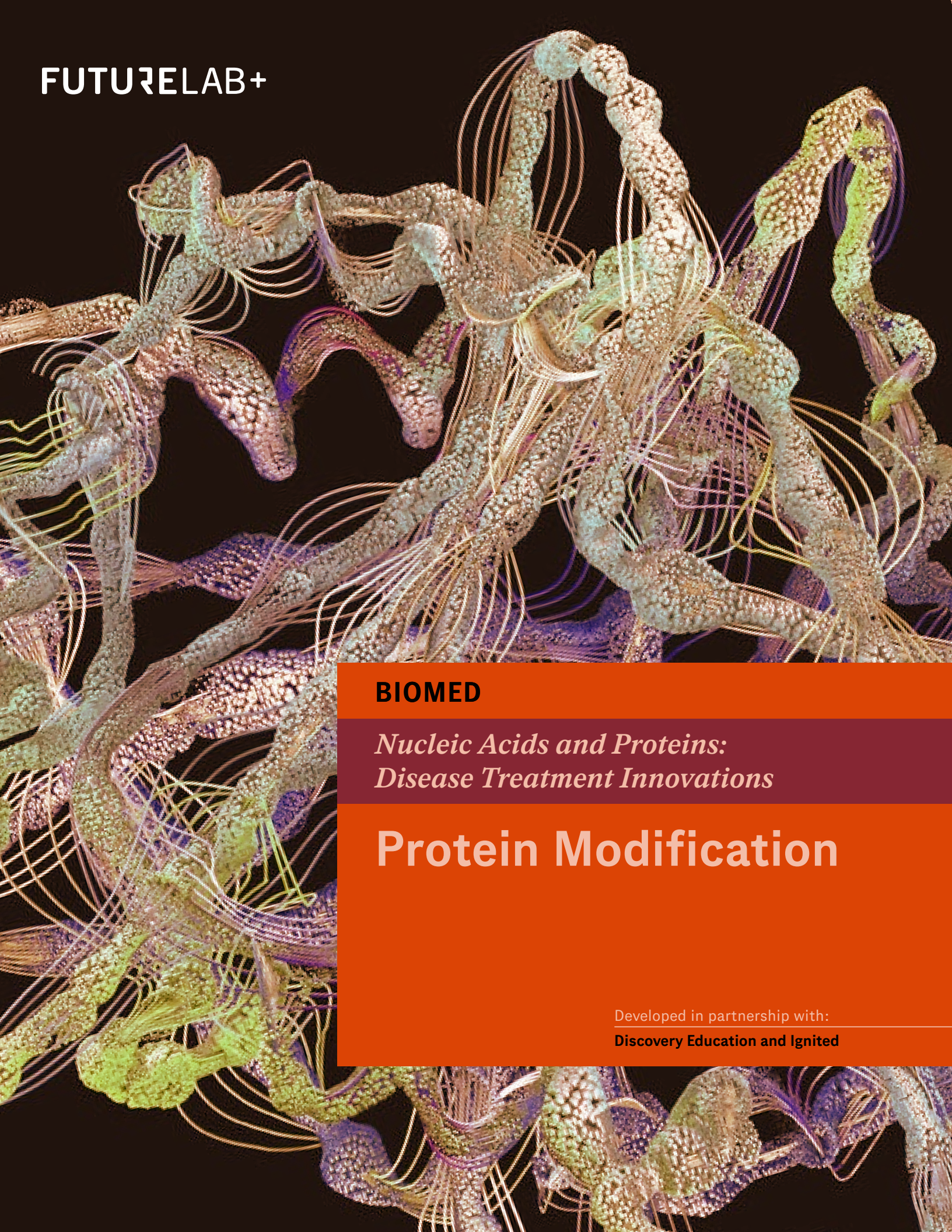
FUTURELAB+



BIOMED

Nucleic Acids and Proteins: Disease Treatment Innovations

Protein Modification

Developed in partnership with:

Discovery Education and Ignited

In this Lesson Plan:

Print the **Teacher Section** →

Print the **Student Section** →

This document is separated into two sections, For Teachers [T] *and* Student Resources [S]*, which can be printed independently.*

Select the appropriate printer icon above to print either section in its entirety.

Follow the tips below in the Range field of your Print panel to print single pages or page ranges:

Single Pages (use a comma): T3, T6

Page Range (use a hyphen): T3–T6

Cover Image
This is an illustration of a protein.

BIOMED / NUCLEIC ACIDS AND PROTEINS: DISEASE TREATMENT INNOVATIONS

Protein Modification

DRIVING QUESTION

How does modifying a protein change its structure and function?

OVERVIEW

Genetic modification might lead to cures for diseases we never thought could be cured. These diseases include Alzheimer's, Type 1 diabetes, cystic fibrosis, and some types of cancers. Enzymes and nucleic acids can now be used as drugs, but are they stable?

In this lesson, students will discuss the various roles of proteins and enzymes within cells. They will learn how alterations of the DNA sequence can translate into changes in protein conformation and function. Students examine how these newly synthesized proteins can alleviate symptoms of a disease and possibly cure it.

ACTIVITY DURATION

Five classroom sessions
(45 minutes each)

The image shows a 3D rendered illustration of DNA molecules in chromosomes.

ESSENTIAL QUESTIONS

How can proteins be modified inside a cell?

What is the purpose of protein modification?

