

Xylem Tissue

A Level
P P P

Part A Function

Xylem tissue is used to transport from the to the .

It also provides plants with .

Items:

- roots
- light
- structural support
- carbon dioxide
- stems and leaves
- water (and minerals)
- sugars
- oxygen

Part B Structure

Xylem tissue includes xylem vessels (the main structures that transport) , parenchyma cells (which can store water, nutrients, and tannins), as well as some other cell types and structures.

Xylem vessels are initially formed as columns of cells. These cells produce a strong polymer called , which is deposited in the cell walls. The cells then die, leaving behind hollow tubes surrounded by the polymer.

Because the polymer is very strong and rigid, xylem vessels also provide the plant with .

Items:

- water
- lignin
- light
- carbon dioxide
- keratin
- chitin
- starch
- structural support

Part C Transport mechanisms

Various mechanisms are involved in the movement of water into and through a plant. Match the mechanism to the description in the table below.

Mechanism	Description
<div></div>	the evaporation of water out of the leaves (through stomata) which pulls water towards the leaves
<div></div>	the attraction between water molecules that ensures that they are pulled upwards together
<div></div>	the movement of water molecules from a region of higher water potential to a region of lower water potential through a partially permeable membrane (e.g. from the soil into the root hair cells)

Items:

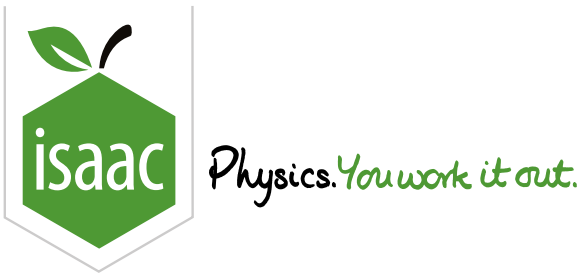
- osmosis
- translocation
- cohesion
- transpiration
- active transport

Part D Xylem statements

Which of the following statements are correct? Select all that apply.

- ☐ xylem provides structural support to plants
- ☐ xylem is only found in the main stem of a plant
- ☐ xylem transports water from the roots to the stems and leaves
- ☐ xylem tissue carries out photosynthesis
- ☐ xylem tissue is entirely non-living
- ☐ xylem vessels are non-living, but other parts of xylem tissue (e.g. parenchyma cells) are living
- ☐ xylem is found in the roots, stems, and leaves of a plant
- ☐ xylem transports sugars from the leaves to the non-photosynthetic parts of the plant (e.g. the roots)

All materials on this site are licensed under the **Creative Commons license**, unless stated otherwise.



Phloem Tissue

A Level

P

P

P

Part A Function

Phloem tissue is used to transport from the to the .

This process is called .

Items:

- water
- transpiration
- translocation
- photosynthetic parts of the plant (e.g. leaves)
- non-photosynthetic parts of the plant
- photosynthates (e.g. sugars and amino acids)

Part B Structure

The main vessels in phloem tissue formed by cells called , which form a column. The cell walls between these cells form large holes and are referred to as , which allows material to move between the cells easily. These cells also lose their nucleus, tonoplast, and some other organelles.

The vessels are surrounded by cells called , which are connected to the vessel cells by . These cells provide energy and materials to the vessel cells.

Items:

- sieve plates
- lignin
- stomata
- sieve tube elements
- gap junctions
- companion cells
- plasmodesmata

Part C The mass flow hypothesis

The mass flow hypothesis offers an explanation of how organic compounds (e.g. sugars) are translocated via phloem tissue.

The hypothesis states that in areas (e.g. leaves, where sugars are produced during photosynthesis), water potential is as the concentration of soluble sugars increases. This causes water to flow into these areas, increasing the hydrostatic pressure.

In areas (e.g. growing roots, where sugars are being used up during respiration), water potential is as the concentration of soluble sugars decreases. This causes water to flow out of these areas, decreasing the hydrostatic pressure.

The water will then flow through from the high pressure area to the low pressure area, taking soluble sugars with it.

Items:

increased

xylem vessels

source

decreased

sink

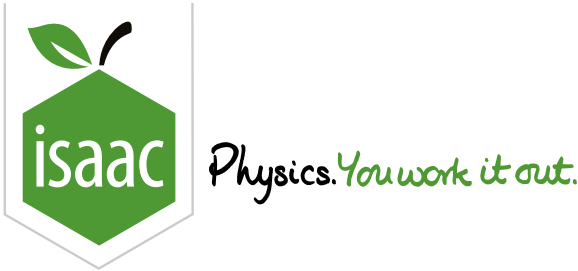
sieve tube elements

Created for isaacphysics.org by Lewis Thomson

Gameboard:

STEM SMART Biology Week 22 - Plant Nutrient & Water Transport

All materials on this site are licensed under the **Creative Commons license**, unless stated otherwise.



Xylem vs Phloem

A Level
C C C

Part A Tissue comparisons

In the table below, identify whether each statement applies to xylem, phloem, or both.

