Athar Batch

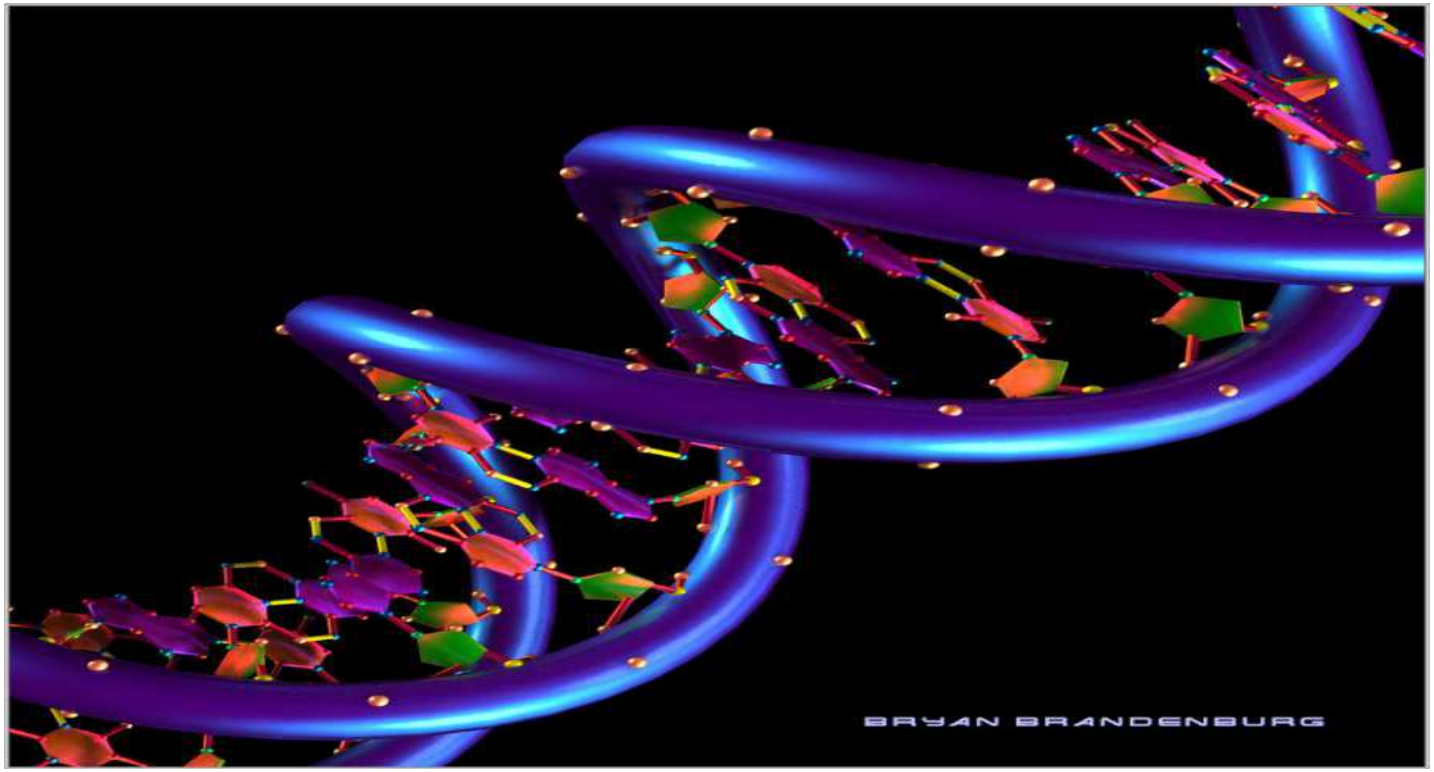
Genetics

Lecture: 1

Done By : Toleen Alkasaji

النادي الطبي

DNA Structure



By
Dr. Walaa Bayoumie El Gazzar

Nucleic acids

- **Polymer of nucleotides.**
- **Two main types:**

Deoxyribonucleic Acid

DNA

Ribonucleic Acid

RNA

Proteins Have Many Structures Like The:
Primary Structure,Secondary Structure,Tertiary Structure And Quaternary Structure.

1.Primary Structure:
-The Number Of The Amino Acids In It.
-The Arrangement Of Those Amino Acids.

any slight change in the arrangement of the amino acids, then a different protein will be produced that can't do the main function (abnormal protein with abnormal function).

- **All cellular functions depend on proteins which consist of chains of amino acids.**

- **The precise arrangement of these amino acids necessitates certain guiding information.**

- **Such information is provided by DNA which can convey information through a group of RNA.**

1.The Proteins In The Cells Are Enzymes And Enter In The Structure Of The Cell Membranes And Function As Receptors For The Cells.

