Lab 6. Cellular Respiration: How Does the Type of Food Source Affect the Rate of Cellular Respiration in Yeast?

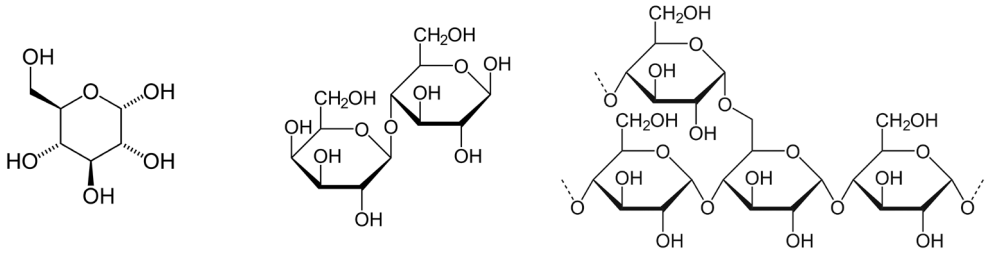
Introduction

One characteristic of living things is they must take in nutrients and give off waste in order to survive. This is because all living tissues (which are composed of cells) are constantly using energy. In plants, animals, and fungi this energy comes from a reaction called cellular respiration. Cellular respiration refers to a process that occurs inside cells. During this process oxygen is used to convert the chemical energy found within a molecule of sugar into a form that is usable by the organism. The following equation describes this process:

Sugar + oxygen (O_2) → water + carbon dioxide (CO_2) + adenosine triphosphate (ATP), a usable form of energy

Sugar is a generic term used to describe molecules that contain the elements carbon, hydrogen, and oxygen with the general chemical formula of $(CH_2O)n$, where n is 3 or more. Biologists also call sugars carbohydrates or saccharides. There are many different types of sugar (see the figure below). Simple sugars are called monosaccharides; examples include glucose and fructose. Complex sugars include disaccharides and polysaccharides. Examples of disaccharides include lactose, maltose, and sucrose. Examples of polysaccharides include starch, glycogen, and cellulose.

Examples of three different types of sugar



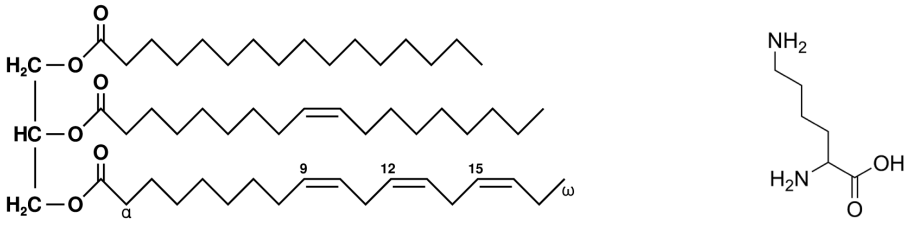
Glucose—a monosaccharide

Lactose—a disaccharide

Starch—a polysaccharide

In addition to carbohydrates there are other type of molecules found in plants and animals that could serve as potential energy sources because they also contain the elements carbon, hydrogen, and oxygen. These molecules include lipids and proteins, as shown in the figure below. Lipids do not share a common molecular structure like carbohydrates. The most commonly occurring class of lipids, however, is triglycerides (fats and oils), which have a glycerol backbone bonded to three fatty acids. Proteins contain other atoms such as nitrogen and sulfur, in addition to carbon, hydrogen, and oxygen.

Examples of (a) a lipid and (b) an amino acid found in proteins



(a) Triglyceride—a lipid

(b) Lysine—an amino acid found in proteins

Yeast, like most types of fungi, produce the energy they need to survive through cellular respiration. In this investigation, you will determine if yeast can use a wide range of nutrients (e.g., proteins, fats, and different types of carbohydrates) to fuel the process of cellular respiration.

Your Task

Design a controlled experiment to determine how the type of food source available affects the rate of cellular respiration in yeast. To do this, you will need to use a CO_2 or O_2 gas sensor as shown in

the figure below to determine if yeast produces CO_2 (or uses O_2) at different rates in response to a change in a food source.

