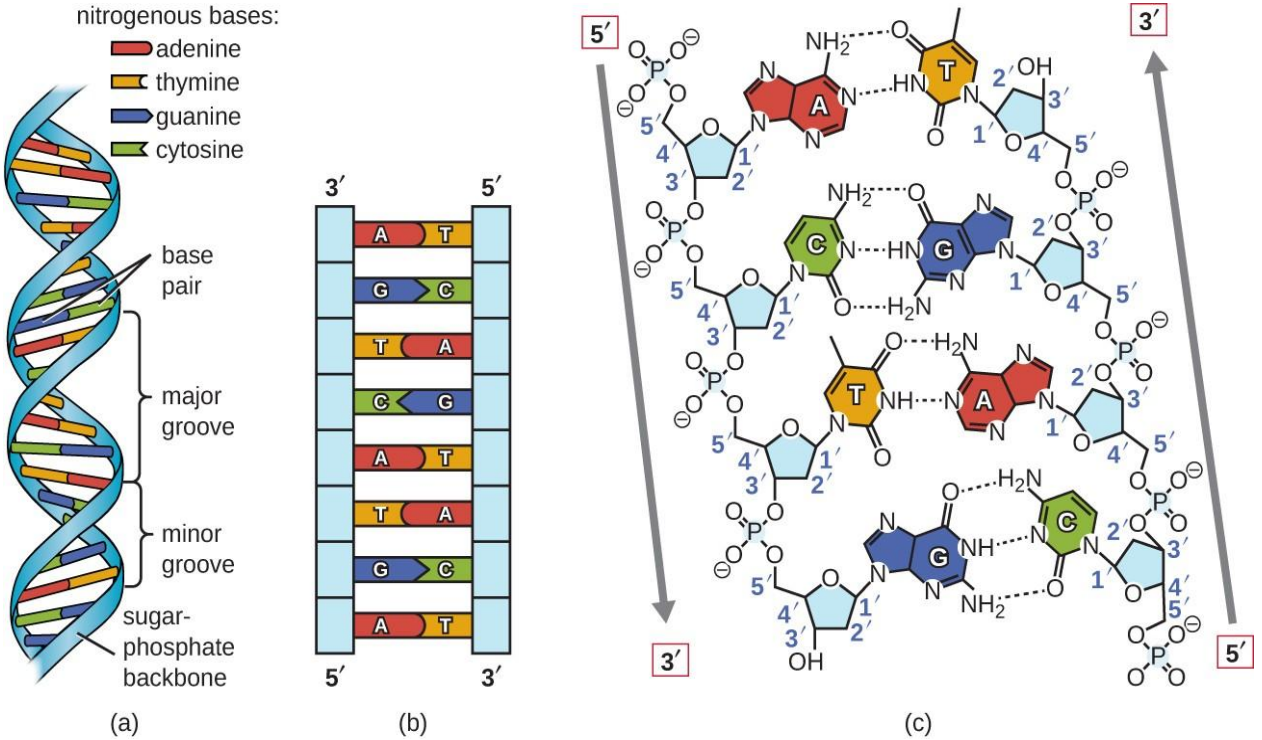
Bhagalpur National College, Bhagalpur

(A Constituent unit of Tilka Manjhi Bhagalpur University, Bhagalpur)

