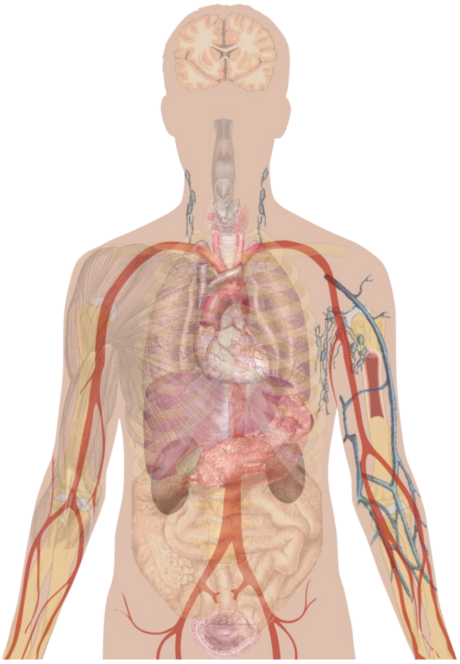
St Ninian's High School

Biology Department



National 5 Biology

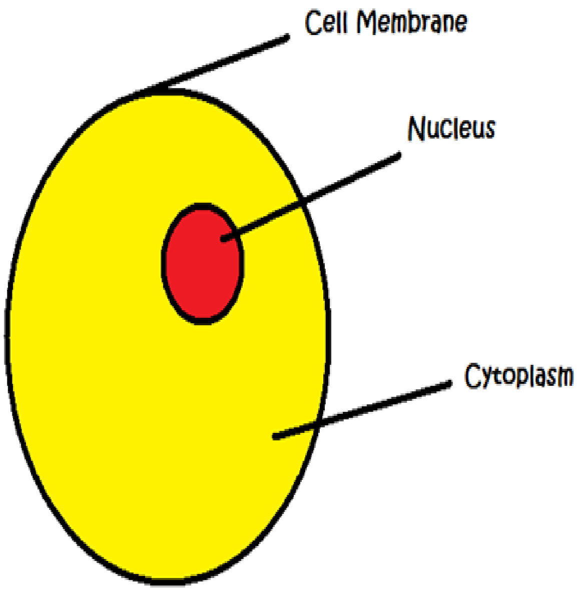
Multicellular Organisms

Revision Notes

Cultivating Excellence in Science

Animal & Plant Cells

Animal Cell

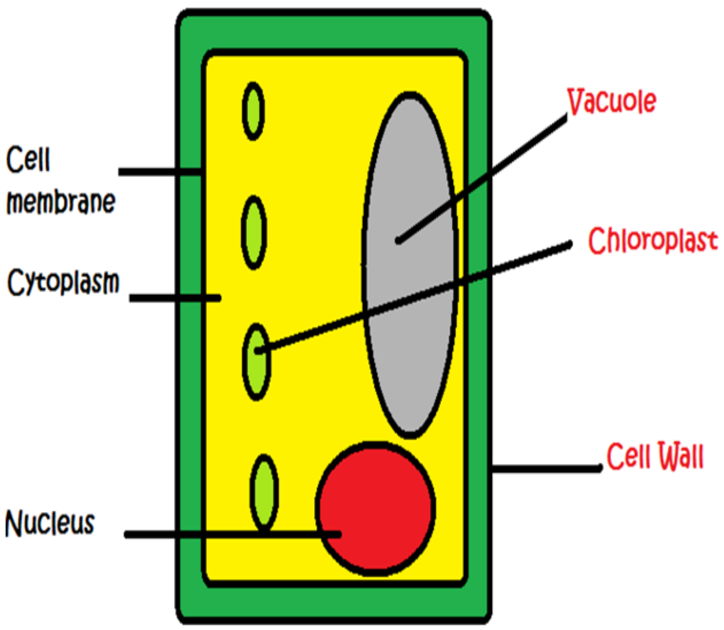


1. <u>Cell membrane</u>
Controls what enters & leaves the cell

2. <u>Nucleus</u>
Controls the cell's activities

3. <u>Cytoplasm</u>
Site of chemical reactions inside cell

Plant Cell



Parts ONLY found in plant cells

1. <u>Vacuole</u>
Contains cell sap

2. <u>Chloroplasts</u>
Site of photosynthesis

(Only in plant leaves, not in plant roots – no light for photosynthesis)

3. <u>Cell wall</u>
Provides support for cell

Specialised Cells

Multicellular organisms
Made up of more than 1 cell type

Unicellular organisms
Made of only 1 cell

Level of organisational hierarchy in Multicellular Organisms

Cells are the most basic unit of life.

Tissues are **groups of similar cells** working together to perform the same function.

Organs are **group of similar tissues** working together to perform the same function.

Organ Systems are made up of **groups of organs** work together.
e.g. Nervous system

cells → tissues → organs → systems.

Specialised cells

In multicellular organisms different cells allow cells to become specialised to their function.

What is a specialised cell?

A cell that is adapted in some way to better suit its function.

Examples of Specialised Cells

Type of Cell	Cell Specialisation	Function
Red blood cell	Contains haemoglobin No nucleus Biconcave shape	Carries MORE oxygen around body
Root hair cells (plants)	Large surface area	Absorbs MORE water from soil
Sperm cell	Has a tail	Swim to the egg for fertilisation
Egg cell	Contains a food store	Provide developing embryo with energy

Stem Cells (Unspecialised Cells)

Stem Cells

Stem cells are **unspecialised** cells

They are needed by the body for **GROWTH and REPAIR of** tissues.

Stem cells allow growth and repair by undergoing two processes.

1. **Self renewal** to produce more stem cells by mitosis.
2. Produce specialised cells

Types of Stem Cells

1. Embryonic stem cells—produce all specialised cells
2. Adult/tissue stem cells—produces only a few cell types

   Location: bone marrow skin muscles Liver

Ethical issue of using embryonic stem cells

Using embryonic stem cells **kills the embryo** which is unethical.

Medical Uses of stem cells

- To treat cancer/diabetes
- Organ transplants
- Make skin for skin grafts

Reproduction

Diploid cells

Diploid cells contain **2 sets** of chromosomes.

Example
All cells are diploid except gametes (sex cells).

Haploid cells

Haploid cells contain only **1 set** of chromosomes.