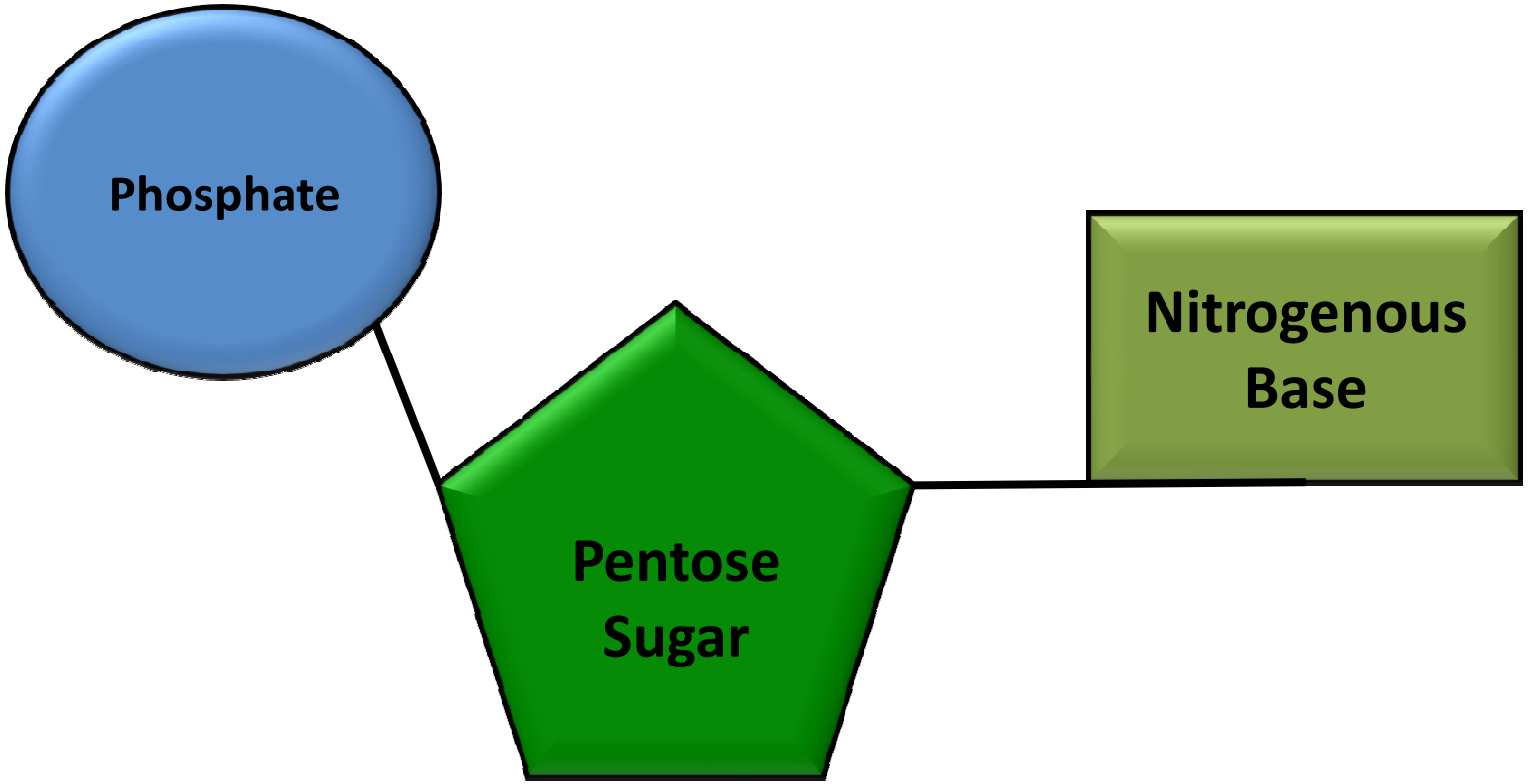
2.The Sequence Of The Nucleotides In The DNA Is Responsible For The Amino Acids That Make Up The Proteins.

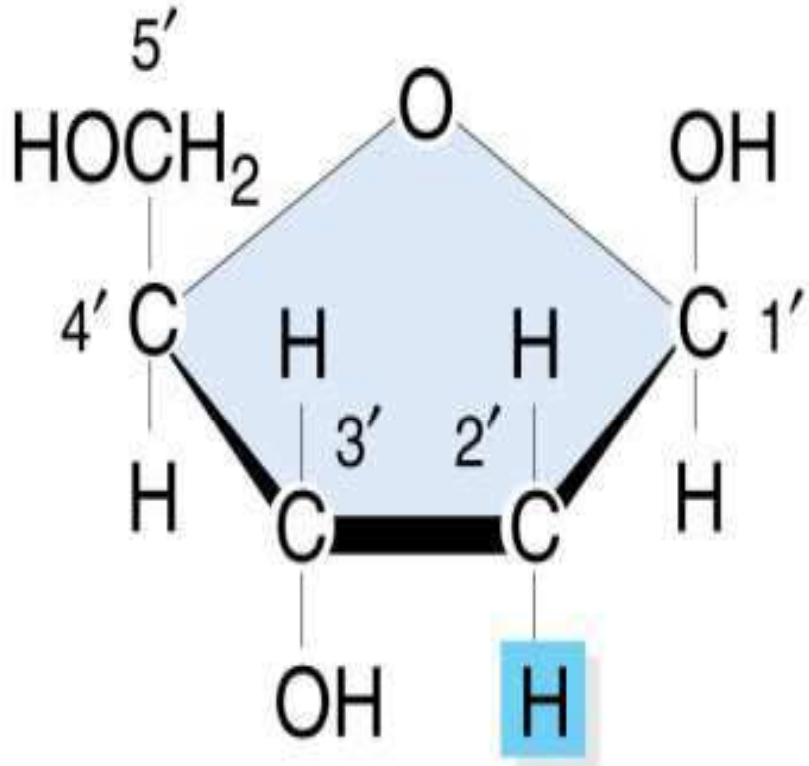
يعني لازم ترتيب الـNucleotides الموجود على الـDNA لازم يكون صحيح ليعطيني ترتيب Amino Acids صحيح لحتى أعمل البروتين المطلوب و اللازم.

3.The DNA Must Make Messengers First In Order To Produce A Protein, And The Translation Of Those Messengers Gives Us The Required Protein.

