Mader/*Biology*, 11/e – Chapter Outline

Chapter 12

12.4 First Step: Transcription

A. Messenger RNA Is Produced
   1. A segment of the DNA helix unwinds and unzips.
   2. Transcription begins when **RNA polymerase** attaches to a **promoter** on DNA. A promoter is a region of DNA which defines the start of the gene, the direction of transcription, and the strand to be transcribed.
   3. As RNA polymerase (an enzyme that speeds formation of RNA from a DNA template) moves along the *template* strand of the DNA, complementary RNA nucleotides are paired with DNA nucleotides of the *coding strand*. The strand of DNA not being transcribed is called the *noncoding strand*.
   4. RNA polymerase adds nucleotides to the 3'-end of the polymer under construction. Thus, RNA synthesis is in the 5'-to-3' direction.
   5. The RNA/DNA association is not as stable as the DNA double helix; therefore, only the newest portion of the RNA molecule associated with RNA polymerase is bound to DNA; the rest dangles off to the side.
   6. Elongation of mRNA continues until RNA polymerase comes to a *stop sequence*.
   7. The stop sequence causes RNA polymerase to stop transcribing DNA and to release the mRNA transcript.
   8. Many RNA polymerase molecules work to produce mRNA from the same DNA region at the same time.
   9. Cells produce thousands of copies of the same mRNA molecule and many copies of the same protein in a shorter period of time than if a single copy of RNA were used to direct protein synthesis.

B. RNA Molecules Undergo Processing
   1. Newly formed pre-mRNA transcript is processed before leaving the nucleus.
   2. **Pre-mRNA transcript** is the immediate product of transcription; it contains *exons* and *introns*.
   3. The ends of the mRNA molecule are altered: a *cap* is put on the 5' end and a *poly-A tail* is put on the 3' end.
      a. The "cap" is a modified guanine (G) where a ribosome attaches to begin translation.
      b. The "poly-A tail" consists of a 150–200 adenine (A) nucleotide chain that facilitates transport of mRNA out of the nucleus and inhibits enzymatic degradation of mRNA.
   4. Portions of the primary mRNA transcript, called *introns*, are removed.
      a. An *exon* is a portion of the DNA code in the primary mRNA transcript eventually expressed in the final polypeptide product.
      b. An *intron* is a non-coding segment of DNA removed by *spliceosomes* before the mRNA leaves the nucleus.
   5. *Ribozymes* are RNAs with an enzymatic function restricted to removing introns from themselves.
      a. RNA could have served as both genetic material and as the first enzymes in early life forms.
   6. Spliceosomes are complexes that contain several kinds of ribonucleoproteins.
      a. Spliceosomes cut the primary mRNA transcript and then rejoin adjacent exons.

7. Smaller nucleolar RNA (snoRNA) is present in the nucleolus, to assist in the processing of rRNA and tRNA molecules.
8. Introns give a cell the ability to decide which exons will go in a particular mRNA.
9. mRNA do not have all of the possible exons available from a DNA sequence. In one mRNA what is an exon could be an intron in another mRNA. This process is termed *alternative mRNA splicing.*
10. Some introns give rise to microRNAs (miRNA). miRNA regulate mRNA translation by bonding with mRNA through complementary base pairing and preventing translation from occurring.
11. Exon shuffling occurs when introns encourage crossing over during meiosis.