



Escuela Profesional de
Ciencia de la Computación

ICC Fase 1

Bioinformatics

DNA structure and replication

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1 Introduction

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Objectives

- Learn all chemical elements of DNA.

Objectives

- Learn all chemical elements of DNA.
- Understand DNA replication process.

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DNA structure

Overview

The following content is extracted from the video **The structure of DNA [1]**.

DNA structure

Overview

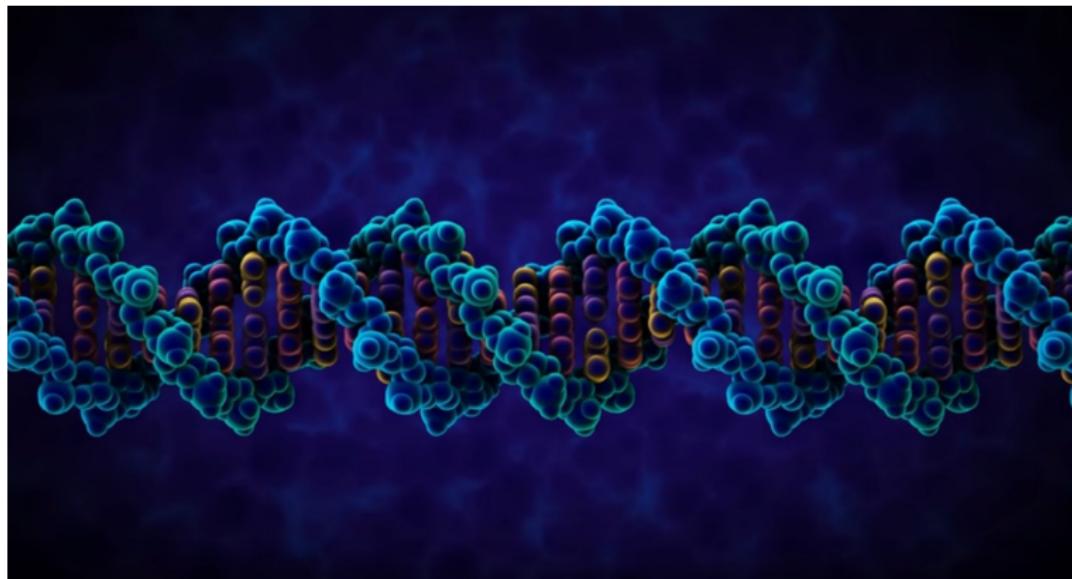


Figure: DNA view

DNA structure

Overview



Figure: Double strand DNA

DNA structure

Overview

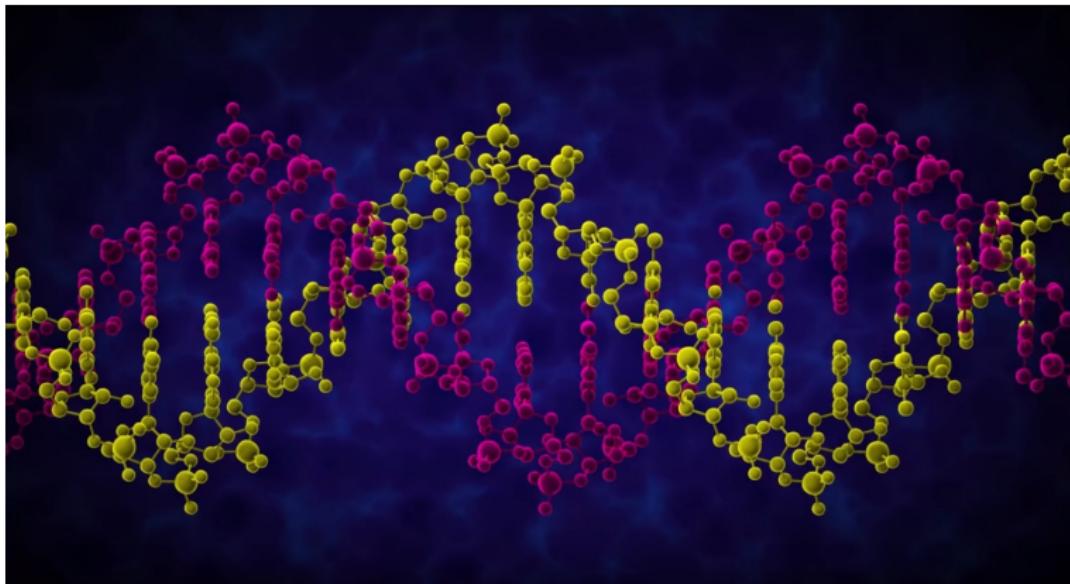


Figure: Simplified view of DNA

DNA structure

Overview

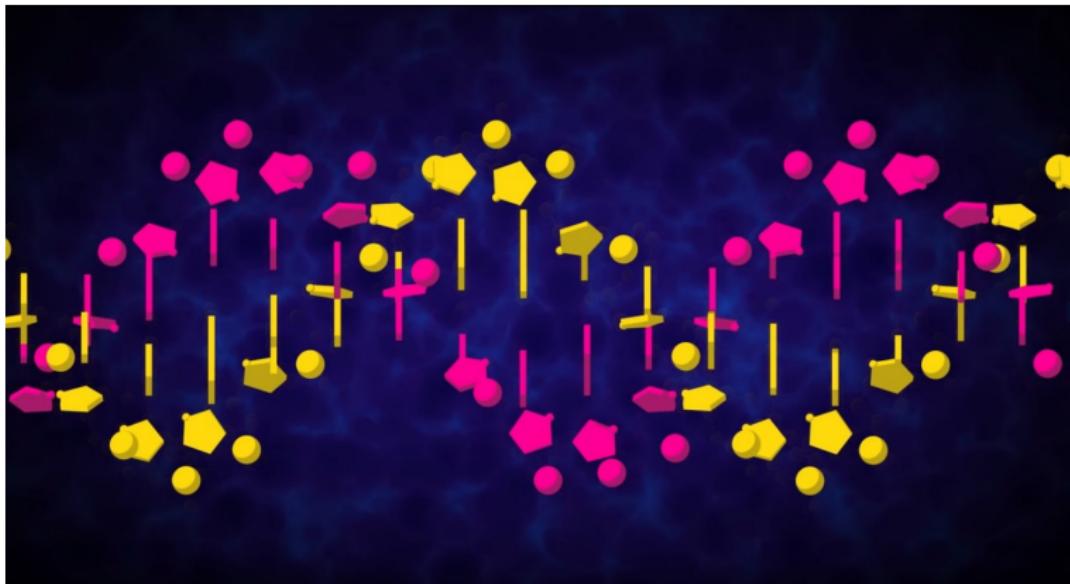


Figure: Simplified view of DNA

DNA structure

Overview

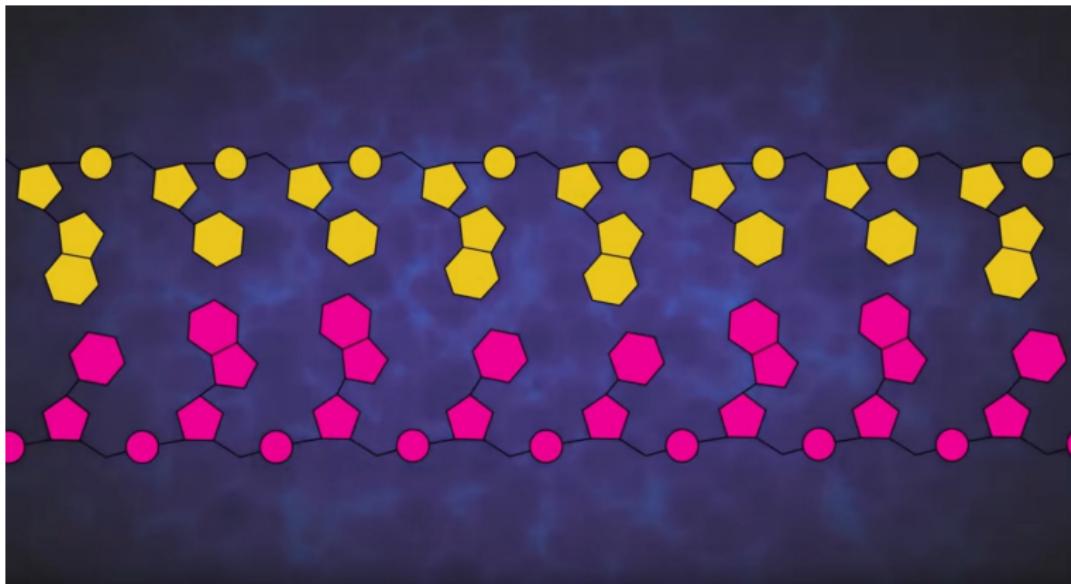


Figure: We unwind the DNA strands.

DNA structure

Overview

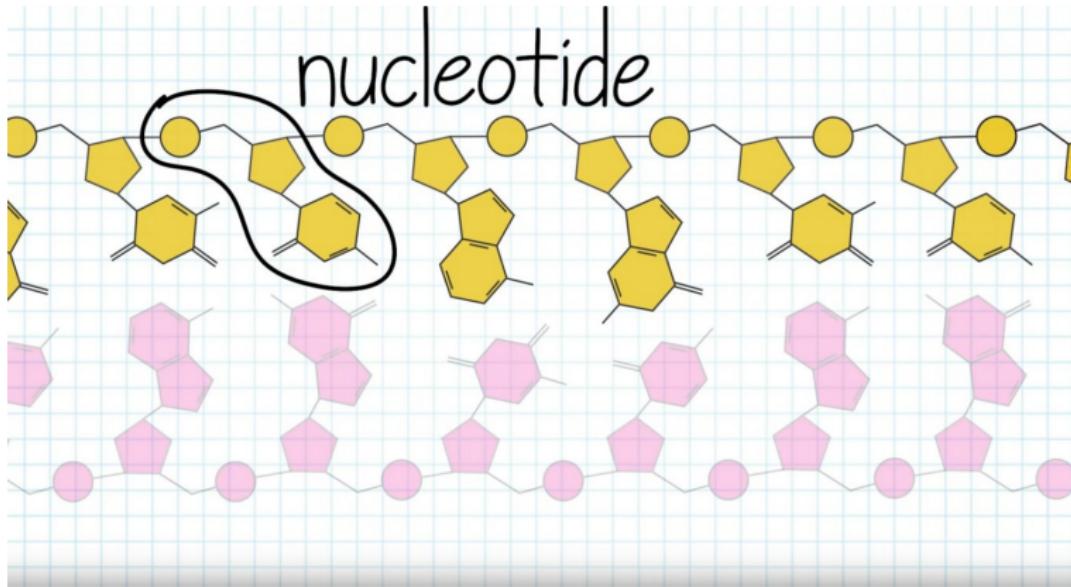


Figure: The nucleotide in a DNA strand.

