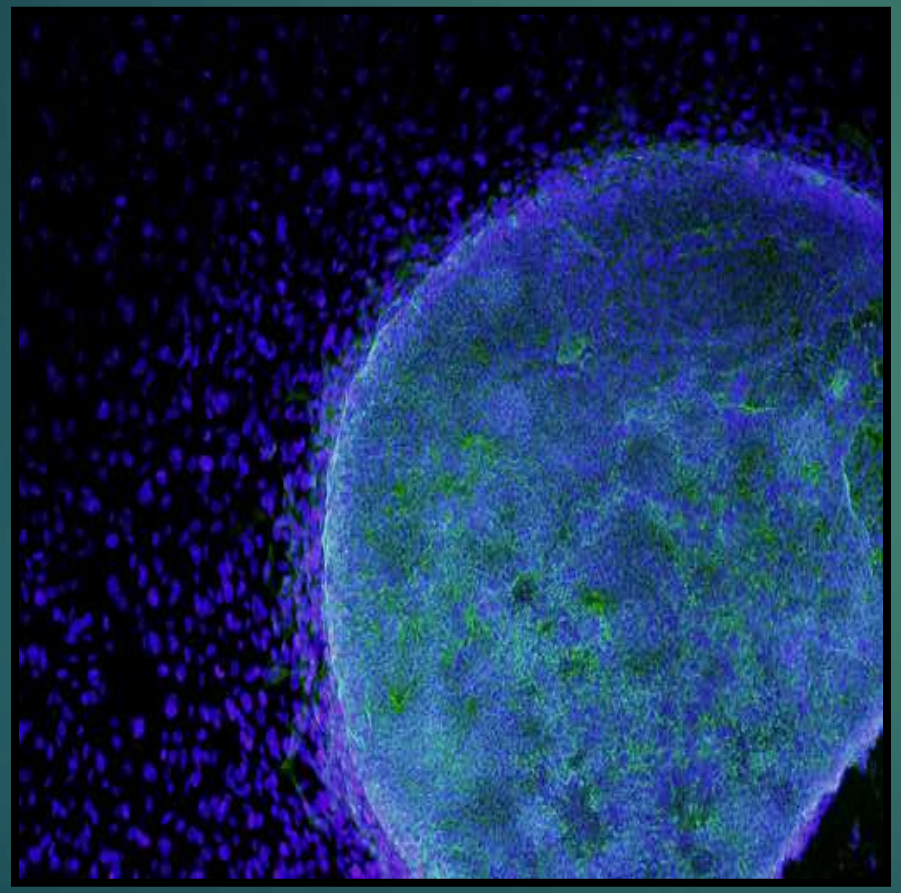
STEM CELLS

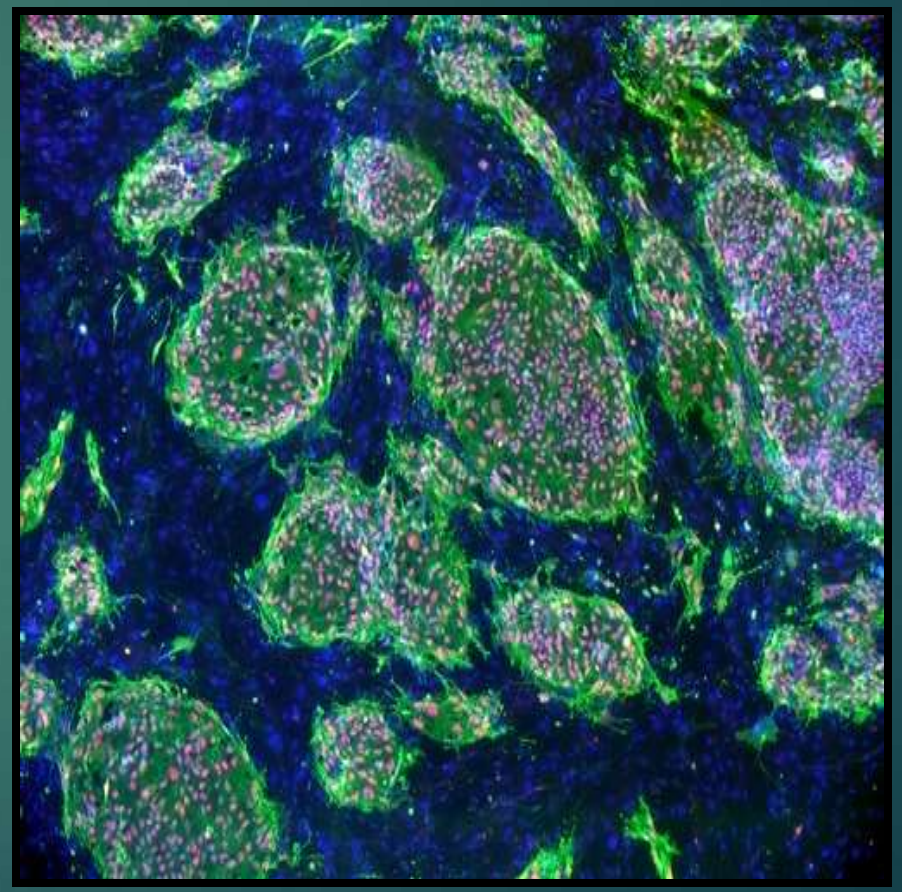
PRESENTED BY-UTKARSH NAGPAL 15BBT0070

What are stem cells?

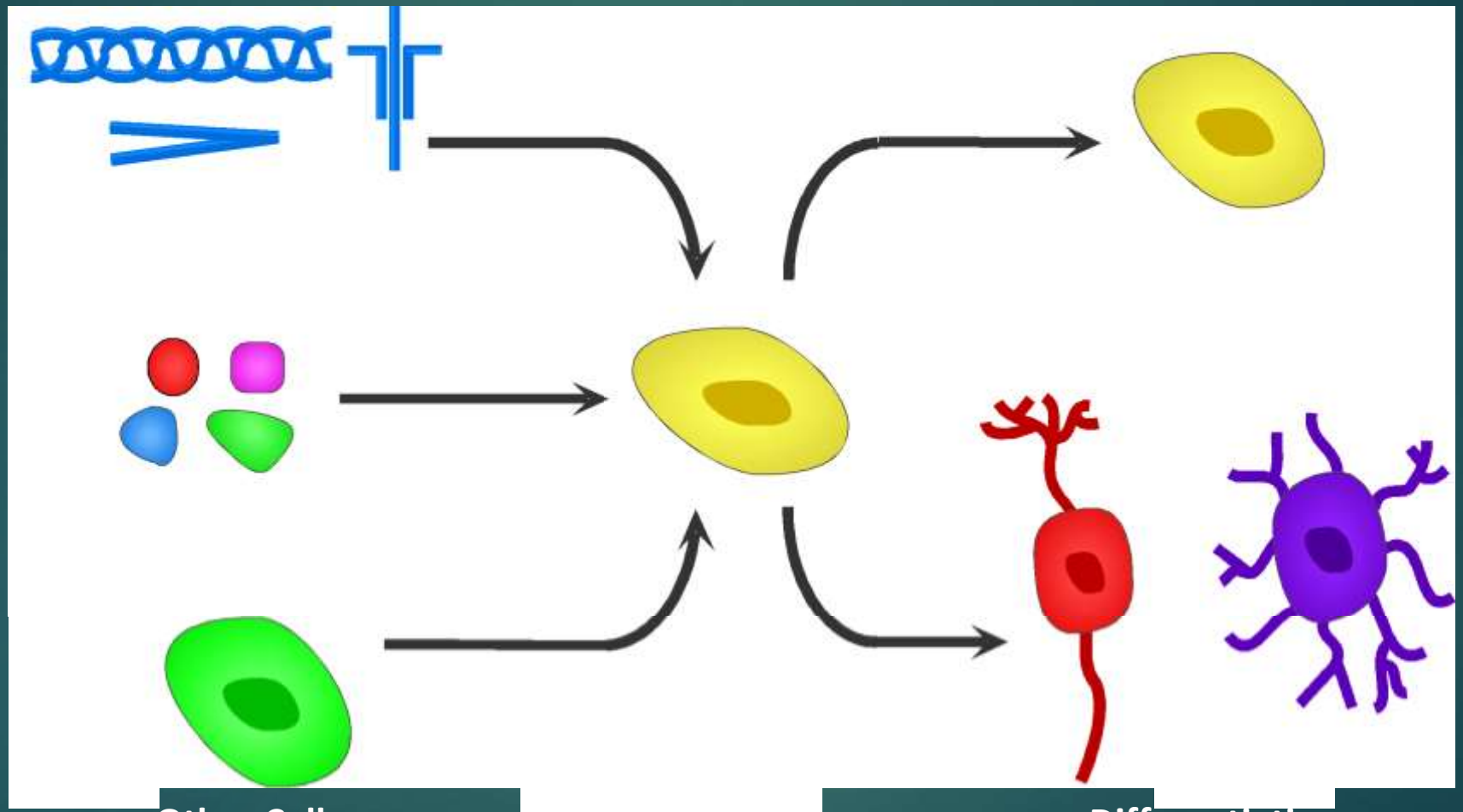
- the body is made up of about 200 different kinds of specialised cells such as muscle cells, nerve cells, fat cells and skin cells
- all cells in the body come from stem cells
- a stem cell is a cell that is not yet specialised
- the process of specialisation is called differentiation
- once the differentiation pathway of a stem cell has been decided, it can no longer become another type of cell on its own

Fluorescent imaging of embryonic stem cell colonies





Signals to Stem Cells



Little, et al. *Chemical Reviews* (2008).

How do cells know what to become?

All cells in a person share the same genotype

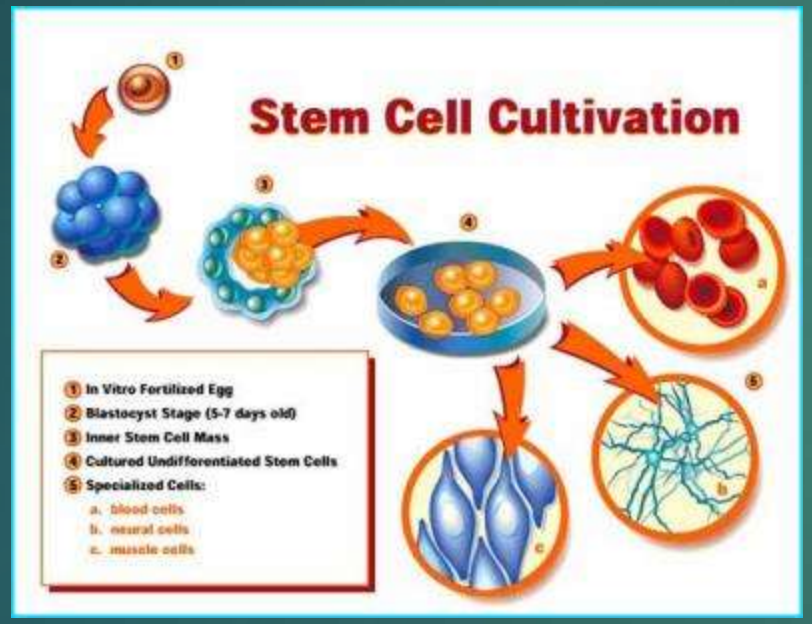
Yet eye cells differ from nose cells

Central dogma of biology

Genetic engineering

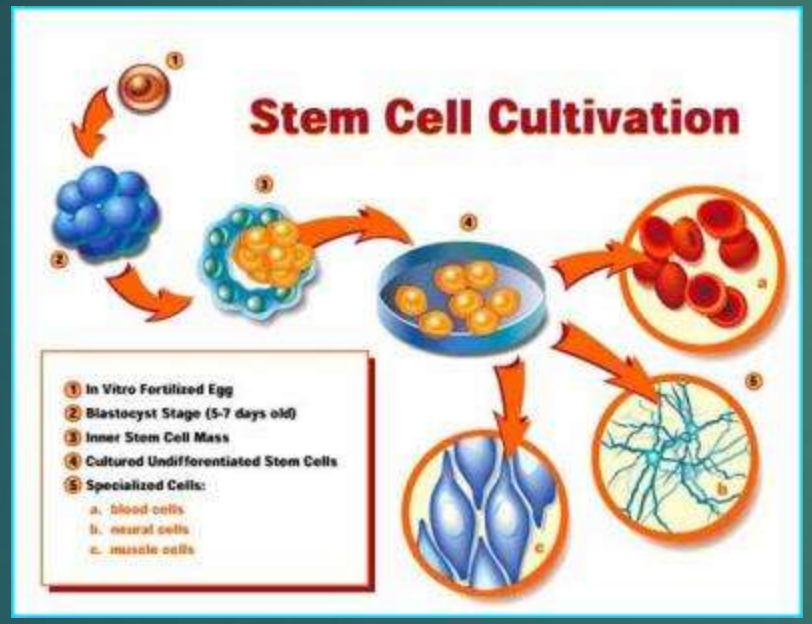
Tissue therapy

Embryonic stem cells



- Totipotent:
  - toti = total
  - potent = capacity
- The state of the cells after the first few divisions of the fertilised egg.
- Have the capacity to become all cell types **plus** placenta.

