

Name:

3.3 Transport and Nutrition	Objectives
3.3.1 Nutrition in the flowering plant	<ol style="list-style-type: none"> <li>1. Understand that plants are Autotrophic</li> <li>2. List the substances that are transported through a plant</li> <li>3. Explain why plants need a transport system</li> <li>4. Describe how water is absorbed by the roots including the role of the root hairs</li> <li>5. Describe how water moves through the root cortex to the Xylem</li> <li>6. Describe how water travels from the root to the leaf</li> <li>7. Explain how Root pressure and Transpiration help bring water to the leaf</li> <li>8. Explain the role of the stomata in water movement</li> <li>9. Explain how minerals are absorbed by the roots</li> <li>10. Explain how minerals move from the root to the leaf</li> <li>11. Explain how the leaf gets Carbon dioxide</li> <li>12. Explain how the carbohydrates, produced in photosynthesis, are transported</li> <li>13. Explain how oxygen, produced in photosynthesis, are transported</li> </ol>
3.3.2 Modified plant storage organs	<ol style="list-style-type: none"> <li>14. Be able to describe one example of a modified Root. Stem and Leaf used for storing food</li> </ol>
3.3.7.H Cohesion- Tension Model of Xylem Transport	<ol style="list-style-type: none"> <li>15. Know the names of the two Irish Scientists that proposed the Cohesion-tension model</li> <li>16. Be able to explain the terms Osmosis, Transpiration, cohesion and adhesion</li> <li>17. Be able to explain how tension arises in a column of water</li> <li>18. Be able to give the main points of Dixon and Joly's proposal on water transport</li> <li>19. Be able to draw and label xylem vessels and xylem tracheids</li> <li>20. Know how xylem is adapted to its function</li> <li>21. Be able to explain how water can move up a plant to great heights against the force of gravity.</li> </ol>
3.4.7.H CO <sub>2</sub> Gaseous Exchange	<ol style="list-style-type: none"> <li>1. Explain how CO<sub>2</sub> levels are a controlling factor in the human breathing (respiratory) system.</li> <li>2. Identify the brain parts concerned with CO<sub>2</sub> detection</li> <li>3. Explain why CO<sub>2</sub> levels rise in the body</li> <li>4. Explain the idea of oxygen debt</li> <li>5. Explain how CO<sub>2</sub> levels are a controlling factor in stomatal opening.</li> </ol>
3.4.3 The structure of an exchange system in flowering plants.	<ol style="list-style-type: none"> <li>6. Outline the structure of the leaf in relation to gaseous exchange and role of lenticels in stem.</li> </ol>

Plants are autotrophic – make their own food.

Plants need to transport water, carbon dioxide, oxygen, minerals and plant growth regulators for their metabolism.

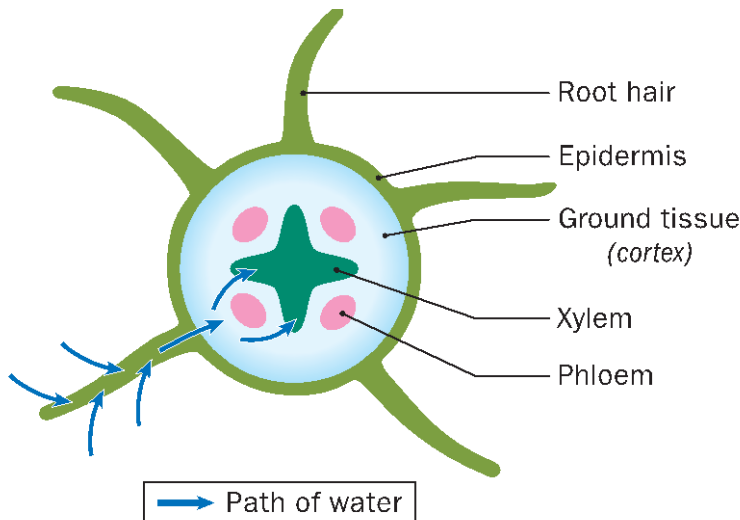
## WATER

Water is needed for photosynthesis, cell metabolism, growth and cell turgidity. It moves upwards within the xylem tissue.

