Introduction of Molecular Biology

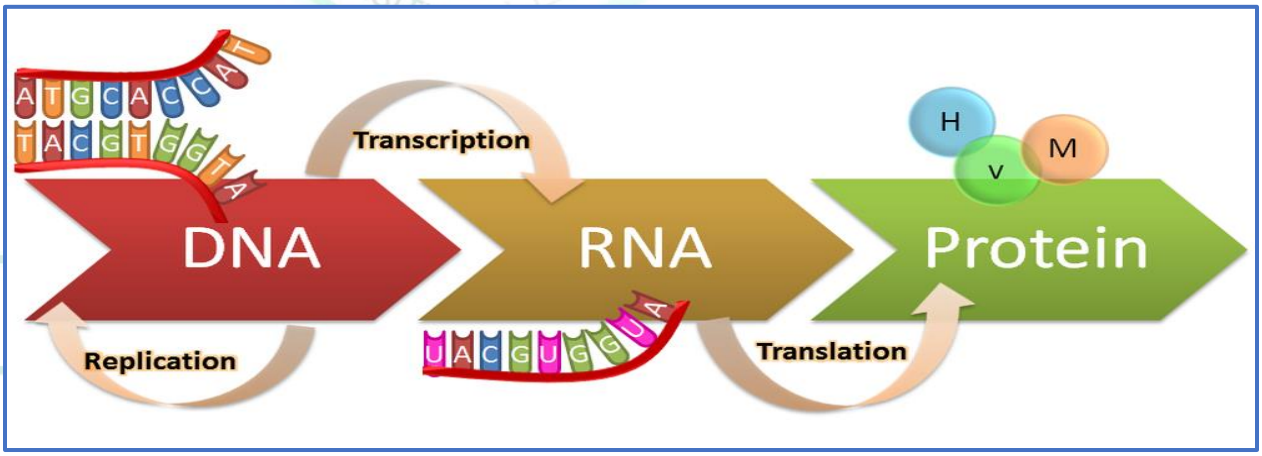
Molecular Biology Defining

The study of the formation, structure, and function of macromolecules essential to life, such as nucleic acids and proteins and their role in cell replication and the transmission of genetic information.

Central Dogma of Molecular Biology

In molecular biology, central dogma illustrates the flow of genetic information from DNA to RNA to protein. It is defined as a process in which the information in DNA is converted into a functional product.

It is suggested that the information present in a DNA is essential to make up all proteins and RNA acts as a messenger that carries information through the ribosomes. It was first stated by Francis Crick in 1957, then published in 1958.



History of deoxyribonucleic acid (DNA):

Nucleic acids, macromolecules made out of units called nucleotides, come in two naturally occurring varieties: **deoxyribonucleic acid** (**DNA**) and **ribonucleic acid** (**RNA**).

The history of deoxyribonucleic acid (DNA) research begins with Friedrich Miescher, a Swiss biologist who in 1868 carried out the first carefully thought-out chemical studies on the nuclei of cells.

In 1928, Frederick Griffith, a British medical officer and geneticist, made a series of unexpected observations while performing an experiment with the disease-causing bacteria pneumococcus and laboratory mice.

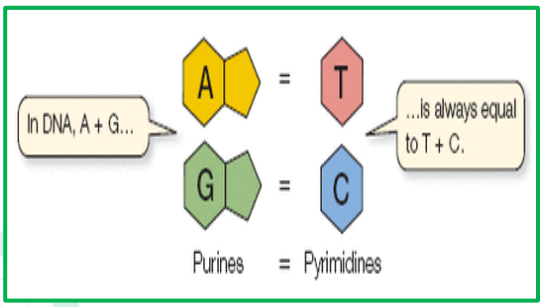
In 1944, group of American scientists Oswald Avery, Colin MacLeod, and Maclyn McCarty published the 1st experiment to demonstrate that DNA was the genetic material. They repeated the Griffith's experiments themselves and tried to purify the transforming principle initially without success.

In 1952, Alfred Hershey and Martha Chase showed by means of radioactive isotope tracer experiments that when a bacterial virus (bacteriophage T2) infects its host cell (the bacterium Escherichia coli), it is the DNA of the T2 virus, and not its protein coat, which enters the host cell and provides the genetic information for replication of the virus.