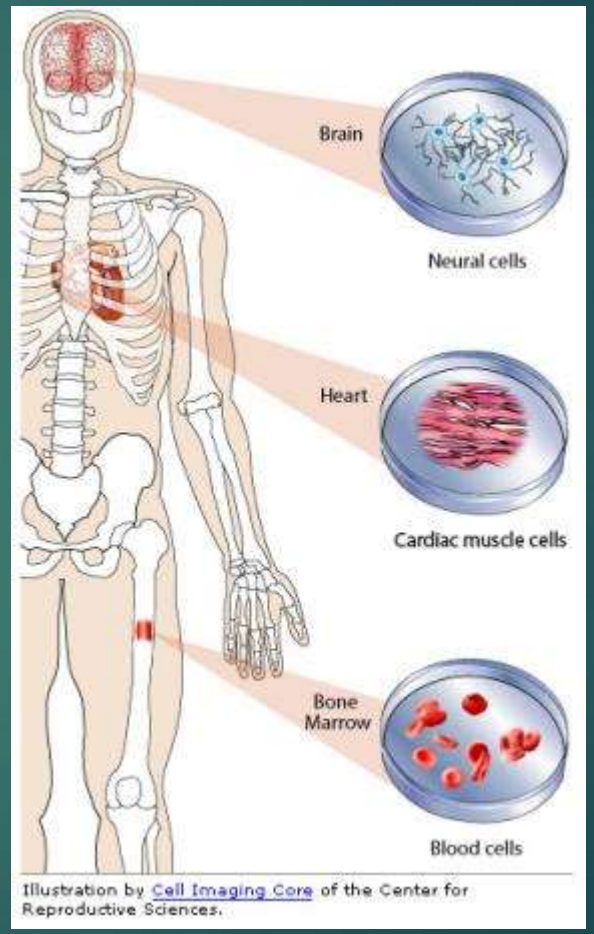
Embryonic stem cells



- Pluripotent:
  - pluri = many
  - potent = capacity
- At blastocyst stage cells become pluripotent.
- Have the capacity to become all cell types but **not** placenta.
- Cells of most interest to research scientists.

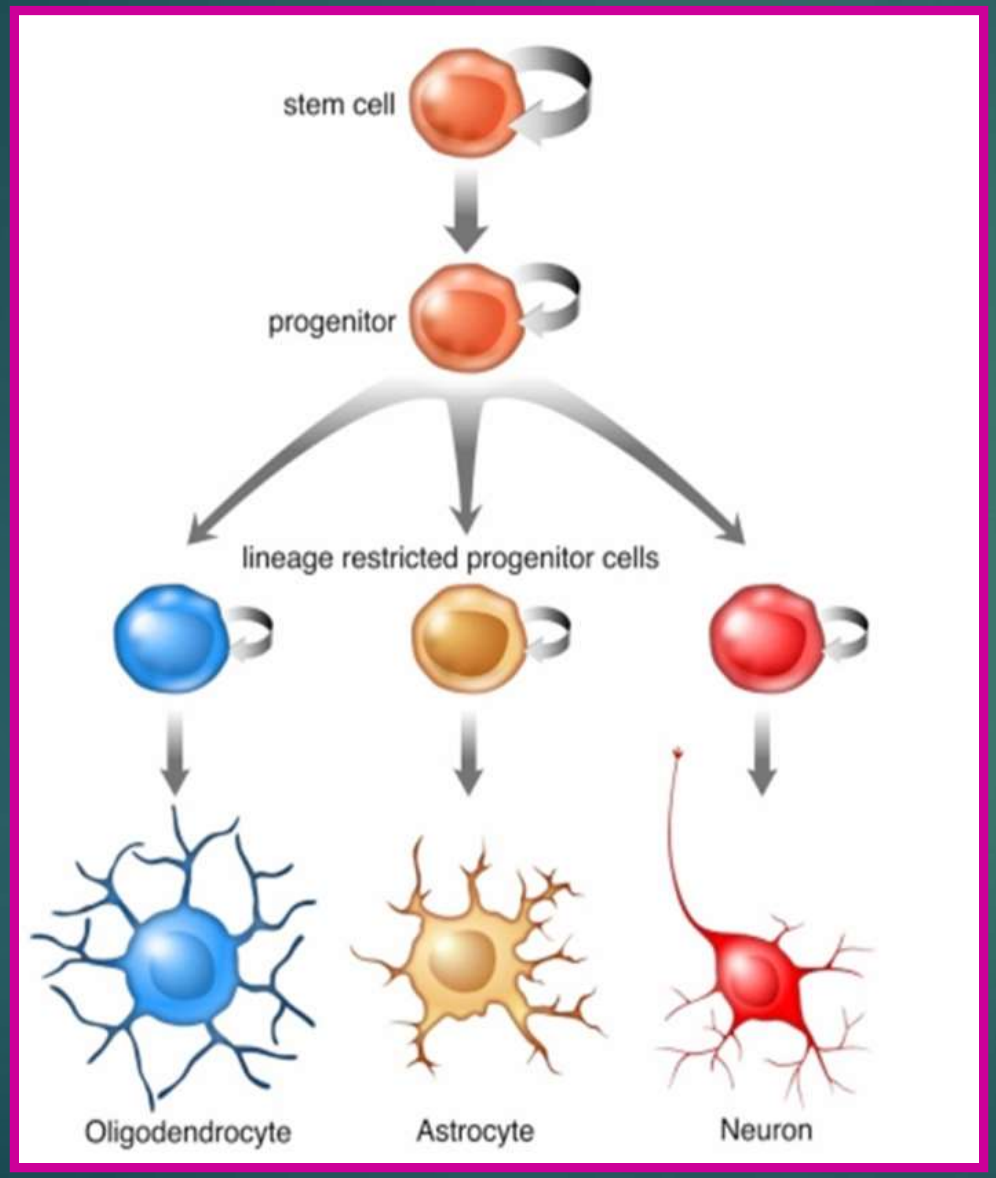
Adult stem cells

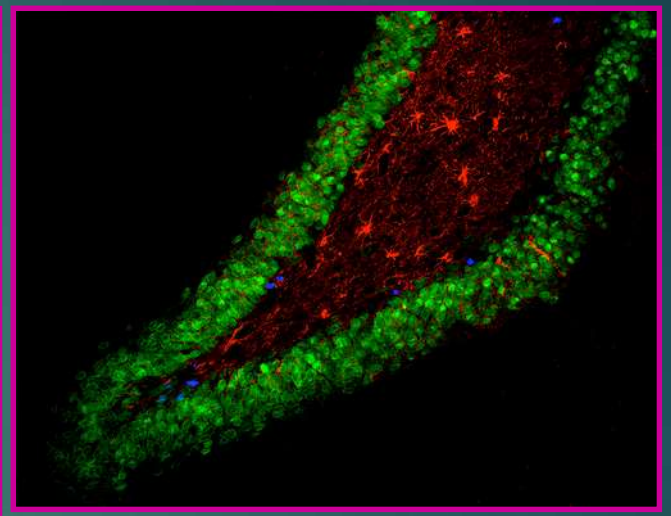
- Multipotent
- Can develop into cells that are closely related.
- Limited number of several cell types.
- Make all cell types from the tissue they come from.
- Found in many parts of the body.
- Can self-renew over a lifetime.

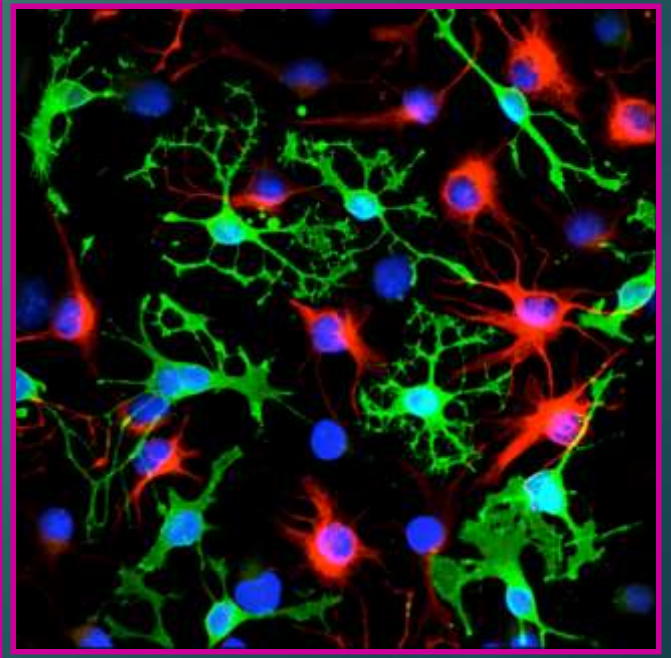


Stem cells in the adult brain:

Are they still working for us now?

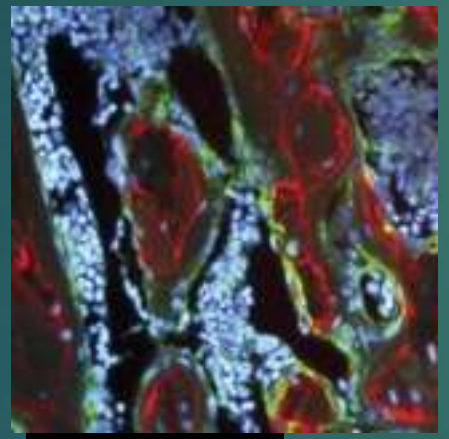




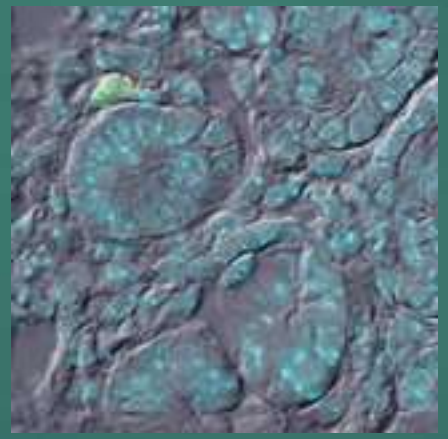


Tissue stem cells

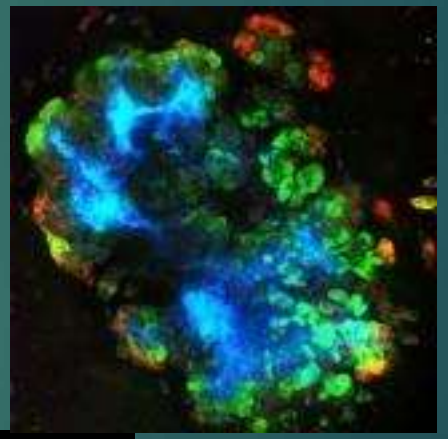
- often known as **adult** stem cells
- also includes stem cells isolated from fetal and cord blood
- reside in most tissues of the body where they are involved in repair and replacement



