

***Campbell's Biology: Concepts and Connections, 7e (Reece et al.)***  
**Chapter 32 Plant Nutrition and Transport**

32.1 Multiple-Choice Questions

1) In an attempt to find out where a growing plant gets its mass, van Helmont planted a willow seedling in a pot of soil. After five years, the willow weighed 76.8 kg, and the soil had lost 0.06 kg of weight. Only water had been added to the pot. Which of the following conclusions *should* van Helmont have drawn?

- A) Plants get their mass from water.
- B) Plants get their mass from water and air.
- C) Plants get their mass from water and atmospheric CO<sub>2</sub>.
- D) Plants get all or almost all of their mass from a source other than soil.

Answer: D

Topic: 32.1

Skill: Knowledge/Comprehension

2) Where do plants get most of their mass?

- A) from nitrogen in the atmosphere
- B) from carbon dioxide in the atmosphere
- C) from water, as van Helmont predicted
- D) from organic molecules taken up from the soil

Answer: B

Topic: 32.1

Skill: Knowledge/Comprehension

3) What is the physical barrier in the root that regulates the flow of water to xylem via cell walls?

- A) phloem
- B) epidermis
- C) Casparian strip
- D) cortex

Answer: C

Topic: 32.2

Skill: Knowledge/Comprehension

4) \_\_\_\_\_ increase the surface area of roots.

- A) Plasmodesmata
- B) Cell walls and endoplasmic reticulum
- C) Casparian strips
- D) Root hairs

Answer: D

Topic: 32.2

Skill: Knowledge/Comprehension

5) Which of the following options correctly lists the sequence of structures through which water passes into a root?

- A) guard cell, endodermis, cortex, xylem
- B) root hair, cortex, xylem, endodermis
- C) epidermis, cortex, endodermis, xylem
- D) root hair, xylem, endodermis, phloem

Answer: C

Topic: 32.2

Skill: Knowledge/Comprehension

6) How do mineral ions get into the xylem cells of a plant root by way of the intracellular route?

- A) They percolate between root cells to the xylem and then enter a xylem vessel.
- B) They are actively taken in to the xylem of root hairs.
- C) They are taken up by root hair cells and transferred from cell to cell via plasmodesmata.
- D) They move in solution through cell walls of the endodermis.

Answer: C

Topic: 32.2

Skill: Knowledge/Comprehension

7) The loss of water from the leaves of plants is

- A) adhesion.
- B) cohesion.
- C) transpiration.
- D) osmosis.

Answer: C

Topic: 32.3

Skill: Knowledge/Comprehension

8) In the water relations of vascular plants, the cohesive property of water is most important in the

- A) epidermis.
- B) xylem.
- C) internal air spaces.
- D) stomata.

Answer: B

Topic: 32.3

Skill: Knowledge/Comprehension

9) What force is responsible for the cohesiveness of water?

- A) osmosis
- B) hydrogen bonding between water molecules
- C) negative pressure created by evaporation
- D) ionic bonding

Answer: B

Topic: 32.3

Skill: Knowledge/Comprehension

10) The two main forces that move water through a plant are

- A) transpiration and root pressure.
- B) root pressure and photosynthesis.
- C) transpiration and pressure flow.
- D) active transport and cohesion.

Answer: A

Topic: 32.3

Skill: Knowledge/Comprehension

11) A hot, dry summer will reduce crop yields in part because

- A) the stomata of the plants stay open to help cool the leaves.
- B) carbon dioxide uptake is reduced by the stomata closing to prevent excessive water loss.
- C) oxygen uptake is reduced by the stomata closing to prevent excessive water loss.
- D) carbon dioxide release is reduced by the stomata closing to prevent excessive water loss.

Answer: B

Topic: 32.4

Skill: Knowledge/Comprehension

12) Under which of the following weather conditions would transpiration be most rapid?

- A) hot, humid weather
- B) cold, humid weather
- C) hot, dry weather
- D) windy, wet weather

Answer: C

Topic: 32.4

Skill: Knowledge/Comprehension

13) Which of the following options best describes the mechanism that causes a stoma to open?

- A)  $K^+$  enters the guard cells and water follows passively, making the cells turgid.
- B)  $K^+$  activates water pumps in the guard cell membrane that make them turgid.
- C)  $K^+$  leaves the guard cells and water follows passively, making the cells flaccid.
- D) Loss of  $K^+$  from guard cells creates positive pressure and expands the guard cells.

Answer: A

Topic: 32.4

Skill: Knowledge/Comprehension

14) The pores that facilitate gas exchange in plant leaves are called

- A) stomata.
- B) guard cells.
- C) lenticels.
- D) plasmodesmata.

