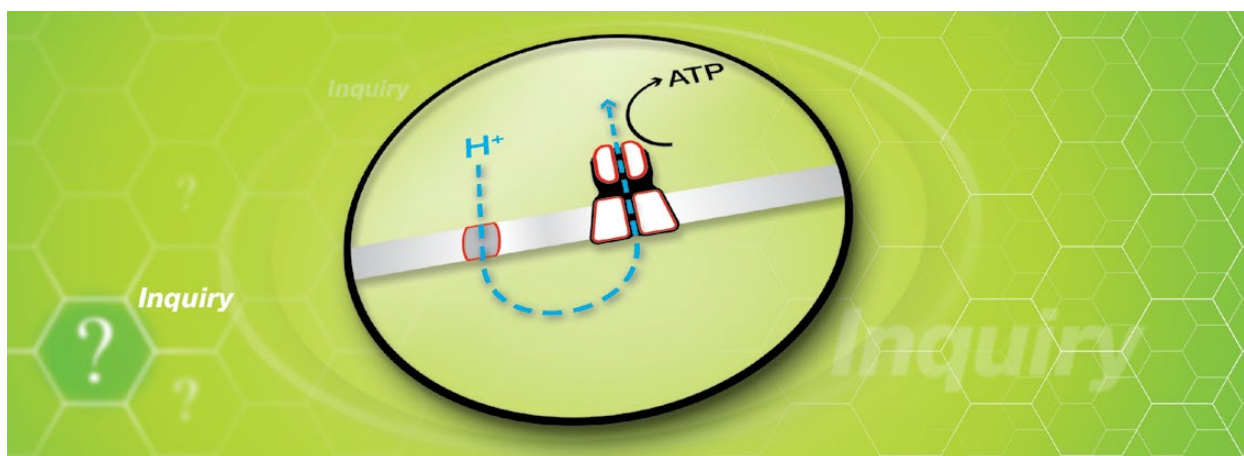


Bio-Rad Explorer™

Photosynthesis and Cellular Respiration Kit for AP Biology: A ThINQ!™ Investigation

Planning Guide explorer.bio-rad.com

Catalog #17001238EDU, Photosynthesis and Cellular Respiration Kit



Note: This document is for planning purposes only and may vary from the final product specifications. Duplication of any part is permitted for classroom use only.

For technical service, call your local Bio-Rad office or, in the U.S., call 1-800-424-6723.

BIO-RAD

Table of Contents

Overview	1
Kit Summary	2
Inquiry Learning Goals	2
ThINQ! Photosynthesis and Cellular Respiration Kit Components	3
Kit Components (included)	3
Required Accessories (not included)	3
Recommended Accessories (optional)	4
Refills (available separately)	4
Additional Resources	4
Timeline for Preparation and Investigations	6

