B1 L7 Revision notes 1 of 4

What stem cells are: real stem cells and a diagram, divide and differentiate

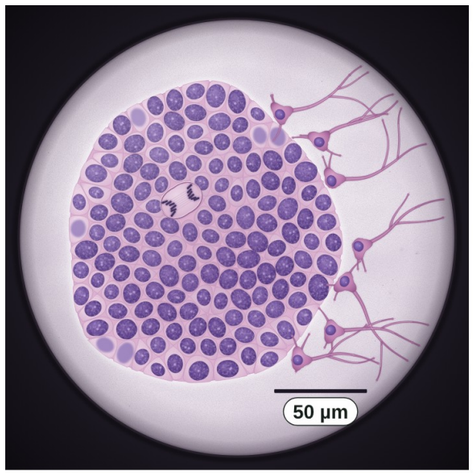
1. What is a stem cell?

A **stem cell** is an undifferentiated cell that can divide to make many more cells of the same type, and can differentiate into certain other types of cell.

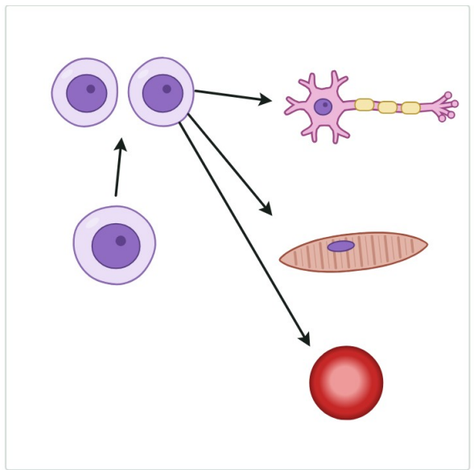
- **Undifferentiated** means not yet specialised for a particular job.
- **Differentiation** is the process by which a cell becomes specialised, gaining the sub-cellular structures it needs for its job.

Watch out: a stem cell is not a "special" cell. It is the opposite: it has not specialised yet.

2. Real stem cells and a diagram



Stem cells in a dish (a painting)



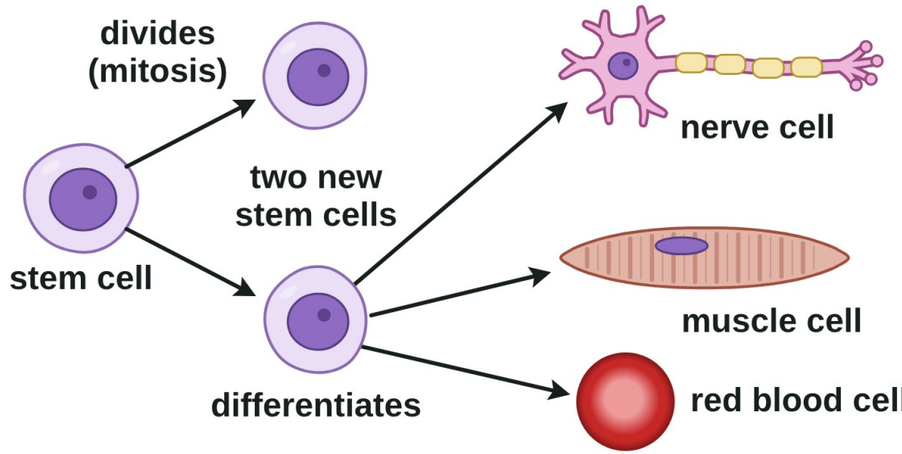
A diagram

A painting based on a light micrograph. Stains colour the cells.

- Real stem cells look plain and alike, and they grow packed together in a colony.
- They are tiny: about 10 µm across.
- The painting's colours are stains. In a diagram, colours only show the types of cell.

Stem cells look plain: they have not yet developed the structures of a specialised cell.

3. Divide and differentiate



- A stem cell divides by **mitosis** to make two genetically identical stem cells.
- Some new cells stay as stem cells, so there is always a supply.
- Others differentiate into specialised cells, such as nerve cells, muscle cells and red blood cells.

Watch out: division makes more cells; differentiation changes what a cell can do. A stem cell does not "divide into a nerve cell".

4. Stem cells in a growing organism

- In an **embryo**, stem cells make all the cells of the body as it grows.
- In an **adult**, stem cells repair the body and replace cells that wear out.
- In a **plant**, stem cells in the meristems make new cells so the plant can grow all through its life.

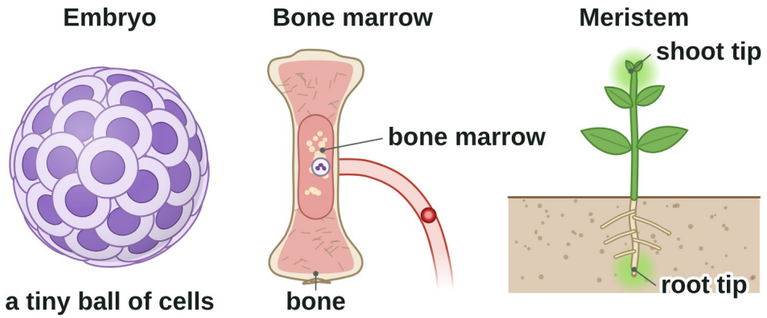
Most animal cells lose the ability to differentiate early. Many plant cells keep it.

B1 L7 Revision notes 2 of 4

Where stem cells come from: embryos, bone marrow and meristems; cloning plants

5. Three sources of stem cells

Stem cells from embryos can be cloned (grown into many identical cells) and made to differentiate into most types of human cell.



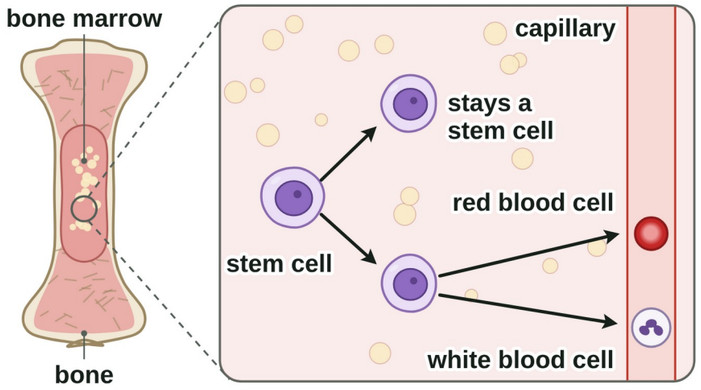
Source	Where	What the stem cells can become
Embryo	an early embryo: a tiny ball of cells	**most** types of human cell
Adult bone marrow	the soft tissue inside some bones	**many** types of cell, including blood cells
Plant meristem	the tips of roots and shoots	**any** type of plant cell, throughout the life of the plant

Watch out: most (embryo), many (adult bone marrow), any (meristem). Adult stem cells form fewer types of cell than embryonic stem cells.

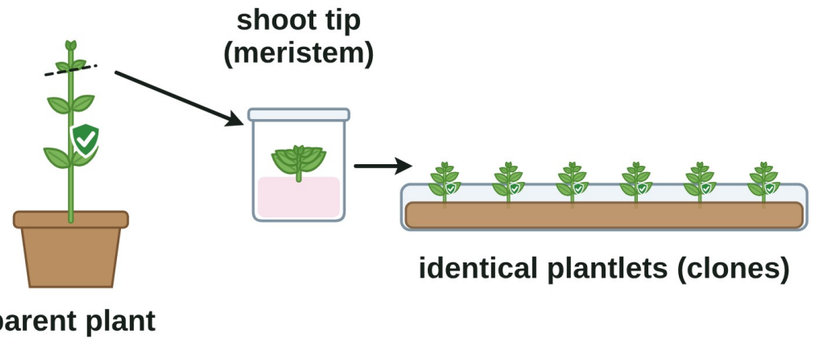
6. Bone marrow makes new blood cells

Stem cells in the **bone marrow** divide all the time. Some new cells become red blood cells or white blood cells.

A bone marrow transplant from a donor already helps people with some blood disorders, such as leukaemia.



7. Cloning plants from meristems



A **clone** is a genetically identical copy of a cell or an organism. Meristem cells can be used to clone plants quickly and economically.

- Rare plants can be cloned to protect them from extinction.
- Crop plants with special features, such as disease resistance, can be cloned to give farmers large numbers of identical plants.

Watch out: clones have no variation. If a new disease can attack one plant, it can attack them all.

8. Maths: percentages from a table

percentage = number with the feature ÷ total number × 100

Worked example: 400 plants are grown from seed. 200 have a useful feature. 200 ÷ 400 × 100 = **50 %**.

Clones from a plant with the feature: all of them have it (100 %).

B1 L7 Revision notes 3 of 4

Using stem cells: medicine, therapeutic cloning, risks, and ethical and religious issues

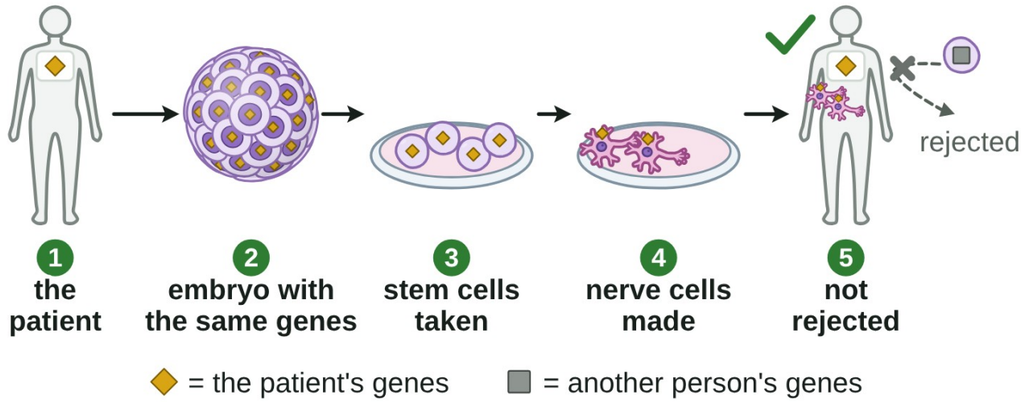
9. Stem cells in medicine

Condition	How stem cells might help	Now?
Blood disorders, such as leukaemia	new blood cells from donated bone marrow stem cells	**used now**
Diabetes	new cells that make insulin	being researched
Paralysis	new nerve cells to repair damaged nerves	being researched

Watch out: write "may be able to help". Most stem cell treatments are not yet cures.

