

**Teacher’s Guide**

**How to Raise a Jellyfish**

***December 2020***

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Activate students’ prior knowledge and engage them before they read the article.

[Reading Comprehension Questions](#_Student_Reading_Comprehension) 3

These questions are designed to help students read the article (and graphics) carefully. They can help the teacher assess how well students understand the content and help direct the need for follow-up discussions and/or activities. You’ll find the questions ordered in increasing difficulty.

[Graphic Organizer 5](#_Graphic_Organizer)

Thishelps students locate and analyze information from the article. Students should use their own words and not copy entire sentences from the article. Encourage the use of bullet points.

[Answers 6](#_Answers_to_Reading)

Access the answers to reading comprehension questions and a rubric to assess the graphic organizer.

[Additional Resources 8](#_Additional_Resources_1)

Here you will find additional labs, simulations, lessons, and project ideas that you can use with your students alongside this article.

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# Anticipation Guide

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Directions: *Before reading the article*,** in the first column, write “A” or “D,” indicating your **A**greement or **D**isagreement with each statement. Complete the activity in the box.

As you read, compare your opinions with information from the article. In the space under each statement, cite information from the article that supports or refutes your original ideas.

|  |  |  |
| --- | --- | --- |
| **Me** | **Text** | **Statement** |
|  |  | 1. Many jellyfish are predators. |
|  |  | 1. Jellyfish live in every ocean on Earth. |
|  |  | 1. Less than 90% of the dissolved ions in seawater come from NaCl. |
|  |  | 1. The pH of the ocean is slightly acidic. |
|  |  | 1. Sodium bicarbonate (NaHCO3) can help maintain the pH of a solution by reacting with added acids or bases. |
|  |  | 1. The CO2 in the air does not enter Earth’s oceans. |
|  |  | 1. Over the past 200 years, the pH of the world’s oceans has decreased slightly. |
|  |  | 1. Planting seagrasses along coastlines could lower the ocean’s pH. |
|  |  | 1. In the polyp stage of its life, a jellyfish is attached to an underwater surface. |
|  |  | 1. Keeping saltwater organisms alive in an aquarium requires constant adjustment of chemicals. |

# Student Reading Comprehension Questions

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Directions**: Use the article to answer the questions below.

1. According to the article, how long have jellyfish been present on Earth?
2. While overfishing and climate change negatively impact some species of sea life, what is happening to the population of jellyfish?
3. What pH range of water is necessary to support jellyfish?
4. List three water quality factors that are important to jellyfish survival in an aquarium.
5. As sea animals release waste into the water, what happens to the pH level of the water?
6. How many ephyra can a polyp shed?
7. Explain what the pH scale measures.
8. If the pH of aquarium water is 4, what substance can be added to increase the pH?
9. If the pH of aquarium water is 10, what substance can be added to lower the pH?
10. Complete the chart below by drawing or describing what a jellyfish looks like in each of the stages of its life cycle.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Larva** | **Polyp** | **Strobila** | **Ephyra** | **Medusa** |
|  |  |  |  |  |

**Student Reading Comprehension Questions, cont.**

**Questions for Further Learning**

***Write your answers on another piece of paper if needed.***

1. Describe the laboratory technique that can be used to monitor calcium ion levels in an aquarium.
2. Explain why the seemingly small decrease of pH by 0.1 pH units is really a large change.
3. Explain two ways that the ocean’s CO2 levels might be reduced and the potential drawbacks of those methods.
4. Use LeChatelier’s principle to explain how CO2 in the air impacts the level of CO2 in the ocean.
5. Perform additional research about potential methods for reducing CO2 in the ocean. Create an infographic explaining the method and why it would be successful.

