Bond... Enzyme Bond

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Target Grade: 9-12 Biology

Time Required: 45 minutes to 2 weeks, depending on lesson(s) used

Standards:

- HS. LS. 1-1: Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells.
- HS. LS. 1-6: Construct and revise and explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules

Lesson Objectives:

Students will:

- Describe the structure and function of specialized proteins known as enzymes and explain their importance to maintaining homeostasis
- Model amino acid chains to create a protein chain illustrating an enzyme using tangible materials, as well as 2D and 3D software online
- Investigate how enzymes work and collect data analysis
- Hypothesize enzyme functions when extreme events occur (i.e. temperature or pH changes
- Create and communicate an argument on the biotechnological ethics of enzyme use and impairment in human usage

Central Focus:

The goal of these lessons is to build upon the student's previous knowledge of enzymes. The first lesson is just an introduction into enzymes focused on what enzymes are and why they are important to the homeostasis of an organism. The second lesson focuses on teaching the students the structure and function of enzymes. The third lesson builds on the previous days by teaching how enzymes function. The next lesson introduces how enzymes can become denatured and the ramifications of this. The final lesson will incorporate information from all previous lessons and require the students to culminate their knowledge to form a debate on the ethics of enzyme inhibition. These lessons build upon one another with increasing complexity. The lessons start from an introduction on enzymes to ending with a debate on the ethics of enzyme inhibition.

Adapted from: https://www.biologycorner.com//worksheets/enzyme-lab-

Background Information:

The first lesson requires the least amount of background information necessary for student understanding. The first lesson is an introduction into what enzymes are and how enzymes are important. The students will need minimal background into macromolecules. The specific macromolecule the students will need information on is proteins. Specifically, how proteins are synthesized from amino acids. It would be beneficial for students to understand the basic concepts of energy, molecular formulas, and terminology. For example, the students may find it helpful to already know what a substrate is, how energy is used in a chemical reaction, and how reactants lead to products.

In the second lesson, the students will need to understand the concepts learned during lesson one. For example, the students will need to understand the purpose of enzymes. The teacher will need to know how to use MolView before the lesson to better help students. It would be helpful for the teacher to also know basic chemical bonding. Students should know basic bonding properties as well.

In lesson three, students will need to be familiar with the information that was presented over the past two days. It is essential that students have a basic knowledge of Excel. When doing the virtual lab, the students will need to know information on basic laboratory equipment (test tube, weigh boat, computer, substrate, etc.), the students should also have an understanding of the pH scale and how it effects enzymes.

In the fourth lesson, the students need to know the names and uses of laboratory materials such as a thermometer, beaker, glass stirring rod, and metal scoop/spatula. They will need to have a strong understanding of lesson three's information. The better they understand the purpose and results of the experiment conducted during lesson three, the greater chance they will have at understanding lesson four's material.

In the final lesson, it is essential that the students are comfortable with the teacher and one another. This lesson revolves around student to student communication and participation in a debate at the end of the lesson. The students will need to understand a large majority of the material from the previous days. This lesson requires basic internet searching skills, because students will be supporting their claim with information from the reading articles provided and online resources. A brief overview in what enzyme inhibition means and its history would help students create a more convincing argument. Finally, it would benefit students to have a basic understanding of ethics.

Materials

Adapted from: https://www.biologycorner.com//worksheets/enzyme-lab-

- Lesson 1
  - Computer (teacher)
  - Projector
  - Video
    - Enzymes: The Amoeba Sisters
      - https://www.youtube.com/watch?v=qgVFkRn8f10
  - Student handouts/notes
    - "Amoeba Sisters Video Recap: *Enzymes*"
    - "Real Life Enzyme Scenarios"
    - Exit Tickets
- Lesson 2
  - Precut pool noodles
  - Student handouts
    - "Pool Noodle Enzymes Modeling"
    - "The Need for Speed – A Look at Enzyme Activity"
      - 30 pennies per group
      - Roll of masking tape
      - Ball
      - Stop watch
      - Lab tray
  - Computers (students)
    - Link for modeling software
      - http://molview.org/
- Lesson 3
  - Computers (students)
  - Enzyme Virtual Lab
  - Student Handouts
    - "Enzyme Lab – Virtual"
  - Link for lab
    - http://biol.co/enzyme1
  - Excel for data analysis
- Lesson 4
  - Fresh pineapple (blended/pureed)
  - 40 mL warm gelatin (Jello™ or Knox®)
  - Thermometer
  - Hot water bath
  - 50 mL beaker (2 per group),
  - Freezer (24 hours)
  - Refrigeration time (24 hours)
  - Glass stirring rod
  - Metal scoop/spatula
  - Label Type (Group #, Period #, Pineapple Type)
  - Student Handout/Data sheets
    - *Effects of Temperature on (Bromelin) Enzyme Activity (AKA "Pineapple Enzyme Lab")*