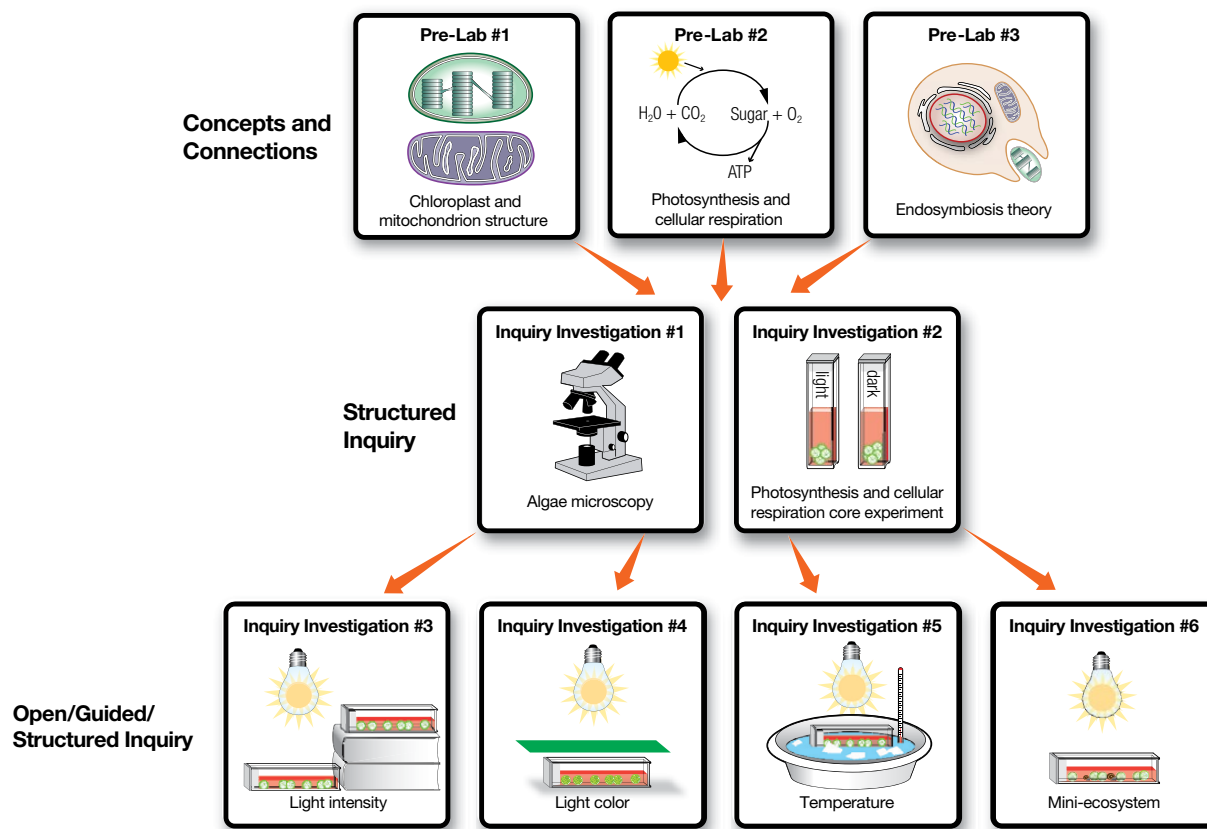
Overview

The intention of this planning guide is to provide an overview of the ThINQ!™ Photosynthesis and Cellular Respiration Kit for AP Biology, including details of timelines, materials included, and equipment requirements, so that instructors may prepare their curriculum and estimate budgetary requirements in advance. These are estimates based on information available when this guide was created.

The ThINQ! Photosynthesis and Cellular Respiration Kit for AP Biology (catalog #17001238EDU) is made up of six wet labs that can be done as structured, guided, and/or open inquiry investigations. We provide a suggested framework below, but the kit is flexible and the Instructor's Guide provides support materials for you to adapt the level of inquiry to your classroom needs. The ThINQ! Kits focus on developing students' ability to navigate the scientific process. The manuals engage and support students in practicing skills such as asking scientific questions, posing hypotheses, designing experiments, analyzing data, and communicating findings.

The Photosynthesis and Cellular Respiration Kit uses a colorimetric pH indicator to track alkalization or acidification of a solution due to CO_2 consumed during photosynthesis or CO_2 produced during cellular respiration. Students will use algae beads with the colorimetric pH indicator solution to explore how the opposing and interconnected photosynthesis and cellular respiration processes work together in a single organism. Then they can investigate how factors such as light color, light intensity, temperature, and other organisms can affect one or both of these processes.

Kit Summary



The ThINQ!™ Photosynthesis and Cellular Respiration Kit includes three pre-lab modeling activities, six hands-on labs, and one case study. The materials in the kit are sufficient for a class of 32, eight workstations of four students. We suggest that you conduct Investigations #1 and #2 as structured inquiry labs and Investigations #3–6 as open, guided, or structured inquiry labs. However, the kit is flexible and you can modify it to accommodate the needs of your class.

Inquiry Learning Goals

Below is an overview of focused goals for each of the activities based on our suggested framework, but this may vary depending on your needs.

