

Cloning

Revision notes · Micropropagation of plants, cloning mammals such as Dolly the sheep, and how cloned transgenic animals make human proteins.

For Pearson Edexcel International GCSE Biology 4BI1 and Science (Double Award) 4SD0. **Biology only** is not in the Double Award and is only examined on Paper 2.

Cloning

Spec 5.17B–5.20B

Biology only

Micropropagation (tissue culture)

Spec 5.17B, 5.18B

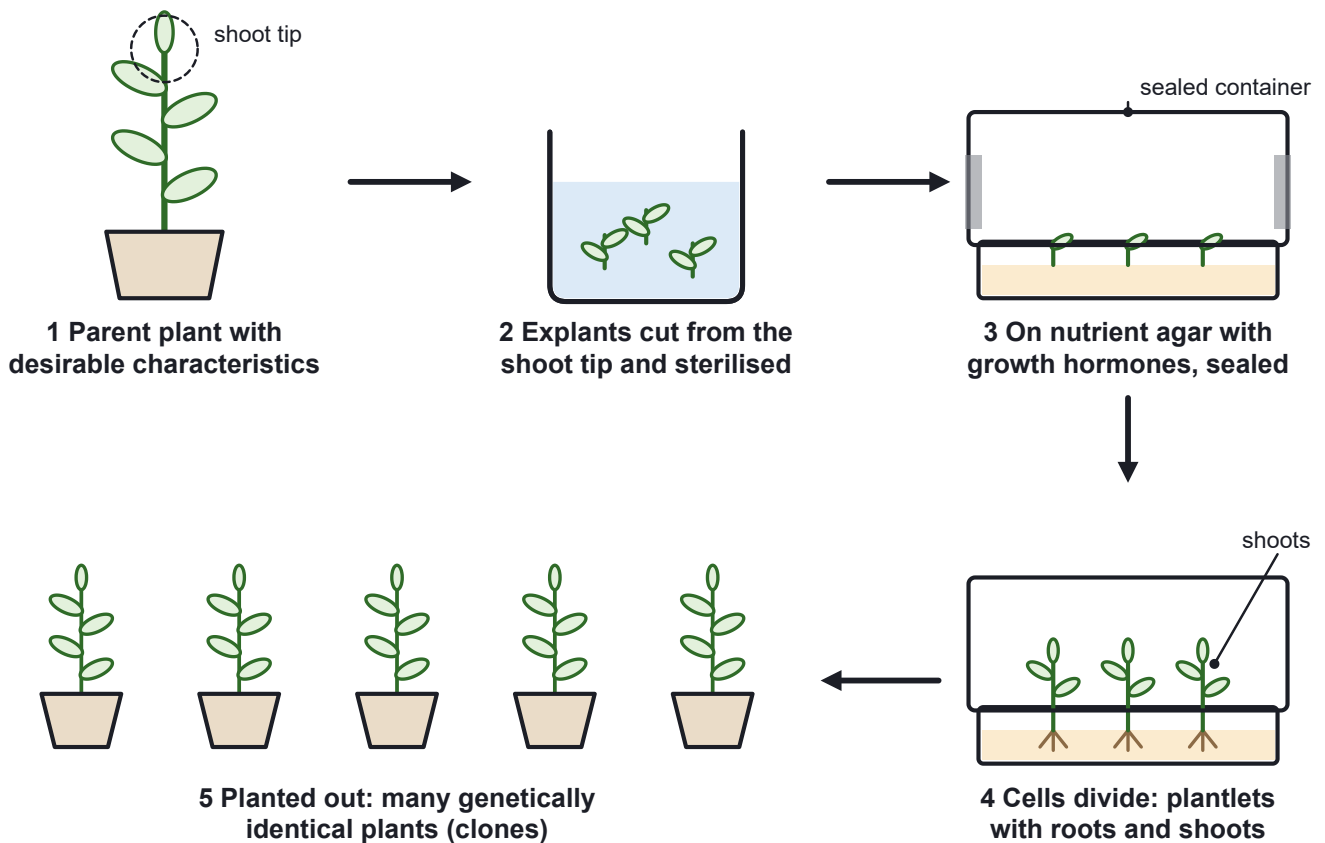
Micropropagation (tissue culture) is growing new plants from small pieces of a plant, called **explants**, in vitro. In vitro means in glass or a container, not in the soil.

1. Take small pieces of tissue (explants) from the parent plant, for example from the shoot tip.
2. Sterilise the explants and use **aseptic technique** so that bacteria and fungi do not contaminate the culture.
3. Place the explants on a sterile **nutrient agar** containing nutrients and plant growth hormones.
4. The cells divide and grow into small plantlets. These can be transferred to fresh medium and then planted out.

Uses and advantages

- Commercial quantities of **genetically identical** plants can be produced quickly from a small amount of tissue.
- Plants with desirable characteristics, such as high yield, are copied exactly.
- Plants can be produced all year round, in a small space.
- Rare plants can be reproduced to help save them.

