Sexual reproduction

There are two main ways by which organisms can reproduce: **sexual** reproduction and **asexual** reproduction.

In sexual reproduction, genes from two parent organisms are combined to produce an organism with a unique genetic code.

The advantage of sexual reproduction is that it produces **natural variation** among a species, enabling it to adapt to environmental change.

Most animals and many plants reproduce sexually.

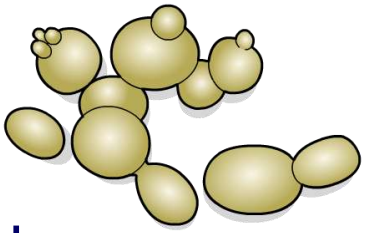
Asexual reproduction

In asexual reproduction, a single organism makes a copy of itself with exactly the same genetic code. The new organism is a **clone** of the original.

Asexual reproduction enables an organism to quickly populate a new habitat and ensures that, if it is well-adapted to its environment, successful characteristics are passed on.

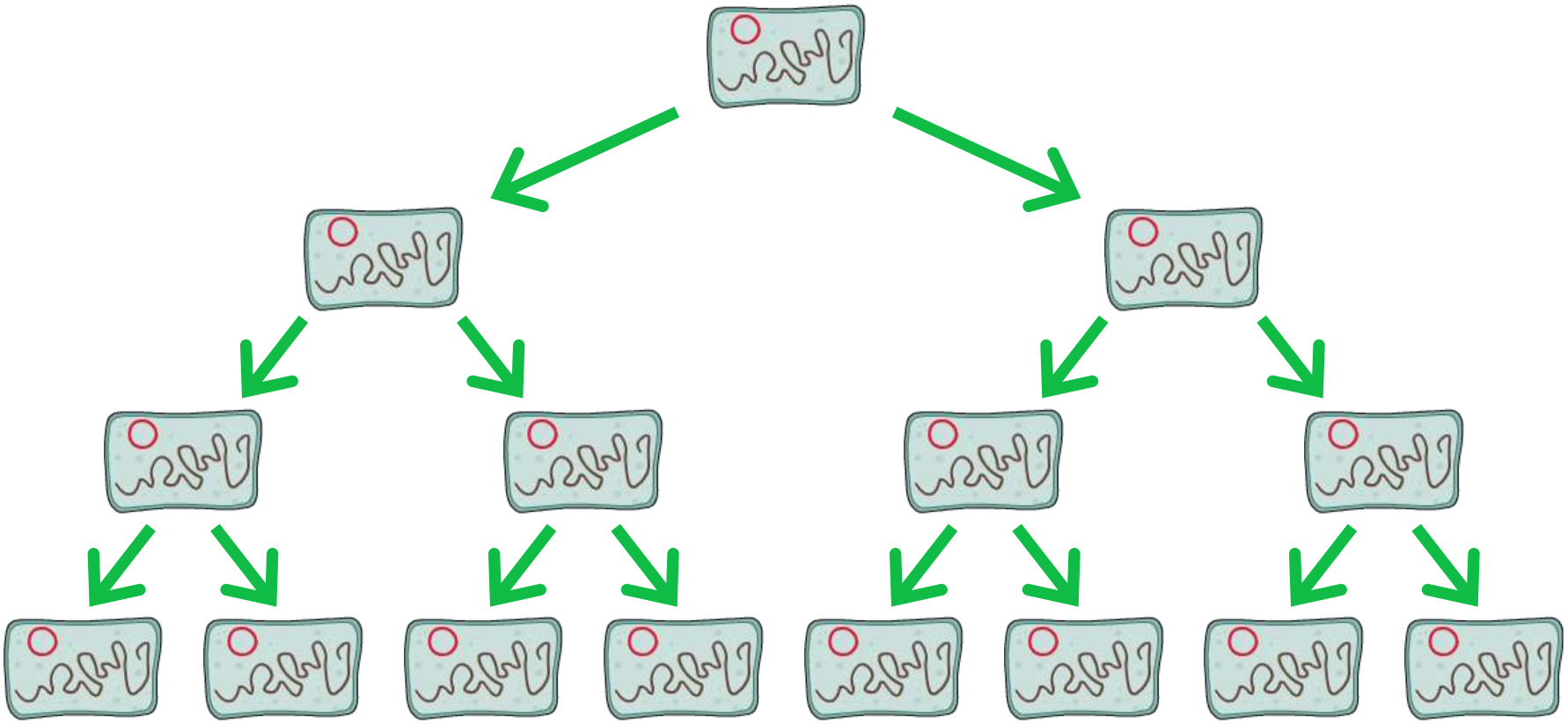
Organisms that reproduce asexually include:

- many plants, such as spider plants, strawberries and potatoes
- micro-organisms, such as bacteria and yeast
- some insects, such as aphids.



Speedy bacterial clones

Bacteria can copy themselves very quickly – their numbers can double every **20 minutes**! That's 10 times faster than the quickest animal cells.



Human clones

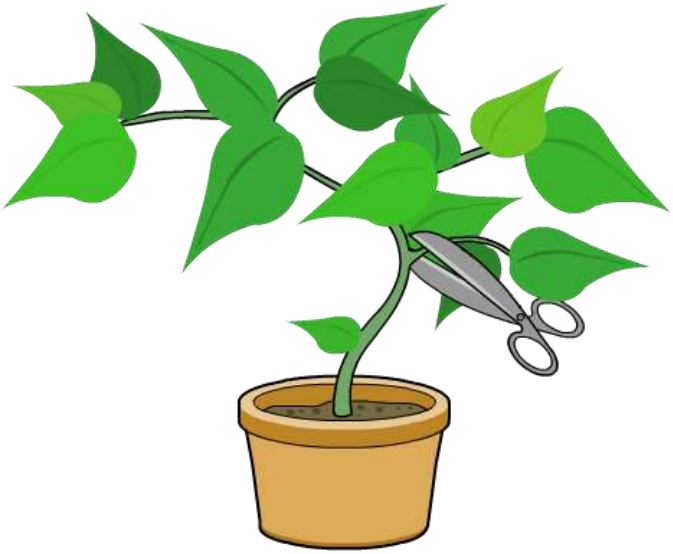
Human clones already exist! Identical twins have exactly the same genes and are therefore clones of each other.

Identical twins are created when a fertilized egg splits in two, creating two separate but genetically-identical embryos.

How does the creation of identical twins differ from that of non-identical twins?

Taking cuttings

A plant can easily and quickly be cloned by taking a **cutting**. This is a fast way of cloning.



stem cut from parent plant

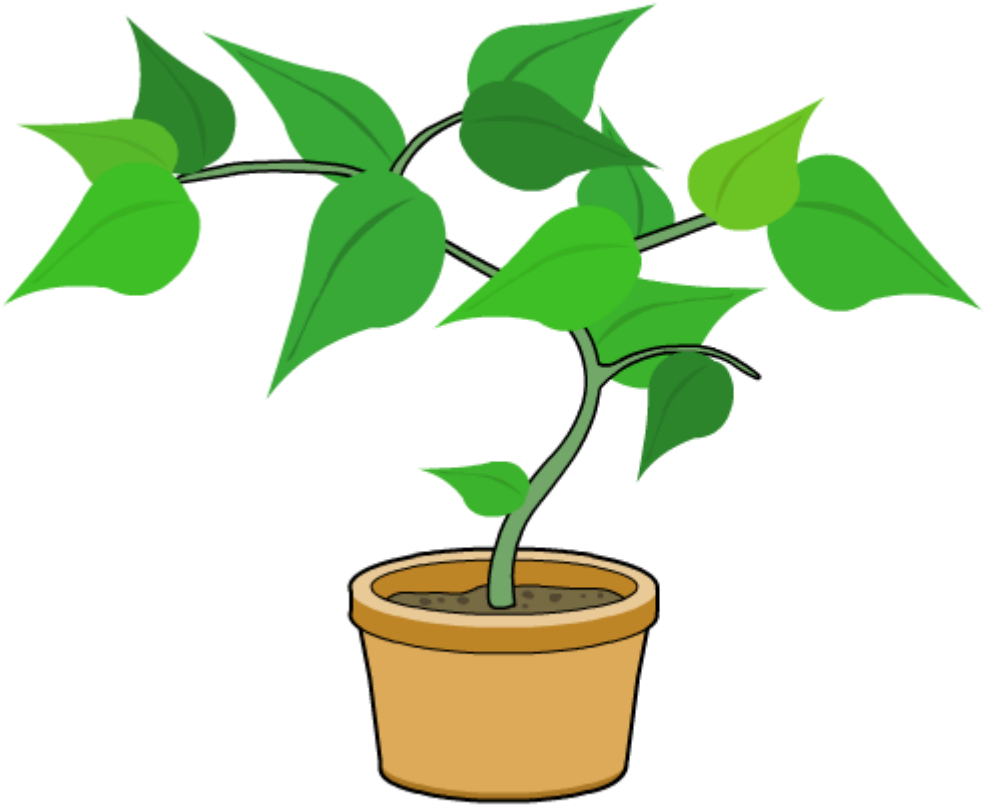
cutting dipped in rooting powder and planted

