STRUCTURE OF DNA AND THEIR FUNCTION

INTRODUCTION

Nucleic acids are biological molecules essential for known forms of life on earth.They include DNA and RNA. Its discovered by Friedrich Miescher in 1869. They are named so because of their initial discovery in nucleus. DNA stands for deoxyribo nucleic acid. This chemical substance is present in the nucleus of all cells in all living organisms. DNA controls all the chemical changes which take place in cells. The kind of cell which is formed, (muscle, blood, nerve etc) is controlled by DNA

- ✓ DNA is a very large molecule made up of a long chain of sub-units
- ✓ The sub-units are called nucleotides
- ✓ Each nucleotide is made up of a sugar called deoxyribose , a phosphate group -PO4 and an organic base(Nitrogenous base).

Nucleic Acids

There are two kinds of nucleic acids in cells:

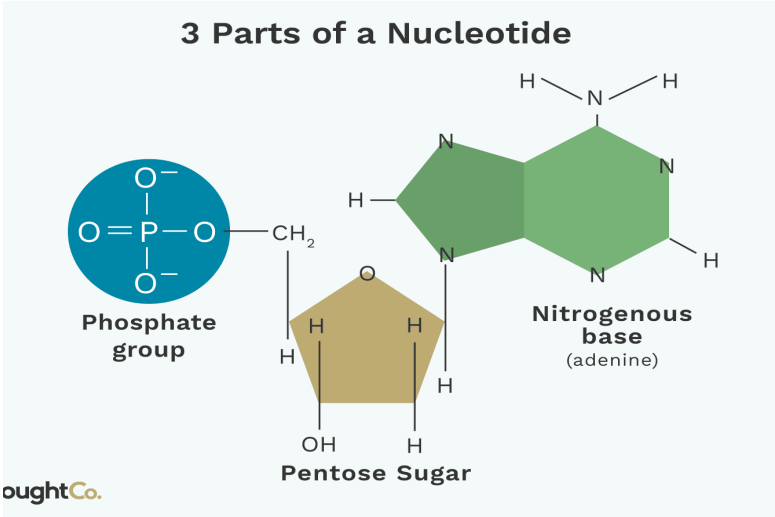
Ribonucleic acids (RNA)

Deoxyribonucleic acids (DNA)

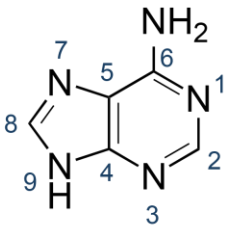
Both RNA and DNA are polymers built from monomers called nucleotides. A nucleotide is composed of a base, a monosaccharide, and a phosphate.

NUCLEOTIDES

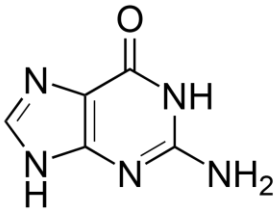
The deoxyribose,the phosphate and one of the bases Combine to form a nucleotide



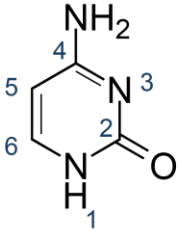
THE BASES



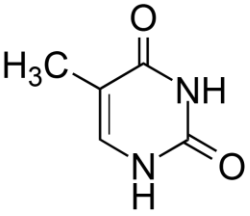
adenine (A)



guanine (G)

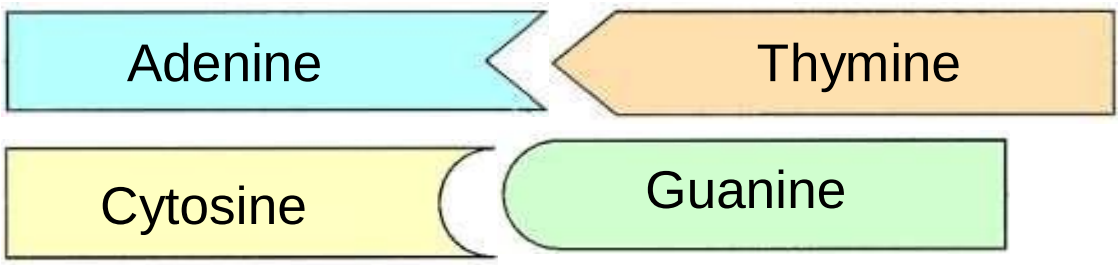


cytosine (C)



thymine (T)

The bases always pair up in the same way Adenine forms a bond with Thymine and Cytosine bonds with Guanine

