The following instructional plan is part of a GaDOE collection of Unit Frameworks, Performance Tasks, examples of Student Work, and Teacher Commentary. Many more GaDOE approved instructional plans are available by using the Search Standards feature located on GeorgiaStandards.Org.

Georgia Performance Standards Framework for Biology 9-12

Unit: Organization
Sternberg Task

Dr. Sam’s Fantastic Stomach Solution™ - Evaluating an Advertising Claim

Overview: Students will investigate the effectiveness of a supplement advertised claiming to assist with lactose intolerance. Students will learn the homeostatic role, compatibility, and effects of enzymes in chemical reactions assisting with food digestion in organisms.

Standards (Content and Characteristics):

SB1. Students will analyze the nature of the relationships between structures and functions in living cells.
   a. Explain the role of cell organelles for both prokaryotic and eukaryotic cells, including the cell membrane, in maintaining homeostasis and cell reproduction.
   b. Explain how enzymes function as catalysts.
   c. Identify the function of the four major macromolecules (i.e., carbohydrates, proteins, lipids, nucleic acids).

SB3. Students will derive the relationship between single-celled and multi-celled organisms and the increasing complexity of systems.
   a. Explain the cycling of energy through the process of photosynthesis and respiration.

SB4. Students will assess the dependence of all organisms on one another and the flow of energy and matter within their ecosystems.
   f. Relate animal adaptations, including behaviors, to the ability to survive stressful environmental conditions.

SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.
   a. Exhibit the above traits in their own scientific activities.
   b. Recognize that different explanations often can be given for the same evidence.
   c. Explain that further understanding of scientific problems relies on the design and execution of new experiments which may reinforce or weaken opposing explanations.
SCSh2. **Students will use standard safety practices for all classroom laboratory and field investigations.**
   a. Follow correct procedures for use of scientific apparatus.
   b. Demonstrate appropriate technique in all laboratory situations.
   c. Follow correct protocol for identifying and reporting safety problems and violations.

SCSh3. **Students will identify and investigate problems scientifically.**
   a. Suggest reasonable hypotheses for identified problems.
   b. Develop procedures for solving scientific problems.
   c. Collect, organize and record appropriate data
   e. Develop reasonable conclusions based on data collected.
   f. Evaluate whether conclusions are reasonable by reviewing the process and checking against other available information.

SCSh4. **Students use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.**
   a. Develop and use systematic procedures for recording and organizing information.
   b. Use technology to produce tables and graphs.

SCSh6. **Students will communicate scientific investigations and information clearly.**
   a. Write clear, coherent laboratory reports related to scientific investigations.
   b. Write clear, coherent accounts of current scientific issues, including possible alternative interpretations of the data.
   c. Use data as evidence to support scientific arguments and claims in written or oral presentations.
   d. Participate in group discussions of scientific investigation and current scientific issues.

SCSh8. **Students will understand important features of the process of scientific inquiry.**
Students will apply the following to inquiry learning practices:
   a. Scientific investigators control the conditions of their experiments in order to produce valuable data.
   b. Scientific researchers are expected to critically assess the quality of data including possible sources of bias in their investigations’ hypotheses, observations, data analyses, and interpretations.

**Enduring Understandings:**
- Cells have particular structures that underlie their functions.
- Most cell functions involve chemical reactions that utilize enzymes that either break down or synthesize compounds.
Georgia Performance Standards Framework for Biology 9-12

- Chemical bonds of food molecules contain energy that is released in the process of cellular respiration; the products are used to synthesize needed molecules.
- All cells are composed of many different molecules that are organized into specialized structures that carry out cell functions.
- Organisms respond to internal changes and external stimuli to maintain homeostasis.

**Essential Question(s):**

1. How does the functioning of enzymes help cells/organisms do the following?
   a. maintain homeostasis
   b. cycle energy
   c. survive stressful conditions
2. Why are enzymes specific to certain substrates within organisms?
3. How can enzymes act to decrease the energy input needed to form and break bonds in biochemical reactions?

