Unit 3: Movement in/out of cells

Diffusion: the movement of particles from a **high** concentration to a **low** concentration, down a **concentration gradient**.

Active transport:
The movement of particles from a **low** concentration to a **high** concentration, through a partially permeable **membrane** using **energy** from respiration (and carrier proteins).

Osmosis:
The diffusion of **water** molecules from a **dilute** solution to a more concentrated solution through a partially **permeable** membrane.

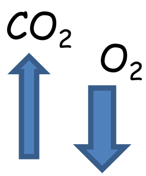
Sports drinks: Isotonic drinks contain water, electrolytes (like sodium and potassium ions) and sugar (often glucose). The **water** helps athletes to rehydrate (water moves by **osmosis** into cells). The **mineral ions** replace lost electrolytes (mineral ions lost in **sweat**) and the **glucose** helps to replace lost energy.

Lung adaptations for rapid exchange.
Many **alveoli** produce a large SA.
Efficient **blood** supply removes absorbed oxygen to maintain the concentration gradient for **diffusion**.
Thin walls of the alveoli and **capillaries** make the diffusion path **short**.

Small intestine adaptations for rapid exchange:
Many **villi** make a large **SA**.
Cells of the villi have **microvilli** to make the SA even larger.
Efficient blood supply removes absorbed **amino acids/sugars** to maintain the concentration gradient for diffusion.
Cells of the villi have many **mitochondria** to provide energy from respiration for **active transport**.

B3: Gas exchange + artificial ventilators

Gas exchange in the lungs:
Label the diagram. Add arrows to show diffusion of O_2 and CO_2



Factor	Inhaling	Exhaling
Ribs	Move **up** + **out**	Move **down** + **in**
Ribs muscle	**contracts**	**relaxes**
Diaphragm muscle	**contracts**	**relaxes**
Thorax volume	**increases**	**decreases**
Pressure inside lungs	decreases	**increases**
Direction of air flow	Into lungs	Out

Negative pressure system (Iron lung): An air pump removes air from the cylinder around the patient creating a **vacuum**. This **lowers** the pressure outside the body which expands the chest, lowering pressure inside the **lungs**, so causing air to move in from outside. When the pump is switched off external pressure returns, the chest falls down, **reducing** the volume, increasing the pressure, forcing air to be squeezed out.

Disadvantage: Patient movements are restricted.

Positive pressure system: Ventilator forces air into **lungs** (similar to inflating a balloon!). When the pressure stops ribs fall down , **reducing** volume, forcing air out of **lungs**.

Advantages:

Patients do not need to be inside system, can move about.

Patients can have some control over system.

Keep people alive after surgery or if paralysed.

Gas exchange in the leaves:

Label to show the diffusion of O_2 and CO_2 and H_2O in or out of the leaf.

Exchange in plant leaves

In **daylight** stomata open to allow **carbon dioxide** to enter by **diffusion**. Carbon dioxide is used for **photosynthesis** and oxygen that is made diffuses into the air.

B3: Exchange in plants

Exchange in plant roots.

Root hair cells have a large SA.

Water enters by **osmosis**.

Mineral ions enter via **active transport**.

Many **mitochondria** provide energy from respiration for this process.

Water loss

Loss of water from a plant is called **transpiration**.

Most water is lost through the leaves **stomata**.