The problem with this method is that it cannot produce many clones at once.

How can plants be cloned by tissue culture?

Tissue culture enables hundreds of clones to be made from a single plant at the same time.

Click "**start**" to find out it works.



start

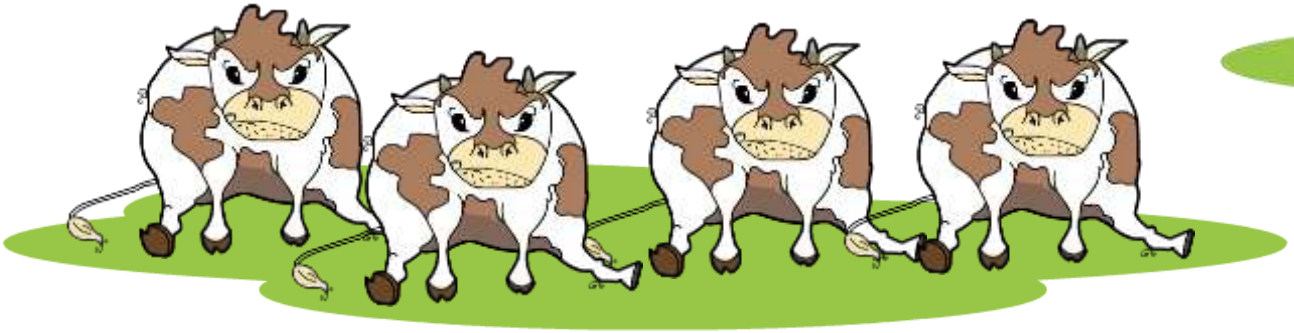
Embryo transplantation

It is more difficult to clone animals than plants. A technique used to create clone animals is **embryo transplanting**. For example, a cattle farmer would follow this process:

1. Sperm is taken from the best bull and used to fertilize an egg from the best cow.
2. The fertilized egg divides to form an embryo containing several cells.
3. The embryo is separated into individual cells, which go on to form new embryos. Each embryo contains the same genes.
4. The embryos are implanted into **surrogate** cows.
5. The cows give birth to calves, which are all clones of each other.

Embryo transplants

Embryo transplantation enables a farmer to produce several new animals that have the characteristics of the best bull and best cow.



Before embryo transplantation takes place, the cow is given fertility drugs to increase the number of eggs she produces. How does that improve the procedure?

Cloning an adult

Embryo transplantation enables animals to be created that are clones of each other, but not clones of the parent.

Cloning a single adult animal, especially a mammal, is much more complicated.

