Name: ……..

Y11 into Y12
Biology transition work

Module 3 – Exchange and Transport

What should you know?

Exchange and Transport

- Describe the process of diffusion
- Explain why a large surface area to volume ratio is important
- Calculate the surface area to volume ratio
- Explain the importance of exchange systems in multicellular organisms
- Explain how lungs are adapted to be a good exchange system
- Explain how root hair cells are adapted to be a good exchange system

Transport in animals

- Describe the role of the circulatory system
- Recall what makes up the circulatory system in humans
- Explain how the different blood vessels are adapted to function
- Explain how the different parts of the blood are adapted to function
- Label a diagram of the Heart
- Describe the route that blood takes through the Heart
- Explain the role of valves in the heart
- Explain why the right side of the heart is thicker than the left
- Recall and apply the equation for cardiac output

Transport in plants

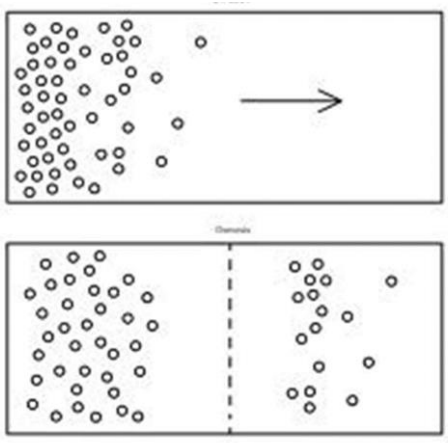
- Describe the importance of transport in plants
- Explain the process of translocation
- Explain the process of transpiration
- Explain how the xylem and phloem are adapted to their function
- Explain how the rate of transpiration can be measured experimentally
- Describe how light intensity, wind, humidity and temperature affect the rate of transpiration

The Basics

Exchange and Transport

Diffusion is the passive movement of substances (without energy) like oxygen or carbon dioxide down the concentration gradient (e.g. from a high concentration to a low concentration).

Osmosis is similar to diffusion, however osmosis is the movement of water across a partially permeable membrane. Water moves from a dilute solution to a concentrated solution (e.g. high water concentration to a low water concentration).



The surface area to volume ratio is how much of the shape is exposed to the outside for the volume for example a smaller cube would have a larger SA:V ratio as there is more of the shape exposed.

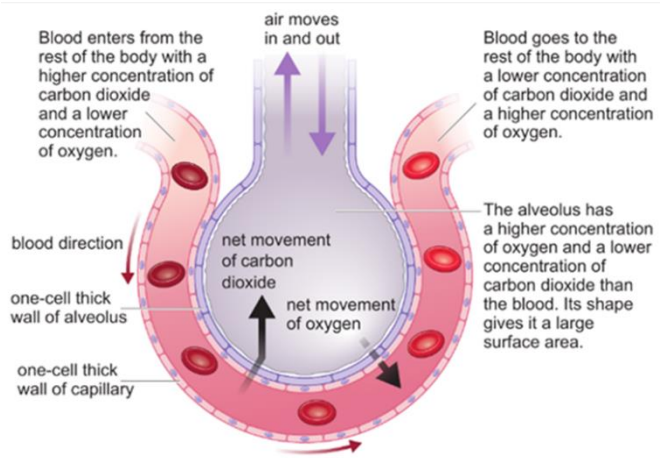
Surface area = (Width x Height) x the number of sides

Volume = Width x Height x Depth

The large this ratio is the more space there is for diffusion to occur so the faster the rate of diffusion. This is important in getting transport as possible. In multicellular organisms like plants and animals exchange systems like the lungs roots and intestines are adapted to increase the SA:V ratio and the rate of diffusion.

The lungs

The lungs are made of the trachea, two bronchi and then bronchioles that end with many alveoli (a bit like the branches of a tree).

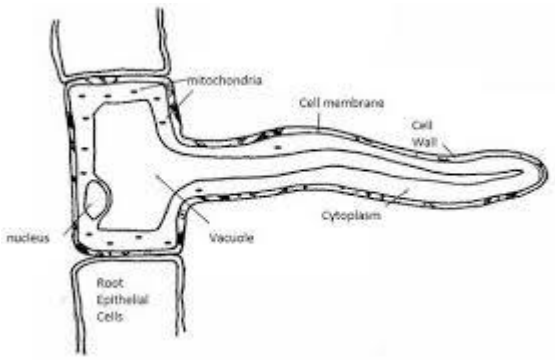


The alveoli increase the surface area massively and are adapted in many ways such as;

- Moist lining for dissolving gases
- Good blood supply – maintains conc. Gradients
- Very thin walls
- Enormous surface area – about 75m^2 in humans
- Covered in a network of veins and arteries for increased spread and gas exchange

The roots

The roots of a plant help absorb minerals and water from the soil for the plant, the roots keep a constant concentration gradient meaning there is less water in the roots than outside so water moves in by osmosis. The roots also contain many root hair cells which are cells with hair like extensions to increase the surface area.



