Synergy Science Knowledge Organiser
5 Systems in the Human Body

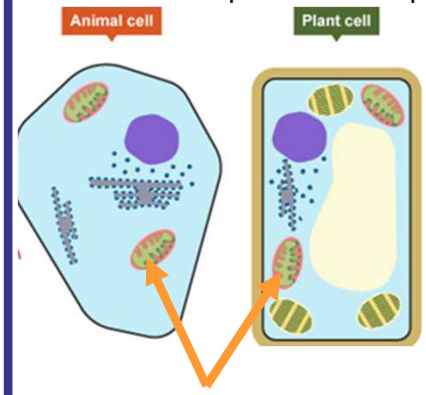
Aerobic respiration

- Respiration using oxygen to break down food molecules

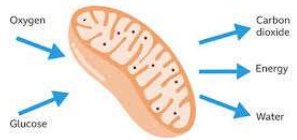
GLUCOSE + OXYGEN ⟶ CARBON DIOXIDE + WATER

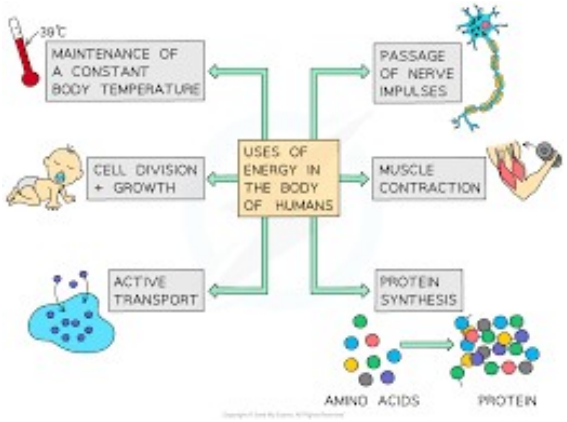
$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$

- During aerobic respiration, glucose (a sugar) reacts with oxygen. This reaction transfers energy that our cells can use. This energy is vital for everything that goes on in the body.
- Carbon dioxide and water are produced as waste products of the reaction.
- Aerobic respiration is an exothermic reaction
- Aerobic respiration takes place in the mitochondria



Mitochondria





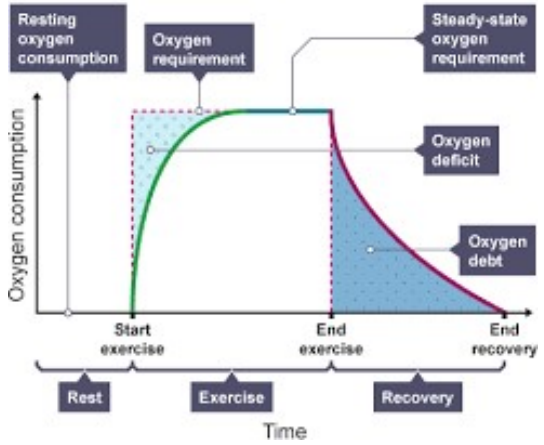
Anaerobic respiration

- Anaerobic respiration in muscles is also exothermic but it gives out less energy. It is represented by the word equation:

GLUCOSE ⟶ LACTIC ACID

Lactic acid stops muscles contracting and relaxing. They become fatigued.

- Because the oxidation of glucose is incomplete in anaerobic respiration much less energy is given out than in aerobic respiration.
- If insufficient oxygen is supplied, anaerobic respiration takes place in muscles. The incomplete oxidation of glucose causes a build-up of lactic acid and creates an oxygen debt. Oxygen debt is the amount of extra oxygen the body needs after exercise to react with the accumulated lactic acid and remove it from the cells.



- Anaerobic respiration takes place in the cell cytoplasm, not in the mitochondria

Anaerobic respiration in Fungi and Yeast

- Anaerobic respiration is economically important – many foods are produced by microorganisms respiring anaerobically.
- Yeast is used to make alcoholic drinks and bread.