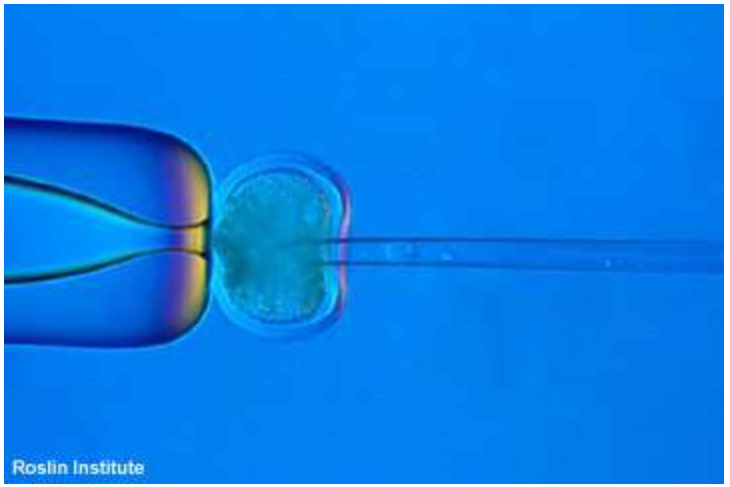
The most famous animal clone is **Dolly the sheep**, who was born on 5 July 1996.

Dolly was not the first animal clone, but the first mammal to be cloned from an adult cell.

What is nuclear transfer?

Dolly was created using a technique called **nuclear transfer**.

In this technique, the nucleus (i.e. DNA) from a body cell of the adult (a **somatic** cell) is removed.



This nucleus is then inserted into an egg cell that has had its own nucleus removed.

The egg cell is then made to divide and develop like a normal fertilized egg. The important difference is that it only contains the DNA from one, rather than two, animals.

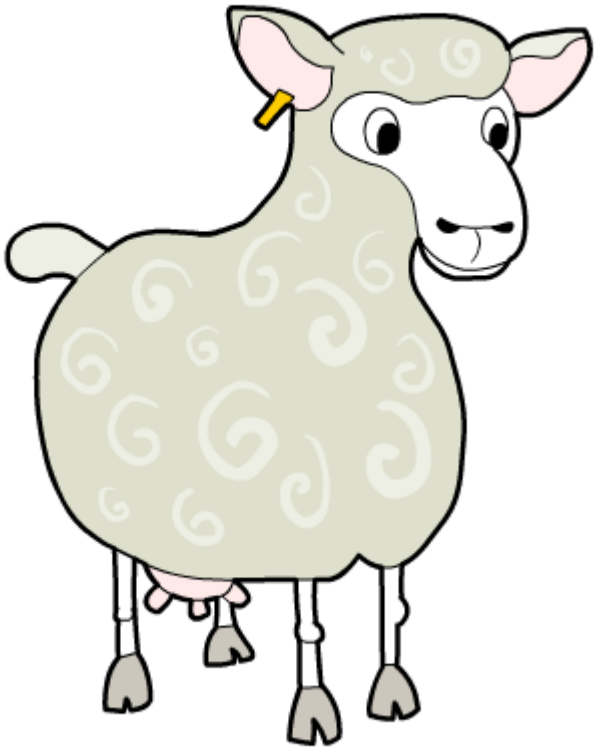
Why couldn't the DNA be taken from a sperm or egg cell?

Because they only contain half the genes of the animal.

How was Dolly the sheep created?

Dolly was the first mammal to be cloned from an adult cell.

Click "**start**" to find out how she was created.



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Advantages and disadvantages

