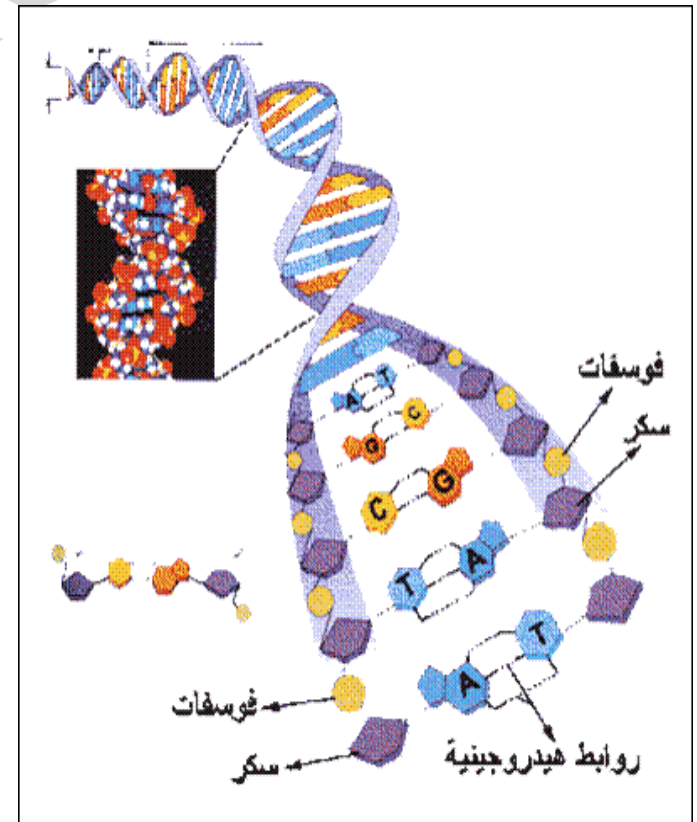


Nucleic acids

Dr. Esraa Mohamed Musa



Definition:

Nucleic acids are large biomolecules that are crucial in all cells and viruses. They are composed of nucleotides, which are the monomer components: a 5-carbon sugar, a phosphate group and a nitrogenous base. The two main classes of nucleic acids are **deoxyribonucleic acid (DNA)** and **ribonucleic acid (RNA)**.

Function of Nucleic acids:

- **Genetic information storage (DNA):** DNA stores the genetic instructions for the growth and development.
- **Genetic information transfer (RNA):** RNA acts as a messenger, translating genetic information from DNA into instructions for building proteins
- **Protein synthesis:** RNA carries out the synthesis of protein, which are essential for cell structure and function regulation.
- **Nucleic acids help regulate gene expression,** allowing cells to respond to their environment.
- **Heredity:** nucleic acids insure the transmission of genetic traits from parents to offspring.
- **Other roles:** functional nucleic acids can act as a catalyst, sensors, and modular molecular.

Types of nucleic acids

There are two types of nucleic acids:

- **Deoxyribose Nucleic Acid (DNA):** is the genetic material in most organisms (humans, animals, bacteria, plants, and some viruses).
- **Ribo Nucleic Acid (RNA): Protein synthesis.** in some viruses, RNA serves as the genetic material.
 - ❖ Each DNA molecule is very long and usually consists of hundreds to thousands of genes.
 - ❖ **A gene** is a small region in the DNA. When a cell divides, its DNA is copied and passed to the next generation of cells.

The basic structure of nucleic acids

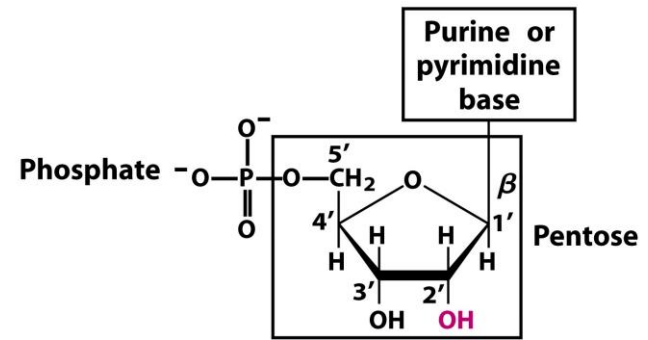
- Nucleic acids (polymers) are made of nucleotides (monomers)

Each nucleotide consists of three components:

- 1) a phosphate group
- 2) a nitrogen base
- 3) pentose sugar

- Pentose sugars:**

- Is a type of simple sugar that plays fundamental roles in various biological processes. Its essential component of nucleotides, which are the building blocks of DNA and RNA.

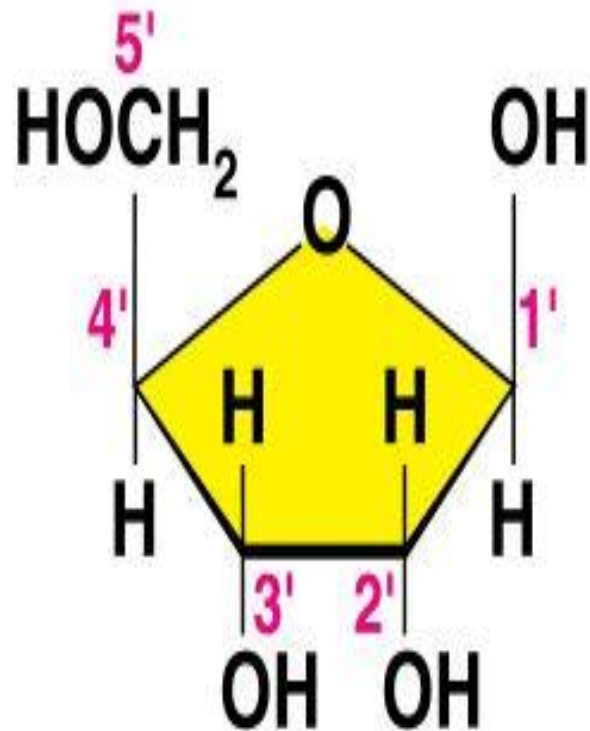


RNA contains **Ribose**

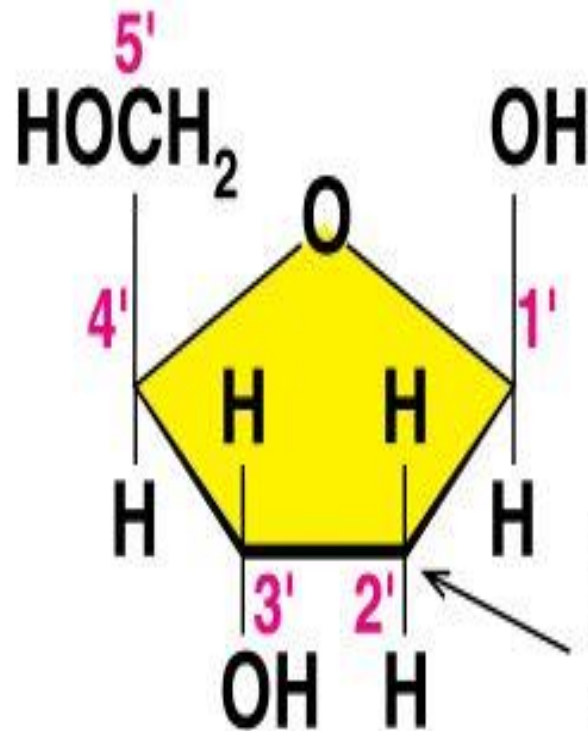
DNA contains **Deoxyribose**

- The sugars in DNA and RNA differ at a single position. In the **DNA**, the sugar is **deoxyribose**, which contains a hydrogen (H) at the second (2') carbon.
- The sugar in **RNA** is **ribose**, which contains a hydroxyl (OH) group at the 2' carbon.
- The carbons of the sugars are numbered 1 to 5.

Pentose sugars in RNA and DNA



Ribose in RNA



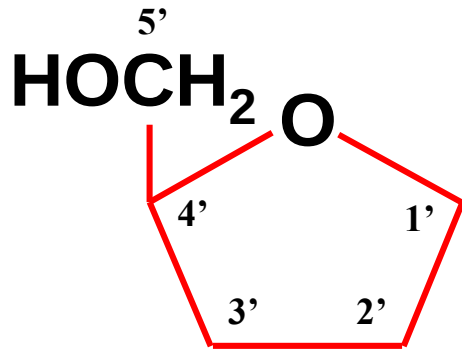
Deoxyribose in DNA

No oxygen
is bonded
to this carbon

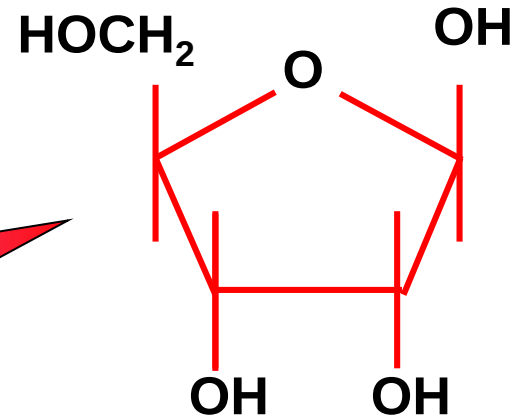


Nucleotide Structure

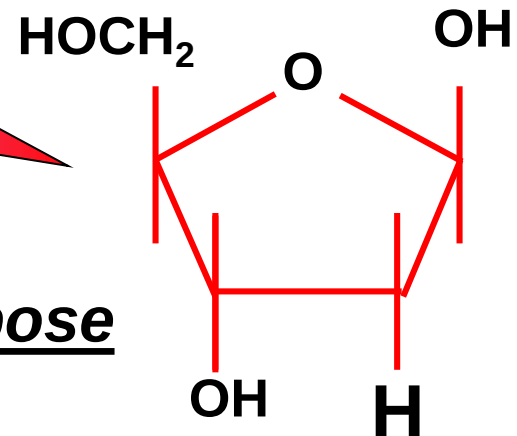
Generic Ribose
Structure



Ribose



Deoxyribose



N.B. Carbons are given numberings as a prime

base (purine, pyrimidine) + ribose (deoxyribose)