Answer: A

Topic: 32.4

Skill: Knowledge/Comprehension

15) Which of the following would be most likely to cause stomata to open?

- A) Water molecules entering the stomatal pore.
- B) Hot, dry weather, and strong winds.
- C) Sunrise on a clear morning.
- D) A cool night is setting in.

Answer: C

Topic: 32.4

Skill: Knowledge/Comprehension

16) If a plant is kept in the dark,

- A) the stomata continue their daily rhythm of opening and closing.
- B) the stomata will remain closed the entire time that the plant is in the dark.
- C) the stomata will remain open the entire time that the plant is in the dark.
- D) the guard cells will open as water is added.

Answer: A

Topic: 32.4

Skill: Knowledge/Comprehension

17) Generally speaking, fluids in plants are

- A) pushed through phloem and pulled through xylem.
- B) pushed through xylem and pulled through phloem.
- C) pulled through both xylem and phloem.
- D) actively pumped throughout the plant.

Answer: A

Topic: 32.3, 32.5

Skill: Knowledge/Comprehension

18) Which of the following would be the best way to determine whether aphids must actively draw phloem sap into their digestive tract or if hydrostatic pressure in the phloem tube could force the sap into them?

- A) Cut a phloem tube off an aphid and see if it can still feed.
- B) Cut a phloem tube from a plant and see if an aphid can still take up sap from it.
- C) Measure relative rates of sugar manufacture in leaves with and without aphids.
- D) Insert mouth parts removed from an aphid, without including the digestive tract, and see if phloem sap keeps flowing through them.

Answer: D

Topic: 32.5

Skill: Knowledge/Comprehension

19) The sugar "sink" in roots is the result of

- A) active transport of mineral ions into xylem cells.
- B) absorption of water from the soil through epidermal cells.
- C) active transport of sugars from phloem to root cells.
- D) pull of gravity on sugar molecules.

Answer: C

Topic: 32.5

Skill: Knowledge/Comprehension

- 20) The existence of a hydrostatic pressure gradient in phloem tubes can be accounted for by
- A) the fact that the leaves are higher than the roots, which means that gravity creates pressure.
  - B) the diffusion of water from one sieve-tube cell to the next.
  - C) the loading of sugars into phloem at sources and removal of sugars at sinks.
  - D) the active transport of water from sugar sources to sugar sinks.

Answer: C

Topic: 32.5

Skill: Knowledge/Comprehension

- 21) How do sugars move from one sieve-tube cell to the next?
- A) by osmotic diffusion through the sieve plate
  - B) by flowing along with water through perforations in the sieve plate
  - C) by active transport across cell membranes at the sieve plate
  - D) by diffusion through a companion cell that spans the sieve plate

Answer: B

Topic: 32.5

Skill: Knowledge/Comprehension

- 22) Which of the following essential macronutrient for plants is obtained directly from the air?
- A) nitrogen
  - B) magnesium
  - C) hydrogen
  - D) carbon

Answer: D

Topic: 32.1, 32.6

Skill: Knowledge/Comprehension

- 23) Micronutrients function in plants mainly as
- A) joining elements in organic molecule carbon skeletons.
  - B) regulators of membrane transport.
  - C) cofactors in chemical reactions.
  - D) food reserves for pollen grains.

Answer: C

Topic: 32.6

Skill: Knowledge/Comprehension

- 24) Which of the following options lists the set of plant macronutrients that make up about 98% of a plant's dry weight?
- A) carbon, oxygen, hydrogen, potassium, zinc, and copper
  - B) carbon, nitrogen, potassium, manganese, sulfur, and phosphorus
  - C) nitrogen, potassium, manganese, sulfur, copper, and phosphorus
  - D) carbon, oxygen, hydrogen, nitrogen, sulfur, and phosphorus

Answer: D

Topic: 32.6

Skill: Knowledge/Comprehension

25) What are the macronutrients present in most commercial fertilizers?

- A) C, H, and N
- B) N, P, and K
- C) C, N, and P
- D) N, C, and K

Answer: B

Topic: 32.7

Skill: Knowledge/Comprehension

26) A fertilizer with which of the following nitrogen-phosphorous-potassium ratios would most likely solve the problem of yellowed leaves and stunted growth?

- A) 20:0:0
- B) 0:20:0
- C) 0:0:20
- D) 0:20:20

Answer: A

Topic: 32.7

Skill: Knowledge/Comprehension

27) Which of the following are important in breaking down organic material in fertile topsoil?

- A) abrasive granite particles
- B) humus and cations
- C) bacteria and fungi
- D) plant roots

Answer: C

Topic: 32.8

Skill: Knowledge/Comprehension

28) If you examine the soil profile revealed by a fresh road cut through a grassy rise, which of the following features will you probably find in the B horizon?

- A) an abundance of worms and burrowing insects
- B) an abundance of decomposing organic material
- C) an abundance of fine clay but not much organic material
- D) a predominance of slightly weathered rock and gravel

Answer: C

Topic: 32.8

Skill: Knowledge/Comprehension

29) Which of the following essential nutrients is most likely to leach from the soil?

- A)  $\text{Ca}^{2+}$
- B)  $\text{Mg}^{2+}$
- C)  $\text{K}^{+}$
- D)  $\text{NO}_3^{-}$

Answer: D

Topic: 32.8

Skill: Application/Analysis

- 30) Why has drip irrigation been developed?
- A) Drip irrigation uses less water than traditional methods.
  - B) Drip irrigation increases soil erosion.
  - C) Drip irrigation increases soil salinity.
  - D) Drip irrigation increases evaporation and drainage.

Answer: A

Topic: 32.9

Skill: Knowledge/Comprehension

- 31) Commercial inorganic fertilizers have greatly increased agricultural productivity. Which of the following is an advantage of using inorganic rather than organic fertilizers?

- A) It is easier for plants to absorb nutrients in an inorganic form.
- B) Nutrients are released faster from inorganic fertilizers.
- C) Inorganic nutrients bind more tightly to soil particles.
- D) Inorganic fertilizers increase the water-holding capacity of the soil.

Answer: B

Topic: 32.9

Skill: Knowledge/Comprehension

- 32) "Smart" plants can reduce overuse of fertilizers by

- A) using photosynthesis and fungal relationships to generate their own fertilizer.
- B) informing the grower of a nutrient deficiency before damage occurs.
- C) slowing the process of minerals washing out of the soils.
- D) binding specifically to certain fertilizers before they are needed and storing them in their root systems.

Answer: B

Topic: 32.9

Skill: Knowledge/Comprehension

- 33) Compared to conventional agriculture, organic farming

- A) uses fewer synthetic pesticides.
- B) increases crop yields.
- C) guarantees the safety and extra health benefits of food.
- D) requires much less hands-on work.

Answer: A

Topic: 32.10

Skill: Knowledge/Comprehension

- 34) Which of the following is a potential problem with the use of transgenic varieties of plants that contain *Bt* toxin?

- A) *Bt* toxin may be harmful to humans.
- B) *Bt* toxin may be harmful to some beneficial insects.
- C) Transgenic crop varieties with *Bt* toxin are not very hardy and require a lot of care.
- D) Transgenic crop varieties with *Bt* toxin require large amounts of fertilizers and chemical insecticides to grow.

Answer: B

Topic: 32.11

Skill: Application/Analysis

35) Why don't the countries that most need high-protein crops raise them?

- A) High-protein crops usually require fertilizers, which may not be affordable to these countries.
- B) High-protein crops require extensive irrigation, which may not be affordable to these countries.
- C) High-protein crops are more difficult to process, making the foods they produce too expensive.
- D) High-protein crops are typically low in most other vital nutrients.

Answer: A

Topic: 32.11

Skill: Knowledge/Comprehension

36) Most plants can absorb and use which of the following forms of nitrogen directly?

- A) nitrite and nitrate
- B) nitrate only
- C) ammonium and nitrogen gas
- D) nitrate and ammonium

Answer: D

Topic: 32.12

Skill: Knowledge/Comprehension

37) Nitrogen fixation consists of

- A) the conversion of ammonia to nitrate.
- B) the production of ammonium from decomposing organic matter.
- C) the conversion of  $N_2$  to ammonia.
- D) the conversion of  $N_2$  to ammonia or nitrate.

Answer: C

Topic: 32.12

Skill: Knowledge/Comprehension

38) On a trip to the Southwest, you and a friend collect some seeds from a piñon, which is a type of pine tree. Your friend also gathers a small bagful of soil from under the piñon tree. Back home, both of you plant your seeds in commercial sterilized potting soil, but your friend adds a spoonful of the collected dirt to each of her pots. Her seedlings do better than yours. Which of the following is the likeliest reason?

- A) Pine seedlings are better adapted to the sandy soil of the Southwest than to commercial potting mix.
- B) The soil from the Southwest probably contained macronutrients missing from the potting mix.
- C) The soil from the Southwest probably contained nitrogen-fixing bacteria that colonized the seedlings' root nodules.
- D) The soil from the Southwest probably contained fungi able to establish a mycorrhizal association with the seedlings' roots.

