Nanobiotechnology and Nanomedicine
Course code: 601104

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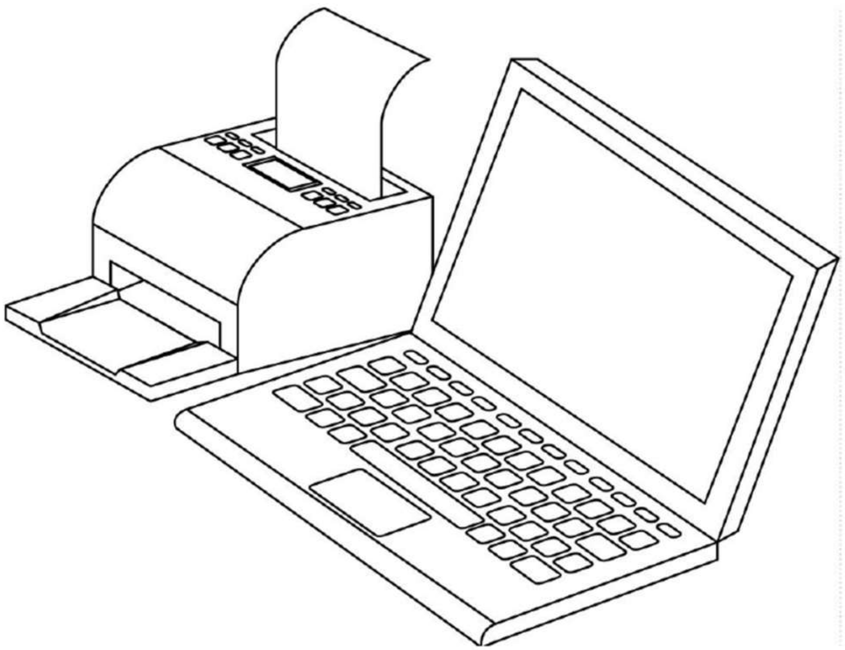
Central Dogma



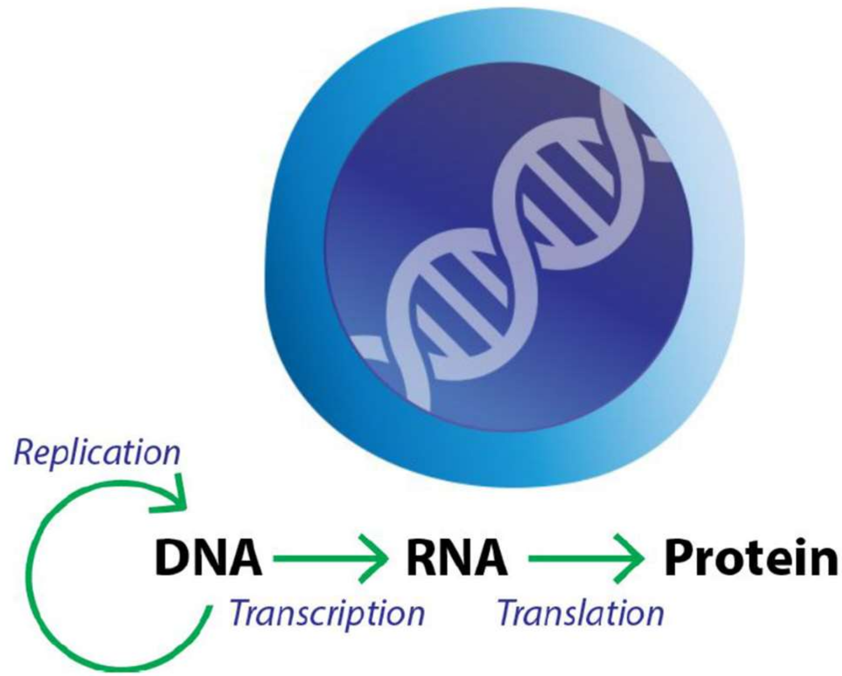


Fig (Right): The flow of genetic information in cells is from DNA to RNA to protein. All cells, from bacteria to humans, express their genetic information likewise— A principle is very fundamental hence it is termed the *central dogma* of molecular biology.

