Active transport

4.1.3.3 · Cell biology · revision notes

Active transport moves substances against a concentration gradient, using energy from respiration. Questions ask you to explain examples in root hair cells and the gut, and to compare active transport with diffusion and osmosis.

Key facts

- Active transport: from a more dilute to a more concentrated solution (against the concentration gradient)
- Root hair cells: absorb mineral ions from very dilute soil solutions
- Many mitochondria = lots of active transport
- Needs energy from respiration
- Small intestine: sugar absorbed from the gut (lower concentration) into the blood (higher concentration)
- Diffusion and osmosis are passive (no energy); active transport needs energy

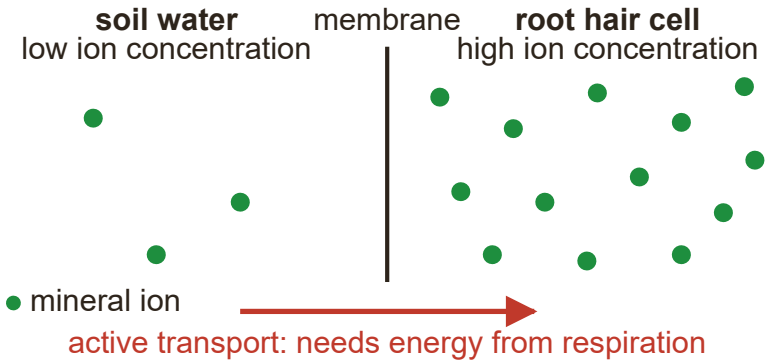
Notes

What active transport is

- **Active transport** moves substances from a more dilute solution to a more concentrated solution: **against** the concentration gradient.
- It needs **energy from respiration**.
- Cells that carry out a lot of active transport have many mitochondria, to release the energy needed.
- Anything that reduces respiration, such as a lack of oxygen or a poison that stops respiration, reduces active transport. Grade 7+ only

Examples

- **Root hair cells** absorb mineral ions from very dilute solutions in the soil. The concentration of ions is usually higher inside the root hair cell, so diffusion would not bring them in.



Active transport moves ions against the concentration gradient, using energy from respiration.

- Plants need mineral ions for healthy growth, e.g. nitrate ions to make proteins.
- In the **small intestine**, sugar molecules are absorbed from a lower concentration in the gut into the blood, which has a higher sugar concentration.
- The sugar is carried to cells and used for respiration.

Comparing the three processes

- **Diffusion**: particles of a gas or solute; from higher to lower concentration; no energy needed.
- **Osmosis**: water only; from a dilute to a concentrated solution, through a partially permeable membrane; no energy needed.
- **Active transport**: substances such as mineral ions and sugar; from a dilute to a more concentrated solution (against the gradient); energy from respiration needed.
- Water enters root hair cells by osmosis, while mineral ions enter by active transport.

How to answer each type of question

Give differences between active transport and diffusion 2 marks **Grade 4**

1. Compare the direction: against or down the concentration gradient.
2. Compare the energy: needed or not needed.
3. Write each point as a comparison.

Example. Root hair cells absorb nitrate ions from the soil by active transport.
Give **two** ways in which active transport is different from diffusion.

Model answer. Active transport moves substances against the concentration gradient / from a dilute to a more concentrated solution, but diffusion moves them from higher to lower concentration (1).
Active transport needs energy from respiration, but diffusion does not (1).

Explain why a cell has many mitochondria

2 marks | Grade 6

1. Say that respiration happens in mitochondria and releases energy.
2. Link the energy to active transport of the named substance.

Example. Root hair cells contain many mitochondria.
Explain why.

Model answer. Mitochondria are where aerobic respiration happens, releasing energy (1). The energy is needed for the active transport of mineral ions into the root hair cells (1).

Compare the three transport processes

3 to 4 marks | Grade 5

1. Say what moves in each process.
2. Say which way it moves relative to the concentration gradient.
3. Say whether energy is needed, and give an example if there is a mark left.

Example. Compare diffusion and active transport. [4 marks]

Model answer. Both move substances into or out of cells across the cell membrane (1). Diffusion moves particles from a higher to a lower concentration, whereas active transport moves them from a lower to a higher concentration / against the gradient (1). Diffusion does not need energy, whereas active transport needs energy from respiration (1). For example, oxygen enters cells by diffusion, but mineral ions enter root hair cells by active transport (1).

Explain data on ion uptake

3 marks | Grade 7

1. Identify the process: ions taken up against a gradient means active transport.
2. Link the variable (oxygen, temperature, poison) to respiration.
3. Link respiration to the energy available for active transport.

Example. Scientists measured how fast barley roots took up potassium ions. Roots in a solution bubbled with air took up ions five times faster than roots in a solution with no oxygen.
Explain this result.

Model answer. Potassium ions are taken up by active transport (1). Active transport needs energy from respiration (1). With oxygen, the root cells carry out aerobic respiration, which releases more energy, so ions are taken up faster (1).

Don’t lose marks

- Forgetting to say 'against the concentration gradient' (or 'from dilute to more concentrated').
- Saying mitochondria 'make energy'. They release energy by respiration.

- Saying mineral ions are absorbed by osmosis. Water enters by osmosis; mineral ions enter by active transport.
- Getting the direction the wrong way round: in active transport, substances move to where they are more concentrated.

More tips

Memory tricks

- 'Active' = needs energy: like pushing a trolley uphill, against the gradient.
- Two examples to learn: 'roots and guts' (mineral ions into root hairs, sugar from the gut into the blood).
- See 'many mitochondria' in a question about absorbing something? Think active transport.

Exam technique

- In any 'explain' answer, use the phrases 'against the concentration gradient' and 'energy from respiration'.
- For comparison questions, cover what moves, the direction, whether energy is needed, and an example.
- In data questions, link anything that changes respiration (oxygen, temperature, a poison) to the energy for active transport.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **State what active transport is**
The movement of substances from a more dilute solution to a more concentrated solution, against a concentration gradient.

Grade 4 — **State where the energy comes from**
Active transport needs energy from respiration.

Grade 5 — **Describe two examples of active transport**
Mineral ions from the soil into root hair cells; sugar from the gut into the blood.

Grade 5 — **Compare diffusion, osmosis and active transport**
Compare what moves, which way it moves relative to the concentration gradient, and whether energy is needed.

Grade 6 — **Explain why root hair cells have many mitochondria**
More respiration releases more energy for the active transport of mineral ions.

Grade 7 — **Explain how oxygen affects active transport**
Less oxygen means less aerobic respiration, so less energy is released and active transport slows.

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