

Name: _____ Period: _____ Date: _____

Open peebedu.com and navigate to **Reaction Diagram Sandbox**. Click the **Start Drawing** button to begin. Read the introduction popup, which describes two interaction modes (Move and Assign), drawing tools for building reaction pathways, and key features including real-time energy calculations and solution checking.

Part 1 – Model Evaluation (MAPP Framework)

Scientific models are simplified representations of complex biological phenomena. Use the MAPP framework below to evaluate the Reaction Diagram Sandbox as a scientific model.

M – Mode

What type of model is the Reaction Diagram Sandbox? Describe how this computational simulation represents chemical reaction pathways. In your answer, identify at least three specific simulation elements and explain what each one is designed to show about enzyme-catalyzed reactions and energy flow.

A – Accuracy

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

(b) Identify two things this simulation **oversimplifies or leaves out** about biochemical reaction pathways. Consider what you cannot observe in the simulation that would be important for a complete understanding of how enzymes catalyze reactions and how energy flows through metabolic pathways.

P – Purpose

What is the learning goal of this simulation? Explain how the Reaction Diagram Sandbox is designed to help you understand how enzymes lower activation energy to speed up biological reactions and how cells couple exergonic reactions with endergonic reactions to drive cellular processes. In your answer, connect at least one specific simulation feature to a biological example of why that concept matters for living organisms.

P – Permanency

Could this model change with new scientific evidence? Describe one way that new discoveries might change or improve a simulation like the Reaction Diagram Sandbox. Explain why scientific models, including computational simulations, are revised as new evidence becomes available.

Small-Group Discussion

With your group, discuss the following:

- What are the strengths of this simulation as a model for enzyme catalysis and energy coupling?
- 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 the concept of activation energy to the role of enzymes in metabolic pathways?

Part 2 – Free Response Questions

Conceptual Analysis

Question 1 – Enzyme Catalysis and Activation Energy

Simulation Task: Drag Molecule A and Molecule B onto the canvas. Switch to Assign Mode and create the reaction $A + B \rightarrow C$. Then drag Enzyme E1 onto the reaction arrow and click Run Simulation. Observe how the reaction rate changes with and without the enzyme present.

(A) (1 pt) **Describe** the role of enzymes as biological catalysts, including how they lower the activation energy required to reach the transition state of a reaction without being consumed in the process.

(B) (1 pt) **Explain** why the reaction in the simulation proceeds faster when Enzyme E1 is added to the reaction arrow.

(C) (1 pt) **Predict** what would happen to the rate of the reaction $A + B \rightarrow C$ if a molecule were added to the simulation that blocks the active site of Enzyme E1, preventing the substrates from binding.

(D) (1 pt) **Justify** your prediction by explaining how competitive inhibition of the enzyme's active site would affect the formation of the enzyme-substrate complex and the overall rate of the catalyzed reaction.

Analyze Model / Visual Representation

Question 2 – Energy Coupling in Metabolic Pathways

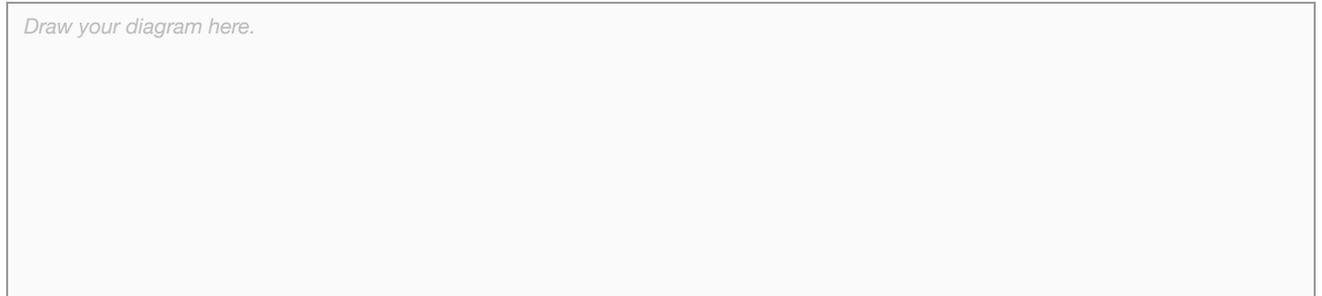
Simulation Task: Select the “6 Molecules – Metabolic Cycle” preset template from the dropdown menu and click Run Simulation. Observe how molecules flow through the pathway. Then switch to Assign Mode and add a negative feedback arrow from the final product back to an earlier step. Run the simulation again and observe how the feedback changes the pathway behavior.

(A) (1 pt) **Describe** the difference between exergonic reactions and endergonic reactions in terms of free energy change.

(B) (1 pt) **Explain** how the metabolic cycle shown in the simulation demonstrates energy coupling, where the energy released by exergonic steps drives the endergonic steps in the pathway.

(C) (1 pt) **Represent** a coupled reaction pathway.

Draw your diagram here.



(D) (1 pt) **Explain** how a mutation in a gene encoding an enzyme in a key metabolic pathway could reduce the organism's ability to couple exergonic and endergonic reactions.

EK 3.3.A.2, EK 3.1.A.1