KIT 470134-806

AP® Biology Investigation #6:

Cellular Respiration

Meets Revised College Board AP Biology Standards

Teacher's Guide

ward's science

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Abstract

Living organisms must metabolize compounds derived from food to produce energy for maintenance, growth and reproduction. Cellular respiration is a process that produces energy by metabolizing glucose in the presence of oxygen (O_2). In this lab, students measure the rate of oxygen consumption related to cellular respiration. This is achieved through the construction and utilization of a microrespirometer. Students compare the results obtained using germinating seeds versus a non-germinating control, acrylic beads. Students then design their own experiments to investigate the effects of various factors on the rate of cellular respiration.

Required Prior Knowledge

Students should:

- be able to make and record good observations.
- understand how the function of a cell is dependent on its structure.
- have a strong understanding of factors that affect enzymes, photosynthesis, fermentation, and cellular respiration.
- understand the gas laws and how they govern the flow of gasses across a cell membrane.
- understand the flow of free energy through a system.

Activity Learning Objectives

Using respirometers, students will measure the rate of respiration from the disappearance of oxygen. Students will design an experiment to compare the respiration rate of different organisms or variables to answer the following question:

How does an organism obtain energy from stored chemical energy in food?

Materials Checklist

*For a list of replacement items, visit: www.**wardsci.com**, and click on the AP Biology tab for this kit/item #.*

Materials Included in Kit:

- 1 bag cotton balls
- 1 bag rayon balls
- 1 lb. pea seeds (viable)
- 360 acrylic beads
- 8 sets of 6 vials with glued washers
- 8 sets of 6 stoppers and washers
- 48 pipets, non-sterile Pyrex, 1 mL × .01
- 15 graduated plastic pipets, 6″
- 16 trays, 21¼ × 11 × 2″
- 1 bottle food coloring
- 1 bottle potassium hydroxide, 15% solution
- 1 Instructions (this booklet and the Student Guide copymaster)

Also Needed:

- Thermometer °C
- Glass marking pens
- Timers or stopwatches
- Paper towels
- 100 mL graduated cylinders
- Ice
- Distilled water
- Petroleum jelly
- Lab notebook
- Safety goggles or glasses
- Gloves
- Lab aprons
- Other materials as determined by students' experiment design

Optional Materials (not provided)

- Hot plates or temp-controlled water baths
- 1 pkg. kidney bean seed, viable, 1 lb
- 1 pkg. seeds, black-eyed peas, 1 lb

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Standards Alignment

This lab activity is aligned with the 2012 AP Biology Curriculum (registered trademark of the College Board). Listed below are the aligned Content Areas (Big Ideas and Enduring Understandings), the Science Practices, and the Learning Objectives of the lab as described in AP Biology Investigative Labs: An Inquiry-Based Approach (2012). *This is a publication of the College Board that can be found at:*

http://media.collegeboard.com/digitalServices/pdf/ap/APBioTeacherLabManual2012_2ndPrt_lkd.pdf

Big Ideas	**2**	Biological systems utilize energy and molecular building blocks to grow, to reproduce, and to maintain homeostasis.
	with links to:	
	1	The process of evolution drives the diversity and unity of life.
	4	Biological systems interact, and these interactions possess complex properties.
Enduring Understandings	**1.B1**	Organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.
	2.A 1	All living systems require constant input of free energy.
	2.A 2	Organisms capture and store free energy for use in biological processes.
	2.B 3	Eukaryotic cells maintain internal membranes that partition the cell into specialized regions (e.g., mitochondria).
	4.A 2	The structure and function of subcellular components, and their interactions, provide essential cellular processes.
	4.A 6	Interactions among living systems and with their environment result in the movement of matter and energy.
Science Practices	**1.4**	The student can use representations and models to analyze situations or solve problems qualitatively and quantitatively.
	2.2	The student can apply mathematical routines to quantities that describe natural phenomena.
	3.1	The student can pose scientific questions.
	6.1	The student can justify claims with evidence.
	6.2	The student can construct explanations of phenomena based on evidence produced through scientific practices.
	7.2	The student can connect concepts in and across domain(s) to generalize or extrapolate in and/or across enduring understandings and/or big ideas.

(continued on next page)

Standards Alignment *continued*

Learning Objectives	**1.15**	The student is able to describe specific examples of conserved core biological processes and features shared by all domains or within one domain of life, and how these shared, conserved core processes and features support the concept of common ancestry for all organisms.
	1.16	The student is able to justify the scientific claim that organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.
	2.2	The student is able to justify a scientific claim that free energy is required for living systems to maintain organization, to grow, or to reproduce, but that multiple strategies exist in different living systems.
	2.4	The student is able to use representations to pose scientific questions about what mechanisms and structural features allow organisms to capture, store, and use free energy.
	2.14	The student is able to use representations and models to describe differences in prokaryotic and eukaryotic cells.
	4.5	The student is able to construct explanations based on scientific evidence as to how interactions of subcellular structures provide essential functions.
	4.14	The student is able to apply mathematical routines to quantities that describe interactions among living systems and their environment, which result in the movement of matter and energy.

Time Requirements

	TIME FRAME	TEACHER TASK(S)	STUDENT TASK(S)
Pre-lab Prep	2 weeks prior to activity 3	See page 11 & 20 if ordering live materials for student experiments.	Read background and answer pre-lab questions.
	2 days prior to starting lab	See page 11 to prepare germinating peas.	
	1 day prior to starting lab	See page 11 to prepare additional materials.	
Activity 1	60 minutes	Assure safe handling of Potassium Hydroxide.	
Activity 2	45 minutes	Optional: This portion of the lab can be done concurrently with activity 1, using additional respirometers.	
Activity 3	Varies, depending on students' experiment designs	If ordering live materials, please do so at least 2 weeks prior to lab.	

Safety Precautions

Lab Specific Safety:

- Potassium hydroxide is a poison if ingested and is **very corrosive to all body tissues**. Handle with extreme caution. Before starting this lab, review the SDS for this chemical.
- It is recommended that students **wear proper protective equipment**, such as gloves, safety goggles, and a lab apron as general laboratory practice and especially when using potassium hydroxide.

General Safety:

- The teacher should 1) be familiar with safety practices and regulations in his/her school (district and state) and 2) know what needs to be treated as hazardous waste and how to properly dispose of non-hazardous chemicals or biological material.
- Consider establishing a **safety contract** that students and their parents must read and sign. This is a good way to identify students with allergies (e.g., latex) so that you (and they) will be reminded of specific lab materials that may pose risks to individuals.
- Students should know where all **emergency equipment** (safety shower, eyewash station, fire extinguisher, fire blanket, first aid kit etc.) is located.
- Require students to remove all dangling jewelry and tie back long hair before they begin.
- Remind students to **read all instructions, SDSs and live care sheets** before starting the lab activities, and to ask questions about safety and safe laboratory procedures. The SDSs and the most updated versions of live care sheets can be found at www.**wardsci.com**. Updated SDSs can also usually be found on each chemical manufacturer's website.
- In student directed investigations, make sure that collecting safety information (like SDSs) is part of the experiment procedure.

At the End of the Lab:

- Before disposing of any chemicals in the trash or down the drain, review local regulations or consult with local authorities.
- All laboratory bench tops should be wiped down with a 10% bleach solution or disinfectant to ensure cleanliness.
- Remind students to wash their hands thoroughly with soap and water before leaving the laboratory.