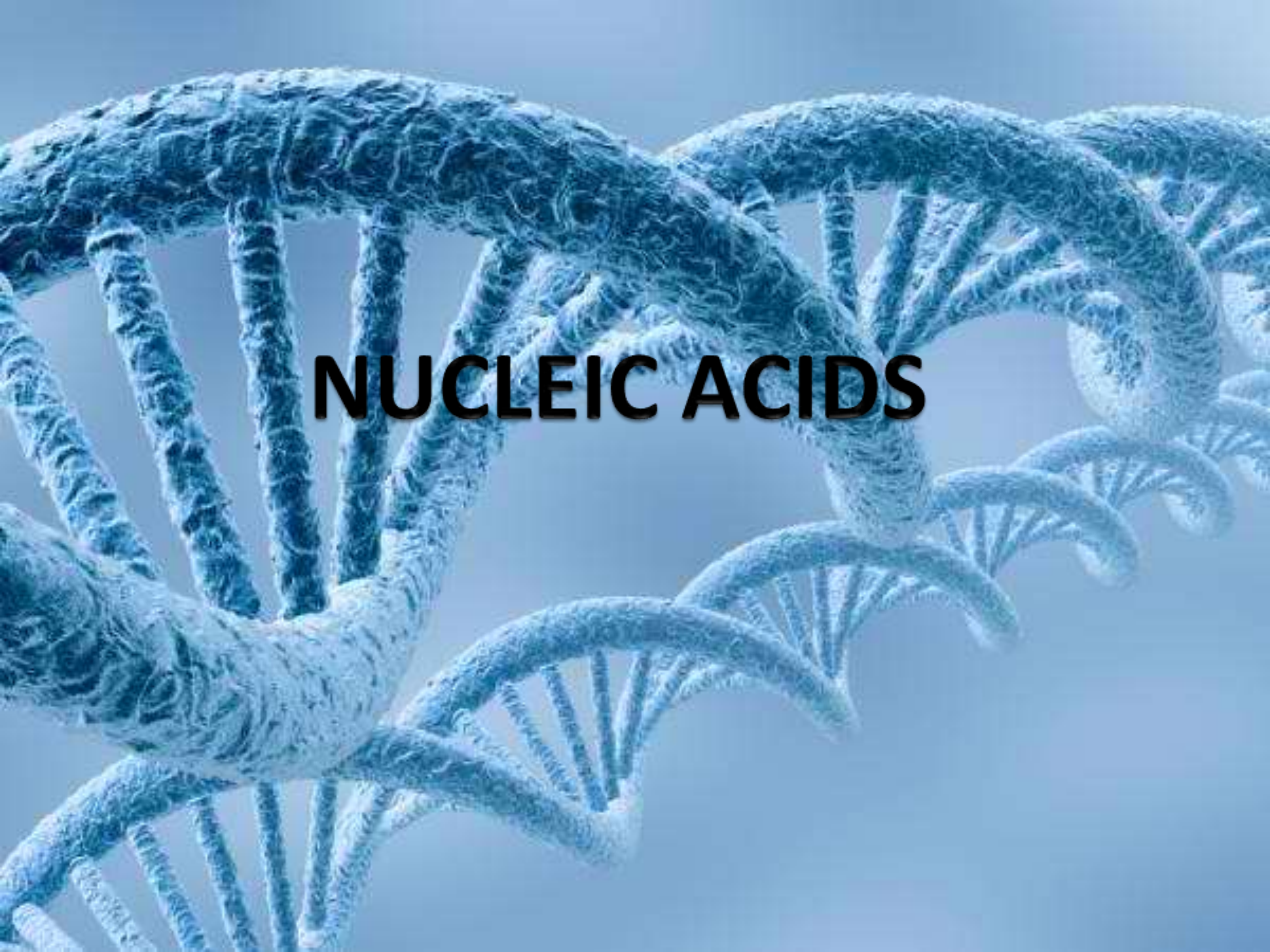

NUCLEIC ACIDS

NUCLEIC ACIDS

Are the largest and the most complex organic molecules. Friedrich Miescher who discovered nucleic acids in 1871

- NUCLIEC ACIDS are macromolecules, found in all cells, which precipitate in the storage, transmission and translation of genetic information.