Example

Animal Gametes (sperm male gamete & egg female gamete)

Plant Gametes (pollen male gamete & ovule female gamete)

Site of gamete production

Males:

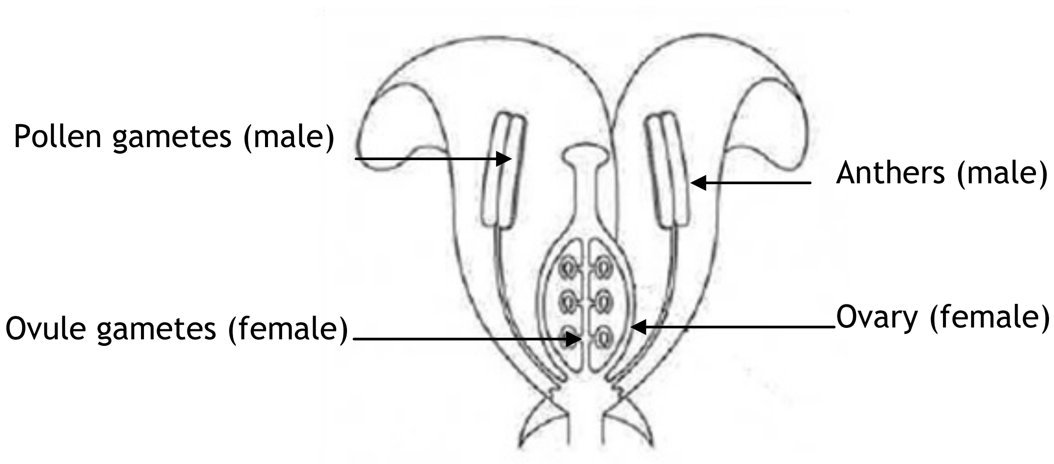
Pollen made in diploid **Anther cells in plants.**

Sperm made in diploid **Testis cells in animals.**

Females:

Ovules made in **diploid ovary** in plants.

Eggs made in **diploid ovary** cells in animals.



Reproduction

<u>Fertilisation</u>

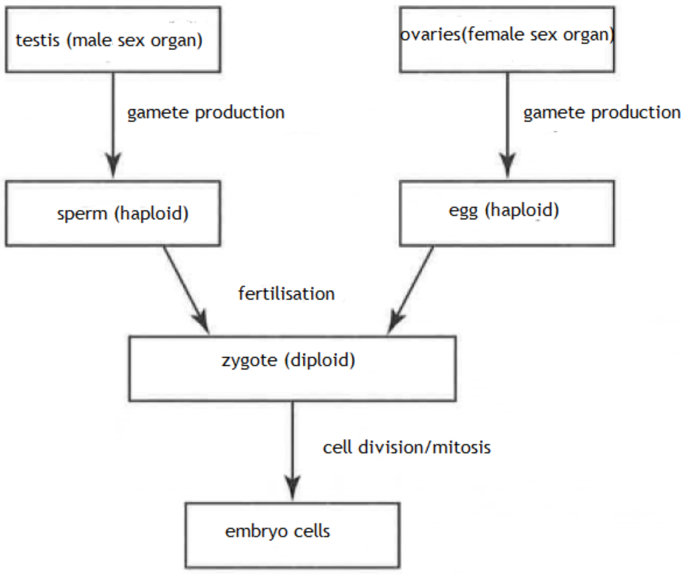
When the **<u>nuclei</u>** of the **<u>haploid</u>** sperm and egg fuse together to form a **<u>diploid zygote</u>**.

<u>Zygotes & Embryos</u>

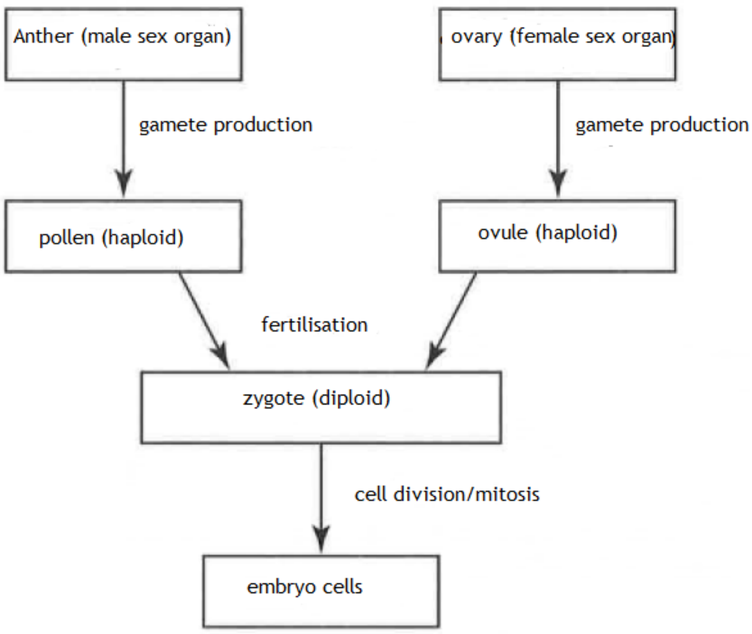
A zygote is a fertilised diploid egg

Zygotes undergo cell division to form an embryo.

Animal Reproduction Summary



Plant Reproduction Summary



Mitosis

What is mitosis

Occurs when one mother cell make two identical daughter cells

i.e. when stem cells **self renew**.

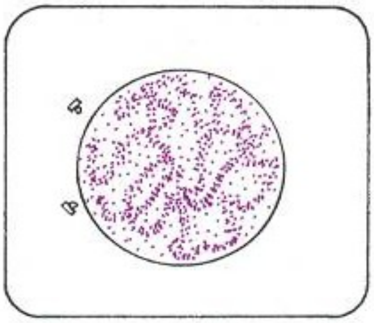
Why do cells undergo mitosis?

Produces new cells for **GROWTH and REPAIR** of damaged cells

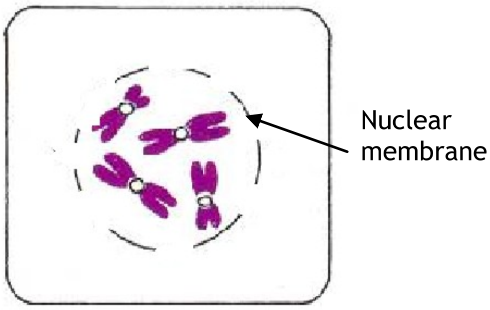
Location of mitosis – **nucleus (DNA found there)**.

