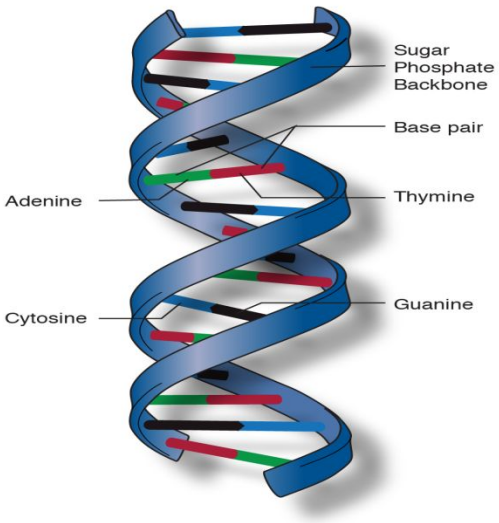
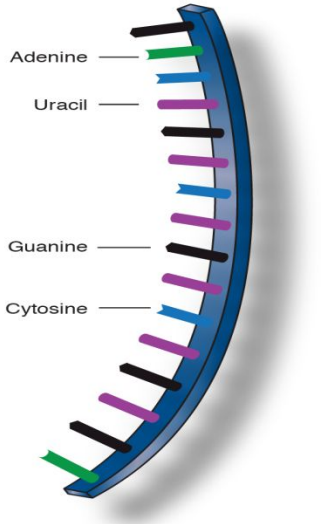
Nucleic acids



Deoxyribonucleic acid
(DNA)



Ribonucleic acid
(RNA)

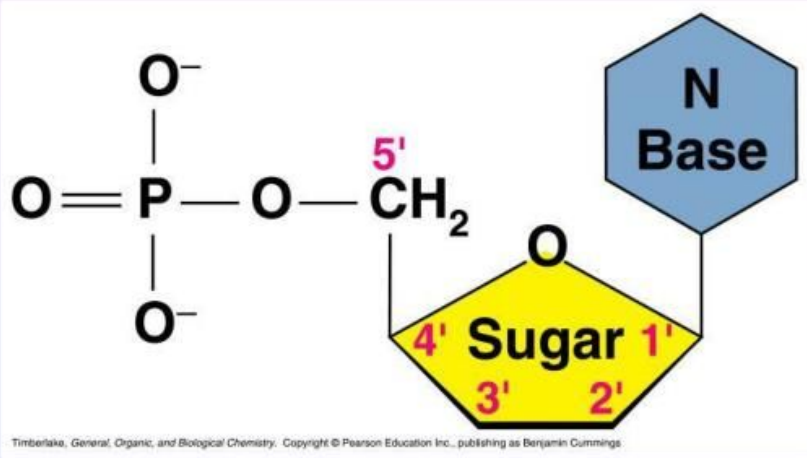
Topics:
Nucleic acids: Importance and classification; Structure of Nucleotides, Watson and crick modal of DNA.

Prepared by,
Dr. Vijay Kant Pandey
HOD, Deptt of Agriculture
(Ph.D., GATE, CSIR-UGC-NET, ARS-NET)