- There are two types of nucleic acids, the ribose nucleic acid (RNA) and the deoxyribose nucleic acid (DNA), which on hydrolysis yield the sugar ribose and deoxyribose respectively.

- **Nucleic acids** were first isolated from the cellular nucleus, hence the name. Nucleic acids are macromolecules, huge polymers with molecular masses of over 100 million.

FUNCTION OF NUCLEIC ACIDS:

- **Functions of DNA (deoxyribonucleic acid):**
  -DNA is a permanent storage place for genetic information.
  -DNA controls the synthesis of RNA (ribonucleic acid).
  -The sequence of nitrogenous bases in DNA determines the protein development in new cells.

- The function of the double helix formation of DNA is to ensure that no disorders occur. This is because the second identical strand of DNA that runs anti-parallel to the first is a back up in case of lost or destroyed genetic information. *Ex*. Down’s Syndrome or Sickle Cell Anemia.

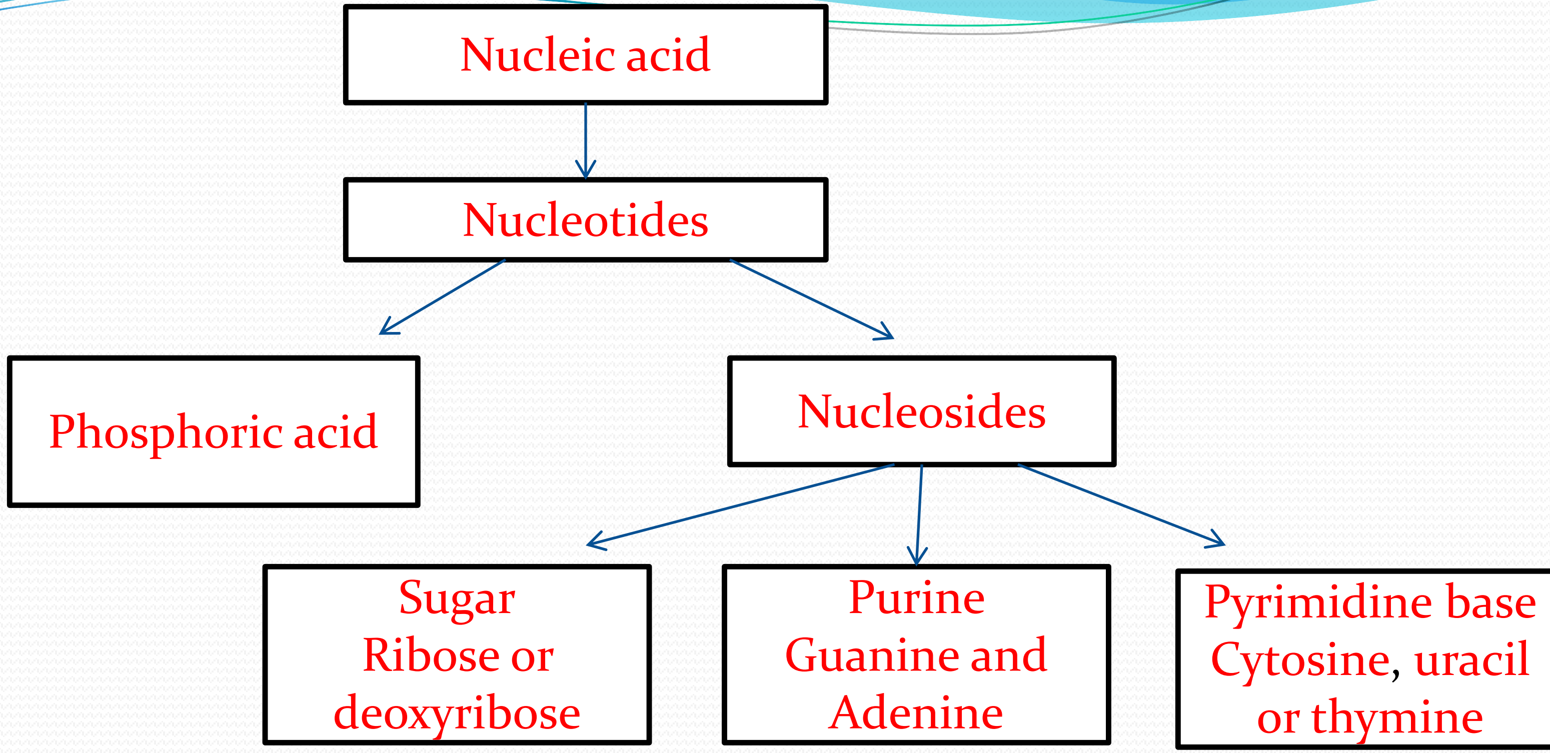
- **Functions of RNA (ribonucleic acid):**
  -RNA is synthesized by DNA for the transportation of genetic information to the protein building apparatus in the cell.
  -RNA also directs the synthesis of new proteins using the genetic information it has transported.
  -mRNA (messenger ribonucleic acid) is used to transfer genetic information through plasma membranes

