WJEC (Wales) Biology A-level

Unit 2.3 - Adaptations for transport

Flashcards

Briefly describe the vascular system of insects.

Briefly describe the vascular system of insects.

- **Open** circulatory system
- Dorsal-tube shaped heart
- Respiratory gases not carried in blood

What is an open circulatory system?

What is an open circulatory system?

- Transport medium pumped by the heart is not contained within vessels, but moves freely
- Transport fluid comes into direct contact with the cells

Briefly describe the vascular system of earthworms.

Briefly describe the vascular system of earthworms.

- Vascularisation
- **Closed** circulatory system
- Respiratory gases carried in blood

What is a closed circulatory system?

What is a closed circulatory system?

- Blood pumped by the heart is contained within blood vessels
- Blood does not come into direct contact with the cells

Describe the advantages of a closed circulatory system.

Describe the advantages of a closed circulatory system.

- Blood pressure can be maintained
- Blood supply to different organs can vary
- Lower volumes of transport fluid required

What type of circulatory system do fish have?

What type of circulatory system do fish have?

Single circulatory system

What is a single circulatory system?

What is a single circulatory system?

- Circulatory system in which the blood travels through the heart once in one circuit
- Blood flows through the heart and is pumped around the body before returning to the heart

What type of circulatory system do mammals have?

What type of circulatory system do mammals have?

Double circulatory system

What is a double circulatory system?

What is a double circulatory system?

- Circulatory system in which the blood flows through the heart twice in two circuits
- Blood is pumped from the heart to the lungs before returning to the heart. It is then pumped around the body, after which it returns to the heart again

What are the benefits of a double circulatory system?

What are the benefits of a double circulatory system?

- Maintains blood pressure around the whole body
- Uptake of oxygen is more efficient
- Delivery of oxygen and nutrients is more efficient
- Blood pressure can differ in pulmonary and systemic circuits

Describe the double circulatory system in humans.

Describe the double circulatory system in humans.

Blood flows through the heart twice in two circuits:

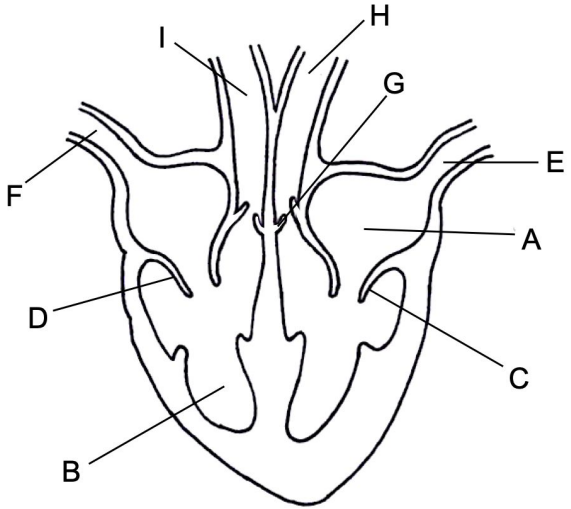
- Pulmonary circuit
- Systemic circuit

Name the four chambers of the mammalian heart.

Name the four chambers of the mammalian heart.

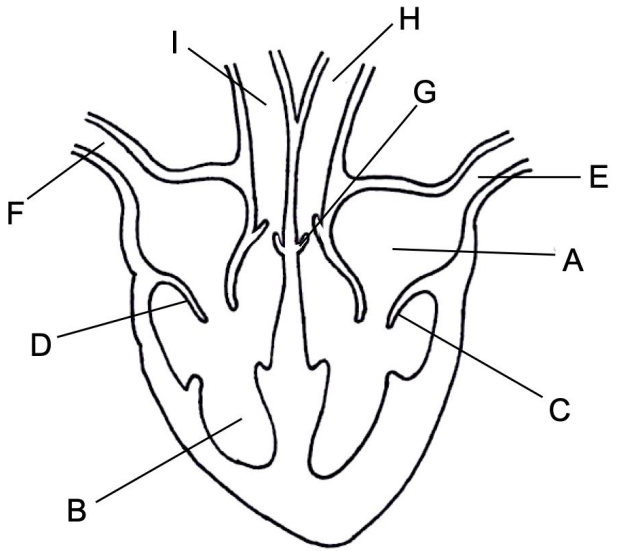
- Left atrium
- Right atrium
- Left ventricle
- Right ventricle

Identify the structures of the mammalian heart labelled in the diagram below.



