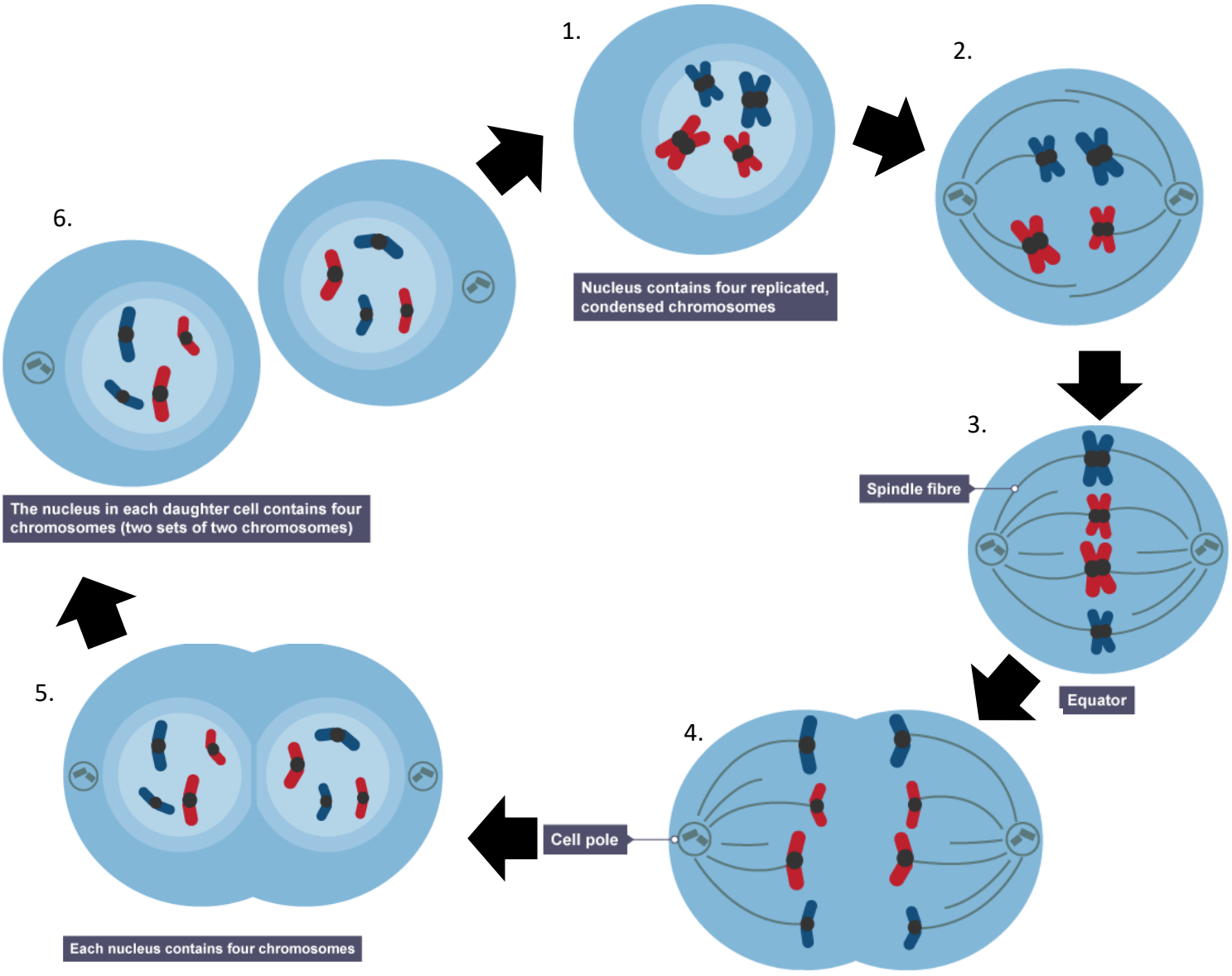
National 5 Multicellular Organisms Summary Notes

Mitosis

Mitosis is the process of cell division. It is important because it provides new cells for growth and repair of damaged cells and maintains the diploid chromosome complement. In a human cell, there are 46 chromosomes. In the two cells made after mitosis (daughter cells), there will be 46 chromosomes in each cell. The main stages of mitosis are:

1. The chromosomes replicate and become visible. Each chromosome is two chromatids joined together.
2. The nucleus breaks down.
3. Chromosomes line up along the equator (middle) of the cell. Spindle fibres attach to the middle of the chromosomes.
4. Spindle fibres pull the chromatids apart. The chromatids are pulled to opposite ends (poles) of the cell.
5. Separated chromatids are now called chromosomes and nuclear membranes form around them.
6. The cytoplasm splits. Two daughter cells are made.