- **Nucleic acids** (specifically DNA) carry out a vital role in the human body. In particular, nucleic acids play an essential role in: **Mitosis**, **Meiosis**
- **Providing Energy / Cellular Respiration**

- **Mitosis** – During cell division, the chromosomes (or genetic information) contained inside the nucleus of the parent cell is duplicated. The two resulting daughter cells have identical genetic information to the parent cell. This is possible only through nucleic acid’s remarkable ability to create identical copies of itself. It is the only molecule known to have this ability. Mitosis is essential to life because it replaces damaged or dead cells, repairs tissues, and allows the body to grow (in mass and size).
- **Meiosis** – Another use for nucleic acid’s duplication ability is meiosis. Meiosis is the process in which sex cells are created. Without nucleic acids, meiosis would be impossible, and so would reproduction.
- **Providing Energy** – Nucleic acids can be used to create energy in the form of ATP (adenosine triphosphate - C10H16N5O13P3). ATP is formed with the nitrogenous bases adenosine and ribose.

Composition of Nucleic Acids:

- Nucleic acids are substances with high molecular weight ranging from 1,286 to 3,000,000. They are made up of carbon, hydrogen, oxygen, nitrogen and phosphorus.
- Nitrogen is from 15 to 16% while phosphorus is from 9 to 10%. On hydrolysis with either an enzyme or by heating with dilute acids or alkalies, nucleic acids yields a group of compound known as nucleotides.


Nucleic acid
Nucleotides
Phosphoric acid
Nucleosides
Sugar
Ribose or
deoxyribose
Purine
Guanine and
Adenine
Pyrimidine base
Cytosine, uracil
or thymine

Kinds of Nucleic Acids

- DNA(deoxyribonucleic acid) –found only inside the nucleus of the cell. Contains the organism's genetic information, including instructions for how to make proteins.
- RNA(ribonucleic acid) – found both inside and outside of the nucleus. Directs the building of proteins.

  -primarily concerned with the synthesis of protein.
- ***POLYPEPTIDES*** are the building blocks of nucleic acids.

DNA

- Deoxyribonucleic acid is a nucleic acid that contains the genetic instructions used in the development and functioning of all known living organisms. The main role of DNA molecules is the long-term storage of information and DNA is often compared to a set of blueprints, since it contains the instructions needed to construct other components of cells, such as proteins and RNA molecules.

- The DNA segments that carry this genetic information are called genes, but other DNA sequences have structural purposes, or are involved in regulating the use of this genetic information.

- Deoxyribose is present in the nucleic acid found in the yeast cell nuclei, while ribose is contained in the nucleic acid obtained from pancreas.
  - There are cases also were both of nucleic acids are found together. So that it is now definitely accepted that both the ribose and deoxyribose nucleic acids are found in plants and animals; and that while the deoxyribose type is found in the nucleic of the cells (white) the ribose type predominate in the cytoplasm

- Some amount of DNA are also housed in the cell’s mitochondria, whose main function is to generate the energy needed for the cell functioning, it couldn’t be in the cell wall, because human cells are bound by membrane and lack the cell walls that plants have.

- There are DNA viruses, like herpes but some of the most prevalent, like the common cold or influenza, as well as other well-known viruses like hepatitis C and are RNA viruses.

RNA

- Ribonucleic acid (RNA) functions in converting genetic information from genes into the amino acid sequences of proteins. The three universal types of RNA include transfer RNA (tRNA), messenger RNA (mRNA), and ribosomal RNA (rRNA). *Messenger RNA* acts to carry genetic sequence information between DNA and ribosomes, directing protein synthesis. *Ribosomal RNA* is a major component of the ribosome, and catalyzes peptide bond formation.

- Transfer RNA serves as the carrier molecule for amino acids to be used in protein synthesis, and is responsible for decoding the mRNA. In addition, many other classes of RNA are now known.
- Ribonucleic acid is found only in plants while the deoxyribonucleic acid is exclusive of animal products

Kinds of RNA

1. Transfer RNA – 10 tO 15%

-small, about 80 nucleotides long.

-transport amino acids to site of protein synthesis.

-exhibits extensive inter chain of bonding represent by clover leaf structure.

2) Ribosomal RNA – 75 to 80%

-several kinds –variable in size

-combines with proteins to form ribosome's, the site oh CHON synthesis.

- molecules to be quite large.

3) Messenger RNA

-variable size(its size varies with the size of CHON)

-directs amino acids sequence of proteins

- extent of it bonding is very little.

- in most cells it constitutes not more than 5% to 10% of the total cellular RNA.

Properties of Nucleic Acids:

- Nucleic acids are insoluble in alcohol, slightly soluble in cold water, but readily dissolved in hot water and dilute alkalies, forming alkali salts. They are precipitated by HCL and by excess of acetic acid.
- Feulgen Test differentiates the DNA from RNA, if the deoxyribose sugar is present, a rd color is produced with the dye. Ribose sugar do not exhibit this reaction.

- **Hydrolysis of nucleic acids gives nucleotide, which can be considered the units that make up the polymer. A nucleotide consists of three parts:**
    1. **Heterocyclic base**
    2. **sugar**
    3. **phosphoric acids**

Sugar

The sugar in nucleotide, and so in nucleic acids , is a PENTOSE. In RNA and its nucleotide the sugar is RIBOSE, whereas in DNA and its nucleotide it is DEOXYRIBOSE. The prefix deoxy - means "without oxygen" .

Nucleotides can be hydrolyzed to yield nucleosides and phosphoric acid.

HETEROCYCLIC BASES

- Present in nucleic acids are divided into two types- PURINES and PYRIMIDINES. The two Purines present both DNA and RNA are adenine and guanine. The Pyrimidines cytosine is present in both DNA and RNA, whereas thymine is found in DNA only and Uracil is present in RNA only.

THE PYRIMIDINES

- **Pyrimidines is a six-membered heterocyclic ring containing two nitrogen atom. Three important derivatives of Pyrimidine found in nucleic acids are thymine(2,4-dioxy-5-methylpyrimidine), cytosine(2-oxy-4-aminopyrimidine), and Uracil(2,4-dioxypyrimidines).**
- **Other important compound containing Pyrimidines are thiamin (vitamin B one).**

THE PURINES

The **Purines** found in nucleic acids are derivatives of a substances, Purine, that does not occur naturally. As indicated by their structures, **adenine** is 6-amino-purine and **guanine** is 2-amino-6-oxypurine.

Other Purine include **caffeine** and **theophylline**. **Caffeine** is a stimulant for the central nervous system and also a diuretic, and found in coffee and tea. Its chemical name is 1,3,7-trimethyl-2,6-dioxypurine. **Theophylline**, 1,3-dimethyl-2,6-dioxypurine, is found in tea and is used medically as a diuretic and for bronchial asthma.Uric acid is the end product of purine metabolism.

- DNA are very long molecules with specific sequence of the for principal bases Adenine,Thymine,Guanine,Cytosine- A,T,G,C.
- The two chains of the helix are coiled to allow the proper hydrogen bonding. They are complementary in terms of appropriate pairing, A to T and C to G.