Adapted from: https://www.biologycorner.com//worksheets/enzyme-lab-

- Lesson 5
  - Computers (students)
  - 6-8 preselected articles
    - Sarin {nerve agent} attacks on Japan (1995/2018)
    - *Novichok* {nerve agent} attack in London (2018)
    - Alzheimer's and Parkinson's disease treatments
    - Articles must represent both sides of the ethical debate for inhibiting enzymes
  - Chart paper or butcher paper for group collaboration
  - Index cards for speeches
  - Student handouts
    - "Graded Fishbowl Discussion Rubric"
    - "Enzyme Quiz"

Instruction

Lesson One: Introduction to Enzymes (45-60 minutes)

Introduction (~10-15 min)

- Teacher will present the objectives
  - Describe the structure and function of specialized proteins known as enzymes and explain their importance to maintaining homeostasis
- Teacher will pass out student handouts
  - "Amoeba Sisters Video Recap: *Enzymes*"
  - "Real Life Enzyme Scenarios"
  - https://www.amoebasisters.com/uploads/2/1/9/0/21902384/video_recap_of_enzymes_by_amoeba_sisters.pdf
- Students will answer the two questions:
  - What are enzymes?
  - Why are they important to the homeostasis of an organism?
- Teacher will go over student responses and give answers to both questions

Exploration: Amoeba Sisters video and Worksheet (15 minutes)

- The teacher will begin the video "Enzymes: The Amoeba Sisters"
  - https://www.youtube.com/watch?v=qgVFkRn8f10
- Students will fill out the recap worksheet as the video is playing
- The teacher will go over the worksheet at the end of the video with the student

Elaboration 1: Real Life Enzyme Scenarios (20 minutes)

- Teacher will begin by asking questions and introducing concepts to the class
  - How they are made
    - Review for protein synthesis and amino acids
  - How do they work?
    - "Pack-Man" or "Lock and Key" set up

Adapted from: https://www.biologycorner.com//worksheets/enzyme-lab-

  - Why are they important to homeostasis?
    - Discuss catalyst and metabolism
  - Enzymes usually end in -ase and will help identify its specific role within the organism
- The students will begin the "Real Life Enzyme Scenarios" portion of the "Amoeba Sisters Video Recap: *Enzymes*"
- The teacher will walk around answering questions and helping guide students towards the right answer.
- The teacher will go over the worksheet once all or a vast majority of the students have finished

Conclude (10-15 minutes)

- The students will finish the lesson by answering the exit ticket question
  - Compare Pac-Man to how an enzyme works. You may write out word or draw a picture (labeled) to explain.
- If there is time, allow students to give their answer to the class and go over it

Lesson Two: Enzyme Modeling (90-120 minutes)

Introduction (15 minutes)

- The teacher will review yesterday's lesson to check for understanding
- The teacher will introduce the objective for the day
  - Model amino acid chains to create a protein chain illustrating an enzyme using tangible materials, as well as 2D and 3D software online
- Students will answer the introductory questions:
  - How are enzymes setup?
    - Structure and function
- Teacher will pass out student handouts

Exploration 1: Pool Noodle Modeling (25-35 minutes)

- Students will read "Pool Noodle Enzymes Modeling"
- The students will create four models exhibiting:
  - An enzyme-catalyzed catabolic reaction
  - An enzyme-catalyzed anabolic reaction
  - Competitive inhibition of an enzyme
  - Non-competitive (allosteric) inhibition of an enzyme
- The teacher will pass out precut pool noodles to each group
- Review student models as they get done to check if the model is correct or how it could be improved

Exploration 2: 2D to 3D modeling on computer (25-35 minutes)

- Teacher will share the modeling software link to the students
  - http://molview.org/
- The students will build a water molecule for practice

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    - The teacher can demonstrate on their own computer how to build the water molecule
- The students will put the "Model" menu into van der Walls spheres to give the students a more realistic views of molecules
- Have the students explore the RCSB Protein Data Bank and set up of the following enzymes
    - DNA helicase, RNA, and DNA polymerase
    - *can add others as it fits into the content