Statement	Tissue
found in roots, stems, and leaves	<input type="text"/>
responsible for translocation	<input type="text"/>
responsible for transpiration	<input type="text"/>
contains living cells	<input type="text"/>
main vessels are composed of lignified non-living tissue	<input type="text"/>
main vessels are composed of sieve tube elements	<input type="text"/>

Items:

- xylem
- phloem
- both

Part B Vascular bundles

Xylem and phloem tissue are found together in "vascular bundles".

A student was investigating the vascular system in a flowering plant and observed a vascular bundle. They identified features of a mature sieve tube element.

The cross-sectional area of a typical xylem vessel is six times greater than the cross-sectional area of this mature sieve tube element.

The cross-sectional area of a typical xylem vessel is $170\,\mu\text{m}^2$

What is the cross-sectional diameter of this sieve tube element? Give your answer to the nearest integer.
(Assume that both cross-sectional areas are circular.)

Part C Radioactive tomatoes

Tomato plants were placed in sunlight in an atmosphere containing radioactively labelled carbon dioxide. After a period of time, radioactively labelled sugars were detected in the roots of the plants.

Drag the statements below into the correct chronological order on the right (with the first step at the top and the last step at the bottom). Only some of the statements will be needed.

Available items

carbon dioxide diffused into the roots

carbon dioxide entered the leaves

the carbon dioxide was transported to the roots by translocation

the carbon dioxide was transported to the roots by transpiration

the carbon dioxide was converted into sugars in the roots

the carbon dioxide was converted into sugars in the leaves

the sugars were transported to the roots by translocation

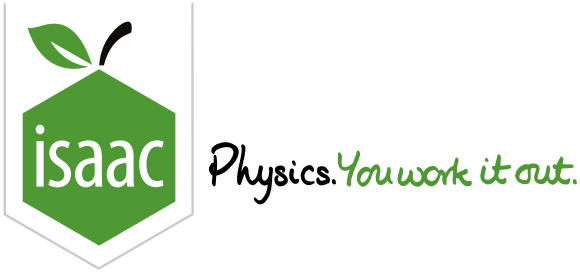
the sugars were transported to the roots by transpiration

Question elements adapted with permission from NSAA 2022 Specimen Paper Section 2 Q26 and Section 1 Q67

Gameboard:

STEM SMART Biology Week 22 - Plant Nutrient & Water
Transport

All materials on this site are licensed under the **Creative Commons license**, unless stated otherwise.



Plant Water Loss



Part A Stomata control

Which of the following statements correctly explain how the stomata are controlled? Select all that apply.

- ☐ when water levels are **high**, the guard cells become turgid, which causes each stoma to **open**
- ☐ when water levels are **high**, the guard cells become turgid, which causes each stoma to **close**
- ☐ when water levels are **low**, the guard cells become less turgid, which causes each stoma to **open**
- ☐ when water levels are **low**, the guard cells become less turgid, which causes each stoma to **close**

Part B Low water environments

What is the general name given to plants that are adapted to living in low water environments?

Which of the following adaptations are commonly found in these plants? Select all that apply.

- ☐ thick waxy cuticle
 - ☐ very thin cuticle or no cuticle
 - ☐ many stomata
 - ☐ few stomata
 - ☐ leaves with a large surface-area-to-volume ratio
 - ☐ leaves with a small surface-area-to-volume ratio
 - ☐ large root system
 - ☐ small root system
-

Part C High water environments

What is the general name given to plants that are adapted to living in high water environments?

Which of the following adaptations are commonly found in these plants? Select all that apply.

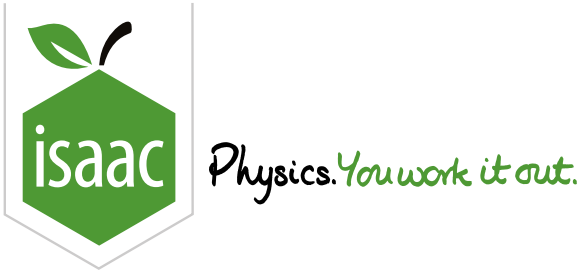
- ☐ thick waxy cuticle
 - ☐ very thin cuticle or no cuticle
 - ☐ many stomata
 - ☐ few stomata
 - ☐ leaves with a large surface-area-to-volume ratio
 - ☐ leaves with a small surface-area-to-volume ratio
 - ☐ large root system
 - ☐ small root system
-

Created for isaacphysics.org by Lewis Thomson

Gameboard:

STEM SMART Biology Week 22 - Plant Nutrient & Water Transport

All materials on this site are licensed under the **Creative Commons license**, unless stated otherwise.



Transpiration and Water Potential

A Level

P

P

P

Water in a plant moves from a high water potential to a low (more negative) water potential. Water potential is measured in MPa.

Part A

MPa values

For a particular plant, the water potential was measured in the soil, in the roots, in the leaves, and in the atmosphere. Match the MPa values to the locations in the table below, assuming that transpiration is occurring normally.