Stem Cells and Specialisation

Stem cells in animals are **unspecialised** cells which can divide to make more stem cells. They have the potential to become different types of cell eg. skin cell, muscle cell. Stem cells are involved in **growth and repair**. Stem cells can be obtained from the embryo at a very early stage. In addition, tissue stem cells can be found in the body throughout life

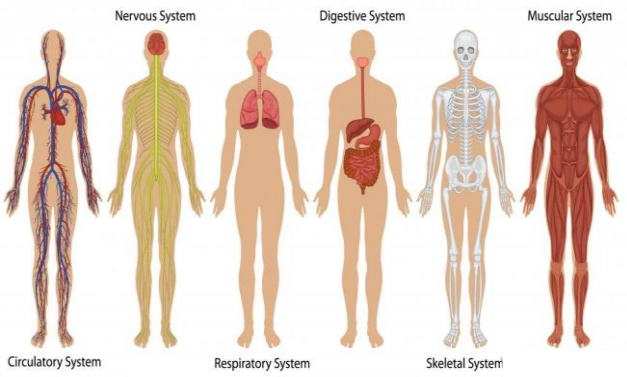
Specialisation is when a stem cell becomes a specific type of cell. It leads to the formation of a variety of cells, tissues and organs.

Cells make up **tissues** – a group of cells that carry out a similar function.

Different tissues come together to make up **organs**.

Organs come together to make **systems**.

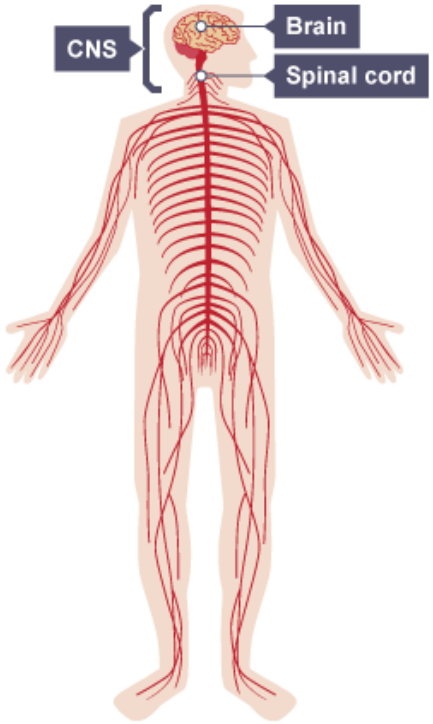
Cells ⟶ Tissues ⟶ Organs ⟶ Systems



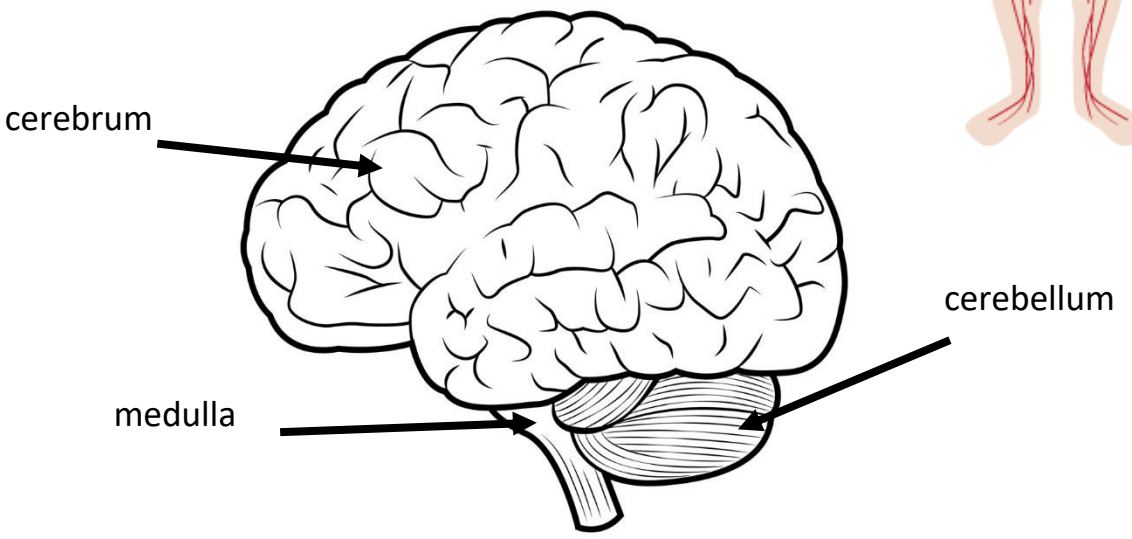
Nervous System

The **nervous system** is made up of the brain, spinal cord and nerves.