Mitosis maintains the **diploid chromosome complement** (number of chromosomes) when producing new cells.

Mitosis Stages



Long uncoiled chromosome not yet visible.

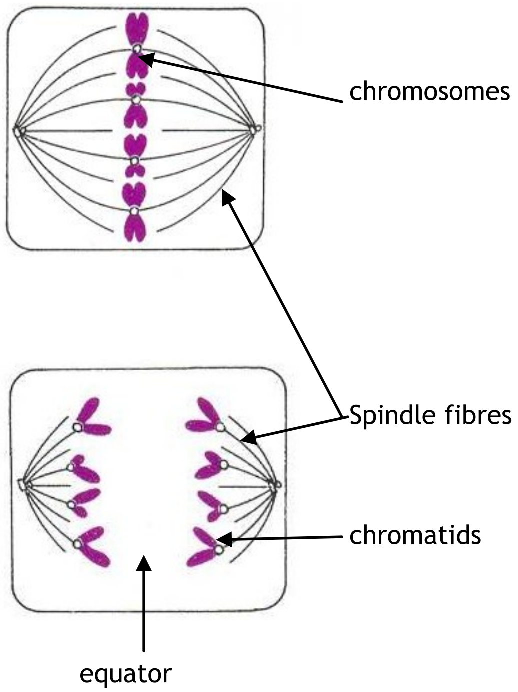


Chromosomes shorten, thicken and replicate to form 2 identical chromatids.

Chromosomes are now visible.

Nuclear membrane disappears

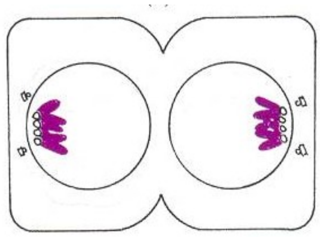
Mitosis



Chromosomes line up at the equator (middle) of the cell.

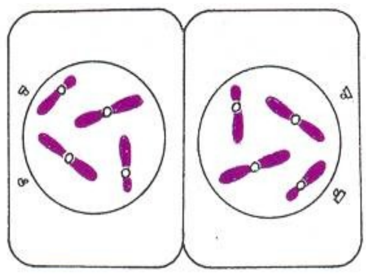
Spindle fibres attach to chromosomes.

Chromatids pulled to opposite poles (ends) of cell by spindle fibres.



1. Nuclear membrane reforms.

2. Cytoplasm divides.



Two identical diploid daughter cells are produced.

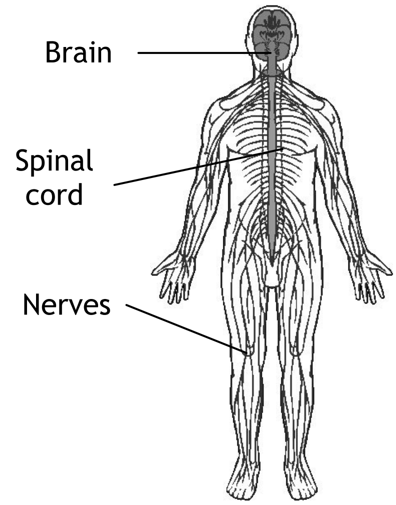
Importance of Mitosis

It is important to maintain the diploid chromosome complement in each daughter cell **to ensure no genetic information is lost**.

Nervous System

Three parts to the Nervous System

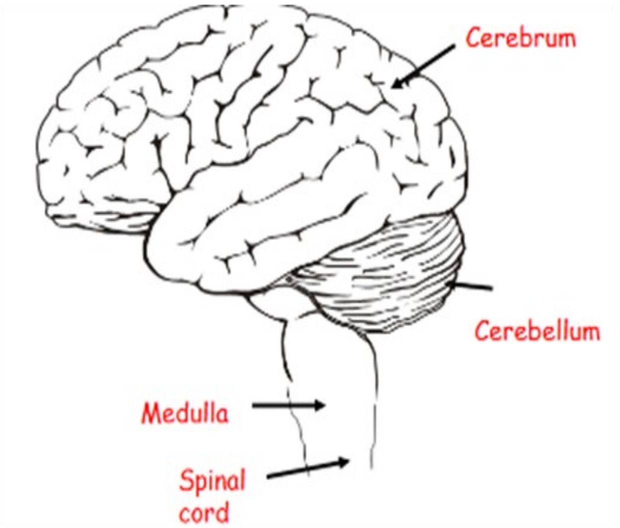
1. brain 2. spinal cord 3. nerves



Central Nervous System (CNS)

1. brain 2. spinal cord

Three parts to the Brain



Structure	Function
Cerebrum	Controls memory & personality
Cerebellum	Controls balance & muscle coordination
Medulla	Controls heart rate & breathing rate

Three types of Nerves/Neurones

1. Sensory nerve

Passes information from **receptors in sense organs** to the **inter nerves** in CNS.

2. Inter nerve

Passes information from the **sensory nerve** to the **motor nerve**.

3. Motor nerve

Passes information from the **inter nerve** in the CNS to the **effector**.

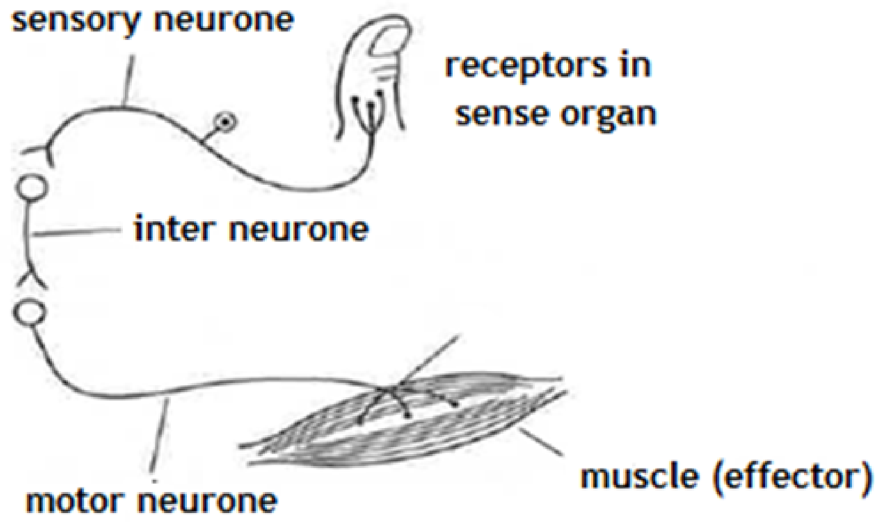
*Only **inter** neurones/nerves are found in the **CNS***

Reflex Arc

Reflex Arc

Reflexes are needed to **protect the body**.

