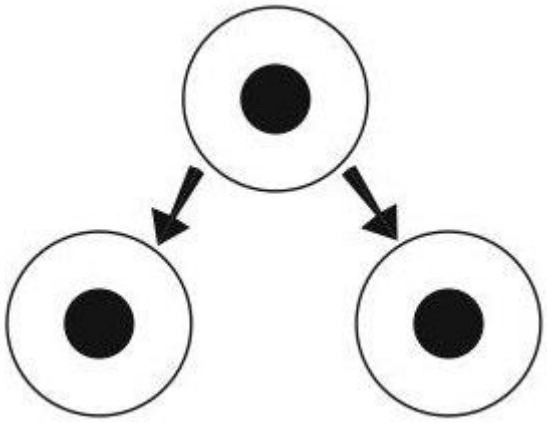
Growth and development



Name	_____
Class	_____
Teacher	_____

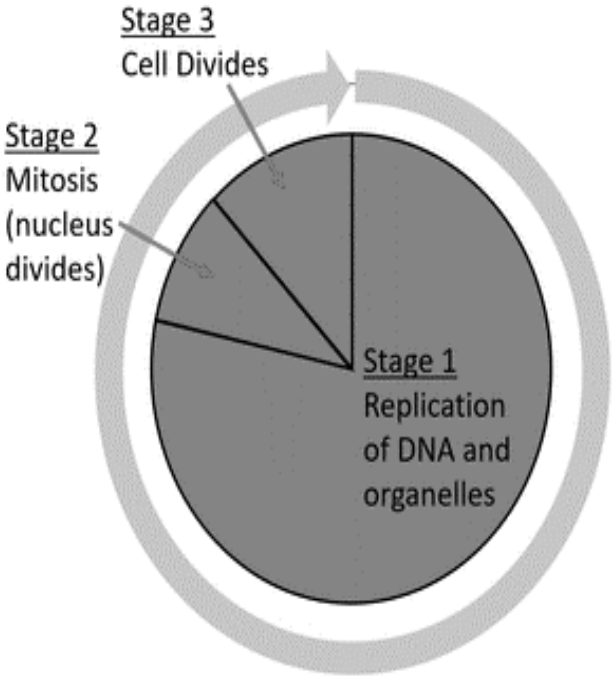
L1 Mitosis and Cell Cycle

Multicellular organisms are made up of many cells, and these cells are genetically identical to each other. The cells are produced by a process called mitosis, which is a type of cell division.

Mitosis produces cells that are genetically identical for

- Growth
- Replacement of old cells
- Repair of damaged tissue
- Asexual reproduction

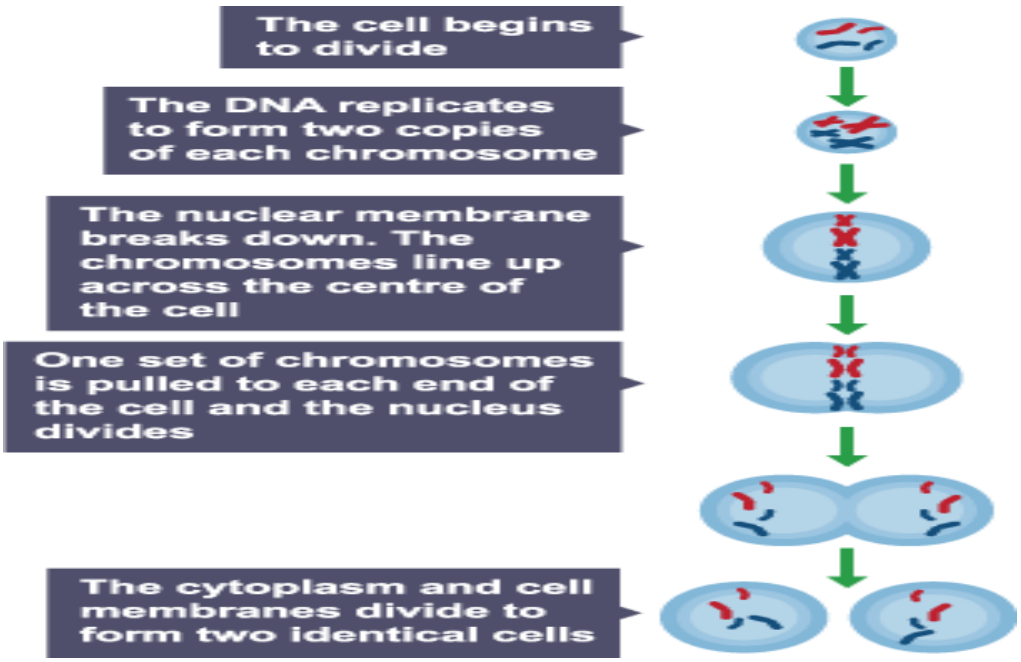
Mitosis is part of the Cell cycle - The series of stages that a cell goes through as it is growing and dividing.



