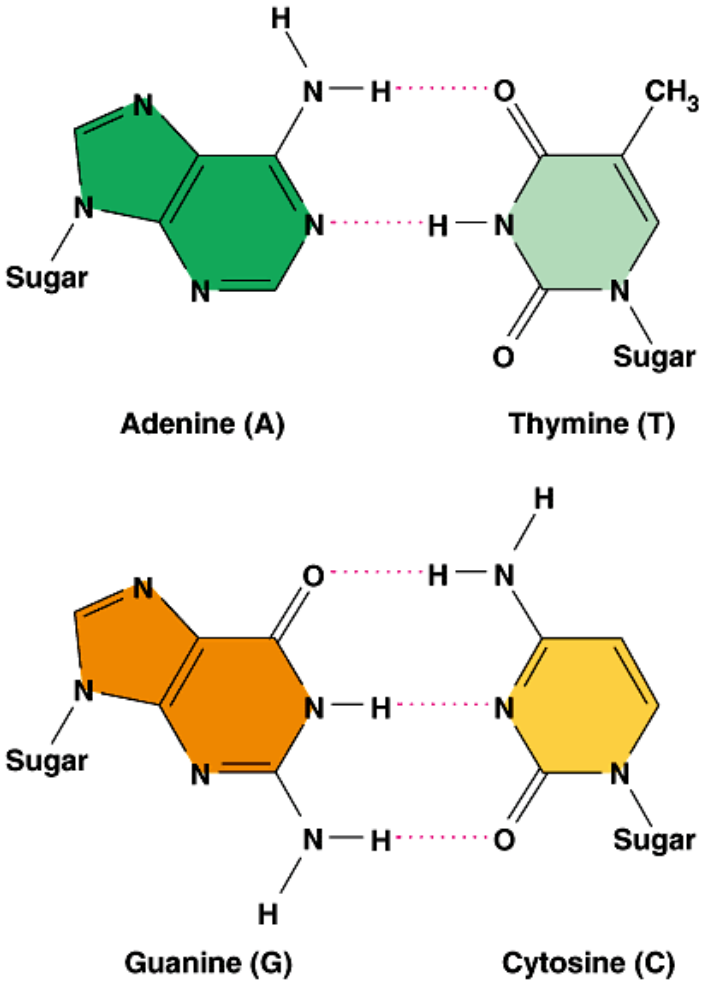


….strong or weak bonds?

How do the bonds fit the mechanism for copying DNA?

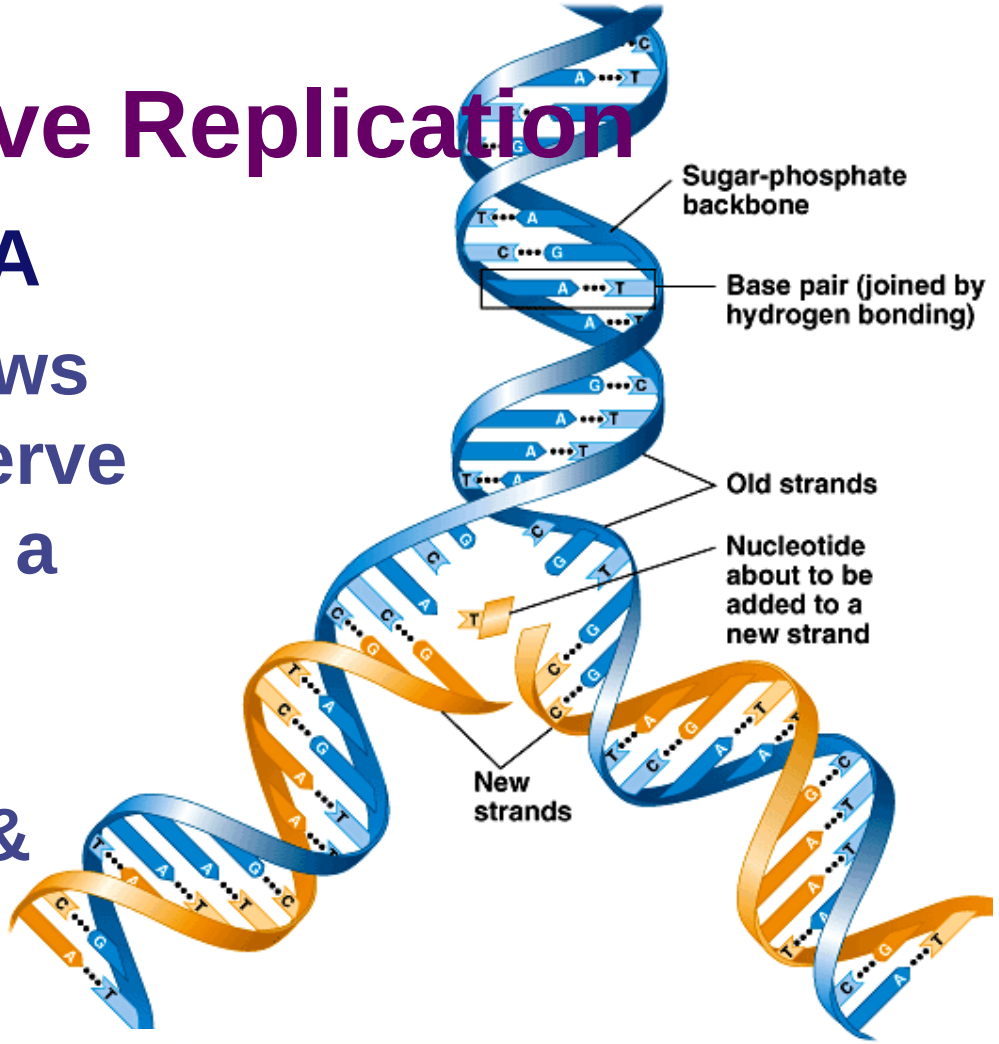
Nitrogen Bases and Pairing in DNA –

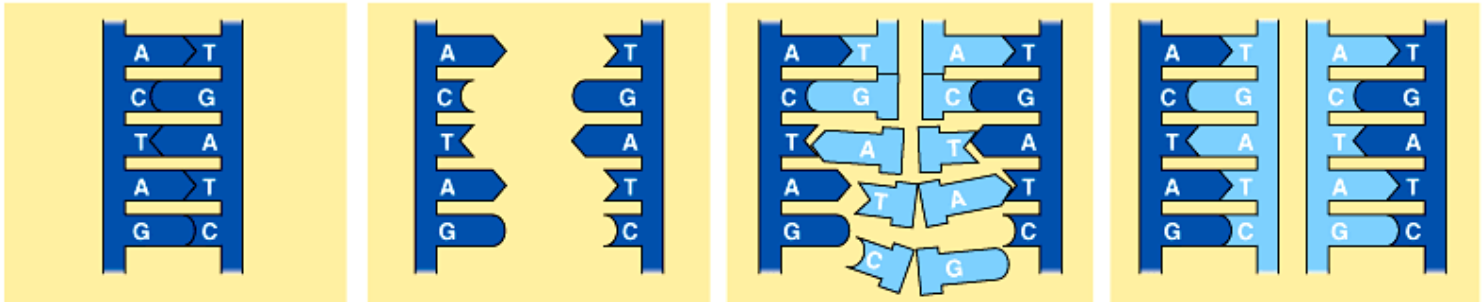
- Purines
  - adenine (A)
  - guanine (G)
- Pyrimidines
  - thymine (T)
  - cytosine (C)
- Pairing
  - A : T
    - 2 Hydrogen bonds
  - C : G
    - 3 Hydrogen bonds



Semi-Conservative Replication

- **Replication of DNA**
  - base pairing allows each strand to serve as a **template** for a new strand
  - new strand is 1/2 parent template & 1/2 new DNA





Prokaryotic DNA Replication

- Replication moves in two directions.
- Always occurs 5’ to 3’ only.

Bacterial chromosomes have a single point of origin.