Reflex arcs are a 5 stage process.



Reflex Arc Steps

1) Sensory **receptors** in sense organs detect stimulus (e.g. sharp object on thumb)

2) Electrical impulse travels along **sensory neurone** to the CNS

3) In CNS, messages are passed from sensory to the **inter neurones**

4) Electrical impulse then pass from the inter to the **motor neurone**.

5) Motor neurone causes response in **effector** (muscle or gland)

   a) Fast response - muscle contraction

   b) Slower response - glands produce hormones (chemical messenger)

Nervous system

Synapses & Neurones

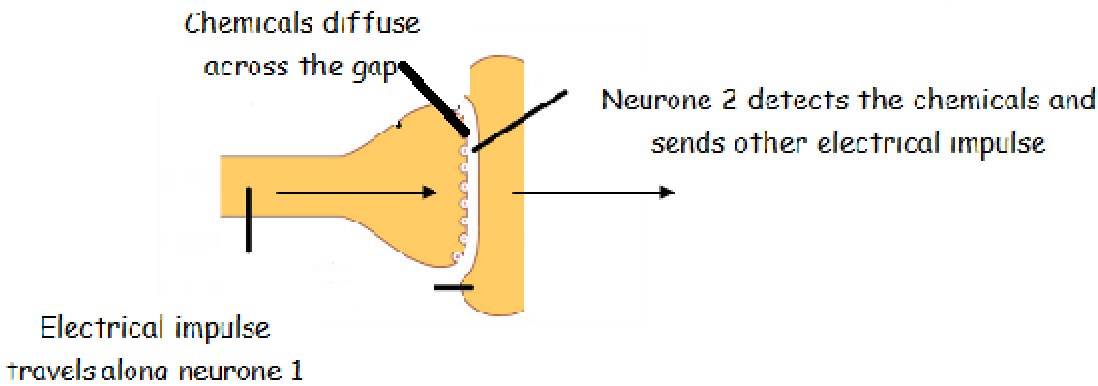
Synapses

Synapses are **small gaps** that occur between the ends of nerve cells.

Electrical & Chemical Messages

Along Nerves
Electrical impulses carry messages along nerves.

Between nerves
Nerve cells communicate with each other by **chemicals** moving across a synapse.



Hormonal Control

Endocrine glands

Produce/release hormones into the blood.

Examples of endocrine organs

1. ovaries 2.testes 3. pancreas

Hormones

Chemical messengers that travel in the blood to a target organ.

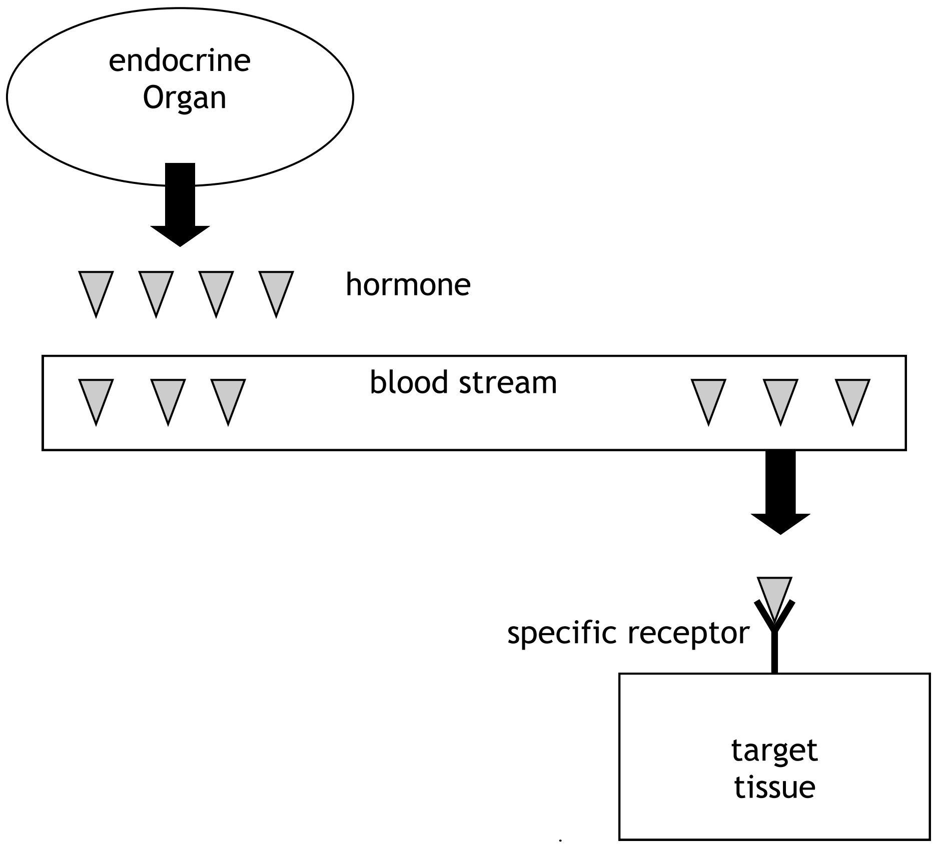
Examples

1. insulin hormone 2. glucagon hormone

Target tissue
Tissue has **specific receptor**s for each hormone

Why have specific receptors for each hormone?

Ensures only certain target tissues are affected by one hormone.



Hormonal Control

Hormone control vs Nerve control

Hormonal control	Nervous control
Chemical messages	Electrical messages
Slower response	Faster response
Long lasting effect	Short lived effect
Carried through blood	Carried along specific nerves

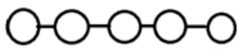
Blood sugar regulation

The **pancreas** is the **endocrine organ** that controls blood sugar.

The **target organ/**tissue is the **liver**.

