Week 12

BIO-1305 - Biology 1 – Campbell Textbook

Hello and welcome to the weekly resources for BIO-1305 - Biology 1 – Campbell Textbook!

This week is Week 12 of class, and typically in this week of the semester, your professors are covering the topics below. If you do not see the topics your particular section of class is learning this week, please take a look at other weekly resources listed on our website for additional topics throughout the semester.

We also invite you to **look at the group tutoring chart on our website to see if this course has a group tutoring session offered this semester**.

If you have any questions about these study guides, group tutoring sessions, private 30 minute tutoring appointments, the Baylor Tutoring YouTube channel, or any tutoring services we offer, please visit our website www.baylor.edu/tutoring or call our drop in center during open business hours (M-Th 9am-8pm on class days at 254-710-4135).

Keywords: Proteins in Replication, 5' → 3' Synthesis, Repair, DNA Packaging

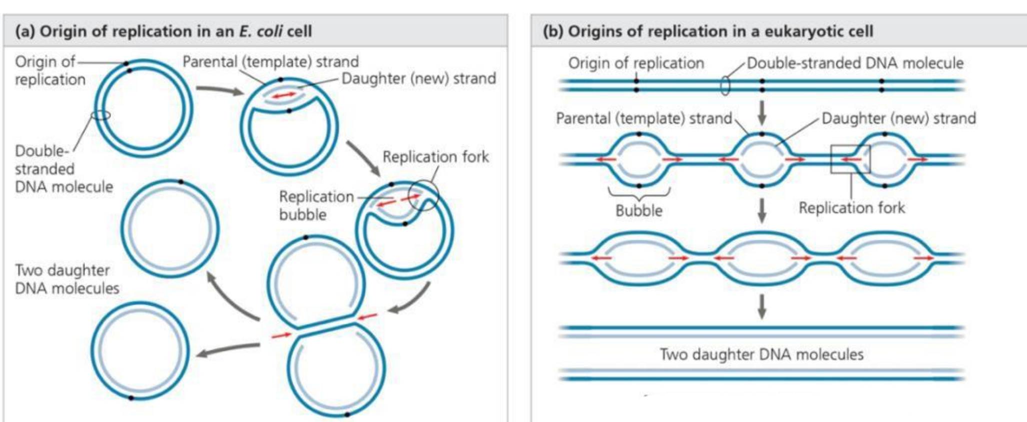
Topic of the Week: Components of DNA Replication

When we consider how DNA is replicated, it is often helpful to consider bacterial DNA as an example. Bacterial DNA is *double stranded and circular*. There are several components of DNA replication we need to talk about before looking at the individual steps.

Origin of replication: specific sequences of DNA that proteins recognize and bind to. This is *where replication of chromosomal DNA starts*

- There is only one origin of replication in bacterial DNA, but there are hundreds to thousands of origins of replication in eukaryotic DNA

Replication fork: a *Y-shaped region* where the strands of DNA are being **unwound**



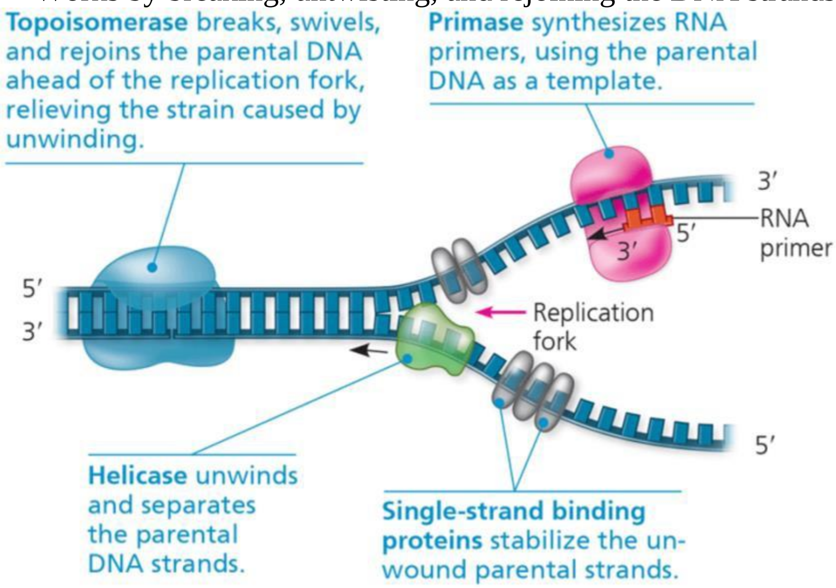
There are many **proteins involved in replication**:

Helicases: untwist the helix at the replication fork

Single-strand binding proteins (ssbps): bind to unpaired DNA after it is unwound to keep them from repairing

Topoisomerase: relieves strain created when the untwisting of the helix causes righter twisting up ahead of the fork

- Works by breaking, untwisting, and rejoining the DNA strands



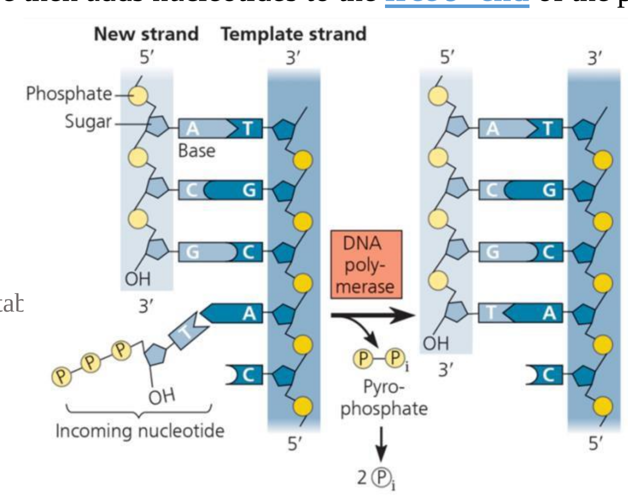
Highlight #1: Synthesis of a New DNA Strand

Now that we have talked about the proteins involved and various important terms, we can discuss the **synthesis of a new DNA strand**.

A primer is required for the synthesis to being. A primer is a *short RNA polynucleotide* with a **free 3' end** that is bound to the template strand and becomes *elongated*. The primer serves as the basis for the newly replicated strand.

- An enzyme called **primase** synthesizes the primer

DNA polymerase then adds nucleotides to the **free 3' end** of the primer and begins to elongate the strand.



The synthesis of DNA proceeds in an **antiparallel fashion.** Remember that DNA has a 3’ and 5’ end. Because DNA polymerase <u>can only add nucleotides to the 3’ end</u>, a given DNA strand is synthesized in the **5’ 3’ direction.**