Central Dogma

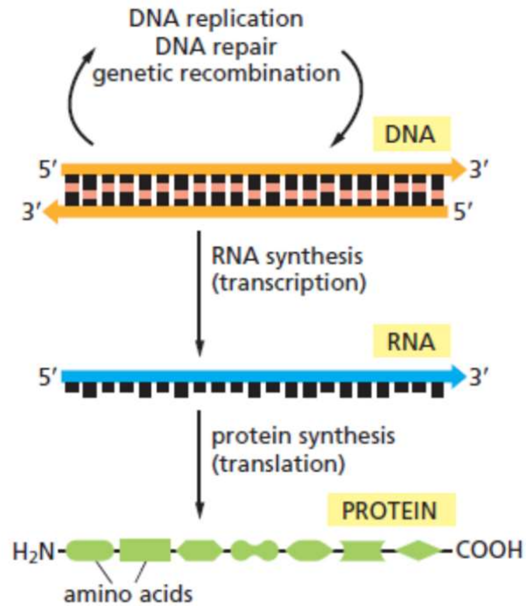
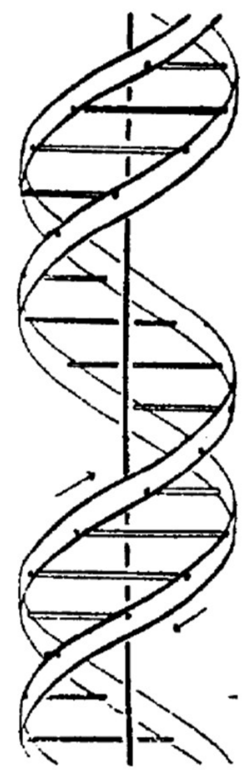


Fig: The pathway from DNA to protein. The flow of genetic information from DNA to RNA (transcription) and from RNA to protein (translation) occurs in all living cells.

