Osmosis: water movement and cell responses

Biology · Year 11 · Starting

Read the explanations and worked teaching examples, then attempt the practice. Type in the answer fields or write on a printed copy. Save the PDF to keep typed responses. PDF responses are not submitted to the platform.

Name: _____ Date: _____

Take the time you need. Complete each phase and revisit any step you cannot yet explain.

Get ready

Learning goal

Predict and explain osmosis, show cell responses and calculate evidence from mass changes.

- I can identify permeability and predict initial net water movement under stated conditions.
- I can explain plant and animal responses using the membrane, water movement and wall.
- I can show every step of a signed percentage mass change and check it.
- I can interpret mass-change data without confusing an estimate with proof.

The idea in context

A tissue sample gains mass in one solution and loses it in another. What moved, why did it move, and what do the measurements actually establish?

Before you begin

Compare a concentration and identify a membrane

A solute is dissolved material; water is the solvent in this lesson. A membrane is a boundary with specified permeability. A concentration is an amount per volume. mol/L means moles of a substance per litre; comparing the same solute does not require counting individual molecules.

solute, solvent, concentration, selectively permeable: Dissolved material; dissolving liquid; amount per volume; permits some substances but not others.

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Watch the prerequisite 1

Cup A has six solute symbols in two equal volume units. Cup B has four in one unit. Which is more concentrated?

Step 1

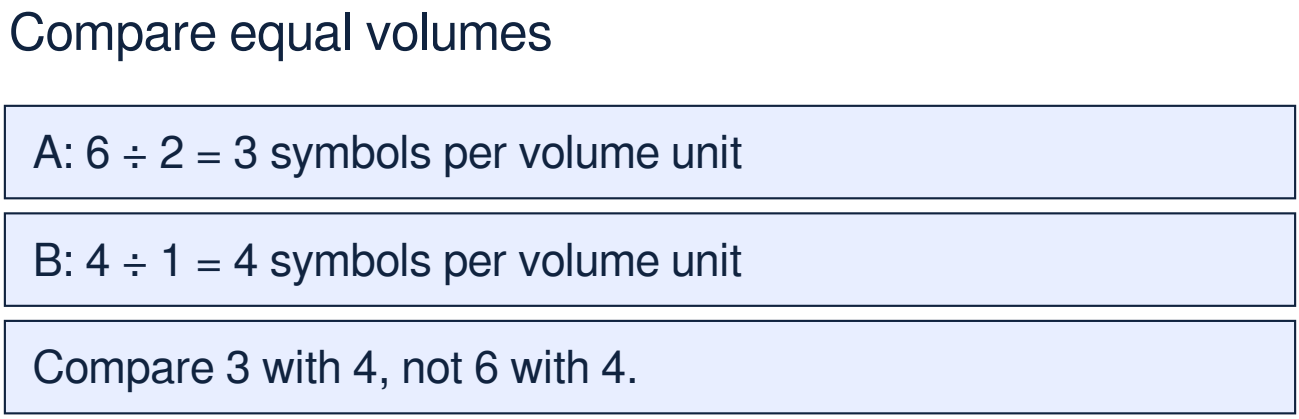
Before: A: 6 symbols in 2 units; B: 4 in 1.

Action: Compare amount per volume.

Operation: Share the six A symbols equally across two units: 3 in each. B already has one unit with 4.

After: A: 6 ÷ 2 = 3 per unit. B: 4 ÷ 1 = 4 per unit.

Why: Concentration is amount divided by volume, not total amount.



Compare equal volumes

Compare equal volumes. A: 6 ÷ 2 = 3 symbols per volume unit; B: 4 ÷ 1 = 4 symbols per volume unit; Compare 3 with 4, not 6 with 4.

Step 2

Before: A: 3 per unit; B: 4 per unit.

Action: Compare the ratios.

Operation: Compare equal one-unit portions.

After: B is more concentrated.

Why: A larger total amount can still be spread through a larger volume.

B is more concentrated: 4 per unit exceeds 3 per unit. More total symbols in A does not reverse the ratio.

Complete the missing step 1

A has 8 symbols in 2 units: 8 ÷ 2 = __ per unit. B has 3 in 1 unit: __ per unit. Compare.

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Complete the missing step — continued

Try a fresh question 1

Compare 9 symbols in 3 units with 4 in 1 unit. Explain.

Subtract, divide and express a change per hundred

Subtract final minus initial to keep direction. A negative difference means loss. Divide the change by the nonzero starting quantity. Multiply the resulting fraction by one hundred to express it as a percentage.

initial, final, signed change, percent: Before; after; a difference retaining gain or loss; per hundred.

Watch the prerequisite 1

What percentage is a change of 2 g compared with an initial 10 g?

Step 1

Before: Change 2 g; initial 10 g.

Action: Find the fraction of the original.

Operation: Divide: 2 g ÷ 10 g = 0.2; g ÷ g = 1.

After: The fraction is 0.2, or two tenths.

Why: The units cancel as matching factors in the ratio.

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Step 2

Before: 2/10 = ?/100.

Action: Express the same fraction per hundred.

Operation: Multiply numerator and denominator by 10: (2 × 10)/(10 × 10) = 20/100.

After: 20 out of 100 is 20%.

Why: Scaling both parts of a fraction equally preserves its value.

A percentage is a ratio per hundred

$$2\ \text{g} \div 10\ \text{g} = 2/10 = 0.2$$

$$(2 \times 10)/(10 \times 10) = 20/100$$

$$0.2 \times 100 = 20\%$$

A percentage is a ratio per hundred

A percentage is a ratio per hundred. 2 g ÷ 10 g = 2/10 = 0.2; (2 × 10)/(10 × 10) = 20/100; 0.2 × 100 = 20%

2 g compared with 10 g is 20%. Check that 20% of 10 g is 0.20 × 10 = 2 g.

Complete the missing step 1

A change of 3 g from an initial 10 g gives 3 ÷ 10 = __; multiply by 100 to get __%.

Try a fresh question 1

A sample loses 1 g from an initial 5 g. Express the signed percentage change.

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Starting-point question 1
Which is more concentrated: 2 symbols in one equal volume unit, or 6 in three units?

Starting-point question 2
A boundary allows water through but blocks sucrose. Which substance can change sides?

Starting-point question 3
What is 8 – 10? What does the negative sign mean for a mass changing from 10 g to 8 g?

Starting-point question 4
A sample changes from 5 g to 6 g. Which value is the initial reference?

Watch — I do

This Starting lesson teaches initial osmosis direction, plant and animal responses, percentage mass change and cautious interpretation of tissue data. It does not teach a complete membrane-transport course, water-potential equations or experimental proof from one measurement.

Osmosis is net water movement across a selectively permeable membrane from higher to lower water potential. Water molecules move in both directions. Net means the difference between the two opposing transfers; it is not every molecule travelling one way.

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Keep the method visible

1. Water can cross the membrane.
2. Check solute permeability and pressure.
3. Compare water potential; draw net movement.

Keep the method visible

Keep the method visible. 1. Water can cross the membrane.; 2. Check solute permeability and pressure.; 3. Compare water potential; draw net movement.

For the first models, compare the same non-penetrating solute at equal temperature and equal initial pressure. Then the more dilute side has higher water potential, so initial net water moves toward the more concentrated side. If pressure differs or solute crosses, do not apply this simplified rule without revising the model.

Choose a method from the question: predicting movement → identify permeability and compare water potential; predicting cell response → also identify the wall; calculating data → final minus initial, divide by initial, multiply by 100; interpreting results → read sign or zero and evaluate limits.

Keep the method visible

Movement: membrane and water potential

Cell response: movement plus wall

Mass change: signed change / initial × 100

Keep the method visible

Keep the method visible. Movement → membrane and water potential; Cell response → movement plus wall; Mass change → signed change / initial × 100

A cell membrane and a plant cell wall are different. The membrane controls passage. A plant wall can resist expansion: water entry raises turgor pressure. Animal cells lack that rigid wall. Water loss reduces plant-cell turgor; enough loss can separate the membrane from the wall, called plasmolysis.

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In this non-penetrating-solute model, hypotonic means the outside is more dilute relative to the cell and tends to cause water entry; hypertonic means more concentrated and tends to cause water loss; isotonic means no sustained volume change from the effective solutes. These terms compare two sides, not a solution by itself. Use the pressure conditions when discussing a plant cell.

Percentage mass change = (final mass − initial mass) ÷ initial mass × 100. The initial mass must be nonzero. Keep units until the ratio is formed; matching mass units cancel. A plus sign means net gain; a minus sign means net loss. A zero means no detected net mass change, not still water molecules.

Keep the method visible

Change = final − initial

Fraction = change ÷ initial

Percentage = fraction × 100

Keep the method visible

Keep the method visible. Change = final − initial; Fraction = change ÷ initial; Percentage = fraction × 100

Tissue mass is evidence, not a direct count of water crossing. Use consistent blotting, matching samples, controlled exposure and repeated measurements. Damage, surface solution or solute exchange can weaken an osmosis explanation. These examples use invented classroom data; they are not measurements from a real experiment.

Read each question by naming the object, membrane, moving substance, initial conditions and required conclusion. Write the comparison before the arrow. For data, write the formula before substituting. Check the sign, units and whether the conclusion answers the original question.

Watch — worked models

Follow the model

A flexible model bag contains 0.6 mol/L sucrose and is in 0.2 mol/L sucrose. The membrane passes water but not sucrose. Temperature and initial pressure are equal. Predict the initial net water movement and bag size change.

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Step 1

Before: Inside 0.6; outside 0.2 mol/L.

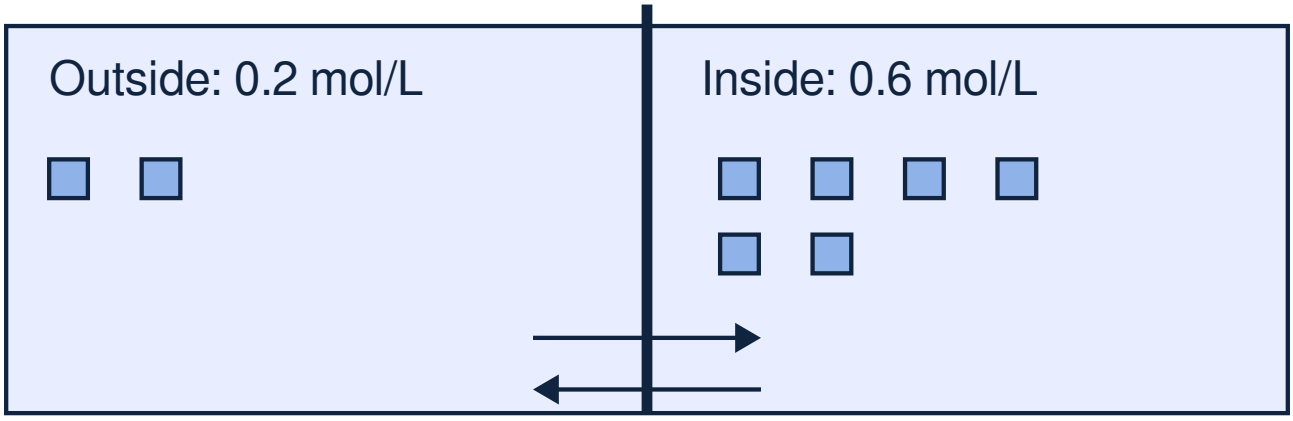
Action: Mark the membrane and compare the same solute.