DNA structure

Overview

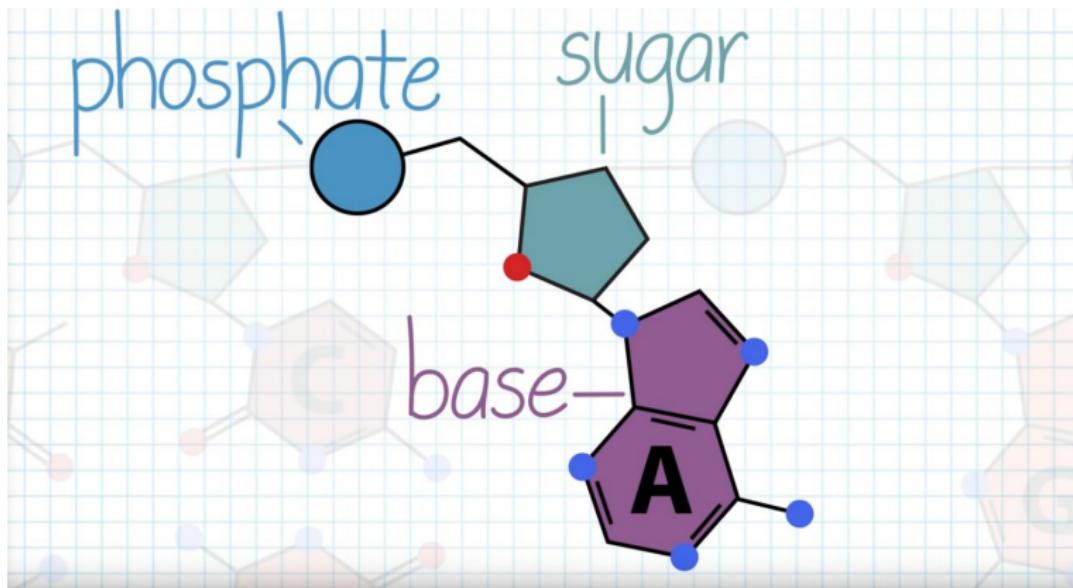


Figure: The nucleotide have three parts: phosphate, sugar and nitrogen base.

DNA structure

Overview

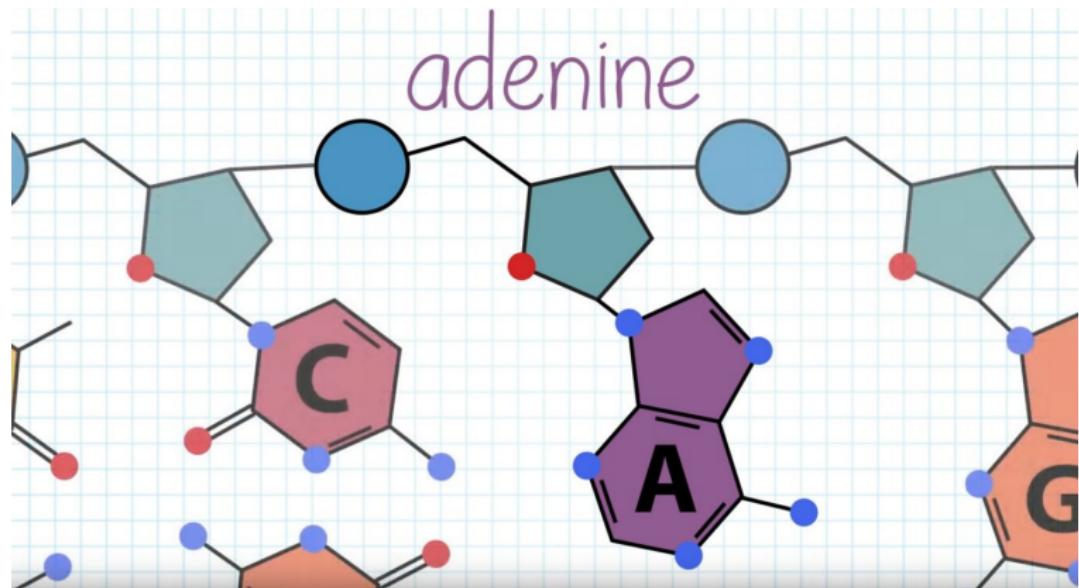


Figure: Adenine.

DNA structure

Overview

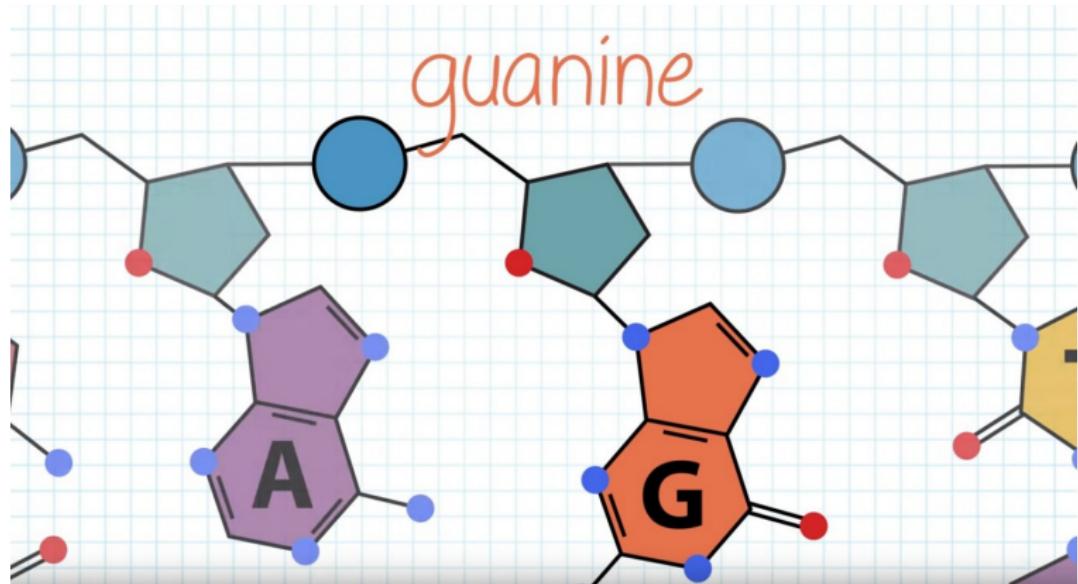


Figure: Guanine.

DNA structure

Overview

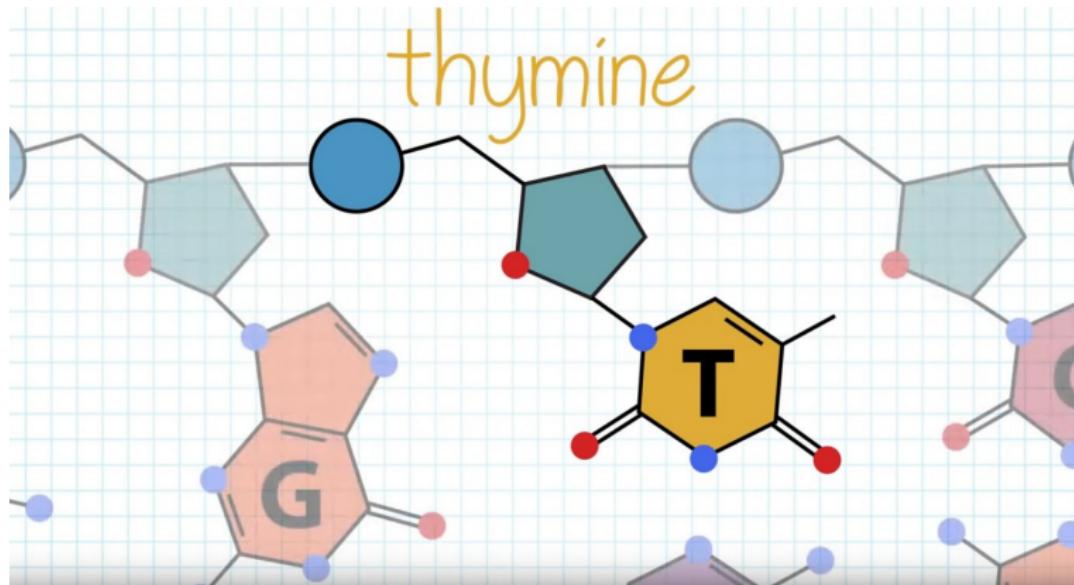


Figure: Thymine.

DNA structure

Overview

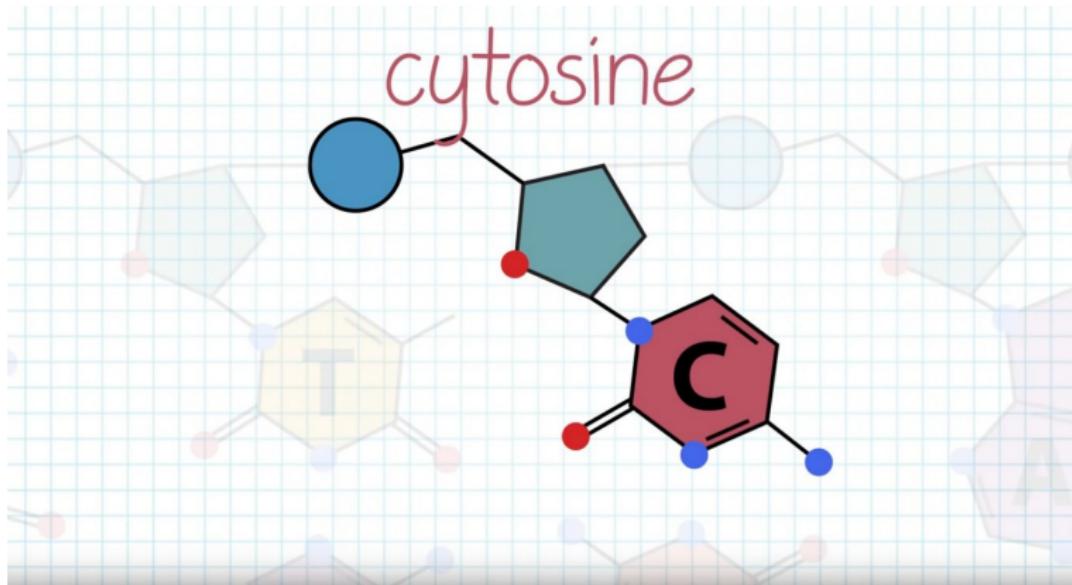


Figure: Cytosine.

