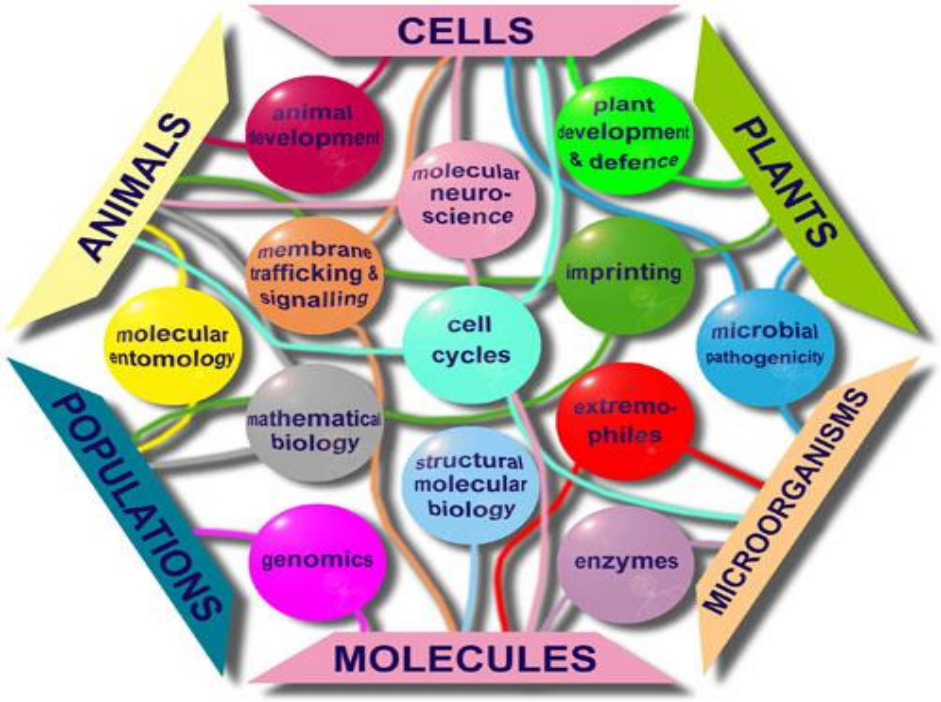
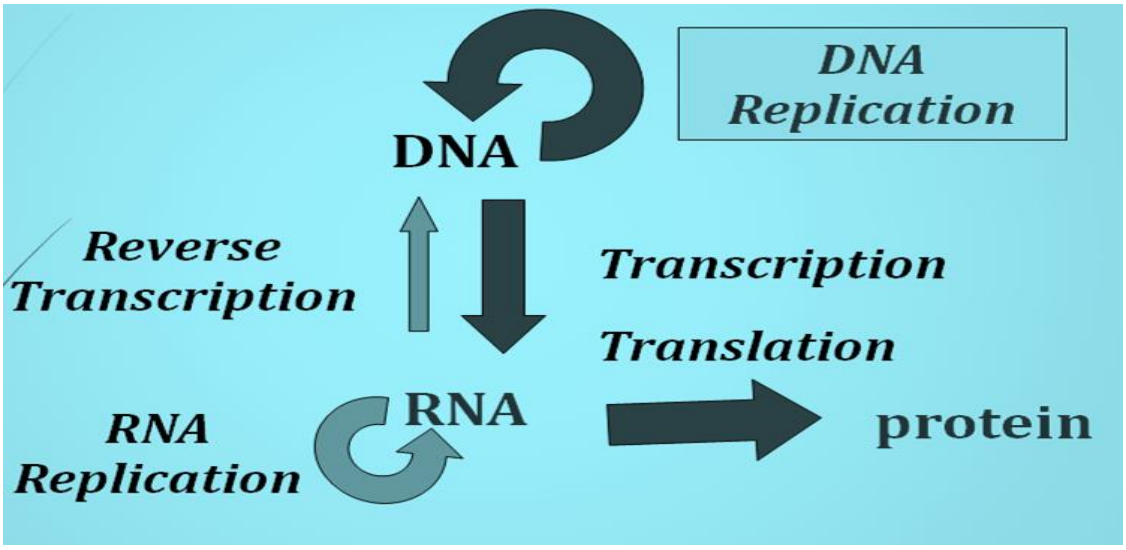
Molecular biology:

Molecular biology is the study of molecular underpinnings of the process of replication, transcription and translation of the genetic material.