Bone marrow



Kidney

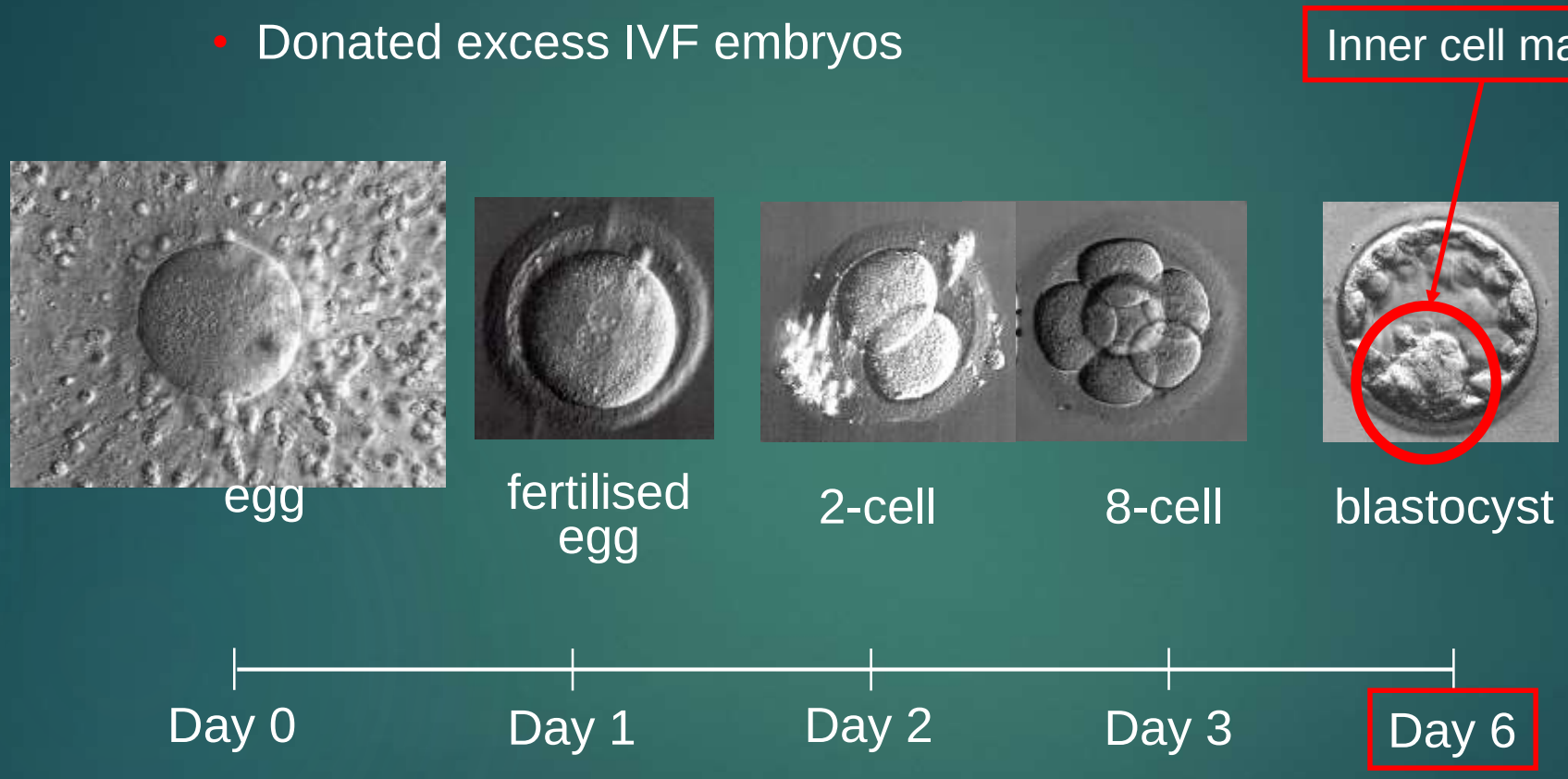


Lung

- generally very difficult to isolate
- already used to treat patients (haematological malignancies, diseases of the immune system)

Where do embryonic stem cells come from?

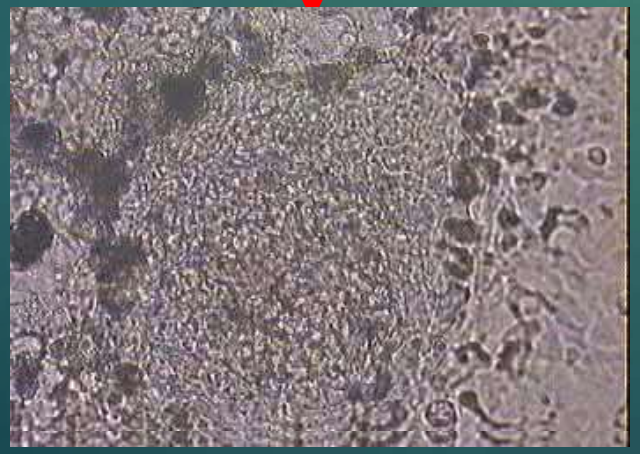
- Donated excess IVF embryos



Images from www.advancedfertility.com

Embryonic stem cells

human embryonic stem cells



- derived from donated IVF embryos
- can be grown indefinitely in the laboratory in an unspecialised state
- retain ability to specialise into many different tissue types – know as **pluripotent**
- can restore function in animal models following transplantation

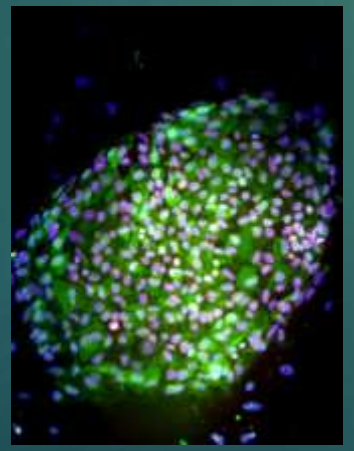
Human embryonic stem cells can become any cell in the body including these beating heart cells

