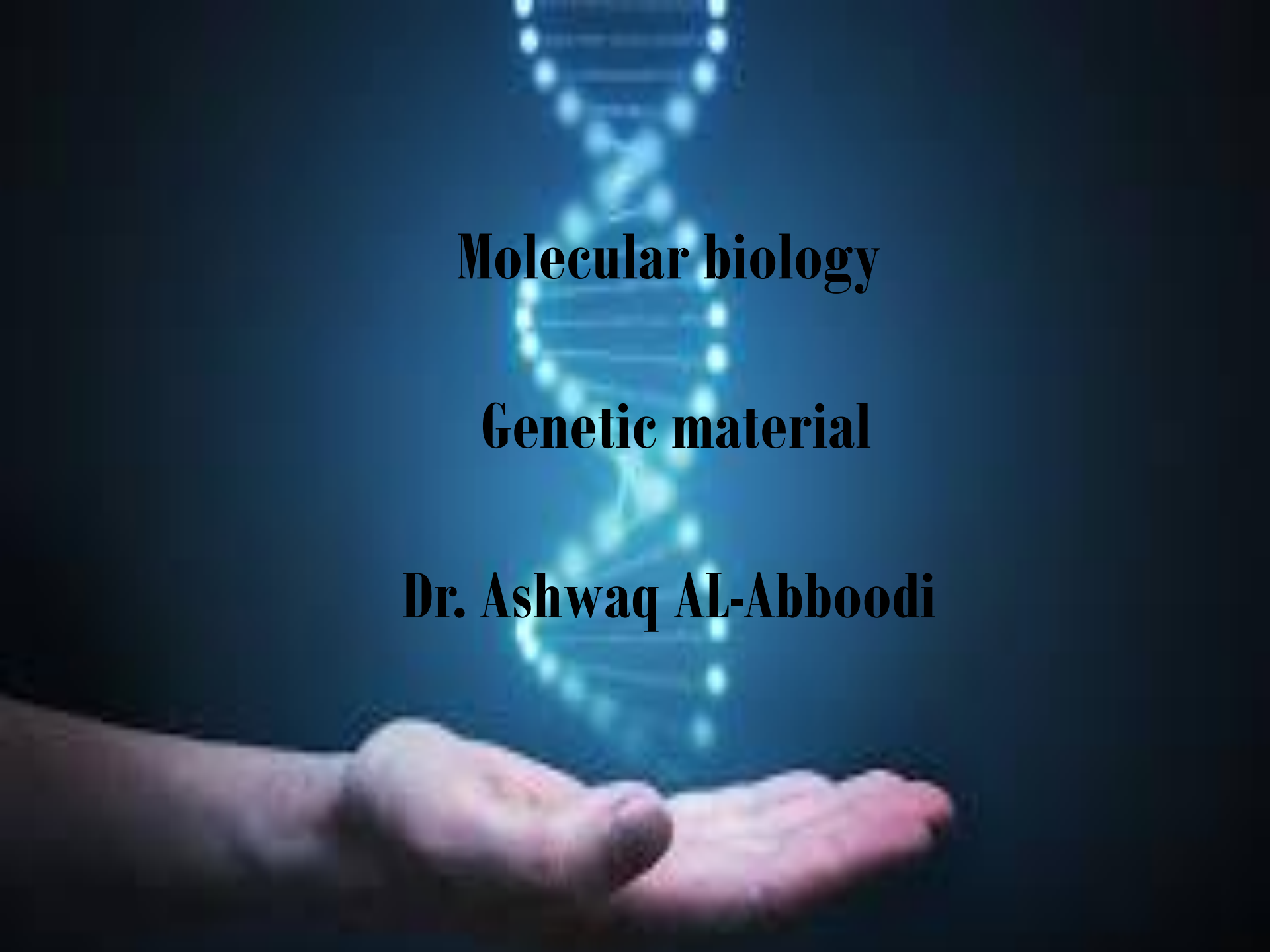

# Molecular biology

## Genetic material

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# Nucleic acids :-

are the **biopolymers or biomolecules** essential to all known forms of life and refer to DNA and RNA .