- This field overlaps with other areas of biology and chemistry, particularly genetics and biochemistry. Molecular biology chiefly concerns itself with understanding the interactions between the various systems of a cell, including the interactions between DNA, RNA and protein biosynthesis as well as learning how these interactions are regulated.
- Much of the work in molecular biology is quantitative, and recently much work has been done at the interface of molecular biology and computer science in bioinformatics and computational biology.
- Since the late 1950s and early 1960s, molecular biologists have learned to characterize, isolate, and manipulate the molecular components of cells and organisms includes DNA, the repository of genetic information; RNA, a close relative of DNA; and proteins, the major structural and enzymatic type of molecule in cells.



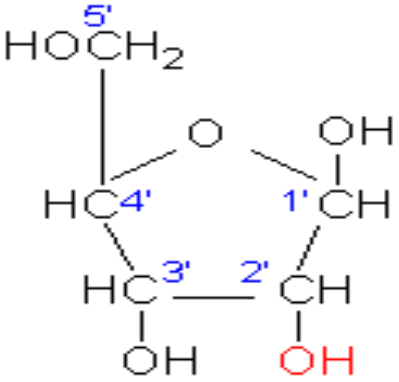
The Structure of Nucleic Acids:

NUCLEIC ACIDS

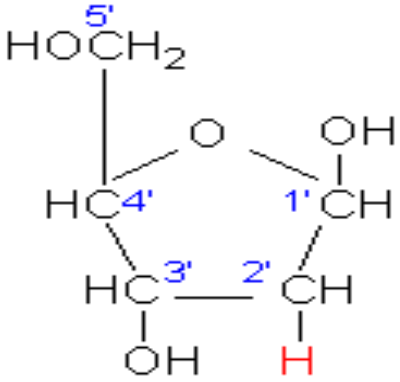
- Nucleic acids are polymers
- Monomer---nucleotides
  - Nitrogenous bases
    - Purines
    - Pyrimidines
  - Sugar
    - Ribose
    - Deoxyribose
  - Phosphates

} Nucleosides

The Sugars



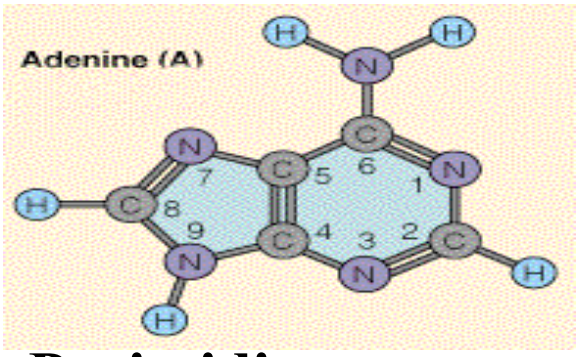
Ribose
(in RNA)

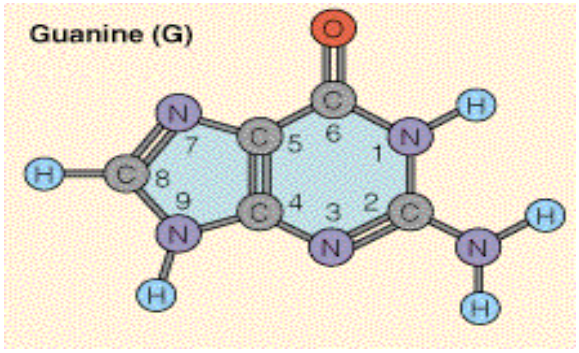


2'-Deoxyribose
(in DNA)

