

## CLASSROOM ACTIVITY

# Acid Oceans

If you're an ocean creature with a hard shell—like a sea urchin, hermit crab, or coral polyp—you prefer ocean water with a pH of about 8.2. This chemistry makes it easy to assemble your armor from carbon-based building blocks dissolved in the ocean. Since the industrial age, though, the ocean's pH has become more acidic from absorbing the greenhouse gas carbon dioxide from the air, dropping to 8.05 on average. Biologists like Gretchen Hofmann are realizing that this tiny change is hampering the development of hard-shelled marine life, leaving it more vulnerable to environmental stressors. Learn more as Hofmann's team recreates an acidic ocean in a lab at the University of California–Santa Barbara and tests how it affects sea urchins.

## CLASS DISCUSSION

### Establish Prior Knowledge

Call on students with aquariums to describe some of the tasks involved in monitoring the aquarium's water. Ask whether they have a saltwater or freshwater aquarium and what they consider to be the proper pH for their aquariums. Elicit that the pH scale ranges from 0 to 14 with 7 being neutral. Water that measures below 7 is more acidic, while above 7 is more basic or alkaline. Ask what could happen in an aquarium if the pH was too acidic or too basic.

Tell students that ocean water is slightly basic. However, increased carbon dioxide is causing ocean water to become more acidic. Tell them that in the feature video they are about to see scientists conduct an experiment to determine how a more acidic ocean will affect marine life. Suggest students take notes as they watch the video.

### Exploration

Have students view the feature and read the synopsis. Use the following questions to guide a class discussion.

- The world's oceans have absorbed what fraction of the CO<sub>2</sub> emitted since the beginning of the Industrial Revolution?  
*(Answers may include: Since the Industrial Revolution the world's oceans have absorbed 1/3 of the CO<sub>2</sub> emitted.)*
- How has CO<sub>2</sub> absorbed by the ocean changed its chemistry?  
*(Answers may include: The increase in carbon dioxide has decreased the ocean's pH from 8.2 to 8.05 on average, making it more acidic.)*
- What is the scientists' hypothesis about the affect that the increase in carbon dioxide will have on marine animals with hard shells?  
*(Answers may include: Marine animals with hard shells depend on calcium carbonate to make their shells. As the ocean's become more acidic, the carbonate levels will be affected and will negatively affect the hard-shelled organisms.)*
- What do scientists predict will be the outcome of their experiment?  
*(Answers may include: The animals in their model oceans will not be able to build their skeletons as effectively as animals in the ocean.)*
- What procedure did the scientists follow?  
*(Answers may include: The scientists created a model ocean in a laboratory. They filled tanks with ocean water mixed with extra carbon dioxide. By watching how the red sea urchin larvae develop they can predict what problems they will encounter as the ocean's become more acidic.)*

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# Acid Oceans (cont'd)

- What did scientists find when they examined the experimental larvae (urchin offspring) and compared them to normal larvae?  
*(Answers may include: The larvae in the test tanks developed skeletons, but were shorter and stumpier than those that developed in sea water not mixed with carbon dioxide. This indicated that the larvae needed to expend more energy to produce their shells.)*

**Wrap-Up**

Use the following question to wrap up your discussion.

- What impact do you think a more acidic ocean would have on the ocean food web? Describe the consequences in detail.  
*(Answers may include: The warming and acidified ocean would impact organisms, such as shrimp, lobsters, crabs, clams, oysters and coral, which depend on calcium carbonate to develop their shells. Changes in the size or abundance of these organisms would affect the humans and marine life that depend on them for food.)*