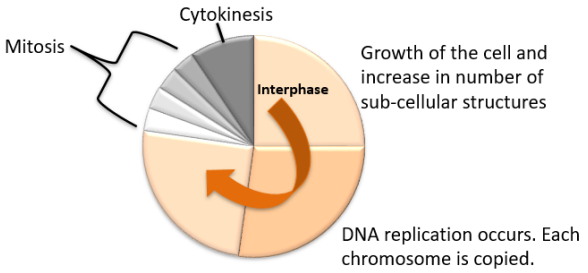
Biology: B2: Cells and Control

Paper 1

Mitosis is a type of **cell division.**
Mitosis occurs during **growth** when the number of cells needs to increase and also to **repair** or replace damaged cells.
Asexual reproduction occurs by mitosis in plants and simple animals.
The overall process of growth and division is known as the **cell cycle**.



In the **cell cycle,** cells divide by **mitosis** in a series of **stages**. The **genetic material** is **doubled** and then **divided** into **two identical cells**.

During interphase in the cell cycle…

Growth must occur: Before a cell can divide it needs to grow and increase the number of sub-cellular structures such as ribosomes and mitochondria. DNA is then duplicated to form two copies of each chromosome.
Mitosis now begins. Four stages occur…

Interphase is the longest stage in the cell cycle.

Prophase: the nuclear membrane dissolves and the chromosomes become shorter and fatter.
Metaphase: the spindle forms and the chromosomes line up on the equator.
Anaphase: the spindle fibres pull the identical chromosomes apart to opposite ends of the cell.
Telophase: Membranes form around the outside of each set of chromosomes. These are the nuclei of the 2 new daughter cells. The cytoplasm and cell membrane divide and two new identical cells are formed. This process of splitting is called **cytokinesis**.

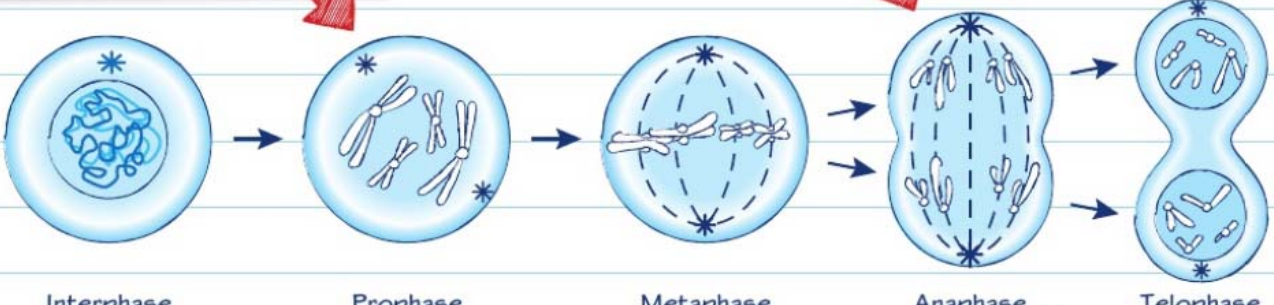
Two diploid daughter cells are produced each with identical sets of chromosomes in the nucleus to each other and the original parent cell.

Stages of mitosis

Each chromosome consists of two chromatids.

The chromatids separate and one chromatid from each pair is pulled to each pole of the cell. The chromatids can now be called chromosomes.

The cell splits into two. This is called **cytokinesis**.



Interphase | Prophase | Metaphase | Anaphase | Telophase

At the end of interphase, chromosomes start to become visible. The DNA has already been copied.

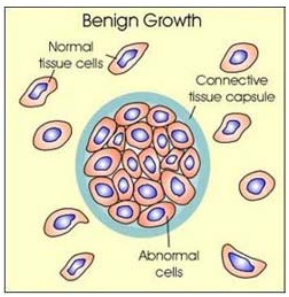
The nuclear membrane breaks down. Chromosomes line up along the middle of the cell.

Spindle fibres disappear and a new nuclear membrane forms round each group of chromosomes.

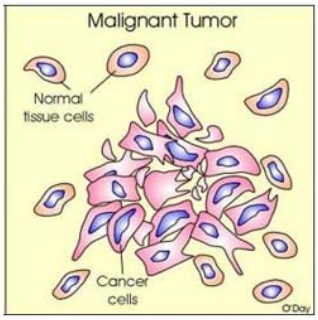
Remember the stages of mitosis using the mnemonic IPMAT:
Interphase
Prophase
Metaphase
Anaphase
Telophase

The **rate** at which **a cell divides** by mitosis is **controlled** by its **genetic information**.
A **mutation** might alter a gene controlling cell division allowing cells to start **dividing uncontrollably**.
This can result in the formation of a **tumour**.