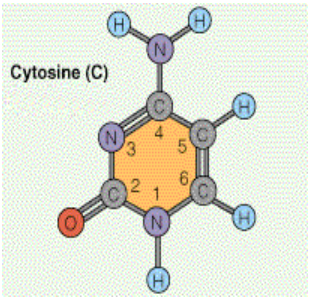
Bases of DNA

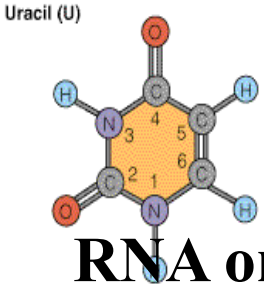
Purines:



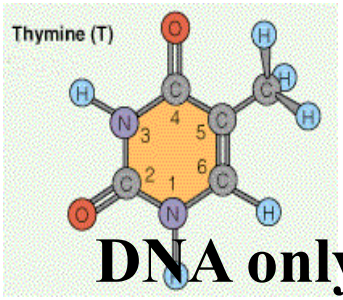


Pyrimidines:





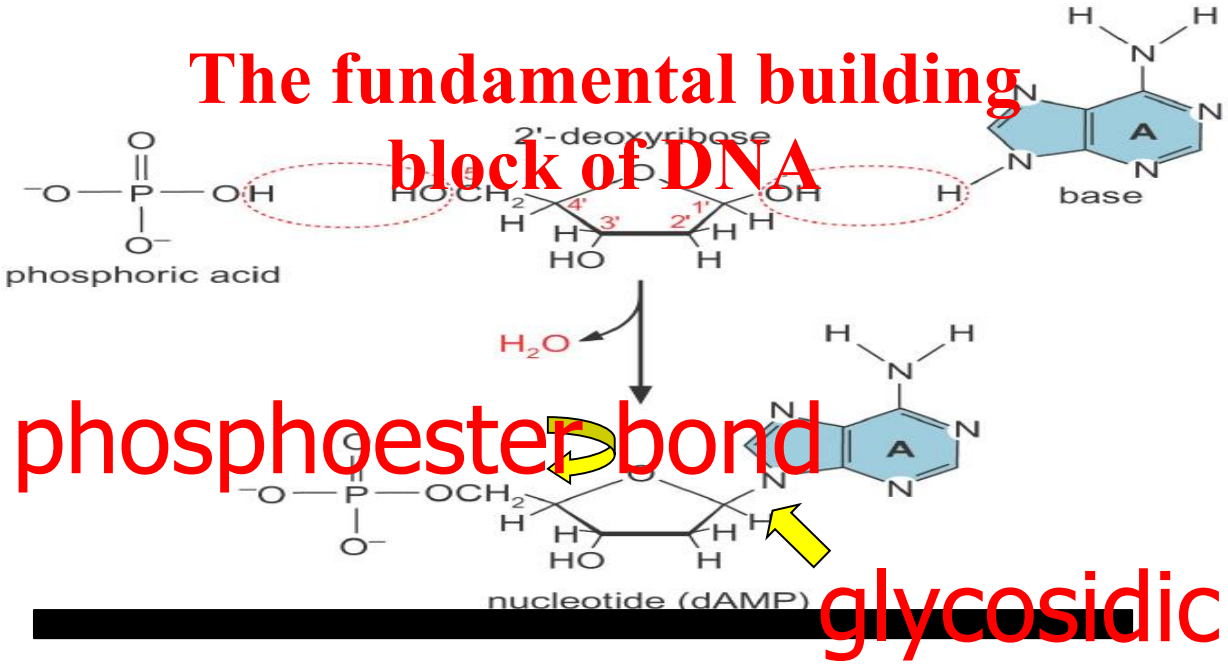
RNA only



DNA only

Nucleoside and Nucleotide

The fundamental building block of DNA

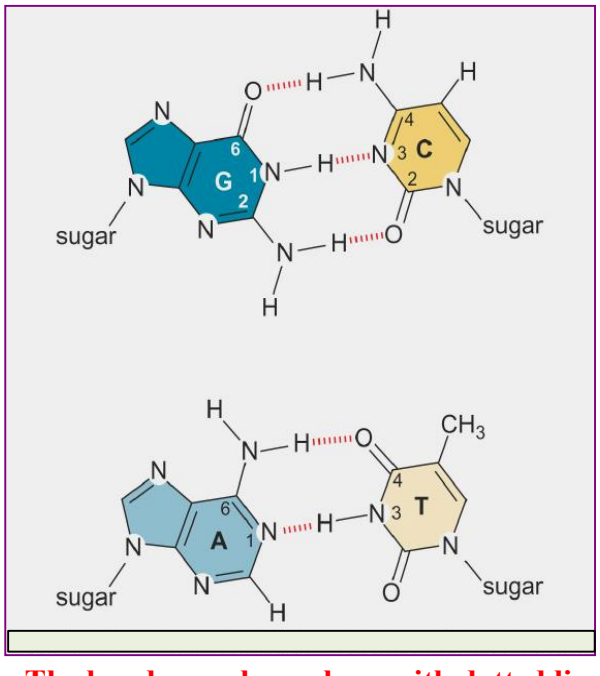


phosphoester bond

glycosidic bond