How are enzymes used as drugs?

OBJECTIVES

Students will be able to:

Identify methods of protein modification.

Apply knowledge of cell machinery to protein synthesis.

Examine differences between proteins and enzymes.

Understand different applications of enzymes as drugs and in industrial processes.

BACKGROUND INFORMATION

In this lesson, students will learn about the synthesis of a protein from the DNA structure to the sequence of amino acids. They will understand the link between a mutation within the DNA molecule and its consequence on protein function and structure. They will analyze the difference between an enzyme and a protein by examining the parameters affecting the reaction rate. Finally, they will understand how some enzymes can be used as drugs and help relieve symptoms associated with a health condition.

Materials

- **Am I an Enzyme or Not? Capture Sheet**
- **Nucleic Acid (DNA), Nucleic Acid (RNA), and Amino Acid Foldable**
- **Protein Assignment**
- **Thumbs Up! Capture Sheet**
- **Table Top Texting Graphic Organizer**
- **Enzymes That Are Used as Drugs—Poster Rubric**
- **The Most Interesting Enzyme in the World! Presentation Rubric**
- **Design Journal**

Pedagogical Framing

Instructional materials are designed to meet national education and industry standards to focus on in-demand skills needed across the full product development life cycle—from molecule to medicine—which will also expose students and educators to the breadth of education and career pathways across biotechnology.

Through this collection, educators are equipped with strategies to engage students from diverse racial, ethnic, and cultural groups, providing them with quality, equitable, and liberating educational experiences that validate and affirm student identity.

Units are designed to be problem-based and focus on workforce skill development to empower students with the knowledge and tools to be the change in reducing health disparities in communities.

SOCIAL-EMOTIONAL LEARNING

Students will demonstrate self-management while working throughout the lesson's activities in small groups to ensure collaboration. Students will learn why older people have a decreased amount of enzymes secreted within their stomach, leading to digestive problems. This will provide them with opportunities to practice empathy toward a vulnerable group of people.

CULTURALLY AND LINGUISTICALLY RESPONSIVE INSTRUCTION

Students will have an opportunity to conduct a respectful discussion on the pigment derived from the amino acid tyrosine, which is called melanin, and is responsible for giving color to human skin and hair. Students will learn exactly where skin and hair color come from and will practice acceptance of such differences, based on scientific evidence. They will also learn about the first African-American woman to earn a Ph.D. in chemistry, working on digestive enzymes. This will allow them to recognize more BIPOC engaged in scientific endeavors.

ADVANCING INCLUSIVE RESEARCH

Enzyme-based therapies are still fairly new and much more research must be done to understand how they affect patients from different backgrounds. Research and drug development organizations must build community partnerships to recruit diverse participants for clinical trials that may result in the production of life-saving therapies.

COMPUTATIONAL THINKING PRACTICES

In this lesson, students identify genetic mutations, compare and contrast proteins and enzymes, and present a poster that shows how three different enzymes can be used as therapies. As they accomplish these tasks, students are utilizing the computational thinking strategies of decomposition, finding patterns, collecting data, and analyzing data.

CONNECTIONS TO THE PRODUCT LIFE CYCLE

This lesson focuses on the **development** phase of the product life cycle, wherein personalized medicine and biometric monitoring allow scientists to pinpoint treatments that work for specific patients.

Have you ever wondered…

What organelle is responsible for protein modification within the cell?

Once a protein has been synthesized within the rough endoplasmic reticulum, most proteins are not ready to function yet, as they need to undergo modification such as the addition of phosphate or sulfate groups. The Golgi apparatus is the organelle responsible for these modifications on proteins.

What is the difference between an enzyme and a protein?

Enzymes are proteins, which means they are made of amino acids. Enzymes act as catalysts to speed up a reaction, while other proteins can have many other roles, such as providing structure, acting as signals for the cell, or transporting molecules. Keratin or collagen, for example, are structural proteins, while insulin and estrogen are hormones.

Who was the first scientist to describe proteins and where did it take place?

The first person to describe proteins was a Dutch chemist named Gerardus Johannes Mulder in 1838. He suggested that most animals take protein in from plants. He identified that plants have similar properties when exposed to chemical reagents, as well as being composed of carbon, hydrogen, nitrogen, and oxygen.

MAKE CONNECTIONS!

How does this connect to the larger unit storyline?

A human body contains between 80,000 and 40,0000 proteins responsible for many functions. From structural proteins like collagen to hormones such as serotonin and progesterone. Proteins are found everywhere in our body! Scientists need a thorough understanding of protein synthesis, structure, and function to develop effective medications to treat diseases. Enzymes are already used as drugs, as well as in industrial processes, and are a crucial part of human wellness through pharmaceutical drug design and delivery.

How does this connect to careers?

Scientific researchers keep up to date on literature and experiments on a topic within biology, medicine, or physics. They collaborate with different fields and regularly publish their findings.

Biochemists study biochemical processes in the cell in a laboratory to understand how to isolate, alter, and use macromolecules in a variety of pharmaceutical and industrial applications.

How does this connect to our world?

Enzymes have a great affinity to their substrate, and therefore, targeting these enzymes with specific inhibitors or altering these enzymes from their coding DNA fragment translates into incredibly effective medications to treat symptoms and diseases. Proteolytic enzymes like trypsin are also used to treat acne vulgaris, which is a common condition in teenagers.