Closure (15 minutes)

- Have students display their enzymes to the class and go over it as a class
- Have students give their own personal recap on the two activities for the day

Optional Extension: Need for Speed Enzyme Lab (40-55 minutes)

- Pass out the extension
- Give a brief overview of the lab before everyone begins to make sure everyone is on the same page before beginning
- Have students begin the extension
- The teacher will walk around answering student questions and making sure students are on task
- Have some students present their conclusions from the lab to the class

Lesson Three: Enzyme Function Virtual Lab (45-60 minutes) 1-2 Class Periods

Introduction (10-15 minutes)

- Start class with a review on the previous two days
- The teacher will introduce the objectives
    - Investigate how enzymes work and collect data analysis

- Have students get their laptops out and go to the virtual lab for the day
    - http://biol.co/enzyme1
- The teacher will go over the lab and purpose of today's lesson

Exploration 1: Virtual Lab (20-25 minutes)

- The students should have 1-2 class periods to work on the virtual lab. If students need more time, time can be adjusted or become homework.
- The students will begin the virtual lab with the lab hand out right next to them.
- The students will conduct the experiment and fill out the data sheets for statistical analysis in Excel
- The teacher will walk around observing student work. The teacher will also answer any questions that the students may have.

Exploration 2: Excel Statistical Analysis (15-20 minutes)

- The students will open up Excel or Google Sheets to graph data

Adapted from: https://www.biologycorner.com//worksheets/enzyme-lab-

- The students will create a graph showing five separate lines for each pH level
- The students will attach this graph to the Virtual Lab worksheet when they submit it
- The students will answer questions on the Analysis sheet that is part of the Virtual Lab worksheet

Closure (10 minutes)

- The students may present their data sheets and graph to the class and explain them
- The teacher may go over the purpose of the lab again and relate it back to the learning objective for the day

Lesson Four: Enzyme Function Inhibition (90 minutes)

Introduction (15-20 minutes)

- Start the class with a review from the previous three days
- The teacher will introduce the learning objective for the day
  - Hypothesize enzyme functions when extreme events occur (i.e. temperature or pH changes
- Give the students the introductory questions to answer
  - What factors (i.e. pH or temperature) can impair enzyme function?
  - Why is enzyme inhibition a serious problem?
- The teacher will pass out the two handout for the day
  - Enzyme Lab Overview
  - Enzyme Student Handout
- The students will be separated into groups for the lab experiment
- The teacher will give an overview of the lab today

Explanation: PowerPoint Presentation Bromelin Lab (15-20 Minutes)

- The teacher will go over the Bromelin Lab PowerPoint
- The PowerPoint goes over the lab and what the students are doing step by step
- The students can follow along with the lab that the teacher handed out earlier

Exploration: Lab "Effect of Temperature on (Bromelin) Enzyme Activity (AKA Pineapple Enzyme Lab)" (30-40 minutes)

- The students will begin the lab
- The teacher will walk around while the students conduct the experiment
- The teacher will answer questions and help guide students as the lab is going on

Closure (10-15 minutes)

- The teacher will go over the lab with the students and relate it back to the learning objective of the day
- The teacher will pick on students to stand up and explain what they observed in the lab today
- The teacher may go over the post lab questions with the students to check for understanding and comprehension

Adapted from: https://www.biologycorner.com//worksheets/enzyme-lab-

Lesson Five: Enzyme Uses-Ethical and Biotechnology (60-120 minutes)

Introduction (15-20 minutes)

- The teacher will remind the students of the major topics from the last four lessons
- The teacher will ask the students to answer a couple of questions
    - What are enzymes used for in organisms? (review of structure and function)
    - How does that apply in the real world? (inhibition of enzymes)
- The teacher will introduce the learning objective for the day
    - Create and communicate an argument on the biotechnological ethics of enzyme use and impairment in human usage
- The groups will be assigned, and the groups will be given their topic and ethical standpoint to defend
- The students will get out their laptops while materials are being passed out and groups are assigned

Exploration 1: Ethical Backing (40-50 minutes)

- The students will be reading through the articles and researching on their computers supporting evidence for their ethical standpoint
- The students will be writing down supporting facts and statements on their group's poster board
- The teacher will be walking around and helping students create their arguments if the students need it

Exploration 2: Creating the Speech (15-20 minutes)

- The students will be organizing their ideas into a coherent argument
- The students will be writing their debate topics on note cards to refer to when they are speaking
- The students will wrap up their final points before we being the debate