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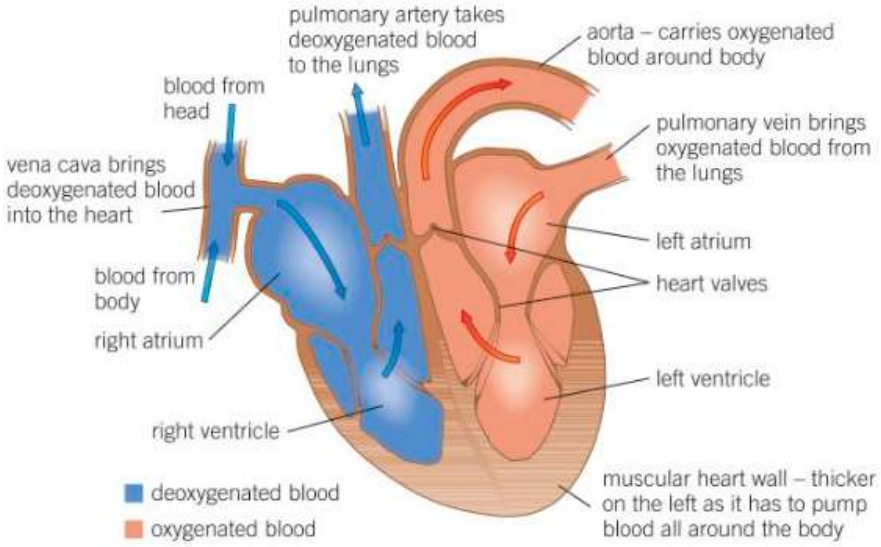
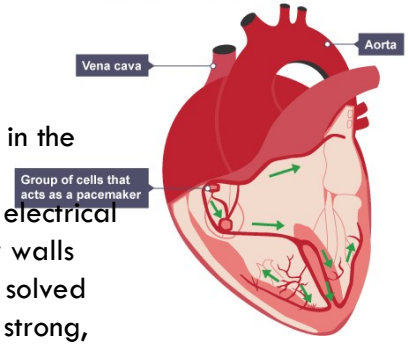
Heart

- The heart is a muscular organ that pumps blood around the body in a dual circulatory system.
- The right ventricle pumps deoxygenated blood to the lungs, where gas exchange takes place. The left ventricle pumps oxygenated blood around the rest of the body.
- Valves prevent the blood from flowing back from the ventricles to the atria.



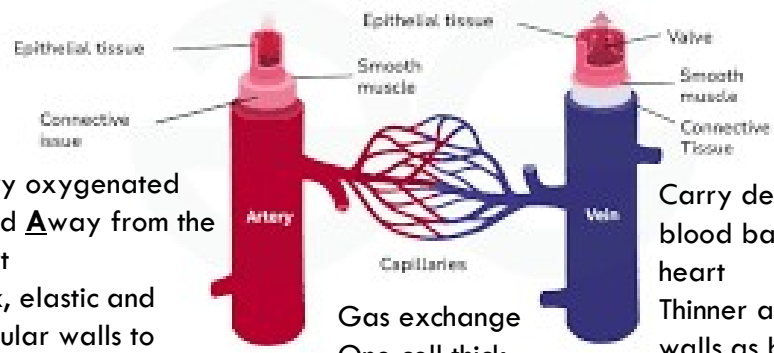
Control of heart rate

- The natural pacemaker is a group of cells in the right atrium
- They control the rhythm of the heart using electrical impulses which travel through the muscular walls
- Problems with the rhythm of the heart are solved using an artificial pacemaker which sends strong, regular electrical impulses to stimulate the heart to beat properly.



Blood vessels

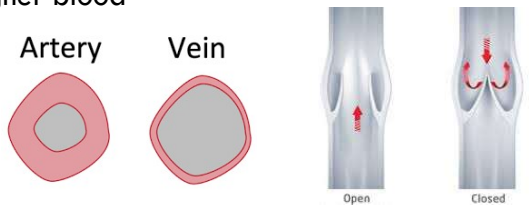
- The body contains three different types of blood vessel:



Carry oxygenated blood **A**way from the heart
Thick, elastic and muscular walls to withstand higher blood pressure

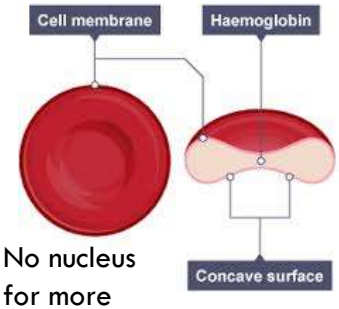
Gas exchange
One cell thick

Carry deoxygenated blood back to the heart
Thinner and less elastic walls as blood pressure is lower
Contain valves to prevent the backflow of blood



