



Recap

We covered the basics of the cell replication process of mitosis, with the three main stages: interphase, mitosis and cytokinesis. We learnt how the cell changes in each of these stages, and in what instances mitosis is used.



Key Aims

1. Embryonic Stem Cells
2. Adult Bone Marrow Stem Cells
3. Plant Stem Cells
4. Treatment with Stem Cells



AQA Specification

A stem cell is an undifferentiated cell of an organism which is capable of giving rise to many more cells of the same type and from which certain other cells can arise from differentiation.



AQA Specification

Students should be able to describe the function of stem cells in embryos in adult animals and in the meristems of plants.

1.2.3. Stem Cells

Types of Stem Cells

A **stem cell** is an undifferentiated cell. This means that it has not yet specialised, and therefore has the ability to differentiate and form a specialised cell.

A stem cell can divide by mitosis to form a tissue of stem cells. Then different cell clusters can differentiate to different things, leading to many tissues of different specialised cells. This is how the human body develops from a single **embryonic** stem cell.

Embryonic Stem Cells

- **Stem cells in embryos are known as embryonic stem cells.** Embryonic stem cells are found in early embryos and are completely undifferentiated. This means that they can be used to turn into any type of cell.
- **Embryonic stem cells can be cloned and made into most types of cells.** Environmental factors can be used to influence their differentiation into almost any type of cell. This has many potential medical applications.

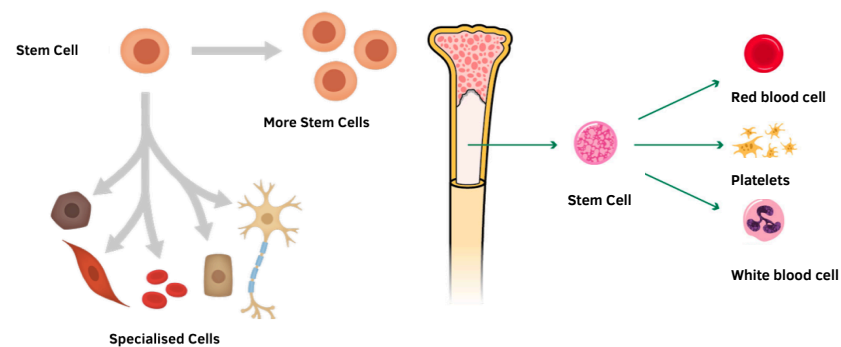


Fig 1. Stem Cells. Stem cells can differentiate into most types of cells.





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Knowledge and understanding of stem cell techniques are not required.



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Stem cells from human embryos can be cloned and made to differentiate into most different types of human cells.



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Stem cells from adult bone marrow can form many types of cells, including blood cells.



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Meristem tissue in plants can differentiate into any type of plant cell.



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Treatment with stem cells may be able to help conditions such as diabetes and paralysis.

Adult Bone Marrow Stem Cells

- **Stem cells in adults are only found in a few places.** Stem cells can be found in the bone marrow, teeth and other areas. These cells cannot differentiate into any type of cells (like embryonic stem cells). Instead, they can only differentiate into a few predetermined cells, such as some blood cells.
- **Adult stem cells can form many types blood cells.** Adult stem cells can be used to form different blood cells, including red blood cells and white blood cells.

Plant Stem Cells

- **Stem cells are found in plant meristems.** Stem cells in plant meristems can differentiate to form any type of plant cell. They are present throughout the lifespan of the plant.

Treatment using Stem Cells

- **Stem cells can be used to treat diabetes.** In **diabetes**, patients suffer from a lack of insulin, and therefore have high blood glucose levels. Stem cells can be made that can produce insulin, in order to treat those who suffer from diabetes (type I). This insulin can be used in insulin injections.
- **Stem cells can be used to treat paralysis.** Stem cells can be differentiated to form nerve cells. These cells are used to treat those who suffer from the nerve damage that causes certain types of **paralysis**.

Therapeutic Cloning

- **Immune rejection is an issue in medical treatment.** Although the above techniques (for diabetes and paralysis) are effective, there is a risk of the recipient's immune system rejecting the 'foreign' cells. Therefore we can use therapeutic cloning to reduce the risk of rejection.





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In therapeutic cloning, an embryo is produced with the same genes as the patient.



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Stem cells from the embryo are not rejected by the patient's body, so they may be used for medical treatment.



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The use of stem cells has potential risks, such as transfer of viral infection and some people have ethical or religious obligations.

- **Therapeutic cloning uses stem cells from the patient.** An embryo is produced, to have the same genetical material as the patient. Stem cells are then taken from the embryo to treat the patient. These cells should not be rejected by the immune system of the patient, as they have the same genetic material as the patient.

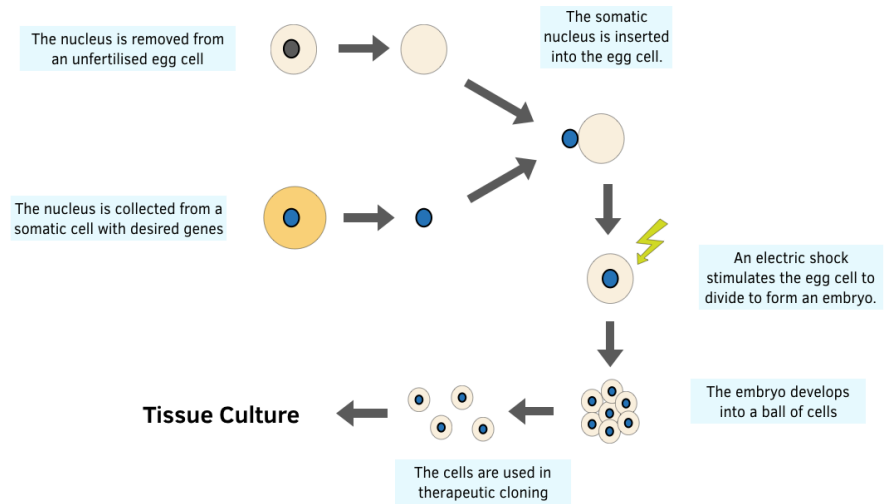


Fig 2. Cloning.

Ethical Debate

There are many ethical opinions for and against the use of stem cells for both treatment and research:

For	Against
Stem cell research can be used to treat many diseases, including diabetes and nerve paralysis. Therefore more lives are saved in the long-run	There is destruction of embryos produced from fertilisation. Some believe that life starts after fertilisation, so it is essentially killing. There are moral issues, and religion can come into play.





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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.



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Crop plants with special features for disease resistance can be cloned to produce large numbers of identical plants for farmers.



Knowledge Recall

1. What is a stem cell?
2. Which diseases can stem cells be used to treat?
3. What are the ethical issues surrounding the use of stem cells?

Stem cell research can be used in research, to aid discovery of treatments for diseases such as cancers.	If the sample of stem cells is contaminated by a virus, they could be transmitted to the patient. This could have negative implications on the health of the patient.
Stem cell research may occur illegally if it was banned, so it is better for the government to legalise it and regulate it heavily.	The current restrictions may not be followed inside labs.

Fig 3. Opinions For and Against the Use of Stem Cells.

- **Meristems can be used to prevent extinction.** Stem cells from the meristems of plants that are threatened by extinction can be harvested. These plants can then be grown in favourable conditions, as clones of the original plant, in order to keep these rare plants in existence.
- **Meristems can be used to produce plants with favourable characteristics.** Stem cells can be harvested from the meristems of plants that have characteristics, such as resistance to particular diseases, ability to withstand extreme temperatures, fast rate of growth. Clones can then be made in large numbers. This will aid the farming industry.