Identify the structures of the mammalian heart labelled in the diagram below.

A	left atrium	F	vena cava
B	right ventricle	G	semi-lunar valve
C	bicuspid valve	H	aorta
D	tricuspid valve	I	pulmonary artery
E	pulmonary vein		

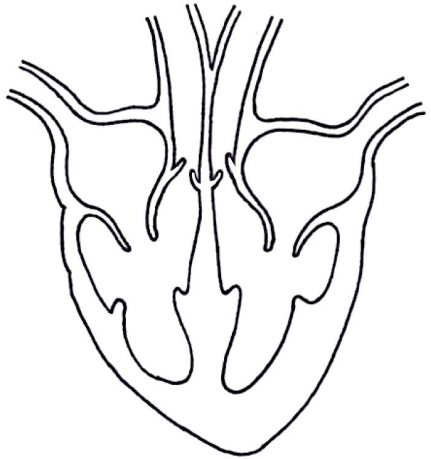


Describe the pathway of blood around the body, naming the structures of the heart.

Describe the pathway of blood around the body, naming the structures of the heart.

Pulmonary vein → Left atrium → Left ventricle → Aorta → Body → Vena cava → Right atrium → Right ventricle → Pulmonary artery → Lungs

Show the direction of blood flow through the heart on the diagram below.



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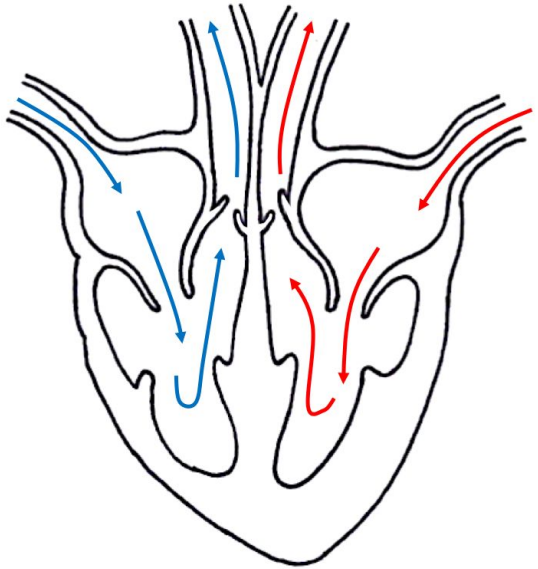


Where are the atrioventricular valves found and what is their function?

Where are the atrioventricular valves found and what is their function?

- Found between the atria and ventricles
- Prevent the backflow of blood from the ventricles into the atria

What are the two types of atrioventricular valves?

What are the two types of atrioventricular valves?

- Bicuspid (left side)
- Tricuspid (right side)

Where are the semilunar valves found and what is their function?

Where are the semilunar valves found and what is their function?

- Found between the ventricles and arteries
- Prevent the backflow of blood from the arteries into the ventricles

Name the five types of blood vessel.

Name the five types of blood vessel.

- Arteries
- Arterioles
- Capillaries
- Venules
- Veins

Describe the pathway of blood through the blood vessels.

Describe the pathway of blood through the blood vessels.

heart → arteries → arterioles → capillaries → venules → veins → heart

What is the function of arteries?

What is the function of arteries?

Carry blood away from the heart to the tissues, under high pressure.

Relate the structure of arteries to their function.

Relate the structure of arteries to their function.

Thick, **muscular walls** to handle high pressure without tearing. **Elastic tissue** allows recoil to prevent pressure surges. **Narrow lumen** to maintain pressure.

What is the function of veins?

What is the function of veins?

Carry blood towards the heart under low pressure.

Relate the structure of veins to their function.

Relate the structure of veins to their function.

Thin walls due to lower pressure. Require **valves** to ensure blood doesn't flow backwards. Have **less muscular and elastic tissue** as they don't have to control blood flow.

What is the function of capillaries?

What is the function of capillaries?

Form a large network through the tissues of the body and connect the arterioles to the venules.

Relate the structure of capillaries to their function.

Relate the structure of capillaries to their function.

