



# What are clones?

- Genetically identical copies



# Cloning

- The possibility of human cloning was raised when Scottish scientists at Roslin Institute created the much-celebrated sheep "Dolly"

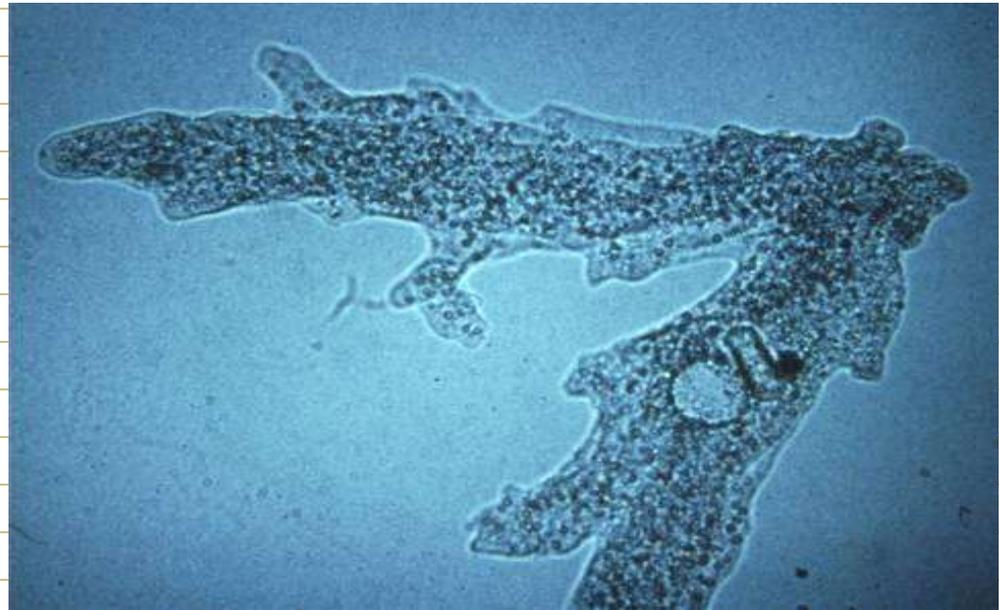


# Cloning

- The idea of cloning aroused worldwide interest and concern because of its scientific and ethical implications.

# Cloning

- In nature, some plants and single-celled organisms are cloned through **asexual** reproduction



# Cloning

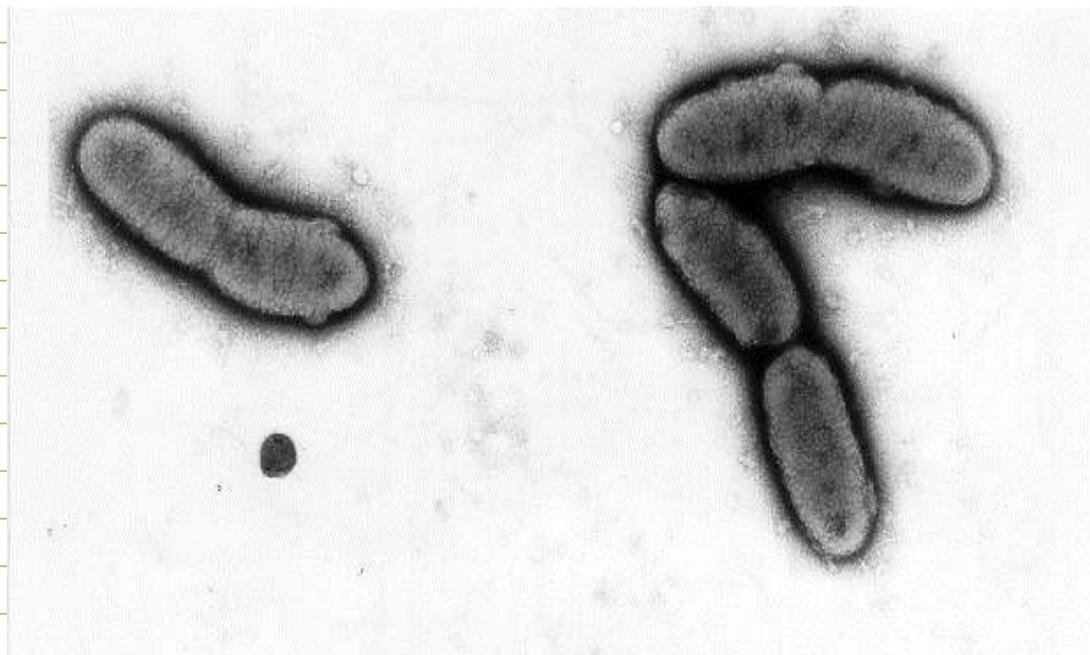
- In **asexual** reproduction, a new individual is generated from a copy of a single cell from the **parent organism**.



Tiny 'buds' grow out from the hydra's side, develop mouth tentacles, and finally nip off at the base to form a separate individual.