N-glycosyl linkage

nucleoside + phosphate

phosphoester linkage

nucleotide

phosphodiester linkage

nucleic acid

Nucleosides and Nucleotides:

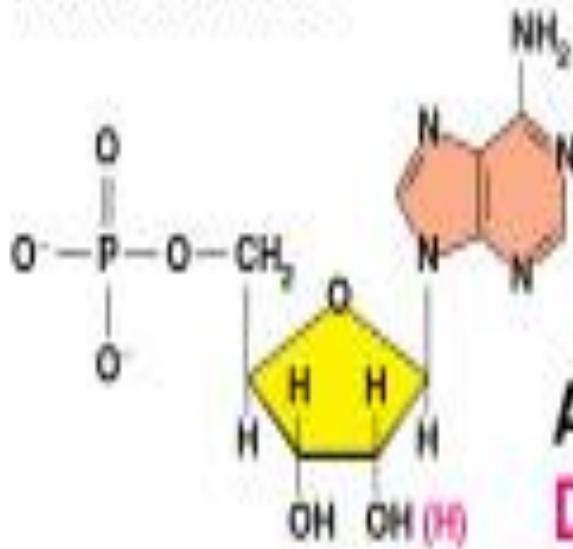
are foundational biological molecules differing by a single component:

a nucleotide is a nucleoside with one or more phosphate group attached. –

Nucleotides	Nucleosides:
building blocks of DNA-RNA	precursors.
Ex: adenosine triphosphate (ATP), deoxythymidine monophosphate (dTMP).	Ex: adenosine, cytidine, uridine.
participate in energy transfer, signaling and form nucleic acid chains.	serves as intermediate role in nucleotide synthesis
consist a base, sugar, and phosphate. (ribose-deoxyribose),	consist only of base and sugar (ribose-deoxyribose),

Nucleosides and Nucleotides

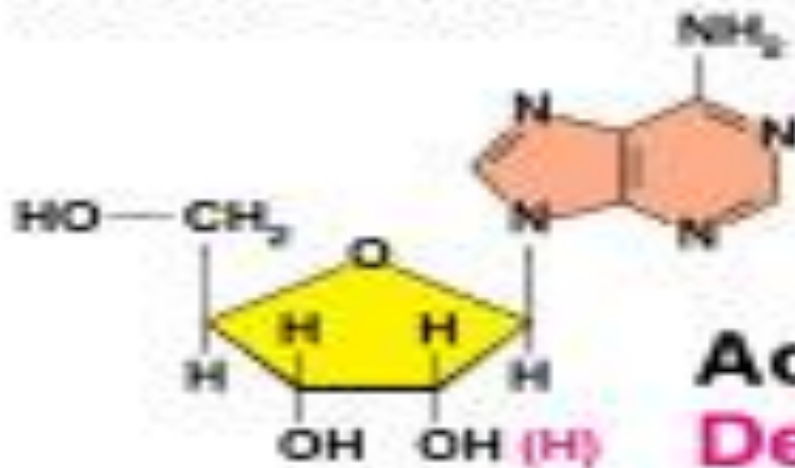
Nucleotides



Adenosine 5'-monophosphate (AMP)

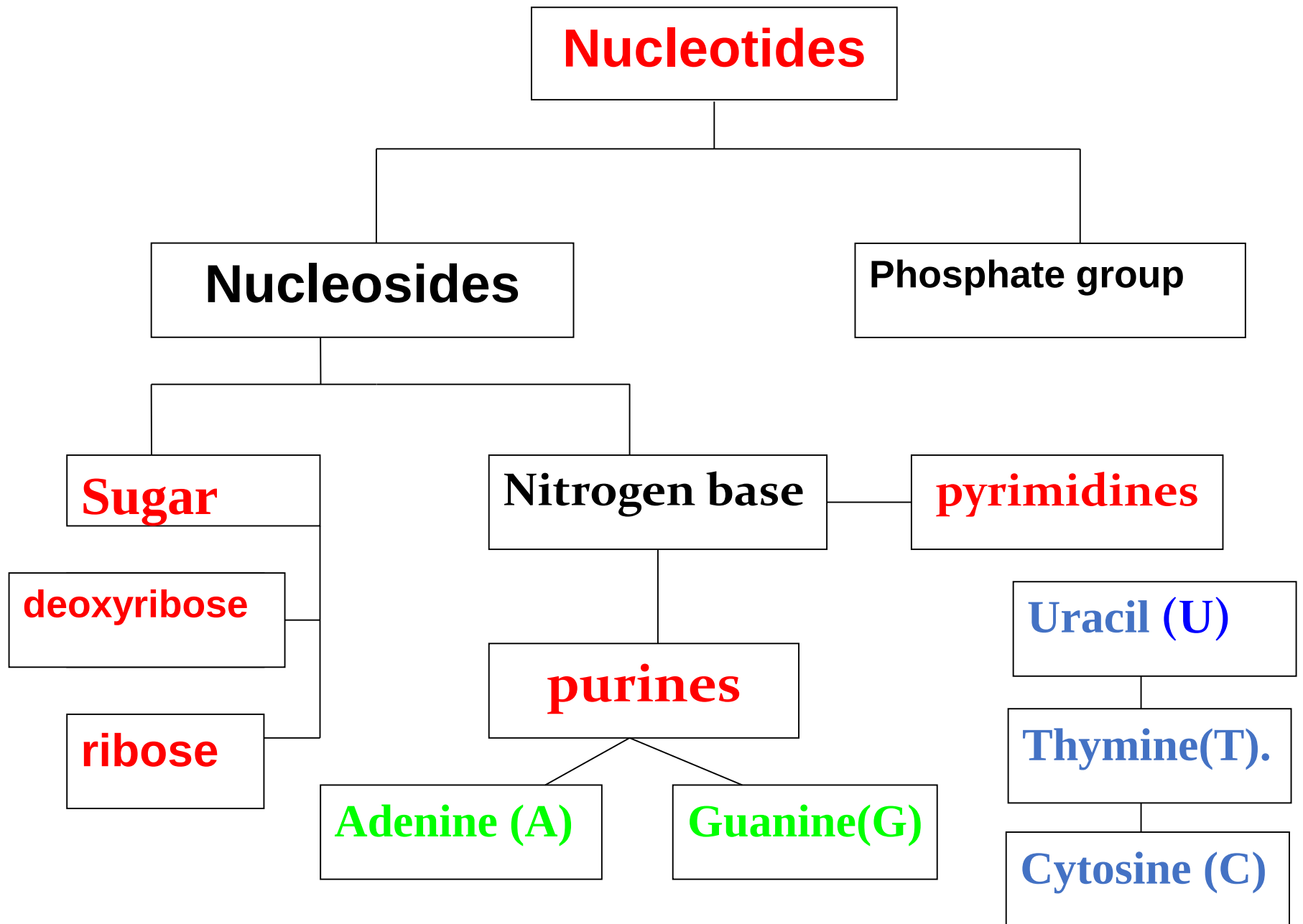
Deoxyadenosine 5'-monophosphate (dAMP)

Nucleosides



Adenosine

Deoxyadenosine



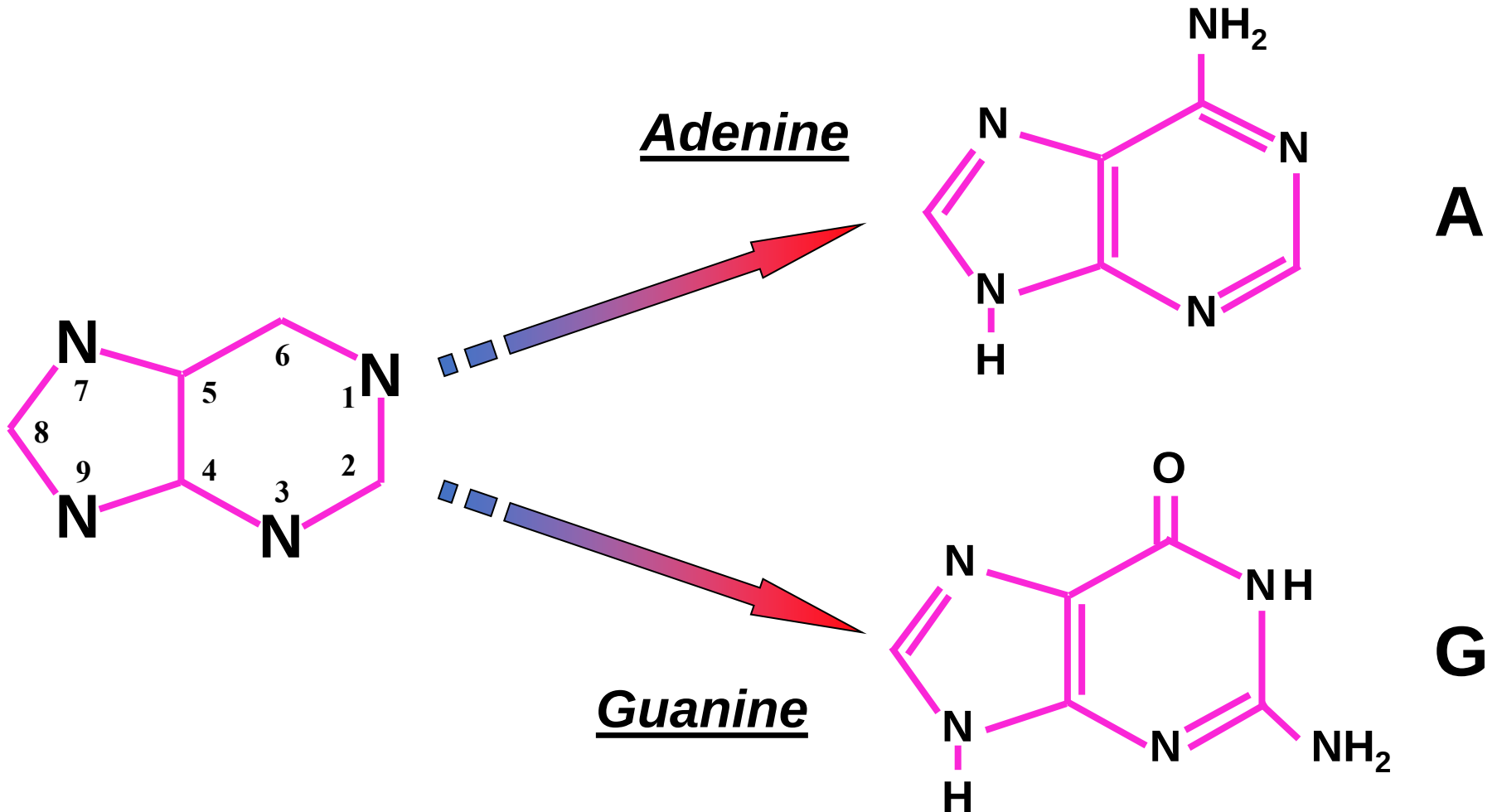
Types of RNA

- 1) **Messenger RNA (mRNA)**: Molecule in cells that carries the DNA sequence information from the nucleus to the ribosomes.
- 2) **Transfer RNA (tRNA)**: Molecule in cells that brings the amino acids and transport them to the ribosome for making protein.
- 3) **Ribosomal RNA (rRNA)**: The structural and functional part of the ribosome.

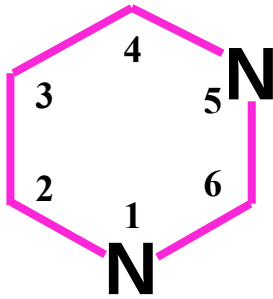
Nitrogen bases in DNA and RNA

- DNA and RNA both have **four nitrogen bases** (rings of carbon and nitrogen), **two purines and two pyrimidines** in their nucleotide chains.
- ❖ **DNA Purine has consist:** adenine (A) and guanine (G) and the pyrimidines consist: cytosine (C) and thymine (T).
- ❖ **RNA Purine has consist:** adenine (A) and guanine (G) and the pyrimidines consist: cytosine (C) and uracil (U).
- DNA strands are held together by **hydrogen bounds** between the basses.
- **Two** hydrogen bonds connect adenine and thymine and **three** connect cytosine and guanine.
- A nucleotide is formed in the cell when a **base** attaches to the **1' carbon** of the sugar and **a phosphate** attaches to the **5' carbon** of the same sugar .

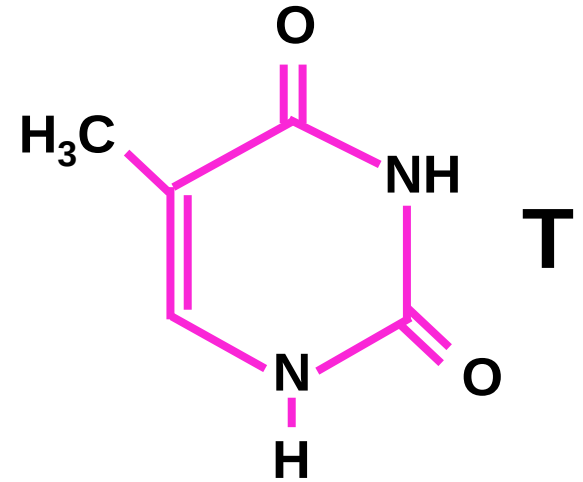
Structure of Nucleotide Purines bases



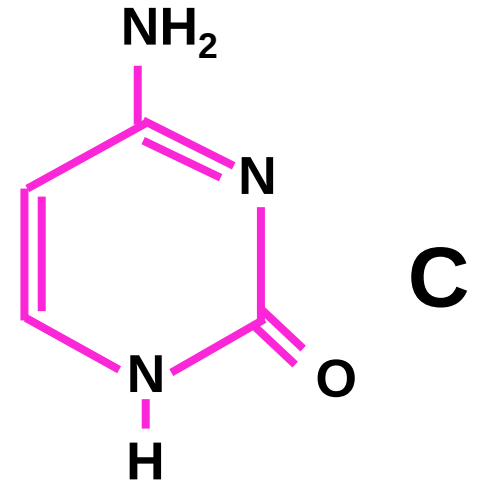
Structure of Nucleotide Pyrimidines bases



Thymine



Cytosine

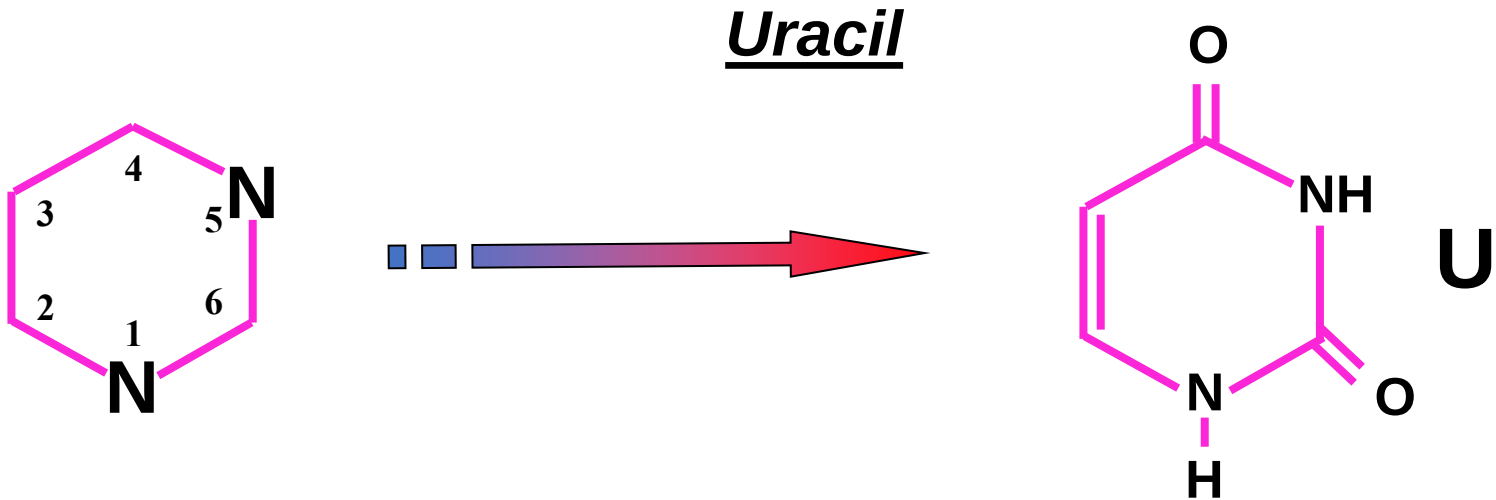


Structure of Nucleotide Uracil bases

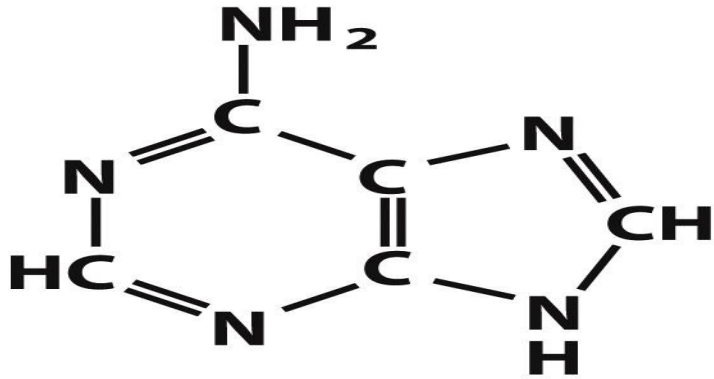
Thymine is found ONLY in DNA.