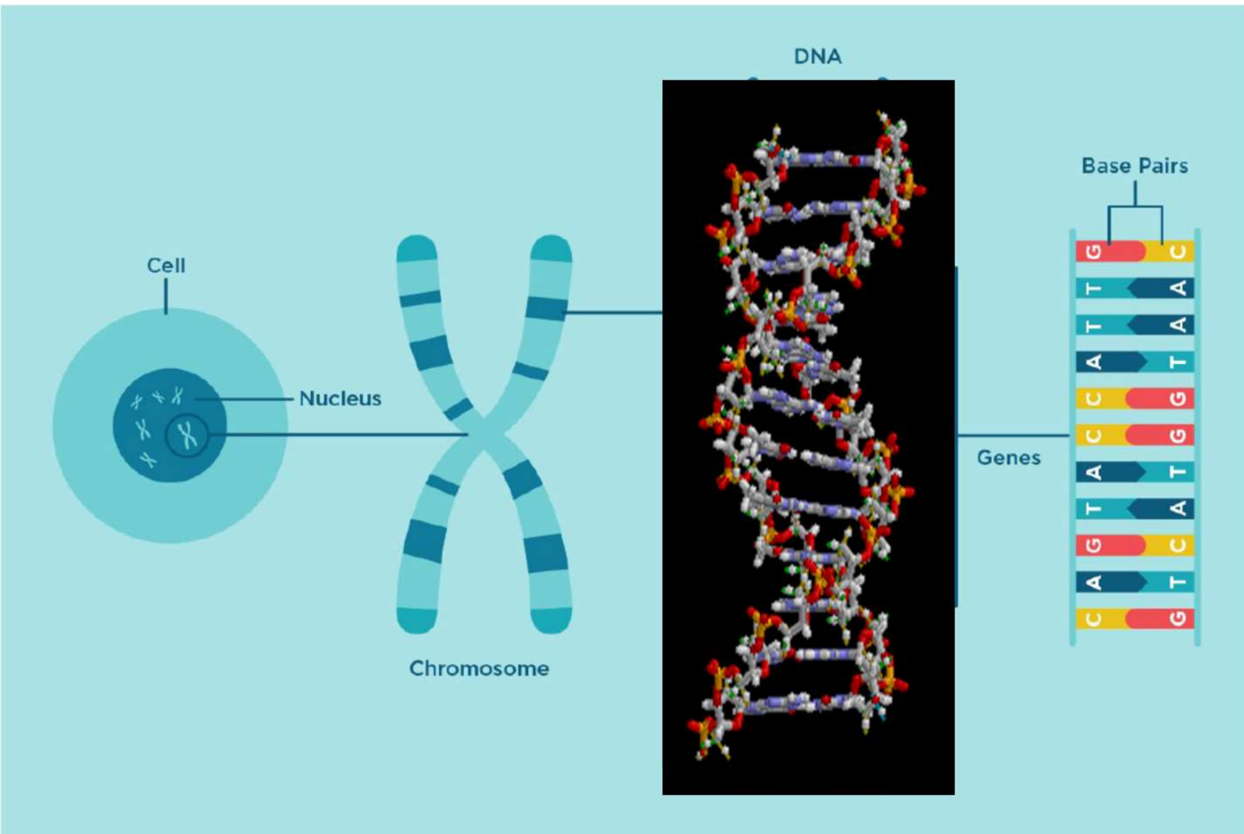
DNA structure

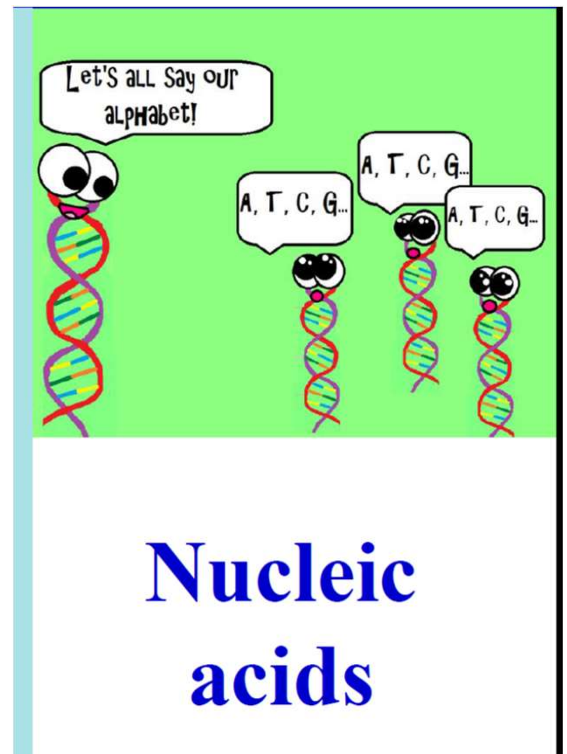
- ❖ Three dimensional double helix structure of deoxyribose nucleic acid i.e D.N.A propsed by J. D. Waston and F.H.C Crick.

- ❖ The right figure is purely diagrammatic. Two ribbon Symbolize the two phosphate-sugar chain, and horizontal strand the pair of bases holds the chain together. The vertical line represent the Coil axis.