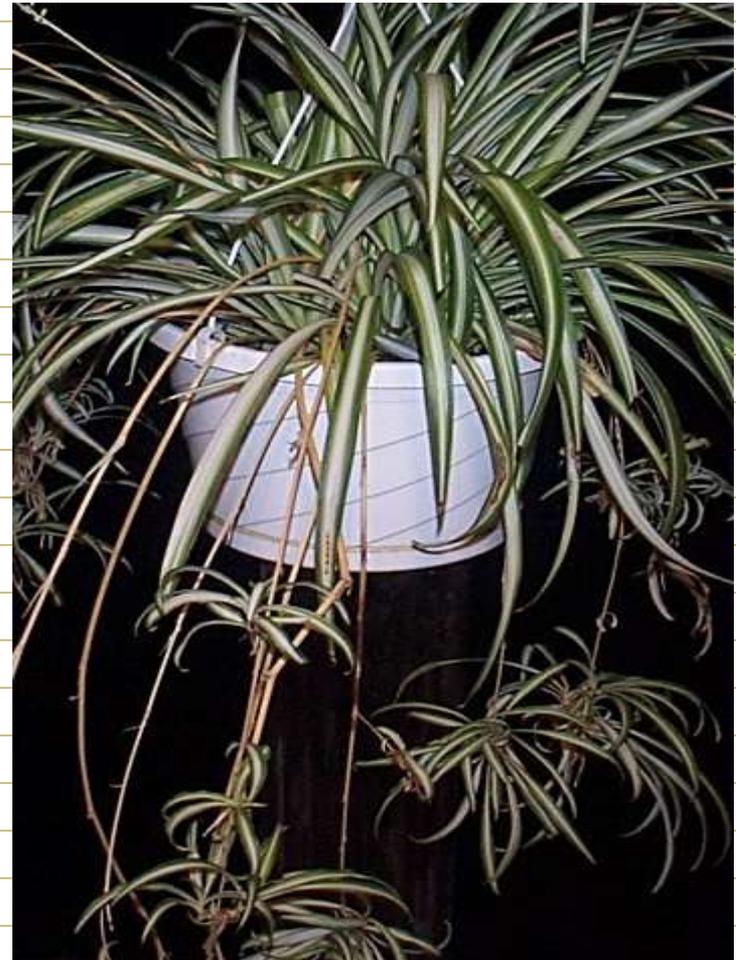
# Bacteria dividing asexually

- These are **CLONES** as only have information from 1 parent



# Spider plant making asexual clones

- Plants retain some **unspecialized** cells
- These cells have the potential to grow into a whole new plant



# Strawberry plants making asexual clones

- Whole new plants grow at the end of the runners



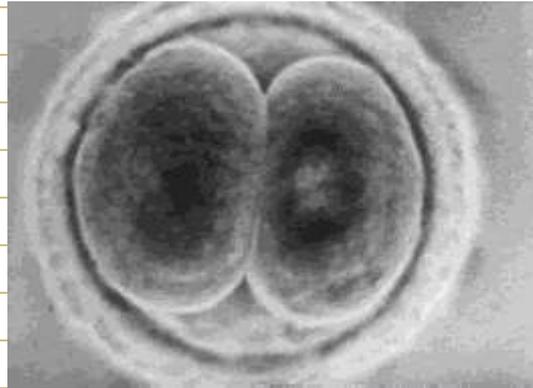
# Cloning

- **Natural clones**, also known as identical twins, occur in mammals.



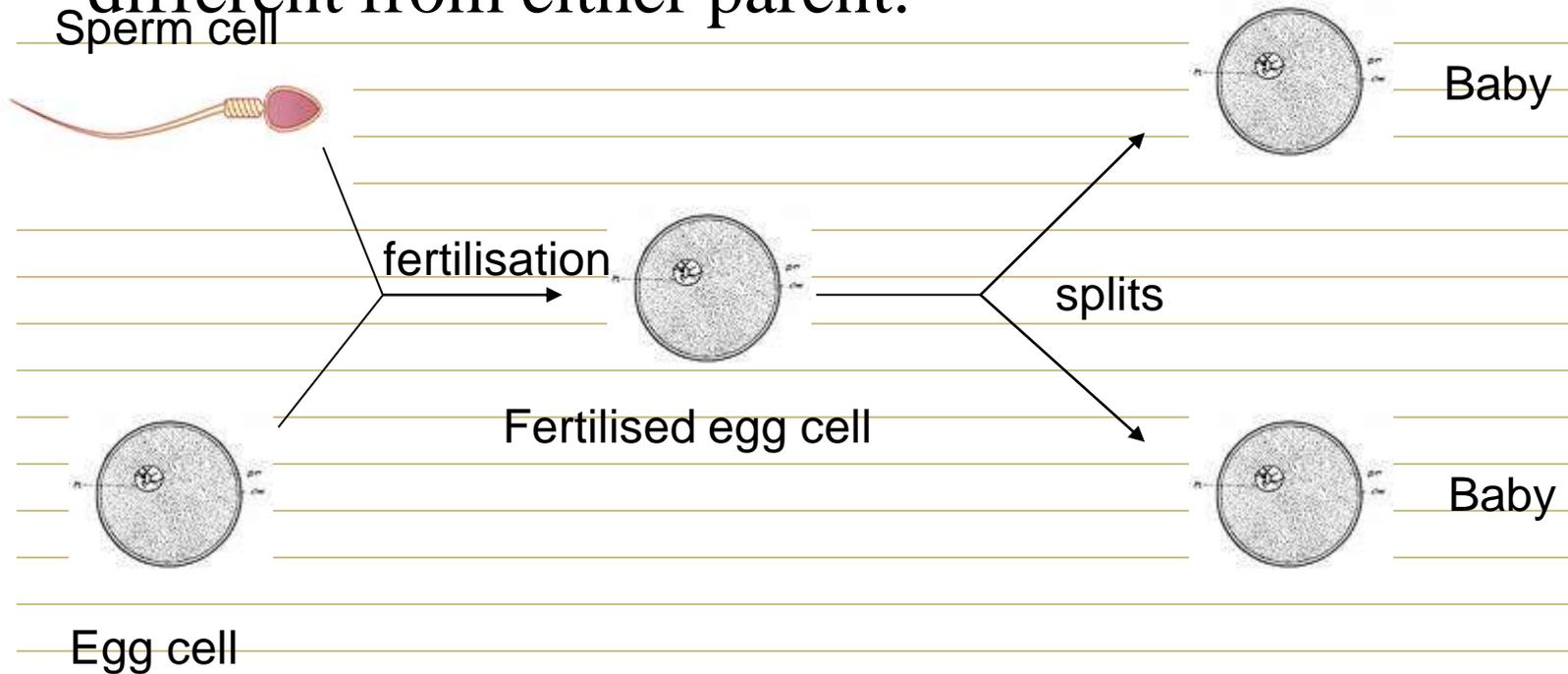
# Cloning

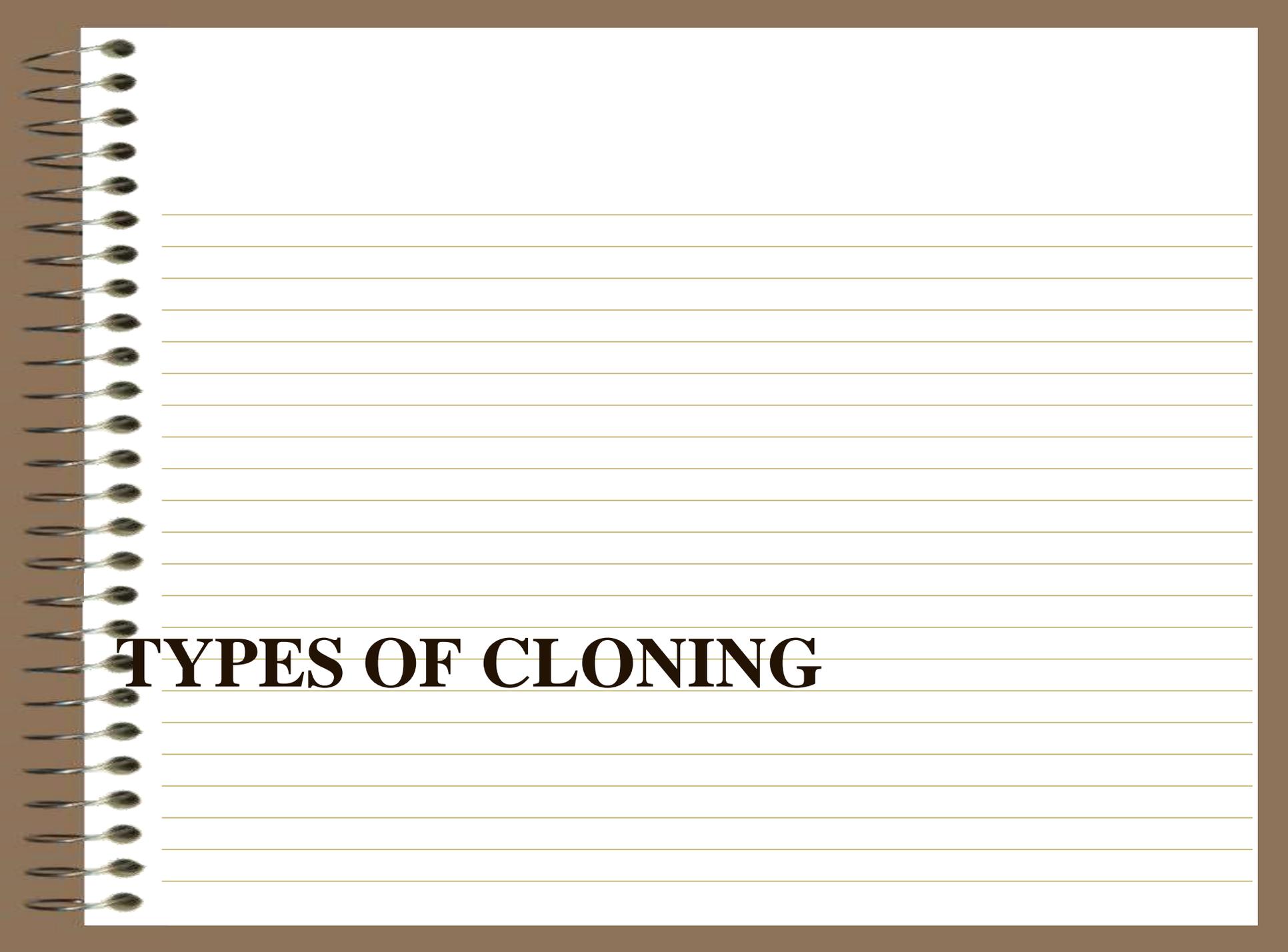
- Twins are produced when a fertilized egg splits, creating two or more embryos that carry almost identical DNA.



# Cloning

- Identical twins have nearly the same genetic makeup as each other, but they are genetically different from either parent.



A spiral-bound notebook with a brown cover and white lined paper. The spiral binding is on the left side. The text "TYPES OF CLONING" is written in a bold, black, serif font across the middle of the page.