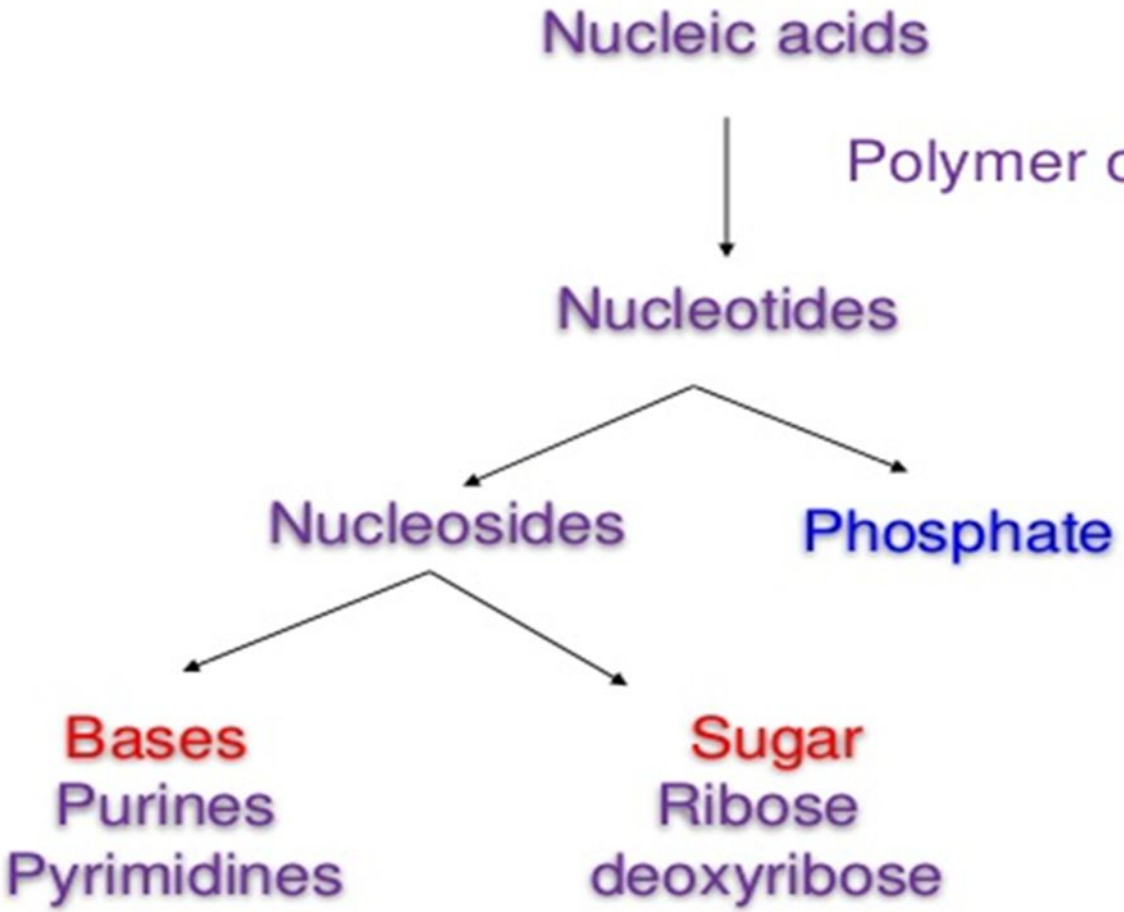
Nucleic Acids

- **Nucleic acids** are molecules that store information for cellular growth and reproduction
- There are two types of nucleic acids:

  - **deoxyribonucleic acid (DNA)** and **ribonucleic acid (RNA)**
- These are polymers consisting of long chains of monomers called nucleotides
- A **nucleotide** consists of a nitrogenous base, a pentose sugar and a phosphate group:



Composition of nucleic acids



NUCLEOTIDE STRUCTURE

A nucleotide is the basic building block of nucleic acids (RNA and DNA).

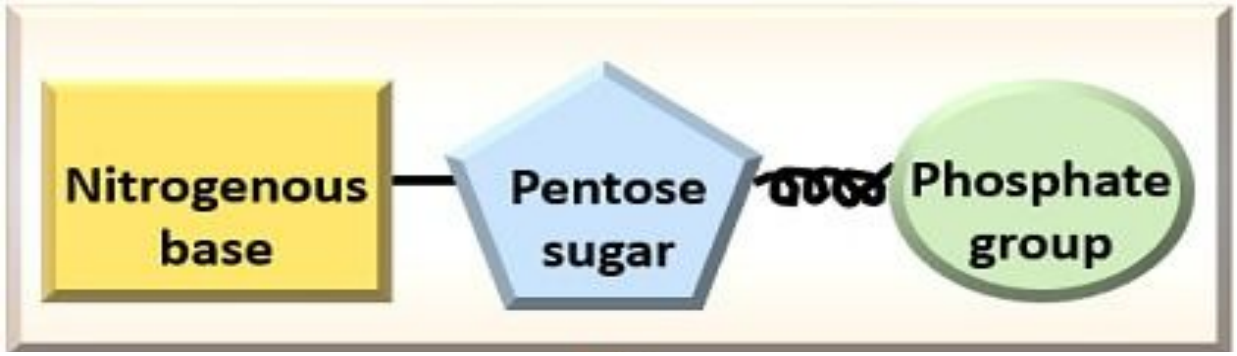
A nucleotide consists of a

Pentose sugar molecule (either ribose in RNA or deoxyribose in DNA) attached to a

