Structure and Function of Molecular Genetics (Part 3 of 3) --Enzymes

This 5E model for instruction connects the concepts of protein synthesis and the function of specific proteins (enzymes) to the evolution of lactose tolerance in humans.

Student Science Performance

Grade: 9-12 Biology	**Title:**
Topic: Enzymes	Bubbly

Performance Expectations for GSE:

SB1. Obtain, evaluate, and communicate information to analyze the nature of the relationships between structures and functions in living cells.

c. Construct arguments supported by evidence to relate the structure of macromolecules to their interactions in carrying out cellular processes.

(*Clarification statement:* The function of proteins as enzymes is limited to a conceptual understanding.)

Secondary GSE:

SB1a. Construct an explanation of how cell structures and organelles (including nucleus, ribosome, endoplasmic reticulum, Golgi, and lysosome) interact as a system to maintain homeostasis.

SB2. Obtain, evaluate, and communicate information to analyze how genetic information is expressed in cells.

a. Construct an explanation of how the structures of DNA and RNA lead to the expression of information within the cell via the processes of replication, transcription, and translation.

The secondary GSE focuses on developing connections between enzymes, protein synthesis, and functions of cell organelles. Students may also link knowledge of enzymes to DNA replication needed for asexual reproduction.

Performance Expectations for Instruction:

Investigate how specialized proteins catalyze reactions and may be altered in response to external factors.

Group Performance: (Engage and Explore)

- Obtain information from scenario and discussion of hydrogen peroxide reacting to produce bubbles in a cut.
- Ask questions to produce a model explaining why hydrogen peroxide produces bubbles when reacting with organisms.
- Carry out investigations (the hydrogen peroxide exploration activity) to obtain data for evidence.
- Analyze and interpret the data to refine your model and explanation constructed for the cause of the hydrogen peroxide producing bubbles when reacting with organisms.

Individual Performance: (Explore and Explain)

- Write an argument using evidence from the investigation.
- Use prior knowledge to develop a model of the production of enzymes (catalase) in the cell.

Group Discussion: (Explore and Explain)

- Use the evidence and explanations shared by others to refine or confirm your model and argument.

Teacher Reflection: (Explain)

- Reflect on students' ability to develop an argument where the evidence supports the explanation.
- Reflect on students' ability to conclude that organisms contain enzymes, which are specialized proteins that catalyze reactions to maintain homeostasis. Ensure that this is supported by evidence in the scenarios, activity, discussions, and model of enzyme production in the cell.

Group Performance: (Elaborate)

- Obtain information (from the teacher demonstration elaboration activity or class lab) regarding the effect of enzyme and substrate concentrations have on the reaction rate.
- Obtain information (from the teacher demonstration elaboration activity or class lab) regarding the denaturing of enzymes due to alterations in temperature and pH.
- Ask questions to make a model and construct an explanation for the cause of altered reaction rates seen in enzymes placed in different conditions.

Individual Performance: (Elaborate and Evaluate)

- Write an argument for your explanation that relates to gathered information and evidence supporting the denaturing of enzymes due to alterations in temperature and pH.

Group Discussion: (Elaborate)

- Use the evidence and explanations shared from others to refine or confirm your model and argument.

Teacher Reflection: (Evaluate)

- Reflect on students' ability to develop an argument where the explanation is supported by evidence.
- Reflect on students' ability to conclude that the function of enzymes required to maintain homeostasis in organisms is influenced by enzyme and substrate concentration or may be altered by temperature or pH.