PPT Presentation for B.Sc. III- DNA : Structure & Function

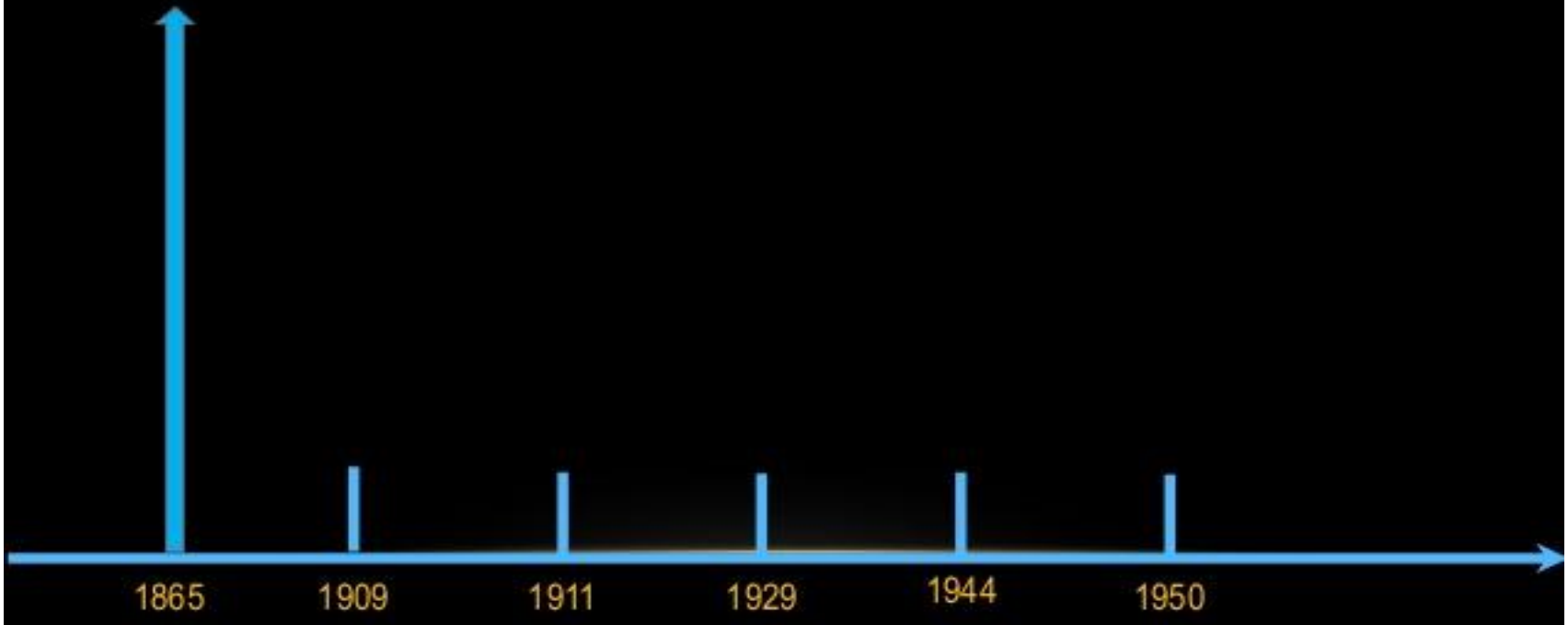


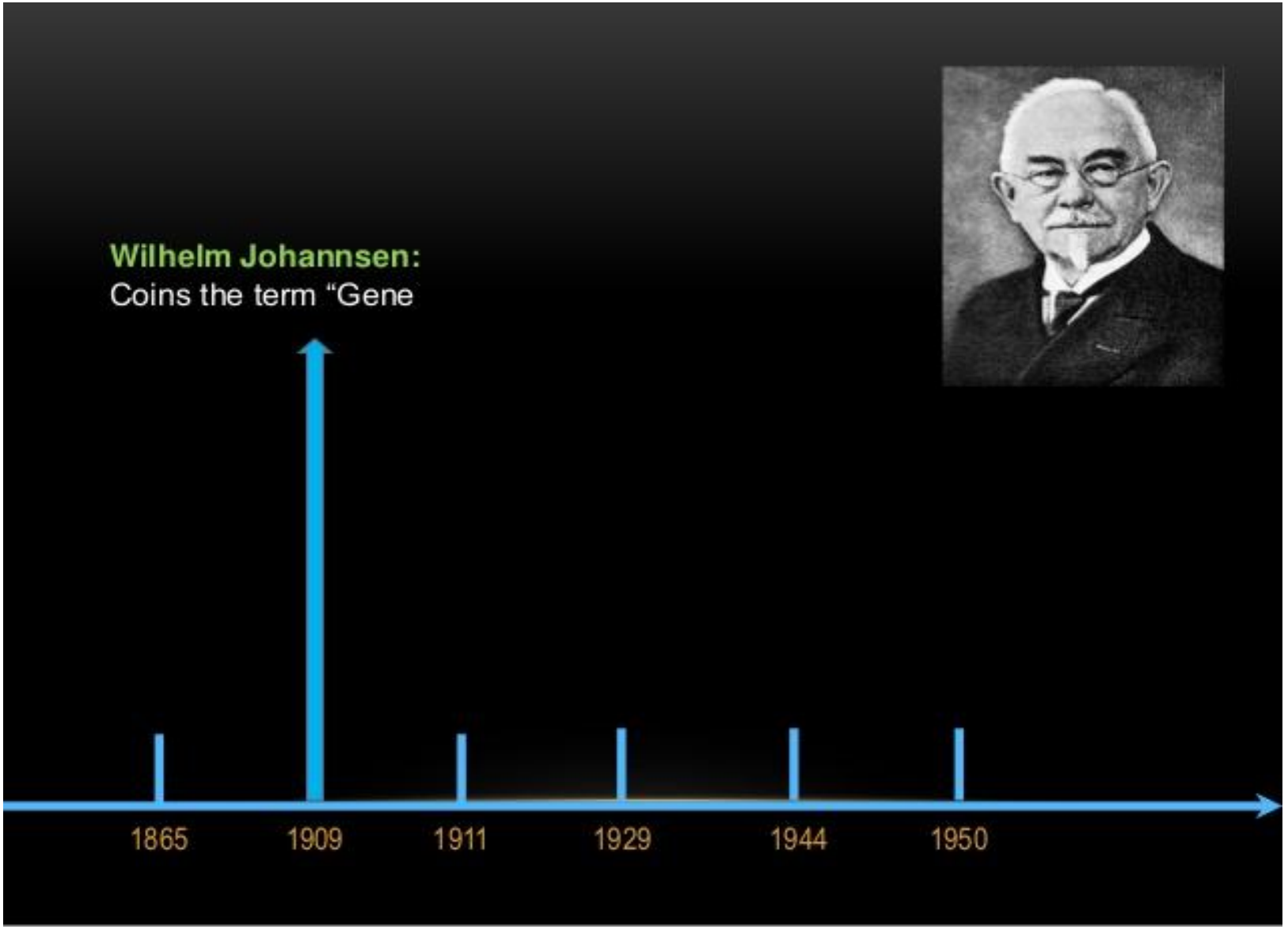
Presented by - Dr. Amit Kishore Singh

Department of Botany

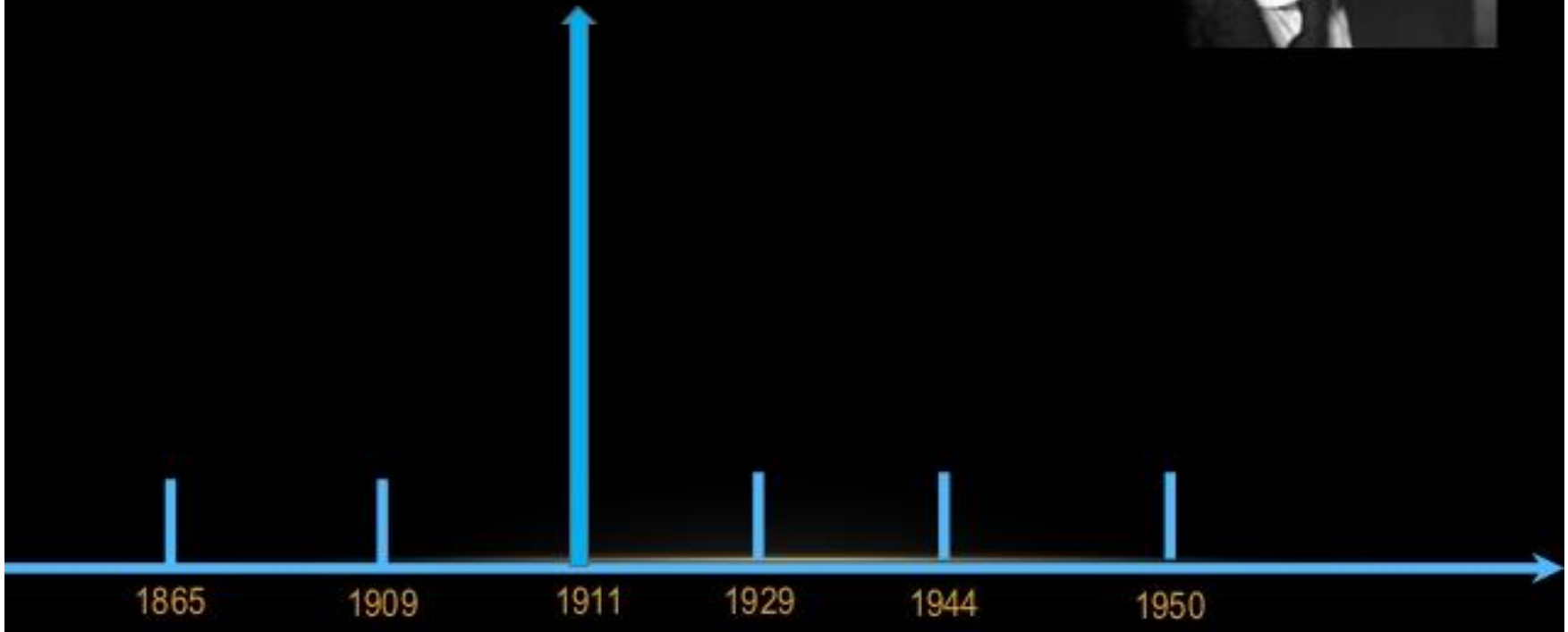
B.N. College, Bhagalpur

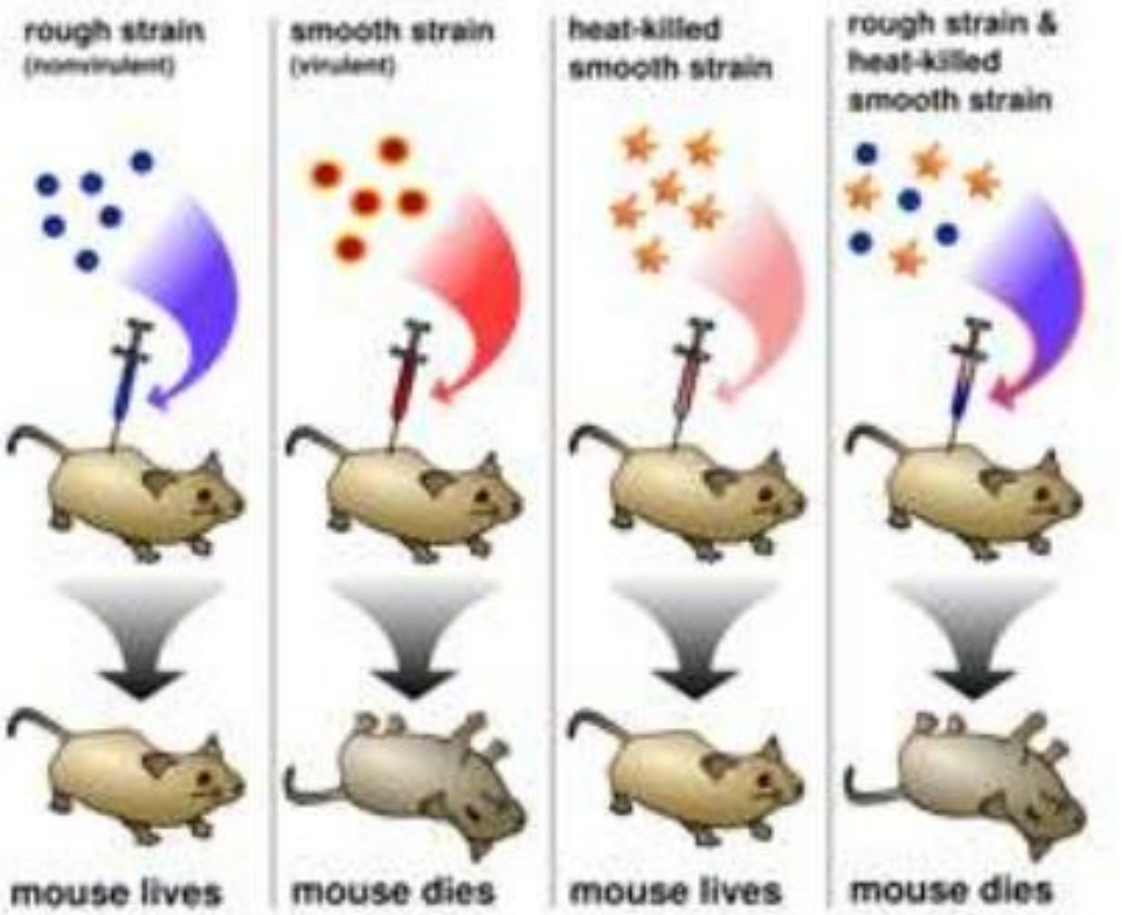
Gregor Mendel:
Introduces the concept of heredity




Wilhelm Johannsen:
Coins the term “Gene
1865
1909
1911
1929
1944
1950

Thomas Hunt Morgan:
Discovers that genes are responsible for inheritance



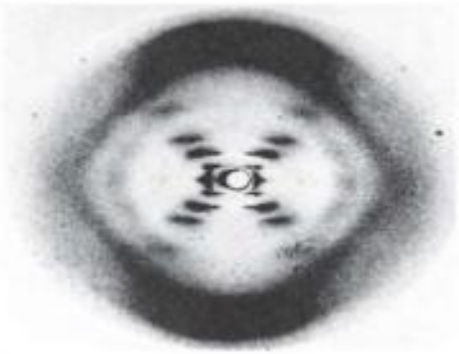


Transformation: Robert Griffith (1928)

HISTORY

- In 1869, **Miescher discovered "nuclein" (DNA) in the** cells from pus & later he separated it into a protein and an acid molecule. It came to known as nucleic acid after 1874.
- 1926 , **Levene proposed "Tetra nucleotide theory"** which states that Nucleic acid consists of only 4 nitridesas it gives 4 different nucleotides on hydrolysis.

Rosalind Franklin used X-ray crystallography to help visualize the structure of DNA

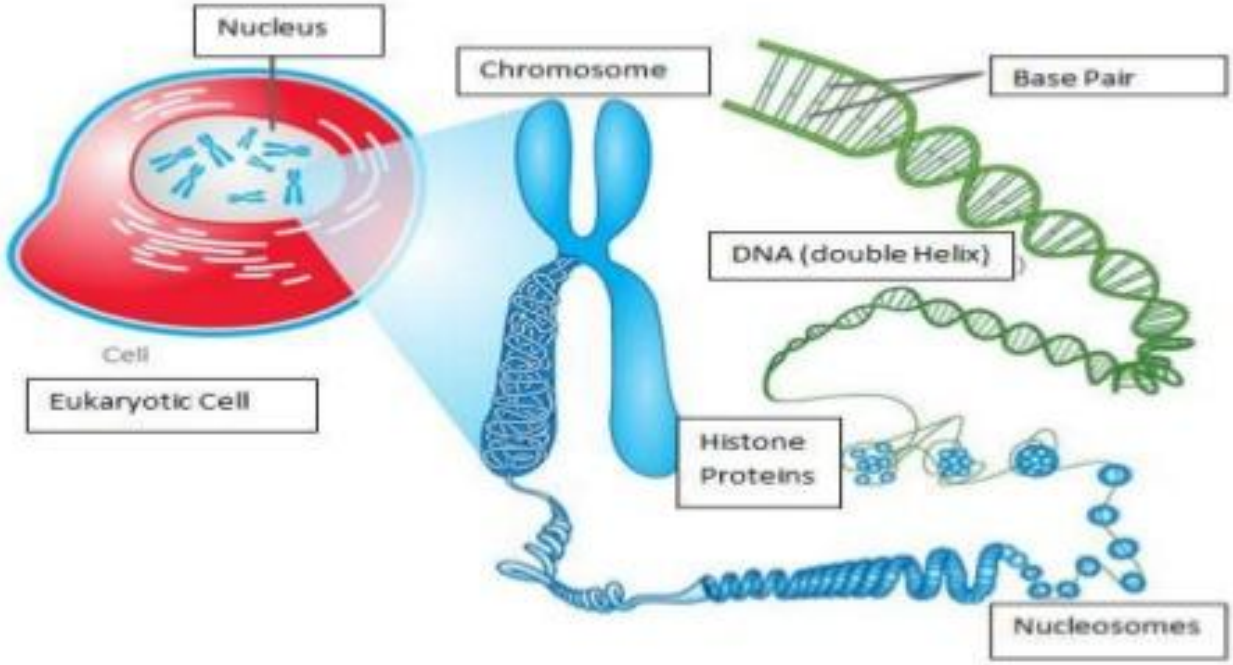


(b) Franklin's X-ray diffraction photograph of DNA

- James D. Watson and Francis Crick, co-originators of the doublehelix model.

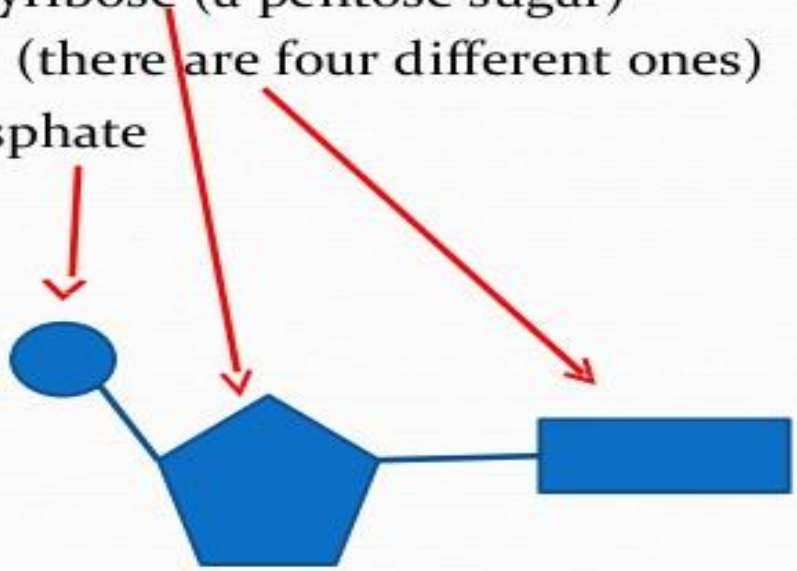
Briefing on DNA…

- DNA is found in the cells of all living things.
- DNA contains all of the genetic information that makes you who you are and every
- individual organism has unique DNA like a finger print.

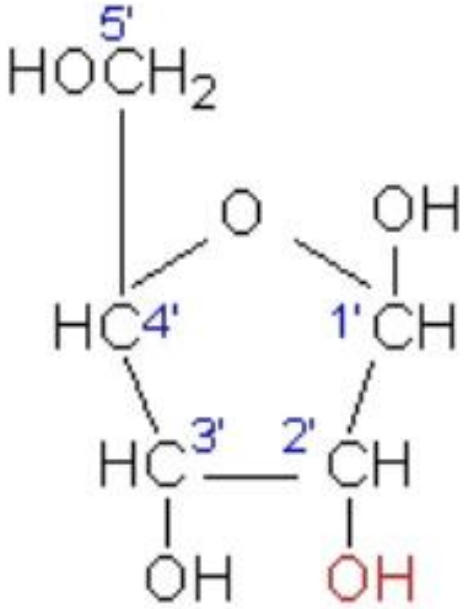


DNA Structure

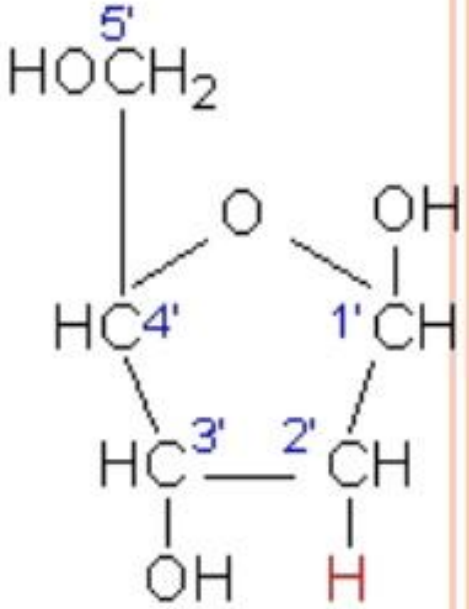
- DNA has three main components
  - 1. deoxyribose (a pentose sugar)
  - 2. base (there are four different ones)
  - 3. phosphate



THE SUGARS

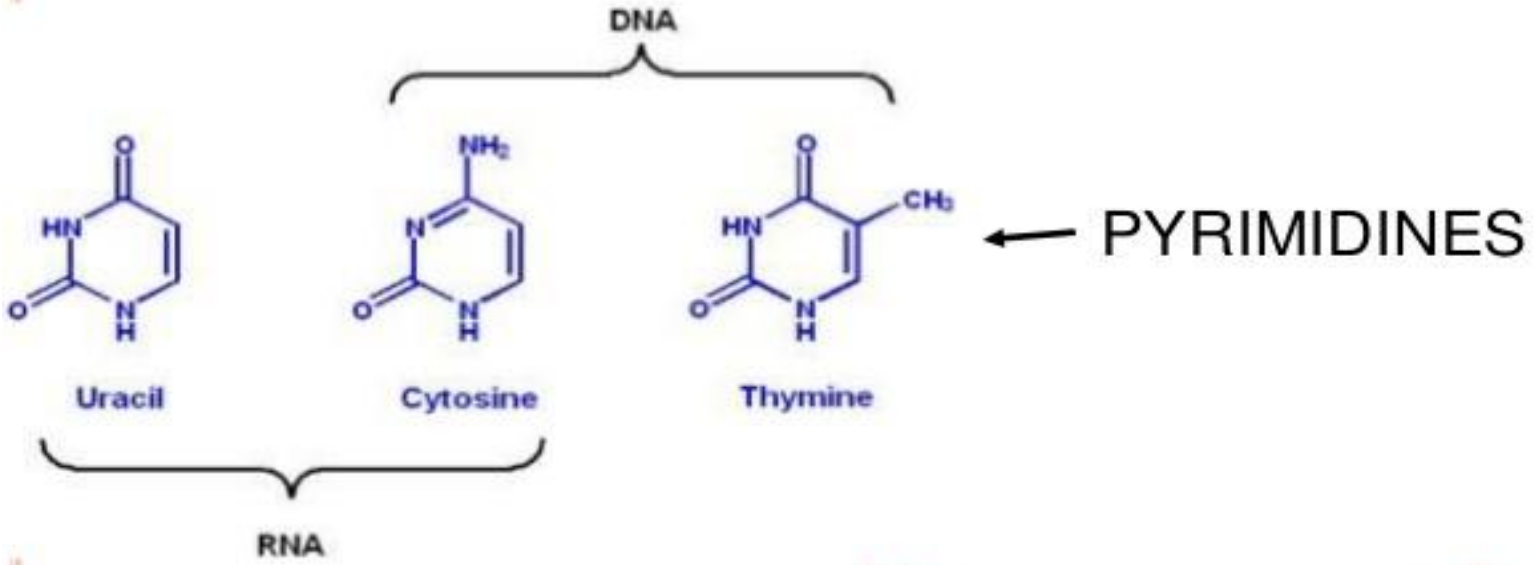


Ribose
(in RNA)

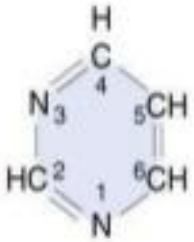


2'-Deoxyribose
(in DNA)

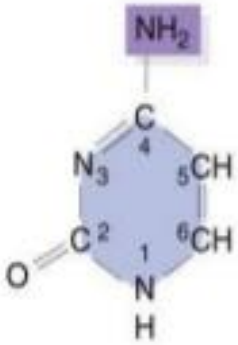
THE BASES


DNA
Uracil
Cytosine
Thymine
PYRIMIDINES
RNA
PURINES
Adenine
Guanine

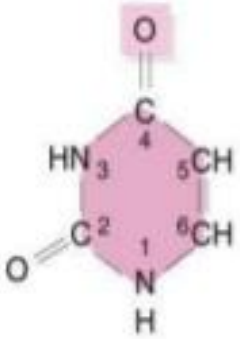
NITROGENOUS BASES



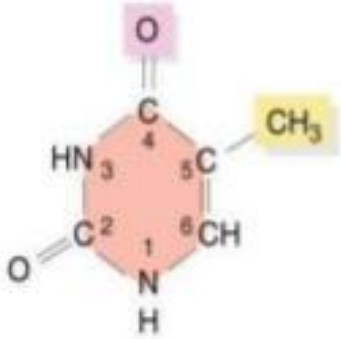
Pyrimidine



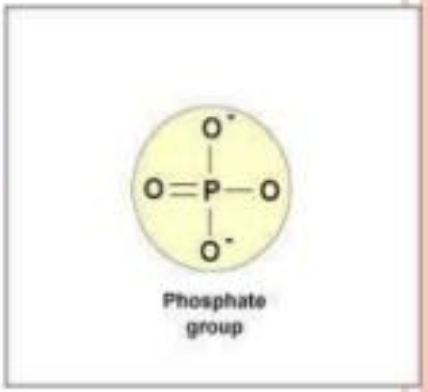
Cytosine (C)



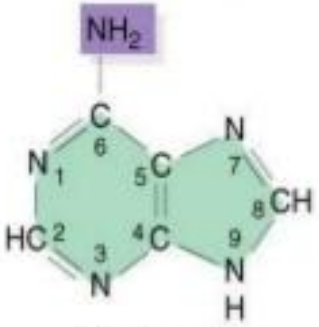
Uracil (U)
(found in RNA)



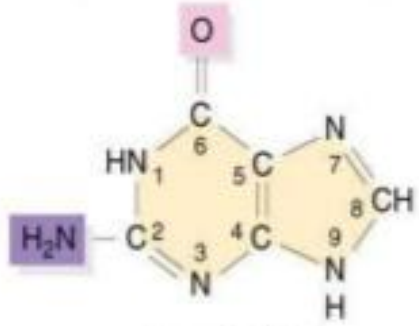
Thymine (T)
(found in DNA)



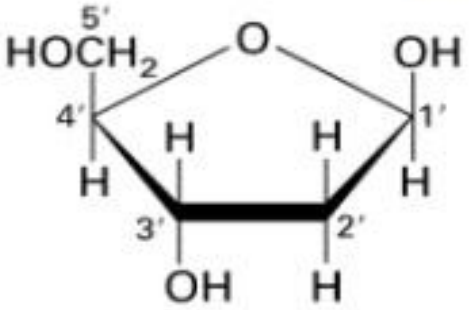
Purine



Adenine (A)



Guanine (G)



2-Deoxyribose

NUCLEIC ACIDS

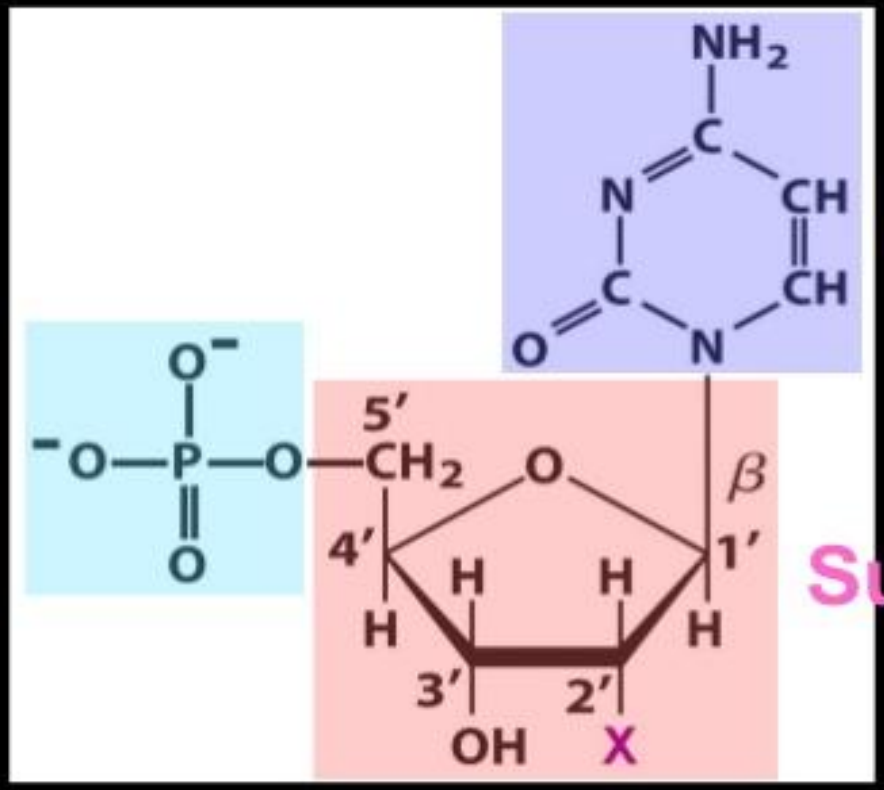
- Nucleic acids are polymers
- Nucleotides are monomer
  - Nitrogenous bases
    - Purines
    - Pyrimidine
  - Sugar
    - Ribose
    - Deoxyribose

  Nucleosides

  - Phosphates + nucleoside = nucleotide

Nomenclature of Nucleic Acid Components

Base	*Nucleoside*	*Nucleotide*	*Nucleic acid*
Purines			
Adenine	Adenosine	Adenylate	RNA
	Deoxyadenosine	Deoxyadenylate	DNA
Guanine	Guanosine	Guanylate	RNA
	Deoxy guanosine	Deoxyguanylate	DNA
Pyrimidines			
Cytosine	Cytidine	Cytidylate	RNA
	Deoxycytidine	Deoxycytidylate	DNA
Thymine	Thymidine (deoxythymidine)	Thymidylate (deoxythymidylate)	DNA
Uracil	Uridine	Uridylate	RNA

