10.15 Review: The flow of genetic information in the cell is DNA → RNA → protein

This figure summarizes the key steps in the flow of genetic information from DNA to protein. These steps are common to all cells.

In transcription (DNA → RNA), the genetic messenger mRNA is synthesized on a DNA template (step ①). In eukaryotic cells, transcription occurs in the nucleus, and the mRNA must travel from the nucleus to the cytoplasm.

Translation (RNA → protein) can be divided into four steps (②–⑤), all of which occur in the cytoplasm. When the polypeptide is complete, the two ribosomal subunits come apart, and the tRNA and mRNA are released (not shown in this figure).

The translation process is very rapid; a single ribosome can make an average-sized polypeptide in less than a minute. Typically, an mRNA molecule is translated simultaneously by a number of ribosomes. Once the start codon emerges from the first ribosome, a second ribosome can attach to it, and thus several ribosomes (collectively known as a polyribosome) may trail along on the same mRNA molecule.

What is the overall significance of transcription and translation? These are the processes whereby genes control the structures and activities of cells, or, more broadly, the way the genotype produces the phenotype. The chain of command originates with the information in a gene, a specific linear sequence of nucleotides in DNA. The gene serves as a template, dictating transcription of a complementary sequence of nucleotides in mRNA. In turn, mRNA dictates the linear sequence in which amino acids appear in a specific polypeptide. Finally, the proteins that form from the polypeptides determine the appearance and the capabilities of the cell and organism.