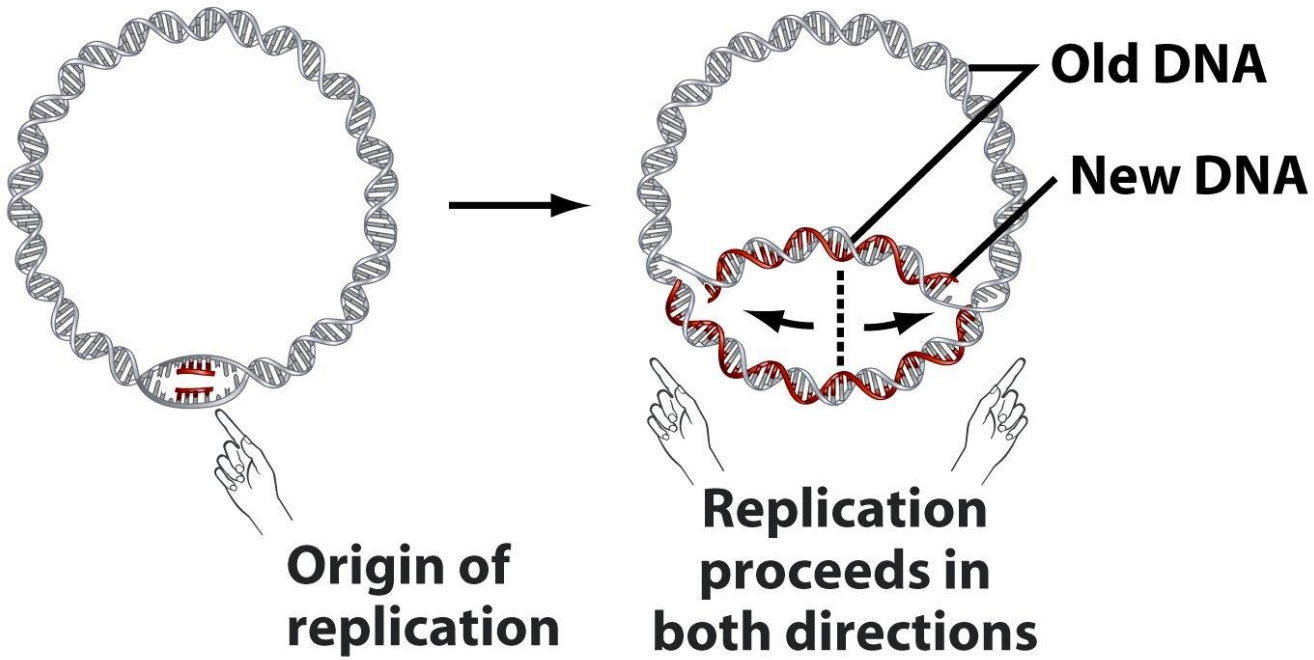
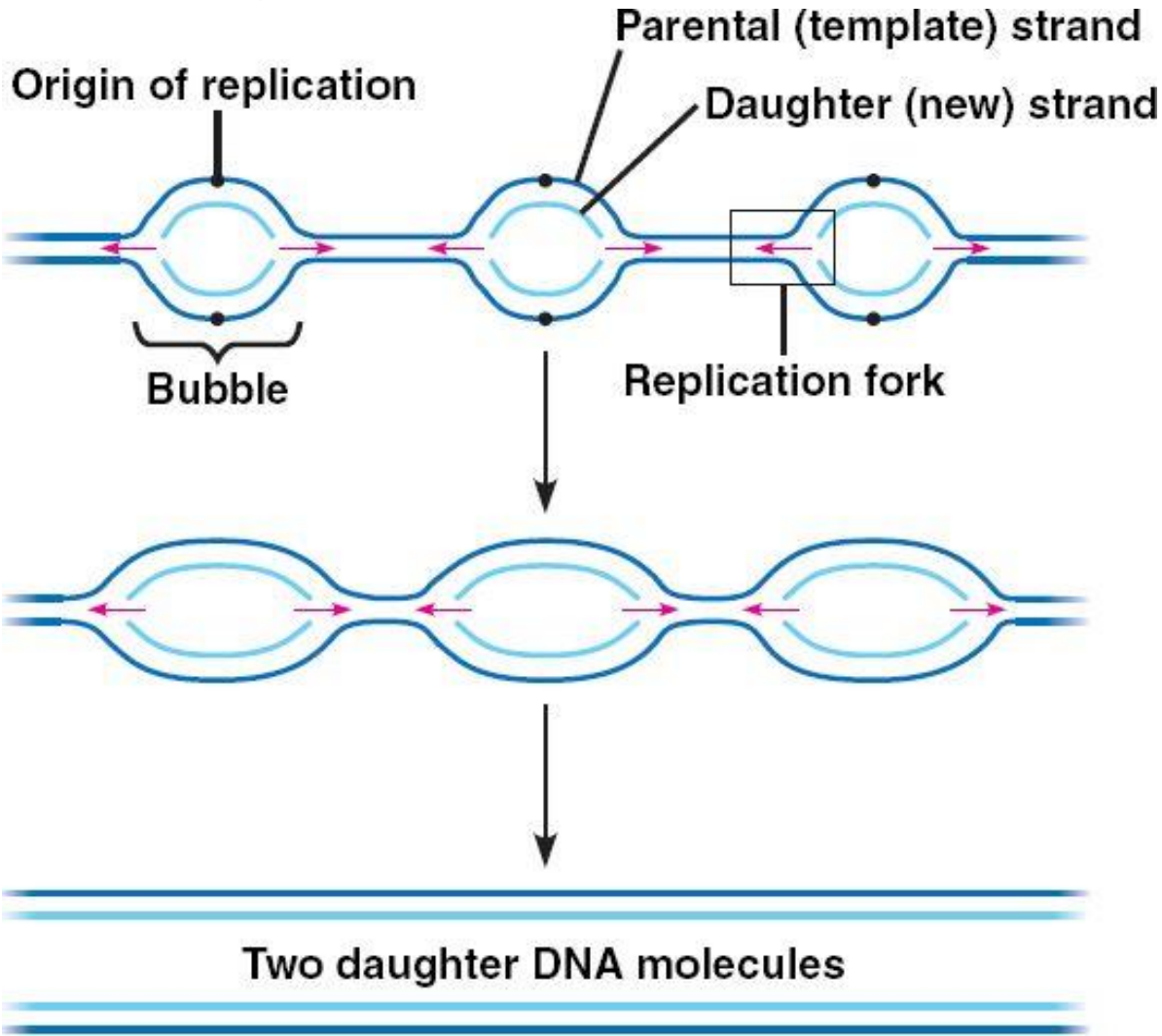


Figure 14-11b Biological Science, 2/e

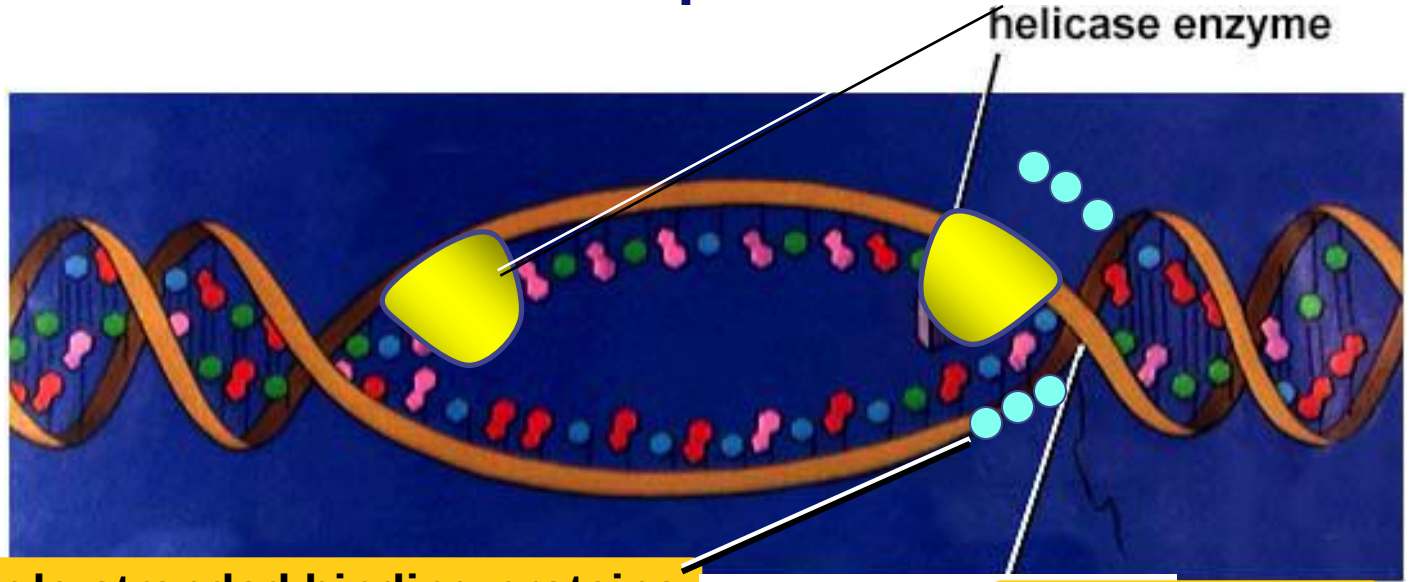
Eukaryotic DNA Replication

- **Multiple origin sites**



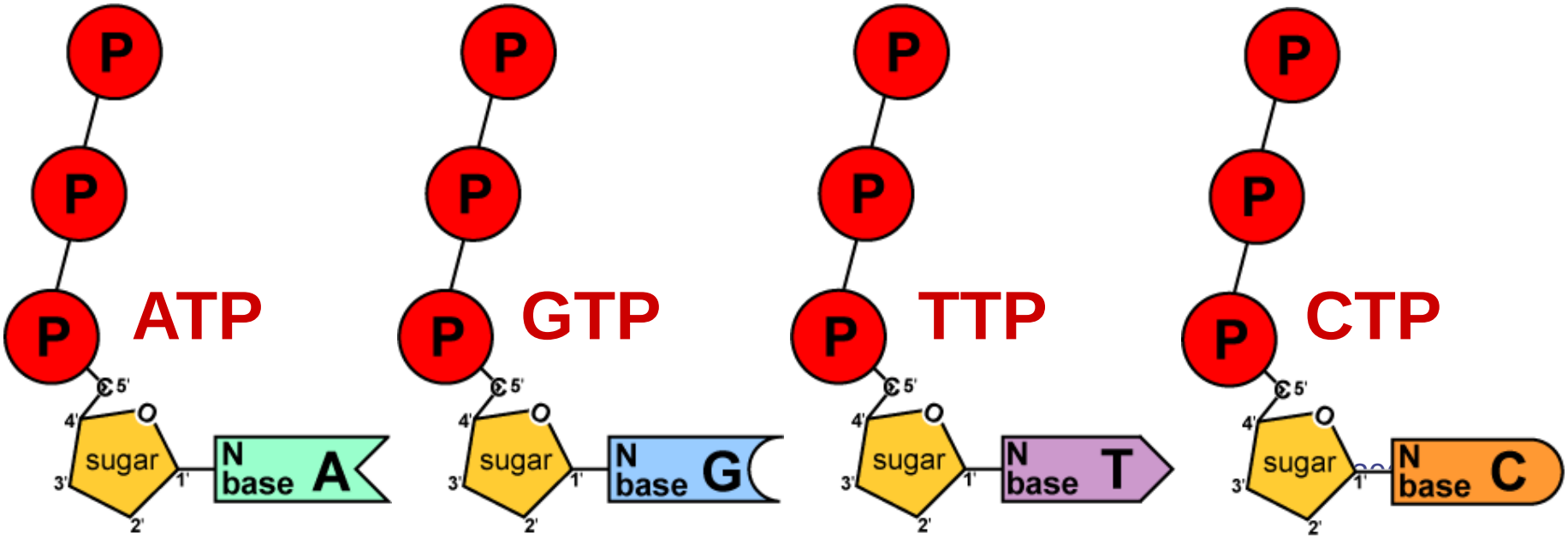
Replication: 1st step

- **Unwind DNA**
  - DNA is unwound by helicase enzyme
  - Makes the replication fork
  - Helicase breaks the hydrogen bonds between the two strands separating them; SSBP's help
- **Free nucleotides are present in the nucleus**



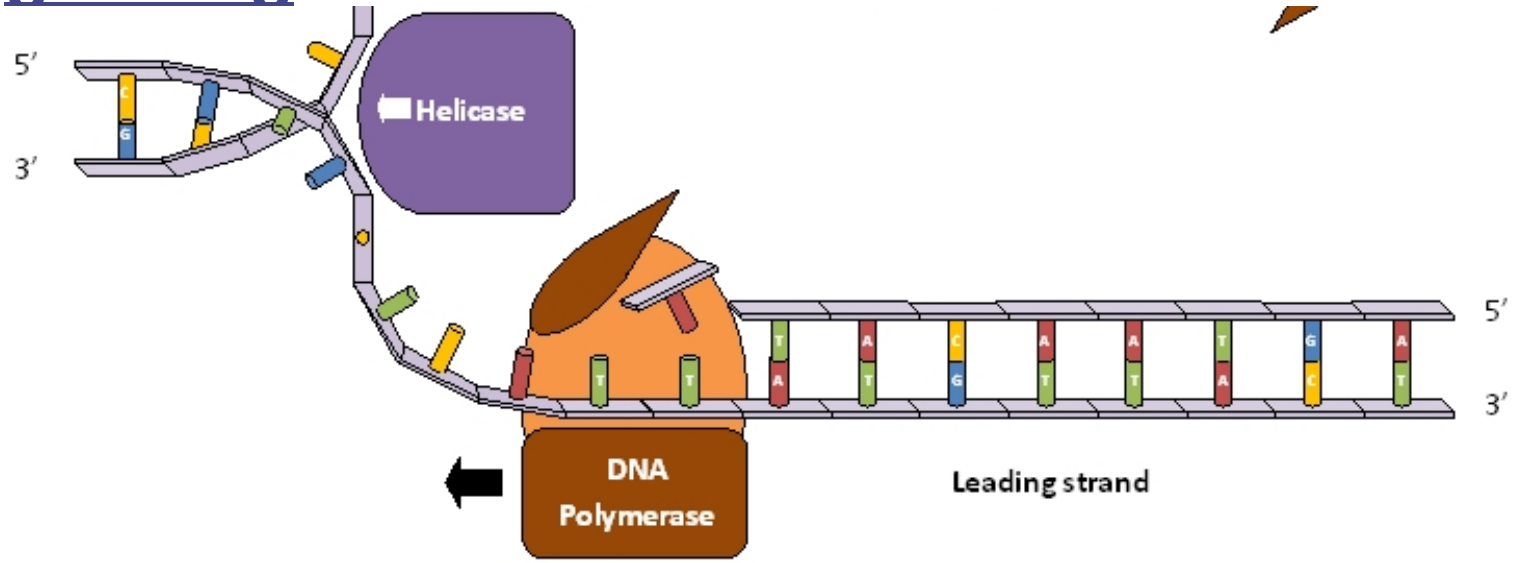
Energy of Replication

- The nucleotides arrive as nucleosides
  - DNA bases with P–P–P
  - DNA bases arrive with their own energy source for bonding
  - bonded by DNA polymerase III



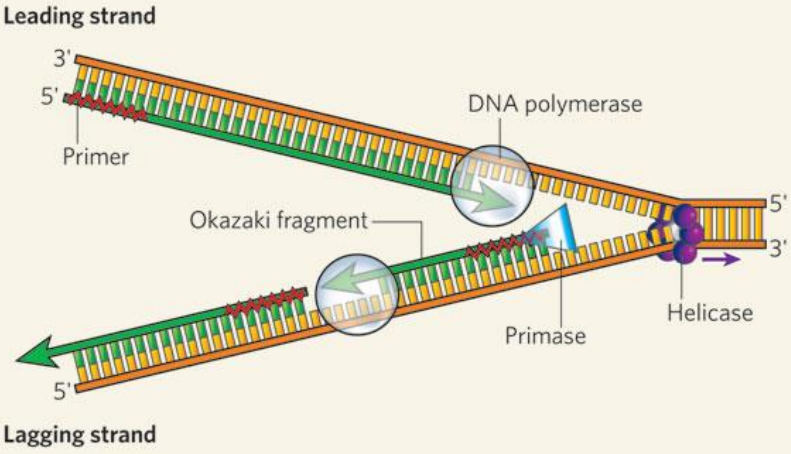
Replication: Leading Strand

- RNA Primer formed from RNA nucleotides bonds to start strand.
- DNA polymerase III lays down the nucleotides 5’ to 3’ direction
- Can only add nucleotides to 3′ end of a growing DNA strand



