

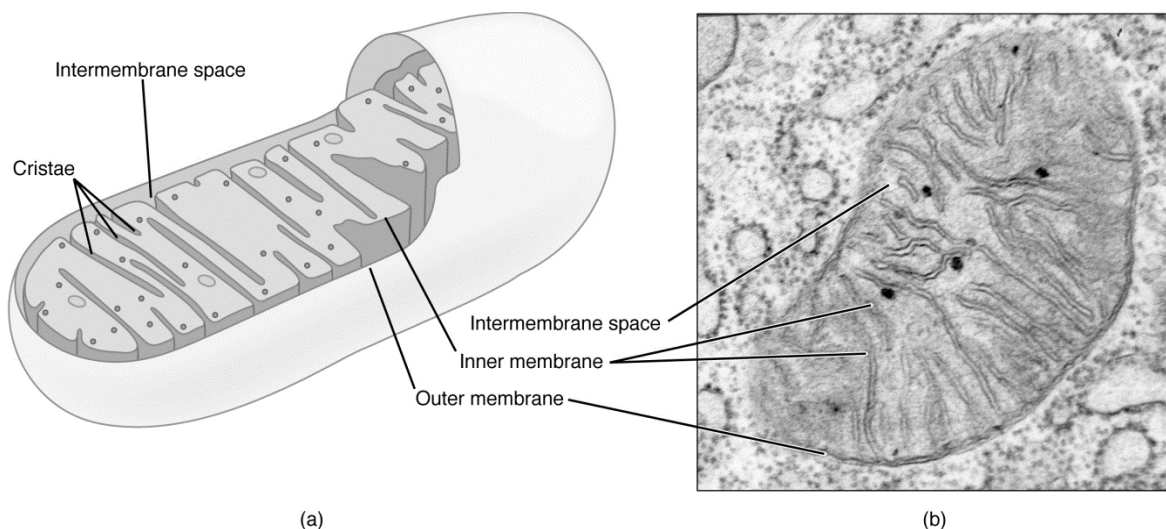
Lab 1. Cellular Respiration: Do Plants Use Cellular Respiration to Produce Energy?

Introduction

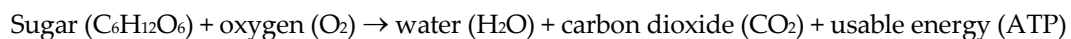
One characteristic of living things is they must take in nutrients and give off waste in order to survive. This is because all living tissues (which are made of cells) are constantly using energy. In animals, this energy comes from a reaction called *cellular respiration*. Cellular respiration refers to a process that occurs inside cells where sugar is used as a fuel source. This process happens in a specific location inside cells called the *mitochondrion* (the plural form is *mitochondria*). Figure L1.1 shows a drawing and an image from an electron microscope of a mitochondrion. Mitochondria are found in both plant and animal cells.

FIGURE L1.1

(a) Drawing and (b) electron microscopic image of a mitochondrion



The energy that cells use comes from the chemical bonds in sugar. During cellular respiration, oxygen helps convert the chemical energy in sugar molecules into a form animals can use. The energy is transferred by moving electrons from one molecule to another. When electrons are added or taken away, new chemical bonds and types of molecules can be formed. The oxygen helps transfer electrons from sugar to the chemical bonds in another molecule. Most living organisms use a special molecule known as ATP to provide energy for all the activities taking place in their cells. The following equation describes this process:



We know that humans use this process to produce energy because when a human breathes, the air that he or she inhales contains about 21% O₂ and less than 1% CO₂; however, when he or she exhales, the air contains about 15% O₂ and 5% CO₂. We also know that all animals use this process to produce energy. It is a unifying characteristic of animals, but what about other types of living things like plants? Do these organisms use this process as well? In this lab investigation you will use an O₂ or CO₂ gas sensor to determine if plants use cellular respiration to produce energy just like animals.

Your Task

Design a scientific investigation to determine if plants use the process of cellular respiration to produce energy. To do this, you will need to use sensors to determine if these organisms cause a change in the CO₂ or O₂ concentrations of air.

The guiding question of this investigation is, **Do plants use cellular respiration to produce energy?**

Materials

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

Consumables	Equipment
<ul style="list-style-type: none">• Germinating peas (i.e., peas that have been soaked in water)• Dry peas• Plastic beads	<ul style="list-style-type: none">• CO₂ or O₂ gas sensor• Biochambers or sealed containers with opening for sensors• Go!Link adaptor and laptop computer• Sanitized indirectly vented chemical-splash goggles• Chemical-resistant apron• Gloves

Safety Precautions

Follow all normal lab safety rules. In addition, take the following safety precautions:

1. Put on sanitized indirectly vented chemical-splash goggles and laboratory apron and gloves before starting the lab activity.
2. Wash hands with soap and water after completing the lab activity.

Investigation Proposal Required? Yes No

Getting Started

During your investigation you will need to determine if the peas are producing CO₂ or using O₂. To do this, you can use CO₂ and O₂ gas sensors (see Figure L1.2). To answer the guiding question, you will need to design and conduct an experiment. To accomplish this task, you must first determine what type of data you need to collect, how you will collect it, and how you will analyze the data.

To determine *what type of data you need to collect*, think about the following questions:

- What information will tell you that cellular respiration is occurring in the peas?
- How will the sensors help you measure cellular respiration?
- What type of measurements or observations will you need to record during your investigation?

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

- What will serve as a control (or comparison) condition?
- What types of treatment conditions will you need to set up and how will you do it?
- How often will you collect data and when will you do it?
- How will you make sure that your data are of high quality (i.e., how will you reduce error)?
- How will you keep track of the data you collect and how will you organize it?

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

- How will you determine if there is a difference between the treatment conditions and the control condition?
- What type of calculations will you need to make?
- What type of graph could you create to help make sense of your data?

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

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

- the importance of looking for and identifying patterns,
- how models are used to study natural phenomena,
- how the structure of an object is related to its function,

FIGURE L1.2

An O₂ or a CO₂ gas sensor can be used to measure changes in gas concentration.



- the difference between laws and theories in science, and
- the difference between data and evidence in science.

Initial Argument

Once your group has finished collecting and analyzing your data, you will need to develop an initial argument. Your argument must include a claim, evidence to support your claim, and a justification of the evidence. The claim is your group's answer to the guiding question. The evidence is an analysis and interpretation of your data. Finally, the justification of the evidence is why your group thinks the evidence matters. The justification of the evidence is important because scientists can use different kinds of evidence to support their claims. Your group will create your initial argument on a whiteboard. Your whiteboard should include all the information shown in Figure L1.2.

FIGURE L1.2

Argument presentation on a whiteboard

The Guiding Question:	
Our Claim:	
Our Evidence:	Our Justification of the Evidence:

Argumentation Session

The argumentation session allows all of the groups to share their arguments. One member of each group stays at the lab station to share that group's argument, while the other members of the group go to the other lab stations one at a time to listen to and critique the arguments developed by their 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 initial 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. To critique an argument, you might 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:

- What did your group do to analyze the data, and why did you decide to do it that way?
- Is that the only way to interpret the results of your group's analysis? How do you know that your interpretation of the analysis is appropriate?
- Why did your group decide to present your evidence in that manner?
- What other claims did your group discuss before deciding on that one? Why did you abandon those alternative ideas?
- How confident are you that your group's 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. The 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!