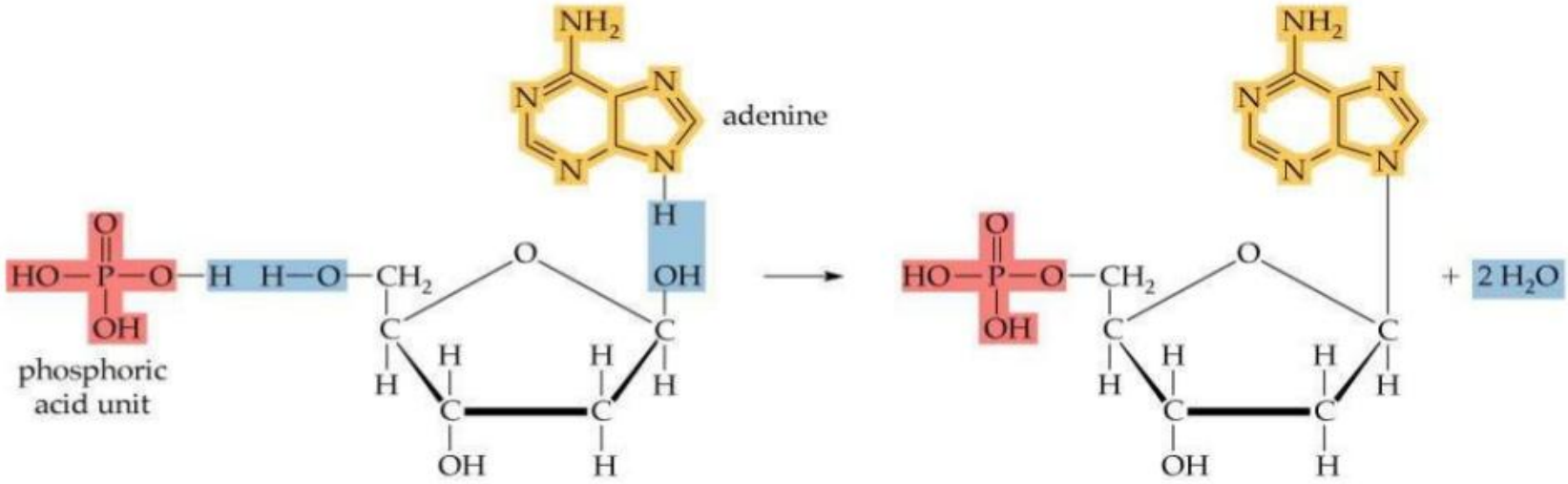


X=H: **DNA**
X=OH: **RNA**

Nucleoside

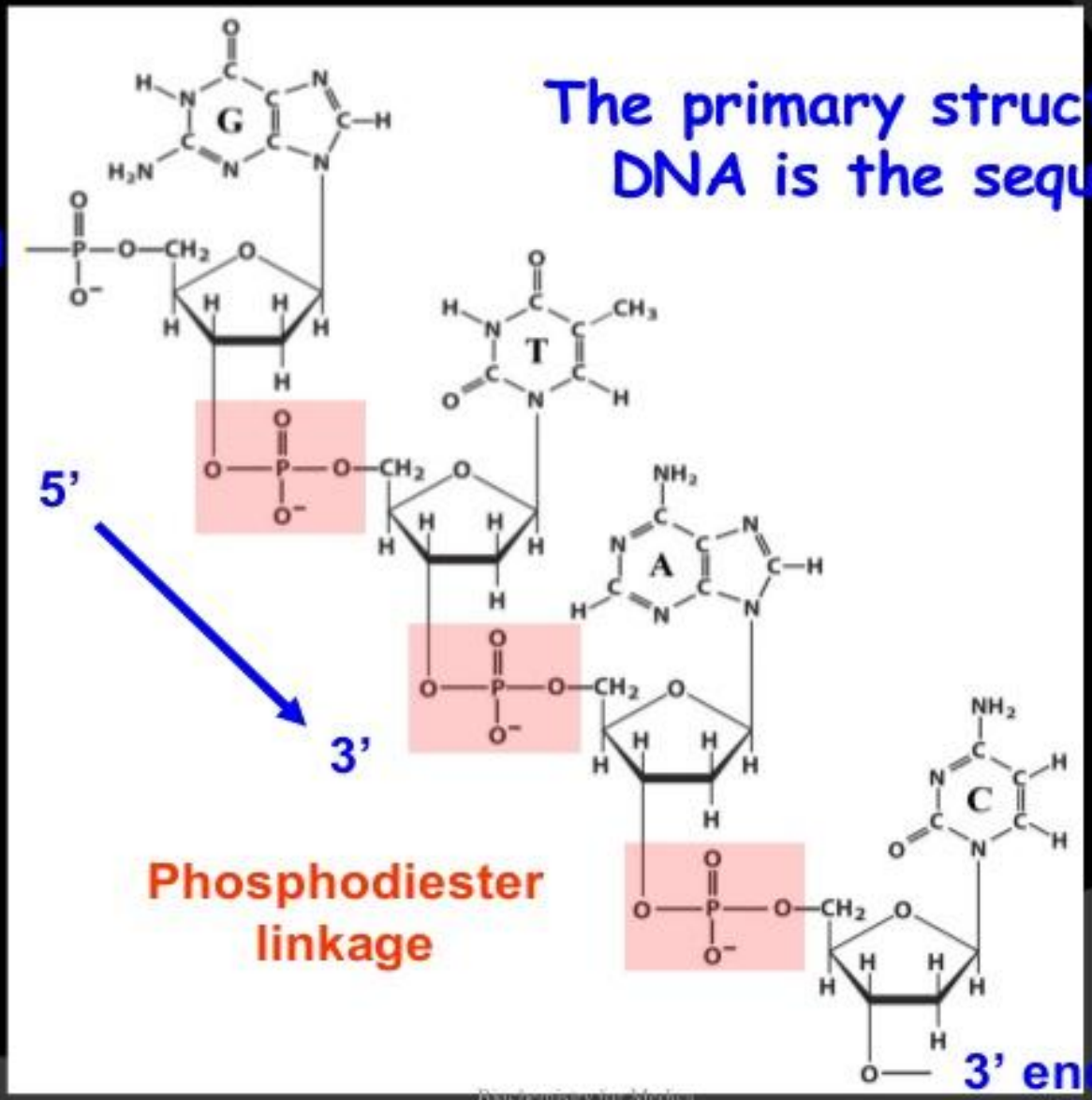
Nucleotide

Formation of a Nucleotide



- Alternating phosphate, sugar molecules form the backbone
- The rxn between phosphate and sugar forms an ester bond with the elimination of water
- The sugar bonds with a base, forming tertiary amine, with the elimination of water

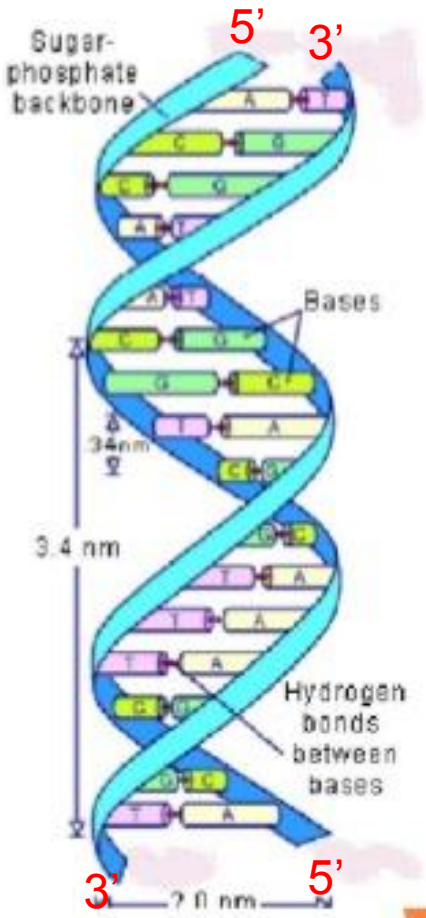
The primary structure of DNA is the sequence



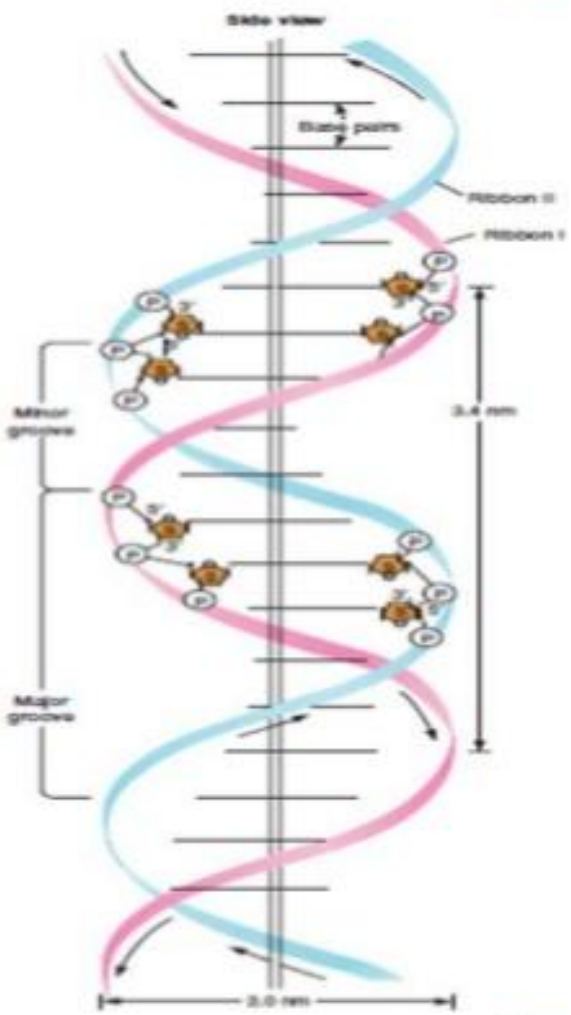
DNA STRUCTURE

In 1953, Watson and Crick postulated a three dimensional model of DNA structure that accounted for both the X-ray data and the characteristic base pairing in DNA.

- It consist of two helical polynucleotide chains.
- Two polynucleotide chains coil around the same axis to form a right –handed double helix.
- In the helix, the two chains or strands are anti parallel i.e. have an opposite polarity.
- Backbone of each chain which consist of alternate sugar-phosphate residues, (hydrophilic) are on the out side of the double helix, facing the surrounding.



- The purine and pyrimidine bases of each strand face inward towards each other.
- The bases are stacked perpendicular to the long axis of the double helix.
- The base pair are 0.34 nm apart in DNA helix. A complete turn of helix takes 3.4 nm, therefore in each helical turn, 10 bases are present. The external diameter of helix is 2 nm.
- The helix has two external grooves, the narrow groove is called as **minor groove** while the wide groove is called as **major groove .** The major groove is the site for DNA binding proteins. The minor grooves often are the site for binding small molecules.