1. **Insulin** is produced when the **pancreas** detects that blood sugar is **too high.**

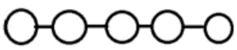
   The effect of insulin production is to **lower blood sugar** by converting:

Glucose  → **Glycogen** 

(simple sugar) (large storage carbohydrate in liver)

2. **Glucagon** is produced when the **pancreas** detects that blood sugar is **too low.**

   The effect of glucagon production is to **increase blood sugar** by converting

Glycogen  → **Glucose** 

(storage carbohydrate in liver) (simple sugar)

Blood sugar Regulation

High Blood Sugar

Pancreas (endocrine gland) produces **insulin**

↓

Insulin travels in blood to **liver** (target organ)

↓

Insulin converts **glucose to stored carbohydrate glycogen** in liver

↓

Blood sugar **decreases** back to normal

Low Blood Sugar

Pancreas (endocrine gland) produces **glucagon**

↓

Glucagon travels in blood to **liver** (target organ)

↓

Glucagon breaks down stored glycogen into glucose which is released from liver

↓

Blood sugar **increases** back to normal.

Diabetes

Pancreas does not work properly as the pancreas **cannot produce insulin**.

Treatment

1. Insulin tablets/ injections
2. Diet or exercise

Digestive System

Small Intestine

The small intestine has a **selectively permeable** Membrane.

Only allows small molecules to pass through into the blood but not large molecules.

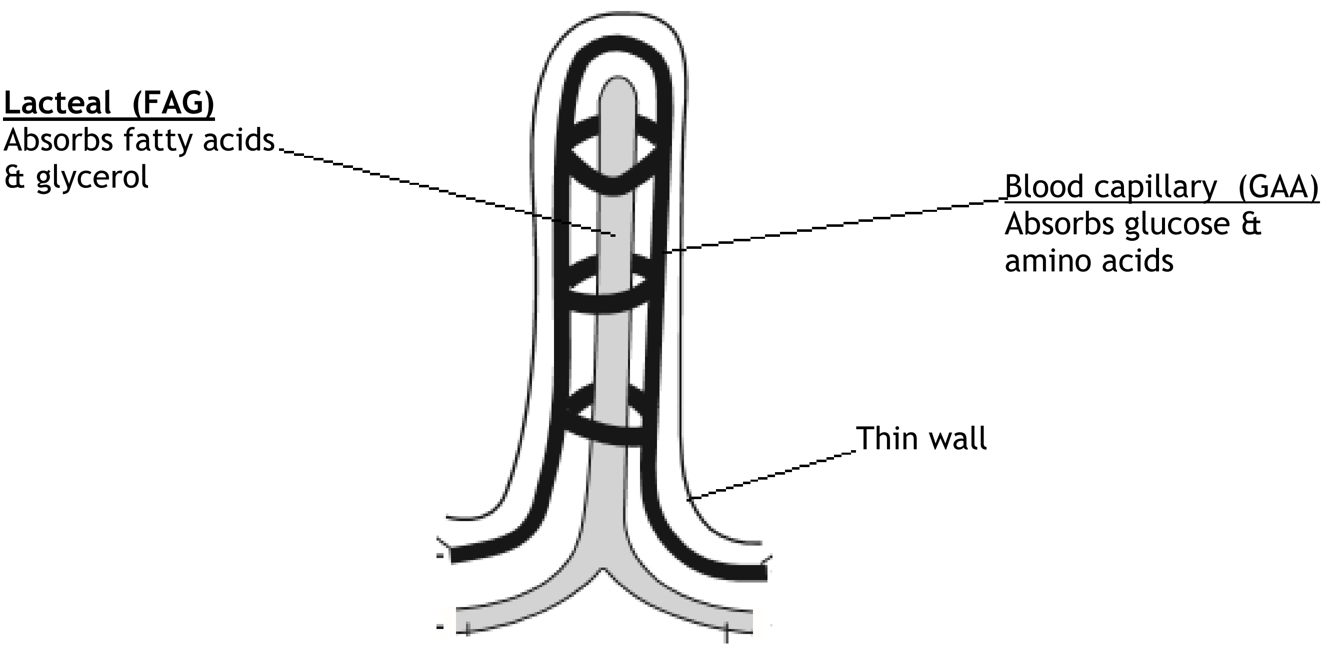
Large molecules		Small molecules
starch Carbohydrate	→	glucose Carbohydrate
fat	→	fatty acids & glycerol
protein	→	amino acids

Role of Small intestine

The small intestine **absorbs nutrients into the blood** via the large numbers of villi.

Features of Villi

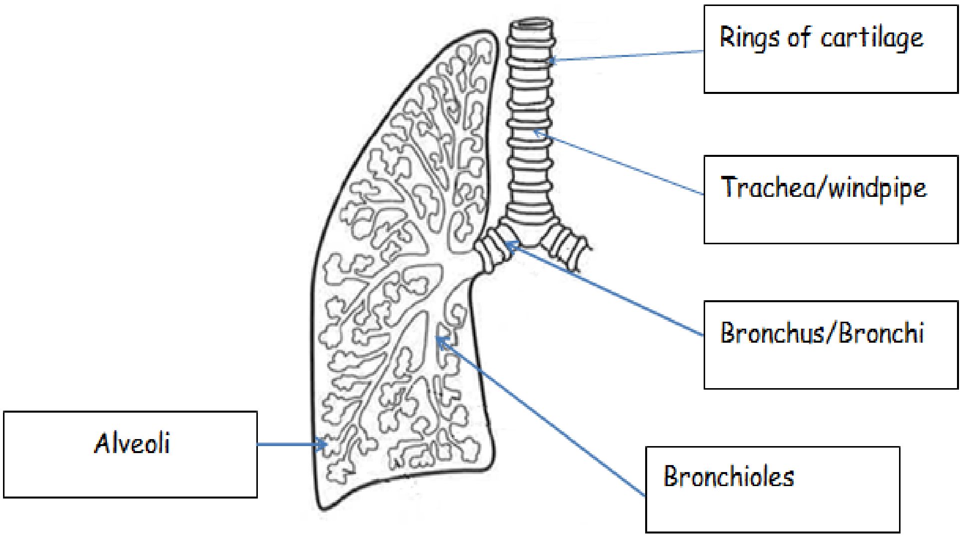
1. large numbers 2. thin wall 3 large surface area 4. good blood supply



Respiratory System

Respiratory System

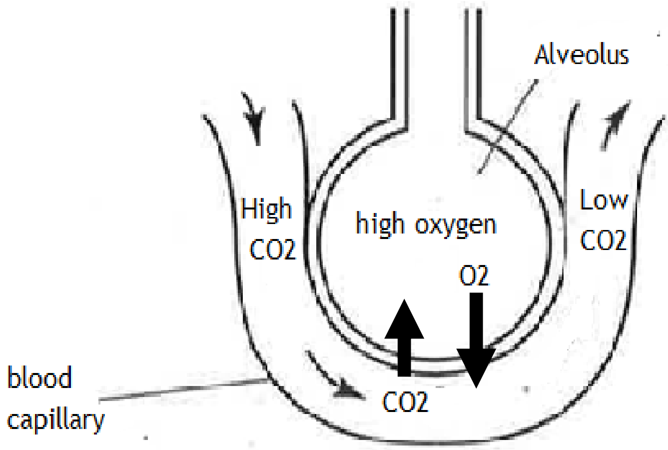
Lungs are the site of **gas exchange** within structures called **alveoli**.



Gas Exchange

Alveolus —oxygen→ Blood capillary

Blood capillary —carbon dioxide→ Alveolus



Features of Alveolus

1. large numbers 2. thin wall 3 large surface area 4. good blood supply

Blood

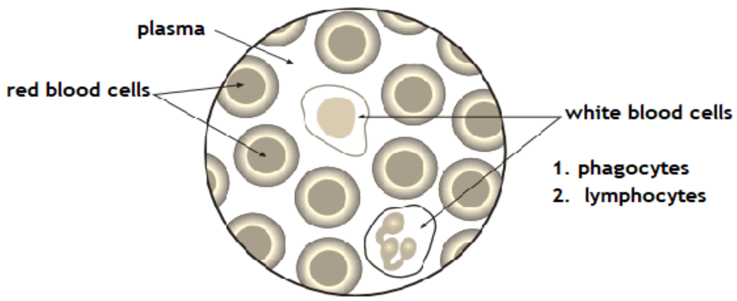
Three Components of the blood

1. Plasma (carries dissolved nutrients & CO_2 in the blood)

2. Red blood cells (carries O_2 & CO_2 in the blood)

3. White blood cells (destroy pathogens)

Components of the blood under the microscope



Plasma

Yellow liquid of the blood which carries nutrients including:

1. amino acids
2. simple sugars (glucose)
3. fatty acids and glycerol

Red Blood Cells

Red blood cells are **specialised** to their function of being able to carry oxygen around the body by having:

1.No nucleus. 2. Biconcave shape (larger surface area) 3. haemoglobin

Lungs: (high O_2) haemoglobin + oxygen → oxyhaemoglobin

Tissues: (low O_2) oxyhaemoglobin → oxygen + haemoglobin

Blood

Substances carried in the blood

During respiration certain substances are carried towards cells to let the cells undergo respiration and other waste substances are removed from cells into the blood.

O_2 & nutrients

blood stream ⟶ cells for respiration

Waste CO_2

cells ⟶ blood stream

White Blood Cells

Two types of white blood cells are part of the **immune system** that **destroy pathogens** (disease causing organisms).

Phagocyte white blood cells

Engulf pathogens by **phagocytosis** & destroy them using **digestive enzymes**.

Lymphocyte white blood cells

Produce **antibodies** which destroy pathogens.

Each antibody is **specific** to a particular pathogen.

Cardiovascular System

The cardiovascular system is made up of 2 key parts:

1. Heart muscle

2. Blood vessels.

There are three types of blood vessels:

1. Arteries
   Take blood away from the heart

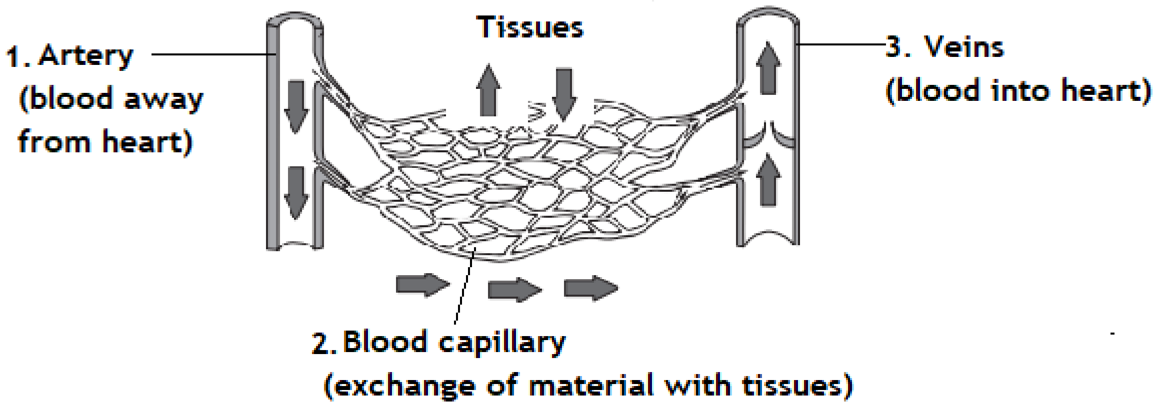
2. Blood capillaries
   Form networks at tissues to exchange materials

3. Veins
   Take blood back towards the heart.

Blood always flows in the following order around the CV system.

Arteries ⟶ Blood Capillaries ⟶ Veins

Away from heart (exchange of materials) Into heart



Blood Vessels

1. Arteries

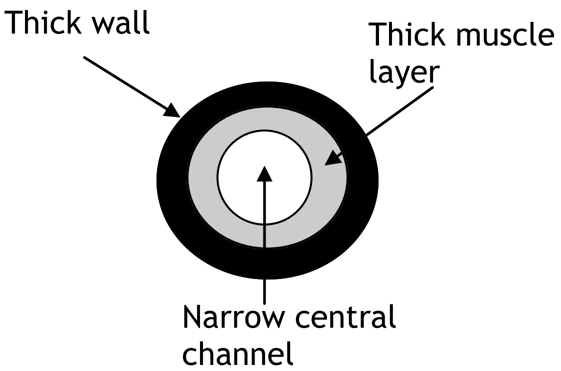
Carry blood away from the heart.

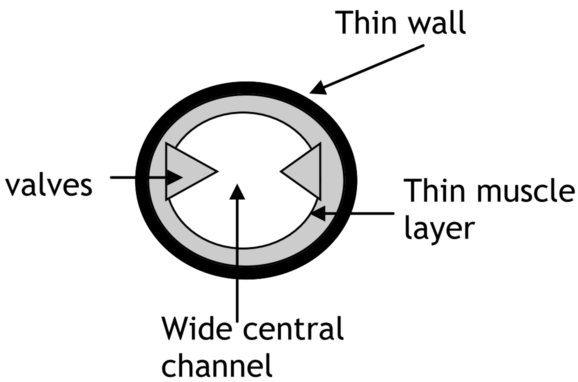
Carries blood under HIGH pressure

2. Veins

Carry blood INTO the heart.