The **central nervous system (CNS)** is made up of the brain and spinal cord.



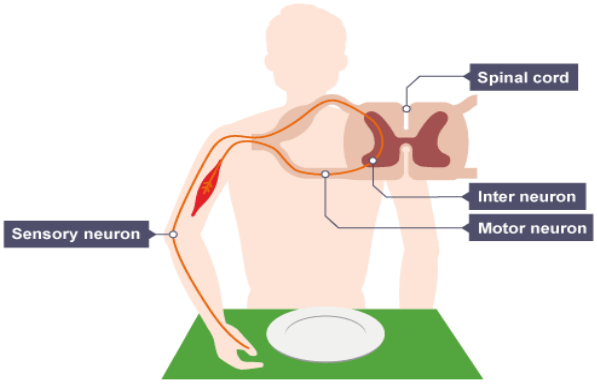
The brain is made up of different regions:



Cerebrum – personality, logic, intelligence, memories

Cerebellum – balance and coordination

Medulla – breathing and heart rate



There are three types of nerve cell (**neuron**) in the nervous system – **sensory, inter and motor**.

Receptors detect stimuli. Sensory neurons pass the information to inter neurons in the CNS. The CNS processes the information. Inter neurons pass the information to motor neurons. Motor neurons enable a response to occur at an effector (muscle or gland). Messages travel along neurons as **electrical impulses**. Chemicals called neurotransmitters transfer these messages between neurons at **synapses** – the space between neurons. This arrangement of neurons is called a **reflex arc**.

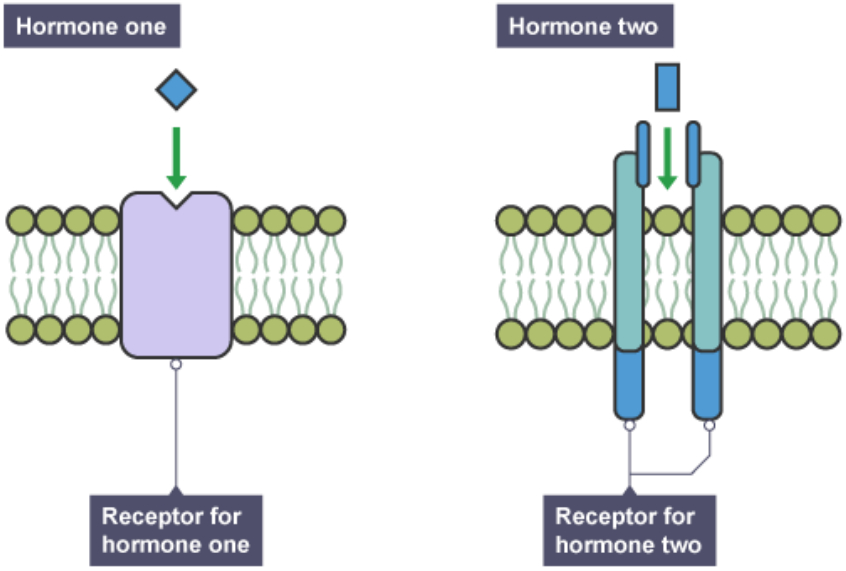
Reflexes are rapid, automatic responses that protect the body from harm. Examples are sneezing, coughing and blinking.

<u>Hormonal Control</u>

Endocrine glands release hormones into the bloodstream.

Hormones are chemical messengers.

A **target tissue** has cells with complementary receptor proteins for specific hormones, so only that tissue will be affected by these hormones.

