Cellular and Molecular Biochemistry [FHS1104]

DNA and RNA

Lecture {7}

MBCHB/BDS
1ST YEAR SEM.-1
2026

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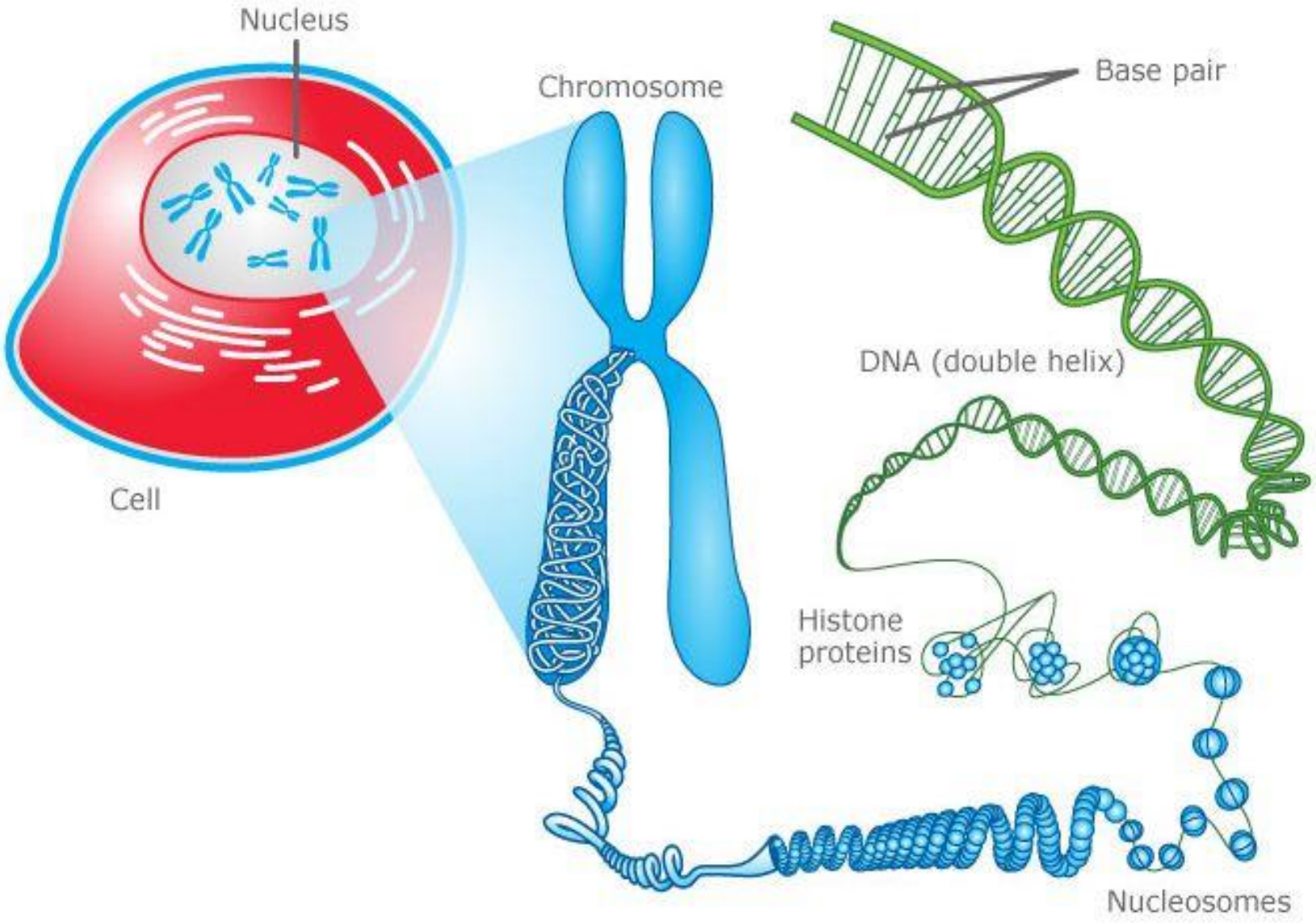
{Lecture (7) Outline}

- DNA Structure
- From DNA to Chromosome
- RNA Structure and Functions
- Type of RNA

DNA

The Structure of DNA:



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Humans DNA:

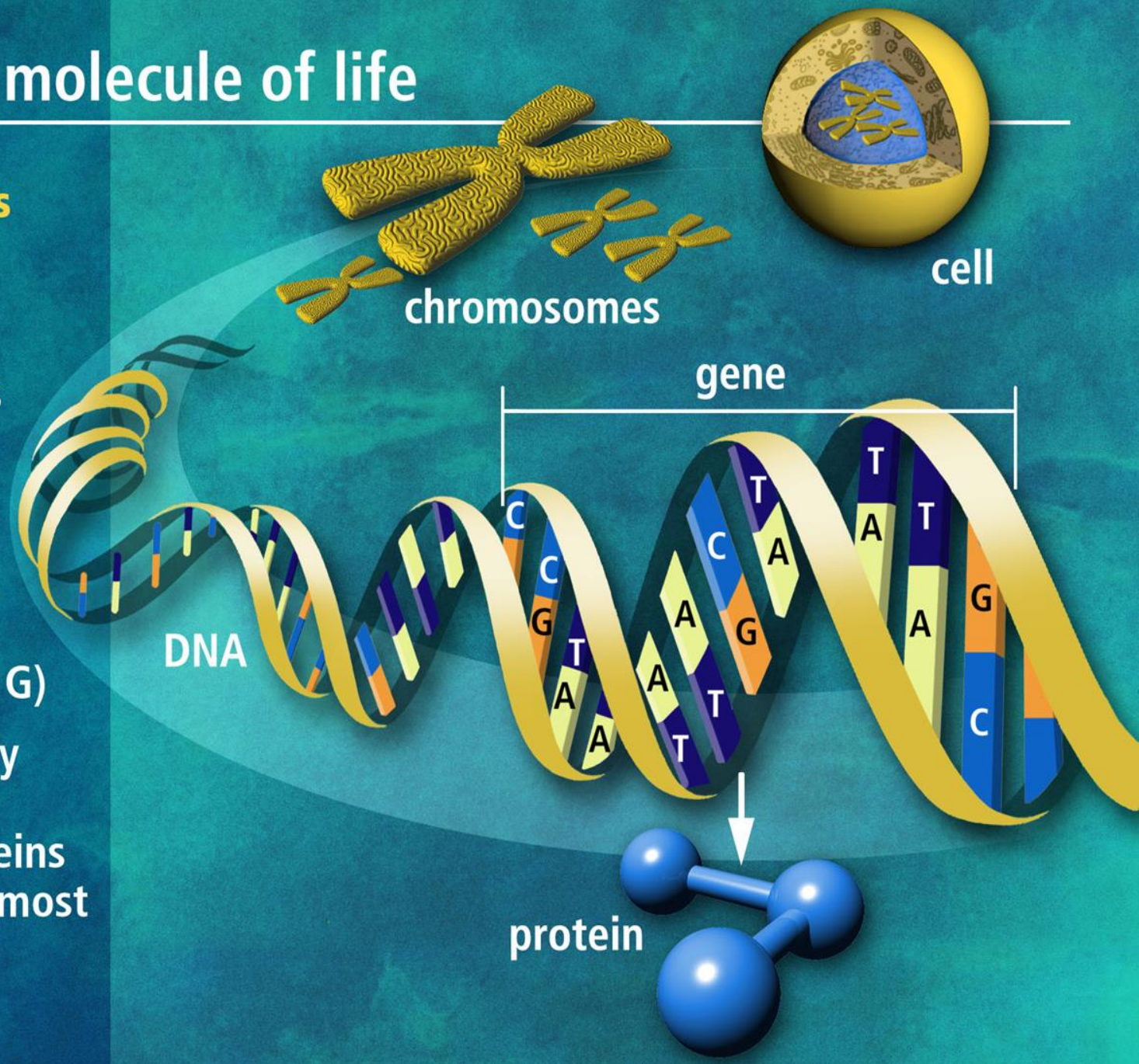
- **Nuclear DNA the approximately 3 billion base pairs of the human genome include approximately 30,000 genes**
- **Mitochondrial DNA (mtDNA) is a circular DNA 16,569 bp in human.**

DNA the molecule of life

Trillions of cells

Each cell:

- 46 human chromosomes
- 2 meters of DNA
- 3 billion DNA subunits (the bases: A, T, C, G)
- Approximately 30,000 genes code for proteins that perform most life functions



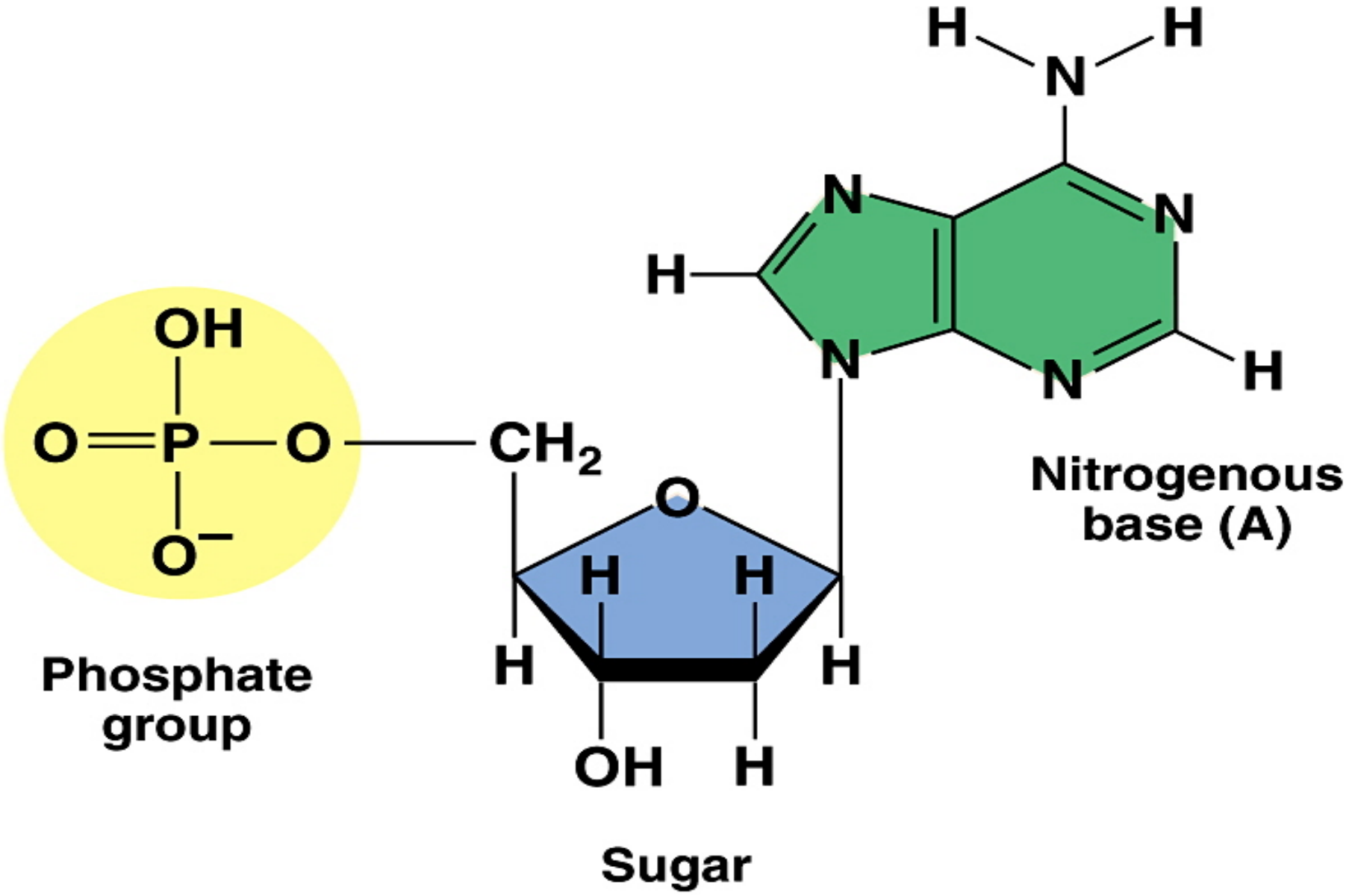
Prokaryote *(E. coli) DNA*

The *E. coli* bacteria chromosome has a circular DNA molecule with 4,6 million base pairs, encode about 4,457 genes.

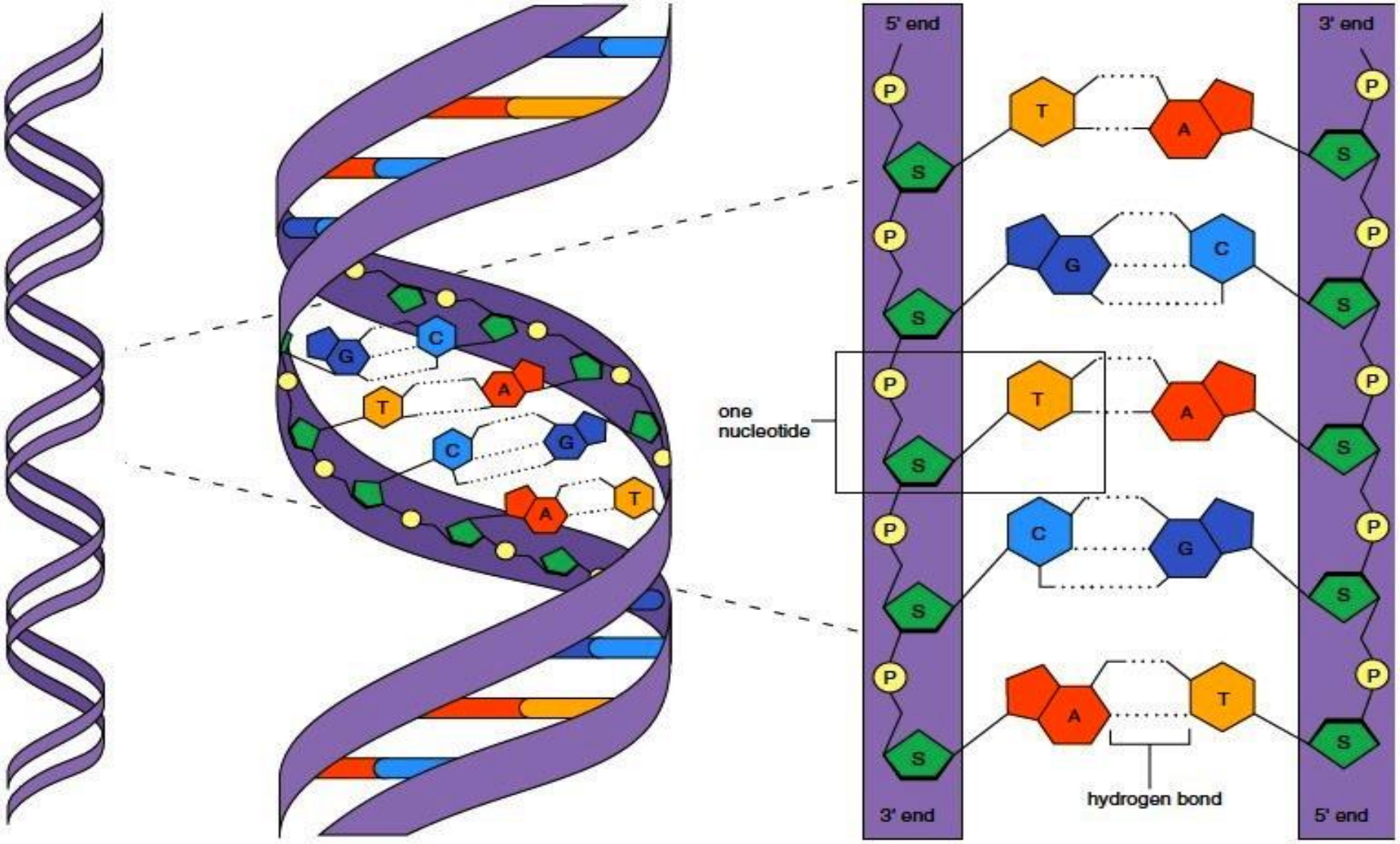
The Structure of DNA:

- DNA is a polymer of deoxyribonucleoside monophosphates covalently linked by 3'→5'–phosphodiester bonds.
- The resulting long, unbranched chain has polarity, with both a 5'-end and a 3'-end.
- The sequence of nucleotides is read 5'→3'.

Structure of Nucleotides:



The Structure of DNA:



The Structure of DNA:

- With the exception of a few viruses that contain single-stranded (ss) DNA, DNA exists as a double stranded (ds) molecule, in which the two chains are paired in an antiparallel manner, and wind around each other, forming a double helix.
- A pairs with T and G pairs with C

DNA:

The DNA is a double helix consists of two polyribonucleotide chains (strands) linked together by phosphodiester bond between C3 of deoxyribose of one nucleotide and C5 of the next one . { phosphodiester bond = one phosphate is linked to 2 sugars .

The Structure of DNA:

DNA double strand is created by hydrogen bonds between nucleotides.

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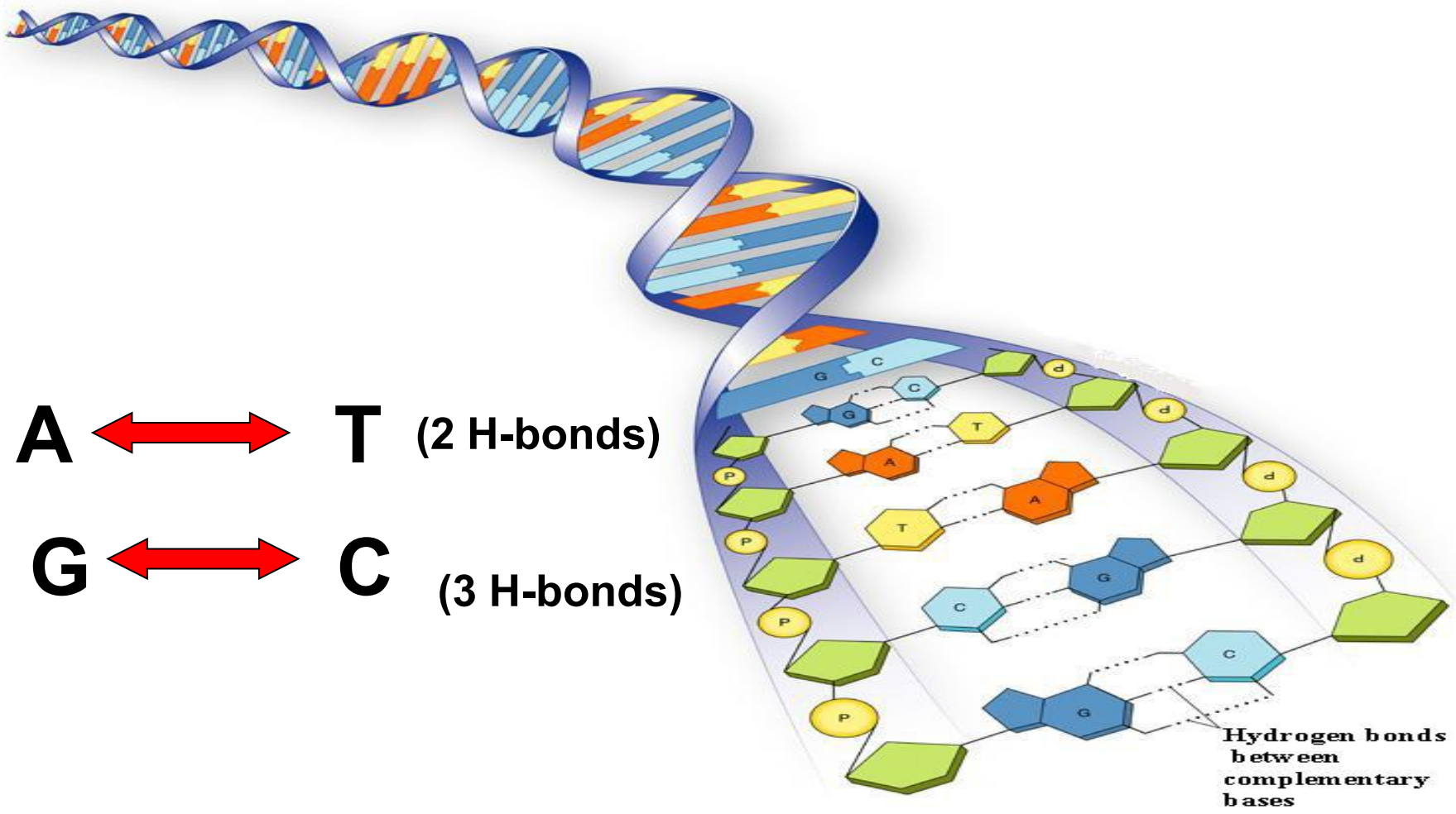
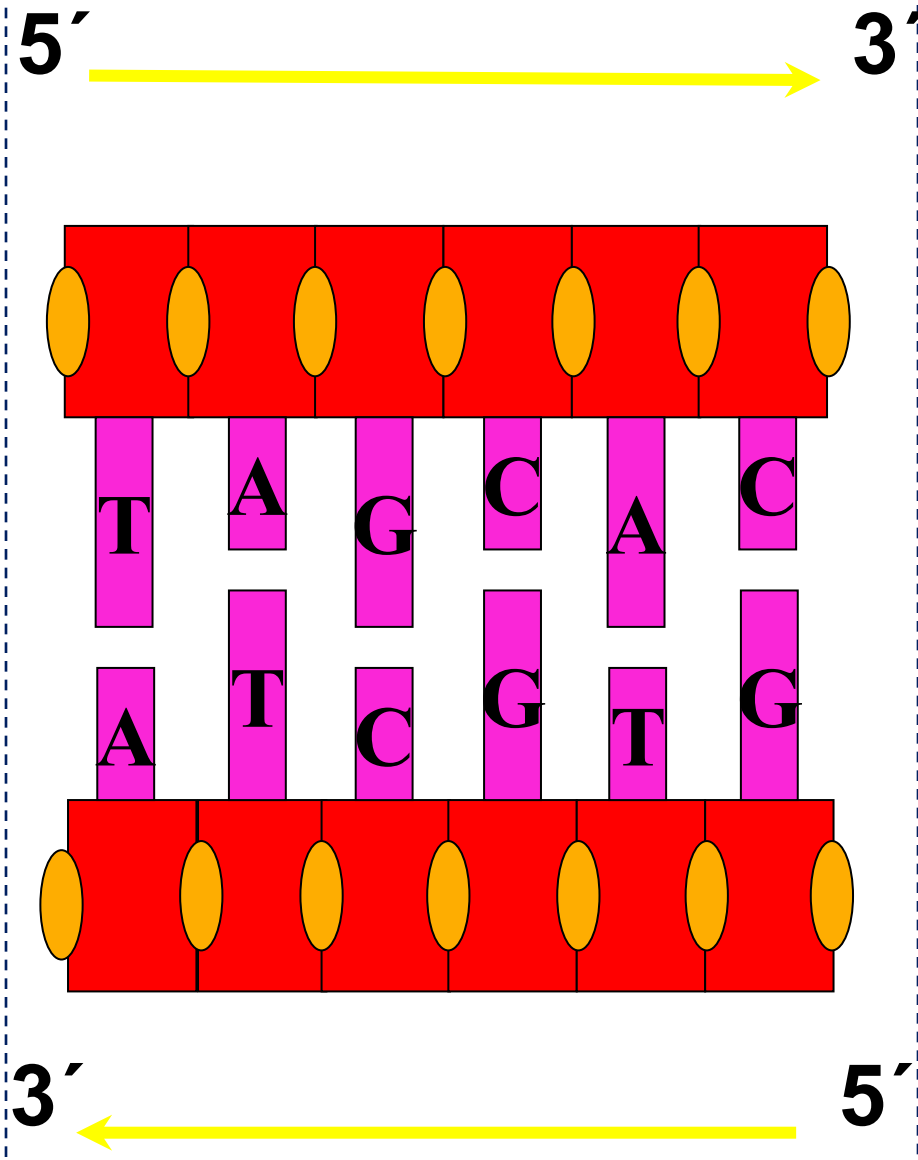
A ⟷ T (2 H-bonds)