Measurement location	Water potential (MPa)
soil	<div></div>
roots	<div></div>
leaves	<div></div>
atmosphere	<div></div>

Items:

−0.033

−75

−0.1

−1.5

Part B

Water transport

What is the name of the tissue responsible for transporting water from the roots to the leaves?

Part C Water loss

What is the name of the structures in leaves through which water is lost?

Adapted with permission from NSAA 2021 Section 2 Q50

Gameboard:

STEM SMART Biology Week 22 - Plant Nutrient & Water

Transport

All materials on this site are licensed under the **Creative Commons license**, unless stated otherwise.



Physics. *You work it out.*

[Home](#) [Gameboard](#) [Biology](#) [Physiology](#) [Plants](#) [Capillary Action and Water Transport](#)

Capillary Action and Water Transport

A Level



An experiment was performed to investigate whether capillary action could account for the movement of water from roots to leaves in a plant.

Figure 1 shows apparatus used to model this effect using narrow glass capillary tubing. The inner diameter of the capillary tubing is 0.5 mm.

The initial height of the water in the tubing was recorded as 0.2 cm.

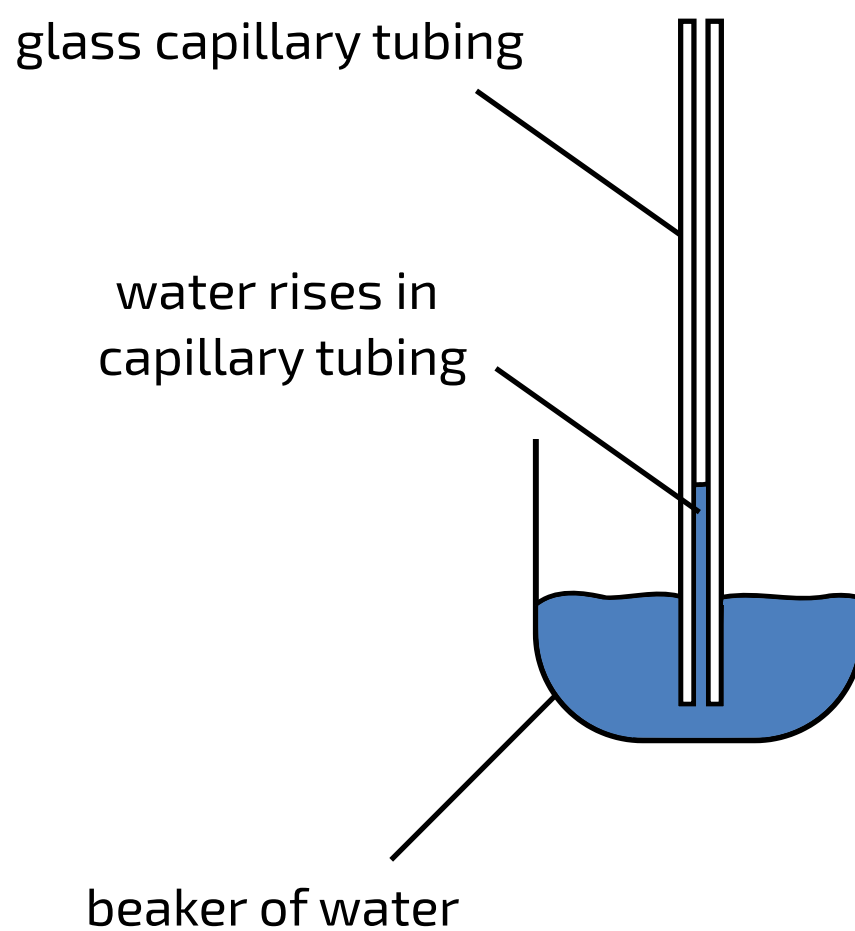


Figure 1: Capillary action experiment. A glass capillary tubing was placed in a beaker of water, and the initial height of water in the capillary tubing was recorded. Over time, the water in the capillary tubing rises as a result of capillary action.

Part A Rate of transport

After 2 minutes the height of the water was recorded as 1.8 cm.

Calculate the rate of water movement in $\text{mm}^3 \text{min}^{-1}$. Give your answer to 3 significant figures.

Part B Transpiration processes

In the experiment above, the water would only travel upwards a certain distance and then stop. In plants, water continuously travels upwards.

This suggests that capillary action cannot fully account for water transport in plants.

Which of the following additional processes are occurring in plants but **not** in the experiment above?

- ☐ adhesion between the water molecules and the surface of the tube (xylem/capillary tubing)
 - ☐ cohesion between water molecules, allowing the water to be pulled upwards
 - ☐ movement of water into the system
 - ☐ evaporation of water, pulling the water upwards
-

Adapted with permission from NSAA 2020 Section 2 Q51

All materials on this site are licensed under the **Creative Commons license**, unless stated otherwise.