Oil Spill Bioremediation

TEACHER'S MANUAL
AND STUDENT GUIDE

Carolina EcoKits®

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Photocopy the Student Guide as needed for use in your classroom.

Oil Spill Bioremediation

Investigative Phenomenon

The role of bioremediation in the *Deepwater Horizon* oil spill serves as the investigative phenomenon for this lab, in which student groups conduct and analyze a controlled biodegradation experiment using drain cleaner microbes, corn oil, and a chemical indicator. Once students make sense of how the experiment serves as an oil spill bioremediation simulation, they ask questions and design their own experiments with biodegradation to see if they can make the simulation even more realistic. Next, they present their claims/evidence/reasoning arguments to their classmates. The investigation culminates in an assessment piece that has the students interpret data from the *Deepwater Horizon* oil spill, consider the role of bioremediation in oil spill cleanup, and summarize oil spill impacts on threatened and endangered species. The Driving Question that serves as the impetus for the lab is: **"How can microbes be used to clean up an oil spill?"**

Related Performance Expectation

The activities in this kit build toward the following Performance Expectation of the Next Generation Science Standards*:

HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

Three-Dimensional Learning

The activities in this kit address the following dimensions of the Next Generation Science Standards.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems • Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. **Engaging in Argument from Evidence** • Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge, and student-generated evidence.	**LS4.D: Biodiversity and Humans** • Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus, sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

*"Next Generation Science Standards" is a registered trademark of Achieve. Neither Achieve nor the lead states and partners that developed the Next Generation Science Standards was involved in the production of, and does not endorse, this product. **Source:** NGSS Lead States, 2013. *Next Generation Science Standards: For States, By States.* Retrieved from **www.nextgenscience.org** or **ngss.nsta.org**.

Accessing Carolina's Digital Resources

This kit includes free 1-year access to digital resources designed to engage your students and support the lab.

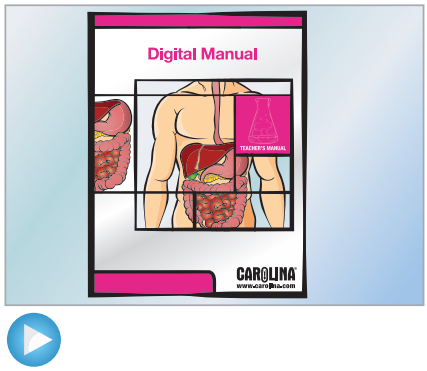
We sent the purchaser of the kit an e-mail with the access code to unlock the free resources for this product. If you did not receive the e-mail, contact the purchaser, call 800.334.5551, or e-mail us at **cso_support@carolina.com** to get the access code. When contacting us, please provide your order number, school/district name, and the purchaser's name if possible.

To redeem your access code, visit **carolinascienceonline.com** and follow these steps:

1. If you do not have an account, click on Teacher Login to create one.
2. If you already have an account, log in.
3. Click "redeem access code" and enter your code.

After you redeem your code, you can access the complete playlist of digital resources bundled with this kit. An example playlist is shown below. See the next page for a list of resources specific to this kit, which may include videos and interactive lessons, as well as a Digital Teacher's Manual.

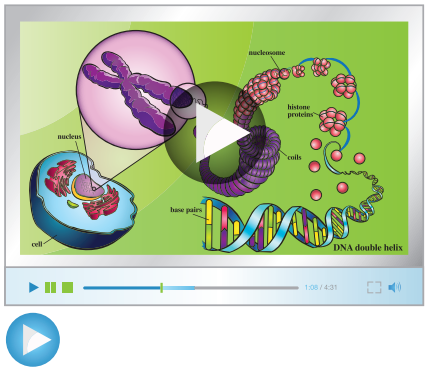
Digital Teacher's Manual



Digital Teacher's Manual:

- Digital version of the printed manual
- Viewable on any device
- Links to downloadable resources

Video



Videos may include:

- Safety
- Animations
- Procedures
- Phenomena

Interactive Digital Lesson

Interactive Digital Lessons may include:

- Prelabs
- Postlabs
- How-to Lessons
- Safety Lessons
- Assessments
- Simulations

You can assign these resources to your students' CSO accounts! Find these tutorials, before log-in, at **carolinascienceonline.com**. Look for this icon:

Your Digital Resources

Your digital resources will be available to you for 1 year after you redeem your access code.

Record the date of first access: _____/_____/_____

Digital Teacher's Manual

The Digital Teacher's Manual is an HTML version of the printed manual. It can be viewed on any device. In addition to the contents of the entire printed manual, the Digital Teacher's Manual includes hyperlinks to the **downloadable** and **printable** resources listed in the table below. If you are currently viewing the Digital Teacher's Manual, you can click on any resource in the table and view, download, or print it.