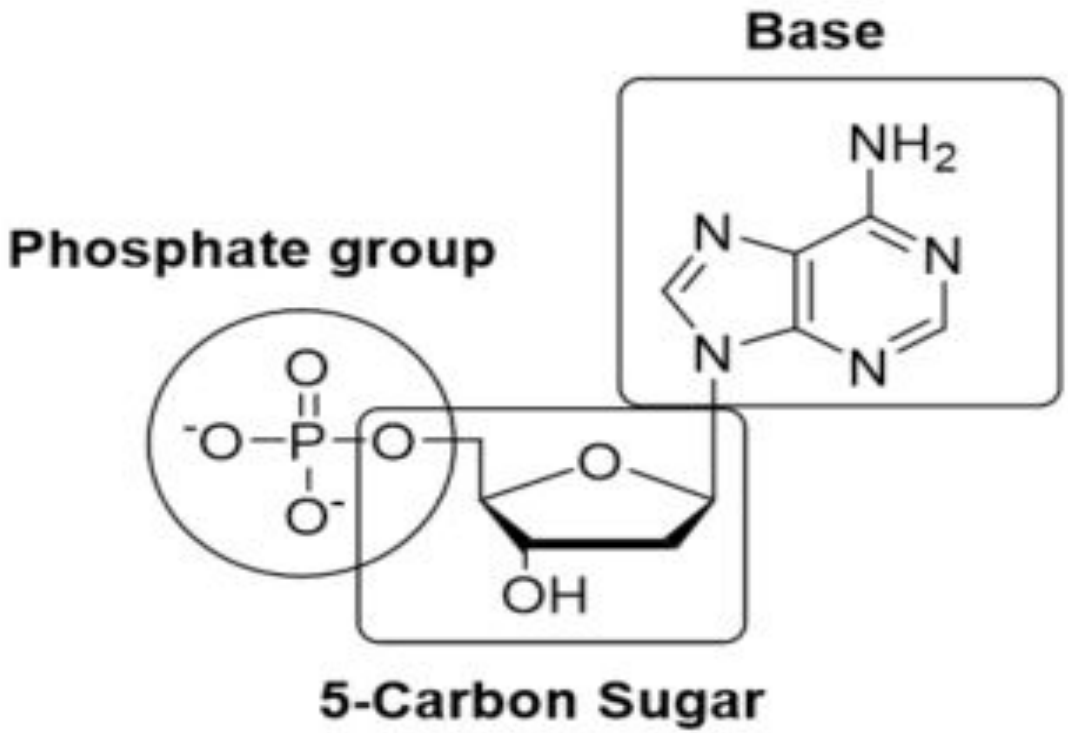
phosphate group and

a nitrogen-containing base.

The bases used in DNA are adenine (A), cytosine (C), guanine (G) and thymine (T).



NUCLEOTIDE STRUCTURE



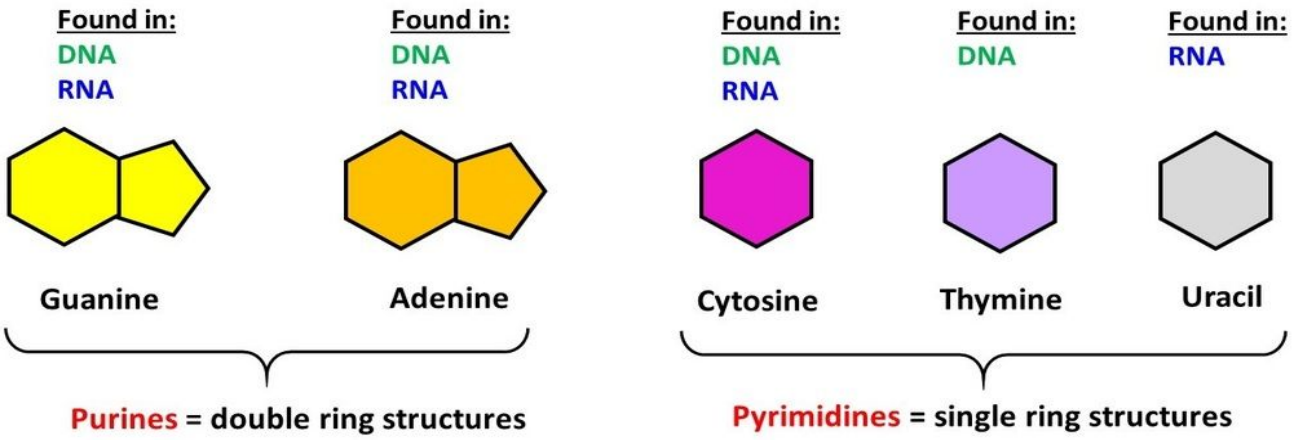
Nucleoside = Base + Sugar

Nucleotide = Base + Sugar + Phosphate group

Nitrogen Bases

- The **nitrogen bases** in nucleotides consist of two genera types:
  - **purines**: adenine (A) and guanine (G)
  - **pyrimidines**: cytosine (C), thymine (T) and Uracil (U)

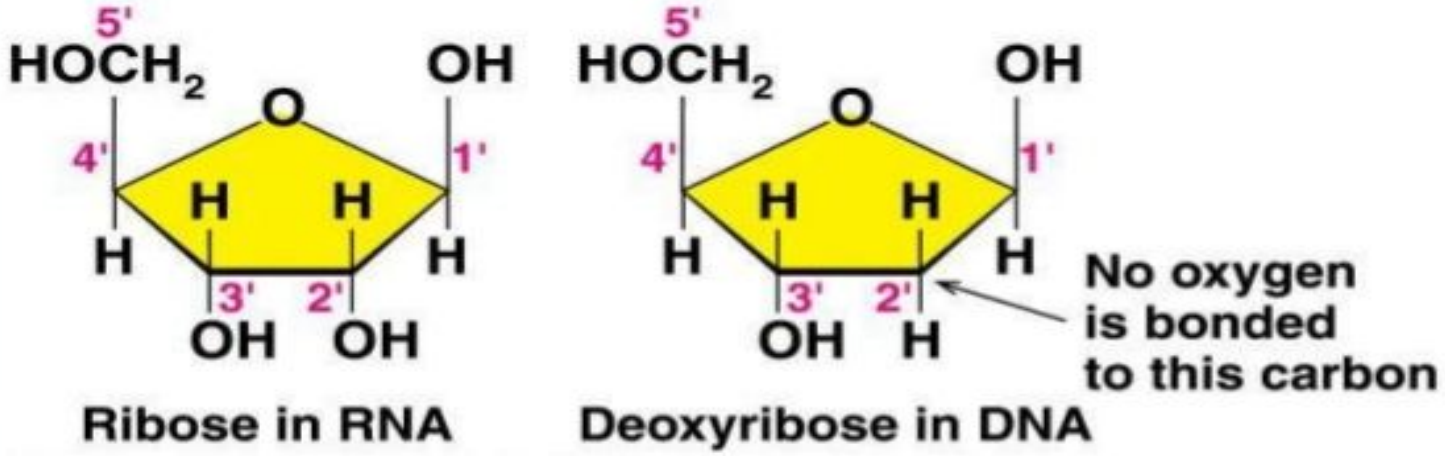
There are five nitrogenous bases in total:



Pentose Sugars

- There are two related **pentose sugars**:
  - RNA contains **ribose**
  - DNA contains **deoxyribose**
- The sugars have their carbon atoms numbered with primes to distinguish them from the nitrogen bases

Pentose sugars in RNA and DNA



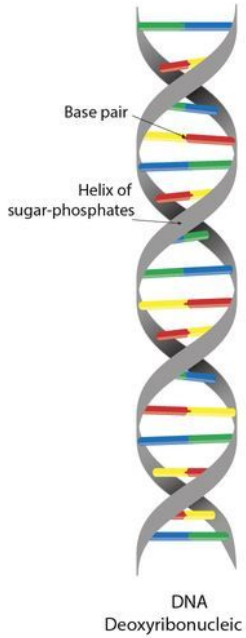
Ribose in RNA **Deoxyribose in DNA**

Ribonucleotides have a 2'-OH

Deoxyribonucleotides have a 2'-H

Classification of nucleic acid

- Deoxyribonucleic acid (DNA) is composed of deoxyribonucleotides.
  - 90% in nuclei and the rest in mitochondria
  - store and carry genetic information; determine the genotype of cells
- Ribonucleic acid (RNA) is composed of ribonucleotides.
  - in nuclei and cytoplasm
  - participate in the gene expression



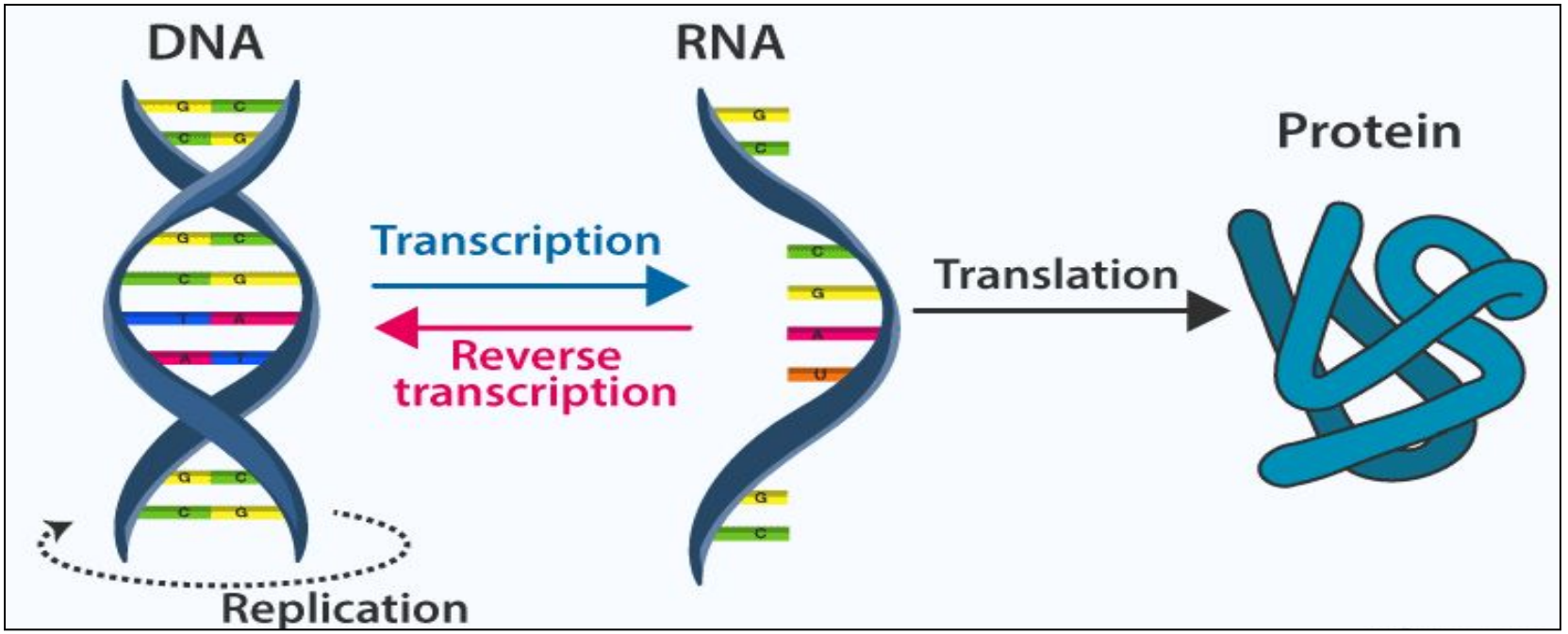
DNA
Deoxyribonucleic acid

	DNA	RNA
Pentose sugar	Deoxyribose	Ribose
Base Composition	Adenine (A) Guanine (G) Cytosine (C) **Thymine (T)**	Adenine (A) Guanine (G) Cytosine (C) **Uracil (U)**
Number of strands	Double stranded (forms a double helix)	Single stranded