- **Benign tumours:**
  - Growths of abnormal cells
  - Contained in one area
  - Usually within a membrane surrounding the cells
  - They do not invade other parts of the body



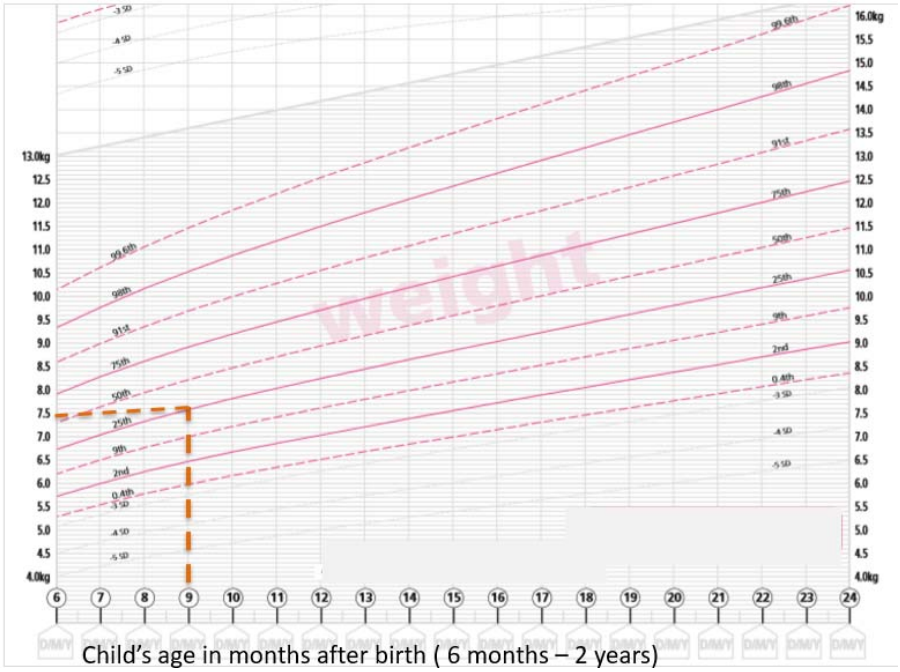
- **Malignant tumour (CANCER):**
  - Growths of abnormal cells
  - These are **cancerous**
  - Invade neighbouring tissues and spread to different parts of the body in the blood where they form secondary tumours
  - Can be caused by lifestyle or genes



Growth is defined as an **increase in size** or **mass**.

Growth occurs in **young animals** by **rapid cell division** all over the body. As animals get **older** most cell division is simply to **replace or repair** damaged cells.

Growth in **plants** occurs by cell division at the **root and shoot** tips. Cells increase in size or height by **cell elongation**.
This happens **throughout the plants life**.



Cell **differentiation** occurs as organisms develop and the cell changes to become **specialised**. As the cell **differentiates,** it forms different sub-cellular structures, e.g. the tail on a sperm cell or the hairs on a root hair cell.

Most types of **ANIMAL** cells **differentiate** in the early stage of development.

Examples: red blood cells, egg and sperm cells

Nerve cells, Bone cells

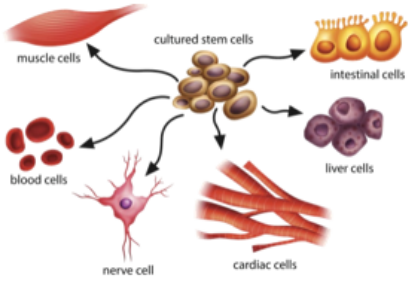
Most types of **PLANT** cells can **differentiate throughout their life** cycle.

Examples: xylem, phloem, root hair cells, stoma cells

Stem Cells

Stem cells are **undifferentiated cells** within an organism. They can produce other stem cells that can then differentiate into many different types of cells.

