**Computer Simulation: Regulation of Gene Expression \_\_\_\_\_ / 30 pts**

In this computer simulation you will explore how gene expression is regulated at the levels of transcription and translation. To start, go to the following URL (or google PHET Gene Expression): https://phet.colorado.edu/sims/html/gene-expression-essentials/latest/gene-expression-essentials\_en.html

**Pre-Simulation Questions** ( \_\_\_\_\_ / 5 pts)

1. Define Gene Expression
2. Define Transcription.
3. Define Translation.

**Part 1:** Click on the box that says “***Expression***.” You are presented with a gene that contains a **regulatory region** and a **transcribed region**. Your goal is to produce **5** proteins from each of three genes. The proteins are indicated by the shapes in the box at the top right. You need to successfully transcribe each gene, and then translate the message from the gene into a protein using your knowledge of how these processes work.

**GENE 1 Questions** ( \_\_\_\_\_ / 10 pts)

1. What two components are required to initiate transcription of the gene? To which region of the gene do they bind?
2. What is the product of successful transcription of Gene 1?
3. What component is necessary to produce a protein from the transcript?
4. Have your teacher initial here \_\_\_\_\_\_\_\_ when you have successfully created 5 proteins from Gene 1.
5. Suppose Gene 1 produces a protein involved in the development of the eye. In the simulation, what are two ways that you can prevent production of Gene 1 protein in other parts of the body? At what points in the progression from gene to protein do these methods act (i.e., what processes do they prevent)?

**GENE 2 and 3 Questions** ( \_\_\_\_\_ / 3 pts)

1. How does initiation of transcription differ in Gene 2 and Gene 3 as compared to Gene 1?
2. Have your teacher initial here \_\_\_\_\_\_\_\_ when you have successfully created 5 proteins from Gene 2-3.

**Part 2:** Click on the box that says “***mRNA***.” You are presented with a gene that contains a regulatory region and a transcribed region. Your goal is to maximize the rate of transcription of the gene into mRNA..

1. What three factors maximize the rate of transcription from the gene? ( \_\_\_\_\_ / 3 pts)
2. Click on the check box on the bottom right. Increase the concentration and affinity of negative transcription factors to high, while decreasing the concentration and affinity of positive transcription factors to low. What effect does this have on the rate of transcription? ( \_\_\_\_\_ / 2 pts)

**Part 3:** Click on the box that says “***Multiple Cells***.” You are initially presented with a single *E. coli* cell that has had the gene for green fluorescent protein (GFP) inserted into its genome. This protein, when present in the cell, causes the bacterial cell to glow green under UV light.

1. Move the slider on the bottom from “one” to “many” cells. Are all of the cells flashing the same way? If not, what might explain any variation observed. Give two possibilities. ( \_\_\_\_\_ / 2 pts)
2. Click on the + signs in each box on the right. Your goal is to make the cells as green as possible by maximizing production of GFP. What change can you make to each of the following to maximize expression of the GFP gene? ( \_\_\_\_\_ / 5 pts)
   1. Positive Transcription Factor Concentration:
   2. mRNA Destroyer (exonuclease) Concentration:
   3. Positive Transcription Factor Affinity for the Gene Regulatory Sequence:
   4. RNA Polymerase Affinity for the Gene Regulatory Sequence:
   5. Protein Degradation: