PEEBEDU

Contractile Vacuole (NGSS)

Name: _____ **Period:** _____ **Date:** _____

> Open **peebedu.com** and navigate to **Contractile**. Click the **Start Game** button to begin. Read the introduction popup, which describes how to control your single-celled organism, the three osmotic zones (hypotonic, isotonic, hypertonic), and how the contractile vacuole expels excess water to prevent lysis.

Part 1 — Model Evaluation (MAPP Framework)

Freshwater protists such as paramecia live in hypotonic environments where water constantly enters their cells through osmosis. Without a mechanism to expel excess water, these cells would swell and burst. The contractile vacuole is a specialized membrane-bound organelle that collects and pumps out excess water, allowing these organisms to survive. In this simulation, you control a single-celled organism navigating through hypotonic, isotonic, and hypertonic water zones while managing your cell's water level and energy.

M — Mode

What type of model is the Contractile simulation? Describe how this computational game represents osmosis and osmoregulation. In your answer, identify at least three specific simulation elements and explain what each one is designed to show about how cells manage water balance.

A — Accuracy

(a) Identify two things this simulation represents **accurately** about osmosis and contractile vacuole function. For each, name the specific simulation feature and explain what biological concept it demonstrates.

(b) Identify two things this simulation **oversimplifies or leaves out** about osmosis and osmoregulation. Consider what you cannot observe in the simulation that would be important for a complete understanding of how cells regulate water balance.

P — Purpose

What is the learning goal of this simulation? Explain how the Contractile game is designed to help you understand how water moves across cell membranes in response to concentration gradients and how freshwater protists use contractile vacuoles to maintain homeostasis. In your answer, connect at least one specific simulation feature to a biological consequence of failing to regulate water balance.

P — Permanency

Could this model change with new scientific evidence? Describe one way that new discoveries might change or improve a simulation like Contractile. Explain why scientific models, including interactive simulations, are revised as new evidence becomes available.

Small-Group Discussion

With your group, discuss the following:

- What are the strengths of this game as a model for osmosis and contractile vacuole function?
- What are its limitations?
- If you could add one feature to improve this simulation, what would it be and why?
- How does the simulation help you connect the concept of tonicity to the survival of freshwater organisms?

Part 2 — NGSS Questions

1.

> *Simulation Task: Navigate your cell into the light blue (hypotonic) zone and watch the water level bar as it rises. Before it reaches 100%, press C to activate the contractile vacuole. Observe how the water level drops and the energy bar decreases.*

Describe the direction of water movement when your cell is in the hypotonic zone. Explain why a freshwater single-celled organism needs a contractile vacuole to pump out excess water and how this process prevents the cell from bursting.

HS-LS1-3

2.

> *Simulation Task: Move your cell through all three zones in order: light blue (hypotonic), medium blue (isotonic), and dark blue (hypertonic). For each zone, read the zone indicator label and observe whether the water level bar increases, stays stable, or decreases.*

Describe how the water level inside your cell changes in each of the three zones. Explain why the direction of water movement differs depending on whether the surrounding environment has a lower, equal, or higher concentration of dissolved substances compared to the inside of the cell.

HS-LS1-3

3.

> *Simulation Task: Stay in the hypotonic zone and let your water level rise to about 80%. Press C to activate the contractile vacuole and note the new water level. Also note how much energy the vacuole used by checking the energy bar before and after pressing C.*

Explain why pumping water out of the cell requires energy. Describe what would happen to a single-celled organism that ran out of energy while still in a hypotonic environment, and explain how this shows that maintaining stable internal conditions is an ongoing process that depends on a supply of energy.

HS-LS1-3

4.

> *Simulation Task: Navigate your cell into the dark blue (hypertonic) zone and observe the water level bar as it drops. Stay in this zone and watch what happens when the water level approaches 0%.*

Describe what happens to your cell in the hypertonic zone and explain why water leaves the cell in this environment. Explain why both too much and too little water inside a cell can be dangerous, and how this demonstrates that cells must keep their internal water levels within a certain range to survive.

HS-LS1-3

5.

> *Simulation Task: Collect several green food particles to raise your energy level. Then move into the hypotonic zone and use the contractile vacuole multiple times to keep your water level stable. Notice how your energy depletes each time you press C.*

Explain the relationship between food intake and the ability of a single-celled organism to regulate its water balance. Describe how collecting food in the simulation represents the way real organisms obtain the energy they need to power processes that maintain stable internal conditions.

HS-LS1-3

6.

> *Simulation Task: Play through the game and observe the full cycle: your cell absorbing water in the hypotonic zone, using the contractile vacuole to expel water, and losing water in the hypertonic zone. Pay attention to the minimap to see where each zone is located.*

In the box below, draw a diagram of a single-celled organism in a hypotonic environment. Label the cell membrane, the contractile vacuole, and the surrounding water. Use arrows to show the direction water moves into the cell by osmosis and the direction the contractile vacuole pumps water out. Include a brief annotation explaining why this pumping action is necessary for the cell's survival.

Draw your diagram here.

HS-LS1-3

7.

> *Simulation Task: Play the game one more time and think about how the different zones represent different environments a real freshwater organism might encounter. Consider what would happen if the organism's environment changed suddenly.*

Imagine that increased rainfall dramatically lowers the concentration of dissolved substances in a pond where single-celled organisms live, making the water even more hypotonic than usual. Explain how this environmental change would affect the water balance of these organisms and predict whether organisms with faster-acting contractile vacuoles would have a better chance of surviving compared to those with slower ones. Describe how this situation could lead to changes in the population over time.

HS-LS4-5