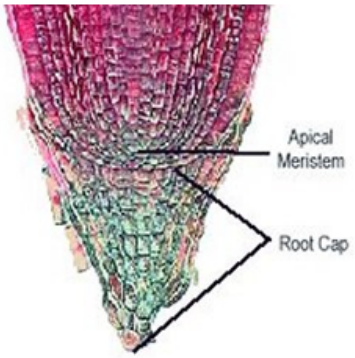
Human embryo stem cells can be cloned and made to **differentiate** into **most** different types of human cells.
Human adult stem cells can form **many** (but not all) types of cells including blood cells.
Human stem cells can be used to **help treat diseases** like **diabetes** and **paralysis.**



Embryos produced by **therapeutic cloning** have the **same genes as the patient**.
This means stem cells from the embryo are **not rejected by the patient's body.**
This is why they can be used for medical treatments.
The **risks** of using stem cells risks such as the **transfer** of **viral infections.**
Some people have objections to stem cell use for **ethical** and **religious** reasons.
During fertility treatment doctors usually fertilise many more eggs than are going to be used. The **embryos** formed are used to **obtain** stem cells.
In the UK, **scientists** can use these embryos for **research** but only under **very strict guidelines**.

Most types of **PLANT** cells can **differentiate throughout their life** cycle.

Undifferentiated stem cells in **plants** are grouped together in **structures called meristems.**
The undifferentiated cells can then specialise e.g. root hair cell, xylem or phloem cells.



Stem cells from **meristems in plants** can be used to produce **clones of plants** quickly and economically.
- **Rare species** can be cloned to protect from extinction.
- **Crop plants** with special features, such as disease resistance, can be cloned to produce large numbers of identical plants for farmers
e.g. potatoes, strawberries and dates.

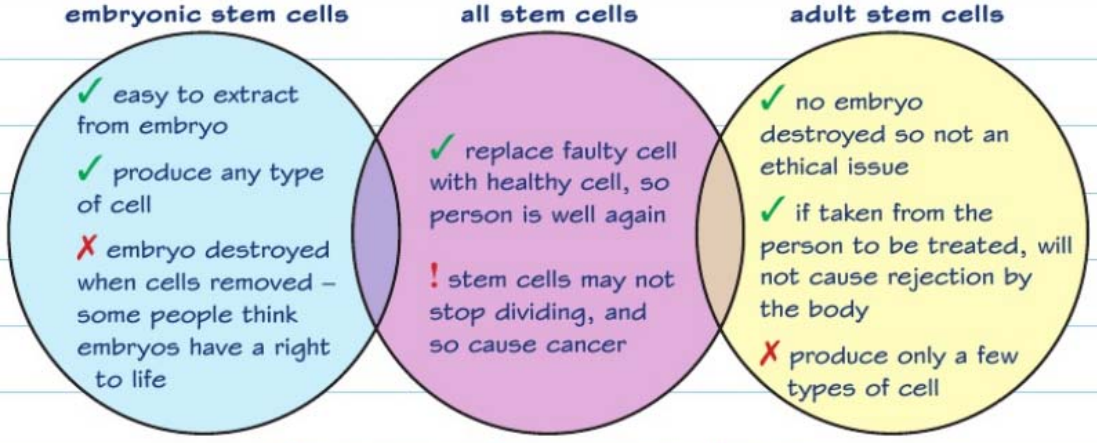
Embryonic stem cells

Embryonic stem cells have many uses, including:
- replacing or repairing brain cells to treat people with Parkinson's disease
- replacing damaged cells in the retina of the eye to treat some kinds of blindness
- growing new tissues in the lab to use for transplants or drug testing.

Adult stem cells

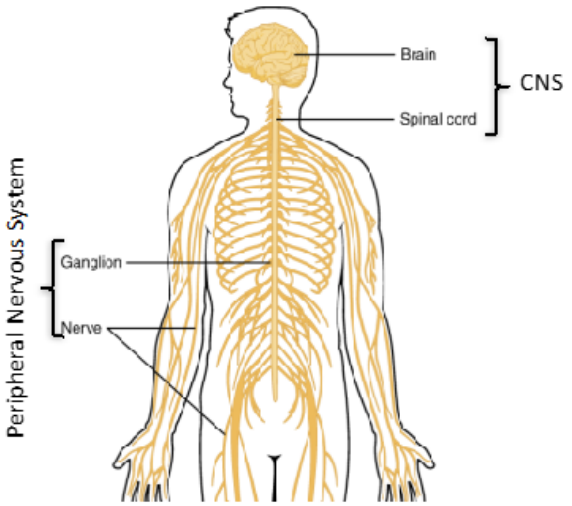
Adult stem cells (from bone marrow) can only form a limited number of cell types. They can be used for:
- treatment of leukaemia
- potentially growing new tissues that are genetically matched to the patient.