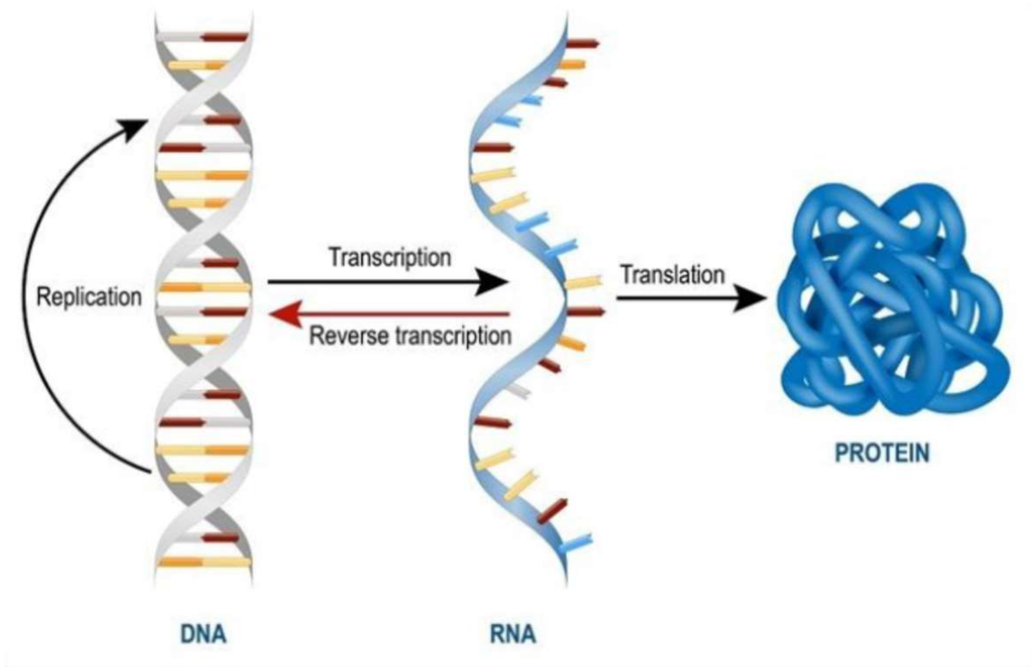
Nucleic Acids





Nucleic Acids to Protein

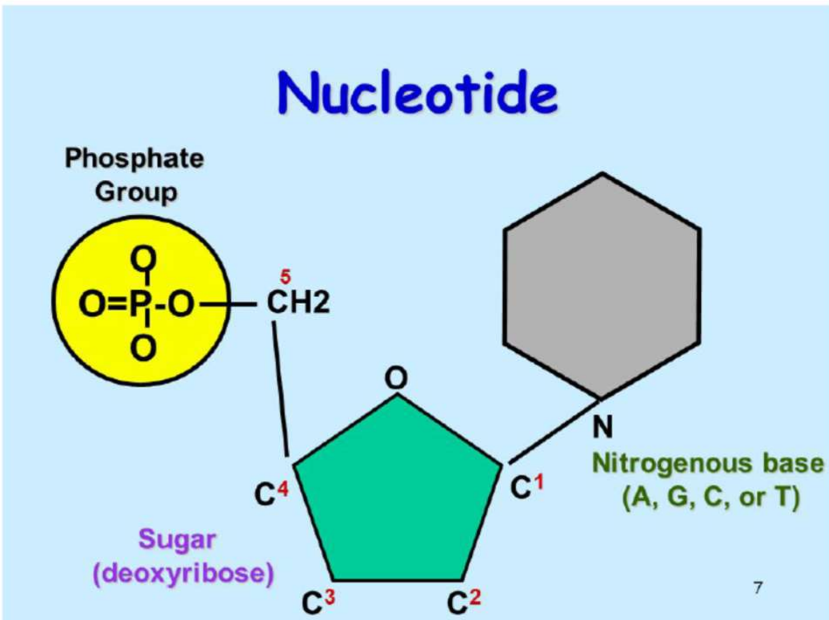
Nucleic acids are macromolecules and contains properties of polymers.
So it is called polynucleotides. The unit of polynucleotides is nucleotide.
Nucleic acids is DNA and RNA that translate the protein.