Carries blood under low pressure



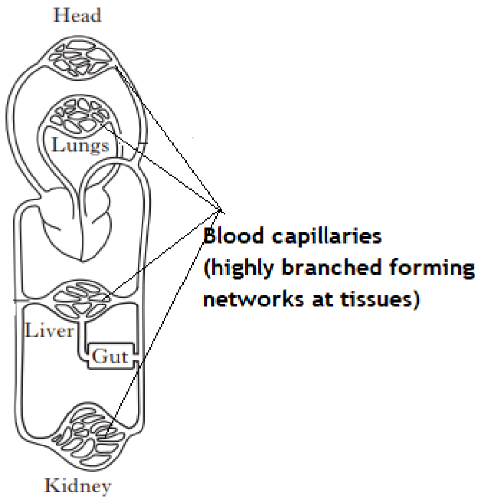


Blood Vessel	Type of wall	Type of muscle layer	Width of central channel	Valves
Arteries	Thick	Thick layer	Narrow	No
Veins	Thin	Thin layer	wide	yes

Valves
Prevent the backflow of blood

3. Blood Capillaries

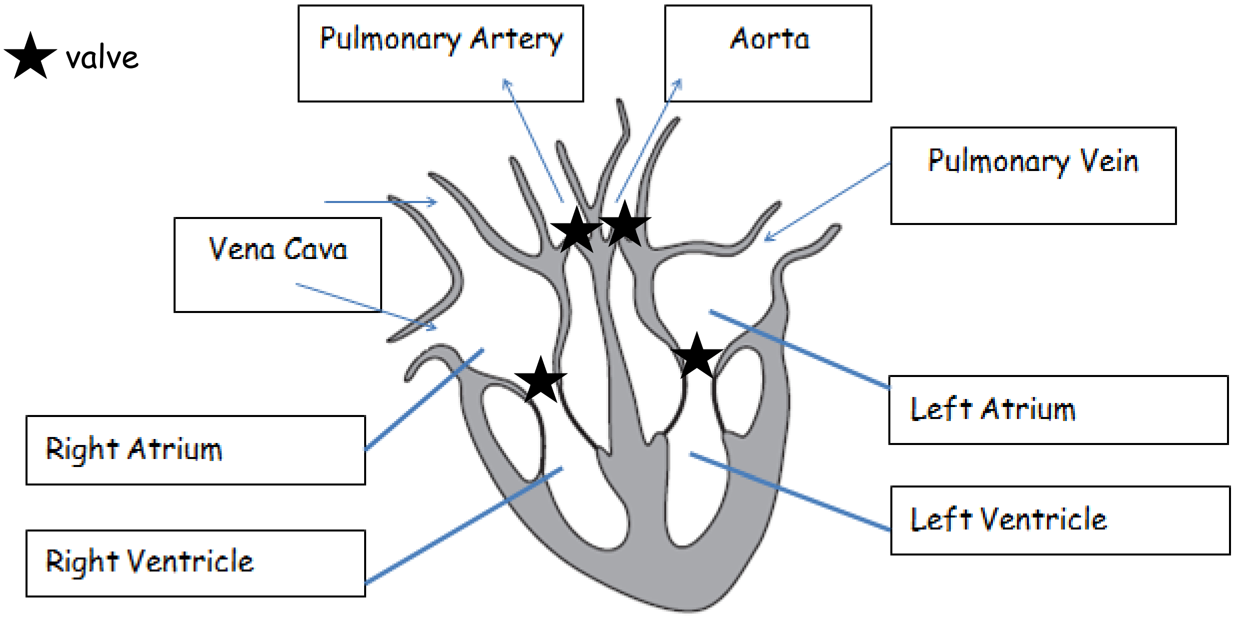
Function: **exchange of materials** in tissues at cellular level .



Features of Blood capillaries

1. thin walled
2. large surface area
3. highly branched forming networks at tissues

The Heart



<u>Four chambers</u>

Two receiving chambers - atria

Two pumping chambers - ventricles

<u>Four valves</u>

Two valves between atria & ventricles

Two valves between ventricles & arteries

<u>Two sides of Heart</u>

LHS - pumps **<u>oxygenated blood</u>** to body - thicker ventricle.

RHS - pumps **<u>deoxygenated blood</u>** to lungs to be oxygenated.

<u>Four key blood vessels</u>

Pulmonary artery
Takes <u>deoxygenated</u> blood from **right ventricle** to the **lungs.**

Pulmonary vein
Takes <u>oxygenated</u> blood from **lungs** to the **left atrium.**

Aorta
Takes <u>oxygenated</u> blood from **left ventricle** to the **body.**

Vena Cava
Carries <u>deoxygenated</u> blood from **body** to the **right atrium.**