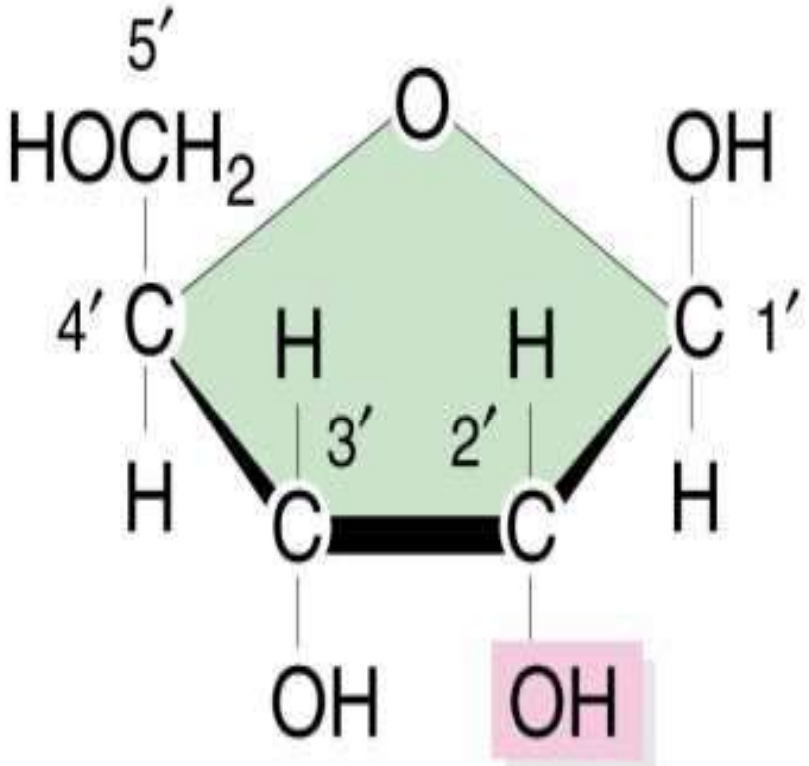
هذا الـDNA بوصل المعلومات تاعته عن طريق الـRNA لأماكن محددة في الخلية ليتمّ ترجمتها و صنع بروتينات.