Replication: Lagging Strand

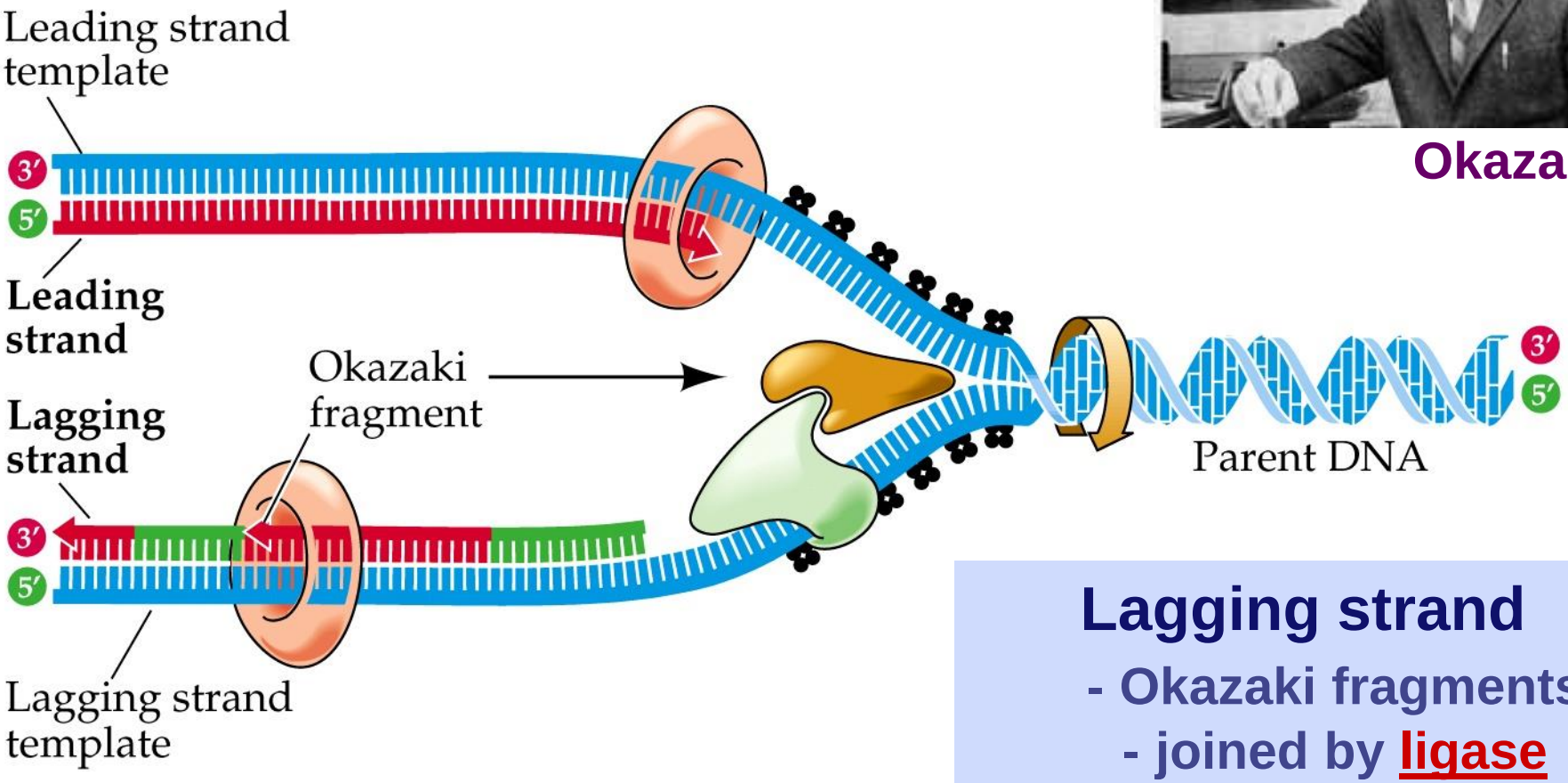
- Runs in the opposite direction of leading strand.
- RNA primer is joined to the parent strand by RNA primase
- DNA polymerase III *lays down* nucleotides from *5' to 3' direction* forming fragments: Okazaki fragments
- RNA primer is removed from the fragments and replaced with DNA nucleotides
- DNA ligase attaches the fragments to each other