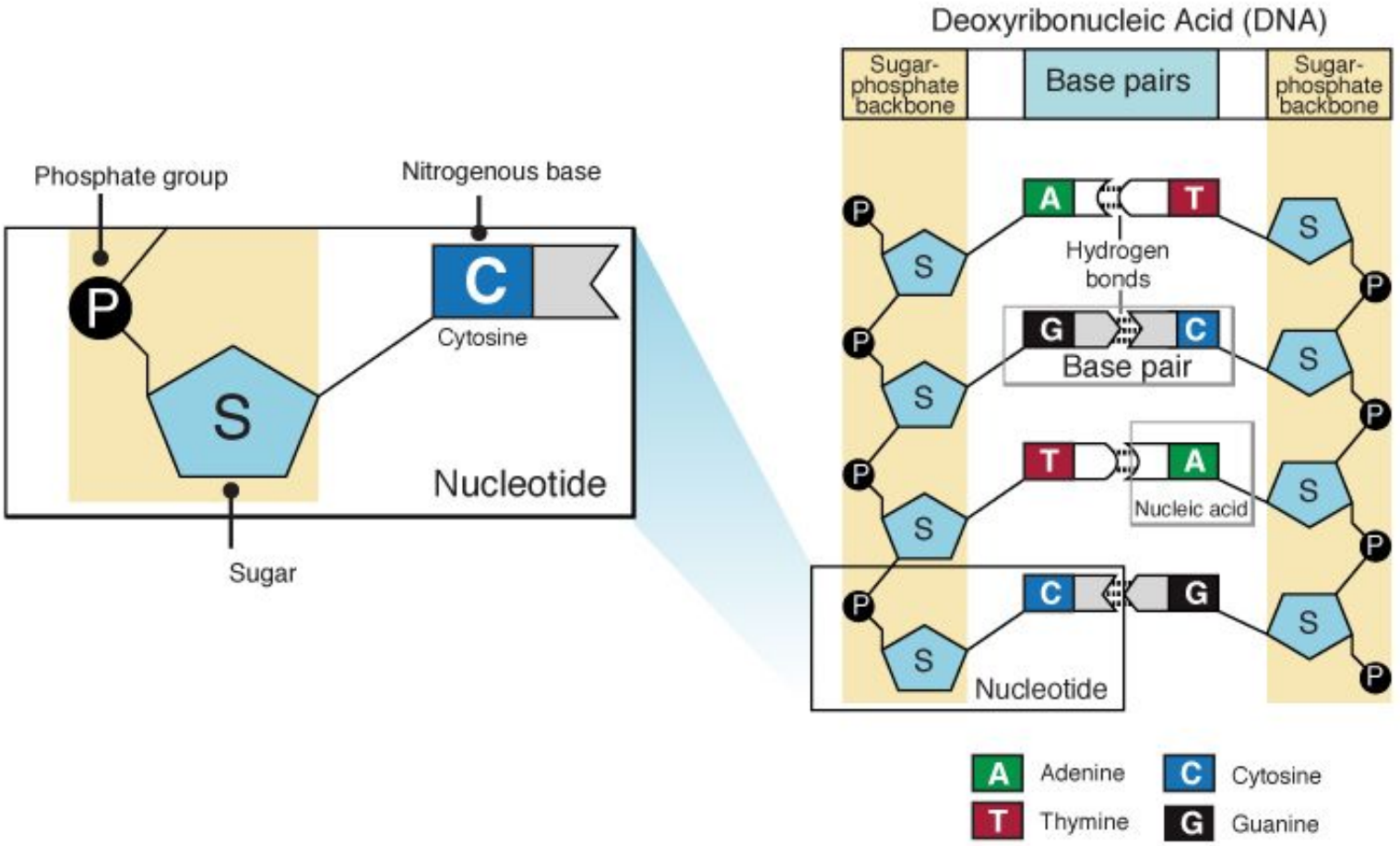
RNA
Ribonucleic Acid

Central Dogma

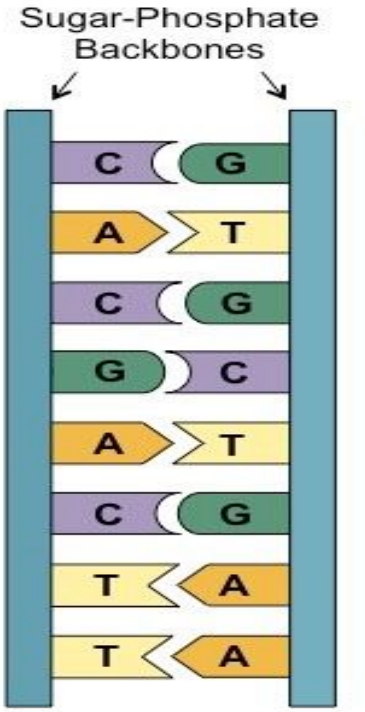
Central dogma is flows of genetic information only in one direction i.e from DNA, to RNA, to protein, or RNA directly to protein.