# **TYPES OF CLONING**

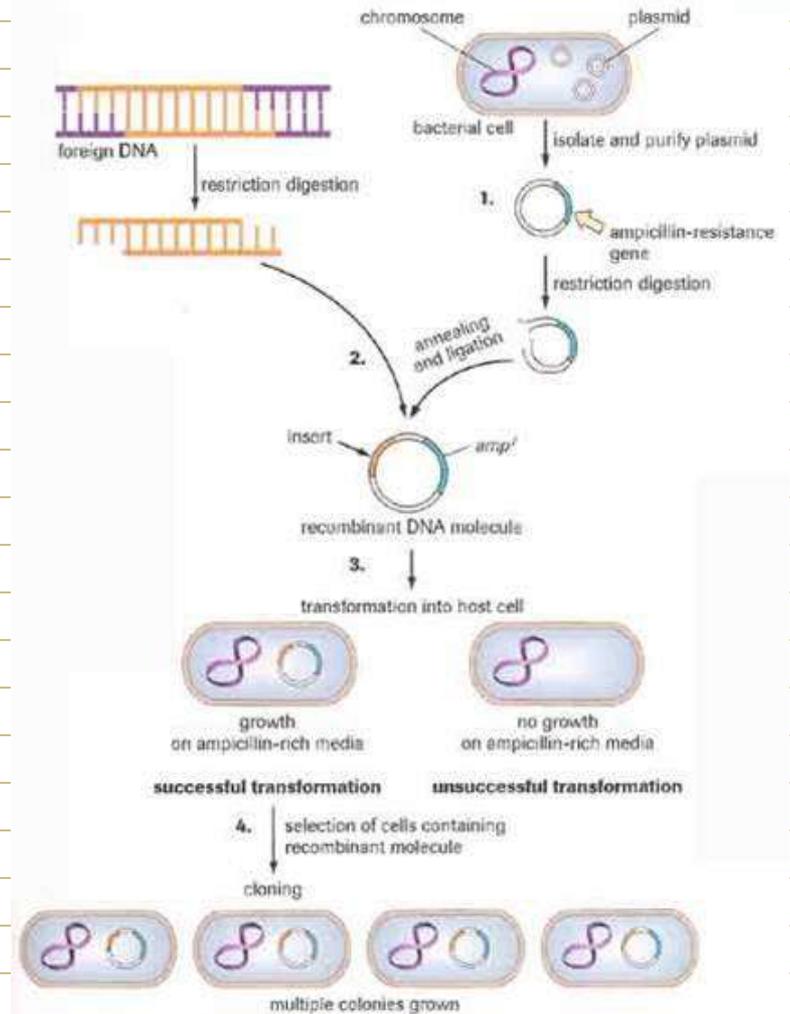
# Cloning

- There are three different types of artificial cloning:
  - gene cloning
  - reproductive cloning
  - therapeutic cloning



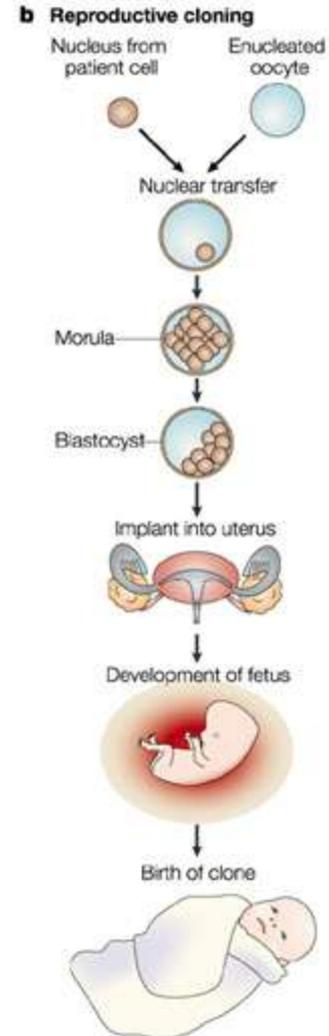
# Cloning

- **Gene cloning** produces copies of genes or segments of DNA.



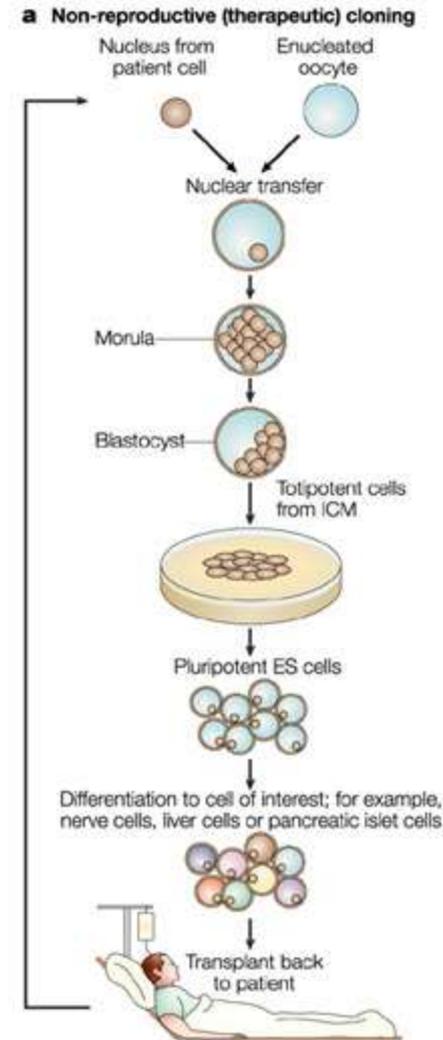
# Cloning

- **Reproductive cloning** produces copies of whole animals.



