

chapter 36 plant transport study guide answers

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Introduction

Understanding plant transport mechanisms is essential for anyone studying plant physiology, agronomy, or related life science fields. Chapter 36 of many plant transport textbooks delves deep into the processes that move water, solutes, and signaling molecules throughout the plant body. Whether you're a student preparing for exams, a teacher designing a lesson plan, or a researcher seeking a refresher, this guide offers clear explanations, concise answers, and practical study tips. We'll walk through the chapter's core concepts, highlight key transport mechanisms, and provide a structured set of study guide answers that align with the most common exam questions. By the end, you'll have a solid grasp of the material and a reliable reference for quick revision.

Overview of Chapter 36: Plant Transport Fundamentals

Chapter 36 typically covers the following major themes:

- Water movement and the cohesion–tension theory
- Passive solute transport: diffusion and osmosis
- Active transport mechanisms and energy coupling
- Transport proteins: channels, carriers, and pumps
- Regulatory signals and feedback loops in transport
- Experimental methods for studying plant transport

These topics build on earlier chapters that introduced basic cell biology and plant anatomy, allowing you to connect microscopic processes with whole plant physiology.

Key Concepts Explained

1. Cohesion–Tension Theory

The cohesion–tension theory explains how water moves from roots to leaves under tension created by transpiration. Cohesive forces between water molecules and adhesive forces to xylem wall fibers maintain a continuous water column, while the evaporation of water from stomata generates negative pressure.

2. Passive Solute Transport

Passive transport relies on concentration gradients and does not require cellular energy. Diffusion moves solutes from high to low concentration, while osmosis specifically refers to the movement of water across a selectively permeable membrane.

3. Active Transport and Energy Coupling

Active transport moves solutes against their concentration gradient using ATP or proton motive force. Key examples include the H^+ ATPase pump in plasma membranes and the Na^+/K^+ ATPase in animal cells, which create electrochemical gradients essential for nutrient uptake.

4. Transport Proteins

Transport proteins fall into three major families:

- Channels: facilitate rapid, passive movement of ions or water.
- Carriers: bind solutes and undergo conformational changes to shuttle them.
- Pumps: use ATP to move solutes actively.

5. Regulation of Transport

Plants regulate transport through hormonal signals (e.g., abscisic acid during drought), feedback from metabolite concentrations, and environmental cues such as light and temperature.

6. Experimental Techniques

Common methods include:

- Pressure chamber (Scholander apparatus) for measuring water potential.
- Fluorescent dyes and confocal microscopy for visualizing ion flux.
- Electrophysiology (patch clamp) for studying channel activity.
- Genetic mutants and RNA i to dissect transporter function.

Detailed Study Guide Answers

Question 1: Explain the cohesion–tension theory and its significance in plant water transport.

Answer: The cohesion–tension theory posits that water moves upward through the xylem due to a combination of cohesive forces between water molecules and adhesive forces to the xylem walls. Transpiration at the leaf surface creates negative pressure (tension) that pulls water upward. This theory explains how tall trees can transport water over 100 meters without the aid of active pumping.

Question 2: Differentiate between diffusion and osmosis.

Answer: Diffusion is the passive movement of solutes from an area of high concentration to an area of low concentration across any permeable barrier. Osmosis is a specific type of diffusion involving water moving across a selectively permeable membrane from a region of low solute concentration to a region of high solute concentration.

Question 3: Describe the role of the H⁺ ATPase pump in nutrient uptake.

Answer: The H⁺ ATPase pump hydrolyzes ATP to export protons (H⁺) from the cytosol into the apoplast, generating an electrochemical gradient. This proton motive force drives the co-transport of nutrients such as nitrate, phosphate, and sugars into the cell via symporters and antiporters, enabling active uptake even against concentration gradients.

Question 4: List three types of transport proteins and give an example of each.

Answer:

- Channels – Aquaporins (water channels)
- Carriers – GLUT transporters (glucose carriers)
- Pumps – Na⁺/K⁺ ATPase (ion pump)

Question 5: How does abscisic acid (ABA) influence stomatal closure?

Answer: ABA accumulates in guard cells during drought, activating calcium channels and increasing cytosolic Ca²⁺. This triggers the opening of anion channels, causing ion efflux, loss of turgor, and stomatal closure, which reduces transpiration and conserves water.

Question 6: Outline a method to measure root water uptake in a greenhouse experiment.

Answer: Use a gravimetric approach: weigh pots before and after irrigation, record soil moisture changes, and

calculate water uptake as the difference between expected and actual water loss, adjusting for evaporation. Alternatively, use a pressure chamber to directly measure root pressure.

Question 7: Explain how the proton motive force drives secondary active transport.

Answer: The proton motive force, generated by H⁺ ATPase pumps, creates a gradient of high H⁺ concentration outside the cell. Transporters such as the H⁺/citrate symporter use this gradient to co-transport citrate into the cell against its concentration gradient, effectively coupling passive proton movement to active solute uptake.

Question 8: What is the significance of the tonoplast in vacuolar transport?

Answer: The tonoplast (vacuolar membrane) contains H⁺ ATPase and H⁺/cation exchangers that maintain a proton gradient across the vacuole. This gradient allows the sequestration of ions (e.g., K⁺, Na⁺) and organic acids, contributing to osmotic balance, detoxification, and storage of secondary metabolites.

Question 9: Describe the role of aquaporins in plant water relations.

Answer: Aquaporins are specialized membrane proteins that facilitate rapid water transport across cell membranes. They are regulated by pH, phosphorylation, and interaction with signaling molecules, allowing plants to adjust water permeability in response to environmental changes.

Question 10: Summarize the experimental evidence supporting the cohesion–tension theory.

Answer: Key evidence includes:

- Measurements of negative water potentials in xylem using pressure chambers.
- Visualization of continuous water columns in xylem vessels via micro-CT imaging.
- Correlation between transpiration rates and water potential gradients.
- Observations that cutting the stem abruptly stops water flow, indicating reliance on a continuous column.

Common Study Tips for Chapter 36

- Use concept maps to connect transport mechanisms with cellular structures.
- Practice drawing diagrams of the cohesion–tension theory, labeling xylem, phloem, and stomata.
- Review experimental data from key papers and understand the methodology.
- Test yourself with flashcards that ask for definitions and mechanisms.
- Discuss transport regulation with peers to reinforce hormonal signaling pathways.

Frequently Asked Questions (FAQs)

Q: Why do tall trees not need a pump to move water?

A: The cohesion–tension theory explains that the negative pressure generated by transpiration pulls water upward, creating a continuous column that can span great heights without active pumping.

Q: How does the plant ensure that essential nutrients are absorbed even when soil concentrations are low?

A: Plants use active transporters, such as H⁺-coupled symporters, that harness the proton motive force to import nutrients against concentration gradients.

Q: Are aquaporins regulated by environmental factors?

A: Yes, aquaporin activity can be modulated by pH, phosphorylation status, and interaction with signaling molecules like calcium and reactive oxygen species.

Conclusion

Chapter 36 of plant transport offers a comprehensive look at how plants move water, solutes, and signals to maintain growth and respond to environmental challenges. By mastering the cohesion–tension theory, passive and active transport mechanisms, transporter families, and regulatory pathways, you'll be well prepared for exams and research projects alike. Use this study guide to reinforce concepts, practice with the provided questions, and explore the experimental techniques that underpin modern plant physiology. With diligent review and active engagement, you'll transform these complex mechanisms into intuitive knowledge, ready to apply in both academic and practical contexts.

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