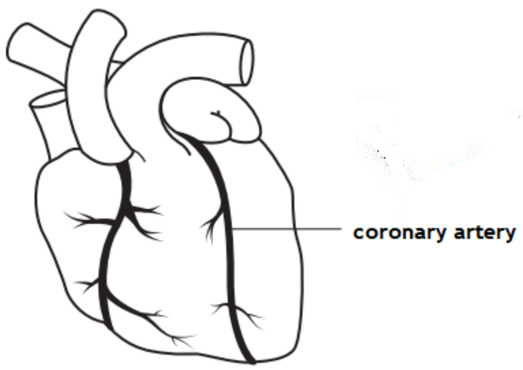
The Heart

Coronary artery

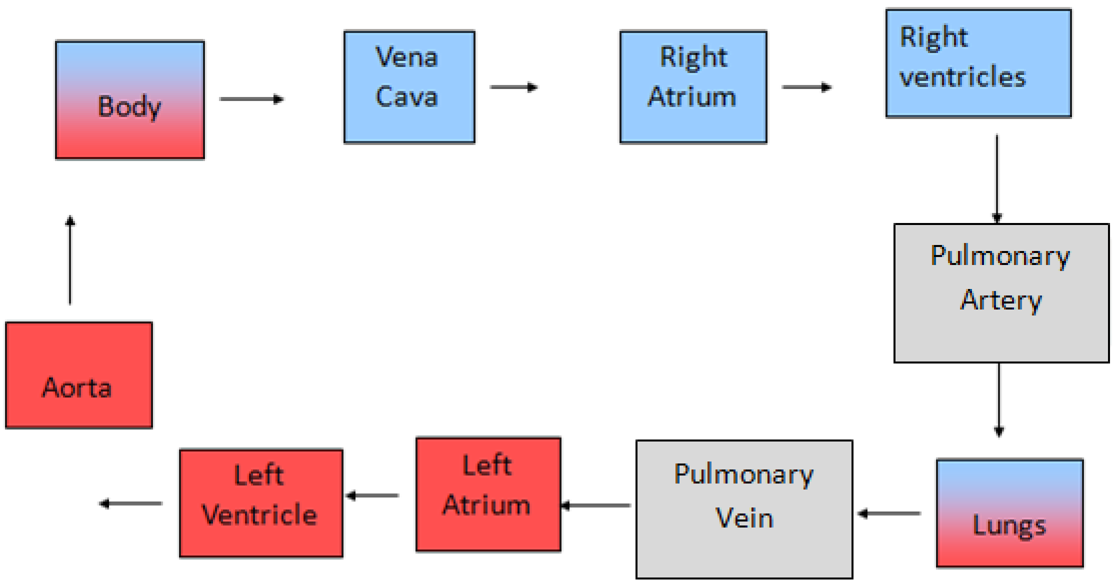
Provides heart itself with nutrients & oxygen.

Heart attack

A **blockage** in the heart **prevents oxygen** getting to the heart muscle causing a heart attack.



Blood flow around heart/body/lungs



Plant Transport

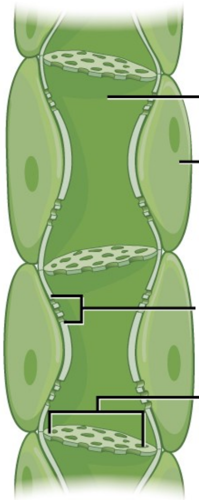
Plant transport vessels

Xylem

1. Transports **water & minerals** UP plant
2. Lignin **provides support** to withstand pressure from water moving up plant

Xylem vessels are **<u>dead.</u>**

Phloem



Transports **sugar** UP/DOWN plant from leaves.

Phloem vessels are **<u>alive.</u>**

Transpiration Stream

Definition

Water moving up through the three plant organs:

1. Roots
2. Stem
3. Leaves

1. Roots

   Roots have root hair cells which have a large surface area to absorb more water from the soil by **<u>OSMOSIS</u>**.

2. Stem

   The stem contains xylem vessels which transport water up plant by **<u>OSMOSIS.</u>**

3. Leaves

   The leaves contain stomata which water evaporates into the air by **<u>TRANSPIRATION.</u>**

Plant Transport

Importance of Transpiration Stream

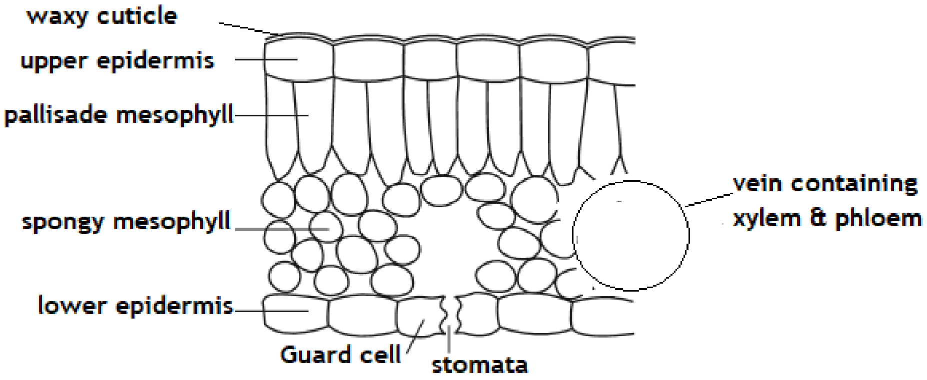
1. Water for photosynthesis
2. Water to cool down plant
3. Water to provide support to plant

Factors affecting Transpiration

The following factors will increase the transpiration stream in a plant.

1. Increased temperature
2. Increased wind speed
3. Increased surface area of leaf
4. Decreased humidity

Structure of a leaf Diagram



Part of leaf	Function
Cuticle	Prevents water loss
Epidermis (upper and lower)	Protection
Mesophyll (spongy & palisade)	Photosynthesis
Stomata	1. gas exchange 2. transpiration
Guard cells	Controls opening/closing of stomata
Vein	Contains xylem to transport water Contains phloem to transport sugar

Variation

Types of Variation

1. Discrete Variation

   A characteristic which can be split into **distinct groups**.

   Discrete variation is controlled by a **single gene**

   Examples—: gender, blood group, eye colour, hair colour, type of earlobes

2. Continuous Variation

   A characteristic that shows a **range of values** from a minimum to a maximum.

   Continuous variation is ALWAYS controlled by **more than one gene** (polygenic inheritance)

   Examples: height, weight, hand span

Importance of variation

Variation is important as it provides different alleles which makes species

adapt to changing conditions.

Genetic terms

Phenotype
The physical appearance of an organism e.g. blue eyes

Genotype
The two alleles present which control an individual's phenotype
i.e. BB or bb or Bb

Allele
different versions of a gene

Dominant allele – controls phenotype (B)

Recessive allele – hidden allele, only shown in phenotype if 2 copies are present

Homozygous/true breeding – two of the same alleles i.e. bb or BB

Heterozygous – two different alleles i.e. Bb

Genetic: Punnet Squares & Family Trees

Punnet Square/ Monohybrid Cross Worked Example

Code B – brown eyes b – blue eyes

P generation BB X bb

F1 generation Bb x Bb

F2 generation Monohybrid cross/Punnet Square

	B	b
B	BB	Bb
b	Bb	bb

Remember ratio: **3 brown: 1 blue eye**

¾ (75%) brown: ¼ blue eyed (25%)

Problems with Ratio

Expected ratio doesn't always equal the observed ratio as **fertilisation is a random process.**

Family tree diagram.

If having earlobes was dominant (E) and not having earlobes was recessive (e), Person P would have a genotype of ee and person Q would have a genotype of Ee (E from one parent, e from another)