G ⟷ C (3 H-bonds)



Base Pairing: DNA base-pairing is antiparallel:

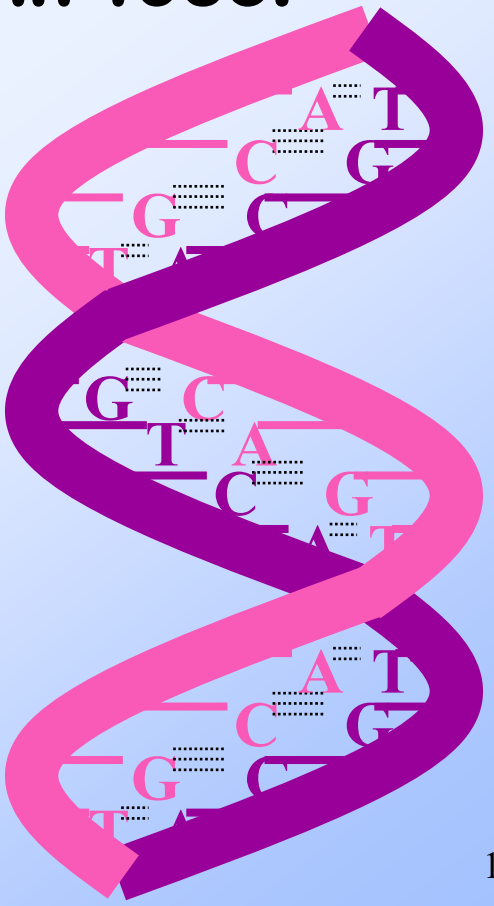
the two strands run in opposite directions; one strand is oriented 5→3 and the other is oriented 3→5. The two polynucleotide chains are not identical but complementary to each other due to base pairing.



The Watson and Crick Model of DNA Structure:

The double helical structure of DNA was proposed by James Watson and Francis Crick in 1953.