# History:-

**In 1869……Johannes Friedrich Miescher :-** was a Swiss physician and biologist, He was the first scientist to isolate nucleic acid.

**In 1880……Albrecht Kossel :-** was purified the substance and discovered its highly acidic properties. He later also identified the nucleobases.

**In 1889……Richard Altmann :-** creates the term nucleic acid.

**In 1938……Astbury and Bell :-** published the first X-ray diffraction pattern of DNA.

**In 1953……Watson and crick :-** determined the structure of DNA.

- A **polynucleotide** is a long chain of nucleotides, the backbone of the polynucleotide chain consists of an alternating series of pentose (sugar) and phosphate residues. The chain is formed by linking the 5' carbon of one pentose ring to the 3' carbon of the next pentose ring via a **phosphate group**; thus the sugar–phosphate backbone is said to consist of **5'–3 phosphodiester linkages**. Specifically, the 3' carbon of one pentose is bonded to one oxygen of the phosphate, whereas the 5' carbon of the other pentose is bonded to the opposite oxygen of the phosphate. The nitrogenous bases "**stick out**" from the backbone.

- The nitrogenous base is a **purine** or **pyrimidine** ring.

- The base is linked to the 1' ("one prime") carbon on a pentose sugar by a **glycosidic bond** from the N of pyrimidines or the N of purines.

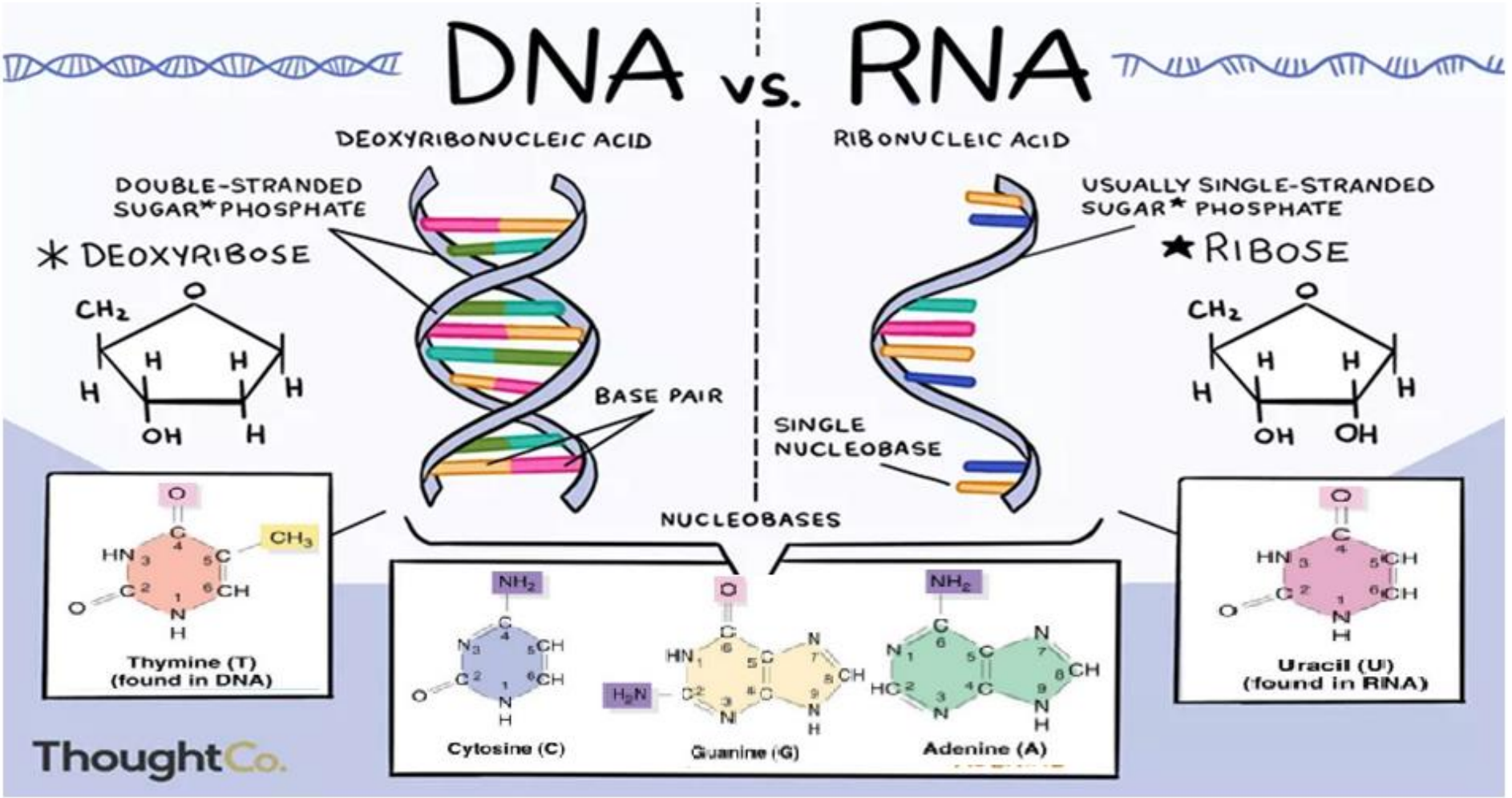
- The pentose sugar linked to a nitrogenous base is called a **nucleoside**.

