

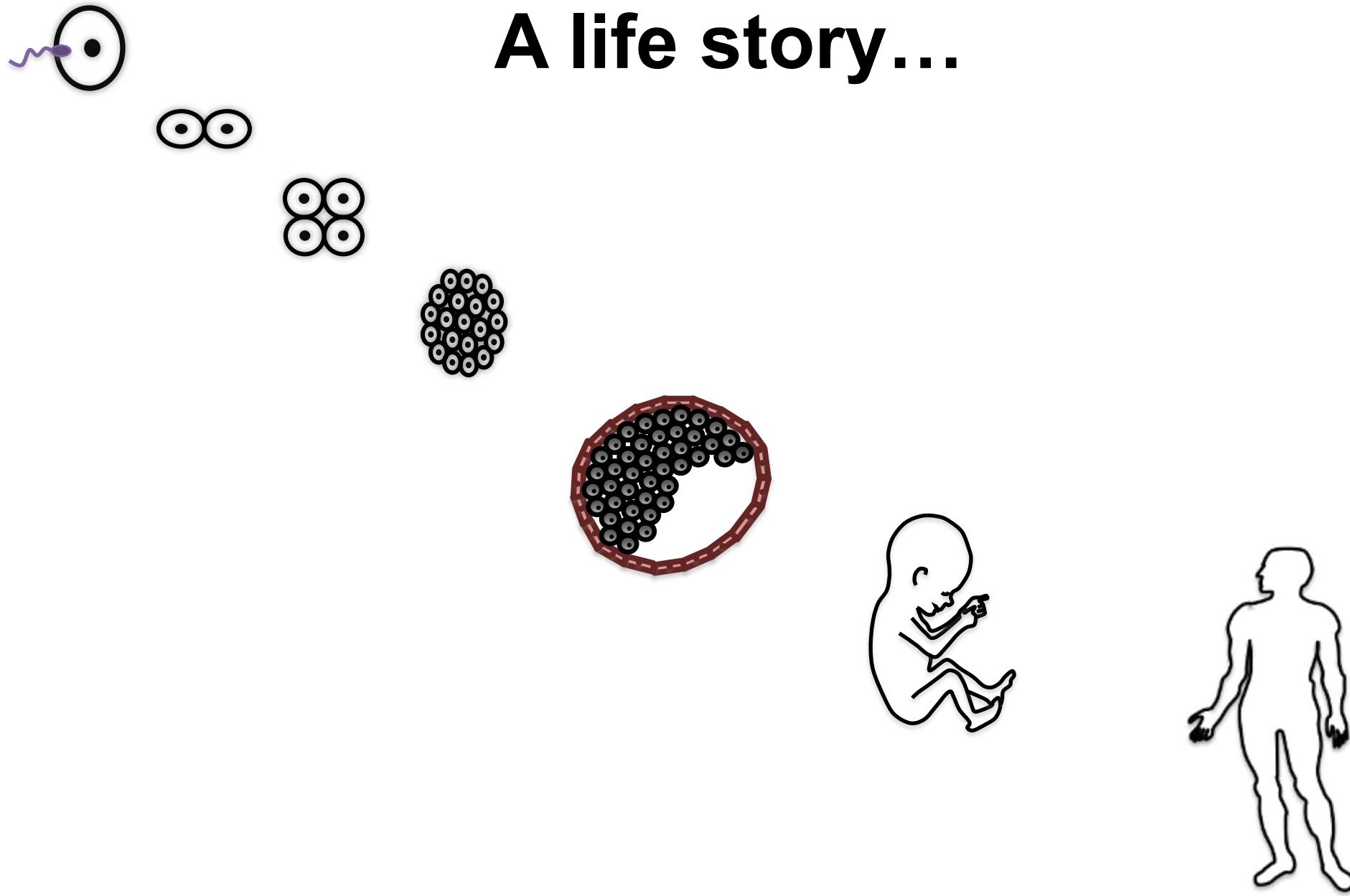
SBL100

Part 1

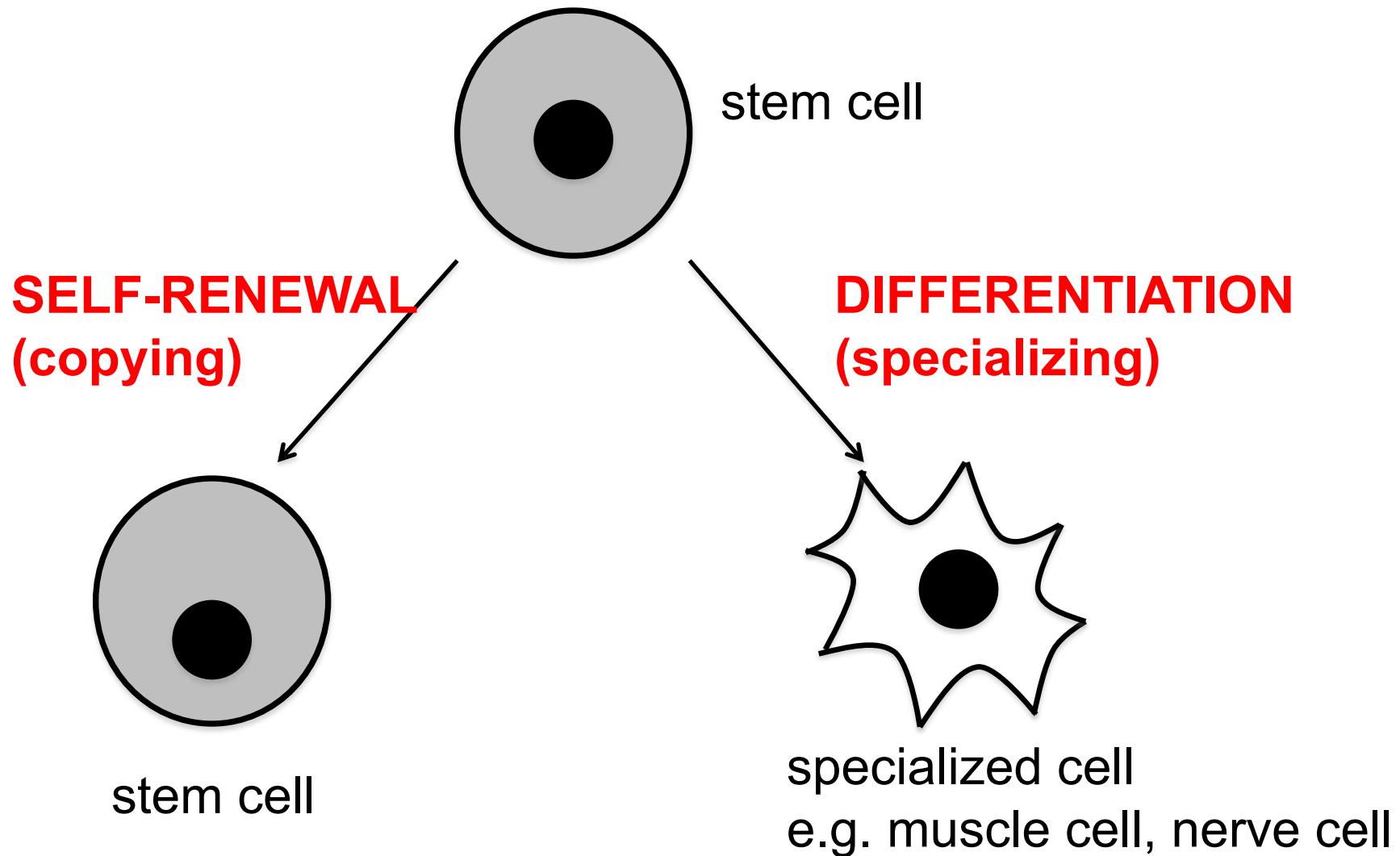
Stem Cells

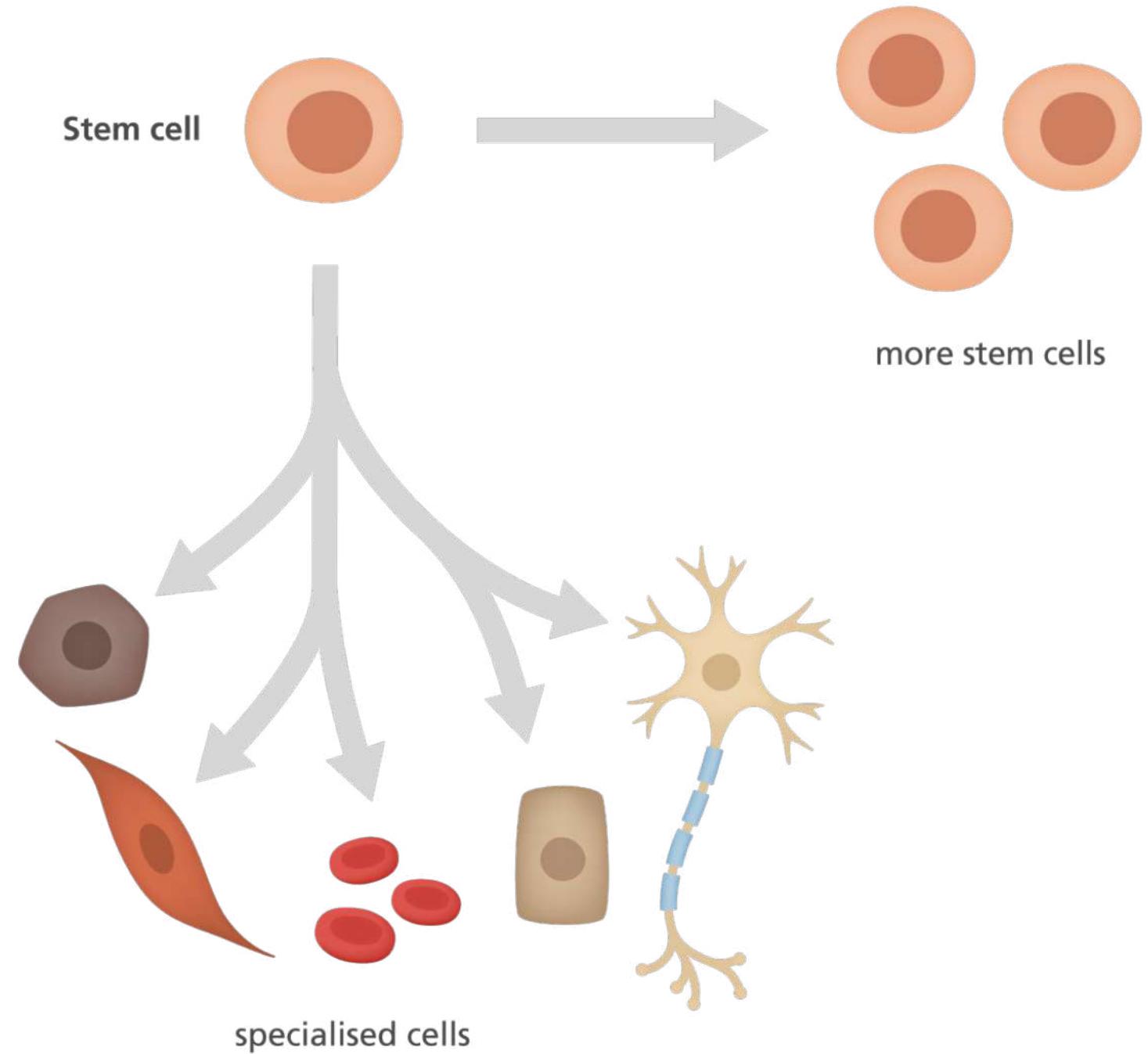
What is a STEM CELL?

A life story...

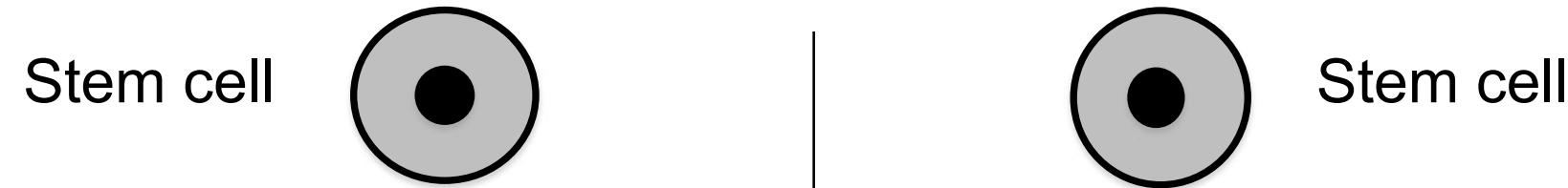


What is a stem cell?





What is a stem cell?



SELF-RENEWAL
(copying)



DIFFERENTIATION
(specializing)

Identical stem cells

Specialized cells

Skin Shedding



30000 to 40000 cells per minute
Epidermis – Completely replaced every 28 days
30 90 mg per hour of skin is shed

Definition?

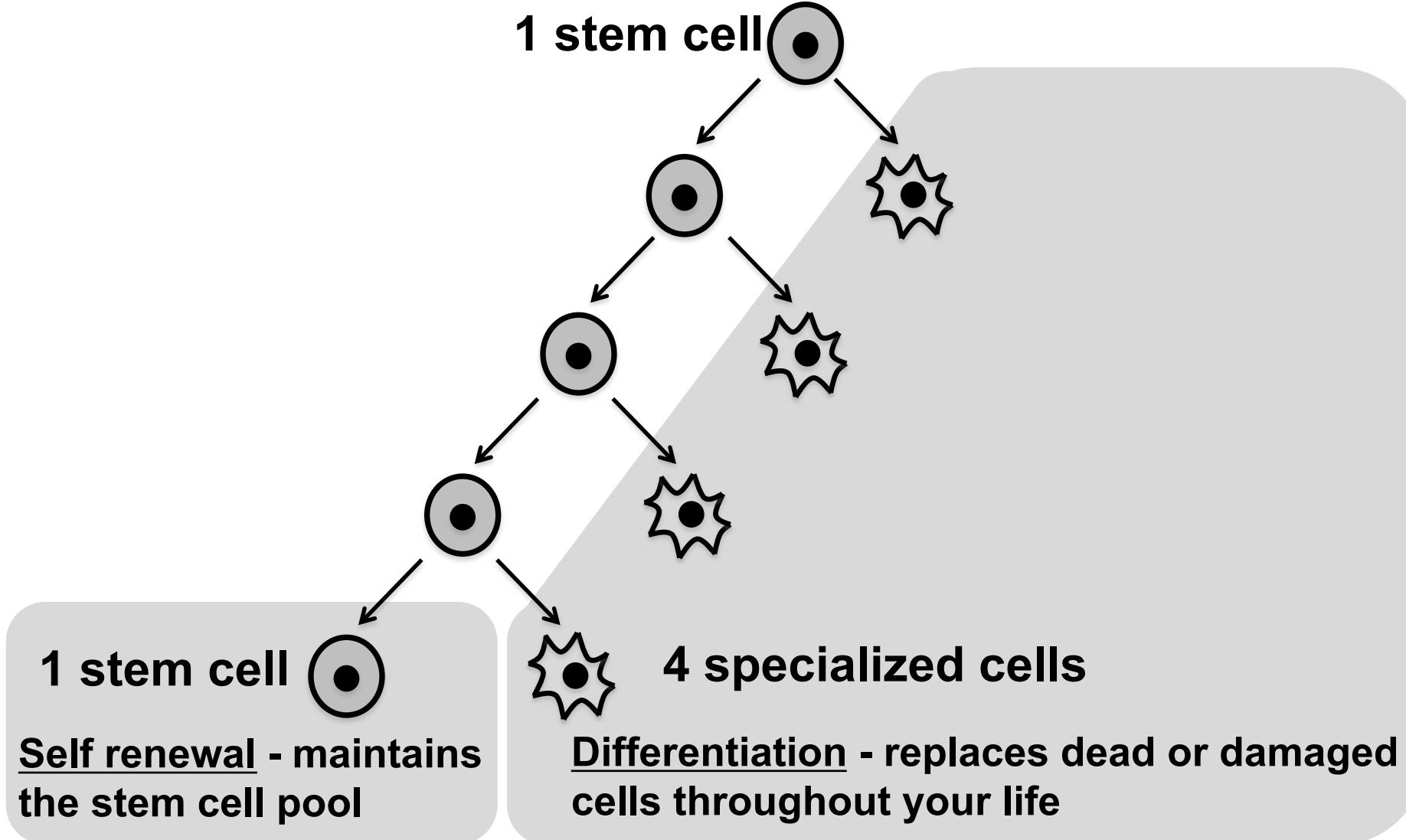
Stem Cell: “functionally defined as having the capacity to self-renew and the ability to generate differentiated cells”.

(Doug Melton, 2013, Essentials of Stem Cell Biology, 3rd Ed)

Self Renewal: Cell capable of dividing and giving rise to one or more cells like the parent

Differentiation: loss of developmental potential and acquisition of specialized traits of a mature cell type

Why self-renew AND differentiate?

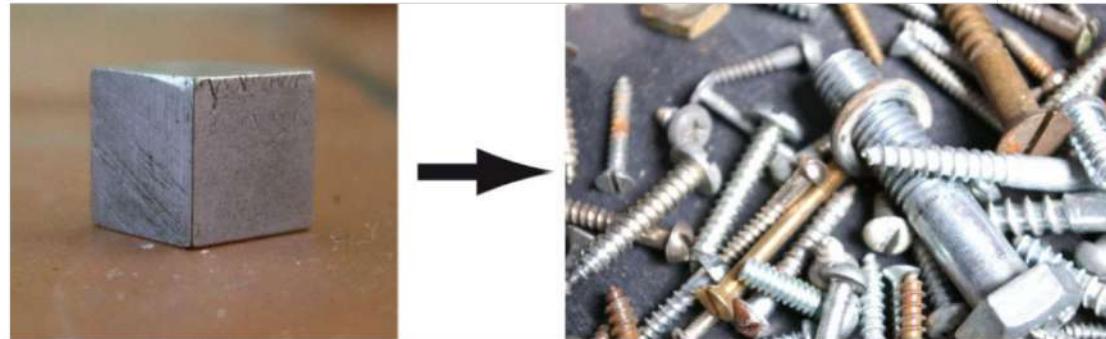
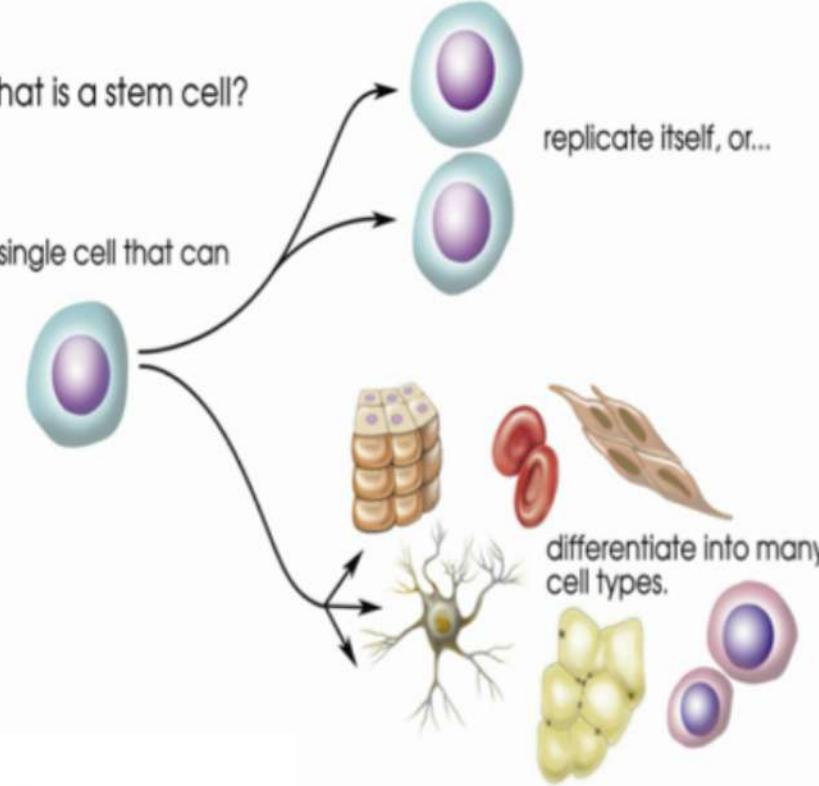


Stem cells

A reserve cell with the capacity to grow and multiply to replace dead or damaged adult cells.

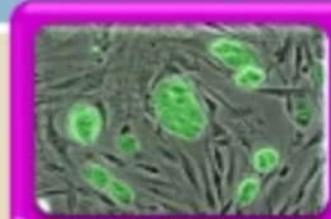
What is a stem cell?