Elaboration: The Debate (25-30 minutes)

- The students will participate in a fishbowl debate
    - Fishbowl setup
        - 10 chairs are set up
            - 5 chairs facing each other 5 chairs in the middle of the debate space
        - 5 students from each side start for each team
            - The students will sit in the chairs facing the other team, with the other members of their team behind them
        - Only members of the teams sitting in the "fishbowl" may speak
            - They may not speak over one another or disrespect on another

Adapted from: https://www.biologycorner.com//worksheets/enzyme-lab-

- When a member from a team who is standing feels that they have a point to contribute, they will tap the shoulder on one member sitting
    - The team member must then finish their thought and leave the seat
        - The student leaving the debate cannot immediately leave and touch another shoulder to come back into the discussion
- The teacher will grade the debates using the rubric provided

Closure (15-20 minutes)

- The students will complete an enzyme quiz
    - 10 multiple choice questions
- The teacher will finish and wrap up the unit with the quiz

Differentiation

- Pass out the labs a day early for the students who have difficulty with reading comprehension.
- Groups should be assigned based on strengths and weaknesses. The students who have difficulty with reading comprehension should be paired with students who are proficient at reading comprehension
- Demonstrate at the beginning of class what students will be doing in the labs to help with students who better learn through visualizations

Assessment

Formative

- The introductory questions for each lesson
- Lesson #1 Exit ticket
    - Compare Pac-Man to how an enzyme works. You may write out or draw a picture (labeled) to explain
- Lab assignment papers
    - Virtual Lab write-up
    - Enzyme Lab write-up
- Debate rubric

Summative

- Enzyme Quiz

Adapted from: https://www.biologycorner.com//worksheets/enzyme-lab-

Name: _____

Amoeba Sisters Video Recap: *Enzymes*

1. In the box below, please illustrate an enzyme and substrate. Label the following key words in your illustration: **enzyme**, **substrate**, and **active site**.

2. Enzymes are typically which type of **biomolecule**?

_____

3. Describe the effects that enzymes can have on **substrates**.

_____

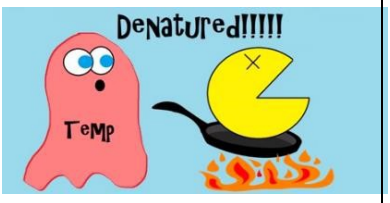
_____

_____

_____

_____

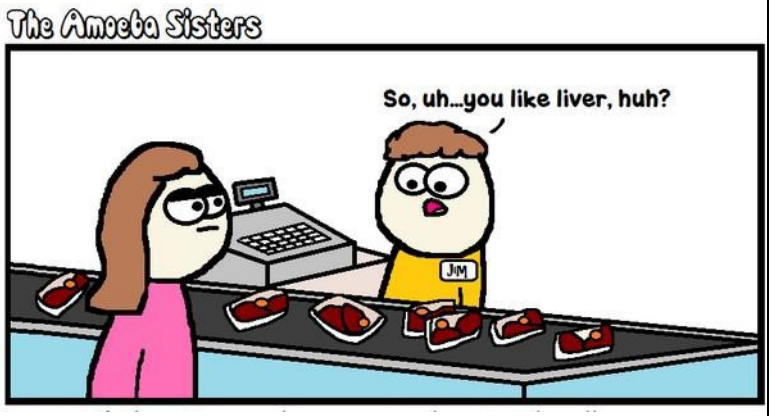
In order to function efficiently, enzymes need to be at an ideal **pH** and **temperature**. Different enzymes have different ideal pH and temperature conditions. If the pH or temperature is extreme for a particular enzyme, it can even **denature** an enzyme, which can prevent it from binding and acting on its substrate. For the following two scenarios, name the variable (temperature or pH) that is affecting the function of the enzyme.



A) ATP is produced by cellular respiration in your human body cells. There are a variety of enzymes that work to produce ATP, but one of those enzymes is called phosphofructokinase-1. This enzyme is sensitive to blood acidity. Blood can become more acidic if a patient is in respiratory distress.

4. **Variable affecting enzyme function:** _____

B) A popular lab that can be performed by students is to test the reaction rate of catalase enzyme when it acts on the substrate hydrogen peroxide. Catalase has the ability to break down hydrogen peroxide. Catalase can be found in beef liver from the grocery store! However, if the beef liver is boiled first, the catalase will not be able to break down hydrogen peroxide.



