Nucleic acids

Nucleic acids are biopolymers, or large biomolecules, essential to all known forms of life. They are composed of monomers called nucleotides. The main function of nucleic acids is store and transfer genetic information. They are found in abundance in all living cells, where they function to create and encode and then store information in the nucleus of every living cell of every life form organism on earth. Nucleic acids were discovered in 1869, by Swiss physician Friedrich Miescher. There are two types of nucleic acids: deoxyribonucleic acid (known as DNA) and ribonucleic acid (known as RNA).

Nucleotides:

Nucleotides are organic molecules that serve as the monomer units for forming the nucleic acid polymers DNA and RNA. Nucleotides are the building blocks of nucleic acids. They are composed of three parts: a nitrogenous base, a five-carbon sugar (pentose sugar) ribose or deoxyribose, and at least one phosphate group. They are also known as phosphate nucleosides. The molecule without the phosphate group is called a nucleoside. Therefore, a nucleoside is a nitrogenous base and a 5-carbon sugar. Thus a nucleoside plus a phosphate group yields a nucleotide.

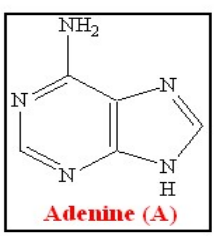
Nucleotides have a number of roles. Most notably they are the monomers for nucleic acid polymers. Nucleoside triphosphates, like ATP and GTP, are energy carriers in metabolic pathways. Nucleotides are also components of some important coenzymes, like FAD, NAD^+ and Coenzyme A.

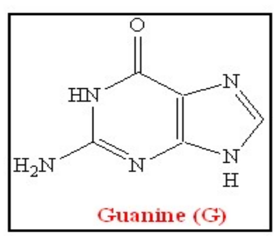
Nitrogenous bases and pentoses:

The nitrogenous bases are derivatives of two parent compounds, pyrimidine and purine. The bases and pentoses of the common nucleotides are heterocyclic compounds. The carbon and nitrogen atoms in the parent structures are conventionally numbered to facilitate the naming and identification of the many derivative compounds. In the pentoses of nucleotides and nucleosides (ribose or deoxyribose) the carbon numbers are given a prime (') designation to distinguish them from the numbered atoms of the nitrogenous bases. The term ribonucleotides are used if the sugar is ribose or deoxyribonucleotides if the sugar is deoxyribose.

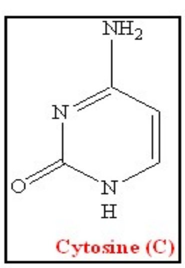
Nucleotides contain either a purine or a pyrimidine base, the nitrogenous base molecule, also known as a nucleobase. The components of the bases are either purines (adenine A and guanine G) or pyrimidines (cytosine C, thymine T, and uracil U). The purine bases adenine and guanine and pyrimidine base cytosine occur in both DNA and RNA, while the pyrimidine bases thymine (in DNA) and uracil (in RNA) in just one. Adenine forms a base pair with thymine with two hydrogen bonds, while guanine pairs with cytosine with three hydrogen bonds.

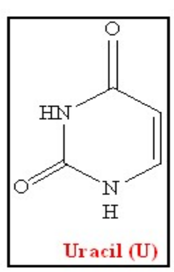
The structures of the two most common purines are:

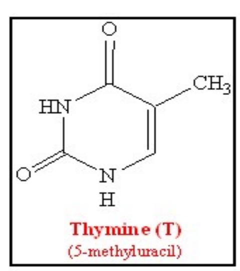




The structures of the three most common pyrimidines are:







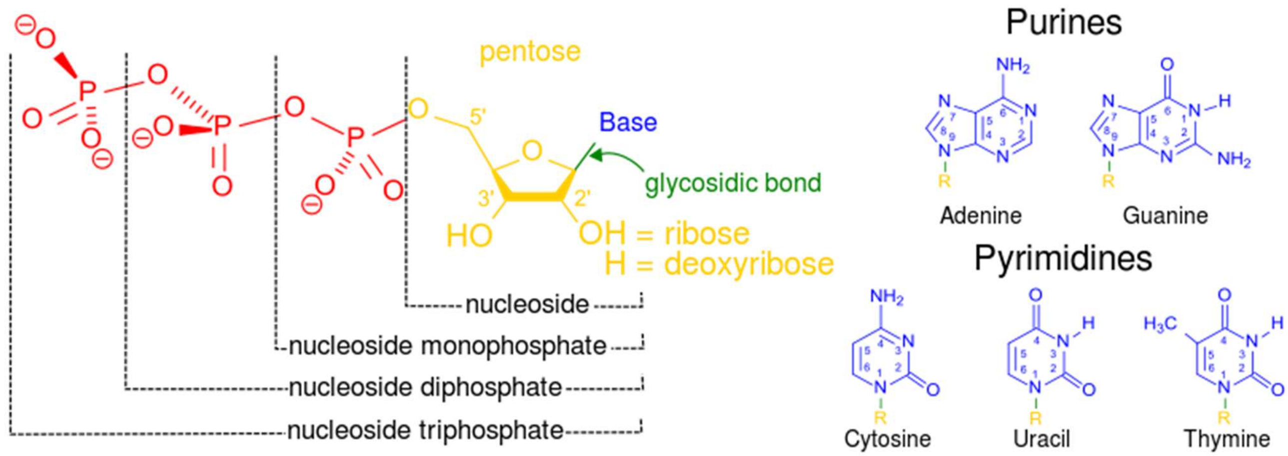


Figure 1: Structural elements of three nucleotides, each in turn is attached to the nucleoside (in yellow, blue, green) at center: 1st, the nucleotide termed as a nucleoside monophosphate nucleotide is formed by adding a phosphate group (in red); 2nd, adding a second phosphate group forms a nucleoside diphosphate nucleotide; 3rd, adding a third phosphate group results in a nucleoside triphosphate nucleotide. The nitrogenous base (nucleobase) is indicated by "Base" and "glycosidic bond" (sugar bond). All five primary bases the purines and pyrimidines are sketched at right (in blue).