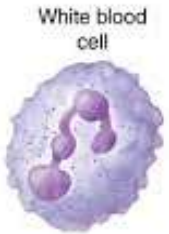
Blood

Transports oxygen



No nucleus for more haemoglobin

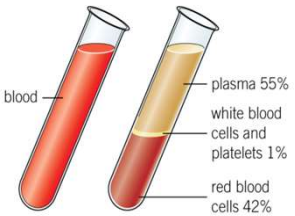
Larger surface area



Ingest pathogens
Produce antibodies
Produce antitoxins

platelets

Cell fragments
No nucleus
Cause blood clot at site of wound



Plasma
Yellow liquid that transports all blood cells and substances around the body
e.g. waste carbon dioxide, urea, digested food molecules, hormones.
Distributes heat

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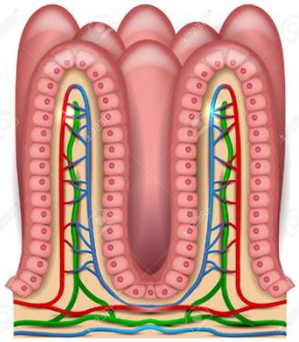
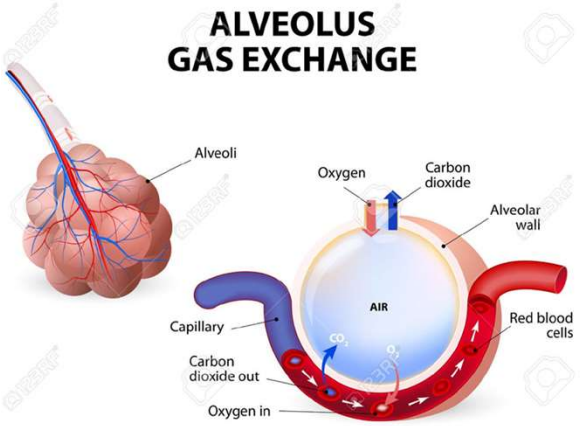
Exchange surfaces

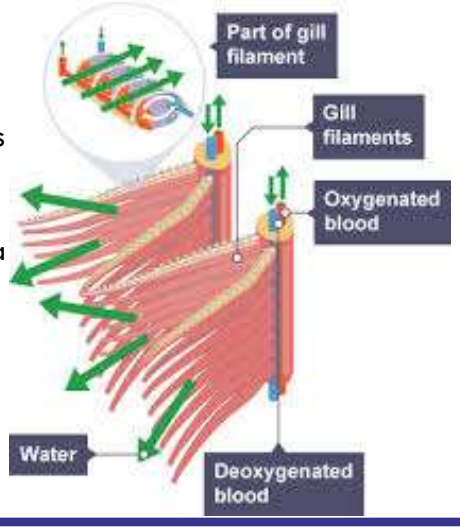
- For efficient diffusion all exchange surfaces must have



Villi in small intestines



- Large surface area to volume ratio
- Thin – short diffusion distance (usually one cell thick)
- Partially permeable cell membrane
- Moist (to allow a medium in which gases can dissolve)
- Maintain a concentration gradient (by a good blood supply in animals)

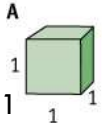


Fish gills

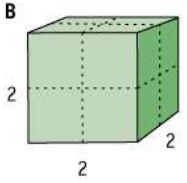
Surface area to volume ratio

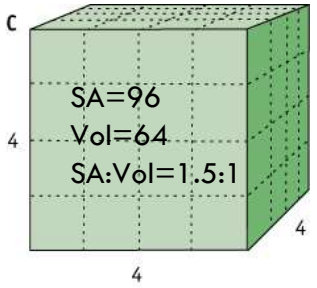
- Every organism, whatever its size, needs to exchange materials with the environment
- The smaller the organism, the larger its surface area to volume ratio so diffusion can happen
- Larger organisms have a smaller surface area to volume ratio so diffusior