# Graphic Organizer

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Directions**: As you read, complete the graphic organizer below to describe how to maintain the pH of a saltwater aquarium.

|  |  |  |
| --- | --- | --- |
| **Desired pH** |  | |
| **Effect of adding limewater** | Effect on pH: | |
| **Effect of adding vinegar** | Effect on pH: | |
| **Effect of adding sodium bicarbonate** | Effect on pH: | **Equation:** |
| **Effect of adding CO2** | Effect on pH: | **Equation:** |
| **Effect of Ca2+** | Effect on pH: | **Explanation:** |
| **Adding iron** | Effect on pH: | **Explanation:** |
| **Planting seagrasses** | Effect on pH: | **Explanation:** |

**Summary:** Write a short description of the chemistry of seawater.

# Answers to Reading Comprehension Questions & Graphic Organizer Rubric

1. **According to the article, how long have jellyfish been present on Earth?**

*Jellyfish have been in the ocean for at least 500 million years.*

1. **While overfishing and climate change negatively impact some species of sea life, what is happening to the population of jellyfish?**

*The jellyfish population are flourishing while other sea life is being threatened.*

1. **What pH range of water is necessary to support jellyfish?**

*The optimum pH of water is between 7.8 and 8.6.*

1. **List three water quality factors that are important to jellyfish survival in an aquarium.**

*Three water quality factors that are important to jellyfish survival are pH, salinity, calcium levels.*

1. **As sea animals release waste into the water, what happens to the pH level of the water?**

*The pH of the water becomes more acidic.*

1. **How many ephyra can a polyp shed?**

*Polyps can shed between 10 and 15 ephyra.*

1. **Explain what the pH scale measures.**

*pH is the measure of how acidic or basic an aqueous solution is and is a measure of the relative amount of free hydrogen and hydroxide ions in the solution.*

1. **If the pH of aquarium water is 4, what substance can be added to increase the pH?**

*Limewater can be added to increase the pH of water.*

1. **If the pH of aquarium water is 10, what substance can be added to lower the pH?**

*Hydrochloric acid or vinegar can be added to lower the pH of water.*

1. **Complete the chart below by drawing or describing what a jellyfish looks like in each of the stages of its life cycle.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Larva | Polyp | Strobila | Ephyra | Medusa |
| *Responses should look like the drawings from the Life Cycle of the Moon Jelly inset.* |  |  |  |  |

**Questions for Further Learning**

1. **Describe the laboratory technique that can be used to monitor calcium ion levels in an aquarium.**

*Calcium ion levels can be monitored by using a titration. Titration is a common lab method that involves the slow addition of a solution with a known concentration and volume to an unknown solution until there is a color change.*

1. **Explain why the seemingly small decrease of pH by 0.1 pH units is really a large change.**

*The pH scale is logarithmic, so a drop of 0.1 represents a change in hydrogen ion concentration from 6 x 10-9 M to 8 x 10-9 M.*

1. **Explain two ways that the ocean’s CO2 levels might be reduced and the potential drawbacks of those methods.**

*Adding limestone to the ocean could cause it to dissolve and consume CO2. Iron fertilization is another method that could reduce CO2 levels because it would cause phytoplankton to grow more rapidly. The phytoplankton would then consume CO2 as it goes through photosynthesis. The downsides of these methods are that they would require too much energy and could have unwanted side effects.*

1. **Use LeChatelier’s principle to explain how CO2 in the air impacts the level of CO2 in the ocean.**

*LeChatelier’s principle is that when a system at equilibrium is disturbed, the system shifts to counteract the disruption. Before the Industrial Revolution CO2 moved between the oceans and the atmosphere until equilibrium was achieved. Over time more CO2 has been introduced into the atmosphere which has increased the partial pressure of CO2. This change in partial pressure shifts the equilibrium so more CO2 is entering the oceans than the air.*

1. **Perform additional research about potential methods for reducing CO2 in the ocean. Create an infographic explaining the method and why it would be successful.**

*Student responses will vary.*

**Graphic Organizer Rubric**

If you use the Graphic Organizer to evaluate student performance, you may want to develop a grading rubric such as the one below.

|  |  |  |
| --- | --- | --- |
| **Score** | **Description** | **Evidence** |
| 4 | Excellent | Complete; details provided; demonstrates deep understanding. |
| 3 | Good | Complete; few details provided; demonstrates some understanding. |
| 2 | Fair | Incomplete; few details provided; some misconceptions evident. |
| 1 | Poor | Very incomplete; no details provided; many misconceptions evident. |
| 0 | Not acceptable | So incomplete that no judgment can be made about student understanding |

