

Bio-Rad Explorer™ Program

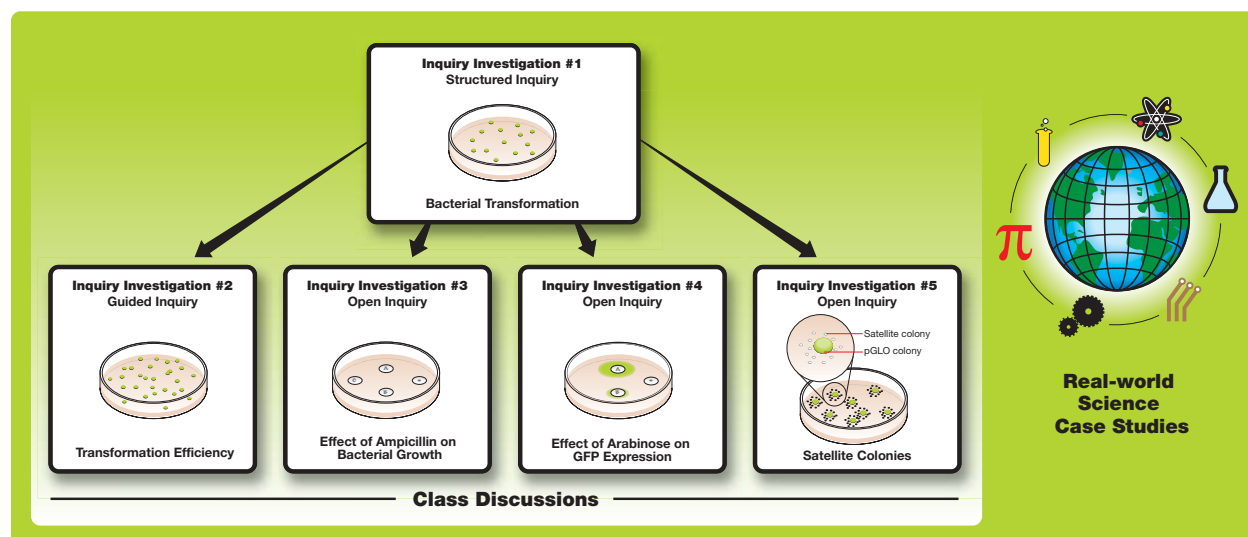
pGLO™ Transformation and Inquiry Kit for AP Biology

A ThINQ!™ Investigation

Planning Guide

explorer.bio-rad.com

Catalog #166-0335EDU



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Overview

The intention of this planning guide is to provide an overview of the pGLO Transformation and Inquiry Kit — A ThINQ! Investigation, 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 current information available, and may change depending on how the activities are implemented in the classroom.

The pGLO Transformation and Inquiry Kit for AP Biology (catalog #166-0335EDU) includes five investigation labs in one kit. Students will first gain critical hands-on experience in genetic engineering by introducing a GFP gene from jellyfish into bacteria, causing the bacteria to glow bright fluorescent green. Then they have the opportunity to expand their understanding of the concepts learned in the bacterial transformation experiment by choosing among four inquiry investigations in which they design and perform their own experiment to explore transformation efficiency parameters, antibiotic resistance, regulation of gene expression, or satellite colony formation.

ThINQ! Investigation kits are Bio-Rad's answer to the changing landscape of science education. While our classical kits that include protocols and procedures for conducting labs and obtaining expected results are always available, ThINQ! Investigation kits include more instruction than just protocols and procedures. These kits include manuals that act as a resource for teachers to guide students through real-world inquiry investigations. The ThINQ! Investigation kits include curricula and consumable materials that align to specific education standards encouraging students to think like real scientists.

If you have further questions about the inquiry-based lab, please contact biotechnology_explorer@bio-rad.com.

pGLO Transformation and Inquiry Kit Components

The instructor's guide provided with the kit (catalog #166-0334EDU) comes with a comprehensive curriculum that includes protocols and background information for the bacterial transformation and inquiry investigations, answer keys, AP Biology alignments, tips and tricks, ThINQ! Points, and a teacher model process to help guide the teacher and student through the inquiry process using the **pGLO Transformation and Inquiry Kit for AP Biology (catalog #166-0335EDU)**.

Kit contains sufficient materials:

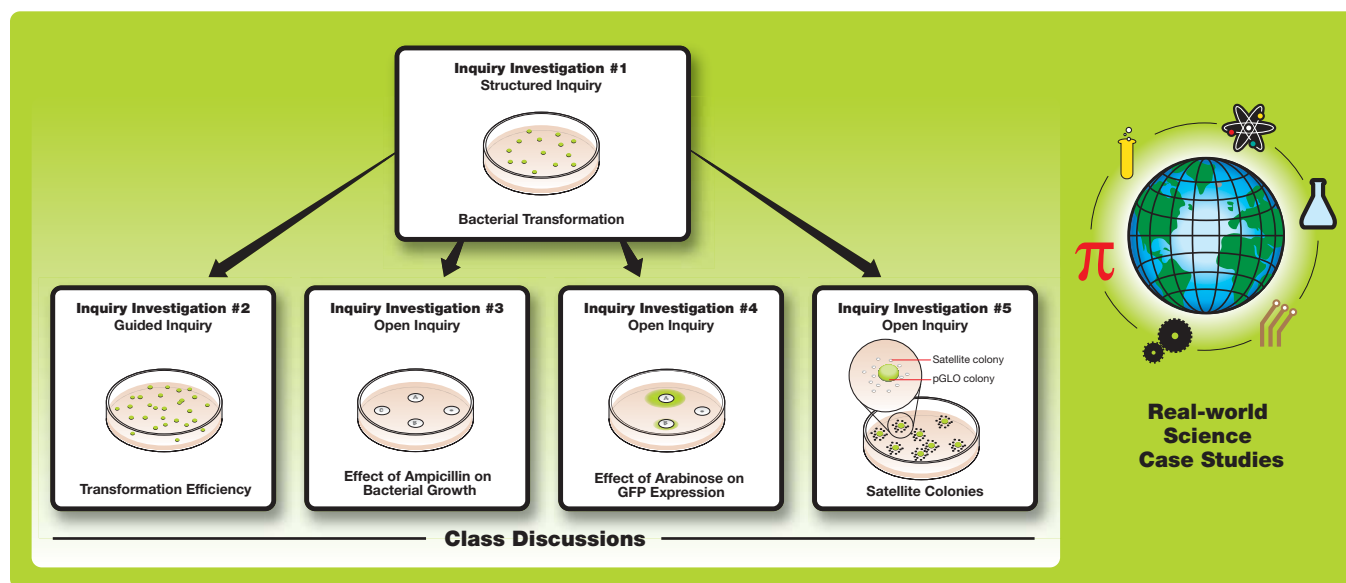
- Serves eight (8) workstations for Investigation #1: pGLO bacterial transformation, (2-4 students per workstation)
- Serves two (2) workstations for each of the four inquiry investigations, (2-4 students per workstation)

Kit Components (included)	Quantity	(✓)
Store at 4°C		
<i>E. coli</i> HB101 K-12, lyophilized	1 vial	<input type="checkbox"/>
Plasmid (pGLO), lyophilized, 20 µg	2 vials	<input type="checkbox"/>
Ampicillin, lyophilized, 30 mg	3 vials	<input type="checkbox"/>
Arabinose, lyophilized, 600 mg	3 vials	<input type="checkbox"/>
Transformation solution, 15 ml	2 bottles	<input type="checkbox"/>
LB nutrient broth, 10 ml	1 bottle	<input type="checkbox"/>
Store at room temperature		
Blank paper disks, 50	1 vial	<input type="checkbox"/>
LB nutrient agar powder, 20 g	2 packets	<input type="checkbox"/>
LB broth capsule (makes 50 ml LB broth)	1 capsule	<input type="checkbox"/>
Microcentrifuge tubes, 2.0 ml	90 (3 packs of 30)	<input type="checkbox"/>
Foam micro test tube holders	8	<input type="checkbox"/>
Inoculation loop, 10 µl	80 (8 packs of 10)	<input type="checkbox"/>
Petri dishes, 60 mm	80 (4 packs of 20)	<input type="checkbox"/>
Disposable plastic transfer pipets (DPTP)	100 (10 packs of 10)	<input type="checkbox"/>
UV pen light	1	<input type="checkbox"/>
pGLO Inquiry AP Bio Instructor's Guide	1	<input type="checkbox"/>

Note: A separate student manual plus a science case study is available online as a downloadable PDF in the documents tab at bio-rad.com/thinq_pglo

Suggested Accessories (not included)	Quantity per Kit	(✓)
Chemical		
Sterile water	50 ml	<input type="checkbox"/>
Bleach (10%)	10 ml	<input type="checkbox"/>
Store at room temperature		
2-20, 20-200 μ l pipet tips (223-9347EDU)	1-8 racks	<input type="checkbox"/>
Parafilm sealing film	1 roll	<input type="checkbox"/>
Store at room temperature		
Ice baths or beakers with ice	8	<input type="checkbox"/>
Bottle or Erlenmeyer flask, 1 L	1-2	<input type="checkbox"/>
Graduated cylinder (500-1000 ml)	1	<input type="checkbox"/>
Chemical		
Water bath set to 42°C (166-0504EDU)	1-2	<input type="checkbox"/>
Mini incubation oven set to 37°C (166-0501EDU)	1-2	<input type="checkbox"/>
Store at room temperature		
2-20 μ l adjustable-volume micropipets (166-0551EDU or 166-0506EDU)	1-8	<input type="checkbox"/>
20-200 μ l adjustable-volume micropipets (166-0551EDU or 166-0507EDU)	1-8	<input type="checkbox"/>
Microwave or magnetic hot plate and stir bar	1	<input type="checkbox"/>
Store at room temperature		
Lab tape (optional)	1 roll	<input type="checkbox"/>
Marking pens	8	<input type="checkbox"/>
Forceps or tweezers	1-8	<input type="checkbox"/>
Thermometer (0-100°C)	1-2	<input type="checkbox"/>
Clock or timer for counting seconds	1-8	<input type="checkbox"/>

Kit Summary



The pGLO Transformation and Inquiry Kit includes five investigative labs in one kit. Students will gain critical hands-on experience in genetic engineering by introducing a GFP gene from jellyfish into bacteria, causing the bacteria to glow bright fluorescent green. Then they have the opportunity to expand and explore their understanding of the concepts learned in the bacterial transformation experiment by choosing among four inquiry investigations in which they design and perform their own experiment to explore transformation efficiency, antibiotic resistance, regulation of gene expression, or satellite colony formation.

From structured to guided to open inquiry, the pGLO Transformation and Inquiry Kit facilitates a new level of teaching and scientific discovery that engages students, promotes critical thinking and active learning, and encourages collaboration in the classroom. The focus is not solely on achieving predetermined results; rather, the curriculum involves students making observations, raising questions, and designing scientific investigations to explore the world around them.

Inquiry Kit Curriculum

Laboratory exercises that utilize an inquiry-based approach instill scientific skills that boost development of critical thinking and enforce science practices, something “cookbook” laboratory exercise fail to develop. This curriculum and kit will guide you and your students through various inquiry-based lab investigations.

The kit curriculum is divided into several stages and levels of inquiry:

- **Investigation #1: pGLO Bacterial Transformation Lab (Structured Inquiry)** — introduce the basics of bacterial transformation, data collection, and analysis of transformation efficiency
- **Investigation #2: Transformation Efficiency (Guided Inquiry)** — investigate and test variables and their effect on transformation efficiency
- **Investigation #3: Effect of Ampicillin on Bacterial Growth (Open Inquiry)** — investigate the effects of different amounts on this antibiotic on bacterial growth
- **Investigation #4: Effect of Arabinose on GFP Expression (Open Inquiry)** — investigate the effects of different amounts of this inducer on transgene expression
- **Investigation #5: Satellite Colonies (Open Inquiry)** — investigation the nature of satellite colonies, why they form, and what they mean
- **Synthesis: Science Case Study, “Can Bacterial Transformation Stop the Spread of Malaria?”** — connects the scientific knowledge students gained with current issues in biological research that are related to bacterial transformation. The science case study with ThINQ! Discussion Points is found online

Timeline for the Laboratory Course

The kit box you receive will contain all of the material needed for five inquiry investigations that will take place at different times. It is up to you to determine when to prepare the material for each investigation and what inquiry investigations you want your class to participate in.

The following is a suggested lab schedule, but is just one of many possible scenarios. In the suggested lab schedule all student groups perform the pGLO Bacterial Transformation lab, and in the succeeding days the four (4) inquiry investigations are divided among eight (8) student work groups. In other words, all student groups will perform the bacterial transformation and two (2) student groups each will perform one of the four (4) inquiry investigations.

Suggested pGLO Inquiry Lab Schedule

<i>Day</i>	<i>Activity</i>	<i>Details</i>
Pre-Lab	Setting the stage	Lecture and discussion – bacterial transformation Assignment: <ul style="list-style-type: none">• Read the pGLO bacterial transformation background and lab procedure• Answer questions and generate queries about the experimental process
<i>Bacterial Transformation Lab</i>		
Day 1	Investigation #1: pGLO Bacterial Transformation Lab (Structured Inquiry)	All student groups perform bacterial transformation
Day 2	Data collection and analysis	Observe transformants and controls Analyze and interpret results Calculate transformation efficiency Assign one of the four inquiry investigations to each student group with the appropriate pre-lab assignment. Students read the inquiry lab background assigned to them and develop their own experiment, using the inquiry lab guidelines, prior to class the next day
<i>Inquiry Investigations</i>		
Day 3	Guided and Open Inquiry Investigation lab(s)	Discuss and review student experimental designs and let student groups perform their experiment(s): <ul style="list-style-type: none">• Investigation #2: Transformation Efficiency (Guided Inquiry)• Investigation #3: Effect of Ampicillin on Bacterial Growth (Open Inquiry)• Investigation #4: Effect of Arabinose on GFP Expression (Open Inquiry)• Investigation #5: Satellite Colonies (Open Inquiry)
Day 4	Data collection and analysis	Observe inquiry exploration results Analyze and interpret results Conduct class discussion Post-lab assignment – Student case study, “Can Bacterial Transformation Stop the Spread of Malaria?”
<i>Synthesis</i>		
Day 5	Class discussion	Connect explanations and concepts with the “Can Bacterial Transformation Stop the Spread of Malaria?” case study discussion (found online at bio-rad.com/thinq)

Preparation: Planning Your Time

The timeline below incorporates steps that can be performed by the instructor and the students depending on the laboratory schedule. Many steps are time dependent and must be performed before the actual laboratory experiment can be run.

Note: Tasks that are shaded in grey are preparatory tasks required for later stages of the experiment and should be conducted when indicated.

Task	Estimated Duration
Instructor's Advance Preparation (3-7 days prior to all inquiry investigations)	
1. Read through instructor's guide and make copies of the student manual found online.	1 hr
2. Prepare nutrient agar plates (for all inquiry investigations)	1 hr prep time (At least 2 days for drying of plates)
3. Prepare starter plates and pGLO stock solution for Inquiry Investigation #1: pGLO bacterial transformation lab	30 min (At least 36-48 hr prior)
4. Organize student workstations	10 min
Inquiry Investigation #1: pGLO Bacterial Transformation Lab (Structured Inquiry)	
1. Prepare +pGLO and -pGLO tubes	5 min
2. Incubate tubes on ice and label agar plates	10 min
3. Heat shock and recovery	3 min
4. Resuspend bacteria and plate	25 min
5. Incubate agar plates	24-36 hr
Instructor's Advance Preparation (1-2 days prior to #2-5 guided and open inquiry investigations)	
1. Prepare fresh E. coli starter plates	24-36 hr
2. Prepare and dispense LB broth and sterile water	12-24 hr
3. Pre-warm nutrient agar plates	2-3 hr
4. Prepare and dispense #2-5 inquiry investigation solutions	1-2 hr
5. Organize workstations	10 min
Inquiry Investigation #2: Transformation Efficiency (Guided Inquiry)	
1. Prepare experiment and control tubes	5 min
2. Perform bacterial transformation lab and change experiment variable	20-40 min
3. Incubate agar plates	24-36 hr
Inquiry Investigation #3: Effect of Ampicillin on Bacterial Growth (Open Inquiry)	
1. Resuspend bacteria	5 min
2. Prepare ampicillin serial dilutions	20 min
3. Plate bacteria and place disks on agar plate	10 min
4. Incubate agar plates	24-36 hr

Task	Estimated Duration
Inquiry Investigation #4: Effect of Arabinose of GFP Expression (Open Inquiry)	
1. Resuspend bacteria	5 min
2. Prepare arabinose serial dilutions	20 min
3. Plate bacteria and place disks on agar plate	10 min
4. Incubate agar plates	24–36 hr
Inquiry Investigation #5: Satellite Colonies (Open Inquiry)	
1. Examine plate containing pGLO colonies and satellite colonies	5 min
2. Prepare and inoculate agar plates to test satellite colonies and pGLO colonies	20 min
3. Incubate agar plates	24–36 hr
Science Case Study, “Can Bacterial Transformation Stop the Spread of Malaria?” (Synthesis - Class Discussion)	



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