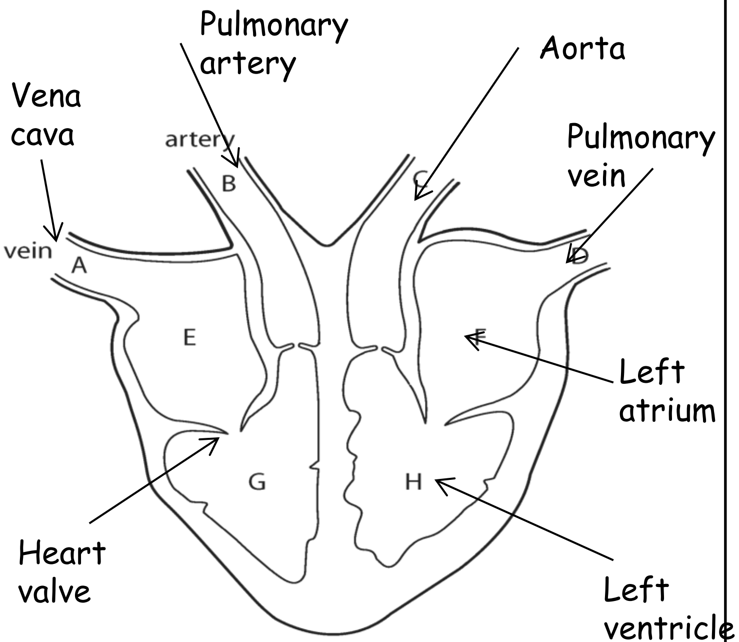
The size of stomata is controlled by the **guard** cells. Stomata **close** at night (and during the day if water loss is too high) to slow water loss.

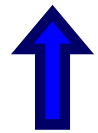
Water evaporates most rapidly when it's **hot**, dry and **windy**.

If plants lose water faster than they can absorb it using their **roots** they **wilt**. Wilting makes their **leaves** floppy reducing the SA exposed to wind/sun which slows evaporation.

B3: The blood system

Label the heart





Valves stop backflow in veins

Double circulation

Blood passes through the **heart twice** on each circuit.

Advantage: Oxygenated blood returns (under **lower** pressure) from the lungs to the heart. Using **high** pressure the heart then quickly sends **oxygenated** blood to rest of the body.

Circulation route

Blood leaves the heart via the **aorta** (main artery) → body → returns to heart via **vena cava** (main vein)→right atrium→ right ventricle → pulmonary **artery** → lungs→ pulmonary **vein**→ left **atrium** → left **ventricle**→ aorta

Feature	Artery	Capillary	Vein
Muscle and elastic in wall	**Thick**	**None**	**Thin**
Valves	**No**	**No**	**Yes**
Blood (oxygenated/ deoxygenated)	**Oxygenated** (except **pulmonary** art')	both	**Deoxygenated** (except **pulmonary** vein)
Blood pressure	**High**	Medium	**Low**
Role	Carry blood **Away** from heart	**Thin walls** allow O_2, CO_2 + sugar etc to exchange.	Carry blood **back** to heart

Artificial Blood Products

Plasma / saline (salt water):
Used in emergencies to replace lost blood volume, helping to keep blood **pressure** normal.
Adv: Can give time for body to make own blood or while awaiting blood transfusion.
Disadv: Plasma has a little dissolved **oxygen**.

PFCs
Perfluorocarbons (PFC's) can carry a lot of **oxygen**.
Advantages:
As they have no **blood cells** can get oxygen to swollen/ damaged tissues.
Long **storage** life.
No danger of disease.
Disadv': breakdown **quickly**, side effects, difficult to dissolve in blood.

Haemoglobin only (no red blood cells)
Haemoglobin taken from human/animal **red blood** cells or made synthetically or made using GM bacteria.
Adv': Carries more **oxygen** than normal blood
Disadv: it's broken down quickly inside the body.

In addition none of the artificial bloods can **clot** or fight **disease**.

Leaky heart valves

Heart valves prevent **backflow** of blood. Faulty/leaky valves can be replaced, a major operation. Mechanical valves made from polymers or titanium are long **lasting**, but patients need drugs for rest of lifetime to stop blood **clotting**.

Biological **valves** use valves from humans, pigs or cattle. Patients do not need drugs after, but they only last about **15 years**.

B3: Transport systems – Evaluation topics

Stents

Stents: A **stent** is a metal mesh placed in an artery. Inflating the tiny **balloon** opens the stent and **widens** the artery.

Used to widen **coronary** arteries of the heart that have narrowed or been blocked by **fatty** deposits like **cholesterol**. This increases blood flow to heart **muscle** helping to prevent heart attacks.

Adv': Can be done with just a **local** anaesthetic for a low cost.

Disadv': Will not open the most severely **blocked** arteries.

Artificial heart

Adv':Temporary solution to keep patients alive whilst they wait for a suitable heart **donor**.