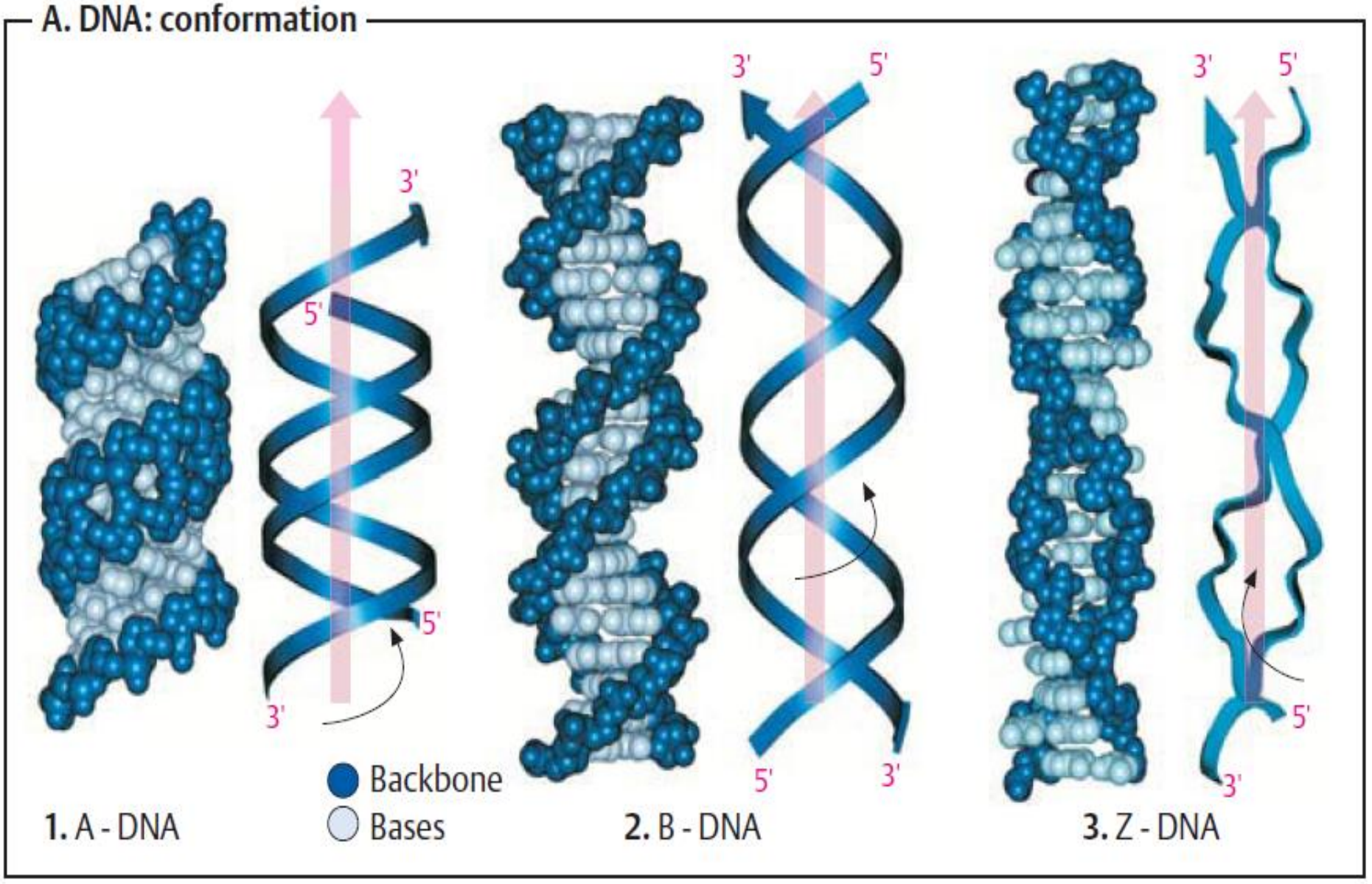
The Watson - Crick Model Of DNA



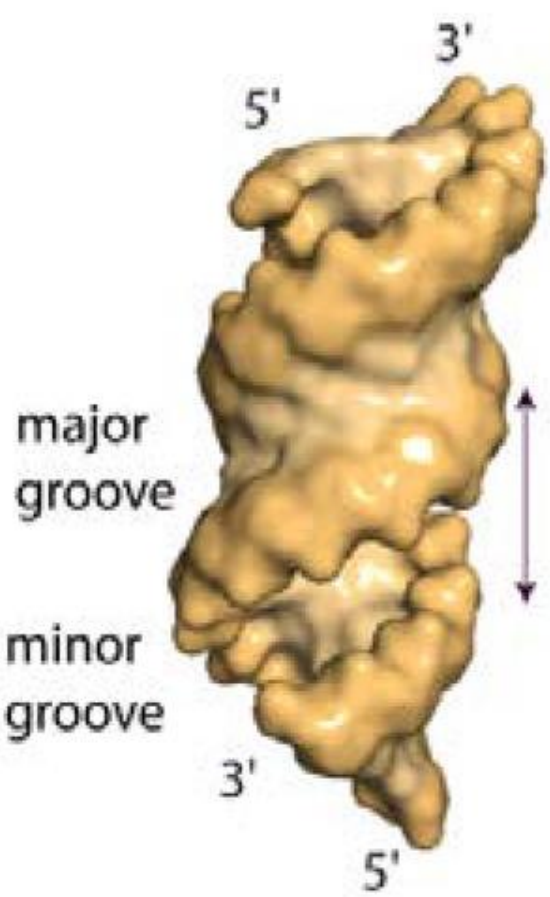
The Structure of DNA:

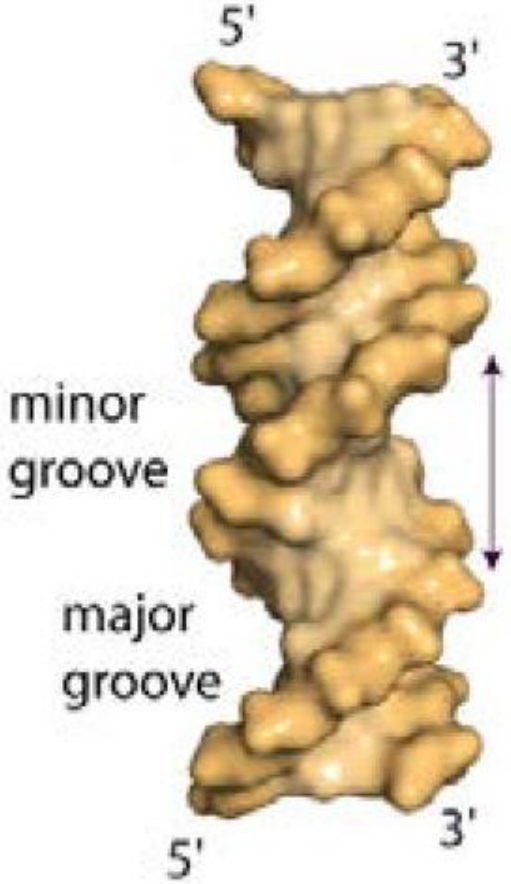
- There are three major structural forms of DNA:
  - B form, described by Watson and Crick in1953
  - A form, and
  - Z form.
- The B form is a right-handed helix with 10 residues per 360° turn of the helix
- Chromosomal DNA is thought to consist primarily of B-DNA

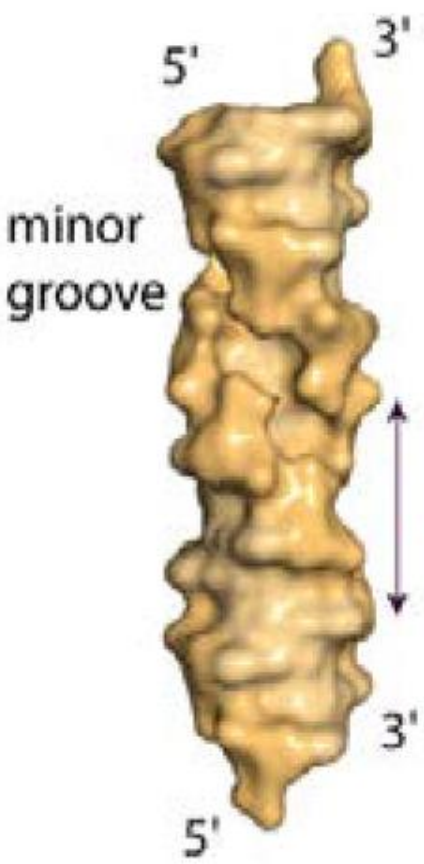
The Structure of DNA:



The Structure of DNA:







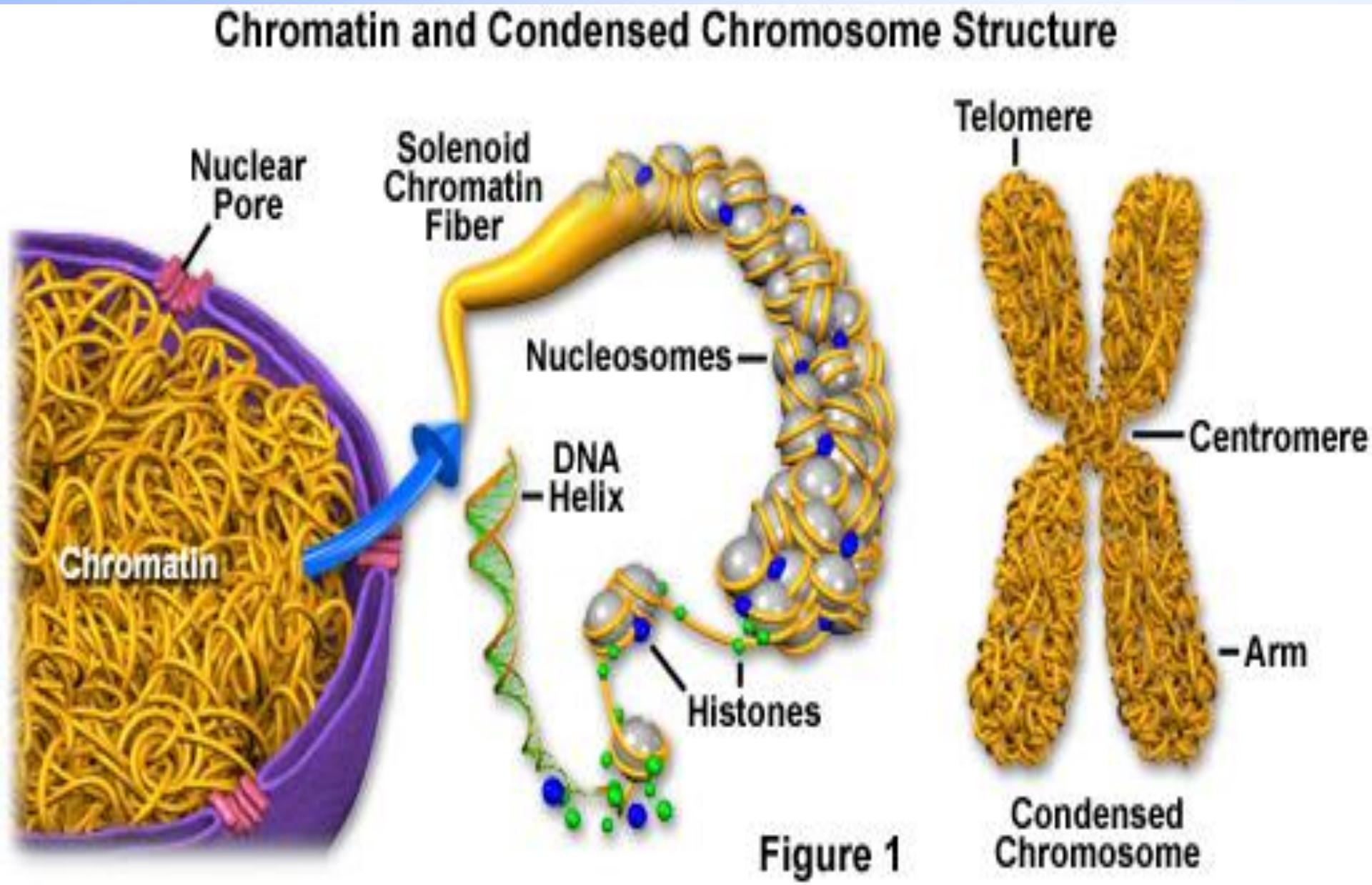
	A-DNA	B-DNA	Z-DNA
handedness	right	right	left
pitch	11-12 bp/turn	10-10.5 bp/turn	12 bp/turn
diameter	23 Å	20 Å	18 Å

From DNA to Chromosome

Chromatin:

- In the nuclei of eukaryotes, DNA is closely associated with proteins and RNA.
- These nucleoprotein complexes, with a DNA proportion of approximately one-third, are known as chromatin.
- It is only during cell division that chromatin condenses into chromosomes that are visible under light microscopy.

Chromatin:


Chromatin and Condensed Chromosome Structure
Nuclear Pore
Solenoid Chromatin Fiber
Nucleosomes
DNA Helix
Chromatin
Histones
Telomere
Centromere
Arm
Condensed Chromosome
Figure 1