Additional notes on student support

Materials

Each group of 4 students will need:

- 150-200 mL of hydrogen peroxide in large beaker
- 3-4 smaller beakers
- Active yeast packet (divide between groups)
- A small piece of raw beef liver (1" chunk)
- A small piece of raw potato (1" chunk)
- Select 2 of the following non-reactive items:
  rock, salt, paper clip, etc.
- Any necessary PPE (gloves, goggles, etc.)
- Optional items: food coloring, tray with walls to contain spills, disposable pipette, plastic knife

For teacher demonstration in ELABORATION:

- 100 mL of hydrogen peroxide in 4 medium beakers
- 50 mL of distilled vinegar
- Several small pieces of raw beef liver
- Several small pieces of cooked (well-done) liver
- Any necessary PPE (gloves, goggles, etc.)
- Optional items: food coloring, tray with walls to contain spills, disposable pipette, plastic knife

For optional class lab in ELABORATION, each group of 4 students will need:

- 4 liver samples (one should be prepared by the teacher to be kept in a water bath at body temperature, two kept a room temperature, and one kept in ice)
- Hydrogen Peroxide

For a class of 30 with 8 groups of 4 students:

- 8 large beakers and 24-32 small beakers
- 1200-1600 mL of hydrogen peroxide
- 4 packets of active yeast
- 8 small pieces of raw beef liver (1" chunks)
- 8 small pieces of raw potato (1" chunks)
- 16 non-reactive items:
  rock, salt, paper clip, etc.
- Any necessary PPE (gloves, goggles, etc.)
- Optional items: food coloring, tray with walls to contain spills, disposable pipette, plastic knife

<table>
<tr><td colspan="2">

- 4 small test tubes and test tube rack
- 1 large test tube (a small one can work if needed)
- Graduated Cylinder
- Forceps
- Hot Plate
- Ruler
- Large Beaker
- Ice
- Liver
- Gloves

</td></tr>
<tr><td colspan="2">Students will continuously be obtaining, evaluating, and communicating information. This is not a linear process. Students should be communicating through writing and discussions to allow for formative assessment. This benefits the teacher, student, and whole group to guide instruction to clarify misconceptions or extend content.</td></tr>
<tr><td rowspan="4">Engaging Learners</td><td>Phenomenon
Hydrogen peroxide “bubbles” or foams when poured on a cut.</td></tr>
<tr><td>Obtaining
Students obtain information from a scenario focused on the phenomenon:
A child falls and scrapes his knee. His mother pours hydrogen peroxide on the open wound. It bubbles furiously, but only on the wound and not the surrounding skin. As she continues to pour the hydrogen peroxide on the cut, the intensity of the bubbling decreases.
Teacher Notes: Use this scenario as a guide. Differentiate scenario as needed--include more scaffolding details to assist students in understanding basic conceptual knowledge or more advanced details to encourage students to make more advanced connections.</td></tr>
<tr><td>Evaluating
Students construct explanations of why hydrogen peroxide bubbles when poured on a cut using only prior knowledge.

Teacher Notes: Have students attempt to explain the phenomenon before and after engaging in a class discussion.

Additional notes on topic, focus, and phenomena.</td></tr>
<tr><td>Communicating
Students engage in discussion of prior knowledge of pouring hydrogen peroxide on a cut.
Teacher Notes: Use discussion to assess prior knowledge and clarify any misconceptions.</td></tr>
<tr><td>Exploring
Revising Model</td><td>Obtaining
Students carry out the activity using the materials above to obtain information. Activity slides are titled: “Bubbly Activity” and can be found in the Teacher Resource Link. An optional handout can be used to guide the investigation.