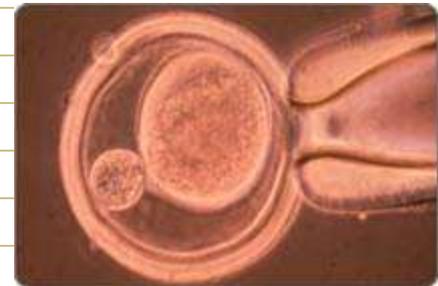
# Cloning

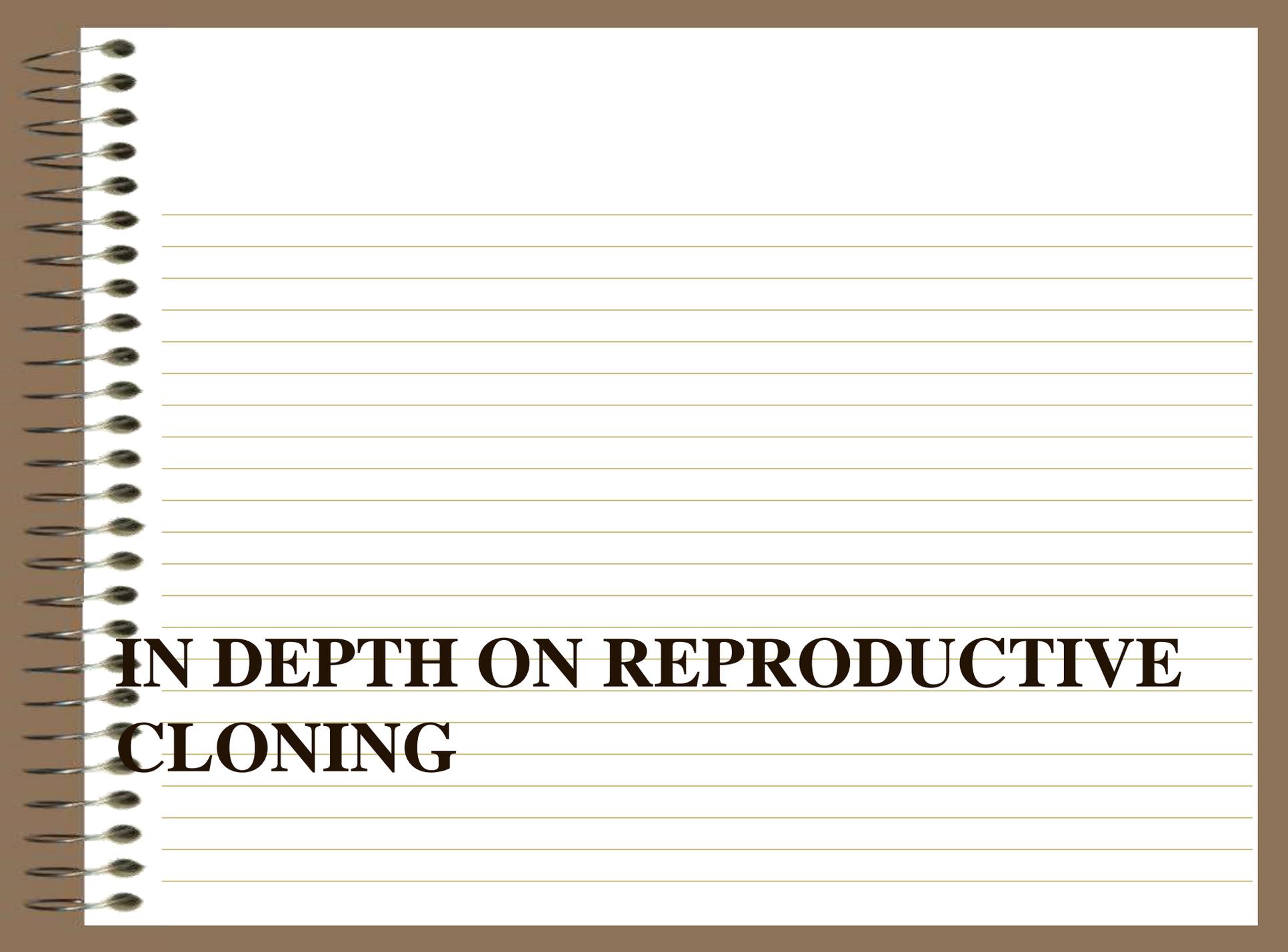
- **Therapeutic cloning** produces embryonic stem cells for experiments aimed at creating tissues to replace injured or diseased tissues.



# Cloning

- Researchers routinely use cloning techniques to make copies of genes that they wish to study.
- The procedure consists of inserting a gene from one organism, often referred to as "foreign DNA," into the genetic material of a carrier called a vector.



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# **IN DEPTH ON REPRODUCTIVE CLONING**

# Reproductive cloning

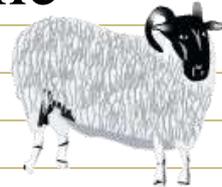
- The technique used to clone whole animals, such as sheep, is referred to as reproductive cloning.



# Reproductive cloning

1. Removed a mature somatic cell from the animal that they wish to copy.

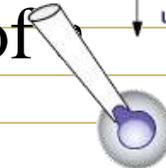
Scottish Blackface ewe



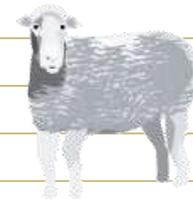
↓ Isolate egg cells from ovaries



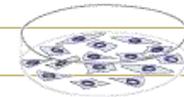
↓ Remove haploid nucleus using micromanipulation



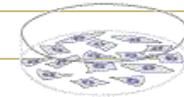
Finn Dorset ewe



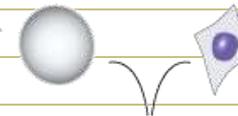
↓ Isolate diploid somatic cells from mammary gland