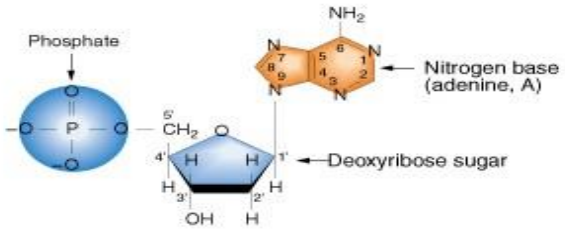
Hydrogen

- The bases attract each other because of hydrogen bonds.
- The 3 bonds between

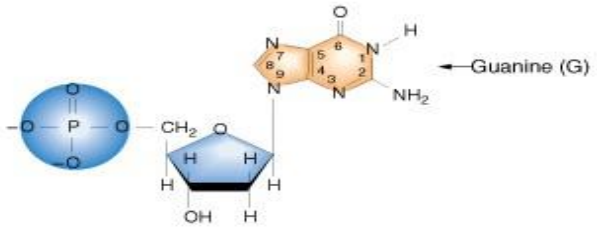


The bonds are shown here with dotted lines.

Purine nucleotides

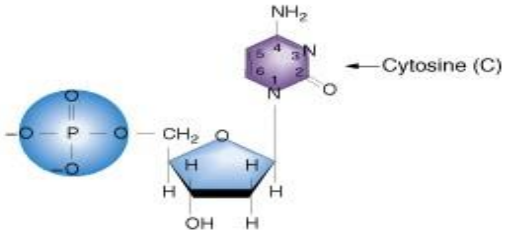


Deoxyadenosine 5'-phosphate (dAMP)

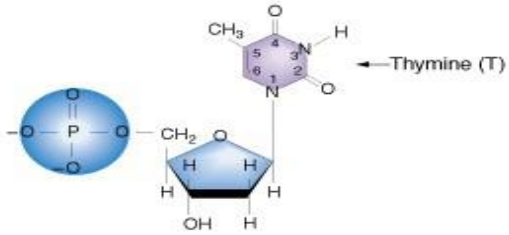


Deoxyguanosine 5'-phosphate (dGMP)