**Pre-Assessment:**

Teacher Notes: The teacher can show pictures of different energy transformations involving conversion of stored chemical energy such as a moving car, people biking and walking, or animal motion through their environments. Fume emissions from the tailpipe of a car could be used for a discussion of the chemical reactions that take place in internal combustion engines. A second set of visuals could include graphs showing how addition of enzymes lowers activation energy for common reactions, illustrations of the lock and key mechanism of catalysts, etc… Groups could offer explanations and hypotheses for the action of this group of chemicals. A KWL chart could be used to complete the pre-assessment.

Interdisciplinary connection: Have students answer the following question: How was the fall of Berlin Wall similar to the functions of enzyme reactions in the cell?

*Teacher Notes: Before the beginning of the activity, student should be aware or be exposed to the following vocabulary:

**Vocabulary to bring students to conceptualization:**

*Primary Vocabulary* (minimal vocabulary to teach the concept):
- Enzyme, substrate, reaction rate (rate of reaction), activation energy, chemical bonds, & energy transformation.

*Secondary Vocabulary* (vocabulary needed to understand concept mastery)
- Dehydration synthesis, hydrolysis, Laws of thermodynamics.
## Georgia Performance Standards Framework for Biology 9-12

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<tr>
<th>Outcome/ Performance Level Indicator</th>
<th>ANALYTICAL</th>
<th>PRACTICAL</th>
<th>CREATIVE</th>
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<td>Explain how biochemical reactions catalyzed by the action of enzymes increases efficiency of nutrient absorption thus maintaining homeostasis and assuring energy supply for an organism. Thoroughly explain the role and mechanisms of homeostasis in maintaining life as they relate to cell structure. Summarize the role of enzymes within an organism. Describe the lock-and-key structure of enzymes and their substrates.</td>
<td>All Students: By using the Resources listed below, the students will test their “Lactose Intolerance Medication” to determine its effectiveness. A scientific lab method will be developed and used to test (established) (or…student-generated) hypotheses. <strong>Analytical Students:</strong> The product from analytical students is a lab report with extensive analysis of experimental data. Mastery is demonstrated when the students create a lab report that clearly indicates their ability to report data analysis using the scientific method to evaluate their student-generated hypothesis and, by using the language of</td>
<td>All Students: By using the Resources listed below, the students will test their “Lactose Intolerance Medication” to determine its effectiveness. A scientific method will be developed to test established (or…student-generated) hypotheses. <strong>Practical Students:</strong> The product from the practical students is a presentation evaluating the advertising claim tested in this investigation. Students must verbally articulate, using the lab reports, visual aids and models from the other two groups, their conclusions about the advertising claim, extending their report by explaining how</td>
<td>All Students: By using the Resources listed below, the students will test their “Lactose Intolerance Medication” to determine its effectiveness. A scientific method will be developed to test established (or…student-generated) hypotheses. <strong>Creative Students:</strong> The products from creative students are visual aids or models which will demonstrate the science occurring in the lab. (or … will illustrate the mechanisms behind the action of enzymes in the body and the catalyzed changes observed in the laboratory) Mastery is demonstrated when visual aids or models are produced and</td>
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<td>the standards, draw reasonable conclusions on the nature of enzymes and their importance in biochemical reactions. <strong>Teachers:</strong> The teacher will work with all students to produce rubrics for assessing each element of this performance task. Furthermore, the teacher will pre-approve the laboratory methods (including all safety precautions). Teachers will also coach the students in necessary elements of the scientific method and possible issues with their experimental designs (see teacher notes). During the lab process, the teacher will monitor for safe and efficient work from all students. The teacher will coach the analytical teammate in the proper construction of a lab report including the addition of tables, graphs, and as outlined in the rubric.</td>
<td>enzyme therapy is used by consumers and in medicine. Mastery is demonstrated when a presentation reports the science behind the advertising claim. Effective reporting of science standards with the data collected clearly reflects the enduring understandings. <strong>Teachers:</strong> The teacher will work with all students to produce rubrics for assessing each element of this performance task. Furthermore, the teacher will pre-approve the laboratory methods (including all safety precautions). Teachers will also coach the students in necessary elements of the scientific method and possible issues with their experimental designs (see teacher notes). During the lab process, the teacher will monitor for safe and efficient work from all students. The teacher will also advise the practical students must explain the concept which illustrates the experiment performed to evaluate the student-generated hypothesis linking enzyme’s effects on biochemical reactions. <strong>Teachers:</strong> The teacher will work with all students to produce rubrics for assessing each element of this performance task. Furthermore, the teacher will pre-approve the laboratory methods (including all safety precautions). Teachers will also coach the students in necessary elements of the scientific method and possible issues with their experimental designs (see teacher notes). During the lab process, the teacher will monitor for safe and efficient work from all students. The teacher will also guide the creative student as they develop quality visual aids that include the language...</td>
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<td>Resources</td>
<td>GRASPS Scenario and <strong>MATERIALS</strong> (Click to view)</td>
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<tr>
<td>Reference Resources:</td>
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<tr>
<td>Glucose Structure used from the following website.</td>
<td><a href="http://www2.glos.ac.uk/gdn/origins/images/sugar.gif">http://www2.glos.ac.uk/gdn/origins/images/sugar.gif</a></td>
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<td>The Exploratorium Teacher Institute has resources that can be used to extend this activity: a link follows:</td>
<td><a href="http://www.exploratorium.edu/snacks/milk_makes-me_sick/index.html">Milk Makes Me Sick</a></td>
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### Homework/Extension