↓ Induce quiescence ( $G_0$ ) by growth in low serum



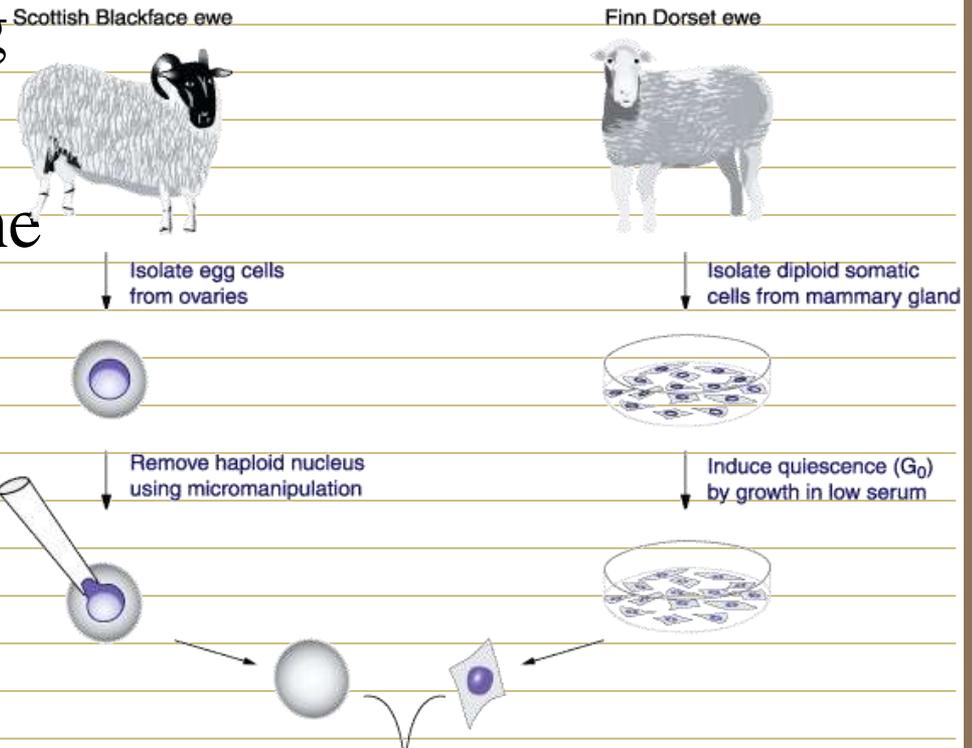
2. Remove an egg cell from the ovaries of donor.



# Reproductive cloning

3. Remove the nucleus from the donor egg cell

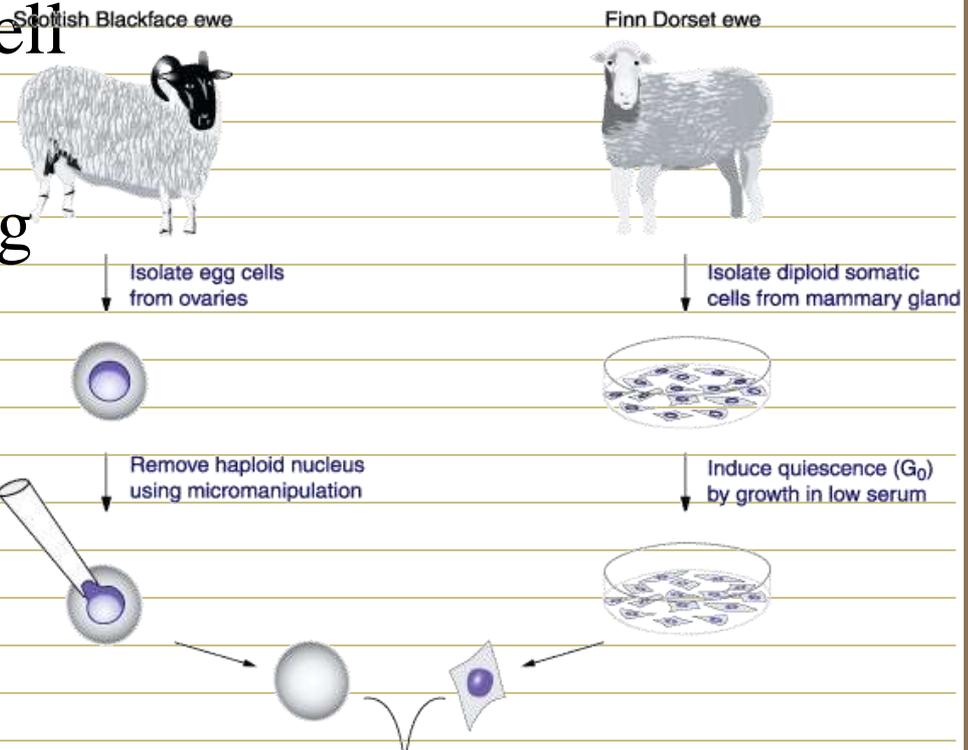
4. Isolate and grow the somatic cells



# Reproductive cloning

5. Remove the nucleus from the somatic cell

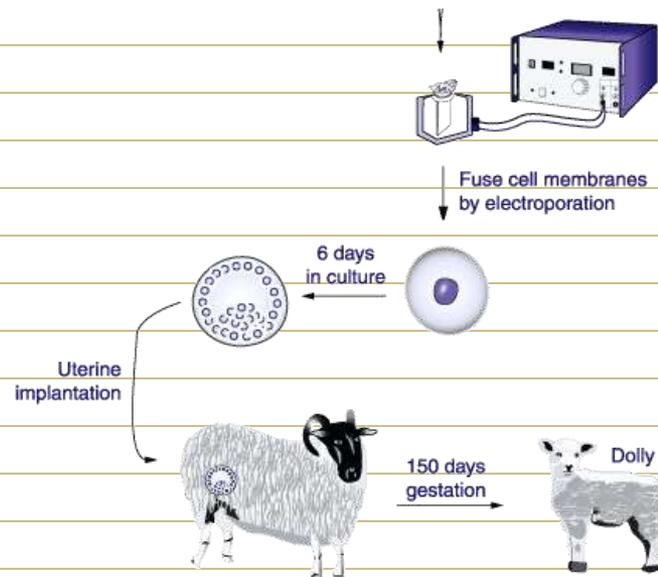
6. Insert the somatic nucleus into the egg



# Reproductive cloning

7. Implant the egg back into the surrogate mother

8. Dolly is born



# Reproductive cloning

- Reproductive cloning is a very inefficient technique and most cloned animal embryos cannot develop into healthy individuals.
- Dolly was the only clone to be born live out of a total of 277 cloned embryos.
- She lived there from her birth in 1996 until her death in 2003 when she was six

# Reproductive cloning

- Cloning animals have special value if the animal produces important products

# Reproductive cloning

- Genetically modified sheep produce several human proteins from their milk
  - Treatment of emphysema
  - Cystic fibrosis

# Reproductive cloning

- Can also produce not just whole animals, but individual organs
- Pigs are being modified so organs will not be rejected by humans

# Reproductive cloning

- This process is know as “pharming”

# Reproductive cloning

- Animals that have had genes transferred from other species are called transgenic animals.

