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K: _____/8 T: _____/10 C: _____/9 A: _____/9

STEM Cases™

Student Guide: Enzymes

Introduction: Claire, a Great Dane, is experiencing extreme weight loss and lethargy despite maintaining a normal appetite. As a veterinary technician, you must learn about metabolism, digestion, and enzymes to help Claire. As part of this Gizmo, you will examine Claire, run lab tests, and analyze data to determine the cause and treat her weight loss.

Vocabulary: As new vocabulary is introduced, the words are presented in the Gizmo as **orange text** - clicking the orange text opens the glossary page for that term. You can use the glossary at any point. **Rephrase answers in your own words to avoid plagiarism!**

1. Launch the Gizmo and follow the instructions provided to collect data on Claire. The questions below are sequential. **Look under Case -> Patient info**

2. What are Claire's symptoms? **[C: 3]**

An increase in appetite
Low energry - not enough to play
No weight gain but is eating

3. Define "metabolism" **Rephrase in your own words. [K: 1]**

Metabolism is a process which is vital in maintianing homeostasis. It is defined as chemical reactions that happen in the body, which combine or break down molecules through reactional processes.

4. **Metabolism** is a combination of two types of reactions. What are these? Define them. **[K: 2]**
Hint: Click on Handbook -> Metabolism, then follow the triangular arrow at the bottom right corner of the simulation window (beside Glossary).

type of reaction	definition
Catabolism	A metabolic reaction responisble for breaking things down, such as food.
Anabolism	A metabolic reaction responsible for building things up, such as msucles.

5. What type of reaction is given in the "Chemical Reactions" example? **[A: 1]**

An anabolic reaction since the reactants combine.

6. The reaction rate is the amount of product produced in a specific time. Why is reaction rate important for biological organisms? **[A: 1]**

The reaction rate is important for biological organisms because metabolism needs to happen quickly in order to grow and digest food.

7. "Enzymes are biological **catalysts**". What does this mean? **[K: 1]**

This means that enzymes are used to increase the rate of chemical reactions.

8. Every chemical reaction, including the reactions that happen inside a living organism, requires an initial input of energy. The energy needed to start a chemical reaction is called the **[C: 1]**

Activation energy

9. Several different types of energy can be used to "give" a reaction its activation energy. List these below: **[C: 2]**

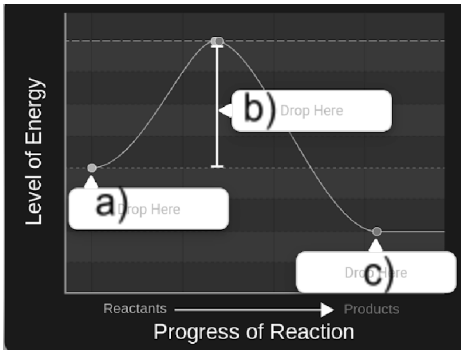
thermal	heat energy can increase the energy but most times, not enough so that it starts the reaction
collision	collision energry is the energy produced when the reactants combine

10. In biological organisms thermal energy cannot be easily added to start a reaction. Instead, enzymes are used. Explain HOW enzymes speed up the rate of a reaction. **[T: 2]**

Enzymes lower the amount of activation energy needed, allowing the reaction to be produced more often thereby increasing the rate of reaction.

11. Label the reaction graph provided with the following labels: **activation energy, reactant energy, produce energy. [C: 3]**

a)	reactant energy
b)	activation energy
c)	produce energy



12. Fill in the blank:

Enzymes do not change the energy of the reactants or the products. They speed up a reaction by lowering the energy of…. **[K: 1]**

activation

13. Each of your 80 000 enzymes has its own highly specific shape, its **structure**. What determines the structure of an enzyme? **[A: 1]**

The interactions that take place between the folding of the enzyme amino acids determine the structure and shape of the enzyme.

14. Because of their specific structure, enzymes differ from each other. Every enzyme has a different **active site.** What happens at the active site of an enzyme? Can the **substrate** of one enzyme fit into the active site of another? **[A: 2]**

At the active site, the reactants are converted into products. Since each enzyme is like a key and a lock, the substrate of one enzyme is not able to fit into another active site.

15. How do high temperature and pH changes affect the workings of an enzyme? Explain. **[T: 2]**

The temperature and pH affect a given enzyme by changing its shape. Enzymes will not work properly as the active site will not be able to fit the substrate properly. It is therefore crucial that organisms maintain the proper temperature and pH level.

16. Once you are back to Claire's Lab Data, fill in the table below: **[K: 3]**

enzyme	location	function
pepsin	The stomach	protein is broken down by pepsin and works best when in an acidic environment
protease	Small intestine	breaks down proteins
carbohydrase	Small intestine	breaks down carbohydrates
lipase	Small intestine	breaks down lipids / fats

17. Low enzyme function can be caused by a range of issues. In your Gizmo, explain how each of these could affect enzyme function and what happens when you test these in Claire. **[T: 3]**

Potential issue	explanation	Claire's results
active site mutation	Enzyme creation can sometimes result in a change in one of the amino acids. This results in a change in activation site since the shape of the enzyme is no longer the same, reendering the enzyme useless	The three enzymes tested from Claire's intestine shows no signs of change in active site, meaning that active site mutation is no longer a potential issue.
abnormal pH	The pH also helps in dictating the shape of the enzyme. This means that if pH was abnormal, her enzymes wouldn't work.	All enzymes measured in Claire's intestine showed an optimal range of 8 to 10 pH and since Claire's intestine had a pH level of roughly 9.1, abnormal pH is no longer a potential issue.
low enzyme production	With more enzymes, the higher the rate of reaction. If there is a low production of enzymes, then food would be broken down too slowly.	Enzyme production in Claire's small intestine showed very low levels in comparison to normal levels, leading us to believe that low enzyme production is the most likely explanation of Claire's symptoms.

18. Science function by asking and testing questions. As more information becomes known new questions can be asked and hypotheses can be revised to make them more and more accurate. At some point, once enough information has been gathered, a conclusion can be made. Explain how this Gizmo illustrates that process. **[T: 3]**

The Gizmo illustrates this process by first taking users through all pertinent information about enzymes. Users are then able to isolate the problem to Claire's small intestine and come up with a hypothesis as to what might be wrong. By running a series of tests to gauge the efficacy of each enzyme in Claire's intestine, users can allow their hypothesis to grow and change as their knowledge surrounding the problem increases. Finally, after all tests have been done, a conclusion is found and the problem is exposed - Exocrine Pancreatic Insufficiency. A prescription and treatment are given and followed, and the case is closed. The Gizmo did a very good job of articulting the proper procedures used in science.

19.

As more evidence gathers, science is replaced by better science. Use a real-life example to explain this. As a good starting point, **have a look at:**
https://www.sciencenews.org/article/coronavirus-covid-19-pandemic-six-months-what-we-know **[A: 4]**

Originally, Chinese officials didn't believe the Covid-19 virus to be as transmissable as we know it is today. We also believed the only symptoms shown were fever and coughing, and that children were not as affected as older people were. Today we know that we can pass the virus without even showing symptoms, we know that symptoms can include body aches, diarrhea, fatigue and even loss of smell and taste. We have also debunked the myth that children are not as affected as others since chidren are only low-risk and still are able to spread the virus. Science should always be replaced with new and better science as that is the only way to continue to advance as a society.