SA=6
Vol=1
SA:Vol=6:1



SA=24
Vol= 8
SA:Vol=3:1

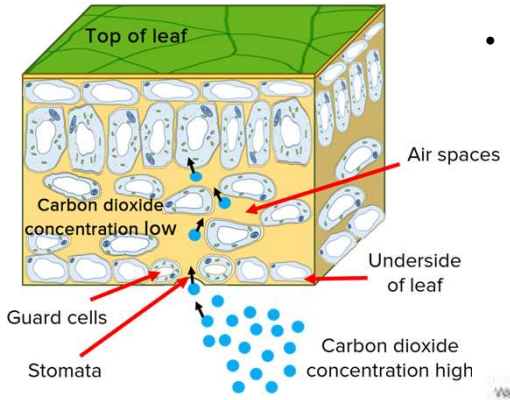




Volume (cm^3) = length x width x height

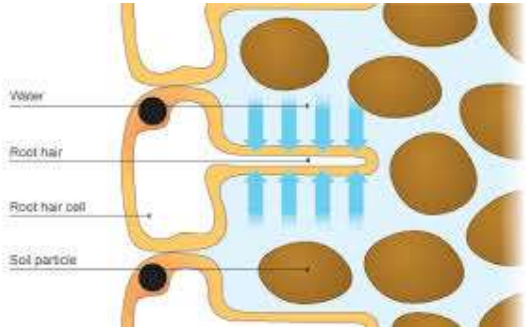
Surface area (cm^2) = number of faces x height x width

Exchange surfaces in plants



- Using the carbon dioxide in photosynthesis maintains the concentration gradient

- Root hair cells have a larger surface to provide more surface to absorb more water and mineral ions



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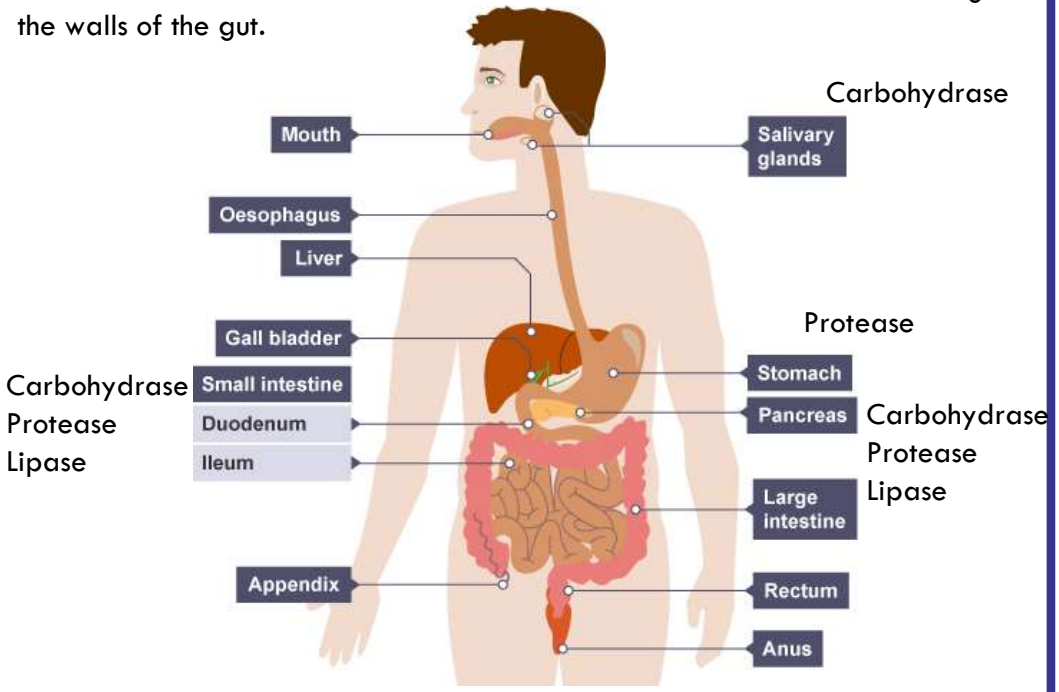
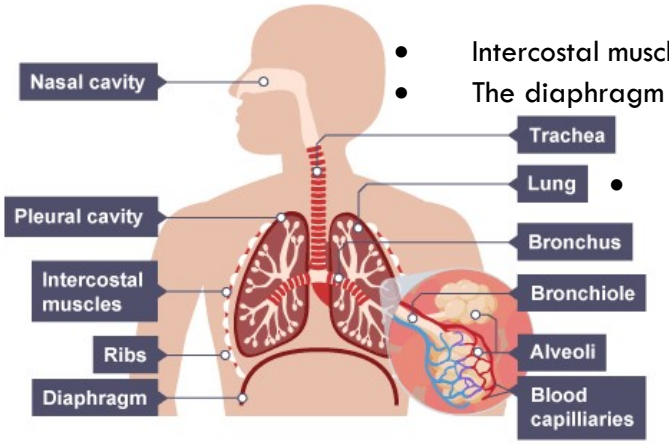
Digestive System

