Key Concept 2: DNA Synthesis

Learning Objectives *Students will be able to ...*	Essential Knowledge *Students need to know that ...*
DNA Synthesis (Replication)	
GEN 2.1(a) Describe the importance of DNA synthesis. **GEN 2.1(b)** Create and/or use models to explain how DNA synthesis occurs. **GEN 2.1(c)** Explain the function of enzymes in DNA synthesis.	**GEN 2.1.1 All living cells have a mechanism for DNA synthesis (replication) in order to pass on genetic information to new cells.** **a.** Each of the two strands of DNA serves as a template for a new complementary strand in a semiconservative process of replication. **b.** DNA helicase and DNA polymerase are the primary enzymes required for the replication process.

Content Boundary: Understanding of in-depth DNA replication processes, such as formation of leading and lagging strands, Okazaki fragments, and DNA polymerase working in the 5'-to-3' direction, is *beyond the scope* of this course.

Key Concept 3: Protein Synthesis

Learning Objectives *Students will be able to ...*	Essential Knowledge *Students need to know that ...*
RNA Transcription	
GEN 3.1(a) Explain structural differences between RNA and DNA.	**GEN 3.1.1 The unique structure of RNA enables its function in protein synthesis.** **a.** Types of RNA may vary in structure but they all have important structural differences from DNA: **1.** All types of RNA contain the sugar ribose instead of deoxyribose. **2.** All types of RNA contain the nitrogen base uracil instead of thymine. **3.** mRNA is single-stranded instead of double-stranded like DNA.
GEN 3.2(a) Describe how heritable information stored in DNA is transferred to RNA through transcription.	**GEN 3.2.1 RNA synthesis, or transcription, results in three forms of the polymer.** **a.** RNA synthesis occurs in the cytoplasm of prokaryotes and in the nucleus of eukaryotes. **b.** During transcription, a single strand of DNA is used as a template to synthesize a complementary strand of RNA. **c.** RNA transcription results in the synthesis of messenger RNA (mRNA), transfer RNA (tRNA), and ribosomal RNA (rRNA).

Learning Objectives *Students will be able to ...*	Essential Knowledge *Students need to know that ...*
Translation	
GEN 3.3(a) Explain how the structure of DNA enables storage of heritable information. **GEN 3.3(b)** Explain the role of mRNA in protein synthesis. **GEN 3.3(c)** Identify the role of amino acids in protein synthesis. **GEN 3.3(d)** Create and/or use models to demonstrate how the information in genes is expressed as proteins.	**GEN 3.3.1 Gene expression includes the process of protein synthesis, which requires transcribing heritable information stored in DNA and translating it into polypeptides.** **a.** Genes are certain sections of DNA on chromosomes that contain the instructions for making specific proteins. **b.** Information carried on genes in the template strand of DNA is transcribed into a strand of mRNA during transcription. **c.** Translation of mRNA into the sequence of amino acids (protein) occurs with the help of ribosomes in the cytoplasm. **1.** mRNA is read by the ribosome three bases at a time (a codon), which corresponds to a specific amino acid that the ribosome incorporates into a growing polypeptide chain. **2.** Translation begins and ends with specific start and stop codons. **3.** The particular sequence of amino acids determines the shape and function of the expressed protein.
Mutations	
GEN 3.4(a) Describe how changes in DNA sequences may affect protein structure and function. **GEN 3.4(b)** Create and/or use models to explain the consequences of changes in the DNA. **GEN 3.4(c)** Analyze data to make predictions about how changes in DNA affect an organism's phenotype.	**GEN 3.4.1 Mutations are heritable changes to DNA sequences.** **a.** Mutations are random changes in DNA sequences that may occur as a result of errors during replication or the effects of environmental mutagens (e.g., UV light, x-rays, and carcinogens). **b.** A change in a DNA sequence occurs when a nucleotide is substituted into the original sequence (causing a point mutation) or inserted into or deleted from the sequence (causing a frameshift mutation). **c.** Depending on how the changes impact gene expression, mutations may cause negative disruption in gene and protein function, have little to no effect on organisms, or produce beneficial variation.

Content Boundary: It is important for students to realize that all forms of RNA are made in the nucleus and to understand how forms of RNA work together to make proteins. However, assessments will not require students to recall a step-by-step list of the process. Instead, they should *focus* on how the structure of each form of RNA fits its role in protein synthesis and why this process is important (from genotype to phenotype understanding). Students should understand that only some regions of DNA carry genetic information for proteins (genes). However, specifics about introns and exons are *beyond the scope* of this course.

Cross Connections: Make *connections to key concepts* from Unit 2: Evolution of how mutations serve as sources of genetic variation on which natural selection mechanisms work.