Teacher Notes: Before beginning the exploration, students will design an experiment to answer questions. Scaffold the prompts below as needed to guide exploration. Do not put</td></tr>
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	any object directly into the large beaker of hydrogen peroxide. You may pour peroxide into the small beakers and then place the material in the liquid, or you may place the material in the small beakers and then pour peroxide on top. You may use a set amount or varying amounts of peroxide in a reaction. You may use some or all a material in a reaction. After individual observations, you may begin mixing materials in the reactions. Remember, observations are more than just visual—try seeing if there is a temperature change during the reaction. Give groups 5-10 minutes to explore, make, and record observations.
	Evaluating Students analyze and interpret data collected to determine patterns in reactions from hands-on investigation.
	Communicating Students write their experimental design before beginning the investigation and record all observations from the activity. *Teacher Notes: A graphic organizer is for scaffolding this step. Students describe patterns seen between the type of materials and whether a reaction occurred or not.*
Explaining Finalizing Model	*Obtaining* Students obtain information about the following concepts: enzyme, active site, substrate, product, and activation energy.
	Evaluating Students construct explanations that compare the ENGAGE scenarios and the EXPLORE activity and relate them to the following concepts: enzyme, active site, substrate, product, and activation energy. Students analyze and interpret data to explain how lowering activation energy increases the rates of chemical reactions.
	Communicating Students develop a model of an enzyme to demonstrate that the substrate binds to the active site and releases a product. *Teacher Notes: It may be useful to have students develop a generic model of an enzyme and then explain the hydrogen peroxide and catalase phenomenon using the model.* ***Formative Assessment of Student Learning*** *Assess through discussions, writings, or analysis of images/models.* Students develop a model to demonstrate how catalase is produced in the cell using prior knowledge of cellular organelle functions. *Teacher Notes: A basic explanation guides students as needed: Catalase is an enzyme that is a specialized protein. Nucleus houses the DNA with the gene that codes for catalase. DNA is transcribed into RNA in the nucleus and then translated into proteins in the ribosome. The endoplasmic reticulum folds and transports catalase to the Golgi body. The Golgi body modifies, refines, packs, and ships the catalase to the peroxisome (or enzymes to lysosome in general). The peroxisome uses the catalase to speed up reactions.* Students use evidence from the ENGAGE scenarios and EXPLORE activities to argue the

	claim that living organisms contain specialized proteins known as enzymes. Enzymes catalyze chemical reactions. Enzymes only react with certain substrates. The substrate must bind to the active site of the enzyme to form the enzyme-substrate complex. The reaction occurs, and the products are released. The enzyme is unaffected and is reused to bind to the next substrate. Enzymes can speed up reactions by lowering the activation energy required to begin a reaction.
Elaborating Applying Model to Solve a Problems	**Phenomenon** Cook meats to a certain temperature for safety. A high fever can impair bodily functions and may cause death. The following are possible OER resources: ● CK-12: Bacteria and Humans--Salmonella Pathogenesis (This video notes that pH of stomach can kill bacteria. This can encourage revisiting natural selection. It also emphasizes the bacterial structure to revisit comparisons of prokaryotes and eukaryotes.) ● FuseSchool: How Enzymes Denature (This video gives a brief overview of how temperature and pH affect the amino acids at the active site of an enzyme) *Teacher Notes: Expand this lesson to include the phenomenon of lactose tolerance, which relates directly back to evolution (natural selection), molecular genetics (point DNA mutation), and ecology (energy flow).* *Secondary elaboration phenomenon:* *Much of the global population is lactose intolerant.* *Lactose intolerance makes connections among the following:* ● *Lactase in an enzyme that speeds up the reaction of the digestion of lactose.* ● *Lactase is made through protein synthesis from a segment of DNA.* ● *Lactase synthesis typically stops after 2 years old, leading to lactose intolerance.* ● *If lactase synthesis continues after 2 years old, there is a point mutation in the DNA segment.* ● *Lactose tolerance correlates with the evolution of agriculture and dairying practices.* ● *99% of Asians are lactose intolerant while only 10% of US Americans, linking to gene pools and gene flows in evolution and passage of hereditary traits to offspring.*
	Obtaining Students ask questions and obtain information to understand the specificity and denaturing of enzymes through a teacher demonstration or a class lab. *Teacher Notes: You can investigate with a class lab or a teacher demonstration. If choosing to demo, recreate the exploration lab to allow students to explain why the beef liver causes the hydrogen peroxide to foam.* *#1: When the foaming ceases, students should engage in discussion for an explanation. To demonstrate the concept that enzymes are reusable, remove the raw beef liver from the foamed beaker and place a new piece of raw beef liver inside. No reaction will occur. Then, place the initial piece of raw beef liver into a new beaker of hydrogen peroxide. The reaction will occur. Explain that enzymes are reusable if the substrate is present.* *#2: Place a few pieces of cooked beef liver in a new beaker of hydrogen peroxide. There is no reaction. Explain that enzymes denature when the temperature is altered.* *#3: Mix hydrogen peroxide with distilled vinegar. Place pieces of raw beef liver in the solution. There is no reaction. Explain that enzymes work best at a specific pH.*

