



# **AQA**

# **GCSE Biology**

## **New Unit 3**

## **Summary Notes**

### **Unit 3 Summary**

We need to understand how biological and environmental systems operate when they are working well in order to be able to intervene when things go wrong. Modern developments in biomedical and technological research allow us to do so.

### **B3.1 Movement of molecules in and out of cells**

#### **Summary**

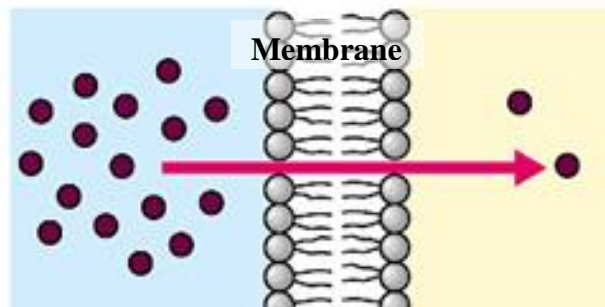
The cells, tissues and organs in plants and animals are adapted to take up and get rid of dissolved substances. Different conditions can affect the rate of transfer. Sometimes energy is needed for transfer to take place.

#### **Dissolved substances**

Dissolved substances move by diffusion and by active transport.

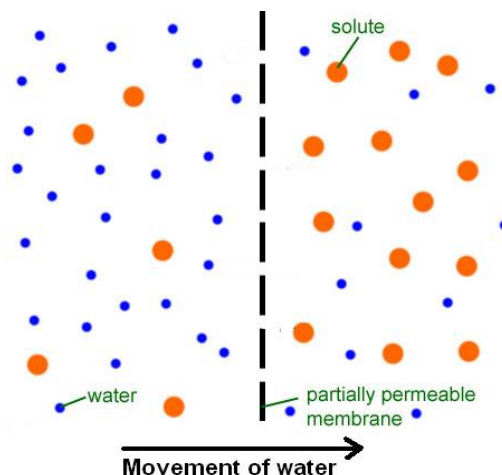
**Diffusion** (covered in more detail in unit 2):

- The movement of particles in a liquid or gas from an area where they are in higher concentration to an area where they are in lower concentration.
- The greater the difference in concentration, the faster the rate of diffusion.
- 2 examples of diffusion through the cell membrane:
  - Oxygen required for respiration diffuses into cells.
  - Carbon dioxide produced by respiration diffuses out of cells.

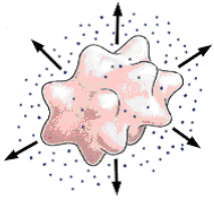


#### **Osmosis:**

- Water often moves across boundaries by osmosis.
- Osmosis is the diffusion of water from a dilute to a more concentrated solution through a partially permeable membrane that allows the passage of water molecules.
- Differences in the concentrations of the solutions inside and outside a cell cause water to move into or out of the cell by osmosis.
- If there is a higher solute concentration on one side of a membrane, water will move in that direction.

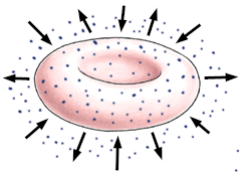
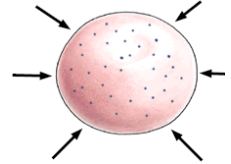


### Osmosis in animal cells:



If animal cells are placed in a solution that has a higher solute concentration than the cytoplasm, then water will leave the cell by osmosis, until it shrinks and dies.

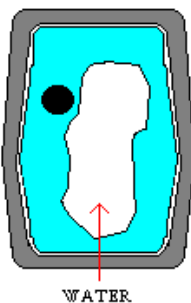
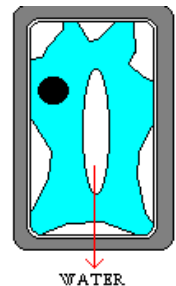
If animal cells are placed in a solution that has a lower solute concentration than the cytoplasm, then water will enter the cell by osmosis until it bursts.



This is why it is vital that we maintain the concentration of our body fluids at an equal solute concentration to our cells' cytoplasm.

### Osmosis in plant cells:

If plant cells are placed in a solution that has a higher solute concentration than the cytoplasm, then water will leave the cell by osmosis, and the cell membrane separates from the cell wall. This will cause a plant to wilt.



If plant cells are placed in a solution that has a lower solute concentration than the cytoplasm, then water will enter the cell by osmosis until it is fully turgid, and the cell wall prevents any more water entering. This is important in enabling plants to remain upright.

### Sports Drinks

- Most soft drinks contain water, sugar and ions.
- Sports drinks contain sugars to replace the sugar used in energy release during the activity.
- They also contain water and ions to replace the water and ions lost during sweating.
- If water and ions are not replaced, the ion / water balance of the body is disturbed and the cells do not work as efficiently.

### Energy drinks

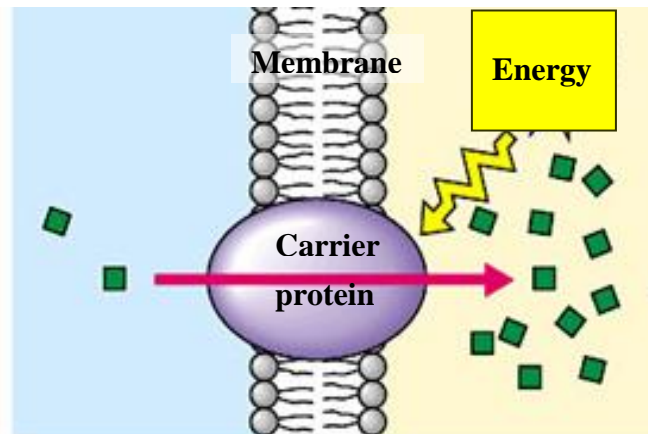
- Contain the same concentration of ions as the body fluids, and a high concentration of glucose.
- This enables rapid uptake of glucose.

### Rehydrating drinks

- These contain lower concentration of ions than in body fluids.
- This enables rapid uptake of water by **osmosis**.
- These drinks enable people to become quickly rehydrated after exercise.

### Active Transport:

- The process by which cells absorb substances against a concentration gradient.
- The substances being transported attaches to large protein molecules in the cell membrane.
- Energy released through respiration is used to change the shape of the protein.
- This releases the substance on the other side of the membrane.
- This process enables cells to absorb substances from very dilute solutions.
- 2 examples:
  - Absorption of mineral ions by the root hair cells in roots in plants.
  - Absorption of glucose by epithelial cells in the small intestine.



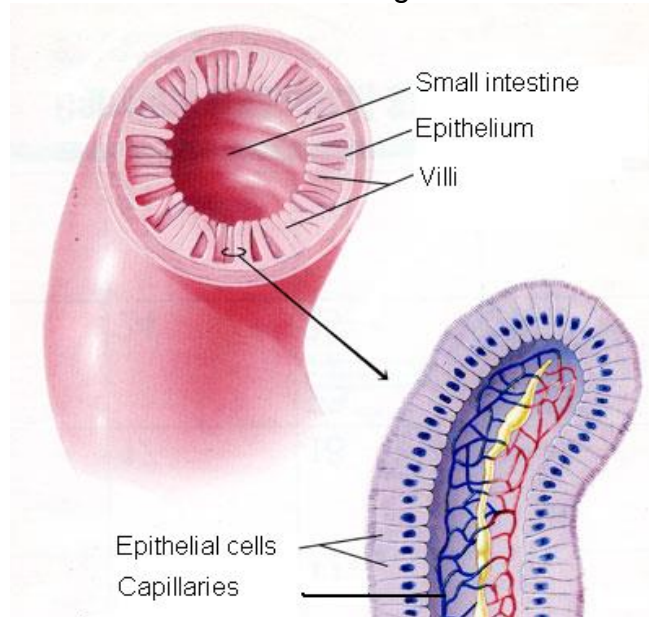
### **Specialised exchange surfaces**

- Many organ systems are specialised for exchanging materials.
- The effectiveness of an exchange surface is increased by:
  - having a large surface area
  - being thin, to provide a short diffusion path
  - Animals can also maintain high concentration gradients:
    - by having an efficient blood supply.
    - for gaseous exchange by being ventilated.
- Gas and solute exchange surfaces in humans and other organisms are adapted to maximise effectiveness.
- The size and complexity of an organism increases the difficulty of exchanging materials.
- Larger organisms have more cells, so have greater requirement for exchange.
- However, the larger an organism, the smaller their surface area to volume ratio.
- Therefore, they require even more complex exchange surfaces to supply their requirements.

### **Exchange systems in humans**

#### **Absorption of nutrients in the small intestine**

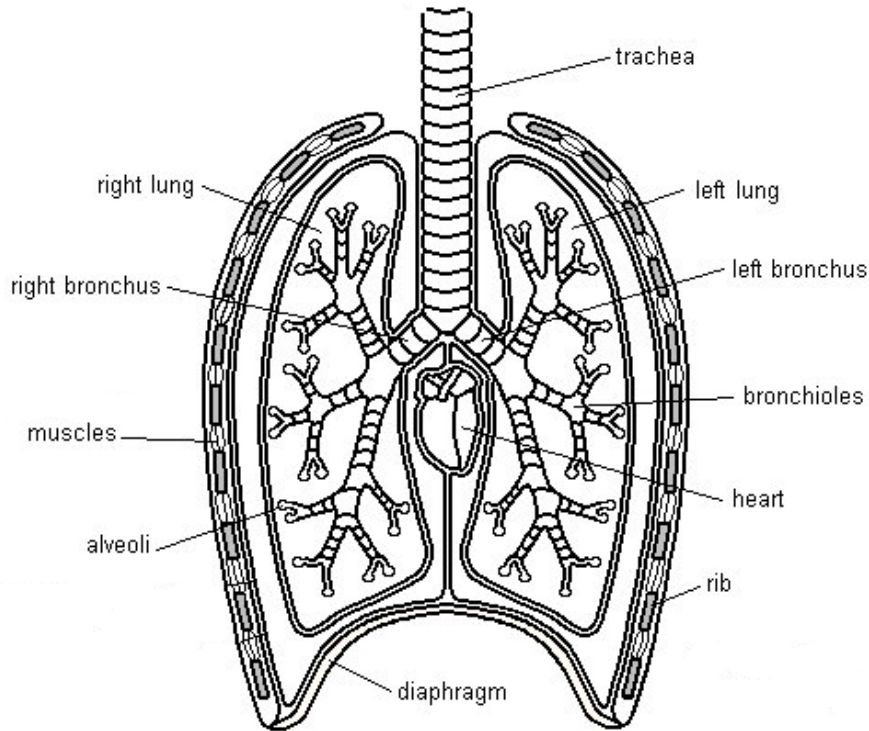
- Food in the small intestine has been digested into:
  - Glucose
  - Amino acids
  - Fatty acids
  - Glycerol
- These nutrients need to be absorbed into the blood across the wall of the small intestine.
- They are absorbed by diffusion and active transport.
- The wall of the small intestine is covered with finger-like extensions called villi.



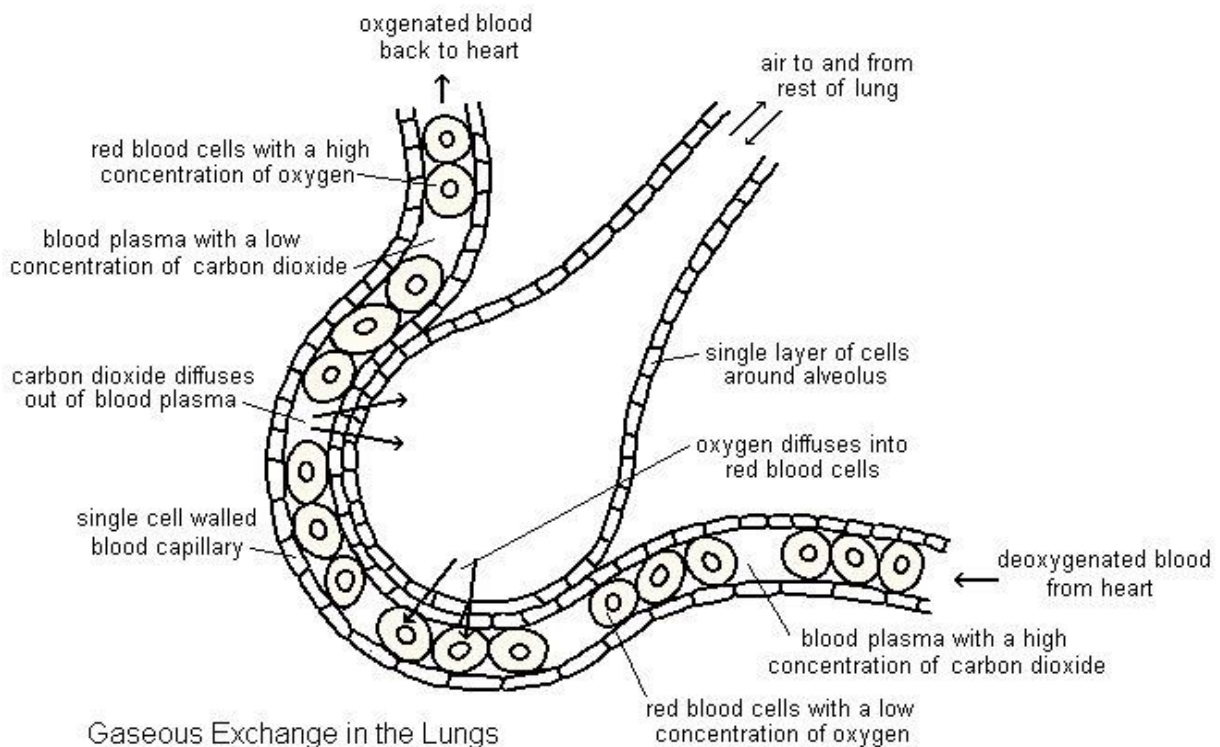
- Many villi provide a large surface area.
- The wall is only one cell thick so the diffusion pathway is short.
- Villi have an extensive network of capillaries to absorb the products of digestion.
- Concentration gradients are maintained because the blood removes the absorbed nutrients.

## Gaseous exchange

- The lungs are in the upper part of the body (thorax).
- They are protected by the ribcage.
- They are separated from the lower part of the body (abdomen) by the diaphragm.



- The breathing system takes air into and out of the body.
- Oxygen from the air diffuses into the bloodstream.
- Carbon dioxide can diffuse out of the bloodstream into the air.
- The alveoli provide a very large, moist surface, richly supplied with blood capillaries so that gases can readily diffuse into and out of the blood.

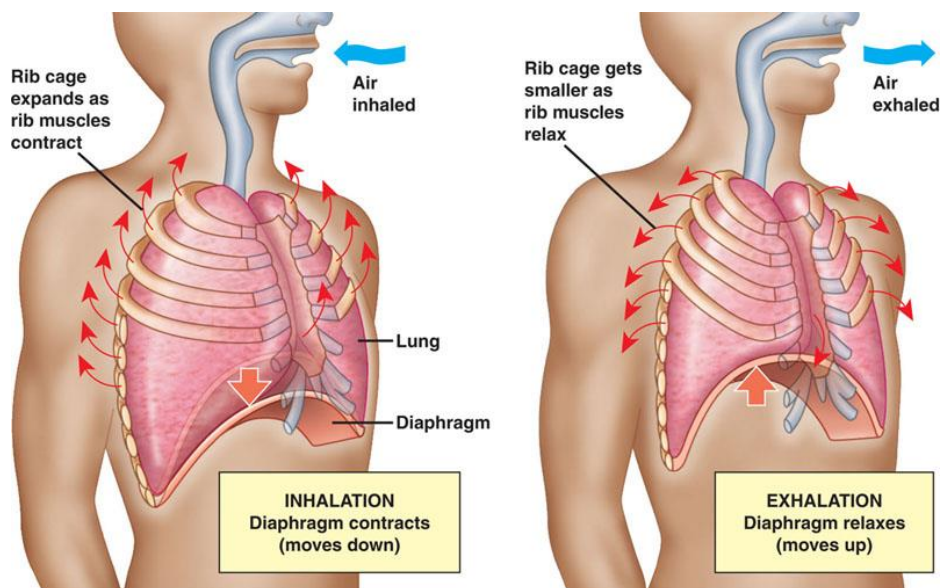


- Many small spherical alveoli provide a large surface area.

- The moist surface helps oxygen to dissolve so that it can diffuse into the cells.
- The capillaries are very close to the alveoli so that the gases have a short distance to diffuse.
- Concentration gradients are maintained by:
  - The blood removing oxygen from and bringing carbon dioxide to the lungs.
  - Breathing, which replenishes oxygen and removes carbon dioxide.

### Ventilation (breathing)

- The movement of air into and out of the lungs is known as ventilation.
- Breathing in (inhalation):
  - The ribcage moves out and up.
  - The diaphragm becomes flatter.
  - This increases the volume inside the thorax.
  - This reduces the pressure inside the thorax.
  - Air enters the lungs.
- Breathing out (exhalation):
  - The ribcage moves down and in.
  - The diaphragm moves upwards into a domed shape.
  - This reduces the volume inside the thorax.
  - This increases the pressure inside the thorax.
  - Air leaves the lungs.



### Artificial ventilators

- Artificial ventilation may be used when someone is unable breathe themselves.
- There are many possible risks with this process, including collapsed lungs, airway injury, damage to the airsacs (alveoli), and pneumonia.
- Therefore, care must be taken to do it properly.
- **Manual ventilators:**
  - Often used for first aid to help someone breathe.
  - A mask attached to a bag is placed over the mouth and nose.
  - The bag can be squeezed, pushing air into the lungs.

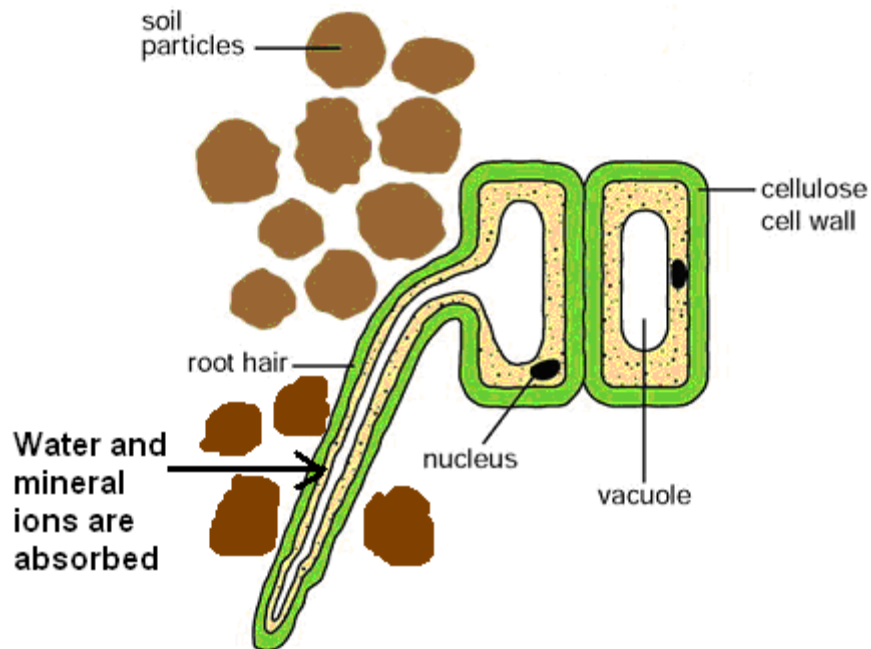
- **Mechanical ventilators:**

- Machines can be used that enable air to move into and out of the lungs:
- **Negative pressure machines.**
  - Often referred to as iron lungs.
  - These are used in cases of paralysis, for example, due to polio.
  - The patient's thorax is contained inside a metal box that can create a very low pressure outside the lungs.
  - This causes the thorax to expand so air enters the lungs
- **Positive pressure machines.**
  - These attach by a tube and mask to the mouth and nose.
  - They are used during surgery or when a patient is unconscious.
  - Air enters the lungs under high pressure.

### Exchange systems in plants

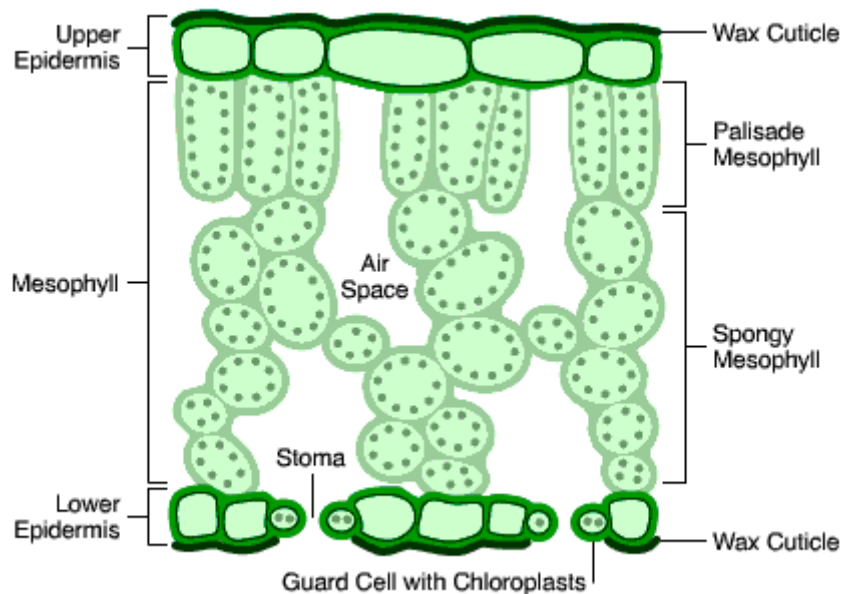
#### **Absorption of water by roots**

- The surface area of the roots is increased by root hairs.
- Most of the water and mineral ions are absorbed by root hair cells.
- Water is absorbed by osmosis.
- Most of the mineral ions are absorbed by active transport.

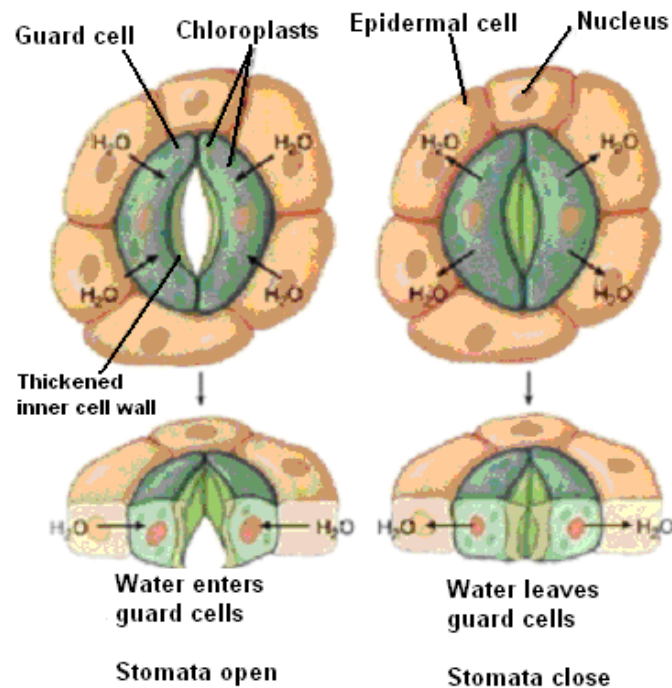


#### **Gas Exchange in the leaf**

- The surface area of leaves is increased by the flattened shape and internal air spaces.

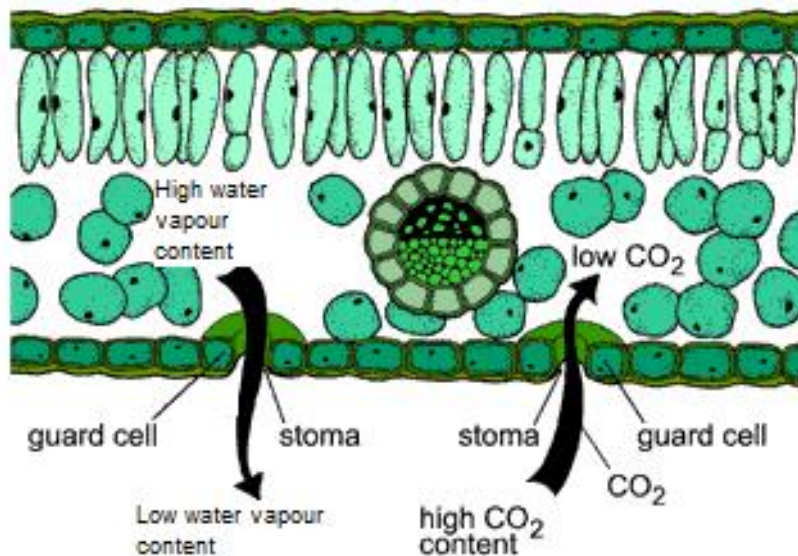


- Most photosynthesis takes place in the palisade cells.
- Carbon dioxide needs to reach the palisade cells.
- Plants have stomata to obtain carbon dioxide from the atmosphere.
- This carbon dioxide is used in photosynthesis.
- The size of stomata is controlled by guard cells, which surround them.
- Stomata open during daylight hours, to enable carbon dioxide to diffuse in.



### Transpiration

- The process by which plants lose water vapour from the surface of their leaves.
- It evaporates into the air spaces in the leaf, and then diffuses out through the stomata.



- Transpiration is more rapid in hot, dry and windy conditions:
  - Heat causes the water to evaporate quicker.
  - Dry conditions increases the water vapour concentration gradient.
  - Wind moves the water vapour away from the leaf, maintaining the concentration gradient.
- Most of the water lost by transpiration leaves through the stomata.
- Stomata close when it is dark, when carbon dioxide is not required.
- This reduces the amount of water lost by the plant at a time when it is not needed for photosynthesis.
- If plants lose water faster than it is replaced by the roots, the stomata can close to prevent wilting.

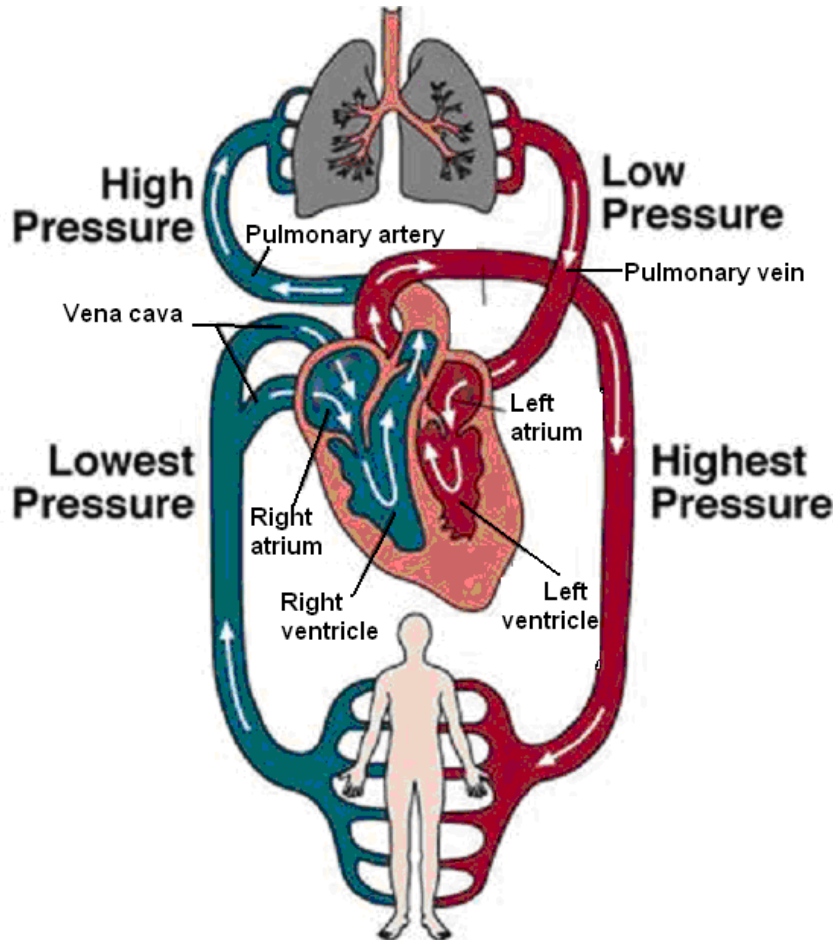
## **B3.2 Transport systems in plants and animals**

### **Summary**

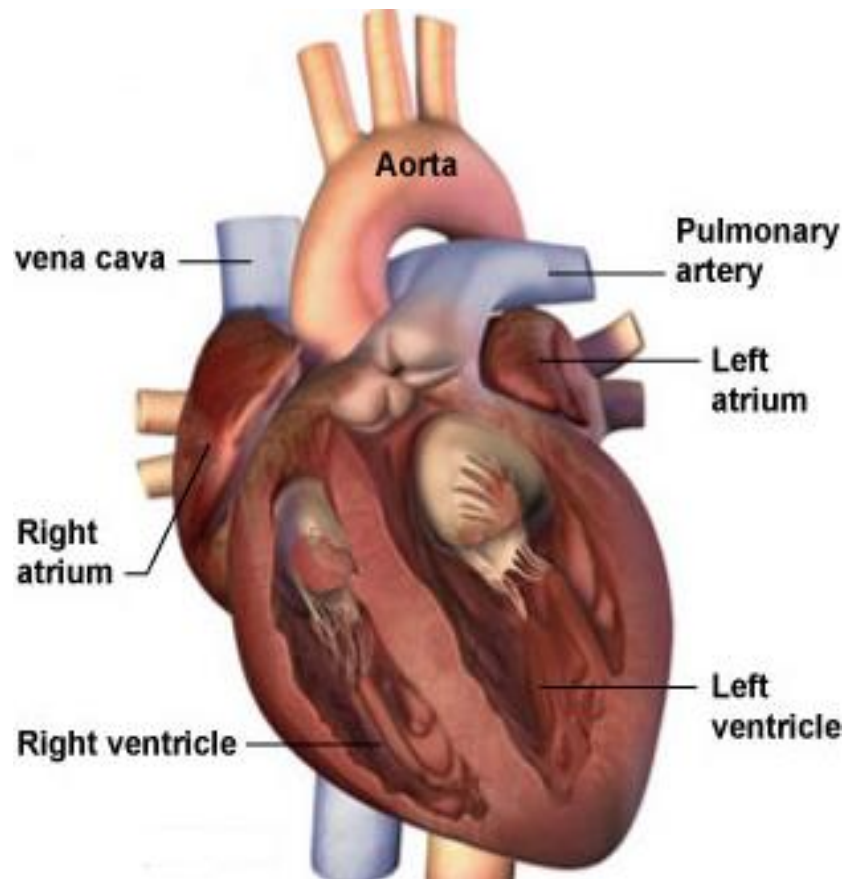
Substances are transported around the body by the circulatory system (the heart, the blood vessels and the blood). They are transported from where they are taken into the body to the cells, or from the cells to where they are removed from the body. Modern developments in biomedical and technological research enable us to help when the circulatory system is not working well. Plants have separate transport systems for water and nutrients.

### **The blood system**

- The circulatory system transports substances around the body.



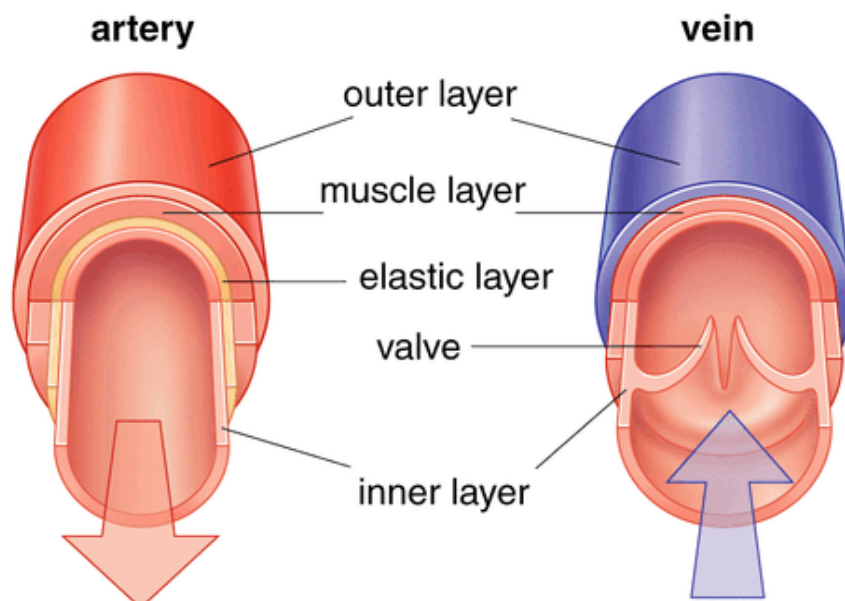
- **The heart** is an organ that pumps blood around the body.
- Much of the wall of the heart is made from muscle tissue.
- This muscle contracts to pump blood through the circulation systems.
- It is a double pump, because there are two separate circulation systems:
  - One to the lungs
  - One to all the other organs of the body.
- The blood passes through the heart twice in order to pass round both of these circulation systems.
- In one cardiac cycle:
  - Blood enters the atria of the heart.
  - The atria contract and force blood into the ventricles.
  - The ventricles contract and force blood out of the heart.
- Valves in the heart ensure that blood flows in the correct direction.
- Blood flows from the heart to the organs through arteries and returns through veins.



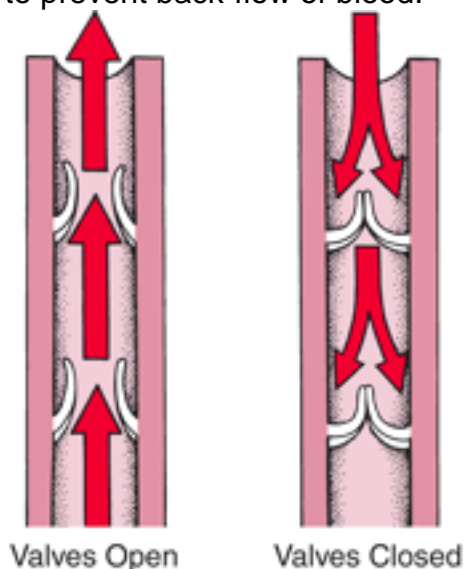
- Blood is pumped to the lungs from the right ventricle through the pulmonary artery.
- The blood returns from the lungs to the left atrium through the pulmonary vein.
- Blood is pumped to the organs of the body from the left ventricle through the aorta.
- Blood returns to the heart from the organs into the right atrium through the vena cava.

### **Blood vessels**

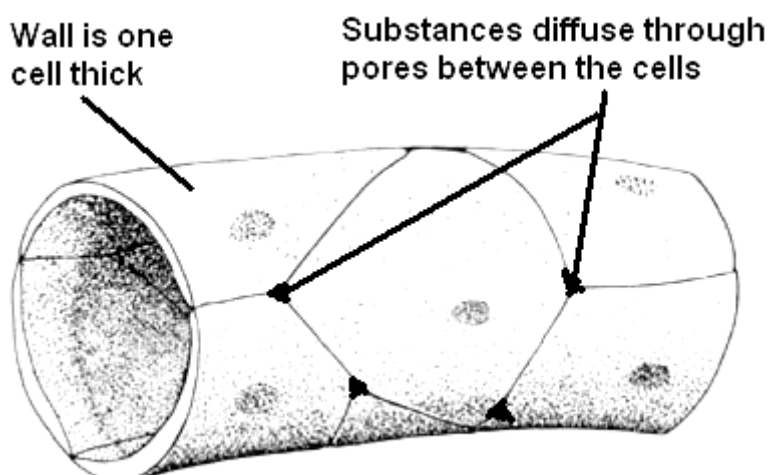
- Blood flows from the heart to the organs through arteries and returns through veins.
- Arteries have thick walls containing muscle and elastic fibres.
- Veins have thinner walls.



- Veins often have valves to prevent back-flow of blood.



- In the organs, blood flows through very narrow, thin-walled blood vessels called capillaries.
- Substances needed by the cells in body tissues pass out of the blood, and substances produced by the cells pass into the blood, through the walls of the capillaries.



Arteries	Capillaries	Veins
Carry blood away from the heart to the organs.	Carry blood away from arteries into organs then back into veins.	Carry blood away from the organs back to the heart.
High blood pressure.	Decreasing blood pressure.	Low blood pressure.
Elastic to withstand high blood pressure.	No elastic tissue – walls one cell thick.	Not elastic.
Muscular walls, to create a pulse, to maintain blood pressure.	No muscle – walls one cell thick.	Very little muscle.
Rarely contain valves.	No valves.	Contain valves to control the direction of blood flow.

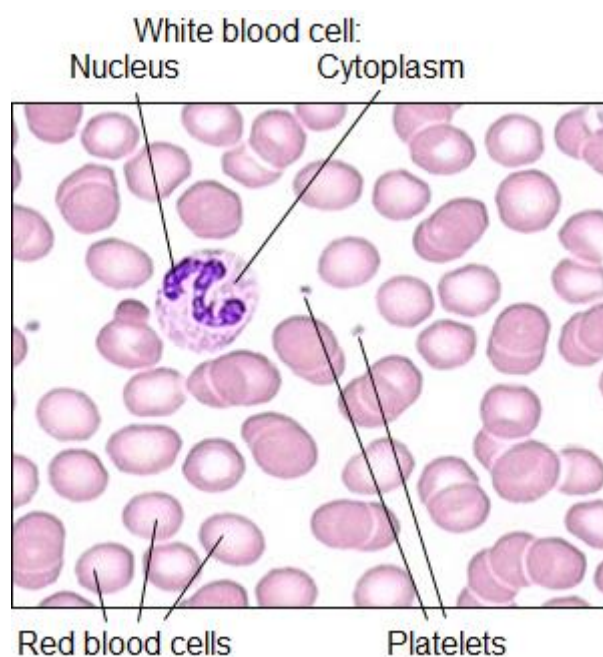
## **Blood**

- Blood is a tissue.
- It consists of a fluid called plasma in which red blood cells, white blood cells, and platelets are suspended.

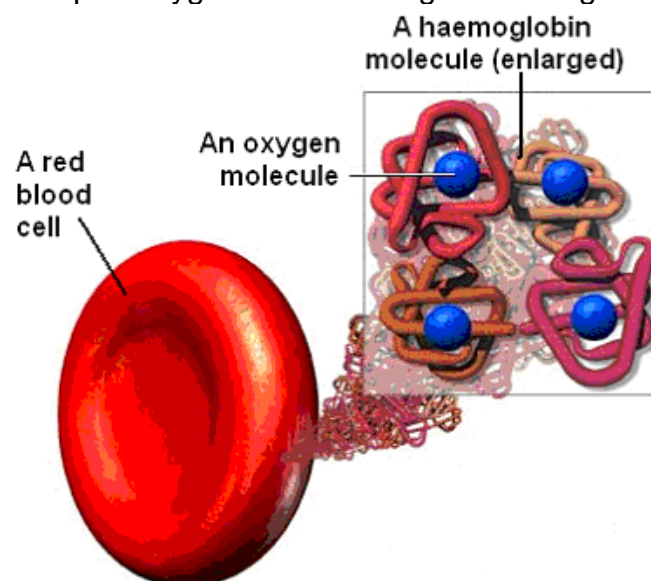
### **Plasma:**

- The liquid part of the blood.
- Blood plasma transports:
  - Carbon dioxide from the organs to the lungs
  - Soluble products of digestion from the small intestine to other organs:
    - Glucose
    - Amino acids
  - Urea from the liver to the kidneys.

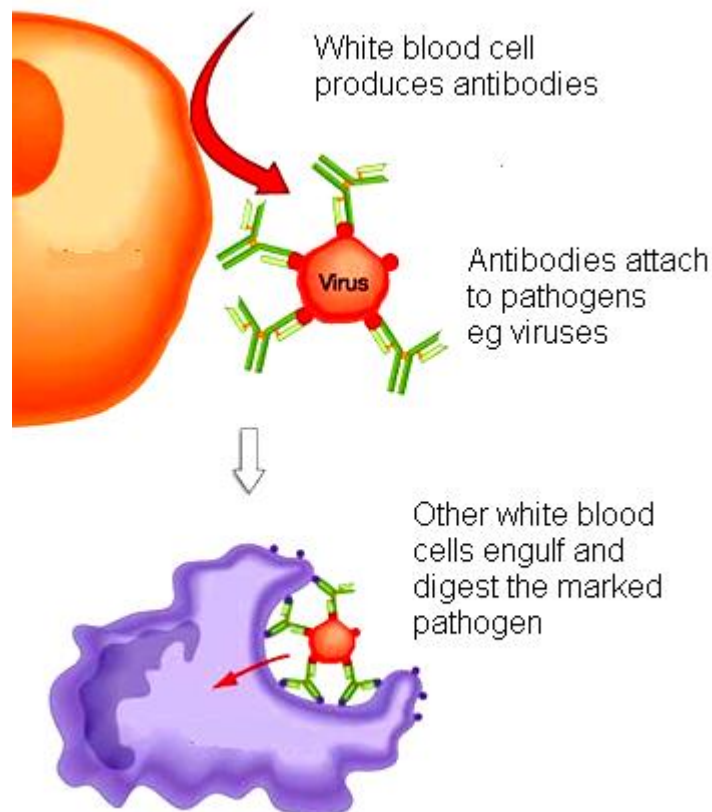
### **Blood cells:**



- **Red blood cells** transport oxygen from the lungs to the organs.



- Red blood cells have no nucleus.
- They are packed with a red pigment called haemoglobin.
- In the lungs:
  - Oxygen diffuses into the red blood cells.
  - Haemoglobin combines with oxygen to form oxyhaemoglobin.
- In the other organs:
  - Oxyhaemoglobin splits up into haemoglobin and oxygen.
  - Oxygen diffuses out of the red blood cell.
- They have a biconcave shape.
- This increases their surface area to increase rate of diffusion across the cell membrane.
- **White blood cells** have a nucleus.
- They form part of the body's defence system against disease causing microorganisms (pathogens)
- Some produce antibodies which help to destroy pathogens.
- Some engulf and digest pathogens.



- **Platelets** are small fragments of cells.
- They have no nucleus.
- Platelets help blood to clot at the site of a wound.

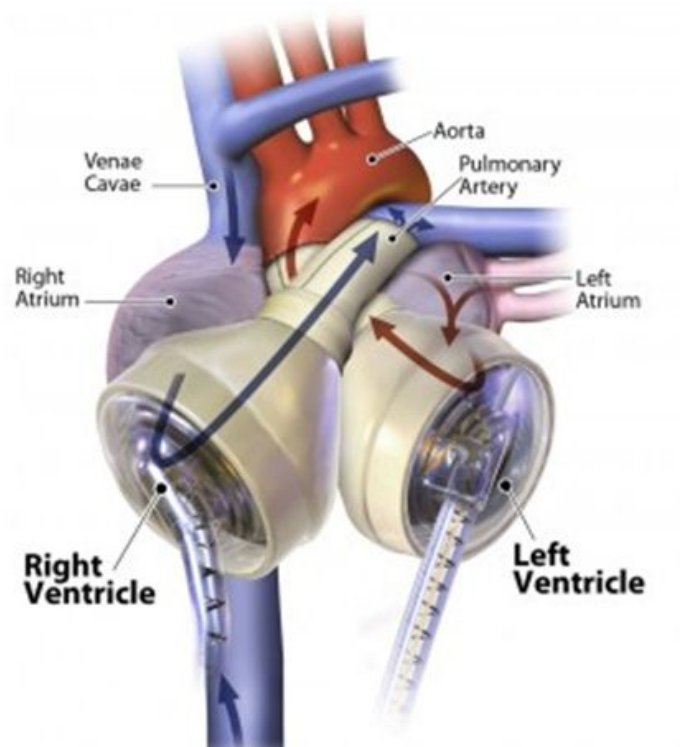
### Medical treatment

- **Artificial blood** products may be used when a patient has lost a lot of blood and there is no donor blood available.
- Plasma can be used, but, without red blood cells and haemoglobin, the blood carries oxygen less efficiently.
- Haemoglobin-based oxygen carriers are made from sterilised haemoglobin, which can come from a variety of sources:

- human blood
- cow blood
- Genetically modified bacteria that can produce haemoglobin
- Human placentas
- It needs to be attached to another substance such as an artificial membrane to stop it breaking down.
- Synthetic oxygen carrying molecules have been also created that absorb oxygen.
- **Stents** are artificial tubes that can be inserted into blood vessels.
- They are made of metal mesh that does not corrode.
- If arteries begin to narrow and restrict blood flow stents are used to keep them open.



- **Artificial hearts** are devices made of plastic or other man-made materials that can replace the ventricles and valves.

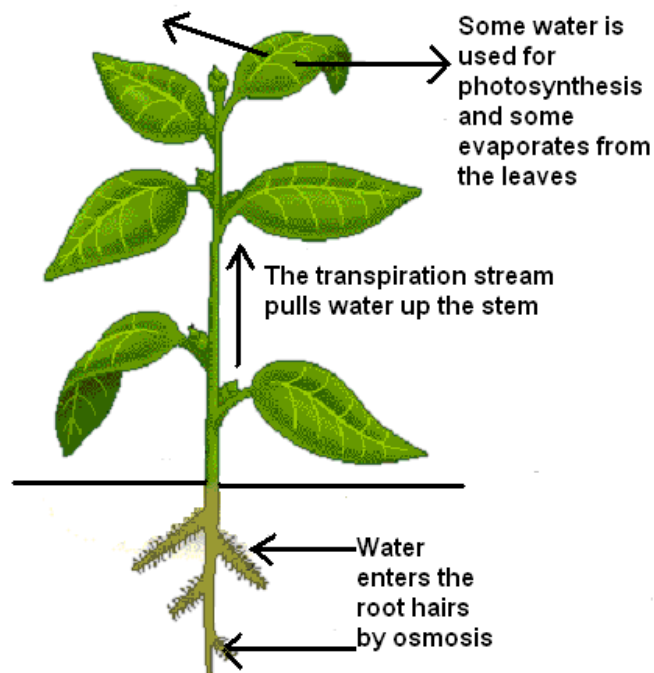


- Some work by using a pump carried externally in a backpack
- Other models use an internal pump and battery.

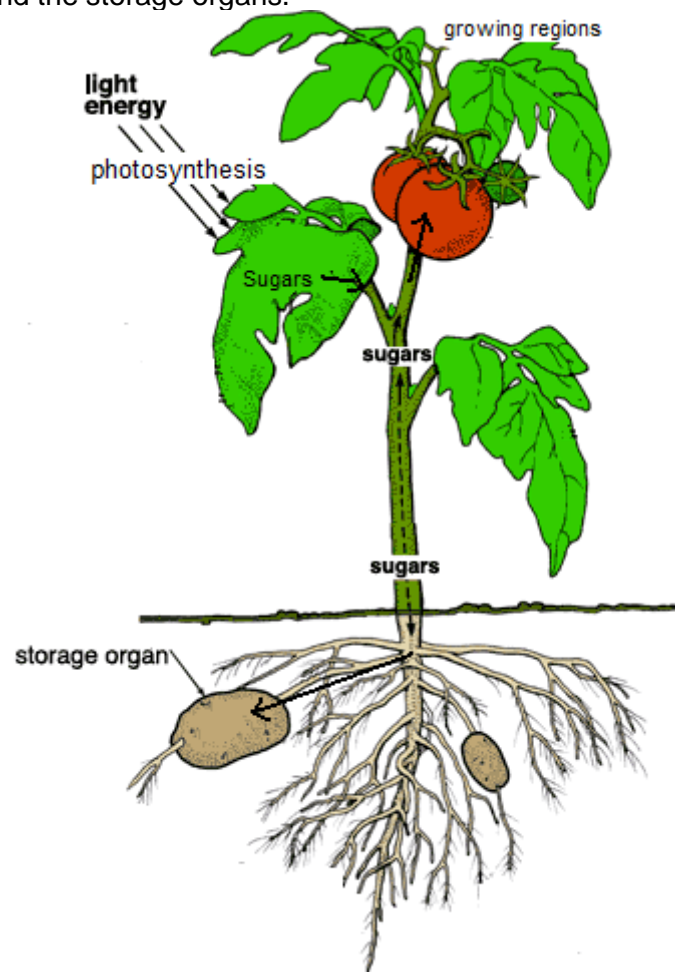
- They can only be used for short periods of time in emergencies where someone's heart stops working and there is no donor heart available.
- However, they are very expensive and not readily available.
- **Artificial heart valves** can be used to replace diseased valves.
- Diseased valves either restrict the flow of blood or the blood leaks backwards.
- Many different mechanical and tissue valves have been implanted in humans.
- The natural valve is cut out and the artificial valve is sewn into its place.
- However, no artificial valve is a perfect substitute for the natural valve.
- The life of the valve is limited by corrosion and damage due to its repeated use.

### Transport systems in plants

- Flowering plants have two separate transport systems:
- **Xylem** tissue transports water and mineral ions from the roots to the stem and leaves.
- The movement of water from the roots through the xylem and out of the leaves is called the transpiration stream.



- **Phloem** tissue carries dissolved sugars from the leaves to the rest of the plant, including the growing regions and the storage organs.



### **B3.3 Homeostasis**

#### **Summary**

Humans need to remove waste products from their bodies to keep their internal environment relatively constant. People whose kidneys do not function properly may die because toxic substances accumulate in their blood. Their lives can be saved by using dialysis machines or having a healthy kidney transplanted. Water and ion content, body temperature and blood glucose levels must be kept within very narrow ranges.

#### **Removal of waste and water control**

- Homeostasis = Controlling internal conditions.
- Waste products which have to be removed from the body include:
  - Carbon dioxide:
    - Produced by respiration in every living cell
    - Removed via the lungs when we breathe out
  - Urea:
    - Produced in the liver by the breakdown of excess amino acids
    - Removed by the kidneys in the urine
    - Urine is temporarily stored in the bladder
- Internal conditions which are controlled include:
  - The water content of the body
  - The ion content of the body
  - Temperature
  - Blood sugar levels

#### **Water balance**

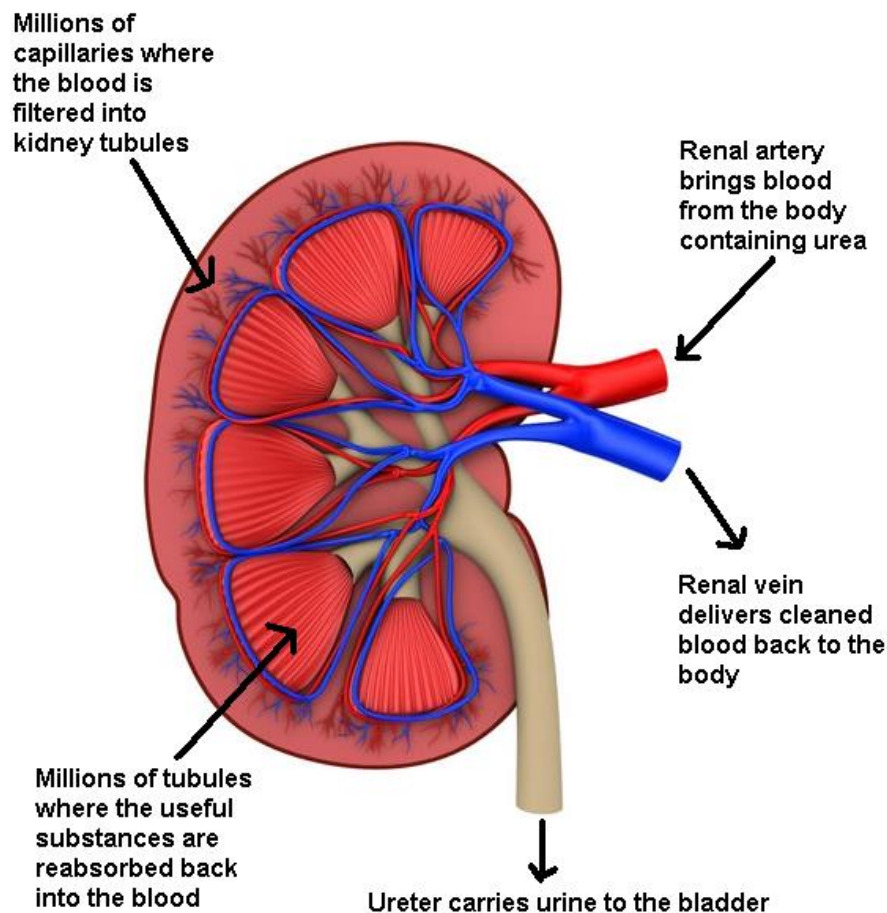
- If the water or ion content of the body is wrong, too much water may move into or out of the cells and damage them.
- Water and ions enter the body when we eat and drink.
- Sweating helps to cool the body.
- More water is lost when it is hot, and more water has to be taken as drink or in food to balance this loss.
- The kidneys control the water content of the blood.

#### **Kidneys**

- Most humans have two kidneys.
- Kidneys have an important role in homeostasis.
- They control the water content of the blood.
- They control the ion (salt) content of the blood.
- They remove the urea from the blood.
- Each kidney receives blood from the renal artery.
- The artery branches into millions of capillaries inside each kidney.
- Each kidney also contains about one million microscopic tubules, which are responsible for forming urine.
- A healthy kidney produces urine by:

##### **1. Filtering the blood**

- Blood enters the capillaries under high pressure.
- Most of the liquid leaves the blood and enters a tubule.
- The cells and large molecule remain in the blood.
- The blood becomes very concentrated.



**2. Reabsorbing all the sugar**

- All of the sugar is reabsorbed from the tubule, back into the blood by active transport.
- It moves against a concentration gradient.

**3. Reabsorbing the dissolved ions needed by the body**

- Some of the ions are also reabsorbed back into the blood by active transport.
- Some salt is left behind to balance what the body needs.

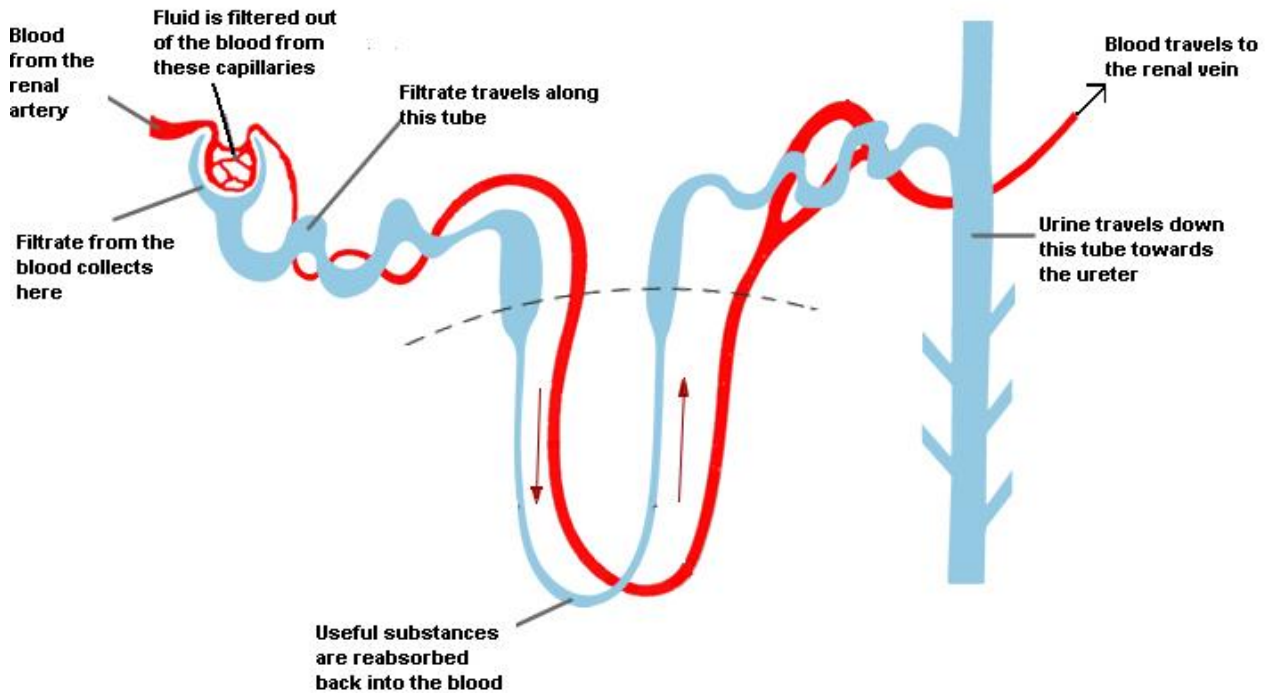
**4. Reabsorbing as much water as the body needs**

- Water is reabsorbed into the blood by osmosis.
- This occurs because there is a much higher solute concentration (lower water concentration) in the blood than in the tubule.
- The body balances how much water it needs by changing how much water is lost in the urine.

**5. Releasing urine**

- Urine is released from the kidney.
- It contains urea, excess ions and water.
- Urine is stored in the bladder, before being expelled from the body.

## A kidney tubule and associated capillaries

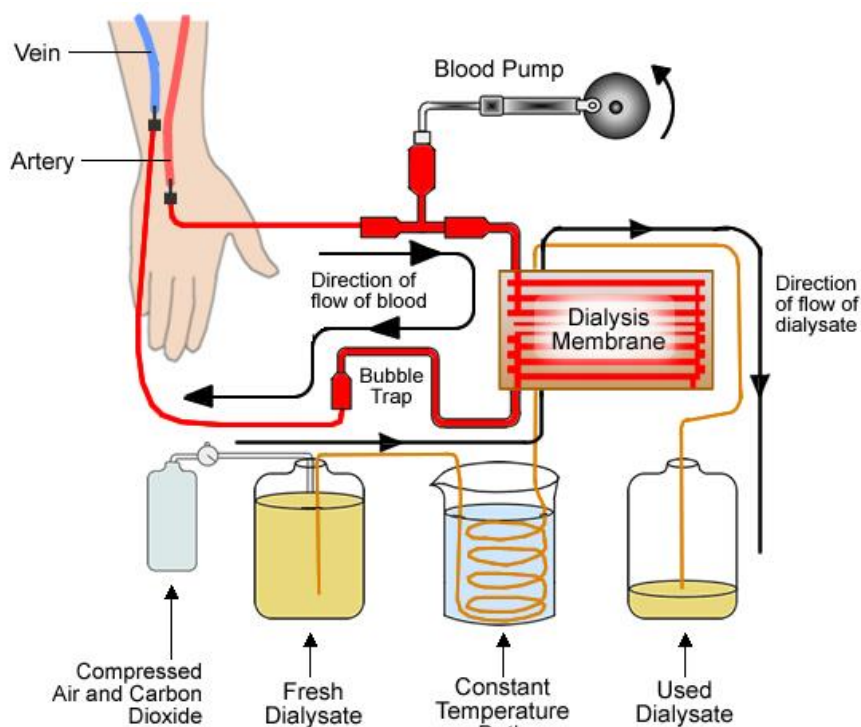


### Treating Kidney Failure

- People whose kidneys do not function properly can die because toxic substances accumulate in their blood.
- Their lives can be saved by using dialysis machines or by having a healthy kidney transplanted.

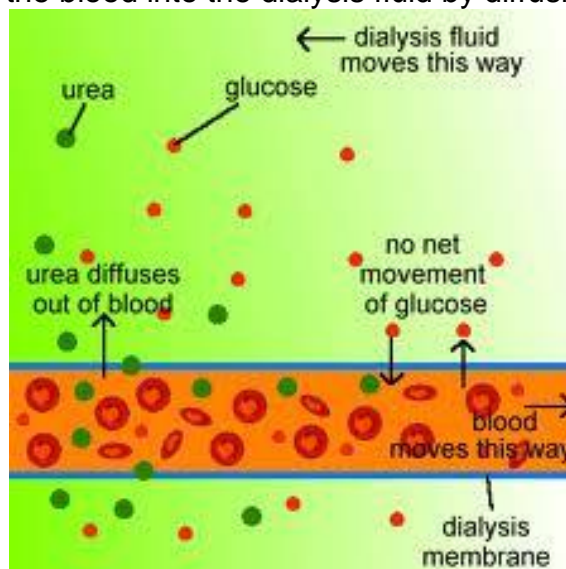
### Dialysis

- The blood vessels in the arm are connected to a dialysis machine.



- In the dialysis machine a person's blood flows between partially permeable membranes.
- The dialysis fluid contains the same concentration of useful substances as the blood.

- This ensures that glucose and useful mineral ions are not lost.
- There is a high concentration of urea in the person's blood, and no urea in the dialysis fluid.
- There is a concentration gradient of urea between the blood and the dialysis fluid.
- Urea passes out from the blood into the dialysis fluid by diffusion.



- Treatment by dialysis restores the concentrations of dissolved substances in the blood to normal levels.
- It has to be carried out at regular intervals.

### Kidney transplants

- A kidney transplant enables a diseased kidney to be replaced with a healthy one from a donor.
- However, the donor kidney may be rejected by the immune system:
  - Antigens are proteins on the surface of cells.
  - The antigens on the cells of the donated kidney may be different to the recipient's antigens.
  - White blood cells do not recognise them as part of the recipient's body.
  - They produce antibodies which attack the antigens on the donor organ.
- To prevent rejection of the transplanted kidney:
  - A donor kidney with a tissue-type similar to that of the recipient is used.
  - The recipient is treated with drugs that suppress the immune system.

	Advantages	Disadvantages
Dialysis	<ul style="list-style-type: none"> <li>• No major surgery needed.</li> <li>• No waiting lists – it prevents people dying.</li> </ul>	<ul style="list-style-type: none"> <li>• Diet needs to be controlled carefully.</li> <li>• Restricts normal life – it takes about 8 hours, several times a week.</li> </ul>
Kidney transplant	<ul style="list-style-type: none"> <li>• No need for dialysis.</li> <li>• The recipient can lead a relatively normal life.</li> <li>• Diet does not need to be controlled.</li> </ul>	<ul style="list-style-type: none"> <li>• Major surgery has many risks.</li> <li>• Possibility of rejection.</li> <li>• Immunosuppressant drugs need to be taken for life.</li> <li>• Some religious groups do not agree with organ donation.</li> </ul>

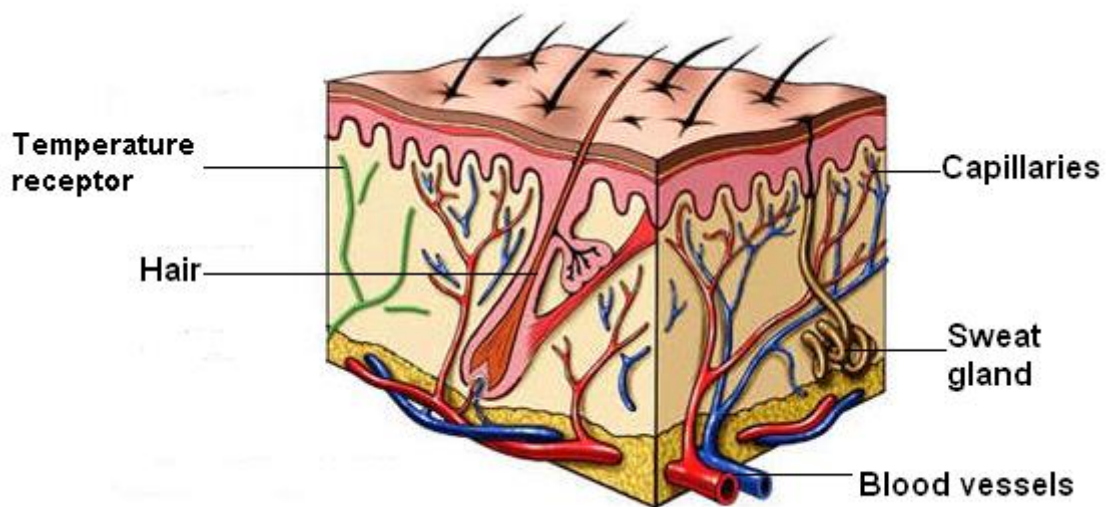
## **Temperature control**

- All enzymes work best at 37°C
- The metabolism of cells releases heat which warms the animal's body.
- Metabolism is most efficient if internal temperature is maintained when the external temperature changes,

## **Thermoregulatory centre**

- Body temperature is monitored and controlled by the thermoregulatory centre in the brain.
- This centre has receptors sensitive to the temperature of blood flowing through the brain.
- Also temperature receptors in the skin send impulses to the centre giving information about skin temperature.

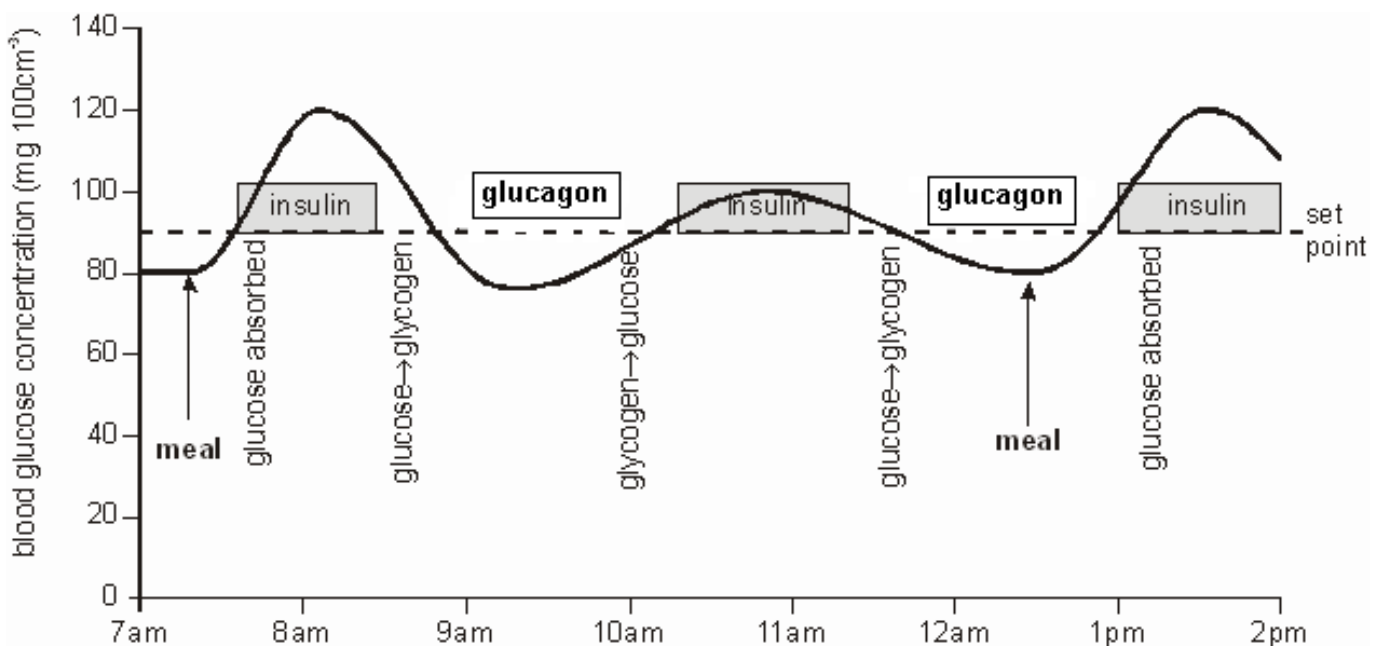
## **Skin**



- Skin contains sweat glands
- Skin has network of capillaries just under the surface
- If the core body temperature is too high:
  - Blood vessels supplying the skin capillaries dilate (get wider):
    - More blood flows through the capillaries.
    - More heat is lost from the skin.
  - Sweat glands release more sweat:
    - This cools the body as it evaporates.
- If the core body temperature is too low
  - Blood vessels supplying the skin capillaries constrict (get narrower):
    - This reduces the flow of blood through the capillaries.
    - This reduces heat loss from the skin.
  - Muscles may shiver.
    - Their contraction needs respiration, which releases some energy as heat.

### Sugar control

- The blood glucose concentration of the body is monitored and controlled by the pancreas.
  - The pancreas produces the hormone **insulin**, which allows glucose to move from the blood into the cells.
1. Food is eaten
  2. Carbohydrates are digested into glucose
  3. Glucose is absorbed into blood
  4. Blood glucose levels rise
  5. This is detected by the pancreas
  6. Insulin is released into blood
  7. Insulin reaches the liver
  8. Glucose is converted in glycogen
  9. Glycogen is stored
  10. Blood glucose levels return to normal
- This process ensures that the blood glucose never rise too high immediately after a meal.
  - A second hormone, **glucagon**, is produced in the pancreas when blood glucose levels fall.
  - This causes glycogen to be converted into glucose and to be released into the blood.



### Diabetes

- Type 1 diabetes is a disease in which a person's pancreas does not produce enough of the hormone insulin.
- After a meal, blood glucose concentration may rise to a very high level.
- This can be fatal if it is not controlled.

### Treating diabetes

- Diabetes may be treated by careful attention to diet and by injecting insulin into the blood.
- Insulin from pigs and cows was used to treat diabetic people for many years.

- Insulin is now produced using micro organisms that have been genetically engineered to contain the human insulin gene.
  - This modern insulin is chemically identical to human insulin.
- Pancreas transplants can also be used to treat diabetes in some people.
  - However, there are not enough dead donors to supply all the people who need them.
  - Also, organ transplants are not always successful.
- In the future, stem cells may be used to cure diabetes.
  - However, this requires the use of human embryos, which many people disagree with.

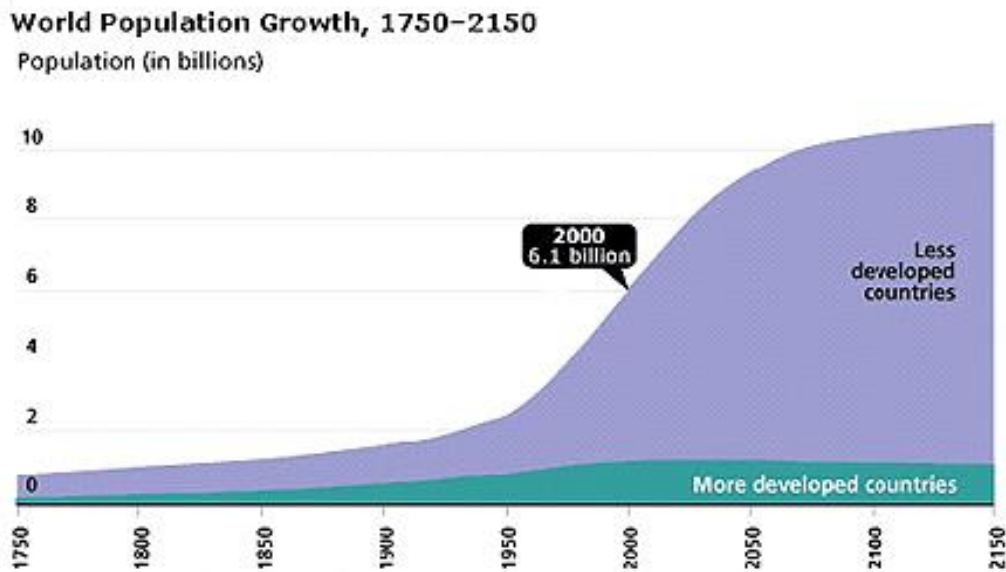
### **B3.4 Humans and their environment**

#### **Summary**

Humans often upset the balance of different populations in natural ecosystems, or change the environment so that some species find it difficult to survive. With so many people in the world, there is a serious danger of causing permanent damage not just to the local environments but also to the global environment unless our overall effect is managed carefully. Humans rely on ecosystems for food, water and shelter.

#### **Human Population Growth**

- The human population is growing rapidly due to an increase in the standard of living.
- Land availability for farming is limited, so it will become more and more difficult to feed the population.
- Also, in less developed countries, where the population is rapidly increasing, the availability of clean water is limited.



#### **Waste from human activity**

- Rapid growth in the human population and an increase in the standard of living mean that increasingly more waste is produced.
- Unless waste is properly handled, more pollution will be caused.
- Waste may pollute:
  - water - with sewage, fertiliser or toxic chemicals;
  - air - with smoke and gases such as sulfur dioxide;
  - land - with toxic chemicals, such as pesticides and herbicides, which may be washed from land into water.
- Humans reduce the amount of land available for other animals and plants by:
  - Building
  - Quarrying
  - Farming
  - Dumping Waste

#### **Deforestation and the destruction of areas of peat**

- Large areas of tropical forest has been cut down:
  - for timber
  - to provide land for agriculture
- Much of the waste wood is burnt or it is decomposed by microorganisms.

- This has increased the release of carbon dioxide into the atmosphere.
- It has also reduced the rate at which carbon dioxide is removed from the atmosphere and 'locked up' for many years as wood.
- Deforestation leads to reduction in biodiversity.
- This means that the population size of many species is reduced and also the number of species that can survive is reduced.
- Deforestation has also occurred to provide agricultural land for:
  - crops to be grown from which biofuels, based on ethanol, can be produced.
  - increases in cattle and in rice fields to provide more food.
    - Both of these organisms produce methane and this has led to increases in methane in the atmosphere.

### **Peat bogs**

- Peat bogs form in areas where plants grow in waterlogged conditions, and when the plants die they do not fully decompose.
- Therefore, lots of which carbon is 'locked up' in these bogs.
- Peat can be as compost used in agriculture to improve the nutrient content of soil.
- Consequently, many peat bogs are being destroyed.
- The destruction of peat bogs and other areas of peat release carbon dioxide into the atmosphere.
- People should be encouraged to use 'peat-free' compost.

### **Greenhouse gases**

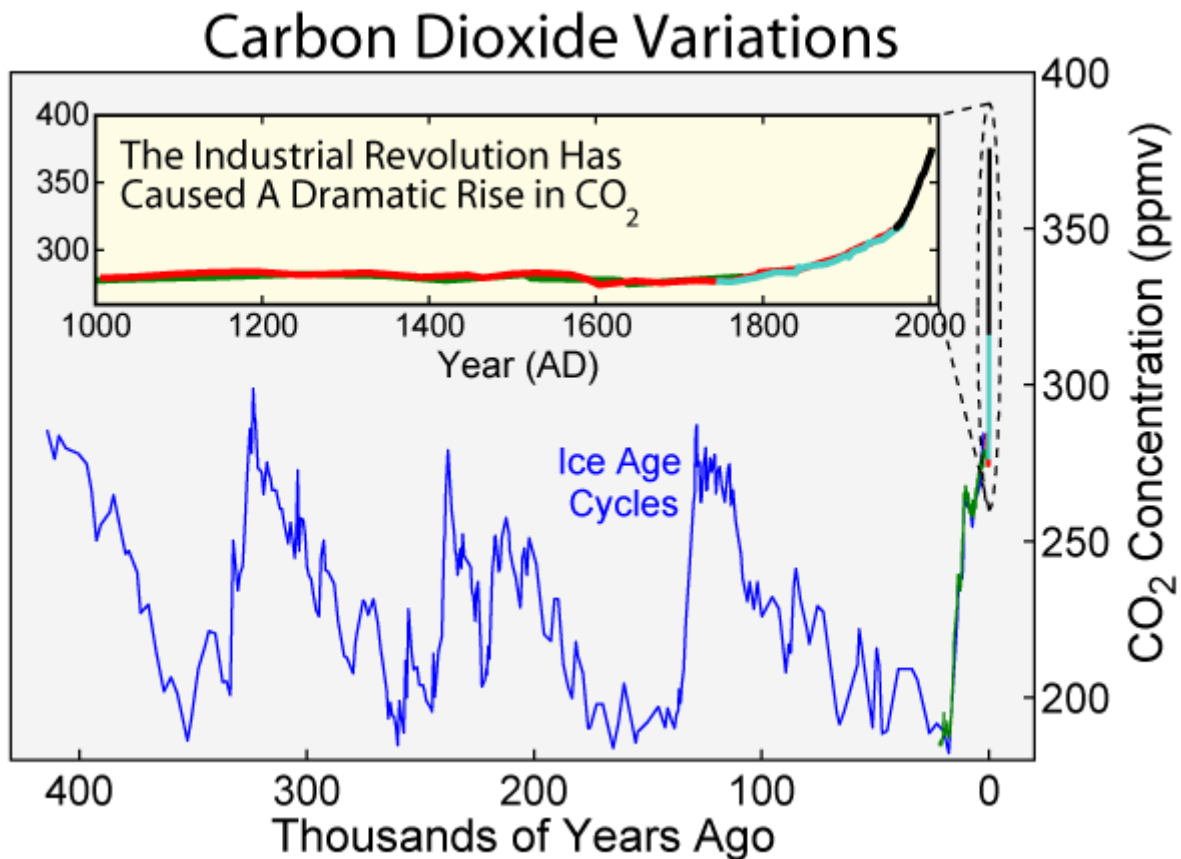
- Carbon dioxide and methane in the atmosphere absorb most of the energy radiated by the Earth.
- Some of this energy is reradiated back to the Earth and so keeps the Earth warmer than it would otherwise be.

### **Global Warming**

- Deforestation has increased the release of carbon dioxide into the atmosphere (because of burning and the activities of microorganisms);
- It has also reduced the rate at which carbon dioxide is removed from the atmosphere and 'locked-up' for many years as wood.
- Increases in the numbers of cattle and rice fields have increased the amount of methane released into the atmosphere.
- These gases may be causing global warming by increasing the greenhouse effect.
- An increase in the Earth's temperature of only a few degrees Celsius may cause:
  - quite big changes in the Earth's climate
  - a rise in sea level
  - a reduction in biodiversity
  - changes in migration patterns of birds
  - changes in the distribution of species.
- Carbon dioxide can be sequestered (removed from the atmosphere) in oceans, lakes and ponds.
- This is an important factor in removing carbon dioxide from the atmosphere.
- However, the solubility of carbon dioxide in water decreases at higher temperatures.
- Therefore, if increasing greenhouse gases increase the global temperature, less carbon dioxide will be sequestered.

### Measuring concentrations of atmospheric carbon dioxide

- Carbon dioxide concentrations naturally change when the Earth's climate changes.
- Scientists can monitor the concentration of carbon dioxide in the atmosphere.
- However, they have only been monitoring this in recent decades.
- To measure atmospheric carbon dioxide concentrations for periods before this, scientists can measure bubbles of air trapped in the polar ice caps.
- Some of the data indicates that carbon dioxide concentration has increased significantly since the industrial revolution.
- Some people argue that we do not have enough data to support this claim.
- They feel that the increase in carbon dioxide may largely be due to natural atmospheric variation or flaws in the measurement procedures.

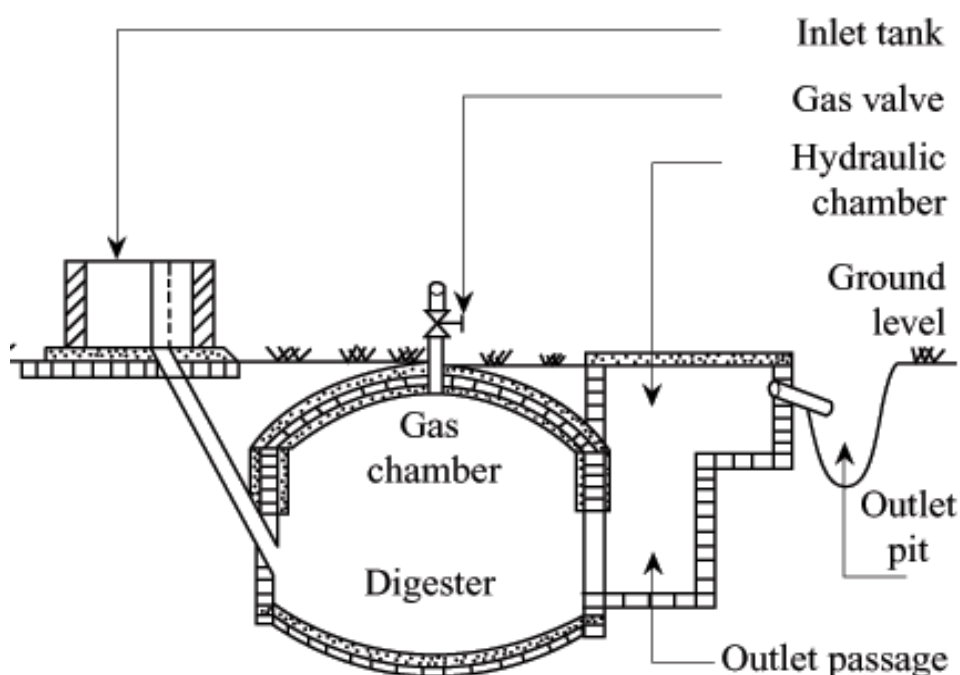


### Biofuels

- Produced by anaerobic fermentation of a wide range of plant products or waste material containing carbohydrates.
- It is mainly **methane**.
- On a large scale industrial waste can be used:
  - From sugar factories.
  - From sewage works.
- On a small scale, biogas generators can be used to supply the energy needs of individual families or farms.
- Organic waste can be used:
  - Plant waste from crops.
  - Animal faeces and urine.
- Many different microorganisms are involved in the breakdown of materials in biogas production.

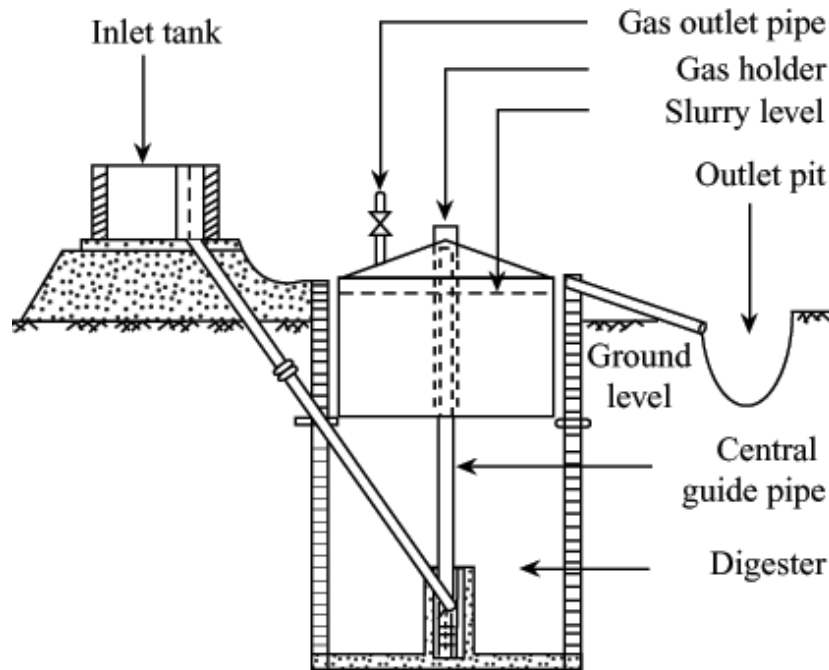
- There are many environmental and economic advantages:
  - It is a useful way to recycle waste material.
  - Initial set up costs are expensive, but the raw materials for biogas production are very cheap (or free).
  - The fuel is readily available.
  - This is particularly useful in developing countries.
  - Waste products from the process can be used as fertilisers.
  - It reduces the use of fossil fuels.
- The output from a biogas generator is higher in warmer climates
- There are various different designs:

### Fixed dome design



Advantages	Disadvantages
Fewer metal parts: Less expensive to set up Does not rust Cheaper to set up – they can be used by single families or small communities	Gas pressure fluctuates. Less straightforward to control. Gas leakage is more likely. Production of methane is low.

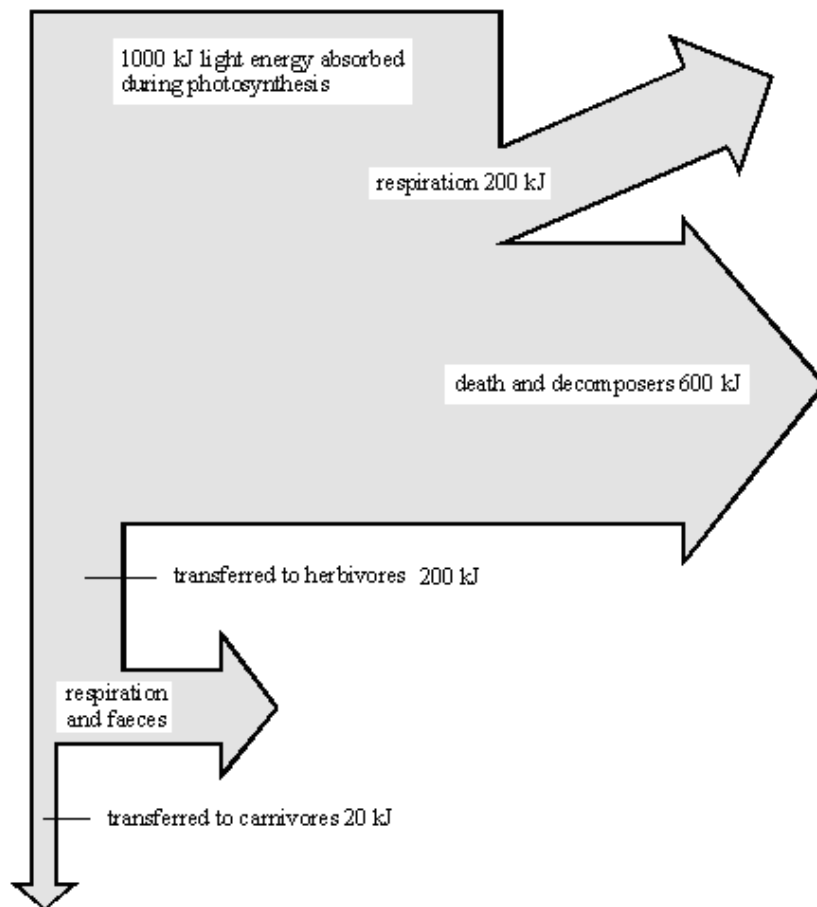
## Floating dome design



Advantages	Disadvantages
<p>Floating dome stabilises the gas pressure</p> <p>Gas production can be monitored more easily.</p> <p>Can be used on a larger scale:</p> <p>For large villages or for commercial production of methane.</p>	<p>Expensive to set up and maintain</p> <p>Requires more management</p> <p>Metal construction:</p> <p>Rusts easily</p>

## **Food production**

- At each stage in a food chain, less material and less energy are contained in the biomass of the organisms.



- The efficiency of food production can be improved by reducing the number of stages in food chains.
- Less energy is lost along the food chain between the producer and the human.
- This requires more people to convert to a vegetarian diet.
- This may be necessary if people in developing countries are to sustain their population growth.
- The efficiency of food production can also be improved by restricting energy loss from food animals by:
  - Limiting their movement.
  - Controlling the temperature of their surroundings.
- This occurs in battery farming, for which there are many ethical concerns:
  - Animals' movement is limited.
  - They suffer pain and discomfort.
  - They do not live in their natural environment.

## **Food miles**

- Food miles describe the distance that food is transported as it travels from producer to consumer.
- This includes imports by boat and air and transport by lorries and cars.
- Food transport is responsible for adding millions of tonnes of carbon dioxide to the atmosphere each year.
- Choosing food that is local and in season means it does not have to travel so far.
- Reducing food miles can have a dramatic effect on reducing carbon dioxide emissions.

### **Sustainable Development**

- As the human population grows we will require more resources.
- Sustainable development is about how we should ensure that we:
  - Conserve natural resources
  - Reduce the damage we make to the environment
  - Maintain biodiversity
- Humans will need to make compromises between competing priorities.

### **Fish stocks**

- Fish stocks in the oceans are declining.
- It is important to maintain fish stocks at a level where breeding continues or some species may disappear altogether in some areas.
- Governments have passed laws to ensure the conservation of fish stocks:
  - The size of nets is restricted.
  - Fishing quotas ensure there are limits on the numbers of fish that can be caught.
- However, this reduces the income for fishermen.
- It is also results in the price of fish increasing.

### **Mycoprotein production**

- The fungus *Fusarium* is used to make mycoprotein (Quorn).
- This is a protein-rich food suitable for vegetarians.
- The fungus is grown on glucose syrup in aerobic conditions.
- The biomass is harvested and purified.
- This method of food production may become more important when land availability for farms becomes restrictive.
- This may not be popular because many people prefer to eat meat.

### **Methods to provide food to an increasing human population**

- Various organisations provide emergency food assistance after natural disasters such as severe drought and earthquakes.
- Countries who struggle to feed their population are encouraged to grow staple crops such as cereals.
- The seeds that are produced are high in protein and they can be stored all year round.
- Some GM crops have been developed that can grow better in dry conditions or resist pests.
- However, the use of these is banned in many countries because of people's concerns about the possible harmful effects of manipulating genes.

### **Methods to provide water to an increasing human population**

- Many people living in less developed countries do not have access to clean water.
- Contaminated water carries many harmful bacteria. These kill many people.
- Some charitable agencies help by funding and developing access to fresh water, by providing pumps, pipes and education.
- In the developed countries the demand for fresh water is often greater than the supply from rivers lakes and underground aquifers.
- As the population increases, the demand increases.
- People need to reduce water use, particularly in irrigation of agricultural land.
- Hosepipe bans are often enforced to reduce residential water use.