DNA structure

Overview

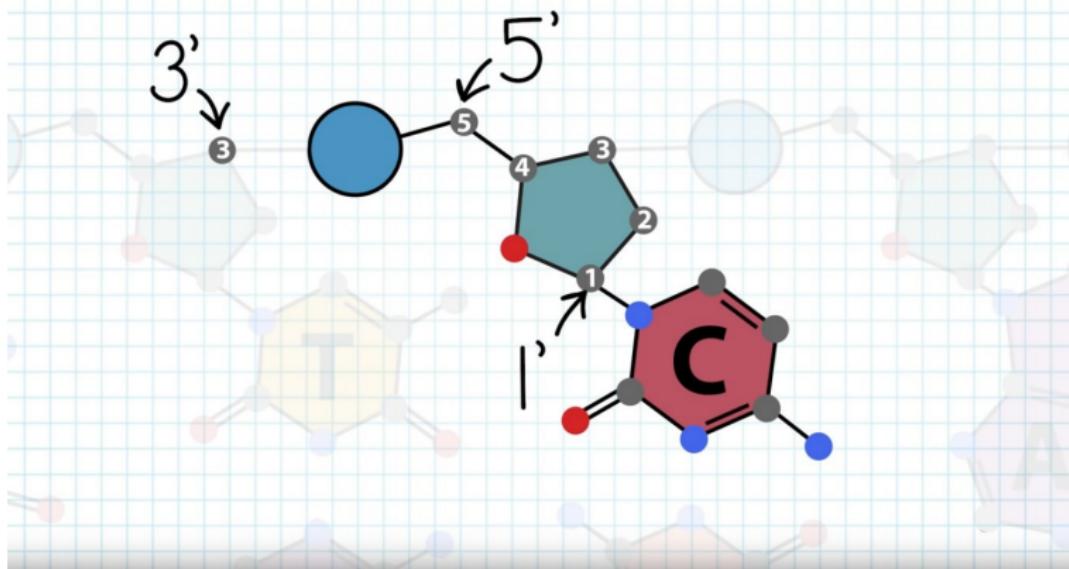


Figure: The 1' carbon of sugar connect to the base and the 3' and 5' connect to phosphate.

DNA structure

Overview

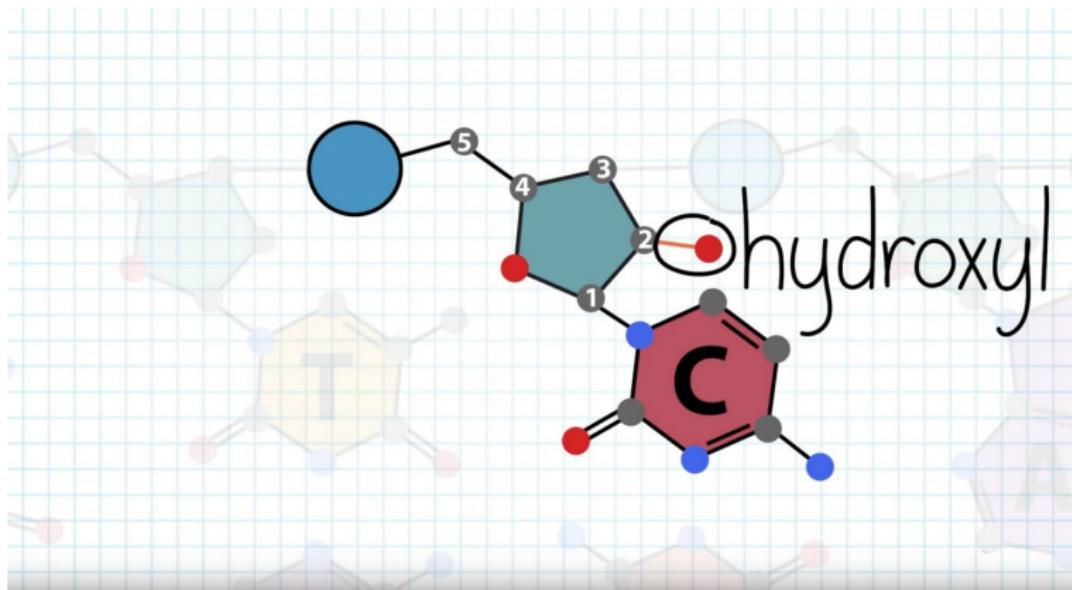


Figure: The sugar is called deoxyribose because it is missing a hydroxyl group at her 2' carbon which is present in ribose.

DNA structure

Overview

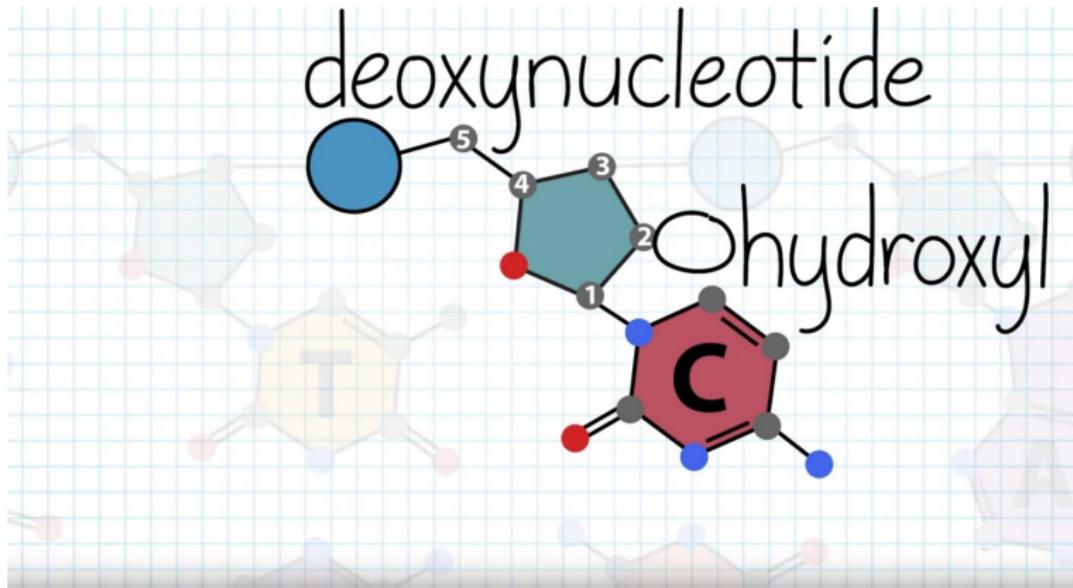


Figure: Because of it, the nucleotides are also called deoxynucleotides.

DNA structure

Overview

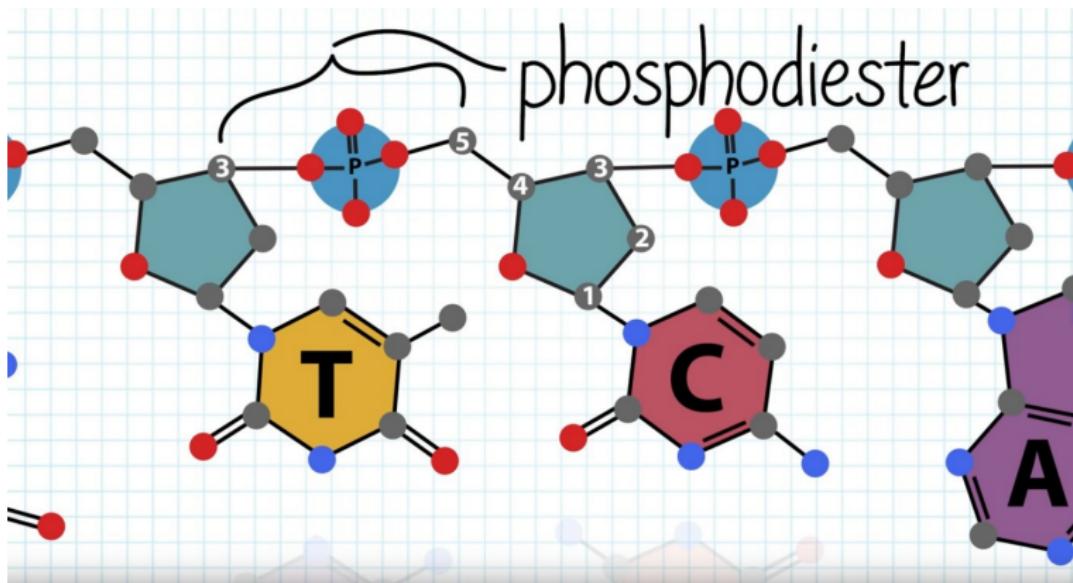


Figure: The phosphate group of one nucleotide bind to the 3' oxygen of the neighbour nucleotide.

DNA structure

Overview

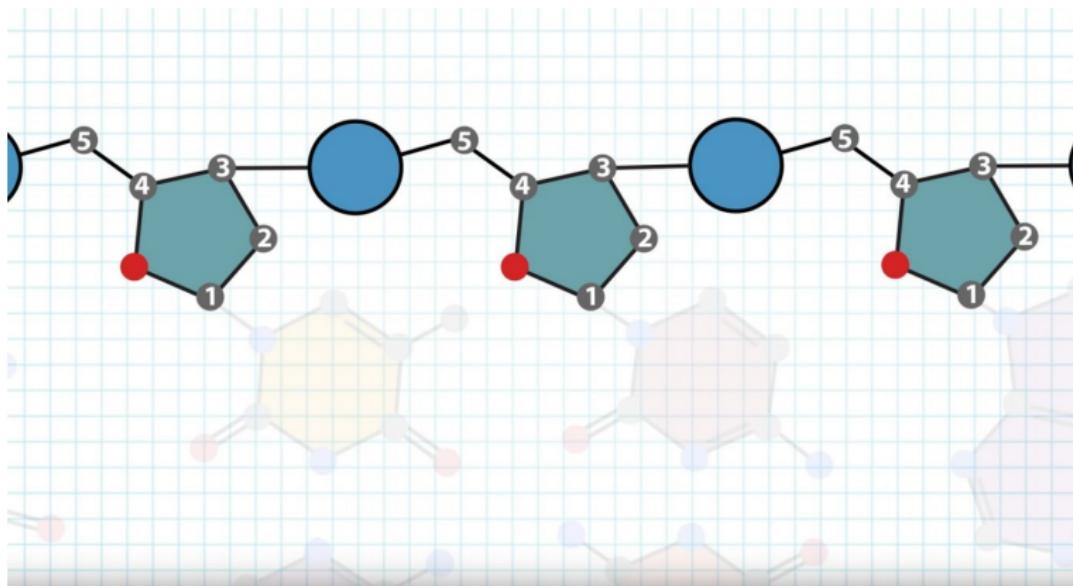


Figure: The carbon number numbering is key to describe the directionality of the DNA strand, 5' to 3'.

DNA structure

Overview

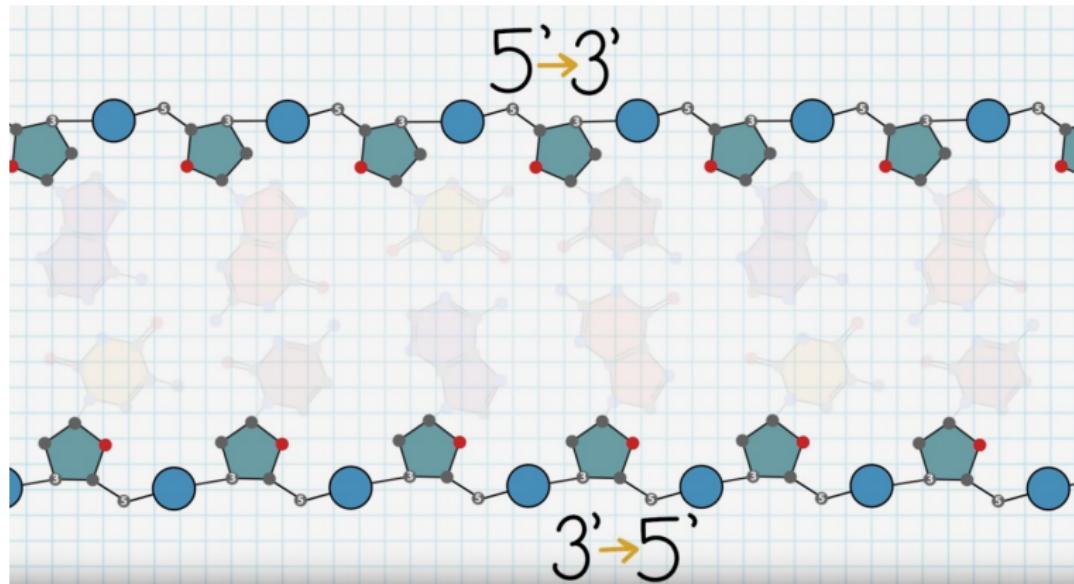


Figure: The directionality of DNA, change in the top and bottom strand. It is also named Watson and Crick.

DNA structure

Overview

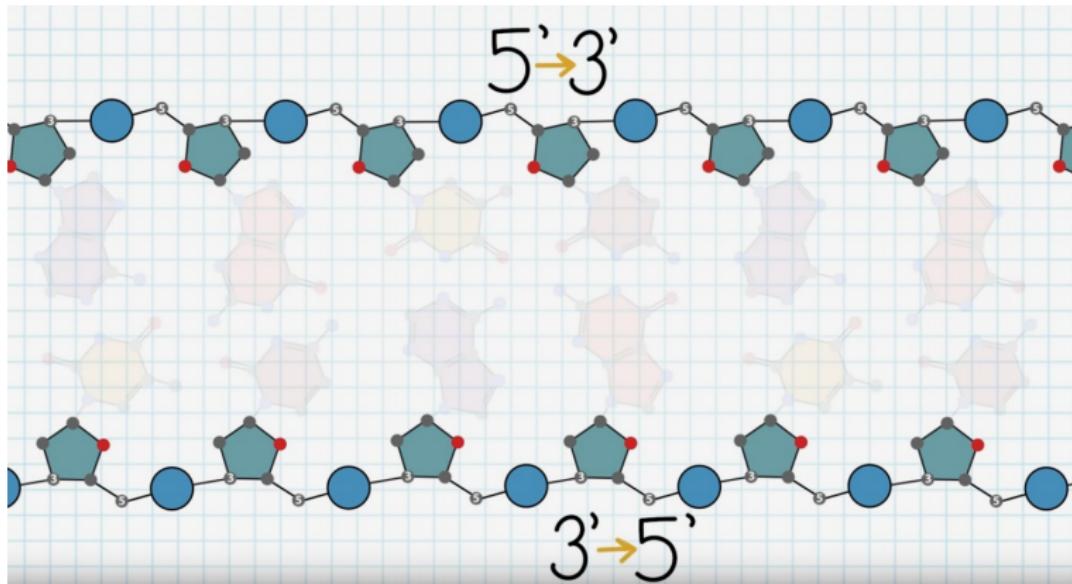


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DNA structure

Overview

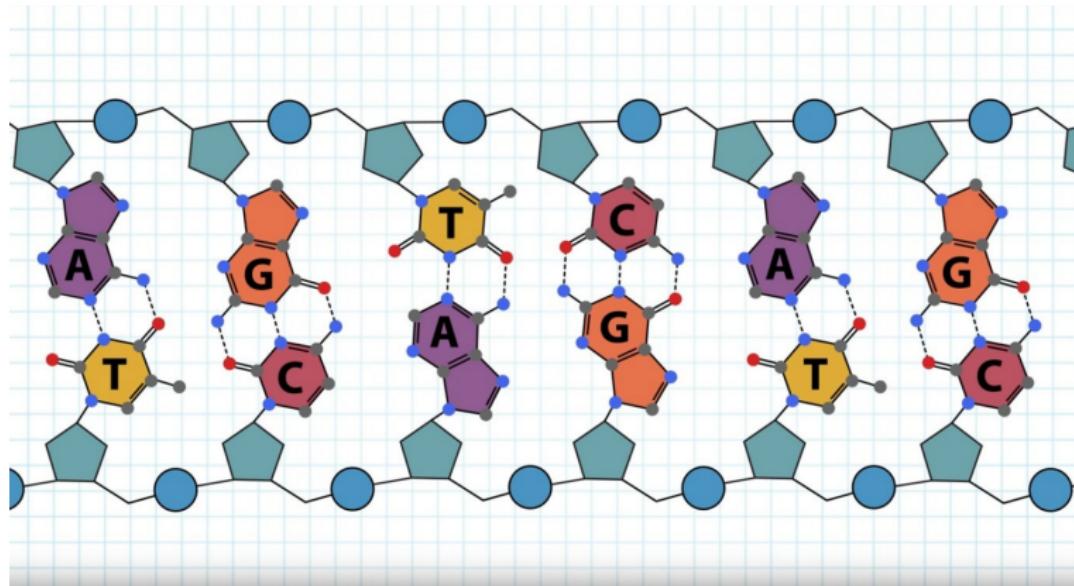


Figure: The two strand interact through non-covalent hydrogen between the bases.

DNA structure

Overview

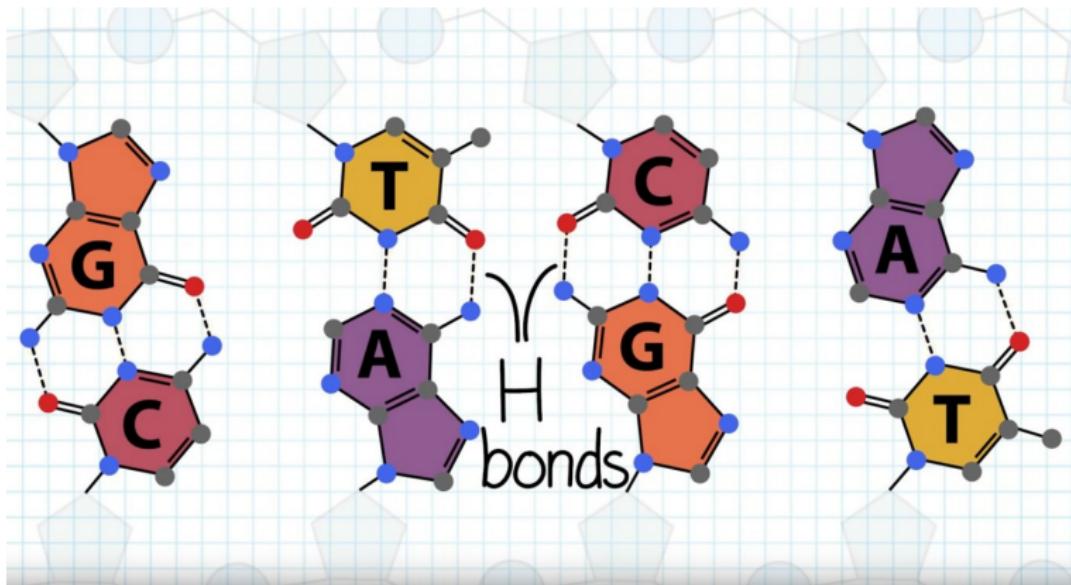


Figure: Each base forms multiple hydrogen bonds with its complementary base on the opposite strand.

DNA structure

Overview

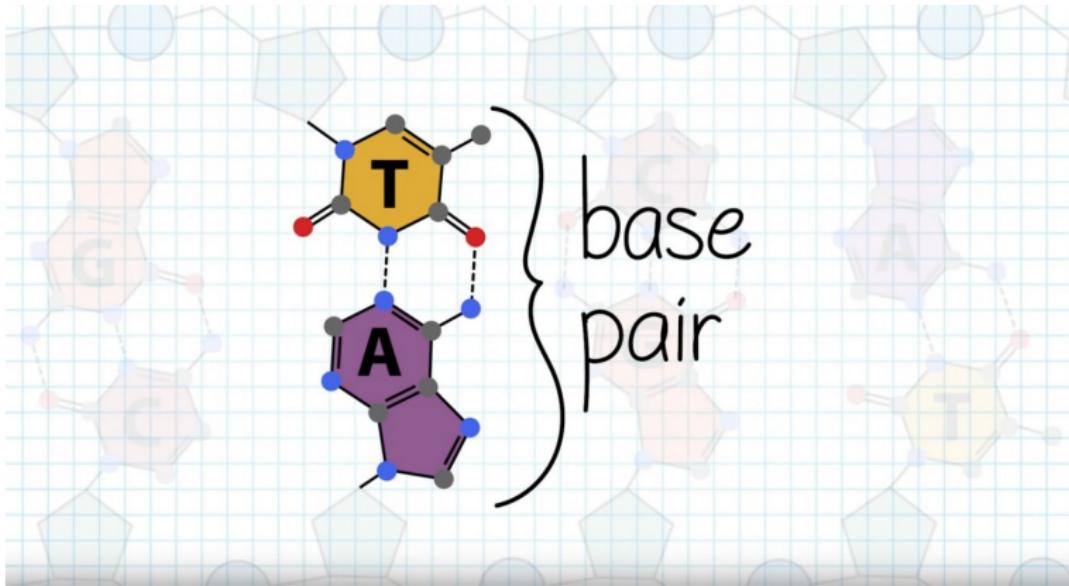


Figure: Each unit is called a base pair.

DNA structure

Overview

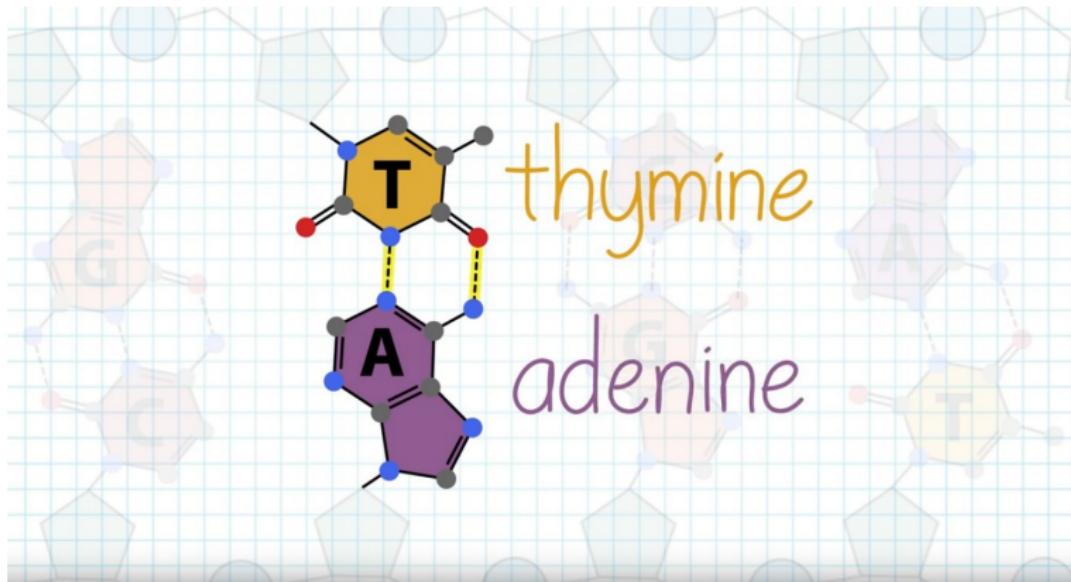


Figure: Thymine preferentially pairs with Adenine with two hydrogen bonds.