Induced pluripotent stem cells

Starting cells from donor tissue

Induced change in gene expression

iPS Cells



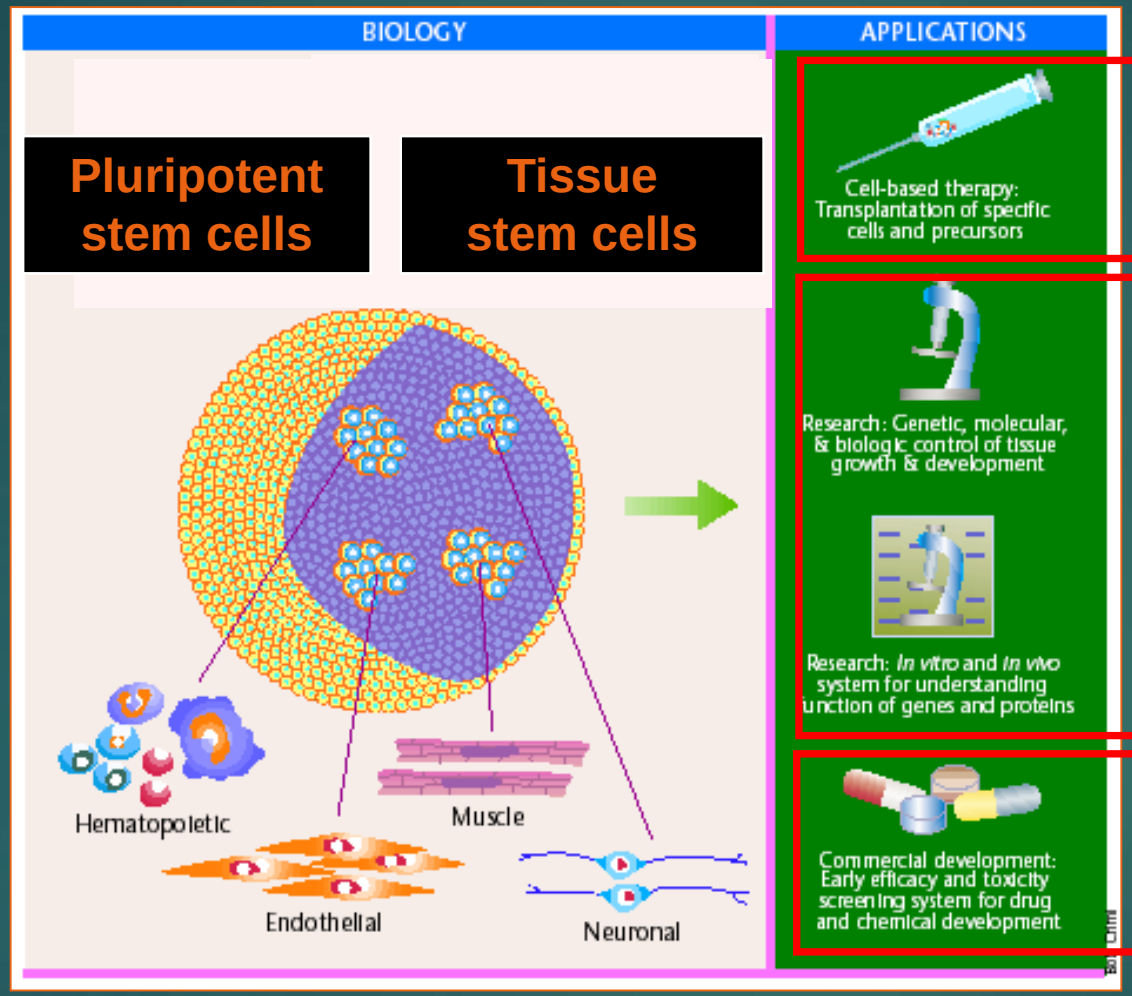
pluripotent stem cells

- derived from adult cells in 2007 - very recent discovery!
- can be grown indefinitely in culture in an undifferentiated state
- similar properties to embryonic stem cells as can differentiate into many different tissue types – **pluripotent**
- can create stem cells directly from a patient for research

Pros and Cons to iPS cell technology

- Pros:
  - Cells would be genetically identical to patient or donor of skin cells (no immune rejection!)
  - Do not need to use an embryo
- Cons:
  - Cells would still have genetic defects
  - One of the pluripotency genes is a cancer gene
  - Viruses might insert genes in places we don't want them (causing mutations)

What makes stem cells so valuable?



Cell Therapy

Research

New Drugs

No one stem cell type fits all applications.
Research must continue using all types of stem cells.

Bone marrow transplant:

Example of adult stem cell-based therapy

Science is discovering the unknown

- Stem cell field is still in its infancy
- Human embryonic stem cell research is a decade old, adult stem cell research has 30-year head start
- Holds hope for curing or improving treatments for 70+ diseases

Stem Cell Tourism

A growing concern to the stem cell community