A single cell that can

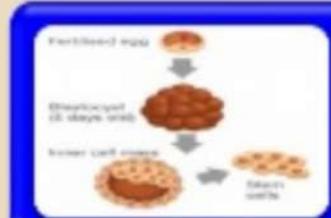


- A cell that has the ability to continuously divide and differentiate (develop) into various other kind(s) of cells/tissues

General properties of Stem Cells



Stem cells are unspecialized cells



Stem cells can divide and renew themselves for long periods of time

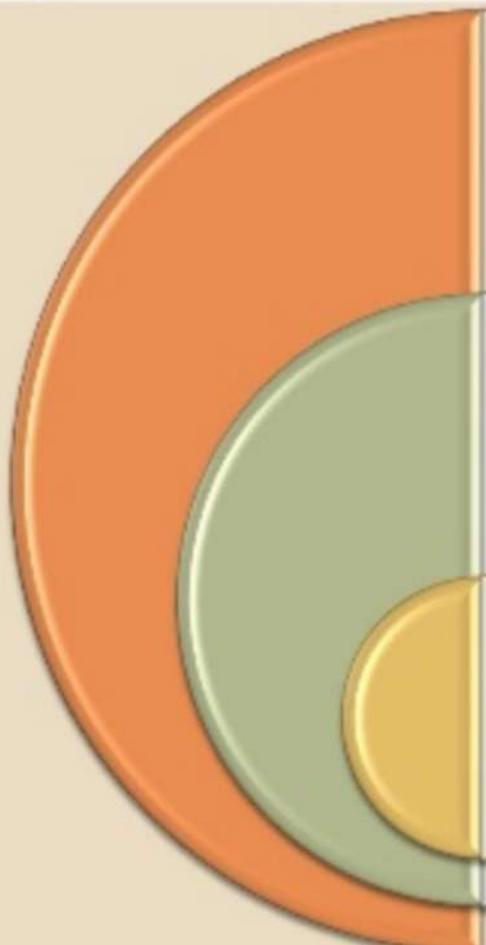


Stem cells can divide and become specific specialized cell types of the body



Stem cells can replace dying, old or damaged cells

Unique features of stem cells

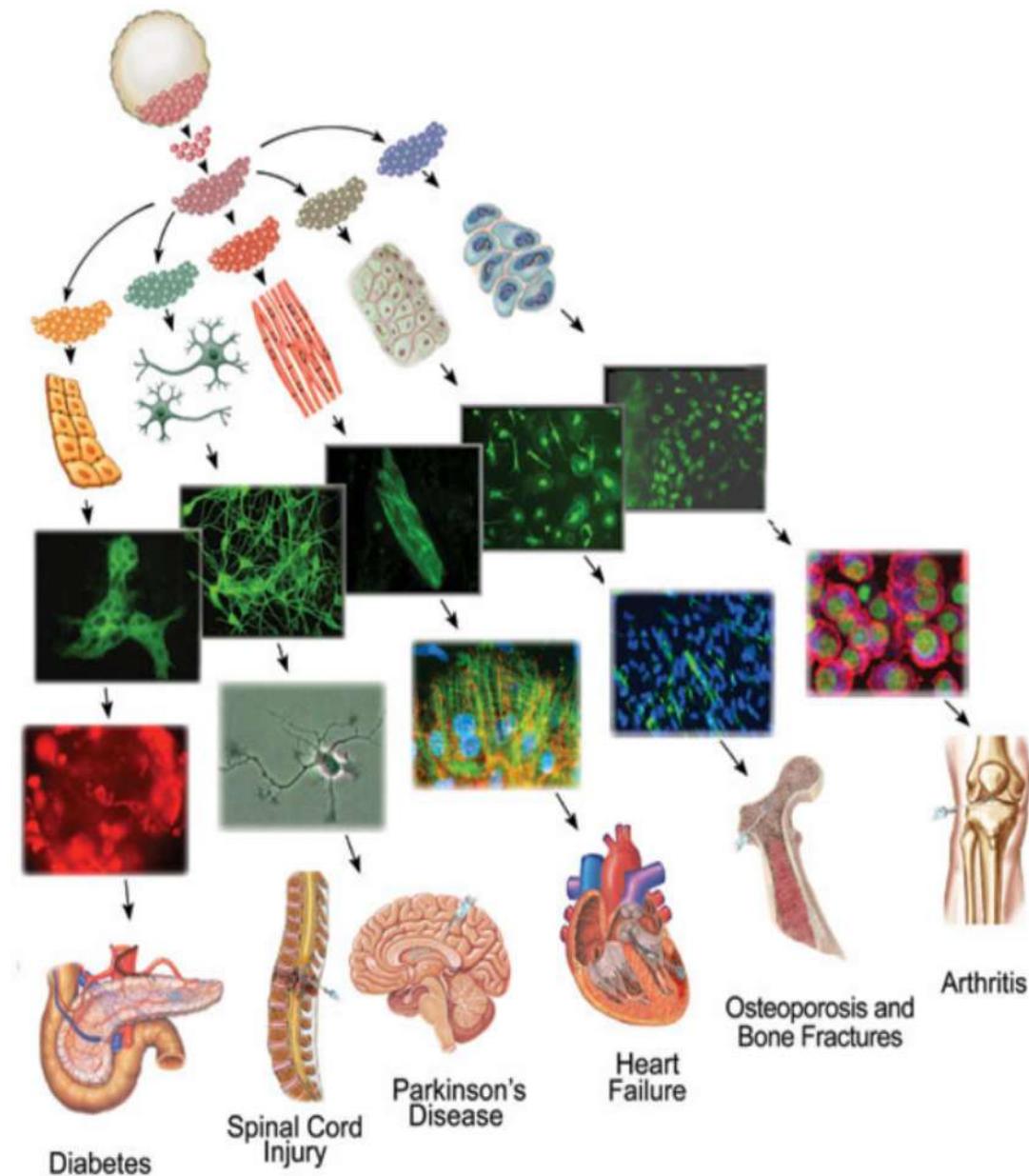


When a stem cell divides, each new cell has the potential to either remain as a stem cell or become another cell with a more specialized function (i.e. a muscle cell, a red blood cell, a brain cell, etc.).

Stem cells are capable of undergoing cell division, after long periods of inactivity.

Under certain physiologic or experimental conditions, they can be induced to become tissue- or organ-specific cells with special functions.

WHY STEM CELLS ??



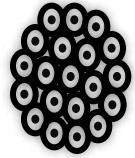
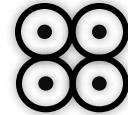
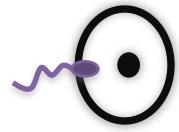
Many disease or disorder can be cured

Tissue repair
Heart disease
Cancer
Arthritis
Parkinsons disease
Diabetes
Leukemia

Stem cell therapy.

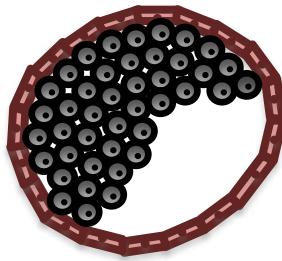
Numerous diseases and damaged organs could potentially be treated with cell therapy.

- ◆ Treatment of neural diseases such as Parkinson's disease, Huntington's disease and Alzheimer's disease.
- ◆ Repair or replace damaged neurons.
- ◆ Repair of damaged organs such as the liver and pancreas.
- ◆ Treatments for AIDS.



Embryonic Stem Cells

blastocyst - a very early embryo



tissue stem cells

fetus, baby and throughout life



Embryonic stem cells come from a five to six-day-old embryo. They have the ability to form virtually any type of cell found in the human body.

Adult stem cells are undifferentiated cells found among specialised or differentiated cells in a tissue or organ after birth. Based on current research they appear to have a more restricted ability to produce different cell types and to self-renew.

Stem cells exist in both embryos and adults

***In
embryos***

- *stem cells function to generate new organs and tissues.*

In adults

- *they function to replace cells during the natural course of cell turnover.*

Stem Cell Jargon

Potency

A measure of how many types of specialized cell a stem cell can make

Totipotent vs Pluripotent

Totipotency

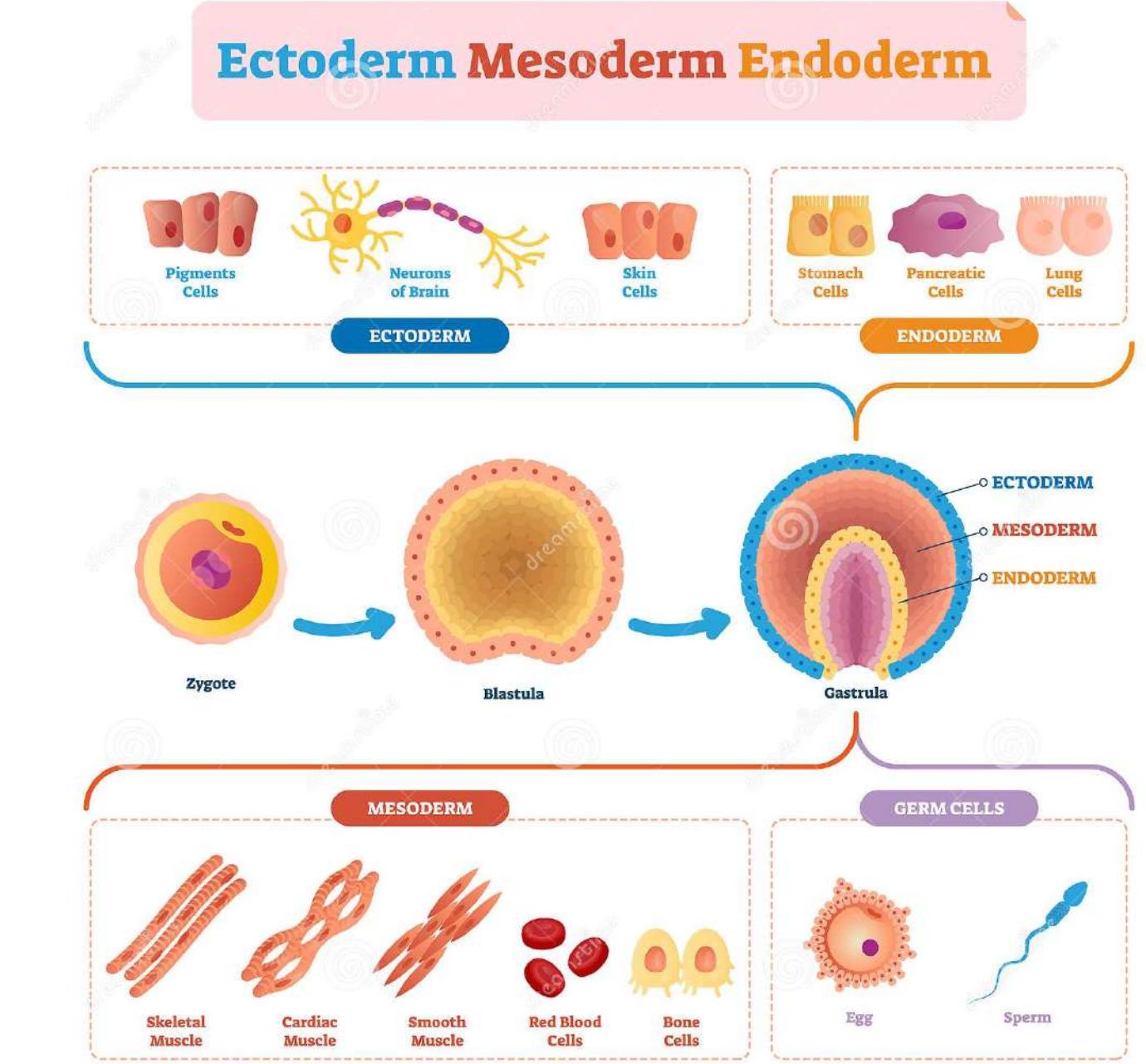
The ability of a cell to make any type of cell in the body

Zygote



Differentiation

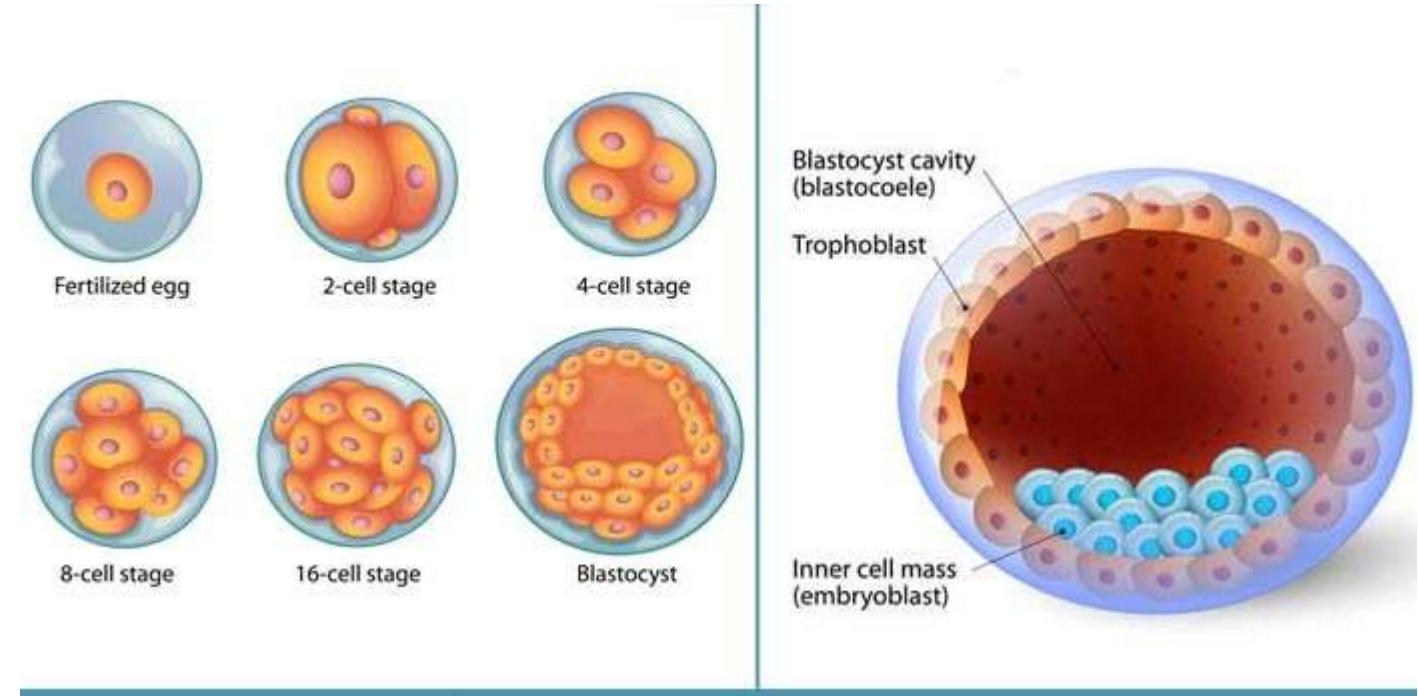
- As the stem cells divide, they are impacted by their spatial positions
- Results in the formation of three germ layers
 - Ectoderm
 - Mesoderm
 - Endoderm



Pluripotency

The ability of a cell to differentiate into cells from any three germ layers

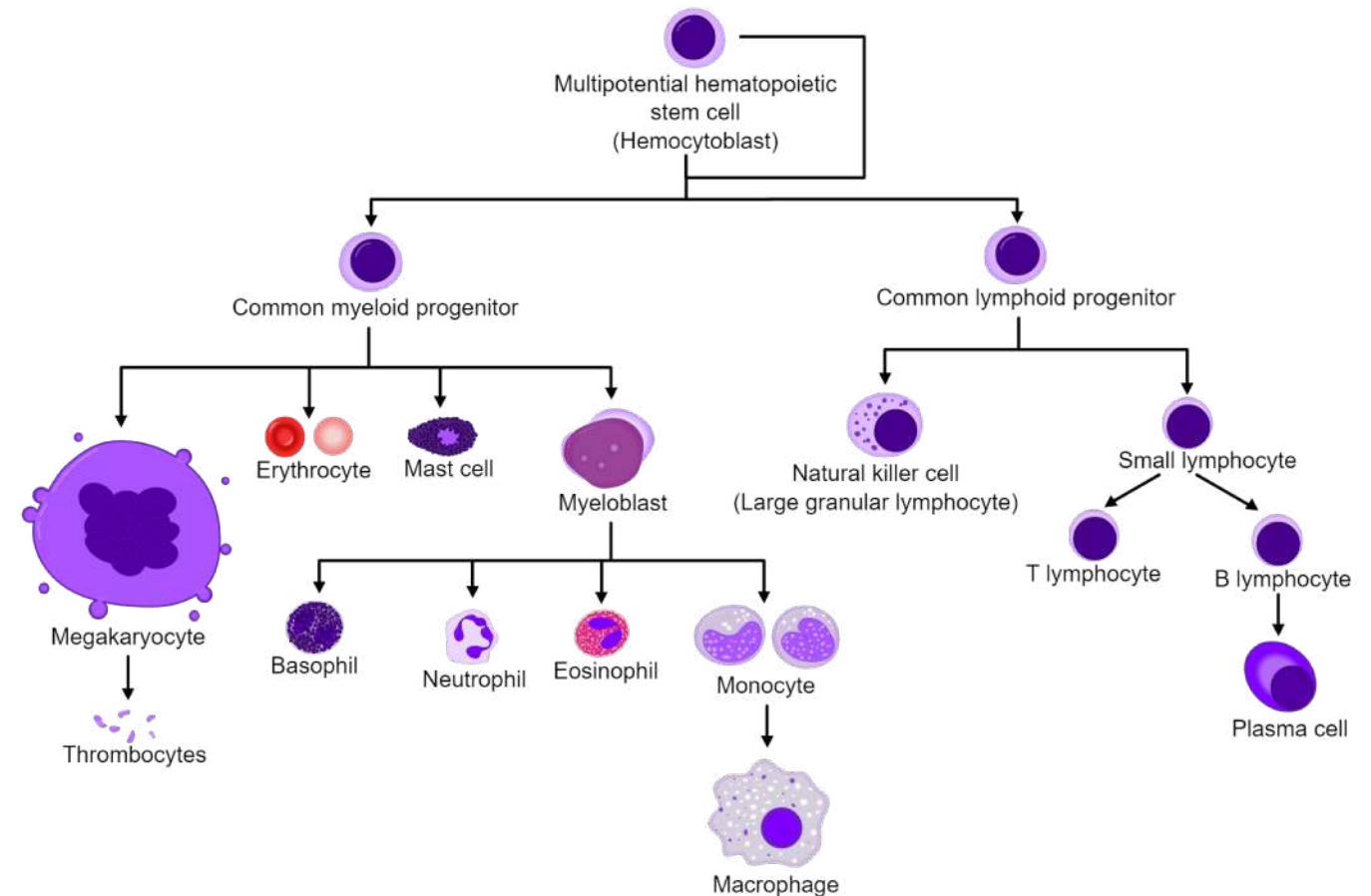
Embryonic Stem Cell (ESC) or
Induced Pluripotent Stem Cell
(iPSC)