Hershey shared the 1969 Nobel Prize in Physiology or Medicine for his “discoveries concerning the genetic structure of viruses.”

In the late 1940s, Erwin Chargaff, an Austrian biochemist who emigrated to the United States during the Nazi era, and his colleagues at Columbia University analyzed the nitrogenous bases in many different forms of life and discovered two rules (now Chargraff's rules, or rules of base pairing, or nucleotide pairing) which state that in DNA:

1. The ratio of pyrimidines to purines must be 1:1, with the amount of the adenine (A) equal to the thymine (T), and guanine (G) equal to cytosine (C).



2. The composition of DNA varies from one species to another.

• The amount of adenine +guanine = 50% of the total. (So 50% of the bases are purines).

• The amount of cytosine +thymine = 50% of the total. (So 50% of the bases are pyrimidines).

Rosalind Franklin was a British chemist and X-ray crystallographer whose work was central to the understanding of the molecular structures of DNA (deoxyribonucleic acid), RNA (ribonucleic acid). In 1951 she applied X-ray diffraction methods to the study of DNA.

In 1953, James Watson and Francis Crick proposed that DNA has a double helix structure made up of two complementary strands, each consisting of a sugar-phosphate backbone and nitrogenous bases.

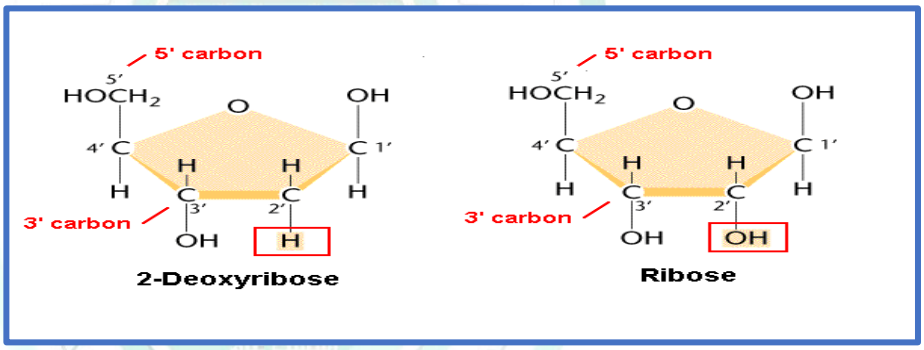
Nucleotide Structure

Nucleic acids (DNA and RNA) are assembled from nucleotides, which consist of three components: a nitrogenous base, a five-carbon sugar (pentose), and phosphate.

1-Five-Carbon Sugars

Nucleic acids are classified according to the pentose they contain.

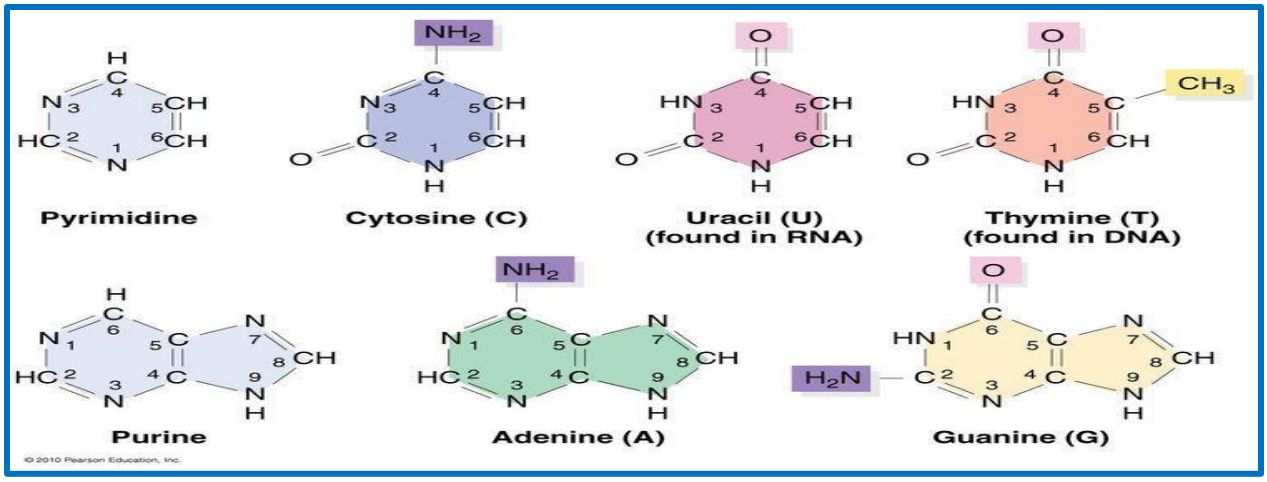
If the pentose is ribose, the nucleic acid is RNA (ribonucleic acid); if the pentose is deoxyribose, the nucleic acid is DNA (deoxyribonucleic acid).