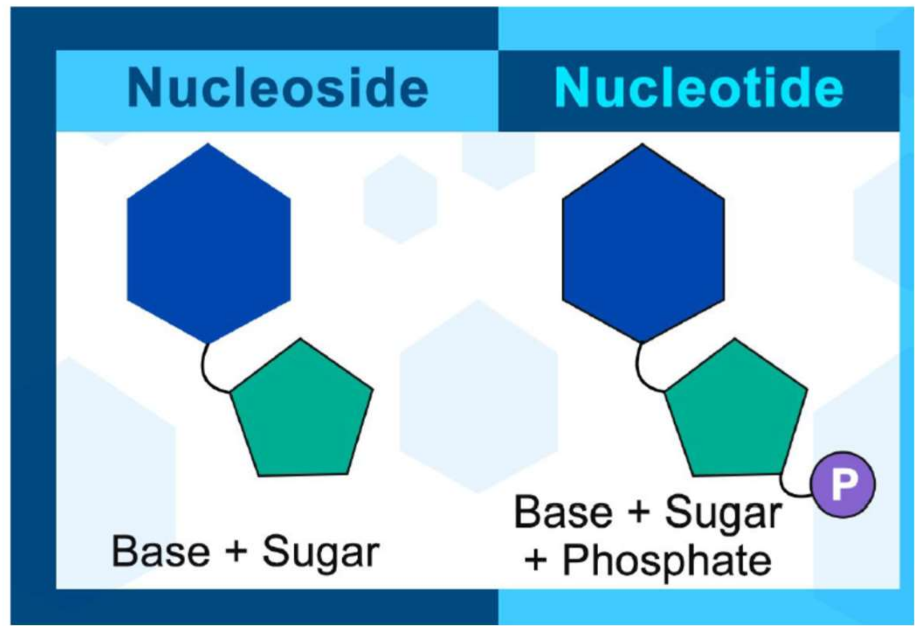


Deoxyribonucleic acid (DNA): Double helix in structure with 2 nm of diameter.
Ribonucleic acid (RNA): Single strand
Protein: Mostly globular in shape, Size: in order of nanometer i.e start from 1 nm roughly.

Base pairing letter code:
A- Adenine
T- Thymine
G-Guanine
C-Cytosine
U- Uracil

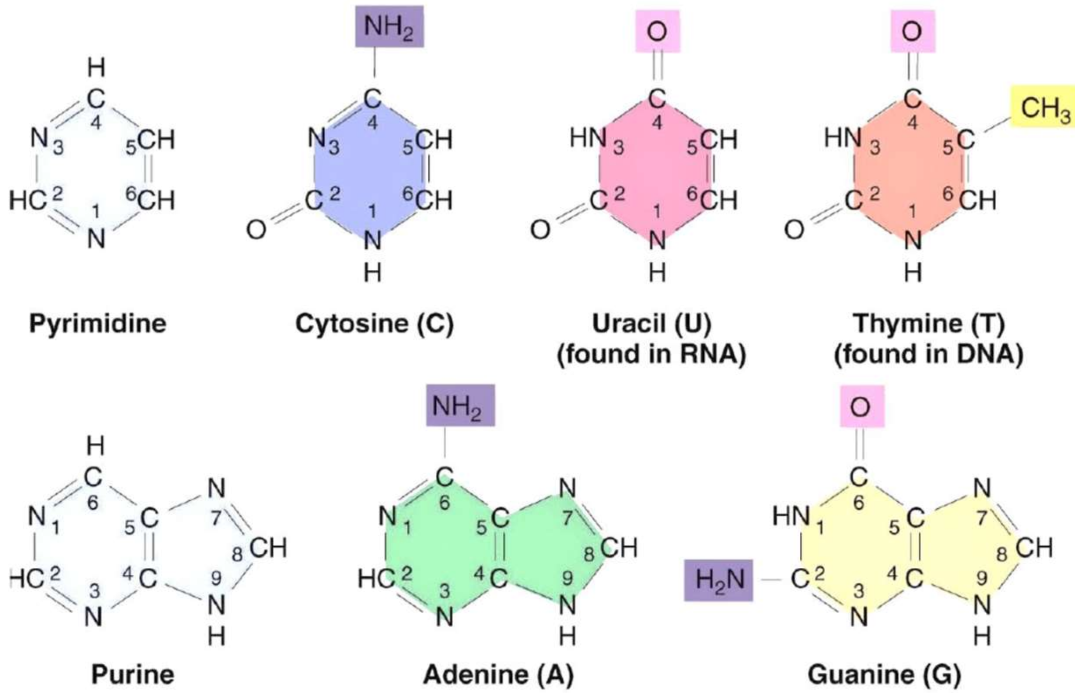
Nucleic Acids





Due to presence of phosphate group DNA and RNA behaves as negatively charged molecules.