Pyrimidine nucleotides

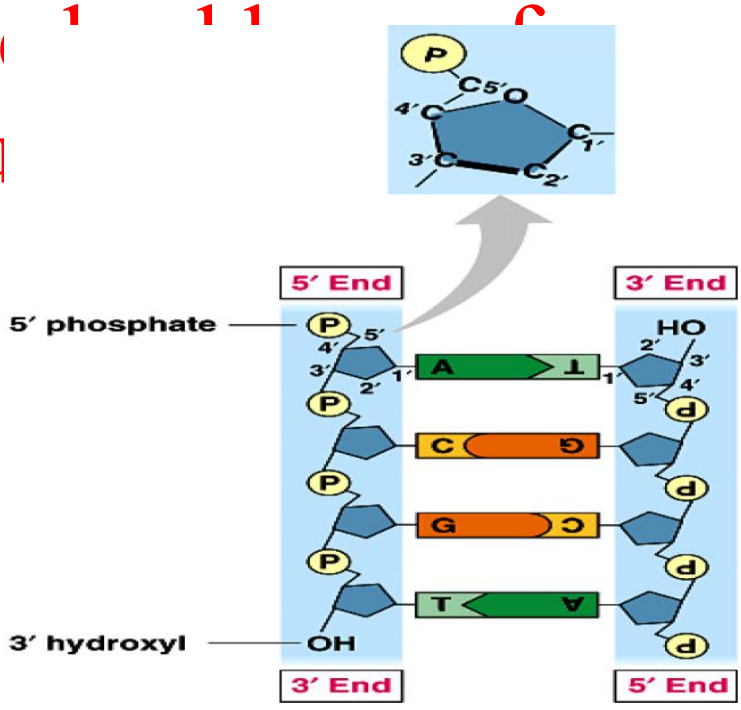


Deoxycytidine 5'-phosphate (dCMP)



Deoxythymidine 5'-phosphate (dTMP)

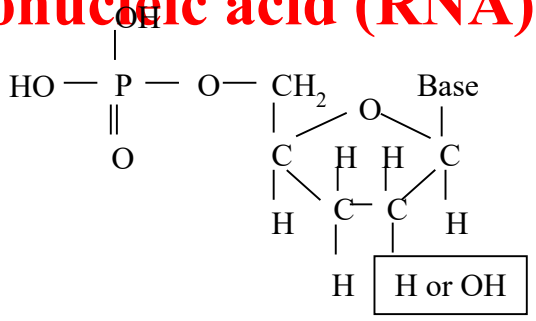
Repeating, sugar-
phosphat
the polynu
DNA strands



Nucleic Acids

make up 13-34% of the dry weight in bacteria

deoxyribonucleic acid (DNA) and ribonucleic acid (RNA)



Sugar:

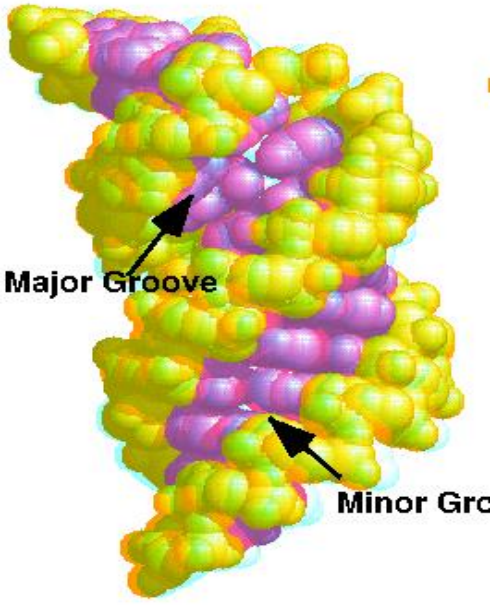
- RNA – ribose (OH)
- DNA – deoxyribose (H)

Bases:

- adenine (A), cytosine (C), guanine (G), thymine (T)
- RNA uses uracil (U) instead of thymine

