

Name: \_\_\_\_\_ Period: \_\_\_\_\_ Date: \_\_\_\_\_

Open **peebedu.com** and navigate to **Water Potential Calculator**. Click the **Start Learning!** button to begin. Read the introduction popup, which describes water potential ( $\Psi$ ), solute potential ( $\Psi_s$ ), tonicity (hypertonic, hypotonic, isotonic), and ionization constants for different solutes.

## Part 1 – Model Evaluation (MAPP Framework)

*Plants growing in saline coastal soils face a constant challenge: the high salt concentration in the surrounding soil water creates a hypertonic environment that can pull water out of root cells. Agricultural scientists use water potential calculations to predict which crops can survive in these conditions and to design irrigation strategies that maintain the right balance between soil and root water potential. Use the MAPP framework below to evaluate the Water Potential Calculator as a scientific model.*

### M – Mode

What type of model is the Water Potential Calculator? Describe how this computational simulation represents water potential and the movement of water across cell membranes. In your answer, identify at least three specific simulation elements and explain what each one is designed to show about water potential.

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## A – Accuracy

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

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

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## P – Purpose

What is the learning goal of this simulation? Explain how the Water Potential Calculator is designed to help you understand how solute concentration, ionization, and temperature determine water potential and predict the direction of osmosis. In your answer, connect at least one specific simulation feature to a biological situation where calculating water potential helps explain water movement in organisms.

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## P – Permanency

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

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## Small-Group Discussion

With your group, discuss the following:

- What are the strengths of this simulation as a model for understanding water potential?
- 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 mathematical calculations to biological outcomes for cells?

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## Part 2 – Free Response Questions

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### Conceptual Analysis

#### Question 1 – Tonicity and Water Movement

*Simulation Task: Select **Plant Cell** from the Cell Type dropdown and **Sucrose** as the solute. Set the temperature to **25°C**. Click **Add Solute** three times, then click **Stir Solution**. Record the Solution Solute Potential ( $\Psi_s$ ) and Concentration (C) from the Live Data panel. Then click **Insert Cell** and observe the direction of water movement and the cell's response.*

**(A)** (1 pt) **Describe** how external environments can be classified as hypotonic, hypertonic, or isotonic relative to a cell's internal environment.

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**(B)** (1 pt) **Explain** why adding sucrose to the beaker solution changes the water potential of the external environment and how this affects the net movement of water relative to the plant cell.

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**(C)** (1 pt) **Predict** what would happen to the plant cell if you clicked **Evaporate** several times to further increase the solution concentration beyond what you observed.

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**(D)** (1 pt) **Justify** your prediction by explaining how increasing the external solute concentration changes the water potential gradient between the solution and the cell, and why water moves from regions of high water potential to regions of low water potential.

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## Analyze Model / Visual Representation

### Question 2 – Osmoregulation and Water Balance

*Simulation Task: Select **Red Blood Cell** from the Cell Type dropdown and **NaCl** as the solute. Note the Cell Internal  $\Psi_s$  value. Click **Add Solute** once, then click **Stir Solution**. Record the Solution  $\Psi_s$ . Now click **Insert Cell** and observe the cell's response. Next, click **Empty Beaker**, then switch to **Bacterial Cell** and repeat the same procedure (NaCl, one addition, stir, insert cell). Compare the two cells' responses.*

**(A)** (1 pt) **Describe** how different organisms maintain distinct internal solute compositions and water potentials.

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**(B)** (1 pt) **Explain** the relationship between a cell's internal solute potential and the external solution's water potential in determining the direction and magnitude of water movement.

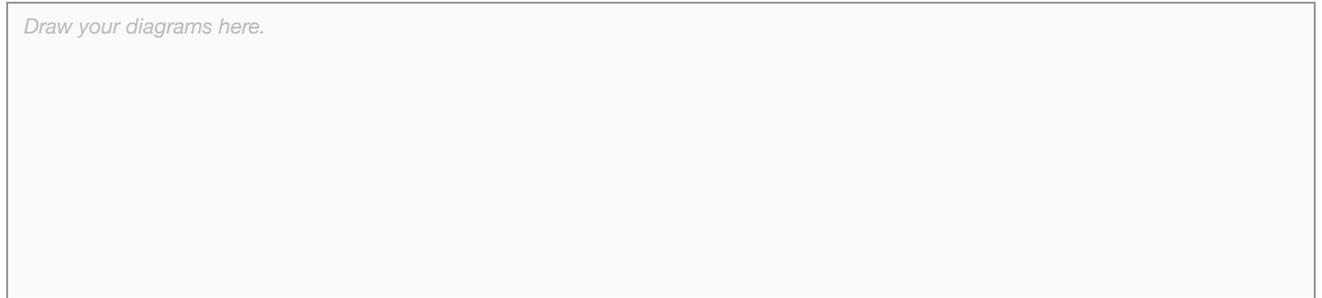
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**(C)** (1 pt) **Represent** the water movement in both cell types.

*Draw your diagrams here.*



**(D)** (1 pt) **Explain** how a disruption in an organism's ability to regulate its internal water potential could affect gene expression and the production of proteins needed for cellular function.

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