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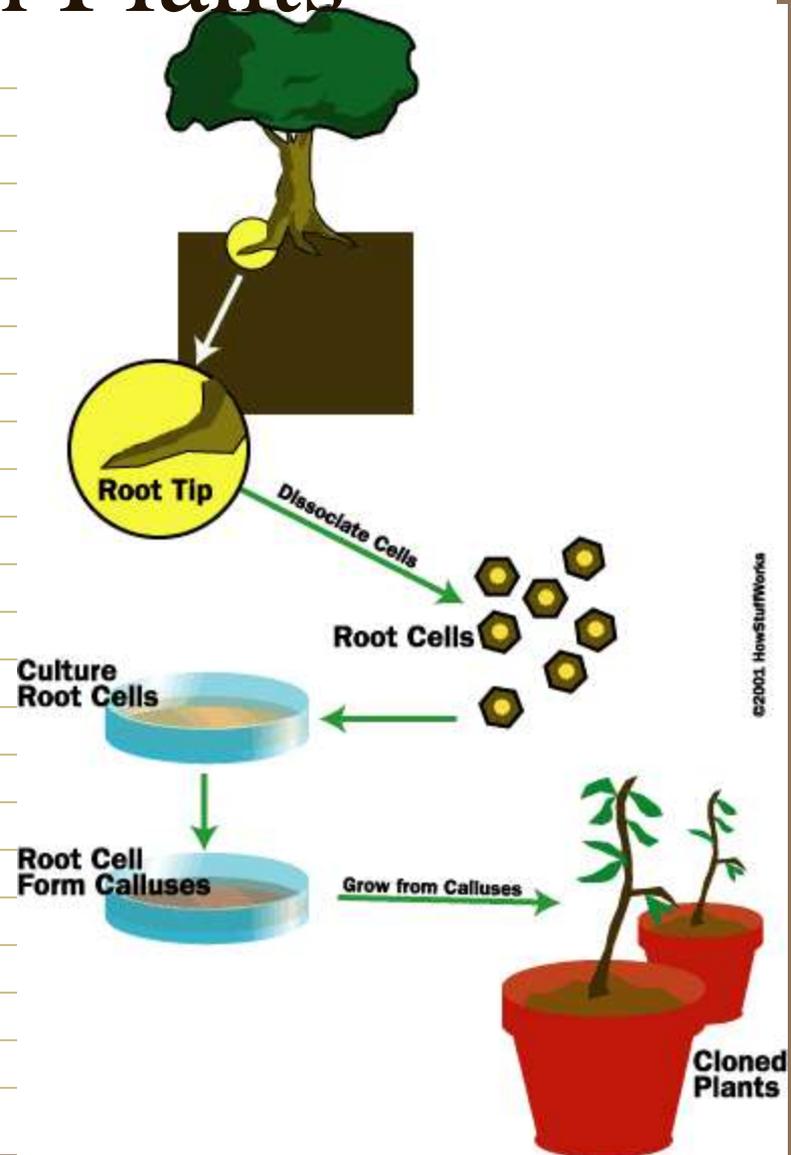
# **CLONING IN PLANTS**

# Cloning in Plants

- All descendants of a single plant, produced by vegetative reproduction.
- Many horticultural plant cultivars are clones, having been derived from a single individual, multiplied by some process other than sexual reproduction

# Cloning in Plants

- Modern cloning techniques are essentially the same as taking cuttings
- The technique of micro propagation is used
- Thousands of plants can quickly be produced from one original.



# Cloning in Plants

- Large numbers of genetically identical plants can be produced rapidly
- Species that are difficult to grow from seed can be propagated in this method