A Helix

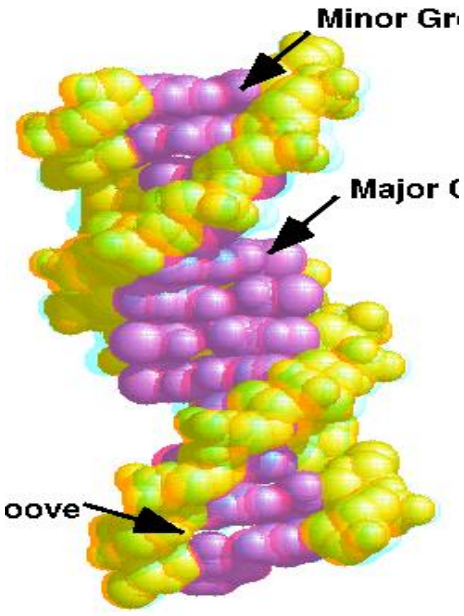
A form	
Helical Sense	Right-handed
Diameter	~26 Å
Base pairs per helical turn	11
Helical twist per base pair	33°
Helix pitch (rise per turn)	28 Å
Helix rise per base pair	2.6 Å
Base tilt normal to the axis	20°
Major groove	Narrow & deep
Minor groove	Wide & shallow
Sugar pucker	C3'-endo
Glycosidic bond	Anti



RNA, DNA/RNA hybrids, dehydrated DNA

B Helix

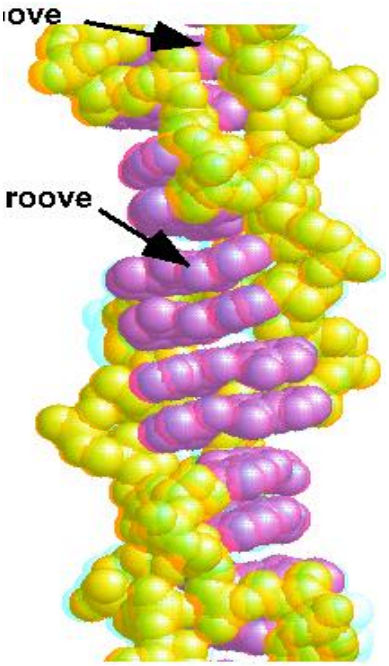
B form	
Helical Sense	Right handed
Diameter	~20Å
Base pairs per helical turn	10
Helical twist per base pair	36°
Helix pitch (rise per turn)	34 Å
Helix rise per base pair	3.4 Å
Base tilt normal to the axis	6°
Major groove	Wide & deep
Minor groove	Narrow & deep
Sugar pucker	C2'-endo
Glycosidic bond	Anti



Normal DNA

Z Helix

	Z form
Helical Sense	Left-handed
Diameter	~18 Å
Base pairs per helical turn	12 (6 dimers)
Helical twist per base pair	60° (per dimer)
Helix pitch (rise per turn)	45 Å
Helix rise per base pair	3.7 Å
Base tilt normal to the axis	7°
Major groove	Flat
Minor groove	Narrow & deep
Sugar pucker	C2'-endo (pyrimidines) C3'-endo (purines)
Glycosidic bond	Anti (pyrimidines) Syn (purines)