Leading & Lagging strands

Leading strand
- continuous synthesis

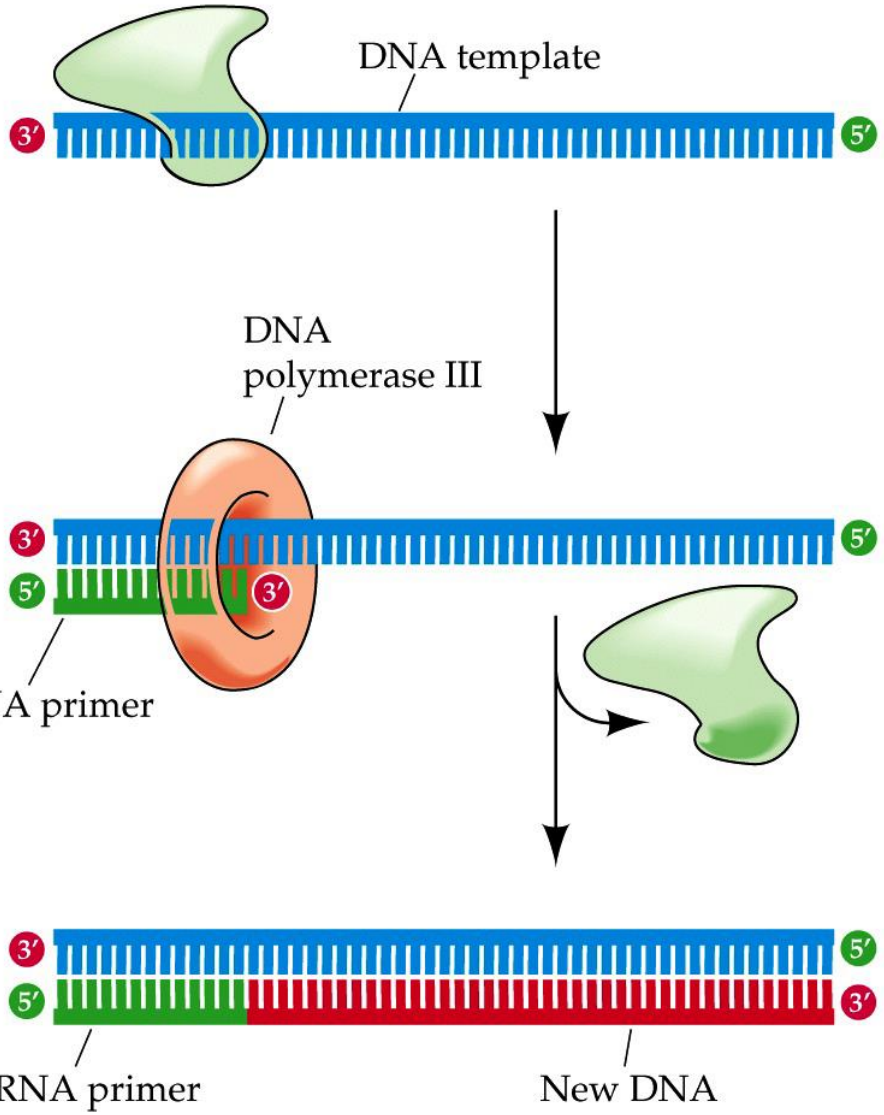
Okazaki



Lagging strand
- Okazaki fragments
  - joined by ligase
  - "spot welder" enzyme

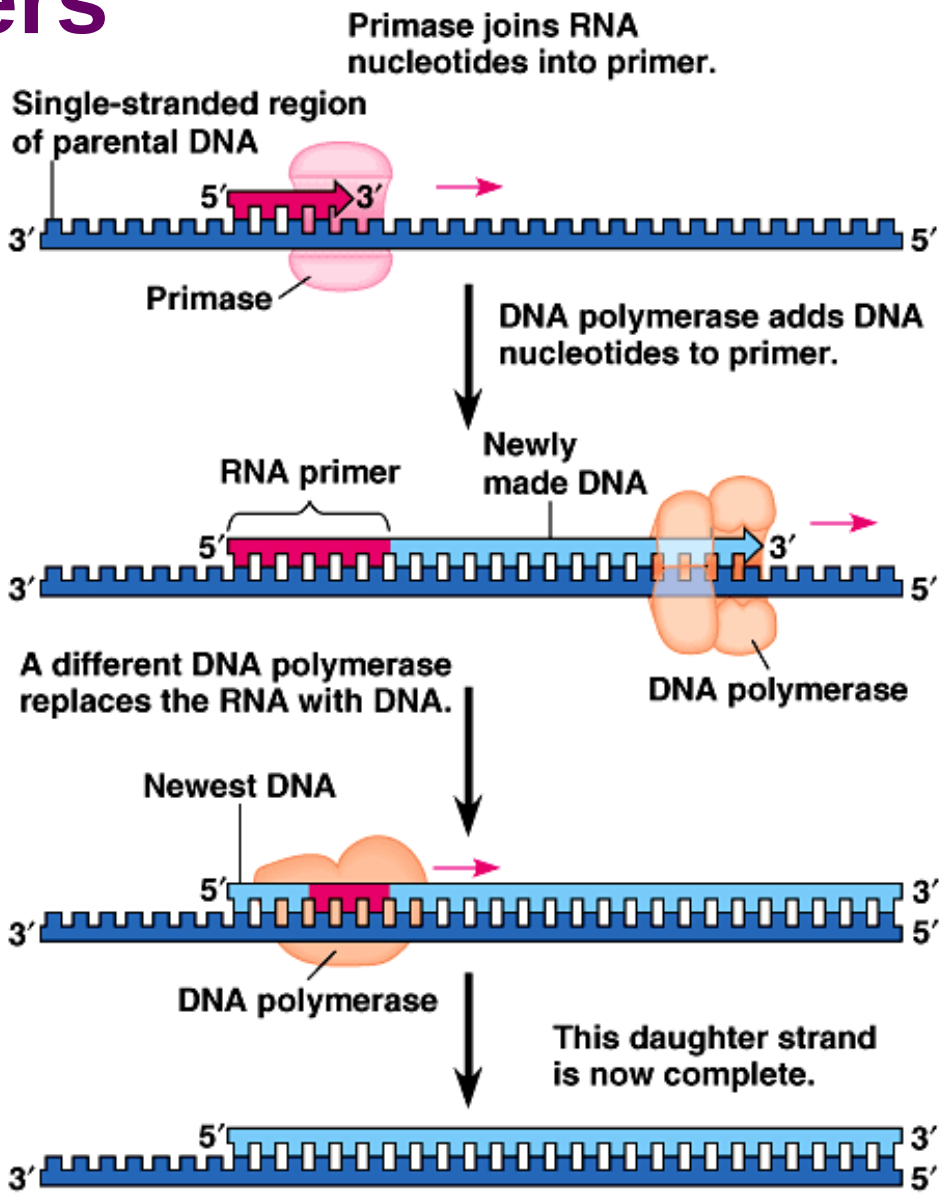
Priming DNA synthesis

- **DNA polymerase III can only extend an existing DNA molecule**
  - **cannot start new one**
    - **cannot place first base**
  - **short RNA primer is built first by primase**
    - **starter sequences**
    - **DNA polymerase III can now add nucleotides to RNA primer**



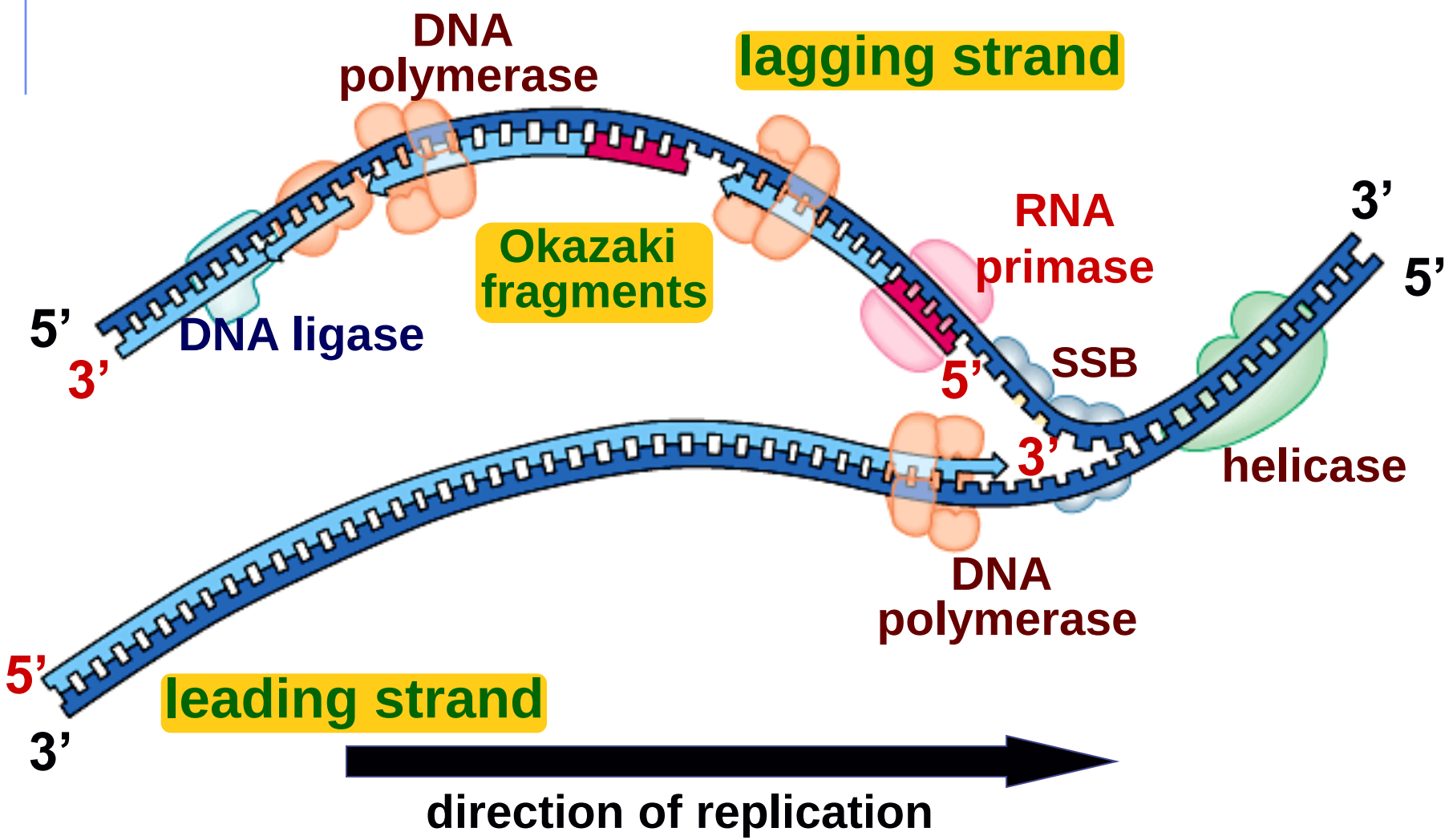
Cleaning up primers

DNA polymerase I removes sections of RNA primer and replaces with DNA nucleotides