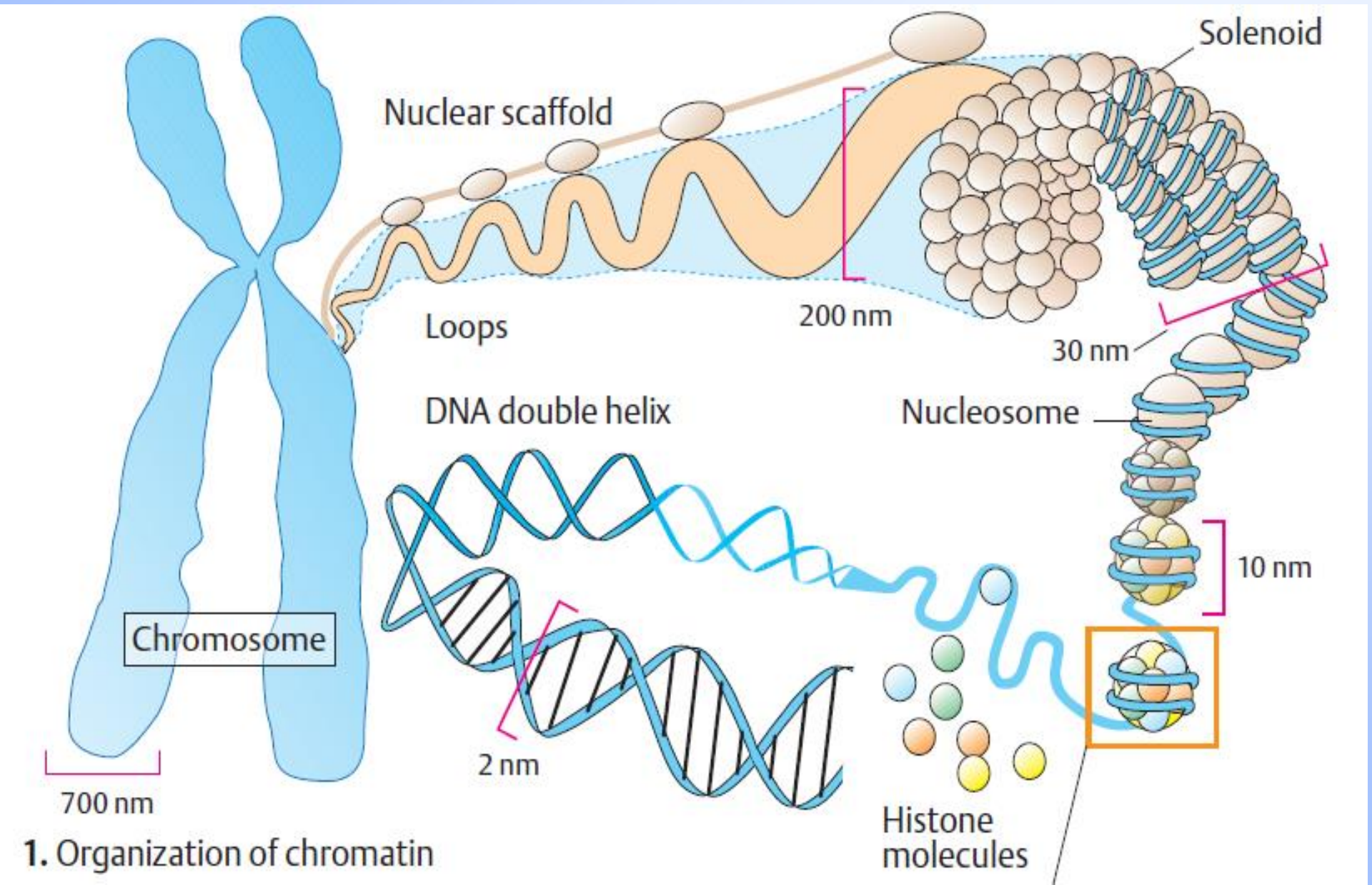
Chromatin:- Histones

- The proteins contained in chromatin are classified as either histone or non-histone proteins.
- Histones are small, strongly basic proteins that are directly associated with DNA.
- The basic amino acids neutralize the negatively charged phosphate groups, allowing the dense packing of DNA in the nucleus.

Chromatin:- Histones/Nucleosome

- Two molecules of Histone types H2A, H2B, H3, and H4 form an octameric complex, around which DNA is wrapped .
- Another histone (H1) binds to DNA segments that are not directly in contact with the histone octamers.
- It supports the formation of structure with diameter of 30 nm, known as solenoid.

Chromatin:- Histones/Nucleosome



1. Organization of chromatin

RNA

RNA:

RNA functions as an intermediate in protein biosynthesis.

Some RNA molecules may function as enzymes (Ribozymes)

RNA:

Site : - nucleus and cytoplasm .

Bases :- A – G – C – Uracil .

Sugar : ribose

There are 3 major types of RNA :-

m RNA { messenger RNA }

t RNA { transfer RNA }

r RNA { ribosomal RNA }

one strand not double helix as in DNA

RNA:

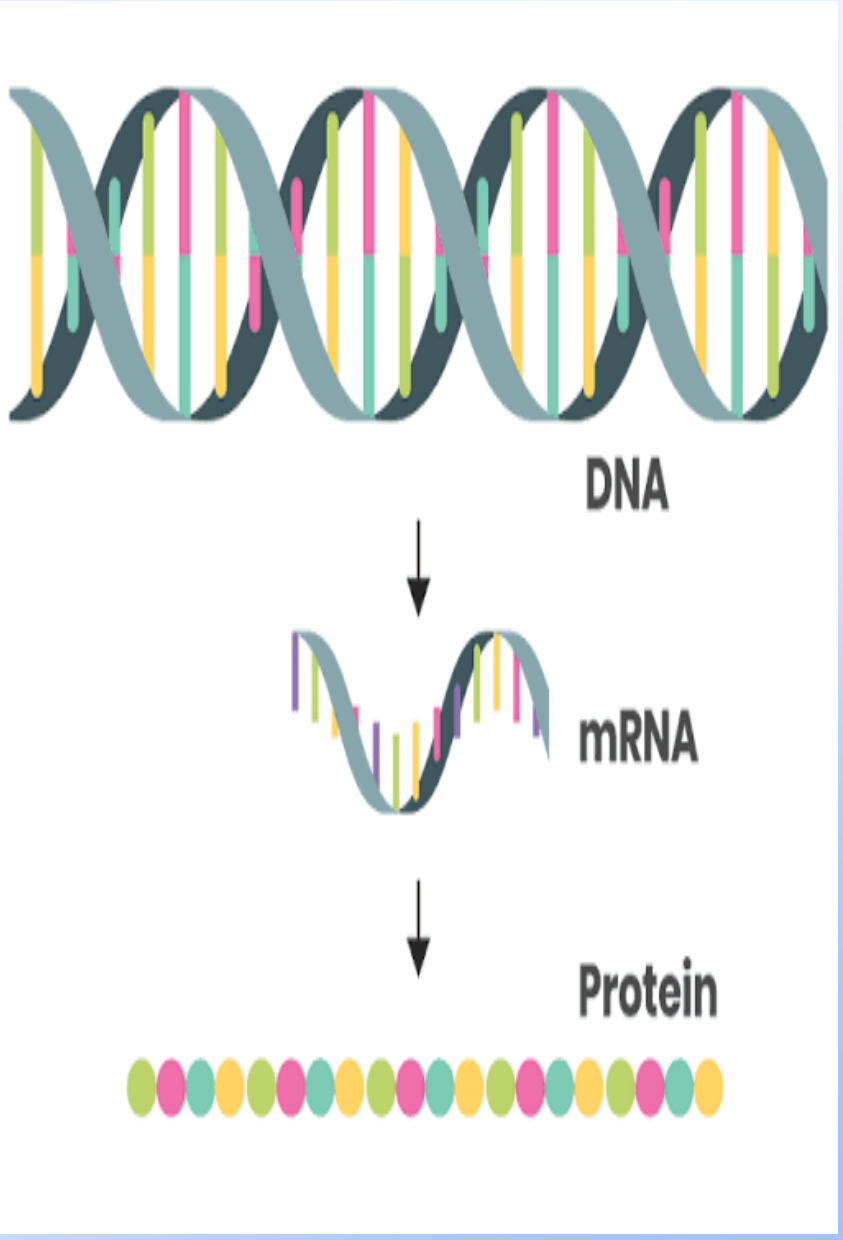
RNA is a polymer chain of Ribonucleotides joined by 3,5 phosphodiester bonds.

The covalent structure is very similar to that for DNA except that uracil replaces thymine and ribose. replaces deoxyribose

RNA molecules are single-stranded.

Types of RNA:

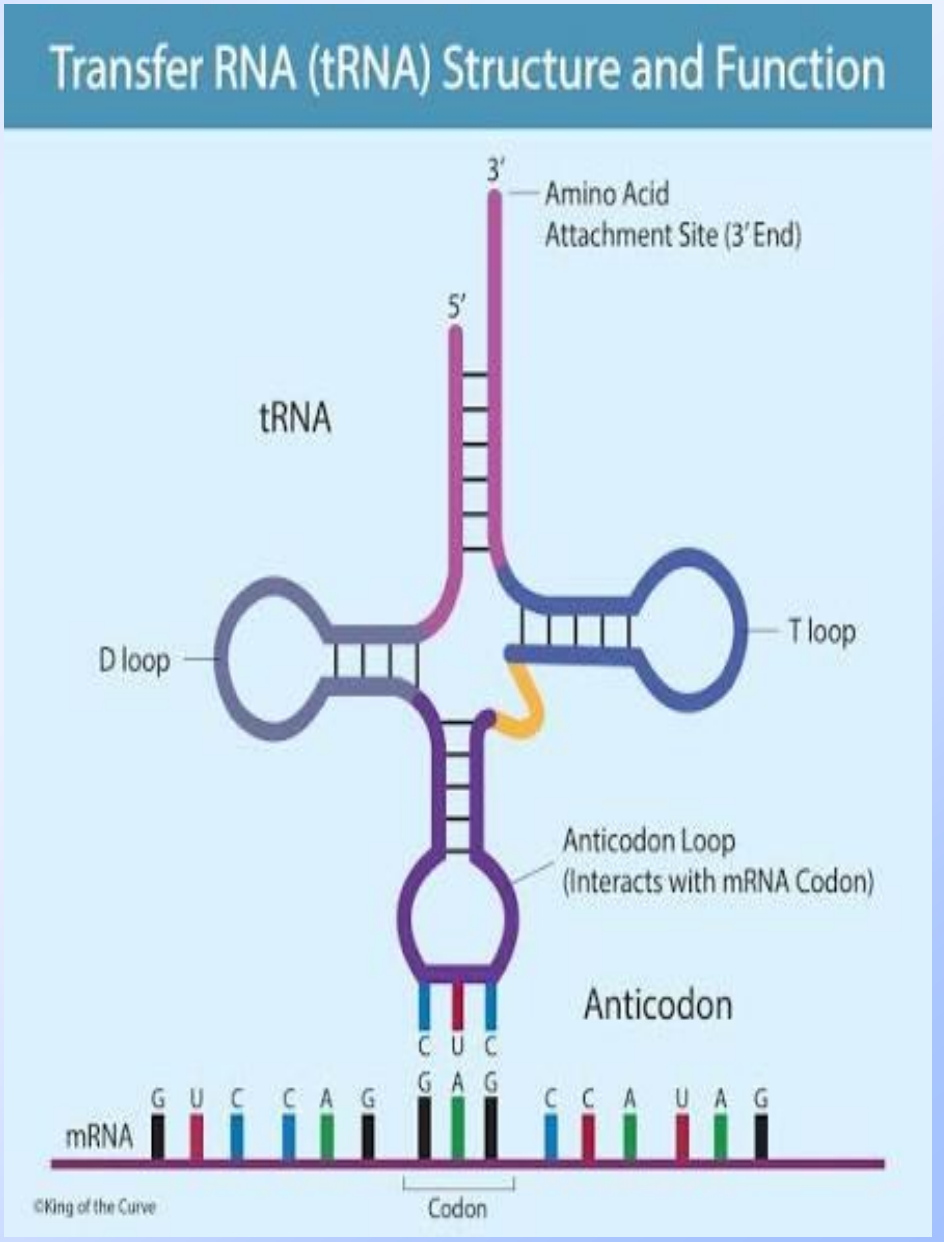
Messenger RNA (mRNA): the mRNA is synthesized in the nucleus and enters the cytoplasm to participate in protein synthesis (carries genetic information).



Types of RNA:

Transfer RNA (t RNA) :

the t RNA carry the amino acids and hand them over to growing peptide chain.

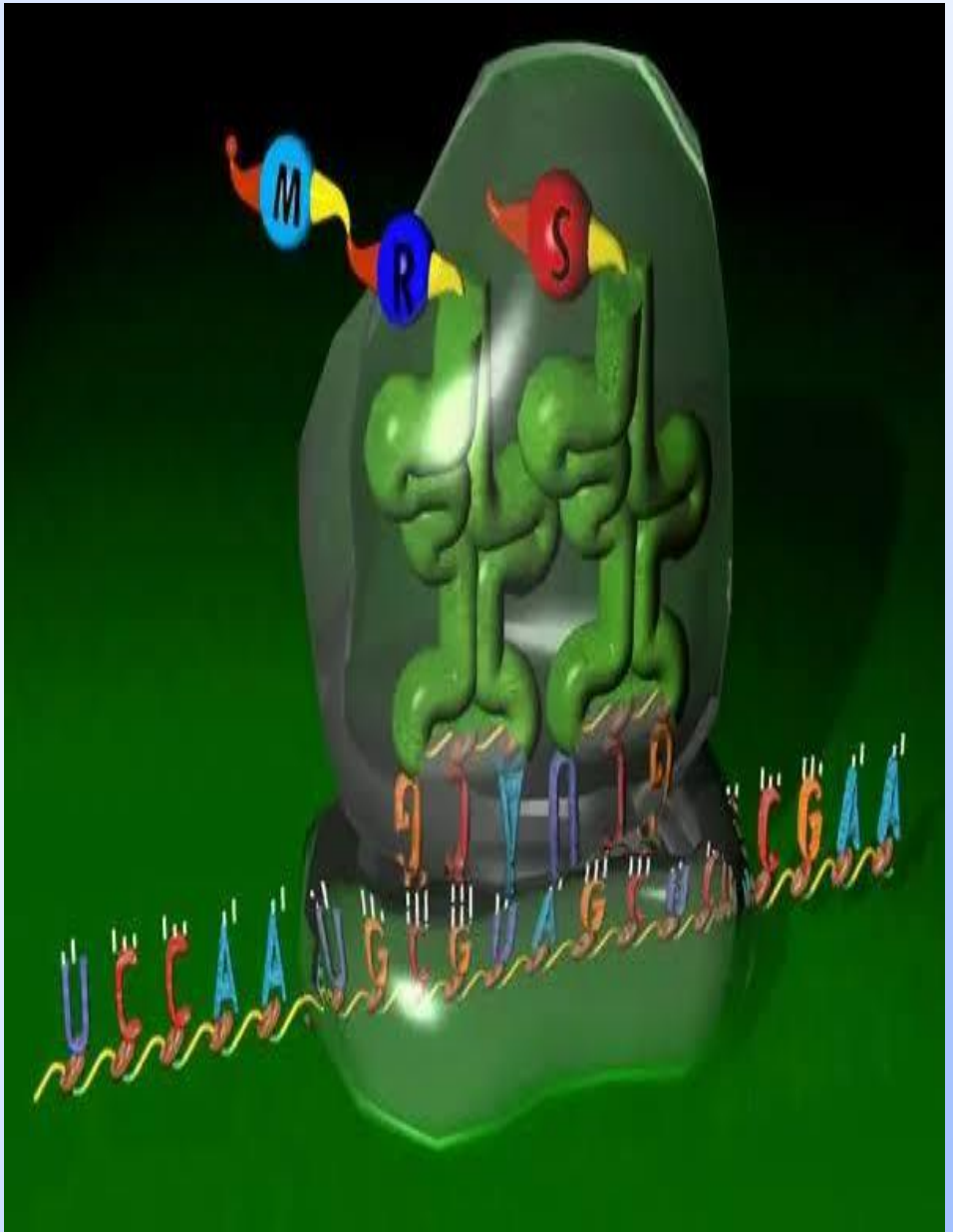


Types of RNA:

Ribosomal RNA (r RNA) :

Ribosomes are huge complex structure of proteins and r RNA.

r RNA play a significant role in the binding of mRNA to ribosomes.



References:

1-lipincotts biochemistry 8th edition 2022

2. Harpers 25th , 27th and 32nd edition 2023

3- Lehninger principles biochemistry 8th edition 2021

4- Medical biochemistry 6th edition 2023

5- Mark Basic Medical biochemistry 6th edition 2023

6- Stryer biochemistry


Thank You