- Nucleic acids are named for the type of sugar: DNA has **2'– deoxyribose**, whereas RNA has **ribose**. The difference is that the sugar in RNA has a **hydroxyl (–OH)** group on the 2' carbon of the pentose ring. The sugar can be linked by its 5' or 3' carbon to a phosphate group.

- A nucleoside linked to a phosphate at the 5' carbon is a **nucleotide**.

The basic building block of nucleic acids (DNA and RNA) is the nucleotide, which has three components:

- A nitrogenous base
- A sugar
- One or more phosphates



- Watson and Crick proposed that the DNA is made up of two strands that are twisted around each other to form a right-handed helix, called **a double helix**.

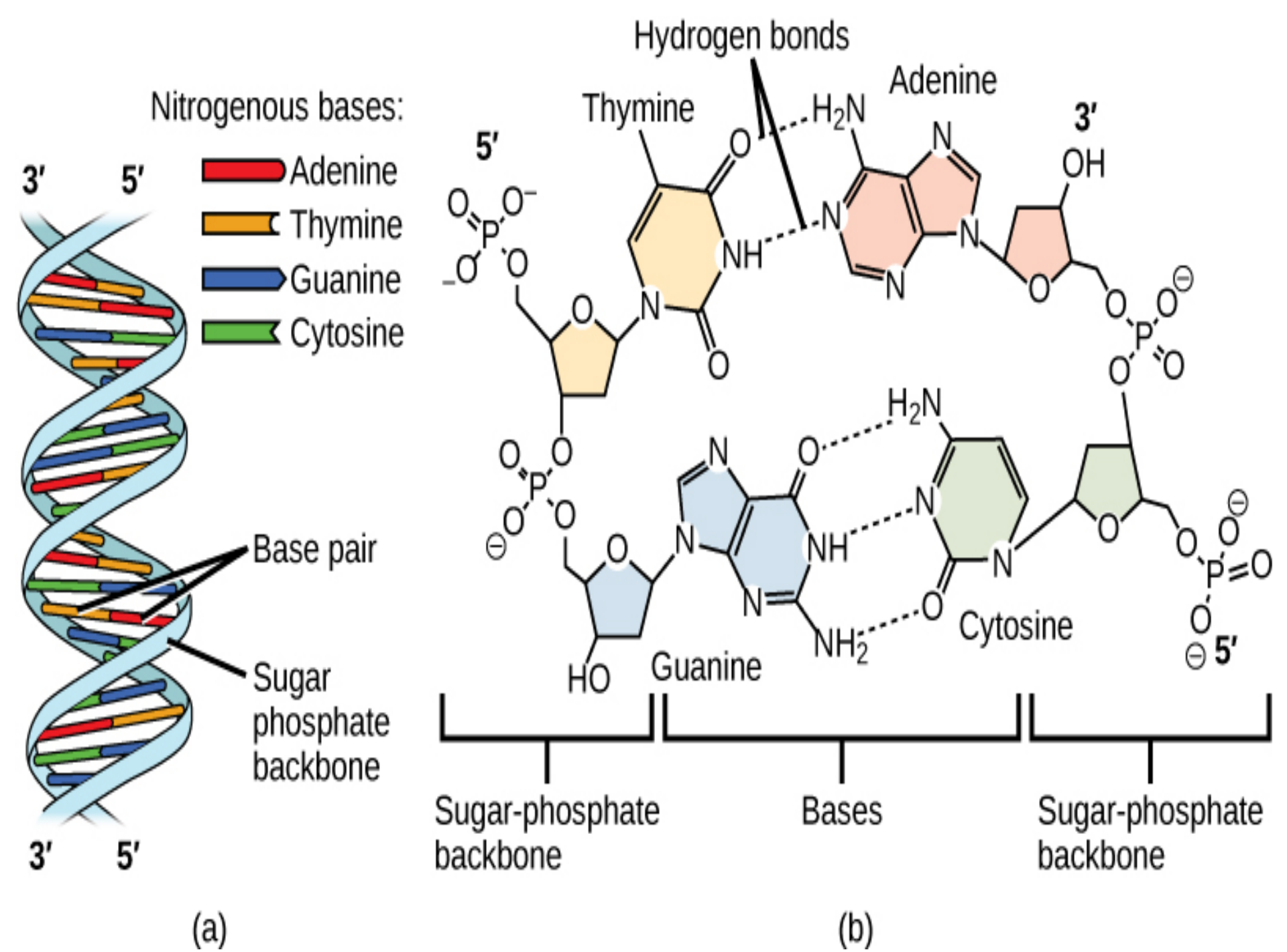
- Base-pairing takes place between a purine and pyrimidine: namely, **A pairs with T, and G pairs with C**. In other words, adenine and thymine are **complementary** base pairs, and cytosine and guanine are also complementary base pairs.

- because of their complementarity, there is **as much** adenine **as** thymine in a DNA molecule and **as much** guanine **as** cytosine.

- Adenine and thymine are connected by **two hydrogen bonds**, and cytosine and guanine are connected by **three hydrogen bonds**.

- The two strands are **anti-parallel** in nature; that is, one strand will have the 3' carbon of the sugar in the “upward” position, whereas the other strand will have the 5' carbon in the upward position.