Multipotency

The ability of a cell to differentiate into limited range of cell types

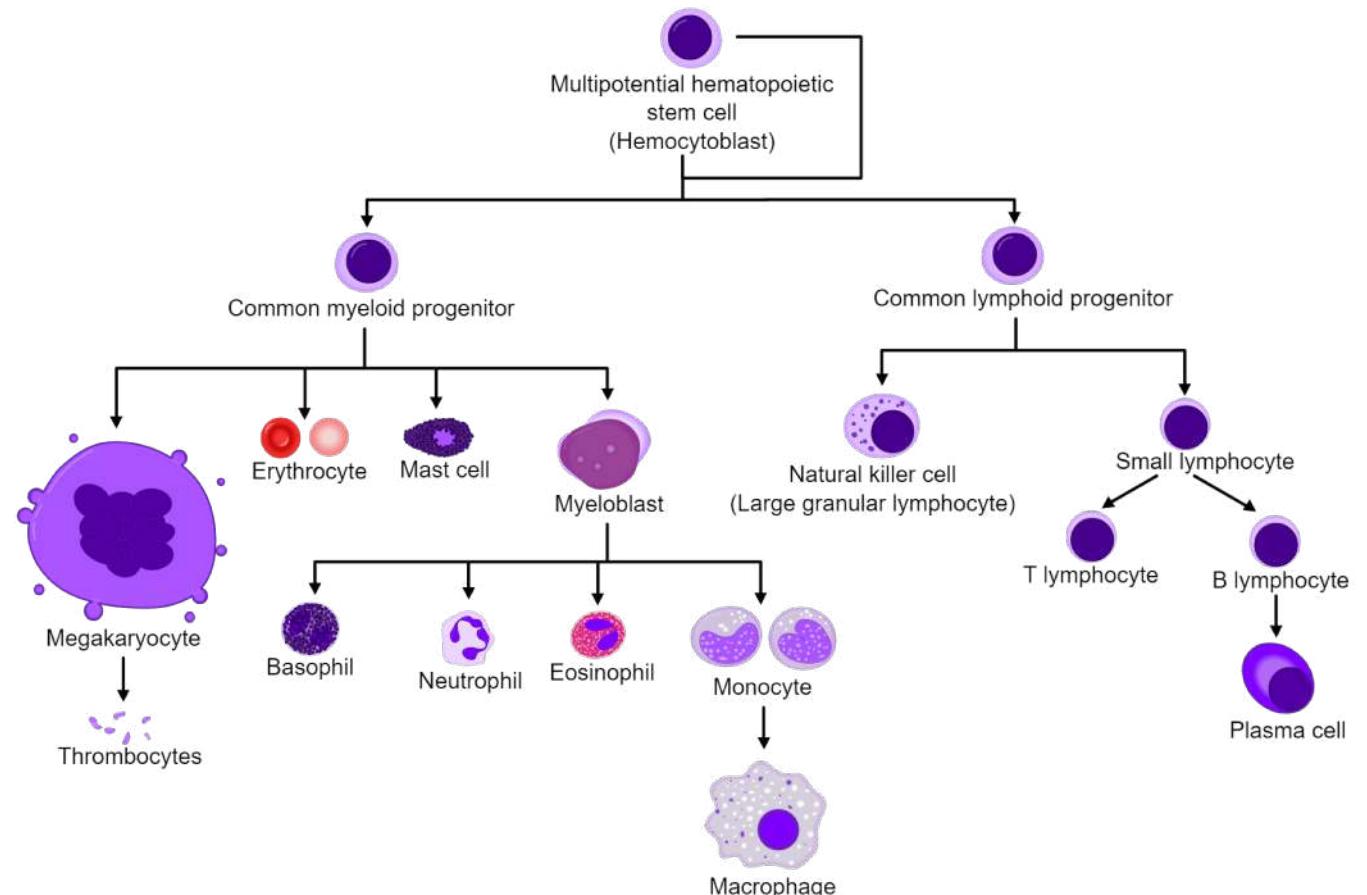
Mesenchymal or
Hematopoietic Stem
Cell



Oligopotency

The ability of a cell to differentiate into limited number of cell types

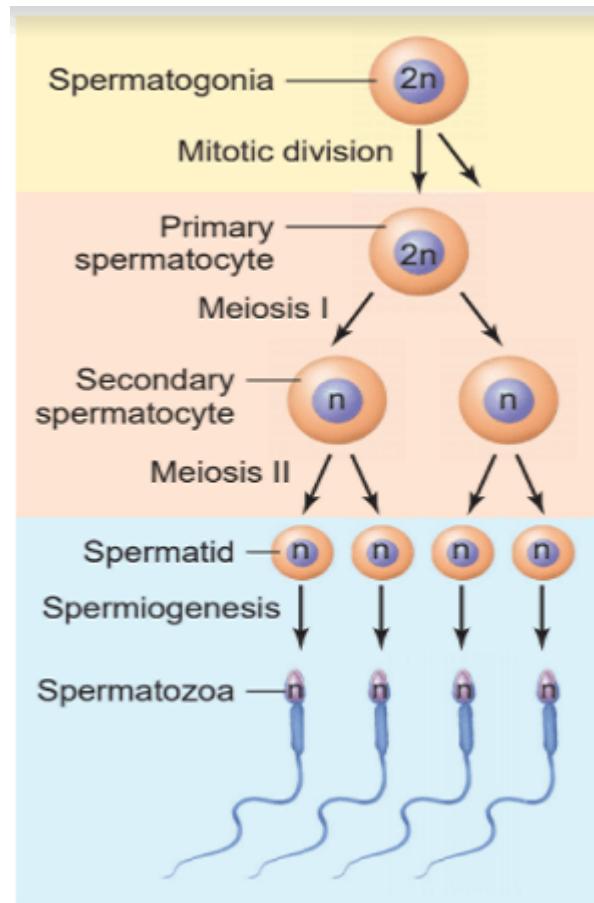
Myeloid or Lymphoid Progenitor

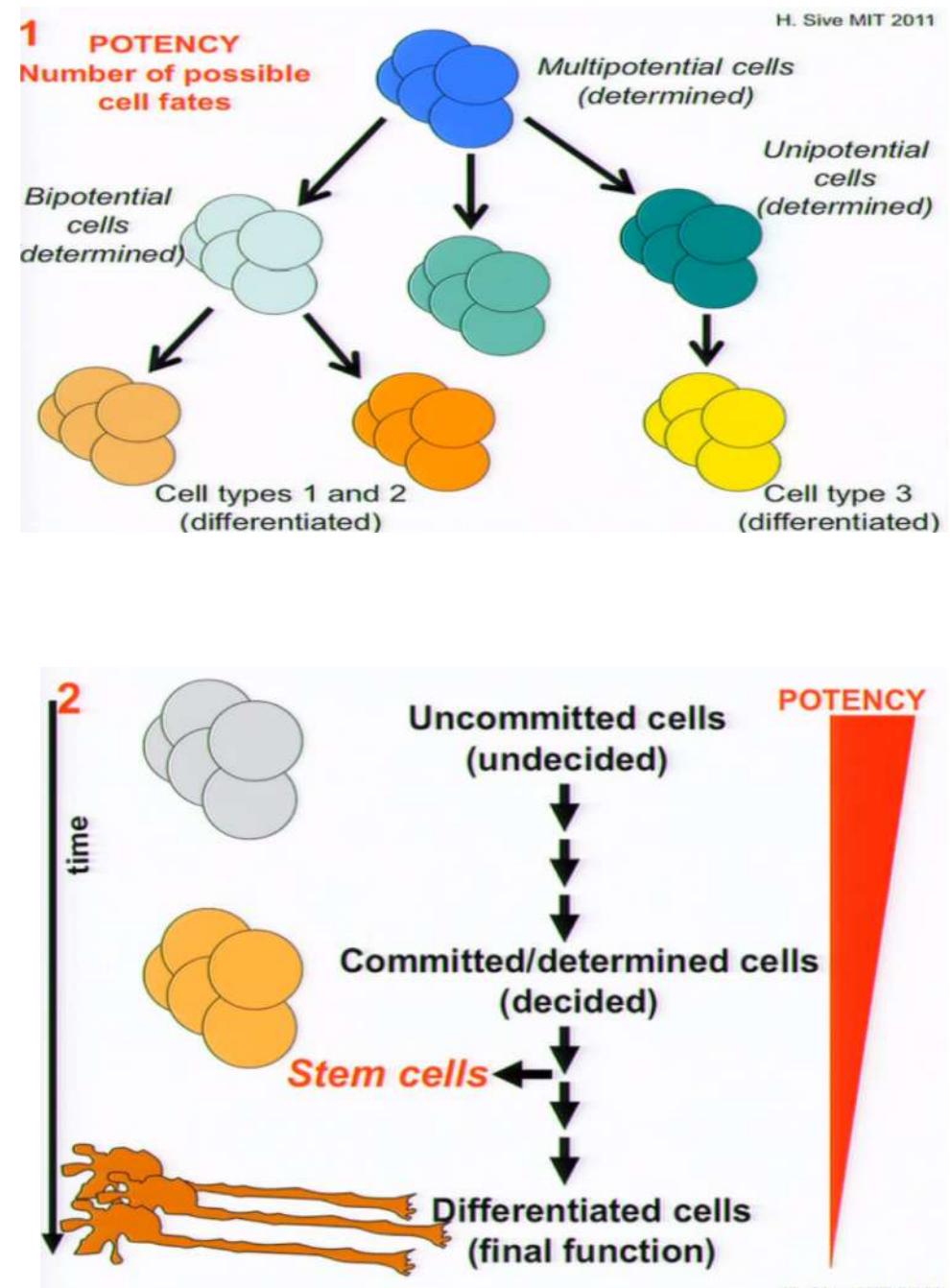
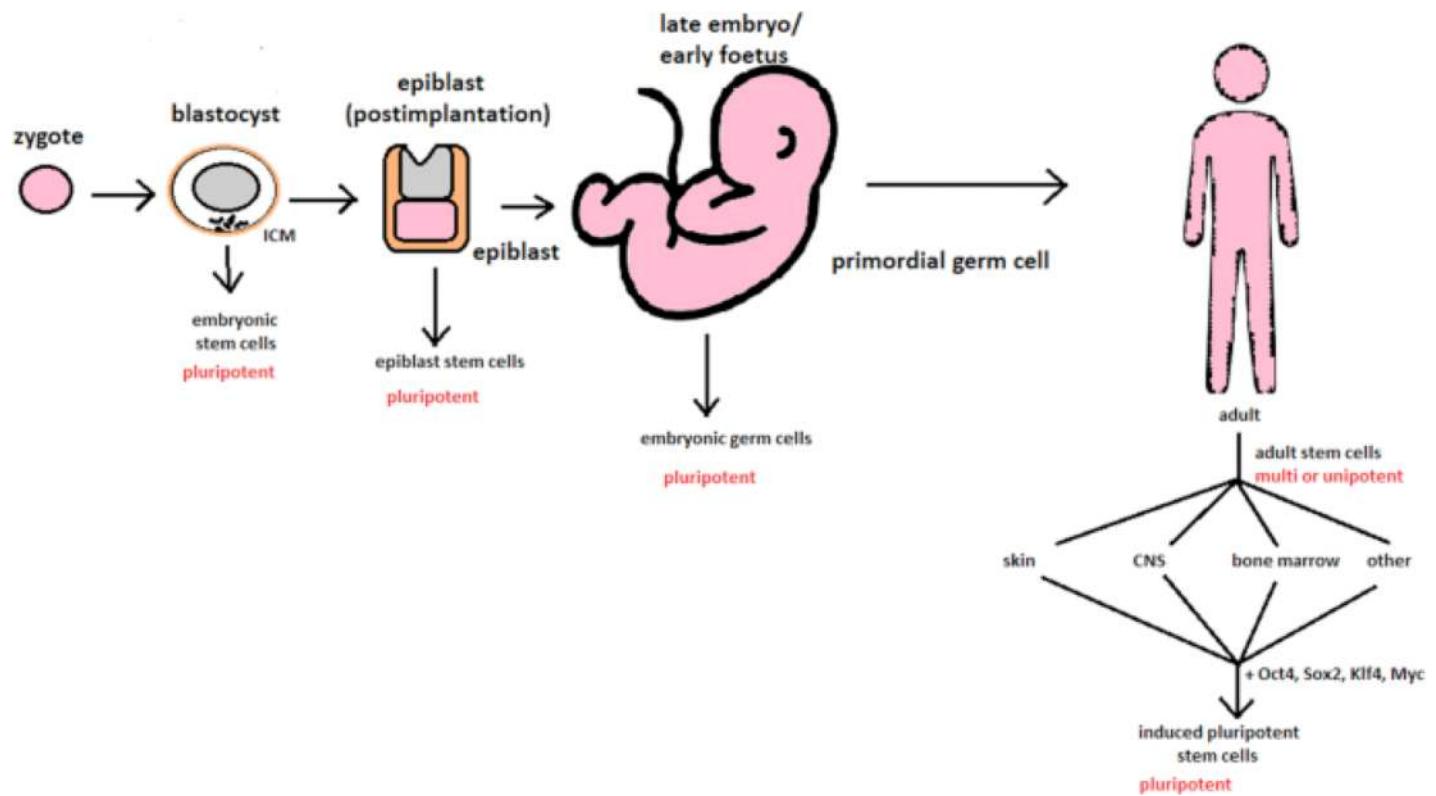


Unipotency

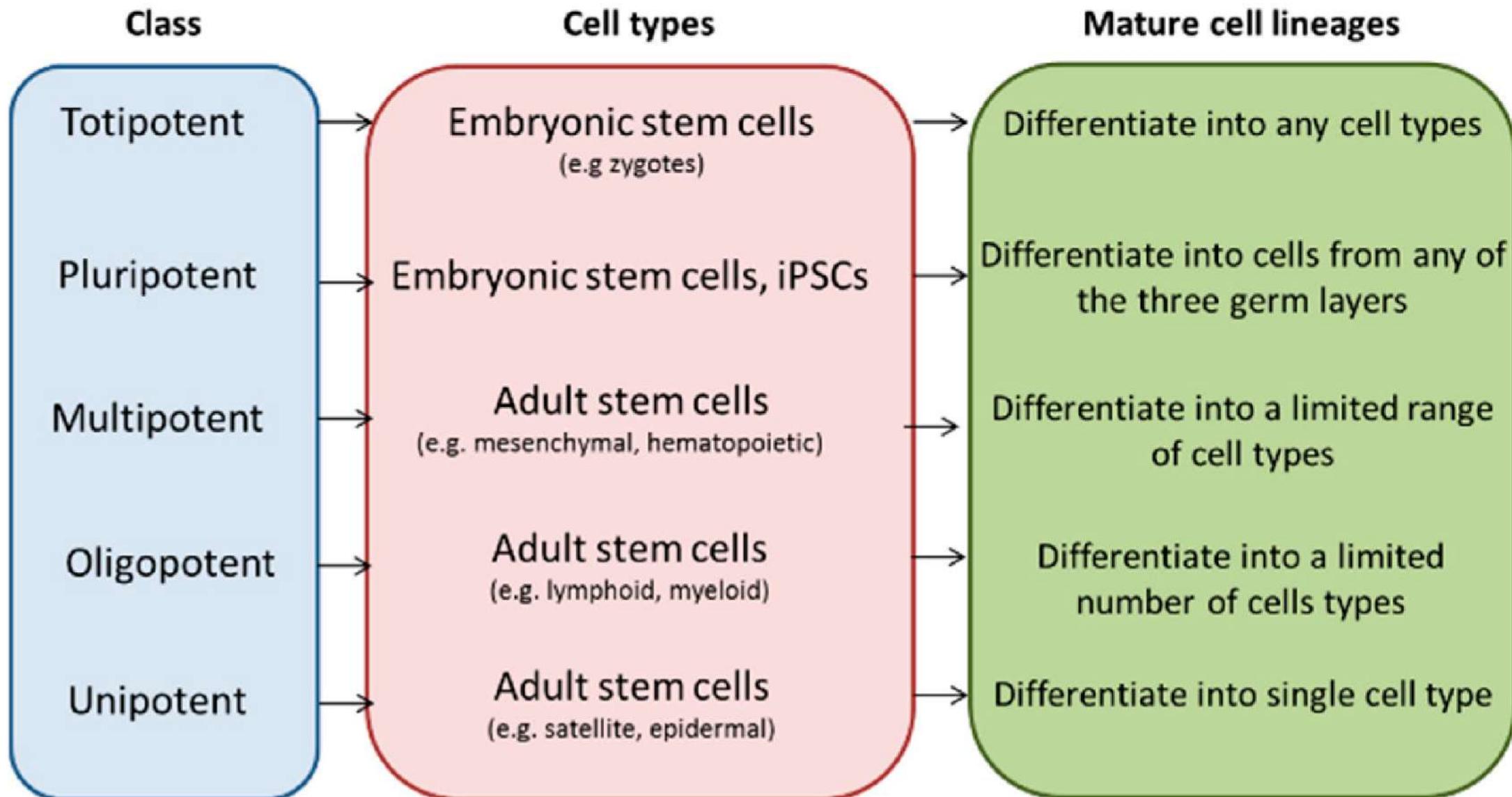
The ability of a cell to differentiate into single cell type

A germ line stem cell
(producing sperm)
Epidermal stem cell
(producing skin)





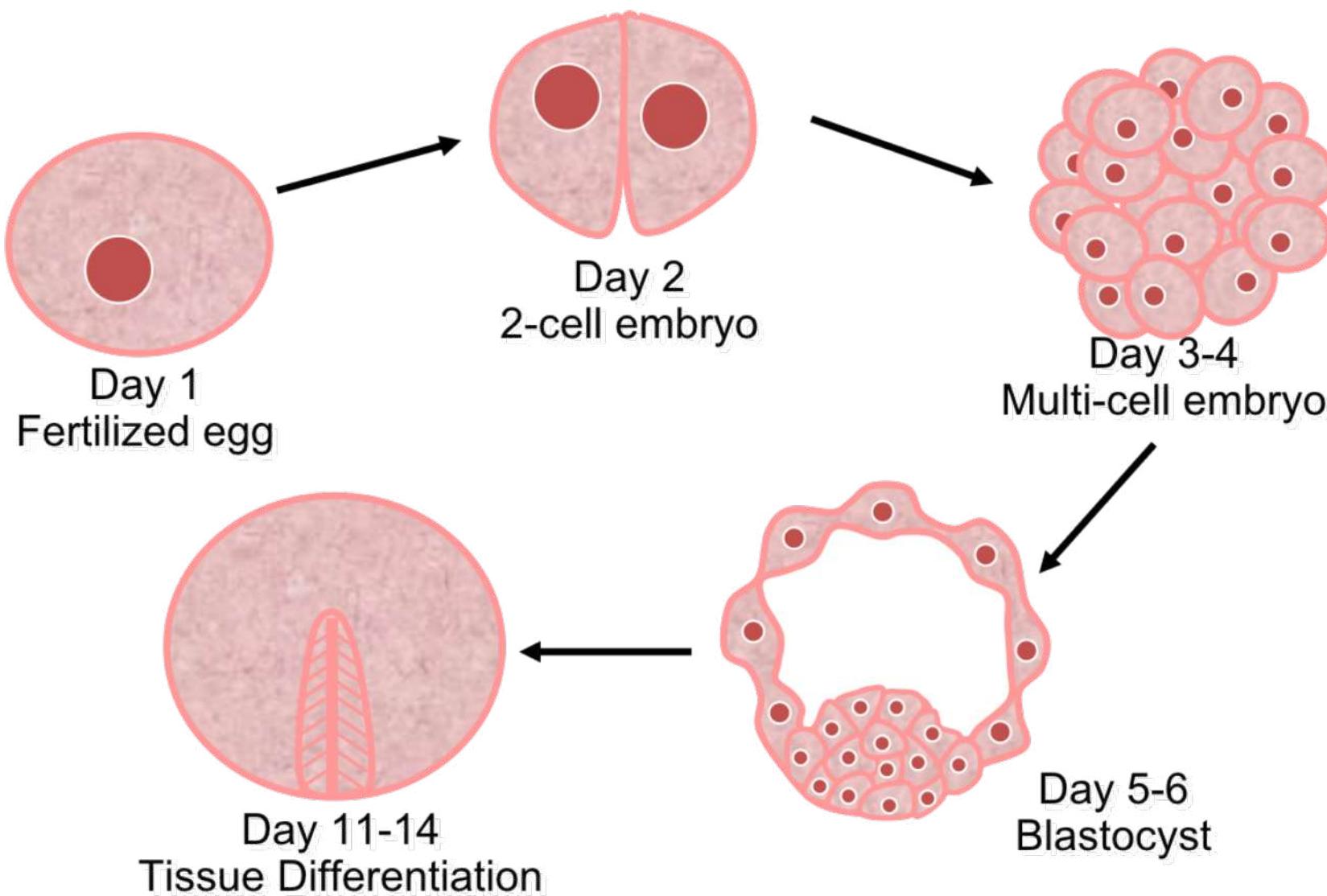
STEM CELLS CLASSIFICATION



Types of Stem Cells

- Embryonic Stem Cells
- Adult Stem Cells
- Induced Pluripotent Stem Cells

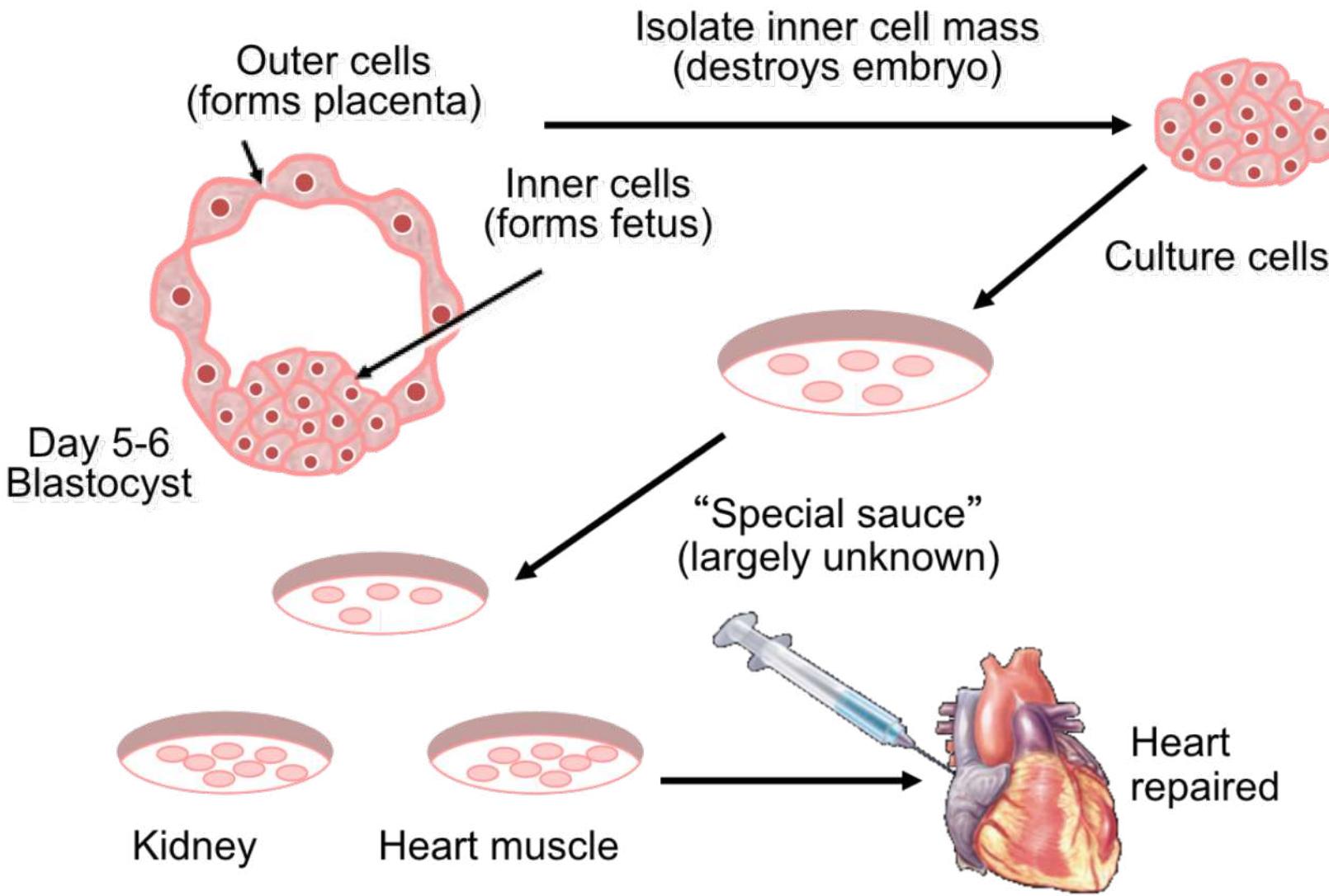
Stages of Embryogenesis



Types of stem cell:

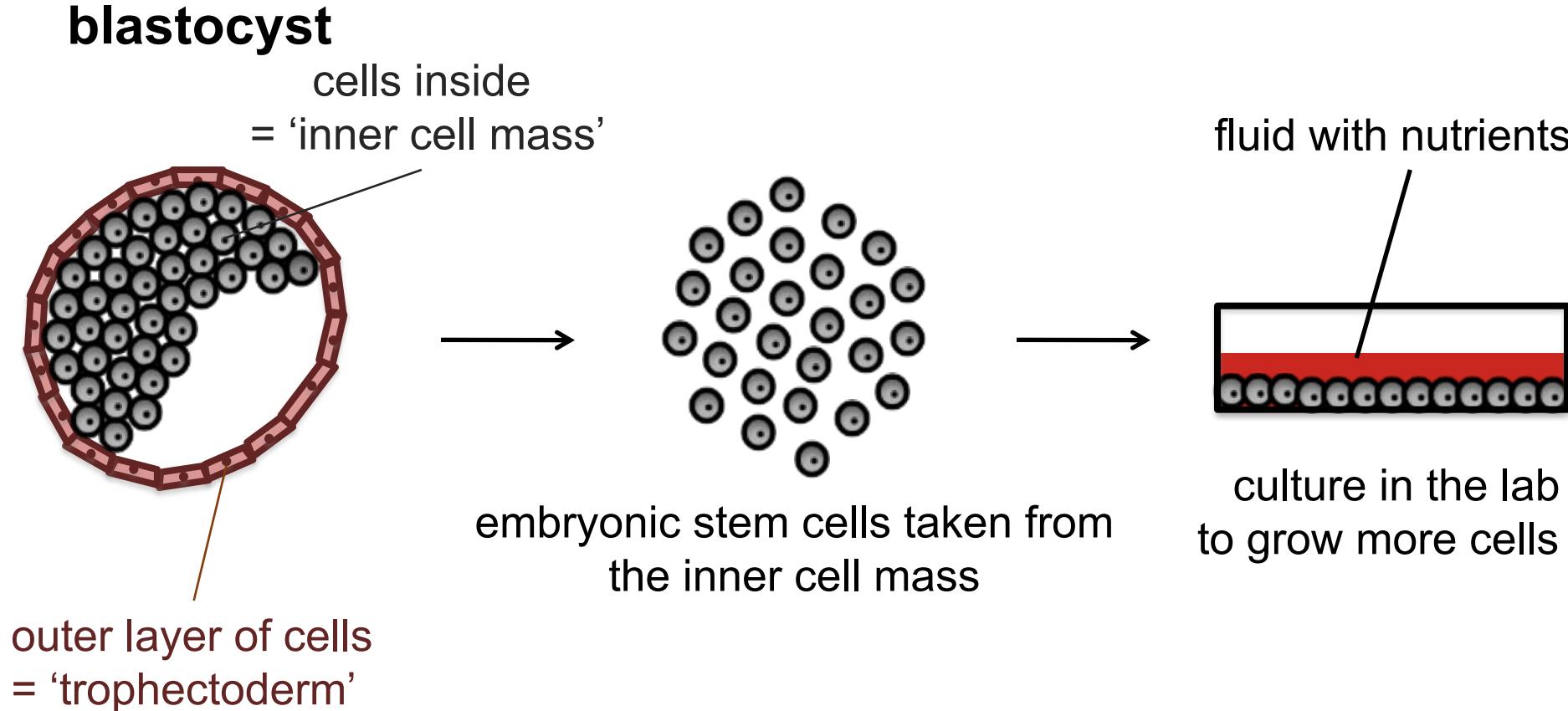
1) Embryonic stem cells

Derivation and Use of Embryonic Stem Cell Lines

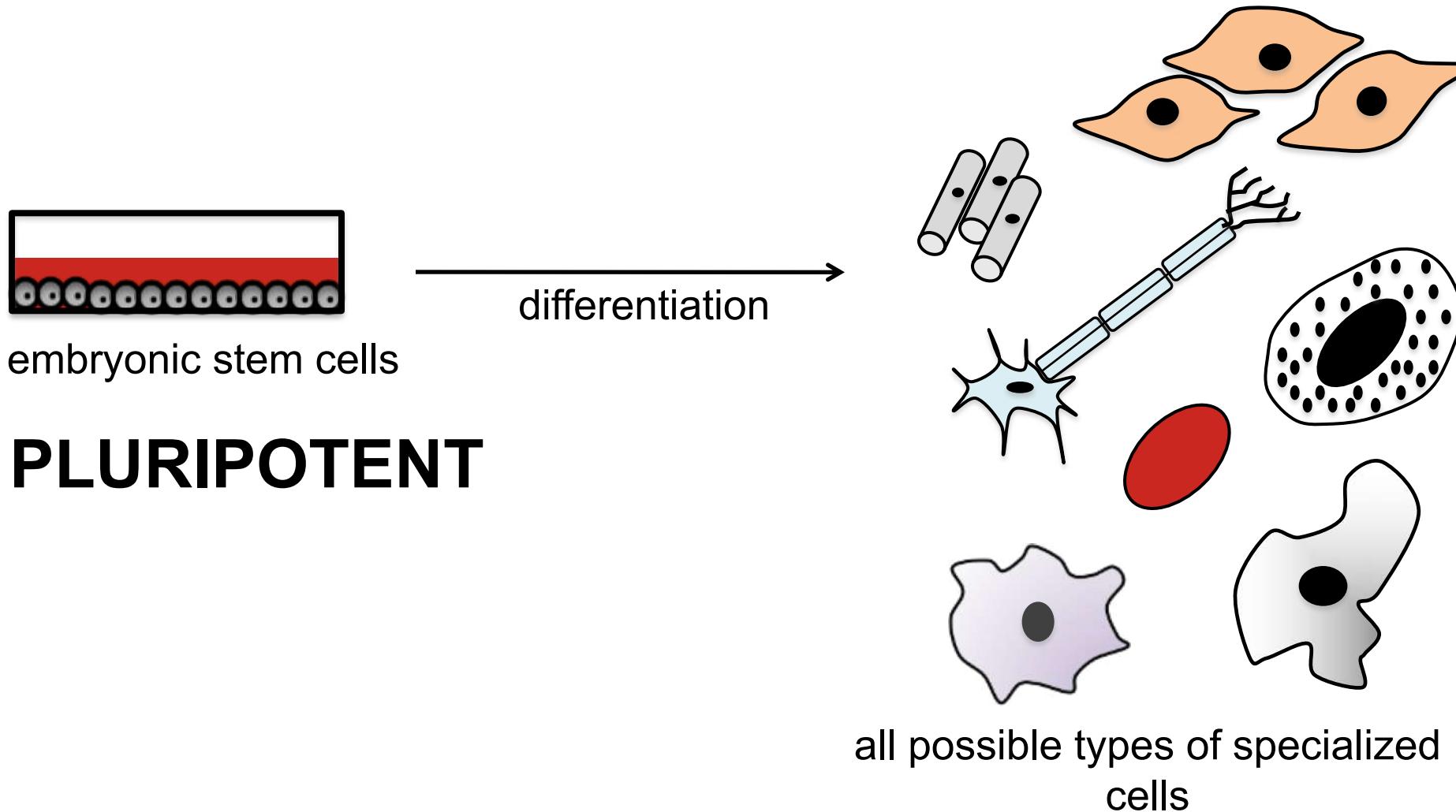


Embryonic stem (ES) cells:

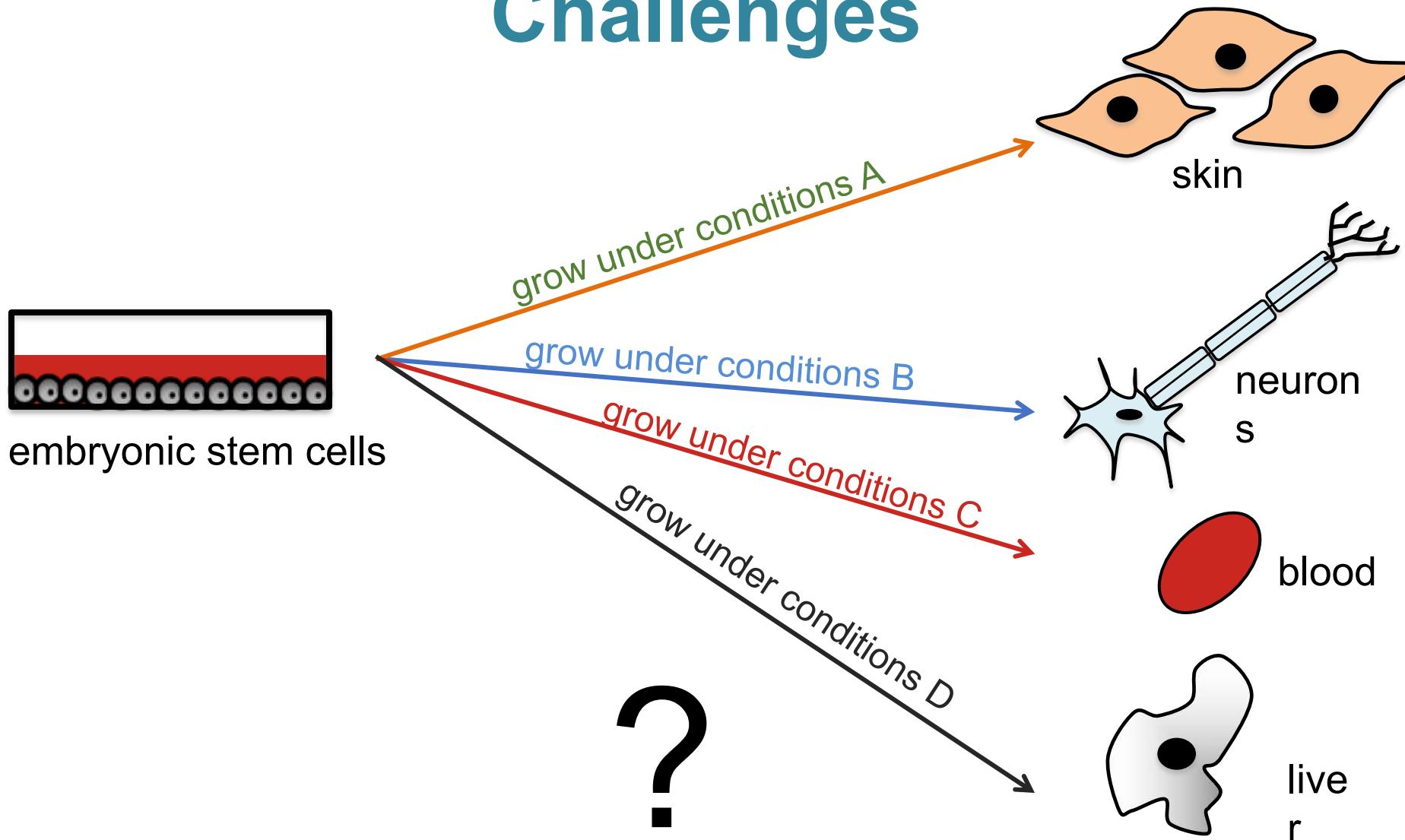
Where we find them



Embryonic stem (ES) cells: What they can do

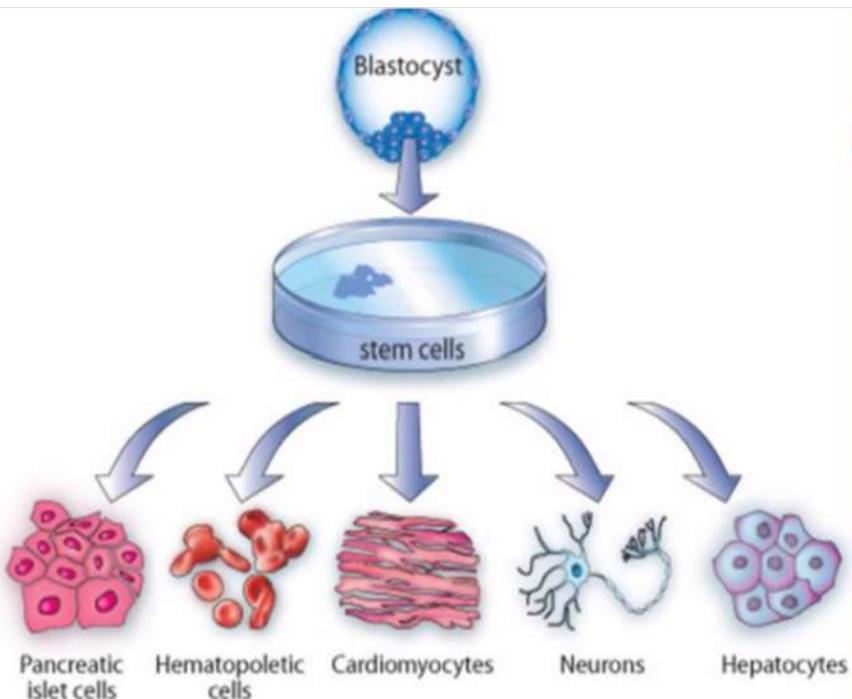


Embryonic stem (ES) cells: Challenges



Advantages of Embryonic Stem Cells

- 1. Flexible - have the potential to make any cell.*
- 2. Immortal –can provide an endless supply of cells.*
- 3. Availability - embryos from in vitro fertilization clinics.*

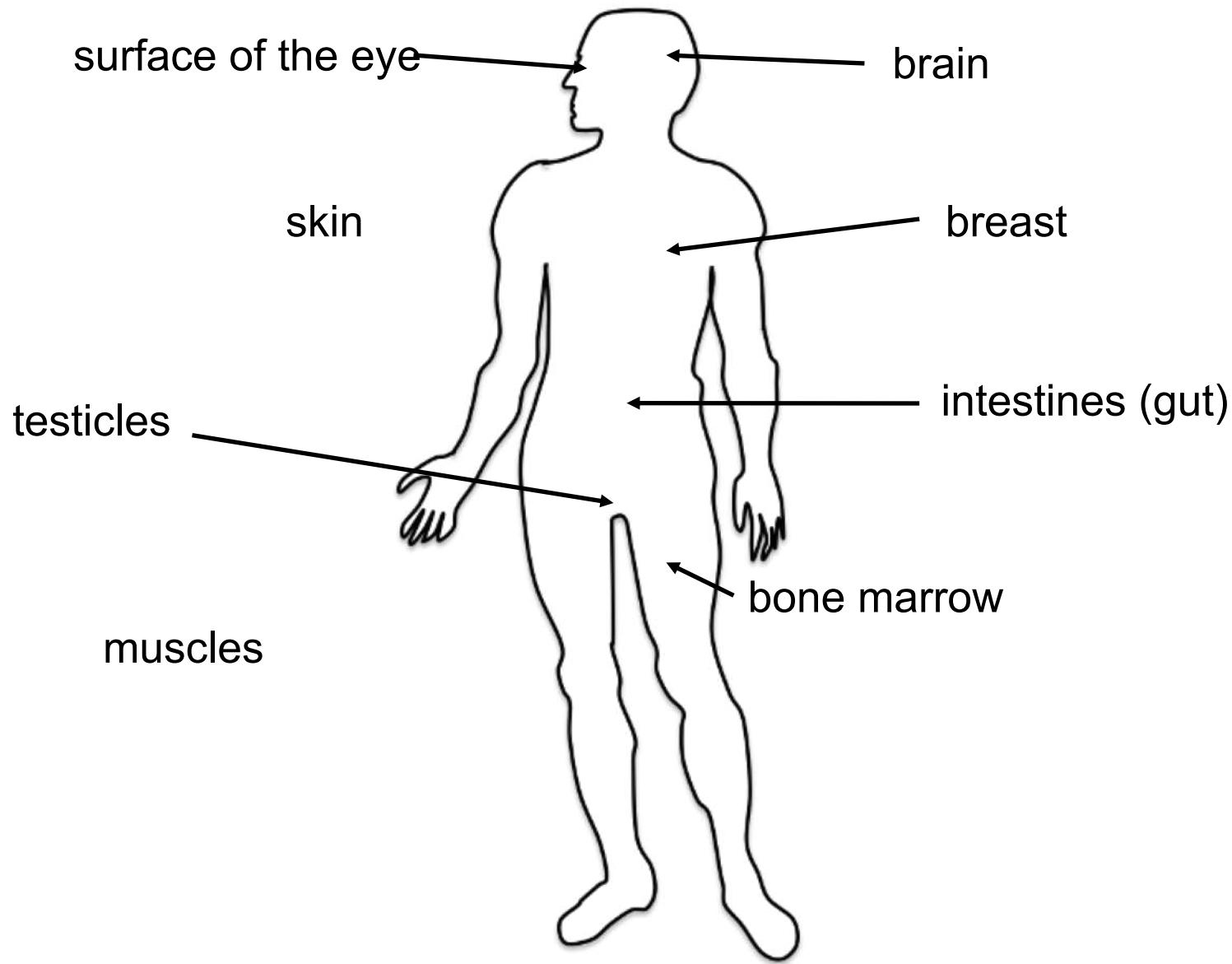


Disadvantages of Embryonic Stem Cells

- 1. Difficult to differentiate uniformly into a target tissue.*
- 2. Immunogenic - cells from a random embryo donor may be rejected after transplantation*
- 3. Tumorigenic - capable of forming tumors.*
- 4. Destruction of developing human life.*

**Types of stem cell:
2) Adult stem cells**

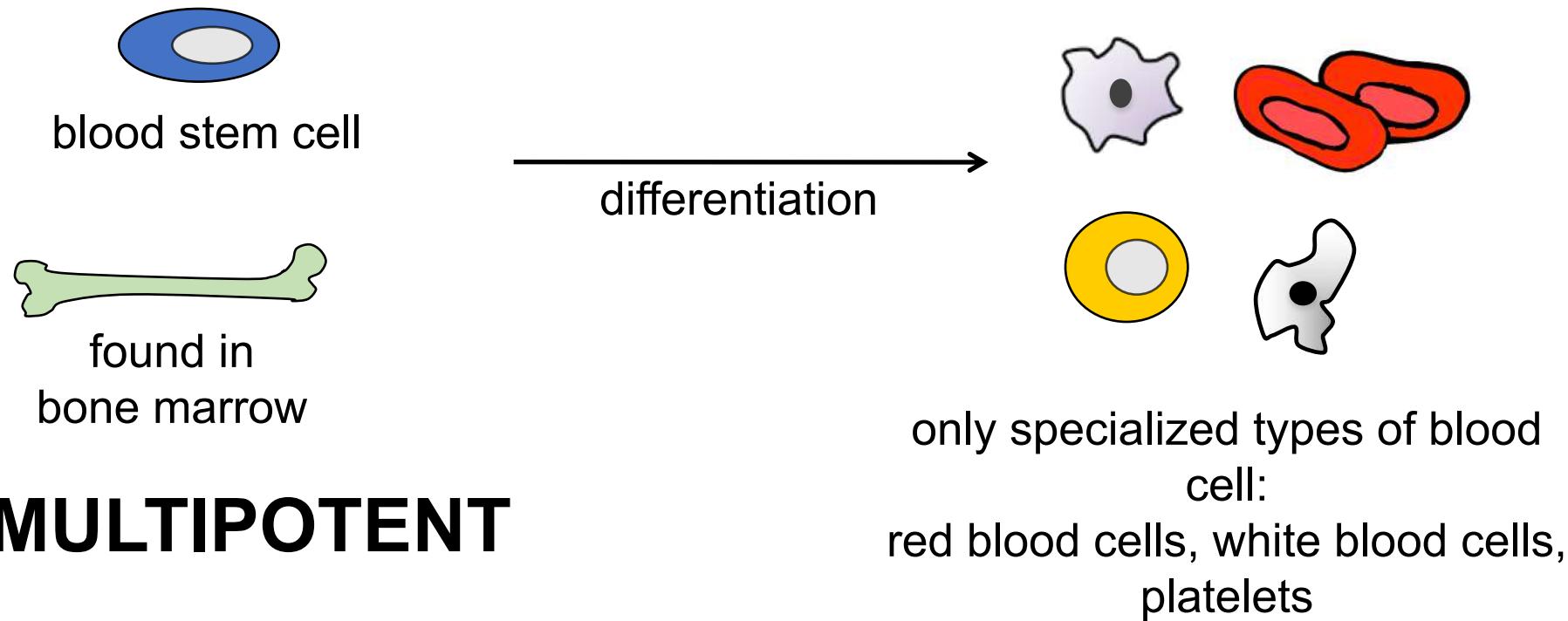
Tissue stem cells: Where we find them



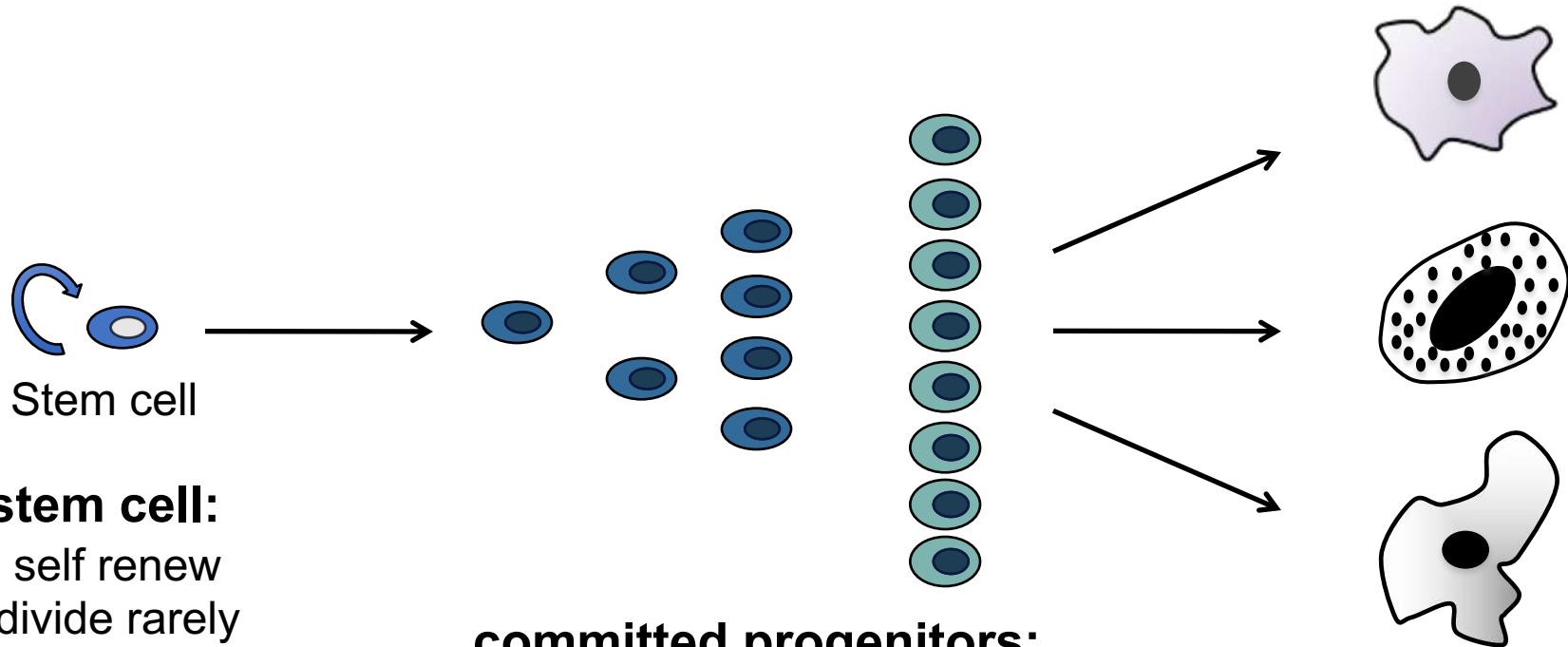
Sources of adult stem cells

- Adult stem cells can be derived from Umbilical Cords, Placentas and Amniotic Fluid.
- Adult stem cells are present within the bone marrow, liver, epidermis, retina, skeletal muscle, intestine, brain, dental pulp and elsewhere.