Knowledge Tasks

1. What is diffusion and how does it work?

   _____

   _____

2. Why is diffusion important in animals and plants?

   _____

   _____

3. What is surface area to volume ratio?

   _____

   _____

4. Why is having a large surface area to volume ratio is important?

   _____

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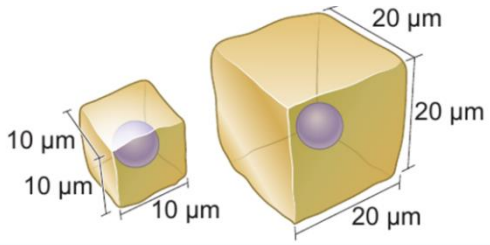
   _____

5. What is the equation to calculate the surface area to volume ratio?

   _____

   _____

6. Calculate the surface are to volume ratio for these two cubes.



surface area = =	surface area = =
volume = =	volume = =
SA:V = =	SA:V = =

7. Why do multicellular organisms such as plants and animals need gas exchange systems?

   _____

   _____

   _____

   _____

8. Explain the role of the lungs in gas exchange and how they adapted to function (you may use a diagram in your answer).

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9. Explain the role of the roots in transport and how they are adapted to function (you may use a diagram in your answer).

_____
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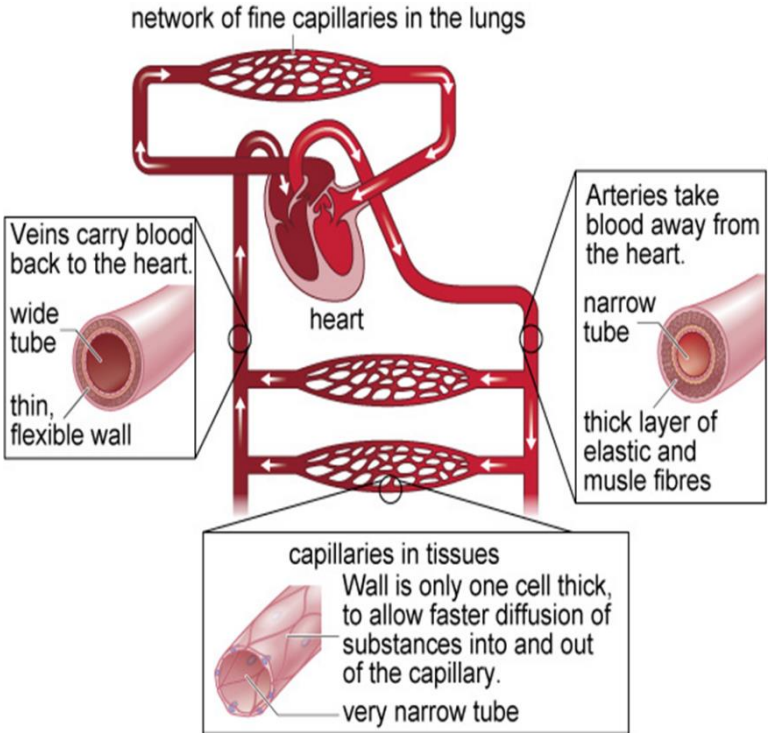
The Basics

Transport in animals

The role of the circulatory system is to transport substances around the body. For example oxygen and glucose is transported to respiring tissues and carbon dioxide is transported away from respiring tissues.

The circulatory system is made up of the heart, blood vessels and blood.



Blood vessels

Arteries

- The arteries always take blood away from the heart.
- In the arteries, the blood is always under high pressure.
- For this reason, the arteries have very stretchy walls containing muscle and elastic fibres.
- Allows them to stretch and spring back

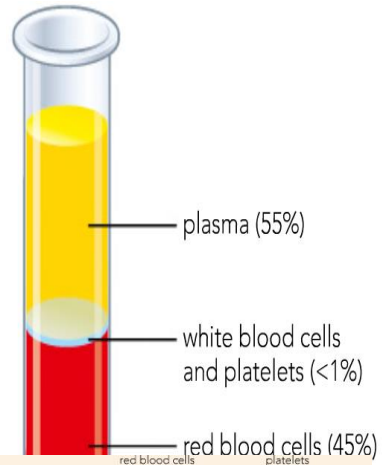
Capillaries

- Arteries branch into capillaries
- Capillaries are the smallest of the blood vessels.
- Their walls are only one cell thick, very narrow
- They are found inside all of our tissues and organs.
- This means they can squeeze in gaps between cells and deliver blood to extremities.
- As their walls are so thin, substances like carbon dioxide and oxygen can diffuse through them easily to get to and from the blood.

Veins

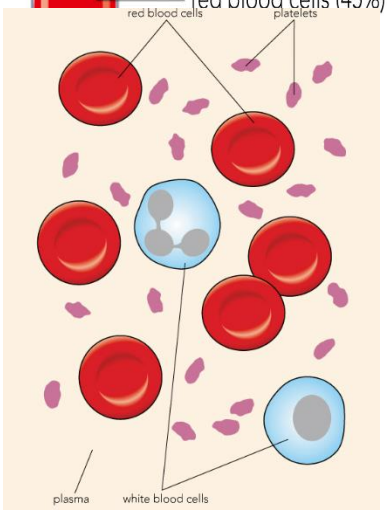
- Capillaries eventually join up to form veins
- Veins have quite thin walls because the blood in them is not under high pressure.
- They have a big lumen (hole) to help blood flow at low pressure
- They also have valves to keep blood flowing in the right direction preventing backflow.

Blood



Red Blood Cells (Erythrocytes)

- Have a **biconcave disc** structure (looks like a donut!)
- This gives it a **large SA to volume ratio** (lots of space to carry oxygen)
- RBCs have **no nucleus** – leaves more room for more haemoglobin to be in the cell (so it can carry more oxygen)
- Contain red pigment called **Haemoglobin,** (contains iron)
- Can combine **reversibly** (reaction can occur both ways) with oxygen.



Plasma

- A **yellow liquid,** carries everything in blood, including RBCs, WBCs, and platelets
- Also transports dissolved substances such as **carbon dioxide, glucose, amino acids, urea, hormones, antibodies and antitoxins (produced by WBCs)**

White blood cells

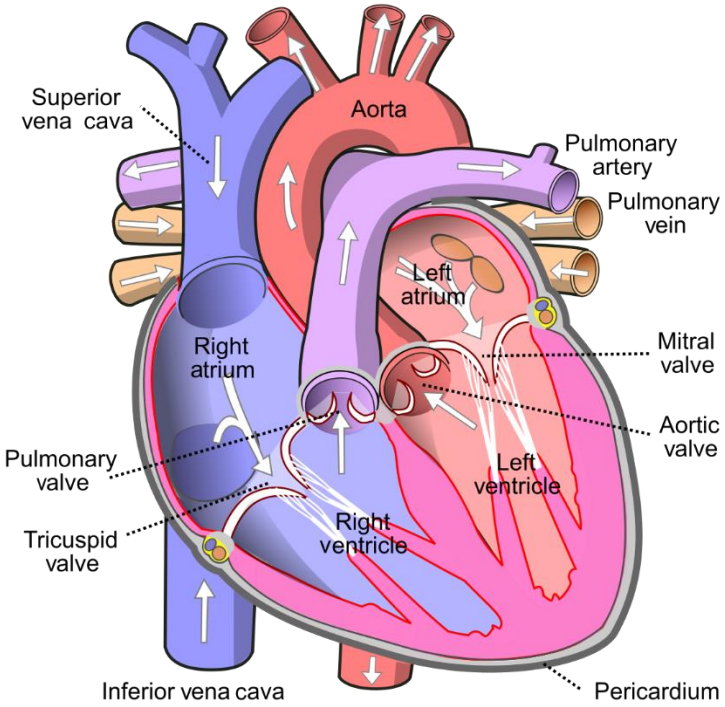
- Defenders against **disease**
- **LYMPHOCYTES** - WBCs that make **antibodies** and some make **antitoxins**
- Antibodies are **proteins** that bind to **microorganisms** and help **destroy** them
- **PHAGOCYTES** – WBCs that change shape and engulf pathogens. This process is called **Phagocytosis**
- All WBCs have a **nucleus**
- When you have an infection, WBCs multiply so a blood test will show high WBC count.

Platelets

- **Tiny fragments** of cells
- Have **NO nucleus**
- They make your blood **clot** if you cut or damage a blood vessel.
- Clot dries and forms a **scab** – this stops microorganisms getting inside body
- Prevents excessive bleeding and bruising

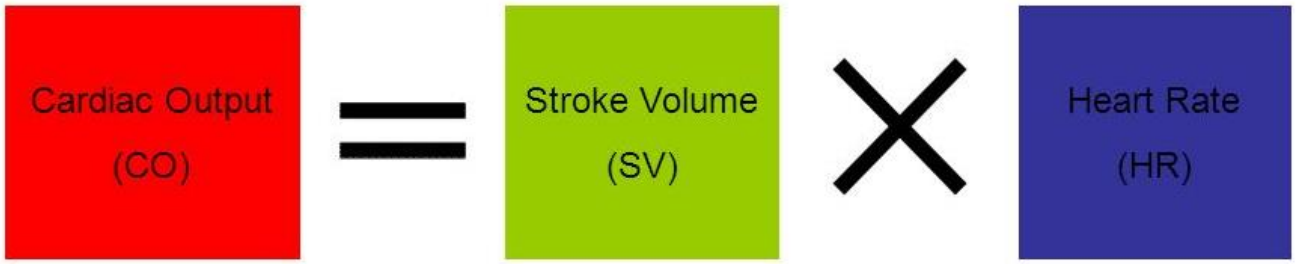
The Heart

1. Oxygenated blood returns to the heart via the pulmonary vein and enters the left atrium
2. The valves are flaps of tissue that stop back flow of blood
3. When the atrium is full, muscles contract and force blood passed the valves into the left ventricle
4. Vena cava (superior and inferior) brings blood into right atrium
5. The pulmonary artery carries blood deoxygenated blood to the lungs to pick up oxygen, and remove carbon dioxide
6. When right ventricle is full of blood, muscles contract forcing blood out via the pulmonary artery
7. When right atrium is full, muscles in the wall contract and force blood through valves into right ventricle



8. The aorta is the largest blood vessel in the body and the blood travels from here to the rest of the body
9. When the left atrium is full, it contracts and forces blood passed valves into the aorta.