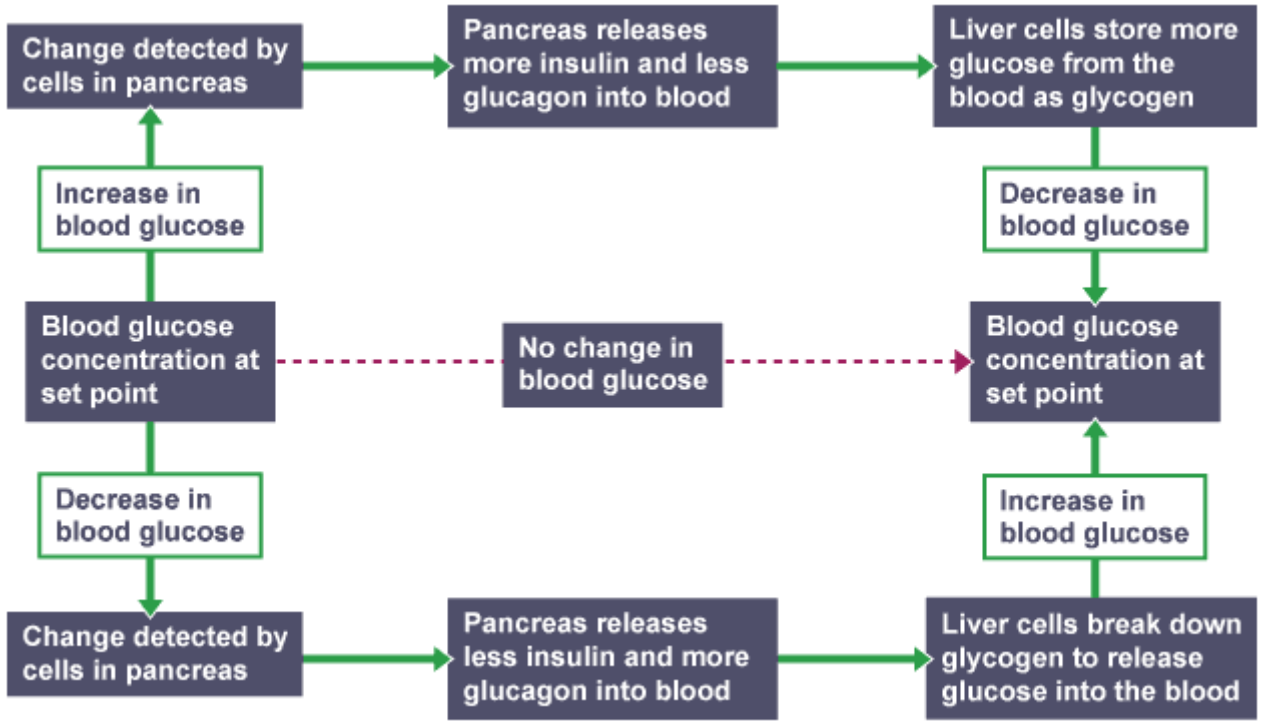


Blood glucose concentration is regulated by two hormones – **insulin and glucagon**. Both hormones are released from the **pancreas**.

Insulin is released when the blood glucose concentration rises. It instructs the **liver** to take up excess glucose and **store it as glycogen**.

Glucagon is released when the blood glucose concentration falls. It instructs the **liver** to **break glycogen down into glucose** and put it back into the blood.

Diabetes is a condition caused when the body cannot regulate its blood glucose concentration.



Reproduction

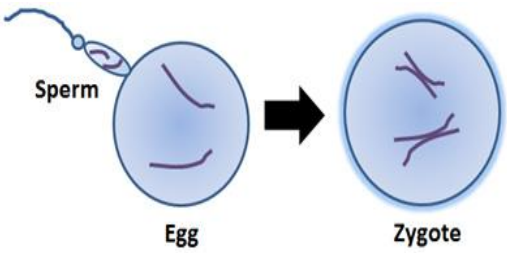
All cells are **diploid** – have 2 sets of chromosomes – except gametes (sex cells) which only have one set. Gametes are **haploid**. In humans, a diploid cell has 46 chromosomes and a haploid cell has 23 chromosomes.

Plants and animals make gametes in certain reproductive organs.

Plant or Animal	Male or Female	Name of gamete	Organ where gamete is made
Animal	Male	Sperm	Testes
	Female	Egg	Ovary
Plant	Male	Pollen	Anther
	Female	Ovule	Ovary

Fertilisation is the fusion of the nuclei of the two haploid gametes to produce a diploid **zygote**, which divides to form an embryo.

Sperm/pollen (haploid) + Egg/ovule (haploid) → Zygote (diploid)



Variation and Inheritance

Variation is the differences that exist between the members of a species. There are two types:

- **Discrete** – can split members of a population into discrete groups eg. blood group, eye colour
- **Continuous** – has a range of values from a minimum to a maximum and can be measured eg. height, heart rate, hand span

Some characteristics (eg. continuous ones) are controlled by more than one gene. They are said to be **polygenic**.

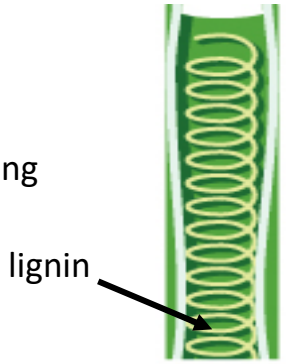
The inheritance of characteristics can be predicted using **family trees** and **monohybrid crosses**. These allow the genes present in an individual to be worked out and the chances of offspring inheriting characteristics calculated.

