Grades 9-10
Curriculum-Embedded Performance Task
Strand V: Genetics, Evolution and Biodiversity

Yeast Population Dynamics

Laboratory Investigation
Teacher Materials

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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 V – Genetics, Evolution and Biodiversity.

Targeted Content Standard

10.6 Living organisms have the capability to produce populations of unlimited size, but the environment can support only a limited number of individuals from each species.

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 relationship between a change in environmental conditions and yeast population. Some of the variables students will investigate include changes in pH, light and temperature.

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

Materials:

25% molasses solution
stock yeast solution
baker's yeast
clean test tubes (18 mm x 150 mm)
clean test tubes (25 mm x 150 mm)
graduated cylinder
splash proof goggles
metric ruler
electronic balance sensitive to .001g (optional)
graduated disposable pipettes

Considerations:

Teams of two students are ideal for laboratory work, but circumstances may necessitate teams of three students. You should allow at least 60 minutes of instructional time for the students to design and set up their experiment and at least 15-20 minutes of instructional time over five days to collect data as the yeast population changes. The school schedule may dictate additional days if classes do not meet everyday. At the conclusion of the experiment you should allow about 30 minutes for the students to write about their results or you may prefer to have the students complete the lab report for homework. A sample scoring rubric is provided or you may design your own.

The lab activity focuses on the growth patterns of yeast cultures and the impact of different environmental factors (e.g., light, temperature, pH, nutrients) on the population dynamics. Students are given the general procedure for growing yeast and measuring the carbon dioxide as a waste product of cell respiration. The quantity of waste product is directly related to the size of the yeast population. Students then may choose their own variable on population growth to investigate (e.g. light, pH, temperature, concentration of food). Remember the collection period is over five days and this will have a major impact on instructional time if you allow students to observe the results of the general procedure before designing their investigation versus performing the general procedure at the same time of their own investigation.

Note: Students may need guidance in measuring the volume of the carbon dioxide. They are provided with a metric ruler to measure the height of the bubble but you may need to give them the formula for a cylinder so they may calculate the volume in cubic centimeters and convert that into milliliters (volume of a cylinder = $\pi r^2 h$).

A 25% molasses (un-sulfured) stock solution needs to be prepared from the concentration at time of purchase from the grocery store. In a 500 ml volumetric flask dilute 125 ml of molasses with water until the solution reaches the glass marking on the neck of the flask (% solution = volume of solute/volume of solution x 100 %.) Failure to dilute the molasses will result in destruction of the yeast cells.

A yeast suspension needs to be prepared one hour before the lab. (1 gram of yeast per 100 ml of water). You may use ordinary baker's yeast from the supermarket (*Saccharomyces cerevisiae*), or you can order yeast strains from a biological supply company.

Safety note: Some students have severe allergies to yeast and will need an alternative laboratory investigation. See the school nurse for specific health-care considerations.

Some background information about population dynamics may be found at these sites:

http://www.nationalgeographic.com/eye/overpopulation/science.html
http://www.accessexcellence.org/AE/AEC/AEF/1996/webb_population.html

This task can be integrated into a unit on population dynamics in any high school biology course. The curriculum-embedded task is intended to be used as a formative assessment during in the appropriate instructional unit. 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.

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.

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