Table 1: Naming of nucleosides and nucleotides.

Base	Nucleoside	Nucleotide	Nucleic acid
Adenine	Adenosine Deoxyadenosine	Adenosine-5'-monophosphate Deoxyadenosine-5'-monophosphate	RNA DNA
Guanine	Guanosine Deoxyguanosine	Guanosine-5'-monophosphate Deoxyguanosine-5'-monophosphate	RNA DNA
Cytosine	Cytidine Deoxycytidine	Cytidine-5'-monophosphate Deoxycytidine-5'-monophosphate	RNA DNA
Thymine	Deoxythymidine	Deoxythymidine-5'-monophosphate	DNA
Uracil	Uridine	Uridine-5'-monophosphate	RNA

Structure of DNA:

DNA is a poly deoxyribonucleotide that contains many ribonucleotides covalently linked by 3' to 5' phosphodiester bonds. With the exception of a few viruses that contain single-stranded DNA, DNA exists as a double-stranded molecule, in which the two strands wind around each other, forming a double helix. Phosphodiester bonds join the 5'-hydroxyl group of the deoxypentose of one nucleotide to the 3'-hydroxyl group of the deoxypentose of an adjacent nucleotide through a phosphate group (Figure 2). The resulting long, unbranched chain has polarity, with both a 5'-end (the end with the free phosphate) and a 3'-end (the end with the free hydroxyl) that is not attached to other nucleotides. The bases located along the resulting deoxyribose-phosphate backbone are, by convention, always written in sequence from the 5'-end of the chain to the 3'-end. For example, the sequence of bases in the DNA shown in Figure 2 is read "thymine, adenine, cytosine, and guanine" (5'-TACG-3'). Phosphodiester linkages between nucleotides (in DNA or RNA) can be cleaved hydrolytically by chemicals, or hydrolyzed enzymatically by a family of nucleases: deoxyribonucleases for DNA and ribonucleases for RNA.

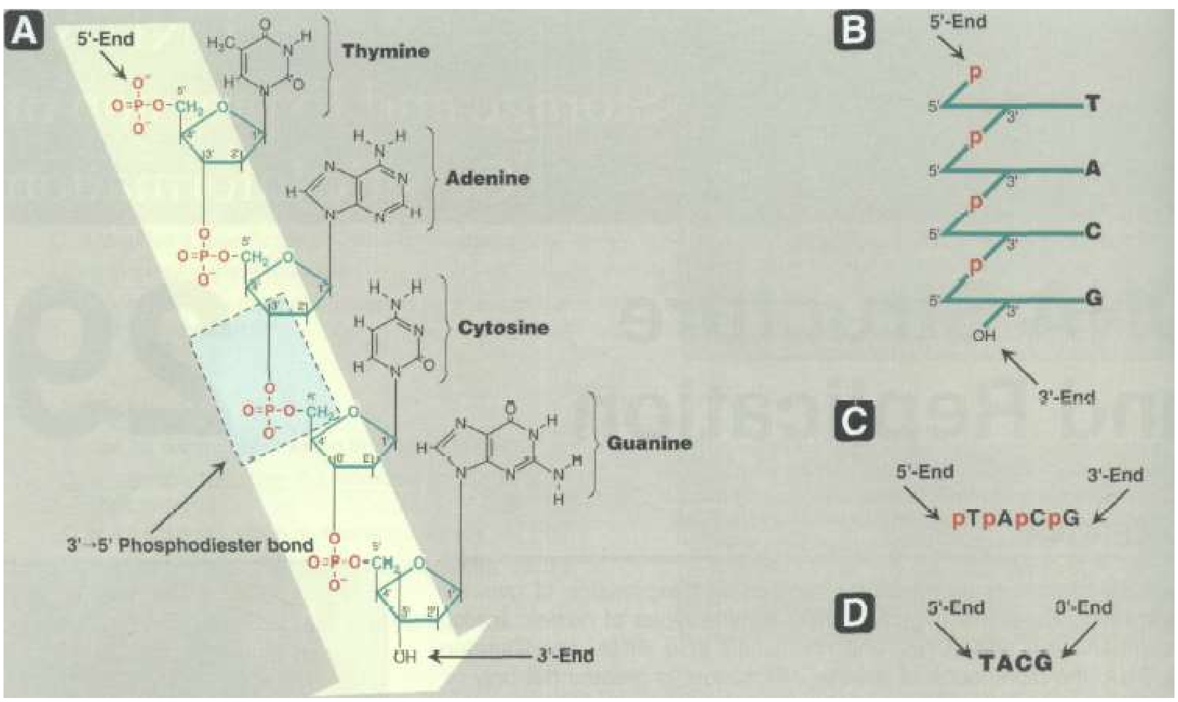


Figure 2: A. DNA chain with the nucleotide sequence shown in 5' to 3' direction. A 3' to 5' phosphodiester bond is shown highlighted in the blue box, and the deoxyribose-phosphate backbone is shaded in yellow. B. The DNA chain written in a more stylized form, emphasizing the ribose-phosphate backbone. C. A simpler representation of the nucleotide sequence. D. The simplest representation, with the abbreviation for the bases written in the conventional 5' to 3' direction.