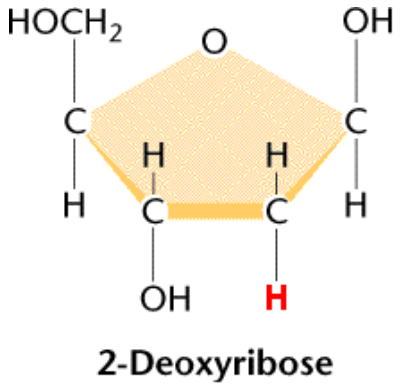


- Adenine and guanine are known as PURINES
- Thymine and cytosine are known as PYRIMIDINES, in RNA instead of thymine it is Uracil
- Adenine pairs with Thymine forming two hydrogen bonds
- Cytosine pairs with Guanine forming with three hydrogen bonds

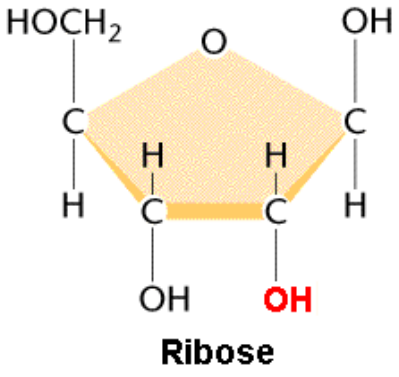
Purines	Pyrimidines
Purines are double ringed structures	Pyrimidines are single ringed structures
Example of purine bases are Adenine and Guanine	Example of pyrimidine bases are Thymine and Cytosine(in DNA), Uracil and cytosine (in RNA)

THE SUGARS:RIBOSE & DEOXYRIBOSE

Ribose is a sugar, like glucose, but with only five carbon atoms in its molecule. Deoxyribose is almost the same but lacks one oxygen atom. Both molecules may be represented by the symbol



2-Deoxyribose



Ribose

(Klug & Cummings 1997)

NUCLEOSIDE	NUCLEOTIDE
Nucleoside is a component formed by the union of a nitrogen base with a pentose sugar	Nucleotide is a component formed by the union of a nitrogen base, a pentose sugar and phosphate
It is a component of nucleotide	It formed after phosphorylation of nucleoside

Nucleic acids made up of nucleotides found in all living cells except RBC

DNA is in the nucleus

RNA is in the cytoplasm

FUNCTIONS OF DNA:

It is the genetic material, therefore responsible for carrying all the hereditary information.

It has property of replication essential for passing genetic information from one cell to its daughters or from one generation to next.

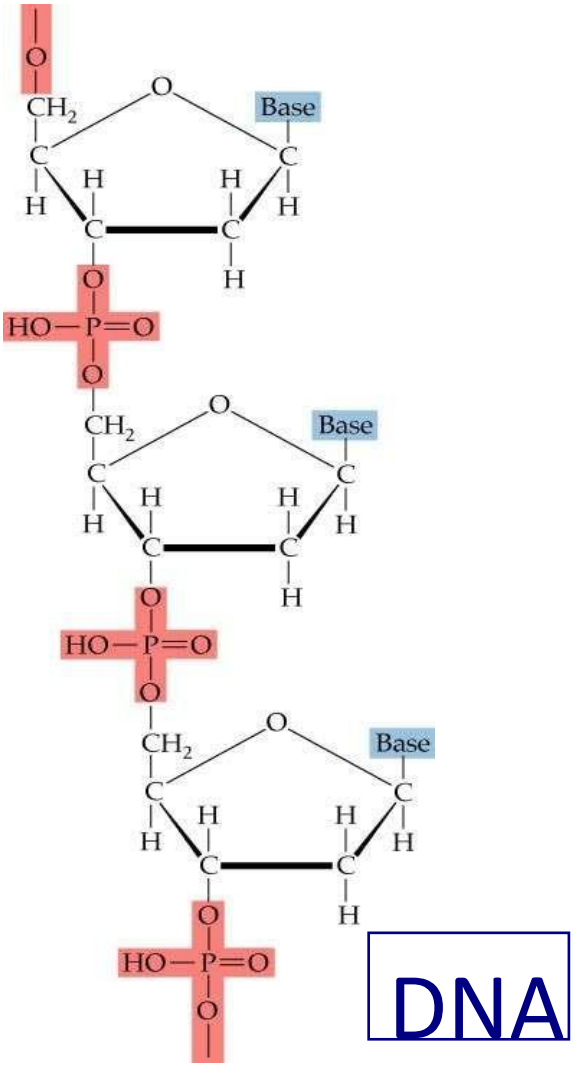
Crossing over produces recombination

Changes in sequence and no. of nucleotides causes Mutation which is responsible for all variations and formation of new species.

It controls all the metabolic reaction of cells through RNAs and RNA directed synthesis of proteins.

DNA and RNA Strand

The sequence of the bases in DNA or RNA form the primary structure. A molecule of DNA is formed by millions of nucleotides joined together in a long chain.



