

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

### Chapter 12

#### 12.3 The Genetic Code of Life

1. Sir Archibald Garrod (early 1900s) introduced the phrase *inborn error of metabolism*.
  - a. Garrod proposed that inherited defects could be caused by the lack of a particular enzyme.
  - b. Knowing that enzymes are proteins, Garrod suggested a link between genes and proteins.
2. George Beadle and Edward Tatum proposed the *one gene, one enzyme hypothesis* based on their study of red bread mold.
- A. RNA Carries the Information
  1. Like DNA, RNA (ribonucleic acid) is a polymer of nucleotides.
  2. Unlike DNA, RNA is single-stranded, contains the sugar ribose, and the base uracil instead of thymine (in addition to cytosine, guanine, and adenine).
  3. There are three major classes of RNA.
    - a. **Messenger RNA (mRNA)** takes a message from DNA in the nucleus to ribosomes in the cytoplasm.
    - b. **Ribosomal RNA (rRNA)** and proteins make up ribosomes where proteins are synthesized.
    - c. **Transfer RNA (tRNA)** transfers a particular amino acid to a ribosome.
- B. The Genetic Code
  1. DNA undergoes **transcription** to mRNA, which is **translated** to a protein.
  2. DNA is a template for RNA formation during transcription.
  3. Transcription is the first step in gene expression; it is the process whereby a DNA strand serves as a template for the formation of mRNA.
  4. During translation, an mRNA transcript directs the sequence of amino acids in a polypeptide.
  5. The process from DNA to protein is the **central dogma** of molecular biology.
  6. The **genetic code** is a *triplet code*, comprised of three-base code words (e.g., AUG).
  7. A **codon** consists of 3 nucleotide bases of DNA.
  8. Four nucleotides based on 3-unit codons allows up to 64 different amino acids to be specified.
  9. Finding the Genetic Code
    - a. Marshall Nirenberg and J. Heinrich Matthaei (1961) found that an enzyme that could be used to construct synthetic RNA in a cell-free system; they showed the codon UUU coded for phenylalanine.
    - b. By translating just three nucleotides at a time, they assigned an amino acid to each of the RNA codons, and discovered important properties of the genetic code.
    - c. The code is *degenerate*: there are 64 triplets to code for 20 naturally occurring amino acids; this protects against potentially harmful mutations.
    - d. The genetic code is *unambiguous*; each triplet codon specifies one and only one amino acid.
    - e. The code has *start and stop signals*: there are one start codon and three stop codons.
  10. The Code Is Universal
    - a. The few exceptions to universality of the genetic code suggest the code dates back to the very first organisms and that all organisms are related.
    - b. Once the code was established, changes would be disruptive.