Operation: Mark sucrose as unable to cross. Mark water as able to cross.

After: Water can change sides; the sucrose stays on its own side.

Why: Osmosis concerns water crossing a selectively permeable boundary.

Water passes; the named solute does not.



Small arrows: water moves both ways.

Predict and justify the net direction.

Squares = solute. Schematic; not to scale.

Compare the two sides: Outside and Inside

Outside: 0.2 mol/L solute; Inside: 0.6 mol/L. A central membrane passes water but not this solute. The net direction is left for the learner to determine. Individual water molecules cross in both directions. Equal initial pressure and temperature are assumed.

Step 2

Before: Outside 0.2; inside 0.6 mol/L.

Action: Identify the lower solute concentration.

Operation: Compare 0.2 with 0.6.

After: The lower concentration is 0.2 mol/L.

Why: For this same-solute model at equal initial pressure, lower solute concentration means higher water potential.

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Step 3

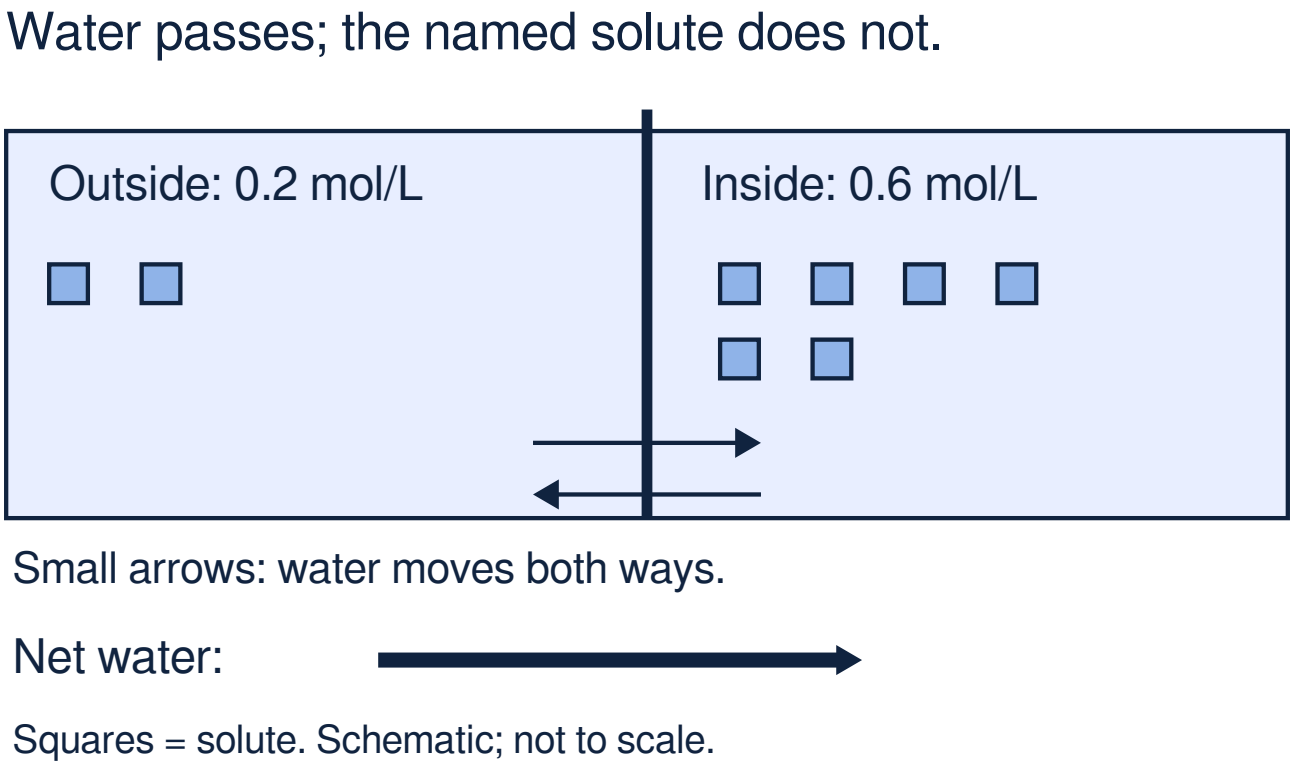
Before: Water molecules cross both ways.

Action: Draw the initial net water direction.

Operation: Draw the larger net arrow outside → inside.

After: Initial net water movement: outside → inside.

Why: More water crosses in this direction than the opposite direction; molecules do not stop moving randomly.



Compare the two sides: Outside and Inside

Outside: 0.2 mol/L solute; Inside: 0.6 mol/L. A central membrane passes water but not this solute. The net water arrow points right. Individual water molecules cross in both directions. Equal initial pressure and temperature are assumed.

Step 4

Before: The bag gains water overall.

Action: Connect water movement to the bag.

Operation: Track the water crossing the bag boundary.

After: The flexible bag initially swells.

Why: Gaining water increases volume; losing water decreases volume. The model contains no rigid wall.

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Step 5

Before: Predicted movement: outside → inside.

Action: Check the assumptions and the prediction.

Operation: Confirm water permeability, blocked sucrose and equal initial pressure.

After: Prediction applies initially; it does not specify the final bag volume.

Why: Water movement changes concentration, and any developing pressure can oppose further net movement.

Initial net water movement is outside → inside; the bag gains water and initially swells. Sucrose is not the substance crossing in this model. Both directions of water movement remain possible.

Follow the model

A flexible model bag contains 0.2 mol/L sucrose and is in 0.6 mol/L sucrose. The membrane passes water but not sucrose. Temperature and initial pressure are equal. Predict the initial net water movement and bag size change.

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Step 1

Before: Inside 0.2; outside 0.6 mol/L.

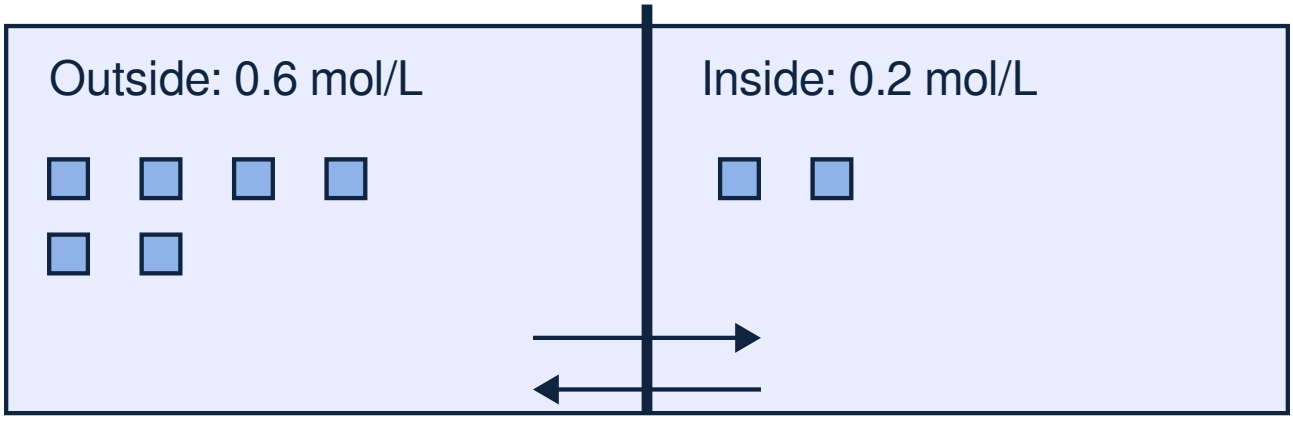
Action: Mark the membrane and compare the same solute.

Operation: Mark sucrose as unable to cross. Mark water as able to cross.

After: Water can change sides; the sucrose stays on its own side.

Why: Osmosis concerns water crossing a selectively permeable boundary.

Water passes; the named solute does not.



Small arrows: water moves both ways.

Predict and justify the net direction.

Squares = solute. Schematic; not to scale.

Compare the two sides: Outside and Inside

Outside: 0.6 mol/L solute; Inside: 0.2 mol/L. A central membrane passes water but not this solute. The net direction is left for the learner to determine. Individual water molecules cross in both directions. Equal initial pressure and temperature are assumed.

Step 2

Before: Outside 0.6; inside 0.2 mol/L.

Action: Identify the lower solute concentration.

Operation: Compare 0.6 with 0.2.

After: The lower concentration is 0.2 mol/L.

Why: For this same-solute model at equal initial pressure, lower solute concentration means higher water potential.