	Evaluating Students explain the presence of enzymes (DNA and protein) in a piece of meat (animal and bacteria) and how they may affect consumers. Students analyze and interpret data that demonstrates the reaction rate of an enzyme is influenced by enzyme and substrate concentrations or altering temperature or pH. Students construct explanations of the effect altering temperature or pH has on an enzyme.
	Communicating Students use knowledge from the EXPLAIN to engage in argument using evidence to determine that altering temperature or pH can affect the function of an enzyme. Students make a model to demonstrate how the denaturing of an enzyme's active site due to a change in temperature or pH affect its function of catalyzing chemical reactions.
Evaluation	***Assessment of Student Learning***
	Students should have conceptual knowledge of enzymes and understand of the following: ● Enzymes are specialized proteins that catalyze reactions. ● Enzymes catalyze reactions by lowering the activation energy. ● Enzymes have active sites that certain substrates must bind to for the reaction to occur and products to be produced. ● Enzymes will be continually reused and cause reactions if substrates are present. ● Enzymes work best at a specific temperature and pH. ● If the temperature or pH is altered, enzymes may become denatured altering the active site so substrates can no longer bind. Students develop models to demonstrate the binding of certain substrates to the active sites of enzymes. The models can also include the reusability of enzymes. Students develop mathematical models to demonstrate how enzymes increase the rate of chemical reactions by lowering activation energy. Students use evidence from models to argue the claim that specialized proteins increase the rate of chemical reactions by lowering activation energy. Students develop models to demonstrate denaturing enzymes by altering temperature or pH. Students explain how high temperatures (in cooking food or high fever during illness) affect the homeostasis of an organism. The temperature difference can denature enzymes necessary for survival. Reactions necessary for life cannot occur quickly enough without enzymes.
SEP, CCC, DCI	**Science Essentials**
Science and Engineering Practices	● Engaging in argument from evidence ● Constructing explanations
Crosscutting Concepts	● Structure and function ● Systems and system models

	• Cause and effect
Disciplinary Core Ideas	From ***A Framework for K-12 Science Education:*** LS1.A Structure and Function LS1.C Organization for Matter and Energy Flow in Organisms

Name_____ Date_____

When Does Peroxide Bubble?

We know that hydrogen peroxide bubbles when poured over an open wound, but why? First, we should investigate surfaces that make peroxide bubble. For this investigation, test the following materials to observe their reaction with peroxide. Be sure to visually observe as well as feel the containers for a temperature change.

Material	Reaction with Peroxide (bubbles or no bubbles?)	Other Observations
Liver		
Yeast		
Salt		
Potato		
Rock		

Discussion Questions:

1. What patterns did you notice?

2. What do the things have in common that produced bubbles from the peroxide?

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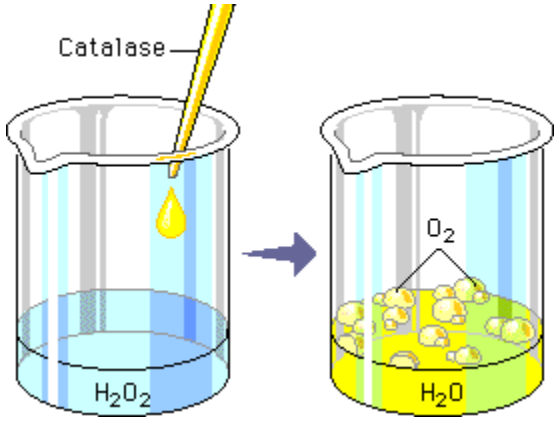
Name_____Date_____Period_____

The Study of Enzyme Reaction Rates with Liver and Hydrogen Peroxide

What would happen to your cells if they made a poisonous chemical? You might think that they would die. In fact, your cells are always making poisonous chemicals. They do not die because your cells use enzymes to break down these poisonous chemicals into harmless substances. Enzymes are proteins that speed up the rate of reactions that would otherwise happen more slowly. **Enzymes are catalysts.** You have hundreds of different enzymes in each of your cells, and they can be used repeatedly!

Each of these enzymes is responsible for one reaction that occurs in the cell. In this lab, you will study an enzyme that is found in the cells of many living tissues. The name of the enzyme is catalase (KAT-uh-LAYSS); it speeds up a reaction which breaks down hydrogen peroxide, a toxic chemical, into 2 harmless substances--water and oxygen.

The reaction is as follows: $2H_2O_2$ ----> $2H_2O + O_2$



In this investigation, you will determine at which temperature catalase works best!

MATERIALS PER GROUP OF 4:

4 liver samples at different temperatures

4 small test tubes and test tube rack

Forceps

Ruler

Ice

1 large test tube

Hydrogen Peroxide

Graduated Cylinder

Hot Plate

Large Beaker

Liver

PROCEDURE:

1. Label the four small test tubes 1, 2, 3, and 4.

2. Label the larger test tube with the letter "B" *(B stands for boiling)*

3. In tube 1, pour 2ml of hydrogen peroxide. Obtain a piece of liver that has been kept at room temperature. Place it inside the test tube, making sure it is pushed down into the hydrogen peroxide. Measure how high up the test tube the bubbles rise (in cm). Record this measurement on the data chart.

4. In tube 2, pour 2ml of hydrogen peroxide. Obtain a piece of liver that has been kept at body temperature. Place it inside the test tube, making sure it is pushed down into the hydrogen peroxide. Measure how high up the test tube the bubbles rise (in cm). Record this measurement on the data chart.

5. In tube 3, pour 2ml of hydrogen peroxide. Obtain a piece of liver that has been kept on ice. Place it inside the test tube, making sure it is pushed down into the hydrogen peroxide. Measure how high up the test tube the bubbles rise (in cm). Record this measurement on the data chart.

6. Next, place a large beaker halfway full of water on a hot plate. Turn the hot plate on high.

7. While the water is heating, obtain a piece of liver kept at room temperature and place it in the tube labeled B.

8. In tube B, pour a small amount of water over the liver (just enough to cover it).

9. Place tube B in the hot water for about 5 minutes. The liver should turn brown.

10. Turn off the hot plate and wait a few minutes for the tube to cool. Carefully, remove the tube and place it on the test tube rack to cool.