# Additional Resources

**Labs and demos**

**The Egg-straordinary Issue:** In this lab students will determine the percent composition of calcium carbonate contained in an eggshell by using a back titration in order to address a farmer’s concerns about his hen’s fragile eggs. <https://teachchemistry.org/classroom-resources/the-egg-straordinary-issue>

**Simulations**

**Salts and Solubility:** Students can utilize this PhET simulation to learn about and experiment with the solubility of different types of salts. <https://phet.colorado.edu/en/simulation/legacy/soluble-salts>

**pH Scale:** Students can utilize this PhET simulation to learn about the pH of various substances on both a macro and micro level. <https://phet.colorado.edu/en/simulation/ph-scale>

**CO2, Shell Building and Ocean Acidification:** This simulation uses chemical reactions to show where organisms must use energy to expel hydrogen ions (H+) from bicarbonate ions (HCO32–) to release carbonate ions (CO3–2) needed for shell building. <http://www.whoi.edu/ocean-acidification/>

**Lessons and lesson plans**

**Iron Fertilization:** In this lesson plan students learn about the Ocean Iron Fertilization Hypothesis and review data from the Monterey Bay Aquarium Research Institute to track the chemical changes that occur during an upwelling event. <http://masweb.vims.edu/bridge/datatip.cfm?Bridge_Location=archive0504.html>

**Projects and Extension Activities**

**Research project on “Ocean Acidification”:** This investigation of “the other carbon dioxide problem” involves the study of the long-term effects of carbon dioxide acidification on aquatic animals. Suggested materials include articles, discussion questions, videos, and a virtual (data based) lab exercise on sea urchins. <https://serc.carleton.edu/eslabs/carbon/7b.html>

# Chemistry Concepts, Standards, and Teaching Strategies

**Connections to Chemistry Concepts**

The following chemistry concepts are highlighted in this article:

* Acids and Bases: indicators, pH, titrations
* Equilibrium: Le Chatelier’s Principle

**Correlations to Next Generation Science Standards**

This article relates to the following performance expectations and dimensions of the NGSS:

**HS-PS1-6**

Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.

**Disciplinary Core Ideas:**

* PS1.B: Chemical Reactions
* ESS3.C: Human Impacts on Earth Systems

**Crosscutting Concepts:**

* Scale, Proportion, and Quantity
* Systems and System Models
* Stability and Change

**Science and Engineering Practices:**

* Analyzing and interpreting data
* Constructing explanations (for science) and designing solutions (for engineering)

**Nature of Science:**

* Scientific knowledge assumes an order and consistency in natural systems.

**Correlations to Common Core State Standards**

See how *ChemMatters* correlates to the[**Common Core State Standards**](https://www.acs.org/content/acs/en/education/resources/highschool/chemmatters/teachers-guide.html)  at www.acs.org/chemmatters.

**Teaching Strategies**

Consider the following tips and strategies for incorporating this article into your classroom:

* **Alternative to Anticipation Guide:** Before reading, ask students if they have ever seen jellyfish, and where they live. Ask students what they think they know about the chemistry of the oceans, including the dissolved minerals and pH. Ask students how increasing CO2 in the air might affect the chemistry of the ocean.
* As they read, students can find information to confirm or refute their original ideas. *Do not tell students the answers prior to reading.*
* After they read, ask students what surprised them about the article. Ask them what ideas they have about maintaining the pH balance of the oceans.
* There is an interesting ACS Reactions video (about 5 minutes long) that relates to some articles in this issue: “Space Mirrors and Other Weird Ways to Fight Climate Change.” suggested in the video. <https://youtu.be/9agoVDFJs8A>
* Consider showing the video after the students have read “Mirror Reflections” and “How to Raise a Jellyfish.” Ask students to think about the risks and benefits of the solutions to problems.