DNA structure

Overview

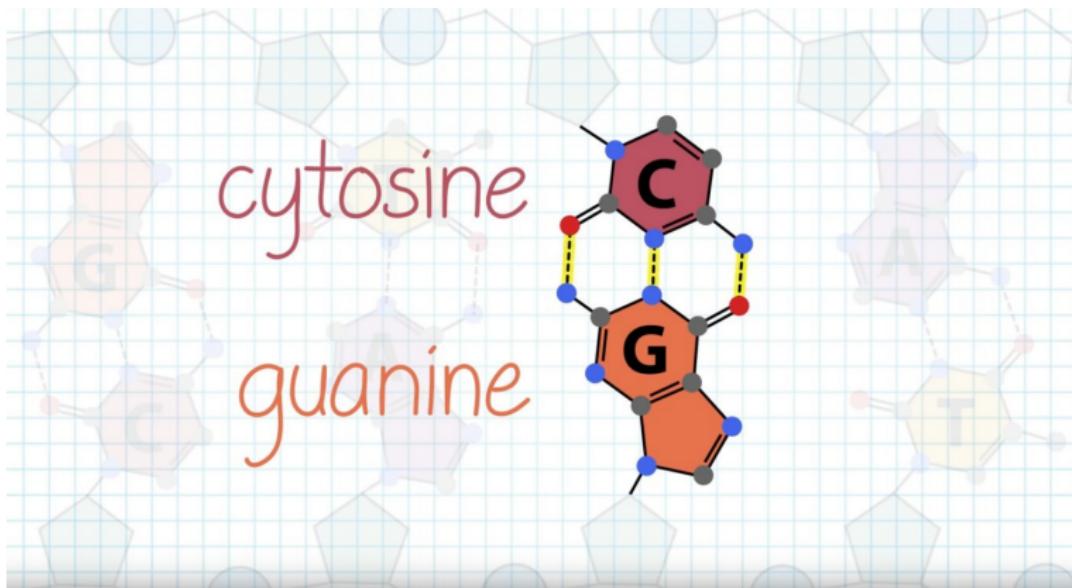


Figure: Cytosine preferentially pairs with Guanine with three hydrogen bonds.

DNA structure

Overview

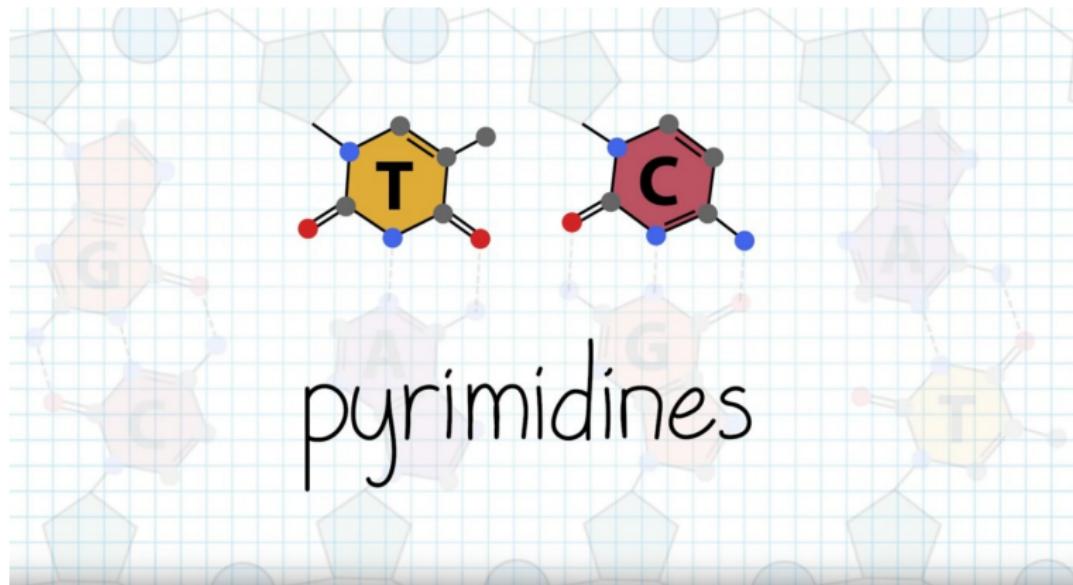


Figure: Thymine and Cytosine are called pyrimidines characterized by a single ring structure.

DNA structure

Overview

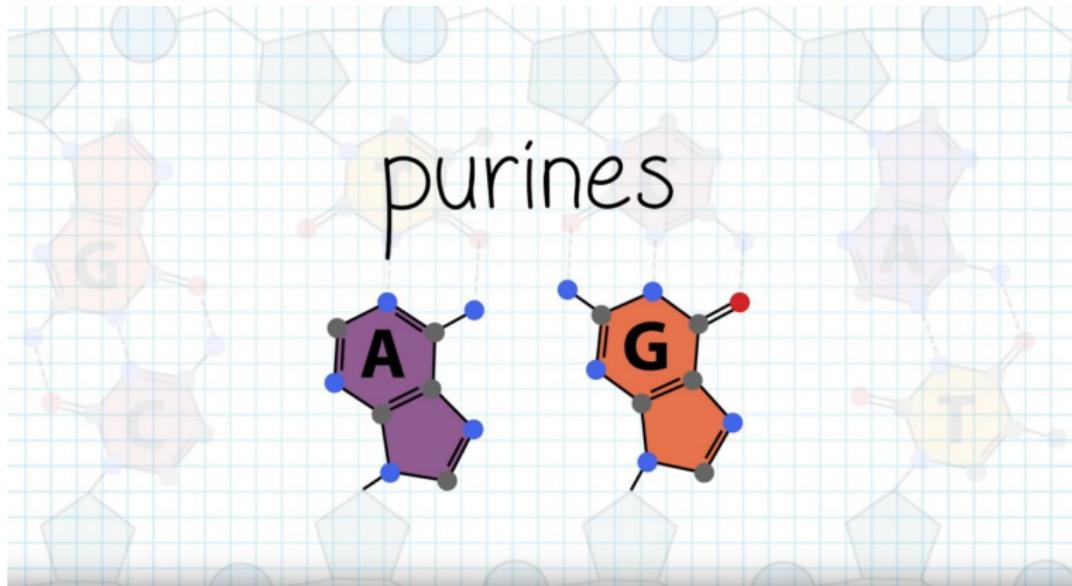


Figure: Adenine and Guanine are called purines which have double rings.

DNA replication

Overview

DNA replication is the biological process of producing two identical replicas of DNA from one original DNA molecule.

The following content is extracted from the video **DNA replication - 3D [2]**.

DNA replication

Overview

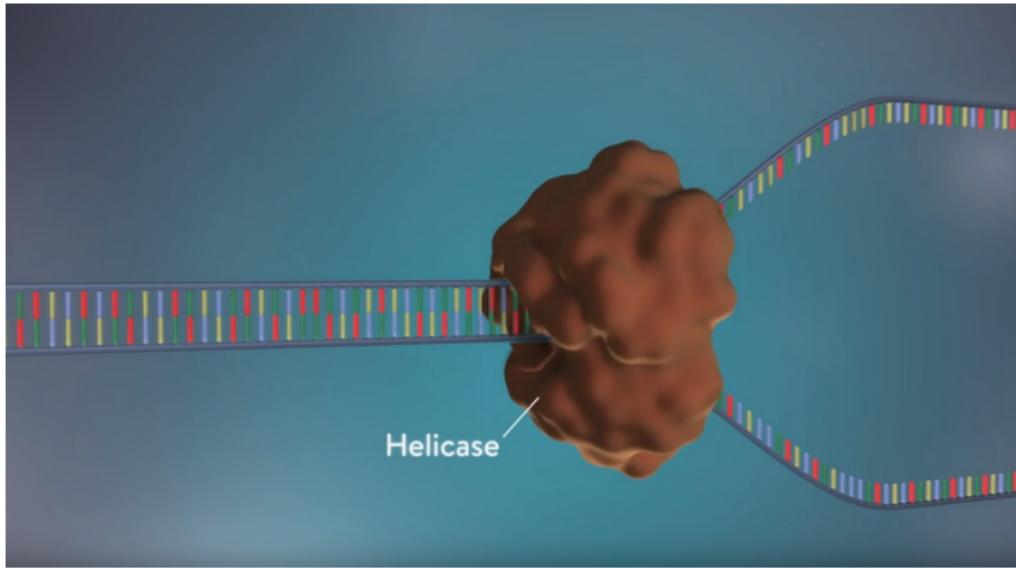


Figure: The first step in DNA replication is to unzip the double helix by an enzyme called **helicase**.

DNA replication

Overview

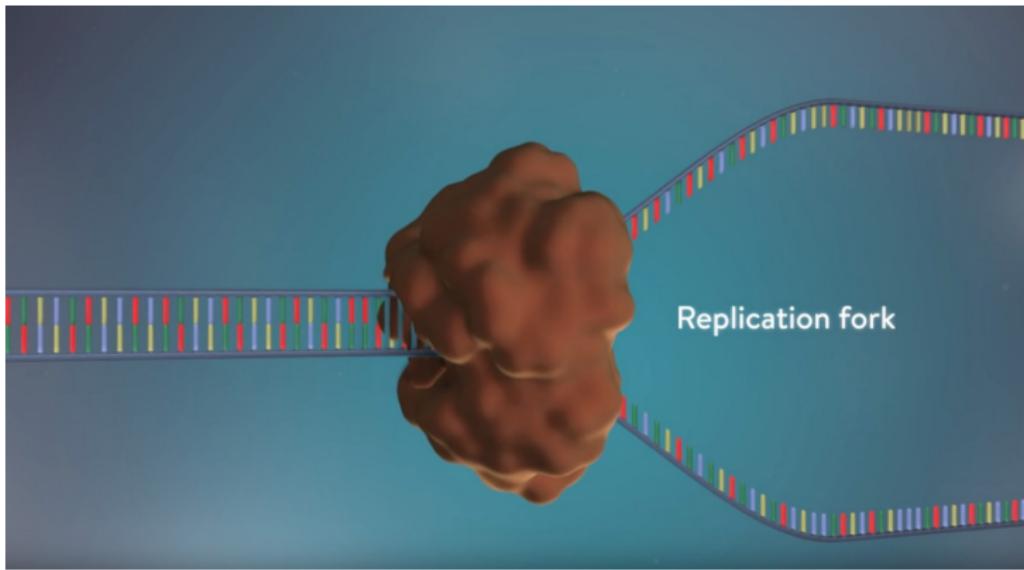


Figure: The separation of the two single strands of DNA creates a **Y** shape called a **replication fork**.

