

Diffusion, Osmosis and Active Transport

Name: _____ Class: _____ Date: _____



Simulation 1: Diffusion
edtechsims.com/diffusion



Simulation 2: Osmosis
edtechsims.com/osmosis



Simulation 3: Active Transport
edtechsims.com/active-transport

By the end of this activity, you should be able to:

- define diffusion, osmosis and active transport
- describe how temperature and particle size affect the rate of diffusion
- explain the movement of water by osmosis across a partially permeable membrane
- explain why active transport needs energy from respiration
- compare the three processes and apply them to plant and animal cells

Part A: Diffusion (Simulation 1)

On the sim: Open Simulation 1. Read the Key Concepts, then work through the Guided Activities.

A1 Define diffusion. [2]

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A2 Start the simulation. Describe how the particles move and how they become spread out over time. [2]

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A3 Change ONLY the Temperature slider. Describe and explain its effect on the rate of diffusion. [2]

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.....

A4 Reset. Change ONLY the Particle size slider. Describe its effect on the rate of diffusion. [1]

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.....

A5 When the particles are evenly spread out, do they stop moving? Explain. [2]

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A6 Complete Check Your Understanding in the sim.

My score: _____ / _____

Part B: Osmosis (Simulation 2)

On the sim: Open Simulation 2. Read the Key Concepts, then use the Guided Activities to complete this part.

B1 Define osmosis.

[2]

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B2 Set Mass of glucose added to 6 units on the right side. Click Apply & Reset, then Start.

(a) Describe what happens to the water levels on the left and right.

[2]

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.....

(b) Why can't glucose molecules cross to the left?

[1]

.....

B3 Repeat with different masses of glucose. Record the final water volumes in Table 1.

[3]

Glucose added / units	Left side / cm ³	Right side / cm ³	Difference / cm ³
0			
2			
6			
10			

Table 1

B4 Describe the relationship between the mass of glucose added and the difference in water level.

[1]

.....

.....

B5 Run the simulation until Dynamic Equilibrium $\rightleftharpoons$ appears, and turn on Show water and glucose molecules. Are water molecules still crossing the membrane? Why do the water levels stay constant?

[2]

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.....

.....

B6 Complete the sentences using hypotonic, hypertonic or isotonic.

[3]

A solution with a higher solute concentration is _____.

A solution with a lower solute concentration is _____.

Two solutions with equal solute concentrations are _____.

B7 Complete Check Your Understanding in the sim.

My score: _____ / _____

Part C: Active Transport (Simulation 3)

On the sim: Open Simulation 3. Read the Key Concepts, then use the Guided Activities to complete this part.

C1 Define active transport.

[2]

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C2 Set the Number of Na⁺ ions to 8. Click Apply & Reset, then Start.

(a) In which direction are the Na⁺ ions transported? Is this with or against the concentration gradient?

[2]

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.....

(b) What role do the yellow carrier proteins play?

[1]

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C3 Let the simulation run until ATP reaches 0. What happens to Na⁺ transport? What does this show?

[2]

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C4 Repeat with different numbers of Na⁺ ions. Record your observations in Table 2.

[2]

Number of Na ⁺ ions	Observations (how quickly ATP is used, how many ions cross)
2	
8	
12	

Table 2

C5 Explain why a cell that stops respiring can no longer carry out active transport.

[2]

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Part D: Comparing the Three Processes

D1 Complete Table 3. Part of the table has been completed for you.

[8]

	Diffusion	Osmosis	Active transport
What moves	Any particles (e.g. O ₂ , CO ₂)		Particles such as ions or glucose
Direction (relative to concentration gradient)		High → low water potential	
Energy from respiration needed?	No		Yes
Partially permeable membrane needed?			Yes (with carrier proteins)
One example in living organisms		Water into root hair cells	

Table 3

Part E: Practice Questions

E1 Potato cylinders of equal size were placed in sucrose solutions of different concentrations for 24 hours. Fig. 1 shows the percentage change in mass of each cylinder.

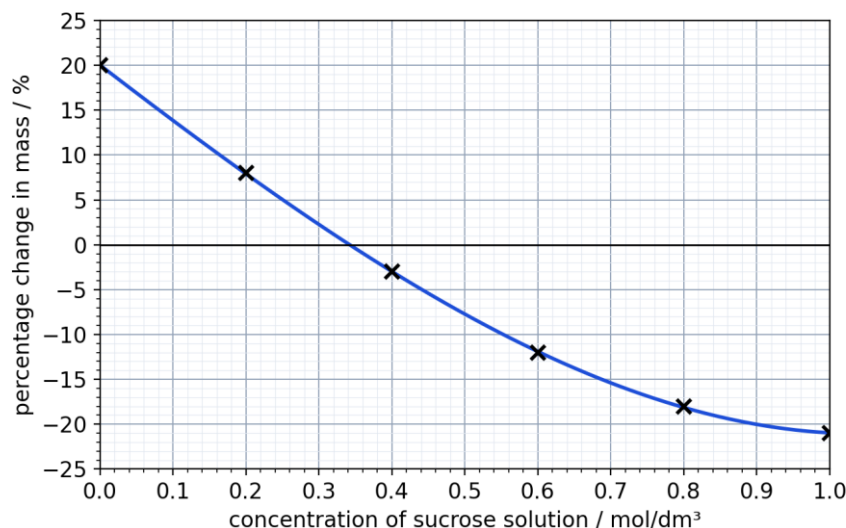


Fig. 1

(a) Explain why the cylinder in 0.0 mol/dm³ (distilled water) gained mass. [2]

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(b) Use Fig. 1 to estimate the concentration of sucrose solution that has the same water potential as the potato cells. Explain your answer. [2]

concentration = ... mol/dm³

.....

.....

.....

(c) Explain why the cylinder in 1.0 mol/dm³ lost mass. [2]

.....

.....

E2 Root hair cells absorb mineral ions from the soil, even when the concentration of ions in the soil is lower than inside the cell.

(a) Name the process by which these ions are absorbed. Explain your answer. [2]

.....

.....

(b) Suggest why root hair cells contain many mitochondria. [2]

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E3 A red blood cell and a plant cell are both placed in distilled water. Explain why the red blood cell bursts but the plant cell does not. [3]

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Answer Key: Diffusion, Osmosis and Active Transport

Part A

A1 The net movement of particles from a region of higher concentration to a region of lower concentration, down a concentration gradient.

A2 Particles move randomly in all directions (Brownian motion). Over time there is a net movement from the region of higher concentration to lower concentration until they are evenly spread.

A3 Higher temperature increases the rate of diffusion, because particles have more kinetic energy and move faster.

A4 Larger particles diffuse more slowly; smaller particles diffuse faster.

A5 No. The particles keep moving randomly, but there is no net movement in any direction (dynamic equilibrium).

A6 Score from the sim.

Part B

B1 The net movement of water molecules from a region of higher water potential (dilute solution) to a region of lower water potential (concentrated solution), through a partially permeable membrane.

B2(a) The water level on the right (glucose side) rises and the level on the left falls, until the levels stop changing.

B2(b) Glucose molecules are too large to pass through the gaps in the partially permeable membrane.

B3 Readings from the sim. At 0 units both sides stay at 30 cm³; the difference increases as glucose increases.

B4 The more glucose added, the greater the difference in water level (the greater the osmotic pressure).

B5 Yes. Water molecules still cross in both directions, but at equal rates, so there is no net movement and the levels stay constant.

B6 hypertonic; hypotonic; isotonic

B7 Score from the sim.

Part C

C1 The movement of particles from a region of lower concentration to a region of higher concentration (against a concentration gradient), using energy from respiration.

C2(a) From left to right, against the concentration gradient (from low to high concentration).

C2(b) Carrier proteins bind the Na⁺ ions and use energy from ATP to move them across the membrane.

C3 Na⁺ transport stops. Active transport requires energy (ATP).

C4 Observations from the sim: ATP is used up with each crossing; with more ions, ATP runs out before all ions can cross.

C5 Respiration produces the ATP that provides energy for active transport. Without respiration no ATP is made, so carrier proteins cannot move particles against the concentration gradient.

D1

	Diffusion	Osmosis	Active transport
What moves	Any particles (e.g. O ₂ , CO ₂)	Water molecules only	Particles such as ions or glucose
Direction	Down the gradient (high → low)	High → low water potential	Against the gradient (low → high)
Energy needed?	No	No	Yes
Membrane needed?	No	Yes	Yes (with carrier proteins)
Example	O ₂ into blood at the alveoli	Water into root hair cells	Mineral ions into root hair cells; glucose uptake in the small intestine

Part E

E1(a) Distilled water has a higher water potential than the potato cells. Water enters the cells by osmosis through the partially permeable membranes, so the mass increases.

E1(b) About 0.34 mol/dm³ (accept 0.32–0.36). At this concentration the percentage change in mass is zero, so there is no net movement of water.

E1(c) The solution has a lower water potential than the potato cells, so water leaves the cells by osmosis and the mass decreases.

E2(a) Active transport. The ions move from a lower concentration in the soil to a higher concentration in the cell, against the concentration gradient.

E2(b) Mitochondria carry out aerobic respiration, releasing the energy (ATP) needed for active transport.

E3 Both cells take in water by osmosis. The red blood cell has no cell wall, so it swells and bursts. The plant cell has a strong cellulose cell wall that resists further expansion, so the cell becomes turgid but does not burst.