

bonds join the 5'-hydroxyl group of the deoxyribose of one nucleotide to the 3'-hydroxyl group of the deoxyribose 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.

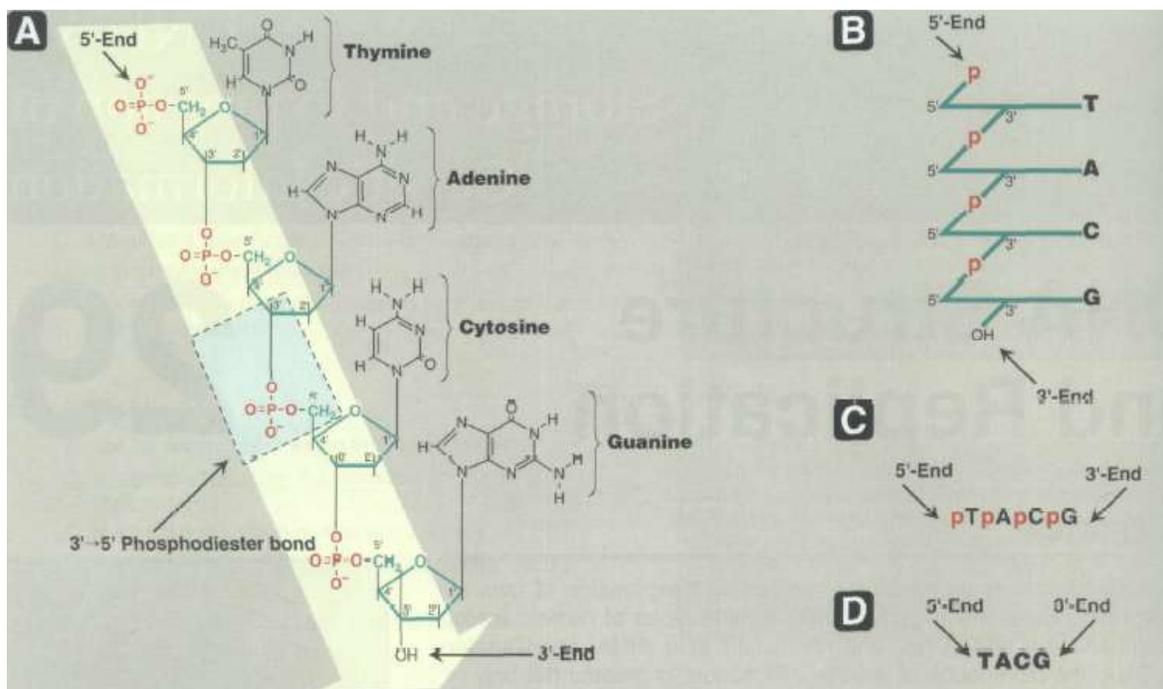


Figure 2: A. DNA chain with the nucleotide sequence shown in 5' to 3' direction. A 3' to 5' phosphodiester bond is shown highlighted in the blue box, and the deoxyribose-phosphate backbone is shaded in yellow. B. The DNA chain written in a more stylized form, emphasizing the ribose-phosphate backbone.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

DNA Double helix:

In the double helix of DNA, the two chains are coiled around a common axis called the 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 (Figure 3). In 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. The overall structure resembles a twisted ladder. The spatial relationship between the two strands in the helix creates.

The bases of one strand of DNA are paired with the bases of the second strand, so that an adenine is always paired with a thymine and a cytosine is always paired with a guanine. Therefore, one polynucleotide chain of the DNA double helix is always the complement of the other. Given the sequence of bases on one chain, the sequence of bases on the complementary chain can be determined (Figure 4). The specific base pairing in DNA leads to Chargaff's Rules: in any sample of double-stranded DNA, the amount of adenine equals the amount of thymine, the amount of guanine equals the amount of cytosine, and the total amount of purines equals the total amount of pyrimidines. The base pairs are held together by hydrogen bonds: two between A and T and three between G and C (Figure 4). These hydrogen bonds, plus the hydrophobic interactions between the stacked bases, stabilize the structure of the double helix.

Example: A sample of DNA contains 20 % adenine on a molar basis. What the percentage of the other bases present?

Melting temperature of DNA (T_m):

The two strands of the double helix separate when hydrogen bonds between the paired bases are disrupted. Disruption can occur in the laboratory if the pH of

the DNA solution is altered so that the nucleotide bases ionize, or if the solution is heated. When DNA is heated, the temperature at which one half of the helical structure is lost is defined as the melting temperature (T_m). The loss of helical structure in DNA is called denaturation. Because there are three hydrogen bonds between G and C but only two between A and T, DNA that contains high concentrations of A and T denatures at a lower temperature than G- and C-rich DNA (Figure 4). Under appropriate conditions, complementary DNA strands can reform the double helix by the process called renaturation (or reannealing).

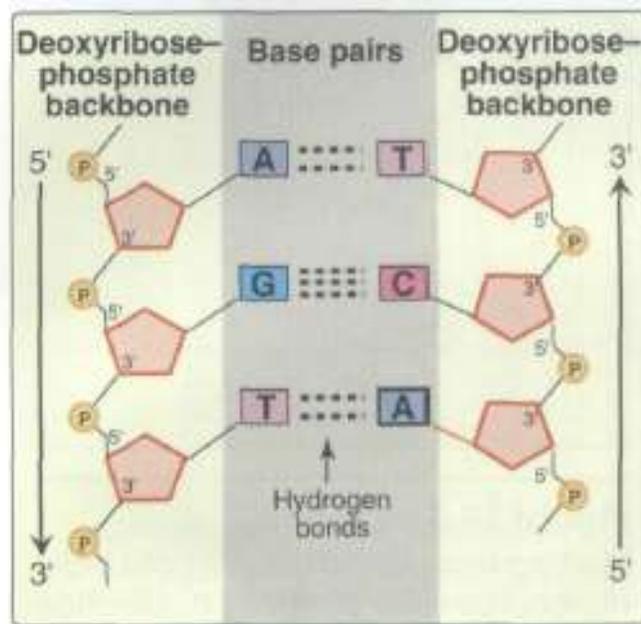
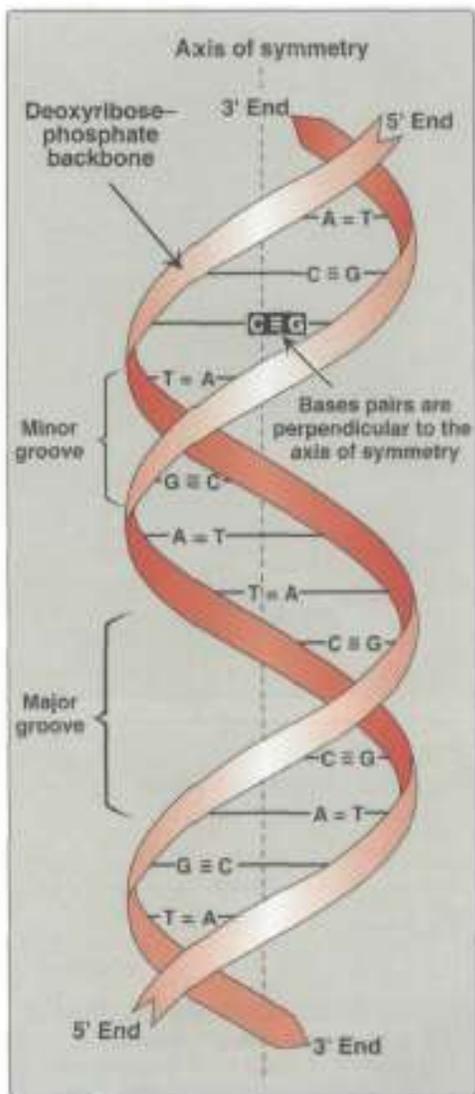


Figure 4: Two complementary DNA sequences.

Figure 3: DNA double helix, illustrating some of its major structural features.

Ribonucleic acid (RNA):

RNA is assembled as a chain of nucleotides, but unlike DNA it is more often found in nature as a single-strand folded onto itself, rather than a paired double-strand. There are three types of RNA that includes messenger RNA (mRNA), ribosomal RNAs (rRNAs) and transfer RNA or tRNA.

The chemical structure of RNA is very similar to that of DNA, but differs in three main ways:

1. Unlike double-stranded DNA, RNA is a single-stranded molecule in many of its biological roles and has a much shorter chain of nucleotides.
2. While DNA contains deoxyribose, RNA contains ribose (in deoxyribose there is no hydroxyl group attached to the pentose ring in the 2' position). These hydroxyl groups make RNA less stable than DNA because it is more prone to hydrolysis.
3. The complementary base to adenine in DNA is thymine, whereas in RNA, it is uracil, which is an unmethylated form of thymine.

The main job of RNA is to transfer the genetic code need for the creation of proteins from the nucleus to the ribosome. This process prevents the DNA from having to leave the nucleus. This keeps the DNA and genetic code protected from damage. Without RNA, proteins could never be made. In fact, RNA is formed from DNA by a process called transcription. RNA is central to protein synthesis, where the messenger RNA (mRNA) carries information from DNA to ribosomes (the sites of protein synthesis (translation) in the cell). The ribosomes are made from proteins and ribosomal RNAs (rRNAs). These all come together and form a complex that can read messenger RNAs and translate the information they carry into proteins. This process requires the help of transfer RNA or tRNA. Transfer RNA (tRNA) transfers a specific amino acid to a growing polypeptide chain at the ribosomal site of protein synthesis during translation.

An example of transcription process:

One strand of DNA contains the following sequence reading from 5'- to 3'-:

TCGTCGACGATGATCATCGGCTACTCGA

This strand will form the following duplex:

5'-TCGTCGACGATGATCATCGGCTACTCGA-3'

3'-AGCAGCTGCTACTAGTAGCCGATGAGCT-5'

The sequence of bases in the mRNA transcribed from DNA written 5'- to 3'- is

5'-UCGUCGACGAUGAUCAUCGGCUACUCGA-3'