- Walls only **one cell thick** ∴ short diffusion pathway
- **Very narrow**, so can permeate tissues and red blood cells can lie flat against the wall, reducing the diffusion distance
- **Numerous** and **highly branched**, providing a large surface area

What is the function of arterioles?

What is the function of arterioles?

Connect the arteries and the capillaries.

What is the function of venules?

What is the function of venules?

Connect the capillaries and the veins.

Relate the structure of arterioles and venules to their function.

Relate the structure of arterioles and venules to their function.

- Branch off arteries and veins in order to feed blood into capillaries
- Smaller than arteries and veins so that the change in pressure is more gradual as blood flows to the capillaries

What is the cardiac cycle?

What is the cardiac cycle?

- The sequence of events involved in one complete contraction and relaxation of the heart
- Three stages: atrial systole, ventricular systole and diastole

Describe what happens during ventricular diastole.

Describe what happens during ventricular diastole.

The heart is relaxed. Blood enters the atria, increasing the pressure and pushing open the AV valves. This allows blood to flow into the ventricles. Pressure in the heart is lower than in the arteries, so SL valves remain closed.

Describe what happens during atrial systole.

Describe what happens during atrial systole.

- The atria contract, pushing any remaining blood into the ventricles
- AV valves pushed fully open

Describe what happens during ventricular systole.

Describe what happens during ventricular systole.

The ventricles contract. The pressure in the ventricles increases, closing the AV valves to prevent backflow and opening the SL valves. Blood flows into the arteries.

Why is cardiac muscle described as myogenic?

Why is cardiac muscle described as myogenic?

It initiates its own contraction without outside stimulation from nervous impulses.

Explain how the heart contracts.

Explain how the heart contracts.

- SAN initiates and spreads impulse across the atria, so they contract
- AVN receives, delays, and then conveys the impulse down the bundle of His
- Impulse travels into the Purkyne fibres which branch across the ventricles, so they contract from the bottom up.

What is an electrocardiogram (ECG)?

What is an electrocardiogram (ECG)?

A graph showing the electrical activity in the heart during the cardiac cycle.

Explain the characteristic patterns displayed on a typical ECG.

Explain the characteristic patterns displayed on a typical ECG.

- **P wave** - depolarisation of atria during atrial systole
- **QRS wave** - depolarisation of ventricles during ventricular systole
- **T wave** - repolarisation of ventricles during ventricular diastole

Describe the structure and function of erythrocytes.

Describe the structure and function of erythrocytes.

- Type of blood cell that is anucleated and biconcave
- Contains haemoglobin which enables the transport of oxygen and carbon dioxide to and from the tissues

What is plasma?

What is plasma?

- Main component of the blood (yellow liquid) that carries red blood cells
- Contains proteins, nutrients, mineral ions, hormones, dissolved gases and waste. Also distributes heat

Describe the role of haemoglobin.

Describe the role of haemoglobin.

Present in red blood cells. Oxygen molecules bind to the haem groups and are carried around the body, then released where they are needed in respiring tissues.

How does the partial pressure of oxygen affect oxygen-haemoglobin binding?

How does partial pressure of oxygen affect oxygen-haemoglobin binding?

Haemoglobin has variable affinity for oxygen depending on the partial pressure of oxygen, $p(O_2)$:

- At high $p(O_2)$, oxygen **associates** to form oxyhaemoglobin
- At low $p(O_2)$, oxygen **dissociates** to form deoxyhaemoglobin

Write an equation for the formation of oxyhaemoglobin.

Write an equation for the formation of oxyhaemoglobin.

$$Hb + 4O_2 \rightleftharpoons Hb \bullet 4O_2$$

(note that full saturation is rare)

What do oxyhaemoglobin dissociation curves show?

What do oxyhaemoglobin dissociation curves show?

Saturation of haemoglobin with oxygen (%), plotted against partial pressure of oxygen (kPa). Curves further to the left show that the haemoglobin has a higher affinity for oxygen.

Explain the shape of oxyhaemoglobin dissociation curves.

Explain the shape of oxyhaemoglobin dissociation curves.

Sigmoidal curve (S-shaped):

- When first O_2 molecule binds, it changes the tertiary structure of haemoglobin so that it is easier for the second and third molecules to bind
- Third molecule changes the tertiary structure of haemoglobin so that it is more difficult for the fourth molecule to bind

How does fetal haemoglobin differ from adult haemoglobin?