10. Therapeutic cloning

Therapeutic cloning is producing an embryo with the same genes as the patient, so that its stem cells are not rejected by the patient's body.



The stem cells are made to differentiate into the cells the patient needs.

Watch out: the embryo is grown only for its stem cells, never to make a baby. The cells are not rejected because they have the same genes as the patient, not because they are stem cells.

11. Risks

- A virus (viral infection) could be passed on with the cells.
- The cells might divide out of control and form a tumour.
- The treatments are new, so long-term effects are not yet known.

12. Ethical and religious issues

An **ethical issue** is a question about whether something is morally right or wrong.

- Taking stem cells from an embryo destroys the embryo.
- Some people, including some religious groups, believe an early embryo should have the same right to life as a person.
- Others think helping patients matters more, especially when spare embryos from fertility treatment would not be used anyway.
- In the UK, research embryos are usually spare embryos from fertility treatment, given with consent; the law allows research only up to 14 days.

13. How to evaluate

1. Give the **benefits**: for example, stem cells may help people with diabetes or paralysis, and cells made by therapeutic cloning are not rejected.
2. Give the **risks**.
3. Give the **ethical issues**, both sides.
4. Then give your own **conclusion** with a reason.

There is no single right answer. People reach different views. In an exam, give both sides, then your own reasoned view.

Watch out: a risk is something that could go wrong, such as a virus being passed on. An ethical issue is about right and wrong, such as destroying an embryo. Do not give one as the other.

Questions or worries about anything here? Talk to a trusted adult. The NHS website has reliable information about stem cells and donating bone marrow.

B1 L7 Revision notes 4 of 4

Key words, exam tips and check yourself

Key words

Adult stem cell: a stem cell found in adult tissue, such as bone marrow, which can form many types of cell, including blood cells.

Bone marrow: the soft tissue inside some bones, where blood cells are made.

Clone: a genetically identical copy of a cell or an organism.

Differentiation: the process by which a cell becomes specialised, gaining the sub-cellular structures it needs for its job.

Embryo: an organism at its earliest stage of development; an early human embryo is a tiny ball of cells.

Embryonic stem cell: a stem cell from an early embryo, which can differentiate into most types of human cell.

Ethical issue: a question about whether something is morally right or wrong.

Genetically identical: having exactly the same genetic material.

Meristem: tissue at the growing tips of shoots and roots, where cells divide to make new cells.

Specialised cell: a cell with a structure that suits it to one job.

Stem cell: an undifferentiated cell that can divide to make many more cells of the same type, and can differentiate into certain other types of cell.

Therapeutic cloning: producing an embryo with the same genes as the patient, so that its stem cells are not rejected by the patient's body.

Undifferentiated: not yet specialised for a particular job.

Exam tips

- Learn the definition: a stem cell is undifferentiated, and it can divide and differentiate.
- Most, many, any: embryonic stem cells, most types of human cell; adult bone marrow stem cells, many types, including blood cells; meristem cells, any type of plant cell, all through the plant's life.
- Write "may be able to help", not "cures". Bone marrow transplants are the treatment used now.
- Therapeutic cloning: write both parts: same genes as the patient, so not rejected.
- "Evaluate" means benefits, risks and ethical issues (both sides), then a conclusion with a reason.
- For a percentage, write number ÷ total × 100, and show your working.

Check yourself

Cover the answers, then check.

1. What does "undifferentiated" mean?
2. Name the two processes that turn one stem cell into many specialised cells.
3. Name two sources of human stem cells.
4. Meristem cells can differentiate into which types of plant cell, and for how long?
5. Give two conditions that stem cells may be able to help.
6. In therapeutic cloning, how do the embryo's genes compare with the patient's genes?
7. Give one ethical or religious objection to using embryonic stem cells.
8. In a group of 300 plants grown from seed, 45 have a useful feature. Calculate the percentage.

Answers

1. Not yet specialised for a particular job.
2. Division (by mitosis) and differentiation.
3. Early embryos and adult bone marrow.
4. Any type of plant cell, throughout the life of the plant.
5. Diabetes and paralysis.
6. They are the same.
7. Taking the stem cells destroys the embryo; some people believe an early embryo should have the same right to life as a person.
8. 45 ÷ 300 × 100 = 15 %.