Exam tip: The key word is 'identical'. The new plants are clones of the parent, so the useful characteristics are kept.



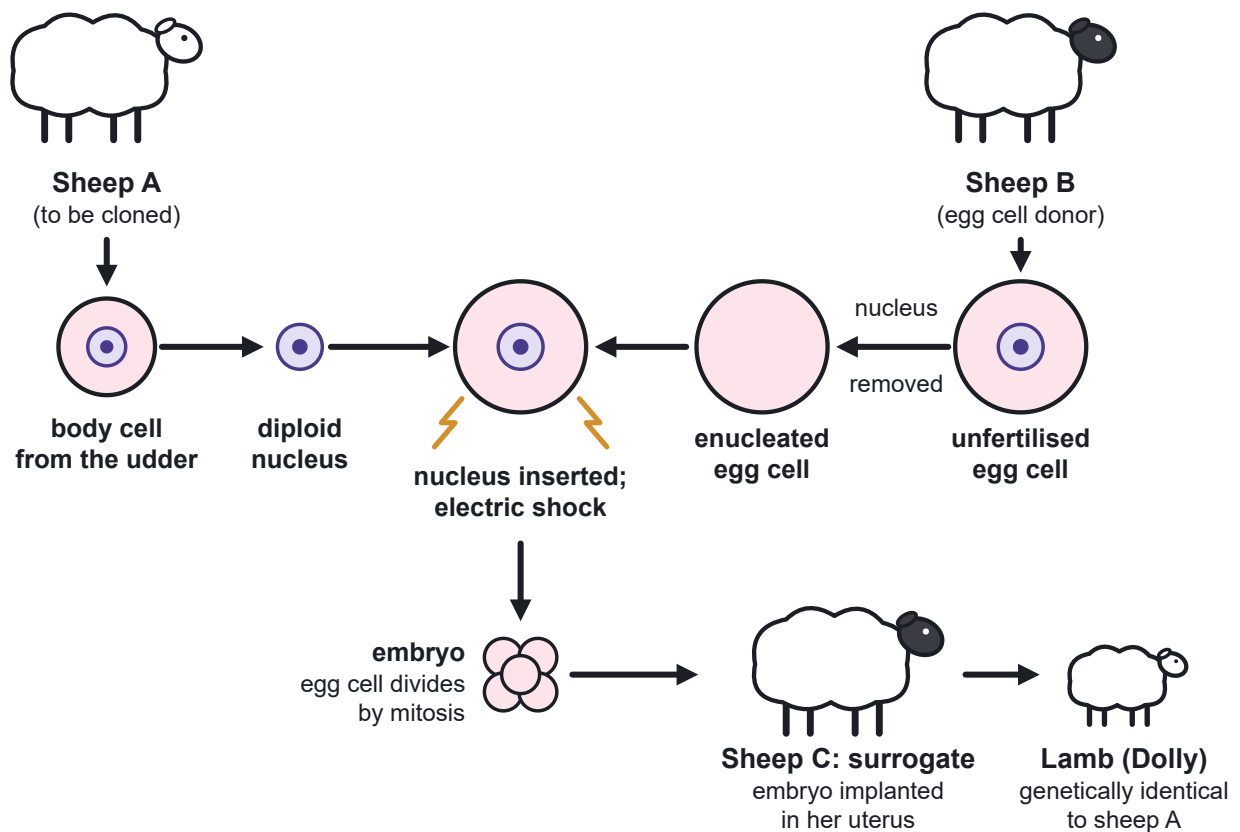
Micropropagation produces many **genetically identical** plants from small explants.

Cloning mammals: Dolly the sheep Spec 5.19B

A **clone** is a genetically identical copy. Mammals can be cloned by putting a **diploid nucleus** from a mature body cell into an **enucleated** egg cell (an egg cell with its nucleus removed). This was how Dolly the sheep was produced.

1. A diploid nucleus is taken from a mature body cell of the animal to be cloned. For Dolly this was a cell from the udder of an adult sheep.
2. The nucleus is removed from an unfertilised egg cell, so the egg cell is enucleated.
3. The diploid nucleus from the mature cell is introduced into the enucleated egg cell. An electric shock is used to fuse them and to stimulate the egg cell to start dividing.
4. The egg cell divides by mitosis to form an embryo.
5. The embryo is implanted into the uterus of a surrogate mother, where it develops. The lamb born is genetically identical to the sheep that gave the nucleus.

Common mistake: The egg cell has its own nucleus removed, and the nucleus from the body cell is diploid. Do not say the egg cell is fertilised by a sperm.



