

Exercise walk-through

2.7

Tonicity and Osmoregulation

AP Biology

Tonicity and endosymbiosis

Water moves toward the **saltier** side. **Water potential** $\Psi = \Psi_S + \Psi_P$.

- **hypertonic**: cell shrinks
- **hypotonic**: cell swells
- **isotonic**: steady volume

Endosymbiotic theory :
mitochondria & chloroplasts were once bacteria – own circular DNA, double membranes, own ribosomes.



Water leaves cells in a hypertonic solution

Water potential, and which way water moves

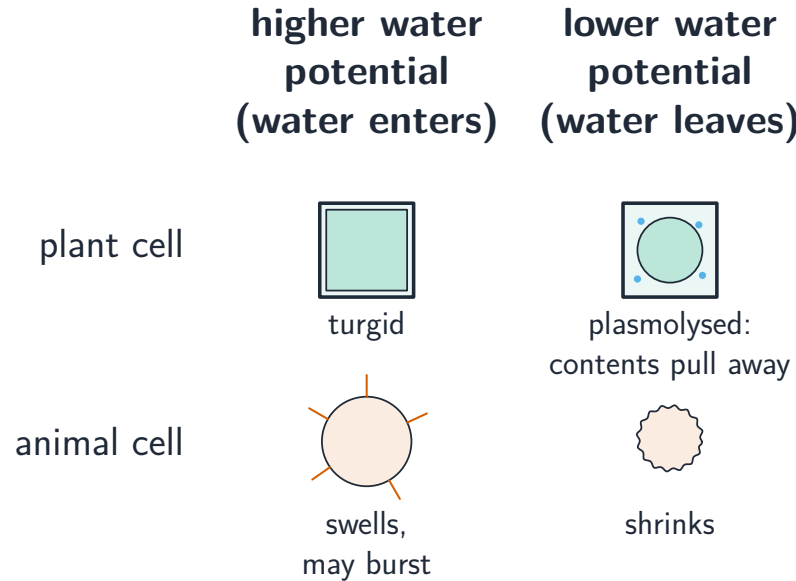
Water potential predicts the direction: water moves to the **lower** Ψ .

$$\Psi = \Psi_p + \Psi_s, \quad \Psi_s = -iCRT$$

0.1 M sucrose, open beaker, 25 °C

$\Psi_s = -(1)(0.1)(0.0831)(298) \approx -2.48$ bar, and $\Psi_p = 0$, so $\Psi \approx -2.48$ bar. A cell at $\Psi = -1.0$ bar sits in it: the solution is **more negative**, so water leaves the cell and it loses turgor.

Water potential, and which way water moves, in detail



Plant and animal cells in solutions of different water potential

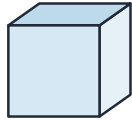
Compartments, and where they came from

Membranes create separate **compartments** so incompatible reactions run at once and pH and ion levels are tuned locally. The internal membranes also **add surface area** for those reactions.

The **endosymbiotic theory** explains mitochondria and chloroplasts: a larger cell engulfed free-living prokaryotes that went on living inside it.

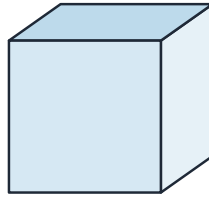
The evidence is three-fold – their own **circular DNA**, their own **ribosomes**, and **double membranes**.

Why Cells Stay Small



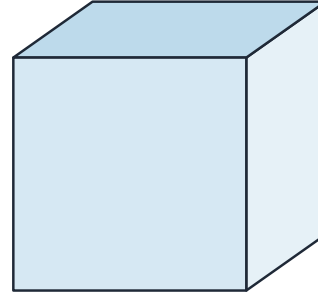
side $L = 1$

SA:V = 6 : 1



side $L = 2$

SA:V = 3 : 1



side $L = 3$

SA:V = 2 : 1

a bigger cube (or cell) has a **smaller** surface area : volume ratio

The surface-area-to-volume ratio falls as a cell gets bigger

Exercises 2.1-2.3

2.1 In a hypertonic solution, which way does water move relative to the cell? [1]

2.2 Does adding solute raise or lower water potential? [1]

2.3 What happens to an animal cell in a hypotonic solution? [1]

Exercises 2.1-2.3

2.1 In a hypertonic solution, which way does water move relative to the cell? [1]

2.1

- Water leaves the cell
-

2.2 Does adding solute raise or lower water potential? [1]

2.2

- Lower
-

2.3 What happens to an animal cell in a hypotonic solution? [1]

2.3

- It swells and may burst (lyse)

Exercise 3.1

3.1 Water moves by osmosis from a region of

[1]

☐

A low to high water potential

B high to low water potential

C high to high water potential

D it does not move

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[1]

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A low to high water potential

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D it does not move

3.1 B

- high to low water potential

Exercise 3.2 (a)

3.2 A plant cell is placed in a very concentrated salt solution.

(a) State whether the solution is hypertonic or hypotonic.

[1]

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3.2 A plant cell is placed in a very concentrated salt solution.

(a) State whether the solution is hypertonic or hypotonic.

[1]

(a)

- Hypertonic

Exercise 3.2 (b)

3.2 A plant cell is placed in a very concentrated salt solution.

(b) Predict the direction of water movement and the effect on the cell.

[3]

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3.2 A plant cell is placed in a very concentrated salt solution.

(b) Predict the direction of water movement and the effect on the cell. [3]

(b)

- Water leaves the cell by osmosis (toward the lower water potential outside), so the cell loses water and the membrane pulls away from the wall (plasmolysis)

Exercise 3.3

3.3 Explain why a freshwater organism must actively remove excess water (osmoregulation). [2]

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3.3

- Its surroundings are hypotonic (higher water potential), so water constantly enters by osmosis; it must actively remove the excess to avoid swelling and bursting