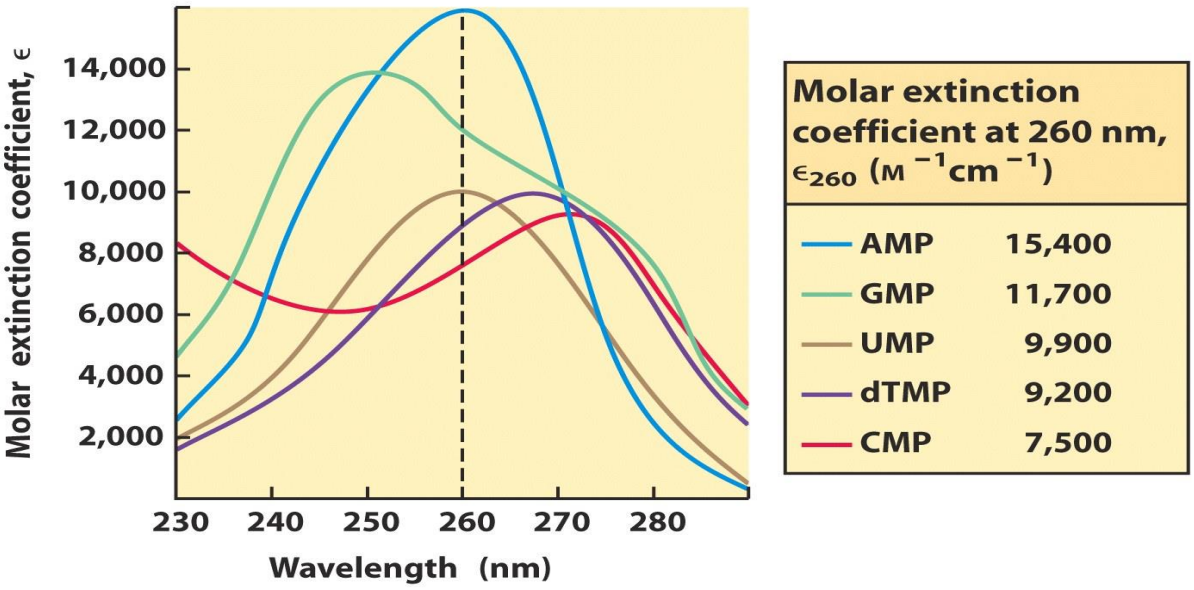


Alternating Purine-Pyrimidine

Helix Parameters

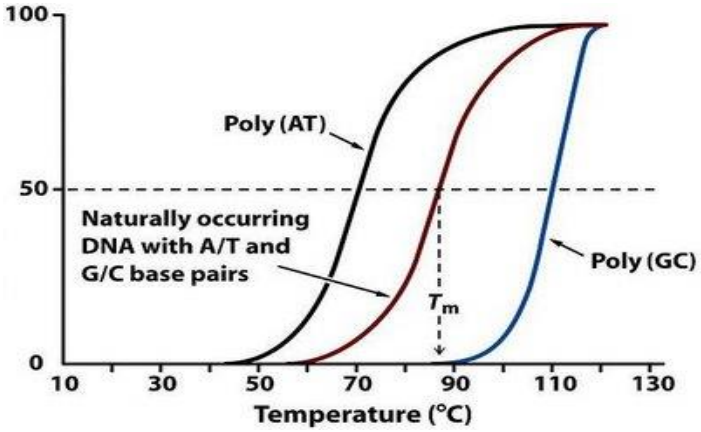
	A form	B form	Z form
Helical Sense	Right handed	Right handed	Left handed
Diameter	~26 Å	~20Å	~18 Å
Base pairs per helical turn	11	10	12 (6 dimers)
Helical twist per base pair	33°	36°	60° (per dimer)
Helix pitch (rise per turn)	28 Å	34 Å	45 Å
Helix rise per base pair	2.6 Å	3.4 Å	3.7 Å
Base tilt normal to the axis	20°	6°	7°
Major groove	Narrow & deep	Wide & deep	Flat
Minor groove	Wide & shallow	Narrow & deep	Narrow & deep
Sugar pucker	C3'-endo	C2'-endo	C2'-endo (pyrimidines) C3'-endo (purines)
Glycosidic bond	Anti	Anti	Anti (pyrimidines) Syn (purines)

Physical Properties - Absorbance



Denaturation: "Melting"

- Heat, alkali cause the double helix to unwind
- As H-bonds break, they form "bubbles"



Different types of RNA :

1. **Informational RNAs**

mRNAs = messenger RNAs

(intermediates in the decoding of genes into polypeptides).

2. Functional RNAs

tRNAs = transfer RNAs

(transport amino acids to mRNA during translation).

rRNAs = ribosomal RNAs

(combine with proteins to form ribosomes).

snRNAs = small nuclear RNAs

(involved in splicing primary transcripts into mRNA in the nucleus).

2. Functional RNAs

scRNAs = small cytoplasmic RNAs

(direct protein traffic within the cell)

siRNAs = small interferring RNAs

(inhibitory effects on gene expression)

miRNA = microRNA (These are tiny (~22 nts) RNA molecules that appear to regulate the expression of messenger RNA (mRNA) molecules.

XIST RNA = This inactivates one of the two X chromosomes in female vertebrates.