- The digestive system uses enzymes to break down large molecules in food into small soluble molecules that can be absorbed into the blood through the walls of the gut.

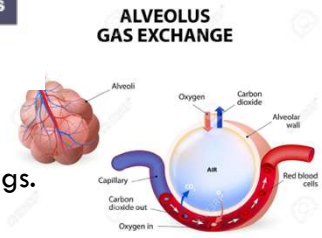


Polymer	Monomer	Enzyme	Use
Carbohydrate (starch)	glucose	carbohydrase	respiration
Lipids (fats and oils)	Fatty acid and glycerol	lipase	Energy store
Protein	Amino acids	protease	Make new proteins

Gas Exchange



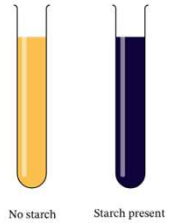
- Intercostal muscles move the ribs up and out
- The diaphragm moves down
- Volume of the chest cavity increase, so the pressure decreases and air rushes in



Lots of alveoli to increase the surface area
Walls of alveoli are thin so gases move easily.
Good blood supply to carry gases to and from lungs.
Oxygen moves into the blood by diffusion

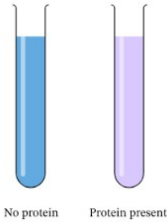
Required Practical: Food Tests

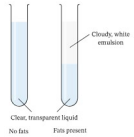
Carbohydrates
Iodine test for starch
Yellow-red iodine solution turns blue-black if starch is present



Sugars
Benedict's test for sugar
Blue Benedict's solution turns brick red on heating if a sugar such as glucose is present

Protein
Biuret test for protein
Blue Biuret solution turns purple if protein is present





Lipids
Ethanol test
Ethanol added to a solution gives a cloudy white layer if a lipid is present

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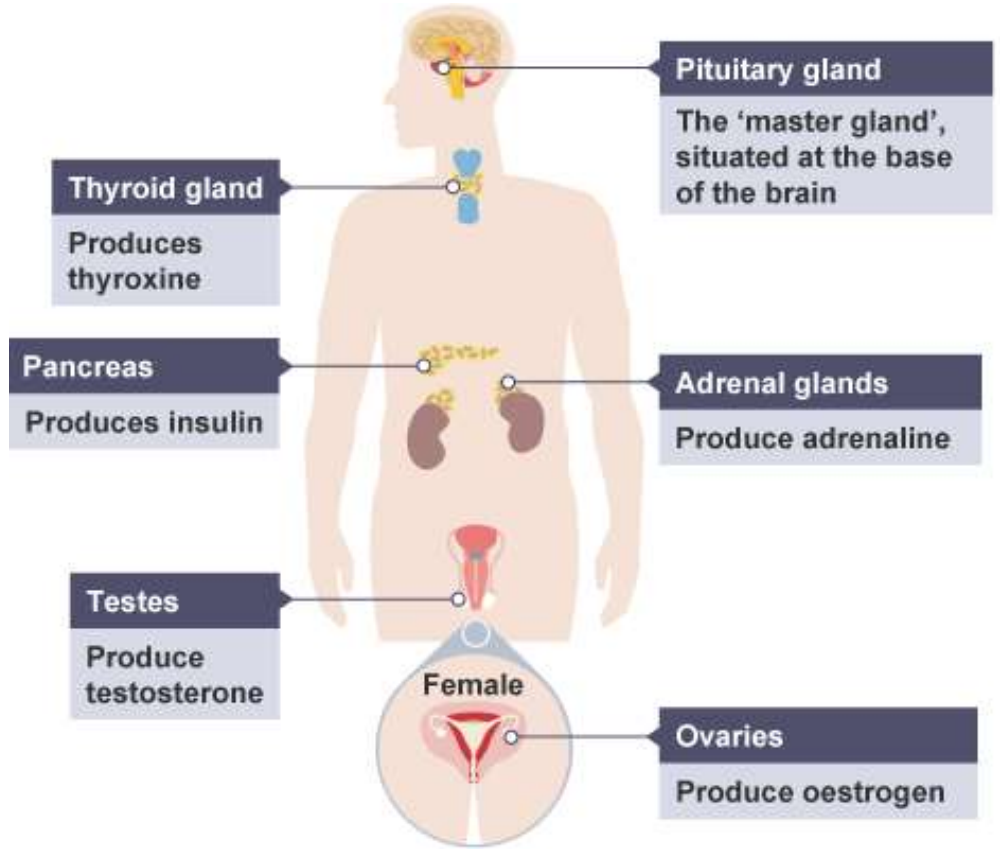
Endocrine System