Nucleotides

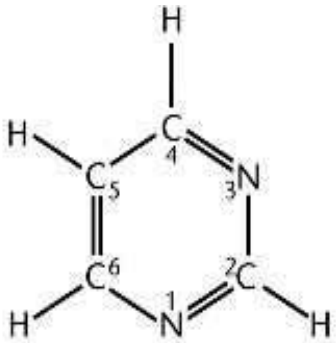




Deoxyribose

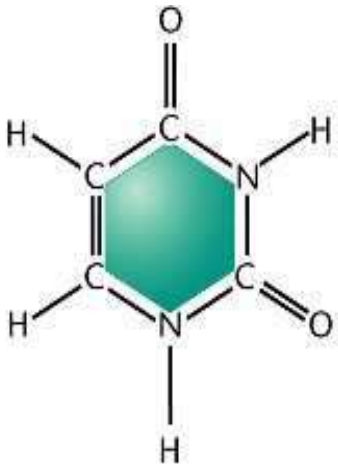


Ribose



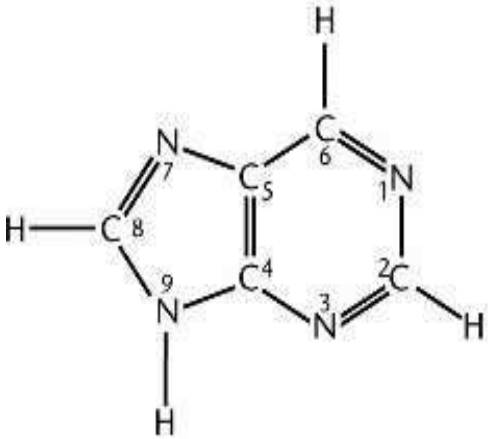
Pyrimidine ring

Cytosine

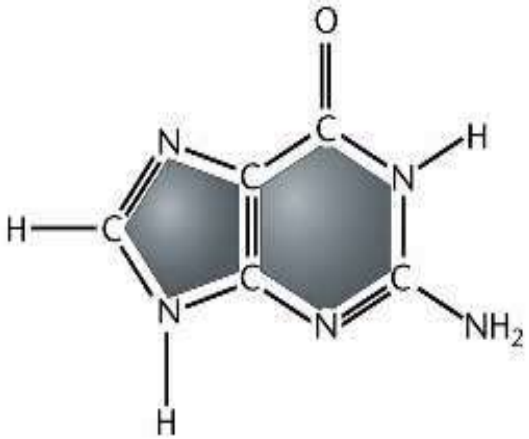


Uracil

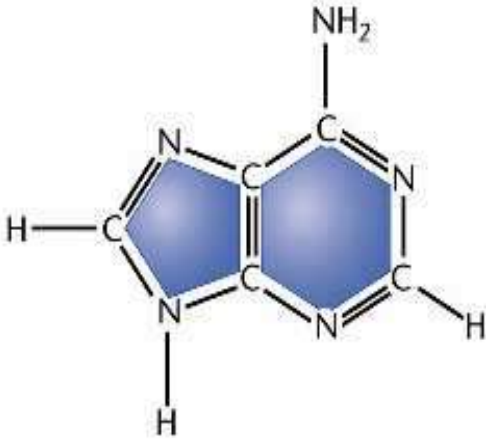
Thymine



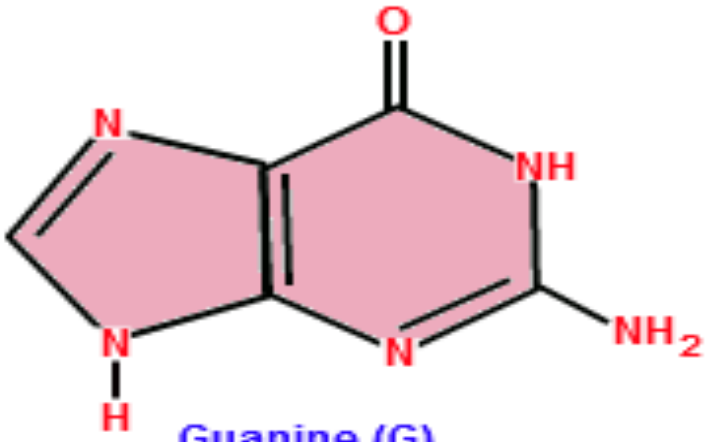
Purine ring



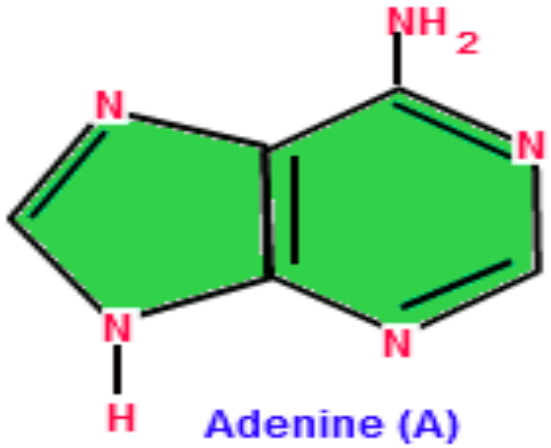
Guanine



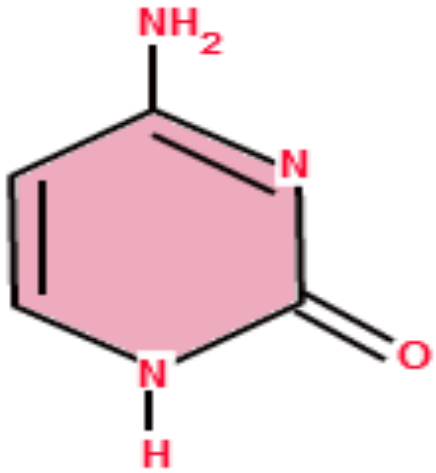
Adenine



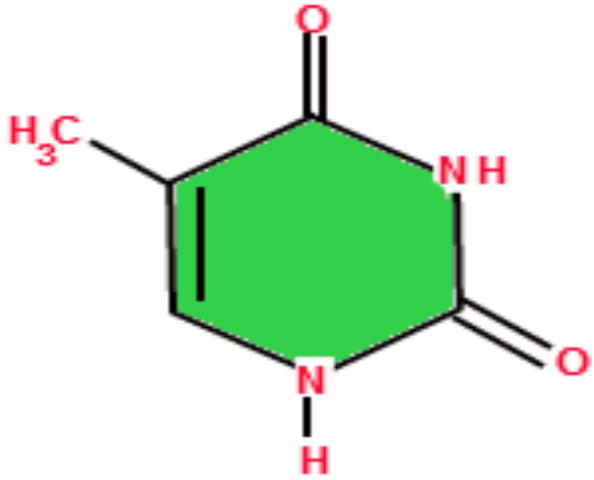
Guanine (G)



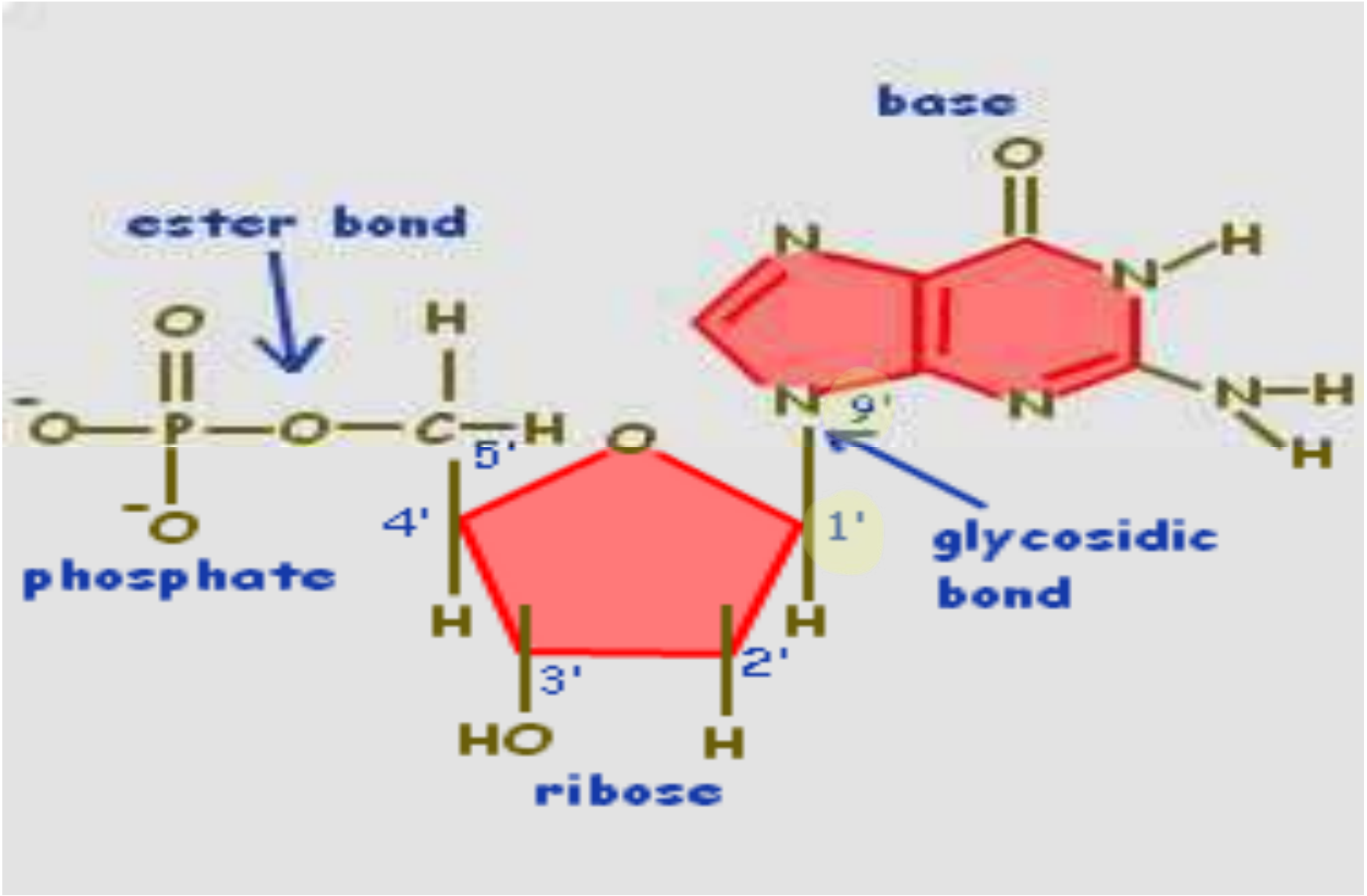
Adenine (A)



Cytosine (C)