The total volume of blood per minute is called the cardiac output and can be calculated by;



Where

- HR = Beats per minute
- SV = Volume of blood pumped by a ventricle per contraction

Knowledge Tasks

1. What is the role of the circulatory system?

2. What is the circulatory system made up of?

3. What are the 3 types of blood vessels?

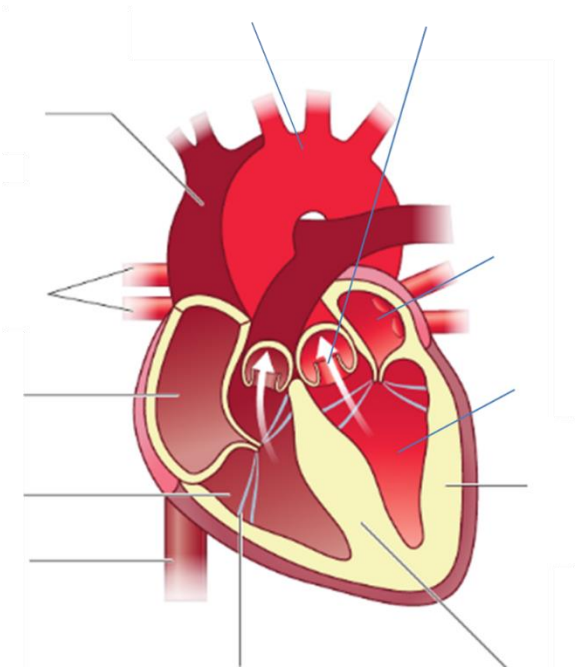
4. How are these blood vessels adapted to function?

5. What components make up the blood?

6. What are the roles of these different parts of the blood?

7. How are these different parts of the blood adapted to function?

8. Label this heart diagram



9. Using a blue (deoxygenated) and a red (oxygenated) pen draw arrows to show the route blood takes through the heart
10. Describe the route blood takes through the heart including the names of all the main structures.

_____
_____
_____
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11. What is the role of the valves in the heart?

_____
_____

12. Why is the left side of the heart thicker than the right?

_____
_____

13. What is the equation for cardiac output?

_____
_____

14. If someone's heart pumps 0.0083 litres 59 times a minute what is their cardiac output?

_____
_____

The Basics

Transport in Plants

Translocation

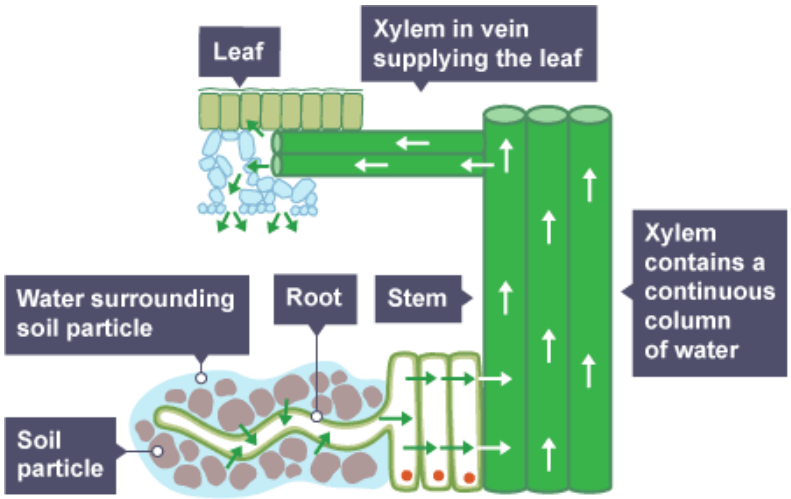
During photosynthesis, plants produce glucose from simple inorganic molecules - carbon dioxide and water - using light energy. Some of the glucose produced by photosynthesis is used for respiration. This releases energy for the seven life processes.

Translocation is the movement of sugar produced in photosynthesis to all other parts of the plant for respiration and the other processes described above. This occurs in phloem vessels.

Transpiration

Transpiration is the movement of water in a plant and occurs due to water evaporating through the stomata in the leaves which pulls the other water molecules up to replace them because of forces between the water molecules.

This process occurs in the Xylem vessels.

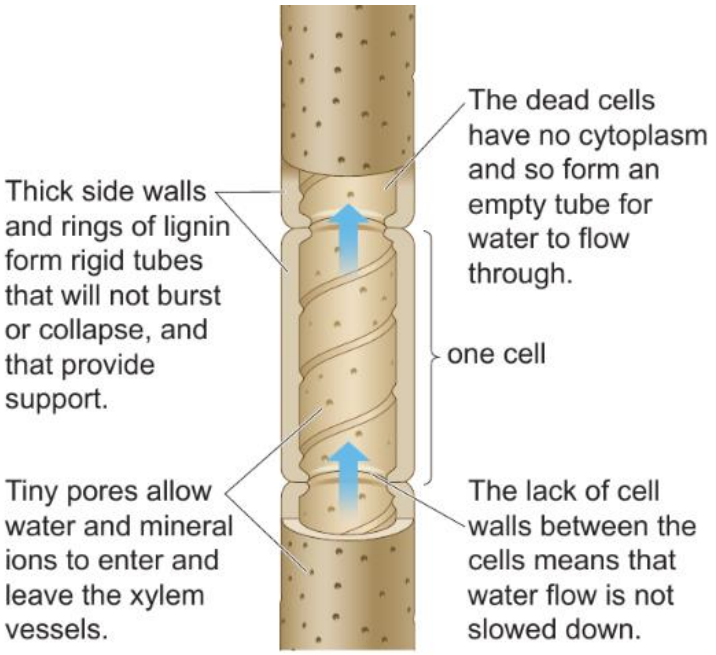


Xylem

The Xylem is adapted to carry water through the plant by transpiration.

During the differentiation of xylem cells, the cell itself dies causing the bottom and top cell walls to disintegrate forming a long tube empty of cytoplasm to allow water to flow through easily.