Disadv': Need lots of machinery to keep working, patients with them often have to stay in **hospital**.

Higher risk of blood **clotting**.

B3 Blood

Red blood cells

Red blood cells have a **biconcave** disc shape creating a large **surface area** to volume ratio for rapid **diffusion** of oxygen.

No **nucleus** inside allows more space for **haemoglobin** which carries **oxygen**. This allows red blood cells to carry oxygen to organs.

Platelets

Platelets are **cell** fragments that help the blood to **clot**.

They do not have a **nucleus**.

Haemoglobin (red pigment in RBC)

Haemoglobin + **oxygen** → **oxyhaemoglobin**

This reaction occurs inside red blood cells at the **lungs** where there is a **high** concentration of **oxygen**, allowing red blood cells to collect oxygen.

Oxyhaemoglobin → haemoglobin + oxygen.

This reaction occurs inside red blood cells at actively **respiring** cells (like muscles) where there is a **low** concentration of **oxygen**, allowing red blood cells to give up oxygen which then **diffuses** into respiring cells.

Plasma

About 55 % of blood is a yellow fluid called **plasma**.

It transports:

CO_2 from organs to lungs.

Urea from liver to kidneys.

Sugars and amino acids from small **intestine** to other organs.

White blood cells

White blood cells have a **nucleus**. They defend us against **pathogens**.

Some make **antibodies** to attach to **antigens** on pathogens. Others make **antitoxins** to neutralise toxins. Some **engulf** pathogens.

B3 Transport systems in plants

Xylem

Xylem tissue transports **water** and **mineral ions** from the **roots** to the stem and leaves.

Xylem vessels are **dead** and hollow.

Transpiration

Water loss by **evaporation** from the leaves of a plant is called **transpiration**. Most water evaporates through holes in the leaves called **stomata**.

Phloem.

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

Factor	Description	Explanation
Light	In bright light transpiration **increases**	The **stomata** (openings in the leaf) **open** wider to allow more **carbon dioxide** into the leaf for photosynthesis
Temperature	Transpiration is faster in **higher** temperatures	**Evaporation** and diffusion are faster at higher temperatures
Wind	Transpiration is **faster** in windy conditions	**Water** vapour is removed quickly by **air** movement, speeding up **diffusion** of more **water** vapour out of the leaf
Humidity	Transpiration is **slower** in humid conditions	Diffusion of water vapour out of the leaf slows down if the leaf is already surrounded by **moist** air

Homeostasis

Homeostasis is maintaining a constant **internal** environment.

Water and ions

Must be kept constant to prevent too much water **entering** or leaving cells by **osmosis** and causing damage

Waste removal

CO_2 produced by **respiration** is removed via the **lungs** when we breathe out.

Urea is made in the **liver** from the breakdown of **amino** acids. Urea is removed by the **kidneys** and stored in the **bladder** with water as **urine**.

Kidney function

1. **Small** molecules like **water**, **urea**, ions and **sugar** are **filtered** out of the blood.

Large cells and **proteins** are too big to be filtered so stay in blood.

2. Useful **sugar** and most ions are **reabsorbed** into blood using **active transport**.

Most water is also reabsorbed by **osmosis**.

3. Waste **urea**, excess ions and some water are **excreted** to form urine. This is stored in the bladder.

B3 Homeostasis – waste removal + water control

Dialysis

In the **dialysis** machine, blood from the patient flows between partially permeable **membranes** which are surrounded by **dialysis** fluid. Waste **urea** and some mineral ions diffuse from a **high** concentration in the **blood** through the dialysis membrane into the dialysis fluid. Glucose is at the **same** concentration in the **blood** as the dialysis fluid, so no net (overall) movement occurs. Blood without the urea is then returned to the patient.

Adv': keep kidney failure patients alive.