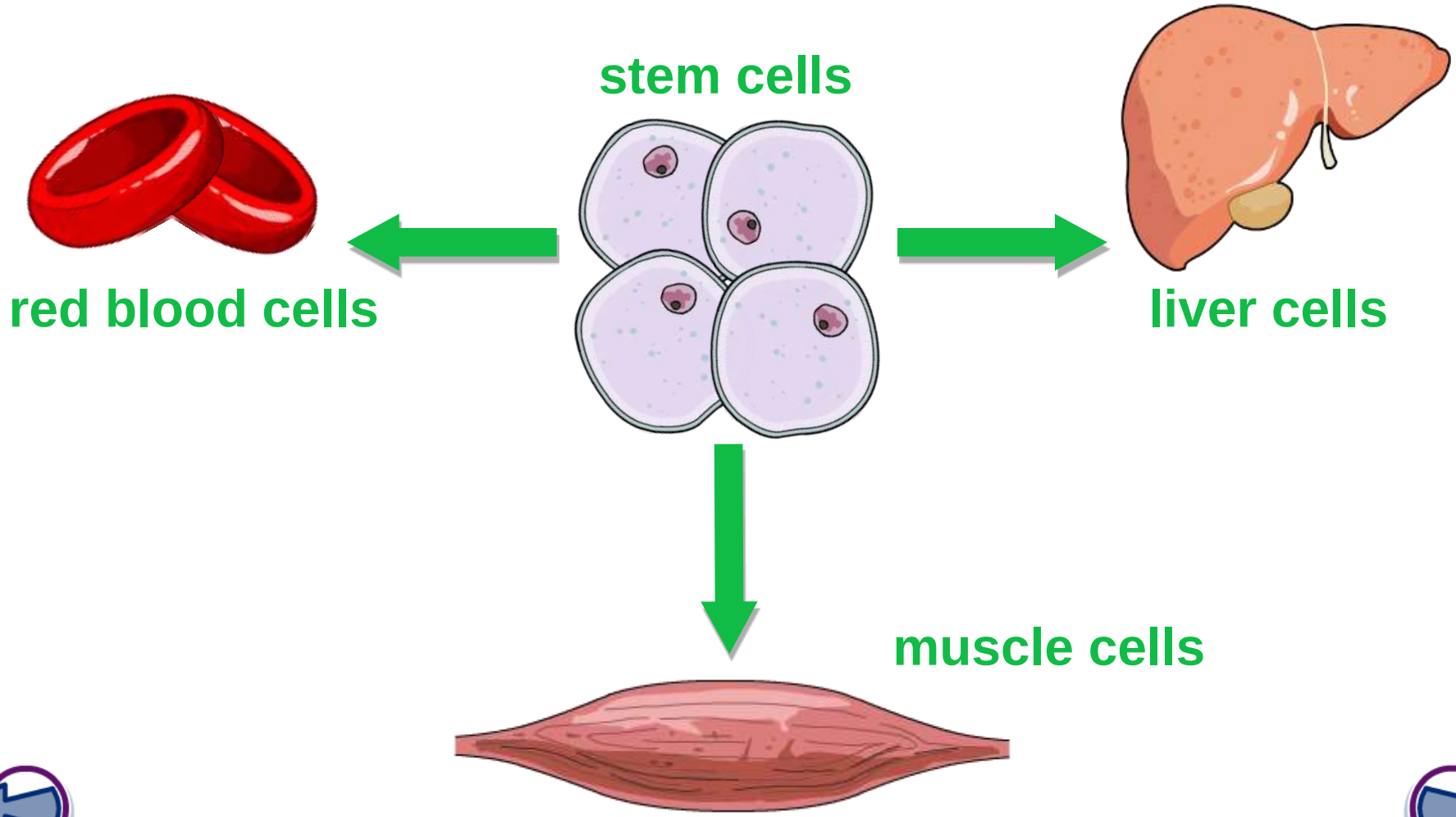
Are these advantages or disadvantages of cloning?

advantages	disadvantages
mass produce animals with desired characteristics ✓	ethical implications, e.g. use of human embryos ✓
can produce embryos to get stem cells for therapy ✓	expensive process with low success rate ✓
can produce animals that provide human products ✓	cloned human organs, grown on animals, may be rejected by the body ✓

Well done!

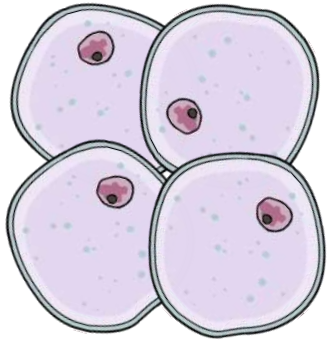
What are stem cells?

Stem cells are unspecialized cells that can develop into any type of cell. Early embryos are good sources of stem cells.