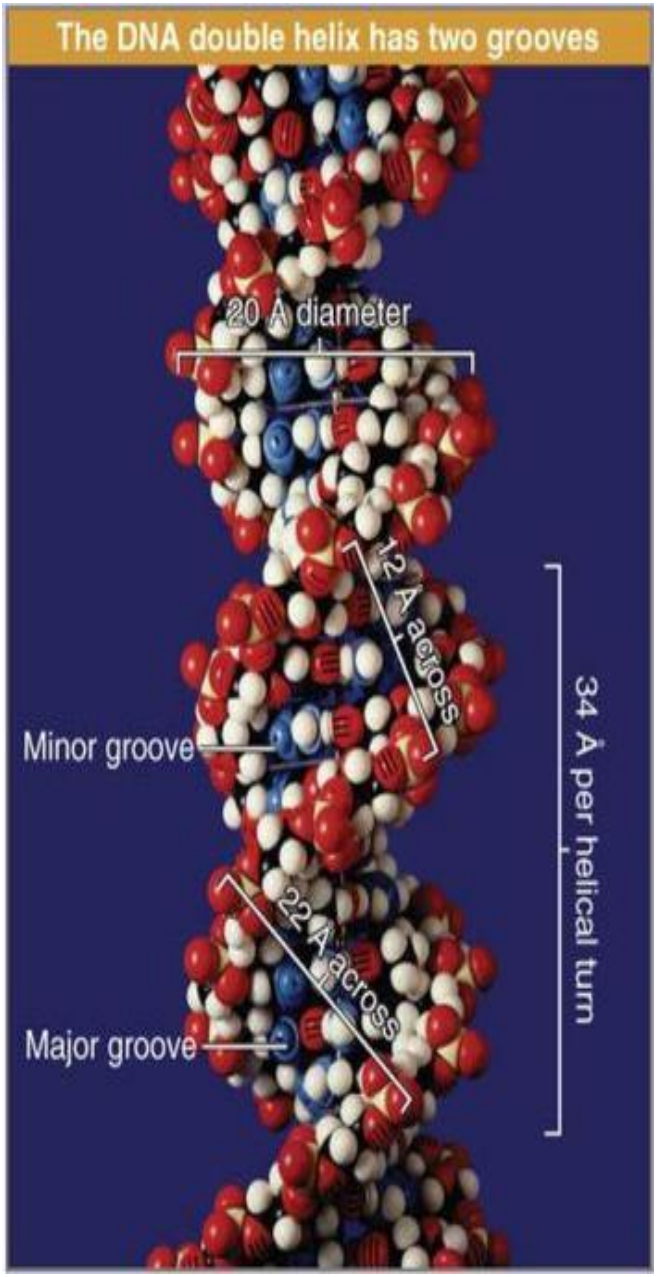
- The diameter of the DNA double helix is **uniform throughout** because a purine (two rings) always pairs with a pyrimidine (one ring) and their combined lengths are always equal.


Nitrogenous bases:
Adenine
Thymine
Guanine
Cytosine
3′
5′
Base pair
Sugar phosphate backbone
3′
5′
(a)
Hydrogen bonds
Thymine
Adenine
5′
3′
OH
HO
Guanine
Cytosine
5′
Sugar-phosphate backbone
Bases
Sugar-phosphate backbone
(b)

- The diameter of the double helix is 20 Å (2 nm), and there is a complete turn every 34 Å (3.4 nm), the distance between adjacent nucleotides is 3.4 Å (0.34 nm); thus, there must be 10 nucleotides per turn.