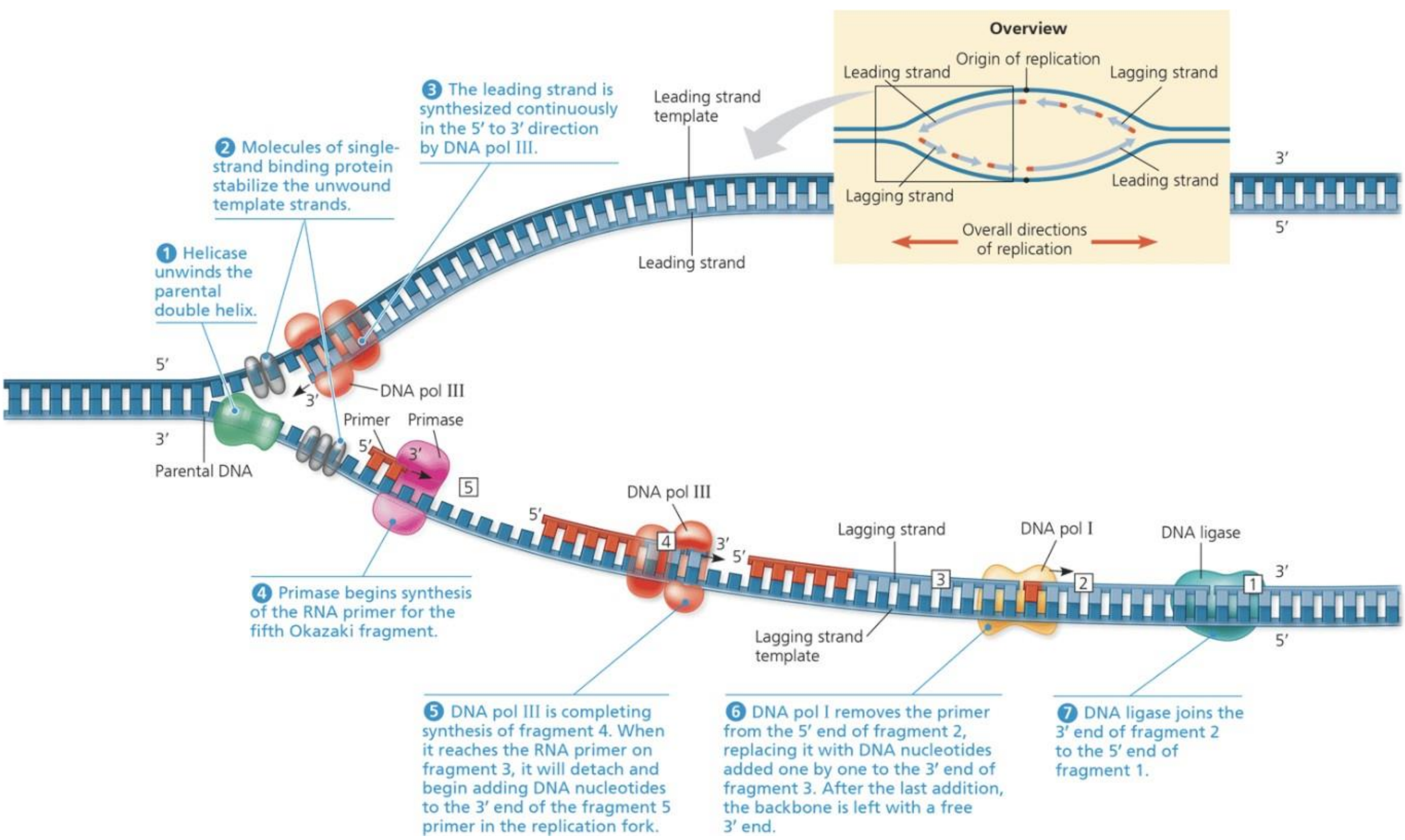
***This means that the 3’ end is the growing end!!!

There are <u>leading and lagging strands</u> involved in DNA synthesis:

Leading strand: synthesized **continuously** because the DNA polymerase keeps moving in the direction that helicase is unwinding the helix

Lagging strand: synthesized **discontinuously** in *<u>Okazaki fragments</u>* because the DNA polymerase is moving away from the helicase unwinding the helicase. DNA polymerase has to keep backtracking to replicate the newly unwound portions

DNA ligase connects the Okazaki fragments!



Highlight #2: Proofreading, Repair, and Ends of DNA Molecules

Sometimes **mistakes** occur during all of the replication our cells are doing! In order to account for this, our cells have **mechanisms** that can repair or fix mistakes that occur.