Using stem cells



✓ – Advantage ✗ – Disadvantage ! – Risk

The nervous system enables humans to react to their surroundings and to coordinate their behaviour.



A **stimulus** is any change in the soundings. These are detected by **receptors** (cells that detect a change) and information passes along cells (neurones) as **electrical impulses** to the **central nervous system** (CNS).

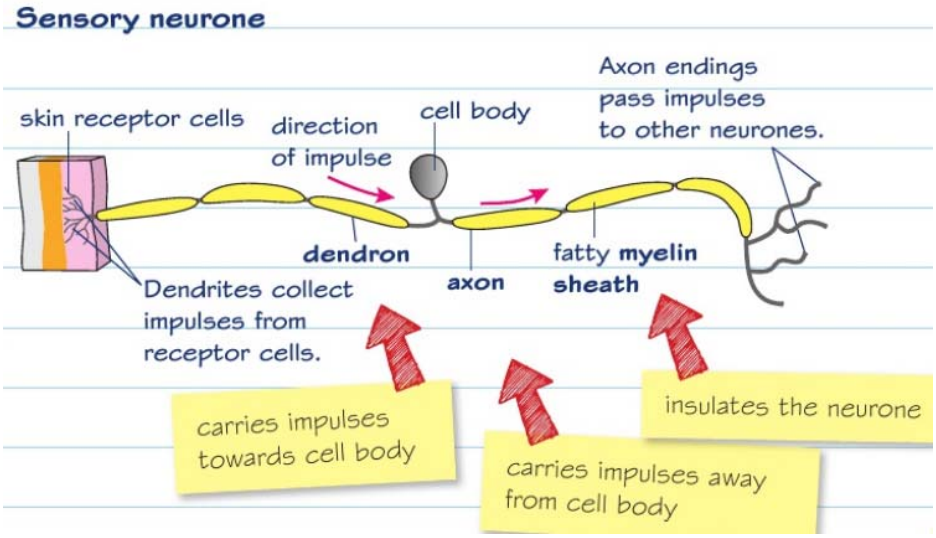
The **CNS** is the **brain** and **spinal cord**.

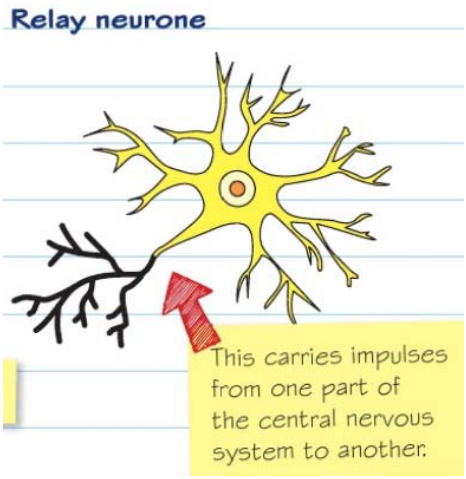
The **CNS coordinates** the **response of effectors** which may be muscles contracting or glands secreting hormones.

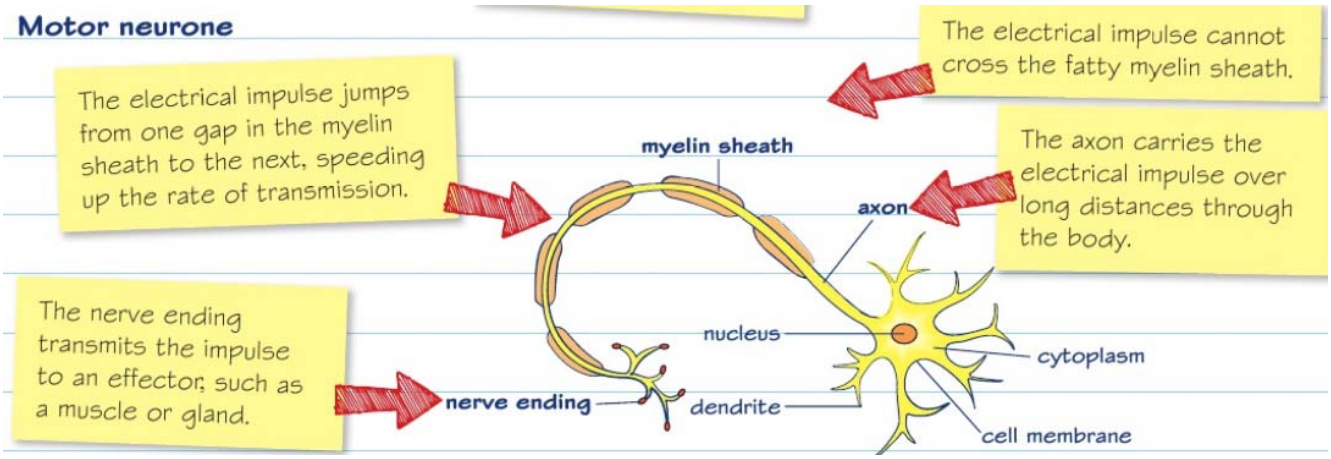
stimulus → receptor → coordinator → effector → response