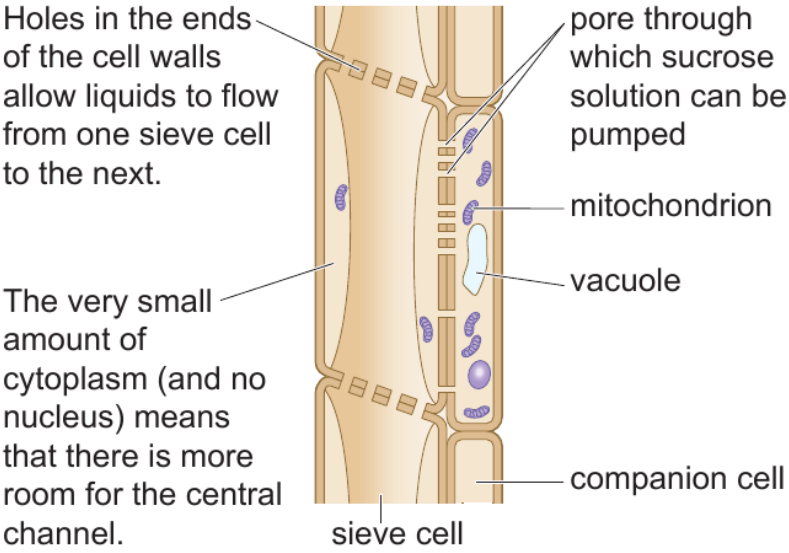
Although the cells are dead the walls of xylem vessels are very thick and have rings of something called lignin. These strong walls are to support the plant and so the water pressure doesn't burst the vessels. Despite these strong walls the xylem vessels do have tiny pores in to allow water and mineral ions to move in and out of the vessel easily.



Phloem

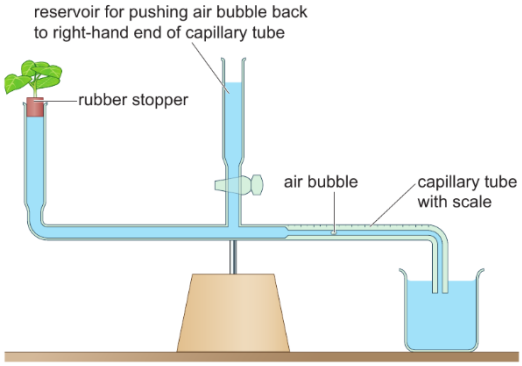
The Phloem contains sieve tubes that allow sucrose (a sugar made from glucose) to be translocated (transported) around the plant.

Unlike the xylem the sieve cells are not dead. They are however long tubes containing little cytoplasm and no nucleus and have holes in the cell walls at the top and bottom of the cell to allow fluid to flow through to the next cell.



The sieve cells have another cell attached to them these are called companion cells and actively pump sucrose into the sieve cells. To help the companion cells do this they are packed full of mitochondria. They also have vacuoles to help support the phloem.

Measuring transpiration



This is a potometer. Potometers show how much water is taken up by measuring the distance moved by the air bubble. The further the bubble moves the more water is taken up. The more water taken up, the faster the rate of transpiration

By changing different factors, we can see how they affect the rate of transpiration using this equipment. For example, you can change light intensity by changing the distance of the plant from a light source. However, you have to place a beaker of water in front of the light so the heat from the light does not affect the rate.

Some of the factors that affect transpiration are;

- **Temperature** – As temperature increases so does the rate of transpiration as particles diffuse quicker.
- **Light intensity** – The higher the light intensity the higher the rate of transpiration and the wider the stomata so more water evaporates.
- **Wind** – As wind speed increases so does the rate of transpiration as wind moves molecules away from the stoma so more can evaporate.
- **Humidity** – As humidity decreases the rate of transpiration increases this is because the lower the humidity the less water molecules there are around the stoma and so more can evaporate.

Knowledge Tasks

1. Why is transport in plants important?

   _____

   _____

2. What is translocation?

   _____

   _____

3. What is transpiration?

   _____

   _____

4. Describe the process of transpiration

   _____

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5. How is the xylem adapted to function? (you may use a diagram in your answer)

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   _____

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   _____

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   _____

6. How is the phloem adapted to function? (You may use a diagram in your answer)

   _____

   _____

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7. Fill in the table below to compare the xylem and the phloem

Part of plant	Xylem	Phloem
Role		
Are cells dead or alive		
Are other cells needed?		
Adaptation one		
Adaptation two		

8. How can the rate of transpiration be measured?

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9. Describe how light intensity affects the rate of transpiration

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10. Describe how wind affects the rate of transpiration

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11. Describe how humidity affects the rate of transpiration

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12. Describe how temperature affects the rate of transpiration

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_____
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_____

13. Explain how you could test the effect that light intensity has on the rate of transpiration including the controls you would use.

14. Explain how you could change this experiment to test the effect of temperature on the rate of transpiration

Exam Style Questions

Q1. Figure 5 shows two potato chips.

