

ScienceNews

EDUCATOR GUIDE



OCEAN EXPLORATION TRUST, NOAA

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**Deep-sea 'Octomoms' Seek
the Heat**



About this Guide

In this Guide, based on the online *Science News* article "[Some deep-sea octopuses aren't the long-haul moms scientists thought they were](#)," students will answer questions about how scientists discovered that octopuses laying eggs in warm waters near geothermal springs are speeding up hatching. Students will then define rates and their units of measurement for biological and chemical processes and discuss factors that affect rates.

This Guide includes:

Article-based Comprehension Q&A — Students will answer questions about the *Science News* article "[Some deep-sea octopuses aren't the long-haul moms scientists thought they were](#)," which describes how octopuses laying eggs in warm waters near geothermal springs are speeding up hatching. Related standards include NGSS-DCI: HS-PS3; HS-LS1; HS-LS4.

Student Comprehension Worksheet — These questions are formatted so it's easy to print them out as a worksheet.

Cross-curricular Discussion Q&A — Students will define rates and their units of measurement for biological and chemical processes before discussing factors that affect rates. Related standards include NGSS-DCI: HS-PS3; HS-LS1.

Student Discussion Worksheet — These questions are formatted so it's easy to print them out as a worksheet.

Article-based Comprehension, Q&A

Directions for teachers: Ask students to read the online *Science News* article "[Some deep-sea octopuses aren't the long-haul moms scientists thought they were](#)," and answer the following questions. A version of the article, "Deep-sea 'octomoms' seek the heat," appears in the April 9, 2022 issue of *Science News*.

1. What is the Octopus Garden? Why is it called that?

The Octopus Garden is a patch of seafloor 3,200 meters deep off the coast of California where deep-sea octopuses congregate. It's called a "garden" because many of the animals there are octopus moms caring for their developing eggs.

2. What did scientists predict about the brooding period in the octopus garden and why?

Scientists thought brooding in the garden would take a very long time, perhaps a record-setting 12 years. Embryonic development tends to slow down in low temperatures, and temperatures in the garden are only about 1.6° Celsius.

3. What data did scientists collect to try to verify their predictions?

Scientists observed the octopuses and their eggs with cameras and took water temperature measurements in nests.

4. What tools did they use to collect that data? Why?

Scientists used remotely operated vehicles with robotic arms because this area of the seafloor is otherwise inaccessible and hard to observe directly.

5. What did the collected data ultimately reveal? List at least two findings.

Water temperatures in the nests were warmer than expected, up to 10.5° Celsius. Also, brooding lasted for about 600 days, or a year and a half.

6. What did researchers conclude based on these findings?

The researchers concluded that octopuses are laying eggs in the warmer water of geothermal springs, which is speeding up embryonic development and thus reducing brooding time.

7. Why is a shorter brooding period beneficial from an evolutionary perspective?

Reducing the brooding time reduces the risk that predators will eat octopus eggs.

8. Are octopus moms the only animals that seek out warm waters for breeding? Explain.

No. A few other animals, including icefish, do it too. The scientists suspect other species probably take a similar approach.

Student Comprehension Worksheet

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- 1. What is the Octopus Garden? Why is it called that?**
- 2. What did scientists predict about the brooding period in the octopus garden and why?**
- 3. What data did scientists collect to try to verify their predictions?**
- 4. What tools did they use to collect that data? Why?**
- 5. What did the collected data ultimately reveal? List at least two findings.**
- 6. What did researchers conclude based on these findings?**
- 7. Why is a shorter brooding period beneficial from an evolutionary perspective?**
- 8. Are octopus moms the only animals that seek out warm waters for breeding? Explain.**

Cross-curricular Discussion, Q&A

Directions for teachers:

Ask students to read the online *Science News* article "[Some deep-sea octopuses aren't the long-haul moms scientists thought they were](#)" then answer the questions below with a partner. A version of the article, "Deep-sea 'octomoms' seek the heat," appears in the April 9, 2022 issue of *Science News*.

Want to make it a virtual lesson? Post the online *Science News* article to your virtual classroom. Discuss the article and questions with your class on your virtual platform.

Reasoning through rates

1. Define rate of change and give an example of a biological rate that's not mentioned in the *Science News* article. Make sure you specify the units for your example.

A rate is a measure of how much one quantity changes when some other quantity changes. It's a ratio of the change of two quantities. Your heart rate, or pulse, is generally measured as the number of times your heart beats per minute, or BPM.