Term	Meaning
Gene	Unit of chromosome
Phenotype	Physical appearance eg. blue eyes, brown eyes etc.
Genotype	Set of genes present eg. BB, Bb or bb
Allele	Forms of a gene eg. allele for blue eyes, allele for green eyes
Dominant	Allele that shows up in the phenotype. Capital letter used eg. B
Recessive	Allele that is masked by the dominant allele. Need two present to show in phenotype Lowercase letter used eg. b
Homozygous/true-breeding	Alleles in genotype are the same eg. BB or bb
Heterozygous	Alleles in genotype are different Bb
P	Parent generation
F1	First generation
F2	Second generation

The predicted ratio of phenotypes is not always achieved because fertilisation is a **random process** and involves an **element of chance**.

Transport Systems in Plants

The roots of the plant absorb water from the soil. Roots have lots of root hairs on them. Water moves by **osmosis** from a higher water concentration in the soil to a lower water concentration in the root hairs. The water then moves into the xylem.

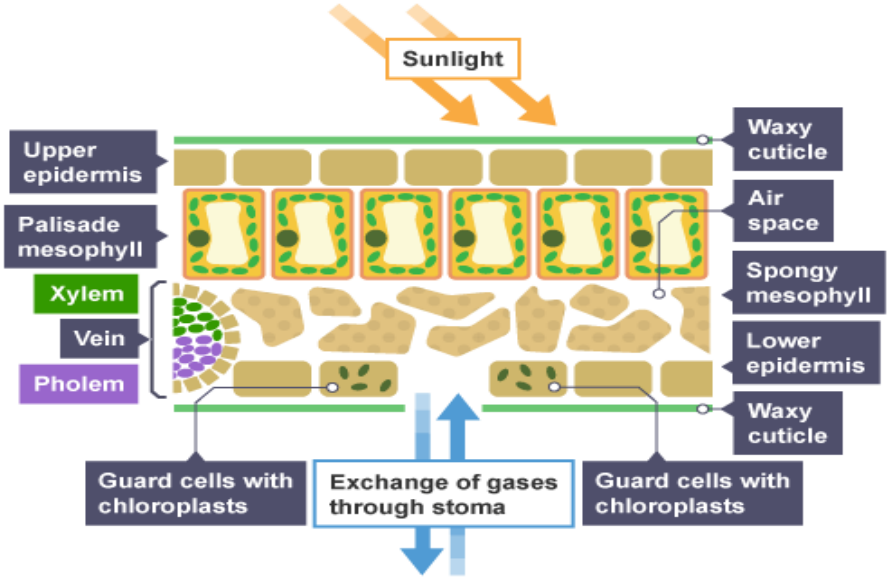


Xylem transports water up from the roots of the plant. It has the following characteristics:

- Dead tissue
- Hollow tubes
- Lignin present - to withstand the pressure changes as water moves through the plant.

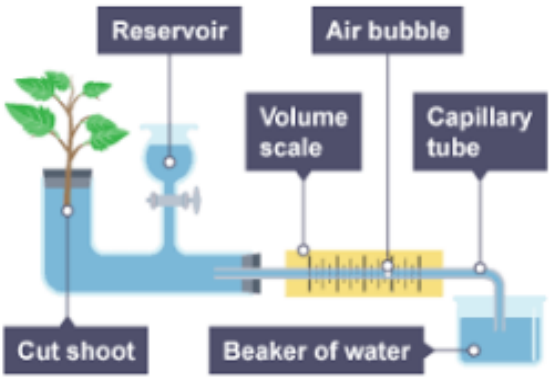
The water moves from the xylem and into the leaf. The **leaf** is made up of different types of cell.

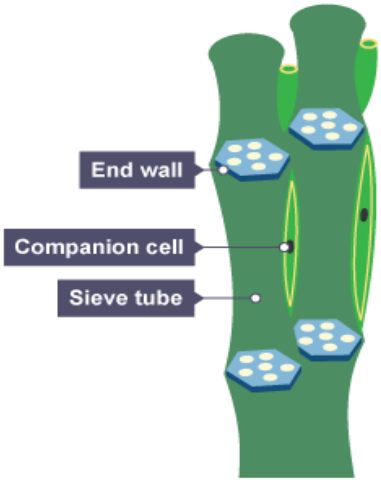
Structure	Function
Upper Epidermis	Has a waxy coating.
Palisade Mesophyll	Contains chlorophyll. Primary site of photosynthesis.
Spongy Mesophyll	Contains chlorophyll. Secondary site of photosynthesis.
Vein	Contain xylem and phloem.
Lower Epidermis	Underside of the leaf. Contains stomata.
Guard Cells	Control the opening and closing of stomata.
Stomata	Pores that allow CO2 in and water and O2 out.



Transpiration is the process of water moving through a plant and its evaporation through the stomata. The rate of transpiration can be measured using a **potometer**. Its rate is affected by:

- Wind speed
- Temperature
- Humidity
- Surface area of leaf





Phloem transports sugar all over the plant. It has the following characteristics:

- Living tissue
- Companion cell
- Sieve plates

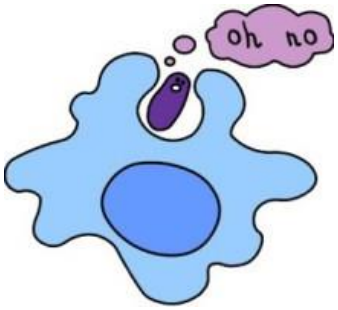
<u>Transport Systems in Animals</u>

Blood

In mammals the blood contains plasma, red blood cells and white blood cells. It transports nutrients, oxygen and carbon dioxide.

Red blood cells are biconcave in shape, have no nucleus and contain **haemoglobin**. This allows them to transport oxygen efficiently in the form of **oxyhaemoglobin**.

White blood cells are part of the immune system and are involved in destroying pathogens. Pathogens are disease-causing micro-organisms (bacteria, viruses, fungi). There are two main types of cells involved:

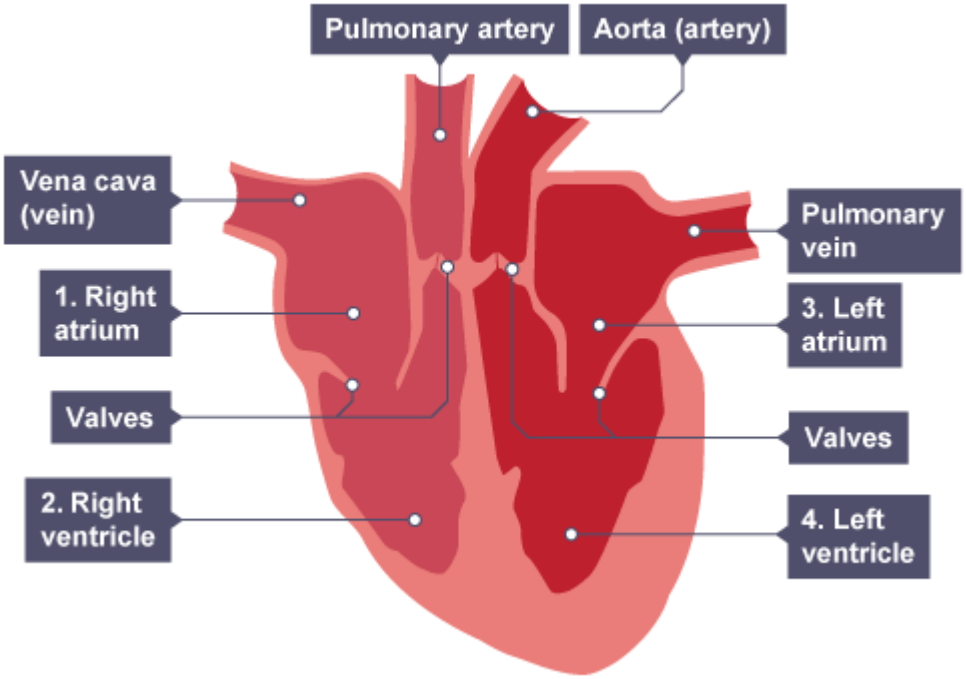


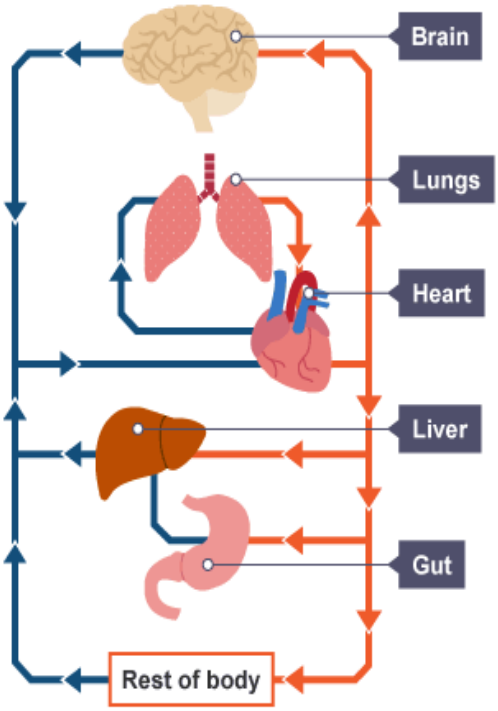
Phagocytes - carry out phagocytosis. The phagocyte wraps itself around the pathogen, engulfs it and then digests it.

Lymphocytes - produce **antibodies** which destroy pathogens. Each antibody is specific to a particular pathogen.

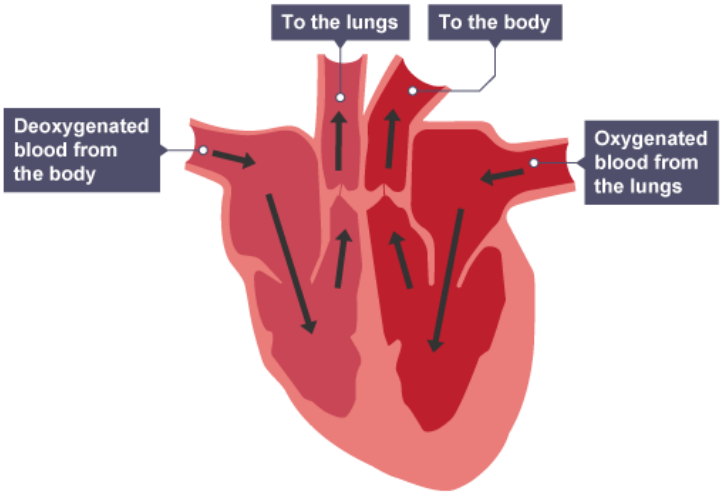
Heart

The heart pumps blood around the body. It has 4 chambers – 2 atria and 2 ventricles.





Name of Blood Vessel	Function
Vena cava	Carries deoxygenated blood from body to heart
Pulmonary artery	Carries deoxygenated blood from the heart to the lungs
Pulmonary vein	Carries oxygenated blood from the lungs to the heart
Aorta	Carries oxygenated blood from the heart to the body



Valves are in the heart and they prevent the backflow of blood – make sure that is travels in the one correct direction.

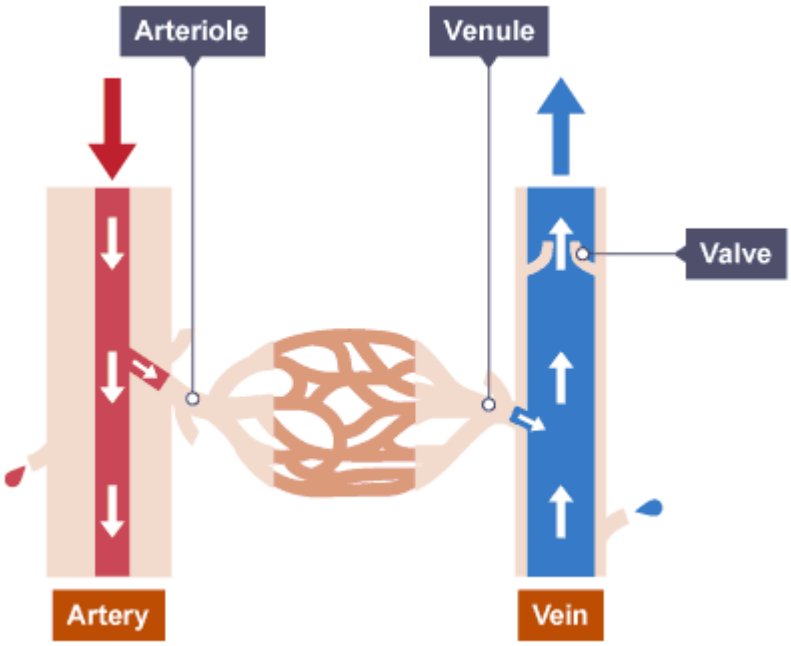
The left side of the heart is thicker than the right side since the left pumps blood to all parts of the body and the right only pumps blood to the lungs.

The heart needs a supply of blood rich in oxygen to function. The **coronary artery** supplies the heart muscle with blood.

Blood Vessels

There are three types of blood vessel:

- **Arteries** – have thick, muscular walls, a narrow central channel and carry blood under high pressure away from the heart.
- **Veins** have thinner walls, a wider channel and carry blood under low pressure back towards the heart. Veins contain valves to prevent backflow of blood.
- **Capillaries** are thin walled and have a large surface area, forming networks at tissues and organs to allow efficient exchange of materials.



<u>Absorption of Materials</u>

Oxygen and nutrients from food must be absorbed into the bloodstream to be delivered to cells for respiration. Waste materials, such as carbon dioxide, must be removed from cells into the bloodstream.

Tissues contain capillary networks to allow the exchange of materials at cellular level.

Surfaces involved in the absorption of materials have certain features in common:

- large surface area
- thin walls
- extensive blood supply.