DNA replication

Overview

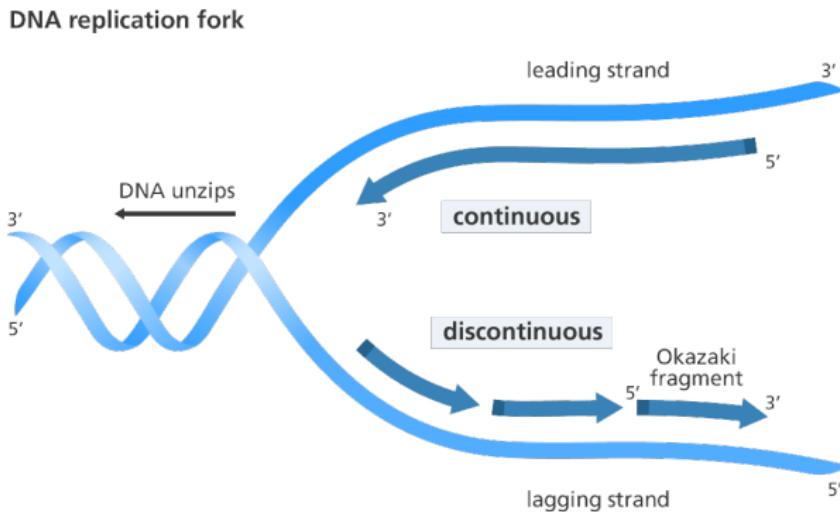


Figure: One of the strands is oriented in the 3' to 5' direction (leading strand). The other strand is oriented in the 5' to 3' direction (lagging strand).

DNA replication

Overview

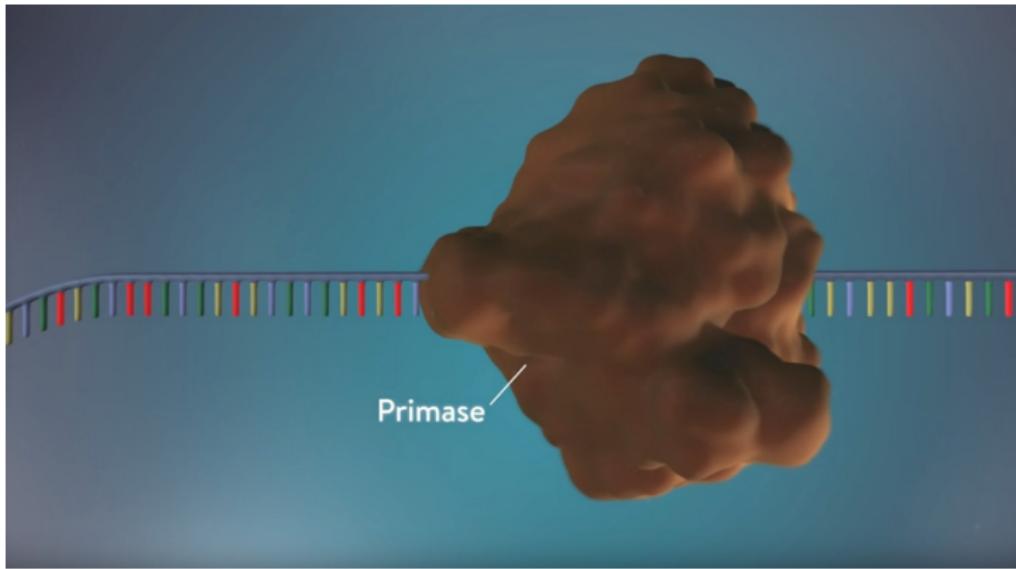


Figure: In the leading strand, an enzyme called **primase** starts the process.

DNA replication

Overview

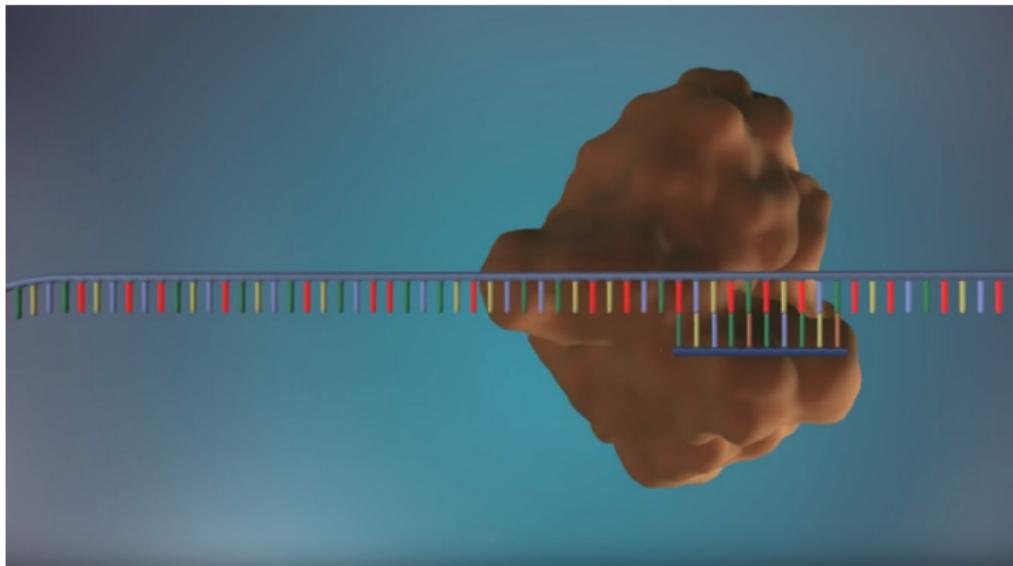


Figure: This enzyme makes a small piece of RNA.

DNA replication

Overview

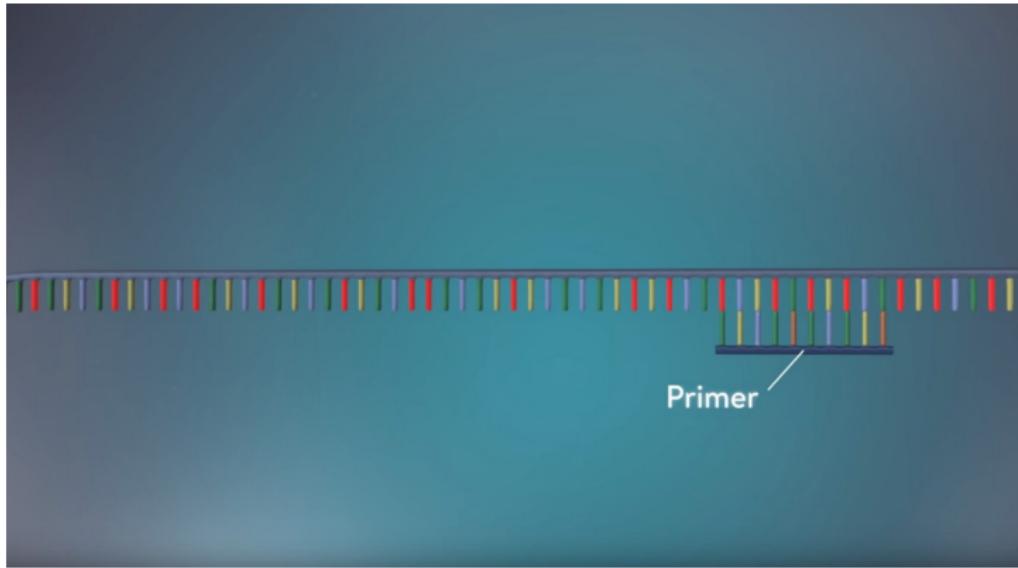


Figure: This small piece of RNA is called **Primer**. This marks the starting point for the construction of the new strand of DNA

DNA replication

Overview

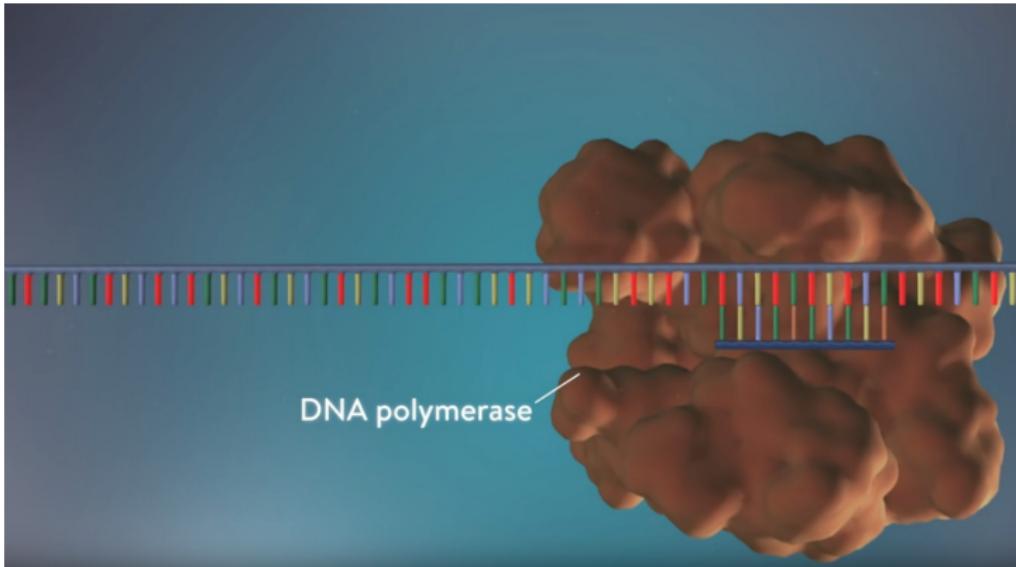


Figure: An enzyme called **DNA polymerase** binds to the primer and will make the new strand of DNA.