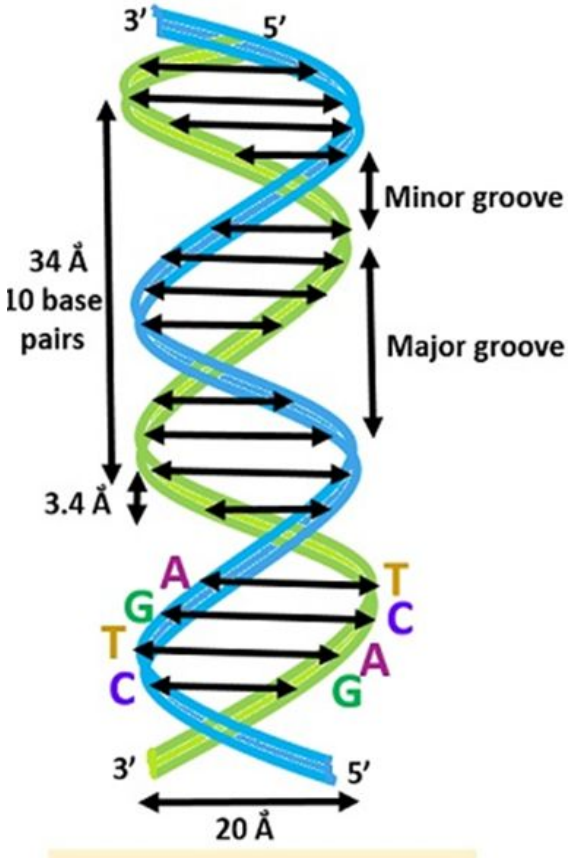
Structure of DNA



Structure of DNA by Watson and Crick

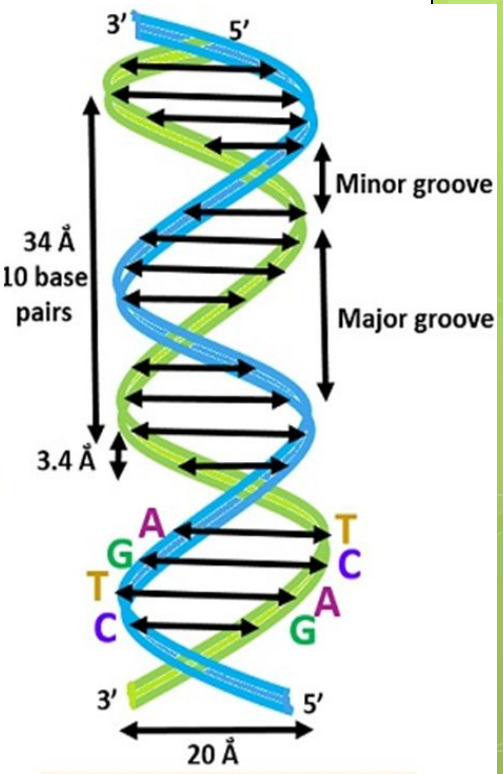


DNA Ladder



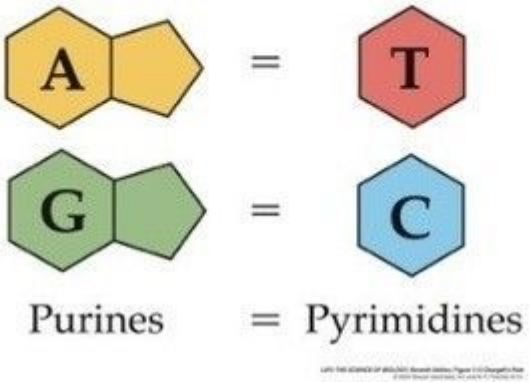
Watson and Crick model of DNA

- Double helical structure was proposed by Watson & Crick in 1953.
- The DNA is a right handed double helix.
- It consists of two polydeoxyribonucleotide chains twisted around each other on a common axis of symmetry.
- The chains are paired in an antiparallel manner, that is, the 5'-end of one strand is paired with the 3'-end of the other strand
- The two strands are antiparallel, i.e., one strand runs in the 5 ' to 3 ' direction while the other runs in 3' to 5 ' direction.
- The width (or diameter) of a double helix is 20A^0 (2nm)
- Each turn of helix is 34 A^0 (3.4nm) with 10 pairs of nucleotides, each pair placed at a distance of about 3.4 A^0
- The DNA helix, the hydrophilic deoxyribose-phosphate backbone of each chain is on the outside of the molecule, whereas the hydrophobic bases are stacked inside.



