Epigenetics Activity: Gene Expression Regulation

AP Biology/College Level Teacher Guide

Overview

This guide supports implementation of the Epigenetics Activity: Gene Expression Regulation using the 5E instructional model.

Learning Objectives

- Students will model the flow of genetic information from DNA to proteins
- Students will analyze the effects of mutations and alternative splicing on protein structure
- Students will evaluate post-transcriptional modifications and their importance

Standards Alignment

Topic 6.3: Transcription and RNA Processing

- **LEARNING OBJECTIVE 6.3.A:** Describe the mechanisms by which genetic information flows from DNA to RNA to protein.
- **ESSENTIAL KNOWLEDGE 6.3.A.2:** RNA polymerases use a single template strand of DNA to direct the inclusion of bases in the newly formed RNA molecule. This process is known as transcription.
- **ESSENTIAL KNOWLEDGE 6.3.A.3:** The enzyme RNA polymerase synthesizes mRNA molecules in the 5' to 3' direction by reading the template DNA strand in the 3' to 5' direction.
- **ESSENTIAL KNOWLEDGE 6.3.A.4:** In eukaryotic cells the mRNA transcript undergoes a series of enzyme-mediated modifications.
- i. The addition of a poly-A tail makes mRNA more stable.
- ii. The addition of a GTP cap helps with ribosomal recognition.

- iii. The excision of introns, along with the splicing and retention of exons, generates different versions of the resulting mature mRNA molecule. This process is known as alternative splicing.

Topic 6.4: Translation

- **LEARNING OBJECTIVE 6.4.A:** Explain how the phenotype of an organism is determined by its genotype.
- **ESSENTIAL KNOWLEDGE 6.4.A.3:** Translation involves many sequential steps, including initiation, elongation, and termination. The salient features of translation include:
- i. Translation is initiated when the rRNA in the ribosome interacts with the mRNA at the start codon (AUG, coding for the amino acid methionine).
- ii. The sequence of nucleotides on the mRNA is read in triplets, called codons.
- iii. Each codon encodes a specific amino acid, which can be deduced by using a genetic code chart. Many amino acids are encoded by more than one codon.

Topic 6.5: Regulation of Gene Expression

- **LEARNING OBJECTIVE 6.5.A:** Describe the types of interactions that regulate gene expression.
- **ESSENTIAL KNOWLEDGE 6.5.A.2:** Epigenetic changes can affect gene expression through reversible modifications of DNA or histones.

Prerequisites

- DNA and RNA structure
- Understanding of codons and amino acids
- Basic knowledge of gene regulation

Time Estimate

50 minutes

Materials Needed

- Computer with internet access
- Student Activity Sheet
- Codon table reference

Teaching Tips by Phase

Phase 1: ENGAGE (5-10 minutes)

- Start with the phenomenon or problem presented
- Elicit student predictions and prior knowledge
- Create cognitive dissonance if possible
- Build excitement for investigation

Phase 2: EXPLORE (15-20 minutes)

- Allow students to investigate with minimal guidance
- Circulate and ask probing questions
- Encourage systematic data collection
- Note common discoveries and difficulties

Phase 3: EXPLAIN (10-15 minutes)

- Have students share their findings first
- Build on their observations to introduce concepts
- Address misconceptions directly
- Connect to broader biological principles

Phase 4: ELABORATE (10 minutes)

- Apply knowledge to new scenarios
- Make real-world connections
- Encourage deeper investigation
- Support transfer of learning

Phase 5: EVALUATE (5-10 minutes)

- Use varied assessment strategies
- Focus on conceptual understanding
- Provide immediate feedback
- Plan follow-up based on results

Remember:

The goal is student discovery through guided inquiry. Resist the urge to explain concepts before students have explored them!