DNA replication

Overview

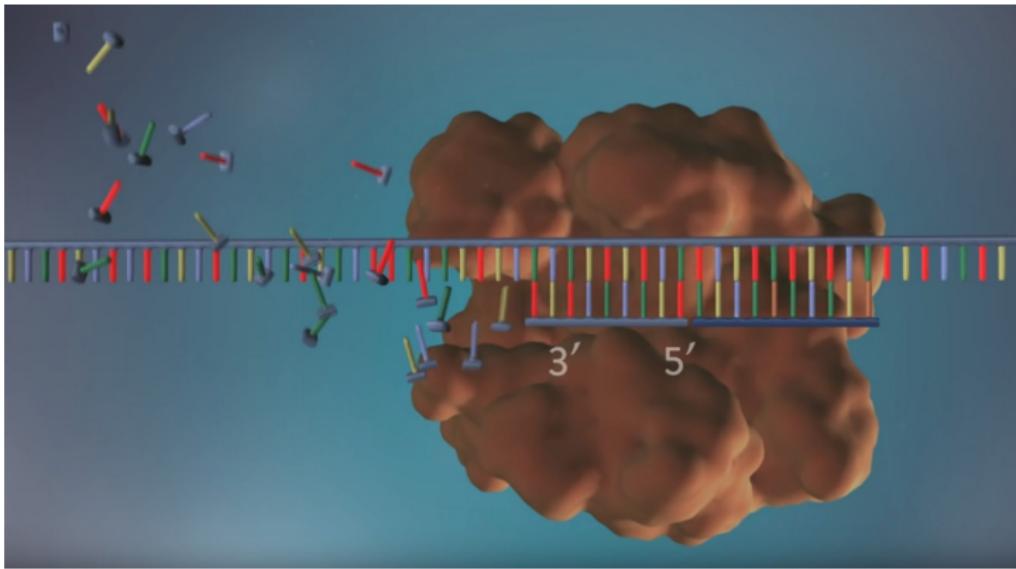


Figure: DNA polymerase add DNA bases in 5' to 3' direction. The **leading strand** is made continuously.

DNA replication

Overview

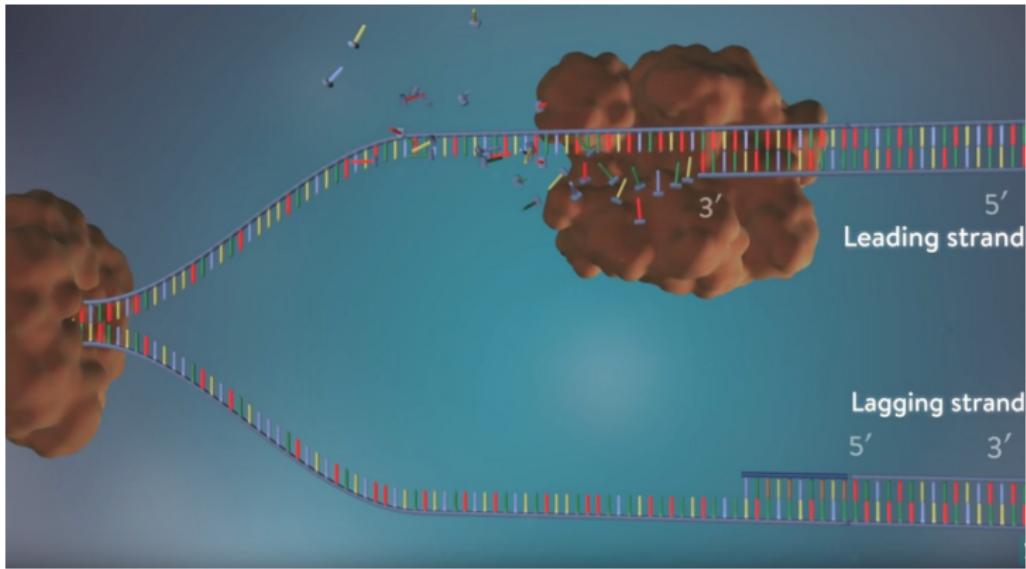


Figure: The leading strand is made continuously but the lagging strand can not because it runs in the opposite direction.

DNA replication

Overview



Figure: In the lagging strand, the DNA polymerase can only make this strand in small chunks (Okazaki fragment).

DNA replication

Overview

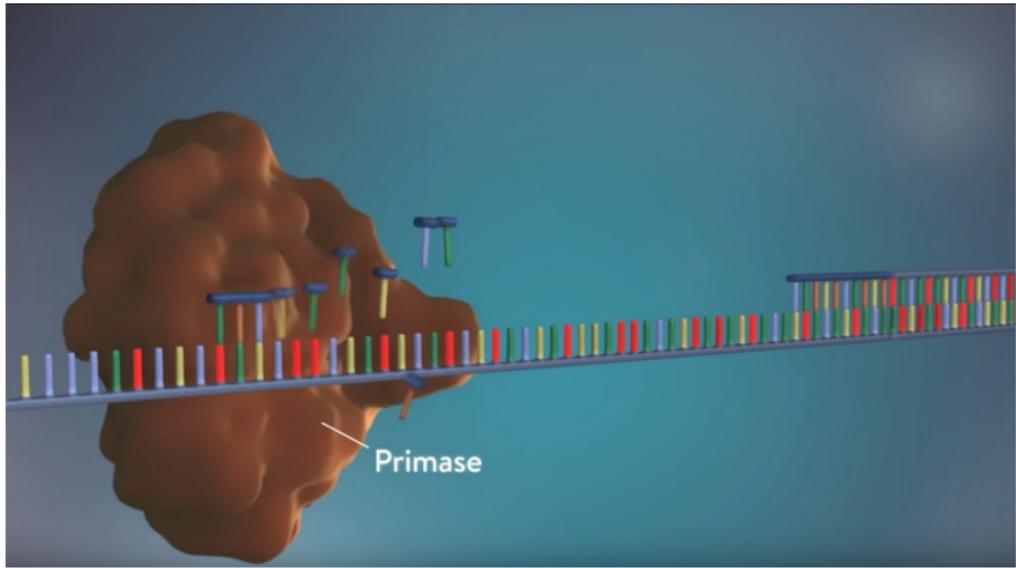


Figure: In the lagging strand, each fragment is started with the enzyme Primase.

DNA replication

Overview

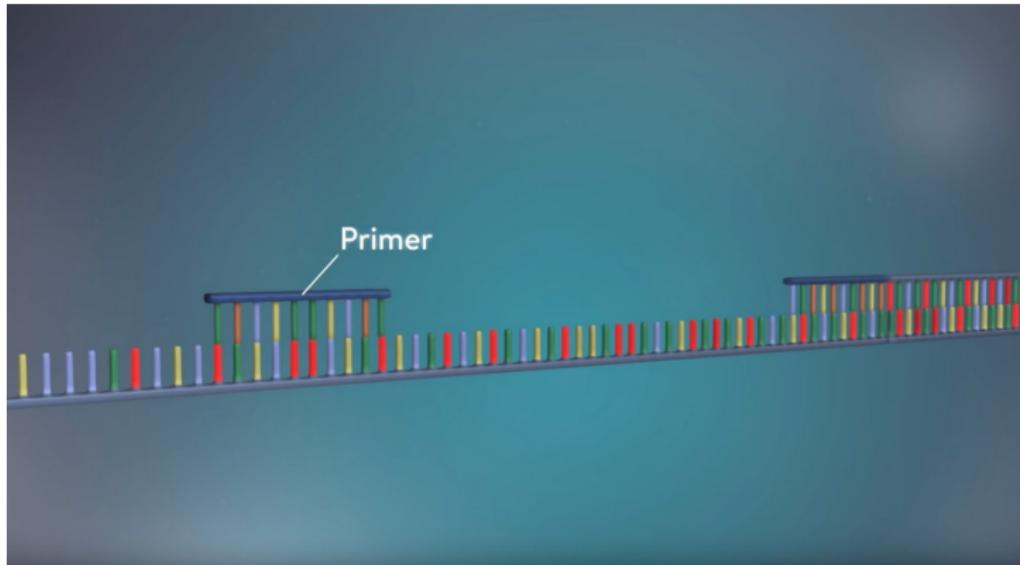


Figure: In the lagging strand, the Primase insert the primer.

DNA replication

Overview

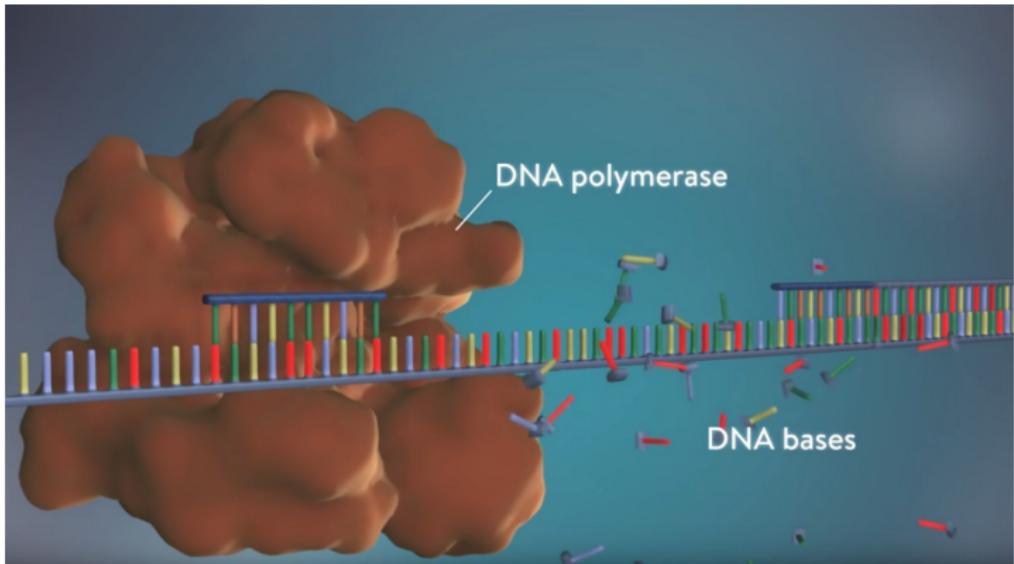


Figure: The DNA polymerase add the DNA bases from 5' to 3' direction.

DNA replication

Overview

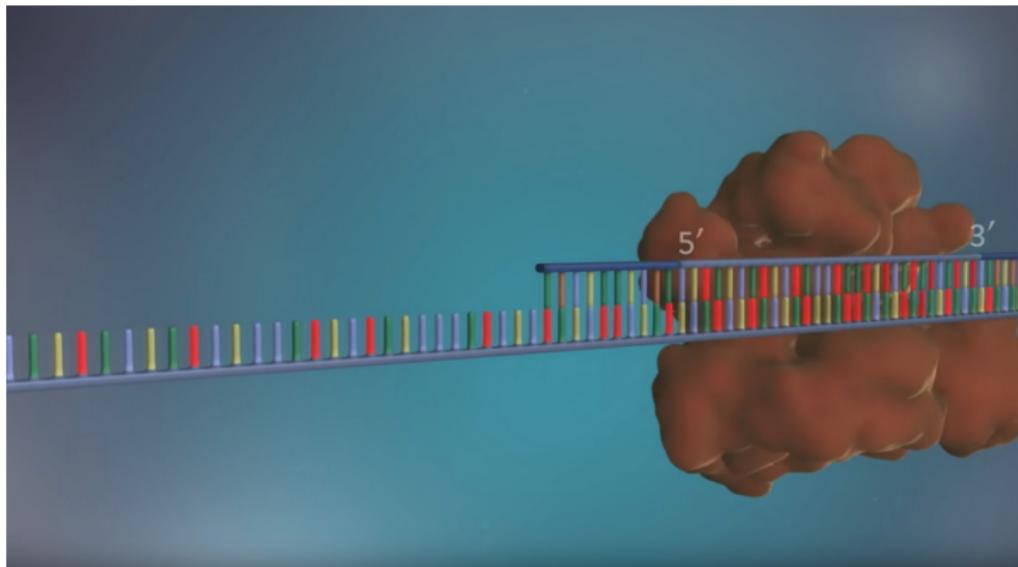


Figure: The DNA polymerase add the DNA bases from 5' to 3' direction.