Disadv':

1.need restricted diet / restricted fluid intake

2. **time** wasted on dialysis

3. blood **clots** may result from dialysis

4. **infection** may result from dialysis

Kidney transplant

Adv':

1. no build-up of **toxins**
2. cheaper than dialysis

Disadv':

1. **rejection** / problem finding tissue match
2. use of **immuno-suppressant** drugs leading to other infections
3. dangers during operation

B3 Homeostasis: temperature control

The **enzymes** in our cells speed up chemical reactions. To function at their optimum speed enzymes need a temperature of **37** °C.

Monitoring body temperature

As blood flows through the **brain** its temperature is monitored by the **thermoregulatory** centre.

Temperature **receptors** in the **skin** send **impulses** to the **thermoregulatory** centre in the brain which coordinates responses to keep the **core** (internal) body temperature constant.

Drinking!

Sweating helps to cool the body. More water is lost when its **hot**, and more water must be taken in as food or drink to balance this loss.

Too hot (Higher Tier only)

Vasodilation

Blood **vessels** supplying skin capillaries **dilate**, increasing blood flow to capillaries (making skin red). This increases **heat** loss.

Sweating

Sweat **glands** release more sweat. **Heat** energy is lost from the skin to make sweat **evaporate**. This cools the body.

Too cold (Higher Tier only)

Vasoconstriction

Blood **vessels** supplying skin capillaries **constrict**, **reducing** blood flow to capillaries. This reduces **heat** loss.

Shivering

Muscle **contraction** needs energy from **respiration**. As blood flows through the **muscle** it is warmed.

B3: Homeostasis - Control of blood sugar

Blood **glucose** levels are monitored and controlled by the **pancreas**. Our cells need a constant supply of glucose for **respiration**.

TOP TIP: remember the 3 G's

1. **Glucose** = type of sugar
2. **Glycogen** = storage carbohydrate
3. **Glucagon** = hormone from pancreas that raises blood sugar

Diabetes

Type 1 diabetes is a disease in which a persons blood glucose concentration may rise too high. This is because the **pancreas** does not make enough insulin.

Without insulin your body cells are poor at absorbing **glucose**, so you lack energy. Your body breaks down fats and proteins instead, making you lose **weight**.

(Type2 diabetes occurs when your body cells do not respond to insulin. Often a s a result of obesity/lack of exercise in people 40+).

High blood sugar

If glucose levels **rise** (eg. after eating a meal) the **pancreas** releases the hormone **insulin**.

Insulin makes **liver** cells take in glucose and store it as glycogen.

Glucose → **Glycogen**

Low blood sugar (HT only)

If glucose levels fall (eg. after **exercise** or fasting) the pancreas releases the hormone **glucagon**.

Glucagon makes the liver convert glycogen into glucose.

Glycogen → **Glucose**

Treating diabetes

Type 1:

Inject **insulin** before meals.

Eat regular meals, carefully controlling **carbohydrate** intake.

Regular exercise

(Type 2:

Lose weight

Exercise regularly

Control carbohydrate intake

Drugs to help insulin production reduce glucose absorption by gut).

Future diabetes treatments

Pancreas organ or cell **transplants** - difficult, need suitable donor. Need to take immuno-suppressant, leading to other infections.

Embryonic stem cells have been used to make insulin producing pancreatic cells, so far only used in mice. Ethical issues against using human **embryo's**.

May be possible to genetically engineer patients own pancreas cells to contain functioning insulin **gene**. Not yet done. Would avoid rejection problems.

B3 Human impact on environment part 1

Deforestation

In tropical areas trees are felled for **timber** and to provide land for agriculture.

Problems

1. **Burning** wood and microbe **respiration** (decay of cut wood) both release CO_2.
2. Less **trees** = less **photosynthesis** = less CO_2 removed from atmosphere.
3. Loss in biodiversity.
4. More cattle on land = more **methane** in atmosphere.
5. More paddy **rice** fields = more **methane** in air from microbes.

Peat bogs

Peat bogs form over thousands of years. Waterlogged, anaerobic, acidic conditions prevent **decay** of plant material so peat acts as a natural **carbon** store.

Burning peat and its removal for compost leads to release of more CO_2. Using "peat free" **compost** is helping to conserve peat bogs.

