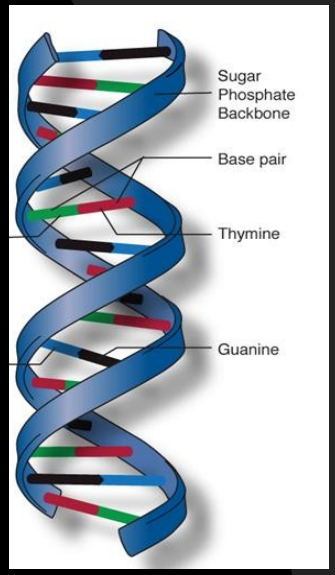
DNA Structure, Functions and Properties



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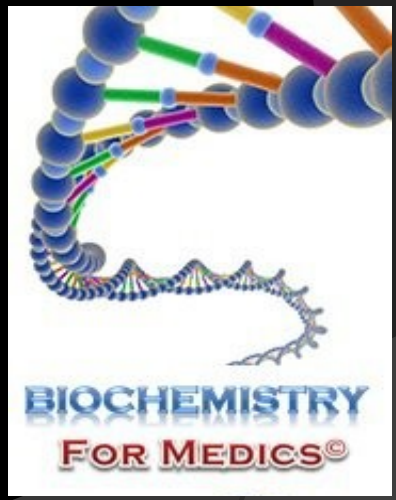
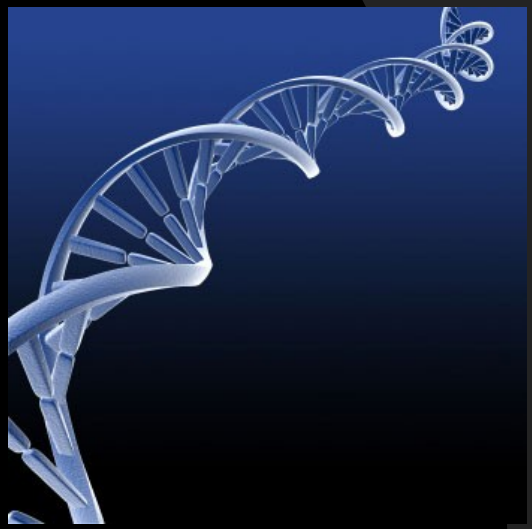


DNA



- DNA - a polymer of deoxyribo nucleotides
- found in chromosomes, mitochondria and chloroplasts
- carries the genetic information

