Hey everyone! Welcome back to another resource. This week we will be finishing our discussion of DNA by going over replication and packaging. Keep up the great work and make sure to stay on top of your work- the end of the semester will be here before you know it! **Reminder: I hold weekly group tutoring sessions on Mondays from 6:30-7:30 pm in room 74 in the basement of Sid Rich! Sign up to join the session here: https://baylor.edu/tutoring. I would love to see you there!**

**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

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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 can only add nucleotides to the 3’ end, a given DNA strand is synthesized in the **5’ → 3’ direction**.

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

There are **leading and lagging strands** 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 [Okazaki fragments](#) 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.

Answers:

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

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