7.6: Nucleic Acids

Nucleic acids (Figure 7.7)are biological macromolecules that store and pass on the genetic information that organisms need to reproduce and synthesize proteins. The two major kinds of nucleic acids are **deoxyribonucleic acid**,**DNA**, which basically stays in place in the cell nucleus of an organism and **ribonucleic acid**, **RNA**, which is spun off from DNA and functions throughout a cell. Molecules of nucleic acids contain three basic kinds of materials. The first of these is a simple sugar, 2-deoxy-β-D-ribofuranose (deoxyribose) contained in DNA and β-D-ribofuranose (ribose) contained in RNA. The second major kind of ingredient consists of nitrogen-containing bases: cytosine, adenine, and guanine, which occur in both DNA and RNA, thymine, which occurs only in DNA, and uracil, which occurs only in RNA. The third constituent of both DNA and RNA is inorganic phosphate, PO_4^{3-}. These three kinds of substances occur as repeating units called **nucleotides** joined together in astoundingly long chains in the nucleic acid polymer as shown in Figure 7.7.

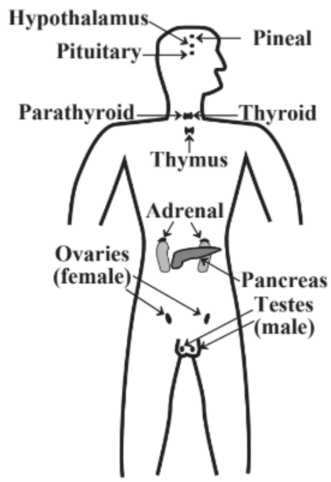

Figure 7.6. Location of important endocrine ductless glands that secrete hormones directly into the bloodstream in the human body. In contrast, exocrine glands including sweat, salivary, and mammary glands secrete hormones through ducts.In addition to secreting insulin into the bloodstream, the pancreas also functions as a ducted gland secreting pancreatic juice into the small intestine. This material contains digestive enzymes that help break down carbohydrate, protein, and fat molecules

The remarkable way in which DNA operates to pass on genetic information and perform other functions essential for life is the result of the structure of the DNA molecule. In 1953, James D.Watson, and Francis Crick deduced that DNA consisted of two strands of material counterwound around each other in a structure known as anα-helix (Figure 7.8), a remarkable bit of insight that earned Watson and Crick the Nobel Prize in 1962. These strands are held together by hydrogen bonds between complementary nitrogenous bases. Taken apart, the two strands resynthesize complementary strands, a process that occurs during reproduction of cells in living organisms. Indirecting protein synthesis, DNA becomes partially unravelled and generates a complementary strand of material in the form of RNA, which in turn directs protein synthesis in the cell.

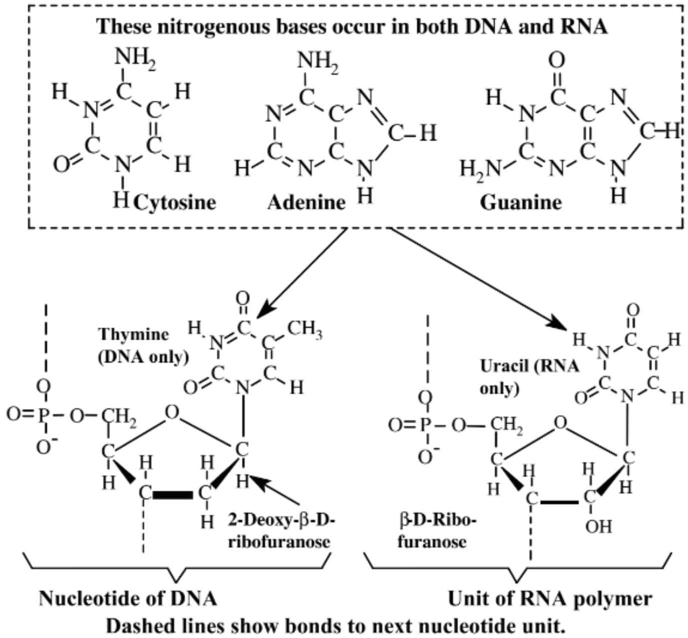

Figure 7.7. Basic units of nucleic acid polymers. These units act as a code in directing reproduction and other activities of organisms.

Consideration of nucleic acids and their function is very important in the development of green chemistry. One aspect of this relationship is that the toxicity hazards of many chemical substances result from potential effects of these substances upon DNA. Of most concern is the ability of some substances to alter DNA and cause uncontrolled cell replication characteristic of cancer. Also of concern is the ability of some chemical substances called **mutagens** to alter DNA such that undesirable characteristics are passed on to offspring.

Another important consideration with DNA as it relates to green chemistry is the ability that humans now have to transfer DNA between organisms, popularly called genetic engineering. An important example is the development of bacteria that have the DNA transferred from humans to make human insulin. This technology of recombinant DNA is discussed in more detail in Chapter 12.