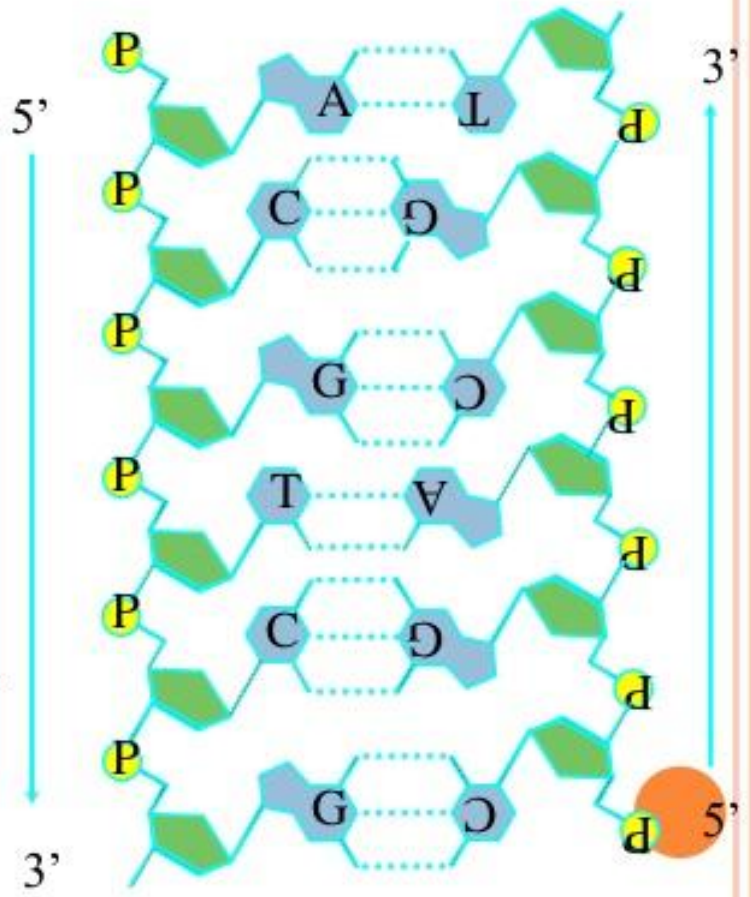


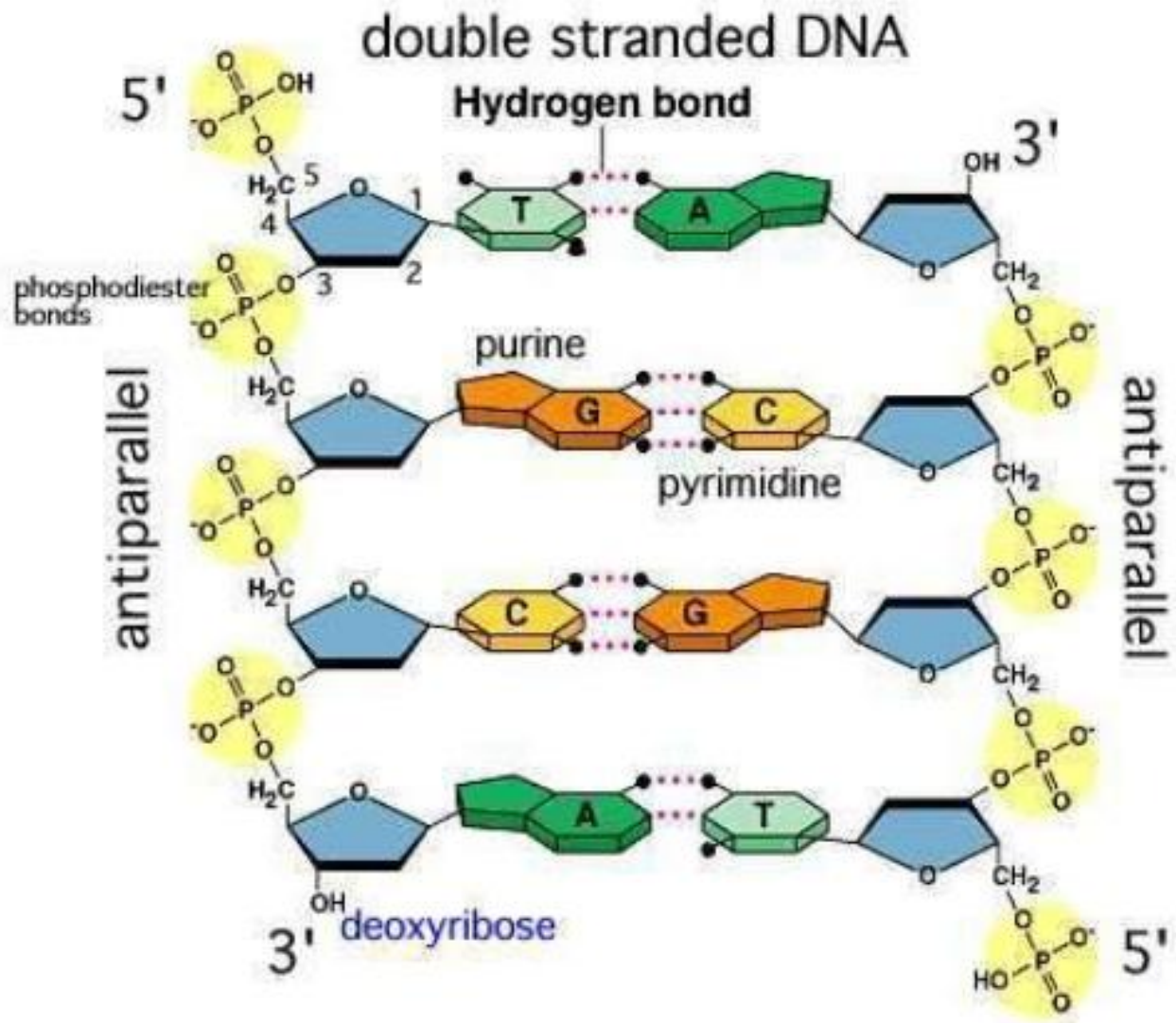
DNA IS A DOUBLE HELIX

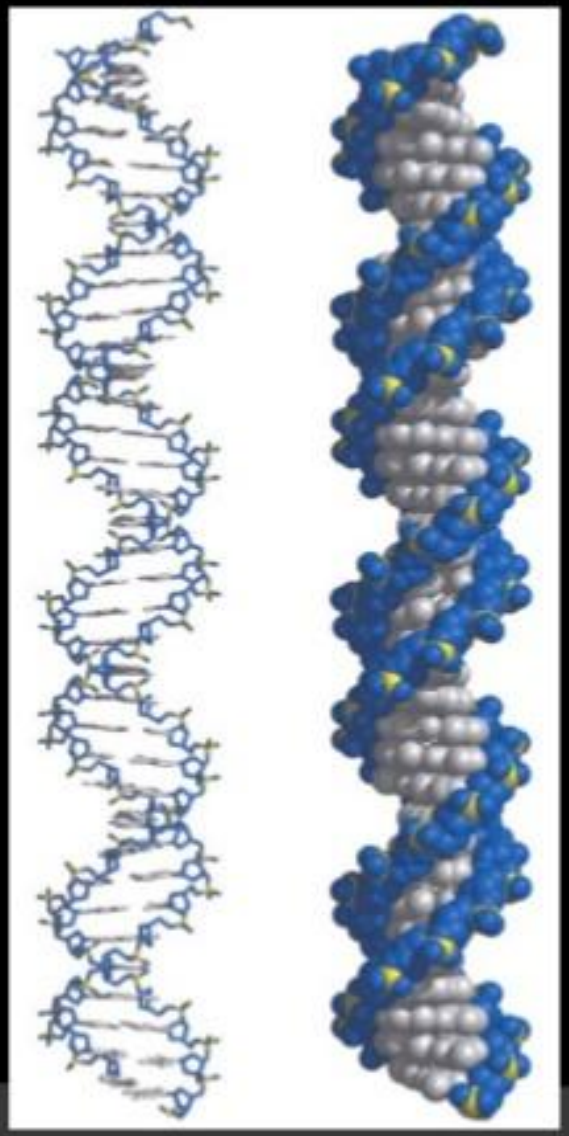
A sugar and phosphate "backbone" connects nucleotides in a chain.

Hydrogen bonds between paired bases hold the two DNA strands together.