During the cell cycle the genetic material is doubled and then divided into two identical cells.

- Before a cell can divide it needs to grow and increase the number of sub-cellular structures such as ribosomes and mitochondria. (Stage 1)
- The DNA replicates to form two copies of each chromosome. (Stage 1)
- In mitosis one set of chromosomes is pulled to each end of the cell (poles) and the nucleus divides. (Stage 2)
- Finally the cytoplasm and cell membranes divide to form two identical cells. (Stage 3). This is called cytokinesis

Mitosis



Independent practice

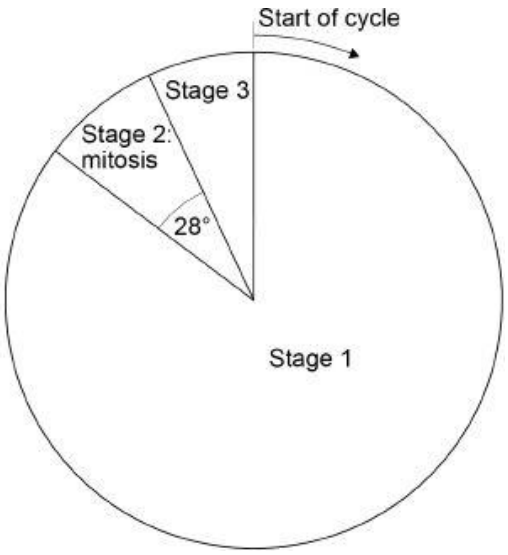
1) Does mitosis produce genetically identical or genetically different cells?
2) How many cells are produced in mitosis?
3) If the starting cell has 14 chromosomes how many chromosomes will the daughter cells have?
4) What must happen to the DNA inside a cell before it can undergo mitosis?
5) If a cell has 50 chromosomes just before it divides, how many chromosomes did it have before hand?
6) Why is it important that the organelles are duplicated before mitosis?
7) After the chromosomes line up along the middle what happens to them?
8) What happens to the nucleus during mitosis?
9) Complete the sentences

a) The cell cycle is…..
b) In stage 1 the organelles are….
c) In stage 1 the DNA is….
d) In stage 2 the…..
e) In stage 3 the …….

10) Embryonic stem cells divide by mitosis.

Figure 1 represents a cell cycle for a human embryonic stem cell.

Figure 1



(a) The mass of DNA in the cell at the start of the cycle is 6 picograms. A picogram is 10^{-3} nanograms. Convert 6 picograms to grams. Give your answer in standard form.

(b) The time taken for this complete cell cycle is 15 hours. Calculate how many hours the cell spent in mitosis. Give your answer to 3 significant figures.

