# 7.2 DNA REPLICATION

Watson and Crick were the Nobel Prize winners in 1962. Their model led to the hypothesis of semi conservative replication. However, it was widely accepted that Rosalind Franklin deserved the award (1950's Kings College London, department of biophysics). She was the first who managed to obtain the sharpest X-ray diffraction images of DNA in existence.

→ If a beam of X-rays is directed at a material, most of it passes through but some is scattered by the particles in the material. This scattering is called diffraction. Diffraction patterns can be recorded by using X-ray film. She developed a high resolution camera containing X-ray film to obtain very clear images of diffraction patterns from DNA!

**Some terms you should know:**

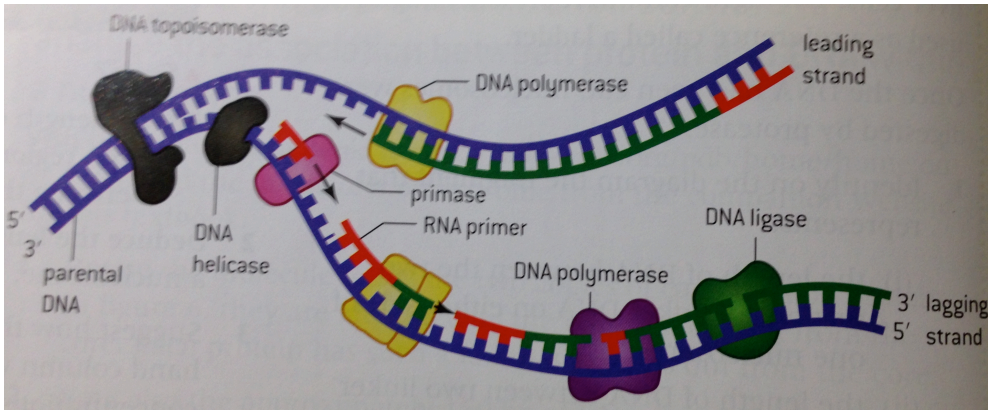
**Nucleoside**: Deoxyribose together with a base.

**Nucleotide:** Nucleoside plus a phosphate group.

**Deoxyribonucleoside triphosphate:** A nucleoside plus three phosphate groups (one is needed for the nucleotide to be formed and the other two are removed during replication to remove energy).

- DNA replication occurs in a 5' → 3' direction because the phosphate group of new DNA nucleotides is added to the 3' carbon of the deoxyribose of the nucleotide at the end of the chain.
- One strand is called the 'leading' strand and the other the 'lagging' strand.
- DNA is continuous on the 'leading' strand because DNA polymerases move in the same direction and discontinuous on the 'lagging' strand because DNA polymerases have to move the opposite direction.

**The role of Enzymes in DNA replication:**




- **Helicase and topoisomerase***

Helicase causes the separation of the two strands of DNA. Topoisomerase releases the strain that develops ahead of the helicase.

- **RNA primase**

Synthesizes the **primers** (short nucleotide chain), giving the signal for the initiation of nucleotide bonding to the parental strands. On the lagging strand there are a number of primers, but only one in the leading strand.

The binding of the primers to the DNA template is catalysed by DNA polymerase I (which also removes the primer and fills the gap).

- **DNA polymerase I**

Links free DNA nucleotides to the 3' end of the growing strand as they line up on the template formed by the original strand of the parental molecule. It also corrects mismatched nucleotides.

DNA polymerase I works together with RNA primase.

- **DNA polymerase II & III**

DNA polymerase III synthesizes most of the new DNA after DNA polymerase I has started the elongation and corrects errors of DNA polymerase I and at the same time DNA polymerase I fills the gaps that

DNA polymerase III has left. The role of DNA polymerase II is not fully understood.

→ All DNA polymerases are complementary

- **DNA ligase**

Helps the formation of **phosphodiester bonds** between the two strands (between the parental and the newly formed in order for a new double stranded DNA to be created). It provides extra "strength" to the DNA molecule since H-bonds are weak.