In RNA, thymine is replaced by uracil

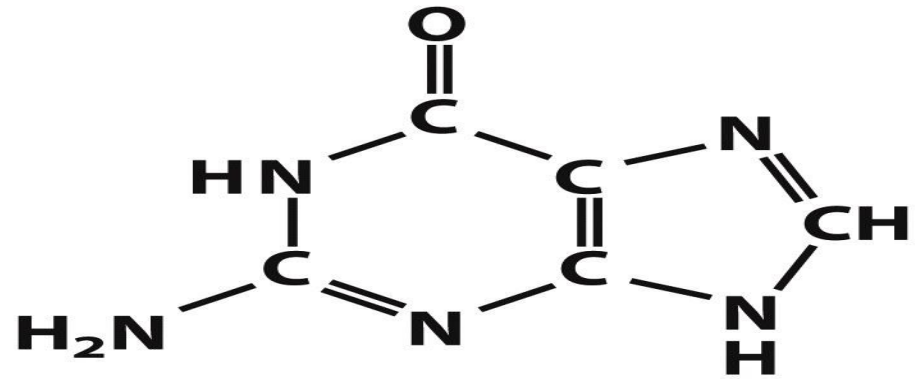
Uracil and Thymine are structurally similar



Nitrogen bases

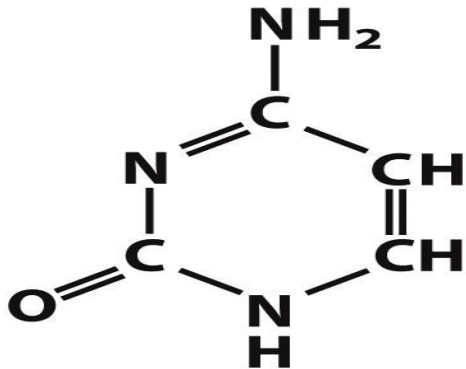


Adenine

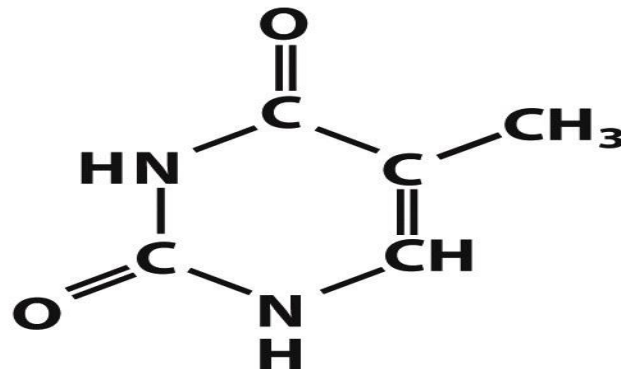


Guanine

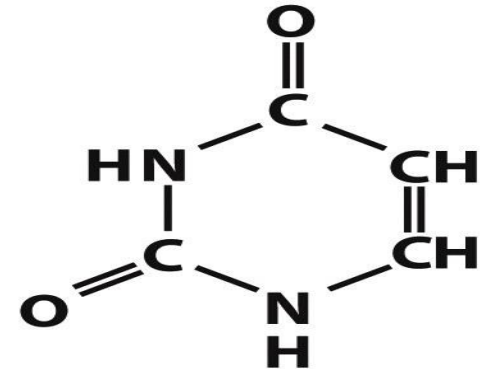
Purines



Cytosine



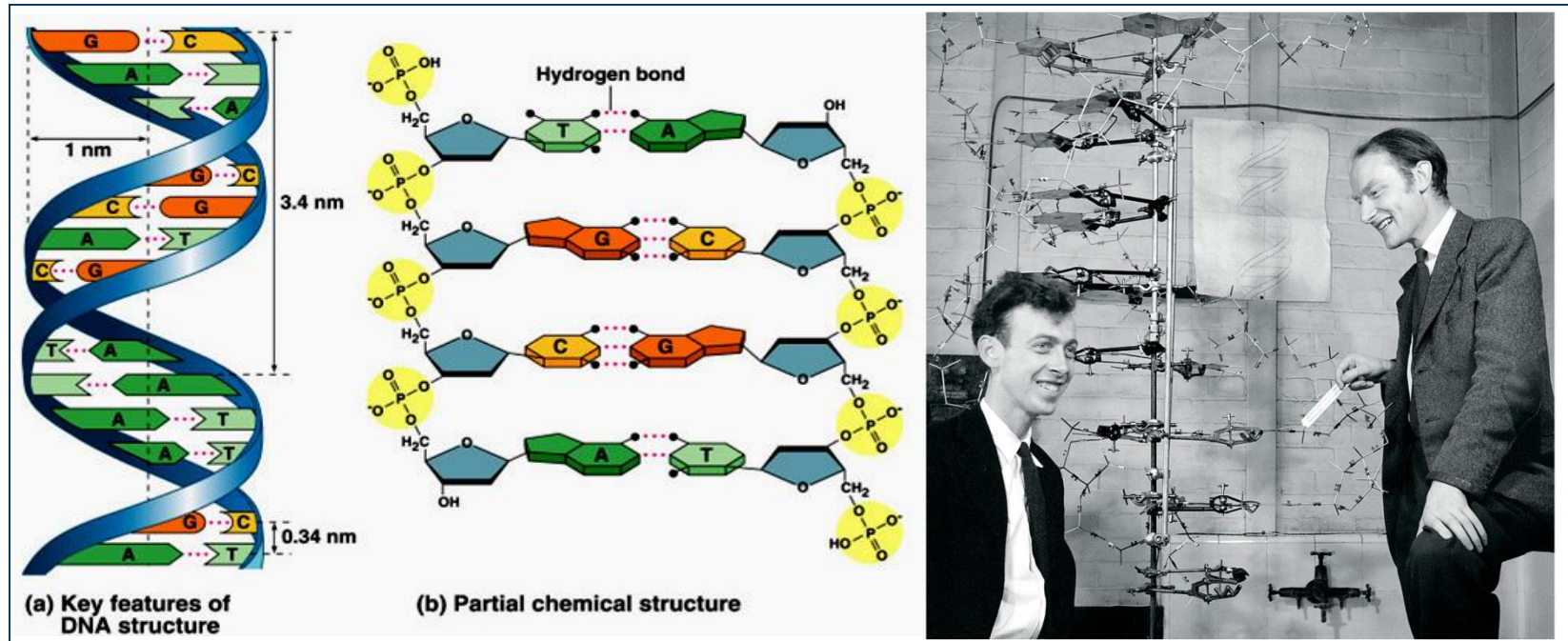
**Thymine
(DNA)**



**Uracil
(RNA)**

Pyrimidines

The Watson-Crick model

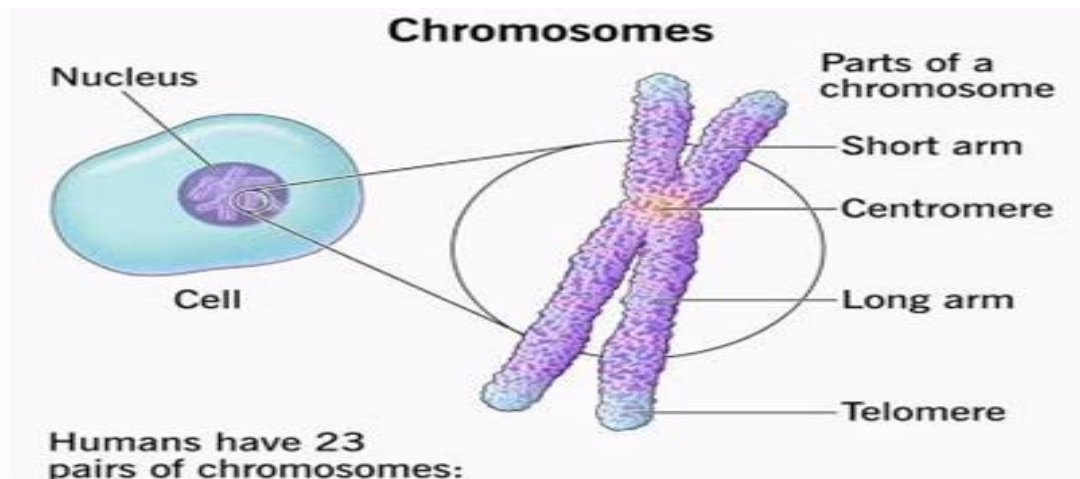
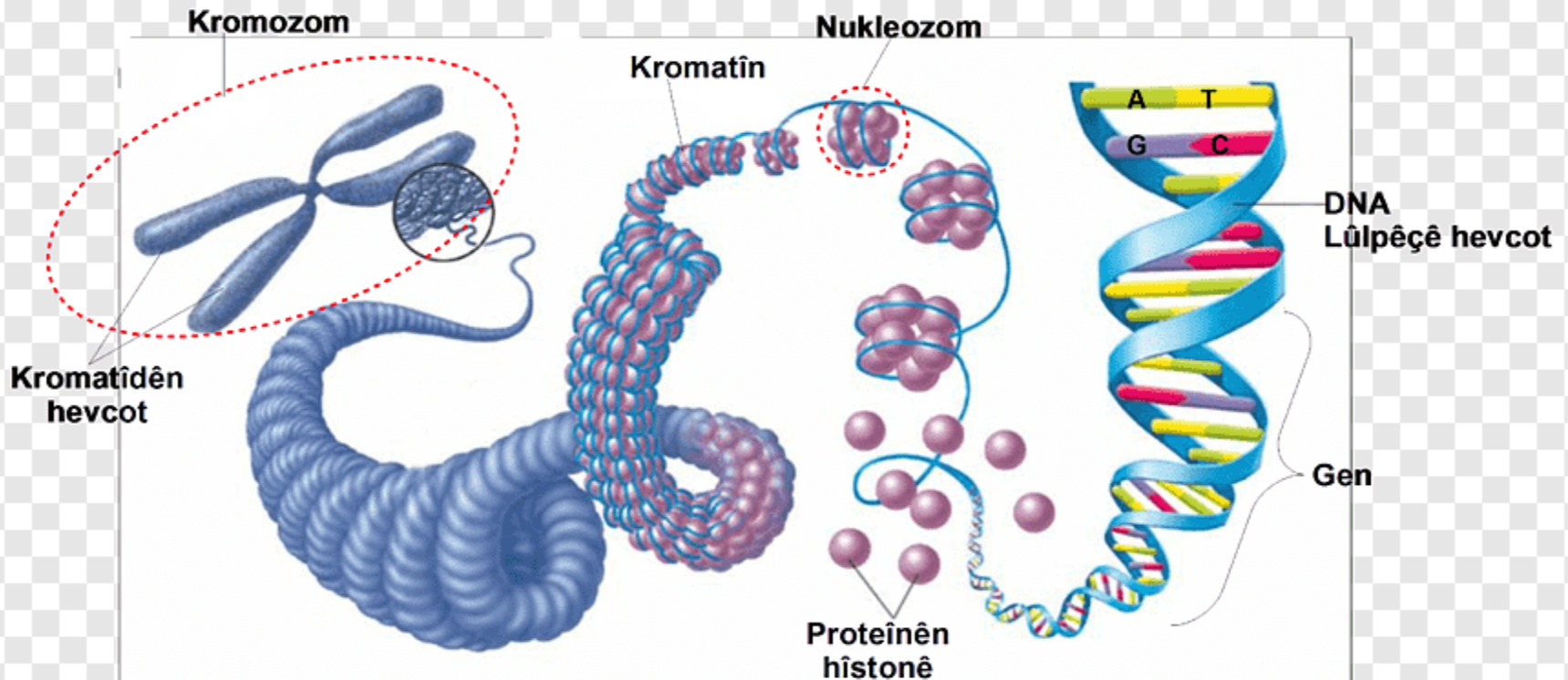


- The structure of **DNA** was discovered by **Watson and Crick** in 1953. They found the DNA is double helix with the sugar-phosphate backbones on the outside and the bases on the inside.