Answer: D

Topic: 32.13

Skill: Application/Analysis

39) The relationship between a plant and mycorrhizal fungi is best described as

- A) parasitic.
- B) competitive.
- C) mutualistic.
- D) commensal.

Answer: C

Topic: 32.13

Skill: Knowledge/Comprehension



40) What is the role of the fungus in a mycorrhizal association?

- A) contributes to photosynthesis
- B) absorption of water, phosphate, and other minerals
- C) secretion of growth factors
- D) release of water

Answer: B

Topic: 32.13

Skill: Knowledge/Comprehension

41) Legumes, such as beans or peas,

- A) form mutualistic associations with nitrogen-fixing bacteria.
- B) form mycorrhizal associations to increase nitrogen fixation in the soil.
- C) form parasitic relationships with other photosynthetic plants.
- D) fix N<sub>2</sub> from the atmosphere in their leaves.

Answer: A

Topic: 32.13

Skill: Knowledge/Comprehension

42) Legumes are frequently grown in rotation with primary field crops. What is the benefit in this?

- A) A greater amount of the primary crop can be harvested each year.
- B) Nitrogen is added to the soil because of the legumes' symbiotic nitrogen-fixing bacteria.
- C) Soil erosion is reduced by frequent plowing.
- D) Legumes decrease the amount of organic material in the soil.

Answer: B

Topic: 32.13

Skill: Knowledge/Comprehension

43) Much research is being done to increase the nitrogen-fixing ability of plants with root nodules. Why is this an important goal for agricultural researchers?

- A) Decreasing the size of nodules will allow plants to fix more nitrogen into their own molecules.
- B) Nitrogen is an essential component of the amino acids used to form protein.
- C) Increasing the nitrogen-fixing ability of plants will allow them to make better use of nitrogen fertilizers.
- D) By removing the bacteria from the root nodules, more fixed nitrogen will be available to the plants.

Answer: B

Topic: 32.13

Skill: Knowledge/Comprehension

44) Carnivorous plants are more likely to grow in acid bogs because

- A) organic matter decays so slowly there.
- B) acid soil inhibits growth of plant roots.
- C) acid rain damages leaves and stems.
- D) mycorrhizal growth is inhibited.

Answer: A

Topic: 32.14

Skill: Knowledge/Comprehension

- 45) Carnivorousness in plants is primarily an adaptation for
- A) growing in soil poor in organic material.
  - B) growing in soil poor in usable nitrogen.
  - C) obtaining supplemental carbon for photosynthesis.
  - D) discouraging herbivorous insects.

Answer: B

Topic: 32.14

Skill: Knowledge/Comprehension

- 46) An example of an organism that parasitizes a host plant is

- A) a mycorrhizal fungus.
- B) nitrogen-fixing bacteria in root nodules.
- C) a Venus flytrap.
- D) mistletoe.

Answer: D

Topic: 32.14

Skill: Knowledge/Comprehension

- 47) Which of the following is most likely to be an epiphyte?

- A) a plant growing on the branches of another plant
- B) a plant that captures insects
- C) a plant with a very deep root system
- D) a plant that parasitizes another plant

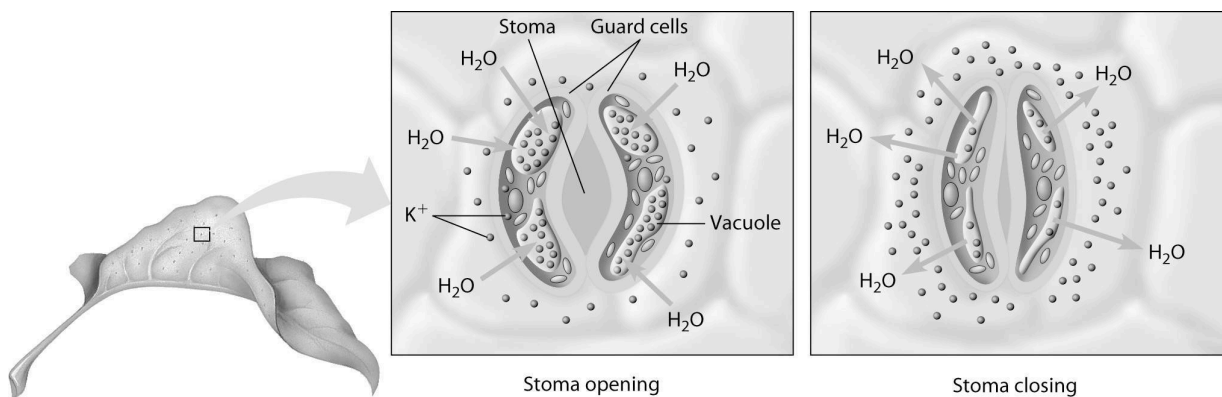
Answer: A

Topic: 32.14

Skill: Knowledge/Comprehension

## 32.2 Art Questions

- 1) What is true of the guard cells shown in the right-hand panel of this figure?