- ***DNA gyrase**

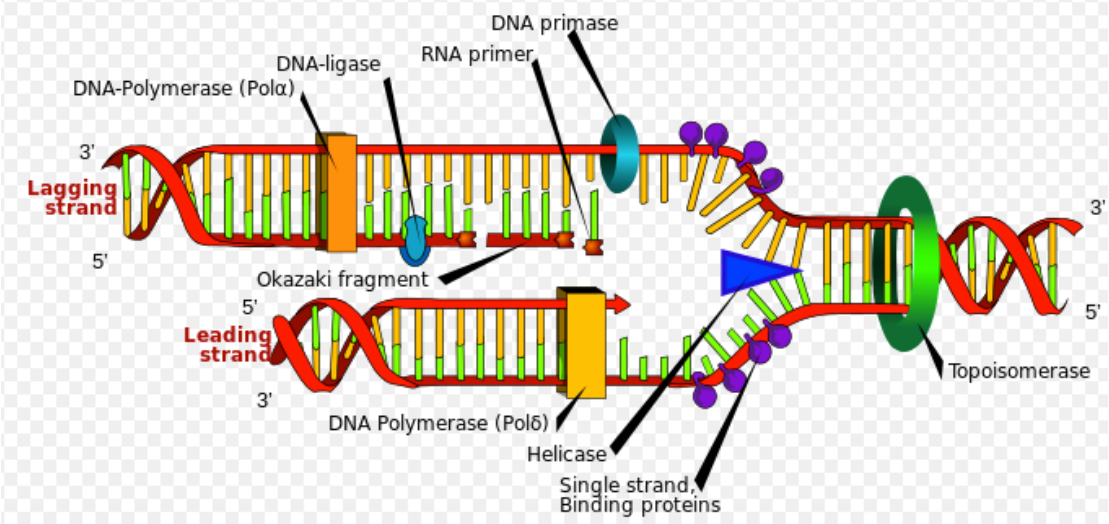
DNA Gyrase is still a (Type II) topoisomerase moving ahead of helicase.

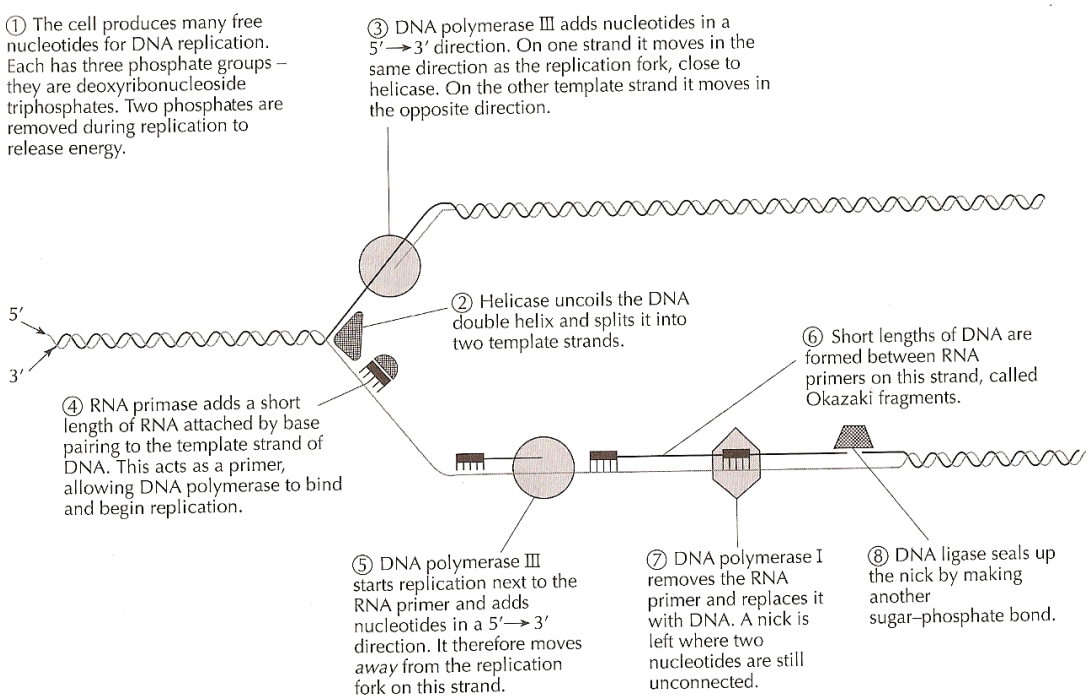
**Okazaki fragment**

Approximately 150 nucleotides bonded to the parental single strand after the initiation signal of the RNA primer.

In eukaryotic chromosomes **replication is initiated at many points** with the help of Okazaki fragments.

**Diagrams of DNA replication:**




① The cell produces many free nucleotides for DNA replication. Each has three phosphate groups – they are deoxyribonucleoside triphosphates. Two phosphates are removed during replication to release energy.
③ DNA polymerase III adds nucleotides in a 5′→3′ direction. On one strand it moves in the same direction as the replication fork, close to helicase. On the other template strand it moves in the opposite direction.
5′
3′
② Helicase uncoils the DNA double helix and splits it into two template strands.
⑥ Short lengths of DNA are formed between RNA primers on this strand, called Okazaki fragments.
④ RNA primase adds a short length of RNA attached by base pairing to the template strand of DNA. This acts as a primer, allowing DNA polymerase to bind and begin replication.
⑤ DNA polymerase III starts replication next to the RNA primer and adds nucleotides in a 5′→3′ direction. It therefore moves *away* from the replication fork on this strand.
⑦ DNA polymerase I removes the RNA primer and replaces it with DNA. A nick is left where two nucleotides are still unconnected.
⑧ DNA ligase seals up the nick by making another sugar–phosphate bond.