DNA strands are antiparallel.




double stranded DNA
Hydrogen bond
5'
3'
phosphodiester bonds
purine
pyrimidine
antiparallel
antiparallel
T
A
G
C
C
G
A
T
deoxyribose
3'
5'

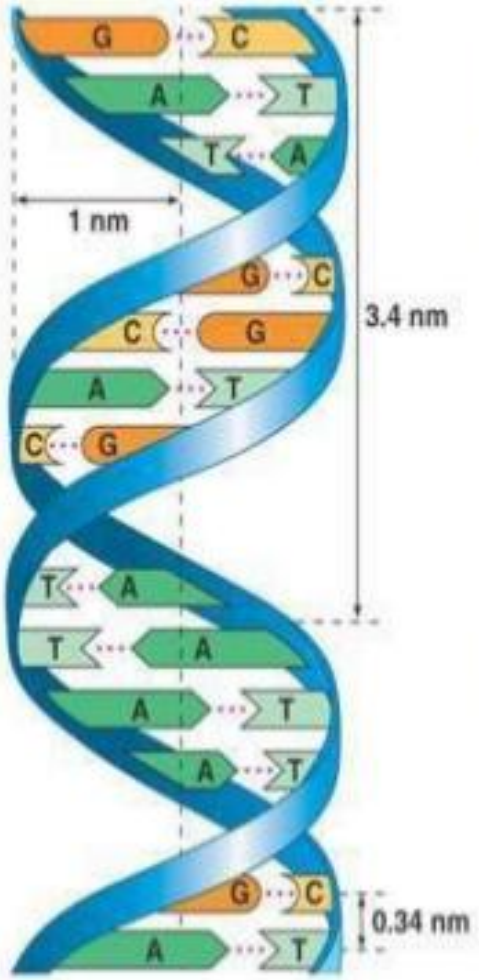


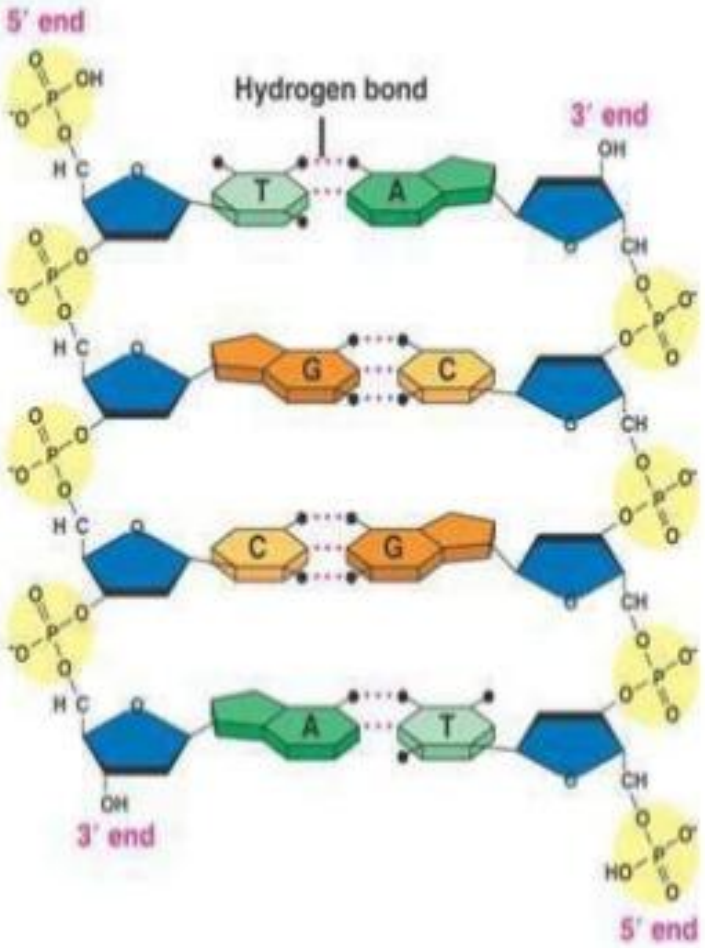
The secondary structure of DNA

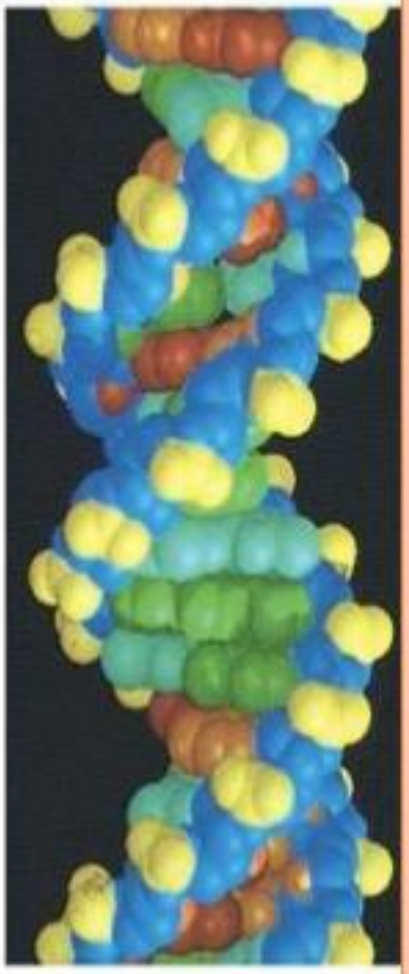
Two anti-parallel polynucleotide chains wound around the same axis.

Sugar-phosphate chains wrap around the periphery.

Bases (*A*, T, *C* and *G*) occupy the core, forming complementary *A* · T and *G* · *C* Watson-Crick base pairs.


1 nm
3.4 nm
0.34 nm


5' end
Hydrogen bond
3' end
3' end
5' end



FORMS OF DNA

A-DNA

- **A-DNA is one of the many possible double** helical structures of DNA.
- It is most active along with other forms.
- Helix has left-handed sense, shorter more compact helical structure.
- It occurs only in dehydrated samples of DNA, such as those used in crystallograph experiments.

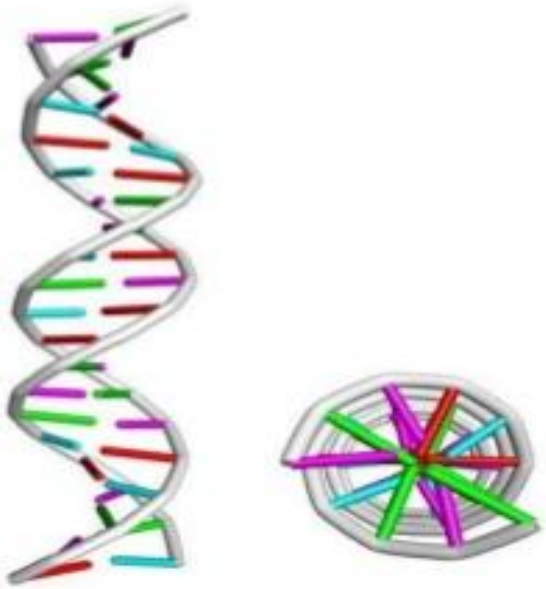
A-DNA

- **Structure**
- A-DNA is fairly similar to B-DNA.
- Slight increase in the number of bp/ rotation (resulting in a tighter rotation angle), and smaller rise/turn.
- deep major groove and a shallow minor groove.
- Favoured conformation at low water concentrations.
- In a solution with higher salt concentrations or with alcohol

added, the DNA structure may change to an **A form, which is** still right-handed, but every 2.3 nm makes a turn and there are 11 base pairs per turn.

B-DNA

- Most common DNA conformation in vivo.
- Favoured conformation at high water concentrations.
- Also known as Watson & Crick model of DNA.
- First identified in fibre at 92% relative humidity.

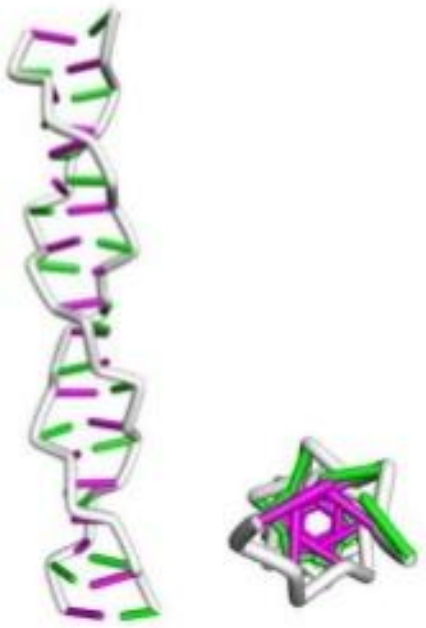


B-DNA

- Structure
- Narrower, more elongated helix than A.
- Wide major groove easily accessible to proteins & Narrow minor groove.
- Base pairs nearly perpendicular to helix axis One spiral is 3.4nm or 34Å.
- Distance between two H-bonds is 0.34nm or 3.4Å.

Z-DNA

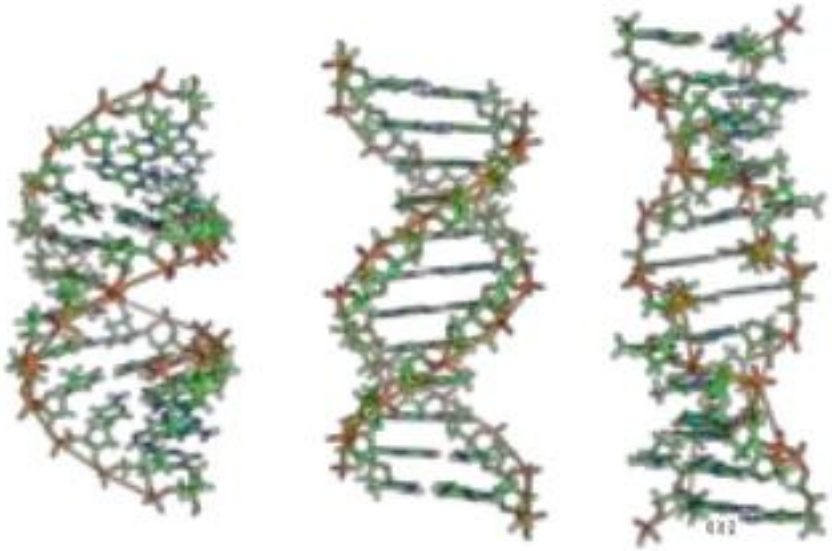
- **Z-DNA is one of the many possible** double helical structures of DNA.
- Helix has left-handed sense.
- It is most active double helical structure.
- Can be formed in vivo, given proper sequence and super helical tension, but function remains obscure.