### Water uptake by roots

- Root hairs (single cells - extensions of epidermal cells) absorb water by osmosis. Water passes from the epidermis across the ground tissue to the xylem where it rises due to transpiration.

### T.S. root – pathway of water



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### Transport of water is caused by root pressure and transpiration.

- **Root pressure** is the forced upward movement of water and mineral salts from the root up through the stem.
- **Transpiration:**  
The loss of water vapour from a plant, mainly through the stomata of the leaves.

### The **cohesion – tension model** of water transport in xylem (Dixon and Joly, Dublin 1895)

Put forward to explain how the transpiration stream is produced.

Cohesion means similar molecules sticking together (water has a high cohesion).

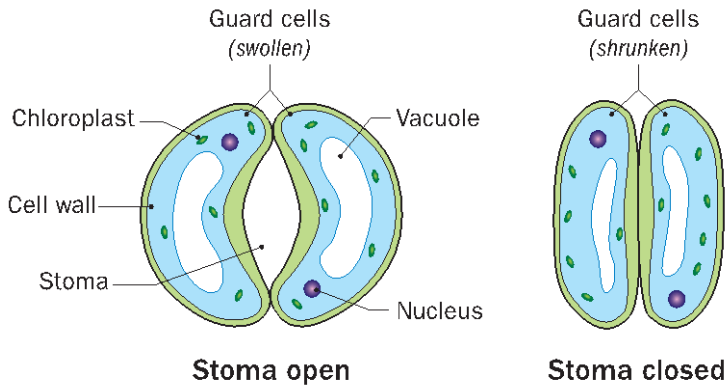
Adhesion means different molecules sticking together (water and xylem have a lower adhesion).

1. Water evaporates from the xylem into the air spaces of the leaf and eventually out into the air.
2. As transpiration pulls each water molecule out of the xylem, the next water molecule is pulled with it due their high cohesion.
3. When water molecules are pulled in this way the entire column is stretched i.e. the water is under tension.
4. This tension is transmitted down to the root xylem due to cohesion between water molecules. This tension is great enough to pull water up 150 metres!
5. The tension produced in the water column causes the xylem and hence the stem to become narrower during the day. To prevent xylem cells collapsing inwards each is strengthened with lignin.
6. When transpiration stops (night – stomata closed), the lack of tension allows the xylem to return to its original wider shape.

### Control of transpiration

1. **Cuticle:** a thick cuticle reduces transpiration.

2. **Stomata:** Mostly on lower surface of leaf. Helps to reduce water loss by transpiration because rate of evaporation is higher on the upper surface.
3. **Stomatal opening /closing** e.g. open as light intensity increases and close at night - this reduces water loss. Environmental conditions can cause stomata to close during the day – if a plant loses too much water and high temperatures.



### Minerals

Needed for synthesizing plant components e.g. calcium, magnesium, nitrates, phosphates and potassium ions. They enter root hairs, dissolved in water, by active transport and are transported by xylem.

### Carbon dioxide

Needed for photosynthesis. Diffuses through stomata and air spaces. Obtained from respiration in cells and atmosphere.

### Oxygen

Obtained from photosynthesis and atmosphere. Diffuses through air spaces. Used for respiration.

### Glucose

Formed by photosynthesis. Used in respiration, stored as starch, translocated as sucrose in phloem sieve tubes (sap).

### Growth regulators

For coordination of plant responses. Move by diffusion and active transport.

## FOOD STORAGE ORGANS IN PLANTS

**Perennials** are plants that survive from one growing season to the next by storing food as starch.

**Modified Leaves (Bulbs) e.g. onion:**

### Diagram

Onion bulbs are edible, but daffodil and tulip bulbs are poisonous – prevents them from being eaten by organisms while in the ground. Other examples include cabbage and lettuce, as are the leaf stalks (petioles) of rhubarb and celery.

### Modified Stems

### Diagram

Stem tubers are the swollen ends of underground stems e.g. potato.

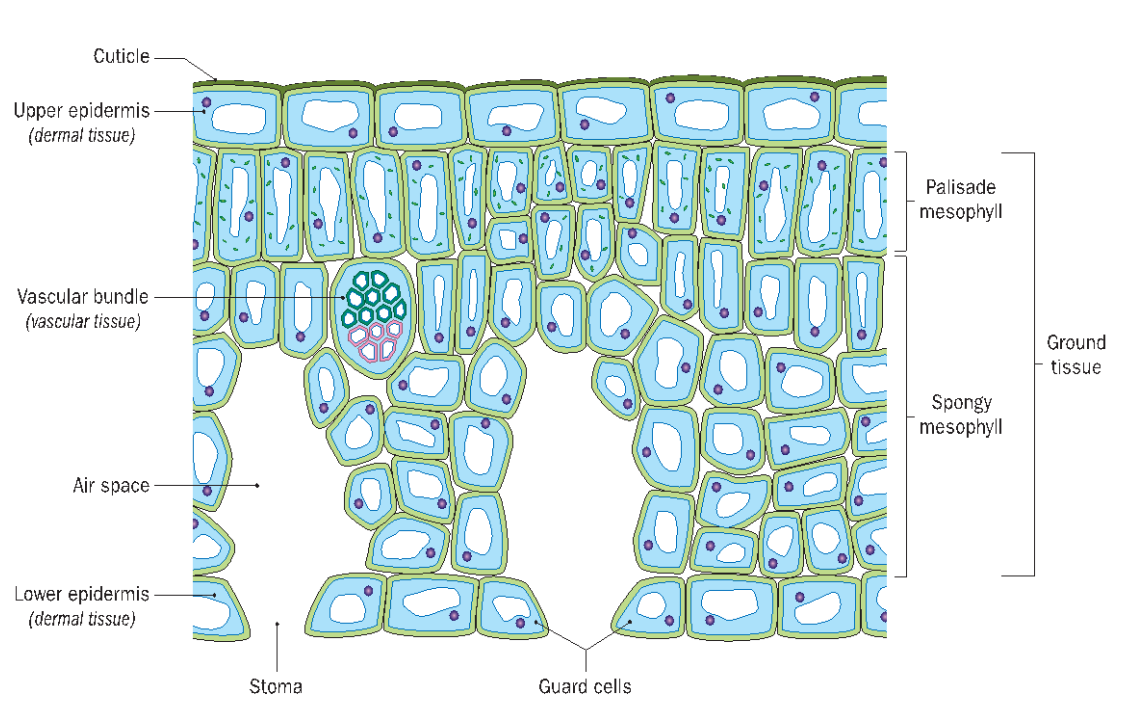
### ***Modified Roots:***

#### **Diagram**

e.g. carrot, turnip and sugar beet are swollen tap roots modified for food storage.

### **Gaseous exchange in plants**

#### **Leaf – internal structure**



#### **Gas exchange in the leaf**

##### **Stomata – lower leaf**

Carbon dioxide in and oxygen out by photosynthesis. Water vapour lost by transpiration.

Generally, stomata are open during the day to allow photosynthesis and closed at night to reduce water loss.

#### **Gas exchange in stems**

Lenticels are openings in the bark of trees that allow oxygen in and carbon dioxide and water vapour out.

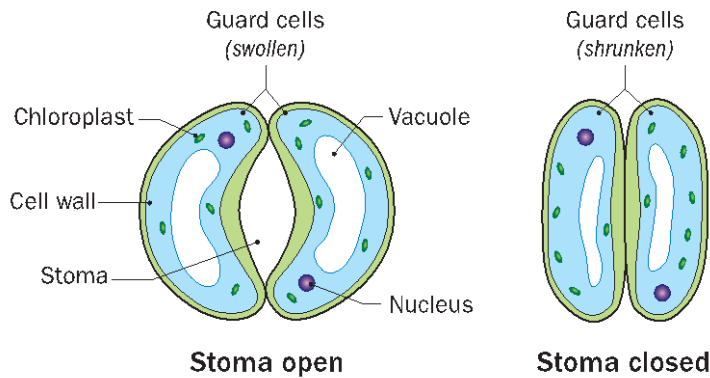
HL - Carbon dioxide also controls gas exchange in leaves - causes the opening and closing of stomata.

#### **Stomatal opening and closing**

When water enters the guard cells by osmosis they swell causing the stoma to increase in size.

Concentration of carbon dioxide is a major factor in the control of stomatal opening and closing. In high concentrations of carbon dioxide the stomata close and vv. In the evening photosynthesis decreases due to decreasing light intensity and then less carbon dioxide is absorbed by the mesophyll cells. Even some carbon dioxide may be produced by respiration.

In the morning photosynthesis resumes reducing carbon dioxide and hence stomata open.



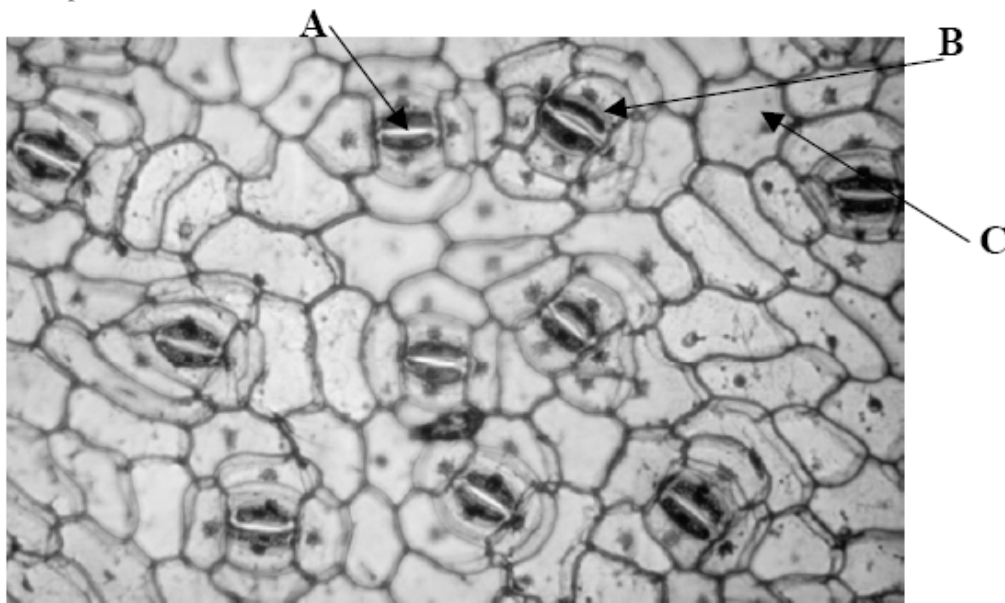
## Questions

2004 HL

1. (a) Name an autotrophic organism .....  
 (c) The conversion of atmospheric nitrogen to nitrates by bacteria is called .....  
 (e) A relationship between two organisms in which both benefit is called .....

2004 HL

4. (a) The diagram shows part of the under surface of a leaf as seen through the microscope.  
 A is an aperture. B and C are cells.



Name A, B, C.

A ..... B ..... C .....

What is the function of A? .....

Name a factor that influences the diameter of A.....

Name the apertures in stems that are equivalent to A.....

- (b) In some species of flowering plants the leaves are modified for the storage of food.  
 Name a plant in which the leaves are modified for food storage .....  
 Name a carbohydrate that you would expect to find in the modified leaves of the plant that you named above .....  
 Name a type of modified stem that functions in food storage.....

2006 HL

6. Distinguish between the members of each of the following pairs by making a brief comment on each.

- (a) Tuber and bulb .....
- .....
- .....

2004 OL

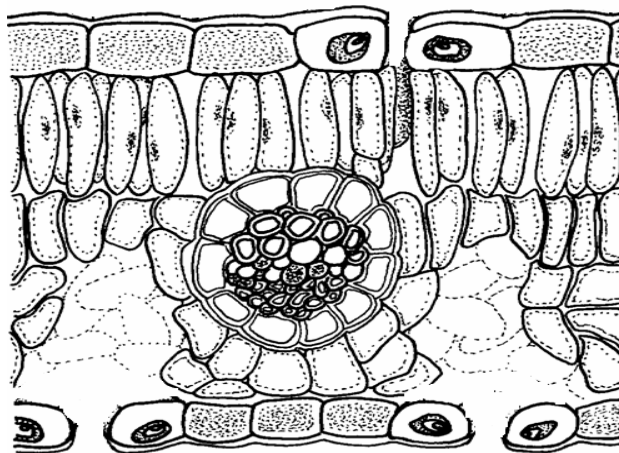
1. (e) Gas exchange between a leaf and the atmosphere takes place through the .....

2006 OL

1. (a) An organism which makes its own food is called a(n) .....

2006 OL

4. The diagram shows part of a section through a leaf.



[Adapted from Livingstone © BIODIDAC]

- (a) Use the letter **A** to show a point of entry of carbon dioxide  
Name this point .....
- (b) Name a gas that **leaves** the leaf at this point .....

2011 OL

4. Indicate whether each of the following statements is true (**T**) or false (**F**) by drawing a circle around **T** or **F** in each case.

- (g) A potato is a modified stem.



**T** **F**

SEC Sample Paper HL

15. (a) (i) Where precisely does water enter a plant?  
(ii) Name the process responsible for this entry of water.  
(iii) Is the process you have named in (ii) also responsible for the uptake of minerals?  
Explain your answer.  
(iv) In which tissue does water ascend through the plant? State one way in which the tissue is adapted for this purpose.  
(v) Explain how water may be raised to great heights in a tree against the force of gravity.

2005 HL

- 14 (a) The passage of water through a plant is known as the transpiration stream. Answer the following questions in relation to the transpiration stream.  
(i) Explain how water enters the plant at the root hair.  
(ii) Do minerals enter the plant by the process that you have indicated in (i)? Explain your answer.  
(iii) How is xylem adapted for its role in water transport?

- (iv) Strong forces of attraction exist between water molecules. Give an account of the importance of these forces in raising water to great height in trees.

**2006 HL**

11. (c) (i) Water is essential for photosynthesis. Briefly outline how water from the soil reaches the leaf.  
(ii) What happens to water molecules when they reach the sites of photosynthesis?

**2008 HL**

14. (a) (i) Name the openings in the leaf which allow the entry of carbon dioxide for photosynthesis.  
State a factor which influences the diameter of these openings.  
(c) (v) Describe how minerals such as nitrates enter the root of a plant from the soil.

**2011 HL**

15. (b) (i) Name the tissue in plant stems through which water rises to the leaves.  
(ii) Give **one** way in which this tissue is adapted for the transport of water.  
(iii) Give a precise location of this tissue in the stem.  
(iv) State another function of the tissue referred to in (i).  
(v) The cohesion-tension model of transport attempts to explain water movement in plants against a particular force. Name this force.  
(vi) Describe the principal features of the cohesion-tension model.  
(vii) Name the two scientists mainly associated with the cohesion-tension model of transport.

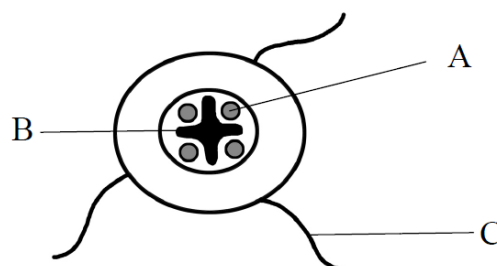
**2010 OL**

15. Answer any **two** of the parts (a), (b), (c).  
(30, 30)  
(a) Water is vital for the survival of living things. Plants absorb water from the soil.  
(i) Through which microscopic **structures** does water enter a plant from the soil?  
(ii) By what **process** does water enter a plant?  
(iii) Name the **tissue** that water travels through in a plant.  
(iv) Draw a labelled diagram of one cell of the tissue referred to in (iii) above.  
(v) Name **one** process that causes water to move upwards in a plant.  
(vi) Consider that night has fallen and the plant is in darkness.  
Suggest what will happen to the **amount** of water moving through the plant **and** give a reason for your answer.  
(vii) State **two** ways by which plants have adapted to protect themselves.

**2011 OL**

15. Answer any **two** of (a), (b), (c)  
(30,30)

- (b) The diagram shows a transverse section through a dicotyledonous (dicot) root.