Day 1

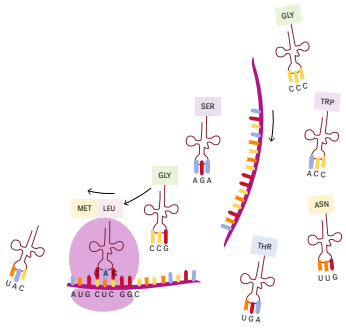
LEARNING OUTCOMES

Students will be able to:

Understand the structure and function of proteins.

Examine the difference between prokaryotic and eukaryotic cells.

Link the synthesis of a protein to the sequence of amino acids.



Procedure

Teacher Note > *Let students know that at the end of this five-day lesson, they will create a presentation on the function of enzymes in the cell, give an example of an enzyme, and describe its role in the cell. Give students the rubric, and point out that the presentation includes finding a solution on how an enzyme's activity can be improved. Students will be able to use information collected throughout the lesson to create a presentation.*

Whole Group (10 minutes)	
1	Begin the class by asking students what a protein is. A protein has many functions such as digesting the food we eat or solidifying our bones or giving our skin its color with melanin. Ask questions to facilitate a discussion. Where is melanin produced? What is the function of melanin in our body? Can we control melanin production? What affects levels of melanin?
2	Using the *Nucleic Acid (DNA), Nucleic Acid (RNA) and Amino Acid Foldable*, ask students to fold the piece of paper in two and cut along the dotted lines, and label flap 1: Nucleic acid (DNA), flap 2: Nucleic Acid (RNA), and flap 3: Protein.
3	Ask students to add all the elements labeled in the *Ribosome game, interactive 2D animation: CSHL DNA Learning Center*. They should add information underneath the corresponding section on the foldable. For example, messenger RNA should be listed under the Nucleic Acid (RNA) flap.

Small Group (10 minutes)	
1	Ask students to form groups of three or four and explore the game: *Cell Anatomy Viewer Game*.
2	Instruct students to explore the different organelles present in an animal, plant, and bacterium cell. They should add these structures under the right flap depending on whether they contain Proteins, Nucleic Acid (DNA), or Ribonucleic Acid (RNA).
3	Ask students to discuss their results and answer the question: Why do bacteria reproduce quickly in our bodies and make us sick?

Continues next page >

Day 1

Continued

Procedure

The image shows the anatomical structure of a biological animal cell with organelles.

Small Group (10 minutes)	
1	Provide students with *Protein Assignment* and tell them they need to answer questions based on the Cell Parts ID Game in the *Cell Anatomy Viewer Game*. Instruct students to find the structures involved in protein synthesis.
2	Tell each group to research three different types of proteins and choose one type to explain to the class.
3	Ask students to focus on the function of the protein in the cell and incorporate information from the Examples of Protein Function Table in the article: *What are proteins and what do they do?*
4	Invite students to share this example with the rest of the class.

Whole Group (15 minutes)	
1	Prompt students to watch a video about protein folding: *Protein Folding.* Ask: What is the difference between protein and DNA? What is the DNA unit name? What is the protein unit name?
2	Next, students should complete *Thumbs Up! Capture Sheet*. Students will need to match the definitions given on the left hand side of the table to the correct term from the word bank.
3	When students are finished, lead a discussion about how protein folding impacts its function. What if the protein does not fold properly? How does this impact its activity in the cell?

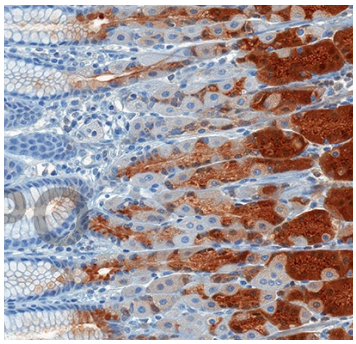
Day 2

LEARNING OUTCOMES

Students will be able to:

Investigate the consequence of a mutation on the sequence of amino acids in a protein.

Differentiate an enzyme from other proteins.



The image shows pepsinogen enzymes in stomach glands (brown areas).

COMPUTATIONAL THINKING IN ACTION

As students learn about specific genetic mutations that cause disease, they employ the computational thinking strategy of abstraction to isolate the disease-generating DNA sequence in the larger context of a person's genome.

Procedure

Teacher Note > *In the previous activity, students were introduced to how proteins are made. Today, they will investigate how mutations can affect proteins. Remind students that they will be giving a presentation on enzymes on Day 5 and should keep working on it as homework.*

Whole Group (15 minutes)	
1	Ask students to compare a protein and an enzyme. Enzymes are a specific and important type of protein.
2	Explain to students that there are many types or classes of enzymes that do various jobs in the body by building and breaking down molecules. One of these classes of enzymes are digestive enzymes.
3	Have students watch the following video and jot (just one, two, or three words) on a sticky note the information they find important: *What are Enzymes?*
4	Ask students: • What factors modify an enzyme's activity? • Can a mutation change an enzyme's activity? • How are mutations on enzymes linked to genetic disease?

Individual Work (15 minutes)	
1	Allow students time to watch the video about how a single mutation can cause a genetic disease: *Promise of Editing Point Mutations*.
2	Ask students to research the different types of mutations and the consequences of these mutations and share with the class.

