

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 – Free Response Questions

---

### Conceptual Analysis

#### Question 1 – Osmosis and the Contractile Vacuole

*Simulation Task: In the Contractile game, navigate your cell into the light blue (hypotonic) zone and observe the water level bar as it rises. Before the water level reaches 100%, press C to activate the contractile vacuole and note the change in both the water level and energy bars. Then move into the dark blue (hypertonic) zone and observe what happens to the water level.*

**(A)** (1 pt) **Describe** the relationship between the tonicity of a cell's external environment and the direction of water movement across the cell membrane, using the terms hypotonic, hypertonic, and osmosis.

---

---

---

**(B)** (1 pt) **Explain** why a freshwater protist living in a hypotonic environment requires a contractile vacuole to survive, and how this organelle prevents the cell from lysing.

---

---

---

**(C)** (1 pt) **Predict** what would happen to the water level and survival of the cell in the simulation if the contractile vacuole were disabled while the cell remained in the hypotonic zone.

---

---

---

**(D)** (1 pt) **Justify** your prediction by explaining how the movement of water by osmosis from regions of high water potential to regions of low water potential would affect a cell that cannot expel excess water.

---

---

---

---

## Analyze Model / Visual Representation

### Question 2 — Tonicity and Cell Survival

*Simulation Task: Play the Contractile game and navigate your cell through all three zones: light blue (hypotonic), medium blue (isotonic), and dark blue (hypertonic). For each zone, observe the zone indicator label and note whether the water level bar increases, stays stable, or decreases. Record the zone color, its tonicity label, and the direction of water movement.*

**(A)** (1 pt) **Describe** how external environments that are hypotonic, isotonic, or hypertonic to the internal environment of a cell determine the net direction of water movement across the cell membrane.

---

---

---

**(B)** (1 pt) **Explain** the relationship between the concentration of solutes outside the cell, the direction of osmosis, and the risk of lysis or desiccation observed in each zone of the simulation.

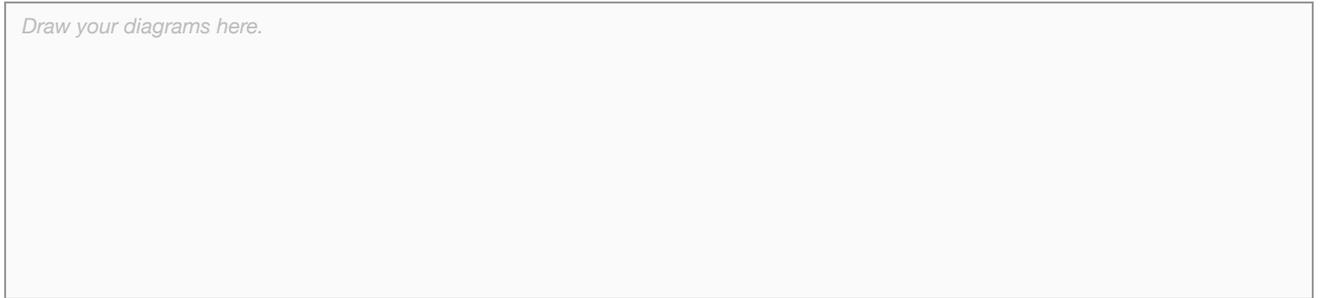
---

---

---

**(C)** (1 pt) **Represent** the movement of water across a cell membrane in each of the three osmotic environments.

*Draw your diagrams here.*



**(D)** (1 pt) **Explain** how the energy cost of operating the contractile vacuole, as shown by the energy bar decrease in the simulation, connects to the concept that maintaining cellular homeostasis requires metabolic energy derived from cellular respiration.

---

---

---

EK 2.7.A.1, EK 2.1.A.7