- (i) Name the parts labelled A, B and C.  
(ii) State **two** functions of a root.



- (iii) From what part of a seed does the root develop?
- (iv) Give **one** example of a root modified for food storage.
- (v) Plants can be monocotyledonous or dicotyledonous.  
Give any **one** difference between a monocotyledonous plant and a dicotyledonous plant.
- (vi) Give **one** example of a monocotyledonous plant **and** one example of a dicotyledonous plant.

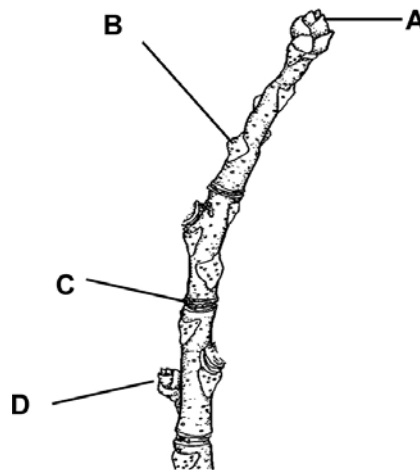
## Gaseous Exchange in Plants

### 2008 HL

14. (a) (i) Name the openings in the leaf which allow the entry of carbon dioxide for photosynthesis.  
State a factor which influences the diameter of these openings.

### 2006 OL

14. Answer any two of (a), (b), (c).  
(30,30)  
(a) The diagram shows the structure of part of a stem.



- (i) Identify A, B, C and D.
- (ii) What is a meristem?
- (iii) Give a location of a meristem in the diagram.
- (iv) How many years' growth are shown in the diagram?  
Explain your answer.
- (v) Give two functions of a stem.

### 2007 OL

15. (b) (i) Draw a diagram of a section through a leaf. Label a stoma and a guard cell.  
(ii) Give a function of the guard cell.  
(iii) Name two gases that enter or leave the leaf.  
(iv) Name the process by which the gases move in or out of the leaf.



Answers

1. 2004 OL Q1

(e)	stomata or dermal tissue or named tissue
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2. 2006 OL Q1

(a) An organism which makes its own food is called a(n) .....

3. 2006 OL Q4

(a)	A on stoma and Stoma
(b)	Oxygen/ water (vapour) / carbon dioxide / nitrogen

4. 2011 OL Q4

(g)	A potato is a modified stem.	<b>T</b>
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5. 2010 OL Q15

(a)	(i)	<b>Root hairs</b>	<b>2(6) +6(2)</b>
	(ii)	Osmosis	
	(iii)	Xylem [ <i>allow dermal or ground or vascular or phloem</i> ]	
	(iv)	Diagram: [ <i>any two valid structures for three marks</i> ] Labels: vessel <b>or</b> tracheid/pits <b>or</b> rings <b>or</b> spirals/lignin/hollow <b>or</b> dead [ <i>allow valid labels for other given tissue</i> ] [ <i>three labels</i> ]	<b>3, 0</b> <b>3(1)</b>
	(v)	Root pressure <b>or</b> cohesion <b>or</b> adhesion <b>or</b> capillarity <b>or</b> transpiration	
	(vi)	Amount of water moving through the plant: decreases <b>(One point)</b> Reason: photosynthesis stops <b>or</b> stomata close in darkness <b>or</b> nighttime is cooler <b>(One point)</b>	
	(vii)	Thorns / stings / bad taste / poison / mimicry / cuticle / heat shock proteins <b>(Two points)</b>	

6. 2011 OL Q15(b)

	(iv)	Carrot / turnip / parsnip / root tuber ...	1(Pt)
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7. 2004 HL Q1

(a)	Any named plant <b>or</b> named photosynthetic bacteria <b>or</b> cyanobacteria [ <i>allow grass, seaweed, fern, moss</i> ]	
(c)	(nitrogen) fixation	
(e)	Mutualism <b>or</b> symbiosis	

8. 2004 HL Q4(b)

(b)	Onion <b>or</b> tulip <b>or</b> daffodil <b>or</b> cabbage other correctly named plant
	Starch <b>or</b> sucrose <b>or</b> cellulose <b>or</b> fructose <b>or</b> glucose [ <i>not 'sugar'</i> ]
	Rhizome <b>or</b> corm <b>or</b> tuber [ <i>allow stolon</i> ]

