Lesson 2: DNA Transcription and Translation

Introduction

This lesson is designed build on students' knowledge of DNA and RNA structure to teach students about DNA transcription and translation. Students will connect these processes to the formation of a functional protein, and how DNA mutations that affect protein structure, like the structure of hemoglobin in sickle cell anemia, can have a large affect on the body.

Student Background Knowledge

Before this lesson, students should have a solid grasp of DNA and RNA base pairing, and the differences in DNA and RNA structure. Students should also understand the function of cell organelles like the nucleus and ribosome. A basic knowledge of the circulatory system is also necessary.

Teacher Background Knowledge

DNA transcription occurs in the nucleus. Messenger RNA (mRNA) makes a complimentary strand to the section of DNA coding for the protein. In mRNA, adenine compliments with uracil instead of thymine, the compliment in DNA. The messenger RNA carries the complimentary strand out of the nucleus to the ribosome, the organelle where proteins are manufactured. This is where translation occurs. Transfer RNA (tRNA) brings the appropriate amino acids to the ribosome where they are attached together like beads on a string to form the protein. tRNA reads a three base pair section (called a codon) of mRNA at a time. Each amino acid has a set of codons that code for that particular molecule.

Each protein has a specific shape; determined by the sequence of amino acids that it consists of. A protein's structure determines its function. Hemoglobin is the protein that is responsible for carrying oxygen in red blood cells. In healthy cells, hemoglobin molecules remain separate both when they are carrying oxygen to the body tissues and when their oxygen supply is depleted and they are returning to the lungs. Individuals with sickle cell anemia have one amino acid substitution; exchanging a valine for the normal glutamic acid. This subtle change causes drastic problems. The hemoglobin protein in sickle cell anemia polymerizes, or sticks to itself, when the oxygen has been transferred to body tissues. This causes the cell to snap into the sickle shape that is characteristic of the disease, instead of remaining plump and round on its journey back to the lungs. Sickle shaped cells easily lodge in the tiniest capillaries, depriving the surrounding tissues of oxygen and causing damage. Sickle cells that return to the lungs can snap back into shape once oxygenated, but the constant popping into and out of shape makes the cells brittle and shortens their life span.

TEKS Objectives:

BIOL.1.05 Organize, analyze, evaluate, make inferences, and predict trends from data.
BIOL.2.02 Interpret the functions of systems in organisms including circulatory, digestive, nervous, endocrine, reproductive, integumentary, skeletal, respiratory, muscular, excretory and immune.
BIOL.2.10 Compare the structures and functions of different biomolecules including carbohydrates, lipids, proteins, and nucleic acids.