Tissue stem cells: What they can do



Tissue stem cells: Principles of renewing tissues



stem cell:

- self renew
- divide rarely
- high potency
- rare

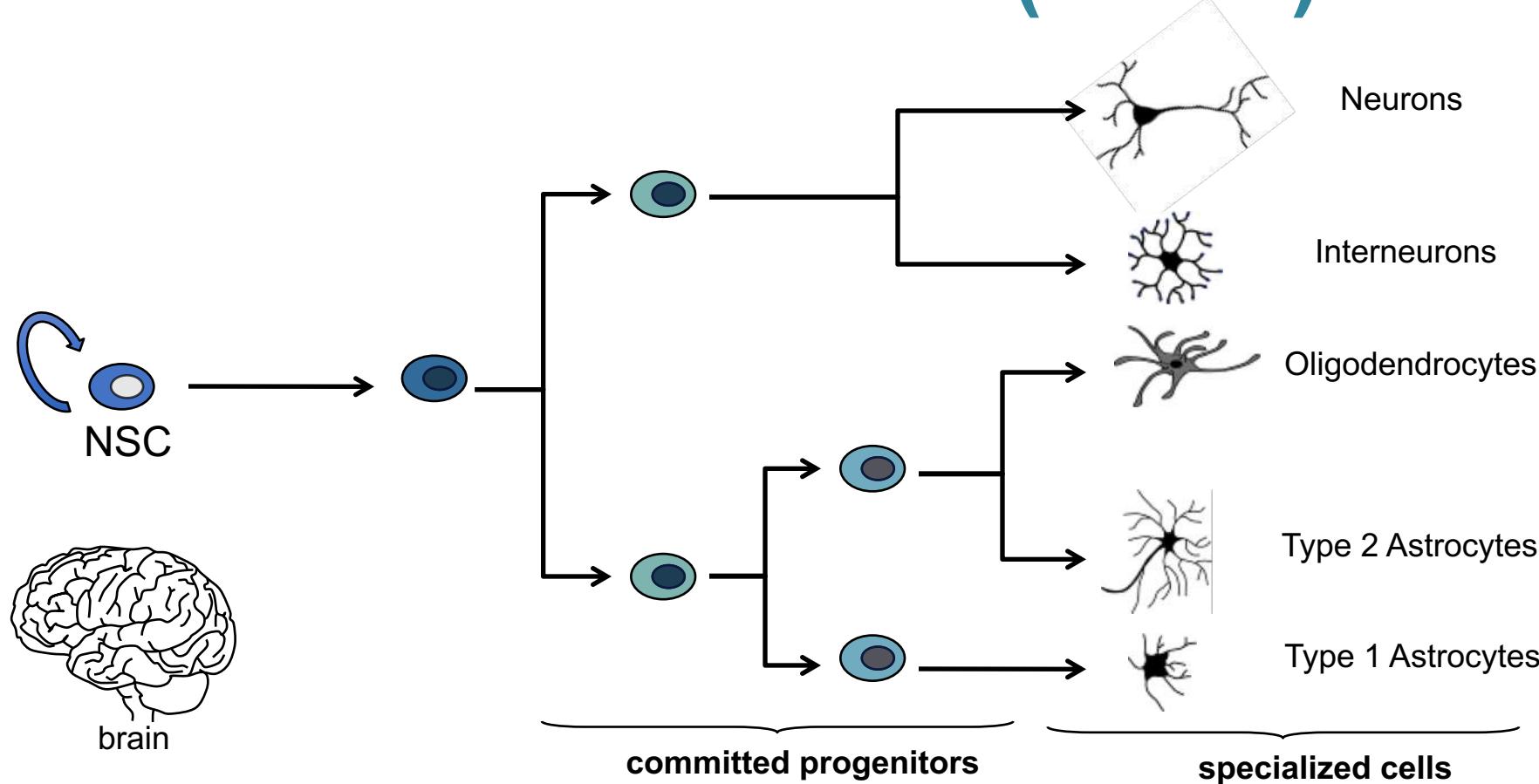
committed progenitors:

- “transient amplifying cells”
 - multipotent
 - divide rapidly
 - no self-renewal

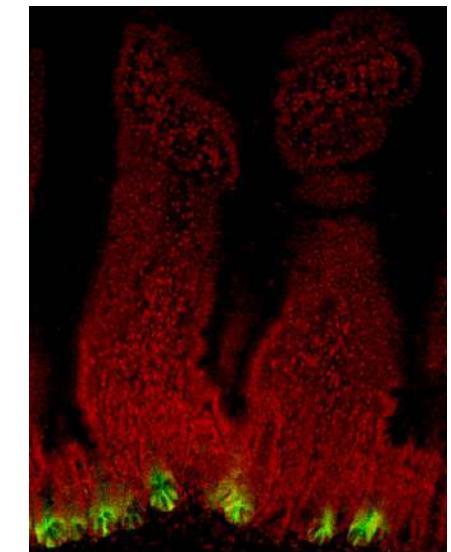
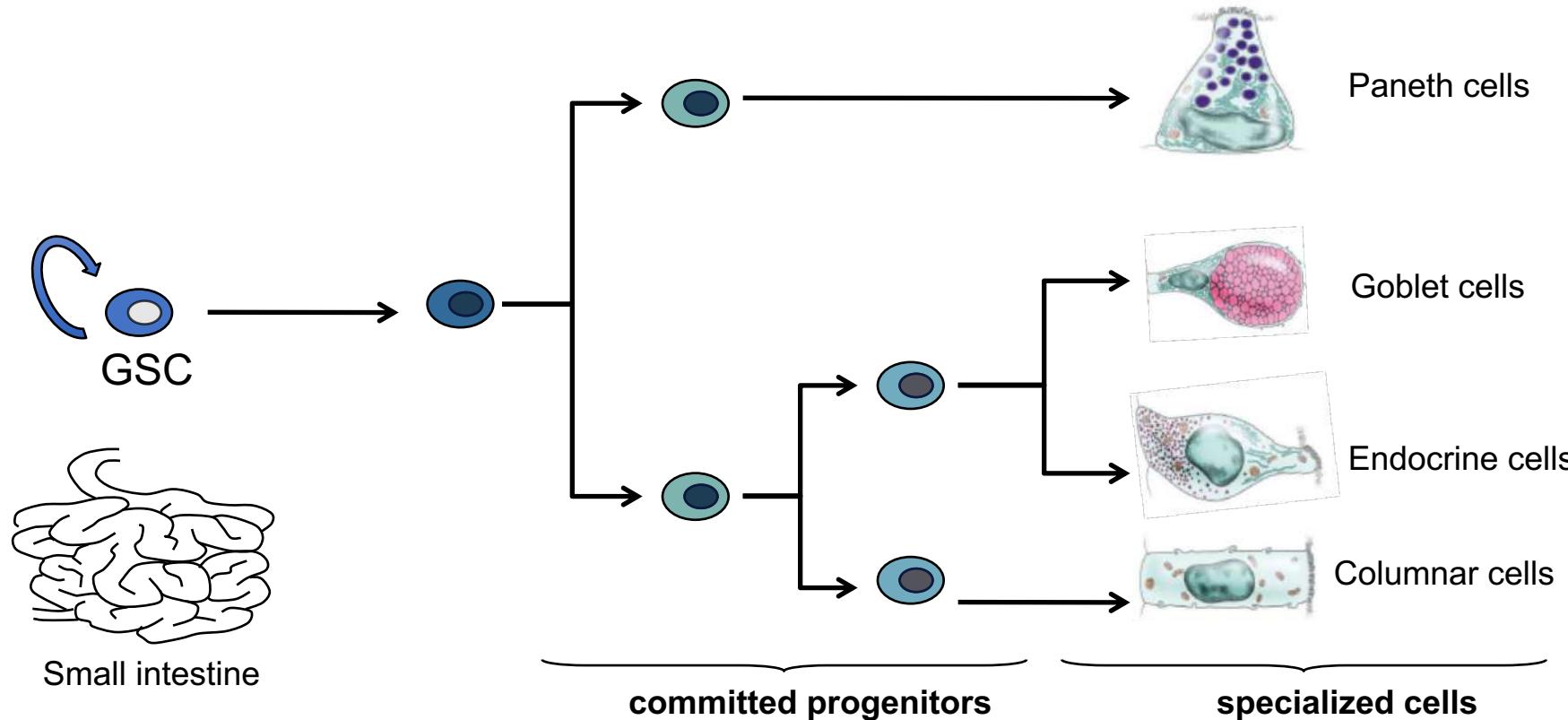
**specialized
cells:**

- work
- no division

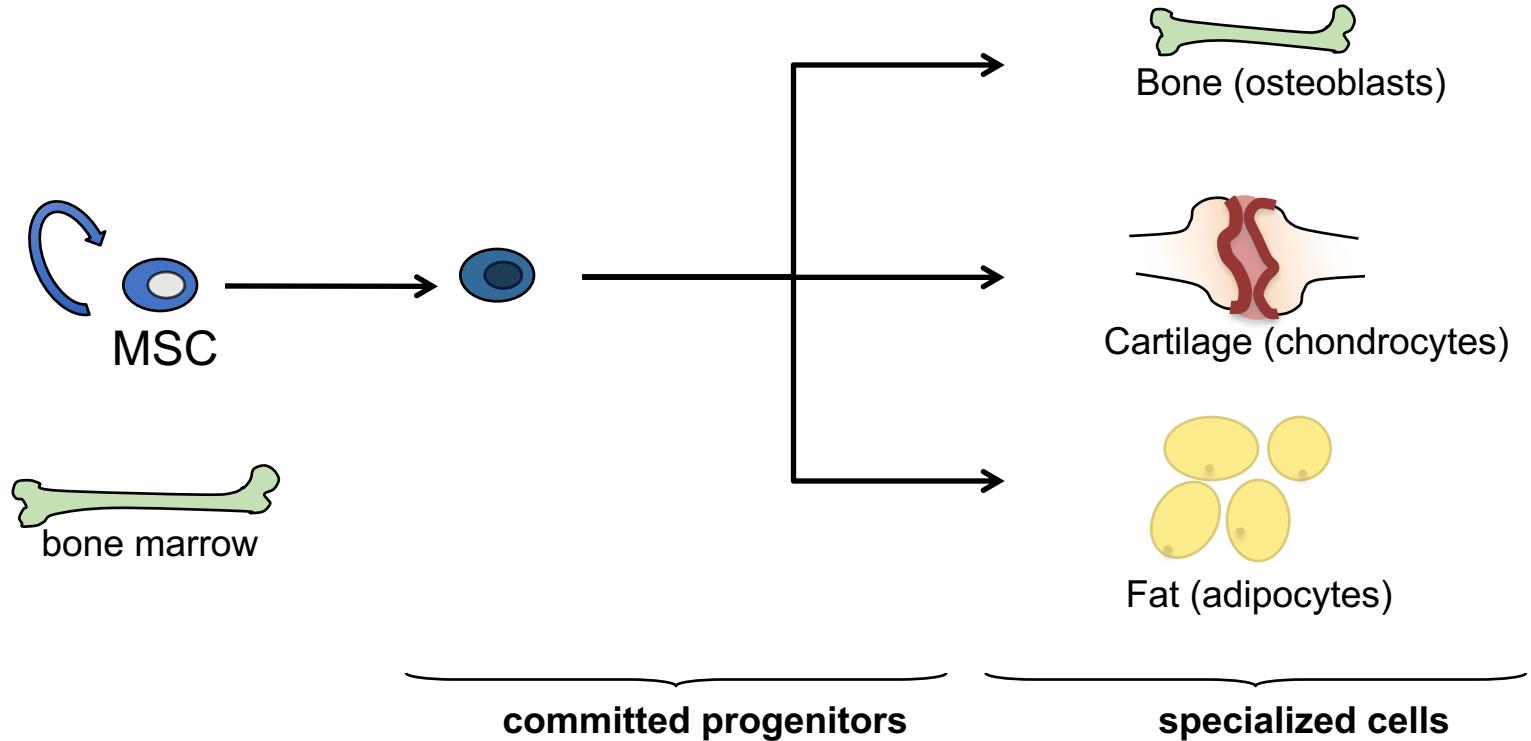
Tissue stem cells: Neural stem cells (NSCs)



Tissue stem cells: Gut stem cells (GSCs)



Tissue stem cells: Mesenchymal stem cells (MSCs)



Advantages of Adult Stem Cells

- 1. Adult stem cells from bone marrow and umbilical cords appear to be as flexible.**
- 2. Somewhat specialized.**
- 3. Not immunogenic - recipients who receive the products of their own stem cells will not experience immune rejection.**
- 4. Relative ease of procurement - some adult stem cells are easy to harvest (skin, muscle, marrow, fat)**
- 5. Non-tumorigenic-tend not to form tumors.**
- 6. No harm done to the donor.**

Disadvantages of Adult stem cell

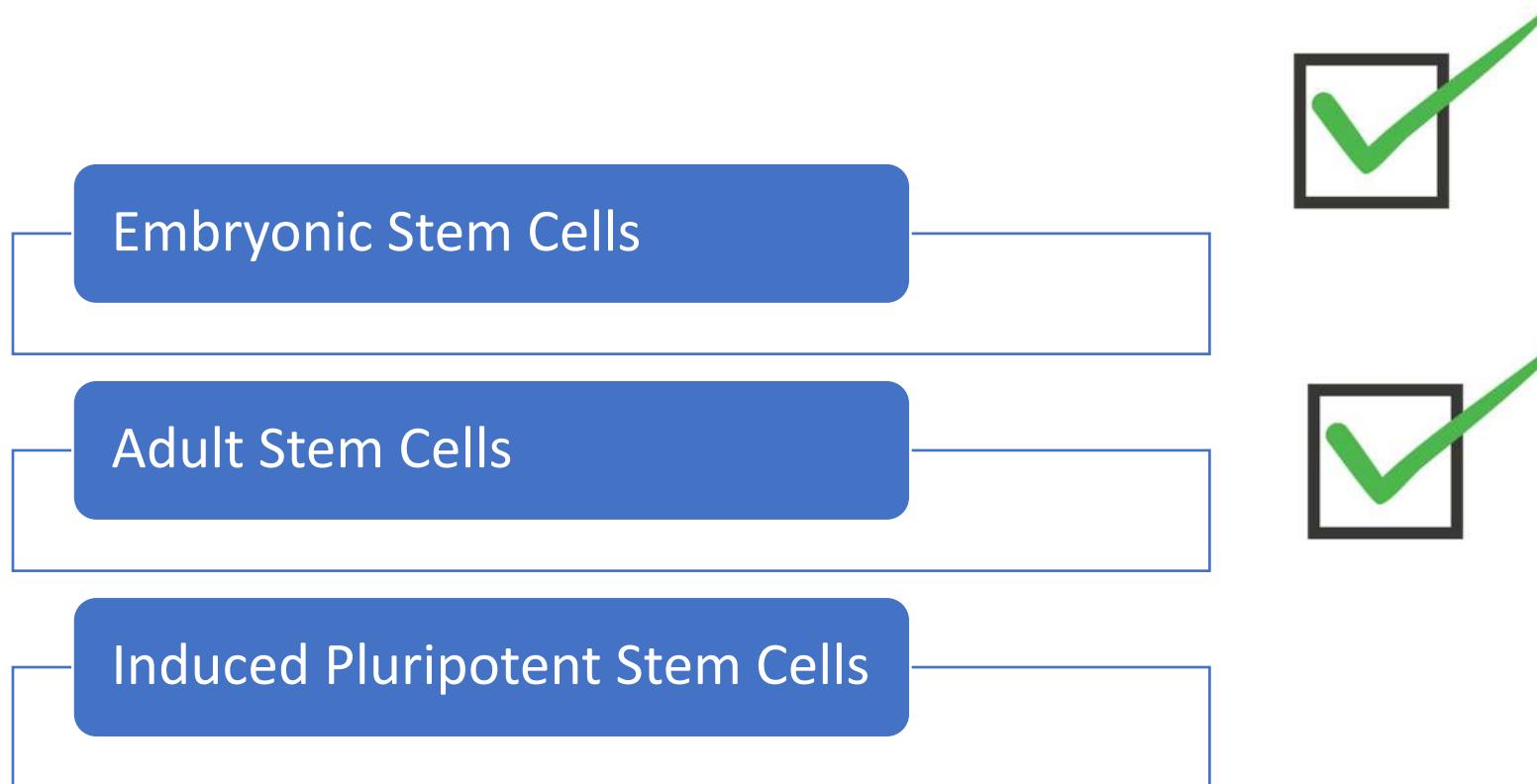
- 1. Limited quantity - can sometimes be difficult to obtain in large numbers.**
- 2. Finite - may not live as long as embryonic stem cells in culture.**
- 3. Less flexible - may be more difficult to reprogram to form other tissue types**

SBL100

Part 2

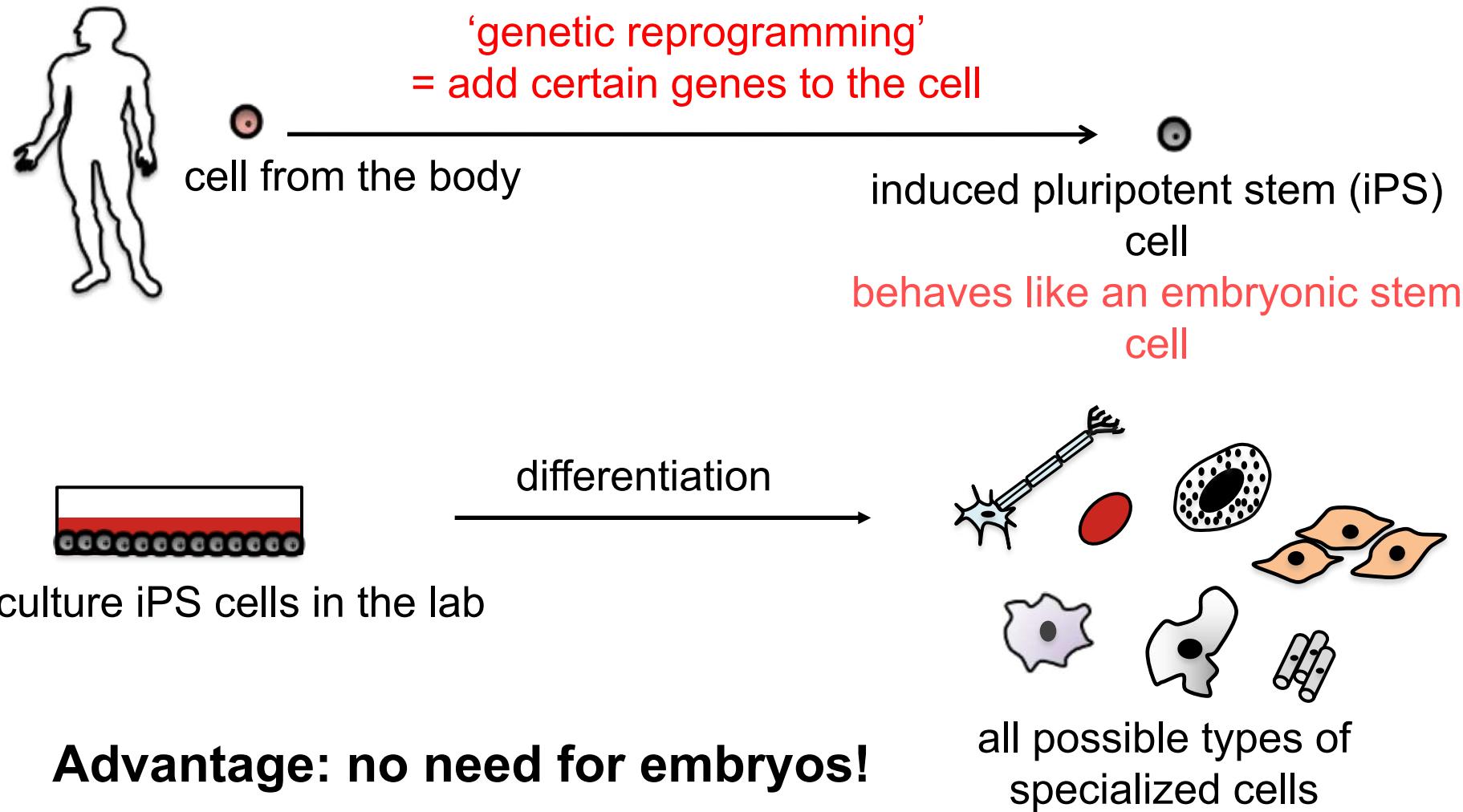
Stem Cells

Types of Stem Cells



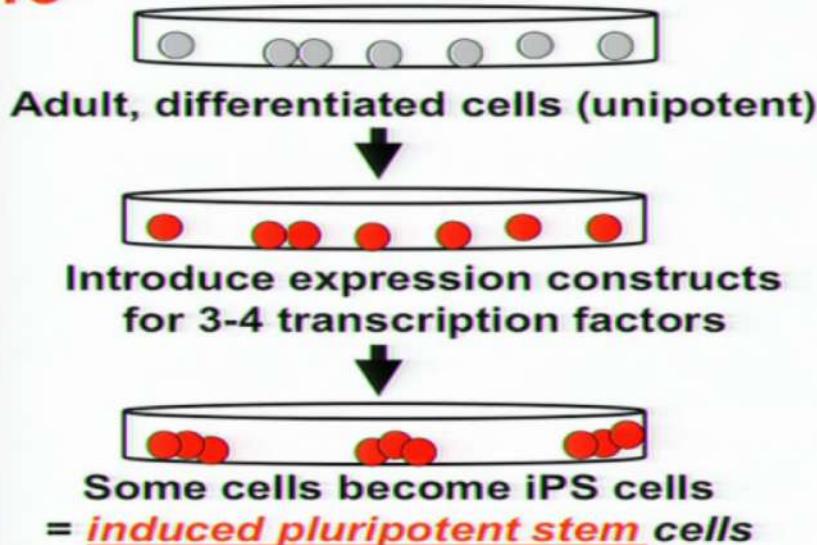
Types of stem cell:
**3)Induced pluripotent (iPS)
stem cells**

Induced pluripotent stem cells (iPS cells)



May be able to make stem cells from a patient's own cells

13



Yamanaka, 2006

Jaenisch, 2007 (MIT)