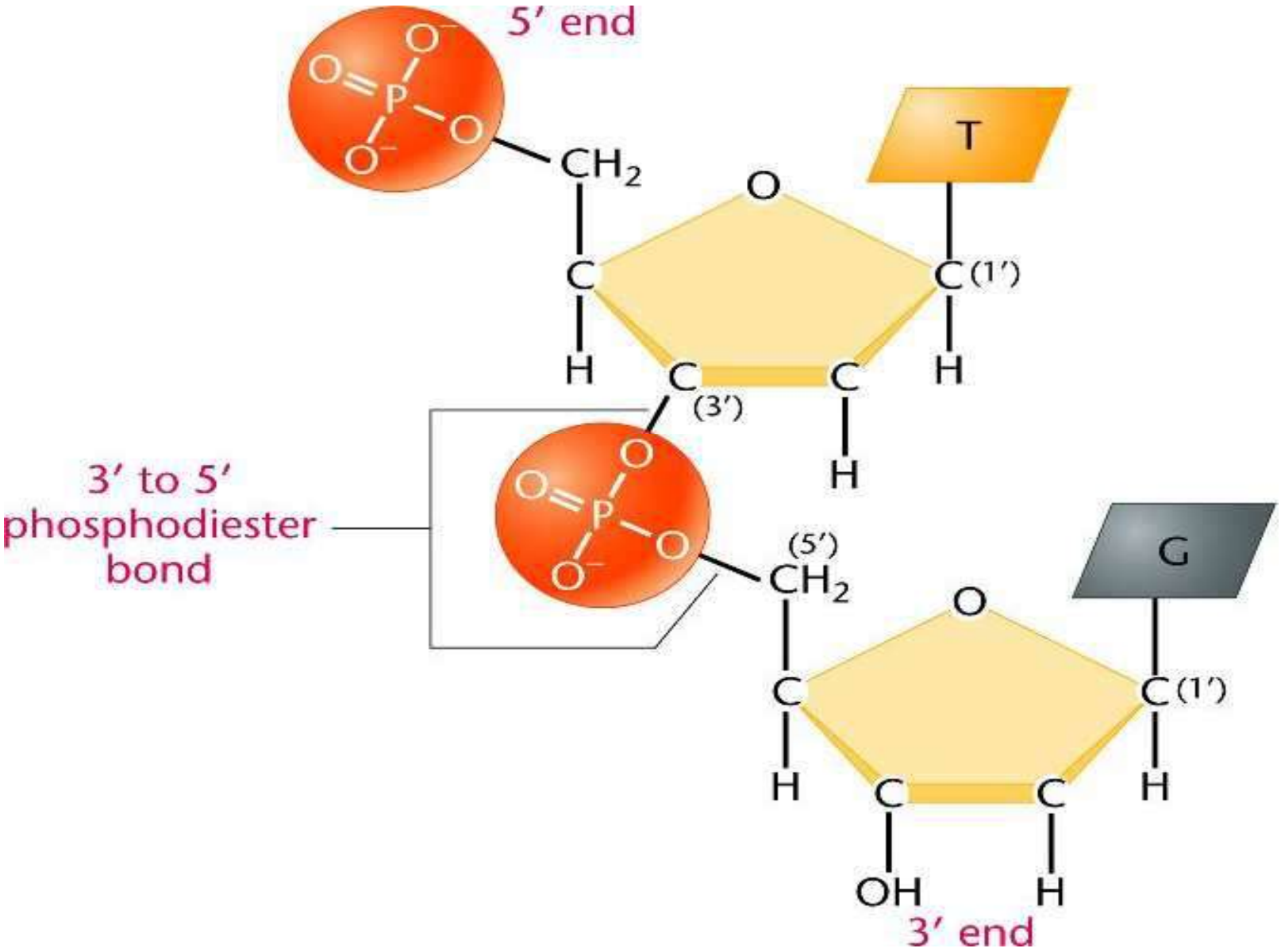
Thymine (T)


base
ester bond
phosphate
glycosidic bond
ribose
5'
4'
1'
9'
3'
2'

1.Notice That The Phosphate Group Has Negative Charges And This Negativity Will Affect Some Functions That Will Be Discussed Later On.

2.The Phosphate Will Attach To The Ribose Through An Ester Bond,This Bond Occurs Between Acids (Phosphate) And Alcohol (Ribose) By The Removal Of H2O Molecule.

3.The Ribose Will Attach To The Ribose Through A Glycosidic Bond, This Bond Occurs Between The Carbon Number 1 From The Ribose And The Nitrogen Number 9 In The Nitrogenous Purine Base.


5′ end
T
G
3′ to 5′
phosphodiester
bond
3′ end

How Does A Nucleotide Attach To Other Nucleotide?
The Phosphate Group From One Nucleotide Will Make An Easter Bond With Carbon Number 3 Of The Ribose From The Other Nucleotide, Thus We'll Have A Di-Ester Bond:
-The Phosphate With The Ribose In The Same Nucleotide.
-The Phosphate With The Ribose In The Other Nucleotide.