2-Nitrogenous Bases

There are two types of nitrogen-containing bases commonly found in nucleotides:

1. Purines contain two rings in their structure. The two purines commonly found in nucleic acids are Adenine (A) and Guanine (G); both are found in DNA and RNA.
2. Pyrimidines have only one ring. Cytosine (C) is present in both DNA and RNA. Thymine (T) is usually found only in DNA, whereas Uracil (U) is found only in RNA.



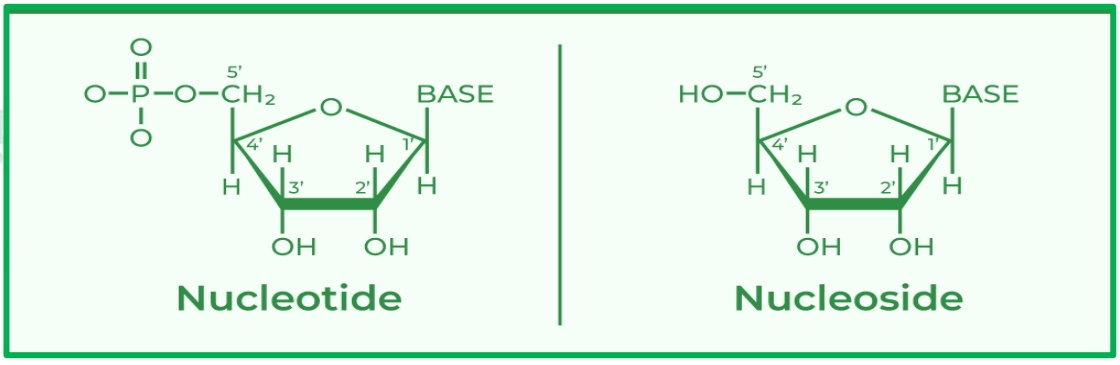
3-Phosphate group

Phosphorus atom surrounded by four oxygen atoms

Nucleosides and Nucleotides

Nucleosides are formed by covalently linking a base to the number 1 (1′) carbon of a sugar. The numbers identifying the carbons of the sugar are labeled with "primes" in nucleosides and nucleotides to distinguish them from the carbons of the purine or pyrimidine base.

Nucleotides are formed when one or more phosphate groups is attached to the 5′ Carbon of a nucleoside.



Experiment. He studied the difference between two strains of bacteria Streptococcus peumoniae – a disease-causing strain and a strain that did not cause pneumonia. The pneumonia-causing strain (the S-strain) was surrounded by a capsule. The other strain (the R-strain) did not have a capsule and also did not cause pneumonia.

Griffith was able to induce a non-pathogenic strain of the bacterium S. pneumoniae to become pathogenic. Griffith injected the different strains of bacteria into mice. The S-strain (virulent) killed the mice; the R-strain (avirulent) did not. He further noted that if heat killed S-strain was injected into a mouse, it did not cause pneumonia. When he combined heat-killed S with live R and injected the mixture into a mouse (remember neither alone will kill the mouse) that the mouse developed pneumonia and died. Bacteria recovered from the mouse had a capsule and killed other mice when injected into them! Griffith referred to a transforming factor that caused the non-pathogenic bacteria to become pathogenic.