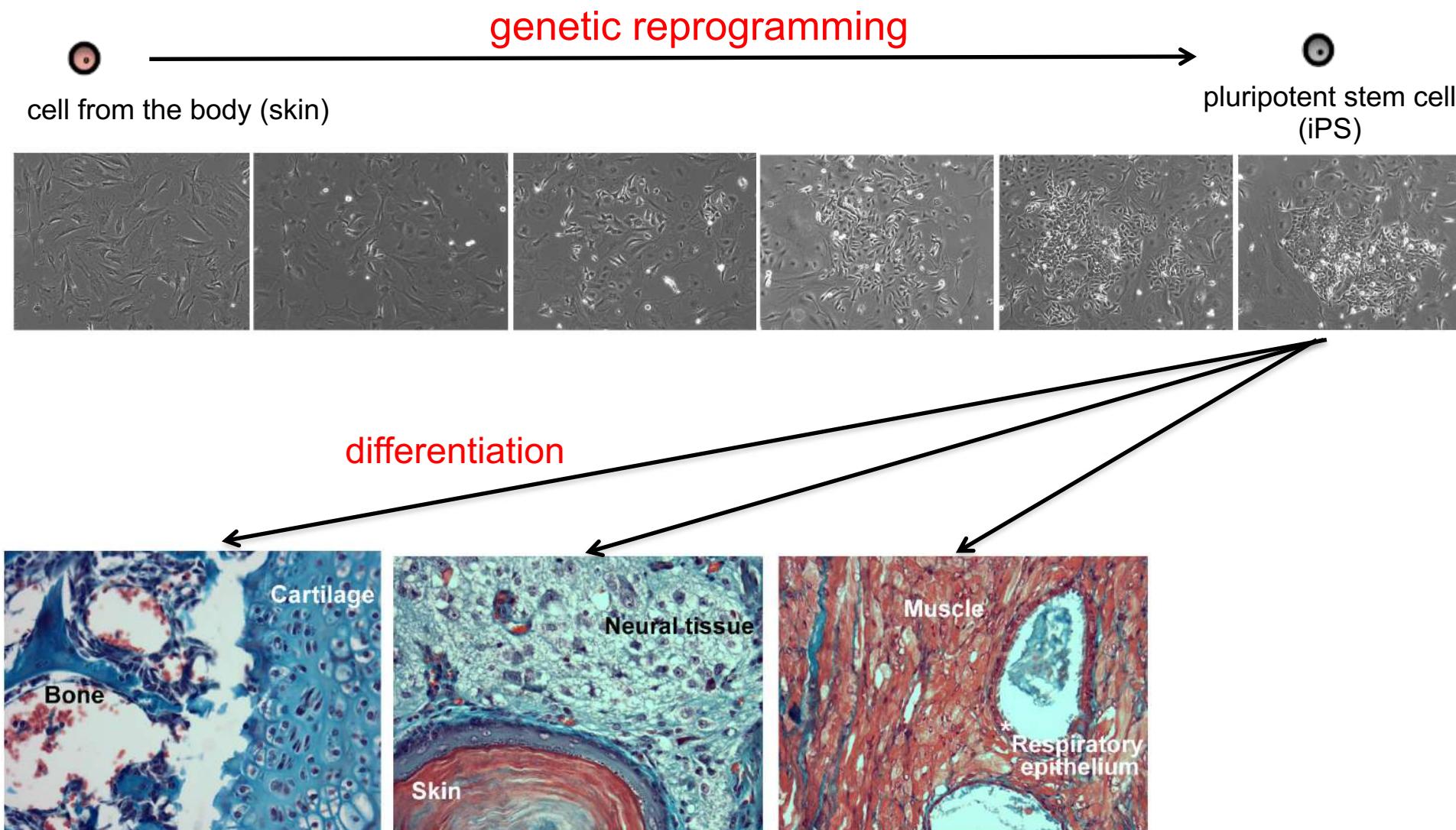
Converting adult cells into stem cells

H. Sive MIT 2011

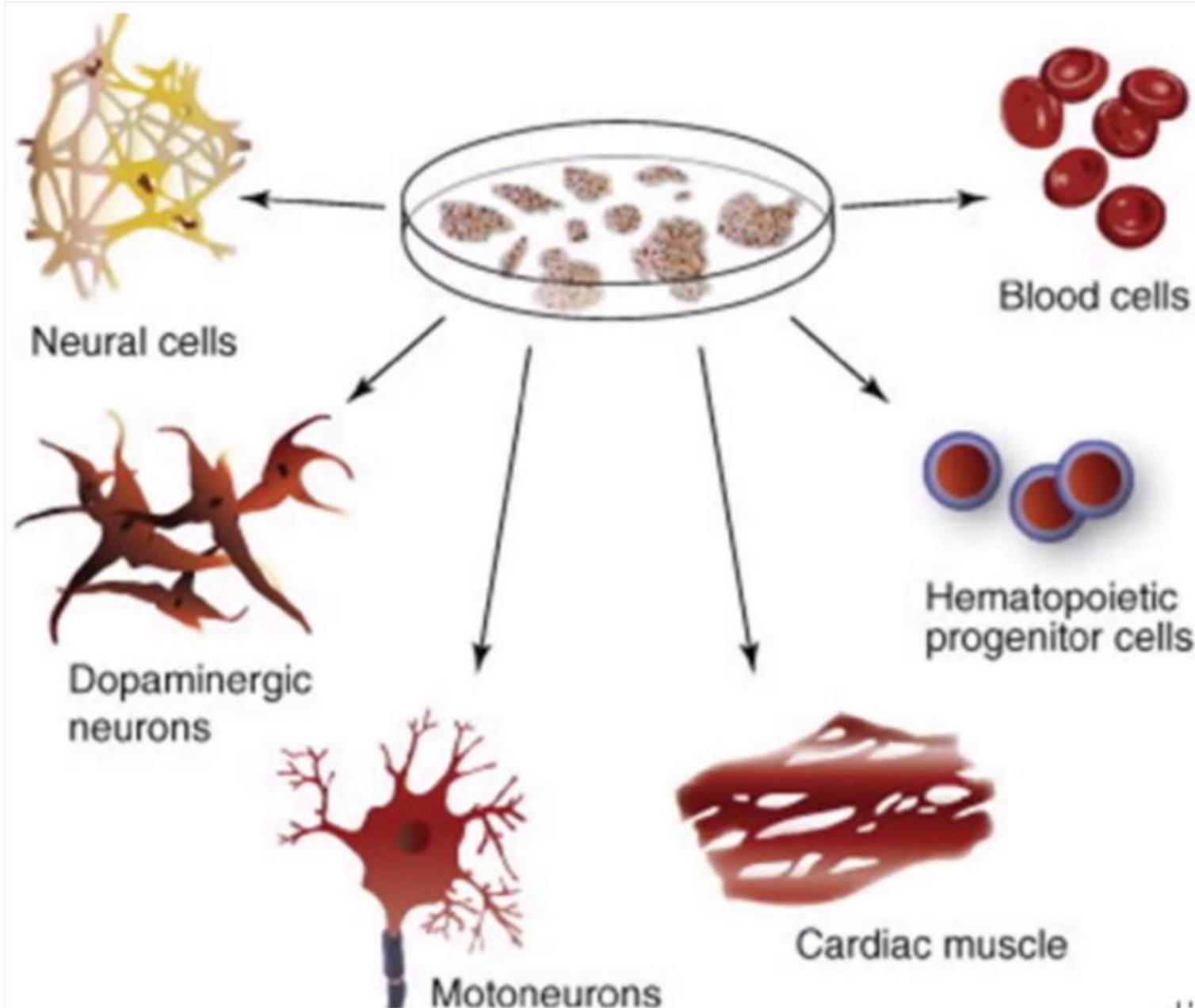
Therapeutics:

- Idea: Inject stem cells to repair damaged organ
- Need stem cells with correct potency
- Adult stem cells are rare, say around 0.01 % only
- So use of iPSC are the clever technology to have Pluripotent SC
- Turned differentiated cells in lab by genetic reprogramming,
- So very very less chance for rejection

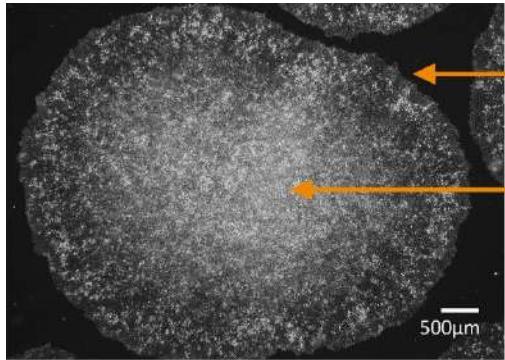
Induced pluripotent stem cells (iPS cells)



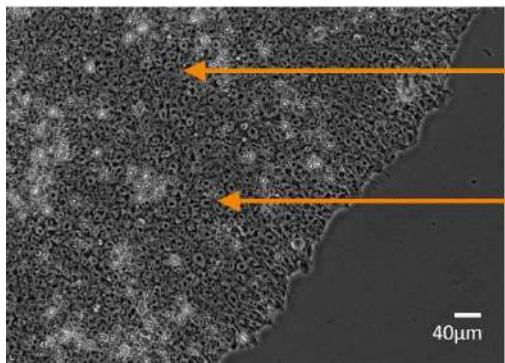
Induced Pluripotent stem cells



Induced pluripotent stem cells (iPS cells)

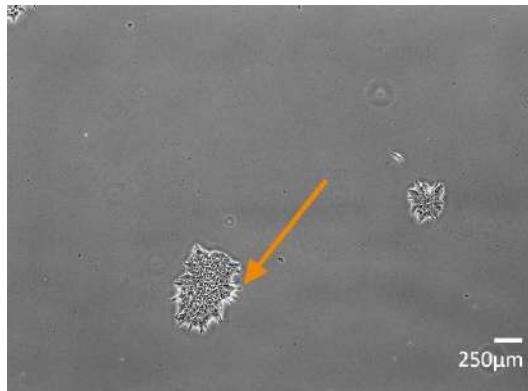


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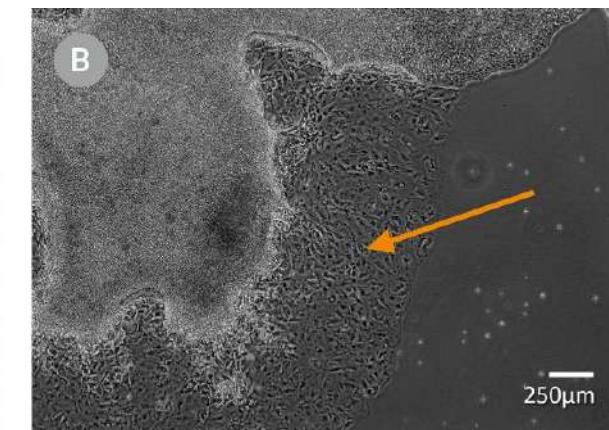
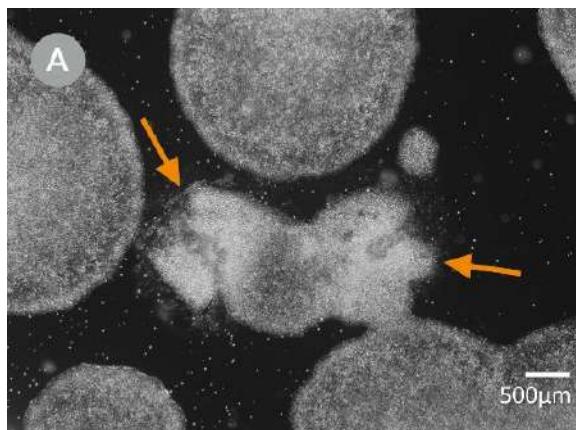
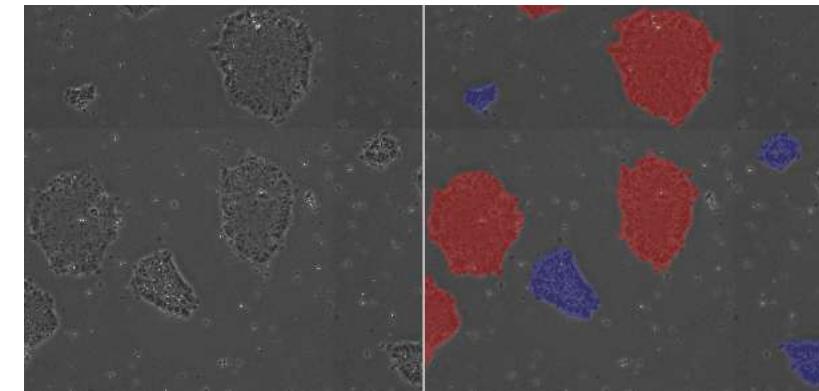


Tight cellular packing

Prominent nucleoli



Phase-bright center



Shinya Yamanaka



The Nobel Prize in Physiology or Medicine
2012 with Sir John Gurdon

“for the discovery that mature cells can be reprogrammed to become pluripotent”

Physician to scientist – due to lack of cure for certain diseases

24 Factors to begin with...

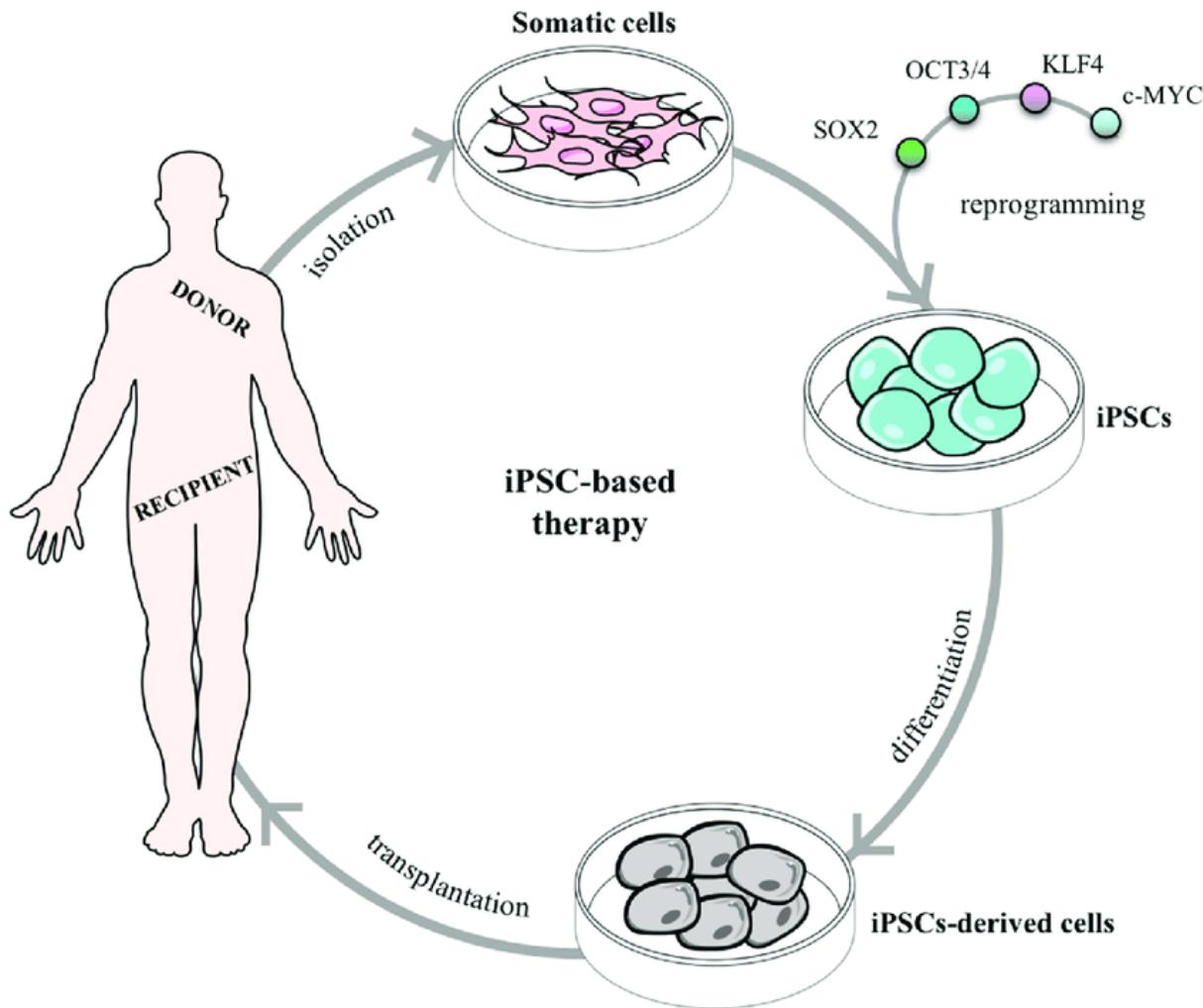
24 Candidate Factors

Group 1: Oct-3/4, Sox2, Nanog

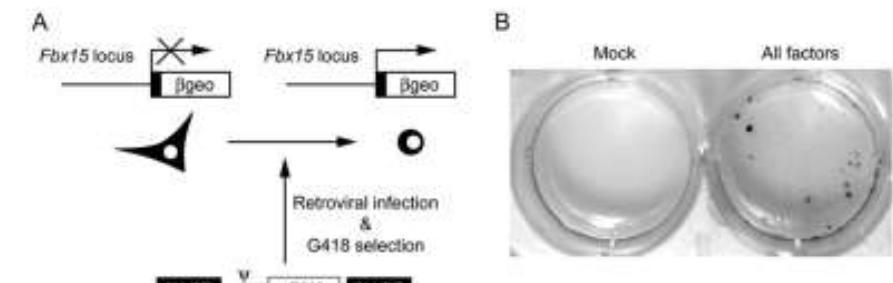
Group 2: Tcf1, Stat3, c-Myc, ERas...

Group 3: ECAT1, ESG1, Fbx15...

Yamanaka Factors - OSKM



Fbx15 – Specifically expressed in mouse ES cells.



Takahashi & Yamanaka, Cell, 2006,

OCT3/4

SOX2

KLF4

c-MYC

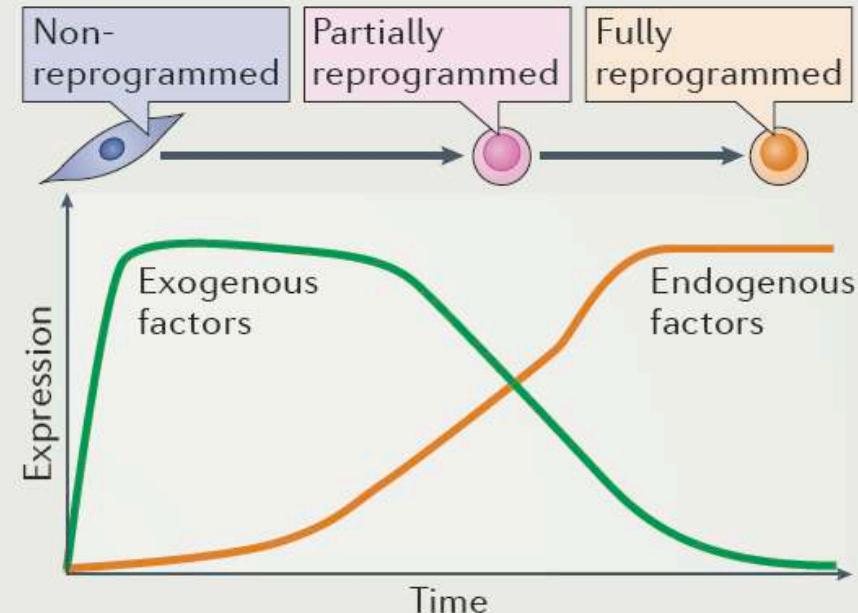
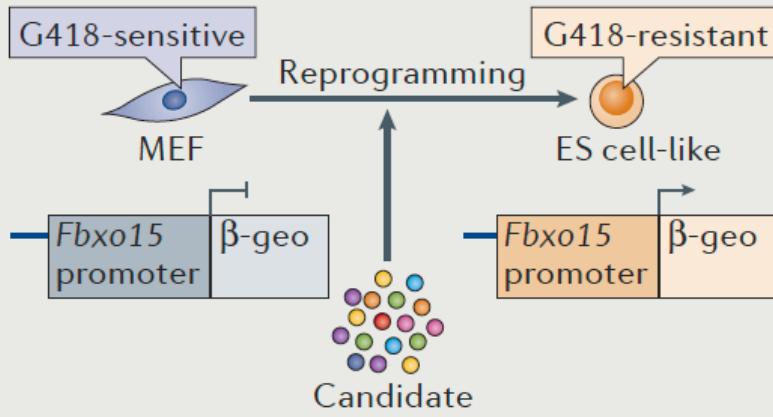
Box 1 | Identifying and screening for pluripotency factors

One of the most important details in the generation of induced pluripotent stem cells (iPSCs) was the identification of the key pluripotency factors. To establish the list of candidate genes (see Supplementary information S1 (table)), we first used *in silico* subtraction to identify cDNAs that are specifically enriched in embryonic stem cells (ES cells) in comparison to somatic cells.

Using this sequence information, we obtained full-length sequences of cDNAs encoding novel genes that were designated ES cell-associated transcripts (ECATs)²⁴.

Yoshimi Tokuzawa, a former graduate student in the Yamanaka laboratory, was a key person in the discovery of iPSCs. She generated knockout mice and ES cells with the disruption of one of the ECATs—F-box only protein 15 (*Fbxo15*)—by using the promoter trap strategy³⁵. In this case, β-galactosidase (β-geo) disrupted the gene, and its expression could be used as a reporter of *Fbxo15* promoter activity, as cells expressing β-geo would be resistant to geneticin (G418).

As FBXO15-null mutant mice developed normally and were fertile, we could readily isolate FBXO15-null mouse embryonic fibroblasts (MEFs). As expected, with no expression of FBXO15 in somatic cells, MEFs were not resistant to G418 treatment, but FBXO15–β-geo ES cells could survive even in an exceptionally high concentration of G418, suggesting that the endogenous *Fbxo15* promoter was strongly and tightly regulated (see the figure). We then used these FBXO15–β-geo MEFs as a system to screen for reprogramming factors. This system was based on transducing various combinations of candidate genes and evaluating the ability of MEFs to survive G418 treatment (see the figure).



<https://www.nature.com/articles/nrm.2016.8>

Comparison of Embryonic v/s Adult Stem Cells

Embryonic stem (ES) cells

almost all the cell types of an adult organism.

from the inner cell mass of the blastocyst.

Adult stem cells

limited range of cells within a tissue type,

within most organs, e.g in bone marrow, brain, liver, etc

Totipotent and pluripotent stem cells –

multipotent stem cells

Cord blood stem cells



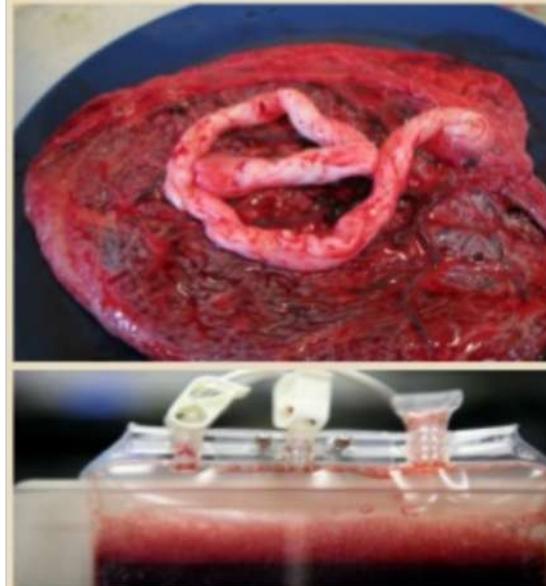
- The umbilical cord and placenta are rich sources of stem cells.
- Cord blood collection is a safe, simple procedure that poses no risk to the mother or newborn baby.



Cord blood stem cells

- Cord blood stem cells can grow into blood forming cells, immune system cells or other types of cells.
- Cord blood stem cells have been used to treat 70 different diseases, including leukemia, lymphoma, and inherited diseases.

Cord- blood banking



- Cord blood banks collect and store the blood within the umbilical cord and placenta after the birth of a baby.
- The stem cells are separated from the rest of the blood and stored frozen in liquid nitrogen.
- There are 2 types of banks i.e. public and family cord blood banks.