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Step 3

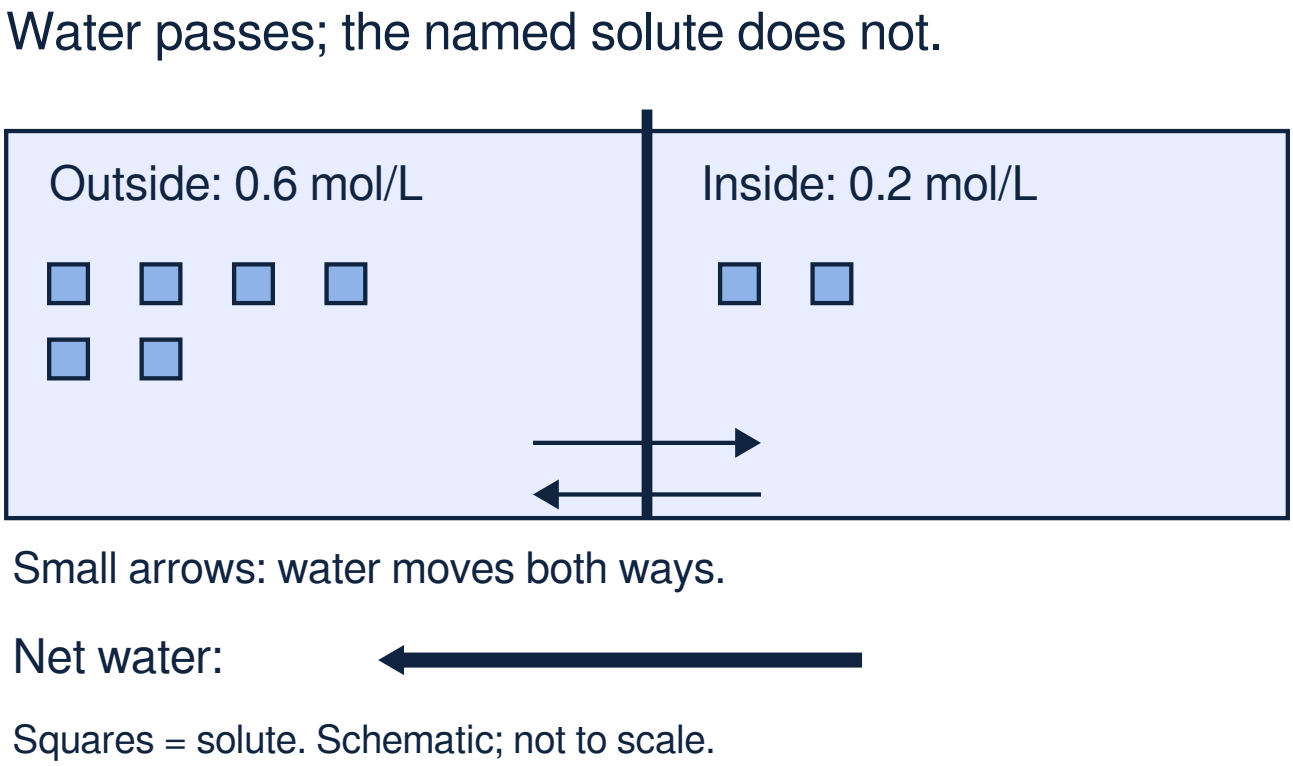
Before: Water molecules cross both ways.

Action: Draw the initial net water direction.

Operation: Draw the larger net arrow inside → outside.

After: Initial net water movement: inside → outside.

Why: More water crosses in this direction than the opposite direction; molecules do not stop moving randomly.



Compare the two sides: Outside and Inside

Outside: 0.6 mol/L solute; Inside: 0.2 mol/L. A central membrane passes water but not this solute. The net water arrow points left. Individual water molecules cross in both directions. Equal initial pressure and temperature are assumed.

Step 4

Before: The bag loses water overall.

Action: Connect water movement to the bag.

Operation: Track the water crossing the bag boundary.

After: The flexible bag initially shrinks.

Why: Gaining water increases volume; losing water decreases volume. The model contains no rigid wall.

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Step 5

Before: Predicted movement: inside → outside.

Action: Check the assumptions and the prediction.

Operation: Confirm water permeability, blocked sucrose and equal initial pressure.

After: Prediction applies initially; it does not specify the final bag volume.

Why: Water movement changes concentration, and any developing pressure can oppose further net movement.

Initial net water movement is inside → outside; the bag loses water and initially shrinks. Sucrose is not the substance crossing in this model. Both directions of water movement remain possible.

Follow the model

A animal cell initially has 0.4 mol/L non-penetrating solute inside and 0.1 mol/L outside. Use the equal initial pressure model to predict the initial water movement and explain the cell response.

Step 1

Before: A animal cell in solution.

Action: Identify the boundary and cell structure.

Operation: Mark the cell membrane. Do not add a cell wall.

After: The membrane controls passage; no rigid wall resists expansion.

Why: A plant wall and cell membrane are different structures.

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Step 2

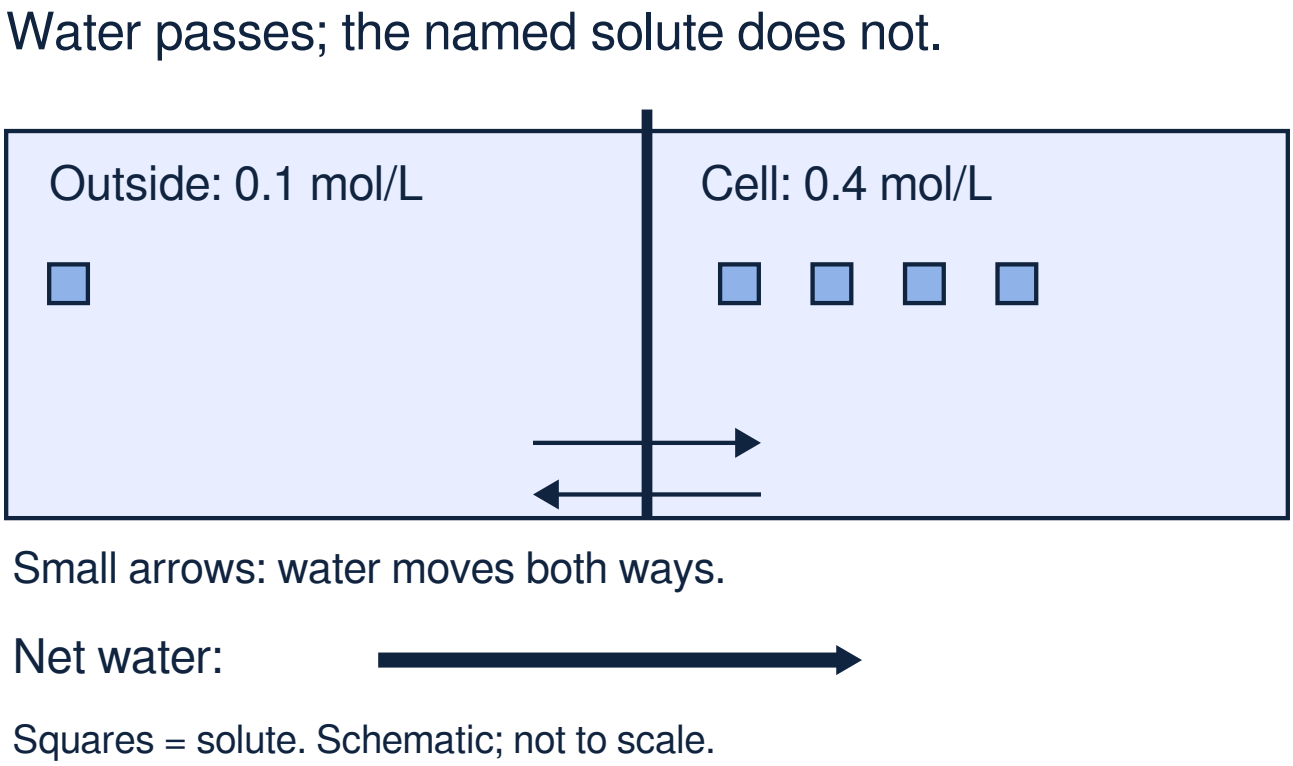
Before: Outside 0.1; inside 0.4 mol/L.

Action: Compare solute concentrations under the stated conditions.

Operation: Use the same non-penetrating solute and equal initial pressure.

After: Initial net water direction: outside → cell.

Why: The lower-solute side initially has higher water potential.



Compare the two sides: Outside and Cell

Outside: 0.1 mol/L solute; Cell: 0.4 mol/L. A central membrane passes water but not this solute. The net water arrow points right. Individual water molecules cross in both directions. Equal initial pressure and temperature are assumed.

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Step 3

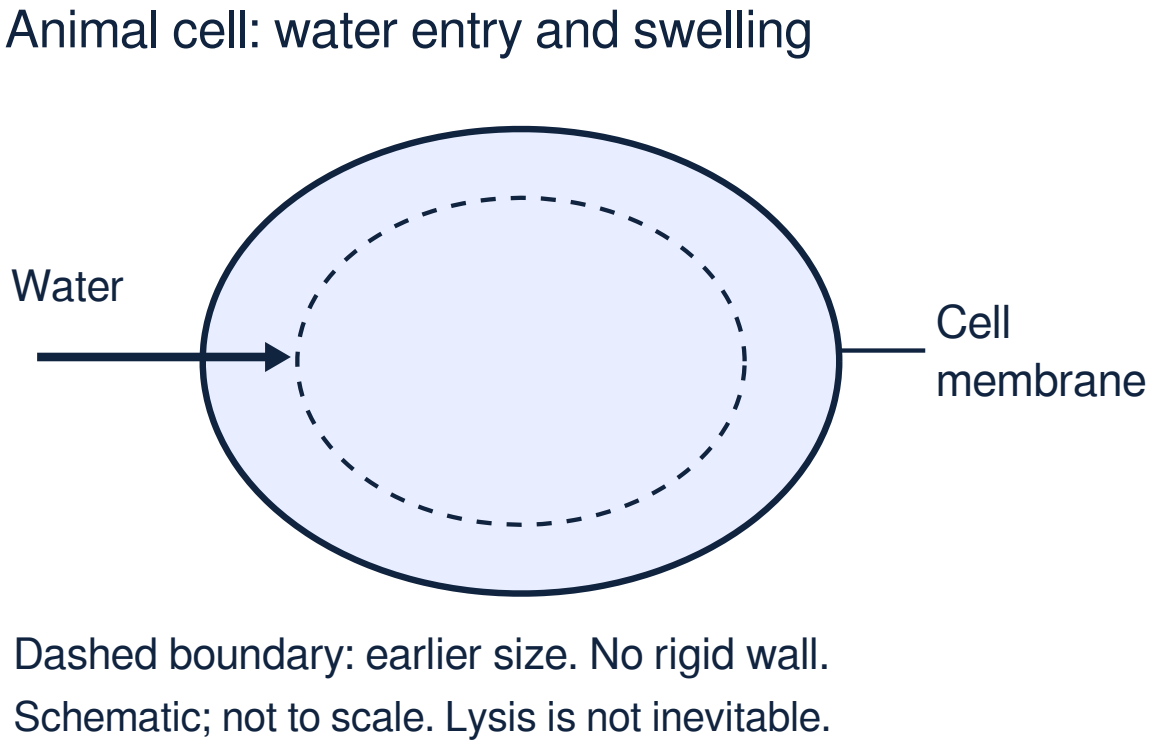
Before: Water enters overall.

Action: Follow the water into the cell response.

Operation: Connect net movement to volume and the presence or absence of a wall.

After: The animal cell swells and may burst if water entry is excessive.

Why: Water gain expands cell contents; water loss reduces their volume. A rigid wall changes the result.



