Cloning

4.6.2.5 · Inheritance, variation and evolution · revision notes

Four ways to produce genetically identical organisms: cuttings, tissue culture, embryo transplants and adult cell cloning, plus their benefits, risks and ethical objections. This is in GCSE Biology only, not in Combined Science. Expect 'describe the steps' and 'evaluate' questions.

Key facts

- Clone = genetically identical organism
- Tissue culture: small groups of plant cells → identical plants; preserves rare species; used in nurseries
- Adult cell cloning: remove egg nucleus → insert adult body cell nucleus → electric shock → embryo → womb
- Main risk: no variation, so a disease could affect all the clones
- Cuttings: older, simple method used by gardeners; many identical plants from one parent
- Embryo transplant: split the cells of an early embryo before they specialise → transplant into host mothers
- An adult cell clone is genetically identical to the animal that gave the body cell nucleus

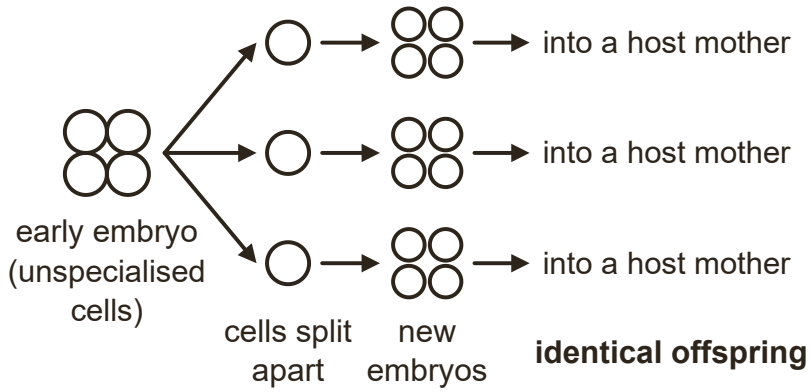
Notes

Cloning plants

- **Cuttings**: an older, simple method used by gardeners to produce many identical new plants from a parent plant. A piece of the plant, such as a shoot with leaves, is cut off and grown into a new plant.
- **Tissue culture**: small groups of cells from part of a plant are used to grow identical new plants, on a sterile medium containing nutrients and plant hormones.
- In tissue culture, the hormones make the cells divide and form roots and shoots; sterile conditions stop microorganisms growing and killing the new plants.
- Tissue culture is important for **preserving rare plant species**, and is used commercially in **plant nurseries**.

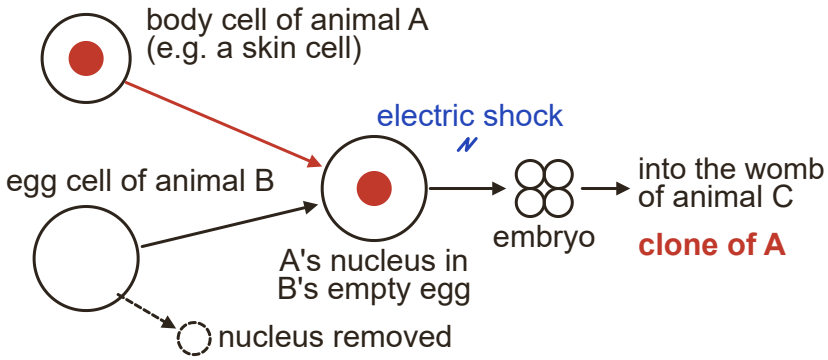
Cloning animals

- **Embryo transplants**: cells are split apart from a developing animal embryo **before they become specialised**, then the identical embryos are transplanted into **host mothers**. The offspring are identical to each other, but not to their parents.



Embryo transplants: one embryo split into several identical ones.

- **Adult cell cloning**, step 1: the **nucleus is removed** from an **unfertilised egg cell**.
- Step 2: the **nucleus from an adult body cell**, such as a skin cell, is inserted into the egg cell.
- Step 3: an **electric shock** stimulates the egg cell to divide to form an embryo. The embryo cells contain the same genetic information as the adult skin cell.
- Step 4: when the embryo has developed into a ball of cells, it is inserted into the **womb** of an adult female to continue its development.



Adult cell cloning: the clone is identical to the animal that gave the nucleus.

Benefits, risks and objections

- Benefits: many identical plants or animals with useful characteristics can be produced quickly; rare species can be preserved; cloned animals might be used to produce substances for medicine.
- Risks: clones have **no genetic variation** between them, so a new disease or a change in the environment could affect them all; some cloned animals have had health problems or shorter lives.
- Objections: some people have **ethical** objections, such as concern for animal welfare or fears that it could lead to cloning humans.

How to answer each type of question

Give advantages and disadvantages of cloning

2 to 4 marks | Grade 5

1. Advantages: many identical organisms quickly; all have the parent's useful characteristics; rare species can be preserved.
2. Disadvantages: no variation, so a disease could affect them all; possible health problems in cloned animals; ethical objections.

Example. A plant nursery uses tissue culture to produce thousands of identical orchids for sale. Give two advantages and one disadvantage of using tissue culture. [3 marks]

Model answer. Advantages (any two): many plants can be produced quickly (1); all the plants have the desired characteristics of the parent, e.g. flower colour (1); only a small amount of tissue is needed from the parent plant (1). Disadvantage: the plants are genetically identical, so a disease could affect them all (1).

Describe embryo transplants

2 to 3 marks | Grade 6

1. An embryo is produced from the chosen parents.
2. Its cells are split apart before they become specialised.
3. The identical embryos are transplanted into host mothers.

Example. A farmer has a cow and a bull with very useful characteristics. Describe how embryo transplants could be used to produce several calves that are genetically identical to each other. [3 marks]

Model answer. An egg from the cow is fertilised by sperm from the bull to form an embryo (1). The cells of the embryo are split apart at an early stage, before they become specialised (1). Each group of cells develops into an embryo, and these identical embryos are transplanted into host mothers (1).

Describe adult cell cloning

4 marks | Grade 7

1. Remove the nucleus from an unfertilised egg cell.
2. Insert the nucleus from an adult body cell (e.g. a skin cell).
3. An electric shock makes the egg cell divide to form an embryo.
4. Put the ball of cells into the womb of an adult female.

Example. Scientists want to clone a prize-winning sheep. Describe how they could use adult cell cloning to produce the clone. [4 marks]

Model answer. Remove the nucleus from an unfertilised egg cell taken from another sheep (1). Insert the nucleus from a body cell (e.g. a skin cell) of the prize-winning sheep into the egg cell (1). Give the egg cell an electric shock to stimulate it to divide and form an embryo (1). When it is a ball of cells, insert the embryo into the womb of an adult female sheep (1).

Explain which animal a clone is identical to

2 marks | Grade 8

1. The genetic information is in the nucleus.
2. The clone is genetically identical to the animal that gave the body cell nucleus, not the egg donor or the host mother.

Example. In adult cell cloning, the nucleus from a skin cell of sheep A is put into an egg cell from sheep B. The embryo is put into the womb of sheep C.
Which sheep will the lamb be genetically identical to? Explain your answer. [2 marks]

Model answer. Sheep A (1). The genetic information is in the nucleus, and the nucleus came from sheep A's skin cell (1).

Don't lose marks

- Saying the clone is identical to the egg donor or the host mother. It is identical to the nucleus donor.
- Saying the egg is fertilised in adult cell cloning. It is an unfertilised egg cell, stimulated to divide by an electric shock.
- Saying calves from embryo transplants are identical to their parents. They are identical to each other.
- Forgetting that the embryo cells must be split before they become specialised.

More tips

Memory tricks

- Adult cell cloning in four words: out, in, shock, womb.
- A clone matches whoever gave the NUCLEUS.
- Embryo transplant offspring are copies of each other, not of their parents, because the embryo came from sexual reproduction.

Exam technique

- In 'describe' questions, give the steps in the right order.
- Use precise terms: unfertilised egg cell, nucleus, body cell, electric shock, embryo, womb, host mother.
- For 'evaluate' questions, include benefits, risks and an ethical point, then give a conclusion.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **Define a clone**
An organism that is genetically identical to another.

Grade 4 — **Describe taking cuttings**
Gardeners cut a piece from a parent plant and grow it into a new, identical plant.

Grade 5 — **Describe tissue culture and its uses**
Small groups of cells from part of a plant are grown into identical plants, to preserve rare species or for nurseries.

Grade 6 — **Describe embryo transplants**

Split apart the cells of an early embryo before they become specialised and transplant the identical embryos into host mothers.

Grade 7

Describe adult cell cloning

Remove an egg's nucleus, insert an adult body cell nucleus, give an electric shock, then put the embryo into a womb.

Grade 8

Evaluate cloning in agriculture and medicine

Weigh the benefits of many identical, useful organisms against reduced variation, possible health problems and ethical objections.

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