**ALL Students:**
Students can extend this activity by predicting which variables will affect the rate of enzyme reaction. The variables would include pH, temperature change, and substrate level. Students could use a seltzer tablet to investigate their predictions of effects of variables on the rates of reaction. Students should create their own procedures to test predictions and develop a summary of the data and results. Follow up this activity by giving students the chemical structure for glucose as a **Graphic** organizer. The teacher can further use the concepts from the task and extension activity to re-teach bond breaking and energy release. *(Teacher Note: Emphasize that enzymes are needed to help break bonds or create a reaction complex with lower energy input, thus making the reaction more efficient - positively affecting survival of the organism. On the other hand, changes in the internal environment, such as pH in various parts of the digestive system, can serve as effective feedback mechanisms to regulate enzyme activity)*

### Instructional Tasks

#### Accommodations for ELL Students

- Modify language requirements for written work and homework summary
- Pair with more advanced native language speaking partner (allow for translation in native language for comprehension) as needed
- Provide paragraph summary template (fill in the blank format) if in analytical group
- Provide bilingual support using word to word translation such as dictionaries, and glossaries
- Create a word wall (with illustrations) for important vocabulary; word wall can be an interactive whereby students use yarn to make connections with key vocabulary

#### Accommodations for Students with Disabilities

- **Review and Implement IEP accommodations for specific student needs**
- Other Accommodations may include
  - Allow student to be in group that fits his/her learning style (for example, drawing/visual aids- creative group or presenting lesson –practical group)
  - Break assignments into smaller steps (written or oral) and check for understanding
  - Word banks for written work (in analytical group) and homework summary
  - Create a word wall for vocabulary; word wall can be an interactive whereby students use yarn to make connections with key vocabulary
FOR ALL STUDENTS:
Materials:
Lactaid milk
Regular milk (2% milk and/or Skim milk)
Lactose Intolerance Medicine (lactase)
Glucose test strips-test for presence of glucose
2% glucose solution (positive control)
Water (negative control)

Dr. Sam’s Fantastic Stomach Solution™ – a Performance Task Challenge
Goal: Evaluate and report on the claims of an advertisement for Dr. Sam’s Fantastic Stomach Solution™ which recently appeared on-line.
Role: You and your team are members of the Junior Squad of the Food and Drug Administration
Scenario: Your team has been given the job of testing and evaluating the claims made in the pop-up banner (shown below) which appears when one logs on to the Internet.