STRUCTURE OF DNA BY WATSON AND CRICK

Chargaff's Rule



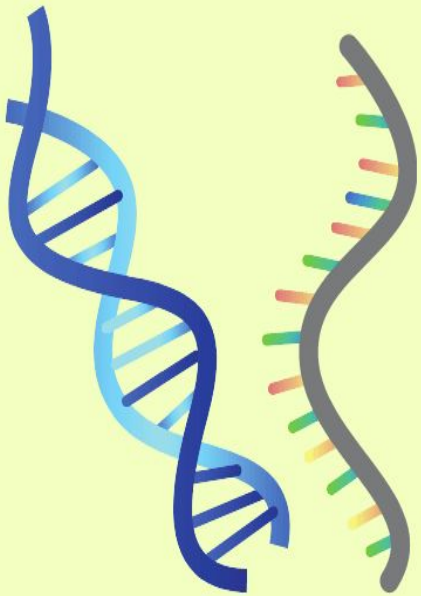
- The amount of Adenine = the amount of Thymine.
- The amount of Guanine = the amount of Cytosine.
- DNA had equal numbers of adenine & thymine residues (A=T) and equal number of guanine & cytosine residues(G=C).
- This is called as *Chargaff's rule of molar equivalence of between purines & pyramidines in DNA structure.*
- RNAs which are usually single stranded, do not obey Chargaff's rule.

Types of DNA

A- DNA	B-DNA	Z-DNA
Right-handed helix	Right-handed helix	Left-handed helix
Widest	intermediate	Narrowest

What is RNA (Ribonucleic Acid)

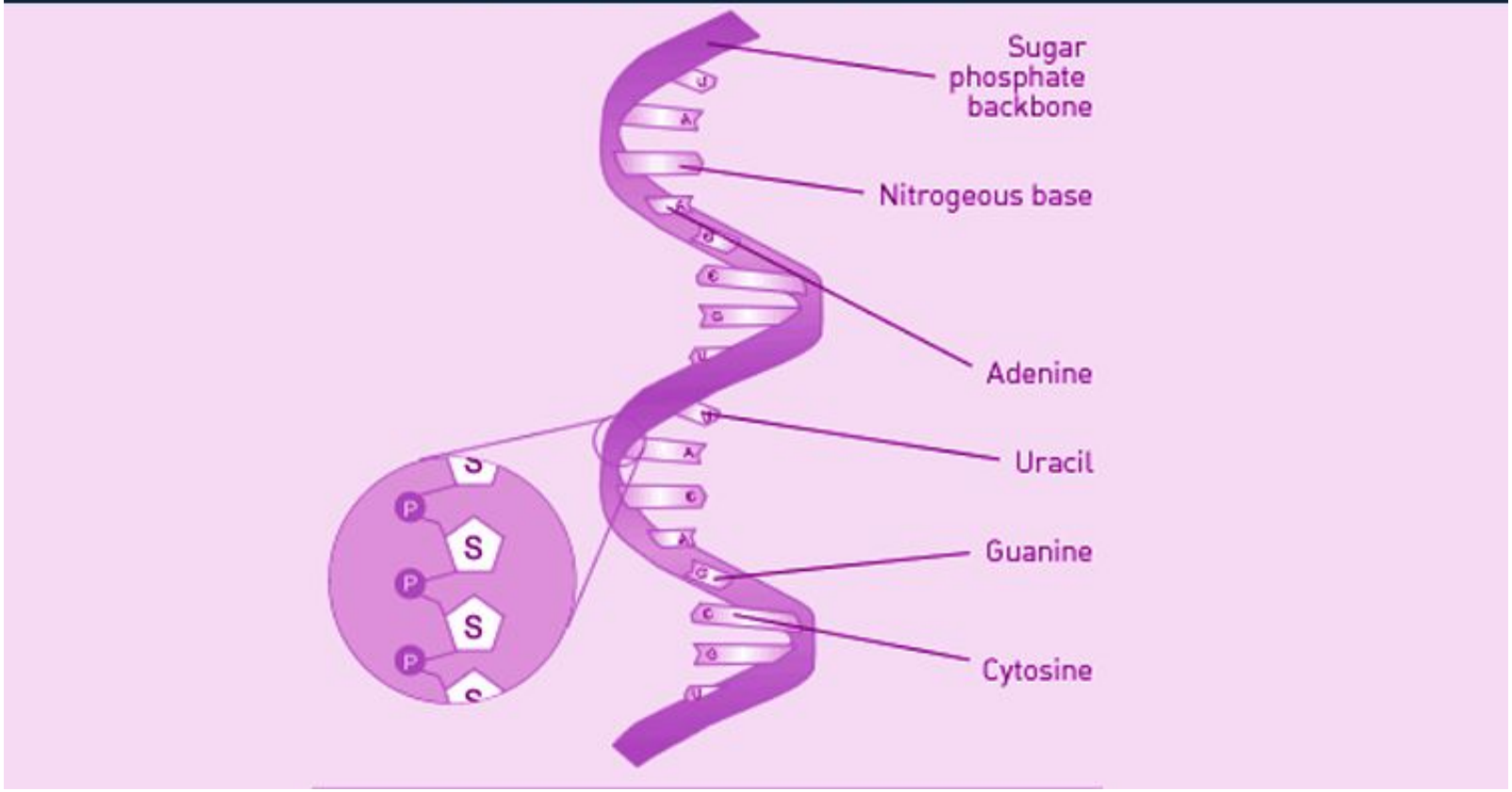
RNA or ribonucleic acid is a biological polymer that codes and decodes genetic information. DNA codes for RNA and RNA codes for proteins.



