SECTION 22 Understanding Complex Chemical Systems in Living Organisms

IN-CLASS ACTIVITY

Why

The chemical principles you learned in previous chemistry courses all apply to the chemical reactions of life that we study in biochemistry. However, the defining characteristics and complexity of living organisms means that we cannot always make direct comparisons to reactions happening in test tubes and we often have to think more critically about the chemical implications of the biological context.

Outcomes

1. Review thermodynamic principles and apply them to a biological context.
2. Distinguish the terms ***equilibrium*** and ***steady state*** and use them appropriately when describing biochemical systems.

Critical Thinking Questions

1. Define the term ***chemical equilibrium*** as you learned it in general chemistry. Include any assumptions made about the system being studied.

2. If concentrations are relatively constant over time, is a system necessarily at equilibrium? Explain your answer.

3. In terms of free energy, what does it mean for a chemical reaction to be at equilibrium?

4. Do living organisms do work? If so give an example. If not, explain why not.

5. What would the ΔG for a chemical reaction need to be in order to do work?

This activity was co-authored by Trey Morgan.

6. Are living organisms open or closed systems? How do you know?

7. Are chemical reactions occurring inside living organisms in chemical equilibrium? Explain your answer using evidence generated from answering the preceding questions.

8. Read the section in your book related to cellular steady state. This is often found in the first chapter of biochemistry textbooks.

    a. Based on your reading do you need to refine any of your answers given previously? If so, how?

    b. Define ***cellular steady state*** in your own words.

    c. Compare and contrast your definition of ***cellular steady state*** with your definition of ***chemical equilibrium***.

9. Imagine a product-favored chemical reaction happening in a living organism in which a substance D goes to substance E. It is known that the concentration of D remains well above zero and constant over time.
    a. Given that the reaction is product-favored, how is the concentration of D maintained? Try to think of at least two different explanations.

    b. How might the catalysis of the reaction maintain the concentration of D?

10. Metabolic pathways, like glucose metabolism, have directionality associated with them. Suggest a way in which this directionality maintained.