- The endocrine system is composed of glands that secrete hormones directly into the bloodstream. Hormones are large molecules. The blood carries the hormone to a target organ where it produces an effect. Compared to the nervous system the effects are slower but act for longer.
- The pituitary gland in the brain is a 'master gland'. It secretes several hormones that act on other glands to stimulate other hormones to be released.

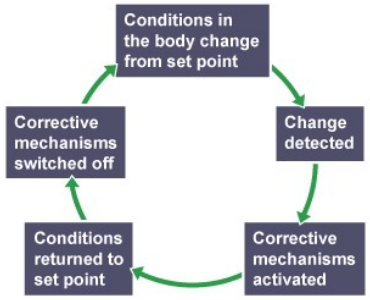
Comparing the Nervous and Endocrine System

	Nervous	Endocrine
Type of signal	Electrical (chemical at synapses)	Chemical
Transmission of signal	By nerve cells (neurones)	By the bloodstream
Effectors	Muscles or glands	Target cells in particular tissues
Speed of response	Very rapid	Slower
Duration of response	Short (until nerve impulses stop)	Long (until hormone is broken down)



Negative Feedback – Higher only

- Adrenaline is produced by the adrenal gland. It boosts the delivery of oxygen and glucose to the brain and muscles and prepares the body for 'flight or fight'.
- Thyroxine from the thyroid gland stimulates the basal metabolic rate. It plays an important role in growth and development.
- The control of thyroxine levels involves negative feedback. Negative feedback tends to stabilise a system. Any change in the system leads to a response that tends to reverse the change.



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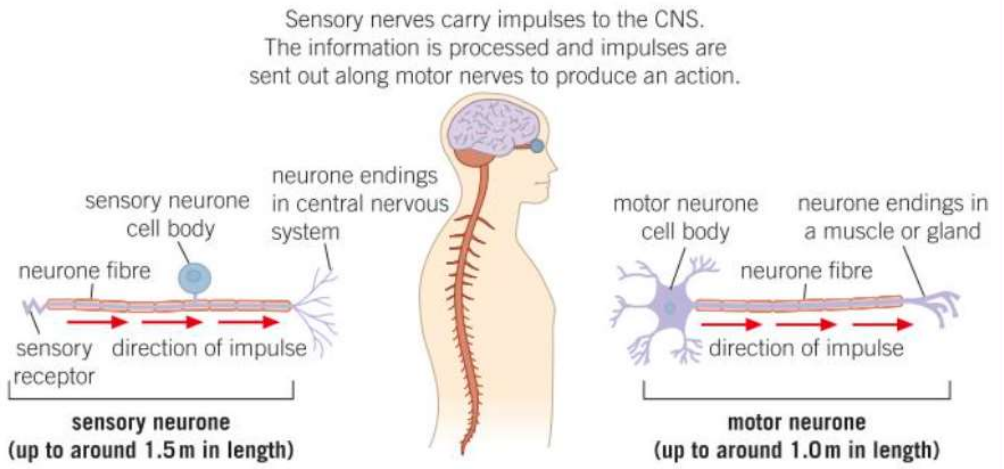
Nervous System

- The nervous system enables humans to react to their surroundings and to coordinate their behaviour.
- Information from receptors passes along cells (neurones) as impulses to the central nervous system, or CNS (the brain or the spinal cord).
- The CNS coordinates the response of effectors which may be muscles contracting or glands secreting hormones.