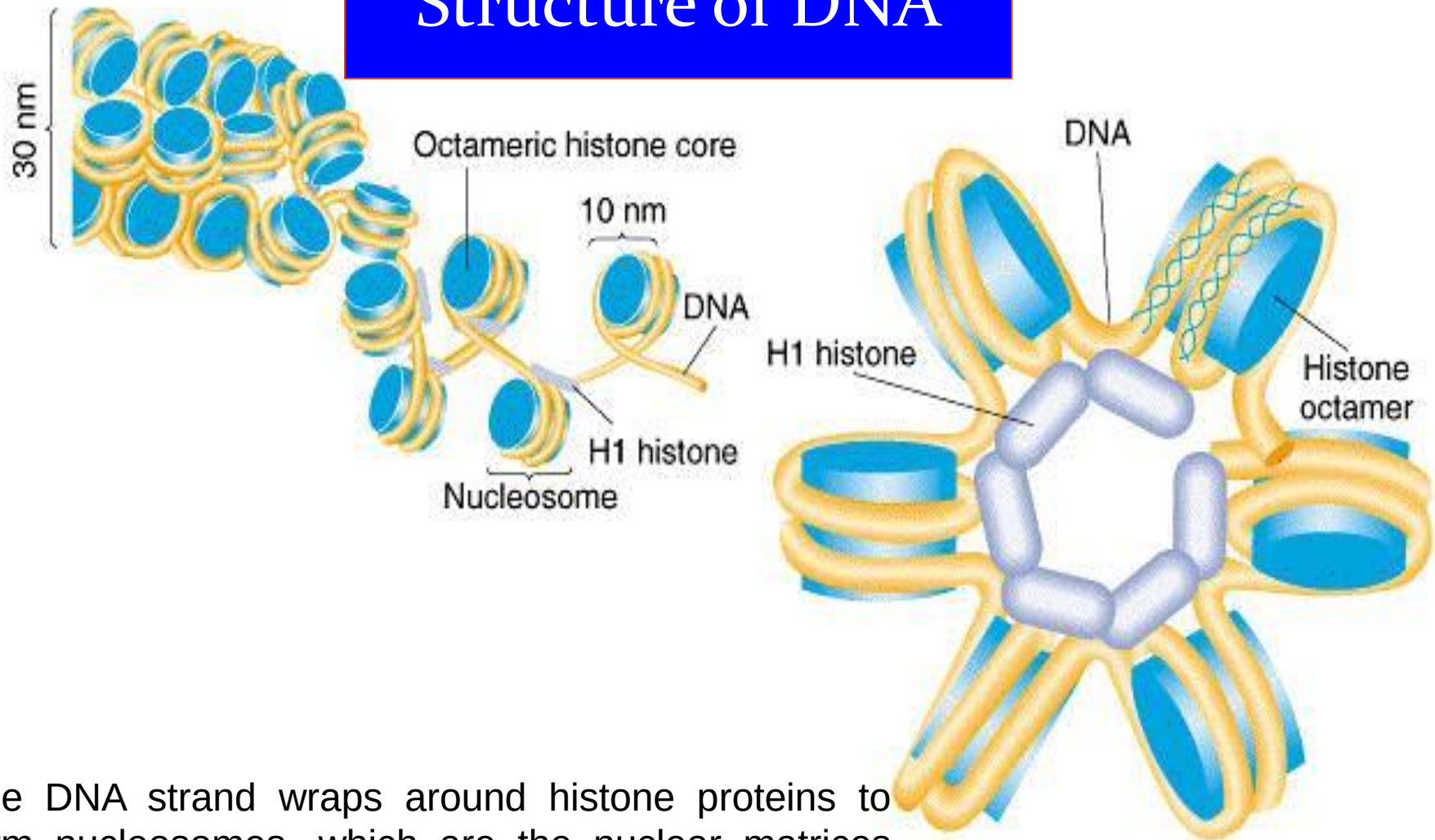
The Differences between DNA and RNA

	DNA	RNA
Name	Deoxyribonucleic Acid	Ribonucleic Acid
Number of strand	Double-stranded	Single-stranded
Type of sugar	Deoxyribose	Ribose
Types of nitrogen bases	Adenine (A), thymine (T), cytosine (C), and guanine (G)	adenine, uracil (U), guanine, and cytosine
Base Pairing	Adenine links to thymine (A-T) and cytosine links to guanine (C-G)	Adenine links to uracil (A-U) and cytosine links to guanine (C-G)
Location	DNA is found in the nucleus, Mitochondria and chloroplast.	RNA is found in the nucleus, cytoplasm, and ribosome