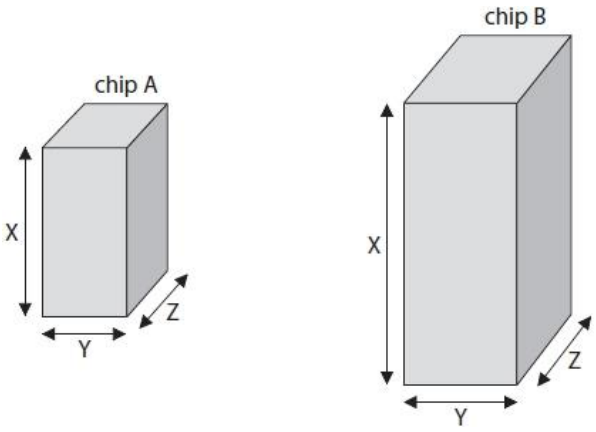

Figure 6 shows some information about each potato chip.

potato chip	length of X in cm	length of Y in cm	length of Z in cm	total surface area of four sides in cm^2	total surface area of top and bottom in cm^2	total surface area of chip in cm^2
A	3.0	1.5	1.5	18.0	4.5	22.5
B	5.0	2.0	2.0	?	?	?

Figure 6

(i) Calculate the total surface area of potato chip B using the formula,

Total surface area = 2XY + 2XZ + 2YZ

(2)

total surface area = ... cm^2

(ii) The potato chips were placed in distilled water for 20 minutes.

Figure 7 shows the increase in mass of each potato chip.

potato chip	increase in mass in grams
A	0.1
B	0.3

Explain why potato chip B has a greater increase in mass than potato chip A.

(2)

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(iii) Potato chip A is transferred from the distilled water into a concentrated salt solution.

Explain what will happen to the cells in potato chip A.

(3)

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(Total for question = 7 marks)

Q2.

Osmosis is one method that single-celled organisms, such as bacteria, use to obtain molecules from their environment.

Which of the following is a correct description of a process involving the transport of molecules? (1)

☐ **A** Diffusion is used to transport molecules against the concentration gradient

☐ **B** Active transport is used to obtain molecules in a low concentration environment

☐ **C** Active transport moves substances along the concentration gradient

☐ **D** Diffusion uses energy to transport molecules into cells

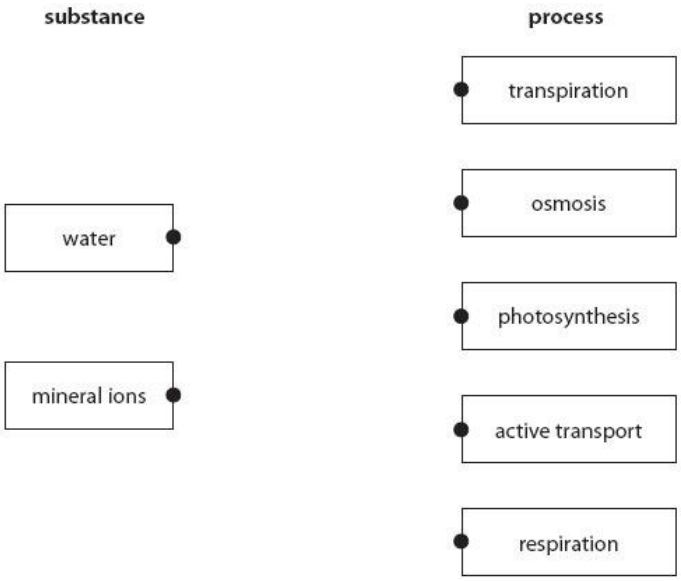
(Total for question = 1 mark)

Q3.

Root hair cells take in water and mineral ions from the soil.

Draw **one** straight line from each substance to the process by which it enters the root hair cell.

(2)



Q4.

Explain, using Fick's law, the factors that affect the diffusion rate of molecules into and out of cells. (6)

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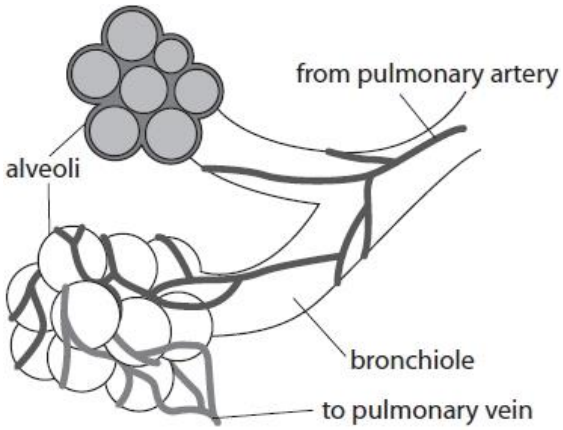
(Total for question = 6 marks)

Q5.

Figure 10 shows alveoli from a lung.



(i) Explain why these alveoli have the internal structure shown in Figure 10. **(3)**

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(ii) How does oxygen move across the alveolar membrane into the capillary? **(1)**

☒ **A** by osmosis

☒ **B** by active transport

☒ **C** by diffusion

☒ **D** by respiration **(Total for question = 4 marks)**

Q6.

Figure 1 shows a diagram of the heart.

