


Gene Expression Essentials Online Lab Instructions

In Part One and Part Two of the investigation, you will discover how RNA polymerase and transcription factors work to create mRNA, and how that mRNA is then translated into proteins on the ribosome. In Part Three, you will identify variables that can increase or decrease the rate of protein synthesis.

Part One: Expression- Gene


This portion of the investigation begins your journey in learning about transcription: how RNA polymerase and transcription factors affect the creation of mRNA. In addition, you will explore the next step of protein synthesis by creating a protein via a ribosome.

Click the “Expression” mode to begin the investigation.

1. Make sure the biomolecule toolbox has all the elements. If not, click the reset button (the orange circle underneath Next Gene on the bottom right). 
2. Drag one of the RNA polymerases from the biomolecule toolbox onto the dotted line on Gene 1 and observe its movements.
3. Next, drag the negative transcription factor from the toolbox and place it on Gene 1, drag the RNA polymerase back to the gene, and observe what happens.
4. Click the reset tool.
5. Drag the positive transcription factor from the toolbox onto the gene. Now, drag an RNA polymerase onto the gene. Observe what happens.
6. While leaving the positive transcription factor in place, continue dragging the RNA polymerase back to its spot on the regulatory region two more times.
7. Drag a ribosome from the toolbox to one of the mRNA strands you created.
8. Place the product of that in your protein collection at the top right. Repeat this process for the other two strands of mRNA.
9. Drag the mRNA destroyer from the toolbox to an mRNA strand. Observe what happens.

Part Two: Expression-Gene 2

This portion of the investigation shows how some genes require multiple positive transcription factors to create different proteins. You will be able to use this knowledge to understand how gene expression works.

1. Reset the simulation by clicking the orange circle underneath Next Gene in the bottom right of the screen. 
2. Click Next Gene (be sure it says Gene 2). Observe the differences you see in the biomolecule toolbox between Genes 1 and 2.
3. Drag the first positive transcription factor to the regulatory region of the gene.
4. Drag the RNA polymerase to the gene. Observe what happens.
5. While leaving the first transcription factor in place, add the second positive transcription factor to the gene. Drag the RNA polymerase back on the gene. Observe what happens.
6. While leaving the second transcription factor in place, remove the first transcription factor and drag the RNA polymerase back on the gene. Observe what happens.

7. Drag a ribosome from the toolbox to the mRNA strand you had created. Place the protein in your protein collection in the top right.

Part Three: mRNA- Determining Regulatory Rates of Transcription

This portion of the investigation shows how positive and negative transcription factor concentration and affinity can impact the rate of protein synthesis.

Affinity and Concentration

Affinity here refers to the strength of the bond between the transcription factors and RNA polymerase on the DNA strand. The higher the affinity, the greater attraction the molecules share.

Concentration is the number of molecules present. Generally speaking, the higher the concentration of molecules, the faster the rate of reaction.

At the bottom of the window, click the “mRNA” mode. Follow the steps to complete the investigation.

1. Click on “mRNA” at the bottom of your screen. In the middle of the screen, you should see a zoomed in version of the gene and two boxes towards the bottom, “Positive Transcription Factor” and “RNA Polymerase.”
2. Using the sliding scale, slide the affinity for both RNA polymerase and the positive transcription factor to low and the concentration of the positive transcription factor to high. Watch what happens.
3. While leaving the positive transcription factor concentration on high, slide RNA polymerase’s affinity to high and let it run for about 30 seconds. Observe the differences.
4. Now, slide the positive transcription factor affinity to high, let it run for about 30 seconds and observe any changes.
5. While keeping the others scales at high, check the box that says, “negative transcription factor.” Move its concentration and affinity to the midway point. Observe what happens.
6. Change only the negative transcription factor concentration and affinity to high. Observe what happens.
7. Finally, slide only the positive transcription factor’s affinity to low. Observe any changes.