Animal cell: water entry can cause swelling

An animal cell membrane is drawn as an enlarged ellipse. A smaller dashed ellipse marks its earlier size. A water arrow points inward. There is no cell wall. This is a schematic, not to scale; no bursting time is predicted.

Step 4

Before: The animal cell swells and may burst if water entry is excessive.

Action: Check what the prediction does not establish.

Operation: Ask whether duration, membrane properties and pressure are known.

After: Do not claim every animal cell bursts or every plant cell plasmolyses immediately.

Why: The direction alone cannot establish the final size, timing or severity.

Initial net water movement is outside → cell. The animal cell swells and may burst if water entry is excessive. The outcome depends on the cell structure and continued conditions.

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Follow the model

A plant cell initially has 0.4 mol/L non-penetrating solute inside and 0.1 mol/L outside. Use the equal initial pressure model to predict the initial water movement and explain the cell response.

Step 1

Before: A plant cell in solution.

Action: Identify the boundary and cell structure.

Operation: Mark the cell membrane. Add a rigid cell wall outside it.

After: The membrane controls passage; the wall can resist expansion.

Why: A plant wall and cell membrane are different structures.

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Step 2

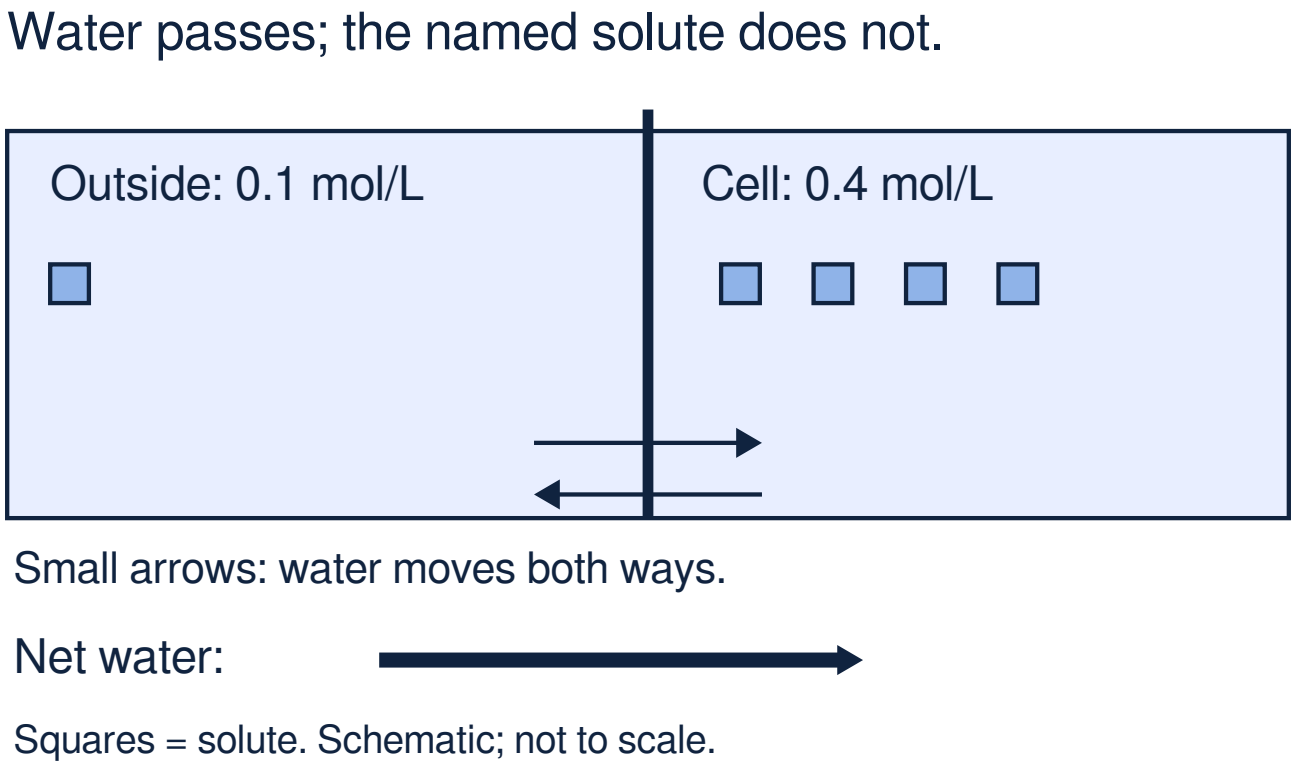
Before: Outside 0.1; inside 0.4 mol/L.

Action: Compare solute concentrations under the stated conditions.

Operation: Use the same non-penetrating solute and equal initial pressure.

After: Initial net water direction: outside → cell.

Why: The lower-solute side initially has higher water potential.



Compare the two sides: Outside and Cell

Outside: 0.1 mol/L solute; Cell: 0.4 mol/L. A central membrane passes water but not this solute. The net water arrow points right. Individual water molecules cross in both directions. Equal initial pressure and temperature are assumed.

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Step 3

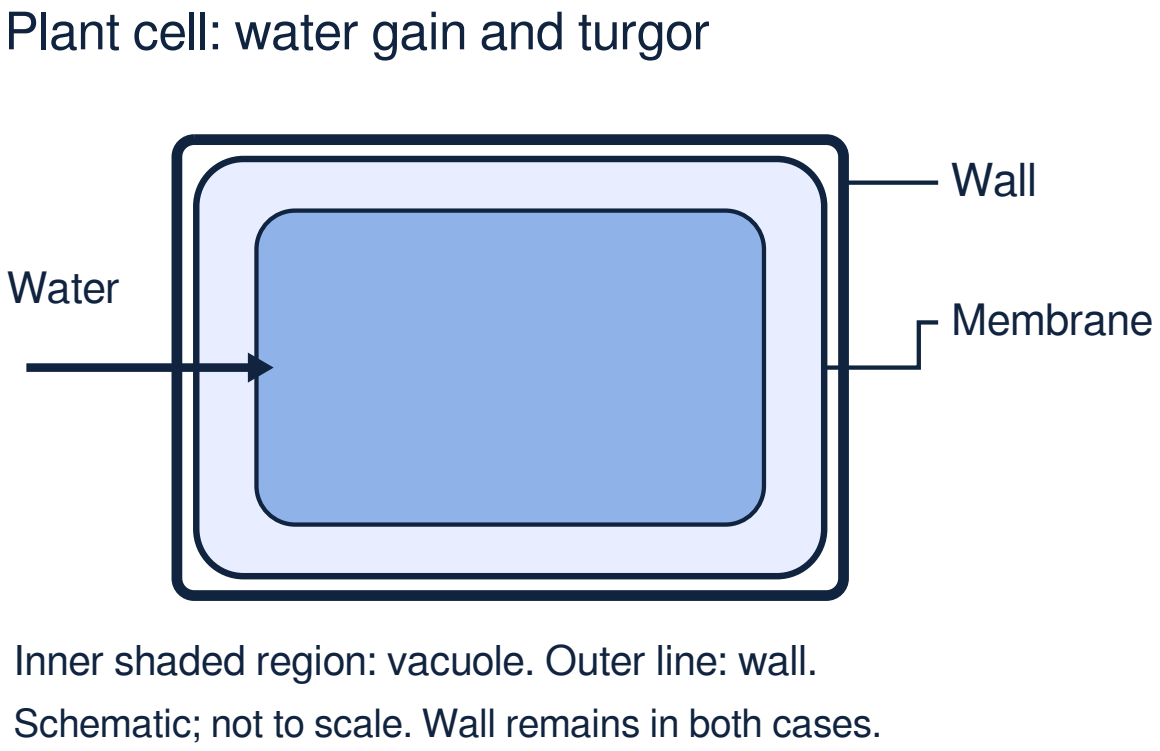
Before: Water enters overall.

Action: Follow the water into the cell response.

Operation: Connect net movement to volume and the presence or absence of a wall.

After: Water entry makes the plant cell turgid as pressure builds against the wall.

Why: Water gain expands cell contents; water loss reduces their volume. A rigid wall changes the result.



Plant cell: turgor builds against the wall

A rectangular cell wall retains its shape. The membrane and expanded contents lie close to the wall, showing turgor. Plain leader lines label the wall and membrane. A water arrow points inward. Schematic, not to scale.

Step 4

Before: Water entry makes the plant cell turgid as pressure builds against the wall.

Action: Check what the prediction does not establish.

Operation: Ask whether duration, membrane properties and pressure are known.

After: Do not claim every animal cell bursts or every plant cell plasmolyses immediately.

Why: The direction alone cannot establish the final size, timing or severity.

Initial net water movement is outside → cell. Water entry makes the plant cell turgid as pressure builds against the wall. The outcome depends on the cell structure and continued conditions.

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Follow the model

A plant cell initially has 0.2 mol/L non-penetrating solute inside and 0.8 mol/L outside. Use the equal initial pressure model to predict the initial water movement and explain the cell response.

Step 1

Before: A plant cell in solution.

Action: Identify the boundary and cell structure.

Operation: Mark the cell membrane. Add a rigid cell wall outside it.

After: The membrane controls passage; the wall can resist expansion.

Why: A plant wall and cell membrane are different structures.

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Step 2

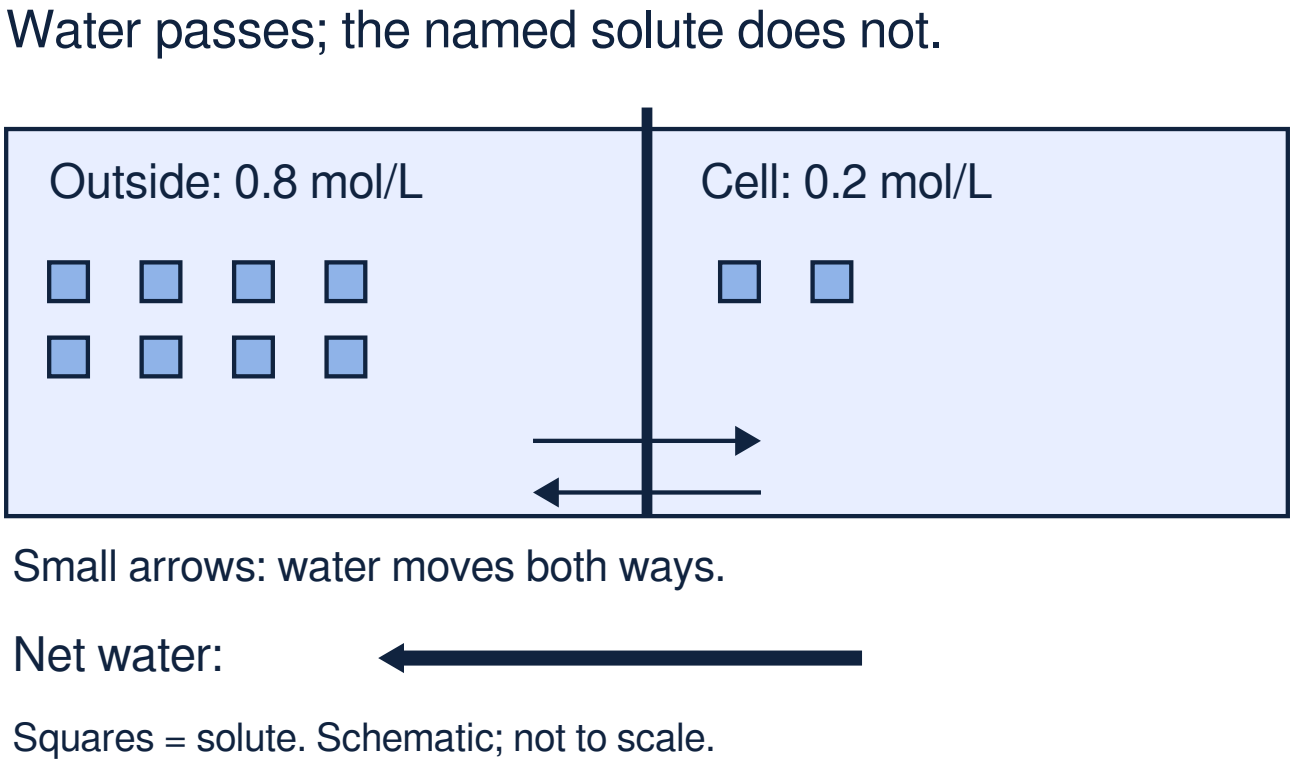
Before: Outside 0.8; inside 0.2 mol/L.

Action: Compare solute concentrations under the stated conditions.

Operation: Use the same non-penetrating solute and equal initial pressure.

After: Initial net water direction: cell → outside.

Why: The lower-solute side initially has higher water potential.



Compare the two sides: Outside and Cell

Outside: 0.8 mol/L solute; Cell: 0.2 mol/L. A central membrane passes water but not this solute. The net water arrow points left. Individual water molecules cross in both directions. Equal initial pressure and temperature are assumed.

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Step 3

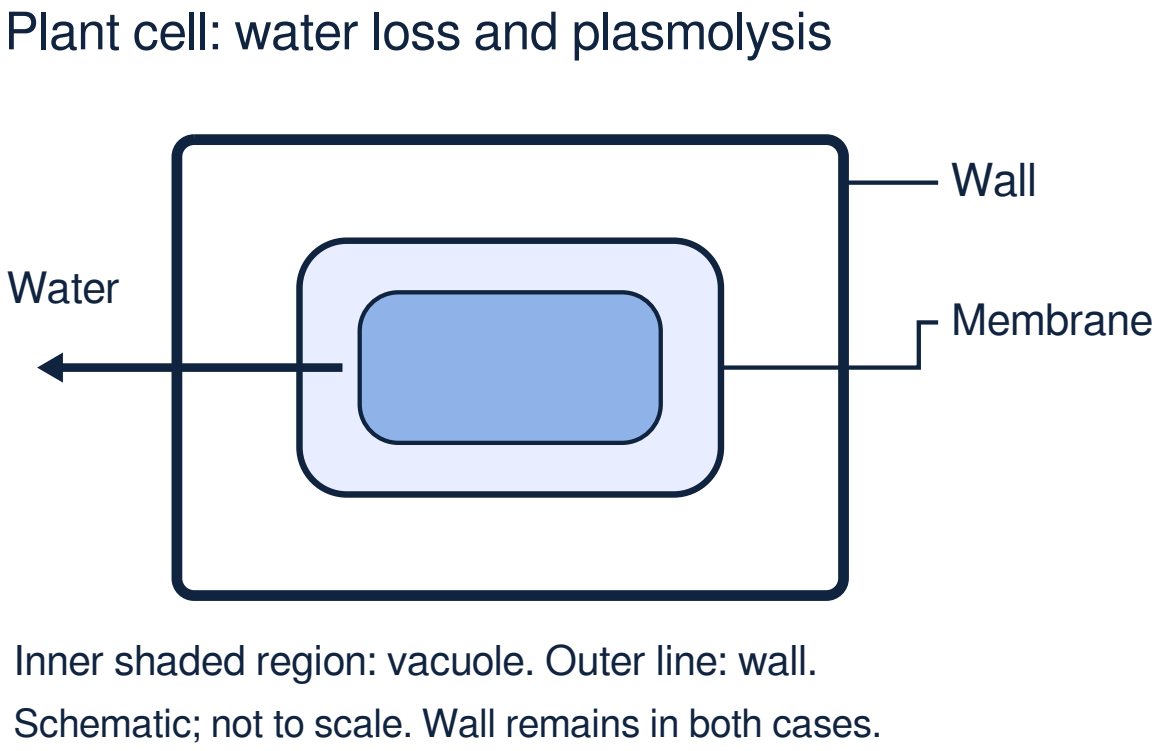
Before: Water leaves overall.

Action: Follow the water into the cell response.

Operation: Connect net movement to volume and the presence or absence of a wall.

After: Water loss reduces turgor; sufficient loss can pull the membrane away from the wall (plasmolysis).

Why: Water gain expands cell contents; water loss reduces their volume. A rigid wall changes the result.



Plant cell: contents shrink away from the wall

A rectangular cell wall retains its shape. A smaller membrane and contents are separated from the wall by a clear gap, illustrating plasmolysis. Plain leader lines label the wall and membrane. A water arrow points outward. Schematic, not to scale.

Step 4

Before: Water loss reduces turgor; sufficient loss can pull the membrane away from the wall (plasmolysis).

Action: Check what the prediction does not establish.

Operation: Ask whether duration, membrane properties and pressure are known.

After: Do not claim every animal cell bursts or every plant cell plasmolyses immediately.

Why: The direction alone cannot establish the final size, timing or severity.

Initial net water movement is cell → outside. Water loss reduces turgor; sufficient loss can pull the membrane away from the wall (plasmolysis). The outcome depends on the cell structure and continued conditions.

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Follow the model

A blotted tissue sample changes from 4.0 g to 4.6 g in solution. Calculate percentage mass change and interpret its sign. Assume mass change mainly reflects water movement.

Step 1

Before: 4.0 g before; 4.6 g after.

Action: Name the initial and final measurements.

Operation: Label initial mass as the starting reference.

After: Initial = 4.0 g; final = 4.6 g.

Why: Percentage change compares the change with the original amount.

Step 2

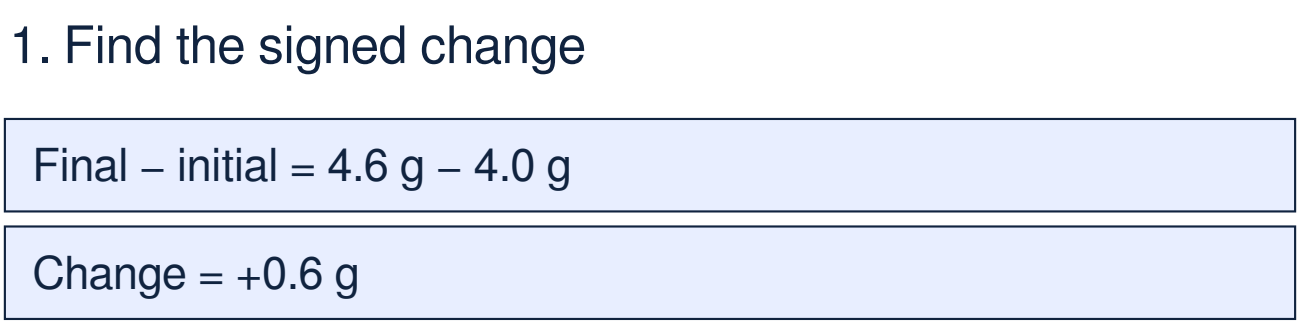
Before: Change = final − initial.

Action: Subtract initial mass from final mass.

Operation: 4.6 g − 4.0 g = +0.6 g.

After: Change = +0.6 g.

Why: Final minus initial is positive for a gain and negative for a loss.



1. Find the signed change

1. Find the signed change. Final − initial = 4.6 g − 4.0 g; Change = +0.6 g

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Step 3

Before: Fractional change = (+0.6 g) ÷ (4.0 g).

Action: Divide by the initial mass.

Operation: Divide the numbers: +0.6 ÷ 4.0 = 0.15. Divide matching units: g ÷ g = 1.

After: Fractional change = 0.15, with no mass unit.

Why: The denominator is the original mass, not the final mass. Matching nonzero units form a dimensionless ratio.

Step 4

Before: Fractional change = 0.15.

Action: Convert the fraction to a percentage.

Operation: 0.15 × 100 = 15.

After: Percentage mass change = 15%.

Why: A percentage expresses the same ratio per hundred.

2. Use the initial mass

$$(+0.6\ \text{g}) \div (4.0\ \text{g}) = 0.15$$

$$0.15 \times 100 = 15\%$$

$$\text{Check: initial} \times (1 + \text{percentage} / 100)$$

2. Use the initial mass

2. Use the initial mass. (+0.6 g) ÷ (4.0 g) = 0.15; 0.15 × 100 = 15%; Check: initial × (1 + percentage / 100)

Step 5

Before: Percentage change = 15%.

Action: Reverse the calculation and interpret the sign.

Operation: 4.0 × (1 + (15/100)) = 4.0 × 1.15 = 4.6 g.

After: The reconstructed final mass matches; the sample had a net water gain.

Why: The sign gives the direction of net mass change. Surface water, damage or solute movement would weaken the osmosis inference.

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(4.6 – 4.0) ÷ 4.0 × 100 = 15%. Reconstruction gives 4.6 g, confirming the calculation. The sign indicates a net water gain under the stated assumptions.

Follow the model

A blotted tissue sample changes from 5.0 g to 4.4 g in solution. Calculate percentage mass change and interpret its sign. Assume mass change mainly reflects water movement.

Step 1

Before: 5.0 g before; 4.4 g after.

Action: Name the initial and final measurements.

Operation: Label initial mass as the starting reference.

After: Initial = 5.0 g; final = 4.4 g.

Why: Percentage change compares the change with the original amount.

Step 2

Before: Change = final – initial.

Action: Subtract initial mass from final mass.

Operation: 4.4 g – 5.0 g = –0.6 g.