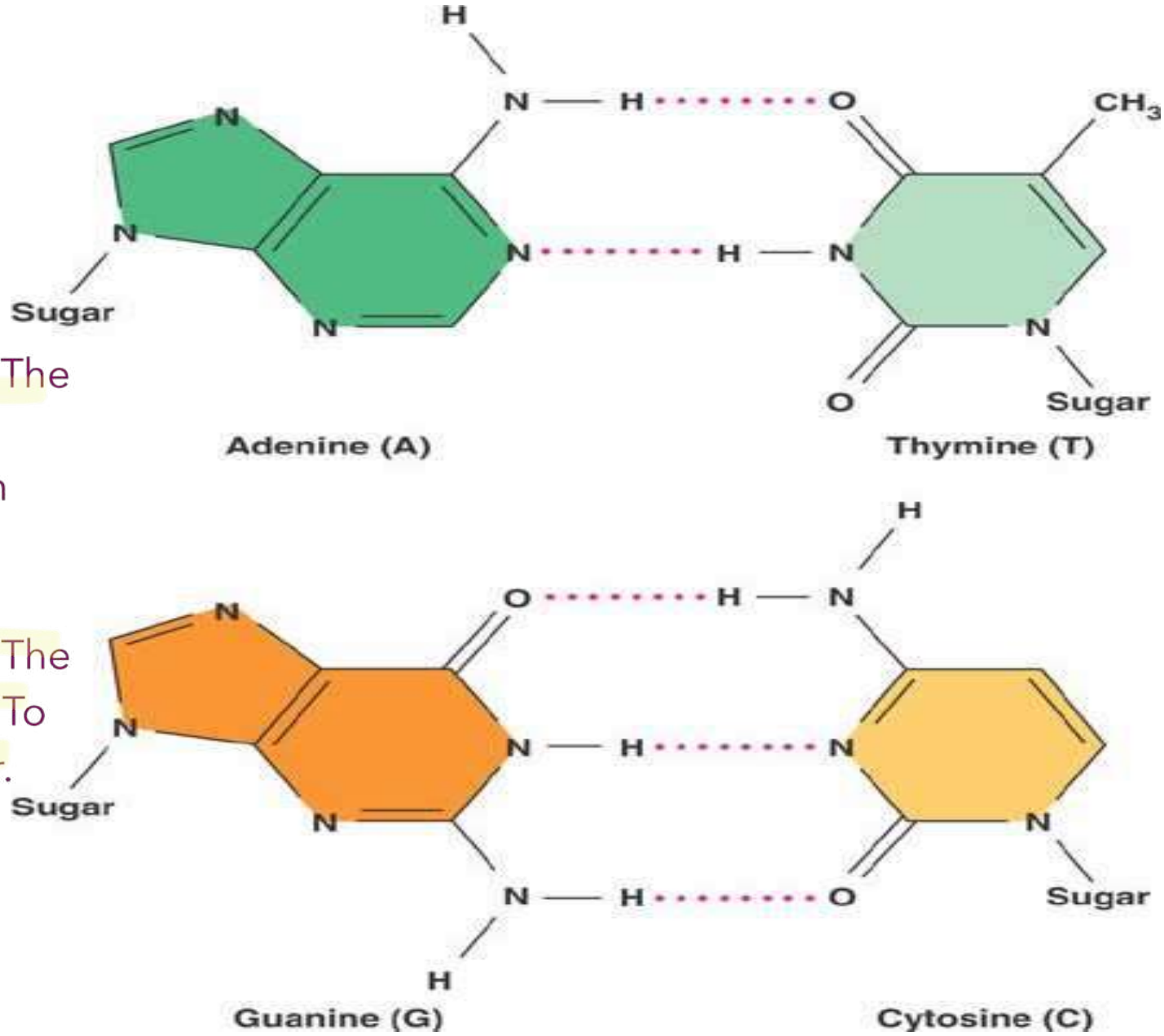
-The Bonds Between The Nucleotides Are Called 3' To 5' Phosphodiester Bonds.

*The Final Shape Of The Strand Will Have A Free 5' End And A Free 3' End.

*I Read The Strand From The 5' End To The 3' End According To The Existing Nitrogenous Bases.

Two Hydrogen Bonds Between The Adenine And The Thymine.

The Bonds Between The Guanine And The Cytosine Are Stronger Than The Bonds Between The Adenine And The Thymine Due To Their Number.



Three Hydrogen Bonds Between The Guanine And The

DNA Structure

- DNA consists of **two strands** of polynucleotides.

DNA 1ry structure :

- The sequence of nucleotides
- The order of nucleotides in any DNA strand is written in the **5' to3' direction**

I Read The Nitrogenous Bases From The 5' End To The 3' End.

- The nucleotide in each strand covalently linked by phosphodiester bonds between phosphate at 5'of one nucleotide and 3\ hydroxyl group of deoxyribose of the next nucleotide.
- Each strand has two ends, **3** end with free hydroxyl group and **5** end with free 5\ phosphate group.
- The two DNA strands run **antiparallel** direction this means that one strands run from 3\to 5\ while the other strand run from 5\to 3\.

The Two Strands Run Antiparallel To Each Other Means That If The First Strand Runs From 3' To 5' Then The Other Strand Will Run From 5' To 3'.

يعني هالشيء بساعد إنه بخلي كل قاعدة نيتروجينية مكملة للقاعدة النيتروجينية في السلسلة

- **The sequence of nucleotide is always read from 5\ to 3\ direction e.g. 5\pGpApCp 3\ or GAC.**
- **The sugar phosphate unites form the backbone of DNA strand (S-P-S-P) while nitrogenous bases are projecting to the inside in between the two strands.**
- **The sequence of bases determines the coding structure of DNA (genetic information)**

1.The 5\pGpApCp 3\ MeansThat:
-The P From The Left Is The Free Phosphate Group In The 5' End.
-The G Is The Nucleotide With The Nitrogenous Base "Guanine".
*We Read The Nucleotide With Its Nitrogenous Base.

2.The Backbone Of The DNA Strands Is The Sugar-Phosphate Units And The Nitrogenous Bases Project To The Inside Between The Two Strands.

3.The Correct Sequence Of Nucleotides Is The Genetic Information And If This Sequence Isn't Mutated Then It Will Produce A Correct RNA,That Will Be Translated To Give Us The Required Proteins.