DNA RNA

- Most RNA is a single-stranded molecule.
- RNA forms a single helix, a loop, a straight molecule, or a twisted shape.
- Types of RNA include messenger RNA (mRNA), transfer RNA (tRNA), and ribosomal RNA (rRNA).
- The bases in RNA are adenine (A), uracil (U), guanine (G), and cytosine (G).
- Some organisms contain RNA, but no DNA.

Structure of RNA



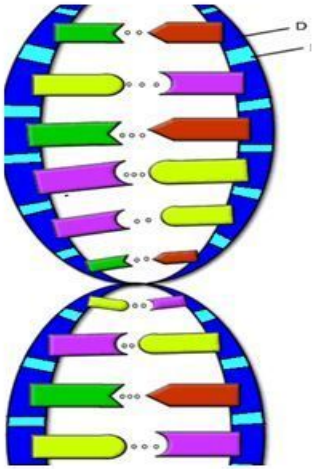
Types of RNA

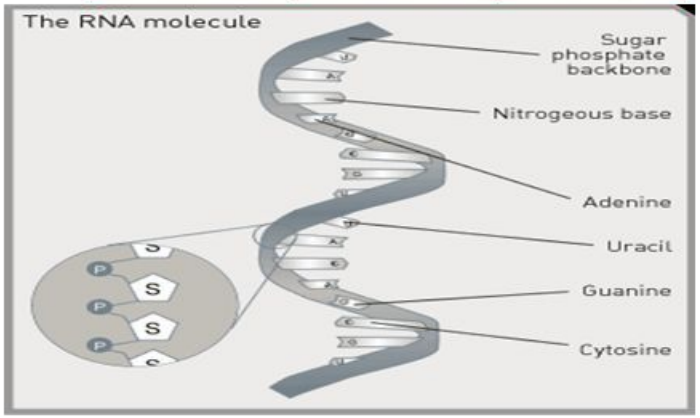
Table 22.3 Types of RNA Molecules

Type	Abbreviation	Percentage of Total RNA	Function in the Cell
Ribosomal RNA	rRNA	75	Major component of the ribosomes
Messenger RNA	mRNA	5–10	Carries information for protein synthesis from the DNA in the nucleus to the ribosomes
Transfer RNA	tRNA	10–15	Brings amino acids to the ribosomes for protein synthesis

Differences Between DNA vs RNA

DNA	vs.	RNA
• Double stranded		• Single stranded
• Deoxyribose sugar		• Ribose sugar
• Bases: C,G A,T		• Bases: C,G,A,U
• Self replicate		• Can't self replicate
		• mRNA, tRNA, rRNA





Both contain a sugar, phosphate, and base.

Differences Between DNA vs RNA

S. No.	DNA	RNA
1	Sugar moiety is Deoxy ribose	Sugar moiety is Ribose
2	The bases present are Adenine, Thymine, Guanine and Cytosine. Uracil is not present.	The bases present are Adenine, Uracil, Guanine and Cytosine. Thymine is rarely present.
3	Double stranded molecules	Single stranded molecules
4	Obeys Chargaff's rule	Does not obey Chargaff's rule
5	Bases are not modified	Bases are modified
6	It is stable and not hydrolysed easily by alkalis	It is unstable and hydrolysed easily by alkalis
7	DNA content is constant in all the cells except during cell division	Varies from cell to cell
8	The life time of DNA is comparatively high.	RNA is short lived.
9	No natural DNA is catalytic	RNA can be catalytic
10	Present in the nucleus, mitochondria and chloroplast	Present in the nucleus, mitochondria, nucleolus, ribosomes and cytosol.

Functions of nucleic acids

- DNA is the chemical basis of heredity
- Reserve bank of genetic information
- Responsible for maintaining the identity of different species of organisms over millions of years
- Cellular function is under the control of DNA
- The basic information pathway
- DNA directs the synthesis of RNA, which in turn directs protein synthesis

Nucleic Acids

- **Function:**
  - store & transmit hereditary information
- **Examples:**
  - RNA (ribonucleic acid)
  - DNA (deoxyribonucleic acid)
- **Structure:**
  - monomers = nucleotides


Thank you!