Description	Learning
Pre-Lab Activity #1: Review Chloroplast and Mitochondrion Structure	<ul style="list-style-type: none"> – Identify similarities and differences between the structures of a chloroplast and a mitochondrion – Make conceptual connections with prior knowledge about chloroplast and mitochondrion function and structure
Pre-Lab Activity #2: Review Evolution of Mitochondrion and Chloroplast	<ul style="list-style-type: none"> – Make conceptual connections between photosynthesis and cellular respiration in prokaryotes and eukaryotes – Use evidence to support and refute the endosymbiosis theory
Pre-Lab Activity #3: Interdependence of Photosynthesis and Cellular Respiration	<ul style="list-style-type: none"> – Make conceptual connections with prior knowledge about the interdependence of photosynthesis and cellular respiration – Generate an initial model of photosynthesis and cellular respiration interactions
Investigation #1: Algae Microscopy	<ul style="list-style-type: none"> – Practice hands-on laboratory skills – Become familiar with working with algae beads

(Continued)

Description	Learning
Investigation #2: Photosynthesis and Cellular Respiration Core Lab	<ul style="list-style-type: none"> – Practice hands-on laboratory skills – Become familiar with the photosynthesis and cellular respiration core experiment – Refine photosynthesis and cellular respiration model based on data – Calculate rates of CO₂ production and consumption based on data
Investigation #3: Effect of Light Intensity	– Engage in the scientific process:
Investigation #4: Effect of Light Color	<ul style="list-style-type: none"> – Observe phenomena – Ask scientific questions
Investigation #5: Effect of Temperature	<ul style="list-style-type: none"> – Construct hypothesis – Design experiments and protocols
Investigation #6: Mini-Ecosystem	<ul style="list-style-type: none"> – Collect and analyze data – Discuss and communicate findings
Case Study	– Synthesize knowledge and apply knowledge to real life science problems

THINQ! Photosynthesis and Cellular Respiration Kit Components

Catalog #17001238EDU, THINQ! Photosynthesis and Cellular Respiration Kit, includes materials for eight workstations.

Kit Components (included)

Description	Quantity	(✓)
Store at 4°C		
Algae beads, 170 beads	1 bottle	<input type="checkbox"/>
10x CO ₂ indicator, 50 ml	1 bottle	<input type="checkbox"/>
Debeading solution, 20 ml	1 bottle	<input type="checkbox"/>
Store at room temperature		
Cuvettes and caps	100	<input type="checkbox"/>
Disposable plastic transfer pipets, sterile	60	<input type="checkbox"/>
Indicator Color Guide	8	<input type="checkbox"/>
Instructor's guide, printed	1	<input type="checkbox"/>
Student manual available for download online		

Required Accessories (not included)

Description	Quantity	(✓)
All Investigations		
Beaker, 250–500 ml	1	<input type="checkbox"/>
Graduated cylinders, 250 ml and 25 ml	1 ea	<input type="checkbox"/>
Distilled water	1 L	<input type="checkbox"/>
Scissors	1–8	<input type="checkbox"/>
Permanent marker pens	1–8	<input type="checkbox"/>
Lamp fitted with 60–100 W bulb	1–8	<input type="checkbox"/>
Clock or timer	1–8	<input type="checkbox"/>
Bleach (household variety), diluted to 10% solution	10 ml	<input type="checkbox"/>
For Investigation #1		
Microscope slide	1–8	<input type="checkbox"/>
Coverslip	1–8	<input type="checkbox"/>
Microscope	1–8	<input type="checkbox"/>
For Investigation #2		
Aluminum foil, 10 x 10 cm sheet	1–8	<input type="checkbox"/>

(Continued)

Required Accessories (not included)

Description	Quantity	(✓)
For Investigations #3 and #4		
Printer and transparency film	1/1–8	<input type="checkbox"/>
or colored cellophane	1–8	<input type="checkbox"/>
Ruler/meter or yard stick/measuring tape (optional, for Investigation #3)	1–8	<input type="checkbox"/>
For Investigation #5		
Thermometer (0–100°C)	2–16	<input type="checkbox"/>
Water baths at various temperatures (foam cups work well)	1–8	<input type="checkbox"/>
Ice bath (foam cups and beakers work well)	≥1	<input type="checkbox"/>
For Investigation #6		
Aquatic snail or other heterotroph	varies	<input type="checkbox"/>

Recommended Accessories (optional)

