DNA Replication

DNA replication

- Produces two identical molecules of DNA from the original.
- Occurs during S phase of interphase.
- Is described as **"semi-conservative"**, because the two new molecules each will contain half of the original; and half from newly matched nucleotides.

The duplicated molecules

- Remain attached at a DNA sequence known as the centromere.
- Are referred to as "sister" chromatids

One DNA molecule in eukaryotes

- Is a long linear piece - equal to one chromosome.
    - However, the term 'chromosome' also includes all the accompanying proteins that congregate on a molecule of DNA
- Contains 50 - 250 million base pairs. Base pairs are bonded together with hydrogen bonds.
- The DNA code consists of matching nucleotides - adenine with thymine; and guanine with cytosine.

DNA is oriented

- With **anti-parallel** strands.
- One end is oriented 5 prime to 3 prime; the complementary strand is oriented 3 prime to 5 prime.
- The numbers refer to the carbons in the deoxyribose sugar.
- The carbons are numbered 1 - 5, starting with the carbon that binds the base.
- The rest are numbered clockwise from the one that binds the base
- One side of the molecule starts with the deoxyribose sugar with its 5 carbon pointing up, and the other side starts with its 3 carbon pointing up.

STEP 1: DNA helicase

- Enzyme that "unzips" the DNA molecule by breaking the base pair hydrogen bonds.
- Unzips the DNA molecule in both directions.
- Opens up a chunk called the **"replication bubble"**.

    Origin of replication

    - Point where the helicases open up the DNA molecule and the first RNA primers are put down. DNA synthesis of the complementary strand will proceed in the 5 to 3 direction from these primers.

STEP 2: RNA Polymerase

- Adds 5 - 10 RNA bases, called an **"RNA primer"** to both strands at the origin of replication.
- Able to add nucleotides without the existing of some already there. This is unique to it, compared with DNA polymerase.

STEP 3: DNA Polymerase

- Adds nucleotides in the 5' to 3' direction

- Can only add matching nucleotides if there are already some there - that's why the primer is necessary. So DNA polymerase adds these nucleotides continuously in the 5 - 3 direction from the origin of replication, following the ever-moving helicase.
- DNA polymerase is able to edit mistakes it makes while matching nucleotides from the pool of free nucleotides within the nucleus.

Continuous Strand

- DNA polymerase continuously adds nucleotides away from the origin of replication, following the opening action of the helicase
- Only requires one primer to get started, and then can keep going without interruption.

Lagging Strand

- Wherever nucleotides cannot be added continuously in the 5 - 3 direction, many more RNA primers are set down,
- DNA polymerase can add nucleotides in the 5 - 3 direction in small chunks
- Still ultimately working its way away from the origin of replication and toward the helicase that is opening up more of the molecule
- These small fragments formed by the "working backward" replication are called **Okazaki Fragments,** named after the scientist that first discovered them within the DNA replication process.
- This chunk by chunk process is slower, and thus this side of the molecule "lags" in its synthesis.

STEP 4: Replacement of RNA primers with DNA nucleotides

- A DNA polymerases comes along and replaces all the RNA nucleotides with DNA nucleotides
- There are many more RNA primers to replace on the lagging strand.

STEP 5: DNA ligase

- Seals up all the spaces between the Okasaki fragments and where there had been an RNA primer replaced with DNA nucleotides.

Topoisomerase

- Makes clips in the phosphate-sugar backbone to relieve the torsional strain on the rest of the DNA molecule as one section is unzipped. Then, once the strain on the helix has shifted to another spot, it seals up the clipped spot and clips a new place to relieve torsional strain in a new place.