Water pollution

1. **Sewage** and fertilisers can wash into rivers, lakes etc.
2. The **nutrients** cause an algal bloom.
3. When some **algae** die, **bacteria** cause decay.
4. They respire using up **oxygen** from the water.
5. Fish and other creatures die.

This is called **eutrophication**.

Toxic chemicals

Toxic chemicals such as herbicides and pesticides can wash into waterways and cause pollution. They can also cause pollution on land as these chemicals build up progressively along food chains = bioaccumulation.

Air Pollution

Burning **fossil fuels** releases smoke particles and gases such as sulphur dioxide.

Sulphur dioxide dissolves in water vapour to form **sulphuric** acid which falls as acid rain.

Problems

Acid rain kills **leaves** of plants such as conifer trees.

It acidifies **lakes** and kills fish.

Global warming

Heat energy from the Sun is **absorbed** by the Earth. The Earth re-**radiates** this heat (as infra-red) back into the atmosphere where **greenhouse** gases (carbon dioxide + methane) absorb/trap it, warming the Earth.

Effects of global warming

Increasing the Earth's temperature may:
change Earth's **climate**; melt ice caps,
making **sea** levels rise; reduce biodiversity;
change **migration** patterns;
change the distribution of species.

Biofuels: are **renewable** fuels made from natural products by fermentation using bacteria or **yeast**….

Glucose → **ethanol** + carbon dioxide + **energy**

Crops for biofuels

Advantages: carbon **neutral** (CO_2 **absorbed** during crops photosynthesis = CO_2 released when **biofuel** burns).

Less **pollution** when fuel burns.

Disadvantages:

Uses mainly edible parts of plants, leaving waste/unused plant material

Less land for **food** crops

Cars need to be adapted to run on ethanol

Biogas: is a mixture of gases (mainly **methane**) made when bacteria breakdown plant or animal waste (mainly carbohydrates) in **anaerobic** conditions.

Label the gas generator below…

Biogas exit

Plant waste, animal manure enters

Waste used as fertiliser

Anaerobic respiration by bacteria makes methane, CO_2 ,, H_2S

Insulated walls, help optimum temp'

B3: Food production Part 1

Improving efficiency

At each stage in a food chain biomass and **energy** are lost.

Food production is more efficient when..

Food chains are short

a) Plankton → shrimp → cod → human

b) Plankton → shrimp → human

Food chain **(b)** is more efficient than **(a)** as less energy is **lost** eg due to movement and faeces from the **cod.**

Animals are kept warm

Keeping animals warm means they lose less **heat** to their surroundings so they spend less energy maintaining their body **temperatures** (most important for birds and **mammals** = warm blooded)

Movement is restricted

Less energy is lost through respiration as **muscles** are contracting less often.

Factory farming animals

Intensive farming involves rearing animals indoors in controlled conditions.

Pros.

Animals **grow** faster so can be sold sooner.

Cons.

1. **Heating** + lighting for barns/houses is expensive.
2. Animals may be stressed in unnatural conditions.
3. High **density** of animals = higher risk of **disease** spreading.
4. Higher feed bills.

Food miles

How far food travels to get to consumers.

Transport uses **fuel**, increasing CO_2 levels in the atmosphere.

People are more aware of "food miles" and may to choose to buy local produce.

B3: Food production Part 2

Sustainable food production: involves producing food in ways that can be continued for many years and caring for the environment.

Fish stocks

Overfishing has depleted many fish stocks. If fishing rates **exceed** breeding rates numbers will keep falling and some species may **disappear**.

Fishing can become sustainable by …

1. Using **quotas** to limit the numbers of fish caught.
2. Limiting the size of **holes** in **nets**, so only **larger** fish are caught and younger ones grow and reproduce.

Mycoprotein:

The **fungus** *Fusarium* is grown on **glucose** syrup (from waste starch) in **aerobic** conditions in a **fermenter**. The fungal biomass is harvested and purified to give a high **protein**, low **fat**, **sustainable** food source suitable for vegetarians (Quorn).

Inside the fermenter **air bubbles** help mix the fungus with the glucose and allow more nutrients to be absorbed. This mixing also allows oxygen to reach the fungus for **respiration**.