Natural Selection

TEACHER’S MANUAL AND STUDENT GUIDE

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

The materials and activities in this kit meet the guidelines and academic standards of the Advanced Placement (AP) Program and have been prepared by Carolina Biological Supply Company, which bears sole responsibility for kit contents.

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Carolina™ Natural Selection Kit for AP Biology

Overview
In the Guided Activity, students first test the effects of salt concentration on the hatching viability of *Artemia* (brine shrimp). Then, they relate the variation in brine shrimp's salt tolerance to the concept of natural selection. In the Inquiry Activity, students develop and follow an experimental plan to investigate another factor that may affect the hatching viability of brine shrimp.

Objectives
Students will
- conduct counts of hatched brine shrimp.
- quantify the effects of salinity on hatching viability of brine shrimp.
- test other factors that affect hatching viability of brine shrimp.
- relate salinity tolerance of brine shrimp to natural selection.

Content Standards
This kit is appropriate for Advanced Placement high school students and addresses the following AP Biology concepts:

**Big Idea #1: The process of evolution drives the diversity and unity of life.**
- Essential knowledge 1.A.1: Natural selection is a major mechanism of evolution.
- Essential knowledge 1.A.4: Biological evolution is supported by scientific evidence from many disciplines, including mathematics.
- Essential knowledge 1.B.2: Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.
- Essential knowledge 1.C.3: Populations of organisms continue to evolve.

This kit addresses the following National Science Content Standards:

**Grades 9–12**

*Science as Inquiry*
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

*Life Science*
- Biological evolution
- Behavior of organisms
**Time Requirements**

Preparation . . . . . . .15 minutes
Guided Activity . . . .Day 1, 30 minutes
Day 2, 15 minutes
Day 3, 15 minutes
Inquiry Activity . . . .Day 1, 30 minutes
Day 2, 15 minutes
Day 3, 15 minutes
Presentation . . . . . . .50 minutes

Start the activities on a Monday, Tuesday, or Wednesday. The Guided Activity must be completed over 3 consecutive class days. The Inquiry Activity also requires 3 consecutive days. The time required for the Inquiry Activity and Presentation may vary depending on students’ plans. Estimates for class time required are provided above.

**Materials**

**Included in the kit:**

<table>
<thead>
<tr>
<th>Item</th>
<th>8-station kit</th>
<th>1-station kit</th>
</tr>
</thead>
<tbody>
<tr>
<td>vial of brine shrimp eggs*</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>sodium chloride, 25 g*</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>petri dishes*</td>
<td>40</td>
<td>5</td>
</tr>
<tr>
<td>double-sided tape*</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>microscope slides*</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>paintbrushes</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>pipets*</td>
<td>40</td>
<td>5</td>
</tr>
<tr>
<td>sulfuric acid, 0.5 M*†</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>calcium carbonate*†</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>sodium hydroxide, 0.2 M*†</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Teacher’s Manual and Student Guide</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

*Included in 8-station refill
†Included for suggested use during the Inquiry Activity

**Needed, but not supplied:**

<table>
<thead>
<tr>
<th>Item</th>
<th>2.4 L</th>
<th>300 mL</th>
</tr>
</thead>
<tbody>
<tr>
<td>dechlorinated water</td>
<td>2.4 L</td>
<td>300 mL</td>
</tr>
<tr>
<td>50-mL beakers</td>
<td>40</td>
<td>5</td>
</tr>
<tr>
<td>stirring rods</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>small plastic bags</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>graduated cylinders</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>scissors</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>laboratory markers</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>stereomicroscopes</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>scale measuring to 0.01 g</td>
<td>at least 1</td>
<td>1</td>
</tr>
<tr>
<td>weigh boats</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lab spoons</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Optional Materials for Inquiry Activity
- thermometers
- cooling packs
- heating pads
- sand
- screens
- lamp
- aluminum foil

Using the Correct Water
Springwater is ideal for this experiment. If you must use tap water, condition it first. Most municipalities add either chlorine or chloramines to kill bacteria in drinking water. Both these disinfectants harm brine shrimp. To remove the chemicals, use a tap water conditioner, available from Carolina Biological Supply (671939) or from a local pet store. If you are certain that your water is treated only with chlorine (not chloramines), you can leave some water in an open container for 24 hours, allowing the chlorine gas to escape. You can then safely use it in the experiment.

Care of Brine Shrimp (Artemia)
After the experiment is completed, you may wish to raise the hatched brine shrimp to adulthood. To culture brine shrimp, fill a container with aged, conditioned tap water. (A rinsed 2-L drink bottle with the top cut off works well.) Dissolve about 2 tablespoons of noniodized salt per liter of water. Drop in a coarse-bubbling air stone or similar bubbler to circulate and oxygenate the water. Prepare a yeast suspension as food for the hatched brine shrimp. Make a salt solution as before and stir in enough baker’s yeast to make the water milky. Refrigerate the yeast suspension. Agitate it before each use to resuspend the yeast. Feed the brine shrimp a few drops of the yeast suspension each day. Avoid overfeeding; the water in the culture should not become clouded. Each week, draw off and replace about one-quarter of the culture water with new saltwater. As the shrimp grow, you may have to set up additional containers to avoid overcrowding. Newly hatched brine shrimp normally reach adulthood in 8 days.