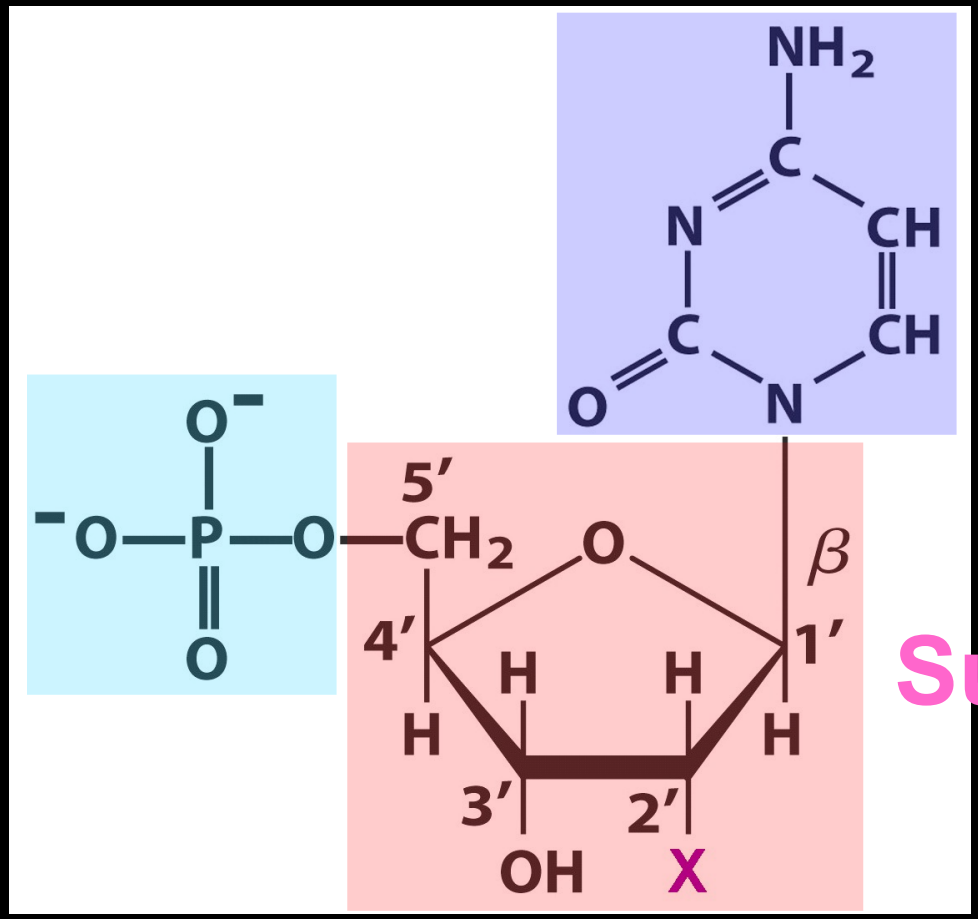
Components of a nucleotide

Base

Sugar

Phosphate

Phosphate



Base

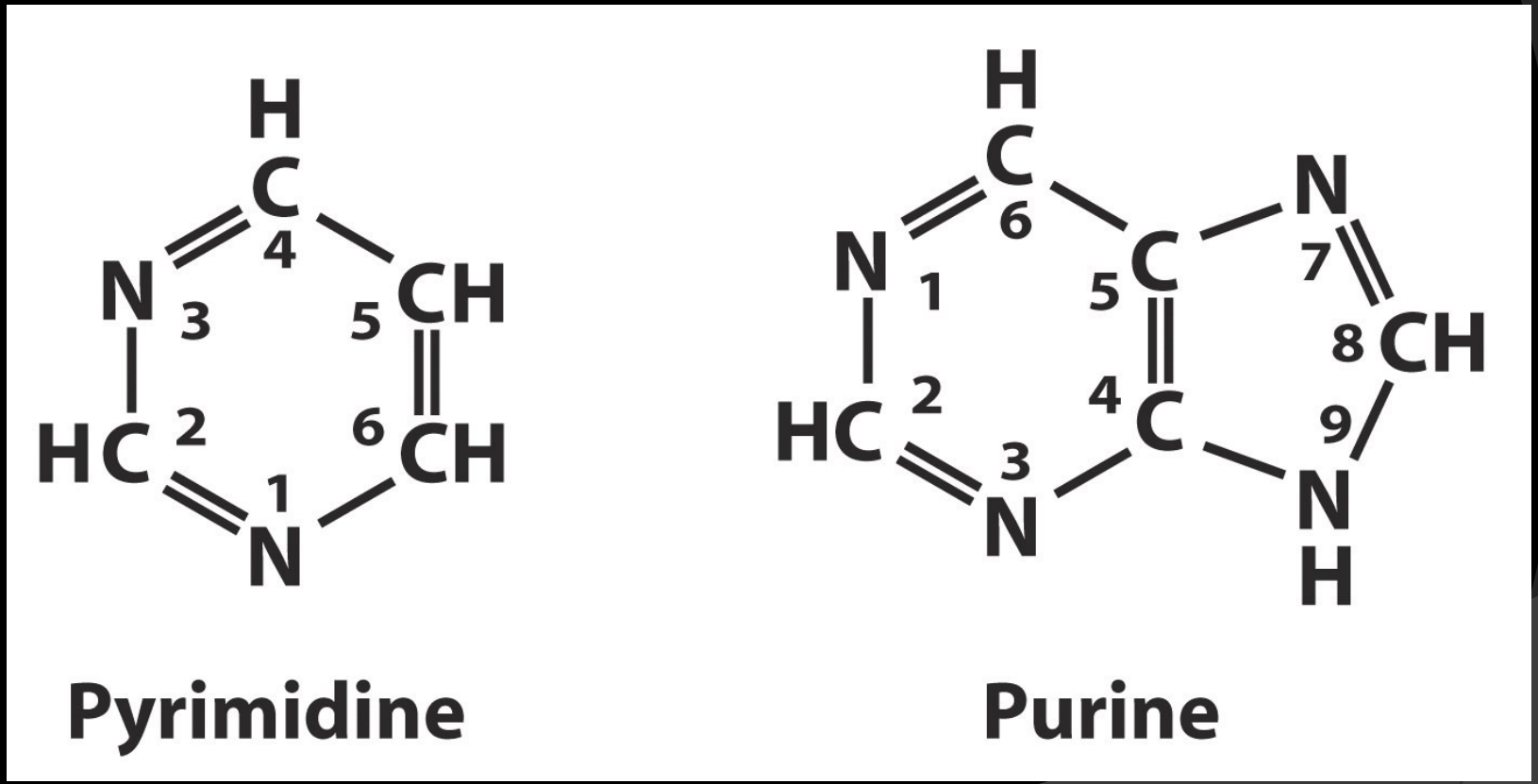
Sugar

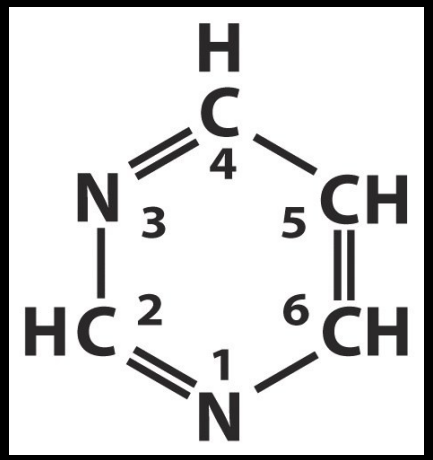
X=H: DNA
X=OH: RNA

Nucleoside

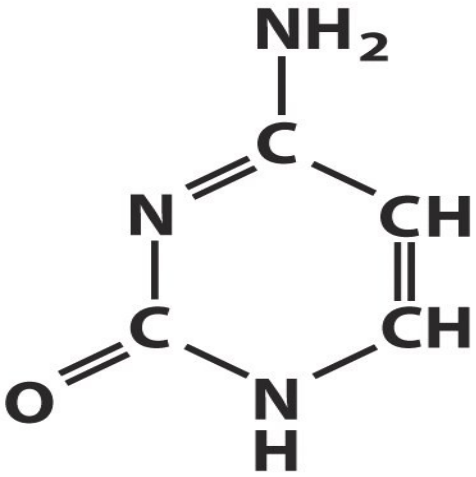
Nucleotide

Basic structure of pyrimidine and purine

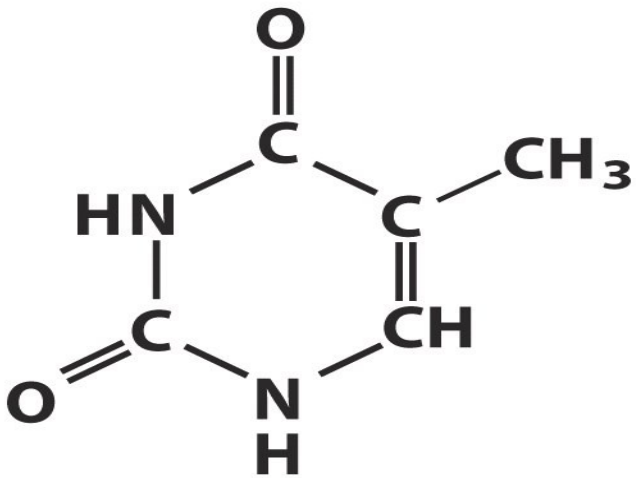




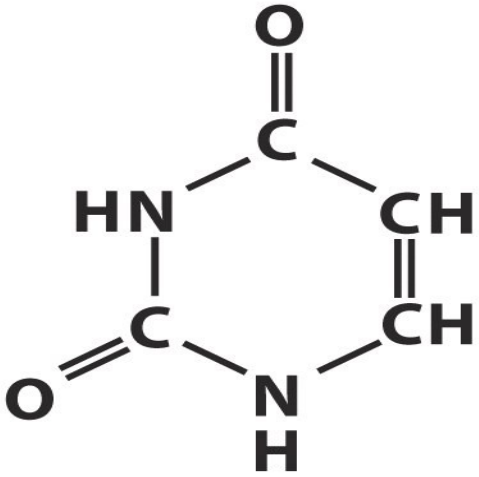
Pyrimidines



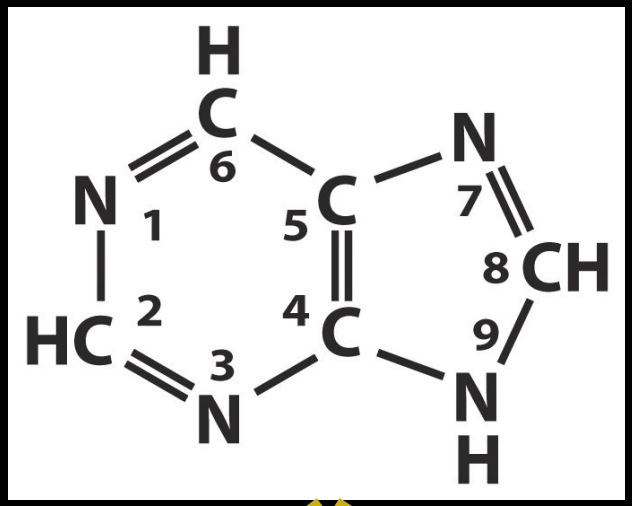
Cytosine



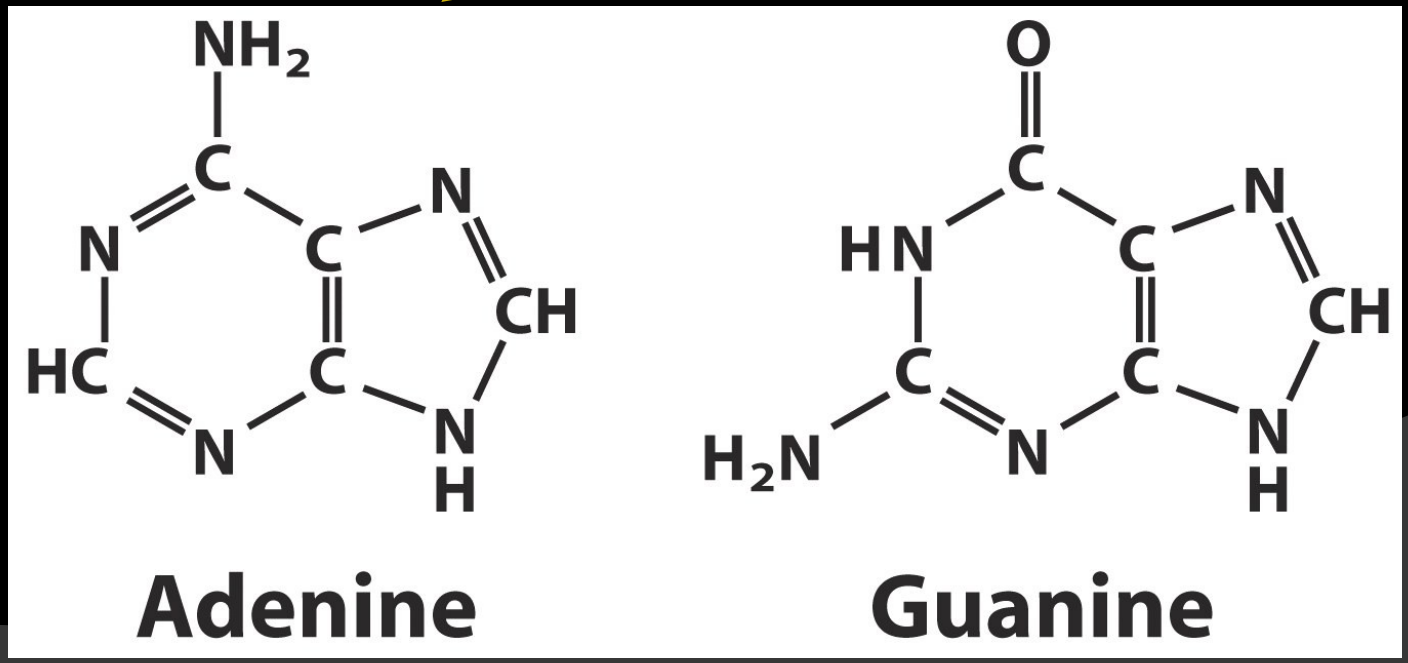
Thymine
(DNA)



Uracil
(RNA)



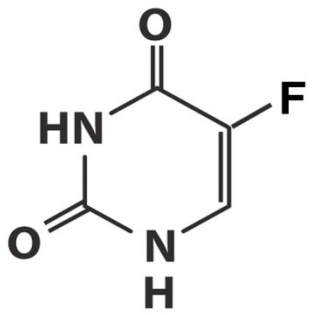
Purines



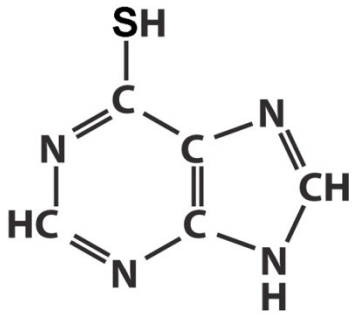
Nomenclature of Nucleic Acid Components

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

Nucleoside and base analogs can be used as anti-cancer and anti-virus drugs

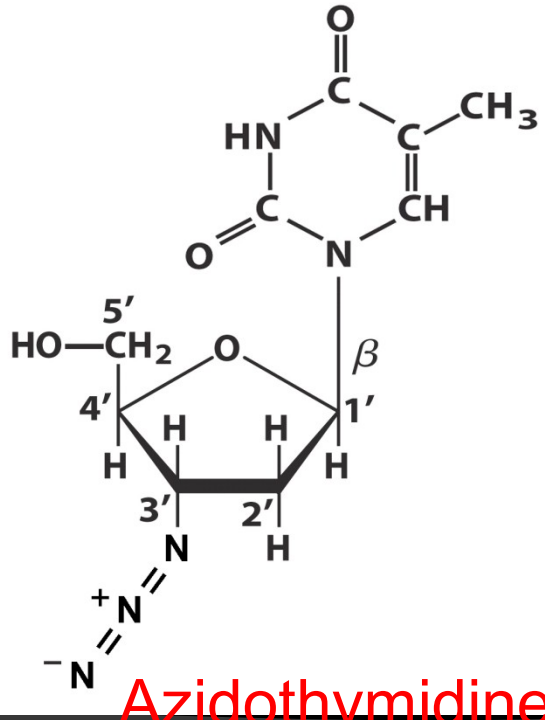


5-Fluorouracil

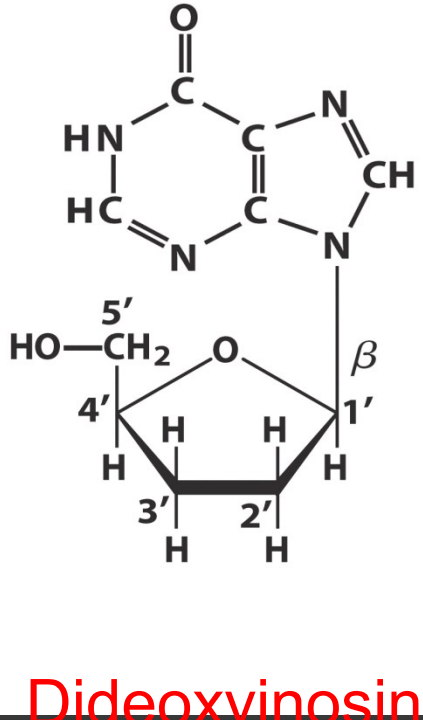


6-Mercaptopurine

Anticancer agents



Azidothymidine



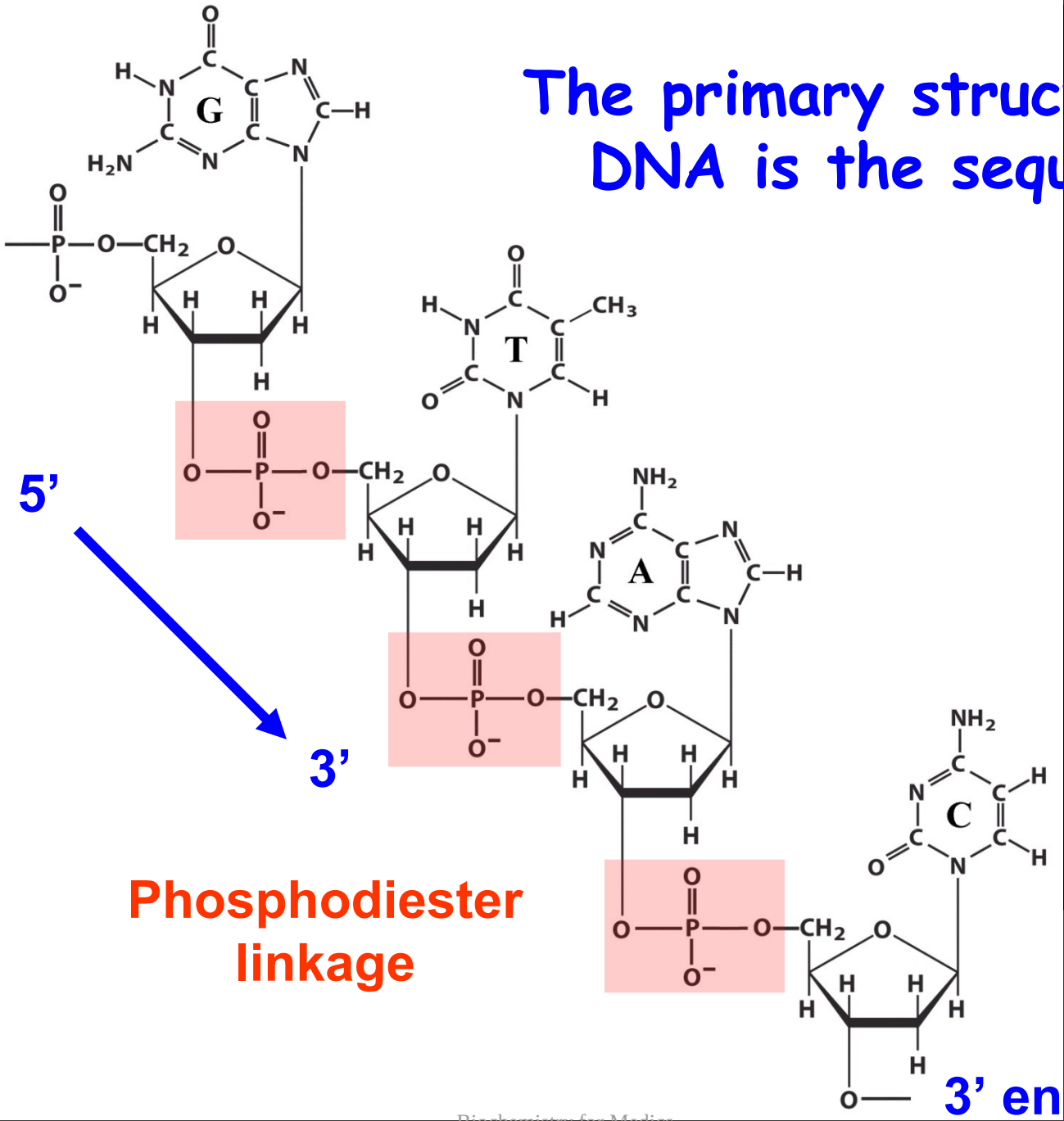
Dideoxyinosine

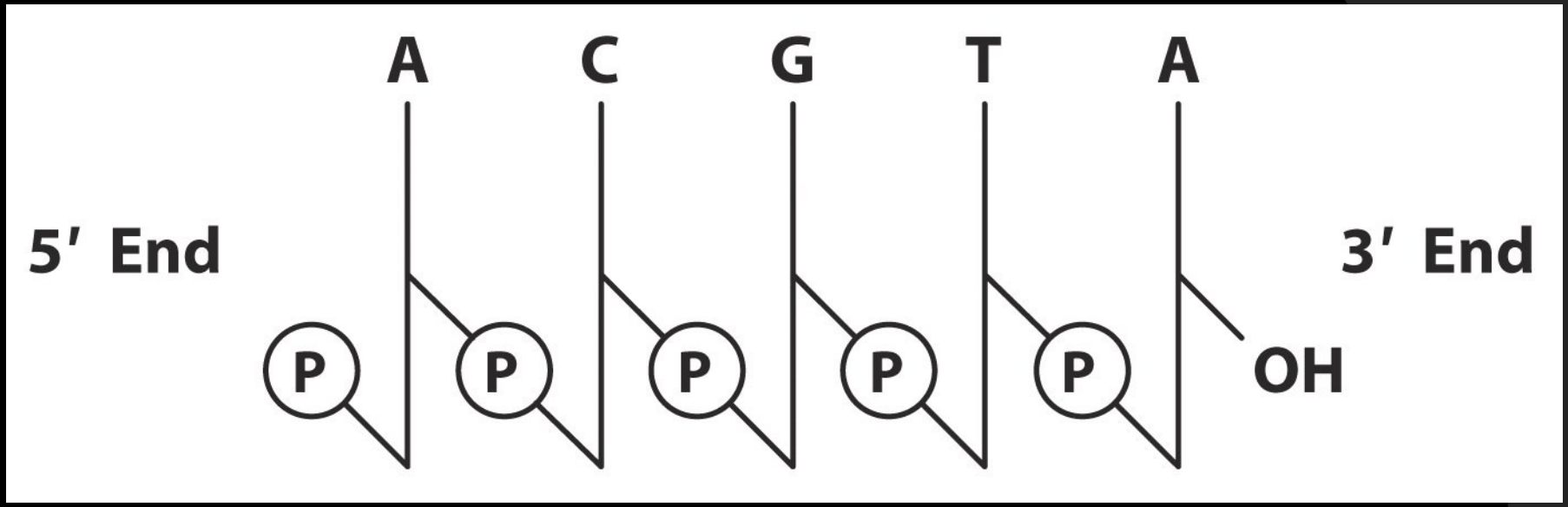
Antiretroviral agents

DNA structure

The primary structure of DNA is the sequence

5’ end