Nitrogenous Bases in Nucleic Acids and Chemical structure of DNA



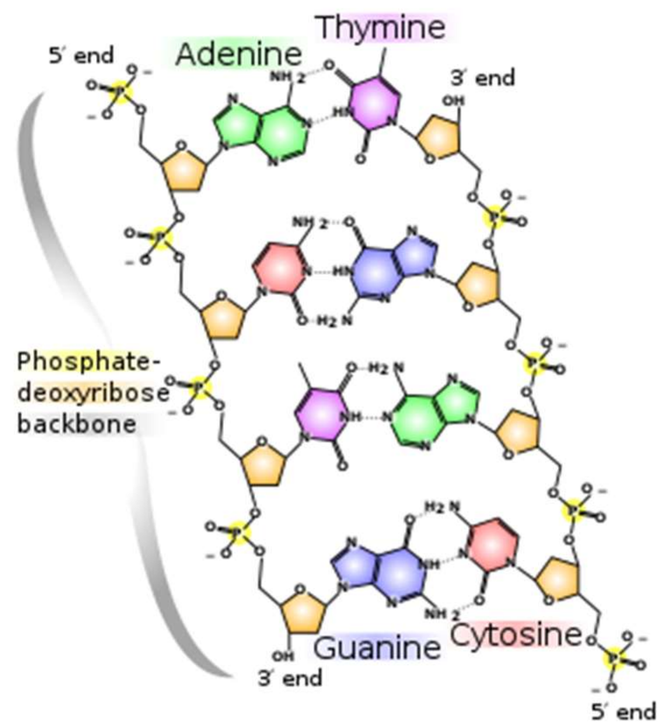
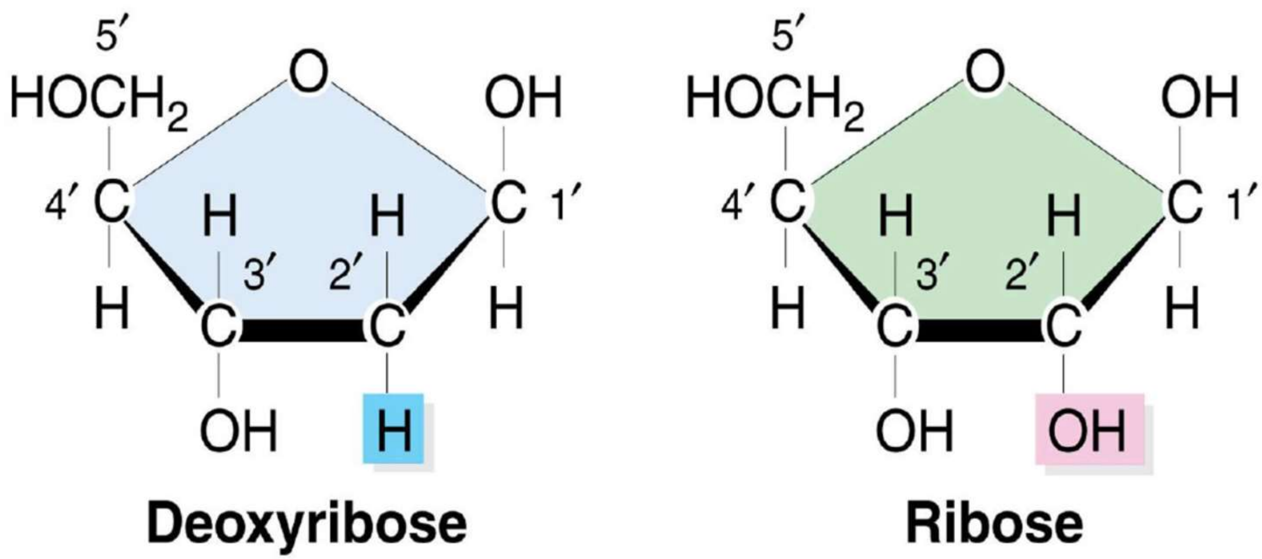


Image source: https://en.wikipedia.org/wiki/DNA

Ribose Sugar



Extra oxygen atom at position (2’) in the RNA nucleotide makes it more reactive and less stable than DNA.