L2 Stem Cells

All cells in our body are derived from stem cells. Stem cells are very simple cells without any adaptations. **They are undifferentiated. Cell differentiation** is the process by which cells **become specialised to perform specific functions in an organism.**

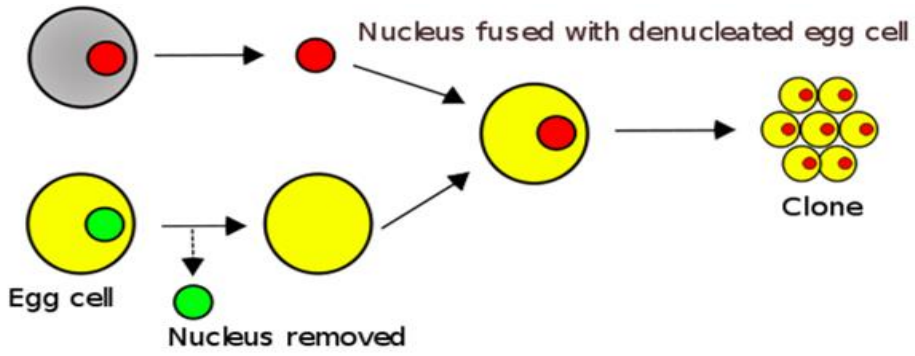
An *embryo* develops from a fertilised egg. Cells at the early stages in the development of the embryo are stem cells. If cells are removed from the embryo – called *embryonic stem cells* - they will differentiate into any cell type. This is important because a developing embryo needs to be able to create all the cells required for the organism to function.

Some stem cells remain in the bodies of adults – *adult stem cells*. Adult stem cells are found in limited numbers at certain locations in the body. Adult stem cells can be found in several regions of the body, including bone marrow. Adult stem cells can differentiate into related cell types only, for example, *bone marrow* cells can differentiate into blood cells and cells of the *immune system* but not other cell types.

It is now possible to use stem cells in the treatments of a variety of different diseases, such as paralysis or diabetes. One method is by a process called therapeutic cloning.

In therapeutic cloning an embryo is produced with the same genes as the patient. Stem cells from the embryo are not rejected by the patient's body.

- A body cell is taken from the patient. The nucleus is separated from the cell.
- The nucleus from the patient's cell is fused with an empty egg cell from the donor.
- The cells are stimulated to divide and develop into an embryo.
- Stem cells are available for therapeutic use.



Treatments can use either embryonic or adult stem cells, which both come with advantages and disadvantages.

Embryonic stem cells

Advantages

- Create many embryos in lab or come from donated embryos
- Painless technique
- Treat many diseases
- Become any type of cell

Disadvantages

- Destroys embryo
- Rights for embryos/embryo cannot consent
- Unreliable
- Can cause cancer

Adult stem cells

Advantages

- No ethical issues
- Can treat some diseases
- Procedure is (relatively) safe
- Reliable technique
- Quick recovery

Disadvantages

- Risk of infection
- Can only treat a few diseases
- Procedure can be painful

Plant stem cells

Cell division in plants occurs in regions called meristems. Cells of the meristem can differentiate to produce all types of plant cells at any time during the life of the plant.The main meristems are close to the tip of the shoot, and the tip of the root. 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