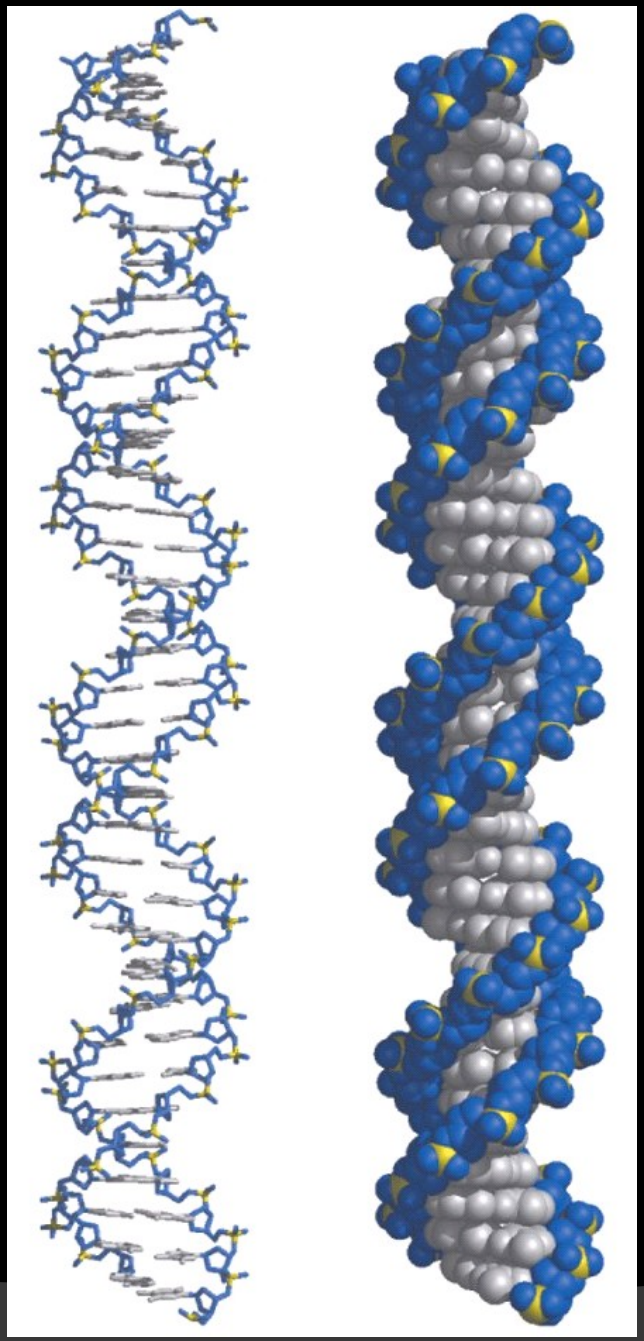




Traditionally, a DNA sequence is drawn from 5′ to 3′ end.

A shorthand notation for this sequence is ACGTA

The secondary structure of DNA is the double helix



The secondary structure of DNA

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

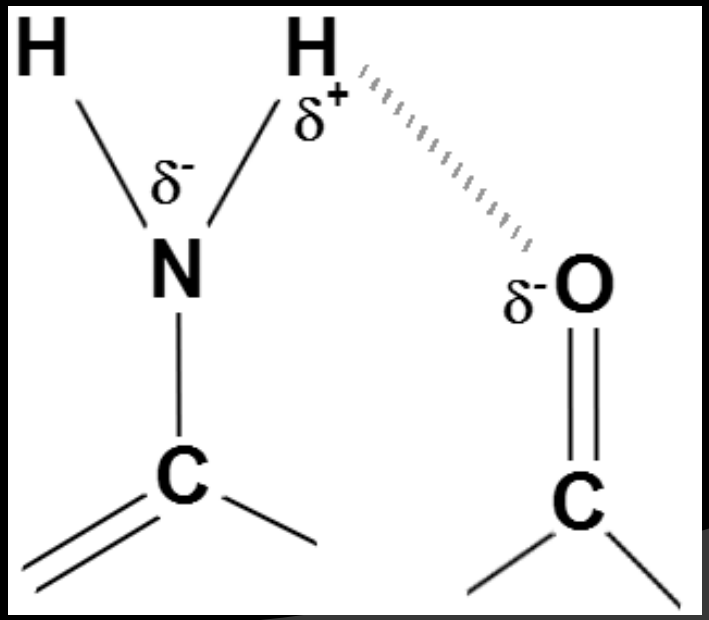
Sugar-phosphate chains wrap around the periphery.

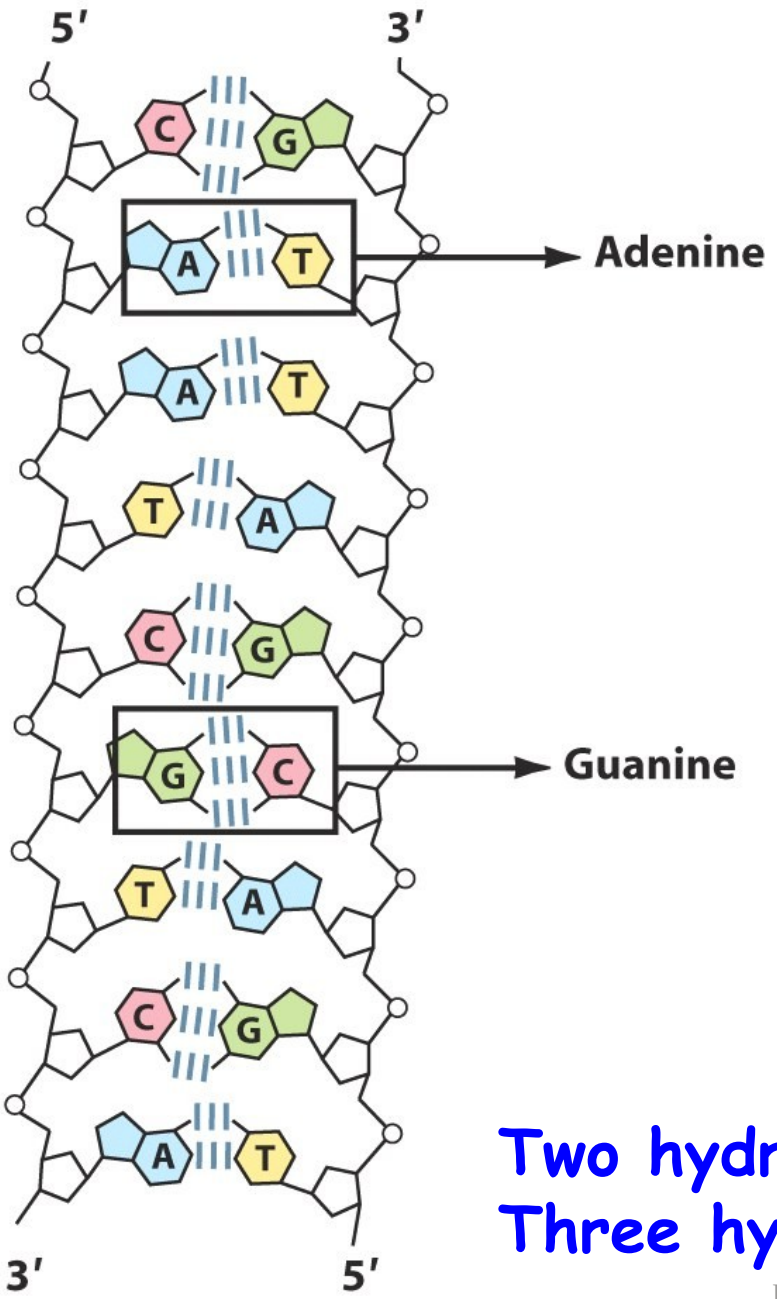
Bases (A, T, C and G) occupy the core, forming complementary A · T and G ·C Watson-Crick base pairs.

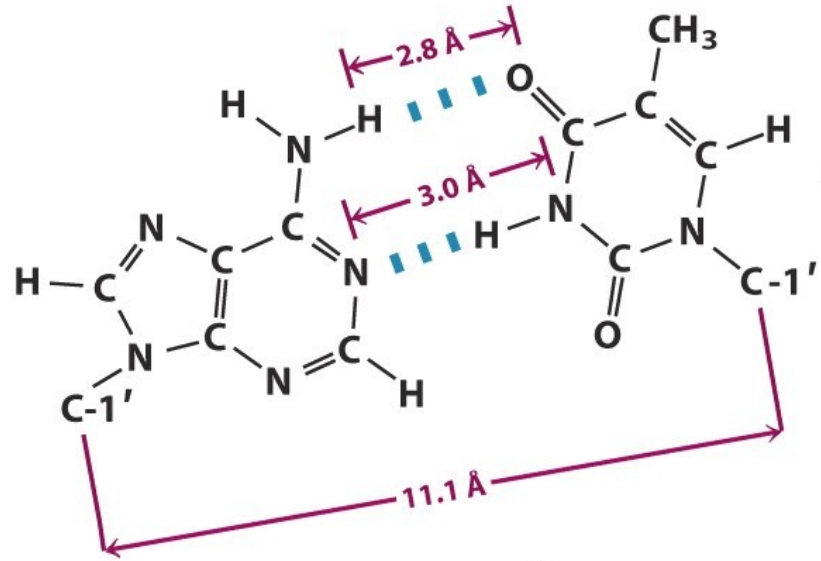
The DNA double helix is held together mainly by- Hydrogen bonds

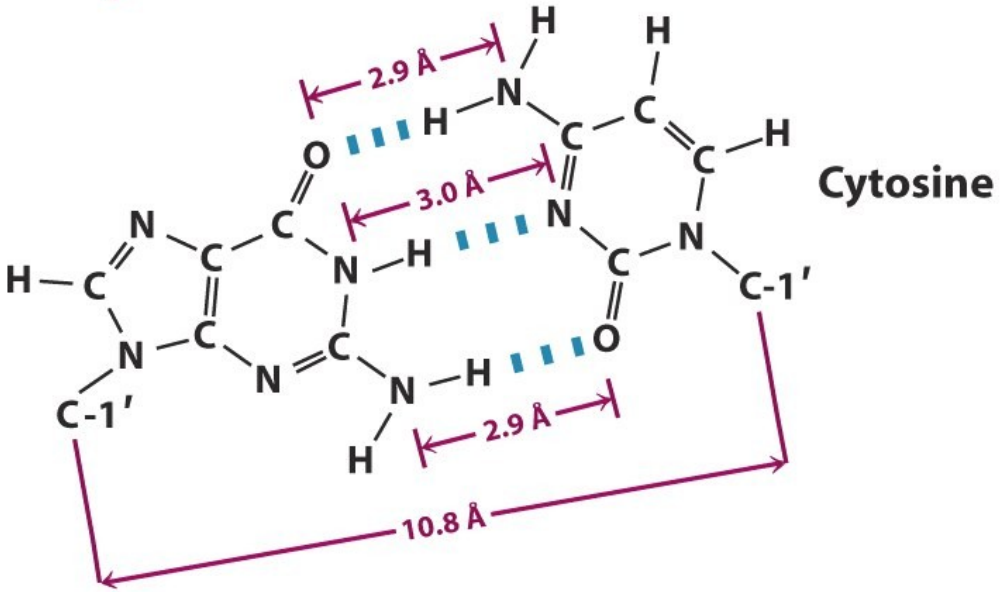
Hydrogen bond

a chemical bond in which a hydrogen atom of one molecule is attracted to an electronegative atom, especially a nitrogen, oxygen, or fluorine atom, usually of another molecule.

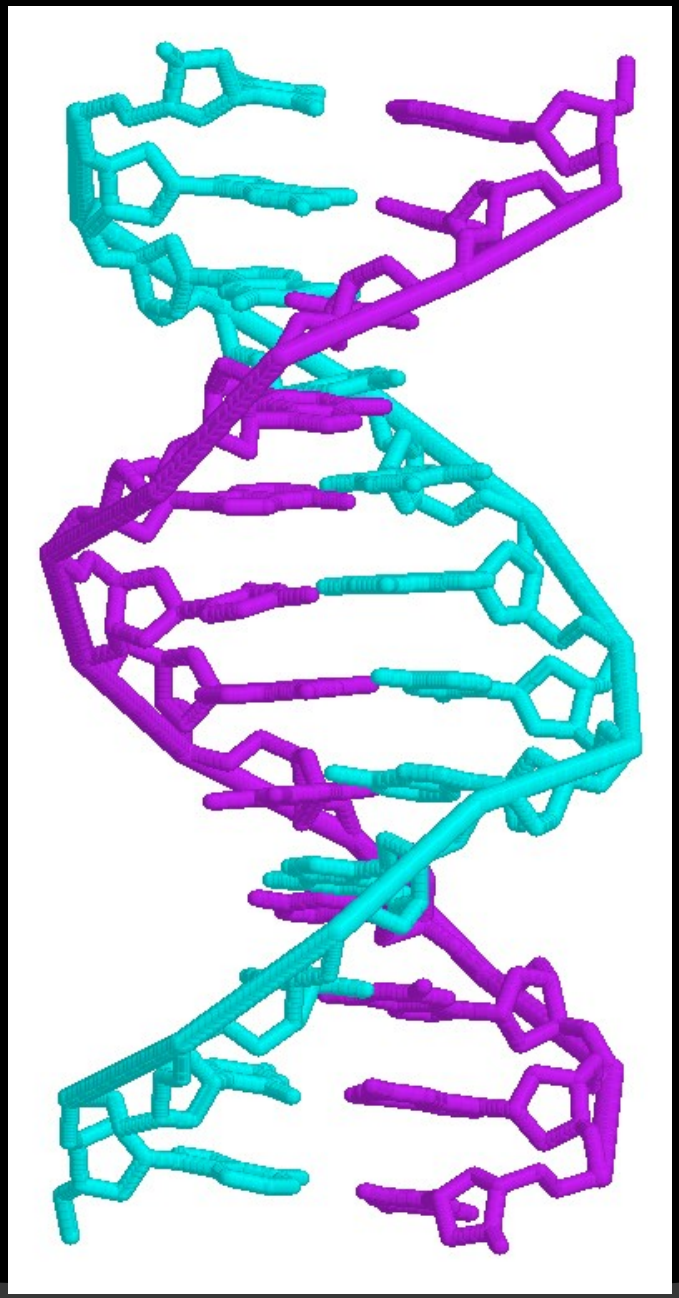








Two hydrogen bonds between A:T pairs
Three hydrogen bonds between C: G paired



Base Stacking

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

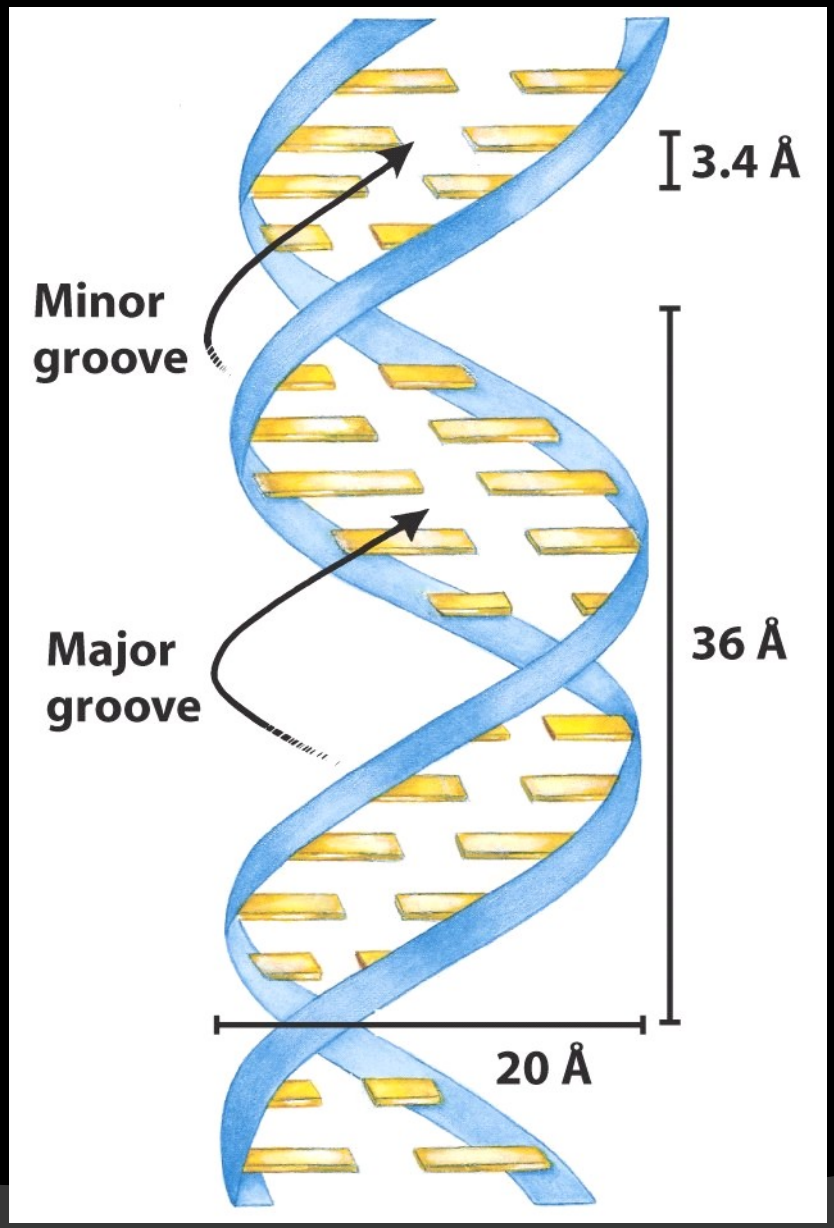
Major stacking forces:

- hydrophobic interaction
- van der Waals forces.