Resource (click to access)	How to Use
Student Guide PDF	This digital version of the Student Guide can be printed and distributed to students or groups. As a paper-saving alternative, however, you also can assign it for viewing on students' electronic devices.
Fill-in Answer Sheets	This is a PDF of the manual's questions and data tables, without lab procedures and illustrations. You can send these to your students electronically or print them. Students can provide their answers digitally, save the document, and send it back to you (or print it out).
Editable Assessment Questions	This Microsoft® Word document contains all the assessment questions found in the Student Guide. You can edit these questions or add your own, and then print them or assign them to students electronically.
Whiteboard Resources	This PDF is a compilation of the important photos and illustrations in the Teacher's Manual and Student Guide. Use them on a whiteboard as instructional tools and incorporate them into laboratory investigations, class discussions, presentations, and assessments. This kit also includes an infographic from the National Oceanographic and Atmospheric Association (NOAA) depicting the potential impacts of oil on aquatic ecosystems (© 2011 NOAA).

Interactive Digital Lessons:

Tutorial: Bacteria and Humans – Students explore ways that humans use bacteria including wastewater treatment, biofuels, and enzymes.

Extension: Human Impact and the Environment – Students explore how humans impact the environment and solutions to environmental problems.

Student Artifacts

Lab Component	Student Action or Behavior	Artifact Generated	3-D Learning Target
Prelab	Students conduct a controlled biodegradation experiment, identify experimental and control variables, and analyze results.	Prelab Questions 1–4, page S-4	CC: Cause and Effect
	Students make sense of how the biodegradation experiment serves as an oil spill bioremediation simulation.	Answers to Stop, Read, and Think questions 1–4, page S-2	DCI: Biodiversity and Humans
Investigation	Student groups pose a question about how varying the conditions of the biodegradation experiment might affect the outcome, and they design and conduct an investigation to answer their question.	Stop and Think questions (a) and (b), page S-5, and experiment procedure, page S-6	SEP: Asking Questions and Defining Problems
	Groups present a claim/evidence/reasoning argument to each other, based on experiment results. They have a chance to revise their argument based on feedback.	Investigation Analysis questions 4 and 5, page S-7, S-8	SEP: Engaging in Argument from Evidence
Assessment	Students connect what they have learned from the bioremediation simulation to what happened with the *Deepwater Horizon* oil spill and they analyze and consider the impact that oil spills have on biodiversity.	Answers to Assessment questions (pages S-9 through S-10)	DCI: Biodiversity and Humans

Objectives

Students' performance objectives are to

- observe the breakdown of corn oil by oil-degrading microbes and learn how microbes can be used in the bioremediation of marine oil spills.
- design and conduct a biodegradation experiment to answer a question posed after the Prelab activity.
- consider the impact that bioremediation had on the *Deepwater Horizon* oil spill (DHOS).
- describe how biodiversity was affected by the DHOS and recommend conservation efforts for endangered species.

Prerequisite Knowledge and Skills

- understanding of what a septic system is
- the definition of "biodegradable"
- familiarity with bacteria and the ways in which different groups obtain and use energy to survive
- basic understanding of biodiversity and its value

Time Requirements

Teacher Preparation	20 minutes
Prelab	60 minutes
Observations after 24 and 48 hours	10 minutes
Investigation	60 minutes
Observations after 24 and 48 hours	10 minutes
Preparing and presenting arguments	60 minutes
Assessment	45 minutes

The Prelab requires one class period for setup and initial observations. Additional brief observations are made and recorded after 24 and 48 hours following the initial setup. Results should be visible in 24 hours, and the pink color of the reduced chemical indicator will deepen over time, as more biodegradation occurs. The investigation, like the Prelab, requires one class period for setup and additional brief observations 24 and 48 hours later.

Safety

Use this kit only in accordance with established laboratory safety practices, including appropriate personal protective equipment (PPE) such as gloves, chemical splash goggles, and lab coats or aprons. Ensure that students understand and adhere to these practices. Know and follow all federal, state, and local regulations as well as school district guidelines for the disposal of laboratory wastes. Students should not eat, drink, or chew gum in the lab and should wash their hands after entering and before exiting the lab.

Download Safety Data Sheets (SDS) at **carolina.com/sds** or scan this code:

Best practices when students conduct their own experiments:

The bacteria in the microbial suspension are not considered pathogenic, but it always is a good idea to follow these simple safety guidelines:

- Wear protective gloves. At the end of the experiment, wash hands thoroughly.
- Wipe down lab benches with a 10% bleach solution before and after the lab.
- Disinfect all tools, whether or not they will be discarded, by autoclaving them according to state recommendations or by soaking them in a 10% bleach solution overnight.