Name_____Date_____Period_____

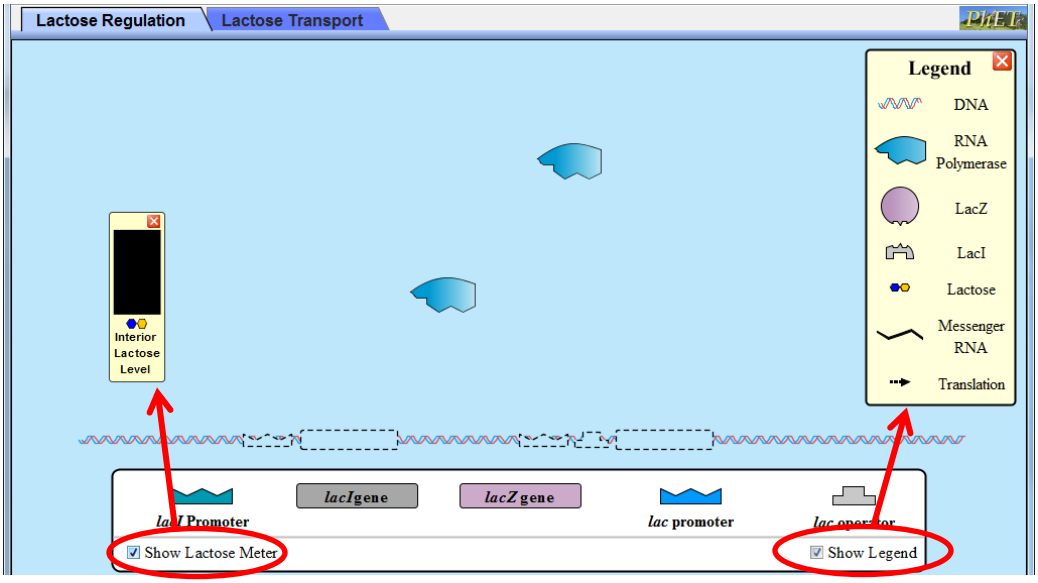
Gene Regulation Feedback Loop: The Lac Operon

Gene Machine PhET activity

1. Go to the Phet website for the Gene Machine: Lac Operon http://phet.colorado.edu/en/simulation/gene-machine-lac-operon

2. Click on run now.

3. Once in the website select – **show legend** and show lactose meter (see circled below)



The **lac operon** is a region of DNA in *E. coli* that includes:

- A ***promoter*** which is a sequence of DNA in that helps the RNA polymerase to recognize a gene.
- An ***operator***, which is a DNA sequence to which a repressor protein produced by a special regulatory gene (the *lacI* gene) can bind to shut off the operon.
- The ***lacZ gene*** (which actually represents <u>several</u> genes) produces the proteins needed to metabolize lactose. (The *LacZ* molecule in the simulation most closely corresponds to the enzyme beta galactosidase).

The ***lacI gene*** produces a ***repressor protein*** that can inhibit the lac operon by binding to the operator. Note that the *lacI* gene and its promoter are NOT part of the lac operon.

4. Drag the different pieces of lac operon to the correct position.

Once the operon and *lacI* gene are working (i.e. being transcribed into mRNA and translated into proteins), answer the following questions about the lac operon's function:

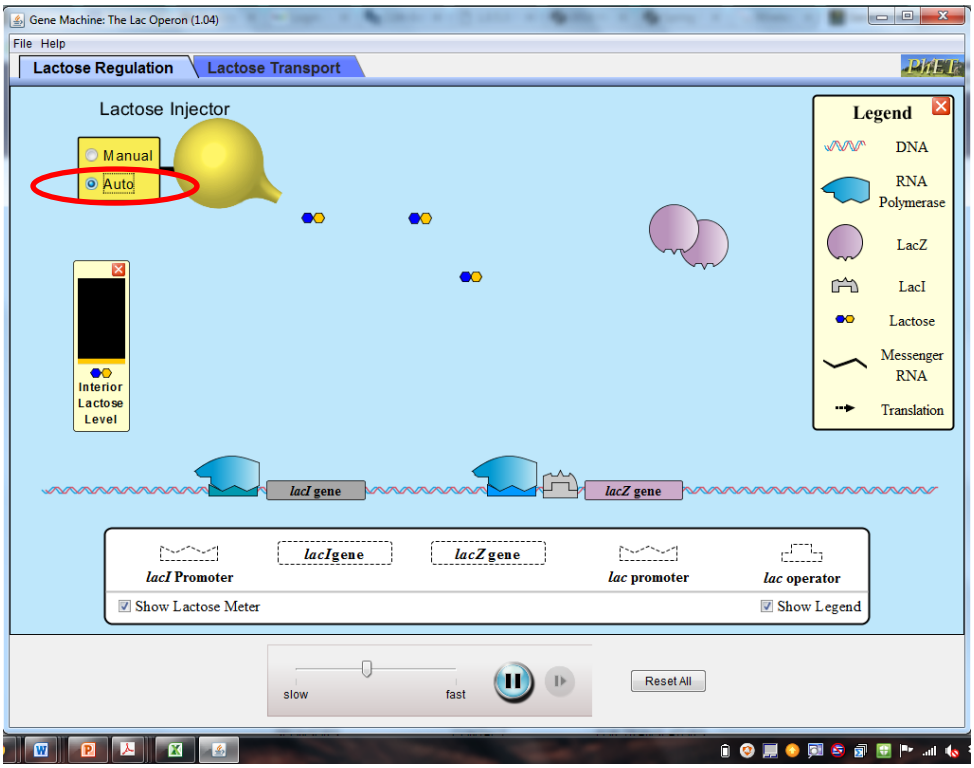
1. Describe the the function of RNA polymerase.

When RNA polymerase is able to bind to the promoter in front of each gene, note that an mRNA molecule is produced which is then used to make a the respective *lacZ* and *lacI* proteins (the step of translation at a ribosome is skipped in this animation.)

2. Describe what happens when the *lacI* protein is bound to the lac operator site in front of the *lacZ* gene.

3. What would be the advantage of inhibiting the production of the *lacZ* enzyme when lactose is not present?

After a few minute a lactose injector will appear, that will increase the concentration of lactose in the cell. Adjust it to be on auto (see circle below).



4. Describe how the system responds to high levels of lactose by answering the following questions.
    A. How does the lactose interact with the *lacI* protein and how does this affect the function of the *lacI* protein?

    B. What is the name for this type of regulation of protein function?

    C. What happens to the levels of the *lacZ* enzyme when this occurs? **Explain why.**

    D. What happens to the levels of lactose? **Explain why.**

5. Describe how the system responds to low levels of lactose.

6. Recap the results: When lactose levels are high the production of *lacZ* _____ and the levels of lactose _____. When levels of lactose are low the production of *lacZ* _____ and the levels of lactose _____.

7. Does this system illustrate a positive or negative feedback loop? **Explain your answer.**