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

Normally hydrated DNA: B-form DNA



Helical sense: right handed

Base pairs: almost perpendicular to the helix axis; 3.4 Å apart

One turn of the helix: 36 Å; ~10.4 base pairs

Minor groove: 12 Å across

Major groove: 22 Å across

In eukaryotic cells,

DNA is folded into chromatin

DNA Tertiary Structure

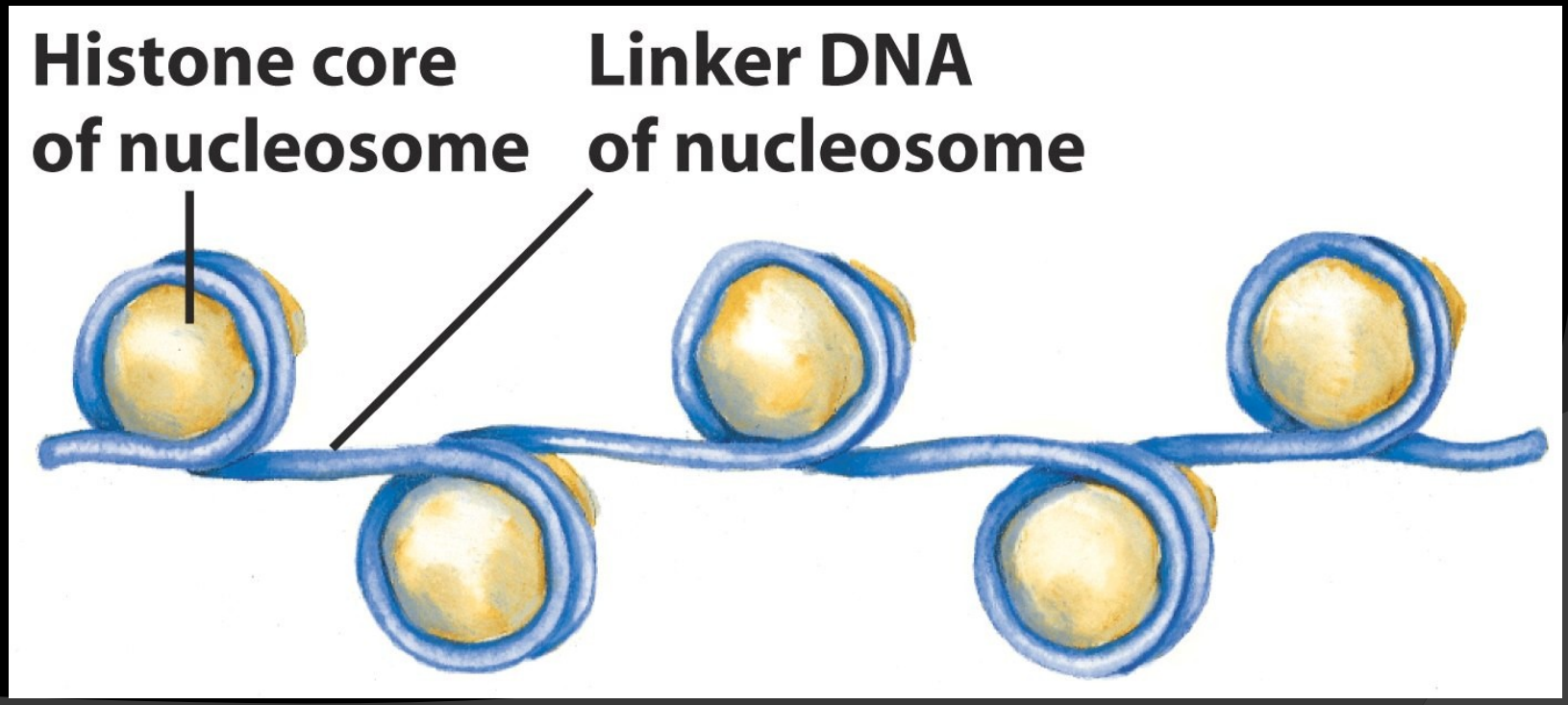
- DNA DOUBLE HELICAL STRUCTURE COILS ROUND HISTONES.
- DNA BOUND TO HISTONES FORMS

NUCLEOSOMES (10nm FIBRES)

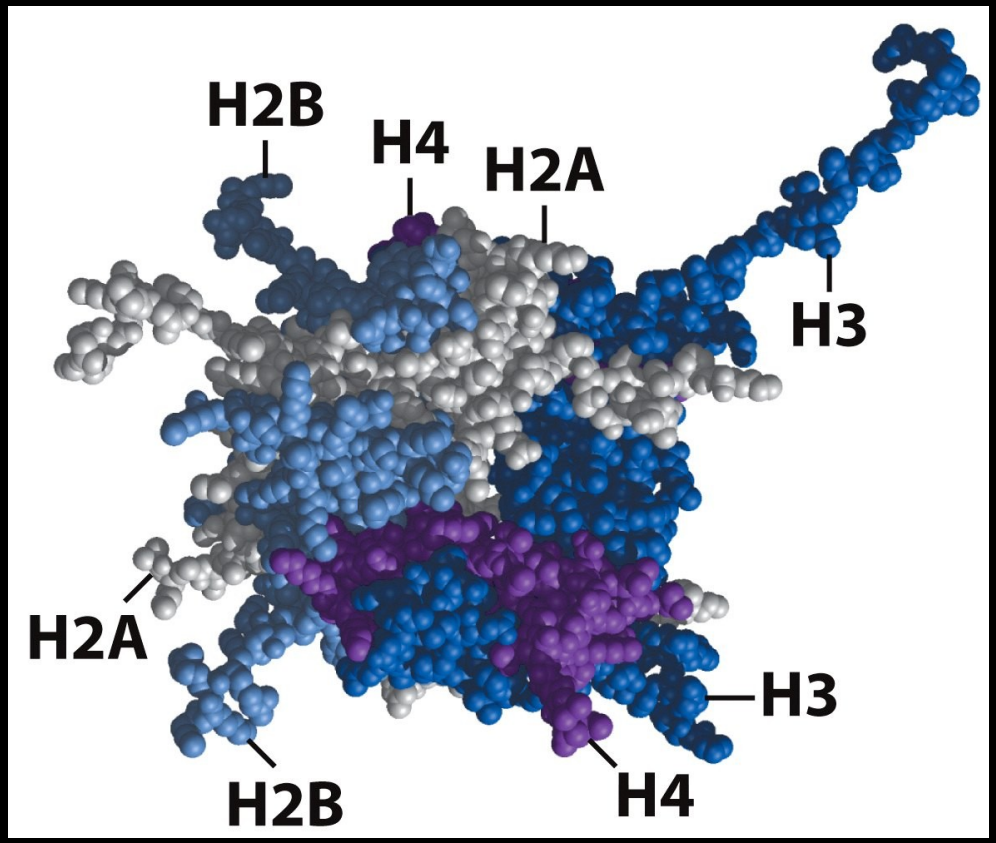
- NUCLEOSOMES CONTAIN 146 NUCLEOTIDES

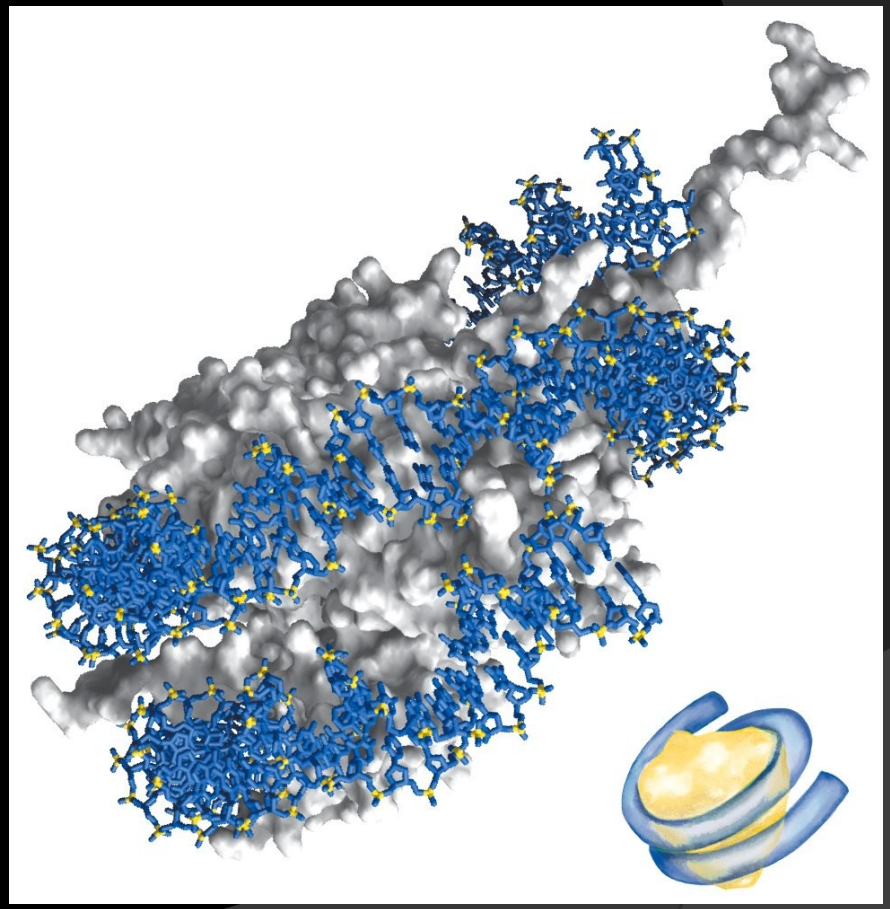
Nucleosomes

any of the repeating globular subunits of chromatin that consist of a complex of DNA and histone