There are **three main types** of neurones:

A. **Sensory neurones** – these carry impulses from the receptors to the central nervous system (CNS).
B. **Relay neurones** – these connect the sensory neurones to the motor neurones in the CNS.
C. **Motor neurones** – these carry impulses from the CNS to an effector.

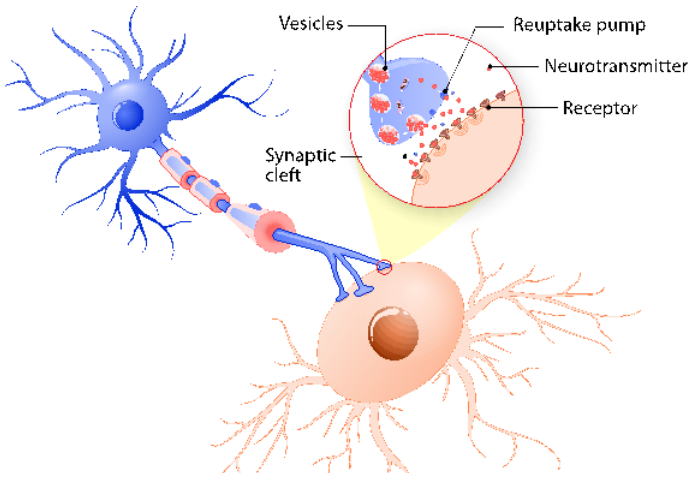






Neurones are not joined together. They have small gap between them. **The gap is called a synapse**

- When an impulse reaches the end of a neurone a chemical (**neurotransmitter**) is released across the gap.
- The chemical then **diffuses** across the synapse.
- When the chemical reaches the next neurone in sufficient quantities this starts **another impulse**.



Structure	Function
Receptor	Specialised cells which detect stimuli and turn them into electrical impulses
Axon	Carries electrical impulses **away** from the cell body
Dendron	Carries electrical impulses from receptor **towards** cell body
Dendrite	Branched ends which receive electrical impulses
Myelin sheath	Layer of fatty insulating material around motor and sensory neurones which speeds up transmission of the impulse
Synapse	Gap between neurones which ensures impulses travel in one direction
Neurotransmitter	Chemical involved in passing impulses from one nerve cell to another across a synapse
Effector	Organ, tissue or cell which produces a response

The reflex arc

Stimulus detected by receptor

↓

Impulses pass along sensory neurone to spinal cord

↓

Impulses pass to relay neurone

↓

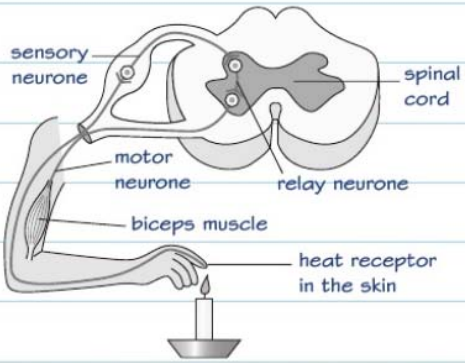
Impulses pass from relay neurone to motor neurone

↓

Impulses pass along motor neurone to effector, in this case a muscle

↓

Hand moves away from stimulus



If the impulses had to go to the brain to be processed, there would be many more synapses, so the response would take longer.

Reflex arcs involve only three neurones, and impulses pass to and from the spinal cord. This provides a fast response that does not involve the brain. Reflex arcs are:

- immediate (happen very fast)
- involuntary (the brain isn't needed)
- innate (not learned)
- invariable (always exactly the same).

These reflexes help protect us from immediate harm, such as the eye blink reflex which protects the eye if something comes close to it.