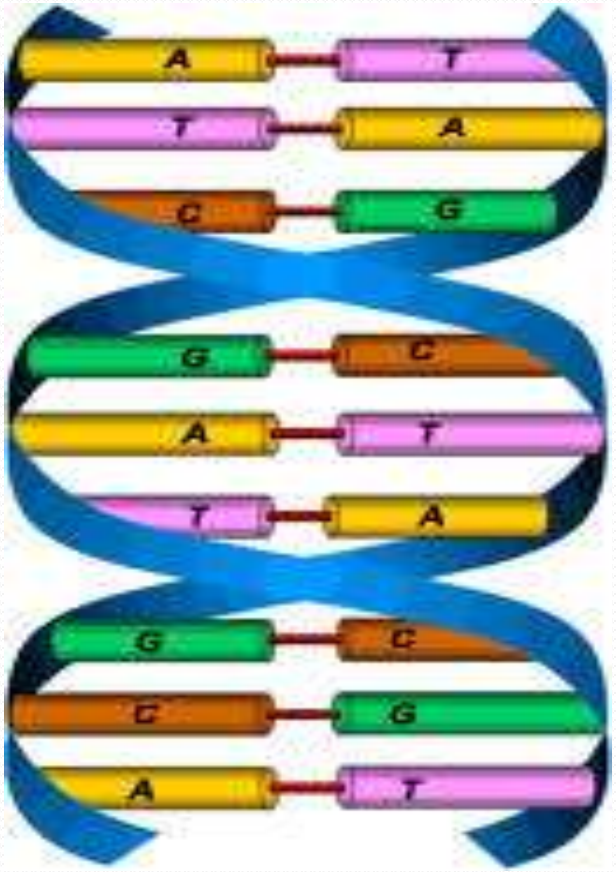
Nucleic acids and their derivatives

- Are not dietary essentials.
- They can be synthesize in vivo from amino acids and other substances.
- They influence the general pattern of metabolism (in chromosomes, viruses and other cells) and act as cytoplasmic regulations of protein synthesis.

Levels of structure in Nucleic acids

1. **Primary structure of nucleic acids is the order of bases in the polynucleotide sequence.**
2. **Secondary structure is the 3-dimensional conformation of the backbone.**
3. **Tertiary structure is specifically the super coiling of the molecule.**

- In the early 1950s, four scientists, James Watson and Francis Crick at Cambridge University and Maurice Wilkins and Rosalind Franklin at King's College, determined the true structure of DNA from data and X-ray pictures of the molecule that Franklin had taken. In 1953, Watson and Crick published a paper in the scientific journal *Nature* describing this research. Watson, Crick, Wilkins and Franklin had shown that not only is the DNA molecule double-stranded, but the two strands wrap around each other forming a coil, or helix. The true structure of the DNA molecule is a double helix, as shown at right.



- **The double-stranded DNA molecule has the unique ability that it can make exact copies of itself, or self-replicate. When more DNA is required by an organism (such as during reproduction or cell growth) the hydrogen bonds between thenucleotide bases break and the two single strands of DNA separate. New complementary bases are brought in by the cell and paired up with each of the two separate strands, thus forming two new, identical, double-stranded DNA molecules. This concept is illustrated in the animation below.**

Secondary structure of DNA

- double helix

-DNA consists of 2 polynucleotide chains wrapped around each other to form a helix.

-the sugar PO_4 backbones, run in antiparallel directions on the 2 strands , lie on the outside of the helix.

-pairs of bases, one on each strands, are held in alignment hydrogen bonds. The bases pairs lie in a plane perpendicular to the helix axis.

-no twists in it other than the helica twists.

Tertiary structure of DNA :