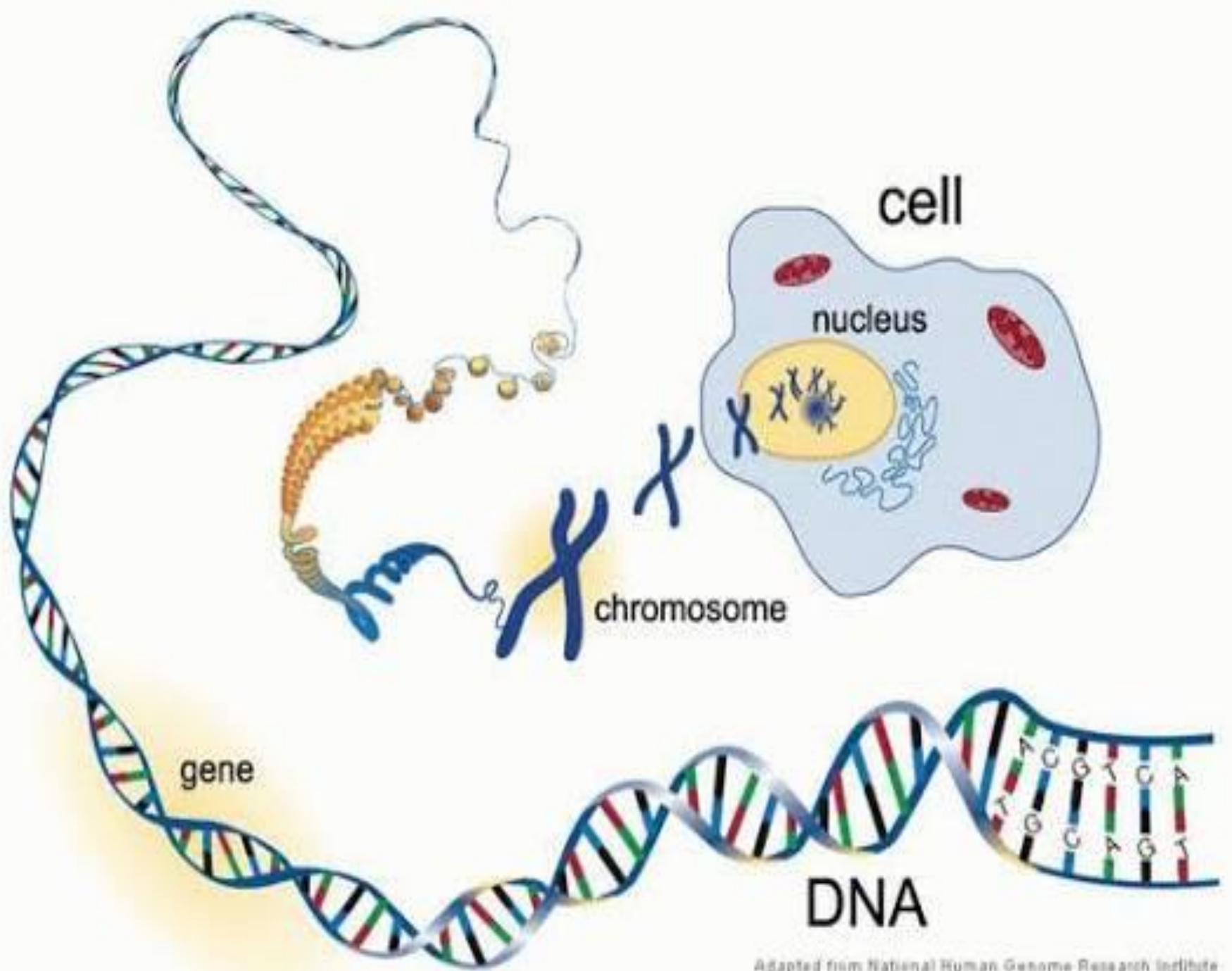
Structure of DNA



Structure of DNA

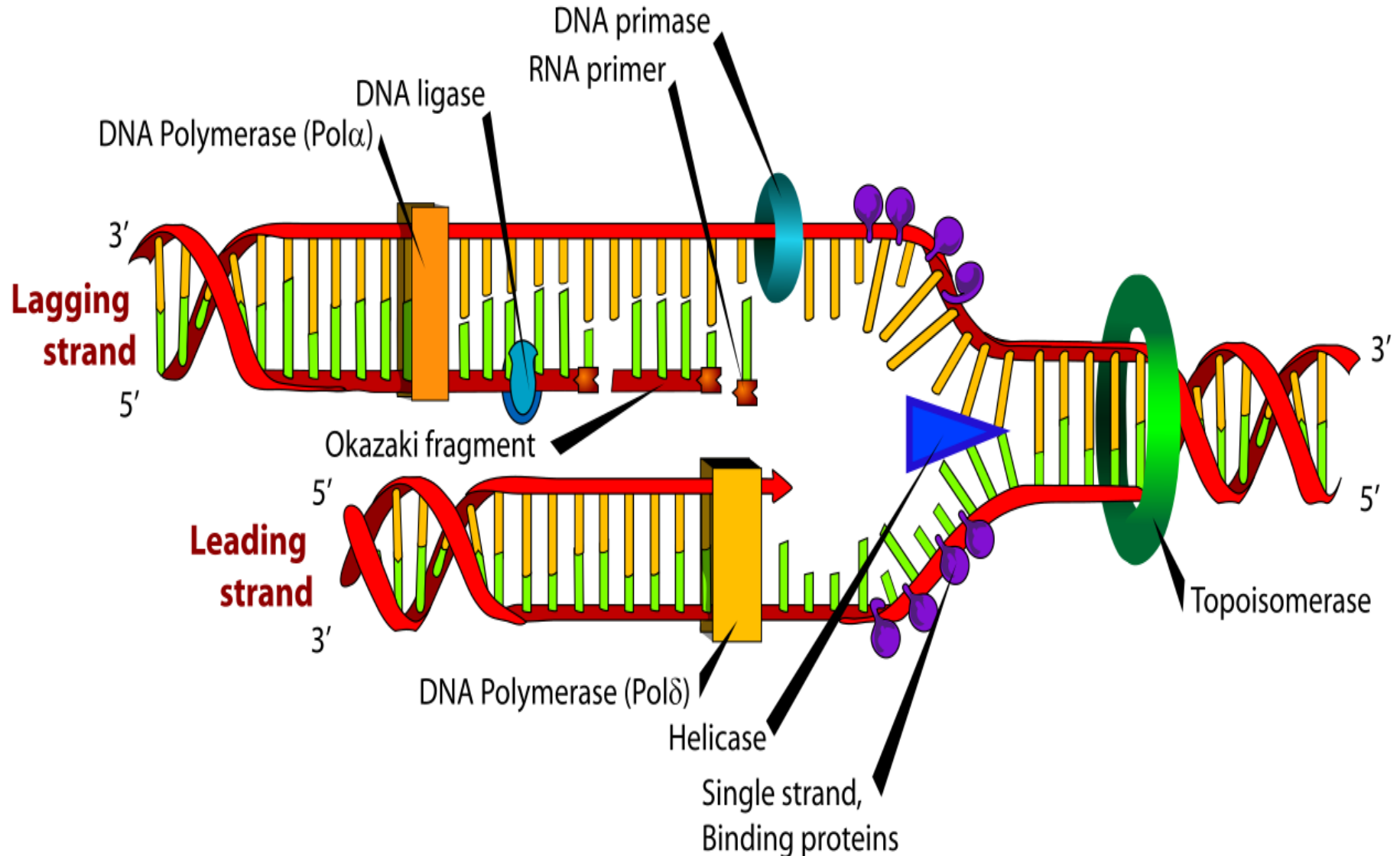


The DNA strand wraps around histone proteins to form nucleosomes, which are the nuclear matrices that are stacked on top of each other to form the chromosome.

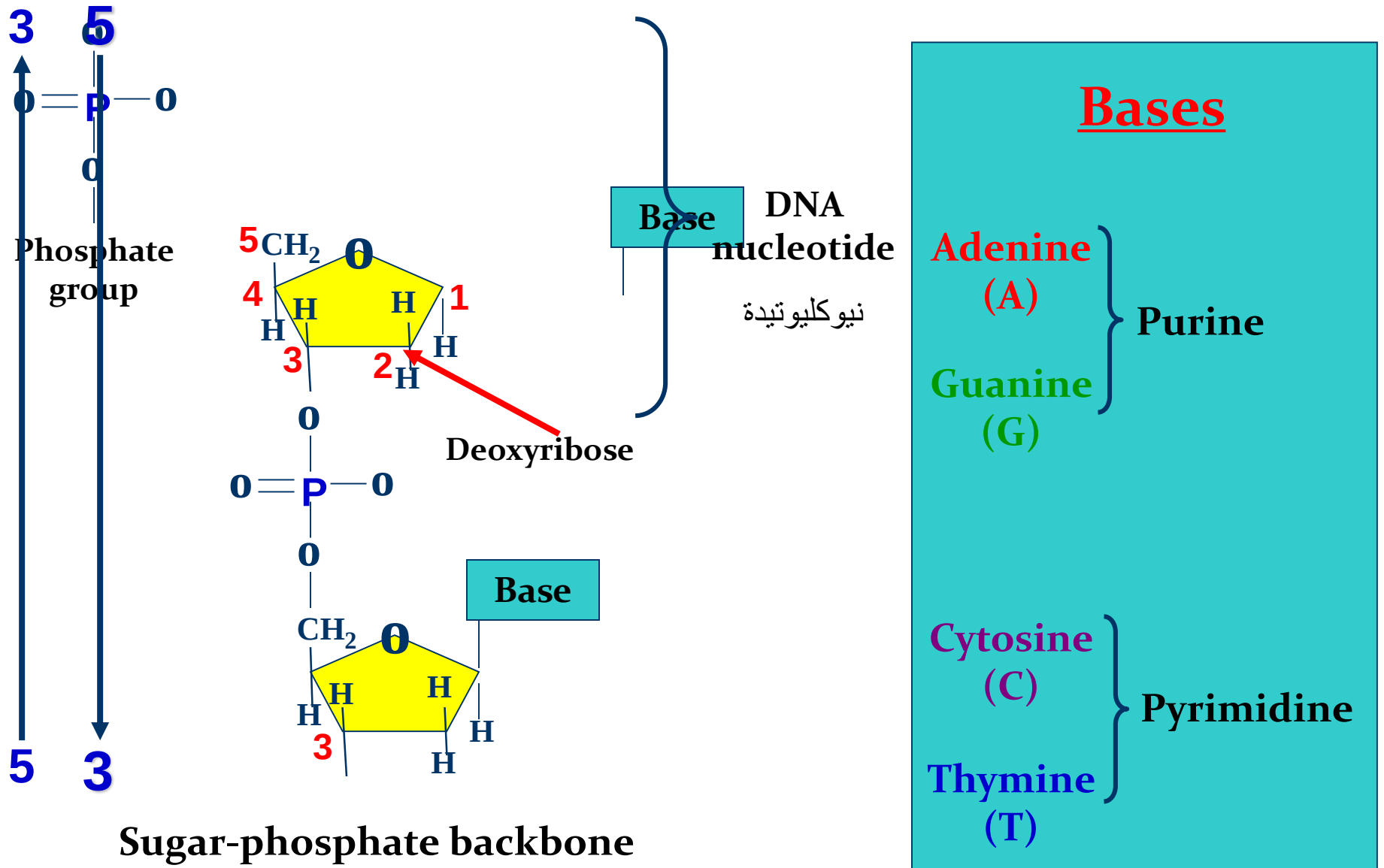


Adapted from National Human Genome Research Institute

Okazaki fragments are DNA fragments that are formed during the replication of genetic material and are short fragments, 5/-3/.