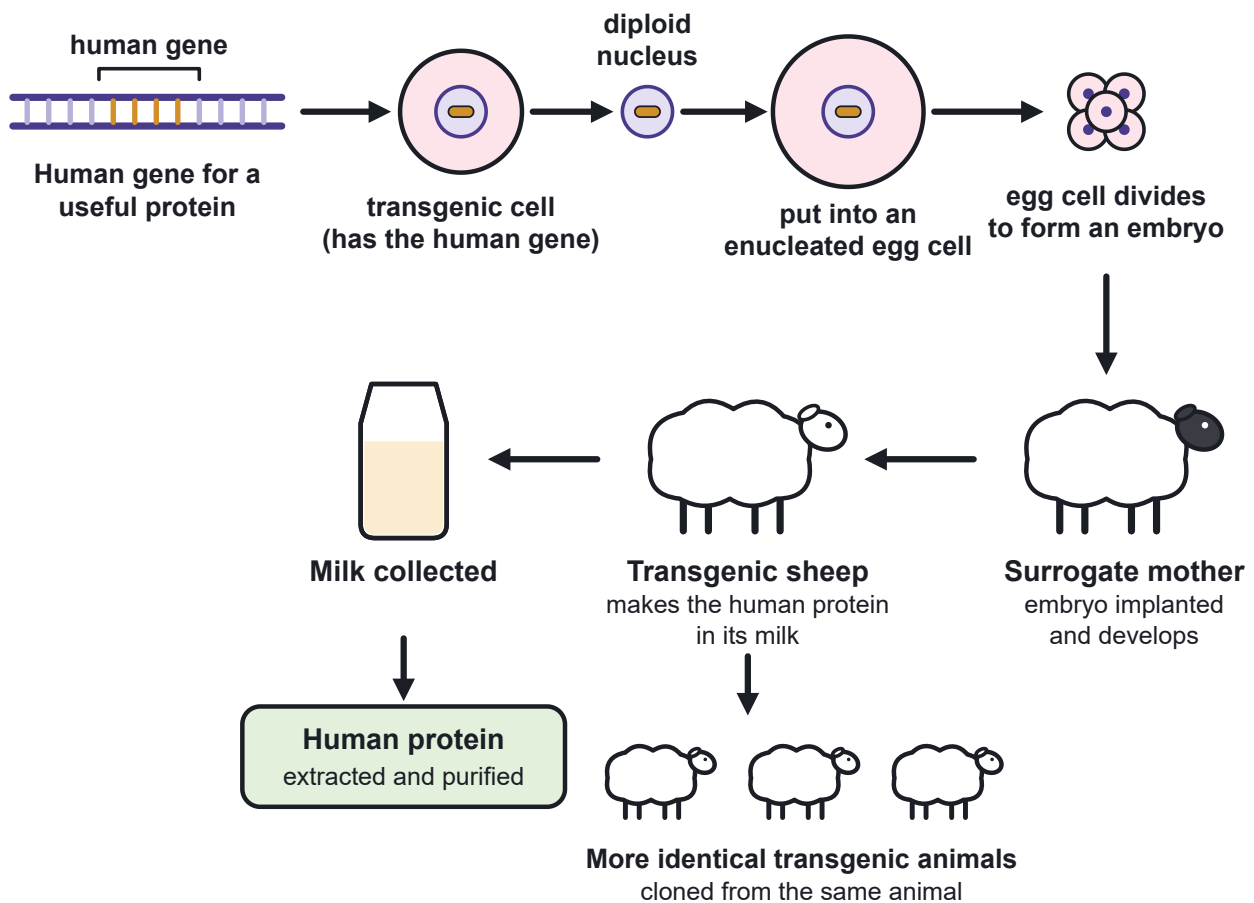
Dolly was a **clone** of the sheep that gave the **diploid nucleus**.

Cloned transgenic animals and human proteins Spec 5.20B

Animals can be made **transgenic** by adding a human gene to their cells. Cloning can then produce many identical animals that all carry that gene. These **cloned transgenic animals** can be used to produce **human proteins**.

1. The human gene for a useful protein is inserted into the cells of an animal, such as a sheep or goat, making them transgenic.
 2. A transgenic cell is used to produce a cloned embryo, using the nuclear transfer method.
 3. The embryo is implanted into a surrogate mother and develops into a transgenic animal.
 4. The animal makes the human protein, often in its milk, where it can be collected and purified.
 5. More identical animals can be cloned from it to make larger amounts.
- Examples of human proteins made this way include alpha-1-antitrypsin (used to treat the lung disease emphysema) and blood clotting factors (used to treat haemophilia).
 - These proteins are used to treat human diseases and conditions.

Exam tip: Two ideas to link: transgenic gives the animal the human gene, and cloning gives you many identical animals that all make the protein.



A **cloned transgenic animal** makes a human protein in its milk, and cloning gives many such animals.

Quick check

1. What is micropropagation?
2. What are the small pieces of plant tissue used in micropropagation called?
3. What type of nucleus is put into the enucleated egg cell to clone a mammal?
4. Name a human protein made by cloned transgenic animals.

Quick check answers

Cloning

1. Growing new plants from explants in vitro, on sterile nutrient medium.
2. Explants.
3. A diploid nucleus from a mature body cell.
4. Alpha-1-antitrypsin (or a blood clotting factor).