2. What rate is discussed in the *Science News* article? How do you think this rate could be measured, and what might the units of measurement be? How did the researchers described in the article measure the rate, and why do you think they used that approach?

The rate of embryonic development of deep-sea octopuses is discussed in the article. One way to measure embryonic development might be through growth. Growth could be measured as the change in mass of the egg or in length of the embryo over some period of time. The units would be grams or millimeters per day (or week or month). Researchers in the study used the overall brood period from egg fertilization to hatching as a proxy for the rate of development probably because it would be challenging to get to and measure the eggs (or the embryos within) directly.

3. How could the rate of a single chemical reaction be measured? What would the units be? How might the rate of a single chemical reaction affect biological rates?

The change in the amount of reactants or products could be measured over time. Depending on the system's conditions and phases of matter, the units could be change in mass per unit time or change in concentration per unit time. The highly coordinated network of chemical reactions that take place in an organism are referred to as its metabolism. These reactions govern the conversion of food to energy and the use of energy for cells to function, which enables breathing, digestion, growth and a host of other processes. If one reaction slows, it might slow down a whole set of reactions, thus affecting the rates at which a body functions and grows.

4. Are chemical and biological rates constant? Explain and give examples.

No. Rates change based on the conditions of the system. Your heart rate changes when you exercise. Many reaction rates change based on the concentrations of reactants and products.

5. Do you think the rate of embryonic development remains constant from fertilization to hatching for deep-sea octopuses? What questions might scientists be able to ask if they had more detail about rate of development?

The rate of development likely changes throughout brooding based on the quantity and complexity of the chemical reactions taking place within the embryo, as well as based on available resources and environmental conditions. With more information, scientists could ask: "What are the stages of embryonic development? How long does each last? What speeds each up or slows it down?"

Impacting rates

1. What environmental factor discussed in the article affects the rate of embryonic development of deep-sea octopuses? Define the factor and explain how it affects the rate?

Temperature affects the rate of embryonic development. Temperature is a measurement of the kinetic energy of the particles within a system. Higher temperatures increase the rate of development.

2. How does temperature typically affect the rate of a chemical reaction? Explain why the relationship exists using the collision model for chemical systems.

For a chemical reaction to occur, particles (atoms or molecules) must collide with each other in the correct spatial orientation and with enough energy to overcome the reaction's activation energy. If the temperature of a system is increased, the kinetic energy of the particles (atoms or molecules) within the system are increased. Particles with greater kinetic energy will travel faster, which means the number of collisions of the particles will increase, likely increasing the number of collisions with the correct spatial orientation. Also, if the energy of the particles is higher, the number of collisions that meet or exceed the activation energy is greater. That's why an increase in temperature will generally increase the rate of a chemical reaction.

3. Based on the explanation above, why might increased water temperature speed rates of development for the octopus embryos?

If higher temperatures speed up the rates of chemical reactions occurring within the cells, that could speed up metabolism overall and so increase the rate of growth and development.

4. What other factors might affect the rate of a chemical reaction? What other factors might affect the rate of embryonic development? Do you think some of the factors are the same? If so, why?

Concentration of reactants and products or the pressure of a system of gases also affect reaction rates. Other factors that likely affect rates of development are oxygen, food and nutrient supplies. Pressure might play a role for underwater animals, too. If some factor consistently speeds up the rate of chemical reactions, then it could also speed metabolism and growth and development overall. Some factors might speed some reactions and slow others, making the overall effect on rates of development hard to predict.

5. Can you think of any ways that people control biological and chemical rates by taking advantage of temperature or other factors that affect those rates?

Student answers will vary. One possible answer is refrigeration. We refrigerate food to slow the rate of bacteria, mold or yeast growth and to slow the rate of ripening.

Student Discussion Worksheet

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Reasoning through rates

1. Define rate of change and give an example of a biological rate that's not mentioned in the *Science News* article. Make sure you specify the units for your example.
2. What rate is discussed in the *Science News* article? How do you think this rate could be measured, and what might the units of measurement be? How did the researchers described in the article measure the rate, and why do you think they used that approach?
3. How could the rate of a single chemical reaction be measured? What would the units be? How might the rate of a single chemical reaction affect biological rates?
4. Are chemical and biological rates constant? Explain and give examples.
5. Do you think the rate of embryonic development remains constant from fertilization to hatching for deep-sea octopuses? What questions might scientists be able to ask if they had more detail about rate of development?

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