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**Student Exploration: Paramecium Homeostasis**

**Vocabulary:** adaptation, cell mouth, cilia, concentration, contractile vacuole, food vacuole, homeostasis, hypertonic, hypotonic, macronucleus, micronucleus, oral groove, osmosis, paramecium, solute, solution, solvent

**Prior Knowledge Questions** (Do these BEFORE using the Gizmo.)

1. The images show red blood cells (RBCs) in three different **solutions**.
2. Which image shows RBCs in normal blood plasma? \_\_\_\_\_\_\_\_\_\_
3. Which image shows RBCs in pure water? \_\_\_\_\_\_\_\_\_\_
4. Which image shows RBCs in a very salty solution? \_\_\_\_\_\_\_\_\_\_
5. What do you think is happening in images A and C? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**Gizmo Warm-up**

A **paramecium** is a one-celled organism that lives in ponds and other bodies of water. One of the challenges for a paramecium is to maintain a stable size and shape.

On the *Paramecium Homeostasis* Gizmo, turn on the **Show labels** checkbox. Try to determine the function of each of the labeled structures.

1. Through which two structures do you think food enters the paramecium? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Which two structures contain DNA? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Which tiny structures help the paramecium to move around? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Which structure pumps out excess water and wastes? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| **Activity A:** **Maintaining a water balance** | Get the Gizmo ready: * Select the **User controlled** setting.
* Check that the **Water solute concentration** is 1.00%.
 | SE3 |

**Introduction:** Every organism needs to maintain stable internal conditions—a process known as **homeostasis**—in order to survive. A paramecium maintains homeostasis by responding to variations in the **concentration** of salt in the water in which it lives. (The concentration of a solution is equal to the amount of **solute** that is dissolved in a given amount of **solvent**.)

**Question: How do changing solute concentrations affect a paramecium?**

1. Predict: In the *Paramecium Homeostasis* Gizmo, the solute is salt and the solvent is water.
	* 1. Look at the top left of the Gizmo. What is the water solute concentration? \_\_\_\_\_\_\_\_\_

A solute concentration of 1.00% means that for every 1 gram of water there is 0.01 grams of solute (salt).

* + 1. What is the concentration of solutes inside the paramecium? \_\_\_\_\_\_\_\_\_

The water solution outside the paramecium is said to be **hypotonic** because it has a lower solute concentration than the solution inside the paramecium.

* + 1. Based on the internal and external solute concentrations, do you think the paramecium will swell up or shrink in this solution? Explain your reasoning.

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1. Observe: Click **Play** (), and observe the size of the paramecium.
	* 1. What do you notice? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
		2. What happens after about 16 seconds? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Observe: Click **Reset** (). Set the **Water solute concentration** to 2.00%. (This is a **hypertonic** solution because it has a higher solute concentration than the solution inside the paramecium.) Click **Play**. What happens to the volume of the paramecium now?

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**(Activity A continued on next page)**

**Activity A (continued from previous page)**

1. Infer: Water moves into and out of the paramecium by a process called **osmosis**. Osmosis is the movement of water across a membrane from a region of lower solute concentration to a region of higher solute concentration.
	* 1. If the solute concentration in the water is low (hypotonic solution), does water move into or out of the paramecium? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
		2. If the solute concentration in the water is high (hypertonic solution), does water move into or out of the paramecium? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
		3. In which situation is the paramecium in danger of swelling up and bursting?

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1. Experiment: The **contractile vacuole** is a star-shaped structure that helps the paramecium to pump out excess water. This **adaptation** allows the paramecium to survive in hypotonic (low solute concentration) solutions.

Click **Reset**, and set the **Water solute concentration** to 1.00%. Click **Play**. When the contractile vacuole fills up, click **Contract**. Do this for a while, and then click **Pause** ().

* + 1. How does contracting the vacuole affect the volume of the paramecium? \_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
		2. Click **Play**, and then click **Contract** many times rapidly. What happens? \_\_\_\_\_\_\_\_\_\_

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1. Experiment: Click **Reset**. This time, try to maintain a steady volume for the paramecium. Pause the simulation after about one minute and select the TABLE tab.

How many contractions per minute were required for the paramecium to maintain a relatively stable internal solute concentration and stay the same size?

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1. Summarize: How does the contractile vacuole help the paramecium survive in a freshwater environment?

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| **Activity B:** **Contractions and concentrations** | SE4Get the Gizmo ready: * Click **Reset**.
* Select the **Paramecium controlled** setting on the DESCRIPTION tab.
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**Question: How does a paramecium respond to changing solute concentrations?**

1. Form a hypothesis: How do you think the number of contractile vacuole contractions will change when the water solute concentration is reduced? Explain why you think so.

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1. Gather data: Set the **Water solute concentration** to 2.00%. Click **Play**. Pause after 30 seconds. On the TABLE tab, add the total number of contractions. Record the results in the table below. Click **Reset**, and repeat this procedure for all of the listed concentrations.

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| **Water solute concentration** | **Contractions in 30 seconds** |
| 2.00% |  |
| 1.50% |  |
| 1.00% |  |
| 0.50% |  |
| 0.00% |  |

1. Analyze: What pattern do you see in your data? How does this compare to your hypothesis?

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1. Predict: How many contractions would you expect in 30 seconds if the water solute concentration was 0.75%? Test your prediction with the Gizmo.

 Predicted contractions: \_\_\_\_\_\_\_\_\_\_ Actual contractions: \_\_\_\_\_\_\_\_\_\_

1. Think and discuss: Paramecia that live in fresh water have contractile vacuoles, while those that live in salt water do not. Why do you think this is the case?

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