Catalog #	Description	Quantity	(✓)
1660504EDU	Temperature-Controlled Water Bath	≥1	<input type="checkbox"/>
1660490EDU	Professional Pipet Controller	1	<input type="checkbox"/>
1660508EDU	Professional Adjustable-Volume Digital Micropipet, 100–1,000 µl	1–8	<input type="checkbox"/>
1660553EDU	Classroom Digital Micropipet, 100–1,000 µl	1–8	<input type="checkbox"/>
2239350EDU	Racked Pipet Tips, TBR-40 tips, 1,000/box, 100–1,000 µl	1	<input type="checkbox"/>
2239040EDU	Bulk Pipet Tips, BR-40 tips, 500/bag, 100–1,000 µl	1	<input type="checkbox"/>
1660485EDU	Cuvette Racks, pkg of 5	2	<input type="checkbox"/>
	Bio-Rad Spectrophotometer*	≥1	<input type="checkbox"/>

* Visit bio-rad.com to see our selection of spectrophotometers.

Refills (available separately)

Catalog #	Description
12002353EDU	Photosynthesis and Cellular Respiration Reagent Refill Pack contains algae beads, 10x CO ₂ indicator, and debeading solution
12002351	Photosynthesis and Cellular Respiration Manual for AP Biology Instructor's Guide
1660474EDU	Disposable Plastic Transfer Pipets, sterile, 500
1660480EDU	Disposable Plastic Transfer Pipets, nonsterile, 500
2239950EDU	Standard Disposable Polystyrene Cuvettes, pkg of 100

Additional Resources

Additional resources can be found at bio-rad.com/plan/algaeAPresources. These include:

- Student's Manual
- Experimental Design and Planning Worksheet
- Light Filter Template
- Color Indicator Guide Template
- Science Case Study
- And many more

Timeline for Preparation and Investigations

The timeline will depend greatly on the level of the students, the length of class periods, and whether other techniques and analyses are performed in addition to the basic protocol. To assist in planning for the laboratory, the following pages provide a timeline that includes teacher preparation (gray boxes), estimated lab times (white boxes), and suggested homework assignments (italicized). Estimated time requirements are shown with incubation times in brackets. The lessons below are based on a 50–60 minute class period and can be modified to suit your classroom situation.

Timeline	Tasks	Estimated Duration
Instructor's Advance Preparation		
4+ days prior to Lesson 1	1. Read Instructor's Guide.	2 hr
	2. Print Student Manual.	30 min
Lesson 1	Pre-Lab Activities	
	1. Guide students through Pre-Lab Activity #1: Chloroplast and Mitochondrion Structure.	15 min
	2. Guide students through Pre-Lab Activity #2: Endosymbiosis Theory.	10 min
	3. Guide students through Activity #3: Interdependence of Photosynthesis and Cellular Respiration.	20 min
	4. Assign homework:	2 min
	– Read background materials, pre-lab materials, and protocol for Investigations #1 and #2.	
	– Complete THINQ! Exercise and Focus Questions for Investigations #1 and #2.	
Instructor's Advance Preparation for Investigations #1 and #2		
3 days prior to Lesson 2	1. Dilute and equilibrate CO ₂ indicator.	10 min (+48 hr)
	2. Acclimate algae beads.	15 min (+6 hr)
2 days prior to Lesson 2	3. Dispense algae beads.	20 min
	4. Activate algae beads.	5 min (+16 hr)
1 day prior to Lesson 2	5. Rest algae beads.	2 min (+6 hr)
	6. Dispense CO ₂ indicator and debeaded solution.	20 min
Day of Lesson 2	7. Set up workstations.	30 min
	8. Turn on spectrophotometer and warm up for 15 min (only if using spectrophotometer).	2 min (+15 min)
Lesson 2	Investigations #1 and #2: Algae Microscopy and Core lab	
	1. Depolymerize algae beads.*	2 min (+30 min)
	2. Observe algae cells under a microscope and document observations.*	5 min
	3. Label cuvettes and transfer algae beads to cuvettes.	3 min
	4. Wash algae beads and add fresh CO ₂ indicator solution.	7 min
	5. Expose algae beads to light and dark conditions.	1 min
	6. Collect time point data, visually using Color Indicator Guide or quantitatively using a spectrophotometer.	30–40 min
	7. Choose Investigations #3, #4, #5, and/or #6 for each workstation.	5 min
	8. Assign homework:	2 min
	– Investigations #1 and #2 data analysis	
	– Preread and complete THINQ! Exercise and Focus Questions for Investigations #3–6	
	– Use worksheet to design experimental protocol (for students with less experience designing experiments, this can be done in an additional 50-minute class session to give students peer and teacher support)	
	* Steps 1 and 2 can be done concurrently with steps 3–6.	

