

MYP 4 UNIT 1

LESSON 7

TOPIC:

- Meristem cells in plants
- Using stem cells in medicine: potential benefits, risks, and ethical issues

Outcome

- I can explain what meristem cells are and give examples of where they are found in plants.
- I can describe examples of how embryonic and adult stem cells could be used in medical treatments, including potential benefits, risks and ethical issues.

Keywords

meristem

unspecialised cells that undergo mitosis and can differentiate into any type of plant cell

shoot

where new plant growth occurs above the ground

root

where new plant growth occurs underground

xylem

a plant tissue that transports water upwards through the plant

phloem

a plant tissue that transports sugars through the plant

Keywords

embryonic stem cell

A cell taken from an embryo that can differentiate into any type of specialised cell.

adult stem cell

A cell found in specific regions of the body that can differentiate into a limited number of related specialised cells.

specialised cell

A differentiated cell that is adapted to carry out a particular function.

immune rejection

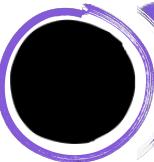
When a patient's immune system attacks non-self cells (e.g. transplants).

ethical

An ethical issue relates to whether an action and its consequences are right or wrong.

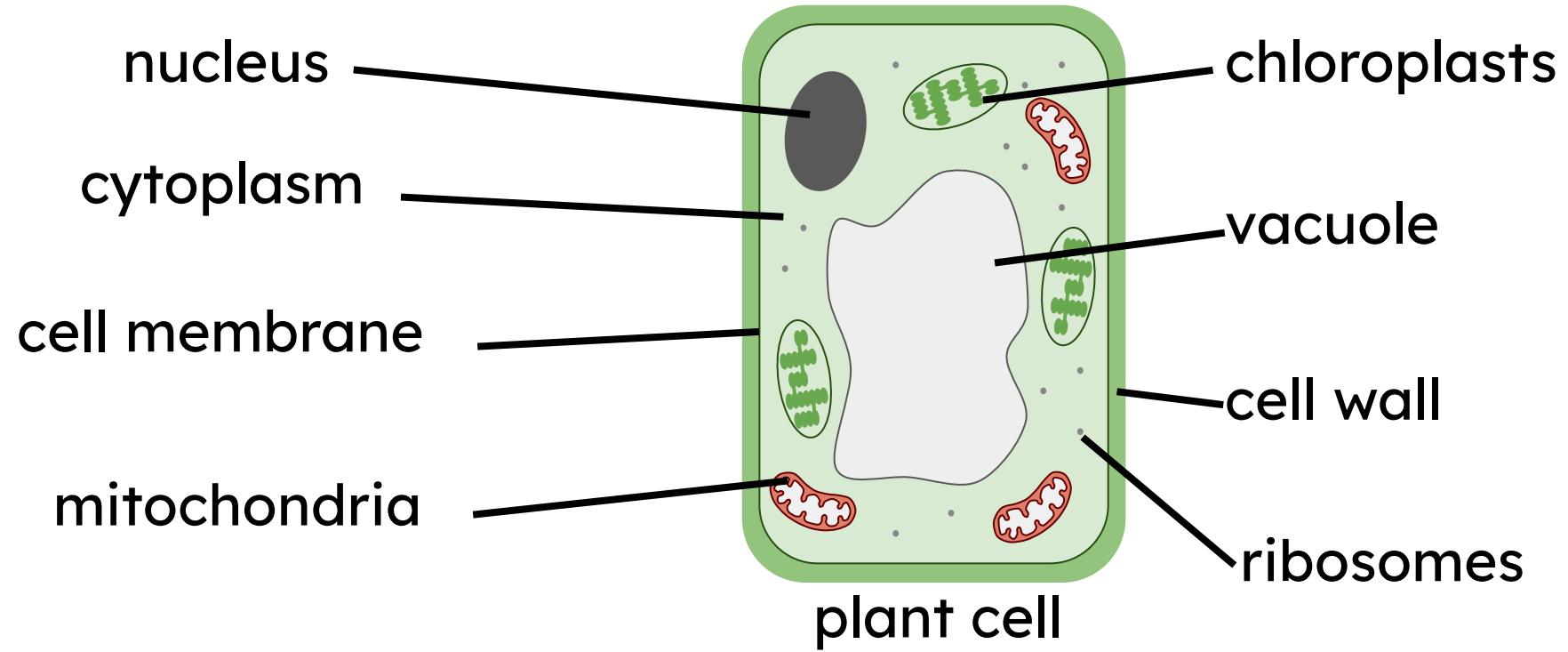
Lesson outline

Meristem cells in plants

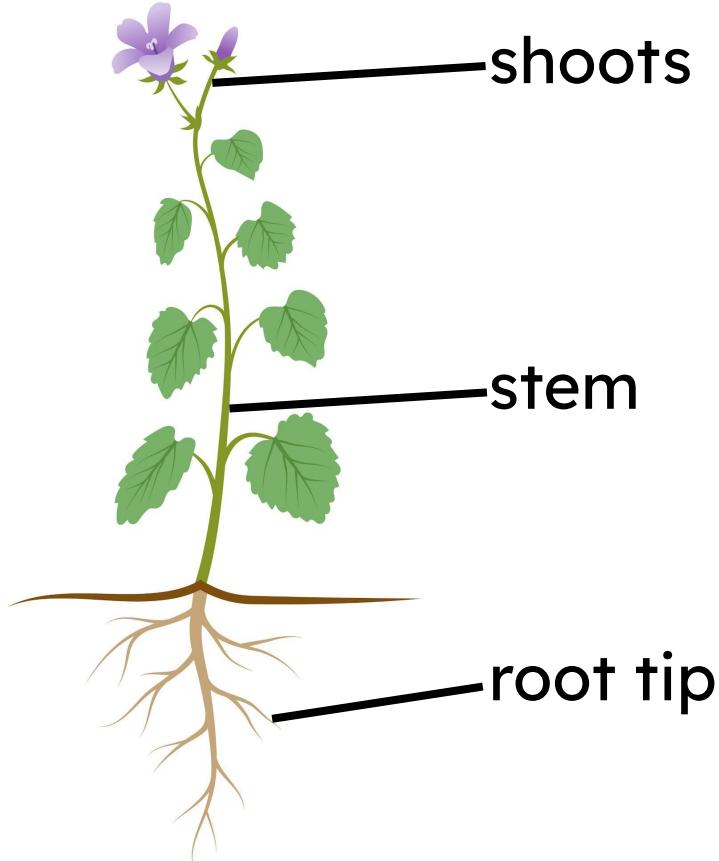
-  Stem cells in plants
-  Differentiation in plants
-  Uses of meristem in agriculture and conservation

Stem cells are cells that are not specialised for a particular function. They can differentiate into any type of cell.

Can you recall the main structures of a plant cell?

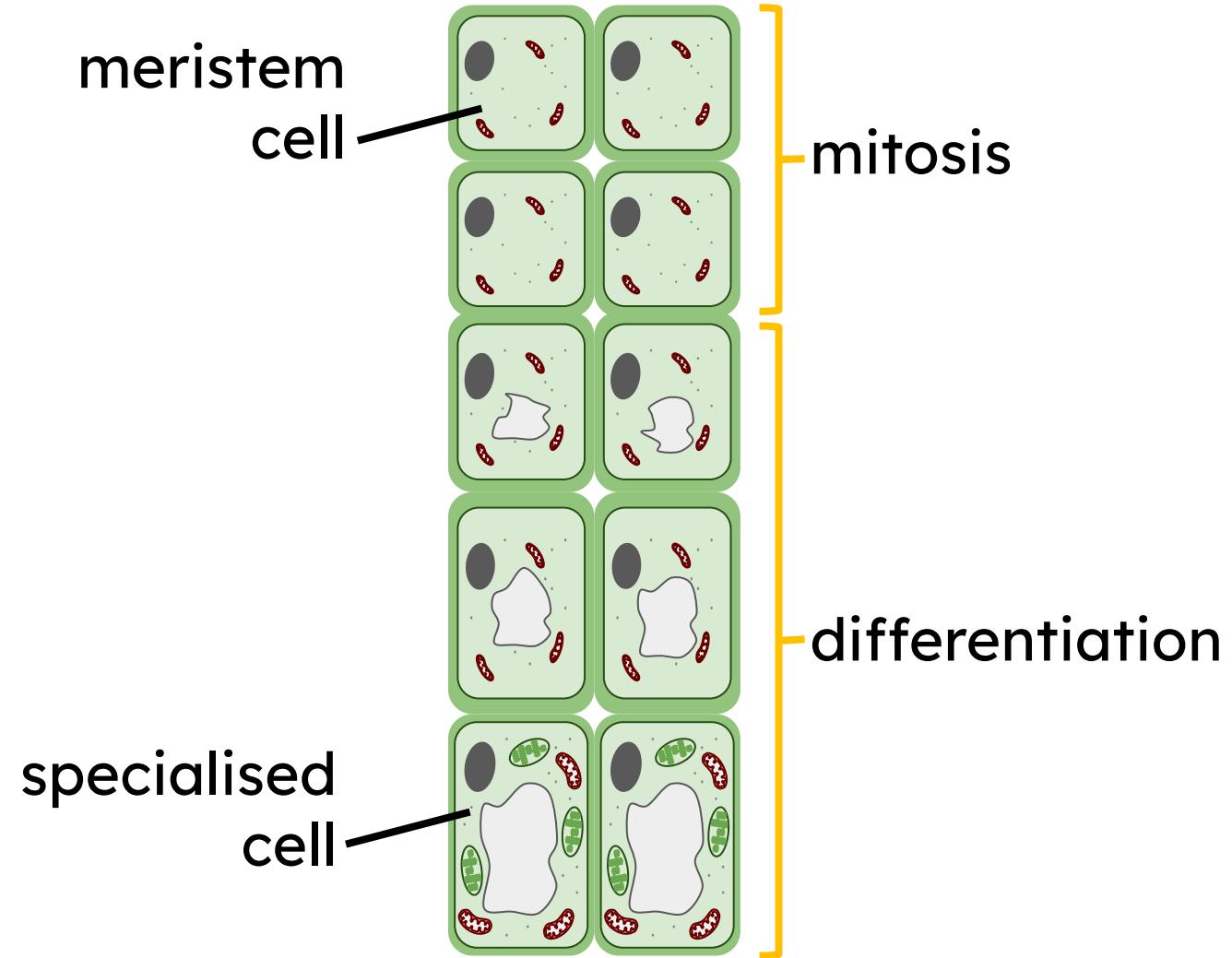


Stem cells in plants are found in particular regions of the plant that contain **meristem** tissue.



Meristem cells undergo mitosis and can differentiate into any type of plant cell.