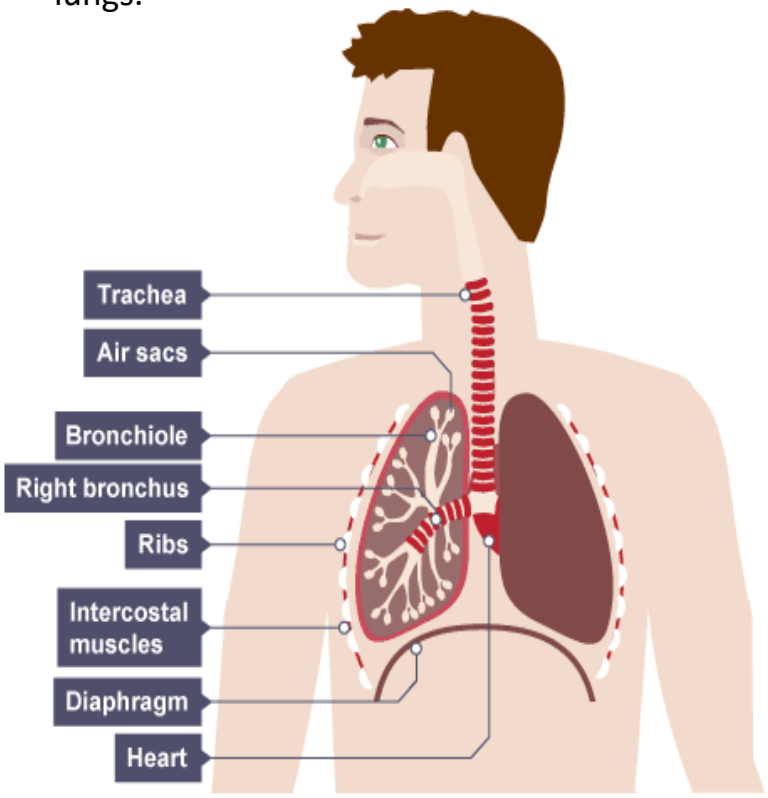
These increase the efficiency of absorption.

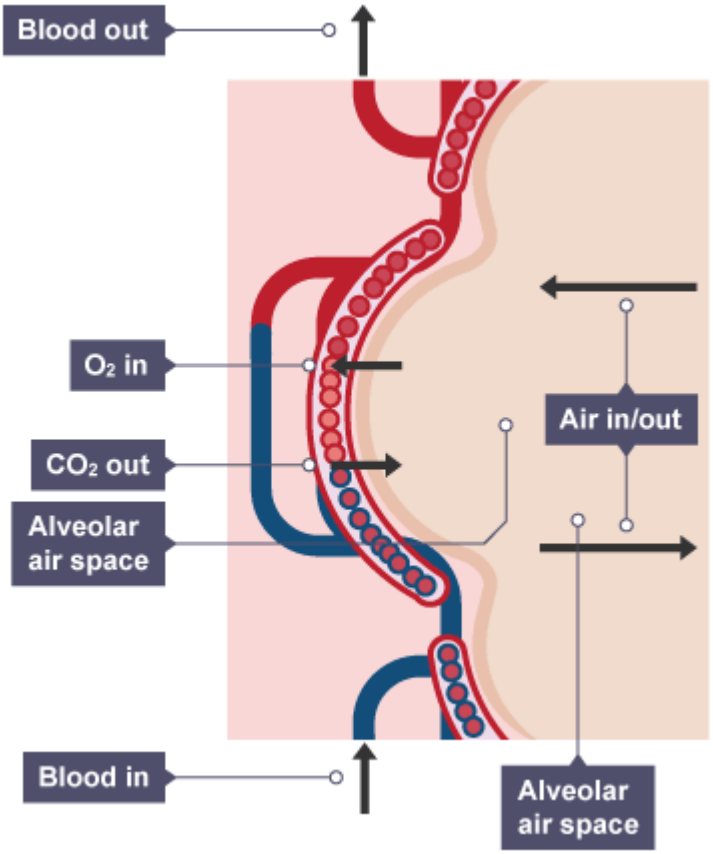
Two locations where absorption of materials occurs is the lungs and small intestine.

Lungs

Lungs are gas exchange organs. They consist of a large number of **alveoli** providing a large surface area. Oxygen and carbon dioxide are absorbed through the thin alveolar walls to or from the many blood capillaries.

Oxygen moves from the lungs to the blood. Carbon dioxide moves from the blood to the lungs.





Small Intestine

Food is broken down in the digestive system. Nutrients from food are absorbed in the small intestine. The small intestine has lots of little structures called **villi**. The villi absorb the nutrients from food. The large number of thin walled villi provides a large surface area. Each villus contains a network of capillaries to absorb glucose and amino acids and a lacteal to absorb fatty acids and glycerol.