Mismatch repair: uses specific enzymes to remove and replace incorrectly paired nucleotides

Nucleotide excision repair: removes and correctly replaces damaged segments of DNA

The Ends of DNA Molecules

In linear DNA, the 5' end of the new DNA strands cannot be completed because there is **no 3' end to add to**

Because of this, repeated replication just ends up *shortening and shortening* the DNA molecules

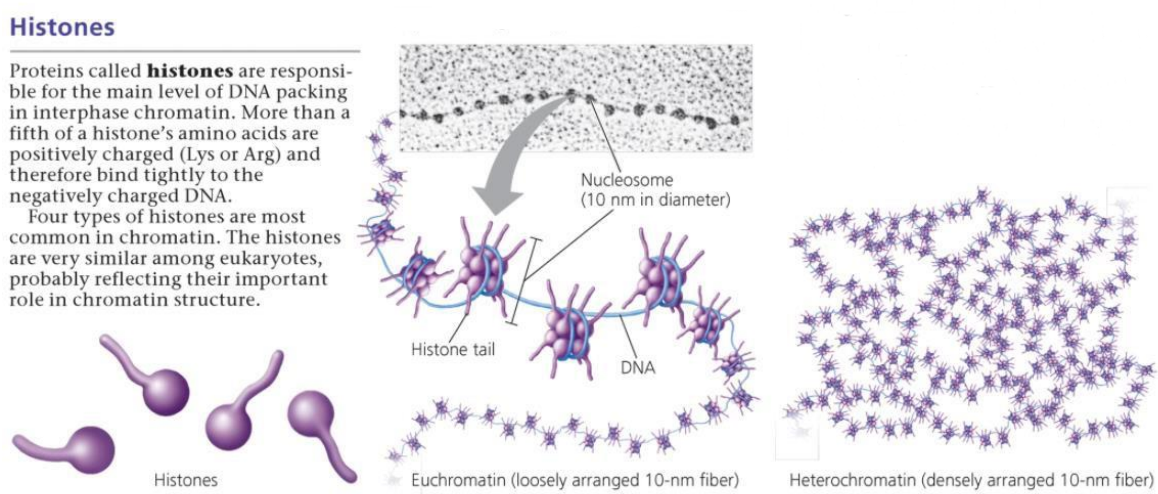
This leads us to the need for telomeres: repetitive DNA at the end of a chromosome that **protects the genes from being cut off during successive replication**

Highlight #3: DNA Packaging

DNA is packaged into **chromosomes** which are made of **chromatin**

- **Chromatin:** complex of DNA and proteins that makes up eukaryotic chromosomes
  - Euchromatin: less condensed form of chromatin that is available to be transcribed
  - Heterochromatin: eukaryotic chromatin that stays compacted during interphase and usually isn't available to be transcribed

The proteins involved in chromatin are called **histones**. There are *four types* of histone proteins. Chromatin consists of DNA wrapped around a complex of histone proteins. This complex is called a **nucleosome**.



CHECK YOUR LEARNING

1. True or false: replication of DNA occurs on two template strands at once and the DNA polymerases both move in the same direction.
2. Label each function with the appropriate enzyme: helicase, ssbp, topoisomerase, primase
   a. Binds to unpaired DNA to keep the strands from repairing
   b. Untwists DNA helix at replication fork
   c. Makes a primer
   d. Relieves strain in the helix

THINGS YOU MAY STRUGGLE WITH

1. It is SUPER IMPORTANT to understand that nucleotides can ONLY be added to the 3' end of a DNA strand! This makes DNA replication occur in the 5' to 3' direction!!! Remember this!!!
2. The reason Okazaki fragments form is because as helicase moves in one direction along a replication fork, one of the strands will have its 3' end moving further and further away from the replication fork. As helicase unwinds the DNA, the part that has just been unwound needs to be replicated, so DNA polymerase must continue moving 5' to 3' but also needs to stop, jump backwards, and keep going. To help visualize this, look at the diagram above.

Thanks for checking out these weekly resources!
Don't forget to check out our website for group tutoring times, video tutorials and lots of other resources: www.baylor.edu/tutoring! Answers to *Check your Learning* questions are below!

Answers:

1. False, the DNA polymerases will move in opposite directions.
2. a: ssbp, b: helicase, c: primase, d: topoisomerase