LOT TEST/QUALITY CONTROL BIOTECH LAB

"Are you gellin'?"

A Problem-Based Learning Activity for Middle School and High School Biology

Designed by

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Background

In this problem-based learning activity, students will simulate the job of quality control technicians at a biotech company that sells DNA. They will use their micropipetting skills to employ the biotechnology technique of agarose gel electrophoresis to separate DNA fragments, differentiate between DNA samples, and verify the purity of a sample before it is sold.

Description of Audience: This problem-based learning activity is designed for use by middle school and/or high school students. This activity can be used in a 1st year Biology, Advanced Biology, or Biotechnology course.

State Standards: This biotechnology/bioinformatics problem-based multimedia learning activity fulfills the following State of California Science Standards:

Biology
- Grade 7: 2e
- Grades 9-12: 1h, 5a, 5d

Investigation and Experimentation
- Grade 7: 7a, 7c, 7e
- Grade 8: 9a-b
- Grades 9-12: 1a-d, 1l

National Standards: This biotechnology/bioinformatics problem-based multimedia learning activity fulfills the following National Science Standards:

- Content Standard A: Science as Inquiry
- Content Standard C: Life Science
- Content Standard E: Science and Technology

Components

Schedule:

Pre-Lab: 45 minutes to make agarose gels, set up samples, and distribute materials; 20 minutes for gels to set. Make sure to take into account 45-60 minutes for gels to run.

Lab: The lab portion of this activity is designed to require one 2-hour block, plus 20 minutes after gels have run to view results. During the 2-hour block, teachers will first pre-assess student knowledge about DNA and biotechnology. Then, students will be introduced to the concept of gel electrophoresis, practice loading gels, be introduced to the problem that they are asked to solve, and then set up their experiment. After the first 2-hour block, gels will run for 45-60 minutes. After gels are finished, 20 minutes are required for students to visualize gels and record data from their experiment.

Presentation Preparation: The teacher should allot 50 minutes for students to synthesize/analyze their results and then create a short presentation to conclude their findings. Another 30 minutes is needed for students to present their powerpoints.

Division of Labor: Students will work in groups of 4 during the lab portion and when presenting their conclusions.

Optional: Students can be designated project roles based on the following (especially if this is part of a larger research project)

1. Project Manager – Check in with group members to see how they are doing. Make sure members stay on task and complete tasks that are assigned. Take overall clarifying questions to teacher.
2. Materials Manager – Make sure materials are available for group. Ensure each member can find what they need in class or suggest resources outside of class. Take materials related questions to teacher.
3. Research Associate – Help group find resources online, in the library, in the classroom, and from the community to assist in their research for the presentation and the paper. Take research related questions to teacher.
4. Editor – Assist all group members with writing portions, divide writing roles, and peer review final written portions.

Research and Production Plan:

Students will be collecting data based on their gel electrophoresis results. They will also have access to the background powerpoint presentation on gel electrophoresis that the teacher presents. Any other background information on molecular techniques and/or quality control testing can be easily found on the web, but is not necessary.

Materials and Equipment List: In conducting this project, the following equipment, materials and supplies are needed:

<u>Lab Materials</u>

Per group:

- Latex gloves
- Safety goggles
- P20 micropipette
- Pipette tips (1 box of 200 µl tips)
- Tube rack
- Loading dye
- Solid waste containers (e.g. plastic cups)
- 1.5 % agarose gel in 1X TAE (or TBE); Ethidium bromide (? ng/µl) already added
- 1X TAE (or TBE) buffer
- Gel box with lid and casting tray
- 2 10-well combs (6 or 8-well may be used as well)
- "Lot" samples (DNA) with loading dye
- Power source

In classroom:

- Supplies with Lot #'s (chemicals, food samples, etc.)
- Molecular weight marker
- UV light box
- Recommended: Digital camera or imaging system to record gel pictures

DNA samples:

Purified PCR products between 100-1000 bp (50 - 200 ng/µl) are recommended for setting up lot samples. However, digested plasmids of the right size and purity could also be used. Teachers can label samples depending on the number of scenarios they want and how many lots are "pure" vs. contaminated. We suggest using at least 2 different types of DNA. In this activity, we used "M" DNA that had one band (900 bp) and "S" DNA with two bands (300 bp and 500 bp). (An example Lot Sample KEY is attached.) Approximately 10 µl should be loaded in 10-12 well gels and 15 µl in 6-8 well gels.

Computer lab:

Students will need access to a computer lab with MS powerpoint and a digital projector/projection screen to present their findings.

Releases List: Remember, if students are using copyrighted photographs or videos they should give credit to the original author. In some instances students must have permission to photograph individuals, be sure to have release forms ready to use.

Description

Activity	Time (min.)
1. Welcome students and introduce instructors	5
2. Pre-Assessment: What do you know and want to know about DNA and Biotechnology?	10
3. Lecture: Intro to Gel Electrophoresis	15
4. Demo: How to load gels	10
5. Hands-on Practice: Pipetting Review and Loading Gels	20
6. Lecture: What is lot testing/quality control? Intro to PBL Scenario; Tie in PBL to Career significance	20
7. Hands-on Practice: Load and start running "Real Gel" (Note: gel will take approximately 45 -60 min. to run.)	30
8. Reflect/Review: Discuss goals and objectives of the morning; Review with students what is happening as their gel is running	10
9. Teachers come back early to prep gels for viewing	15
10. Hands-on Practice: Teachers lead viewing of gel results in groups Students draw gel data on worksheet (and/or teachers take digital images of gels) Group time: Students work in groups to discuss results, to begin answering questions, and to design powerpoint content	20
11. Lecture: Discuss Presentation Format, Audience, and Purpose of students' powerpoint presentation; Discuss rubric with students and ask for questions	5
12. Tutorial: Demonstrate to students how to access powerpoint template and save files	5
13. Group time: Students work on powerpoint	50
14. Presentation: Begin student presentations (5 min. per group)	30
15. Reflection/Review: Discuss goals and objectives of PBL; Give students feedback on their presentations; Fill out Student Feedback forms	10

Sharing Student Learning

1. In groups, students will create a powerpoint presentation (based on a template) that compiles their findings. (It is important to remind students to adhere strictly to the template to mimic the professional restrictions in place and uniformity of presentation expected in a work setting.)
2. Each group will be given 5 minutes to share their conclusions using their powerpoint.

Assessment

1. Students will be assessed both on their groupwork as well as their final powerpoint presentation.
2. A rubric (attached to end of student worksheet) will be given to students before they begin their powerpoint. They will be scored accordingly during the presentation. After their presentation, they will receive both oral and written feedback on their groupwork dynamics and presentation.

Career Connection

Proficiency with common microbiology laboratory techniques is incredibly important in today's increasingly biotech-driven economy. Quality control and quality assurance are integral parts of any manufacturing company, and this activity introduces the problem-solving and technical mastery that would be expected in this type of career. The skills they learn and practice in this activity could also be applied to research laboratory in a variety of fields including, but not limited to: cell and molecular biology, ecology, genetics, immunology, plant and agrictultural biology, forensice science, etc.

The ability to summarize results and present conclusions confidently using speech and graphics is another important skill that is necessary in many professions. Powerpoint is the corporate standard for presentations and becoming familiar with this technology will be undoubtedly useful in an industry setting.