

Overview and Purpose

Enduring Understanding: The use of bacterial transformation can be used to generate bacteria that can be used for bioremediation of beaches suffering an oil spill.

2008
Winning Lesson Plan
from Auburn,
Washington

In what ways can bacterial transformation impact the research and technology of bioremediation?

by Deborah Rumbaugh,
Auburn Mountainview
High School

Subject: Biology – Oil
Spills, Bioremediation,
Bacterial Transformation

Grade Level: 10

Duration: Three weeks

As a result of this project, I want my students to have hypothesized, experimented, constructed new knowledge and discussed the following:

“In what ways can bacterial transformation impact the research and technology of bioremediation?”

This particular lesson plan is innovative in that it spans three very distinct areas of study. Students are also able to complete this unit using multiple learning tools: building an ecosystem, predicting results and performing laboratories, studying histories of Alaska waterways, and Fred Griffith, and consider the responsibility they have to educate others on the possibilities they have discovered.

Materials

All materials are listed in lab protocols, see pages 3–5. The lab protocol for bacterial transformation are from FHCRC bacterial transformation SEP materials.

Procedure

All procedures are listed in lab protocols, see pages 3–5. The lab protocol for bacterial transformation are from FHCRC bacterial transformation SEP materials.

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Educational Standards Addressed

- GLE Descriptors/Evidences of Learning
- 1.2.7 Understand how genetic information (DNA) in the cell is encoded at the molecular level and provides genetic continuity between generations. (Bacterial transformation)
 - 1.3.10 Analyze the living and nonliving factors that affect organisms in an ecosystem. (Beach ecosystem/oil spill impact)
 - 2.1.2 Understand how to plan and conduct systematic and complex scientific investigations. (Bacterial transformation)
 - 2.2.4 Analyze scientific investigations for validity of method and reliability of results. (Transformation efficiency)
 - 3.1.1 Analyze local, regional, national, or global problems or challenges in which scientific design can be or has been used to design a solution. (Bioremediation as a clean-up technique)
 - 3.1.2 Evaluate the scientific design process used to develop solutions to problems or challenges. (Current clean-up procedures of oil spills)
 - 3.1.3 Evaluate consequences, constraints, and applications of solutions to a problem or challenge. (Limitations of bioremediation)

Activities Outside of the Classroom

Homework identified on the daily lesson plan, follow-up lab work to test transformation efficiency is done after school, as well as poster distribution and field trip to SBRI.

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Procedure – Conceptual Approach (Inquiry-Based, Ubd Designed)

<p>Day One: "What is an oil spill?"</p>	<p>Begin with Warm-up question: "What types of living and nonliving factors can be found in a beach ecosystem?"</p> <ol style="list-style-type: none"> 1. Introduce beach ecosystem and lead class discussions on what problems such ecosystems might face as a result of human behaviors. 2. "Expert Groups" will read sections of a report of Prince William Sound (provided by Exxon to determine what occurred at the sound in Alaska. Expert groups will report the findings from their portion of the reading to the class. 3. Introduce and begin design of beach ecosystems, with use of supplementary materials.
<p>Day Two: "Design a Beach!"</p>	<p>Begin with warm-up question: "What variations can be found among beach ecosystems?"</p> <ol style="list-style-type: none"> 1. Continue discussion and design of lab group beach designs. 2. Teacher "approval" of beach design. Begin construction of beaches. 3. Predict and select best clean-up materials (cotton, paper, foam)
<p>Day Three: "Oil Spill Day"</p>	<p>Begin with warm-up question: "What type of oil is in a 'real' oil spill?"</p> <ol style="list-style-type: none"> 1. Lab groups confirm completeness of beach ecosystems and select clean-up tools from item chosen previously. 2. Simulate oil spill based upon supplementary materials. 3. Begin "clean up" of oil spill, recoding effectiveness of each tool.
<p>Day Four: "What is bioremediation?"</p>	<p>Begin with warm-up question: "What does the term bioremediation bring to mind?"</p> <ol style="list-style-type: none"> 1. Video clip on Prince William Sound and the suggested use of bacteria to clean up fossil fuel spills. 2. Transition discussion of how might a scientist "make" such bacteria? 3. Can bacteria be genetically engineered or "transformed into something new or different in some way?"
<p>Day Five: "Griffith"</p>	<p>Begin with warm-up question: "What happens to Bruce Banner when he gets angry?"</p> <ol style="list-style-type: none"> 1. Informational reading from supplemental text on Frederick Griffith, his experiment with mice and the principle of bacterial transformation.

Procedure (Cont'd)

<p>Day Five: "Griffith" (Cont'd)</p>	<p>2. Expert groups will report back to the class on their discoveries to pre-assigned questions:</p> <ol style="list-style-type: none"> What microorganisms did Frederick Griffith study? What were Griffith's ideas before his tests? Summarize Griffith's four tests What did Griffith discover as a result of test #4? What is bacterial transformation? <p>3. Follow-up questions in lab book, all students write responses.</p>
<p>Day Six: "Lab Prep"</p>	<p>Begin with warm-up question: "Sketch the major steps in bacterial transformation"</p> <ol style="list-style-type: none"> Read and prep "Bacterial Transformation" lab (FHCRC) in lab book. Teacher stamp of student predictions in lab book is exit slip.
<p>Day Seven: "Lab Day #1"</p>	<p>Begin with warm-up question: "How many seconds will you heat shock the bacteria?"</p> <ol style="list-style-type: none"> Perform Day One of the lab via protocol. Stop at 24 hour incubation of <i>E. coli</i> in microcentrifuge tubes. Teacher stamp in lab book is exit slip.
<p>Day Seven: "Lab Day #2"</p>	<p>Begin with warm-up question: "Why will we inoculate four plates today?" What do the two control plates represent?"</p> <ol style="list-style-type: none"> Perform Day Two of the lab via protocol. Stop at 24 hour incubation of plates. Teacher stamp in lab book is exit slip.
<p>Day Eight: "Lab Day #3"</p>	<p>Begin with warm-up question: "Refer back to your predictions; what are we hoping to see today?"</p> <ol style="list-style-type: none"> Perform Day Three of the lab via protocol. Teacher stamp of recorded data is exit slip.
<p>Day Nine: "Transformation Efficiency"</p>	<p>Begin with warm-up question: "Can we use math to calculate how efficient <i>E. coli</i> were at taking up the pBLU plasmid?"</p> <ol style="list-style-type: none"> Work as a class on how to calculate transformation efficiency. Each lab group reports on their efficiency results. Question: How might we <i>increase</i> transformation efficiency in this lab? Question: How might <i>increasing</i> bacterial transformation be used to solve the environmental problem of oil spills through the use of bioremediation? Lab groups write a proposal to both questions, finish as homework.

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Day Ten: "Proposals"	<p>Begin with warm-up question: "Which proposal from yesterday's homework is your group's choice as the <i>best choice</i> for today's discussion?"</p> <ol style="list-style-type: none"> 1. Each lab group elects one proposal for an increase in transformation efficiency and how this might impact bioremediation to share with the class. 2. Class discussions of group proposals. 3. Whole-class election to determine best choice to implement in lab!"
Day Eleven: "Proposals and Global Awareness Posters"	<p>Begin with warm-up question: "How could we make the entire world aware of our ideas on bacterial transformation and bioremediation?"</p> <ol style="list-style-type: none"> 1. Instructions for class on performing the chosen protocol to increase transformation efficiency trial. (Trial is done by "winning" lab group after school over 3 days.) 2. Begin "Global Awareness Posters" Poster Parameters: (see rubric) <ol style="list-style-type: none"> a. Identify the problem at Prince William Sound b. Identify and describe Bioremediation c. Identify and describe Bacterial Transformation d. Connect and explain Bioremediation and Bacterial Trans.
Day Twelve and Thirteen: "Poster Work Days"	<p>Begin with warm-up question: "What constitutes a high quality educational poster?"</p> <ol style="list-style-type: none"> 1. Review of rubric. 2. Work day (posters to be placed around school upon completion).
Day Fourteen: "Field Trip" (Often does not actually fall on "Day Fourteen")	<p>Begin with warm-up question: "What do we know about SBRI and how can we connect it to our study on oil spills, bacterial transformation, and <i>E. coli</i>?"</p> <ol style="list-style-type: none"> 1. Field Trip 2. Student complete lab write-up provided by SBRI. 3. Turn-in of SBRI lab write-up is exit slip.

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Rubric for “Global Awareness Poster”

PART I (Poster Assembly)

You will receive a maximum of 50 points for being present AND actively participating in the assembly of your poster. If a group member is absent or not participating it is your responsibility to inform the teacher. The rubric below describes the scoring for this portion of your project:

Criteria	Excellent (50–40 points total)	Acceptable (39–30 points total)	Poor (29-0 points total)
Attendance	Present Both Work Days	Present One of Two Work Days	Present Less than One Full Day
Participation	Helped in all stages of poster design and assembly.	Helped in some stage of poster design and assembly; did not fully participate.	Was not helpful in the design or assembly of the poster.

PART II (Poster Completeness and Quality)

This portion of the project will earn you a maximum of 50 points. This part of your project is essential for your success in the completion of this lab. You will be making a poster (extra large size) that will teach your classmates what you discovered by performing this lab/unit over these last three weeks. Your poster must be accurate, attractive, and in COLOR—there are samples throughout the room. Your poster must clearly display the following:

1. Title, something interesting, eye catching
2. Visual Summary of Oil Spills and Bacterial Transformation
3. Written Summary/Explanation of all both concepts
4. Final Summary Statement (What did you learn overall?)
5. Names and Period on back of poster

Criteria	Excellent (50–40 points total)	Acceptable (39–30 points total)	Poor (29-0 points total)
Poster Completeness	Poster contains all 5 elements listed above, and summarizes ALL portions of the lab, including final summary statement.	Poster contains some of the elements listed above. Poster does not fully summarize all portions of the lab including final summary statement.	Poster does not meet the above expectations. Summaries and explanations are absent or of poor quality.
Poster Quality	Poster is accurate, attractive and in COLOR. Excellent effort is applied to the poster.	Poster is partially accurate, attractive and partially COLORED. Acceptable effort is applied to the poster.	Poster is not accurate, attractive and is not colored. Effort is poor or absent.

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