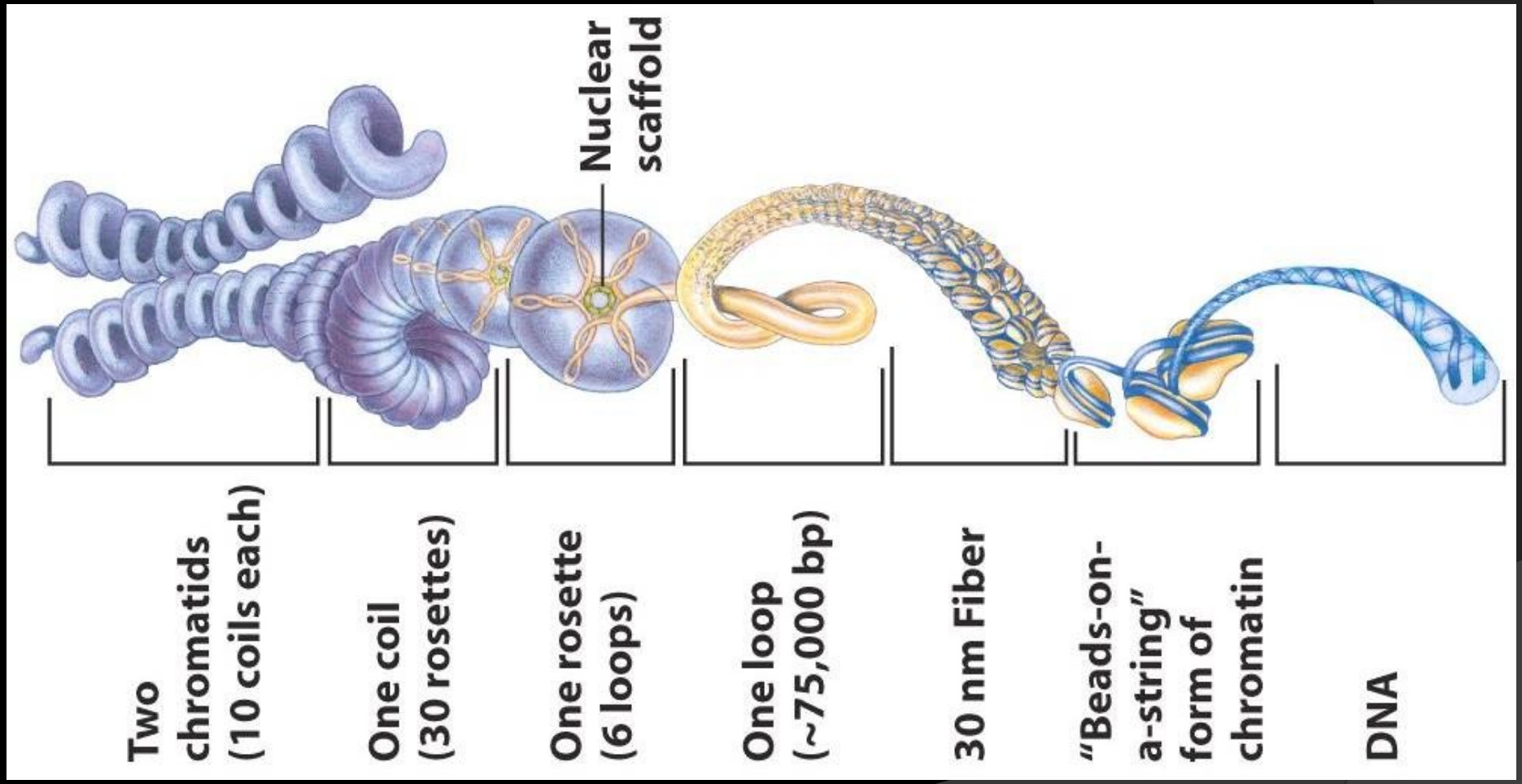


Structure of nucleosome core

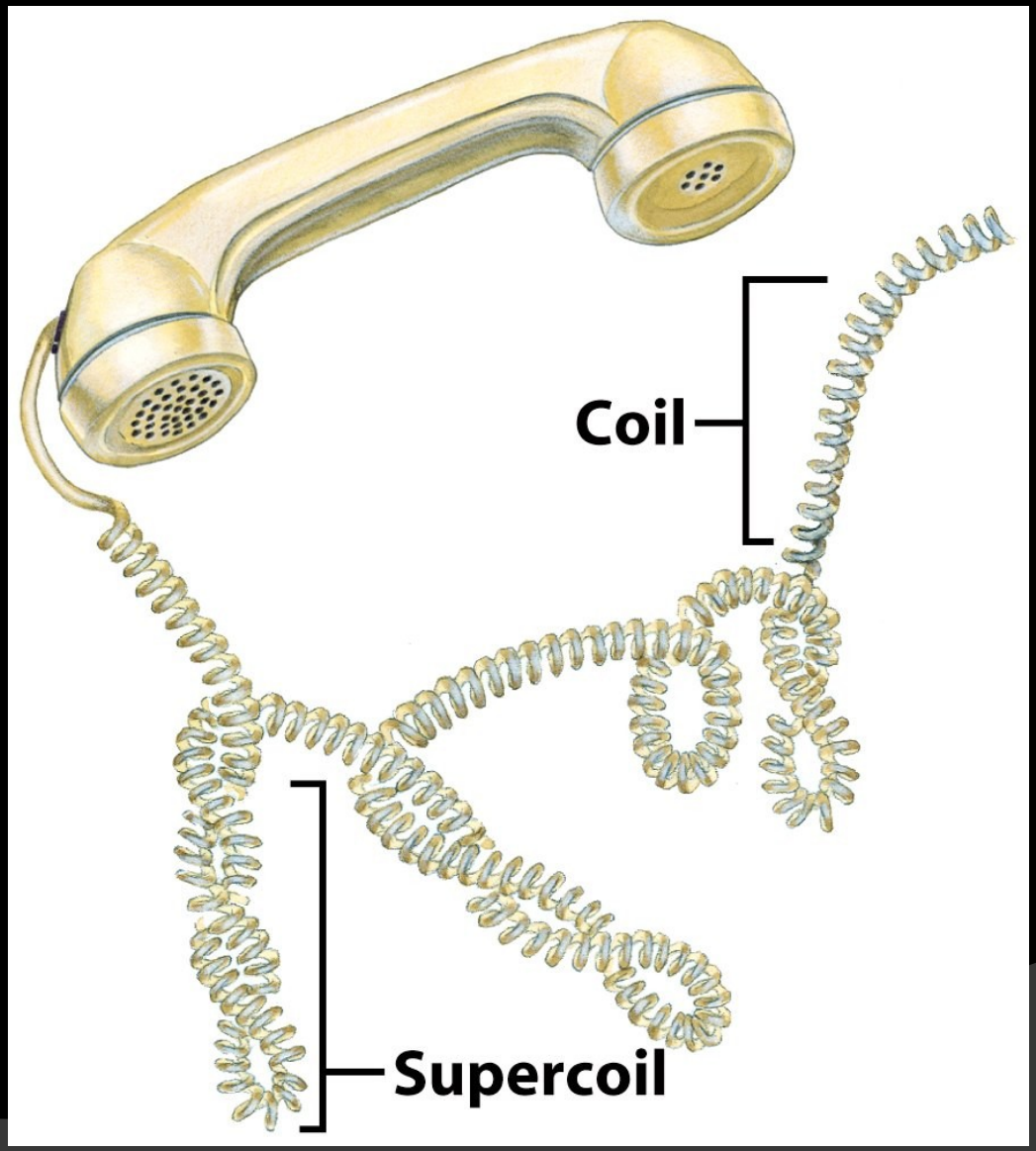




Compaction of DNA in a eukaryotic chromosome

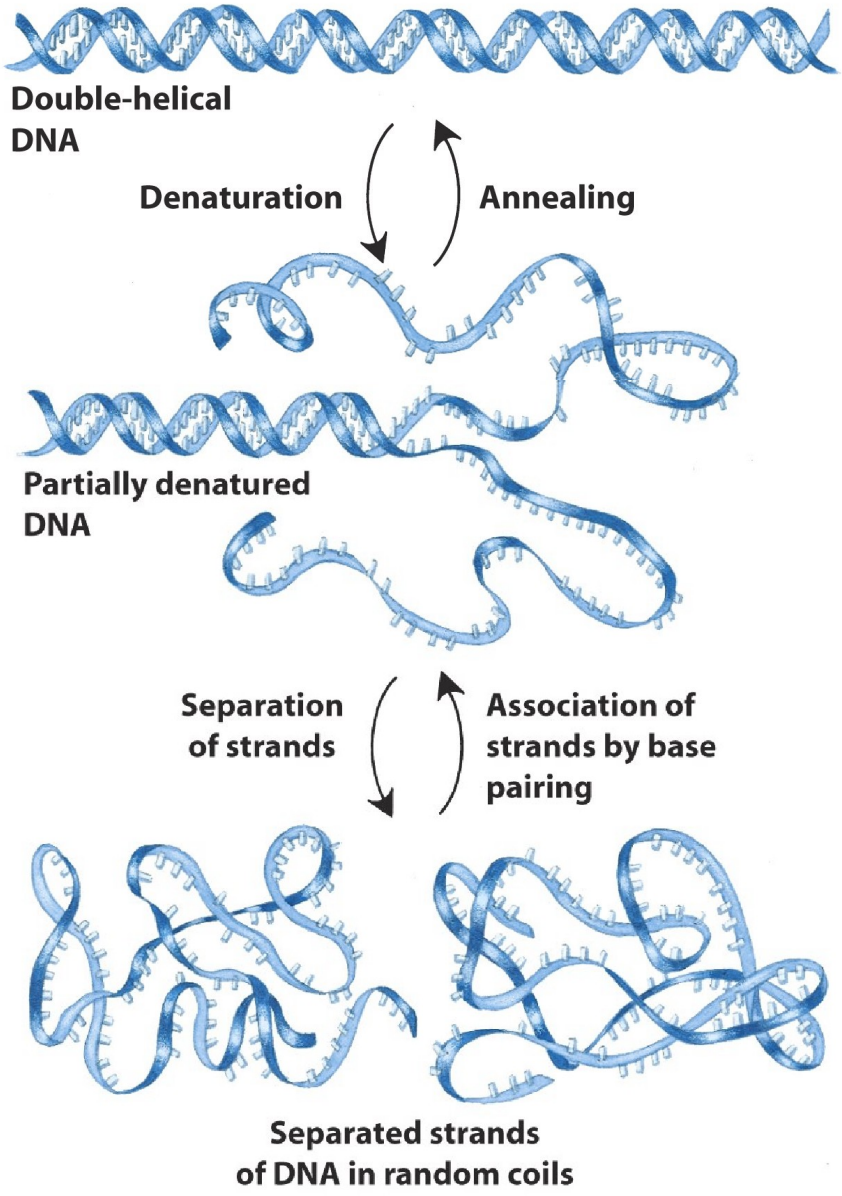


Supercoil = coil over coil



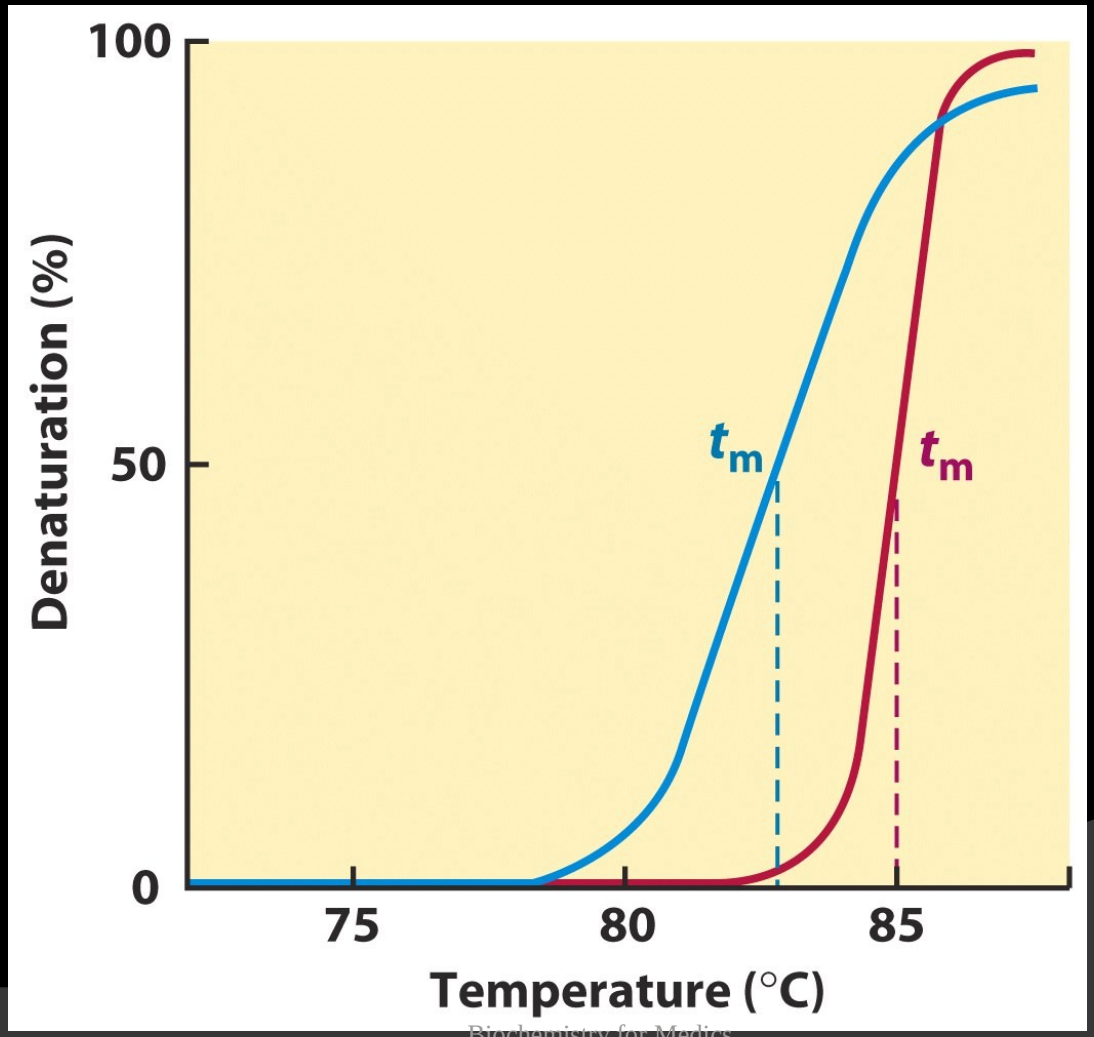
DNA melting and annealing

