

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 Matthei (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.