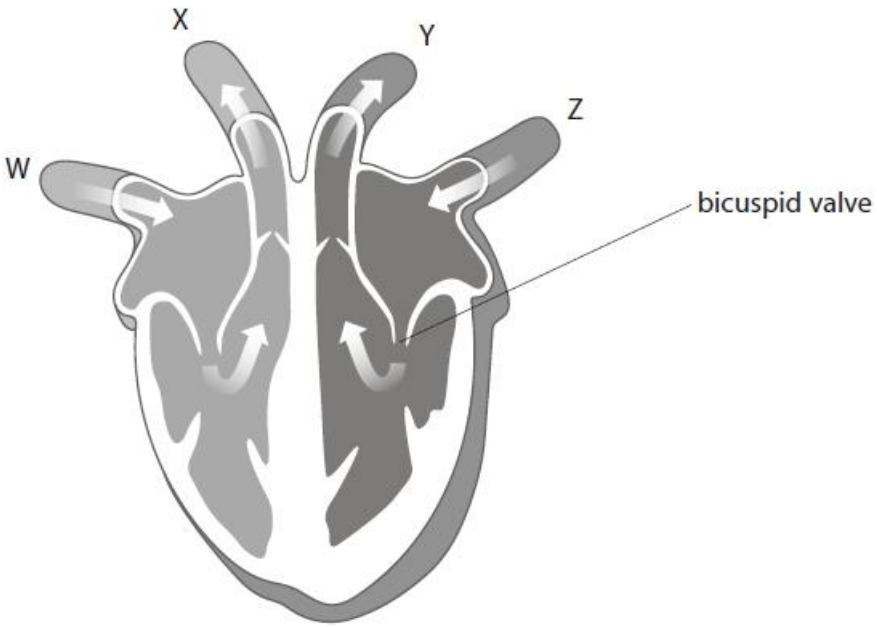

Figure 1

(i) Vessel X takes **(1)**

- ☒ **A** deoxygenated blood to the body
- ☒ **B** deoxygenated blood to the lungs
- ☒ **C** oxygenated blood to the body
- ☒ **D** oxygenated blood to the lungs

(ii) Give one reason why the wall of the left ventricle is thicker than the right. **(1)**

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Valves in the human heart may become damaged and no longer function.

(iii) Describe what would happen to the flow of blood in the left side of the heart if the bicuspid valve did not function effectively.

(2)

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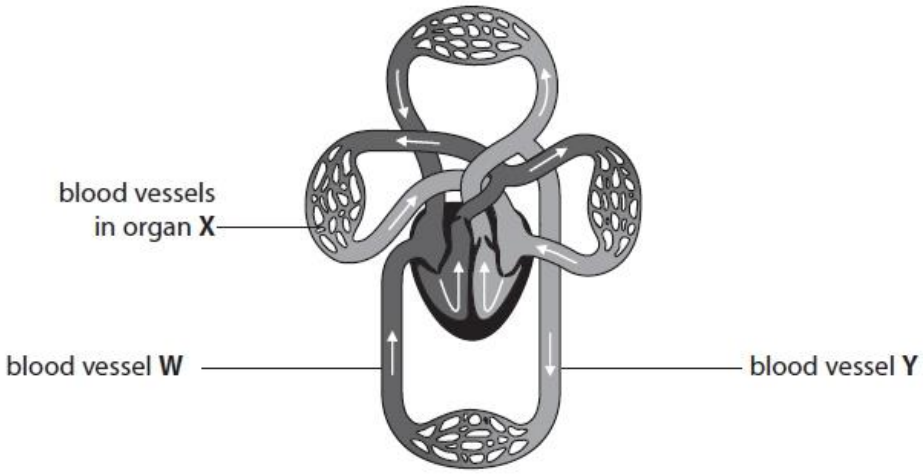
(Total for question = 4 marks)

Q7.

The diagram shows the human circulatory system.



(i) Name organ **X**. **(1)**

.....

(ii) Explain how the heart causes blood to move to organ **X**. **(2)**

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(iii) Which row shows the names of blood vessels **W** and **Y**?

Place a cross (☒) in the box next to your answer.

(1)

	blood vessel W	blood vessel Y
☐ A	pulmonary vein	aorta
☐ B	vena cava	pulmonary artery
☐ C	pulmonary artery	vena cava
☐ D	vena cava	aorta

(iv) Describe how the blood in vessel **W** is different from the blood in vessel **Y**.

(2)

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Q8.

* Blood from the body enters the heart through the vena cava.

Describe how this blood flows through the heart and lungs to leave the heart through the aorta.

Include references to the chambers of the heart and the relevant valves in your answer. **(6)**

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..... **(Total for question = 6 marks)**

Q9.

Figure 10 shows the estimated blood flow through some parts of the body when a person is at rest and during exercise.

part of the body	estimated rate of blood flow in cm^3 per minute	
	at rest	during exercise
brain	750	748
heart muscle	350	1 150
digestive system	2 500	1 200
other muscles	1 200	14 500
all other organs (except lungs)	1 423	1 420

Figure 10

A person has a cardiac output of 4.9 litres per minute. The stroke volume of each heart beat is 70 ml.

Calculate the heart rate.

(2)

..... beats per minute

(Total for question = 2 marks)

Q10.

Figure 13 shows a cross-section of a blood vessel.

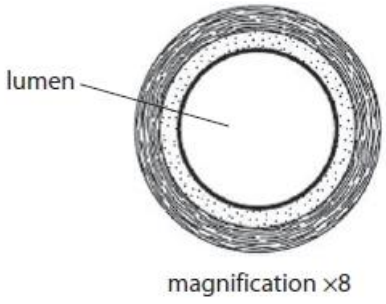

Figure 13

(i) The diameter of the lumen in Figure 13 is 25.0 mm

What is the actual diameter of the lumen of this blood vessel?

(1)

- ☒ **A** 3.1×10^{-2} m
- ☒ **B** 3.1×10^{-3} m
- ☒ **C** 2.0×10^{-2} m
- ☒ **D** 2.0×10^{-3} m

(ii) Which blood vessel delivers deoxygenated blood to the heart?