Continues next page >

Day 2

Continued

Procedure

INDUSTRY AND CAREER CONNECTION

In this activity, students will be tasked with using a scientific researcher's sense of open-mindedness and attention to detail by working in small groups and identifying enzymes that are not proteins.

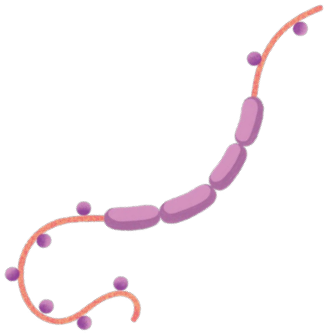
COMPUTATIONAL THINKING IN ACTION

Here, students are using the computational thinking strategies of finding patterns and collecting data to spot the differences between proteins and enzymes.

Small Group (15 minutes)

1 Lead students in a discussion about how to recognize an enzyme from other types of proteins. Do enzymes transform a substrate into a product while proteins do not? Would the product formed confirm the enzyme type? Remind students that enzymes often end in 'ase' to distinguish them from other proteins. For example, protease is an enzyme that digests proteins, so it uses proteins as its substrate and breaks them down into smaller units (amino acids).

2 Ask students to complete the *Am I an Enzyme or Not? Capture Sheet* by checking Yes or No, depending if the protein is an enzyme or simply a protein. Once students have decided on their answers without using any resources, allow them to check their answers by conducting an Internet search. Review the final correct answers with the class. Ask students: Why do you think that some of the enzymes listed do not end in 'ase?'



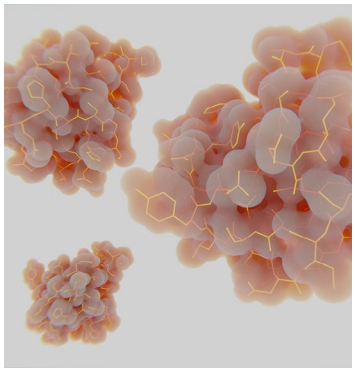
Day 3

LEARNING OUTCOMES

Students will be able to:

Identify the factors affecting enzyme reaction rate.

Investigate enzymes used as pharmaceuticals.



The image shows a 3D rendering of insulin molecules.

Procedure

Teacher Note > *In the previous lesson, students worked on enzymes and the consequence of mutations. In this section, students will study the optimal conditions for enzymatic reactions. Remind students that they will be giving a presentation on a specific enzyme on Day 5.*

Whole Group (10 minutes)

1. Post each one of these questions around the classroom on chart paper.
   - Why does our body temperature have to stay around 37°C?
   - What is the pH of our blood?
   - Why do enzymes slowly stop functioning when organisms stop eating and die?
   - Why are enzymes secreted in smaller quantities in the digestive tracts of individuals over the age of 65?
2. Students can then move onto the individual activity and try to find answers to the questions. When they find an answer, they should write it on the chart paper.
3. Once students have recorded their responses, review the answers written on the chart paper with the class and address any misconceptions.

Individual Work (10 minutes)

1. Ask students to read the information about the rate of reaction as a function of the pH, temperature, and substrate concentration using the following links:
   - **a.** *Enzymes and Concentration Effects*
   - **b.** *Enzymes and Temperature Effects*
   - **c.** *Enzymes and pH Effects*
2. Using the *Table Top Texting* strategy, prompt students to complete the *Table Top Texting Graphic Organizer* based on the links above.

Continues next page >

Day 3

Continued

Procedure

3 Ask students to raise their hands if their texting organizer contains any of the answers to the questions below. Then ask volunteers to share their answers.

- **a.** Why does the rate of reaction of an enzyme reach an optimum temperature and then drop suddenly?
- **b.** Why does the graph of substrate concentration look so different from the temperature one?
- **c.** What does protein denaturation mean?

Small Group (25 minutes):

1 Ask students to create a poster using paper or a free online program, such as *Canva*, about enzyme replacement therapy. The poster should include a description of three enzymes that are used as drugs. Students can choose the enzymes. They should do an Internet search on enzyme replacement therapy to discover diseases that use this as a treatment. The poster should include information about the enzyme's origin, classification name, target, and the symptoms or disease treated. Students can use the following links for their research:

- **a.** *Pancrelipase*
- **b.** *Overview | NIH*
- **c.** *Drug Development and Drug Interactions: Table of Substrates, Inhibitors and Inducers*

2 Once all posters have been completed, allow students to evaluate each other's posters and give feedback on what they liked and what they think could be improved.

COMPUTATIONAL THINKING IN ACTION

In order to develop their posters, students must utilize the computational thinking strategy of collecting data. As they compile their data and review the posters of other teams, they are using the computational thinking strategy of analyzing data.

Day 4

LEARNING OUTCOMES

Students will be able to:

Understand how enzymes are used for specific industrial applications.

Explore how proteins help create vaccines.

INDUSTRY AND CAREER CONNECTION

In this activity, students will be tasked with using an immunologist's sense of attention to detail and organizational skills by collecting facts and writing down statements about antibodies.

