Question 5: Analyze Model or Visual Representation of a Biological Concept or Process — 4 points

Figure 1 shows the reactions of the metabolic pathway used to synthesize amino acid B from amino acid A in cells.

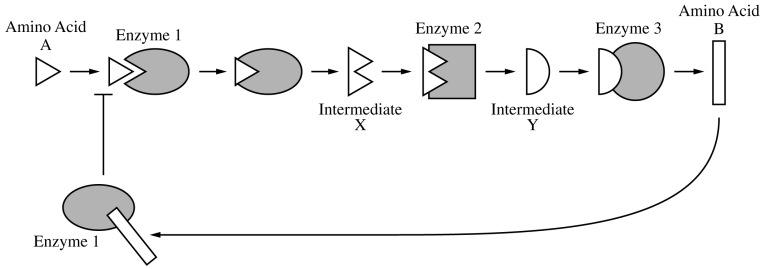

Figure 1. Synthesis of amino acid B from amino acid A

A	**Describe** a characteristic of an enzyme's active site that allows it to catalyze a specific chemical reaction. Examples of acceptable responses may include the following: • (The active site) is able to bind to a (specific) substrate/amino acid. • The shape/charge of the active site of an enzyme is compatible with a (specific) substrate/amino acid. • (The active site) positions the substrate/amino acid in a way that makes the reaction more likely. • Induced fit stresses bonds so that a reaction is more likely to occur.	**1 point**
B	Based on Figure 1, **explain** how the binding of amino acid A to enzyme 1 is regulated by amino acid B. Examples of acceptable responses may include the following: • Amino acid B inhibits the binding of amino acid A to enzyme 1. • Amino acid B binds to an allosteric site of enzyme 1 and prevents amino acid A from binding to enzyme 1. • The binding of amino acid B causes the enzyme to change shape and prevents amino acid A from binding to enzyme 1.	**1 point**
C	Using the information in Figure 1, **identify** the product of the reaction catalyzed by enzyme 2: intermediate X, intermediate Y, or amino acid B. • (Intermediate) Y	**1 point**
D	Based on Figure 1, **explain** how a change in pH could affect enzyme 3 in such a way that amino acid B cannot be produced. Examples of acceptable responses may include the following: • (A change in pH) could change the structure/active site/enzyme so that intermediate Y/the substrate cannot bind. • (A change in pH) could denature (enzyme 3) so that intermediate Y/the substrate cannot bind.	**1 point**

Question 3: Scientific Investigation — 4 points

Fireflies emit light when the enzyme luciferase catalyzes a reaction in which its substrate, D-luciferin, reacts to form oxyluciferin and other products (Figure 1). In order to determine the optimal temperature for this enzyme, scientists added ATP to a solution containing D-luciferin, luciferase, and other substances needed for the reaction. They then measured the amount of light emitted during the first three seconds of the reaction when it was carried out at different temperatures.

$$\text{D-Luciferin} + O_2 + \text{ATP} \xrightarrow{\text{Luciferase}} \text{Oxyluciferin} + CO_2 + \text{AMP} + PP_i + \text{Light}$$

Figure 1. Light is emitted as a result of the reaction catalyzed by luciferase.

(a)	**Describe** a characteristic of the luciferase enzyme that allows it to catalyze the reaction. Accept one of the following: • It has an active site/a shape that can bind with the substrate(s)/brings reactants together**.** • It has a charge that is compatible with the substrate(s).	**1 point**
(b)	**Identify** the dependent variable in the experiment. • The amount of light emitted	**1 point**
(c)	**State** the null hypothesis for the experiment. • Temperature has no effect on the amount of light emitted.	**1 point**
(d)	A student claims that, as temperature increases, there will be an increase in the amount of light given off by the reaction in the first three seconds. **Support** the student's claim. Accept one of the following: • Higher temperature increases the frequency of collisions/interactions between molecules, resulting in an increase in reaction rate. • The higher temperature results in a change to the active site that enhances substrate binding.	**1 point**
	Total for question 3	**4 points**