Reversible denaturation and annealing of DNA



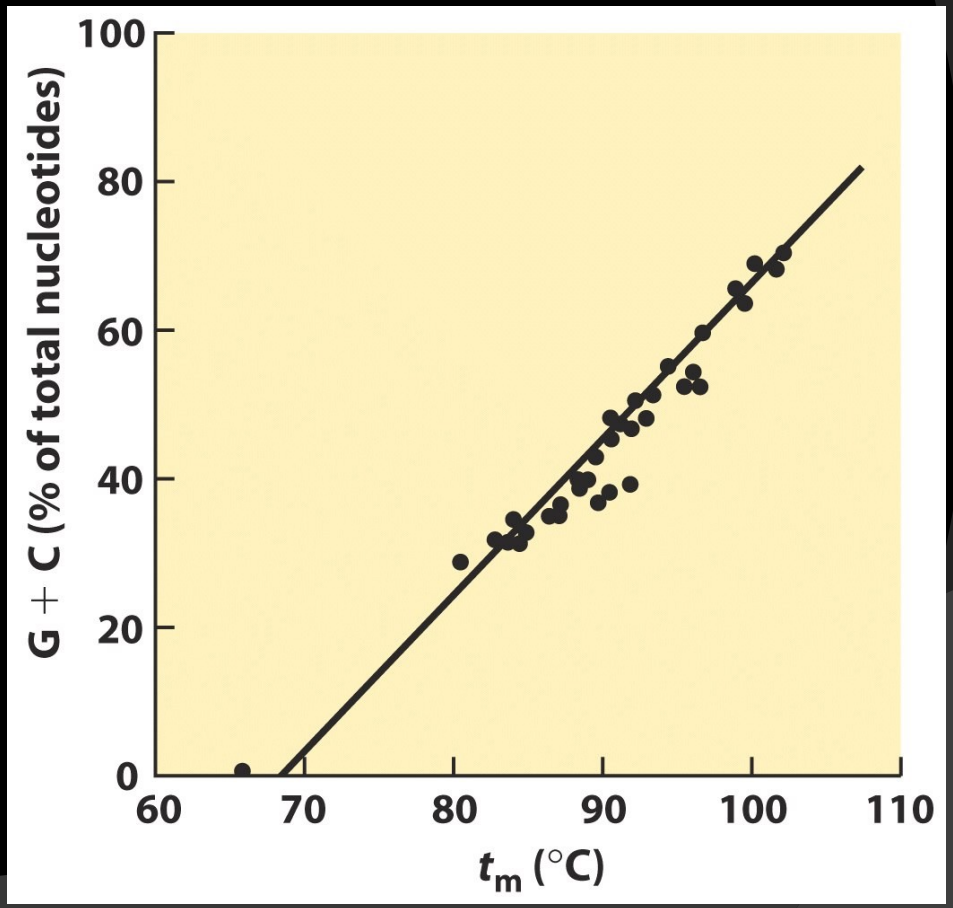
Melting point (t_m) of DNA

The temperature at the mid-point of the transition



The t_m of DNA depends on:

- Content of G·C base pairs
- size of DNA
- pH
- ionic strength



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.