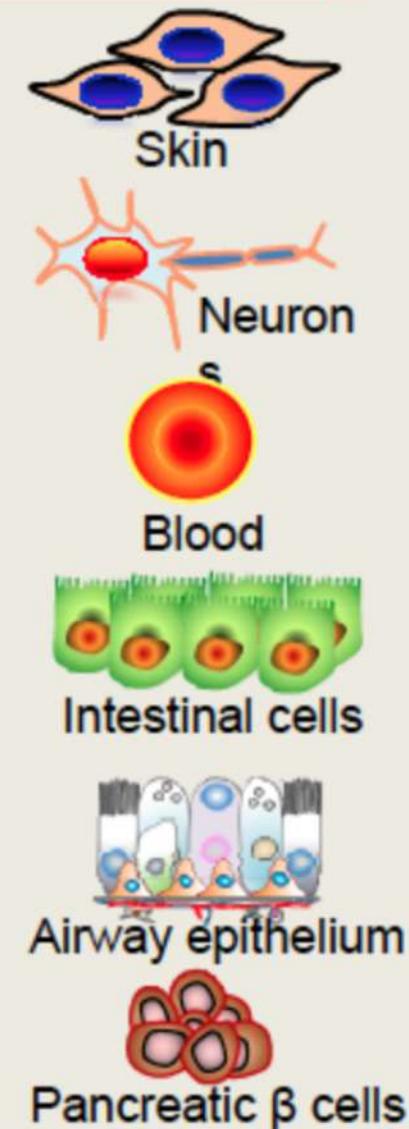
Stem cell therapy: Challenges

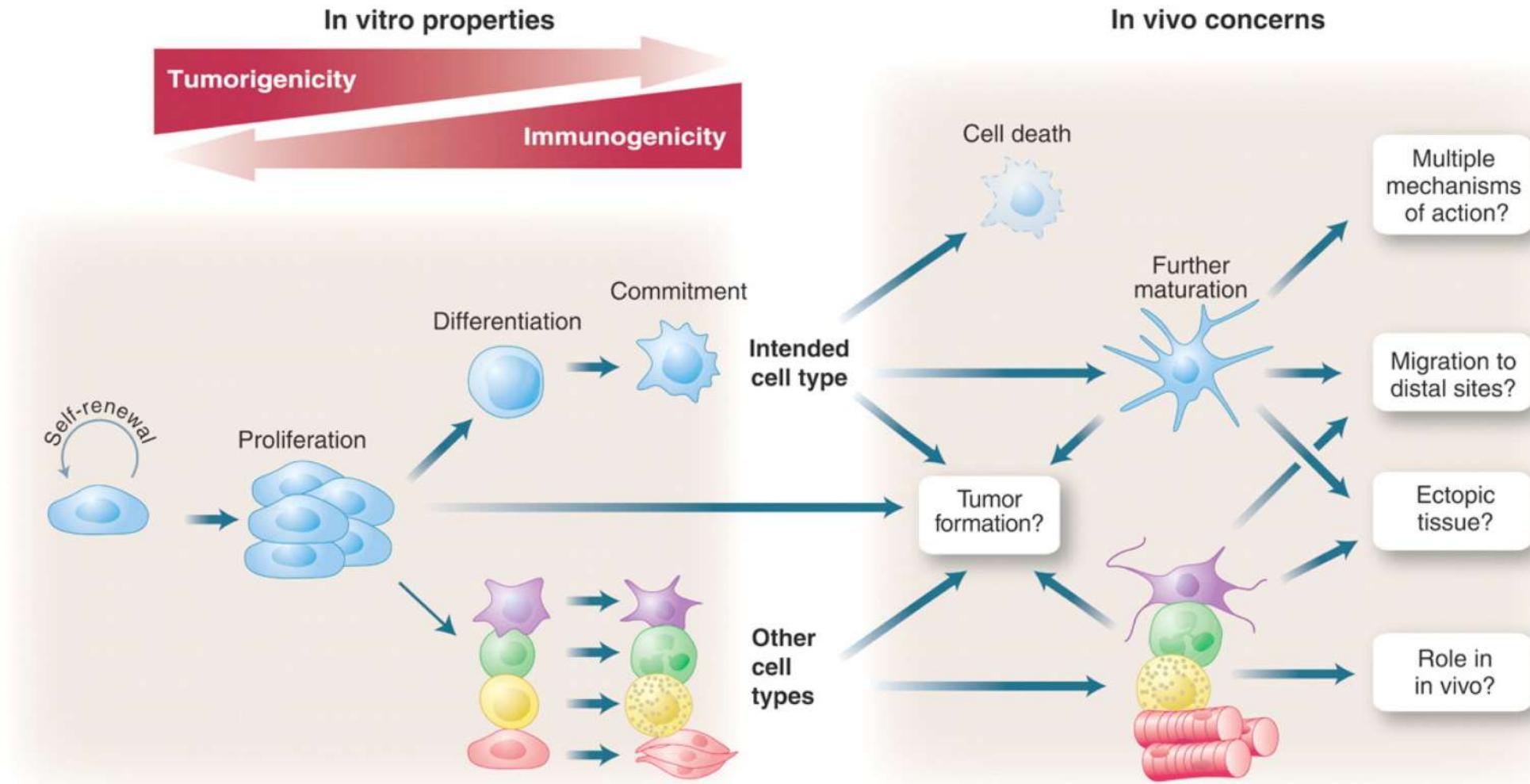
34



embryonic stem cells/
iPSC/Adult stem cell

- How to control stem cells after injection
- Marker identification for isolating pure SCs pool
- Finding right expansion conditions
- Different Differentiation conditions
- Different Scaffolding required
- Different delivery system and monitoring
- Long term storage for future use





<https://www.science.org/doi/10.1126/science.1173712>

Risk assessment of stem cell-based products. The potential for tumor formation (tumorigenicity) represents a concern correlated with the self-renewal of undifferentiated cells, whereas cells at other levels of maturation may also pose risk. Many stem cell-based therapies will not consist of a pure, homogeneous target cell population, which raises additional questions about risks that nontarget cells may present, as well as their physiologic role after administration. Ectopic tissue formation and migration from the site of transplantation are also concerns, particularly when stem cell-based products are introduced to anatomically sensitive sites. Additionally, differentiation of stem cell-based products that are allogeneic with respect to the recipient results in increased immunologic incompatibility due to expression of foreign nonself antigens. Death of large proportions of the transplanted cell population, not unique to stem cells, may constitute further risk.

HOW DO WE DELIVER SAFE AND EFFECTIVE STEM CELL THERAPIES TO PATIENTS AS RAPIDLY AS POSSIBLE?

- I) UNDERSTANDING DISEASE ACCELERATES THERAPY DEVELOPMENT
- II) ENHANCING SAFETY ACCELERATES INITIATION OF CLINICAL TRIALS
- III) ACCURATE COMMUNICATION ACCELERATES RESPONSIBLE CLINICAL TRIALS

Dream is to get Stem cell population for every organ of our body
Dream is to get repaired any damaged organ or limb
Just inject correct stem cells to get any organ repaired.

How Stem Cells Are Changing the Way We Think About Disease: Latest stories

35



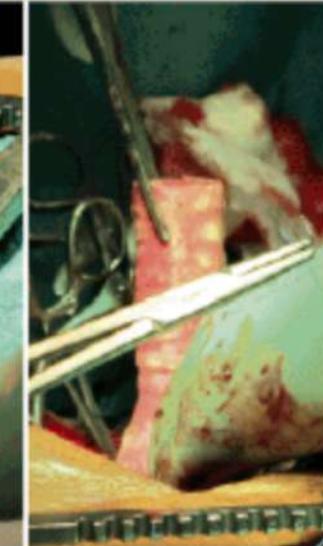
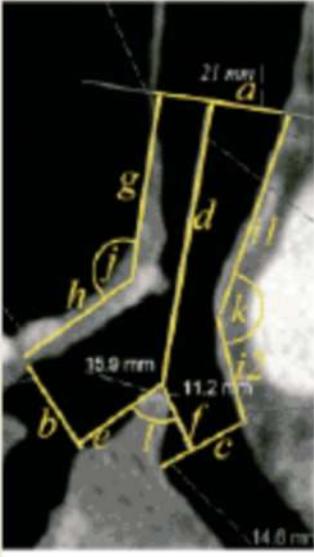
<http://www.dailymail.co.uk/sciencetech/article-2599568/UK-scientists-make-body-parts-lab.html>

- Professor Alexander Seifalian (pictured) made a nose for a man who lost his to cancer.
- Stem cells were taken from the patient's fat and grown in the lab for 2 weeks before being used to cover the scaffold.
- Dr Michelle Griffin (pictured) said ears are harder to make than noses



Stem cell based therapy

36

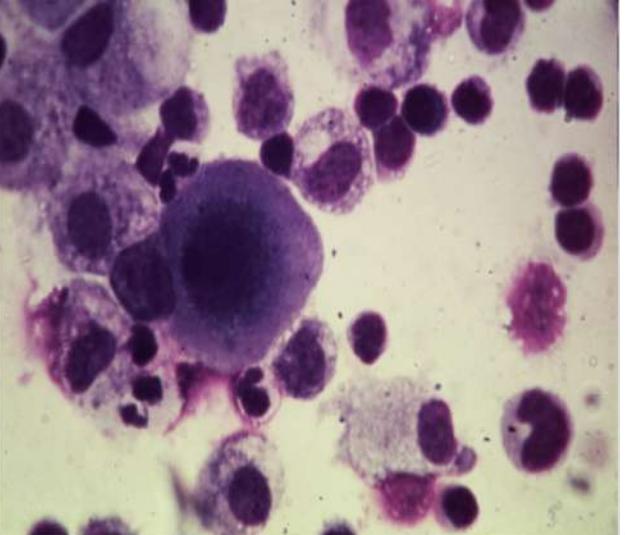


Paolo macchiarini (scaffolding, seeding) and Harvard bioscience

windpipe

- Artificial trachea grown from her own stem cells on a 3-inch-long frame of plastic fibers
- Bone marrow stem cells seeded on scaffold and grown in a bioreactor before transplantation
- Hannah died after three months of the surgery
- Though controversies exist but this story suggest the future use of stem cells for therapy

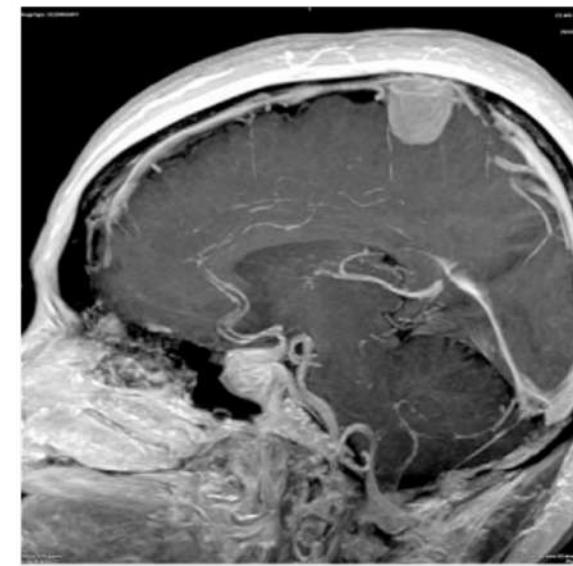




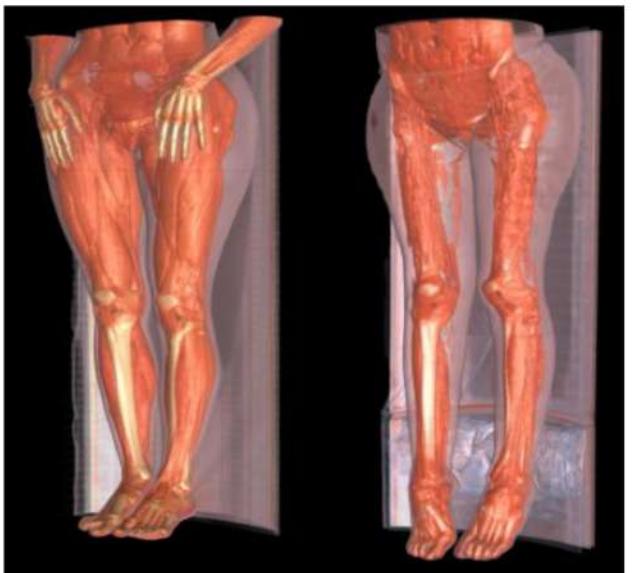
Bone marrow cancer



Haemophilia



**Brain
tumour**



Muscular Dystrophy



**Skin wounds and
burns**



Stem cells in Plastic Surgery

- Example: *Correction of a deformity by autologous fat transfer:*
- Current- injection of large numbers of heterogeneous cells manually- primitive- unpredictable



Recent advancement in stem cells

24 July 2015, University of Texas used silk fibers to provide salivary gland stem cells with a 3D scaffold on which to grow a matrix of salivary gland stem cells.

The achievement is significant because "salivary gland stem cells are some of the most difficult cells to grow in culture and retain their function.

<http://uthscsa.edu/hscnews/singleformat2.asp?newID=5099>



There are currently no treatments for dry mouth, where the salivary glands do not produce enough saliva.

Artificial blood grown in a lab from stem cells is one step closer to being available to people with complex blood types for whom it is difficult to find matching donors.

UK's NHS (National Health Service) Blood and Transplant manufactured blood may be used in clinical trials with humans within 2 years



http://www.nhsbt.nhs.uk/news-and-media/news-articles/news_2015_06_25.asp

Stem cell therapy.

Numerous diseases and damaged organs could potentially be treated with cell therapy.

- ◆ *Treatment of neural diseases such as Parkinson's disease, Huntington's disease and Alzheimer's disease.*
- ◆ *Repair or replace damaged neurons.*
- ◆ *Repair of damaged organs such as the liver and pancreas.*
- ◆ *Treatments for AIDS.*

Stem cell transplantation (SCT)/ Bone marrow transplantation (BMT).

- *When a patient's bone marrow fails to produce new blood cells, for whatever reason, he or she will develop anemia, persistent infections and bleeding problems.*
- *In order to restore blood cell production a patient may be given Stem cell transplantation (SCT) for healthy stem cells.*
- *Stem cell transplants are used to treat malignant diseases, mainly leukemia, lymphoma or myeloma which involve the bone marrow.*

Cancer treatment

- *Intense chemotherapy damages a person's bone marrow.*
- *A chemo-cancer patient is left vulnerable to infection, anemia and bleeding because of the depletion of fresh blood cells.*
- *Transplanting bone marrow tissue into a chemo-cancer patient may be carried out.*

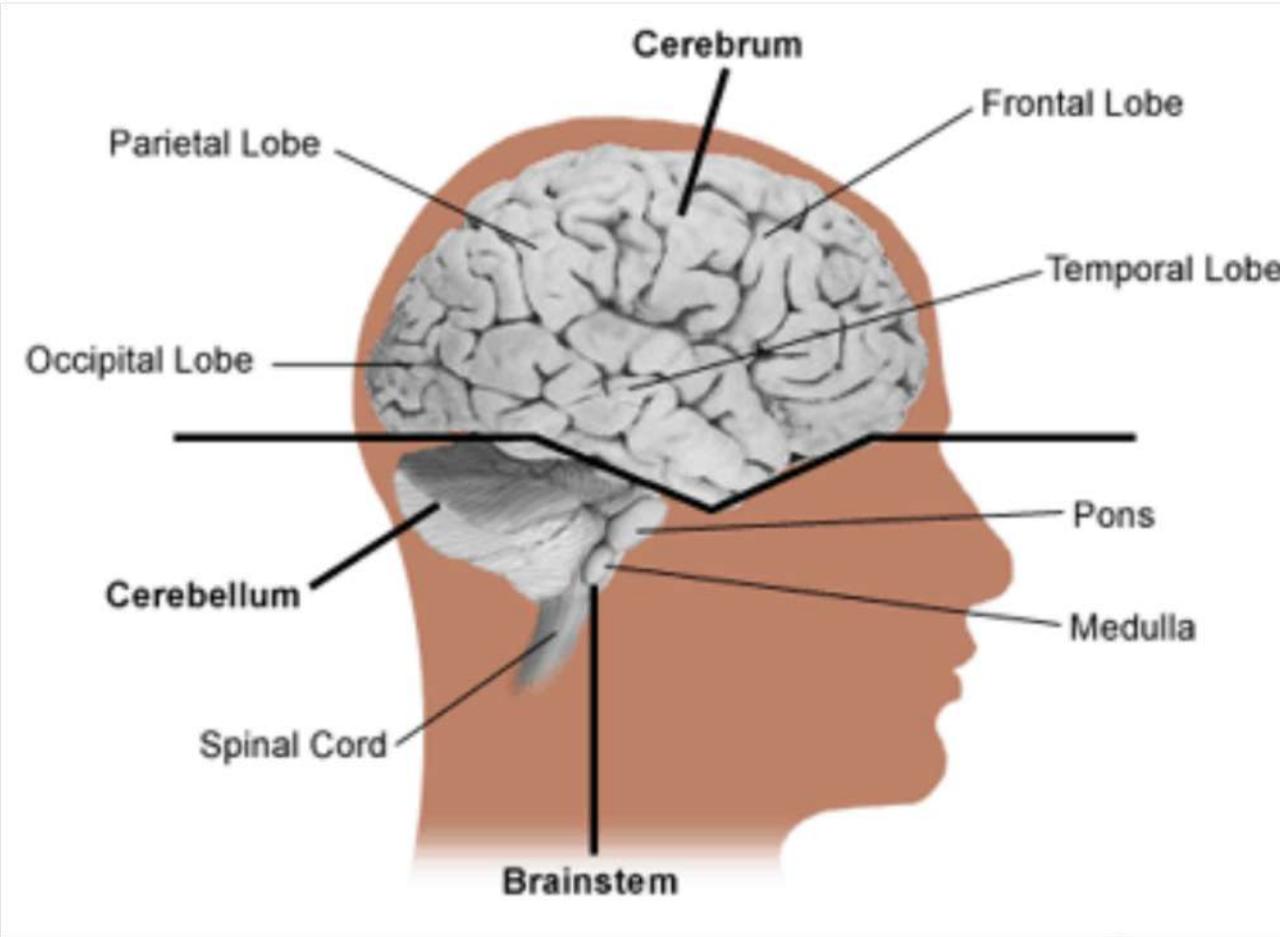
Skin tissue repair

- *skin, is readily cultured to provide replacement tissue for burns victims.*
- *Healthy skin cells from the patient can be grown rapidly in vitro to provide self-compatible skin grafts.*

POSSIBLE USES OF TISSUE DERIVED FROM STEM CELLS TO TREAT DISEASE

Cell type	Target disease
Neural (nerve) cells	Stroke, Parkinson's disease, Alzheimer's disease, spinal cord injury, multiple sclerosis
Heart muscle cells	Heart attacks, congestive heart failure
Insulin-producing cells	Diabetes
Cartilage cells	Osteoarthritis
Blood cells	Cancer, immunodeficiencies, inherited blood diseases, leukemia
Liver cells	Hepatitis, cirrhosis
Skin cells	Burns, wound healing
Bone cells	Osteoporosis
Retinal (eye) cells	Macular degeneration
Skeletal muscle cells	Muscular dystrophy

- In China a man with Parkinson's was treated with human ES cells which turned into a tumor (teratoma) in his brain that killed him.



- The power of ESCs is also the source of their peril.

- Embryonic stem cell research requires human cells. This could create a commercial market for human cells. Some may say: “This devalues life”



\$\$\$\$\$
\$\$\$\$\$

- ◆ The buying and selling of human reproductive material may be seen by some as a devaluation of human life. Human life is invaluable. It should not be given a price tag.
- ◆ The salesman in this cartoon treats the eggs, sperm and embryos he is selling in the same way that a salesman would treat kitchen appliances or used cars.

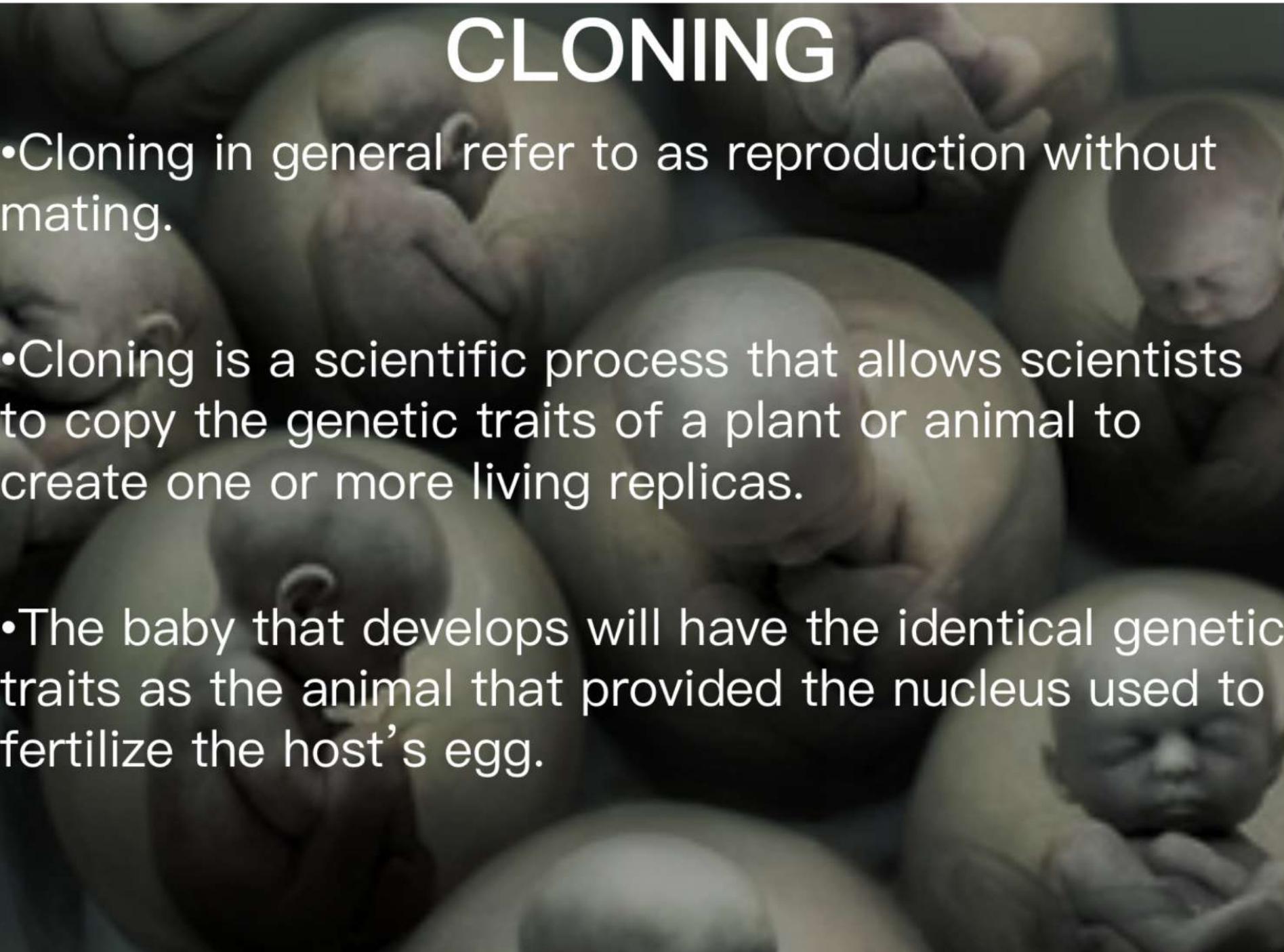
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Part 3

Stem Cells

Cloning

CLONING

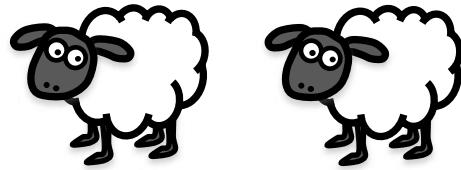


- Cloning in general refers to reproduction without mating.
- Cloning is a scientific process that allows scientists to copy the genetic traits of a plant or animal to create one or more living replicas.
- The baby that develops will have the identical genetic traits as the animal that provided the nucleus used to fertilize the host's egg.