Biophysical Structure of DNA

- The 5’ prime and 3’ represent the position of phosphate group and pentose sugar.
- Hydrogen bond shown in dotted line.

- The structure of DNA is dynamic along its length, it has a coiling capacity into tight loops and other shapes. In all species it is composed of two helical chains, the helical chain hold together by hydrogen bonding between two base pair. Both chains are coiled around the same axis, and have the same pitch of 34 Å (3.4 nm). The pair of chains has a radius of 10 angstroms (1.0 nm). When measured in a different solution, the DNA chain measured 22 to 26 angstroms wide (2.2 to 2.6 nanometres), and one nucleotide unit measured 3.3 Å (0.33 nm) long.

- The DNA double helix is stabilized primarily by two weak forces such as hydrogen bonding between nucleotides and base stacking interactions among aromatic nucleobases.

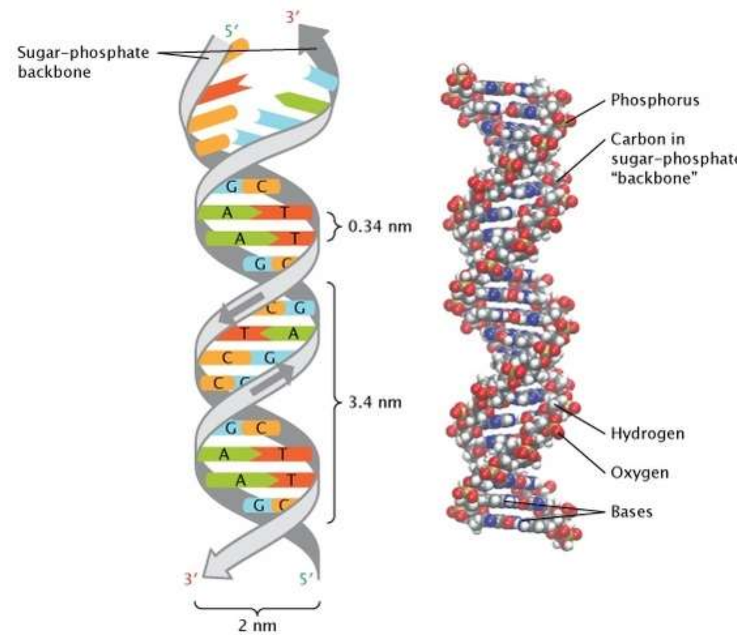


Image source: https://www.nature.com/scitable/topicpage/discovery-of-dna-structure-and-function-watson-397/

Biophysical properties of DNA

- As shown in previous slide, The DNA molecules bound together in a helical fashion by noncovalent bonds. This double-stranded (dsDNA) structure is maintained by the intrastrand base stacking interactions, which are strongest for G,C stacks.
- The two strands can separate—a process known as melting and form two single-stranded DNA (ssDNA) molecules.
- Melting occurs at high temperature, low salt and high pH.
- The stability of the dsDNA form depends not only on the GC-content (% G,C basepairs), also on sequence (since stacking is sequence specific) and also length (longer molecules are more stable).
- The stability can be determine by different ways such as "melting temperature." The temperature at which 50% of the ds molecules are converted to ss molecules.
- Melting temperature is dependent on ionic strength and the concentration of DNA.
- As a result, it is both the percentage of GC base pairs and the overall length of a DNA double helix that determines the strength of the association between the two strands of DNA. Long DNA helices with a high GC-content have stronger-interacting strands, while short helices with high AT content have weaker-interacting strands.

to be continued in next session---------

References

- J. D. Watson and F.H.C Crick, Nature 171, (1953), 737-738.

- B. Alberts, A. Johnson, J. Lewis, D. Morgan, M. Raff, K. Roberts and P. Walter, Molecular Biology of the Cell, 6th edition, Garland Science, Taylor and Francis group.

- https://en.wikipedia.org/wiki/DNA

- https://www.nature.com/scitable/topicpage/discovery-of-dna-structure-and-function-watson-397/