9. 2006 HL Q6(a)

(a)	<i>tuber</i> : stem <b>or</b> root [2 for all who attempt question] <i>bulb</i> : leaf <b>or</b> bud
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10. SEC Sample Paper HL Q15

(a)	(i)	At the root hairs	3
	(ii)	Osmosis	3
	(iii)	No as osmosis is exclusive to water but, minerals move into the roots by diffusion, with the water	2(3)
	(iv)	Xylem Lignified/ narrow/ hollow/ continuous pipe	3 3
	(v)	water evaporates from the surface of leaves ( transpiration)/ and is replaced / creating an upward pull or tension/the continuous stream/ ensures movement of water upwards/ the water column is hard to break	4(3)

11. 2005 HL Q14

(a)	(i)	Osmosis / reference to different concentrations / membrane partially (selectively) permeable / comment on surface area of root hair(s) or no cuticle present <b>any three</b>	3(3)
	(ii)	No Only water (solvent) moves by osmosis or other correct comment	3 3
	(iii)	Tubular or continuous lumen / reinforced (lignified) walls / end to end / pits / lateral movement of water / wettable lining /	2(3)

		narrow (bore) <b><u>any two</u></b>	
	(iv)	(called) cohesion / water evaporates in leaf or transpiration / is replaced / upward pull or tension / continuous stream / ensures movement / water column hard to break <b><u>any three</u></b>	<b>3(3)</b>

**12. 2006 HL Q11**

(c)	(i)	concentration gradient / root hair / osmosis / cell to cell / root pressure / xylem / cohesion <b>or</b> explained / adhesion <b>or</b> capillarity <b>or</b> explained / Dixon and Joly / transpiration <b>or</b> evaporation [ <i>accept water loss</i> ] / tension <b><u>any six</u></b>	<b>6(3)</b>
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**13. 2008 HL Q14**

(a)	(i)	Stomata	3
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©	(v)	diffusion <b>or</b> passive transport	3
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**14. 2011 HL Q15**

(b) .

	(v)	*Gravity	<b>3</b>
	(vi)	Water (molecules) stick together / (due to) H-bonding / continuous chain (of water molecules) / water tends to adhere to xylem walls / transpiration (or water loss) 'pulls' (the column of) water up <b><u>Any 3</u></b>	<b>3(3)</b>
	(vii)	*Dixon	<b>3</b>
		*Joly	<b>3</b>

**Gas exchange**

**2008 HL Q14(a)**

14.	Any <b>two</b> of (a), (b), (c)		<b>(30, 30)</b>
	(a)	(i)	Stomata
			light <b>or</b> CO <sub>2</sub> <b>or</b> potassium ions (K) <b>or</b> wind <b>or</b> turgidity of guard cells <b>or</b> water availability <b>or</b> high temperature
			3
			3

**2006 OL Q14(a)**

14.	ANY TWO OF (a), (b), (c).		
	(a)		
			<b>5(5)+3+2</b>

		(i)	<b>A</b> = terminal or apical bud <b>B</b> = leaf scar <b>C</b> = scale, girdle or growth scar <b>D</b> = lateral or axillary bud [Allow "bud" once only] <b>any two correct answers</b>	
		(ii)	Growth region or region of mitosis	
		(iii)	Bud or cambium or under bark or stem tip	
		(iv)	Award marks for candidates who attempt this question	
		(v)	Transport/ support/ displays flower or leaf or fruit / photosynthesis / reproduction / gaseous exchange / storage / perennation <b>any two</b>	

**2007 OL Q15(b)**

	(b)			6, 3, 0 for diagram + 2(6)+4(3)
		(i)	diagram (epidermis or cuticle, rectangular cells, air spaces) labels (stoma, guard cell)	
		(ii)	controls stomatal size [allow controls passage of gas or water vapour]	
		(iii)	carbon dioxide/ oxygen/ nitrogen/ water vapour [allow maximum of 3 marks if air alone mentioned]	any two
		(iv)	diffusion or passive transport	