5. **Variable affecting enzyme function:**

_____

Adapted from: https://www.biologycorner.com//worksheets/enzyme-lab-

Real Life Enzyme Scenarios

Please fill in the chart for every real life scenario listed below. Some boxes have been filled in for you!

Scenario	 **Identify Enzyme:**	 **Identify Substrate:**	**Illustrate the Scenario (label <u>enzyme</u> and <u>substrate</u> in illustration):**	**Describe the relationship between the substrate and enzyme in the scenario.**
Lactase is an enzyme that breaks down a sugar found in dairy products known as lactose. Some people are lactose intolerant, and this can be due to not having enough lactase production. People who are lactose intolerant may not feel well after eating foods containing lactose.	6.	lactose	7.	8.
An enzyme called glucocerebrosidase breaks down a glycolipid in the body known as glucocerebroside. However, in a genetic disease known as Gaucher's disease, the body does not produce enough glucocerebrosidase. Therefore glucocerebroside can build up in the body and this can cause serious side effects such as anemia and swelling of the liver and spleen.	9.	10.	11.	12.
Pancreatitis is an inflammation of the pancreas which can damage pancreatic tissue. The pancreas produces digestive enzymes such as amylase and lipase. These enzymes assist in breaking down certain food biomolecules. In this disorder, enzyme production from pancreatic tissue may be stopped.	13.	14.	15.	Since the pancreatic tissue can be damaged in this disorder, the production of the enzymes in this tissue (amylase and lipase) may be disrupted as well. This would affect the ability to break down certain types of food biomolecules (substrate).

Adapted from: https://www.biologycorner.com//worksheets/enzyme-lab-

Name: _____

Exit Ticket: Compare Pac-Man to how an enzyme works. You may write out word or draw a picture (labeled) to explain.

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Name: _____

Pool Noodle Enzymes Modeling

Use the pool noodle models and sharpies on your butcher paper/poster board to create labeled images that demonstrate your understanding of the following concepts (take a picture of each image for your

reference):

1. **An enzyme-catalyzed catabolic reaction**
   Example: the breakdown of hydrogen peroxide by the enzyme catalase

2. **An enzyme-catalyzed anabolic reaction**
   Example: the building of glycogen by the enzyme glycogen synthase in animal cells

3. **Competitive inhibition of an enzyme**
   Example: in the biosynthetic pathway for folic acid, the antibiotic sulfanilamide competitively inhibits the enzyme dihydropteroate synthase from converting PABA into folic acid

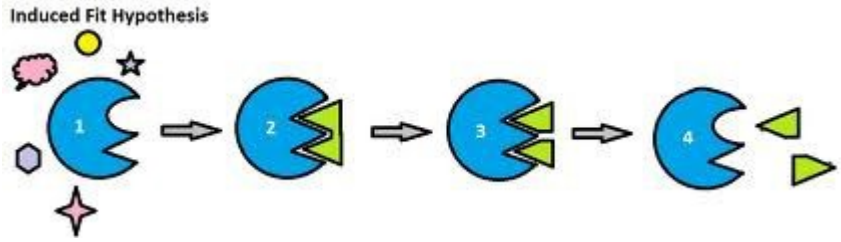
4. **Non-competitive (allosteric) inhibition of an enzyme**
   Example: in the biosynthetic pathway for alanine (an amino acid), alanine non-competitively inhibits the enzyme pyruvate kinase from converting phosphophenol pyruvate into pyruvate

****Use this image as an idea to get you going with your own models. ****

Adapted from: https://www.biologycorner.com//worksheets/enzyme-lab-

Name: _____

The Need for Speed—A Look at Enzyme Activity



Introduction:

Enzymes are **proteins** that are **catalysts**. This means they speed up **chemical reactions** in living organisms, but they aren't consumed in those reactions. Here are some important things you should know about enzymes:

- Enzymes are effective in **small amounts** (often too small to be detected by ordinary chemical tests) because they are **not used up** in the reaction that they catalyze.
- Enzymes are **specific** to the reactions that they catalyze, that is, each enzyme only catalyzes one specific chemical reaction. This relationship between the enzyme and its specific reaction is illustrated above in the picture and is described as a **"lock and key" relationship** (e.g. only one key fits into each lock).
- Enzymes do not affect the direction of the reaction but make the reaction reach equilibrium sooner by **lowering the activation energy** needed for the reaction to take place. **Activation energy** refers to the energy needed to get the reaction started.

Problem: How do enzymes function under different conditions?

