Kaur, 2017b; Thakur et al., 2017). As stated by Hench, "The ionic dissolution products released from bioactive glass stimulate the genes of cells towards a path of regeneration and self-repair" (Hench, 2009). This hypothesis signifies the importance of ionic dissolution products in regulating the gene expression. To understand the behavior of material in vitro and in vivo, it is important to have an insight into the ion dissolution products and the ion release kinetics.

6.2 GENES AND THEIR SIGNIFICANCE

Genes are the molecular units of heredity as are the locus of deoxyribonucleic acid (DNA) that encodes proteins. Proteins dictate cell function; hence, the fate of a cell is decided by the various genes expressed by the cell. Human chromosomes can contain more than 500 million base pairs of DNA containing thousands of genes. DNA contains four nucleotide subunits, that is, a five-carbon sugar (2-deoxyribose), one phosphate group, and either of the four bases adenine (A), cytosine (C), guanine (G), and thymine (T). The DNA double helix is formed when two chains of DNA twist around each other (phosphate-sugar backbone spiraling around outside and A-T, C-G pairing inward). DNA strands possess directionality because the DNA replication, transcription, and nucleic acid synthesis occur in the 5′–3′ direction where the 3′ end of the molecule is the exposed hydroxyl group on the de-oxyribose and the 5′ end is the exposed phosphate group. The gene expression in DNA initiates by transcribing genes into RNA. RNA is another nucleic acid with long chains of nucleotides. Like DNA, RNA contains phosphate units, nitrogenous bases (adenine, cytosine, guanine, and uracil), and ribose sugar (Fig. 6.1). RNA is vital for living beings as these molecules dictate the protein assembly on ribosomes. The amino acids are transferred to the ribosomes via transfer RNA (tRNA) and amino acids are linked together to form proteins via ribosomal RNA (rRNA)

During gene expression, the flow of information occurs from DNA-RNA-proteins, thereby providing potential control points to the cell. Genes contain sequence elements with a structure that is almost similar to that of eukaryotes and prokaryotes (Fig. 6.2). Genes can be copied (transcribed) from DNA to RNA [can be a noncoding RNA (nc-RNA) or messenger RNA (mRNA)], which then gets translated to protein. Genes contain a regulatory sequence at the extreme ends, which can be separated by the enhancers/silencers. Genes also contain promoter sequences, which are important for gene expression. For the initiation of the transcription process, RNA polymerase and transcription factors (which bind promoters) are required. Promoters can be strong or weak, that is, strong promoters are highly transcribed genes that initiate transcription frequently, whereas weak promoters bind poorly and transcript less frequently. The eukaryotic transcripts are more complex than the prokaryotic transcripts. In eukaryotes, RNA polymerase synthesizes primary transcripts, which are not a part of mature RNA. These intervening sequences are known as introns and are removed before mature mRNA is ready to leave the nucleus. The remaining