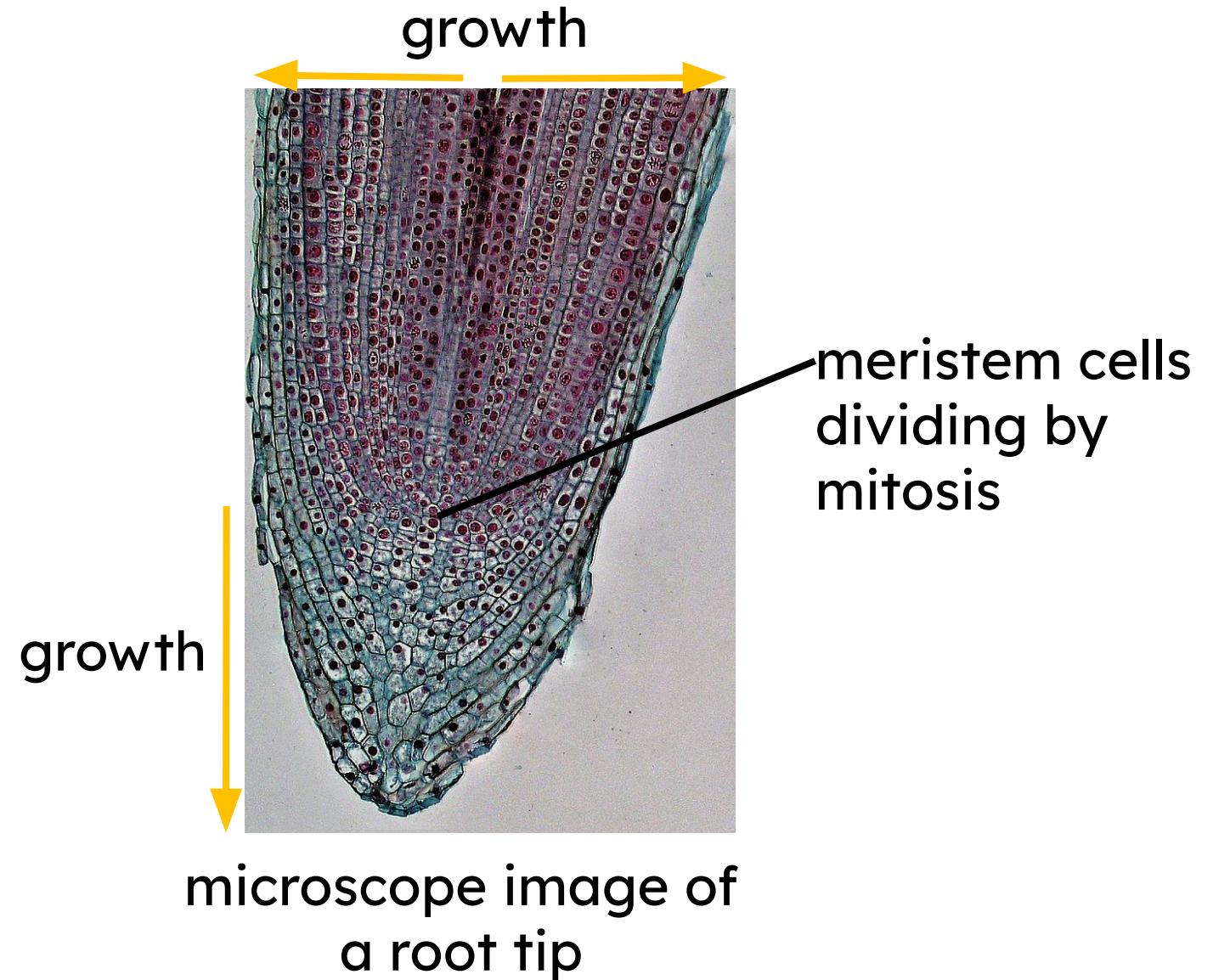
This can happen throughout the life of the plant.



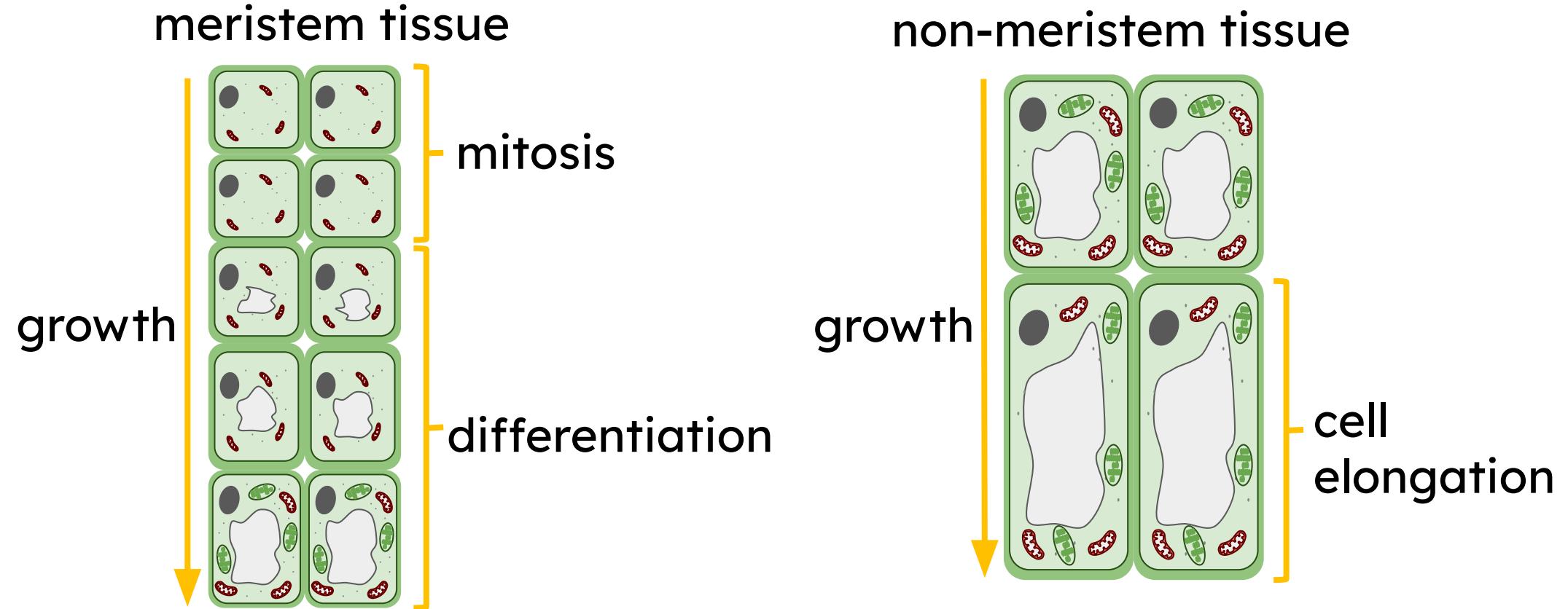
Stem cells in plants



The mitosis and differentiation of **meristem** tissue allows each part of a plant to grow in height, length and width.



Mitosis only occurs in **meristem** tissue. All other growth in a plant is due to cell elongation.

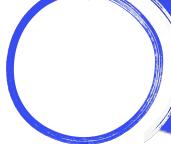


Select the parts of a plant that contain meristem tissue.

- a root tips ✓
- b shoots ✓
- c petals
- d stem ✓

Lesson outline

Meristem cells in plants

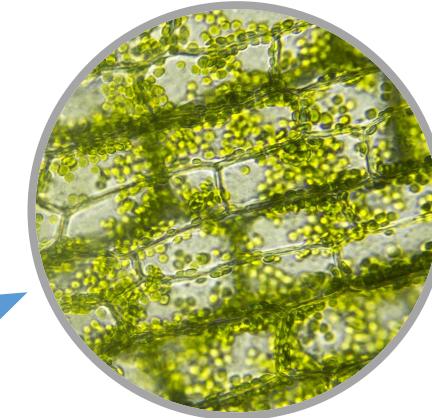
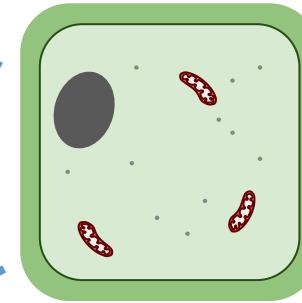
-  Stem cells in plants
-  Differentiation in plants
-  Uses of meristem in agriculture and conservation

Meristem cells can differentiate into many different types of specialised cells in a plant.

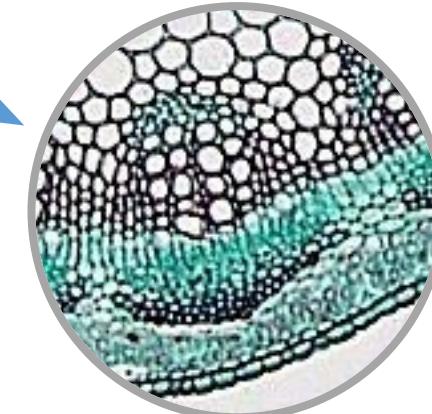
root hair cells



guard cells in a leaf

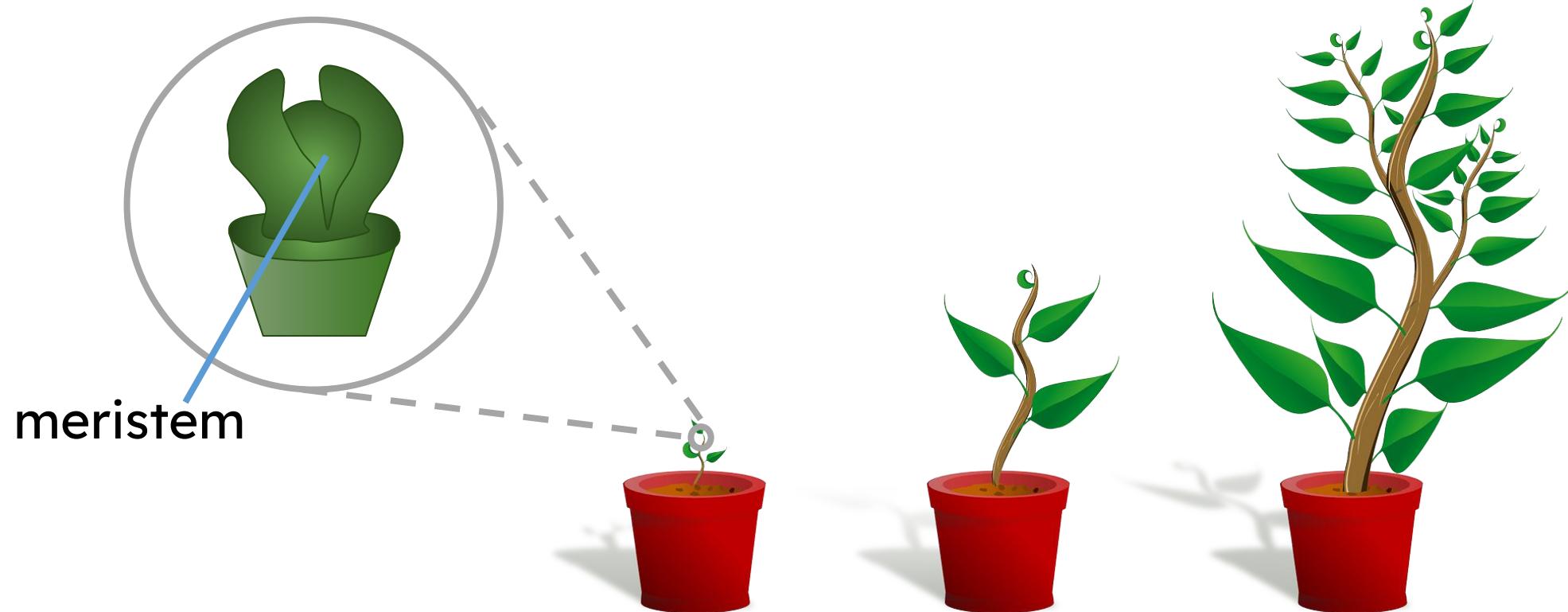


palisade cells in a leaf

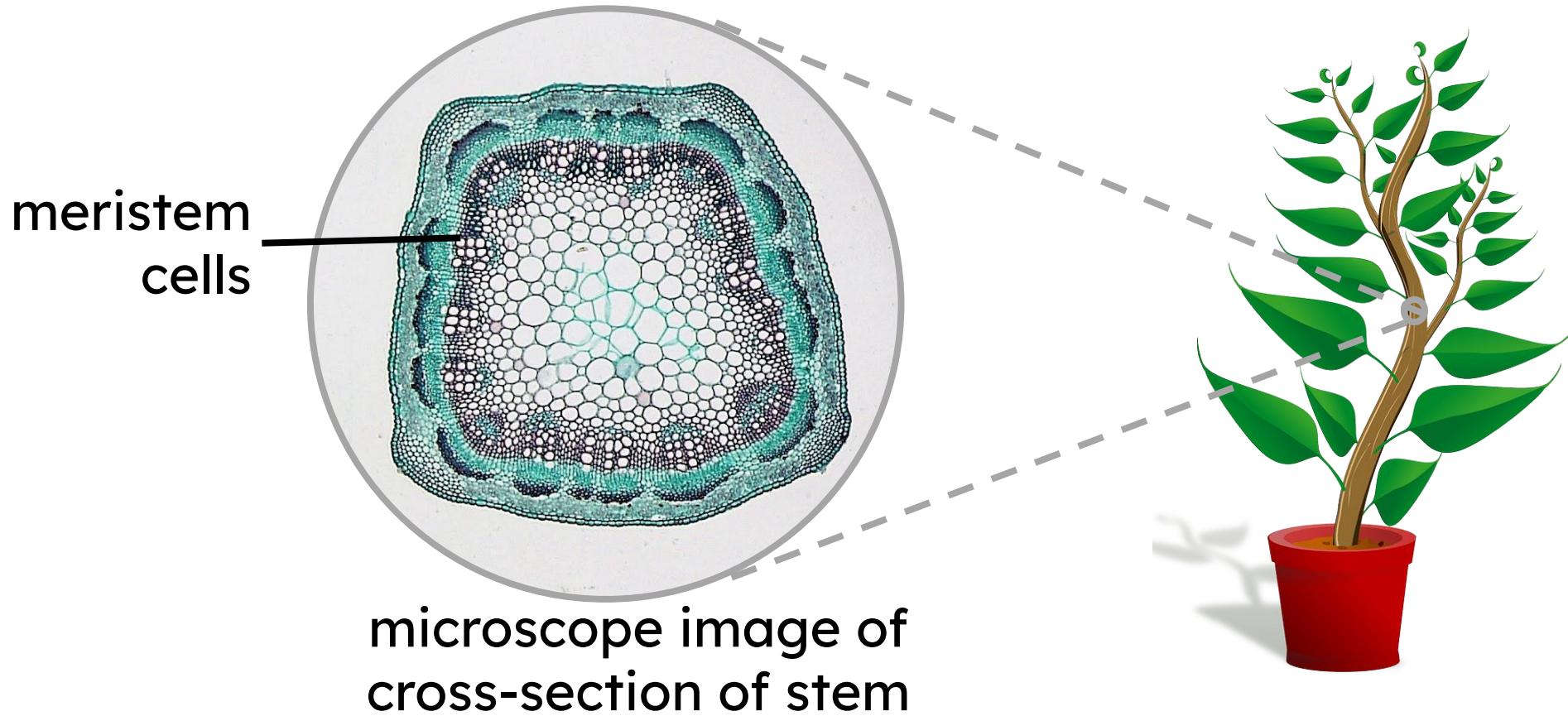


xylem and phloem cells in the stem

Meristem cells in the tips of **shoots** divide by mitosis and differentiate to form new leaves and flowers. This process continues as the stem grows.