11. While you are waiting, pour 3ml of hydrogen peroxide into tube 4.

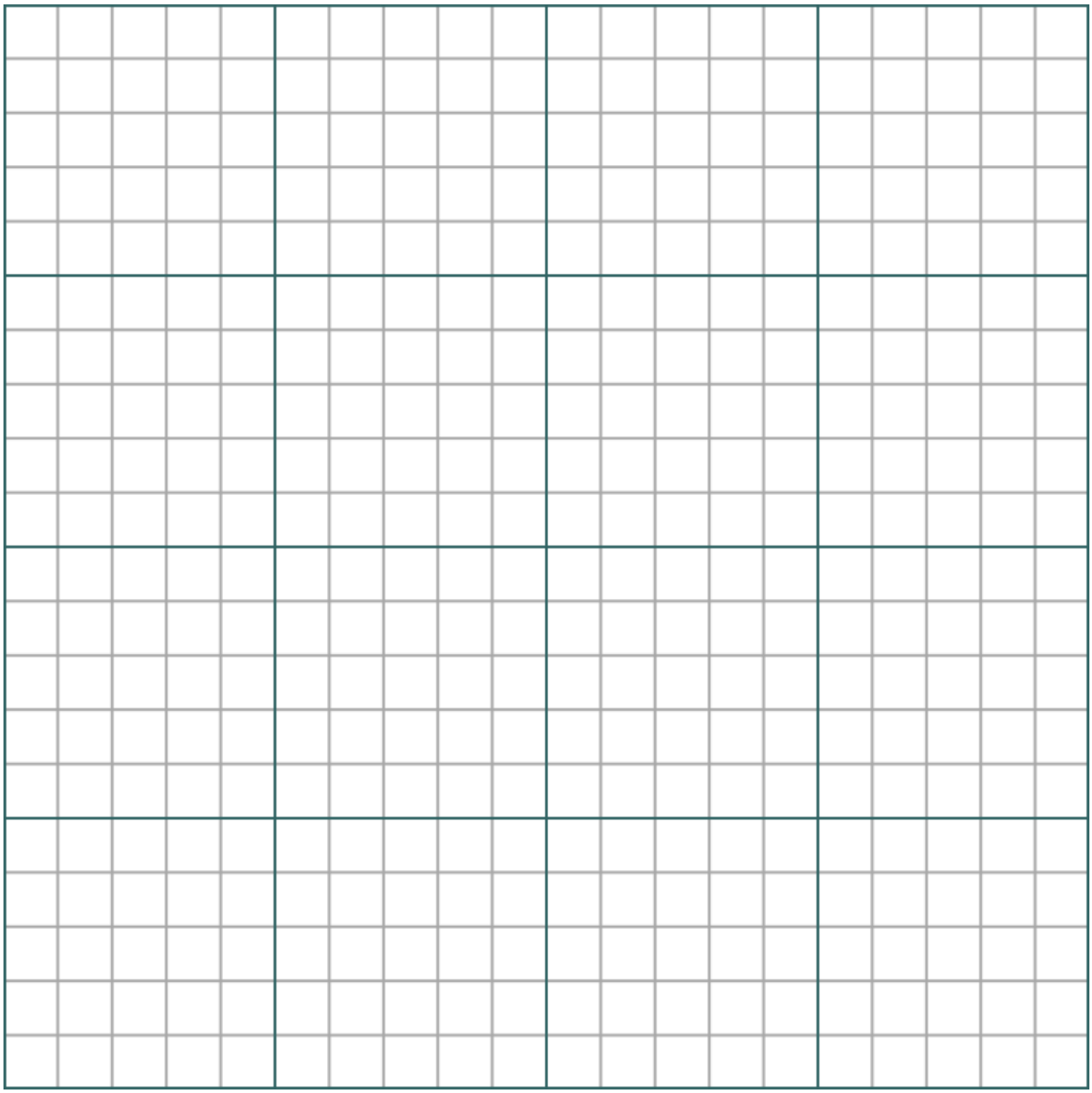
12. Once the boiled liver has cooled, remove it with tweezers and place it in the 4^{th} test tube, making sure it is pushed down into the hydrogen peroxide. Measure how high up the test tube the bubbles rise (in cm). Record this measurement on the data chart.

DATA TABLE

Temperature of the Liver	Height of the Bubbles in the Test Tube (cm)
Cold (kept on ice at 0 degrees Celsius)	
Room temperature (23 degrees Celsius)	
Body temperature (37 degrees Celsius)	
Boiled (100 degrees Celsius)	

ANALYSIS AND UNDERSTANDING:

1. Graph the results of your experiment----temperature vs enzyme activity (height of oxygen bubbles). Do not forget to title your graph and label the axes. Think about what type of graph is to best to use. Enzyme activity is directly related to the temperature.