Procedure

Teacher Note > *On Day 3, students worked on factors affecting enzyme's activity. Today, they will understand the many applications that use enzymes. Remind students that their presentation is due on the following day.*

Whole Group (20 minutes)	
1	African-Americans and Latinx peoples are underrepresented in science despite their invaluable participation in many areas, including chemistry and biochemistry. Ask students to guess how many years passed between when the first female earned a Ph.D. in chemistry and when the first African American female earned a Ph.D. in the same field. Marie Maynard Daly earned her Ph.D. in 1947, which was 60 years after the first female earned her Ph.D. in chemistry. She studied amylase and other enzymes from the digestive system.
2	Let students watch the video about Marie Maynard Daly: *16 BHM Marie Maynard Daly*. As students view the video, have them take notes about Marie Maynard Daly's contributions to science as well as important details about her life and career in their **Design Journal**.
3	Ask students why enzymes were important to study when Marie Maynard Daly was doing her research. Then ask which enzyme reduces starch into simple sugars. Give them a clue by sharing that amylose is the sugar found in starch. Students should be able to figure out the answer, "amylase," by knowing the substrate the enzyme acts on, and by replacing part of the substrate with the suffix 'ase.' Ask: What applications can enzymes have other than medicine?
4	Ask students to read the article about the role of enzymes in industrial processes: *Enzymes in Food Industry*.
5	Direct students to name the enzymes used in the food industry.

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Day 4

Continued

Procedure

Small Group (20 minutes)	
1	Instruct students to review the information on vaccines: *The Antibody Initiative—Antibody Animations and Explanations*.
2	Let students skim through the article and videos for five minutes.
3	Place students in small groups. Ask them to share ideas that they discovered, using the instructional strategy *Snowball Fight*.
4	On a piece of paper, ask each group member to write a question about a term defined in the link. Have them crumble this into a ball and throw their "snowball" into the air. Then, each student needs to take a new "snowball," open it up, and add their answer. Ask students to read their answers to the group.
5	Before class wraps up, have students respond to the lesson questions in their **Design Journal**. They will explain the purpose and process of protein modification and how enzymes are used in drugs.

Day 5

LEARNING OUTCOMES

Students will be able to:

Explain the role of enzymes in industrial processes.

Find a solution that can increase the rate of activity of enzymes.

Create a presentation showcasing new knowledge about enzyme action and specificity.

INDUSTRY AND CAREER CONNECTION

In this activity, students will be tasked with using a biochemist's communication skills by presenting their results in front of the class. Students will also use a biochemist's sense of open-mindedness by accepting feedback from others.

Procedure

Teacher Note > *At the end of this lesson, students will present their work on enzymes. Remind them to look over the rubric. They need to have access to a computer to upload their presentation or access it from the Internet.*

Individual (45 minutes)	
1	Allocate a couple of minutes to allow students to organize their presentation.
2	Ask students to give feedback on others' presentations and to ask questions when appropriate at the end of each presentation.

National Standards

Next Generation Science Standards

LS1.A: Structure and Function

Systems of specialized cells within organisms help them perform the essential functions of life. All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells.

Science and Engineering Practices

Obtaining, evaluating, and communicating information

Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

Crosscutting Concepts

Structure and Function

Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

Patterns

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Cause and Effect

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Career and Technical Education (CTE)

A3.2

Describe enzyme structure and function, diagram the impact of enzymes and catalysts on reaction rates, and recognize the emerging role of enzymes in replacing industrial chemicals.

A3.4

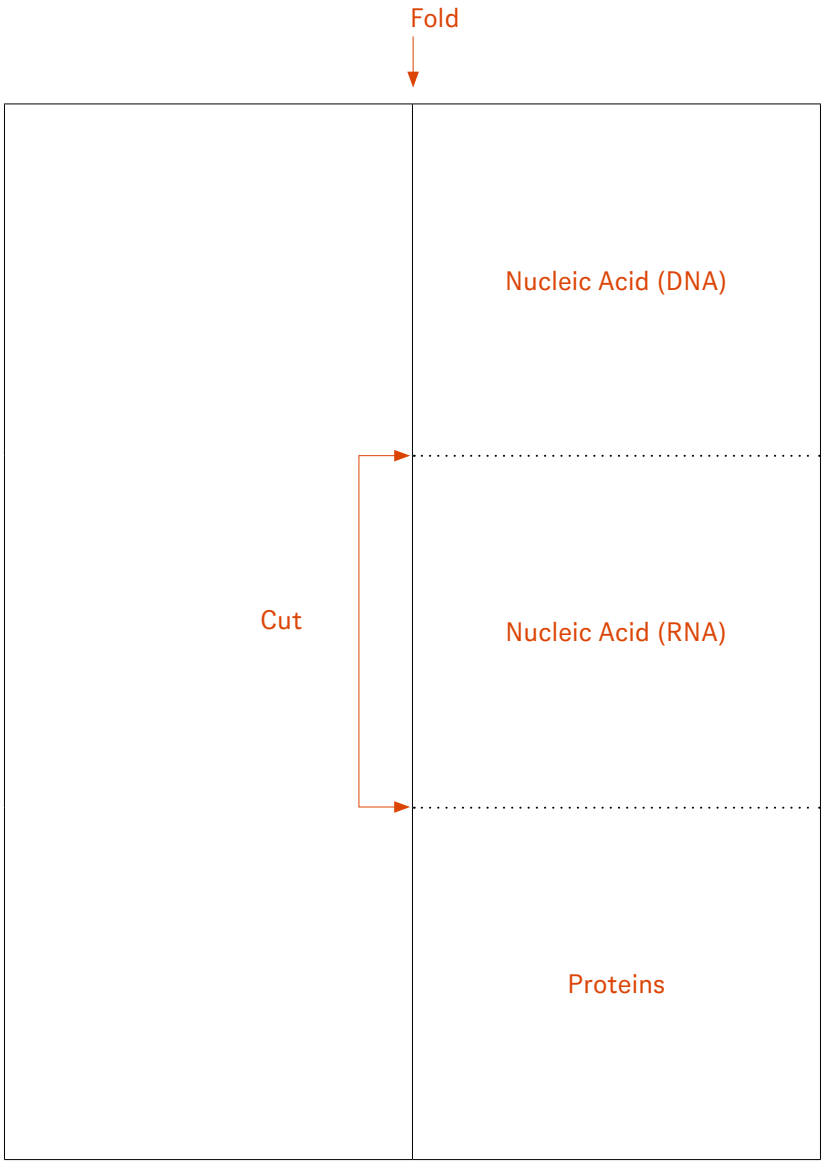
Employ standard protein techniques, including antibody production, enzyme assays, spectrophotometry, gel electrophoresis, and chromatography and document and evaluate results.

Nucleic Acid (DNA), Nucleic Acid (RNA) and Amino Acid Foldable

ANSWER KEY — **Do not share with students**

Directions

Fold the piece of paper in half and cut along the dotted lines. Label each of the front flaps: Nucleic Acid (DNA), Nucleic Acid (RNA), and Protein. Add the elements labeled in the Ribosome game, interactive 2D animation underneath the corresponding section. For example, messenger RNA can be found under the Nucleic Acid (RNA) flap.



Found under the Nucleic Acid (DNA) flap:

Animal: Nuclear DNA, mitochondria

Plant: Nuclear DNA, nucleolus, mitochondria

Bacterium: Nucleoid, plasmid

Found under the Nucleic Acid (RNA) flap:

messenger RNA
ribosome
tRNA
tRNA anticodon
mRNA codon

Animal: Ribosome

Plant: Nucleolus, ribosome

Bacterium: Ribosome

Found under the Protein flap:

ribosome
amino acid
peptide chain

Animal: Rough ER, Golgi complex, mitochondria, lysosomes, ribosome, cytoskeleton

Plant: Nucleolus, mitochondria, chloroplast, cytoskeleton

Bacterium: Ribosome

Protein Assignment

ANSWER KEY **Do not share with students**

Directions
Answer questions based on the Cell Parts ID Game in the Cell Anatomy Viewer Game.

1. In which structure does protein synthesis happen?

Rough endoplasmic reticulum

2. What is the organelle that transports proteins to their right location within the cell?

Golgi complex

3. What happens if proteins are sent to the wrong location?

The function attached to the protein stops.

4. Research another function of the organelle responsible for protein transport.

Modification of proteins

Thumbs Up! Capture Sheet

ANSWER KEY — **Do not share with students**

Directions
Use the word bank to fill in the term that matches each definition.

Word Bank

Amino acids	C, G, A, and T
DNA	Peptide bond
Protein	RNA and DNA
Serine	

Definition	Term
An amino acid	Serine
All the DNA nucleotides	C, G, A, and T
There are 20 different ones.	Amino acids
The bond formed when two amino acid are joined	Peptide bond
Composed of amino acids	Protein
Nucleic acids	RNA and DNA
Contains the genetic information necessary to build proteins	DNA

Am I an Enzyme or Not? Capture Sheet

ANSWER KEY — **Do not share with students**

Directions

Make a prediction by checking Yes or No, depending on whether you think the protein is an enzyme or not. Then use Internet resources to check your answers.

	Yes, I am!	No, I am not!	Function of enzyme
Insulin		X	Regulates blood sugar levels
Protein kinase	X		Catalyses the transfer of a phosphate from ATP to a protein
Lipase	X		Digests fats coming from food
Protease	X		Catalyses the hydrolysis of a protein
Keratin		X	Has a protective function around the extremities and main organ (brain)
Collagen		X	Found in the skin to give support and elasticity
Haemoglobin	X		Transfers oxygen via the red blood cells from the lungs to the rest of the body

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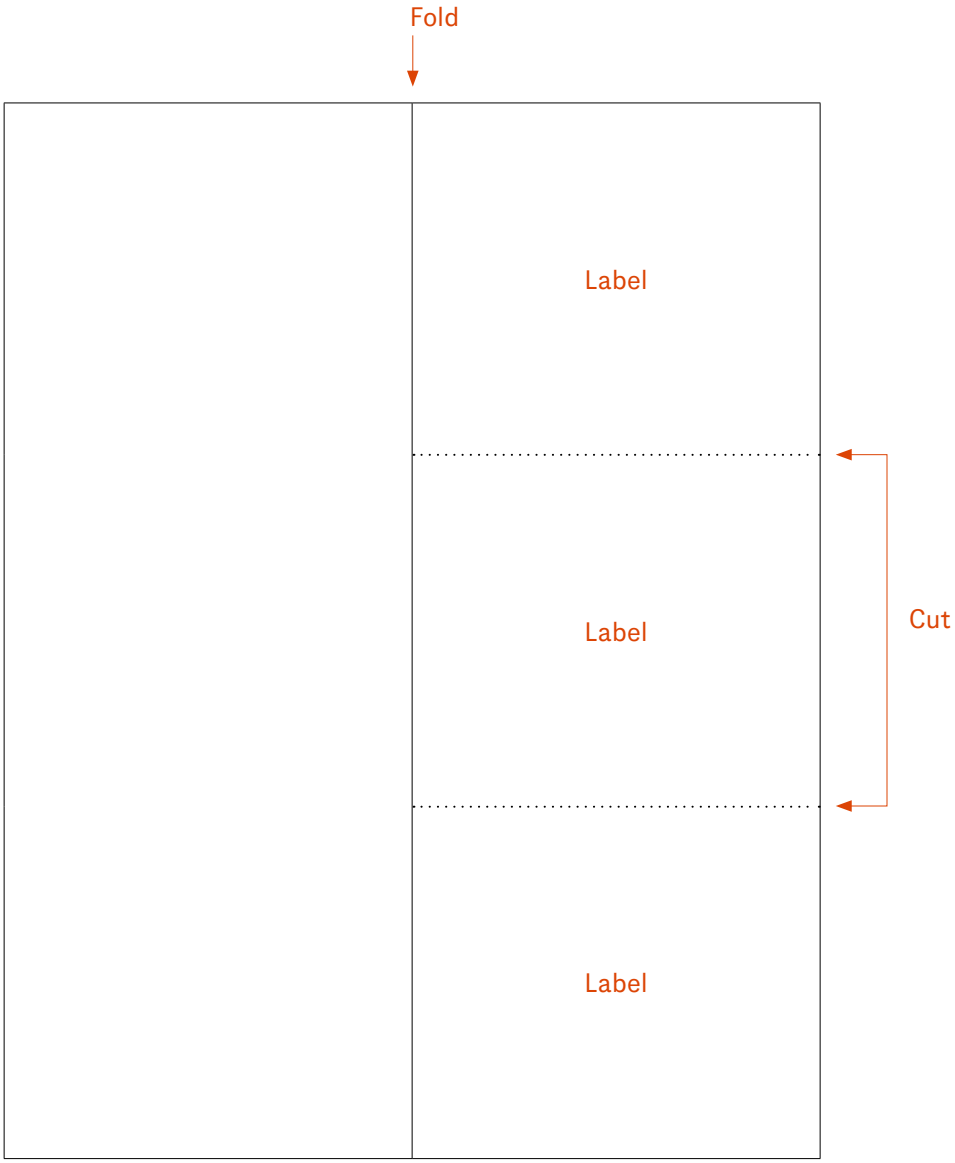
Nucleic Acid (DNA), Nucleic Acid (RNA) and Amino Acid Foldable

Directions

Fold the piece of paper in half and cut along the dotted lines. Label each of the front flaps: Nucleic Acid (DNA), Nucleic Acid (RNA), and Protein. Add the elements labeled in the Ribosome game, interactive 2D animation underneath the corresponding section. For example, messenger RNA can be found under the Nucleic Acid (RNA) flap.



Nucleic Acid (DNA), Nucleic Acid (RNA), and Amino Acid Foldable

Template

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Protein Assignment

Directions
Answer questions based on the Cell Parts ID Game in the Cell Anatomy Viewer Game.

1. In which structure does protein synthesis happen?

2. What is the organelle that transports proteins to their right location within the cell?

3. What happens if proteins are sent to the wrong location?

4. Research another function of the organelle responsible for protein transport

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Thumbs Up! Capture Sheet

Directions
Use the word bank to fill in the term that matches each definition.

Word Bank

Amino acids	C, G, A, and T
DNA	Peptide bond
Protein	RNA and DNA
Serine	

Definition	Term
An amino acid	
All the DNA nucleotides	
There are 20 different ones.	
The bond formed when two amino acid are joined	
Composed of amino acids	
Nucleic acids	
Contains the genetic information necessary to build proteins	

FUTURELAB+

Am I an Enzyme or Not? Capture Sheet

Directions

Make a prediction by checking Yes or No, depending on whether you think the protein is an enzyme or not. Then use Internet resources to check your answers.

	Yes, I am!	No, I am not!	Function of enzyme
Insulin			
Protein kinase			
Lipase			
Protease			
Keratin			
Collagen			
Haemoglobin			

