Phosphodiester Linkage

Nucleotides are, in turn, joined to each other in polynucleotide chains through the 3' – hydroxyl of 2'-deoxyribose of one nucleotide and the phosphate attached to the 5' – hydroxyl of another nucleotide. This is a **phosphodiester linkage** in which the phosphyoryl group between the two nucleotide has one sugar esterified to it through a 3'-hydroxyl and a second sugar esterified to it through a 5'-hydroxyl. Phosphodiester linkages create the repeating, sugar-phosphate backbone of the polynucleotide chain, which is a regular feature of DNA. In contrast, the order of the bases along the polynucleotide chain is irregular. This irregularity as well as the long length is the basis for the enormous information content of DNA.

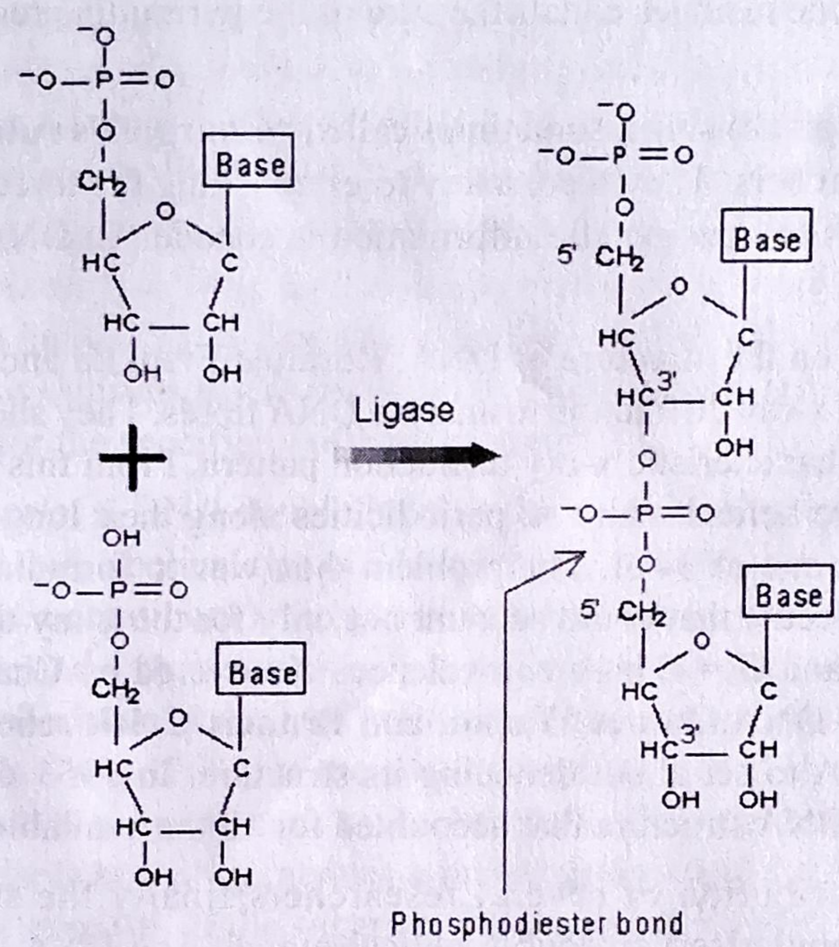

Fig. 1.2. *Structure and formation of a typical phosphodiester linkage.*

The phosphodiester linkages impart an inherent polarity to the DNA chain. This polarity is defined by the asymmetry of the nucleotides and the way they are joined. DNA chains have a free 5'-phosphate or 5'-hydroxyl at one end and a free 3'-phosphate or 3'-hydroxyl at the other end. The convention is to write DNA sequences from the 5' end (on the left) to the 3' end, generally with a 5'-phosphate and a 3'-hydroxyl. Thus, the covalent backbones of nucleic acids consist of alternating phosphate and pentose residues, and the nitrogenous bases may be regarded as side groups joined to the backbone at regular intervals. The backbones of both DNA and RNA are hydrophilic. The hydroxyl groups of the sugar residues form hydrogen bonds with water. The phosphate groups, with a pK_a near 0, are completely ionized and negatively charged at pH 7, and the negative charges are generally neutralized by ionic interactions with positive charges on proteins, metal ions, and polyamines.