<u>Independent practice</u>

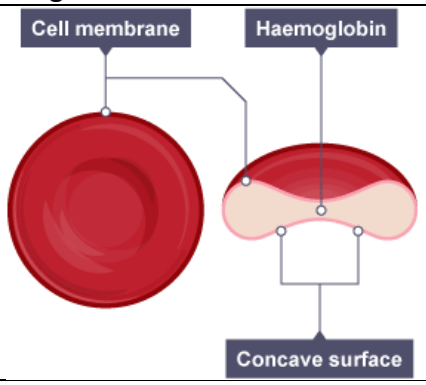
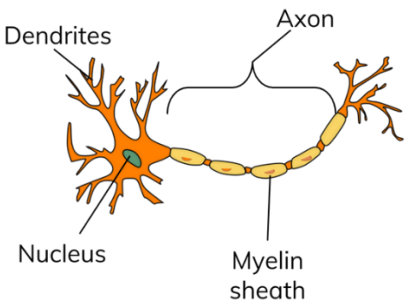
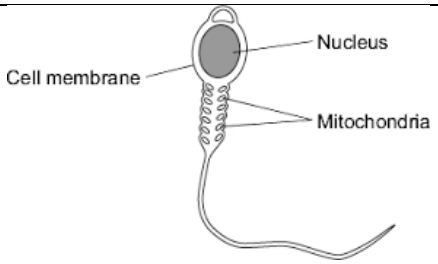
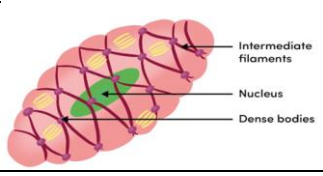
1. Correct this definition “Stem cells are differentiated cells”
2. Explain the term differentiation.
3. What are the two types of stem cells in humans?
4. Which type of stem cell in humans can differentiate into any cell type?
5. Describe the function of stem cells in embryos.
6. Why can treatments with stem cells potentially help conditions like diabetes and paralysis?
7. Why does therapeutic cloning not have a risk of rejection for when being used to treat diseases.
8. Name an objection to the use of embryonic stem cells.
9. Treatments using which type of stem cell are more reliable?
10. Stem cells from human embryos are used to treat some diseases in humans. Explain why.
11. Where are stem cells found in plants?
12. Stem cells can be obtained from human embryos. Evaluate the use of stem cells from a patient’s own bone marrow instead of stem cells from an embryo. Give a conclusion to your answer. (6 marks)
    - Structure
    - Advantages of embryonic stem cells
    - Disadvantages of embryonic stem cells
    - Advantage of adult bone marrow stem cells
    - Disadvantage of adult bone marrow cells
    - Conclusion.

L3 Specialised cells

Animals and plants produced by sexual reproduction begin life as a single cell – a fertilised egg or zygote. This cell must divide to produce a multicellular organism. It must also differentiate (become specialised) so that its cells develop features that enable them to fulfil specific roles.

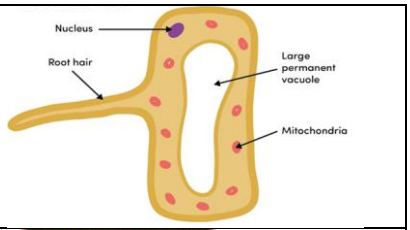
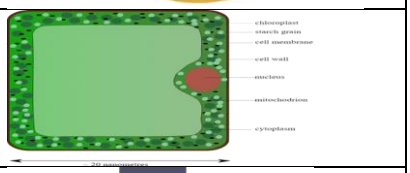
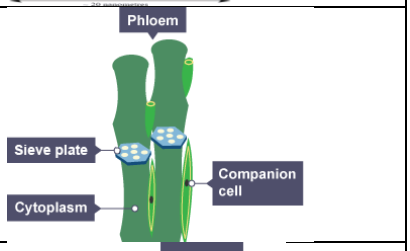
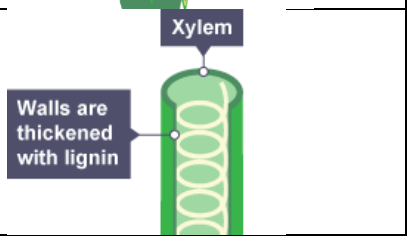
Specialised cells in animals.

Experts estimate that there are around 200 cell types in the human body. Cell types can look different, and carry out distinct roles within the body. Below are some of the commonly assessed specialised cells found in animals.

Cell Type	Specialisations	Diagram
Red blood cells – Primary function to carry oxygen around the body.	Contains **haemoglobin (**which oxygen binds to). Has no nucleus so more space for oxygen. Biconcave shape to increase surface area.	
Nerve cell – To carry electrical impulses around the body.	Many dendrites to connect to many different nerve cells. longer shape than other cells, as signals need to go over large distances in the body. Myelin sheath insulates the cell and allows impulses to travel faster.	
Sperm Cell – Male sex cell (gamete)	Enzymes in head to get into the egg. Head contains nucleus with half the number chromosomes for fertilisation. The mid piece is full of mitochondria. Tail/ flagellum to move to egg.	
Muscle cell	Contains many mitochondria. contain filaments of protein that slide over each other to cause muscle contraction.	