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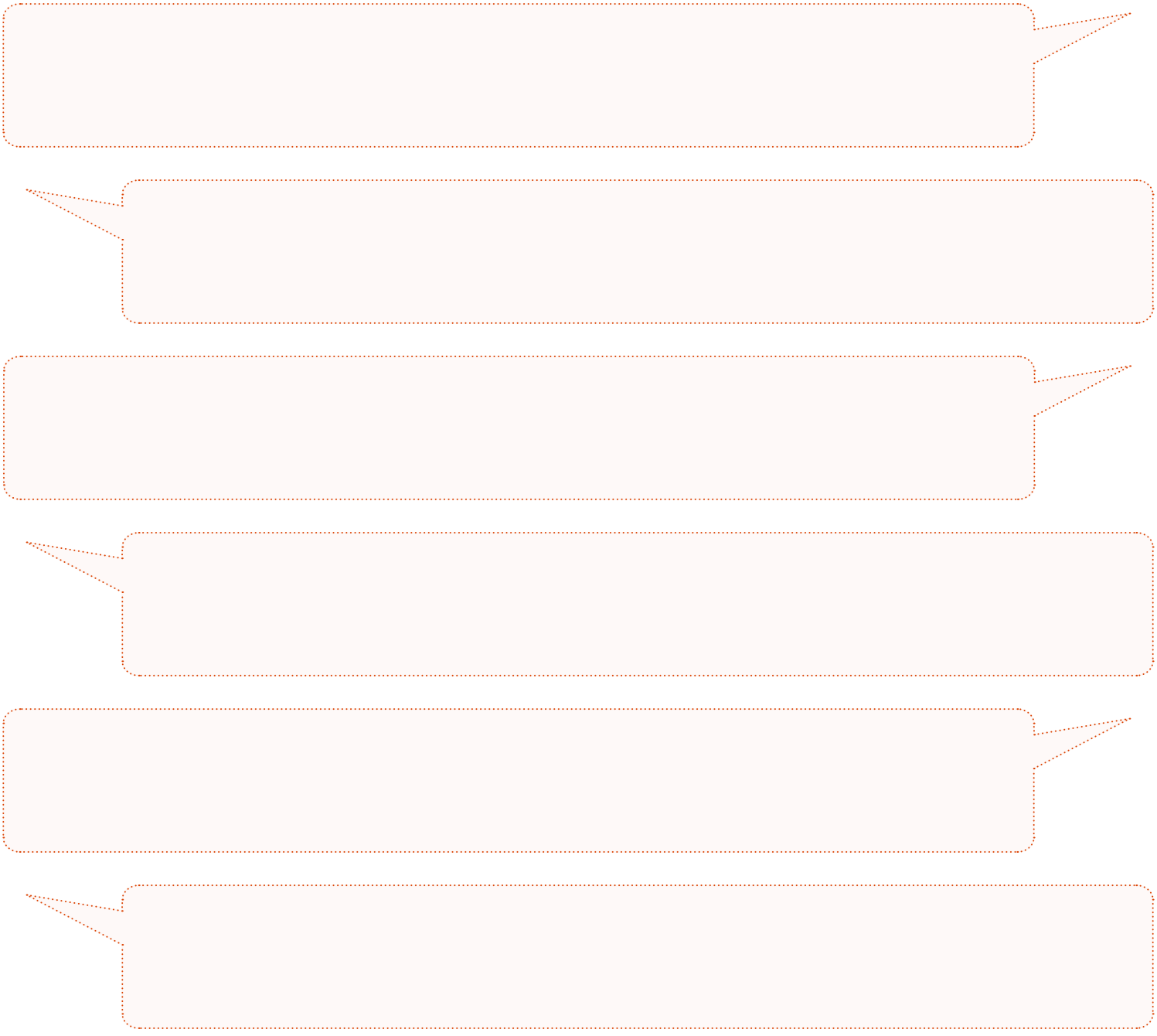
Table Top Texting Graphic Organizer

Directions

Make a statement in the first text bubble, then ask a question. Pass the paper to a partner who will answer the question, make another statement, and ask a follow-up question. Continue to pass the paper back and forth following the answer-statement-question pattern.



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Enzyme Replacement Therapy—Poster Rubric

Score	4	3	2	1
Description	Poster includes detailed descriptions of three different enzymes used in medicine.	Poster includes descriptions of three different enzymes used in medicine.	Poster includes descriptions of two different enzymes used in medicine.	Poster includes a description of one enzyme used in medicine.
Required Elements	Poster includes information in addition to the required elements: origin, classification names, and targets of each enzyme.	All required elements are included on the poster: origin, classification names, and targets of each enzyme.	All but one of the required elements are included on the poster.	Several required elements are missing.
Content	Ideas are interesting, thought-provoking, and demonstrate depth of knowledge.	Ideas are interesting and somewhat thought-provoking.	Ideas do not demonstrate a depth of knowledge.	Ideas are illogical or unclear.
Appearance	Poster is eye-catching and attractive to look at, includes images, color, and design that support the information on the poster.	Poster includes images, color, and design that support the information on the poster.	Poster shows some attempts at including color, images, or design features.	Poster lacks any color or design elements.
Final Score				

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The Most Interesting Enzyme Presentation Rubric

Score	4	3	2	1
Function	Presentation provides a clear, detailed explanation of the function and role of enzymes in the cell.	Presentation provides a clear explanation of the function and role of enzymes in the cell.	Explanation of the function and role of enzymes is present but lacking.	Function or role of enzyme is not present.
Application	Presentation outlines optimal conditions for enzymatic reactions and provides many uses for enzymes.	Presentation outlines conditions for enzymatic reactions and uses for enzymes.	Presentation includes brief explanation of enzymatic reactions and limited examples for how enzymes are used.	Presentation includes little explanation of conditions for enzymatic reactions or no examples of use.
Solution	Solution is creative, realistic, and very likely to work.	Solution is realistic and likely to work.	Solution is unrealistic but could possibly work.	Solution is unrealistic and unlikely to work.
Presentation Skills	Presenters demonstrate a thorough understanding of content and speak knowledgeably about content.	Presenters demonstrate a good understanding of content and are able to speak knowledgeably about most talking points.	Presenters demonstrate a limited understanding of content and rely upon notes for most of the presentation.	Presenters demonstrate little or no understanding of content and read notes directly to the audience.
Multimedia	Content is supported by effective use of images, videos, and links that enhance understanding.	Content is adequately supported by the use of photos, videos, or links.	More visual elements would add to the presentation.	Presentation does not include visual elements.
Final Score				