The guiding question of this investigation is, **How does the type of food source affect the rate of cellular respiration in yeast?**

Materials

You may use any of the following materials during your investigation:

- Yeast suspension
- Food source 1: starch (polysaccharide)
- Food source 2: sucrose (disaccharide)
- Food source 3: lactose (disaccharide)
- Food source 4: glucose (monosaccharide)
- Food source 5: protein
- Food source 6: lipid
- CO_2 or O_2 gas sensor
- Sensor interface
- 2 Erlenmeyer flasks (each 250 ml)
- Ring stand and clamps
- Beaker (600 ml)
- 7 Test tubes
- Test tube rack
- Safety goggles and aprons

Safety Precautions

1. Safety goggles and aprons are required for this activity.
2. Use caution when working with electrical equipment. Keep away from water sources in that they can cause shorts, fires, and shock hazards. Use only GFI-protected circuits.
3. Wash hands with soap and water after completing this lab.
4. Follow all normal lab safety rules.

Getting Started

To answer the guiding question, you will need to design and conduct a controlled experiment. To accomplish this task, you must determine what type of data you will need to collect, how you will collect it, and how you will analyze it. To determine *what type of data you need to collect*, think about the following question:

- What type of information will you need to collect during the experiment to determine the respiration rate of yeast? (Hint: The figure to the right shows a sensor being used to measure changes in CO_2 or O_2 levels in a 250 ml flask.)

A CO_2 or an O_2 gas sensor can be used to measure changes in gas concentration.

To determine *how you will collect your data*, think about the following questions:

- What will serve as the dependent variable during the experiment?
- What will serve as the independent variable?
- What other factors will you need to keep constant?
- What will serve as a control condition?
- How will you make sure that your data are of high quality (i.e., how will you reduce measurement error)?
- How will you keep track of the data you collect and how will you organize the data?
- To determine *how you will analyze your data*, think about the following questions:
- What type of calculations will you need to make?
- What type of graph could you create to help make sense of your data?

Investigation Proposal Required? ☐ Yes ☐ No

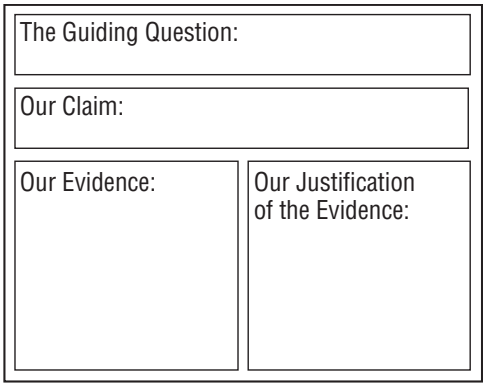
Connections to Crosscutting Concepts and to the Nature of Science and the Nature of Scientific Inquiry

As you work through your investigation, be sure to think about

- the importance of identifying the underlying cause for observations,
- how energy and matter move within or through a system,
- how structure determines function in living things,
- the difference between theories and laws in science, and
- the importance of imagination and creativity in science.

Argumentation Session

Argument presentation on a whiteboard



Once your group has finished collecting and analyzing your data, prepare a whiteboard that you can use to share your initial argument. Your whiteboard should include all the information shown in the figure to the right.

To share your argument with others, we will be using a round-robin format. This means that one member of your group will stay at your lab station to share your group's argument while the other members of your group go to the other lab stations one at a time to listen to and critique the arguments developed by your classmates.

The goal of the argumentation session is not to convince others that your argument is the best one; rather, the goal is to identify errors or instances of faulty reasoning in the arguments so these mistakes can be fixed. You will therefore need to evaluate the content of the claim, the quality of the evidence used to support the claim, and the strength of the justification of the evidence included in each argument that you see. In order to critique an argument, you will need more information than what is included on the whiteboard. You might, therefore, need to ask the presenter one or more follow-up questions, such as:

- How did you collect your data? Why did you use that method? Why did you collect those data?
- What did you do to make sure the data you collected are reliable? What did you do to decrease measurement error?
- What did you do to analyze your data? Why did you decide to do it that way? Did you check your calculations?
- Is that the only way to interpret the results of your analysis? How do you know that your interpretation of your analysis is appropriate?
- Why did your group decide to present your evidence in that manner?
- What other claims did your group discuss before you decided on that one? Why did your group abandon those alternative ideas?
- How confident are you that your claim is valid? What could you do to increase your confidence?

Once the argumentation session is complete, you will have a chance to meet with your group and revise your original argument. Your group might need to gather more data or design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the most valid or acceptable answer to the research question!

Report

Once you have completed your research, you will need to prepare an investigation report that consists of three sections that provide answers to the following questions:

1. What question were you trying to answer and why?

2. What did you do during your investigation and why did you conduct your investigation in this way?
3. What is your argument?

Your report should answer these questions in two pages or less. This report must be typed, and any diagrams, figures, or tables should be embedded into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid!