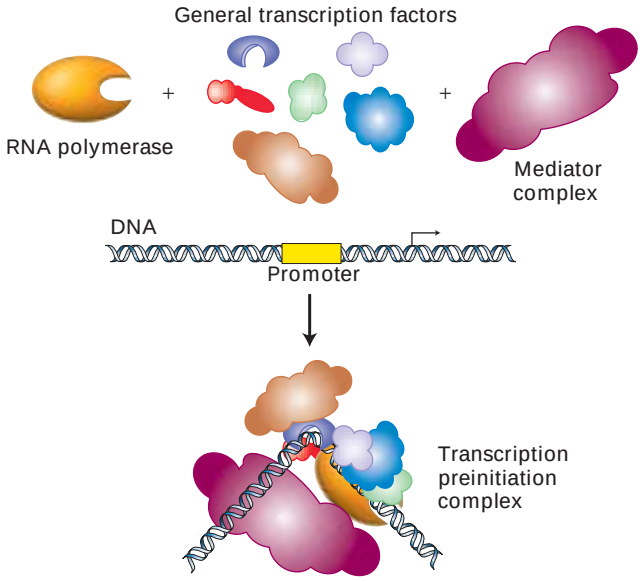


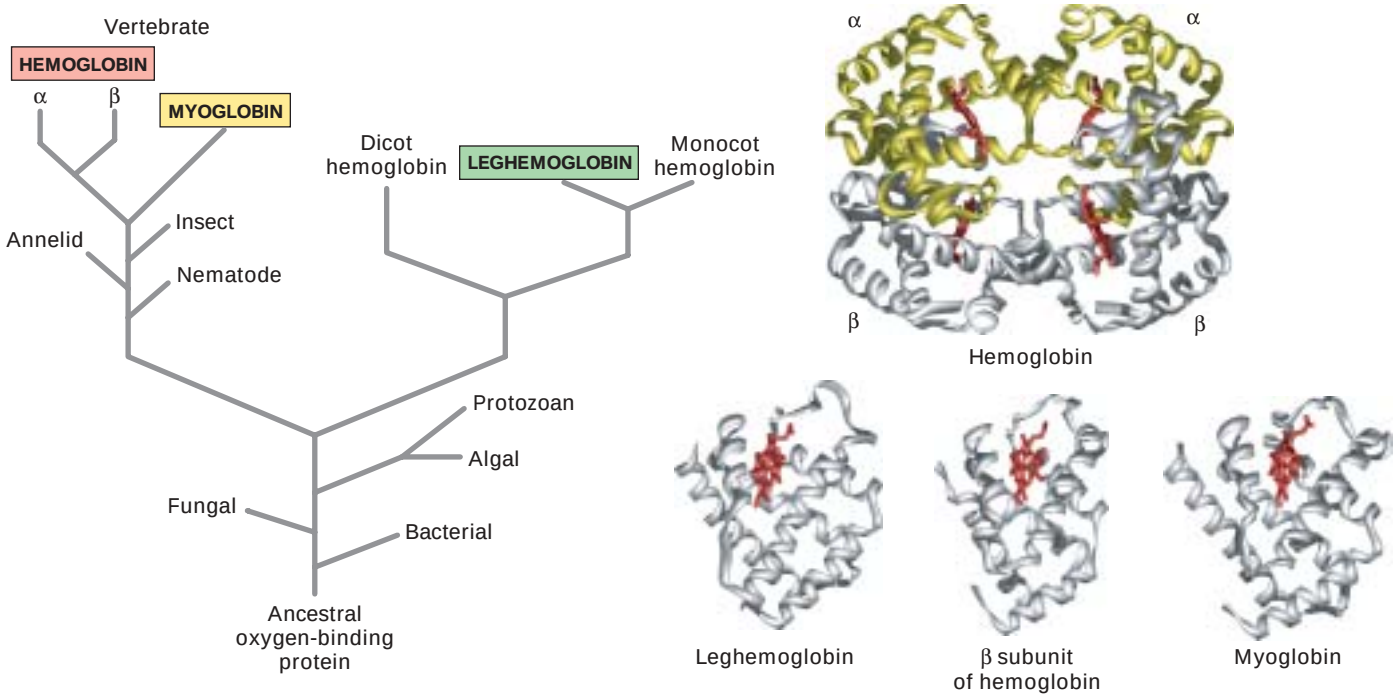
▲ FIGURE 3-9 **The mRNA transcription-initiation machinery.** The core RNA polymerase, general transcription factors, a mediator complex containing about 20 subunits, and other protein complexes not depicted here assemble at a promoter in DNA. The polymerase carries out transcription of DNA; the associated proteins are required for initial binding of polymerase to a specific promoter, thereby initiating transcription.

Members of Protein Families Have a Common Evolutionary Ancestor

Studies on myoglobin and hemoglobin, the oxygen-carrying proteins in muscle and blood, respectively, provided early evidence that function derives from three-dimensional structure, which in turn is specified by amino acid sequence. X-ray crystallographic analysis showed that the three-dimensional structures of myoglobin and the α and β subunits of hemoglobin are remarkably similar. Subsequent sequencing of myoglobin and the hemoglobin subunits revealed that many identical or chemically similar residues are found in identical positions throughout the primary structures of both proteins.

Similar comparisons between other proteins conclusively confirmed the relation between the amino acid sequence, three-dimensional structure, and function of proteins. This principle is now commonly employed to predict, on the basis of sequence comparisons with proteins of known structure and function, the structure and function of proteins that have not been isolated (Chapter 9). This use of sequence comparisons has expanded substantially in recent years as the genomes of more and more organisms have been sequenced.

The molecular revolution in biology during the last decades of the twentieth century also created a new scheme



▲ FIGURE 3-10 **Evolution of the globin protein family.** (*Left*) A primitive monomeric oxygen-binding globin is thought to be the ancestor of modern-day blood hemoglobins, muscle myoglobins, and plant leghemoglobins. Sequence comparisons have revealed that evolution of the globin proteins parallels the evolution of animals and plants. Major junctions occurred with the divergence of plant globins from animal globins and of myoglobin from hemoglobin. Later gene duplication gave rise to the α and β subunits of hemoglobin. (*Right*) Hemoglobin is a tetramer of two α and two β subunits. The structural similarity of these subunits with leghemoglobin and myoglobin, both of which are monomers, is evident. A heme molecule (red) noncovalently associated with each globin polypeptide is the actual oxygen-binding moiety in these proteins. [(*Left*) Adapted from R. C. Hardison, 1996, *Proc. Natl. Acad. Sci. USA* **93**:5675.]