ROLE OF PHOSPHODIESTER LINKAGE

Phosphodiester Bonds Link Successive Nucleotides in Nucleic Acids.The successive nucleotides of both DNA and RNA are covalently linked through phosphate-group “bridges,” in which the 5’- phosphate group of one nucleotide unit is joined to the 3-hydroxyl group of the next nucleotide, creating a phosphodiester linkage .

DNA - 2° Structure

Secondary structure: the ordered arrangement of nucleic acid strands – the double helix model of DNA 2° structure was proposed by James Watson and Francis Crick in 1953.

Double helix: a type of 2° structure of DNA in which two polynucleotide strands are coiled around each other in a screw-like fashion.

Like a spiral staircase:

The phosphate sugar backbone represents the hand rail, the bases represent the steps

Hydrogen bonding occurs between the bases

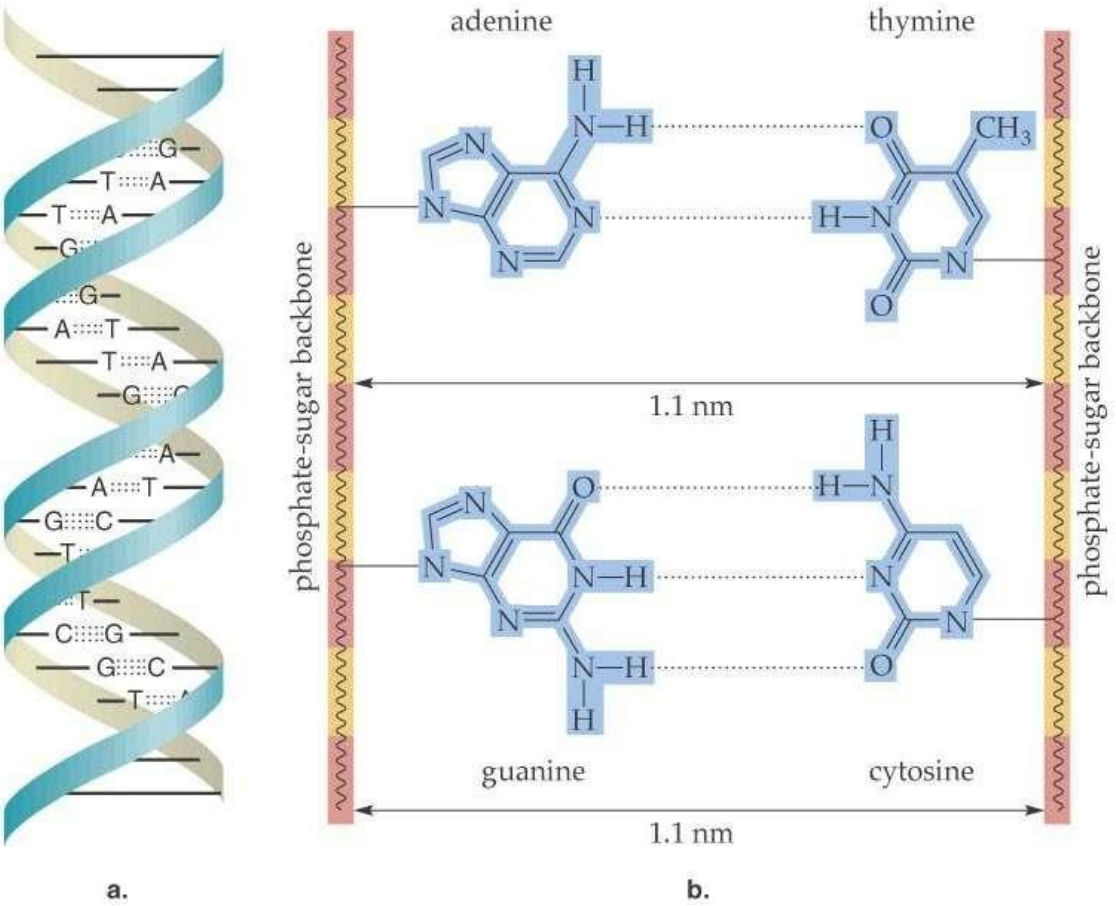
For DNA:

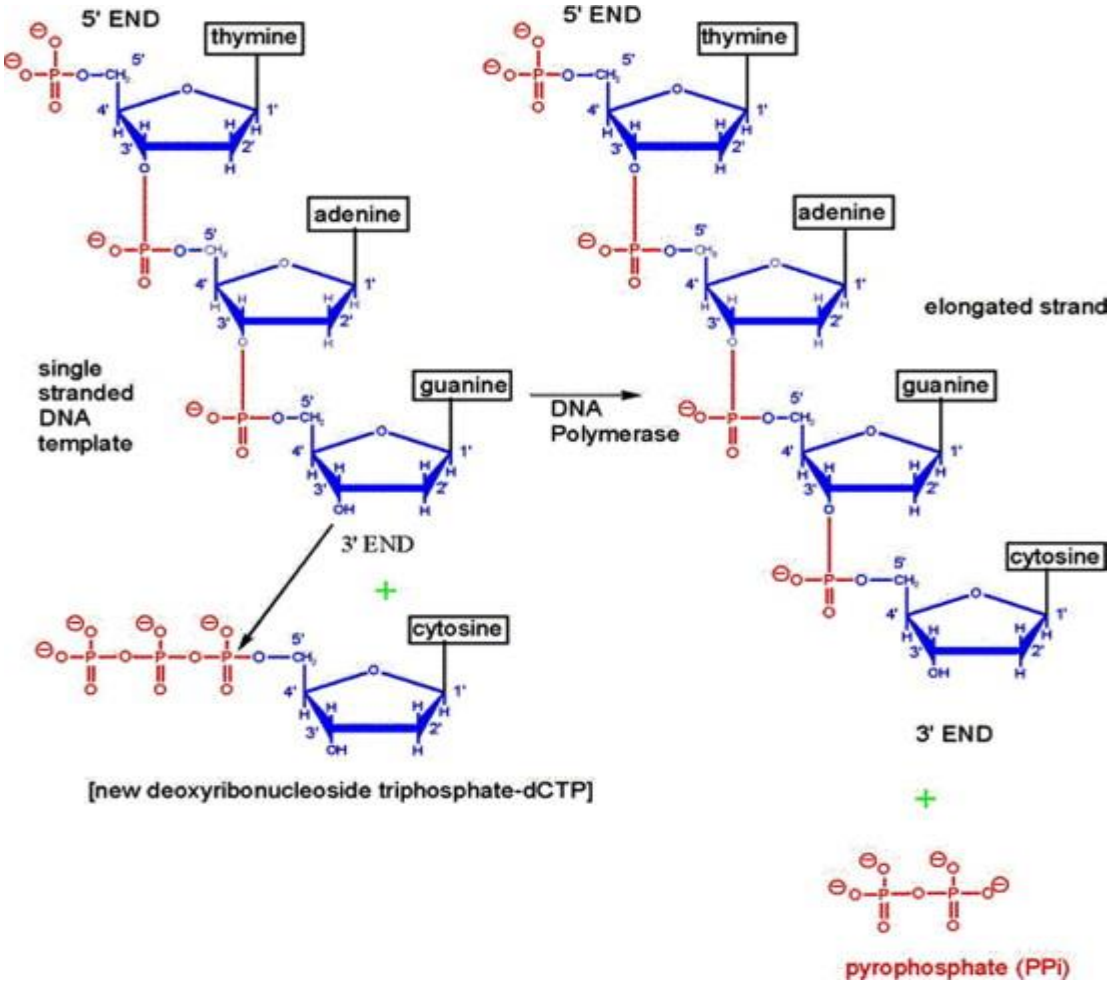
A bonds with T C bonds with G

For RNA:

A bonds with U C bonds with G

(a) Schematic diagram of double helix of DNA (b) Base pairings in DNA





ANTI PARALLEL NATURE:

The two strands of DNA are also antiparallel(run in opposite directions) to one another.

A strand of DNA can have the direction 5'-3' or 3'- 5'.

One strand in the DNA molecule is 5'-3'and the other strand is 3'-5'

Two helical polynucleotide chains are coiled around a common axis. The chains run in opposite directions.

The sugar-phosphate backbones are on the outside and, therefore, the purine and pyrimidine bases lie on the inside of the helix.Adenine always pairs with Thymine, Guanine binds with Cytosine

The bases are nearly perpendicular to the helix axis, and adjacent bases are separated by 3.4 Å.

The helical structure repeats every 34 Å, so there are 10 bases (= 34Å per repeat/3.4 Å per base) per turn of helix.

There is a rotation of 36 degrees per base (360 degrees per full turn/10 bases per turn).

The diameter of the helix is 20 Å.

Higher Structure of DNA

DNA is coiled around proteins called histones.

Histones are rich in the basic amino acids Lys and Arg, whose side chains have a positive charge.

The negatively-charged DNA molecules and positively-charged histones attract each other and form units called nucleosomes.

Nucleosome: a core of eight histone molecules around which the DNA helix is wrapped.

Nucleosomes are further condensed into chromatin.

Chromatin fibers are organized into loops, and the loops into the bands that provide the superstructure of chromosomes.