After: Change = –0.6 g.

Why: Final minus initial is positive for a gain and negative for a loss.

1. Find the signed change

Final – initial = 4.4 g – 5.0 g

Change = –0.6 g

1. Find the signed change

1. Find the signed change. Final – initial = 4.4 g – 5.0 g; Change = –0.6 g

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Step 3

Before: Fractional change = (–0.6 g) ÷ (5.0 g).

Action: Divide by the initial mass.

Operation: Divide the numbers: –0.6 ÷ 5.0 = -0.12. Divide matching units: g ÷ g = 1.

After: Fractional change = -0.12, with no mass unit.

Why: The denominator is the original mass, not the final mass. Matching nonzero units form a dimensionless ratio.

Step 4

Before: Fractional change = -0.12.

Action: Convert the fraction to a percentage.

Operation: -0.12 × 100 = -12.

After: Percentage mass change = -12%.

Why: A percentage expresses the same ratio per hundred.

2. Use the initial mass

$$(-0.6\ \text{g}) \div (5.0\ \text{g}) = -0.12$$

$$-0.12 \times 100 = -12\%$$

$$\text{Check: initial} \times (1 + \text{percentage} / 100)$$

2. Use the initial mass

2. Use the initial mass. (–0.6 g) ÷ (5.0 g) = -0.12; -0.12 × 100 = -12%; Check: initial × (1 + percentage / 100)

Step 5

Before: Percentage change = -12%.

Action: Reverse the calculation and interpret the sign.

Operation: 5.0 × (1 + (-12/100)) = 5.0 × 0.88 = 4.4 g.

After: The reconstructed final mass matches; the sample had a net water loss.

Why: The sign gives the direction of net mass change. Surface water, damage or solute movement would weaken the osmosis inference.

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(4.4 – 5.0) ÷ 5.0 × 100 = -12%. Reconstruction gives 4.4 g, confirming the calculation. The sign indicates a net water loss under the stated assumptions.

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Follow the model

Illustrative tissue data: at 0.1, 0.2, 0.3 and 0.4 mol/L external sucrose, mean mass changes are +8%, +4%, 0% and –4%. What does the zero suggest?

Step 1

Before: External concentration and mean percentage mass change.

Action: Read the quantities before interpreting the pattern.

Operation: Name concentration as the changed condition; mass change as the measured response.

After: Positive means gain; negative means loss.

Why: The axes describe different quantities; neither is a count of water molecules.

Illustrative results, not measured data

External sucrose (mol/L)	Mean change (%)
0.1	+8
0.2	+4
0.3	0
0.4	–4

Illustrative results, not measured data

Illustrative results, not measured data. External sucrose (mol/L) Mean change (%); 0.1 +8; 0.2 +4; 0.3 0; 0.4 –4

Step 2

Before: The mean changes from positive to zero to negative.

Action: Find the no-net-change result.

Operation: Select the 0% row, then read its concentration.

After: The no-net-mass-change concentration is about 0.3 mol/L in this model.

Why: With suitable controls, this is evidence of approximately equal water potential across the tissue boundary.

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Step 3

Before: Mean mass change is zero.

Action: Separate net change from molecular movement.

Operation: Draw equal opposing water arrows rather than no arrows.

After: Water molecules can continue crossing both ways with no net gain.

Why: Dynamic balance is not molecular stillness.

Step 4

Before: A mean of zero was reported.

Action: Qualify the claim with the measurement limits.

Operation: Check repeats, balance precision, tissue damage and blotting.

After: The data estimate a condition of no net mass change; they do not prove every cell has identical solute concentration.

Why: Biological variation and measurement error can produce an average near zero.

About 0.3 mol/L gave no mean net mass change. Under the stated controls this supports approximate water-potential balance. Water can still cross in both directions.

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Follow the model

Illustrative results show +6% at 0.2 mol/L and −2% at 0.4 mol/L. Neither tested concentration gives 0%. What can be concluded?

Step 1

Before: At 0.2 mol/L: +6%. At 0.4 mol/L: −2%.

Action: Interpret each sign separately.

Operation: Read plus as a net gain and minus as a net loss.

After: The response changes sign between the two tested conditions.

Why: This comparison uses the same tissue protocol and a continuous response assumption.

Bracket the estimate; do not invent a result

0.2 mol/L: +6%: net mass gain

0.4 mol/L: −2%: net mass loss

Test additional concentrations between them.

Bracket the estimate; do not invent a result

Bracket the estimate; do not invent a result. 0.2 mol/L: +6% → net mass gain; 0.4 mol/L: −2% → net mass loss; Test additional concentrations between them.

Step 2

Before: A positive and a negative response surround zero.

Action: State the interval supported by the data.

Operation: Place the no-net-change estimate between 0.2 and 0.4 mol/L.

After: The data support an interval, not an exact value.

Why: Two points alone do not establish a straight-line biological relationship.

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Step 3

Before: The zero lies somewhere within the bracket if the assumed trend holds.

Action: Choose an informative next measurement.

Operation: Test several concentrations within the interval with repeated samples.

After: A denser set of results can narrow the estimate.

Why: New evidence improves precision; writing extra decimal places does not.

The estimated no-net-change condition lies between 0.2 and 0.4 mol/L under the stated trend. Repeat and test intermediate concentrations; no exact concentration is established.

Together — We do

Follow the guided example

Complete together: initial 6.0 g, final 6.3 g. Show the change, reference and percentage.

Step 1

Before: Change = final − initial.

Action: Fill the subtraction before dividing.

Operation: 6.3 − 6.0 = __ g.

After: Now use change ÷ 6.0 × 100.

Why: The starting mass is the reference.

6.3 − 6.0 = +0.3 g; 0.3 ÷ 6.0 = 0.05; 0.05 × 100 = +5%. Check 6.0 × 1.05 = 6.3 g.

Explain a step in your own words or add your working.

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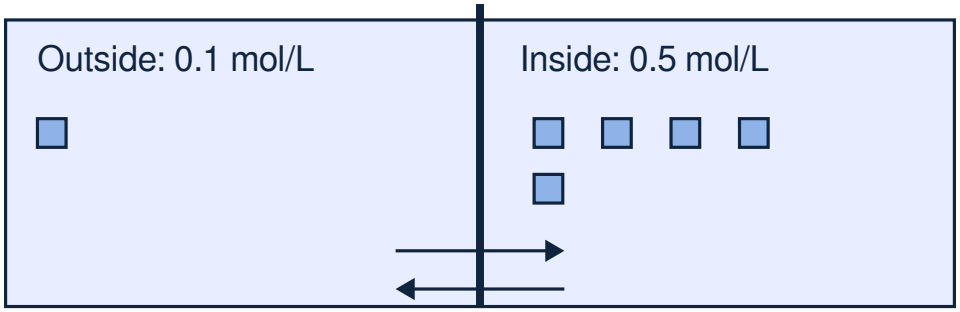
Question 1

Water passes; the named solute does not.



Small arrows: water moves both ways.

Predict and justify the net direction.

Squares = solute. Schematic; not to scale.

Compare the two sides: Outside and Inside

Outside: 0.1 mol/L solute; Inside: 0.5 mol/L. A central membrane passes water but not this solute. The net direction is left for the learner to determine. Individual water molecules cross in both directions. Equal initial pressure and temperature are assumed.

Complete the explanation: outside 0.1 mol/L, inside 0.5 mol/L. Water crosses; solute does not. Equal initial pressure. The lower-solute side is __, so initial net water moves __. Explain why.

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Question 2

Complete the working for a sample changing from 8.0 g to 7.2 g: change = __; fraction = change ÷ __; percentage = __. Explain the sign.

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Question 3

Two structures, two roles

Cell membrane: controls passage.

Cell wall: supports the plant cell.

Explain how these roles interact.

Two structures, two roles

Two structures, two roles. Cell membrane: controls passage.; Cell wall: supports the plant cell.; Explain how these roles interact.

A plant cell gains water. Complete the chain: water entry → larger cell contents → pressure against __ → increased __. Explain why this differs from an animal cell.

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Question 4

Put the steps for finding a no-net-change condition in order. Then apply them to +5% at 0.1 mol/L, 0% at 0.2 mol/L and –5% at 0.3 mol/L.

Number the items from 1 to 3 in the correct order:

____ Find the zero percentage response

____ Check repeats and measurement precision

____ Read its matching concentration

With help

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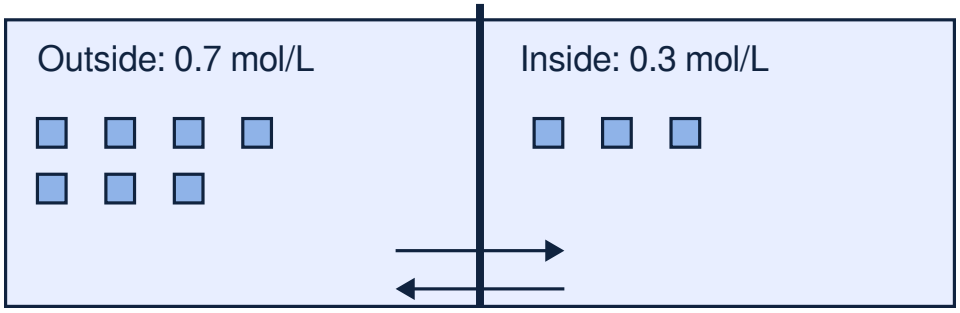
Apply the method: teaching example

A plant cell has lower water potential than the surrounding solution. Use the hints to explain its initial response.

Question 5

Water passes; the named solute does not.



Small arrows: water moves both ways.

Predict and justify the net direction.

Squares = solute. Schematic; not to scale.

Compare the two sides: Outside and Inside

Outside: 0.7 mol/L solute; Inside: 0.3 mol/L. A central membrane passes water but not this solute. The net direction is left for the learner to determine. Individual water molecules cross in both directions. Equal initial pressure and temperature are assumed.

A bag contains 0.3 mol/L non-penetrating solute; outside is 0.7 mol/L. Predict initial net water movement at equal pressure and explain the volume change.

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Question 5 — continued

Question 6

A sample changes from 2.5 g to 3.0 g. Calculate percentage mass change and verify it backwards.

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Question 7

At water-potential balance across a water-permeable membrane, which statement is correct? Explain why.

Circle your answer:

A. Water stops moving entirely.

B. Water can cross both ways with no net transfer.

C. Only solute crosses when water is balanced.

Question 8

Mean mass changes are +3% at 0.25 mol/L and –4% at 0.45 mol/L. Give a defensible estimate range and a useful next step.

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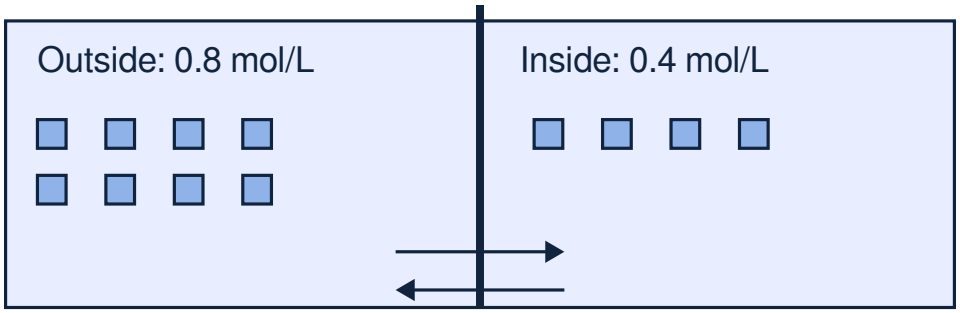
On my own

Question 9

Water passes; the named solute does not.



Small arrows: water moves both ways.

Predict and justify the net direction.

Squares = solute. Schematic; not to scale.

Compare the two sides: Outside and Inside

Outside: 0.8 mol/L solute; Inside: 0.4 mol/L. A central membrane passes water but not this solute. The net direction is left for the learner to determine. Individual water molecules cross in both directions. Equal initial pressure and temperature are assumed.

Outside 0.8 mol/L; inside 0.4 mol/L. A membrane passes water but not this solute. Equal initial pressure. Explain initial net movement and what could limit further change.

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Question 9 — continued

Question 10

Sample A changes from 3.0 g to 3.3 g; sample B changes from 6.0 g to 6.3 g. Which has the larger proportional increase? Show both calculations.

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Question 11

A plant cell in concentrated external solution loses water. Explain the sequence from the membrane boundary to plasmolysis, including a limit on the prediction.

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Question 12

A group forgets to blot tissue before the final mass measurement. Explain the likely bias, its effect on calculated percentage change and how to improve the comparison.

Come back

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Question 13

A bag has 0.2 mol/L solute inside and pure water outside. Water crosses; solute does not. Equal initial pressure. Predict initial movement.

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Question 14

A bag has pure water inside and 0.5 mol/L non-penetrating solute outside. Predict initial movement at equal pressure.

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Question 15

Both sides have 0.3 mol/L of the same non-penetrating solute at equal pressure. Describe both individual and net water movement.

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Question 16

A diagram shows four solute symbols in 1 volume unit on the left and six in 3 units on the right. Which side is more concentrated?

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Question 17

An animal cell begins in a more dilute external solution with non-penetrating solute and equal initial pressure. Explain why “it must instantly burst” is too strong.

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Question 18

A plant cell is placed in a more dilute solution. Explain how its wall affects the response without claiming the wall blocks all water.

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Question 19

In a plant cell losing water, which changes first in the explanation: reduced cell contents or a wall that disappears? Repair the false option.

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Question 20

A blotted sample changes from 10.0 g to 11.5 g. Calculate percentage mass change and reverse-check it.

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Question 21

A blotted sample changes from 4.0 g to 3.2 g. Calculate percentage mass change and interpret it.

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Question 22

A learner calculates a 6.0 g to 6.6 g change as 0.6 ÷ 6.6 × 100. Identify and correct the denominator error.

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Question 23

Samples A and B each gain 0.4 g. Their initial masses are 2.0 g and 8.0 g. Compare proportional gains.

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Question 24

A tissue sample keeps a measured mass of 5.0 g. Calculate percentage change and explain what it does not prove.

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Question 25

Illustrative means are +7% at 0.1 mol/L, 0% at 0.25 mol/L and –6% at 0.4 mol/L. Identify the observed no-net-change condition and qualify the claim.

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Question 26

Illustrative means are +2% at 0.3 mol/L and –3% at 0.5 mol/L. Can you state an exact no-net-change concentration?

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Question 27

Two repeats at the same concentration give +1% and −1%. Their mean is 0%. Explain why this is weaker than proof that each sample was unchanged.

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Question 28

A group blots only the initial tissue, leaving visible solution on the final sample. Explain the effect on its calculated change.

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Question 29

The membrane is freely permeable to both water and the stated solute. Explain why the simple non-penetrating-solute prediction needs revision.

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Question 30

A turgid plant cell has more dissolved solute inside than outside but no net water entry. Does this automatically disprove osmosis?

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Question 31

A gardener sees wilted leaves after soil becomes very concentrated in dissolved salts. Explain a possible water-movement mechanism and why this observation alone is not a complete diagnosis.

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Question 32

A report says: “The tissue lost 12%, so solute must have moved out.” Replace it with a reasoned interpretation and state the necessary assumptions.

Come back — fresh retrieval

Retrieval 1

Outside 0.2 mol/L, inside 0.9 mol/L blocked solute, equal initial pressure. Explain the initial water direction.

Retrieval 2

Initial mass 12.0 g, final mass 10.8 g: calculate signed percentage change.

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Retrieval 2 — continued

Retrieval 3

How does a plant wall change the consequence of net water entry?

Retrieval 4

A mean is zero but repeats are +2%, 0% and −2%. What should the conclusion include?

Apply your understanding

Sample X changes from 4.0 g to 4.4 g; Y changes from 8.0 g to 8.4 g. A report says their equal gram gains prove equal osmotic responses. Evaluate the claim and identify two further controls.

Compare relative changes

X: initial 4.0 g: final 4.4 g

Y: initial 8.0 g: final 8.4 g

Calculate each change relative to its own start.

Compare relative changes

Compare relative changes. X: initial 4.0 g → final 4.4 g; Y: initial 8.0 g → final 8.4 g; Calculate each change relative to its own start.

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Apply your understanding — continued

Lesson review

- I can identify permeability and predict initial net water movement under stated conditions.
- I can explain plant and animal responses using the membrane, water movement and wall.
- I can show every step of a signed percentage mass change and check it.
- I can interpret mass-change data without confusing an estimate with proof.

Use the learning goal to review your work. Explain the main idea in your own words and identify a step to revisit.

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Practice hints

Try each question first. Cover the hints and reveal one at a time when you need support.

Question 1

1. Identify water as the moving substance.
2. Compare the two values under equal pressure.
3. Name the higher-water-potential side and connect the net arrow to a gain or loss.

Question 2

1. Use final minus initial.
2. Subtract 8.0 from 7.2 and keep the negative sign.
3. Divide the signed change by 8.0, then express that fraction per hundred.

Question 3

1. Separate cell wall from membrane.
2. Trace what expanding contents press against.
3. Name the pressure effect and compare the missing animal-cell structure.

Question 4

1. Start with the measured response, not the largest concentration.
2. Locate the zero percentage row.
3. Read its concentration and distinguish balanced crossing from absent movement.

Question 5

1. Mark which substance can cross.
2. Compare 0.3 and 0.7 under equal initial pressure.
3. Draw the net arrow from higher water potential and connect it to volume.

Question 6

1. Use the initial mass as reference.
2. Calculate final minus initial: 3.0 – 2.5.
3. Divide the change by 2.5 and convert the fraction to a percentage.

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Question 7

1. Separate an individual movement from a net total.

2. Draw two opposing arrows through a water-permeable membrane.

3. Explain what must balance, then check whether pressure was specified.

Question 8

1. Interpret the positive and negative signs.

2. Place zero between a gain and a loss.

3. State only the supported interval and choose measurements inside it.

Question 9

1. Name the moving substance and conditions.

2. Compare the two solute concentrations.

3. Trace the resulting water loss and consider what changes as water moves.

Question 10

1. Equal gram gains need not be equal proportions.

2. Find the signed change for each sample.

3. Divide each change by its own initial mass before comparing.

Question 11

1. Follow water, not solute, across the membrane.

2. Connect water loss to the volume of cell contents.

3. Compare the flexible membrane with the supporting wall and state a limit.

Question 12

1. Ask what the balance weighs besides tissue.

2. Extra surface liquid increases the final measurement.

3. Follow that increase through final minus initial, then propose a consistent correction.

Question 13

1. Identify the substance that crosses.

2. Compare zero added solute with 0.2 mol/L.

3. Use higher to lower water potential, then describe the bag.

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Question 14

1. Mark the two sides.

2. Inside has less non-penetrating solute.

3. Follow water from higher water potential and connect to volume.

Question 15

1. There are two different meanings of movement.

2. Draw arrows in both directions through a permeable membrane.

3. State what balances and what continues.

Question 16

1. Concentration compares quantity with volume.

2. Divide each solute count by its own volume.

3. Compare the ratios rather than total counts.

Question 17

1. First establish initial water direction.

2. Relate the direction to cell volume and lack of wall.

3. Separate a possible later result from an inevitable immediate result.

Question 18

1. Distinguish membrane and wall.

2. Track expansion of the contents against the wall.

3. Explain pressure rather than inventing an impermeable wall.

Question 19

1. Identify what loses water.

2. Compare flexible contents with the rigid supporting wall.

3. Describe the membrane position after sufficient loss.

Question 20

1. Use final minus initial.

2. Divide the signed change by the initial 10.0 g.

3. Multiply the fraction by one hundred and reconstruct the final mass.

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Question 21

1. Keep the order final minus initial.
2. The change is negative; do not discard its sign.
3. Divide by 4.0 and convert to a percentage.

Question 22

1. A change is compared with where it started.
2. Label 6.0 g as initial and 6.6 g as final.
3. Divide 0.6 by the initial value before multiplying by one hundred.

Question 23

1. The same gain can be a different fraction of the start.
2. Form one ratio for each starting mass.
3. Convert both ratios before comparing.

Question 24

1. Apply the same formula even when the values match.
2. Subtract first, then divide by the initial mass.
3. Distinguish no detected net change from no microscopic movement.

Question 25

1. Read response and concentration as a pair.
2. Choose the zero response, not the largest concentration.
3. State it as an estimate with the relevant measurement limits.

Question 26

1. Check whether either response is zero.
2. A gain and loss bracket a crossing under the stated trend.
3. Give the supported interval and identify further evidence needed.

Question 27

1. Read individual values before their average.
2. Add the signed values and divide by two.
3. Describe what the opposite signs reveal about the samples.

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Question 28

1. Identify extra material counted in the final weighing.

2. Trace a larger final value through subtraction.

3. Explain the direction of bias and how to standardise the method.

Question 29

1. Check which assumption changed.

2. Both substances can now change their distributions.

3. Explain why a model that traps solute cannot simply be reused.

Question 30

1. Recall the equal-pressure condition.

2. A turgid cell has pressure against its wall.

3. Explain how pressure can oppose the solute effect without stopping individual movement.

Question 31

1. Relate outside solution to root-cell water potential.

2. Connect reduced water supply with turgor in plant tissues.

3. Distinguish a plausible mechanism from proof of the sole cause.

Question 32

1. A percentage describes total measured mass, not molecule identity.

2. Use the non-penetrating-solute assumption from the model.

3. Give the supported water interpretation and state what the measurement cannot establish alone.

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Practice answers and review

Starting-point answers

Starting-point question 1
They match: 2 ÷ 1 = 2 and 6 ÷ 3 = 2 per unit.

Starting-point question 2
Water can change sides; sucrose cannot cross this boundary.

Starting-point question 3
8 – 10 = –2; two grams were lost from the starting mass.

Starting-point question 4
5 g is the initial mass; 6 g is the final mass.

Independent practice answers

Question 1
Compare 0.1 with 0.5: outside has lower solute concentration.

At equal initial pressure its water potential is higher.

Water crosses both ways, but the initial net movement is outside → inside.

The bag initially gains water.

Question 2
Change = 7.2 – 8.0 = –0.8 g.

Divide by initial mass: –0.8 g ÷ 8.0 g = –0.1.

Multiply by 100: –0.1 × 100 = –10%.

Check 8.0 × 0.90 = 7.2 g.

The negative sign indicates net mass loss, consistent with net water loss under the assumptions.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

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Question 3

Water enters the cell contents and vacuole.

They expand against the cell wall, increasing turgor pressure.

The wall resists expansion and can oppose further net entry.

An animal cell has no rigid wall and can swell or lyse.

Water can still cross both ways in a turgid cell.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

Question 4

Find the 0% response first, then read its concentration: about 0.2 mol/L.

No net mass change means gains and losses balance overall.

It does not mean water molecules stop crossing.

Check repeated samples and measurement precision before claiming an exact balance.

Question 5

Water can cross; the named solute cannot.

Inside has lower solute concentration ($0.3 < 0.7$ mol/L), hence higher initial water potential at equal pressure.

Initial net water movement is inside $\rightarrow$ outside.

The flexible bag loses water and initially shrinks.

This does not calculate its final volume.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

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Question 6

Change = 3.0 – 2.5 = +0.5 g.

Fraction = 0.5 g ÷ 2.5 g = 0.2.

Percentage = 0.2 × 100 = +20%.

Reverse check: 2.5 × (1 + 20/100) = 2.5 × 1.2 = 3.0 g.

The positive sign indicates net gain.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

Question 7

The statement confuses net movement with individual movement.

If water can cross, its molecules continue moving in both directions.

At water-potential balance the opposing transfers balance overall, so there is no net water gain.

Equal solute concentration alone is insufficient if pressure differs.

Question 8

The sign changes from gain to loss, so a no-net-change condition is expected between 0.25 and 0.45 mol/L under the same continuous trend.

The data do not prove linearity or an exact midpoint.

Test repeated samples at several concentrations within that interval to narrow the estimate.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

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Question 9

Inside has lower solute concentration and higher initial water potential under equal pressure.

Initial net water movement is inside → outside.

The bag loses water.

Concentrations change as water moves; any developing pressure difference also affects water potential.

Thus the initial comparison does not determine a final volume.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

Question 10

A: 3.3 – 3.0 = +0.3 g; 0.3 ÷ 3.0 = 0.1; 0.1 × 100 = 10%.

B: 6.3 – 6.0 = +0.3 g; 0.3 ÷ 6.0 = 0.05; 0.05 × 100 = 5%.

A has the larger proportional increase although both gain 0.3 g.

Reverse checks: 3.0 × 1.1 = 3.3; 6.0 × 1.05 = 6.3.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

Question 11

Water crosses the cell membrane outward overall when outside has lower water potential.

The cell contents and vacuole lose volume; turgor decreases.

With sufficient loss, the cell membrane pulls away from the wall: plasmolysis.

The wall itself does not shrink in the same way.

The extent and timing are not determined without further information.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

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Question 12

Surface solution adds to the final measured mass without necessarily entering cells.

Final minus initial becomes more positive or less negative, so the calculated percentage change is biased upwards.

Blot all samples using the same gentle procedure before weighing, and keep starting dimensions, solution exposure, temperature and weighing method consistent.

Repeat samples to assess variation.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

Question 13

Pure water has zero added solute, lower than 0.2 mol/L.

At equal pressure it has higher water potential.

Initial net water moves outside → inside; the bag gains water.

Solute remains inside and water still moves individually both ways.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

Question 14

Inside has zero added solute and higher water potential at equal pressure.

Initial net water moves inside → outside, so the bag loses water.

The non-penetrating solute cannot enter to produce this change.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

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Question 15

The water potentials are equal in the model.

Water can cross in both directions, with no net transfer when the opposing movements balance.

Equal means no net change, not motionless molecules.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

Question 16

Left: 4 ÷ 1 = 4 symbols per volume unit.

Right: 6 ÷ 3 = 2 symbols per volume unit.

Compare 4 with 2: the left is more concentrated despite fewer total symbols.

With blocked solute and equal initial pressure, net water would initially move right → left.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

Question 17

The more dilute outside has higher initial water potential, so net water initially enters.

The cell may swell because it lacks a rigid wall.

Bursting depends on the amount and duration of entry and membrane properties, so initial direction alone cannot prove instantaneous lysis.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

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Question 18

Water crosses the cell membrane into the contents overall.

The contents expand against the cell wall; turgor pressure rises.

The supporting wall resists expansion, and the resulting pressure can oppose further net entry.

The wall is not an impermeable water barrier.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

Question 19

Water loss reduces the volume of cell contents and turgor.

With sufficient loss, the membrane may detach from the wall.

The cell wall does not need to disappear for plasmolysis; it remains a supporting boundary.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

Question 20

Change = 11.5 – 10.0 = +1.5 g.

Fraction = 1.5 ÷ 10.0 = 0.15.

Percentage = 0.15 × 100 = +15%.

Reverse check: 10.0 × 1.15 = 11.5 g.

The positive sign means mass gain.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

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Question 21

Change = 3.2 – 4.0 = –0.8 g.

Fraction = –0.8 ÷ 4.0 = –0.2.

Percentage = –0.2 × 100 = –20%.

Check: 4.0 × 0.8 = 3.2 g.

The sample lost mass, consistent with net water loss if other mass changes are negligible.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

Question 22

The change is 6.6 – 6.0 = +0.6 g.

The reference is the starting mass 6.0 g, not final mass 6.6 g.

Correct fraction: 0.6 ÷ 6.0 = 0.1.

Percentage: 0.1 × 100 = +10%.

Check: 6.0 × 1.1 = 6.6 g.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

Question 23

A: 0.4 ÷ 2.0 = 0.2; 0.2 × 100 = 20%.

B: 0.4 ÷ 8.0 = 0.05; 0.05 × 100 = 5%.

A has the greater proportional gain.

Check final masses: 2.0 × 1.2 = 2.4 g; 8.0 × 1.05 = 8.4 g.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

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Question 24

Change = 5.0 – 5.0 = 0 g.

Fraction = 0 ÷ 5.0 = 0.

Percentage = 0 × 100 = 0%.

There was no detected net mass change.

This does not prove water stopped moving, exact balance in every cell, or absence of measurement error.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

Question 25

Locate 0%, then read the matched concentration: 0.25 mol/L.

Under the protocol this is an estimate of a no-net-mass-change condition.

Repeats and measurement precision are needed; it is not proof of identical internal solute concentration in every cell.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

Question 26

No.

The sign change supports a value between 0.3 and 0.5 mol/L if the response is continuous and the protocol is comparable.

Two measurements do not establish a linear relationship.

Test intermediate concentrations and repeat samples; do not invent an exact midpoint.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

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Question 27

Add the results: +1 + (−1) = 0.

Divide by two repeats: 0 ÷ 2 = 0% mean.

One sample gained mass and the other lost mass; they were not individually unchanged.

Variation and measurement error must be considered before interpreting the mean as exact balance.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

Question 28

The final weighing includes surface solution.

This raises final mass, so final minus initial is more positive or less negative.

Dividing by the same positive initial mass preserves that upward bias in percentage change.

Blot initial and final samples consistently without damaging them.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

Question 29

The earlier model assumed solute stayed on its own side.

If solute crosses too, both water movement and solute diffusion can alter the concentrations.

The initial solute comparison alone is insufficient to predict sustained tonicity or the final cell volume.

State permeability and pressure information before choosing a model.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

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Question 30

No.

The simple lower-solute-to-higher-solute rule assumed equal pressure.

Pressure inside a turgid cell can raise its water potential and balance the solute effect.

At balance there is no net entry even though water still crosses both ways.

Pressure must be included before drawing a conclusion.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

Question 31

Concentrated soil solution can have lower water potential than root-cell contents.

Water uptake may be reduced or net water loss may occur, reducing cell turgor and contributing to wilting.

The observation alone does not measure soil water potential or rule out root damage, heat or other causes; further evidence is needed.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

Question 32

A –12% mass change means final mass was 88% of initial mass: 100 – 12 = 88.

If samples were blotted consistently, membranes remained functional and solute movement was negligible, the loss is consistent with net water leaving by osmosis.

Mass data alone do not identify the moving molecule without those assumptions.

• Names the relevant quantities or evidence.

• Shows the method with the necessary intermediate reasoning.

• Checks the result and states its conditions.

With help — worked answer 1

A plant cell has lower water potential than the surrounding solution. Use the hints to explain its initial response.

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Step 1

Before: Outside has higher water potential.

Action: Find the starting direction.

Operation: Water crosses the membrane both ways.

After: Choose the net direction, then explain the wall.

Why: Net movement follows the water-potential difference.

Net water initially enters the plant cell. The contents expand against the wall and turgor increases. Pressure may eventually oppose further net entry.

Later retrieval — worked answers

Retrieval 1

Outside has higher water potential under these conditions; net water initially enters. Individual crossings still occur both ways.

Retrieval 2

10.8 − 12.0 = −1.2 g; −1.2 ÷ 12.0 = −0.1; ×100 = −10%; 12.0 × 0.9 = 10.8 g.

Retrieval 3

The expanding contents press against the supporting wall, raising turgor pressure that can oppose further entry; the wall does not stop all water passage.

Retrieval 4

The mean is (2 + 0 − 2) ÷ 3 = 0%; individual samples vary. Report no mean net change under the protocol, not identical unchanged samples or stopped molecular movement.

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