**Problem Posing Template for Individual Activity**

(Copy this template and share your ideas for incorporating problem posing in one of your courses. Share your work in the Collections.)

**Module Overview**: Investigating differences in nutrient use by yeast during cellular respiration and/or fermentation

**Setting**: Introductory Biology (majors and non-majors) and/or Cell Biology courses. Lab activity for class sizes <25 students.

Learning Outcomes for the activity

* Describe how nutrient preferences can be tested experimentally
* Identify the reactants and products of the cellular respiration and/or fermentation reactions being performed by the experimental organism
* Connect the nutrient preferences of an organism with the metabolic fate of the nutrient after it has been taken in to the organism’s cells
* Connect the nutrient preferences of an organism with physical characteristics of the organism that may accentuate and/or impede use of certain nutrients.

How does data acumen align with this learning outcome? Place an “X” in the column next to the skills practiced in this activity

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| --- | --- | --- | --- | --- | --- |
| **Quantitative Pillars** |  | **Data Life Cycle** |  | **Social/Pedagogical Concepts** |  |
| Mathematical | X | Data import |  | Communication | X |
| Computational | X | Management |  | Equity, Diversity, Inclusivity |  |
| Statistical thinking | X | Curation |  | Universal Design for Learning |  |
| Reproducibility | X | Analysis | X | Ethics |  |
|  |  | Sharing/ Reporting |  |  |  |

**Activity/Module**:

Describe the activity:

Students will respond to a prompt to come up with questions they might be able to test regarding the nutrient preferences for yeast. Available nutrient sources will be a dilute protein mixture, several different carbohydrates (glucose, fructose, galactose, sucrose, lactose, starch), and a dilute fatty acid (oil) mixture. Students will then experimentally determine the amount of CO2 produced when yeast is fed each nutrient source (ideally triplicate experiments should be performed).

After collecting data, students should calculate averages and standard deviations. Students should graph the data using a bar graph, with error bars included.

After analyzing the data, students might then be additionally prompted to determine a reason for why specific nutrients are preferred over others. This could incorporate another question prompt that guides students to think about diffusion and transport of substances across membranes. Additionally, this could incorporate another question prompt that guides students to think about where the nutrients would enter the metabolic reaction pathways in yeast.

For more advanced courses, students could be directed to databases of transport proteins (<http://ytpdb.biopark-it.be/ytpdb/index.php/Main_Page>) and/or databases of metabolic pathways (<http://biocyc.org>). The intent would then be for students to delve into those databases to search for where the nutrient they tested would enter a metabolic pathway (or not), and how many reactions might be needed for the nutrient to be broken down into something that would junction into the citric acid cycle or glycolysis (central metabolic pathways). Also, students could search for the presence of transport proteins that might be able to transport certain nutrients (or are perhaps absent), which would then correlate with nutrient preference

Course type (e.g. Lecture, lab): Lab

Pedagogy: Lab activity

Describe the data and the tools used to interact with the data:

Data obtained will be amount of CO2 produced (a metric for cellular respiration and/or fermentation) in a specified amount of time at a specified temperature. Data should be obtained for several nutrients and data will be graphed to interpret nutrient usage differences. Ideally, several replicates of each experimental condition should be performed so that averages and standard deviations can be calculated.

Tools used to measure data will be inverted test tubes for yeast to grow in, with larger tubes around the inverted tubes so that CO2 can be trapped in the inverted tubes. Amount of CO2 produced can be measured using a ruler (easier to use than attempting to determine volume of gas produced).

Other tools used will include spreadsheet and graphing software (Excel) to calculate averages and standard deviations and to produce bar graphs representing the amount of CO2 produced when yeast was feeding on certain nutrient sources.

Describe where problem posing will be used and how you as the instructor will use problem posing to shape the activity:

* What is the Question Focus?

The prompt will be: “Most organisms, including yeast, have preferred nutrient sources that they use to obtain energy and support their growth.”

* How is the Question Focus introduced?

The problem posing will occur immediately, before students are even made aware of the different nutrients they might be able to test, and before they are made aware of the testing apparatus that will be used.

* Describe the student products: Ideally, students will produce questions like: “which nutrients are preferred?”, “how can nutrient preferences be determined?”, “how are the nutrients used to provide energy?”

**Assessment**:

How will this learning outcome be assessed?

 Lab worksheet and/or lab report. Worksheet/report should include:

* A data table of the amount of CO2 measured due to yeast cellular respiration and/or fermentation in different nutrient conditions.
* Calculations of averages and standard deviations of measured data
* A graph of data collected, including error bars
* Answers to question prompts about the relationship between nutrient preferences and nutrient metabolism
* Answers to question prompts about the relationship between nutrient preferences and nutrient transport into the cell

A component of this experiment (possibly graphical analysis) would be present on the Lab Final Exam.

Will students practice this skill again? In what setting (same topic, new topic)?

 Not sure.

**Extra information**:

What will students need to know before completing this activity?

Before completing the activity, students should know that the product of cellular respiration and/or fermentation that is being measured is CO2. Students should know that certain nutrients are preferred because of their entry points into cellular metabolism (glycolysis versus beta oxidation versus citric acid cycle versus secondary metabolism). Students should know that certain nutrients are preferred due to the ability of the cell to actually take those nutrients in due to the presence of certain transporters and/or the chemical nature of the nutrients themselves.