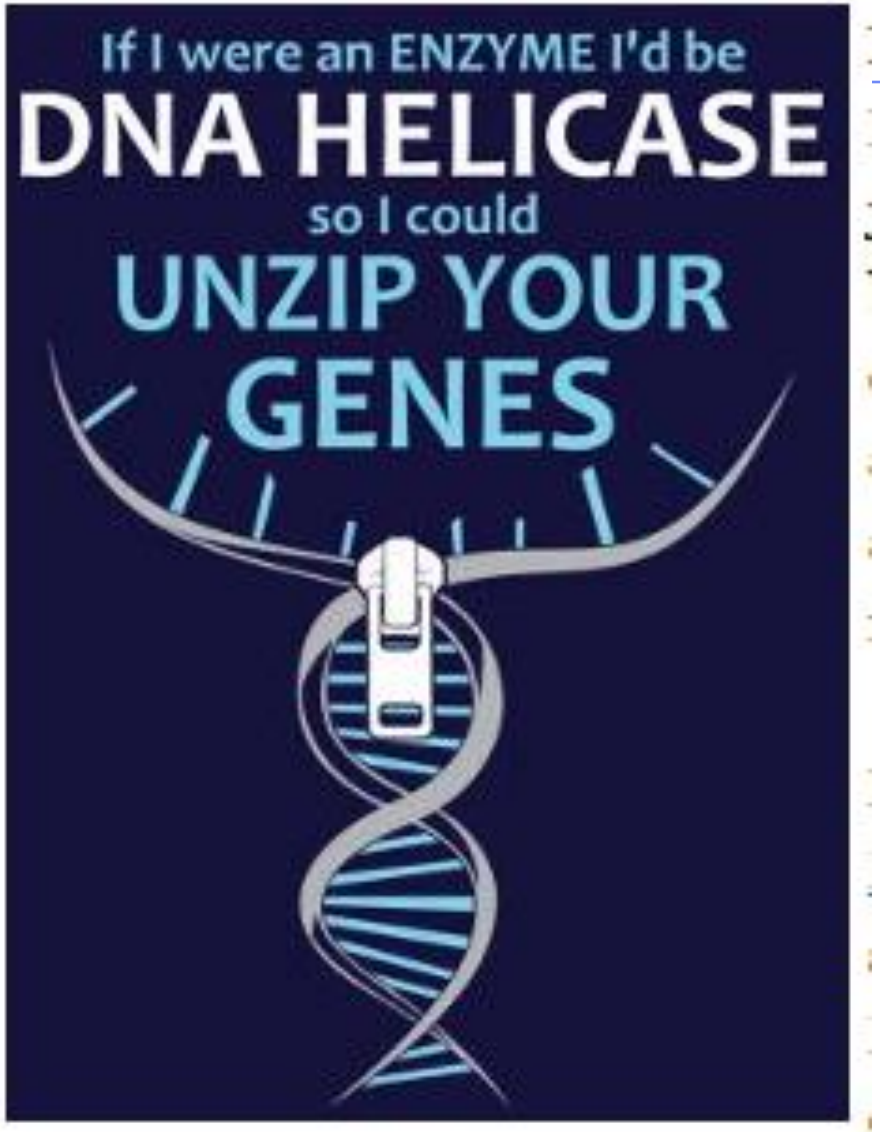


Replication fork

Animation



SSB = single-stranded binding proteins


If I were an ENZYME I'd be
DNA HELICASE
so I could
UNZIP YOUR
GENES

Wednesday/Thursday, April 22-23rd

QUESTION TO PONDER

List the enzymes that are involved with replication. **Provide** a summary of their function.

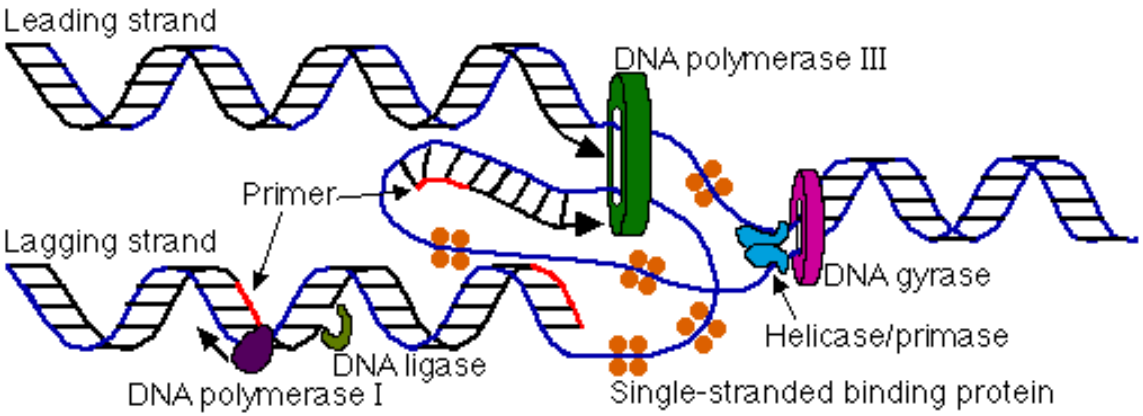
McGraw-Hill review

Today I will…

1. *Summarize* replication.
2. *Model* replication using manipulatives.
3. *Describe* the process of meiosis.
4. *Explain*

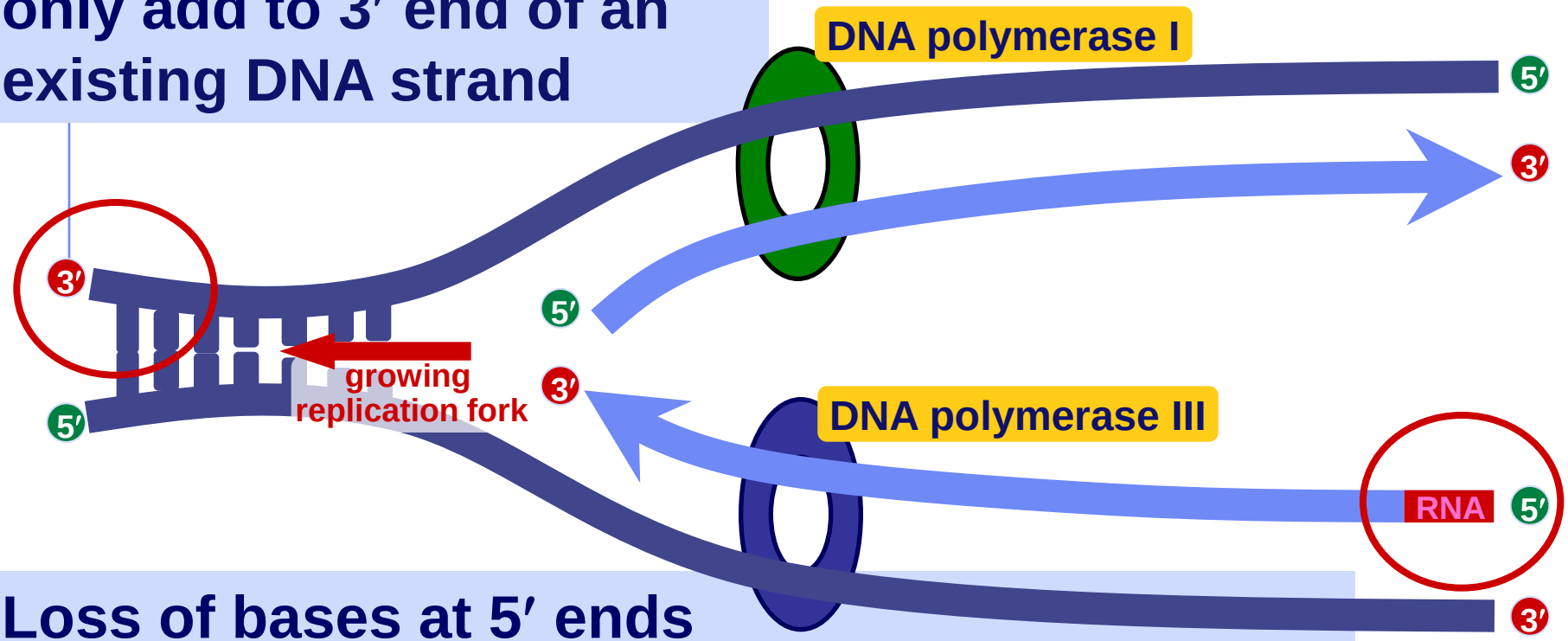
Replication enzymes

- helicase
- DNA polymerase III
- primase
- DNA polymerase I
- ligase
- single-stranded binding proteins



Chromosome erosion

All DNA polymerases can only add to 3′ end of an existing DNA strand



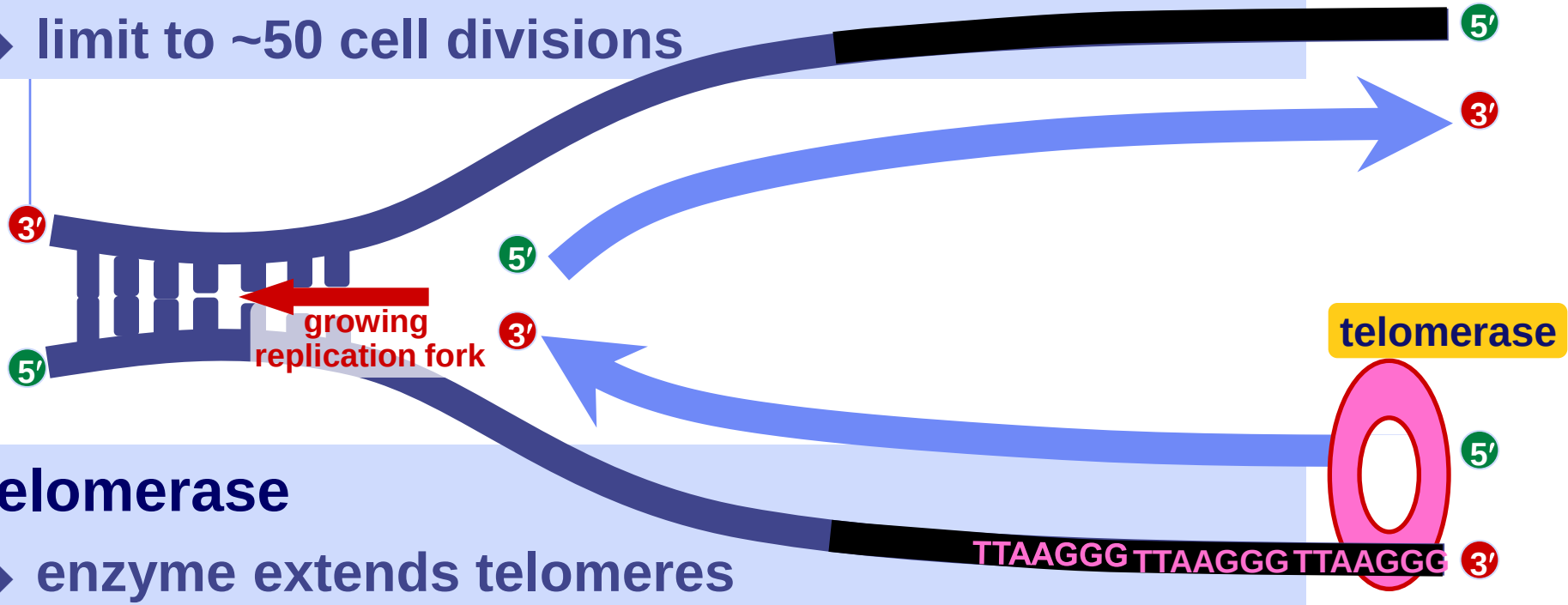
Loss of bases at 5′ ends in every replication

- chromosomes get shorter with each replication
- limit to number of cell divisions?

Telomeres

Repeating, non-coding sequences at the end of chromosomes = protective cap

- limit to ~50 cell divisions

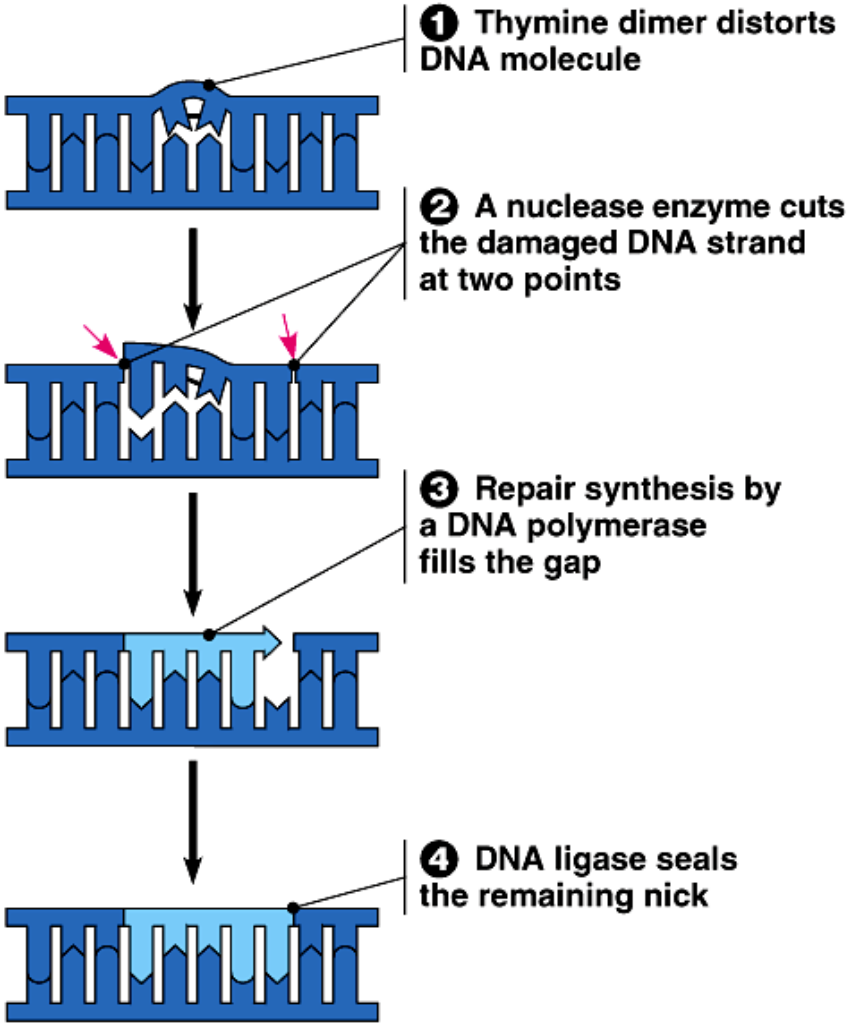


Telomerase

- enzyme extends telomeres
- can add DNA bases at 5′ end
- different level of activity in different cells
  - high in stem cells & cancers -- Why?

Editing & proofreading DNA

- Many different types of polymerases and nucleases
  - Cuts and removes abnormal bases
  - proofreads & corrects typos
  - repairs mismatched bases
- Reduces error rate to 1 in 10 billion



Replication Activity Instructions

1. Take the DNA "parent" strands, 5 nucleotides long, and **color** 1 of them **yellow** and the other parent **green**.
2. Color the RNA primers **blue**.
3. Cut out the enzymes from the sheet that is provided.
4. Grab 2 additional nucleoside sheets.

   Color the DNA nucleosides as follows:

A=orange T=green C=yellow G=red

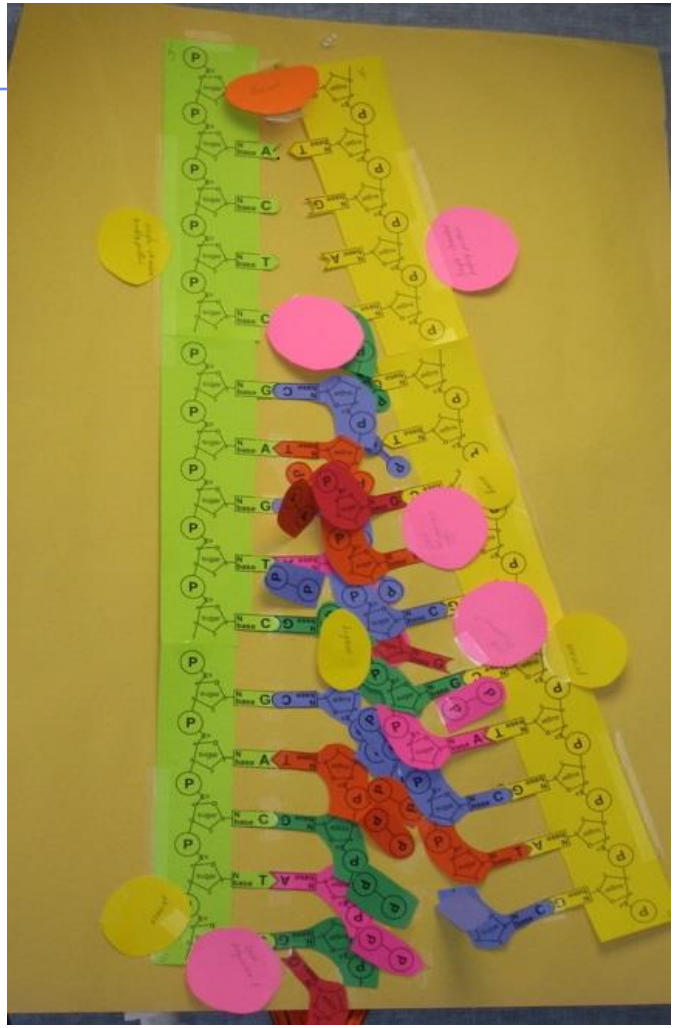
Now here is what you will need to do…

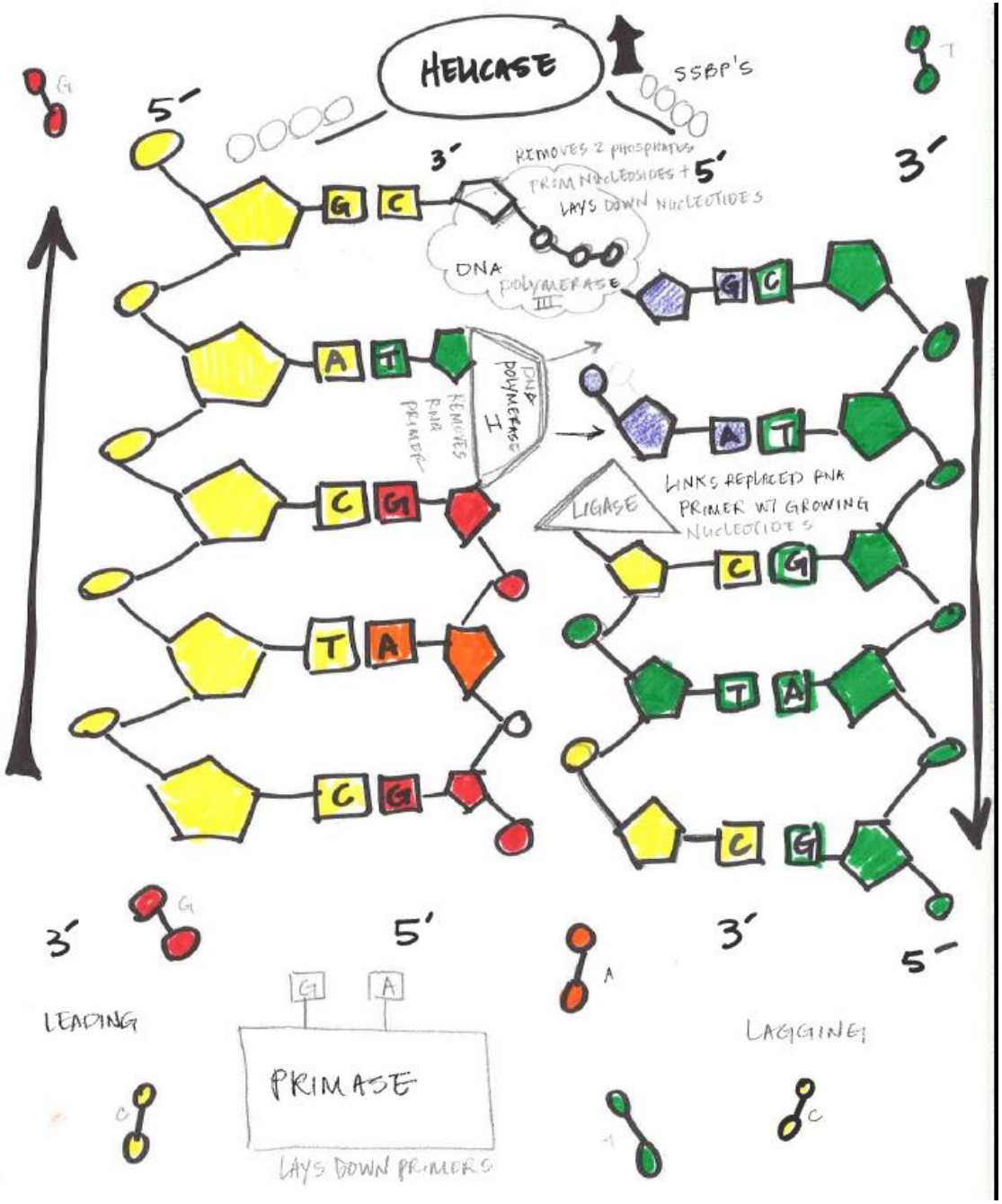
Attach the DNA parent strands (yellow & green) to a long sheet of paper.

"Replicate" the parent strands. Model the action of all enzymes that are required in this process.

1. Reminder: **RNA PRIMASE** will "lay down" primer sequences. The primer compliments the two nucleotides with the **C T** sequence.
2. Once the compliments are built, attach them. OUTLINE the compliments blue.
3. Label the 5' and 3' ends of each parent/compliment strand(s).

Helpful photos




HELICASE
SSBP's
5′
3′
REMOVES 2 PHOSPHATES FROM NUCLEOSIDES + LAYS DOWN NUCLEOTIDES
DNA POLYMERASE III
DNA POLYMERASE I
REMOVES RNA PRIMER
LIGASE
LINKS REPLACED DNA PRIMER WT GROWING NUCLEOTIDES
LEADING
LAGGING
PRIMASE
LAYS DOWN PRIMERS

Review Questions:

Chapter 16 - DNA

Who conducted the X-ray diffraction studies that were key to the discovery of the structure of DNA?

a) Griffith
b) Franklin
c) Meselson and Stahl
d) Chargaff
e) McClintock

How do the leading and the lagging strands differ?

a) The leading strand is synthesized in the same direction as the movement of the replication fork, whereas the lagging strand is synthesized in the opposite direction.

b) The leading strand is synthesized at twice the rate of the lagging strand.

c) The lagging strand is synthesized continuously, whereas the leading strand is synthesized in short fragments that are ultimately stitched together.

d) The leading strand is synthesized by adding nucleotides to the 3' end of the growing strand, whereas the lagging strand is synthesized by adding nucleotides to the 5' end.

If the result of the Hershey and Chase experiment had been that radioactive sulfur (^{35}S) was found inside the cells instead of radioactive phosphorus (^{32}P), what could have been concluded?

What is the %T in wheat DNA?

a) approximately 22%

b) approximately 23%

c) approximately 28%

d) approximately 45%

Source of DNA	Adenine	Guanine	Cytosine	Thymine
Sea urchin	32.8%	17.7%	17.3%	32.1%
Salmon	29.7	20.8	20.4	29.1
Wheat	28.1	21.8	22.7	

Data from several papers by Chargaff: for example, E. Chargaff et al., Composition of the desoxypentose nucleic acids of four genera of sea-urchin, *Journal of Biological Chemistry* 195:155–160 (1952).

What enzyme does a gamete-producing cell include that compensates for replication-associated shortening?

a) DNA polymerase
b) DNA ligase
c) telomerase
d) DNA nuclease
e) helicase