DNA 2ry structure :

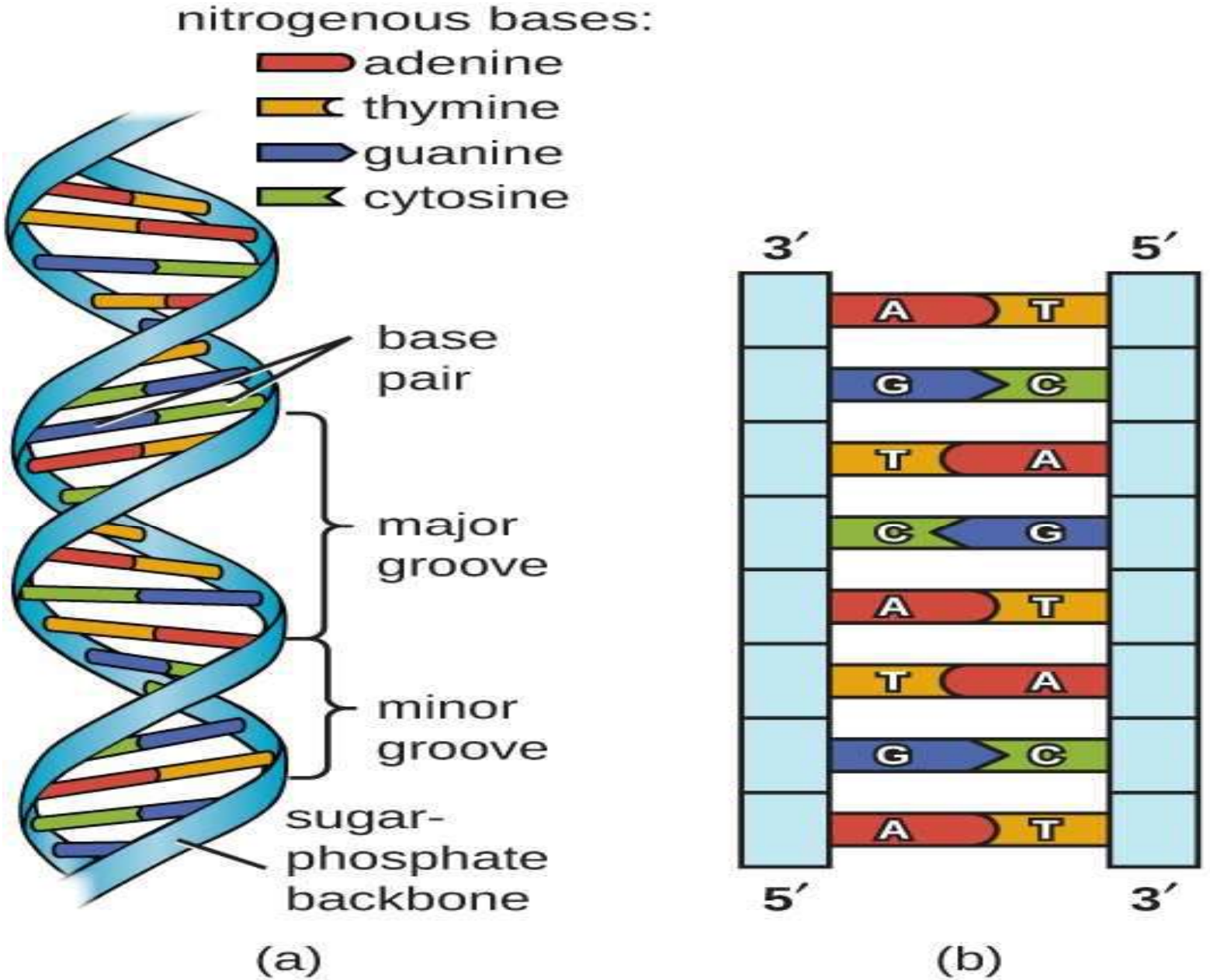
- Watson and crick proposed a structure for DNA in the form of a double helix (B form) which is the most common physiological form. It has the following characters:

1-Two antiparallel strands form a right handed helix: one runs in the 5’ to3’ direction and the other in the 3’ to 5’ direction. The two strands are paired to each other & coil around a common axis to form a right handed helix.

1.The Secondary Structure Of DNA Takes A Special Shape In The Form Of A Double Helix,The DNA Will Be In The B Form.

2.The Right Handed Helix Means That The Two Strands Run With The Clock-Wise (باتجاه عقارب الساعة).

- **2-complementary base pairing**: The two strands are held together by hydrogen bonds between the complementary base pairs, adenine forms two hydrogen bonds with thymine and guanine forms three hydrogen bonds with cytosine. Thus the number of adenine equals that of thymine and the number of guanine equals that of cytosine in DNA.
- The sequence of bases in one strand determines the sequence of the other during **DNA replication** to transfer genetic information in a correct manner as each of the original DNA strand acts as a template for synthesis of a new complementary strand to form two daughter DNA molecules.


nitrogenous bases:
adenine
thymine
guanine
cytosine
base pair
major groove
minor groove
sugar-phosphate backbone
(a)
3′
5′
A
T
G
C
T
A
C
G
A
T
T
A
G
C
A
T
5′
3′
(b)

- **3- Base stacking: the base pairs are stacked above each other by van der waals forces and hydrophobic interactions so stability of the helix is provided by :**

- **Van der waals forces**
- **Hydrophobic interactions**
- **Hydrogen bonding between complementary base pairs**

- **Van der waals forces:** a class of transient electrostatic interaction. The attraction between molecules is greatest at a distance called the Van der waals distance (0.3 to 0.4 nm). If molecules approach each other more closely, a repulsive force develops, by the negative charges of their outer electron shells.
- **Hydrophobic interactions:** nonpolar molecules cannot form hydrogen bonds with water molecules and tend to cluster together and they are insoluble in water

1.The Non Polar Molecules Tend To Cluster To Each Other Inside The Structure Of The Molecule And Those Hydrophobic Interactions Will Be Formed.

2.Hydrophobic Interactions Will Be Between The Nitrogenous Bases And Lead To

- **4-Dimensions**:

-2 nm wide, each complete turn is 3.4 nm long in which there is 10.4 base pairs.

-Two grooves are apparent from outside, a major groove (2.2 nm) and a minor groove (1.2 nm), through which many drugs or proteins can make contact with the nitrogenous bases without any need to open the helix as in these grooves the bases are exposed.

1.The Width Of The Double Helix: 2 Nanometer.

2.The Complete Turn's Length: 3.4 Nanometer.

3.Each Turn Has 10.4 Base Pairs.