Safety
Ensure that students understand and adhere to safe laboratory practices when performing any activity in the classroom or lab. Demonstrate the protocol for correctly using the instruments and materials necessary to complete the activities, and emphasize the importance of proper usage. Use personal protective equipment such as safety glasses or goggles, gloves, and aprons when appropriate. Model proper laboratory safety practices for your students and require them to adhere to all laboratory safety rules.

Disposal
After the exercises have been completed, dispose of the brine shrimp and any contaminated materials. In a plastic bucket, cover the material with a solution of
1 part bleach to 9 parts water. Keep the bucket covered to contain the odor of bleach. Keep the brine shrimp immersed in the bleach solution for 24 hours. Then, pour the mixture into a laboratory sink and rinse generously with tap water.

Teaching Inquiry

Since the National Research Council published the National Science Education Standards in 1996, the inquiry approach to science education has become recognized as a method that actively engages students in a learning process that results in a greater mastery of scientific concepts. The findings of the National Research Council support the evidence that an inquiry approach to education helps students gain an in-depth understanding of science by building upon previous knowledge (Inquiry and the National Science Education Standards 2000). Students become empowered, taking responsibility for their learning by conducting inquiry investigations and communicating their discoveries.

Inquiry activities encourage students to explore questions in a scientific way. In structured inquiry, the question is supplied to the student. A systematic procedure for exploring the question and reaching a conclusion may also be provided. In open inquiry, the student directs the entire scientific investigation, determining the question to explore, the materials to use, the procedure to follow, and the methods used to analyze data. Current models of inquiry in science instruction derive from the work of several researchers, including Schwab (1962), Herron (1971), and Rezba, Auldridge, and Rhea (1999).

Carolina’s Approach

Carolina™ Investigations for AP Biology follow an inquiry approach to science instruction. A Guided Activity in which students investigate a pre-determined question using an established procedure is followed by an Inquiry Activity in which students determine a question to investigate and a procedure to carry out the investigation. The Guided Activity is designed to provide students the skills and techniques they need as they move to a higher level of inquiry.

During the Inquiry Activity, each student team develops a question. Calling upon the skills they gained from the Guided Activity, they design an experiment to test their question. They secure teacher approval and proceed with their experiment. Teachers assist by providing the materials needed, ensuring safe laboratory practice, and asking questions that encourage critical thought about the teams’ progress and findings.

Pre-laboratory questions test students’ prior knowledge. Big Idea Assessments administered after the activities provide practice for the AP Biology exam’s free-response questions and help students internalize and effectively communicate the scientific concepts addressed by the investigation.

Background Information

See the Student Guide for the science content background. Also examine the Web sites listed in the Resources section.
Student Prior Knowledge

Before beginning this activity, students should be familiar with

- use of a stereomicroscope.
- preparation of solutions.

Preparation

Guided Activity

At least 1 day before beginning the lab

1. Upon arrival of the kit, remove the brine shrimp eggs and freeze them in an airtight container to maintain their viability. Brine shrimp eggs are susceptible to mold in warm, humid conditions; storing them in a freezer inhibits mold growth.

2. Locate the materials that are needed but not supplied.

3. Photocopy the Student Guide for each student or group.

On Day 1 of the Guided Activity

1. Divide the brine shrimp eggs into the eight small plastic bags.

2. Distribute the materials to the eight lab stations. At each station, place the following:
   - a bag with a few brine shrimp eggs
   - double-sided tape
   - graduated cylinder
   - 5 microscope slides
   - 5 petri dishes
   - stereoscope
   - 5 beakers
   - laboratory marker
   - paintbrush
   - stirring rod

3. Provide a central location where students can access the water (springwater or dechlorinated water).

4. Provide a weigh station stocked with sodium chloride, at least 1 scale, weigh boats, and lab spoons.

5. Divide the students into groups of four. Assign each group to a lab station. Review all safety protocols with the students before they begin the procedure.

Day 2

1. If you wish for the students to save the hatched brine shrimp, mix up a solution of salt water by dissolving 2 tablespoons of salt in 1 L of water.

2. Pour approximately 100 mL of the saltwater solution in each of 8 beakers.

3. Distribute the needed materials to the eight lab stations. Each lab station should have 5 labeled petri dishes, 5 pipets, 1 beaker of saltwater solution, and a stereomicroscope.

Day 3

Set up the eight lab stations as on Day 2.