(Continued)

Timeline	Tasks	Estimated Duration
1 day prior to Lesson 3	Instructor's Advance Preparation for Investigations #3–6	
	1. Dispense algae beads. If the algae beads have not been used in more than 2 days, budget an extra day for reactivation.	20 min
Day of Lesson 3	2. Dispense CO ₂ indicator.	20 min
	3. Set up required equipment and materials (for example, water baths).	30 min
	4. Set up workstations.	30 min
Lesson 3	5. Turn on spectrophotometer and warm up for 15 min (only if using spectrophotometer).	2 min (+15 min)
	Investigations #3–6:	
	1. Review student experimental designs.	10 min
	2. Label cuvettes and transfer algae beads to cuvettes.	3 min
	3. Wash algae beads and add fresh CO ₂ indicator solution.	7 min
	4. Expose algae beads to chosen conditions.	3 min
	5. Collect time point data, visually using Color Indicator Guide or quantitatively using a spectrophotometer.	30–40 min
6. Pool data.	3 min	
At least 1 day prior to Lesson 4	7. Assign homework:	2 min
	– Investigations #3–6 data analysis	
	– Post-lab assessment questions	
	– Lab assessment project (poster, presentation, lab report, and/or other activity)	
	– Preread case study (optional)	
	Instructor's Advance Preparation for Science Case Study	
1. Download and read the Instructor's Guide to the Case Study and the Science Case Study: Where Have All the Brown Shrimp Gone?	45 min	
Lesson 4	Science Case Study: Where Have All the Brown Shrimp Gone?	
1. Part 1, Read background story and information.	20 min	
2. Part 2, Make connections between oxygen cycles, algae blooms, and the Dead Zone.	15 min	
3. Part 3, Design experiment to test correlation between rainfall and Dead Zone size.	15 min	
4. Assign homework:	2 min	
– Complete lab assessment project (for example, poster, presentation, lab report, and/or other activity)		
Lesson 5	Photosynthesis and Cellular Respiration Lab Assessment	
1. Assess student understanding with a poster, presentation, lab report, and/or other activity.	50 min	

AP is a trademark of The College Board.



**Bio-Rad
Laboratories, Inc.**

Life Science
Group

Web site bio-rad.com USA 1 800 424 6723 Australia 61 2 9914 2800 Austria 43 1 877 89 01 177 Belgium 32 (0)3 710 53 00 Brazil 55 11 3065 7550 Canada 1 905 364 3435 China 86 21 6169 8500 Czech Republic 420 241 430 532 Denmark 45 44 52 10 00 Finland 358 09 804 22 00 France 33 01 47 95 69 65 Germany 49 89 31 884 0 Hong Kong 852 2789 3300 Hungary 36 1 459 6100 India 91 124 4029300 Israel 972 03 963 6050 Italy 39 02 216091 Japan 81 3 6361 7000 Korea 82 2 3473 4460 Mexico 52 555 488 7670 The Netherlands 31 (0)318 540 666 New Zealand 64 9 415 2280 Norway 47 23 38 41 30 Poland 48 22 331 99 99 Portugal 351 21 472 7700 Russia 7 495 721 14 04 Singapore 65 6415 3188 South Africa 27 (0) 861 246 723 Spain 34 91 590 5200 Sweden 46 08 555 12700 Switzerland 41 026674 55 05 Taiwan 886 2 2578 7189 Thailand 66 662 651 8311 United Arab Emirates 971 4 8187300 United Kingdom 44 020 8328 2000