4.The Two Grooves Appear From The Outside.
-The Major Groove: 2.2 Nanometer.
-The Minor Groove: 1.2 Nanometer.
-The Importance Of The Two Grooves Is Facilitating The Out Reach To The Nitrogenous Bases Because Those Bases Are Exposed And Can Be Easily Seen,The Proteins Or The Drugs Can Contact With Those Nitrogenous Bases Without The Need To Open Up The Helix.

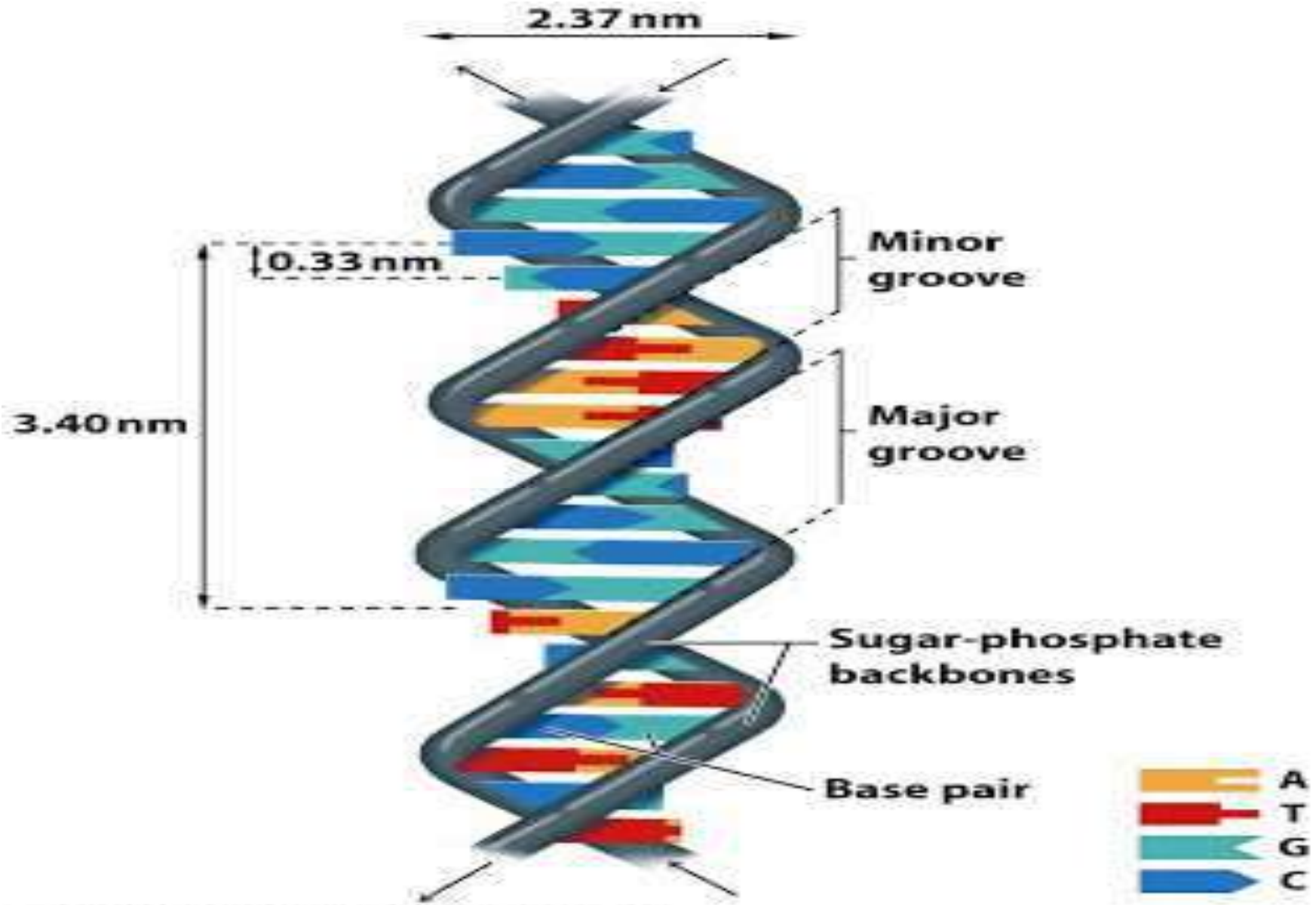
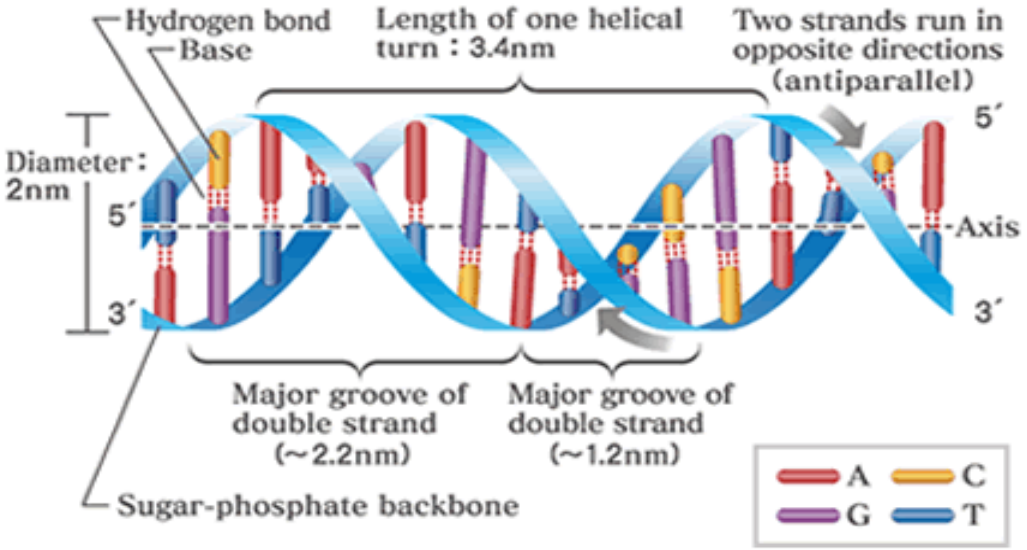


Figure 19-14 Principles of Biochemistry, 4/e

Ribbon model



Space-filling model