- **super coiling**
- **further twisting & coiling of double helix.**

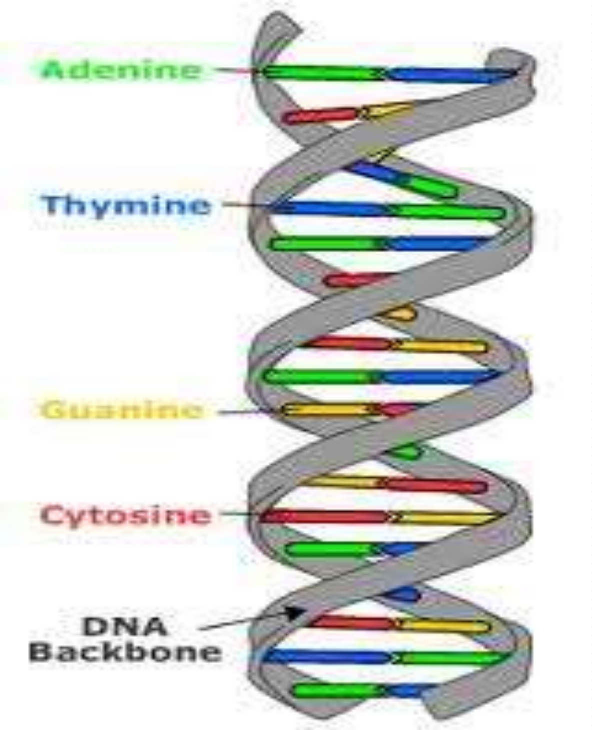
Ex: prokaryotes and eukaryotes

RNA

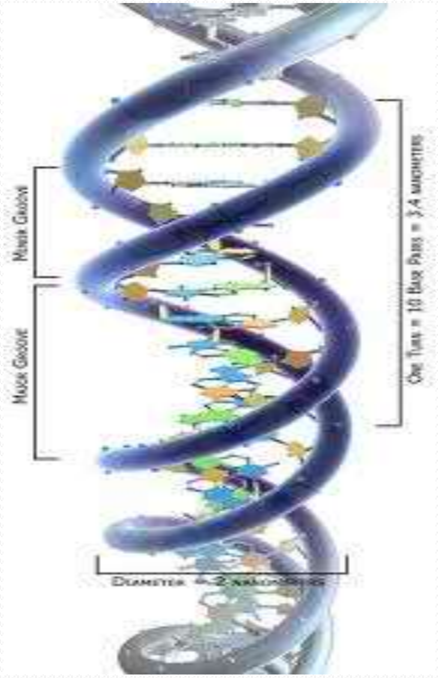
Ribonucleic acid, or RNA, gets its name from the sugar group in the molecule's backbone - ribose. Several important similarities and differences exist between RNA and DNA. Like DNA, RNA has a sugar-phosphate backbone with nucleotide bases attached to it. Like DNA, RNA contains the bases adenine (A), cytosine (C), and guanine (G); however, RNA does not contain thymine, instead, RNA's fourth nucleotide is the base uracil (U)

- Unlike the double-stranded DNA molecule, RNA is a single-stranded molecule. RNA is the main genetic material used in the organisms called viruses, and RNA is also important in the production of proteins in other living organisms. RNA can move around the cells of living organisms and thus serves as a sort of genetic messenger, relaying the information stored in the cell's DNA out from the nucleus to other parts of the cell where it is used to help make proteins.