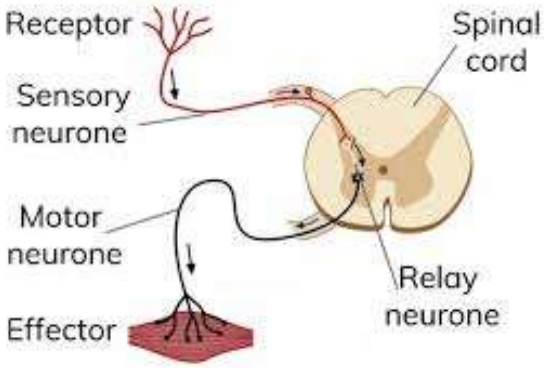
Stimulus → receptor → coordinator → effector → response



Reflex Arc

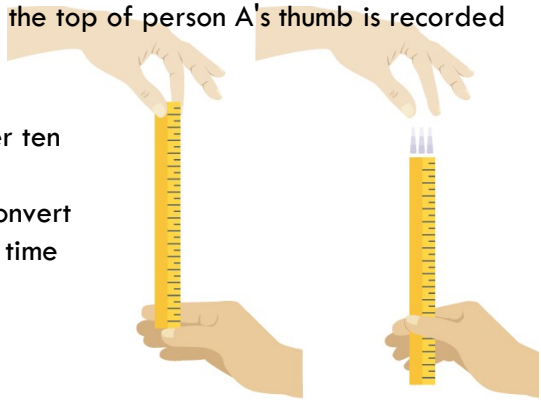
- Reflex actions are automatic and rapid; they do not involve the conscious part of the brain.
- An example of a simple reflex action is the pain withdrawal reflex.
- Sensory neurones carry impulses from receptors to the spinal cord and brain. Relay neurones carry impulses within the CNS. Motor neurones carry impulses from the CNS to effectors.

- Where two neurones meet, there is a tiny gap called a synapse. Impulses cross this gap using chemicals.



Required Practical: Reaction Times

1. Work with a partner.
2. Person A holds out their hand with a gap between their thumb and first finger.
3. Person B holds the ruler with the zero at the top of person A's thumb.
4. Person B drops the ruler without telling Person A and Person A must catch it.
5. The distance on the ruler level with the top of person A's thumb is recorded in a suitable table.
6. Repeat this ten times.
7. Swap places, and record another ten attempts.
8. Use a conversion table to help convert ruler measurements into reaction time



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Respiration

Task: Complete the table to show the differences between aerobic and anaerobic respiration

	Reactants	Products	Location	Energy released
Aerobic				
Anaerobic				

Exchange Surfaces

Task: Complete the sentences

For efficient diffusion all exchange surfaces must have

- Large _____ _____ to _____ ratio
- _____ – short diffusion distance (usually one cell thick)
- Partially permeable cell _____
- _____ (to allow a medium in which gases can dissolve)
- Maintain a _____ _____ (by a good blood supply in animals)

Reflex Arc

Task: What is the correct order for a reflex arc?

Sensory neurone	Receptor	Motor neurone	Effector	Stimulus	Relay neurone
				1	

Task: Complete the sentences

The gap between nerve cells is called a _____

Reflex actions are _____ and _____; they do not involve the conscious part of the brain.

Endocrine System

Task: Match the gland to the hormone it produces

Gland
Thyroid
Pancreas
Adrenal
Testes
Ovaries

Hormone
Adrenaline
Testosterone
Thyroxine
Oestrogen
Insulin

Highlight the keywords: glucose, oxygen, carbon dioxide, water, Aerobic, exothermic, respiration, Anaerobic, lactic acid, Left Ventricle, Right Ventricle, Right Atrium, Left Atrium, Pulmonary Artery, Pulmonary Vein, Aorta, Vena Cava, Valve, Valve strings, Artery, Vein, Capillary, Trachea, bronchi, bronchioles, alveoli, intercostal muscles, ribs, Red Blood Cell, White Blood Cell, Platelets, Plasma, Amylase, Protease, Lipase, Starch test: red/orange, blue/black, Glucose test: brick red, Protein test: purple, Stimulus, Receptor, Coordinator, Effector, Response, Relay Neurone, Sensory neurone, Motor neurone, Gland, Pituitary, Adrenal, Thyroid, Testes, Pancreas, Ovaries