

Name: \_\_\_\_\_ Period: \_\_\_\_\_ Date: \_\_\_\_\_

Open [peebedu.com](http://peebedu.com) and navigate to **Enzyme Lock-and-Key Interactive**. Click the **Introduction** button to read the concept cards about Enzymes, Active Site, Specificity, Substrate, ES Complex, and Rate Factors. Then close the introduction and familiarize yourself with the Simulation Controls panel on the left.

## Part 1 – Model Evaluation (MAPP Framework)

*Scientific models are simplified representations of complex biological phenomena. Use the MAPP framework below to evaluate the Enzyme Lock-and-Key Interactive as a scientific model.*

### M – Mode

What type of model is the Enzyme Lock-and-Key Interactive? Describe how this computational simulation represents enzyme catalysis. In your answer, identify at least three specific simulation elements and explain what each one is designed to show about how enzymes function.

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### A – Accuracy

(a) Identify two things this simulation represents **accurately** about enzyme structure and function. For each, name the specific simulation feature and explain what concept of enzyme catalysis it demonstrates.

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(b) Identify two things this simulation **oversimplifies or leaves out** about enzyme catalysis. Consider what you cannot observe in the simulation that would be important for a complete understanding of how enzymes regulate biological reactions.

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## **P – Purpose**

What is the learning goal of this simulation? Explain how the Enzyme Lock-and-Key Interactive is designed to help you understand how the structure of an enzyme determines which substrates it can catalyze. In your answer, connect at least one specific simulation feature to why enzyme specificity matters for the regulation of biological processes.

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## **P – Permanency**

Could this model change with new scientific evidence? Describe one way that new discoveries might change or improve a simulation like the Enzyme Lock-and-Key Interactive. Explain why scientific models, including computational simulations, are revised as new evidence becomes available.

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## **Small-Group Discussion**

With your group, discuss the following:

- What are the strengths of this simulation as a model for enzyme-substrate interactions?
- What are its limitations?
- If you could add one feature to improve this simulation, what would it be and why?
- How does the simulation help you connect enzyme structure to enzyme function?

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## Part 2 – NGSS Questions

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1.

*Simulation Task: Select **Triase** as the enzyme and **Triangle substrate** as the substrate. Set Enzyme Concentration to 1 and Substrate Concentration to 10. Click **Start** and observe the animation area for 15 seconds, then click **Stop**. Note the Total Reactions count.*

Describe what happens when the Triase enzyme encounters the triangle substrate in the simulation. Explain why the shape of the enzyme's active site allows it to bind with this particular substrate and catalyze a reaction.

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2.

*Simulation Task: Click **Reset**. Select **Triase** as the enzyme again but change the substrate to **Square substrate**. Set the same concentrations (Enzyme 1, Substrate 10). Click **Start** and observe for 15 seconds. Compare the Total Reactions count to your result from Question 1.*

Explain why Triase does not catalyze a reaction with the square substrate. Describe how the lock-and-key model of enzyme specificity accounts for what you observed in this trial compared to the previous one.

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**3.**

*Simulation Task: Click **Reset**. Select **Squarase** as the enzyme and **Square substrate** as the substrate. Set Enzyme Concentration to 3 and Substrate Concentration to 25. Click **Start** and watch the animation area closely. Look for the yellow glow that appears when an enzyme and substrate bind together.*

Describe the steps you observe in enzyme-mediated catalysis, from the moment a substrate approaches the enzyme to the release of the product. Explain why the enzyme is able to catalyze additional reactions after releasing the product.

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**4.**

*Simulation Task: Click **Reset**. Select **Triase** and **Triangle substrate**. Run two trials: first with Enzyme Concentration at 1 and Substrate Concentration at 10 for 15 seconds, then reset and run again with Enzyme Concentration at 5 and Substrate Concentration at 10 for 15 seconds. Compare the Total Reactions counts and the Molecules vs Time graphs from both trials.*

Describe how increasing the enzyme concentration affected the reaction rate. Explain why having more enzyme molecules in the simulation area leads to more enzyme-substrate complexes forming per unit of time.

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5.

*Simulation Task: Use the **Discover Reactions** section at the bottom of the controls panel. Experiment with different enzyme-substrate combinations by selecting different enzymes and substrates in the main simulation area. Try to fill in at least two of the four reaction rows by identifying which substrate each enzyme acts on and what product is formed.*

Explain how the simulation demonstrates that each enzyme in a biological system catalyzes a specific reaction. Describe why cells need many different enzymes rather than a single enzyme that works on all substrates.

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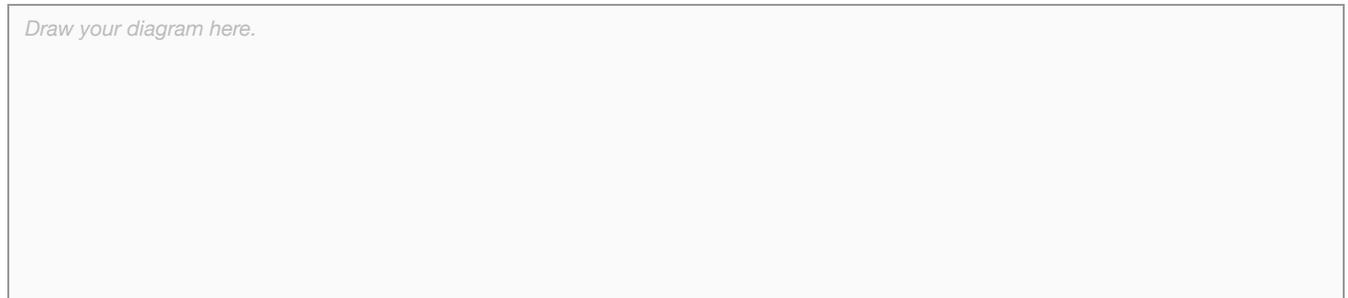
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6.

*Simulation Task: Select **Squarase** and **Square substrate**. Set Enzyme Concentration to 1 and Substrate Concentration to 5. Click **Start** and carefully observe how a single enzyme molecule binds to a substrate, forms the enzyme-substrate complex (yellow glow), and releases the product before binding another substrate.*

In the box below, draw a labeled diagram showing the complete catalytic cycle of an enzyme. Include: (1) the free enzyme with its active site, (2) a substrate approaching the active site, (3) the enzyme-substrate complex, and (4) the enzyme releasing the product and returning to its original shape. Label the enzyme, active site, substrate, enzyme-substrate complex, and product.

*Draw your diagram here.*



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7.

*Simulation Task: Run the simulation one more time with any matching enzyme-substrate pair. As you watch the enzyme catalyze reactions repeatedly, consider what would happen to an organism if a genetic change altered the shape of one of its enzymes.*

The shape of an enzyme's active site is determined by the protein's amino acid sequence, which is encoded in DNA. Explain how a change in an organism's DNA could alter the shape of an enzyme's active site and affect the organism's ability to carry out a specific chemical reaction. Describe how such a change could influence whether the organism survives in its environment.

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