Text of Advertising Banner:

Dr. Sam’s Fantastic Stomach Solution™
Do you have trouble eating foods containing milk sugar (lactose) because you are lactose intolerant?
Use Dr. Sam’s Fantastic Stomach Solution™ and your troubles will be over.
With Dr. Sam you can drink regular milk right off the store shelf and be symptom free.
How?
We guarantee that Dr. Sam’s Fantastic Stomach Solution™ will convert the lactose (milk sugar) which you cannot digest into sugars which are simpler and easier to digest (glucose and galactose), giving you the same amount of sugar conversion as in the leading lactose-free milk product.
No need to buy that Lactose-free milk which costs more and tastes bad!
Try Dr. Sam’s Fantastic Stomach Solution™ today!
Your tummy will thank you!
Student Product Assignments: all students will produce product A and one of three types of product B assignments

Product A - For all groups -
You and your group are to design and report results for an experiment which will investigate Dr. Sam’s advertising claims. Your teacher must pre-approve your written laboratory methods (including all safety precautions) before you begin your investigation. Upon conclusion of your investigation, you must report your results and conclusions to your teacher.
What will you have to work with in the lab?
Lactaid milk
Regular milk (2% milk and/or Skim milk)
Dr. Sam’s Fantastic Stomach Solution (provide students with repackaged tablets for lactose intolerance such as Lactaid)
Pure lactase (available from biological supply houses)
Glucose test strips – test for presence of glucose
2% glucose solution (positive control)
Water (negative control)

Product B - Design the product for the group to which you are assigned by your teacher.

Analytical Student Groups:
The product from analytical students is a lab report with extensive analysis of experimental data. Mastery is demonstrated when the students construct a lab report that clearly indicates their ability to perform the scientific method to evaluate their student-generated hypothesis and, by using the language of the standards, draw reasonable conclusions on the nature of enzymes and their importance in biochemical reactions. Your teacher will work with all students to produce a rubric for assessing each element of this performance task.

Practical Student Groups:
The product is a presentation evaluating the advertising claim tested in this investigation. Students must verbally articulate, using the lab reports, visual aids and models from the other two groups, their conclusions about the advertising claim, extending their report by explaining how enzyme therapy is used by consumers and in medicine. Mastery is demonstrated when a presentation is delivered that effectively uses these tools to evaluate the advertising claim. Your teacher will work with all students to produce a rubric for assessing each element of this performance task.
Creative Student Groups:
The products from creative students are visual aids or models which will illustrate the mechanisms behind the action of enzymes in the body and the catalyzed changes observed in the laboratory.

Mastery is demonstrated when visual aids or models are produced that illustrate the experiment performed to evaluate the student-generated hypothesis linking enzyme’s effects on biochemical reactions as well as the primary functions of enzymes in maintaining homeostasis in organisms.

Your teacher will work with all students to produce a rubric for assessing each element of this performance task.

Teacher notes: Allow students to work with safe experimental designs to initially investigate the claim. Encourage students to CAREFULLY READ THE INGREDIENTS IN THE commercial lactase tablets before designing their final experiments in part A. The tablets under review will include glucose or sucrose as an additive ingredient. This additive will impact the validity of their experimental design. Help students to arrive at this conclusion. Students will therefore need to refine their experimental design to test the pure lactase enzyme without the presence of glucose or sucrose to determine if the enzyme itself is responsible for the conversion of lactose sugar and the subsequent positive test for simple sugars.

Needs for the day of the activity in addition to what you order to keep on-hand:
A performance task challenge with student-designed rubrics
Milk
Lactaid lactose-free milk
Mortar and pestle
2% glucose (you can grind tablets)
Small Dixie cups
Stirring rods (wooden sticks etc)

Lactose will undergo hydrolysis with the addition of the enzyme lactase to produce glucose and galactose.
The Exploratorium website given in the resources section will include references to the prevalence of lactose intolerance among specific segments of the world-wide human population. An interesting connection to natural selection might be ask students to hypothesize why native populations in certain geographic areas experience early loss of the lactase enzyme while other geographic populations keep the ability to synthesize lactase long into adulthood.

**Graphic Model of Glucose (use with extension follow up). Recommend printing for students)**

Questions for wrap-up of task:
What do the bonds of this molecule represent in terms of energy for use by the cell?”
Why do the bonds release energy faster with enzymes present in the reaction?
Are enzymes specific to their substrate? (lock & key) Why?
How is homeostasis controlled by enzyme reaction rate?