Hypothesis: Form a hypothesis to answer the question above using "If...then...because..."

Purpose:

The purpose of this investigation is to demonstrate enzyme reactions and the environmental variables that affect these reactions.

Materials: Each team will need...

30 pennies ball lab tray roll of masking tape stop watch

Procedure:

Part 1: Normal Enzyme Activity

1. Spread 30 pennies on one side of your lab table. The pennies represent the substrate and your hand will represent the enzyme.
2. One team member will attempt to pick up as many pennies as possible in 10 seconds. ***You must stop when the timer sounds!***
3. Place the lab tray on the other side of the lab table.
4. The team member picking up the pennies must observe the following rules:
    a. Pick up only one penny at a time.
    b. Take it back to the lab tray.
    c. Lay it down FACE UP. This represents the product.

Adapted from: https://www.biologycorner.com//worksheets/enzyme-lab-

Name: _____

5. The other team members will be responsible for correctly recording the number of pennies picked up. ***Record your data in Data Table under Part 1.***
6. This process will be repeated for five more times.
7. Do not return the pennies until the end of Part 1.

Part 2: Denaturation

Denaturation is a form of non-competitive inhibition in which the enzyme changes shape. As a result, the substrate is not able to bind correctly and the enzyme becomes ineffective.

8. Tape your fingers together with masking tape. This represents denaturation. Your enzyme does not have the proper shape.
9. Your team will have 6 attempts at 10 second intervals to pick up as many pennies as possible.
10. ***Record your data in Data Table under Part 2.***

Part 3: Competitive Inhibition

Competitive inhibition occurs when a substance other than the substrate blocks the active site, preventing the enzyme from binding.

11. Remove the tape from your fingers and tape the ball to the palm of your hand. This represents a molecule that binds with the enzyme to get in the way of the enzyme functioning.
12. Your team will have 6 attempts at 10 second intervals to pick up as many pennies as possible.
13. ***Record your data in Data Table under Part 3.***
14. Calculate the averages for each part by adding the number of pennies collected in each trial and dividing by the number of trials.

Data Table *Use a ruler to copy and complete.*

Trials	Part 1 Normal Enzyme Activity	Part 2 Denaturation	Part 3 Competitive Inhibition
1			
2			
3			
4			
5			
6			
Averages			

Analysis *Answer in complete sentences.*

1. In this activity, what object represented the enzyme? the substrate? the inhibitor?
2. If we assume that the enzyme is represented by the hand, what happened to the active site during Part 2?
3. Why does an enzyme not work as well if its active site is changed?
4. What environmental factors affect the enzyme shape?
5. What effect did inhibition have upon the reaction rate?

Adapted from: https://www.biologycorner.com//worksheets/enzyme-lab-

Name: _____

6. Does your data support your hypothesis? Explain why or why not using your data.
7. Gelatin recipes that include frozen fruit often say not to use pineapple. Gelatin is mostly a protein. Pineapple contains an enzyme that is often used in meat tenderizers. What effect might pineapple have on gelatin? Why?

Conclusion

Write 3-5 meaningful sentences explaining what you learned about enzyme activity. Use appropriate vocabulary words in your explanation.

Adapted from: https://www.biologycorner.com//worksheets/enzyme-lab-

Name: _____

Enzyme Lab - Virtual

Site: http://biol.co/enzyme1

Overview: In this investigation, you will determine the effects of substrate concentration and pH on the rate of an enzyme-catalyzed reaction.

Background:

Amylase is an enzyme that catalyzes the hydrolysis of starch into sugars. It is present in the saliva of humans and some other mammals, where it begins the chemical process of digestion. Foods that contain large amounts of starch, like bread, may acquire a slightly sweet taste as they are chewed because amylase degrades that starch into sugar.

In the reaction shown, the enzyme is the amylase and the substrate is starch. The program measures the amount of produce produced after the reaction has progressed for 1 minute, allowing you to compare rates of reaction by looking at the amount of end product.

Procedure: The simulation allows you to change two variables: pH level and the amount of available substrate. Data from the simulation can be viewed by clicking on the computer monitor.

**The simulation allows you to input data and print, but due to technical issues with browsers and networked computers, it is preferable to copy the data onto this page.*

Data: Collect data for each of the variables and complete the table below. The data collected is "number of molecules of product formed per minute."