2. What temperature produced the most bubbles (oxygen)?

3. What happened to the enzymes in the liver that had been boiled? Why did that test tube show the least reaction?

4. Define activation energy.

5. What is the name of the enzyme found in the liver?

6. What molecule is the substrate for the enzyme (hint: what is it trying to bind to and break up)?

7. Other than temperature, what is another factor that might influence enzyme reactivity?

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Structure & Function of Molecular Genetics GSE: **SB1a, SB1b, SB1c, SB2a, SB2b, SB2c, SB3c, SB4c, SB6a, SB6c**			
Anchoring Phenomenon: Sickle cell disease is a genetic mutation that may be reversed with gene therapy.			
Topic	**Focus**	**Lesson Phenomenon**	**GSE/Notes/Language**
Cancer and DNA Mutations	Emphasize that cancer is a result of uncontrolled mitosis that can arise from damaged DNA (inherited or from environmental factors).	The HPV vaccine is recommended for both sexes to help reduce the number of cancer cases. X-ray and UV radiation can cause cancer. Doctors use family medical histories of cancer when assessing patients.	SB2b/SB1b/SB3c/SB4c Make connections between cancerous cells with damaged DNA reproduce asexually via mitosis; these cancerous cells will produce genetically identical cancerous cells which can lead to the development of a tumor. Use the HPV phenomenon to review viral structure and brief overview of replication. Preview--Caused by a mutation in DNA that is copied during the S phase of Cell Cycle
Structure of DNA and Nucleotides	Nucleic acids are macromolecules formed from nucleotides; emphasize structure of nucleotide and connect to the structure of DNA.	The Human Genome Project mapped out the complete sequence for each chromosome.	SB1c/SB2a Practice complementary base pairing to prepare for protein synthesis. Emphasize hydrogen bonding to prepare for DNA replication. Connect nitrogenous bases to the nitrogen cycle with an emphasis on bacteria.
DNA Replication	Emphasize replication is a semi-conservative process needed to make	**Biotechnology Link:** The DNA segment that codes for Insulin are	SB2a Preview the function of enzyme (speed up reaction) when discussing enzymes

	an identical copy for asexual reproduction.	inserted into bacteria for mass production.	necessary for DNA replication: DNA helicase, DNA polymerase, and DNA ligase.
Protein Synthesis	Translation: DNA to RNA Emphasize RNA structure and the process of transcription; compare between DNA and RNA structure while noting both are nucleic acids composed of many nucleotides. Transcription: RNA to protein Emphasize that a codon codes for one amino acid; these amino acids are the monomers of proteins.	The Human Genome Project mapped out the complete sequence for each chromosome. **Biotechnology Link:** The DNA segment that codes for Insulin are inserted into bacteria for mass production. **Biotechnology Link:** Bt-corn is now able to ward off pests because of the insertion of a gene from *Bacillus thuringiensis.* Viruses cannot reproduce without infecting a host cell.	SB2a/SB2c Use the genetic code to analyze a DNA sequence. It may be beneficial to show students different examples of the code. (table/wheel) **Biotechnology Link:** Relate the medical and agricultural uses of DNA back to evolution with increasing fitness and/or combating resistance. Extend with macromolecule connection: Nucleic acids are composed of nucleotides that are genetic instructions, directing the production of an amino acid sequence that composes proteins. The connection between living organisms and viruses can be enhanced here. Viruses are composed of nucleic acid and a protein capsid. However, they lack ribosomes to produce the protein capsid. They are unable to produce the necessary proteins by themselves, so they must inject their nucleic acid into a host cell for protein synthesis to occur.
Enzymes	Enzymes are specialized protein catalysts that speeds up reactions by lowering activation energy; substrate binds to active site; active site	Hydrogen peroxide "bubbles" when put on an open wound.	SB1c The production of enzymes with organelles: --DNA in nucleus is transcribed into mRNA.

	may be denatured by changing temperature or pH.		--mRNA is translated into amino acids (protein/enzyme) in the ribosome. --Protein/enzyme is folded in ER and transported to Golgi. --Golgi modifies, refines, and distributes protein/enzyme to lysosome/peroxisome. Review enzymes involved in DNA replication and how they help make the process of mitosis possible.
	Connect the lactase enzyme production with a point mutation in the DNA sequence; this mutation allows humans to continue to digest lactose found in milk.	Being lactose tolerant is an evolutionary adaptation that increased fitness from a random genetic mutation.	SB1c/SB2a/SB2b/SB6a/SB6c Key Connections: --DNA Mutations --Protein Synthesis to produce enzyme --Need for lactose (sugar) --Random mutations may lead to increased fitness and natural selection.
Bio-technology Connections	Several examples of genetic modification and genetic engineering may be addressed throughout this unit. Involve students in discussions on the scientific process and the advantages and disadvantages in each example. Discuss the logistics as well as impact on society, humans, ecosystems, and evolution/heredity. Preview for Patterns in Heredity & Selection by discussing how inserted genes pass from parent to offspring.		