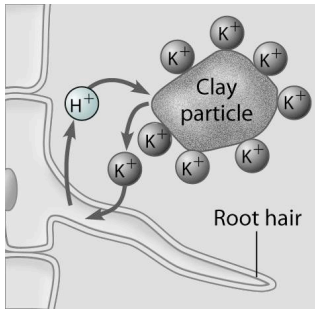
- A) Their turgor pressure is increasing.
- B) Water is entering these cells.
- C) These cells are hypertonic to their immediate surrounding.
- D) These cells are hypotonic to their immediate surrounding.

Answer: D

Topic: 32.4

Skill: Application/Analysis

2) What is implied by this figure?



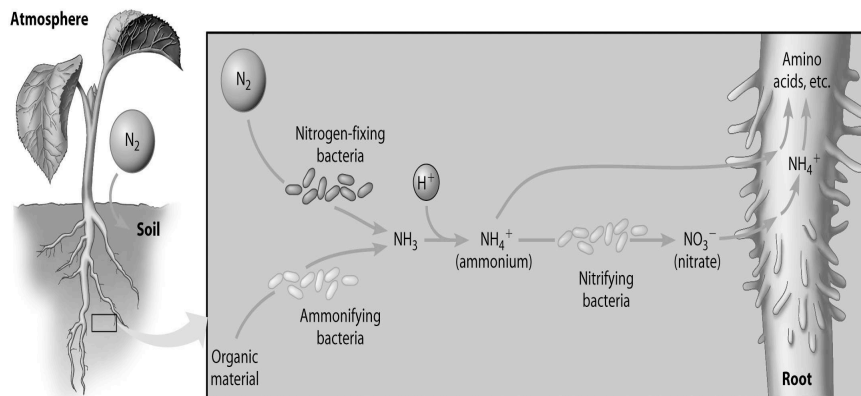
- A) The clay particle has a negative charge at its surface.
- B) The clay particle has a positive charge at its surface.
- C) The root hair has a negative charge at its surface.
- D) The plant does not need  $K^+$ .

Answer: A

Topic: 32.8

Skill: Application/Analysis

3) According to this figure, which of the following can directly use atmospheric  $N_2$ ?



- A) plant roots
- B) nitrogen-fixing bacteria
- C) ammonifying bacteria
- D) nitrifying bacteria

Answer: B

Topic: 32.12

Skill: Knowledge/Comprehension

### 32.3 Scenario Questions

*After reading the paragraph, answer the question(s) that follow.*

Over the next several decades, world population growth will necessitate as much as a 60% increase in food production, primarily in developing countries. These countries are often the most seriously affected by drought and salinity. Even if irrigation water is available, flooding fields with irrigation water leads to the gradual accumulation of sodium ions and other salts in the soil.

To respond to this growing problem, scientists at the University of Connecticut have genetically engineered a plant that can survive in salty soil and withstand extended drought conditions. The new transgenic plant contains a gene for an ion pump. Salt ions are transported from the soil and stored in vacuoles in the cytoplasm. The enhanced uptake of ions into their vacuoles in turn improves water retention in the transgenic plants and their resistance to drought. The concentration of solutes inside and outside plant cells affects the direction of water movement through osmosis.

The researchers found that the salt concentration in the cells of the new transgenic plants was significantly higher than in wild plants used as a control. In addition, the transgenic plants survived longer when deprived of water.

- 1) The experimental plants were more drought resistant because
- A) their vacuoles pumped water directly into the cytoplasm.
  - B) salt stored in their vacuoles enabled the cytoplasm to retain water better.
  - C) salt stored in their vacuoles was equal in amount to the salt in the soil.
  - D) water was stored in their vacuoles until the next rainfall.

Answer: B

Topic: 32.2, 32.9

Skill: Application/Analysis

- 2) In addition to drought resistance, planting these transgenic crops periodically would be beneficial to the environment because
- A) the plants would help clean accumulated salts deposited in the soil by irrigation.
  - B) the transgenic plants would also fix nitrogen and improve soil fertility.
  - C) the plants would remove carbon dioxide and decrease global warming.
  - D) the plants would resist diseases and decrease herbicide use.

Answer: A

Topic: 32.10

Skill: Application/Analysis