How does fetal haemoglobin differ from adult haemoglobin?

Has a higher affinity for oxygen than adult haemoglobin due to the presence of two different subunits that allow oxygen to bind more readily.

Why is the higher affinity of fetal haemoglobin important?

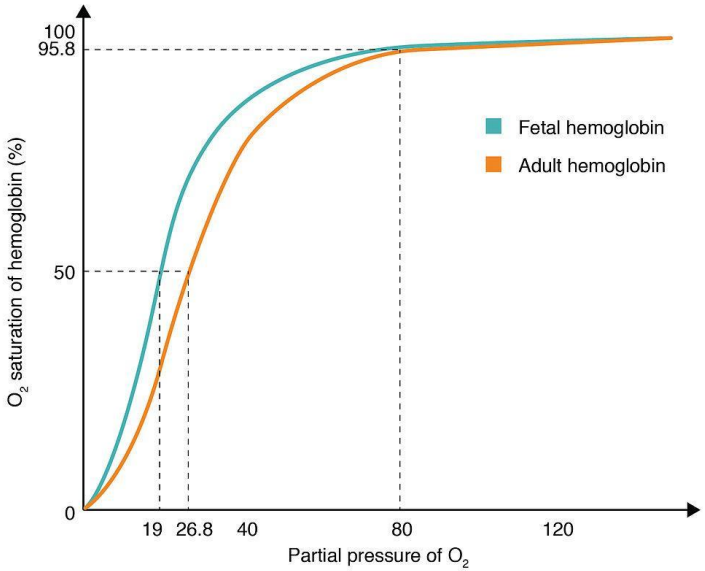
Why is the higher affinity of fetal haemoglobin important?

Enables the fetus to obtain oxygen from the mother's blood.

Compare the dissociation curves of adult and fetal haemoglobin.

Compare the dissociation curves of adult and fetal haemoglobin.

Fetal haemoglobin dissociation curve to the **left**. At the same partial pressure, % oxygen saturation is greater due to fetal haemoglobin having a higher affinity.



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Predict the shape of the dissociation curves of animals adapted to low oxygen level habitats.

Predict the shape of the dissociation curves of animals adapted to low oxygen level habitats.

- Haemoglobin has a greater affinity for oxygen
- Haemoglobin is saturated at a lower $p(O_2)$
- ∴ dissociation curve to the **left**

How is carbon dioxide carried from respiring cells to the lungs?

How is carbon dioxide carried from respiring cells to the lungs?

- Transported in **aqueous solution** in the plasma
- As **hydrogen carbonate ions** in the plasma
- Carried as **carbaminohaemoglobin** in the blood

What is the chloride shift?

What is the chloride shift?

- Process by which chloride ions move into the erythrocytes in exchange for hydrogen carbonate ions which diffuse out of the erythrocytes
- One-to-one exchange

Why is the chloride shift important?

Why is the chloride shift important?

It maintains the electrochemical equilibrium of the cell.

What is the function of carbonic anhydrase?

What is the function of carbonic anhydrase?

Catalyses the reversible reaction between water and carbon dioxide to produce carbonic acid.

Write equations to show the formation of hydrogen carbonate ions in the plasma.

Write equations to show the formation of hydrogen carbonate ions in the plasma.

Carbonic anhydrase enzyme catalyses:

$CO_2 + H_2O \rightleftharpoons H_2CO_3$ (carbonic acid)

Carbonic acid dissociates:

$H_2CO_3 \rightleftharpoons HCO_3^-$ (hydrogen carbonate ions) + H^+

State the Bohr effect.

State the Bohr effect.

The loss of affinity of haemoglobin for oxygen as the partial pressure of carbon dioxide increases.

Explain the role of carbonic anhydrase in the Bohr effect.

Explain the role of carbonic anhydrase in the Bohr effect.

- Carbonic anhydrase is present in red blood cells
- Catalyses the reaction of carbon dioxide and water to form carbonic acid, which dissociates to produce H^+ ions
- H^+ ions combine with the haemoglobin to form haemoglobinic acid
- Encourages oxygen to dissociate from haemoglobin

What is tissue fluid?

What is tissue fluid?

- Fluid that surrounds the cells of animals
- Same composition as plasma but does not contain red blood cells or plasma proteins

Describe the different pressures involved in the formation of tissue fluid.