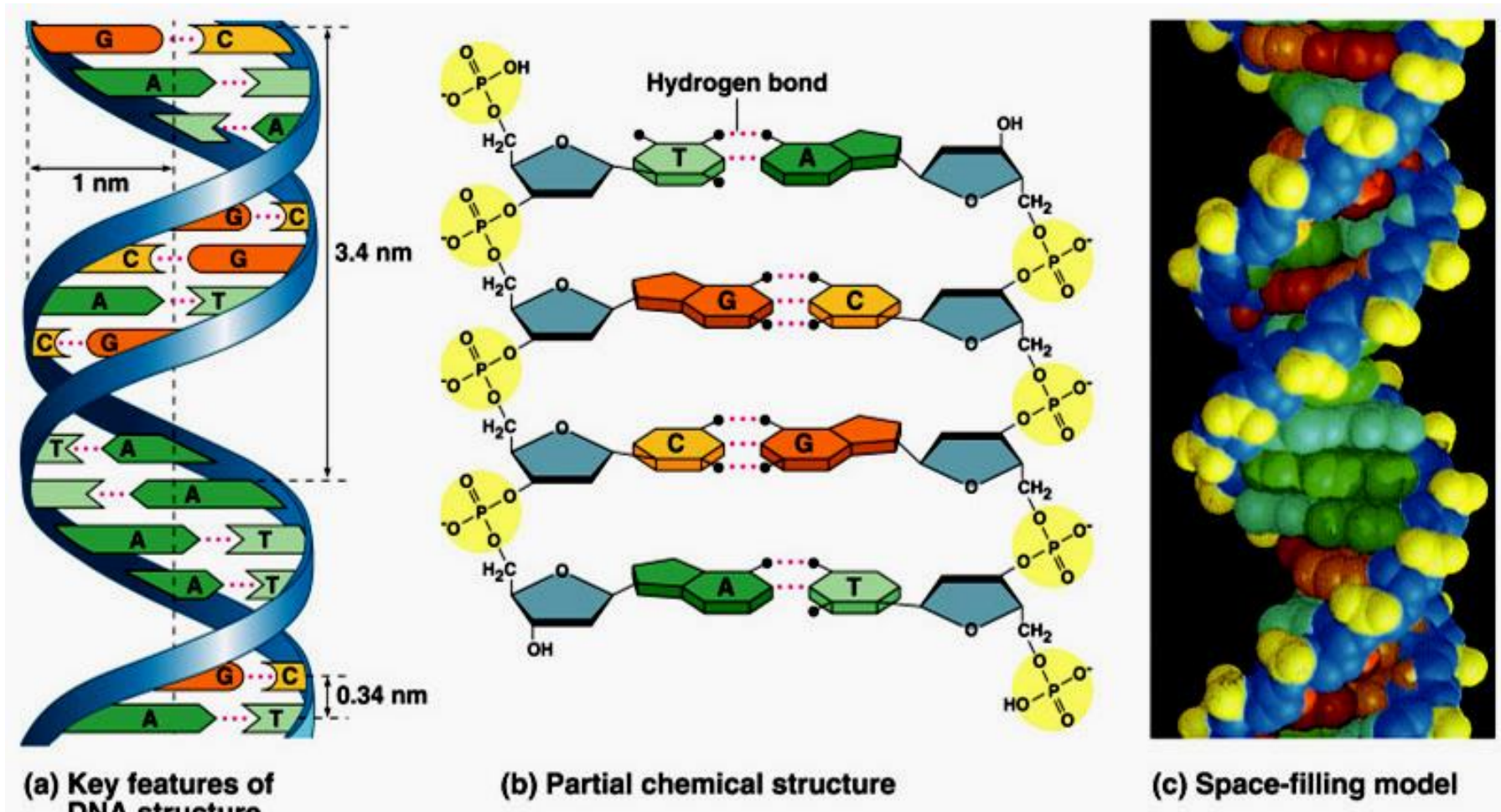


Structure of DNA



Nucleic acids (DNA)

- ❖ Nucleotides are linked together by the **phosphodiester bond** between the **phosphate at the 5' carbon** of one nucleotide and the **hydroxyl group at the 3' carbon** of an adjacent sugar.