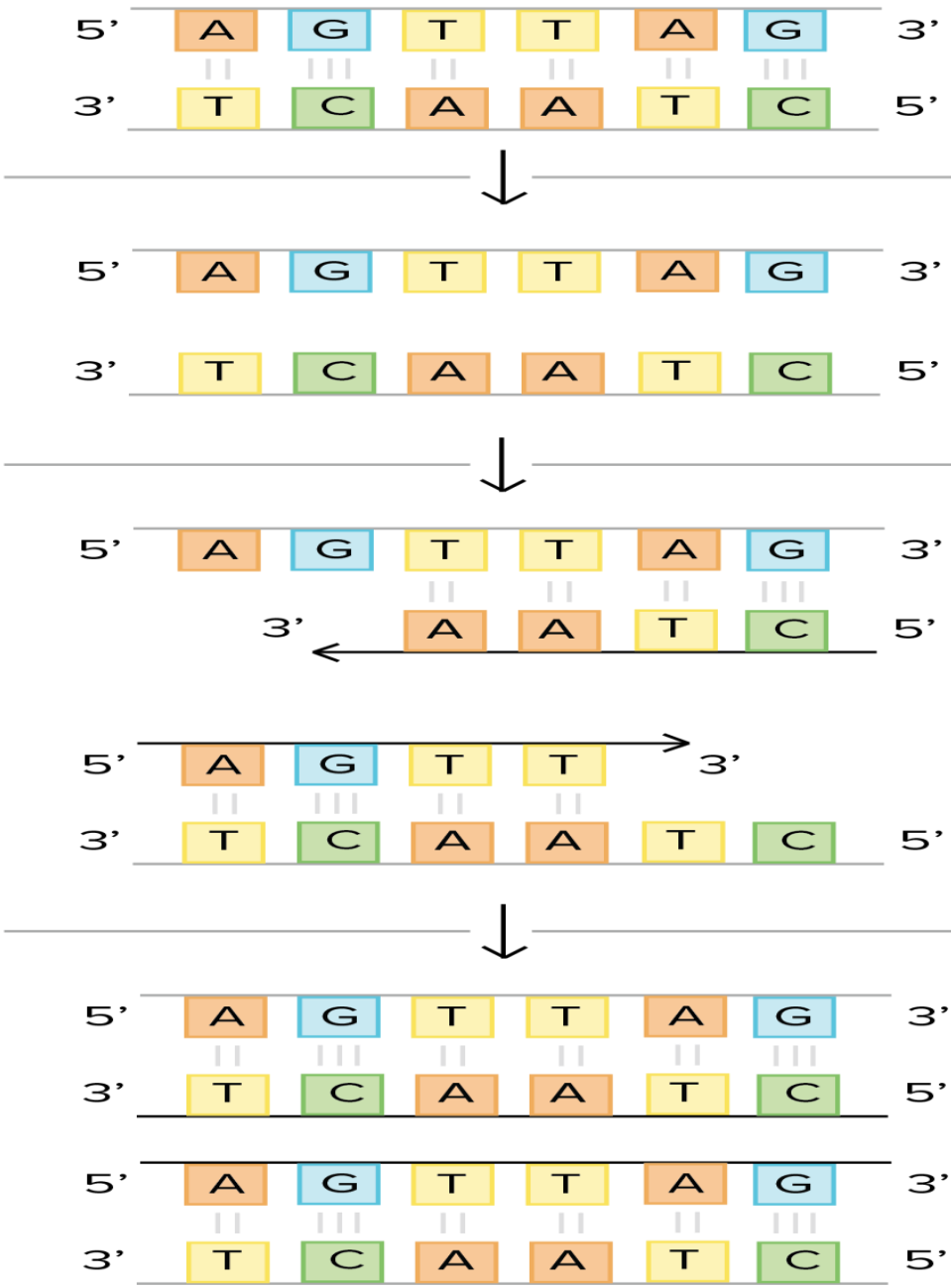
- the proportion of G is always the same as the proportion of C in DNA, and the proportion of A is always the same as that of T.

- Each base pair is rotated about 36° around the axis of the helix relative to the next base pair, so approximately 10 base pairs make a complete turn of 360°. The twisting of the two strands around each other forms a double helix with a **minor groove** that is about 12 Å (1.2 nm) across and a **major groove** that is about 22 Å (2.2 nm) across



# The principle of DNA replication :-

- To ensure the fidelity of genetic information, it is crucial that DNA is reproduced accurately.
- the mechanism of DNA replication depends on base pairing.
- The two polynucleotide strands are joined only by hydrogen bonds, so they are able to separate without the breakage of covalent bonds.
- The specificity of base pairing suggests that both of the separated parental strands could act as template strands for the synthesis of complementary daughter strands.
- The sequence of the daughter strand is determined by the parental strand: An A in the parental strand causes a T to be placed in the daughter strand; a parental G directs incorporation of a daughter C.
- This pattern of replication has been called (semiconservative replication) which was confirmed experimentally by **Matthew Meselson and Franklin Stahl in 1958**.




DNA double helix

Hydrogen bonds break and helix opens

Each strand of DNA acts as a template for synthesis of a new, complementary strand

Replication produces two identical DNA double helices, each with one new and one old strand

- The top part of above figure shows an unreplicated parental duplex with the original two parental strands.

- The third part shows the two daughter duplexes produced by complementary base pairing. Each of the daughter duplexes is identical in sequence to the original parent duplex, containing one parental strand and one newly synthesized strand.

- The parental duplex is replicated to form two daughter duplexes, each of which consists of one parental strand and one newly synthesized daughter strand.