Amount of Substrate	pH 3	pH 5	pH 7	pH 9	pH 11
0.5g					
1.0g					
2.0g					
4.0g					
8.0g					

Adapted from: https://www.biologycorner.com//worksheets/enzyme-lab-

Name: _____

Analysis:

1. Use a graphing program like Excel or "Google sheets" to graph the data showing 5 separate lines for each pH level. Attach this graph to this worksheet when you turn it in. *To get started, you will be copying the data on the table above to your spread sheet.*

Identify the dependent and independent variables (hint: there are two independent variables you investigated, but only one dependent variable.)

2. Describe the relationship between substrate and the product. What happens when you increase the amount of substrate? Predict what would happen if you used 20.g of substrate and explain your reasoning behind the prediction.

3. Explain why the maximum initial reaction rate cannot be reached at low substrate concentrations.

Adapted from: https://www.biologycorner.com//worksheets/enzyme-lab-

4. What is the optimum pH level for this enzyme? How do you know? Make a prediction about what you think the reaction rate would look like a pH = 2.

5. Enzymes function most efficiently at the temperature of a typical cell, which is 37 degrees Celsius. Increases or decreases in temperature can significantly lower the reaction rate. What does this suggest about the importance of temperature-regulating mechanisms in organisms? Explain.

Name: _____ Date: _____ Per: ___

Title: Effect of Temperature on (Bromelin) Enzyme Activity (AKA "Pineapple Enzyme Lab")

Background Information:

1) Gelatin (Jello™) is made of a protein called *collagen*. When prepared, gelatin is a warm liquid. When cooled over several hours it will turn solid (or semi-solid).
2) There are enzymes in some tropical fruits (like pineapple) that break down proteins (like *collagen*). You will be working with one such enzyme called *bromelin*.
3) In this lab, *bromelin* is the enzyme and its substrate is collagen (Jello™).
4) You will apply two heat treatments to a sample of pureéd (blended) pineapple: freeze or heat it
5) If "**live**" (non-denatured) enzyme is mixed with Jello™ then Jello™ will **remain liquid even after it has been cooled.**
6) If "killed" (denatured) enzyme is mixed with Jello™, then the Jello™ will turn solid.

Question:

Hypothesis (Use the "If…then…because…" format):

Experimental Design (TT-Chart):

Experimental Group: MV_1 (5°C)	Control Group (25°C)	Experimental Group: MV _(50°C)

Manipulated Variable: Temperature

Levels:

Repeated Trials: (Hint: How many lab groups are doing the experiment besides yours?)

Experimental Control Condition: (Hint: What's the MV? This, then, is the opposite of that!)

Responding Variable: (Hint: What are you measuring or looking for?)

Controlled Variables: (Please list at least three)

Materials: Fresh pineapple (blended/pureéd) Warm Gelatin (Jello™) Thermometer Hot Water Bath	Containers (2 per group) Freezer (24 hours/already completed) Refrigeration Time (24 hours) Glass Stir rod

Name: _____ Date: _____ Per: ___

Procedures: Write a list of steps to be followed based on Pineapple Enzyme Lab video provided at: https://www.youtube.com/watch?v=3nkTmILG3HM&list=UUOzCtBgDNmSNBb4ft8nFSVA

Note:
- I already froze the pineapple (#7)
- Groups 1-2 will take care of frozen pineapple.
- Groups 3-5 will take care of heated pineapple.
- Mr. Smith will take care of the fresh pineapple.

Data & Observations:

Levels	What did the gelatin look like? (Day #1)	What did the gelatin look like? (Day #2)
Gelatin alone (CG)		
Gelatin + Bromelin @ 5°(MV_1)		
Gelatin + Bromelin @25°C(ECC)		
Gelatin + Bromelin @50°C(MV_2)		

Conclusion:

Declarative Statement (Options: Supported/Not Supported/Contradicted):

Data (minimum of two: high vs. low or before vs. after doing experiment):

Explanatory Language (Answer the experiment's question and explain the background concepts that show why/how the data and the hypothesis are connected):

Adopoted from: https://betterlesson.com/lesson/632304/pineapple-enzyme-lab-day-1-

Name: _____ Date: _____ Per: ___

Scientific Explanation:

Post-Lab Questions:

1a) Describe the difference (in gelatin on day #2) between the CG and **MV_1**

1b) Describe the difference (in gelatin on day #2) between the CG and **MV_2**

1c) Describe the difference (in gelatin on day #2) between the CG and ECC

2) Why were they different?

3) What **kind** of an enzyme is in the pineapple? (not its name-"bromelin") (extra credit if you find the name)

4) In which condition(s) was the enzyme denatured and unable to catalyze the substrate (gelatin)?

CG **ECC** **MV_1** **MV_2**

How can you be sure?

5) What does this experiment have to do with enzymes?

Adopted from: https://betterlesson.com/lesson/632304/pineapple-enzyme-lab-day-1-

Graded Fishbowl Discussion Rubric

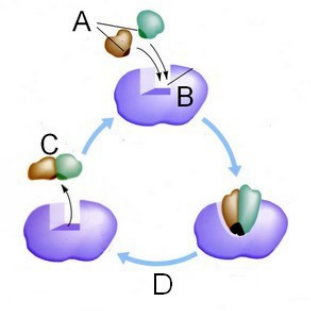
	6-4 points	3-1 points	0 points
Respect	Student was respectful to others both during their discussion and while observing	N/A	Student acted in a disrespectful way at any time during the discussions
Relevancy of Comments	Student comments were relevant to the question being discussed and used accurate information	Student comments and information were somewhat, but not entirely accurate to the question or topic	Student comments and information were not relevant or student did not participate
Interaction During DIscussion	Student interacted with other members of their group	Student participated minimally with members uring the discussion	Student did not interact with froup members during discussion
Resources	Student referenced the primary document using specific sections as support for their arguments and opinions	Student referenced the primary document sometimes, but did not always support answer using the text	Students did not reference the rext to support their answer
Preparation	Student showed that they had read the article and prepared thoughtful questions to use during the discussion	Student showed that they had read most of the article and prepared questions, but questions are not thoughtful or relating to text	Student was not prepared with the text and/or questions

Total Points:_____

Enzyme Quiz

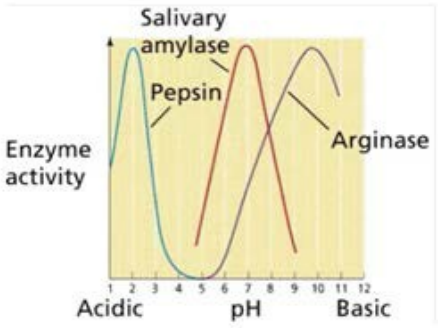
Teacher Copy

1. The part of the enzyme where the substrate binds is called the: a. Active site
   b. Catalyst
   c. Inhibitor
   d. Large subunit
2. Some people cannot digest milk products because they lack a certain enzyme. Which enzyme would be used to break down the lactose milk?
   a. Hydroxylase
   b. Maltase
   c. Peroxisomes
   d. Lactase



3. On the image above, which letter represents the enzyme?
   a. A
   b. B
   c. C
   d. D
4. On the image above, which letter represents the substrate?
   a. A
   b. B
   c. C
   d. D
5. Enzymes are made from which organic molecule?
   a. Carbohydrates
   b. Lipids
   c. Proteins
   d. Nucleic Acids

6. Enzymes make reactions go_____by_____the activation energy of the reaction.
   a. Slower; raising b
   b. Faster; lowering c
   c. Slower; lowering d
   d. Faster; raising c



7. What is the optimal pH for the enzyme Salivary Amylase?
   a. 5
   b. 7
   c. 11
   d. 9
   e. 2
8. Enzymes are designed for very specific chemical reactions. a. True
   b. False
9. A higher_____can increase the reaction rate.
   a. Concentration of enzyme or substrate
   b. pH
   c. Number of inhibitors
10. Which of the following pH levels will most likely NOT affect enzyme activity?
   a. 2 (very low pH)
   b. 3
   c. 7
   d. 12
   e. 14 (very high pH)

Enzyme Quiz

Name: _____

Period: _____

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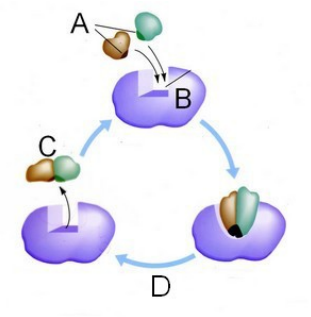

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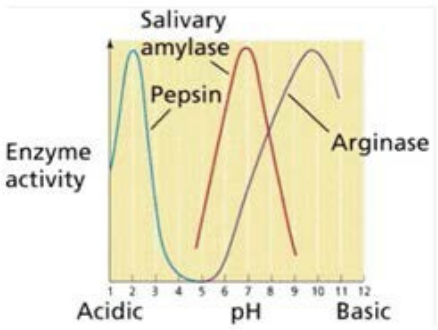

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