

Challenge Quiz

A Level Biology

Test your Knowledge!

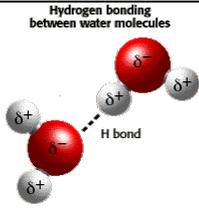
This document contains 20 critical facts that you will need from Year 1 of the A level course.
You will be tested on these by completing the challenge multiple choice quizzes 1 & 2

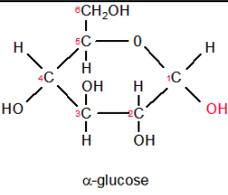
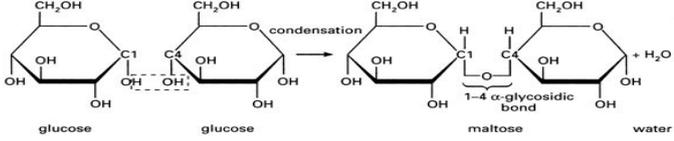
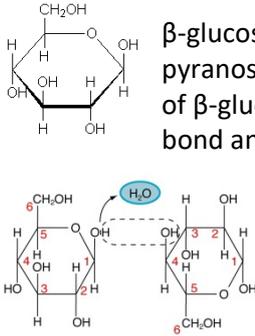
1. Surface area to volume ratio
2. Magnification and resolution
3. Hydrogen bonding in water
4. Differences and significance of α and β glucose
5. Triglycerides and saturated and unsaturated fatty acids
6. Cohesion-tension theory
7. Fluid mosaic model of membrane structure
8. Osmosis
9. Amino acid structure
10. Enzyme specificity
11. Enzyme activity is sensitive to environmental conditions
12. DNA is a polynucleotide
13. Tissue fluid formation
14. Cardiac cycle
15. Translocation
16. Open and closed circulation
17. Ventilation

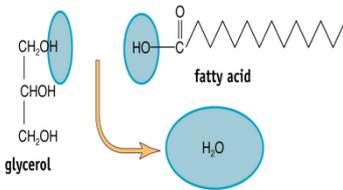
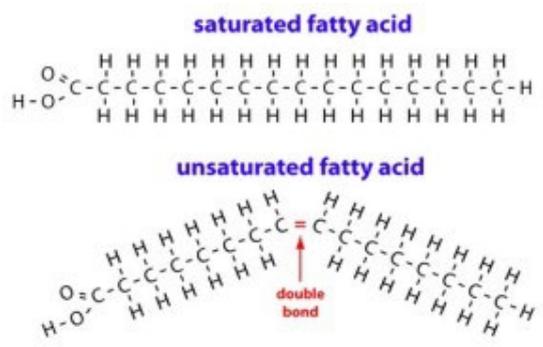
Please note: these resources are non-board specific. Please direct your students to the specifics of where this knowledge and skills most apply.

Definition: Surface area to volume ratio (SA:Vol)	AQA	EDX	OCR
A measure of the surface area of an organism in relation to its overall volume. The greater the diameter of a unicellular organism, the less surface area it has relative to its volume.	✓	✓	✓
 <p>As the size of an organism increases, the surface area to volume ratio decreases. An amoeba is SMALL and so has a LARGE surface area to volume ratio. Substances such as oxygen and carbon dioxide are able to diffuse into and out of the cell sufficiently quickly as the diffusion pathways are short. Larger, multicellular organisms require specialised exchange surfaces e.g. alveoli. A LARGE organism has a SMALL surface area to volume ratio. SA:Vol is important in limiting the size of cells and has a significant impact on an organism's physiology and behaviour.</p>			

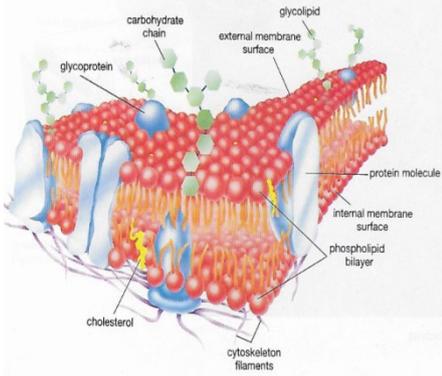
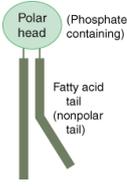
Definition: Magnification and resolution	AQA	EDX	OCR
Magnification is the number of times that an image is bigger than the specimen. Resolution is the ability to distinguish between two objects.	✓	✓	✓
<p>When using a light microscope the total magnification is found by multiplying the power of the eyepiece lens (e.g. X10) by the power of the objective lens (e.g. X40) so $10 \times 40 = X400$. Magnification is given by the formula:</p> $\text{magnification} = \frac{\text{size of image}}{\text{size of specimen}}$ <p>The resolution of a light microscope is the shortest distance between two objects that allows them to be viewed as separate features i.e. not blur into one. This is determined by the wavelength of light which is about $0.2\mu\text{m}$ so two objects less than $0.2\mu\text{m}$ apart will appear as one object. Electron microscopes have a far greater resolving power as the electron beam has a wavelength of about 5nm.</p>			

Definition: Hydrogen bonding in water	AQA	EDX	OCR
A bond which holds one molecule of water to another and largely accounts for the unusual properties of water.	✓	✓	✓
 <p>Covalent bonds exist between the oxygen and hydrogen atoms in water. However, the oxygen nucleus draws electrons on the hydrogen atoms closer to it causing an unequal distribution of charge creating a polar molecule. There is an electrostatic attraction between the negatively charged region of one water molecule (oxygen atom) and the positively charged region of another water molecule (hydrogen atom). This forms a weak hydrogen bond. It is the hydrogen bonds that causes water to be attracted to charged particles and charged surfaces.</p>			

Definition: Differences and significance of α and β glucose	AQA	EDX	OCR
Glucose is a hexose sugar that exists in two biologically important forms: α and β .	✓	✓	✓
 <p>α-glucose</p> <p>α-glucose is a form of glucose where a hydrogen atom attached to carbon 1 is 'up' when the pyranose ring is closed. This leaves OH 'down' on carbon 1. This is highly significant as when another α-glucose molecule appears, the OH which is 'down' on carbon 4 of the second molecule can form a 1,4 glycosidic bond via a condensation reaction (a water molecule is removed).</p>  <p>β-glucose is a form of glucose where a hydrogen atom attached to carbon 1 is 'down' when the pyranose ring is closed. This means that in order to form a 1,4 glycosidic bond, every other unit of β-glucose needs to 'flip' through 180° in order to bring two OH groups together to form the bond and create a molecule of water (condensation reaction).</p>  <p>Cellulose is an unbranched polysaccharide made up of units of β-glucose and is an important component of plant cell walls.</p>			

Definition: Triglycerides and saturated and unsaturated fatty acids	AQA	EDX	OCR
Triglycerides are major components of plant and animal lipids. They are composed of a glycerol molecule joined to three fatty acids. These fatty acids can be saturated or unsaturated.	✓	✓	✓
 <p>Triglycerides are formed when three fatty acid molecules join to a glycerol molecule by condensation reactions. Three molecules of water are produced and ester bonds are formed.</p> <p>Saturated fatty acids have no double bonds ($-C=C-$) between carbon atoms in their hydrocarbon tail.</p> <p>Unsaturated fatty acids have at least one double bond ($-C=C-$) between carbon atoms. Fats with several double bonds are polyunsaturated.</p>  <p>saturated fatty acid</p> <p>unsaturated fatty acid</p> <p>Unsaturated fatty acids have lower melting points as the hydrocarbon tails cannot pack so closely together.</p>			
Definition: Cohesion-tension theory	AQA	EDX	OCR

The idea of intermolecular attraction that explains the movement of water up through the xylem of plants.			
	✓	✓	✓
<p>Water travels through a plant via the transpiration stream. Water enters the root hair cells by osmosis, travels across the root cortex and into the xylem of the stem. It then moves up the plant stem (against the force of gravity) and eventually across the leaf mesophyll layer and out to the atmosphere via the stomata.</p> <p>The process starts with water vapour diffusing out of stomata. Lost water from the leaf is replaced by water in the xylem. As water molecules leave the xylem they pull up other water molecules and this force is transmitted down the entire water column to the roots and a tension is created within the xylem. This is made possible by the cohesive forces between the water molecules which, in turn, are due to the hydrogen bonds between the water molecules. Attraction between the water molecules and the walls of the xylem (adhesion) can also help with the movement of water up the xylem.</p>			

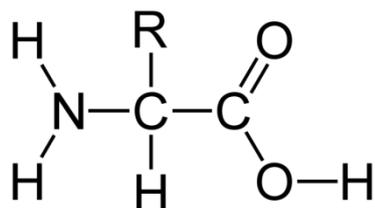
Definition: Fluid mosaic model of membrane structure	AQA	EDX	OCR
The phospholipids looked like small mosaic tiles packed tightly together. The larger proteins are dispersed between the phospholipids. The proteins in the membrane are not fixed in one particular position. They are free to move around & through the phospholipids around the outside of the cell.	✓	✓	✓
<p>The plasma membrane is a lipid bilayer made of phospholipids.</p> <p>The head of the molecule is polar and has hydrophilic properties. The hydrocarbon tails are nonpolar and are hydrophobic. Hydrophilic heads position themselves towards the outside with the hydrophobic tails orientated towards the inside forming a phospholipid bilayer.</p>			
 			

Definition: Osmosis	AQA	EDX	OCR
The net movement of water molecules through a partially permeable membrane from a solution of higher water potential (less negative value) to a solution of lower water potential (more negative value).	✓	✓	✓
<p>Osmosis needs to be explained in terms of water potential (Ψ). Pure water as a water potential of 0. Adding a solute gives the water potential a negative value. The more solute is dissolved in the water, the more negative the water potential.</p> <p>If two solutions are separated by a partially permeable membrane, water will move from high to low water potential. In other words, it will move from the more dilute solution to the more concentrated solution through the partially permeable membrane. This is because the more 'watery' solution will dilute the less 'watery' solution and osmosis will continue until the water potential (Ψ) is equal on either side of the membrane i.e. equilibrium is reached.</p> <p>Osmosis is a special case of diffusion (passive process).</p>			

Definition: Amino acid structure	AQA	EDX	OCR
---	-----	-----	-----

Proteins are large molecules typically made up of thousands of amino acids joined in long chains called polypeptides. There are 20 amino acids in the body which all share a common structure.

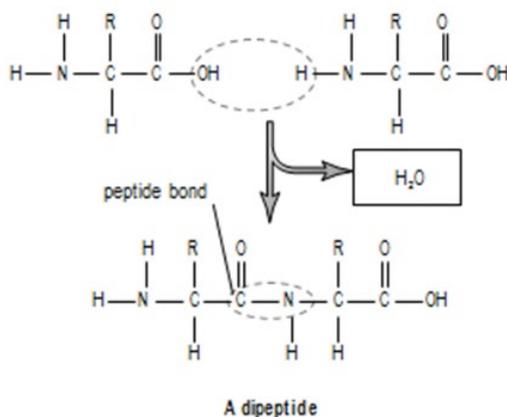
✓	✓	✓



Generalised structure of an amino acid

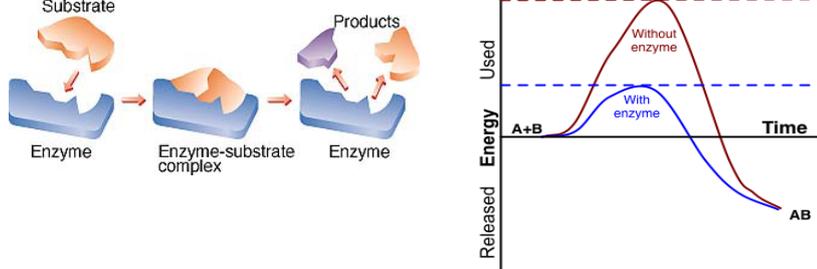
Amino acids all have a central carbon atom which is attached to a hydrogen atom plus a basic amino group (-NH₂) and an acidic carboxyl group (-COOH). The R group is the variable part of the amino acid molecule and determines its identity. The R group can be as simple as another hydrogen molecule (glycine) or can have a complex ring structure (phenylalanine).

Amino acids can join together by peptide bonds via a condensation reaction to form a dipeptide. Additional amino acids can join the chain to eventually form a polypeptide.



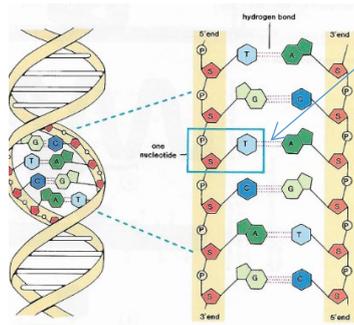
Definition: Enzyme specificity	AQA	EDX	OCR
Enzymes are biological catalysts which have an active site with a specific 3D shape. Enzymes are highly specific as only one type of substrate with the correct shape can fit into the active site (lock and key theory).	✓	✓	✓

As the substrate binds to the active site, the shape of the active site changes to fit the substrate. This is the induced fit theory. The binding of the substrate results in an enzyme-substrate complex. Enzymes reduce the activation energy of a reaction and so make it easier to activate the reacting molecules.



Definition: Enzyme activity is sensitive to environmental conditions.	AQA	EDX	OCR
Enzymes are globular proteins with a tertiary structure. They can be affected by			

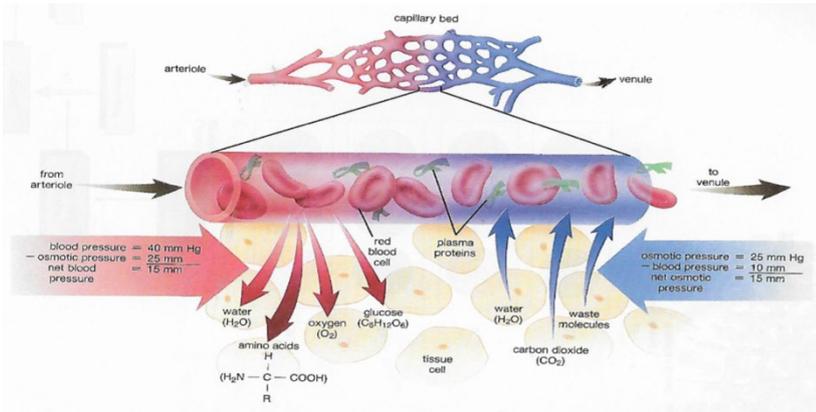
environmental conditions such as temperature, pH, enzyme concentration and substrate concentration.	✓	✓	✓
<p>The tertiary structure of a protein is its overall 3D shape. This is determined by the order of the amino acids which make up the polypeptide chain. Interactions between the amino acids and the aqueous environment cause the polypeptide to fold and twist. Hydrogen bonds, ionic bonds and disulphide bridges stabilise this shape, especially the active site. Excessive heat can cause these stabilising bonds to break and so cause the active site to change shape (becomes denatured).</p> <p>A change in pH can also change the shape of the active site and cause it to denature as the change in distribution of charge can cause the hydrogen bonds to break and so prevent the substrate from binding. The relative concentration of enzyme and substrate also affect the rate of an enzyme catalysed reaction. If there are unoccupied active sites available, adding additional substrate will result in a greater number of enzyme-substrate complexes being formed and so more product. However, once the active sites are saturated, adding further substrate will not increase the speed of the reaction any further. The reaction has reached maximum velocity (V_{max}).</p>			

Definition: DNA is a polynucleotide	AQA	EDX	OCR
The DNA double helix is made up of two polynucleotide strands held together by hydrogen bonds. Each strand is made up of repeating nucleotides which consist of a deoxyribose sugar, a phosphate group and one of four bases (adenine, guanine, cytosine or thymine).	✓	✓	✓
 <p>DNA is a nucleic acid and is built up from repeating units called nucleotides. <u>Each nucleotide</u> consists of a deoxyribose sugar, a phosphate group and one of four bases (adenine, guanine, cytosine or thymine). Nucleotides are joined by a phosphodiester bond between a phosphate group and the adjacent deoxyribose sugars in the polynucleotide chain. The nitrogenous base of one chain forms a hydrogen bond with its complementary pair on the other chain. Adenine and guanine are purines and cytosine and thymine are pyrimidines (memory help: letter y). Adenine always pairs with thymine and guanine always pairs with cytosine. This is called complimentary base pairing.</p> <p>The two polynucleotide chains are orientated in 'opposite' directions. This is called antiparallel.</p>			

Definition: Semi-conservative replication	AQA	EDX	OCR
The method by which DNA is able to replicate itself. The two polynucleotide strands separate and each strand acts as a template to synthesise a new strand from free DNA nucleotides.	✓	✓	✓
<p>In order for DNA to replicate, the two strands must first separate. Hydrogen bonds between complimentary bases are broken by an enzyme, DNA helicase.</p> <p>Each original 'parent' strand then acts as a template to form a new 'daughter' strand. Free DNA nucleotides in the nucleus move down to the parent strand and position themselves according to the base pairing rule. DNA polymerase is involved in this process and in creating a new polynucleotide chain.</p> <p>It is called semi-conservative replication as half of the molecule is conserved and half is synthesised from new nucleotides.</p> 			
Definition: Tissue fluid formation	AQA	EDX	OCR

Tissue fluid is formed from blood plasma and plays an important role in the delivery of nutrients to cells and the removal of waste products.

✓	✓	✓



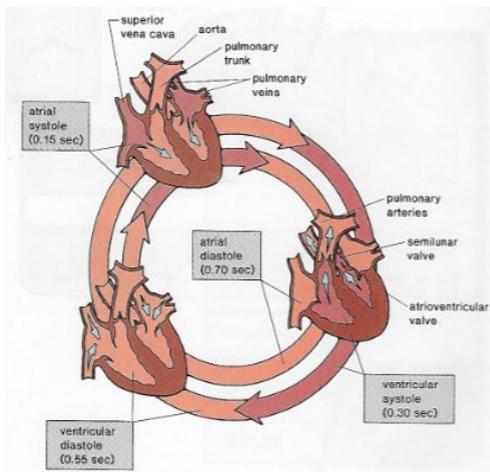
Blood enters the capillary bed at the arteriole end and the hydrostatic pressure generated by the heart beating, forces liquid (blood plasma) out of the capillary. This tissue fluid bathes the adjacent cells and contains oxygen, glucose, amino acids, fatty acids, vitamins and ions which diffuse into the cells. Waste products such as CO₂, unwanted metabolites and excess ions pass from the cells into the tissue fluid.

Towards the venule end of the capillary bed, most tissue fluid is returned to the circulation. Large plasma proteins that stayed in the blood provide a suitable water potential to cause a net inflow of tissue fluid back into the capillary. The reduced hydrostatic pressure at the venule end of the capillary bed also helps this process.

Definition: Cardiac cycle

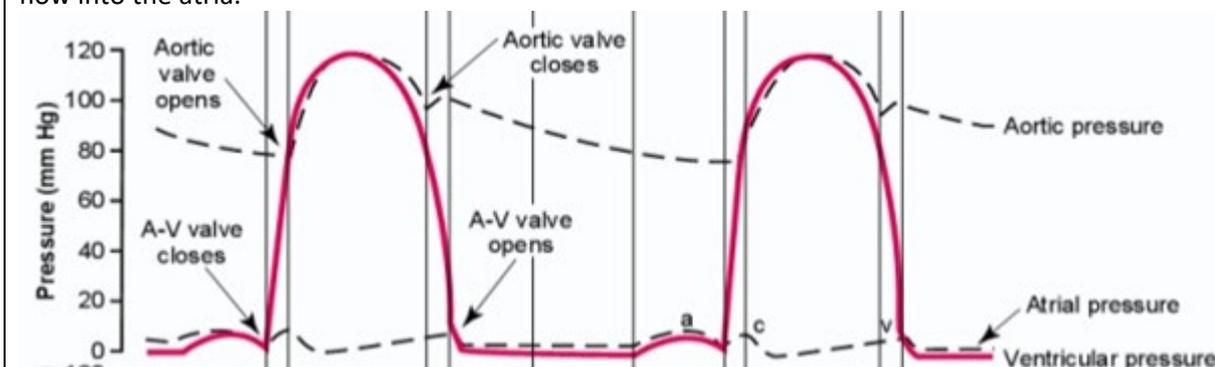
The series of events of one complete heartbeat.

AQA	EDX	OCR
✓	✓	✓



A heartbeat can be divided into two stages, systole and diastole. During systole, the heart muscle (cardiac muscle) contracts (think 'squeezing' for systole) and during diastole it relaxes. Both sides of the heart function together in the same way: Once the atria are full, the walls of the atria contract (remember, the atria themselves are chambers). This is **atrial systole**. Pressure forces the atrioventricular (**AV**) valves open and blood is pumped into the ventricles. The atria now relax (**atrial diastole**) and the walls of the ventricles contract (**ventricular systole**). In doing so the rising pressure of the blood in the ventricles caused the AV valves to shut (prevents backflow to the atria) and the semi-lunar valves at the base of the aorta and pulmonary artery to open. The ventricles then relax (**ventricular diastole**). This lasts about 0.5 seconds during which time the atria remain in diastole and blood begins to

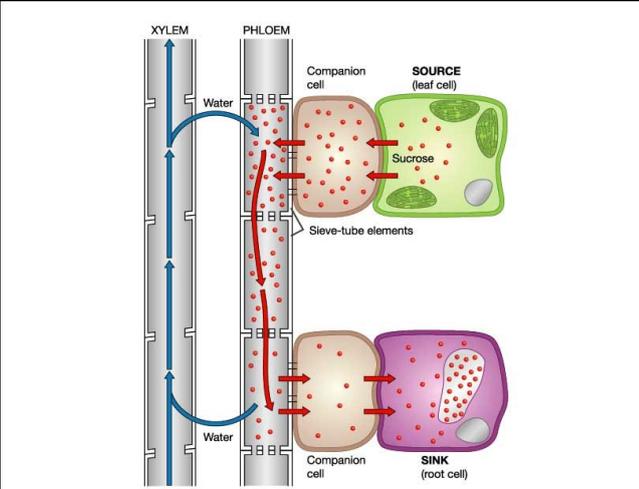
flow into the atria.



Definition: Translocation

AQA	EDX	OCR
-----	-----	-----

The movement of organic material from the source (e.g. leaf) to a sink (e.g. root) through the phloem (mass flow hypothesis).			
	✓	✓	✓



Phloem is living tissue consisting of sieve tube elements and companion cells. The **mass flow hypothesis** states that solutes flow through the phloem from an area of higher hydrostatic pressure (source) to an area of lower hydrostatic pressure (sink). The source cell where sugar is formed e.g. mesophyll cell. It is actively loaded into the sieve tube from the companion cell which lowers the water potential of the sieve tube. Water flows in from the xylem raising the hydrostatic pressure. Where sugar is converted into starch e.g. root cells, the hydrostatic pressure is low as the removal of solute raises the water potential. This creates a flow of organic material from source to sink.

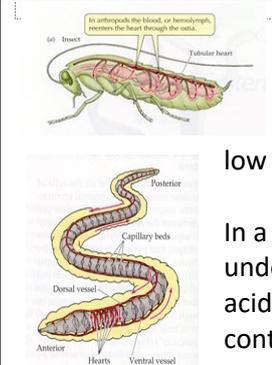
Definition: Biodiversity	AQA	EDX	OCR
The variety of living things. However, biodiversity needs to be considered both within species and between species.	✓	✓	✓

Biodiversity is now commonly considered in three ways:

- Species diversity
- Genetic diversity
- Habitat diversity

When measuring species diversity it is helpful to consider both species richness (number of species) and species evenness (relative abundance of each species). If there are 1000 individuals in an area made up of approximately even numbers of 10 different species (i.e. 100 members of each species) this is considered a high level of species evenness. If 950 of those individuals belonged to just two dominant species and the other 50 were represented by the other 8 species, this is an example of low species evenness.

Definition: Open and closed circulation	AQA	EDX	OCR
An open circulation system is one where blood is pumped under into body cavities called sinuses. In a closed circulation, blood is circulated in a continuous system of vessels and is pumped under high pressure.	✓	✓	✓



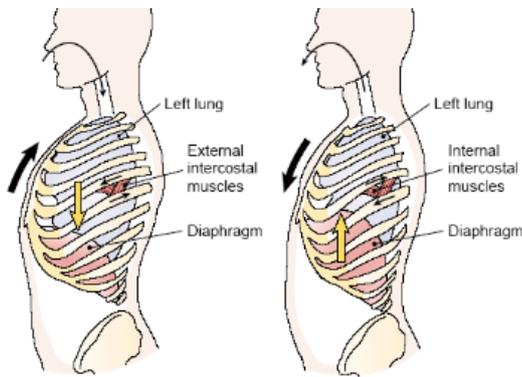
Open circulatory systems empty blood into sinuses around the body i.e. the blood leaves the blood vessels. Blood bathes the adjacent cells directly where exchange of materials can take place. As the heart relaxes the corresponding drop in pressure helps blood from the sinuses to be drawn back into the heart. This all happens at relatively low pressure and so is less efficient than a closed system.

In a closed circulatory system, blood remains within the blood vessels. Blood is pumped under high pressure. Exchange of materials such as respiratory gases, glucose, ions, amino acids, hormones, occurs across the walls of capillaries which are only one cell thick and contain small pores. Larger, more active animals have closed systems.

Definition: Ventilation	AQA	EDX	OCR
--------------------------------	-----	-----	-----

✓	✓	✓

The movement of air into and out of the lungs.



Ventilation relies on changes in volume and pressure within the thorax.

During inspiration:

- external intercostal muscles contract moving the ribcage up and outwards
- diaphragm contracts and moves down

This increases the volume and so decreases the pressure in the thorax below atmospheric pressure: air flows into the lungs.

During expiration:

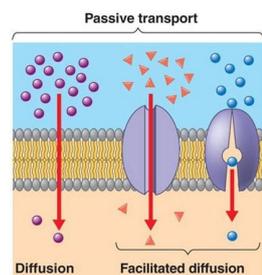
- internal intercostal muscles contract moving the ribcage down and inwards
- diaphragm relaxes and moves upwards.

This decreases the volume and so increases the pressure in the thorax above atmospheric pressure: air flows out of the lungs.

Definition: Facilitated diffusion

AQA	EDX	OCR
✓	✓	✓

A form of diffusion which is helped by carrier or channel proteins.



Some molecules such as glucose cannot diffuse through the phospholipid bilayer as they are too large. Once the glucose collides with the carrier protein, the protein changes shape and the glucose moves through the membrane. Other substances pass through the membrane through specific channel proteins.

Like diffusion, facilitated diffusion does not require cellular energy and is a **passive** process.