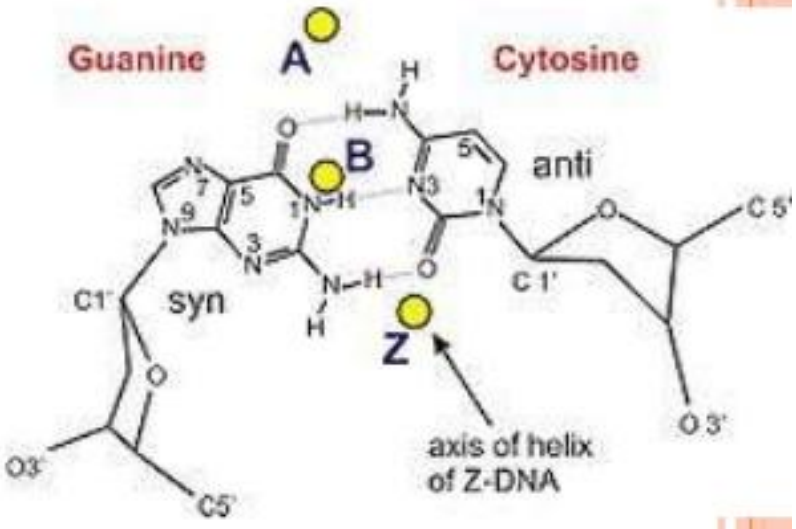
Z-DNA

Structural forms of DNA

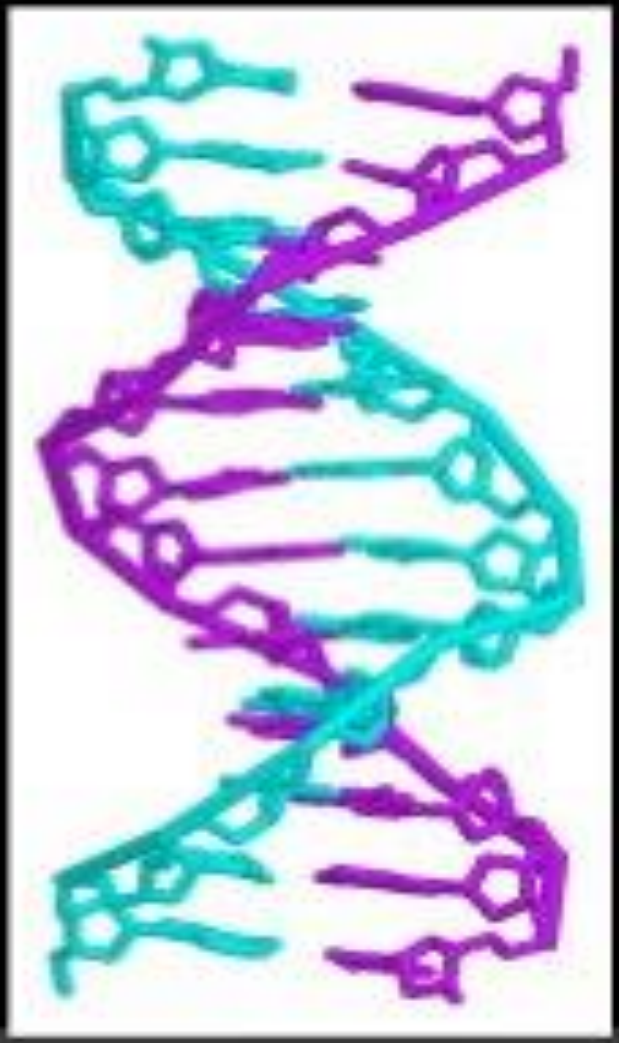
Property	A-DNA	B-DNA	Z-DNA
Helix Handedness	Right	Right	Left
Base Pairs per turn	11	10.4	12
Rise per base pair along axis	0.23nm	0.34nm	0.38nm
Pitch	2.46nm	3.40nm	4.56nm
Diameter	2.55nm	2.37nm	1.84nm
Conformation of Glycosidic bond	anti	anti	Alternating anti and syn
Major Groove	Present	Present	Absent



Side view of A-, B-, and Z-DNA.



The helix axis of A-, B-, and Z-DNA.



Base Stacking

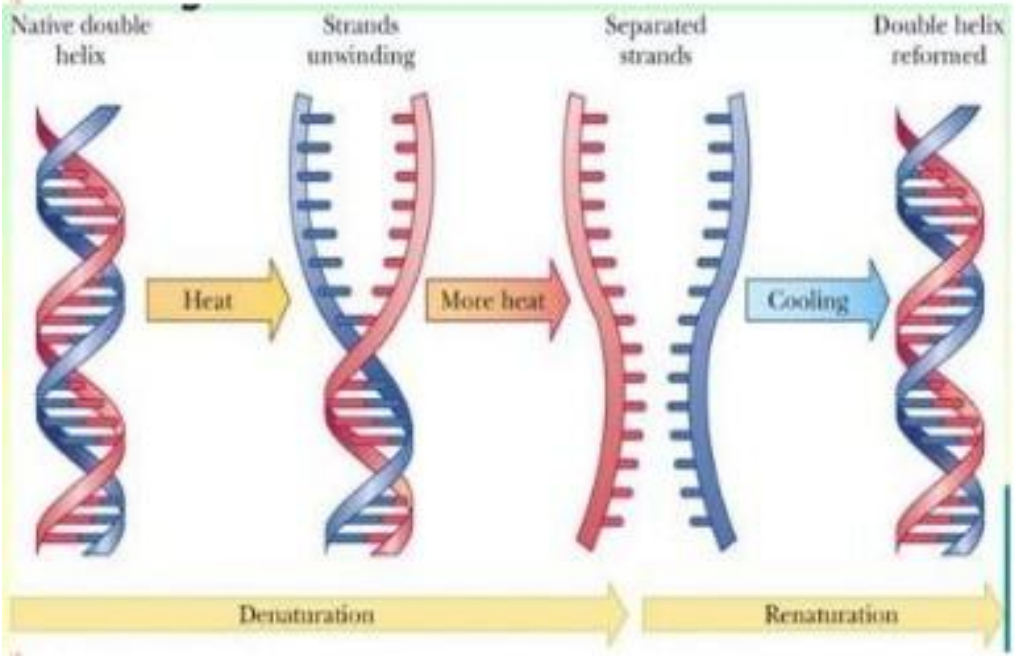
The bases in DNA are planar and have a tendency to "stack".

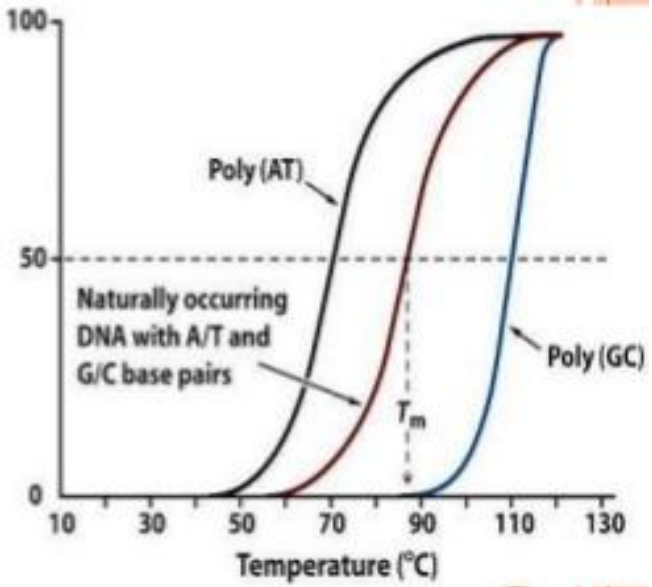
Major stacking forces:

- hydrophobic interaction
- van der Waals forces.

."DNA DENATURATION"

- DNA Denaturation is the separation of a double strand into two single strands, which occurs when the **hydrogen bonds** between the strands are broken.





Functions of DNA and summary of structure

DNA consists of four bases—A, G, C, and T—that are held in linear array by phosphodiester bonds through the 3' and 5' positions of adjacent deoxyribose moieties.

DNA is organized into two strands by the pairing of bases A to T and G to C on complementary strands. These strands form a double helix around a central axis.

The 3×10^9 base pairs of DNA in humans are organized into the haploid complement of 23 chromosomes.

DNA provides a template for its own replication and thus maintenance of the genotype and for the transcription of the roughly 30,000 human genes into a variety of RNA molecules.

Conclusion

- The secondary structure of DNA is important in many events in cellular life. Replication, transcription and regulation of expression of many genes depends on local differences or changes in DNA structure. Recombination which leads to rearrangement of genes takes advantage of the ability to form an unusual structure called a Holliday's structure. Also different kinds of mutations occur as a result of specific DNA structure.


THANK YOU