(1)

- ☒ **A** aorta
- ☒ **B** pulmonary artery
- ☒ **C** pulmonary vein
- ☒ **D** vena cava

(iii) Capillary walls are much thinner than the wall of the blood vessel in Figure 13.

The lumen of a capillary is also much smaller.
Explain how each of these features of the capillary helps it to function efficiently.

(2)

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(Total for question = 4 marks)

Q11.

(i) Complete the sentence by putting a cross (☒) in the box next to your answer.

A group of the same type of cells, such as red blood cells, is known as **(1)**

- ☒ **A** an organ
- ☒ **B** an organ system
- ☒ **C** an organism
- ☒ **D** a tissue

(ii) In humans, each mature red blood cell does not have a nucleus.

Suggest why not having a nucleus in a red blood cell is an advantage. **(2)**

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Q12.

The table shows the number of different components found in the blood of a healthy person and the blood of two other people.

	number of components per dm^3 of blood		
component of blood	**healthy person**	**person A**	**person B**
red blood cells	5×10^{12}	6×10^{12}	3×10^{12}
white blood cells	7×10^{9}	5×10^{10}	8×10^{10}
platelets	3×10^{11}	3×10^{11}	3×10^{11}

(i) Calculate the difference in the number of white blood cells per dm3 of blood between the healthy person and person A.

(2)

.....

(ii) Describe the functions of white blood cells. **(2)**

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(iii) Person B has a low number of red blood cells compared to the healthy person.
Suggest an effect this may have on person B. **(1)**

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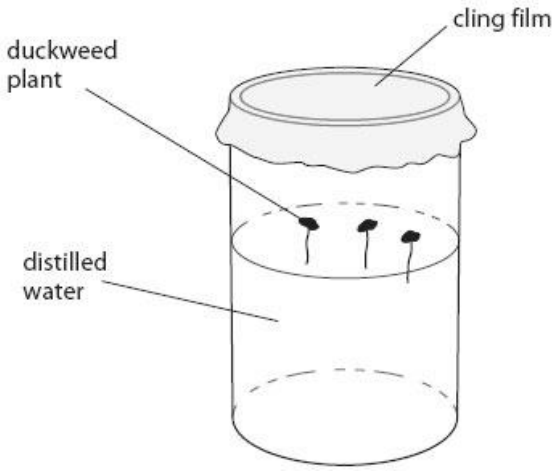
Q13.

The diagram shows three duckweed plants in a beaker of distilled water.



(a) (i) Explain how the water moves into these plants.

(3)

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(ii) Salt was added to the water in the beaker to form a salt solution.
Explain how the salt solution would affect the movement of water into and out of the plant. **(2)**

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(iii) Complete the sentence by putting a cross (☒) in the box next to your answer.
When the concentration of mineral ions in the soil is greater than in the root hair cell, mineral ions are transported into the root hair cells by

(1)

☒ **A** diffusion
☒ **B** osmosis
☒ **C** respiration
☒ **D** transpiration

*(b) Explain how water, glucose and mineral salts are transported through a plant.

(6)

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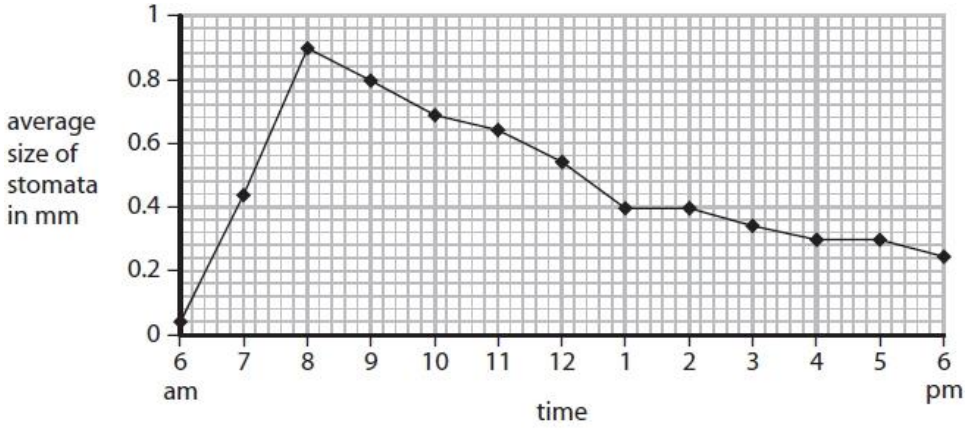
(Total for Question = 12 marks)

Q14.

Figure 7 shows the average size of stomata in a leaf during one day.



(i) Name the cells that change the size of stomata. **(1)**

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(ii) Describe the trend shown in Figure 7. **(2)**

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(iii) The temperature increased from 8 am to 1 pm.

Explain why this affected the size of the stomata. **(2)**

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..... **(Total for question = 5 marks)**

Q15.

(i) Water enters a plant through root hair cells.

Root hair cells have

(1)

- ☒ **A** a small surface area and thin cell walls
- ☒ **B** a small surface area and thick cell walls
- ☒ **C** a large surface area and thin cell walls
- ☒ **D** a large surface area and thick cell walls

(ii) Explain how water in the root is transported to the leaves of the plant.

(2)

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..... **(Total for question = 3 marks)**