Repeated Sugar - Phosphate



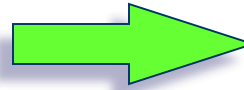
DNA backbone

Phosphate - Sugar - Base



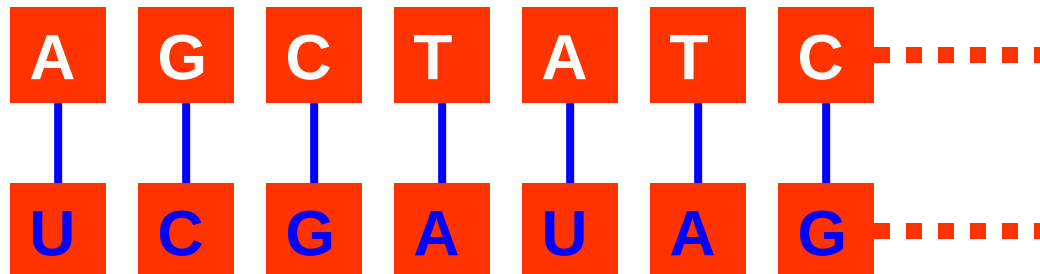
One nucleotide

Polynucleotide

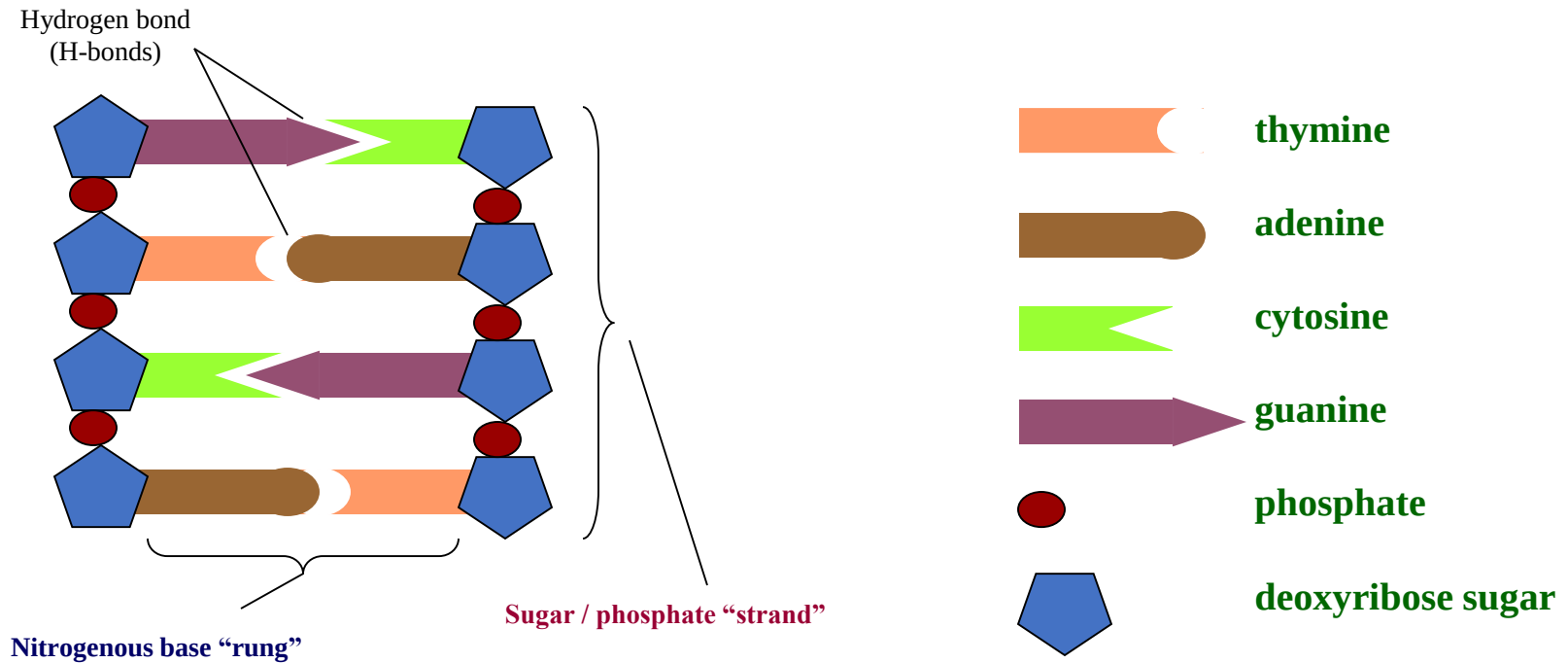


DNA Molecule

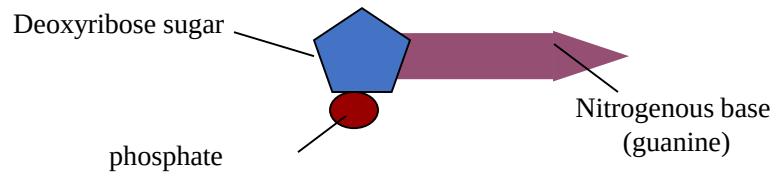
DNA
mRNA



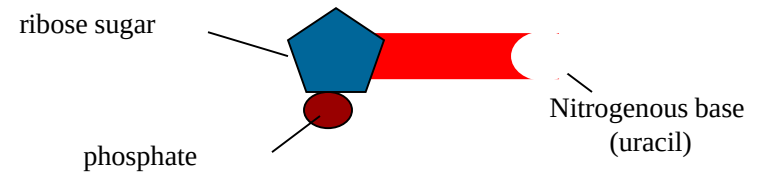
DNA Replication



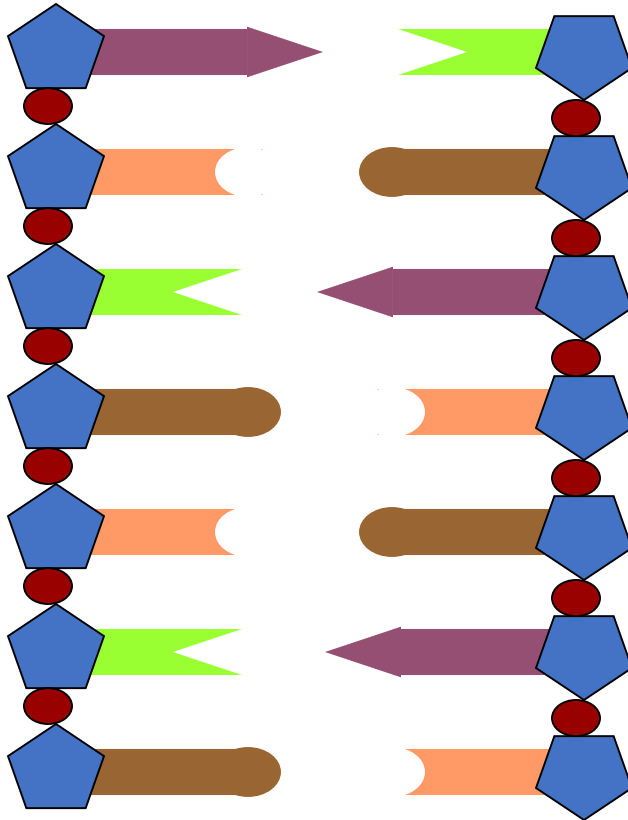
DNA nucleotide



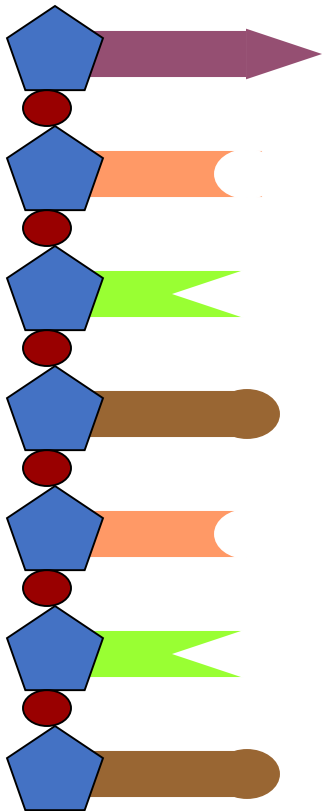
RNA nucleotide



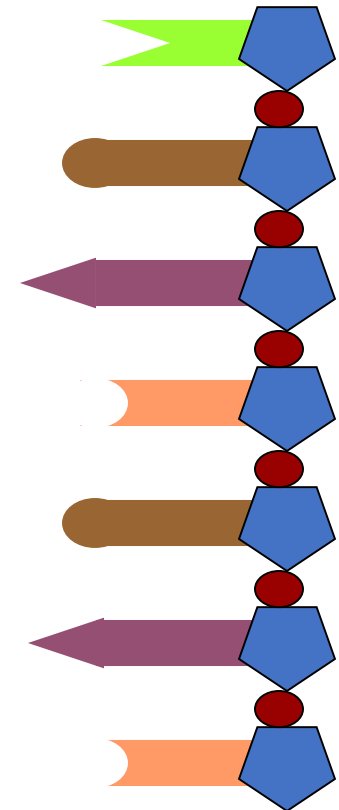
DNA Replication



Step 1: The hydrogen bonds between the two DNA strands break. The DNA strand becomes open.

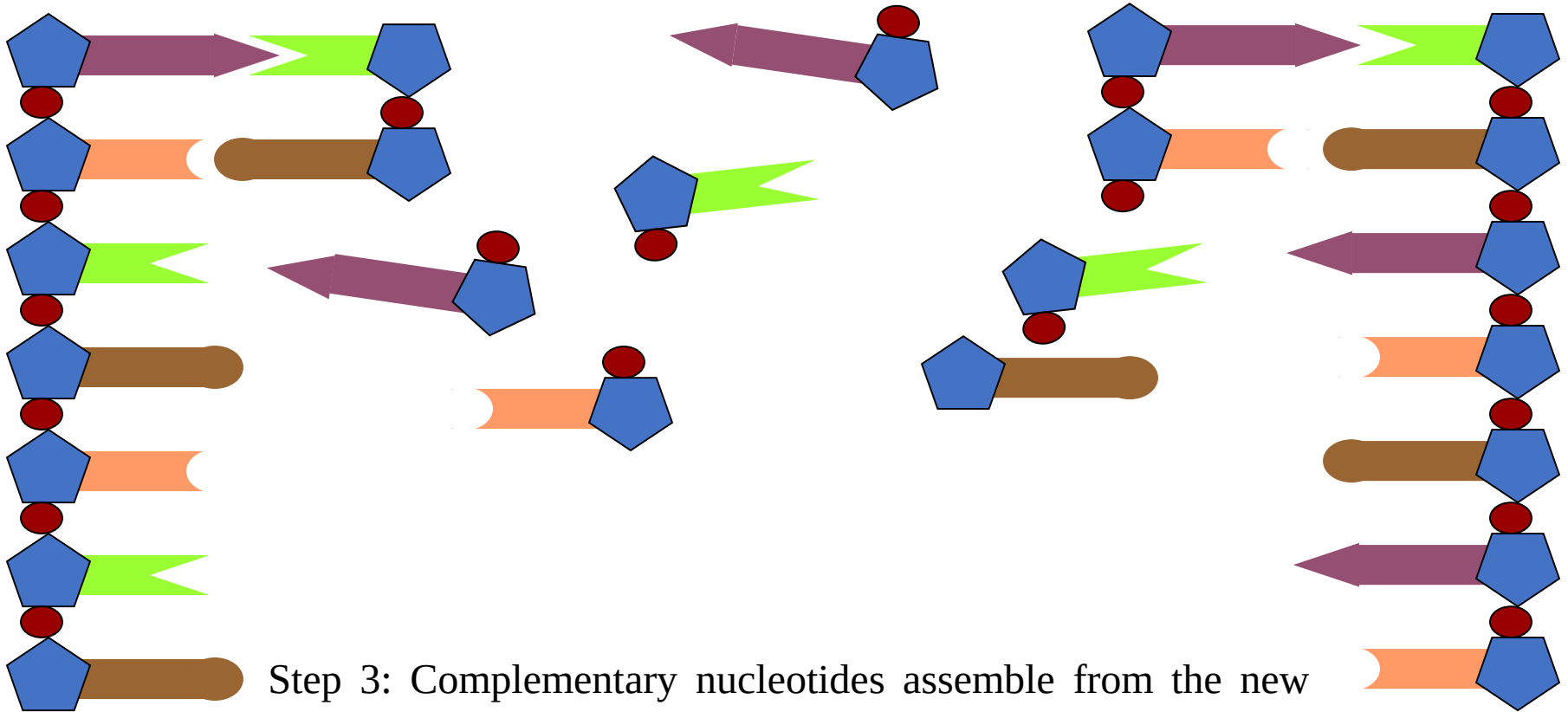


Step two: The two strips move away from each other.



DNA Replication

DNA Replication



Step 3: Complementary nucleotides assemble from the new strand to bind to the nucleotide from the old strand. Thus, each old DNA strand complements its complementary new strand.(This is how each new strand of DNA is complemented.)



THANK YOU