# Cloning in Plants

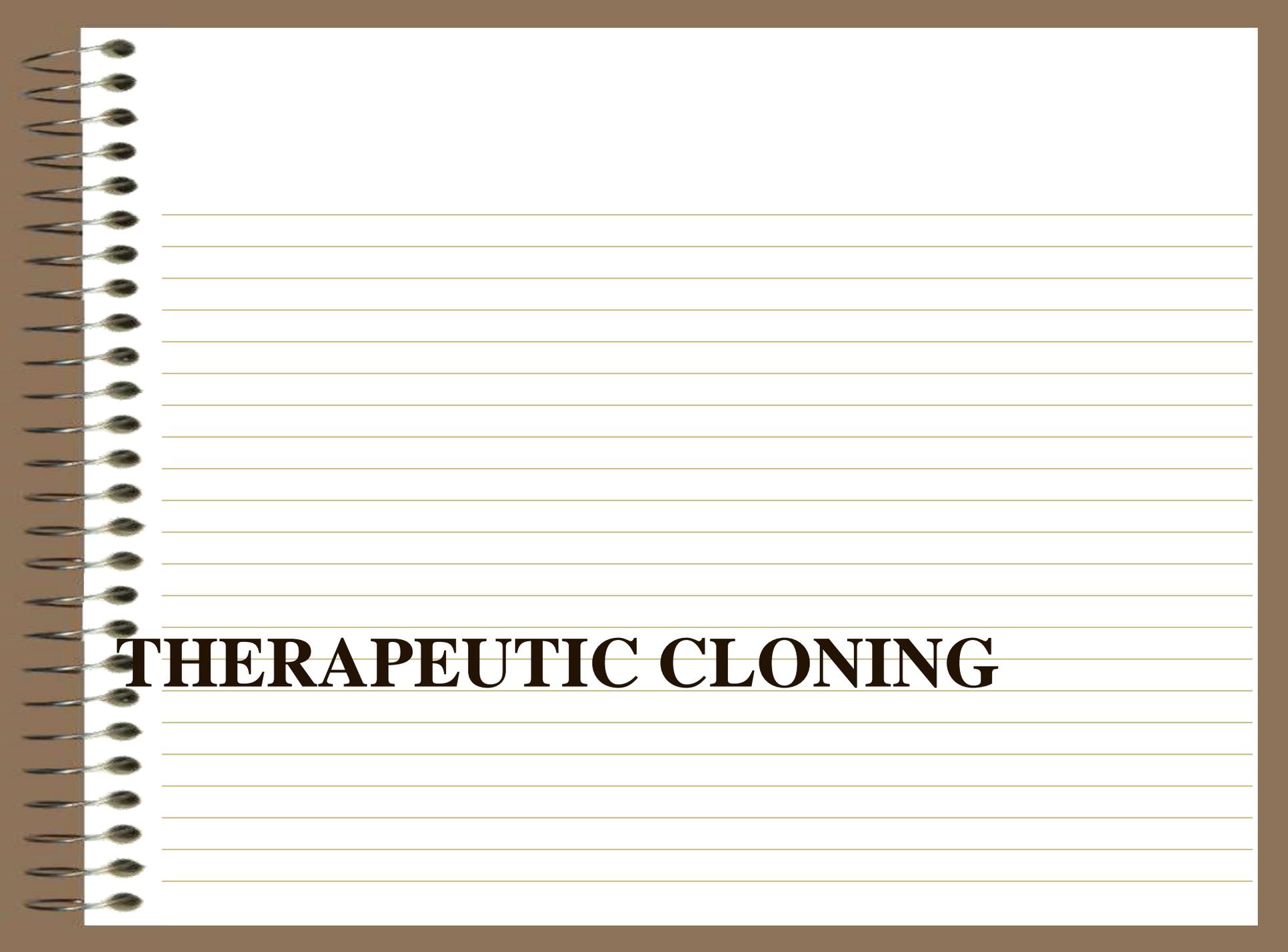
- Large numbers of plants can be stored easily
- Genetic modification can be introduced into thousands of plants quickly



# Cloning in Plants

- Bananas are infertile, they are commonly reproduced by micropropagation

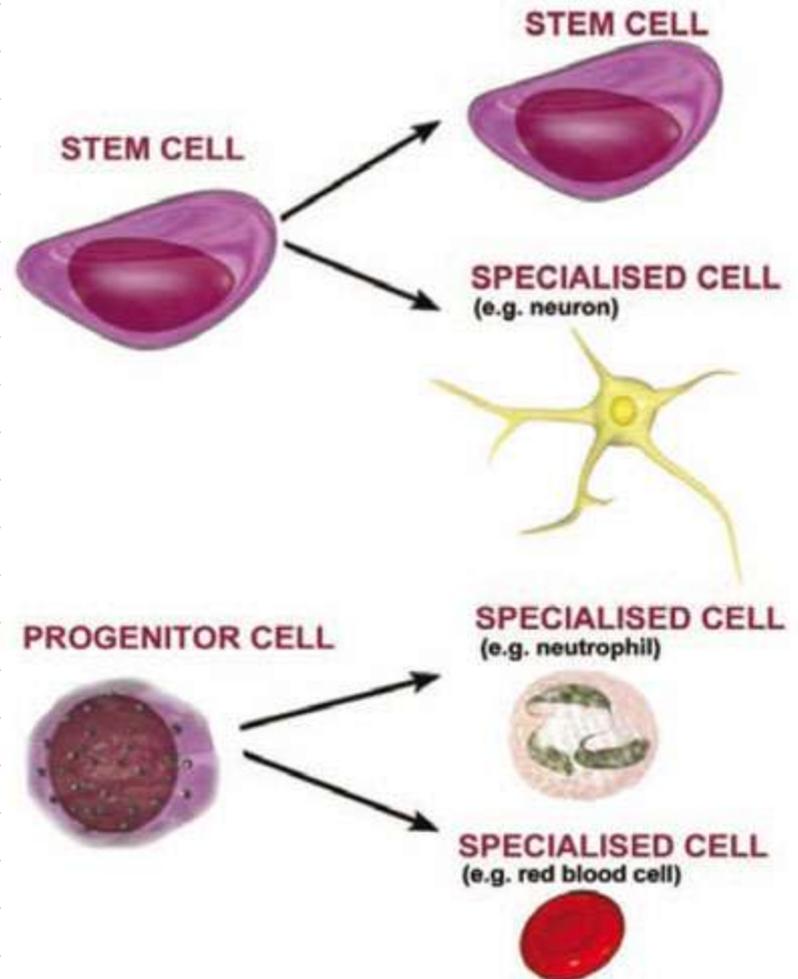


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# **THERAPEUTIC CLONING**

# Therapeutic Cloning

- Therapeutic cloning involves creating a cloned embryo for the sole purpose of producing embryonic stem cells with the same DNA as the donor cell.



# Therapeutic Cloning

- These stem cells can be used in experiments aimed at understanding disease and developing new treatments for disease.



# Therapeutic Cloning

- To date, there is no evidence that human embryos have been produced for therapeutic cloning.

# Therapeutic Cloning

1. Create cloned embryo of the patient.
2. Harvest stems cells from that embryo.
3. Use stem cells to create replacement organs or tissues.