Rings of meristem cells in the **shoot** stem divide and differentiate so that stems grow wider and taller.

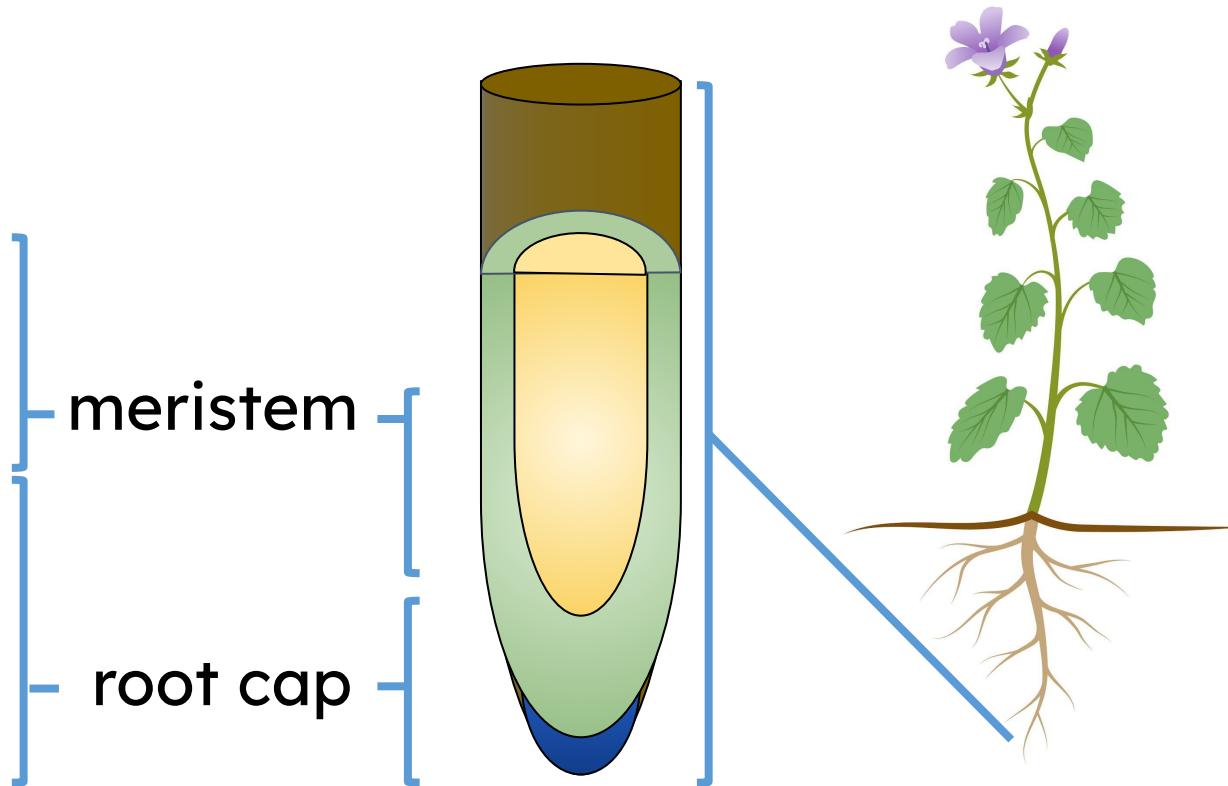
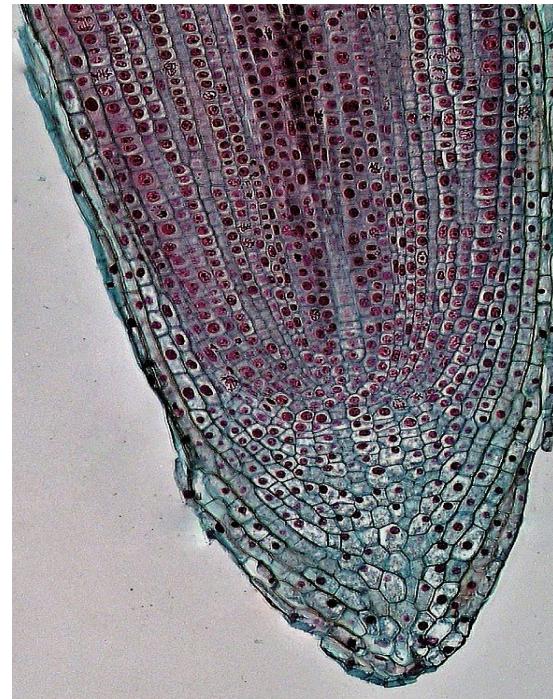


Differentiation in plants



Meristem cells at the tips of **roots** provide a constant supply of new cells allowing roots to grow longer and wider.

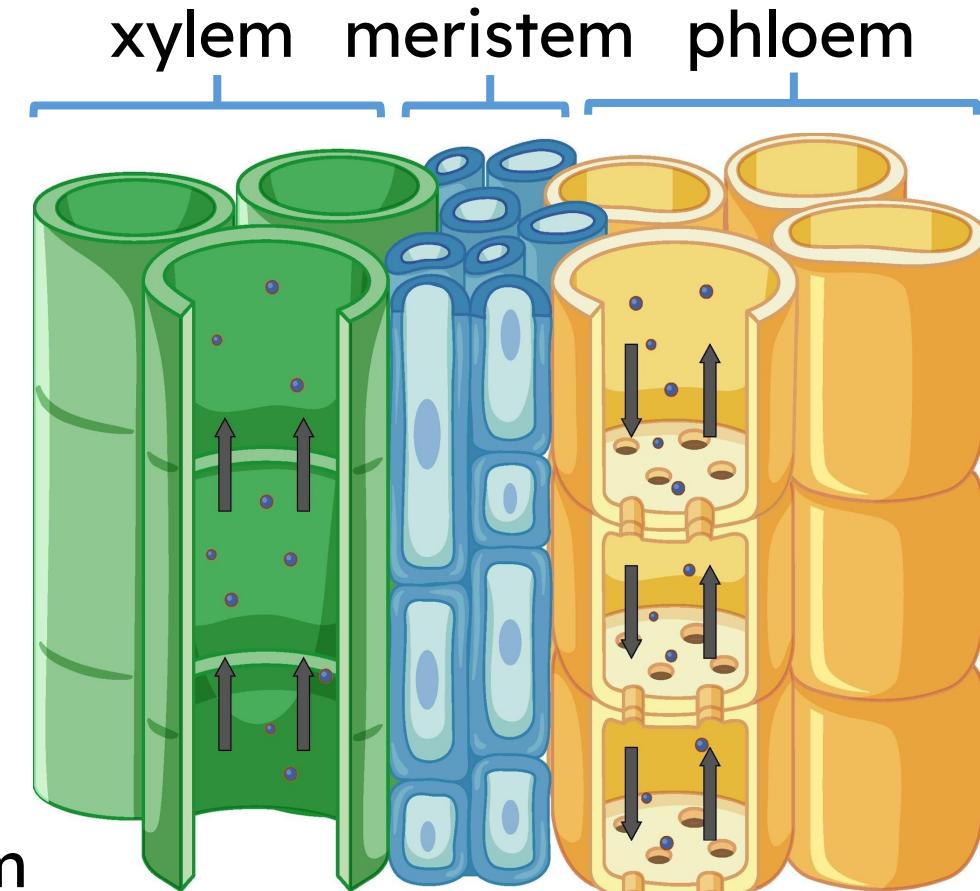
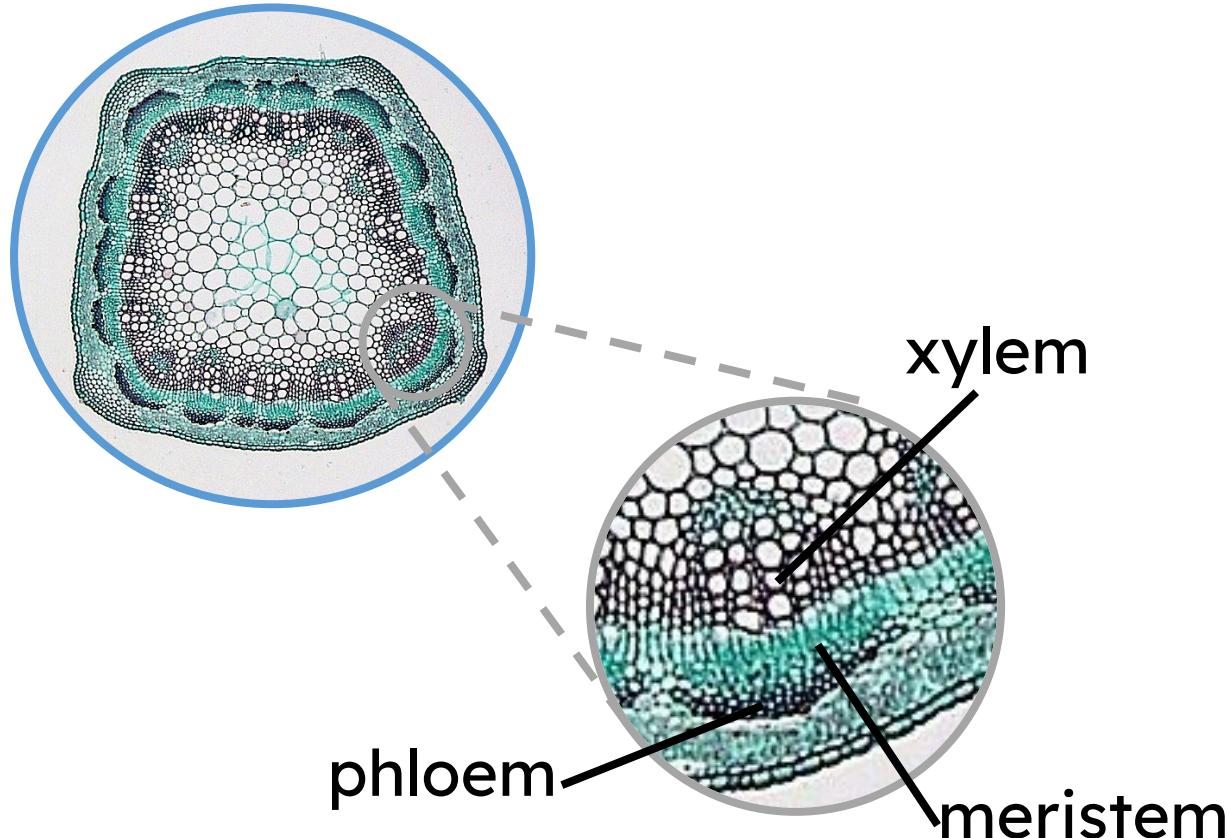
The root cap is made of older cells that protect the meristem tissue, as the root pushes through the soil.



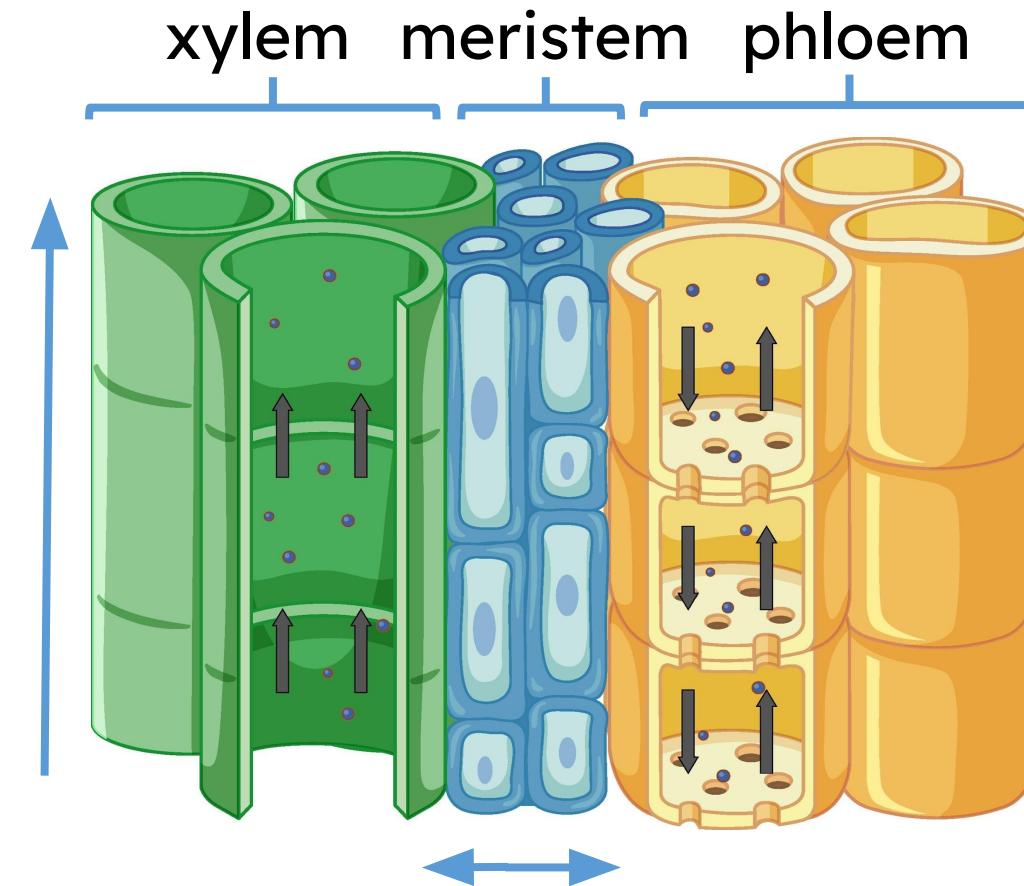
Differentiation in plants



The **meristem** cells also divide and differentiate to make tissues such as **xylem** and **phloem**.

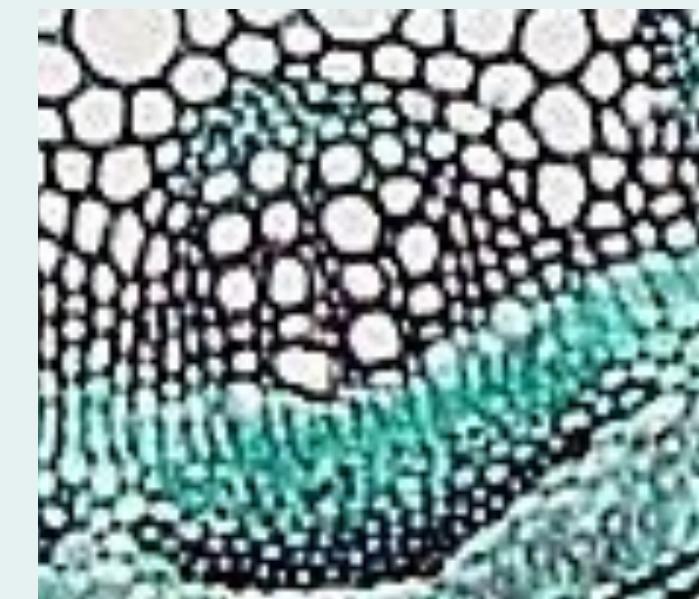
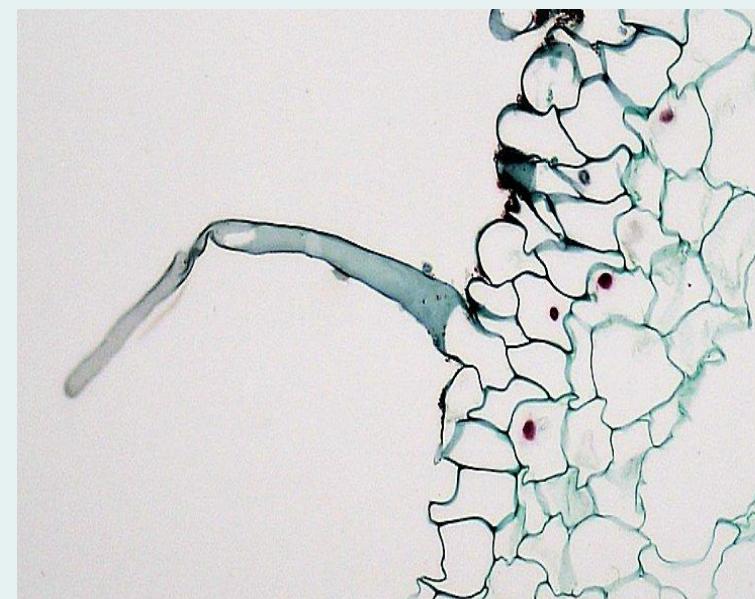
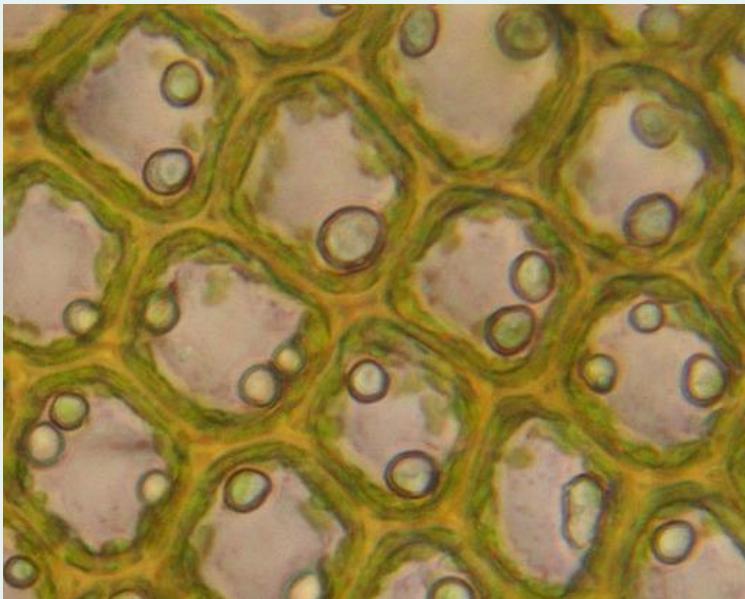


Meristem cells between the **xylem** and **phloem** increase the width and height of a plant. This growth can be seen in the rings in cross sections of tree trunks.



Differentiation in plants

Identify the specialised cells in a leaf.



a ✓

b

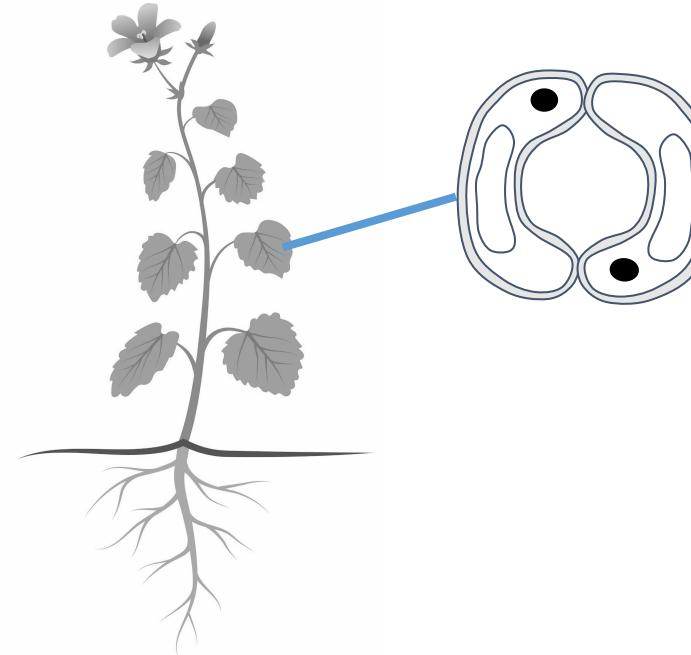
c

Task B Differentiation in plants

Meristem cells differentiate into many different types of cells, which allows the plant to grow.

1. Add labels to the diagram of a plant to show where specialised cells are found in different parts of the plant.
2. Indicate which meristem tissue each type of specialised cells differentiated from.

An example has
been done for you.



guard cells in the
leaf are
differentiated from
shoot meristem

Task B

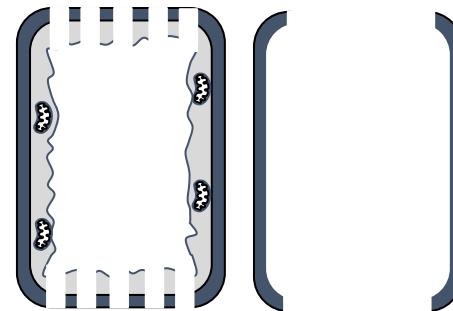
Differentiation in plants



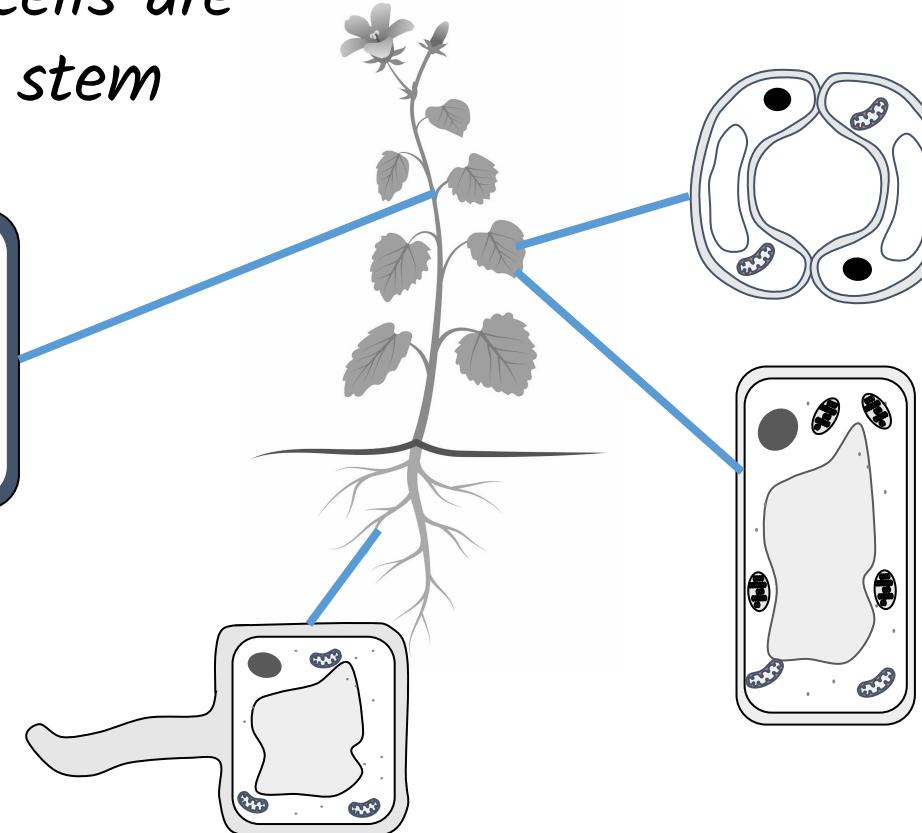
Feedback

1. Add labels to show where specialised cells are found in the plant.
2. Indicate which meristem tissue each type of specialised cells differentiated from.

phloem and xylem cells are differentiated from stem meristem



root hair cells are differentiated from root meristem



guard cells in the leaf are differentiated from shoot meristem

palisade cells in the leaf are differentiated from shoot meristem

Lesson outline

Meristem cells in plants



Uses of meristem in agriculture and conservation



Stem cells from **meristem** tissue enable clones of plants to be grown quickly and economically from cuttings.

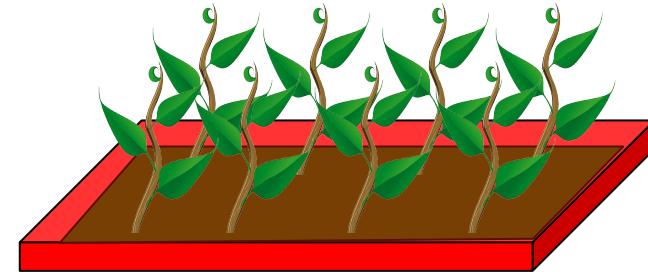
The clones are genetically identical to the parent plant.



parent plant is selected



cuttings are taken from the shoot, which contains meristem cells



meristem cells differentiate to form all the tissues needed to grow whole plants from the cuttings

Uses of meristem in agriculture and conservation



Producing plants this way is quicker than by traditional reproduction and it allows many genetically identical copies of the plant that donated the **meristem** cells to be produced.

This is useful commercially as it preserves characteristics such as flavour.

Sexual reproduction would introduce variation, which may not be desirable.



tea plants, and grapes in vineyards, are both grown from cuttings

Why does growing plants from cuttings help to preserve characteristics such as flavour?

a it introduces variation in the offspring

b it is a form of sexual reproduction

c the plants are all genetically identical



Uses of meristem in agriculture and conservation



Some plants, such as ornamental orchids prized for their appearance, do not grow well from cuttings.

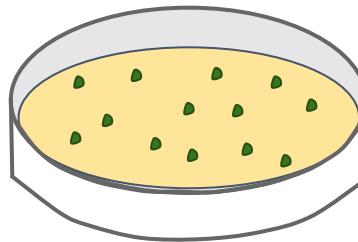
Stem cells from **meristem** tissue samples can be used to produce genetically identical clones via tissue culture.



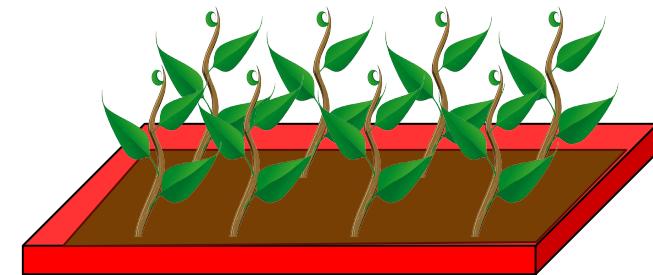
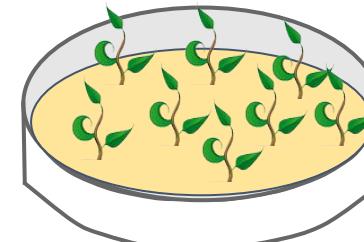
parent
plant is
selected



tissue
samples
taken



tissue samples placed in agar with nutrients and growth hormones; roots, leaf and stem cells differentiate from the meristem cells



plantlets planted
in compost

Uses of meristem in agriculture and conservation



Meristem tissue samples can also be taken to produce clones of rare and endangered species; this can help to protect them from extinction.

Hill's thistle is a rare plant found in North America. It is threatened with extinction.

Hill's thistle has low rates of germination when seeds are planted.

Using lab-based cloning from meristem cells, hundreds of plants were grown and successfully transplanted into the wild.



Hill's thistle

Uses of meristem in agriculture and conservation



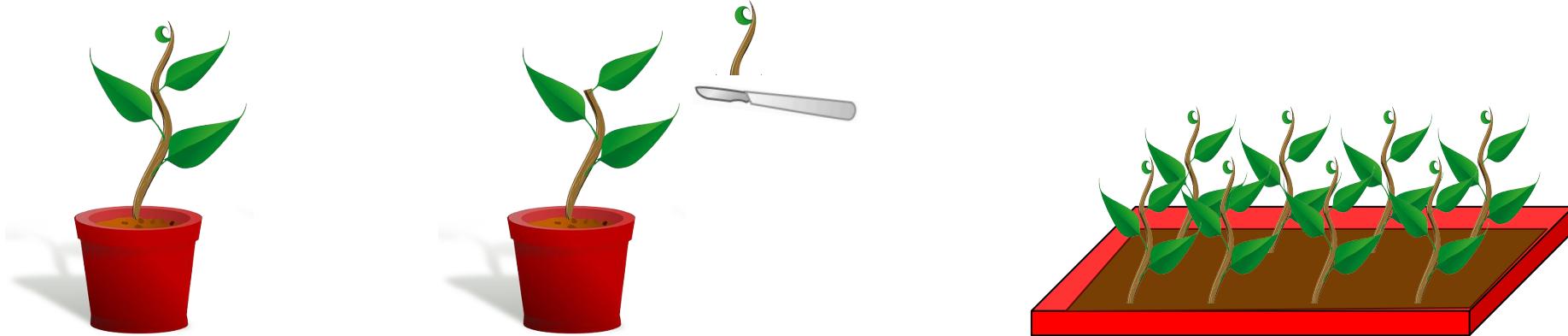
Put these steps in the correct order for making a clone from meristem cells via tissue culture.

- a** plant the plantlets in compost 4
- b** take a sample of meristem tissue from parent plant 1
- c** allow meristem cells to grow into plantlets 3
- d** place meristem cells on agar with nutrients and growth hormones 2

Task C

Uses of meristem in agriculture and conservation

Crop plants can be cultivated from meristem tissue samples.



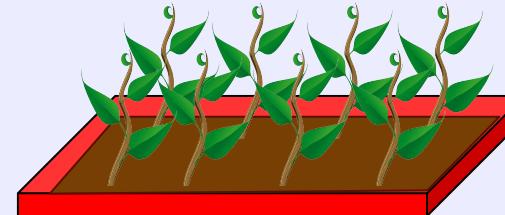
1. Use these images to explain how crop plants, such as tea, can be produced from meristem from a single parent plant.
2. Explain the advantages of this method.

Task C

Uses of meristem in agriculture and conservation



1. Use these images to explain how crop plants, such as tea, can be produced from meristem from a single parent plant.
2. Explain the advantages of this method

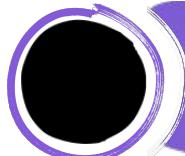


1. A cutting is taken from the shoot of the parent plant. The cutting contains shoot meristem tissue. Meristem cells can differentiate into any type of cell. Roots, stem and leaves develop to form plants. The new plants are all genetically identical to the parent selected for its desirable characteristics. The plantlets are planted and grow into adult plants.
2. This is a quicker method of producing lots of crop plants that have the desired characteristics such as flavour.

Using stem cells in medicine: potential benefits, risks and ethical issues

Lesson outline

Using stem cells in medicine: potential benefits, risks and ethical issues



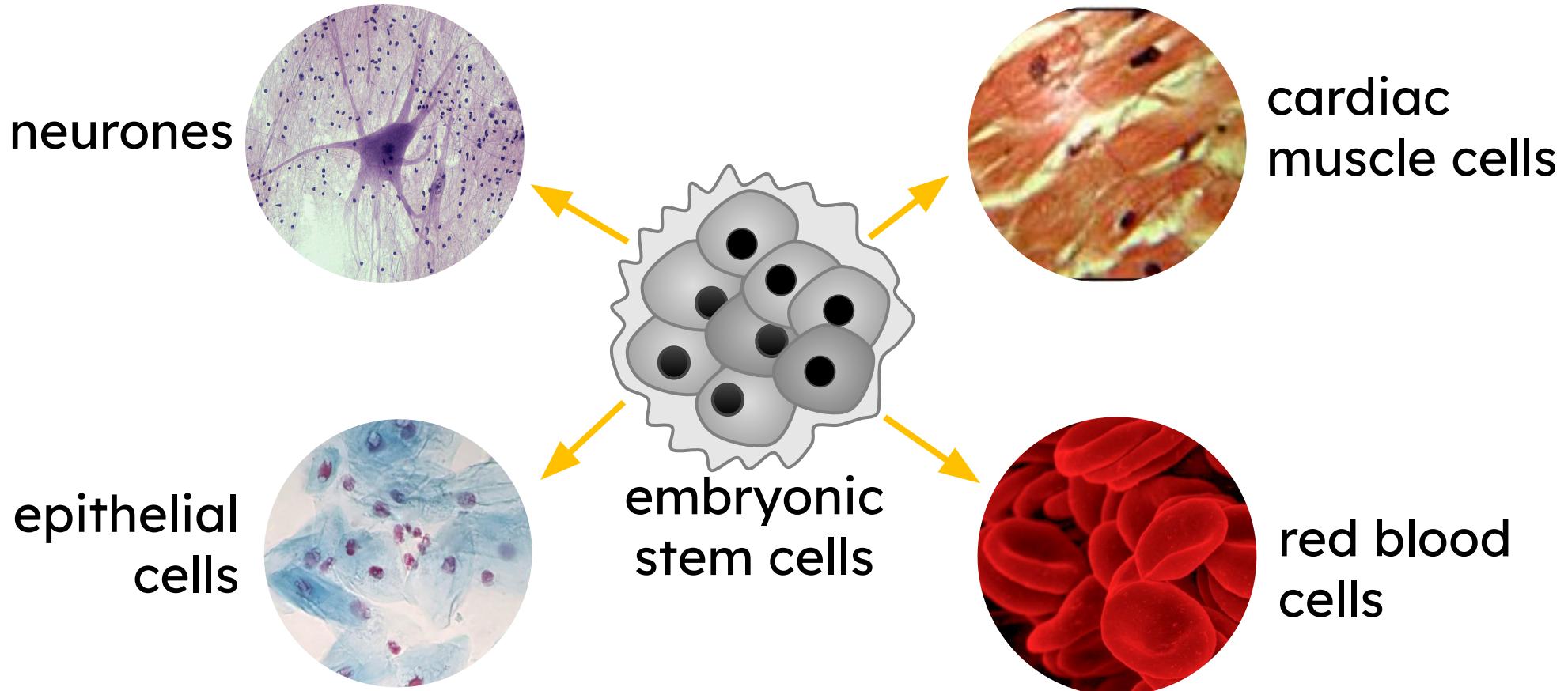
Stem cell uses in medicine



Benefits, risks and ethical issues

There are two types of human stem cell:

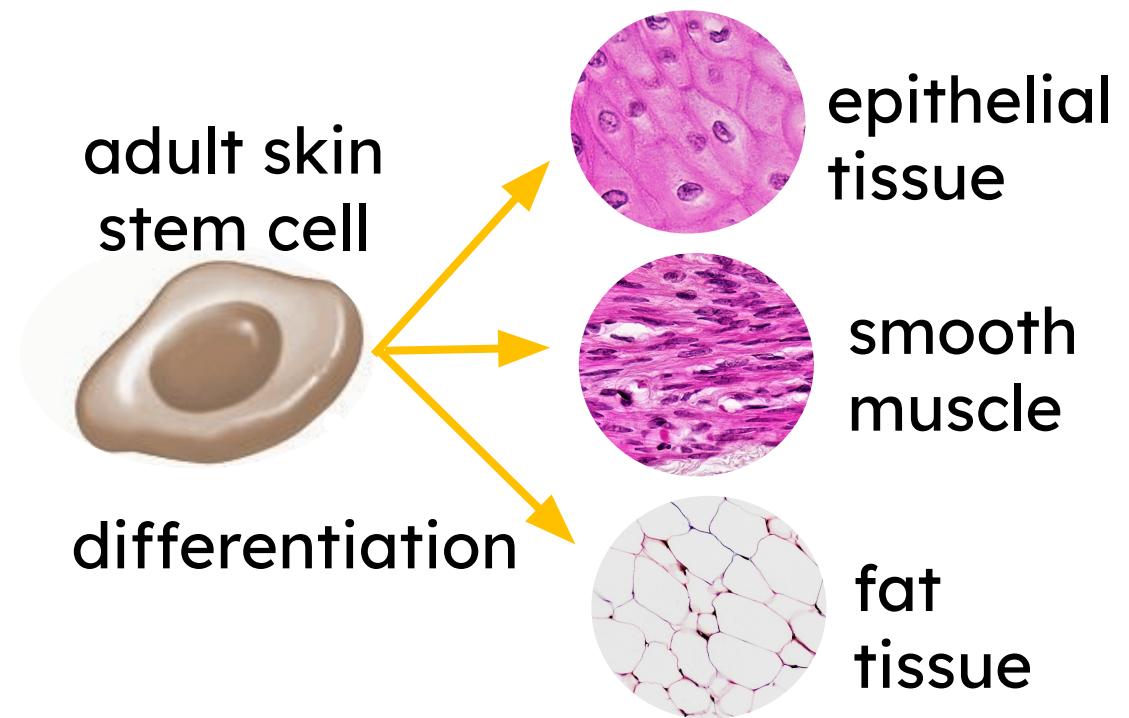
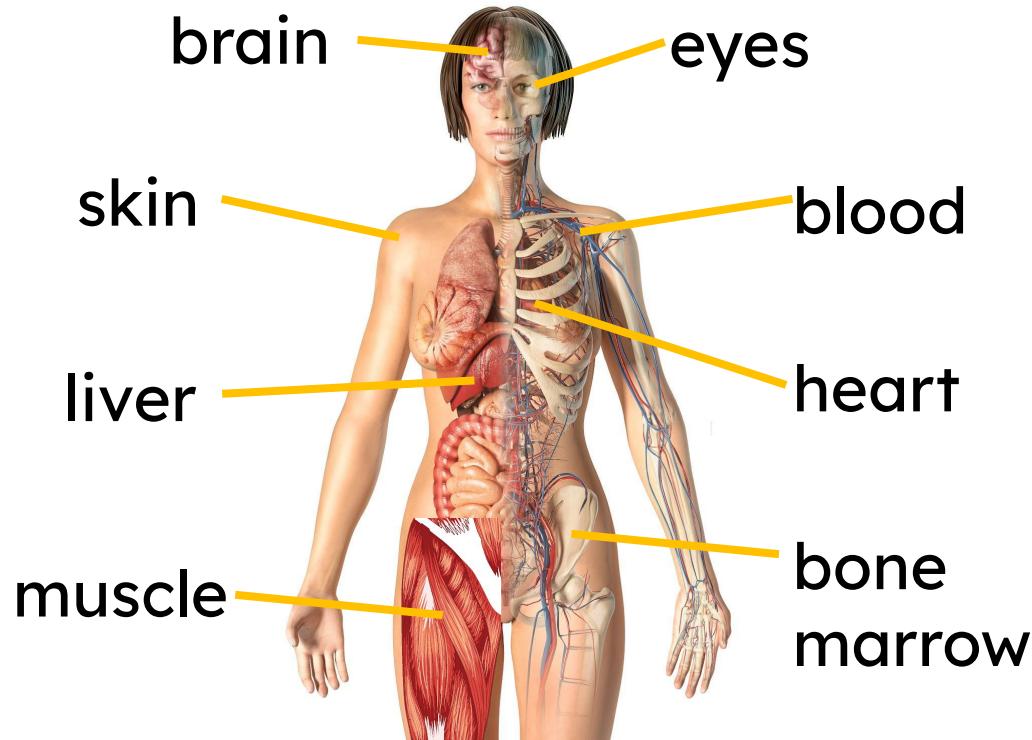
- **Embryonic stem cells** can differentiate into any type of **specialised cell**.



Stem cell uses in medicine



- **Adult stem cells** can differentiate into a limited number of related **specialised cells** in certain regions of the body.



Choose the two sources of stem cells for use in medicine.

a adult stem cells



b childhood stem cells

c embryonic stem cells

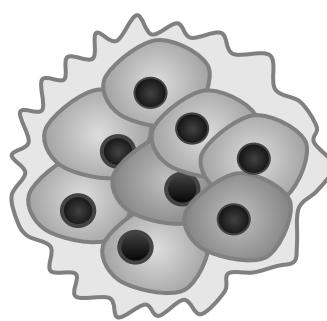


d plant stem cells

Embryonic stem cells can be taken from a 5-day-old embryo, before differentiation has occurred.

Embryos can be sourced from IVF clinics where they are no longer required.

In a lab, the stem cells can be stimulated to differentiate into many types of **specialised cell** that could potentially be used to treat disease, genetic disorders and injuries.

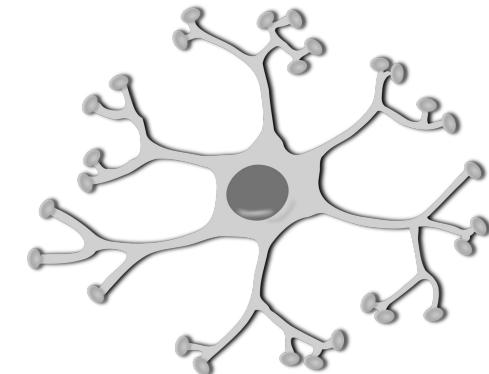


cell removed



5-day-old embryo

differentiation stimulated



embryonic stem cell

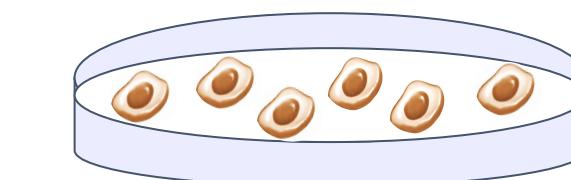
specialised cell

Example:

Type 1 diabetes is a genetic disorder in which the patient cannot control their blood sugar concentration.

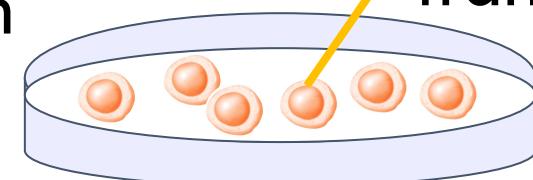
Beta cells in the pancreas are destroyed, so the hormone insulin is not produced.

Scientists are researching a potential treatment. Embryonic stem cells are stimulated to differentiate into beta cells, which could be transplanted into the pancreas.

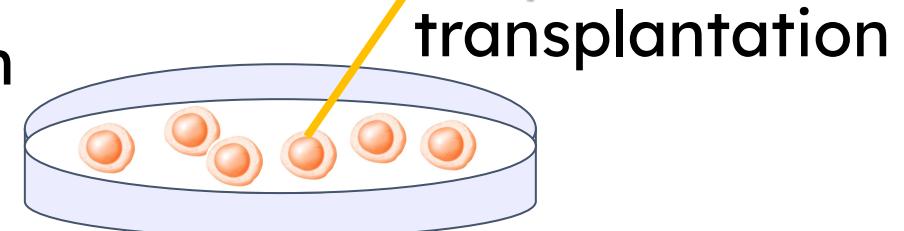
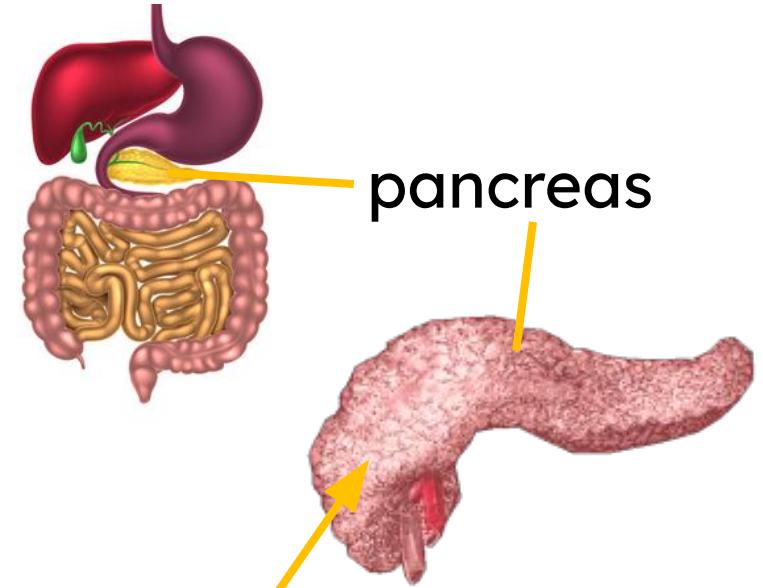


embryonic stem cells

differentiation



beta cells



Stem cell uses in medicine



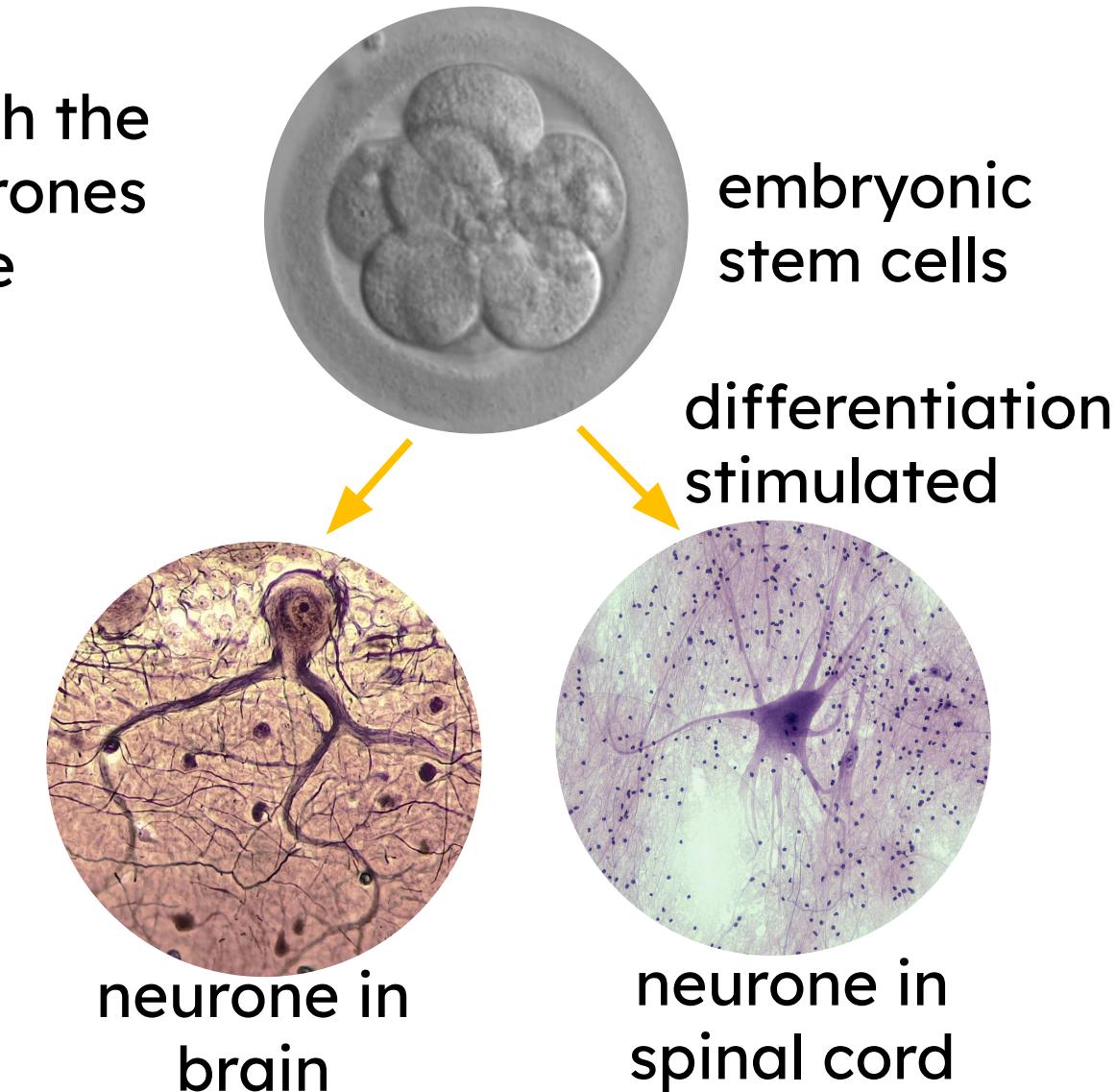
Example:

Multiple sclerosis is a condition in which the myelin sheath around the axon of neurones is damaged. This slows down the nerve impulses that control the body.

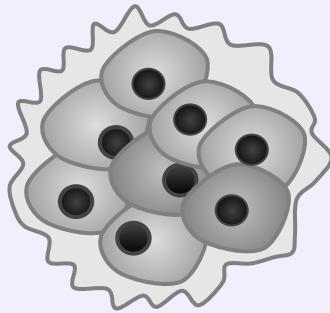
Damage to the brain and spinal cord neurones can lead to permanent changes in body function.

Neurones do not divide (by mitosis), so cannot replace themselves.

Scientists are researching a potential treatment using embryonic stem cells.



In the procedure below, which is a specialised cell?



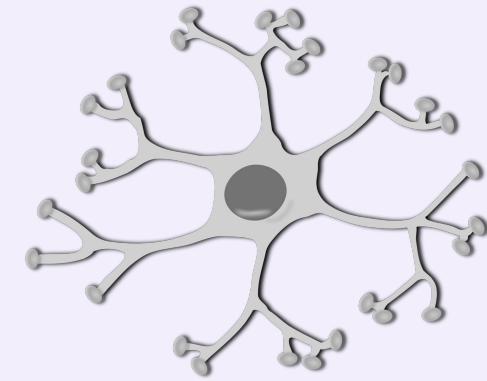
cell removed



a

5-day-old
embryo

differentiation
stimulated



b

embryonic
stem cell

c



neurone cell (used
to treat spinal cord
injury)

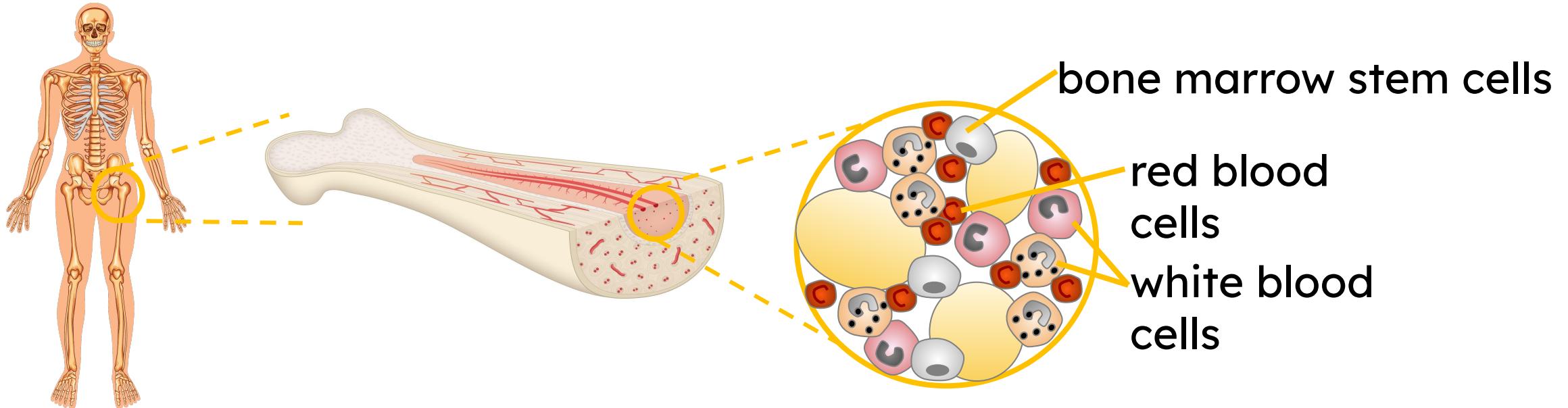
Adult stem cells can also potentially be used as treatments.

Example:

All blood cells are made from adult stem cells in our bone marrow.

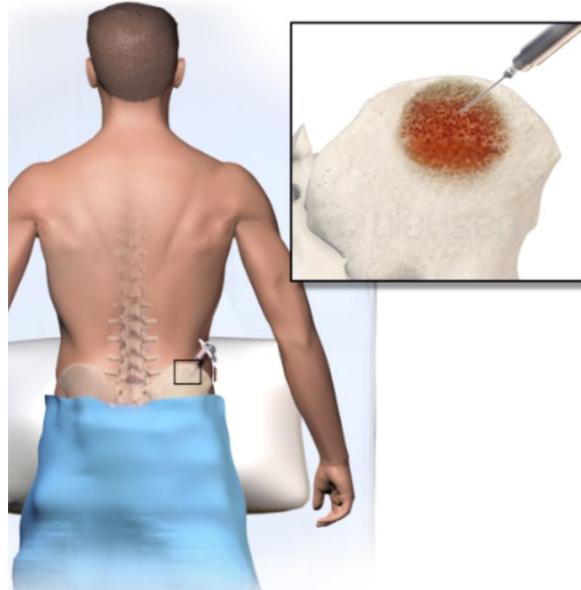
Leukaemia is a type of cancer that results in faulty blood cells being made.

Adult stem cells from a donor's bone marrow can be used as a treatment.

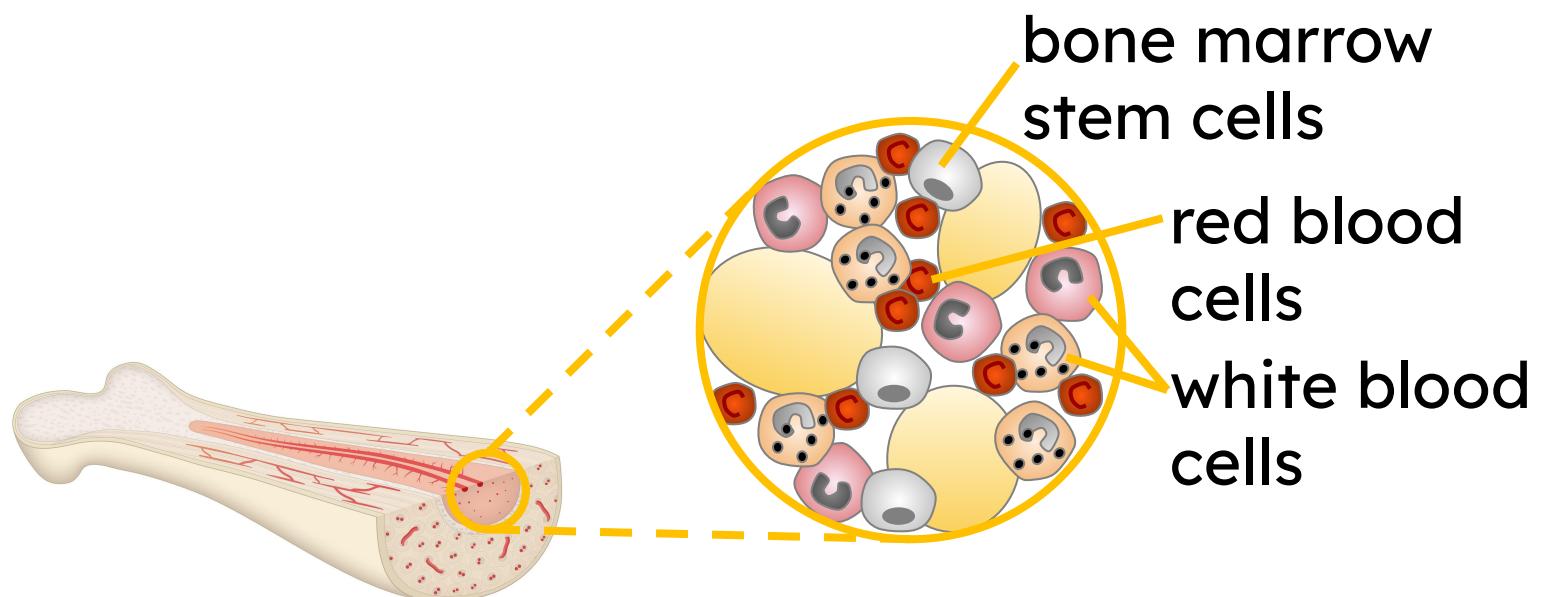


Adult stem cells from bone marrow are donated by members of the public in a surgical procedure.

These stem cells can be transplanted into a patient with leukaemia to replace their faulty bone marrow stem cells.



bone marrow donation



True or false?

Adult stem cells are used in treatments for leukaemia.

T

True ✓

F

False

Justify your answer

- a They are used to replace blood cells damaged by the disease. ✓
- b They differentiate into a limited number of different cells.

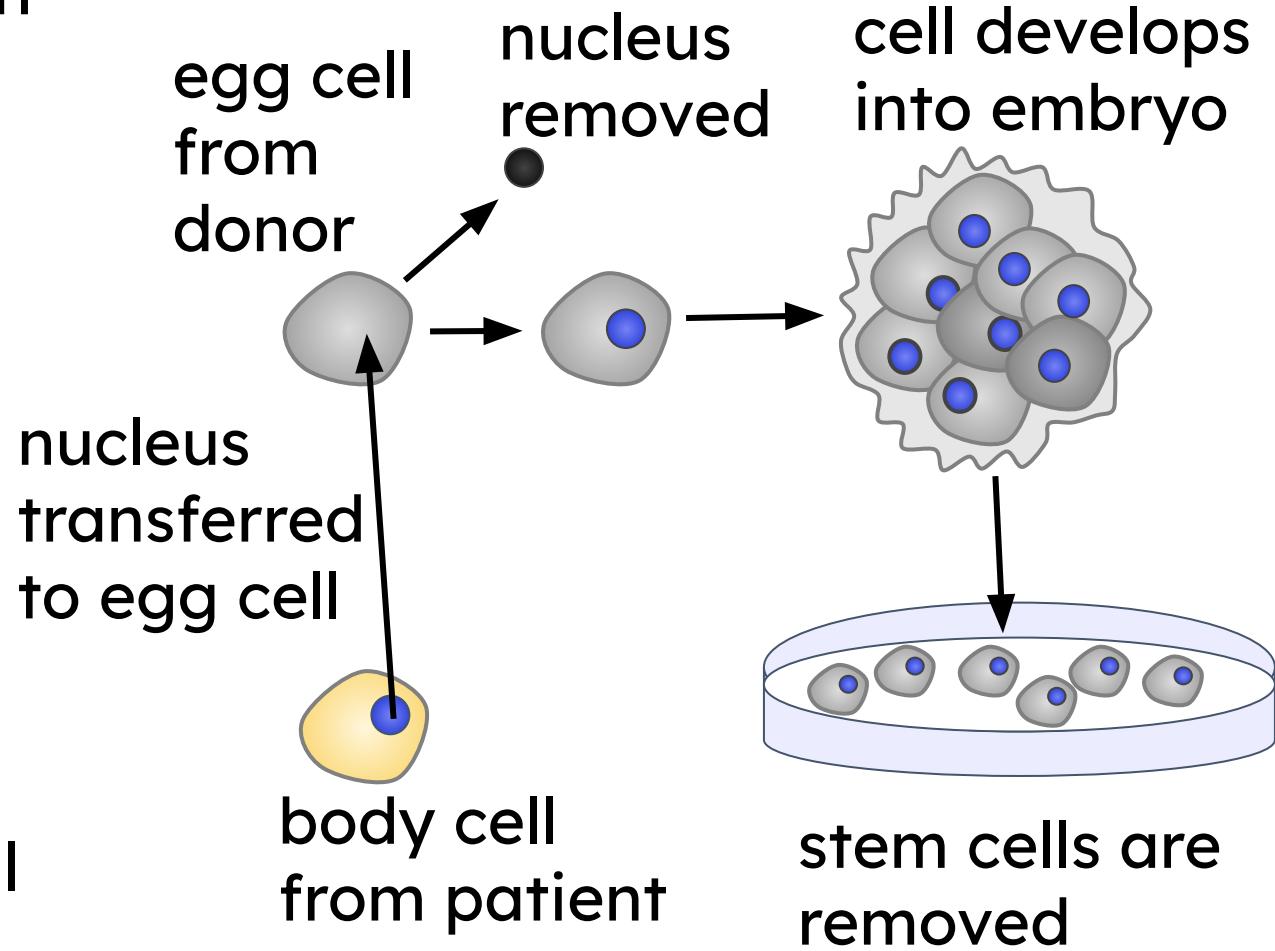
Stem cell uses in medicine



Adult stem cells can be donated, or a patient's own stem cells can be harvested.

Another source of stem cells for research is therapeutic cloning. This technique takes an egg cell and replaces its nucleus with a nucleus from one of the patient's body cells.

The stem cells formed in the embryo are genetically identical to the patient.



Choose the conditions that stem cells could be used to treat.

a

spinal cord damage



b

malaria

c

measles

d

diabetes



Stem cells could potentially be used to treat a number of disorders, in addition to the examples we've already seen.

Carry out research into Parkinson's disease and write a summary of the use of stem cells in their treatment.

Include basic details of the condition, the process and the outcomes achieved.



Carry out research into Parkinson's disease and write a summary of the use of stem cells in their treatment.

Include basic details of the condition, the process and the outcomes achieved.

Example:

- Parkinson's disease causes the destruction of neurones which help to control movement and mood.
- Embryonic stem cells can be used and differentiated into neurones.
- The neurones are transplanted into the brain of the patient with Parkinson's disease.
- Improvements in symptoms have been proved but research continues.

Lesson outline

Using stem cells in medicine: potential benefits, risks and ethical issues



Stem cell uses in medicine



Benefits, risks and ethical issues

Benefits, risks and ethical issues

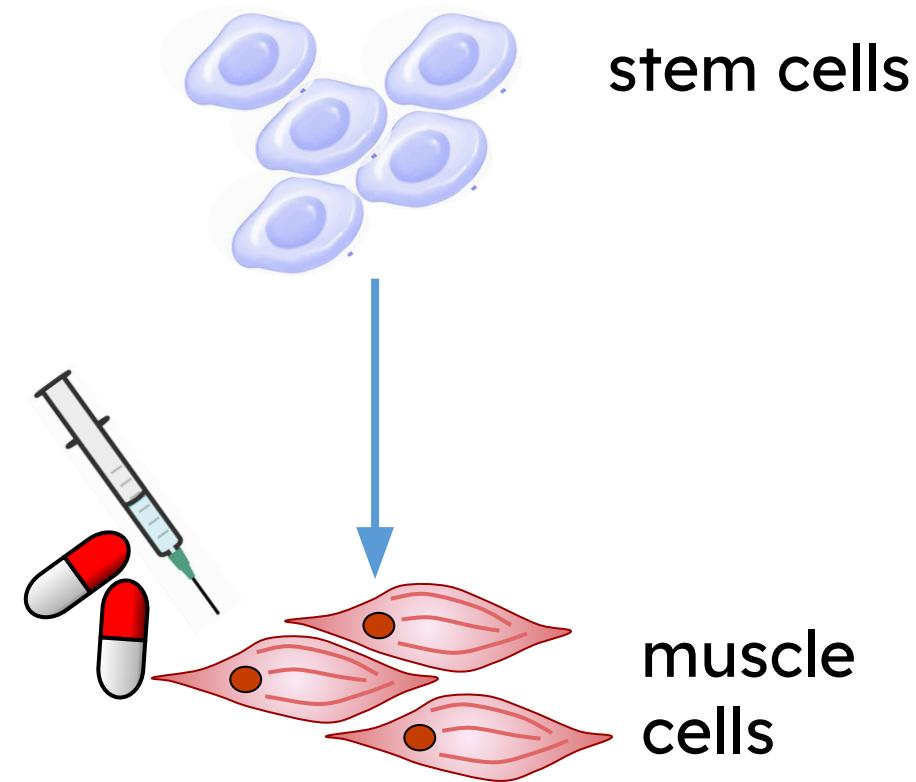


Potential uses of stem cells are the subject of lots of research; the full extent of their use is still not known.

However, in some cases stem cells have been used to:

- help patients with currently untreatable conditions
- grow organs (e.g. skin) for transplants
- reduce symptoms of progressive diseases.

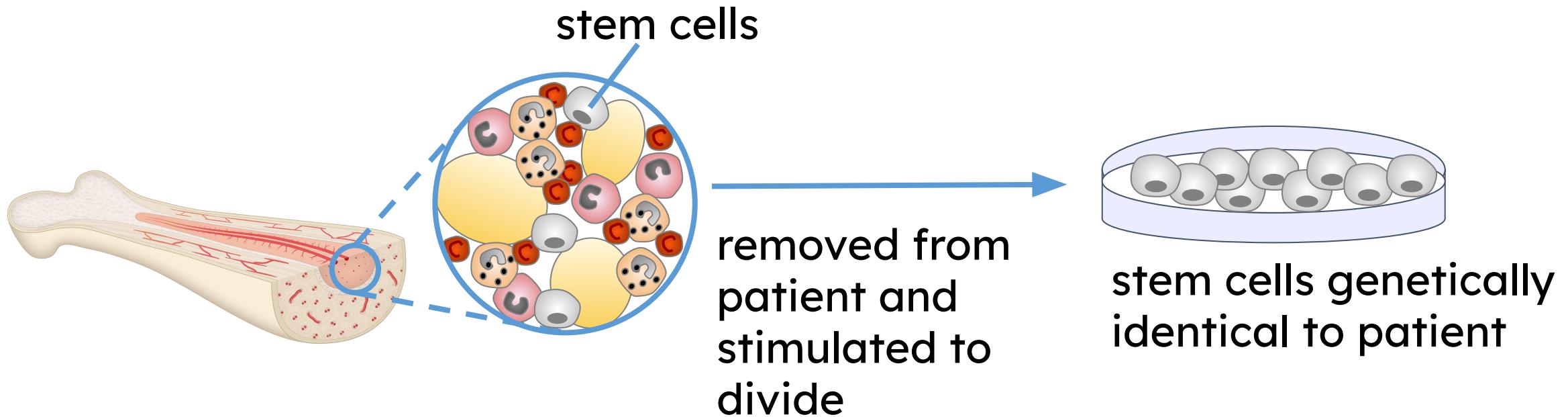
They can also be used in research to study the effect of drugs (i.e. toxicity) on different types of cells.



testing cells with drugs to treat heart disease

Adult stem cell transplants are a treatment for leukaemia.

Using a patient's own stem cells prevents **immune rejection** as the cells are genetically identical and recognised as 'self'.



Immune rejection is where the patient's immune system attacks non-self cells.

Stem cells from a close relative can be used, but the patient has to take medicines called immunosuppressants to prevent immune rejection.

This makes the patient more susceptible to other infections.



patient taking medication

Select the current uses of stem cells.

- a grow tissues and organs for transplant ✓
- b producing human clones
- c replace cells damaged by drug treatments ✓
- d replace cells damaged by diseases (e.g. Parkinson's) ✓

True or false?

It is more effective to use a donor rather than the patient's own cells for stem cell transplants.

T

True

F

False



Justify your answer

a

A donor might not be a close relative and could have different types of cells.

b

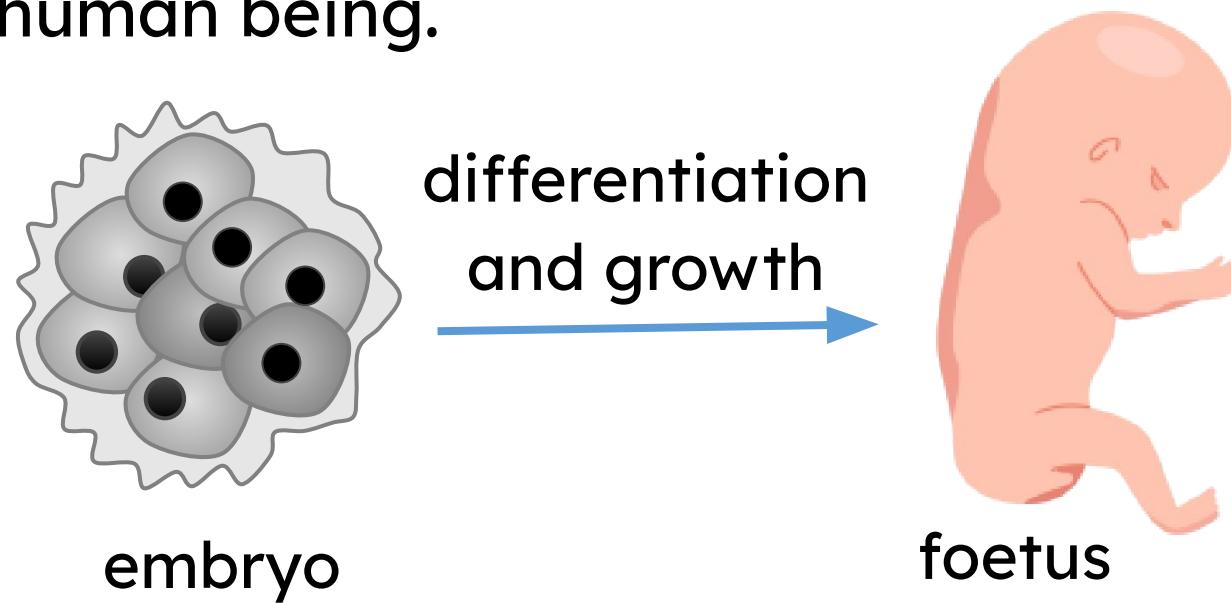
A donor is genetically different, so their cells may be rejected by the patient's immune system.



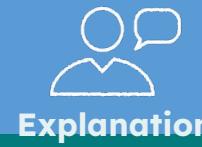
The use of embryos for stem cells and in therapeutic cloning raises some **ethical** issues.

An ethical issue relates to whether an action and its consequences are right or wrong.

The embryos used in medical research are those that would be destroyed as medical waste. But they are also the first development stage of a new human being.



Benefits, risks and ethical issues



Individuals and groups have differing opinions on when life begins.

Using embryos from IVF or making them in therapeutic cloning risks them becoming seen only as a commodity.

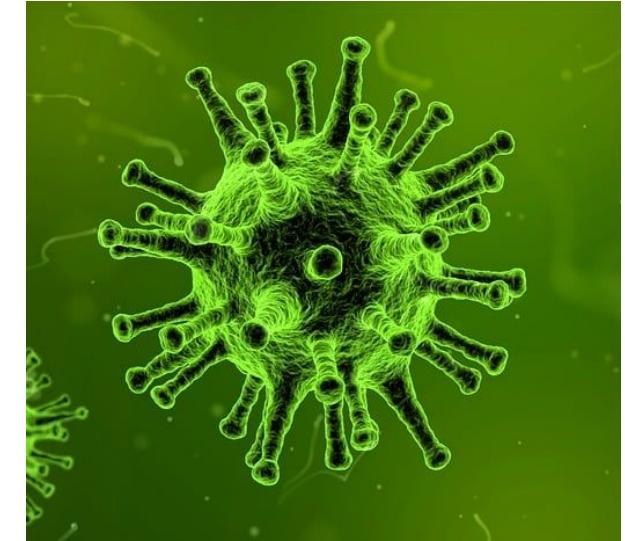
In the UK, the Human Fertilisation and Embryology Authority (HFEA) oversees the use of gametes and embryos.

The owners of the gametes that formed the embryo must consent to its use. Embryos must not be developed further than 14 days in a lab.



There are also some clinical issues that limit the use of stem cell technology:

- the success rate for therapies varies between patients
- access to embryonic stem cells is limited
- there is difficulty in recruiting stem cell donors
- stem cells can have a higher rate of mutations that can lead to cancer
- viruses can spread between stem cells in culture.



viruses cause diseases

Benefits, risks and ethical issues

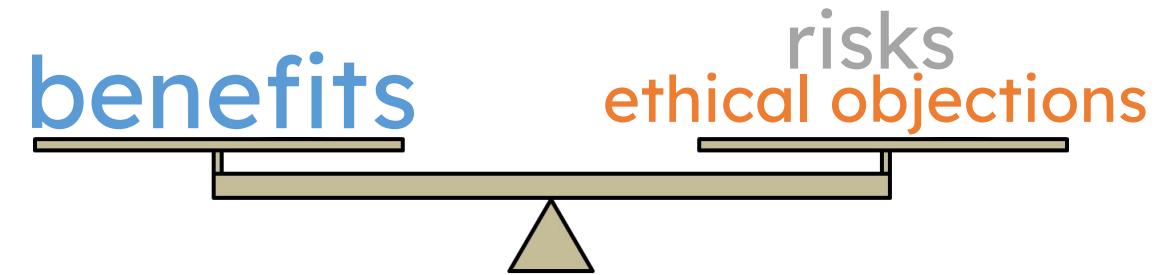


There are also issues related to society's understanding and opinion on the use of stem cells.

Support for research and the use of stem cells requires education of the public on their benefits and where the current research is.

It is not currently clear whether the benefits outweigh the risks and ethical objections.

As lots of the research is carried out by clinics for profit, it could mean that patients have their hopes raised or are exploited.



Which of these is an ethical issue with using stem cells in medicine?

- a** Using an adult's own stem cells to avoid immune rejection.
- b** Lack of public understanding of the potential uses.
- c** Objections to the use of embryos. 
- d** Varied success rates of treatments.

END