Module 07: Genetics — DNA, RNA, & Protein Synthesis (OpenStax Chapter 9) — Keys to Success

Key Learning Objectives

1. DNA Structure and Function

- Describe the structure of a DNA molecule (double helix, sugar-phosphate backbone)
- Identify the four DNA nucleotide bases: adenine (A), thymine (T), guanine (G), cytosine (C)
- Explain complementary base pairing rules (A–T, G–C)
- Describe how hydrogen bonds hold the two strands together
- Explain why DNA is called the "blueprint of life"

2. DNA Replication

- Explain why DNA must be copied before a cell divides
- Describe the semi-conservative model of DNA replication
- Identify the roles of key enzymes: helicase (unwinds), DNA polymerase (builds), ligase (seals)
- Distinguish between the leading strand and lagging strand
- Understand how proofreading mechanisms ensure accuracy

3. Central Dogma of Molecular Biology

- State the central dogma: DNA → RNA → Protein
- Explain the flow of genetic information from gene to functional product
- Distinguish between the three main types of RNA: mRNA, tRNA, rRNA
- Describe the key differences between DNA and RNA (sugar, uracil vs thymine, single-stranded)

4. Transcription

- Define transcription as the synthesis of mRNA from a DNA template
- Identify the role of RNA polymerase
- Distinguish between the template strand and coding strand of DNA
- Describe the steps of transcription: initiation (promoter), elongation, termination
- Explain how the mRNA base sequence is complementary to the template strand (A→U, T→A, G→C, C→G)

5. The Genetic Code

- Define a codon as a three-nucleotide sequence on mRNA
- Use a codon table to determine which amino acid a codon specifies
- Identify the start codon (AUG = methionine) and the three stop codons (UAA, UAG, UGA)
- Explain what it means that the genetic code is "degenerate" (redundant) and nearly universal

6. Translation

- Define translation as the synthesis of a polypeptide from mRNA at the ribosome
- Describe the roles of mRNA (message), tRNA (adapter carrying amino acids), and rRNA (ribosome structure)
- Explain anticodon–codon pairing at the ribosome
- Describe the steps of translation: initiation, elongation, termination
- Trace how a DNA sequence ultimately determines the amino acid sequence of a protein

7. Mutations and Their Effects

- Define a mutation as a change in the DNA base sequence
- Distinguish between point mutations (substitution, insertion, deletion) and their effects
- Explain how a mutation can change the amino acid sequence and protein function
- Provide examples of diseases caused by mutations (e.g., sickle cell anemia)

Study Tips

1. **Practice converting sequences** — work through DNA → mRNA → amino acid chains by hand
2. **Memorize the base pairing rules** — DNA: A–T, G–C; RNA: A–U, G–C
3. **Use a codon table frequently** — the more you use it, the faster you get
4. **Draw the central dogma diagram** — sketch DNA → Transcription → mRNA → Translation → Protein
5. **Compare DNA and RNA** side by side in a table
6. **Trace a gene to a protein** — pick a short sequence and walk through every step