DNA replication

Overview

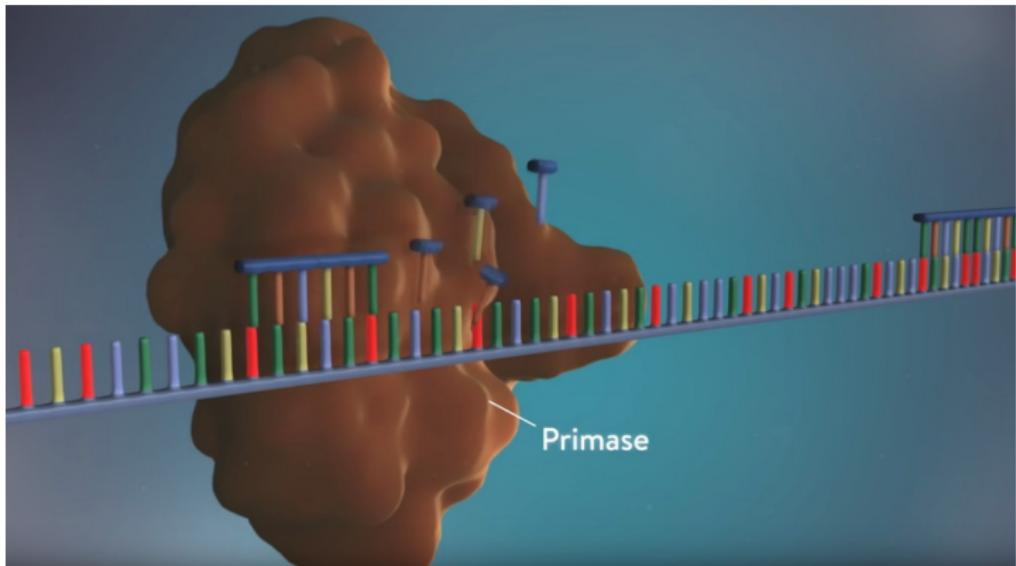


Figure: The primer is added further down the lagging strand.

DNA replication

Overview

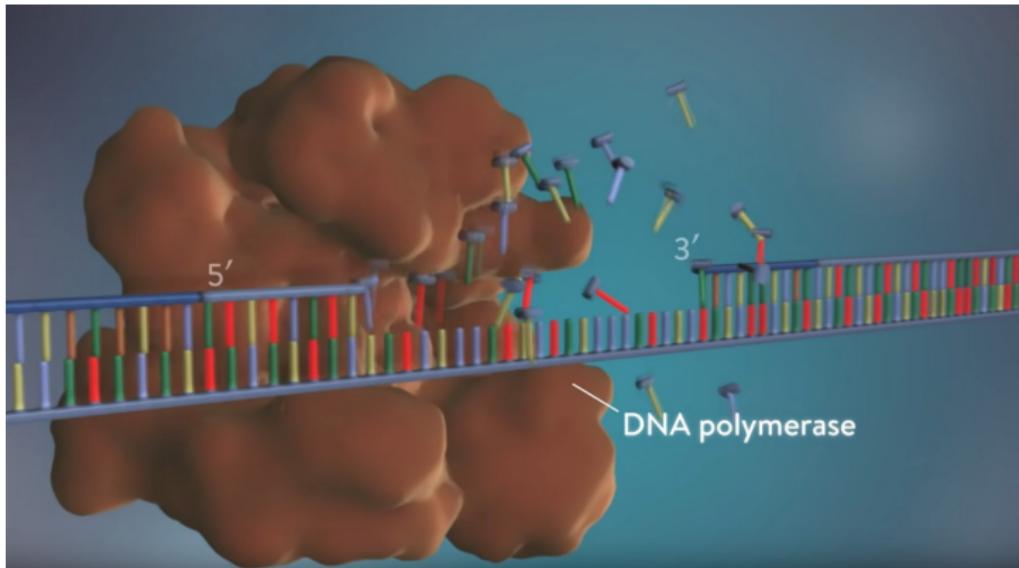


Figure: Another Okazaki fragment is then made and the process is repeated again.

DNA replication

Overview

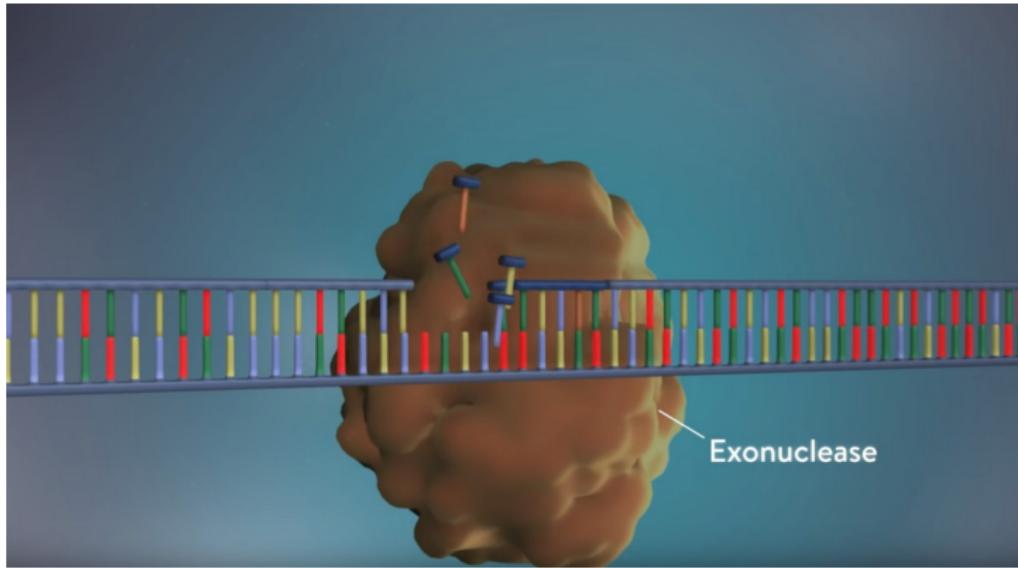


Figure: Once the DNA has been made, the enzyme **Exonuclease** removes all the RNA primers from both strands of DNA

DNA replication

Overview

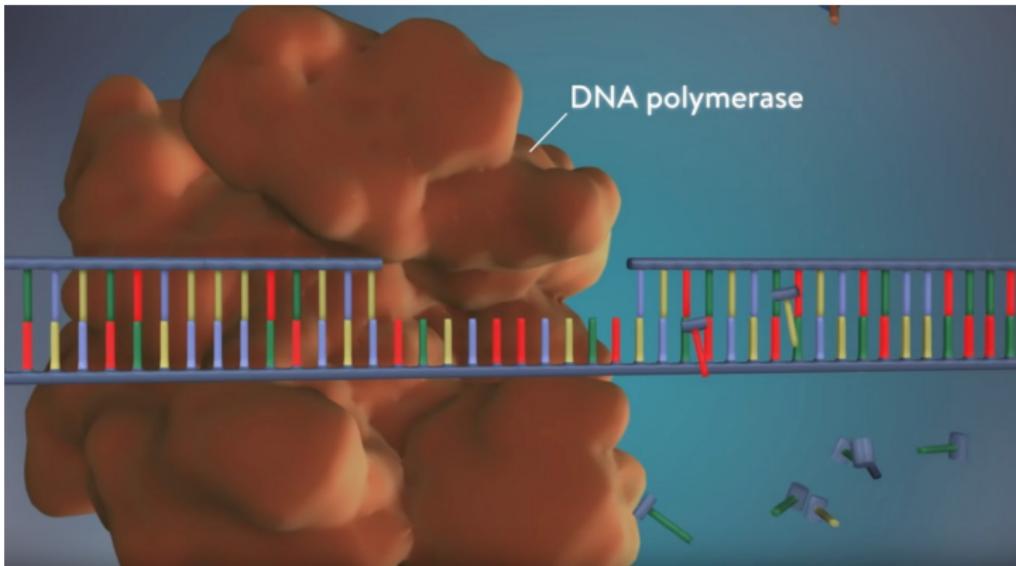


Figure: Another DNA polymerase enzyme then fills in the gaps.

DNA replication

Overview

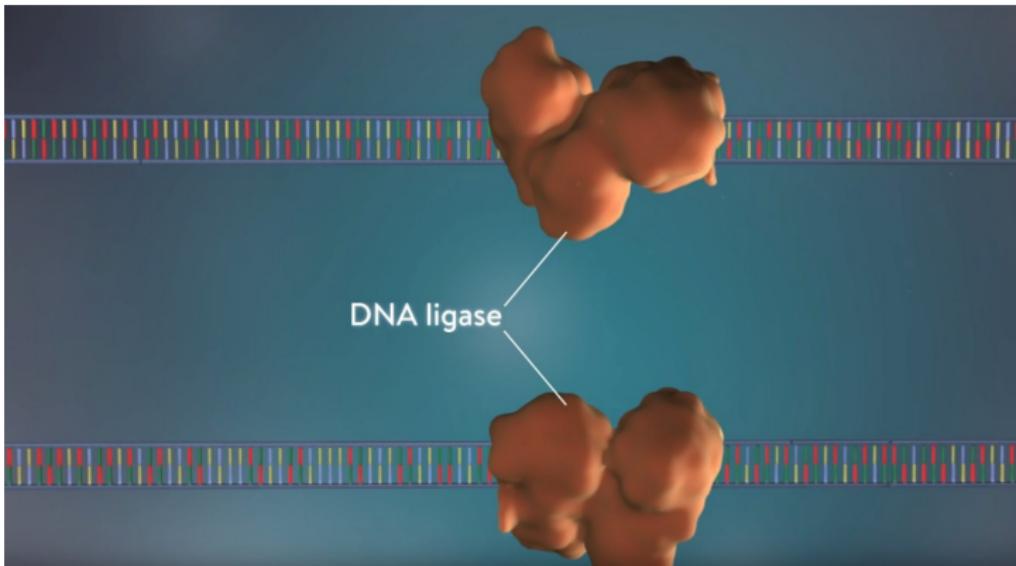


Figure: Finally the enzyme **DNA ligase** seals up the fragments of DNA.

DNA replication

Overview



Figure: DNA replication is described as semi-conservative because each DNA molecule is made up from one old, conserved strand of DNA and one new.

References I

-  yourgenome, "Dna replication - 3d,"
<https://www.youtube.com/watch?v=TNKWgcFPHqw>, 2020,
accessed: 2020-03-20.
-  M. Bio, "The structure of dna,"
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accessed: 2020-03-20.