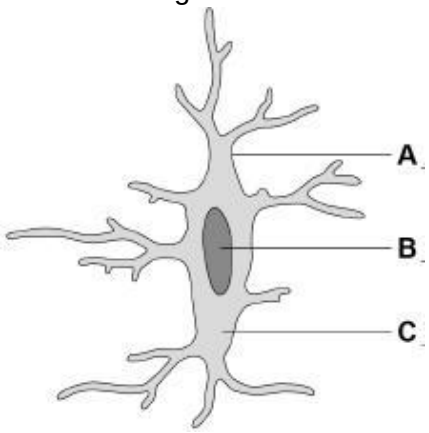
Specialised plant cells

Like animals plants are multicellular organisms, which different cell types. Below are some of the common cell types found in plants.

Root hair cells – In the roots for the absorptions of substances such water and nutrients	Root hair cells have a large surface area to absorb water and minerals. Large number of mitochondria for active transport No chloroplasts.	
Palisade cell – Found in the leaf and for photosynthesis.	Many chloroplasts	
Phloem – involved in transport of sugars. (Translocation)	No nucleus and they have a large vacuole. Have pores in the walls between cells. Have companion cells.	
Xylem – involved in the transport of water. (Transpiration/Transpiration stream)	Dead hollow cells. Have no end walls between the cells. External cells strengthen with lignin.	

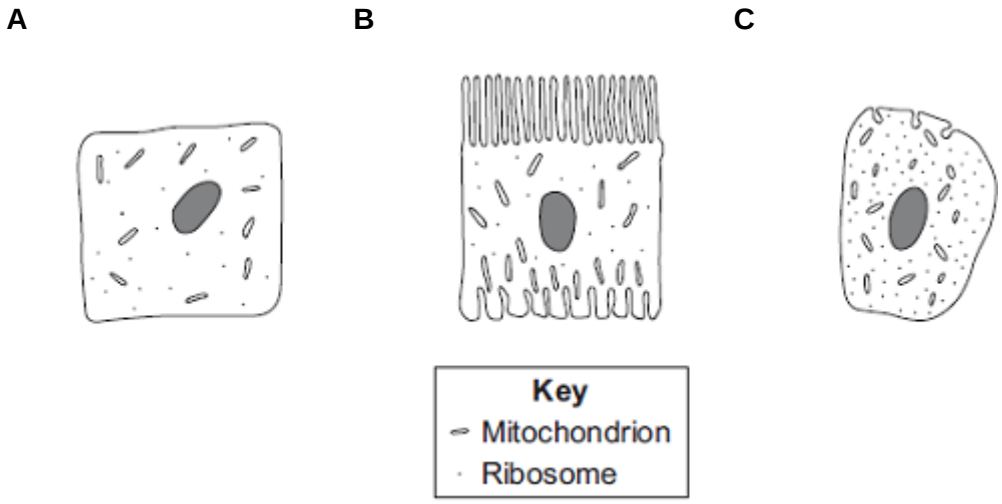
<u>Independent practice</u>

1. Are stem cells differentiated cells?
2. Explain the term differentiation.
3. Name which type of animal cell is packed with haemoglobin.
4. Which two animal cells have more mitochondria than others?
5. Why do nerve cells have many dendrites?
6. True or false: Phloem are dead cells.
7. True or false: Xylem cells have pores in the walls between cells.
8. Which type of plant cell have cell walls strengthen with lignin.
9. Compare palisade cells and root hair cells (3 marks)
10. The diagram below shows a human bone cell.



a) Name structures A, B and C (3)
b) Which structure contains DNA? (1)

11) Diagrams **A**, **B** and **C** show cells from different parts of the human body, all drawn to the same scale.



(a) Which cell, **A**, **B** or **C**, appears to be best adapted to increase diffusion into or out of the cell? Give **one** reason for your choice. **(1)**

(b) (i) Cell **C** is found in the salivary glands. Name the enzyme produced by the salivary glands. **(1)**

(ii) Use information from the diagram to explain how cell **C** is adapted for producing this enzyme. **(2)**