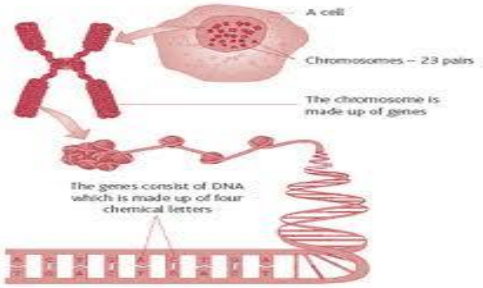
Each encoded by different genes

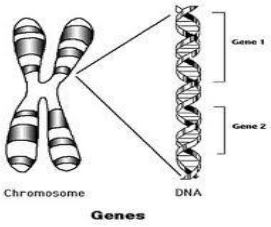
Difference between RNA & DNA

RNA	DNA
RNA nucleotides contain ribose sugar	DNA contains deoxyribose
RNA has the base uracil	DNA has the base thymine
presence of a hydroxyl group at the 2' position of the ribose sugar.	Lacks of a hydroxyl group at the 2' position of the ribose sugar.
RNA is usually single-stranded	DNA is usually double-stranded

Gene : Unit of hereditv

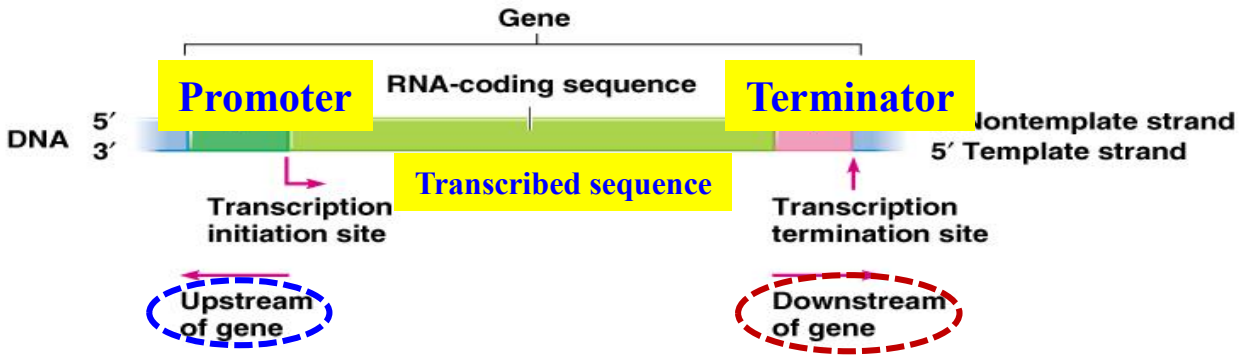
- The DNA segments that carries genetic information are called genes.





Basic Components of a Gene

Each gene has



LECTURE 1 QUESTIONS SHEET

1- Which of the following is a nitrogenous base?

- ribose
- guanine
- enzyme

- cysteine

2- What is an example of complementary base pairing?

- an adenine binds with thymine
- a purine binds with a pyrimidine
- cytosine binds with adenine
- thymine binds with guanine

3- Which structure is cytosine found in?

- both DNA and mRNA
- DNA
- neither DNA nor mRNA
- mRNA

4- A nucleic acid monomer is called:

- Ribose
- A nucleosome
- A nucleoside
- A nucleotide
- Deoxyribose

5- Which of the following bases are categorized as purines?

- Thymine and adenine
- Thymine, cytosine and uracil
- Guanine, adenine and uracil
- Guanine and cytosine
- Guanine and adenine

6- The following concepts led to the hypothesis that DNA has a double helix structure:

I. The ratio of A:T is 1:1.

II. The ratio of G:C is 2:1

III. DNA strands are antiparallel

- II

- I and III
- I, II and III
- I and II

7- The Central Dogma is a framework used to represent which of the following?

- The flow of protein to RNA
- The flow of genetic information from DNA to RNA to protein
- The flow of RNA to DNA
- The flow of protein to RNA to DNA

WITH OUR BEST WISHES