470134-770

AP® Biology Investigation #5:

Cell Processes: Photosynthesis

Meets 2013 College Board AP Biology Standards

ward's science

WACP470132-876

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LIT WACP470132-876 – Rev. 3/15

abstract

This lab illustrates the ability of plants to capture, store, and use light energy for growth and reproduction. Activity 1 is a structured inquiry in which students observe the pigments present in various plant leaves through the use of basic paper chromatography techniques. Activity 2 is a guided inquiry in which the students indirectly measure the rate of photosynthesis under specific environmental conditions using the floating disc assay. Students also observe how interactions of the cells with the environment enable both uptake of specific components necessary for photosynthesis and expulsion of waste products that result from cellular metabolism. Activity 3 is an open inquiry, in which students design an experiment that allows them to further explore the process of photosynthesis.

required prior knowledge

Students should:

- be able to make and record good observations.
- demonstrate an understanding of the physical properties of light including the intensity and wave nature.
- understand the process of photosynthesis and how it supports the flow of energy through an ecosystem.
- construct a graph as a quantitative representation of photosynthetic rate.

activity learning objectives

In this laboratory investigation, students will conduct the floating disk assay to determine the rate of photosynthesis in a leaf portion. Students will separate the pigments exhibited in a leaf by chromatography. These activities will help them answer the following question:

What happens to an ecosystem if water becomes unavailable and the plants die?

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 aluminum foil, 12" x 25' roll *(useful for activity 3 open inquiry options)*
- 20 syringe, non-sterile, 10 mL
- 1 sodium bicarbonate, 50 g
- 15 graduated pipets, 6"
- 8 one-hole paper punch
- 4 film, rainbow: 8-1/2 x 11 *(useful for activity 3 open inquiry options)*
- 1 buffer set: Includes envelopes of pH 2-11 (one each, for a total of 10 envelopes), & 500 mL buffer *(useful for activity 3 open inquiry options)*
- 1 pkg. chromatography paper strips
- 8 glass vials with caps
- 1 pkg./4 chromatography solvent, 30 mL
- 50 clear plastic cups
- 1 Instructions (this booklet and student guide copymaster)

materials needed but not provided:

- Lab notebook
- Timers
- Light source
- Baby spinach leaves
- Forceps
- Liquid soap (dish washing liquid)
- Wax pencil
- Rulers
- Coins (quarters or dimes)
- Scissors
- Fume hood

optional materials (not provided)

- Light sensor (item 9200003 or other)
- Thermometer
- Variety of collected plant leaves
- Light bulbs, variety (40 watt, 100 watt, 150 watt suggested)
- Ring stand with ring
- Balance or scale
- PAR (photosynthetic active radiation) meter

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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 Learning Objectives, and the Science Practices 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.
	Also connects 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.A1	All living systems require constant input of free energy.
	2.A2	Organisms capture and store free energy for use in biological processes.
	2.B3	Eukaryotic cells maintain internal membranes that partition the cell into specialized regions (e.g., chloroplasts).
	4.A2	The structure and function of subcellular components, and their interactions, provide essential cellular processes.
	4.A6	Interactions among living systems and 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.

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standards alignment

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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 the 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

Activity 1	45 minutes. Optional: Start Activity 2 during solvent migration
Activity 2	45 minute lab period
Activity 3	Varies, depending on students' experiment designs

lab-specific safety

- Chromatography solution (used in paper chromatography) is an irritant to the skin and eyes, use with caution.
- Chromatography solvent is extremely flammable, a serious health hazard, and moderately reactive. Use this chemical in an approved fume hood.

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.
- As general laboratory practice, it is recommended that students **wear proper protective equipment**, such as gloves, safety goggles, and a lab apron.

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.

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