Anchoring Phenomenon:

Sickle cell disease is a genetic mutation that may be reversed with gene therapy.

Students will explain the phenomenon using the following concepts:

- Sickle cell disease is caused by a single point mutation in the DNA sequence.
- Because the mutated DNA sequence undergoes DNA replication, exact copies of the mutated sequence are in all somatic cells produces through mitosis.
- The mutated DNA is transcribed and translated into a misshapen protein that is not able to be used effectively.
- Using biotechnology, scientists are attempting to reverse sickle cell disease with gene therapy.

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Additional Supports for struggling learners:

The following supports are suggestions for this lesson and are not the only options to support students in the classroom. These supports target students that struggle with science material, this lesson or a previous lesson. These are generalized supports and do not take the place of IEP accommodations as required by each student's Individualized Education Program.

General supports for the following categories:

Reading:	Writing:	Math:
1. Provide reading support by reading aloud or doing partner reads 2. Have the teacher model what they are thinking when reading the text 3. Annotate the text with students so that they may refer to it as they work through the lab	1. The teacher can provide a sentence starter for the students. 2. The teacher can give students an audience to write to (i.e. Write a letter to your sibling explaining this topic). 3. The teacher can provide constructive feedback during the writing process to help students understand the expectations.	1. The teacher should model data collection in the activity 2. The teacher should model the graph on the board.

Supports for this specific lesson if needed:

Performance expectations for instruction:

1. The teacher should try to connect this to something personal for the student (see notes in the engagement section).
2. The teacher should provide multiple formats that the student can use to express their knowledge.
3. At the end of the lesson the teacher should reflect on the following topics:
   -The teacher should reflect on grouping of students. Was it beneficial and were all students able to contribute? Why or Why not?
   -The teacher should reflect on supports for struggling learners. Were the supports enough for the student population? Why or why not? Then make a list of other supports that the teacher can try in the classroom.

Engaging Learners:

Obtaining

1. The teacher could start with questions like, how many of you have experience with hydrogen peroxide? Show the students the bottle that hydrogen peroxide is packaged in to try and have then make connections to the real world. Then the teacher should ask one of

the students that has experience with hydrogen peroxide to explain what happened. Ask them what the peroxide did and if they know why. 2. Have the other students give some predictions of why the example student experienced this bubbling cut scenario.
Exploring: 1. Provide handouts to the struggling students as a place to record data, questions that they have and to answer questions that will help them make sense of the data. 2. Students may require assistance graphing and analyzing their data. The teacher should do or show a practice graph on the board. This will let students see what the graph should look like and what information they should be able to get from the graph. 3. This lab is meant to be open ended and have the students complete an experimental design portion. Struggling students may need support doing this. The teacher should provide a template/ graphic organizer and some direction on what is important for this lab.
Explaining: 1. The students may need articles and videos to help them recall or define the vocabulary. Remind students that they may have a working definition of the vocabulary from the lab, but the teacher should ensure that they have the correct definition. 2. The teacher should emphasize the lowering activation part of a graph as the method by which enzymes function.
Elaborating: 1. As students are elaborating on this topic it might be beneficial to struggling students to help them identify enzymes. Give them the names of 5 or 6 enzymes and have them find a pattern in the naming. Most enzymes can be identified by the "-ase" suffix. 2. Remind students as the do investigations or see demos that they may refer to the lab that they have completed to help with explanations, predictions and arguments.
Evaluating: 1. Students may need additional time to construct a model 2. Writing can be a major struggle for some students. Some choice as to how students express their knowledge may be warranted. Students could express their knowledge in the form of a picture, cartoon, slides presentation, or verbally.

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