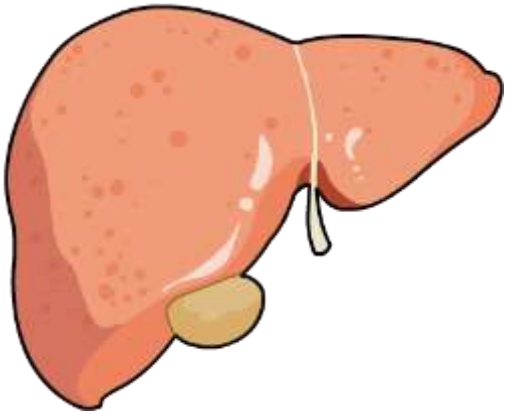
Using stem cells

Stem cells could be injected into damaged organs to rebuild the tissues. This would reduce the need for organ transplants.



stem cells

injected into patient with diseased liver



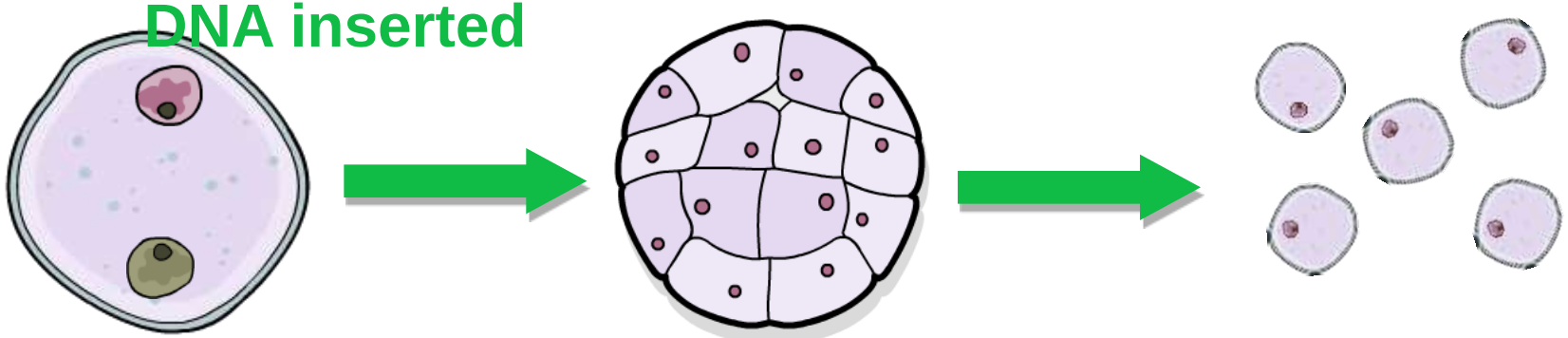
liver is repaired

The stem cells would need to have the same genes as the patient, otherwise they would be rejected by the patient's immune system. They would need to be clones.

How could you make an embryo that only contained your genes?

Human therapeutic cloning

The DNA of an embryo cell can be replaced with the DNA from a patient's cell.



The embryo produces stem cells containing the patient's genes. The cells will not be rejected, so immune-suppressing drugs are not needed. This process is **therapeutic cloning**.

Opinions on human cloning

Do you agree or disagree with these opinions on human cloning?

Mrs Green (Housewife)
"Killing an embryo when it is 5 days old is wrong. It's the same as killing a child."

-5 -4 -3 -2 -1 **0** 1 2 3 4 5

disagree not sure agree

Glossary

- **asexual –** The type of reproduction that produces naturally-occurring clones.
- **clone –** An organism that has exactly the same genetic code as another organism.
- **nuclear transfer –** A technique used to clone an adult body cell and which was used to create Dolly the sheep.
- **stem cells –** Cells that have yet to specialize and can potentially be made to become any type of cell.
- **therapeutic cloning –** A technique that uses nuclear transfer to create stem cells for treating diseases.
- **tissue culture –** A simple way of making large numbers

Anagrams

How quickly can you unscramble anagrams of words about

c l o n i n g ?

start

Multiple-choice quiz