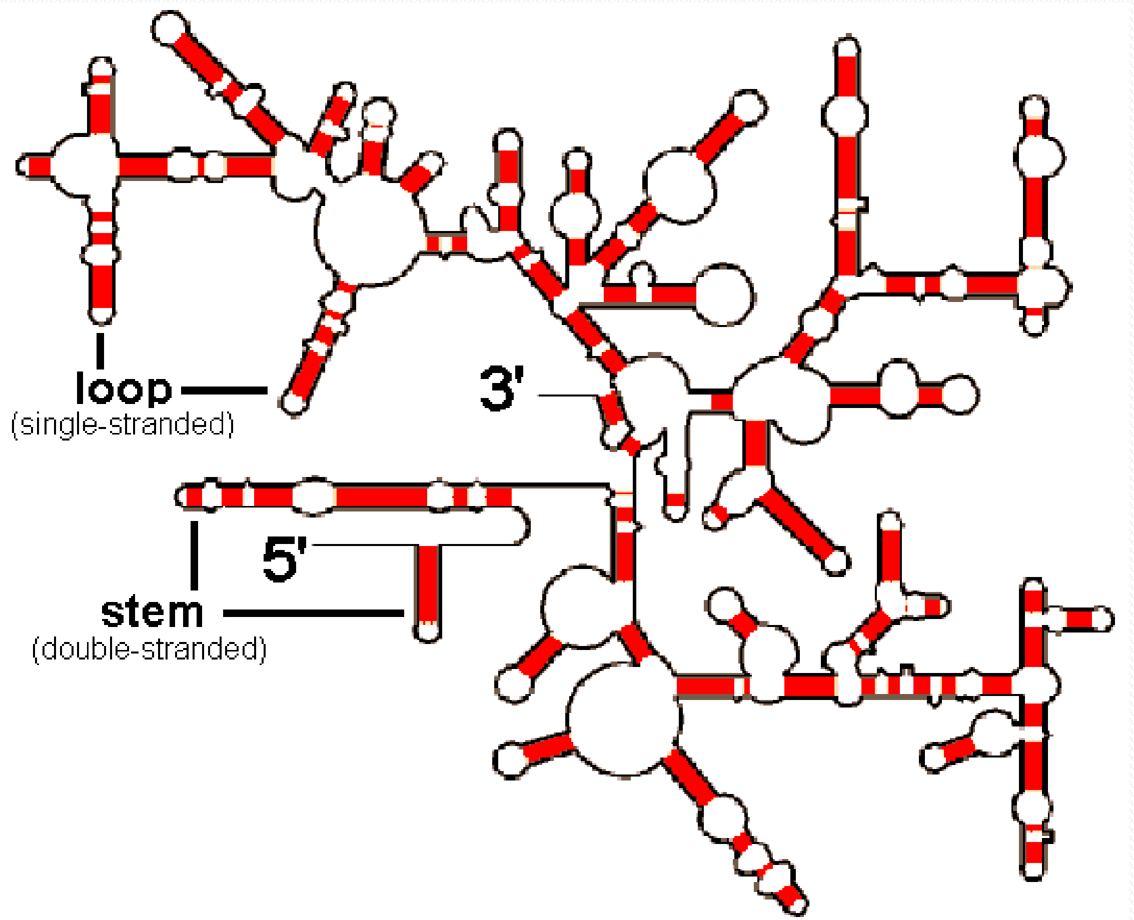
DNA BASES



DNA STRUCTURE



RNA STUCTURE



- NUCLEOPROTIENS

Properties of Nucleoprotein:

- Nucleoproteins are frankly acidic and are soluble in alkalies with which they form salt. They precipitated from their solutions by acetic acid -- are redissolved by dilute HCL. They are not coagulated by -- but exhibit the precipitation and color reactions characteristic of protein substances.

Importance of nucleoproteins:

- Their importance lies in the increasing evidence that they are closely associated with the chromosomes of the cells.
- In the bacteria cells, substances have been demonstrated, which can transform one genetic type of bacteria into another genetic strain. They have been proven to be deoxyribonucleic acid

MUTATION

- Mutations can involve large sections of DNA becoming duplicated, usually through genetic recombination. These duplications are a major source of raw material for evolving new genes, with tens to hundreds of genes duplicated in animal genomes every million years. Most genes belong to larger families of genes of shared ancestry. Novel genes are produced by several methods, commonly through the duplication and mutation of an ancestral gene, or by recombining parts of different genes to form new combinations with new functions.

- **nucleoprotein,** conjugated protein consisting of a protein linked to a nucleic acid, either DNA (deoxyribonucleic acid) or RNA (ribonucleic acid). The protein combined with DNA is commonly either histone or protamine; the resulting nucleoproteins are found in chromosomes. Many viruses are little more than organized collections of deoxyribonucleo proteins. Little is known about the proteins linked with RNA; unlike protamine and histone, they appear to contain the amino acid tryptophan.
- The term nucleo is derived from the early erroneous belief that nucleoproteins occurs only in the nucleic cells.

Nucleotides and Nucleosides

- **Nucleotides are the building blocks of all nucleic acids.** Nucleotides have a distinctive structure composed of three components covalently bound together:
- **a nitrogen-containing "base"** - either a pyrimidine (one ring) or purine (two rings)
- **a 5-carbon sugar** - ribose or deoxyribose
- **a phosphate group**

- **The combination of a base and sugar is called a *nucleoside*.** Nucleotides also exist in activated forms containing two or three phosphates, called nucleotide diphosphates or triphosphates. If the sugar in a nucleotide is deoxyribose, the nucleotide is called a deoxynucleotide; if the sugar is ribose, the term ribonucleotide is used.
- **The structure of a nucleotide is depicted below.** The structure on the left - deoxyguanosine - depicts the base, sugar and phosphate moieties. In comparison, the structure on the right has an extra hydroxyl group on the 2' carbon of ribose, making it a ribonucleotide - riboguanosine or just guanosine