

Grades 9-10
Curriculum-Embedded Performance Task
Strand IV: Cell Chemistry and Biotechnology



Enzymes

Laboratory Investigation
Teacher Materials

Enzymes

Teacher Materials

This curriculum-embedded science performance task is related to the content standards and expected performances for high school, as described in the Core Science Curriculum Framework, under Scientific Inquiry, Literacy and Numeracy, Strand IV – Cell Chemistry and Biotechnology.

Targeted Content Standard

10.1 The fundamental life processes depend on the physical structure and the chemical activities of the cell.

Targeted Scientific Inquiry, Literacy and Numeracy Standards

D INQ. 1 Identify questions that can be answered through scientific investigation.

D INQ. 3 Formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.

D INQ. 4 Design and conduct appropriate types of scientific investigations to answer different questions.

D INQ. 5 Identify independent and dependent variables, including those that are kept constant and those used as controls.

D INQ. 6 Use appropriate tools and techniques to make observations and gather data.

D INQ. 7 Assess the reliability of the data that was generated in the investigation.

D INQ. 9 Articulate conclusions and explanations based on research data, and assess results based on the design of an investigation.

Learning objective:

Students will be able to identify the best enzyme for juice production and variables that affect the ability of an enzyme to function.

Listed below are the suggested materials for the laboratory exercise. You may use additional materials if they are available.

Materials:

apple sauce
pectinase enzyme
cellulase enzyme
funnels
filter paper
lab aprons

droppers
stirring rods
graduated cylinder
access to tap water
paper cups
access to a stopwatch, watch or clock

splash-proof safety goggles
access to a balance
paper towels for cleanup

Considerations:

Teams of two students are ideal for laboratory work, but circumstances may necessitate teams of three students. Students will need a minimum of 90 minutes to complete this laboratory exercise if you expect their lab reports to be written during class time. You should allow at least 60 minutes of instructional time for the students to design and conduct their experiment and a minimum of 30 minutes for the students to write about their results. As an alternative the students can complete the lab report for homework. A sample scoring rubric is provided for your convenience or you may design one of your own.

A guideline for the quantity of enzyme to be used is provided due to the concern about conserving costly supplies. Once students identify which enzyme or combination produces the greatest quantity of juice, you can encourage them to explore another variable effect on juice production such as change in temperature or pH. This extension relies on the availability of enzyme supply and instructional time. Check with the science supply house of your choice for the availability and cost of the enzymes. Remember the shelf life of the enzymes is six months when refrigerated.

The task can be integrated into a unit on cell chemistry in any high school biology course. The curriculum-embedded task is intended to be used in the course of normal instruction as a formative assessment. The Connecticut Academic Performance Test-Generation III will include some open-ended items that will assess scientific inquiry and communication skills in the same context as this task.

Background Information on the Enzymes Used in This Activity

Cellulase

The enzyme **cellulase** breaks down **cellulose**. Cellulose is a polymer made out of long branching chains of glucose and it is one of the main components of plant cell walls. Cellulose accounts for about 50 percent of all the organic materials on Earth. Unfortunately, humans, like all other mammals, do not contain the enzyme cellulase and therefore can't digest cellulose.

Scientists purified the enzyme cellulase and currently it is used in the food industry for the production of wine and juices. The enzyme is also used in the production of plant-based materials such as paper, light basswood, rayon fibers and photographic films.

Pectinase

The enzyme **pectinase** breaks down **pectin**. Pectin is a complex carbohydrate that is part of the plant cell wall. Pectin acts like “glue,” holding plant cell walls together. Pectin is soluble in water, and in a mild acidic environment it becomes sticky. These properties make pectin very useful in the production of jams and jellies. When the enzyme pectinase is added to mashed fruits it breaks down the pectin in the fruit cell walls, thus facilitating the industrial production of fruit juices.

Curriculum-Embedded Laboratory Investigation Scoring Rubric

Statement of Problem and Hypothesis

- 3 The problem and hypothesis are stated clearly and completely. Clear identification of independent and dependent variables.
- 2 The problem and hypothesis are stated adequately. Adequate identification of independent and dependent variables.
- 1 The problem and/or hypothesis are poorly stated. Poor identification of independent and dependent variable.
- 0 The statement of the problem and/or hypothesis is very limited or missing altogether. No identification of independent and dependent variables.

Experimental Design

- 3 The experimental design matches the stated problem. Variables are held constant. The procedures are clear, complete and replicable. A control is included when appropriate.
- 2 The experimental design generally matches the stated problem. Attempt at holding variables constant is made. Procedures are generally complete. Minor modifications or clarifications may be needed.
- 1 The experimental design matches the stated problem to some extent. Little attempt to hold variables constant. Procedures are incomplete. Major modifications or clarifications may be needed.
- 0 The experimental design does not match the stated problem, is very incomplete or missing. There is no attempt to hold variables constant.

Data Presentation

- 3 Data are well organized and presented in an appropriate manner.
- 2 Data are organized and presented in an appropriate manner. Minor errors or omissions may be present.
- 1 Data are poorly organized or presented in an inappropriate manner. Major omissions or errors may be present.
- 0 Data are very poorly organized or presented in an inappropriate manner or missing altogether.

Conclusions

- 3 Conclusions are fully supported by data and address the hypothesis. Reliability of data and validity of conclusions are thoroughly discussed.
- 2 Conclusions are generally supported by data and address the hypothesis. Minor errors in interpretation of results may be present. Discussion of reliability of data and validity of conclusions is limited.
- 1 Conclusions are supported by data and address the hypothesis to a limited extent. Major errors in interpretation of results may be present. There is little discussion of the reliability of the data or validity of conclusions.
- 0 Conclusions are not supported by data, do not address the hypothesis or are missing. There is no discussion of the reliability of data or validity of conclusions.

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| Excellent performance | 10-12 points |
| Proficient performance | 7-9 points |
| Marginal performance | 4-6 points |
| Unsatisfactory performance | 0-3 points |