PhET Tips for Teachers **Gene Expression - The Basics**

Tips for controls:

- Use **Teacher** Menu on the "Cell Gene Expression" tab to Zoom  helping students understand scale – the sim is a magnified simplified cellular process.
- Try all the different tabs at the top of the simulation. The tabs are designed to help teachers scaffold lessons or make lessons age appropriate by using only some tabs.
- You can **Pause** the sim and then use **Step** to incrementally analyze. 

Important modeling notes / simplifications:

- The cell being modeled is prokaryotic cell, and so has no nucleus
- On the "Multiple Cells" tab, the protein production being modeled is GFP (green fluorescent protein)
- On the "Cell Gene Expression" tab and on the "Messenger RNA Production" tab the RNA polymerase and the transcription factors have a movement that is "pseudo random" and tends to drive towards the Gene region.

Insights into student use / thinking:

- One of the learning goals of the "Multiple Cells Tab" tries to lead students to see the difference between the *average* protein level expressed by a single cell and multiple cells. Students will likely need to pay attention to the level of fluctuations on the dynamic protein level graph to make sense of this connection.
- Students may not immediately see the goal of the "Messenger RNA Production" tab, considering asking students to describe the factors that affect RNA production, or first challenge them to produce RNA as quickly as possible.

Suggestions for sim use:

- For tips on using PhET sims with your students see: **Guidelines for Inquiry Contributions** and **Using PhET Sims**
- The simulations have been used successfully with homework, lectures, in-class activities, or lab activities. Use them for introduction to concepts, learning new concepts, reinforcement of concepts, as visual aids for interactive demonstrations, or with in-class clicker questions. To read more, see **Teaching Physics using PhET Simulations**
- For activities and lesson plans written by the PhET team and other teachers, see: **Teacher Ideas & Activities**

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