Describe the different pressures involved in the formation of tissue fluid.

- **Hydrostatic** pressure = higher at arterial end of capillary than venous end
- **Oncotic** pressure = changing water potential of the capillaries as water moves out, induced by proteins in the plasma

How is tissue fluid formed?

How is tissue fluid formed?

As blood is pumped through increasingly smaller vessels, **hydrostatic pressure** is **greater** than **oncotic pressure**, so fluid moves out of the capillaries. It then exchanges substances with the cells.

Why does blood pressure fall along the capillary?

Why does blood pressure fall along the capillary?

- Friction
- Lower volume of blood

What happens at the venous end of the capillary?

What happens at the venous end of the capillary?

- **Oncotic pressure** is **greater** than **hydrostatic pressure**
- Fluid moves down its water potential gradient back into the capillaries

Where does some tissue fluid drain?

Where does some tissue fluid drain?

Some tissue fluid drains into the lymphatic system and eventually returns to the blood.

Define vascular bundle.

Define vascular bundle.

- Vascular system in herbaceous dicotyledonous plants
- Consists of two transport vessels, the xylem and the phloem

Describe the structure and function of the vascular system in the roots of dicotyledons.

Describe the structure and function of the vascular system in the roots of dicotyledons.

Xylem arranged in an X shape to provide resistance against force. Phloem found as patches between the arms. Surrounded by endodermis, aiding water passage.

Describe the structure and function of the vascular system in the stem of dicotyledons.

Describe the structure and function of the vascular system in the stem of dicotyledons.

Vascular bundles organised around a central pith. Xylem on the inside of the bundle to provide support and flexibility, phloem on the outside. Cambium is found between the two.

Which structure in plants is adapted for the uptake of water and minerals?

Which structure in plants is adapted for the uptake of water and minerals?

Root hair cells

How is water taken up from the soil?

How is water taken up from the soil?

- Root hair cells absorb minerals by active transport, reducing the water potential of the root
- Water potential of root hairs cells is lower than that of the soil
- Water moves into the root by osmosis

Outline how plant roots are adapted for the absorption of water and minerals

Outline how plant roots are adapted for the absorption of water and minerals

Plant roots are composed of millions of root hair cells which have:

- **Long hairs** that extend from the cell body, **increasing the surface area** for absorption
- Many **mitochondria** which produce energy for the active transport of mineral ions

State the three pathways by which water moves through the root.

State the three pathways by which water moves through the root.

- **Apoplast** pathway
- **Symplast** pathway
- **Vacuolar** pathway

Describe the apoplast pathway.

Describe the apoplast pathway.

Water moves through **intercellular spaces** between cellulose molecules in the cell wall. It diffuses down its water potential gradient by **osmosis**.

Describe the symplast pathway.

Describe the symplast pathway.

Water enters the cytoplasm through the plasma membrane and moves between adjacent cells via **plasmodesmata**. Water diffuses down its water potential gradient by **osmosis**.

Describe the vacuolar pathway.

Describe the vacuolar pathway.

Water enters the cytoplasm through the plasma membrane and moves between **vacuoles** of adjacent cells. Water diffuses down its water potential gradient by **osmosis**.

Describe the structure and function of the endodermis.

Describe the structure and function of the endodermis.

- Innermost layer of the cortex of a dicot root
- Impregnated with suberin which forms the **Casparian strip**
- Endodermal cells actively transport mineral ions into the xylem

What is the function of the Casparian strip?

What is the function of the Casparian strip?

- Blocks the apoplast pathway, forcing water through the symplast route
- Enables control of the movement of water and minerals across the root and into the xylem

What molecule makes the Casparian strip waterproof?

What molecule makes the Casparian strip waterproof?

Suberin

Relate the structure of the xylem to its function.

Relate the structure of the xylem to its function.

- **Long, continuous columns** made of dead tissue, allowing the transportation of water
- Contain **bordered pits**, allowing the sideways movement of water between vessels
- Walls impregnated with **lignin**, providing structural support

Define transpiration

Define transpiration

- The loss of water vapour from the parts of a plant exposed to the air due to evaporation and diffusion
- Consequence of gaseous exchange; occurs when the plant opens the stomata to exchange O_2 and CO_2

What is the transpiration stream?

What is the transpiration stream?

The flow of water from the roots to the leaves in plants, where it is lost by evaporation to the environment.

How does water move up the stem?

How does water move up the stem?

- Root pressure
- Cohesion tension theory
- Capillarity

What is root pressure?

What is root pressure?

The force that drives water into and up the xylem by osmosis due to the active transport of minerals into the xylem by endodermal cells.

Explain the cohesion-tension theory.

Explain the cohesion-tension theory.

- Water molecules form hydrogen bonds with each other, causing them to ‘stick’ together
- Surface tension of the water also creates this sticking effect
- Therefore as water is lost through transpiration, more is drawn up the stem from the roots

Define capillarity.

Define capillarity.

The tendency of water to move up the xylem, against gravity, due to adhesive forces that prevent the water column dropping back.

State the factors that affect the rate of transpiration.

State the factors that affect the rate of transpiration.

- Light
- Temperature
- Humidity
- Air movement

How does temperature affect the rate of transpiration?

How does temperature affect the rate of transpiration?

A higher temperature increases random motion and rate of evaporation, therefore increasing rate of transpiration.

How does light affect the rate of transpiration?

How does light affect the rate of transpiration?

A higher light intensity increases the rate of photosynthesis, causing more stomata to open for gas exchange, therefore increasing rate of transpiration.

How does humidity affect the rate of transpiration?

How does humidity affect the rate of transpiration?

High humidity means the water content of the air next to the leaf is high. This reduces the concentration gradient, therefore decreasing rate of transpiration.

How does air movement affect the rate of transpiration?

How does air movement affect the rate of transpiration?

Large amounts of air movement blow moist air away from the leaves, creating a steep concentration gradient. Therefore increases rate of transpiration.

What is a hydrophyte?

What is a hydrophyte?

A plant that is adapted to live and reproduce in very wet habitats, e.g. water lilies.

Give adaptations of hydrophytes that allow them to live in wet conditions.

Give adaptations of hydrophytes that allow them to live in wet conditions.

- Thin or absent waxy cuticle
- Stomata often open
- Wide, flat leaves
- Air spaces for buoyancy

What is a xerophyte?

What is a xerophyte?

A plant that is adapted to live and reproduce in dry habitats where water availability is low, e.g. cacti and marram grass.

Give adaptations of xerophytes that allow them to live in dry conditions.

Give adaptations of xerophytes that allow them to live in dry conditions.

- Small/rolled leaves
- Densely packed mesophyll
- Thick waxy cuticle
- Stomata often closed
- Hairs to trap moist air

What are mesophytes?

What are mesophytes?

- Terrestrial plants adapted to live in environments with average conditions and an adequate water supply
- They have features that enable their survival at unfavourable times of the year

Relate the structure of the phloem to its function.

Relate the structure of the phloem to its function.

- **Sieve tube elements** transport sugars around the plant
- **Companion cells** designed for active transport of sugars into tubes
- **Plasmodesmata** allow communication and the exchange of substances between sieve tubes and companion cells

What are cytoplasmic strands?

What are cytoplasmic strands?

Small extensions of the cytoplasm between adjacent sieve tube elements and companion cells.

Describe the function of cytoplasmic strands.

Describe the function of cytoplasmic strands.

- Allow communication and the exchange of materials between sieve tube elements and companion cells
- Hold the nucleus in place

Define translocation.

Define translocation.

The movement of organic compounds in the phloem, from sources to sinks.

Summarise the mass-flow hypothesis of translocation.

Summarise the mass-flow hypothesis of translocation.

- Sugar loaded into sieve tubes via active transport
- Lowers water potential, causing water to move in from the xylem
- Hydrostatic pressure causes sugars to move towards the sink

Give evidence for the mass-flow hypothesis.

Give evidence for the mass-flow hypothesis.

- Sap is released when the stem is cut ∴ must be pressure in phloem
- Sap exuding from the stylet (mouthpart) of an **aphid** inserted into sieve tubes provides evidence that sugars are carried in the phloem
- There is a higher sucrose concentration in the leaves than the roots
- **Autoradiographs** produced using carbon dioxide labelled with radioactive carbon provide evidence for translocation in the phloem

What is autoradiography?

What is autoradiography?

A technique used to record the distribution of radioactive material within a specimen.

What is a potometer?

What is a potometer?

An apparatus used to measure water uptake from a cut shoot.