Cloning

There are two **VERY different types of cloning:**

Reproductive cloning

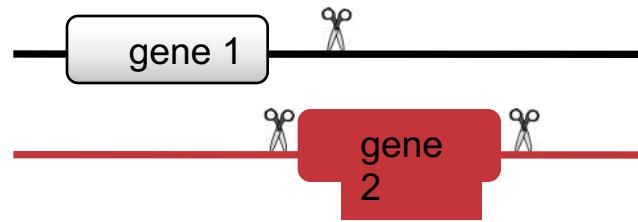


Use to make two identical individuals

Very difficult to do

Illegal to do on humans

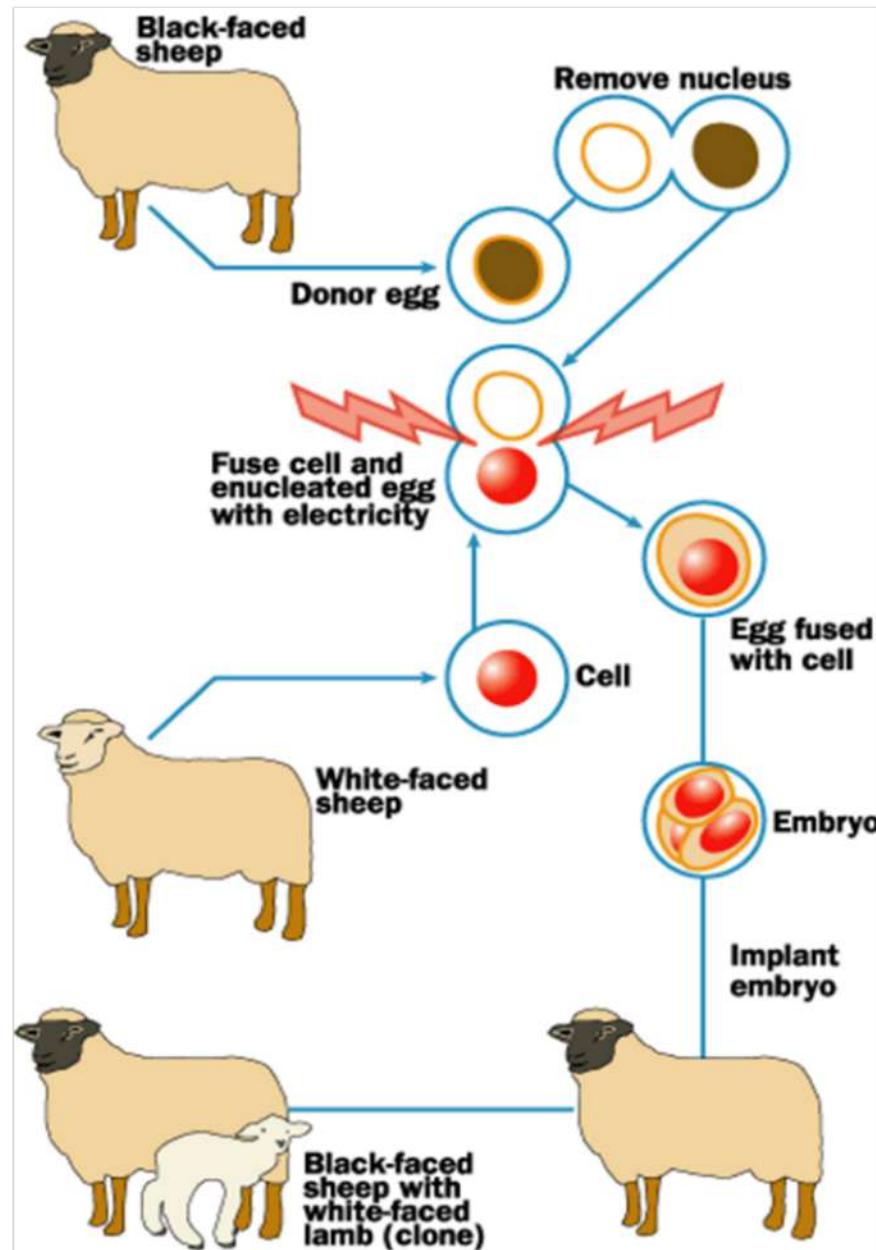
Molecular cloning



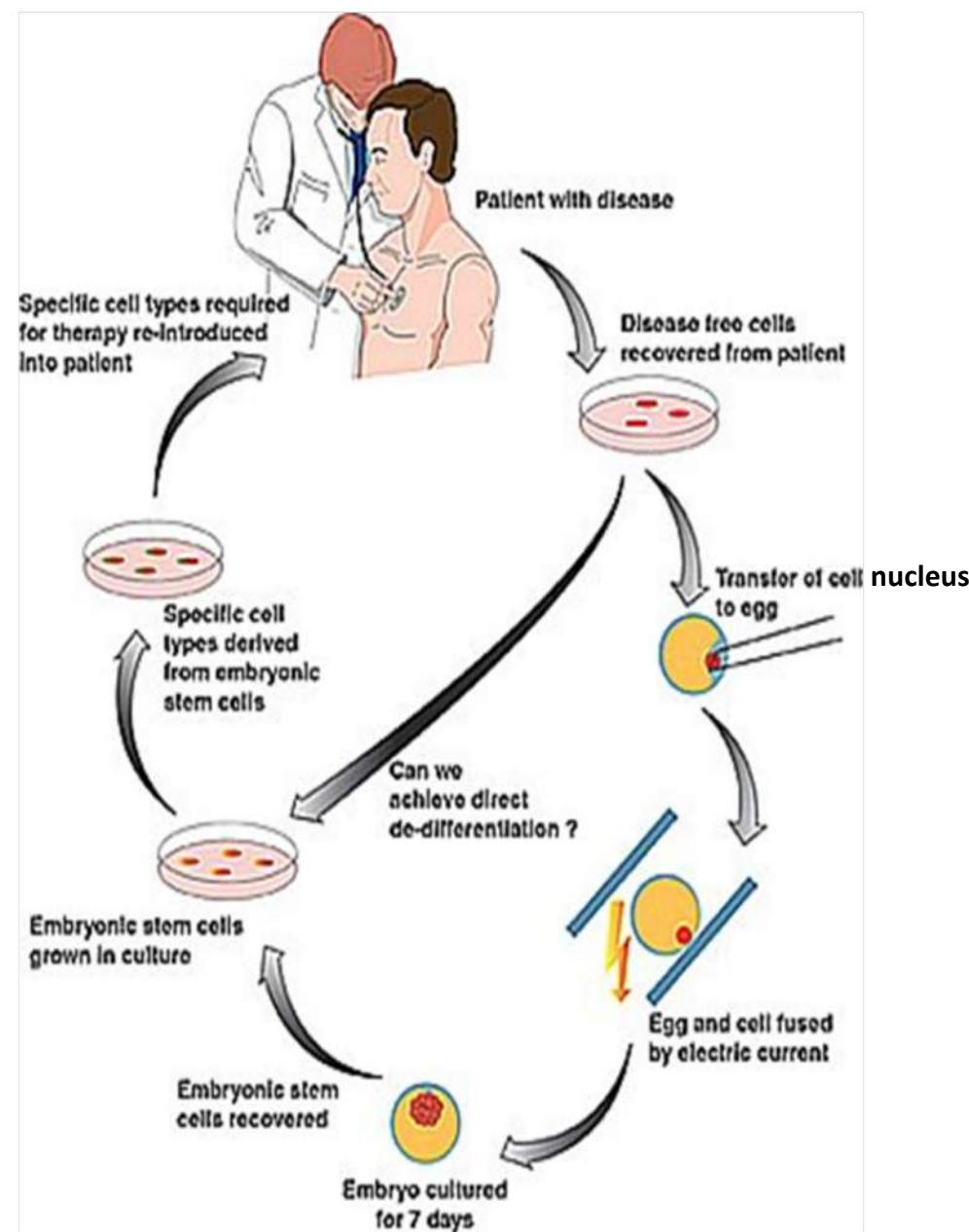
Use to study what a gene does

Routine in the biology labs

Reproductive Cloning



Therapeutic Cloning



THERAPEUTIC CLONING VERSUS REPRODUCTIVE CLONING

THERAPEUTIC CLONING

The production of embryonic stem cells for the use in replacing or repairing damaged tissues or organs, achieved by transferring a diploid nucleus from a body cell into an egg whose nucleus has been removed

Creating embryo develops under laboratory conditions

Responsible for creating embryonic stem cells to treat diseases such as diabetes and Alzheimer's disease

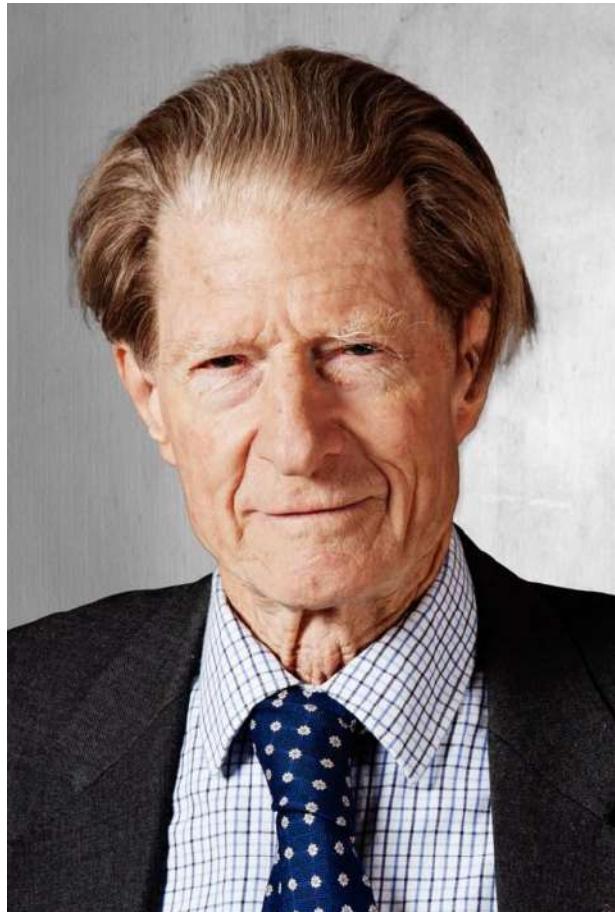
REPRODUCTIVE CLONING

The deliberate production of genetically identical individuals; each newly produced individual is a clone of the original

Creating embryo develops under uterine conditions

Important for harvesting stem cells that can be used to study embryonic development

Stem Cells : A Historical Perspective



Sir John Gurdon

British Geneticist

Early struggles – Removed from all science classes

Nuclear Transfer with Xenopus, Year 1962

Hypothesis – “Nucleus of a specialized cell contains the complete genome”

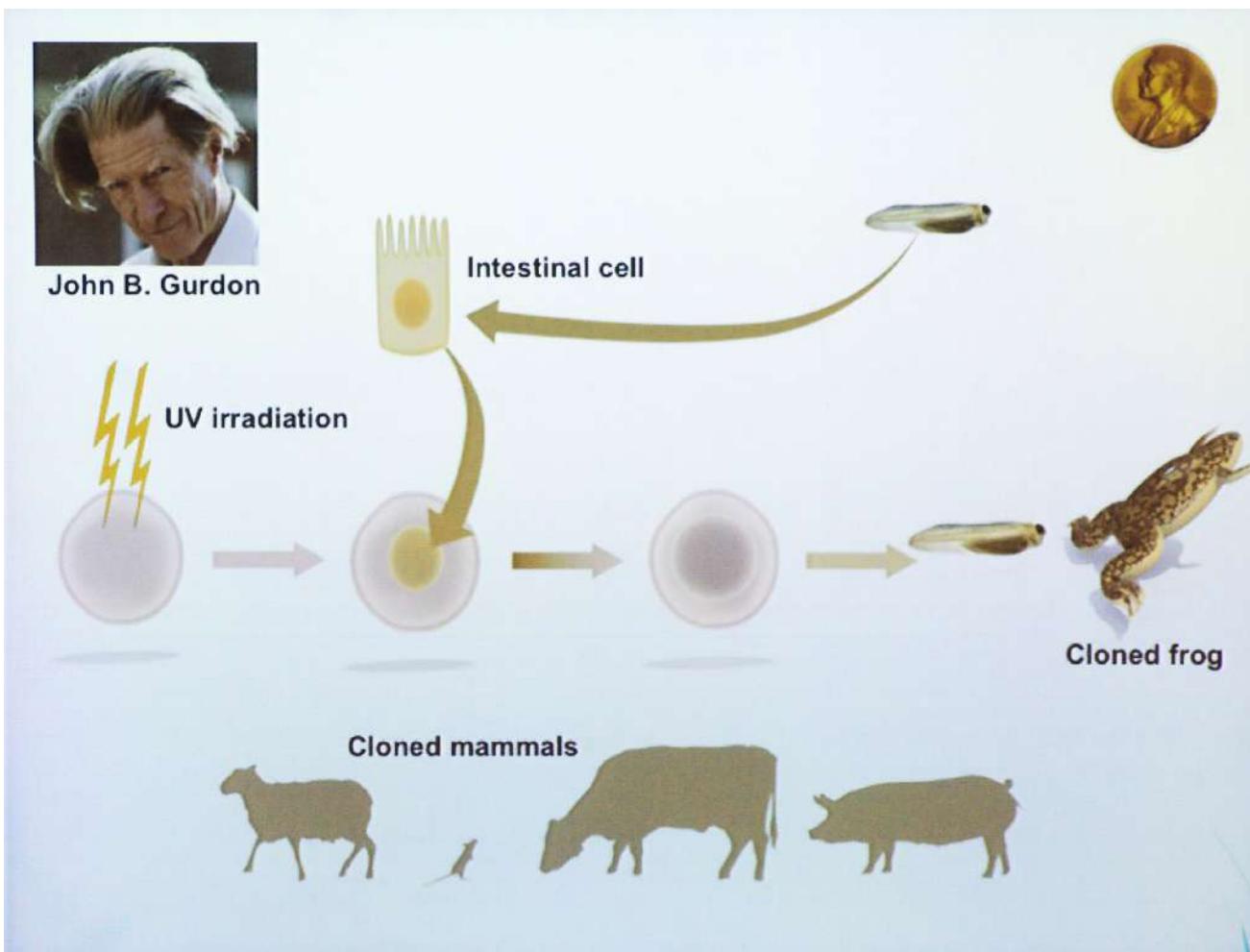
Nobel Prize – 2012 Physiology and Medicine

Xenopus laevis vs *Rana pipiens*

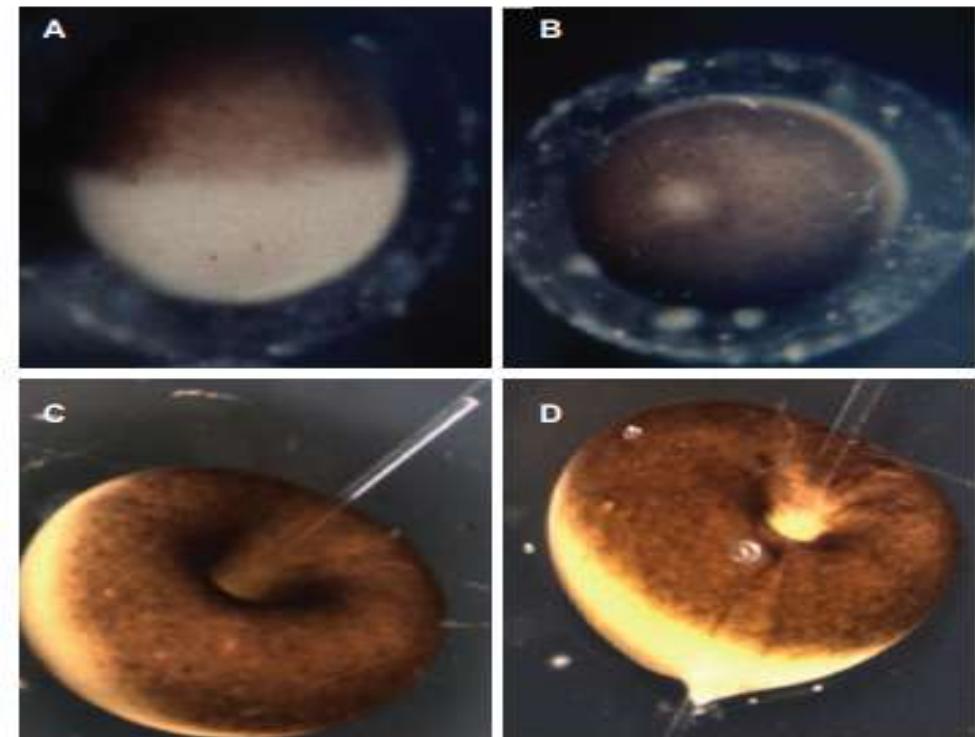


<i>Xenopus laevis</i>	<i>Rana pipiens</i>
South African Origin	European and North American Origin
Responds to mammalian hormones (FSH, LH)	Pituitary Gland Extract
Eggs laid throughout the year	Seasonal (Spring)
Aquatic Frog	Terrestrial
One year life cycle	Four year life cycle
Resistant to many infections	More susceptible to infections

“The Egg and the Nucleus: A battle for Supremacy”



Hypothesis – “Does all cell types in the body have the same set of genes?”



Nobel Prize – 2012 Physiology and Medicine

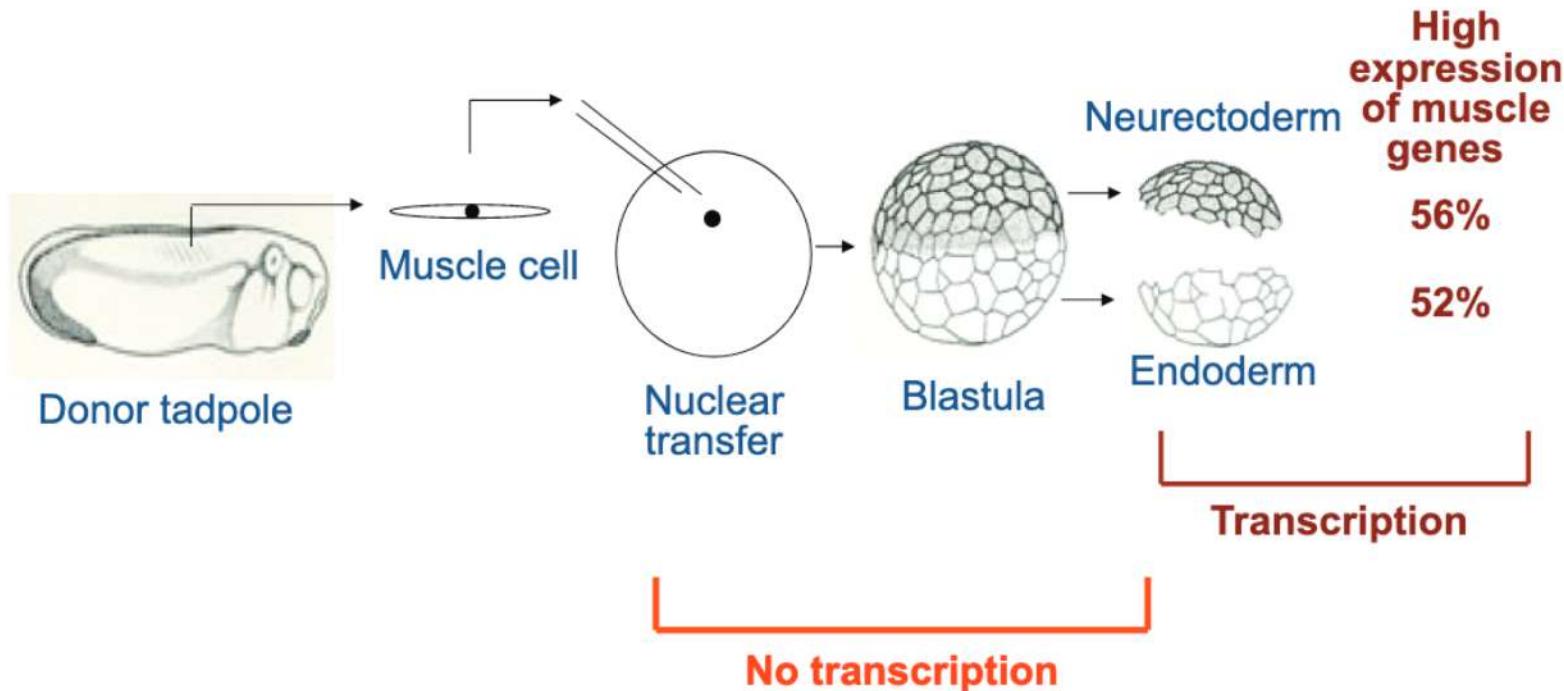


FIGURE 7. Epigenetic memory in nuclear transplant embryos. Nuclear transplant embryos derived from muscle nuclei were grown to the blastula stage, and then depleted of the mesoderm region (muscle lineage). The remaining regions (neurectoderm for nerve/skin cells and endoderm for intestine lineages) express the muscle gene marker MyoD to an excessive extent in about half of all such embryos (Ng and Gurdon 2008).

Sir Martin J Evans

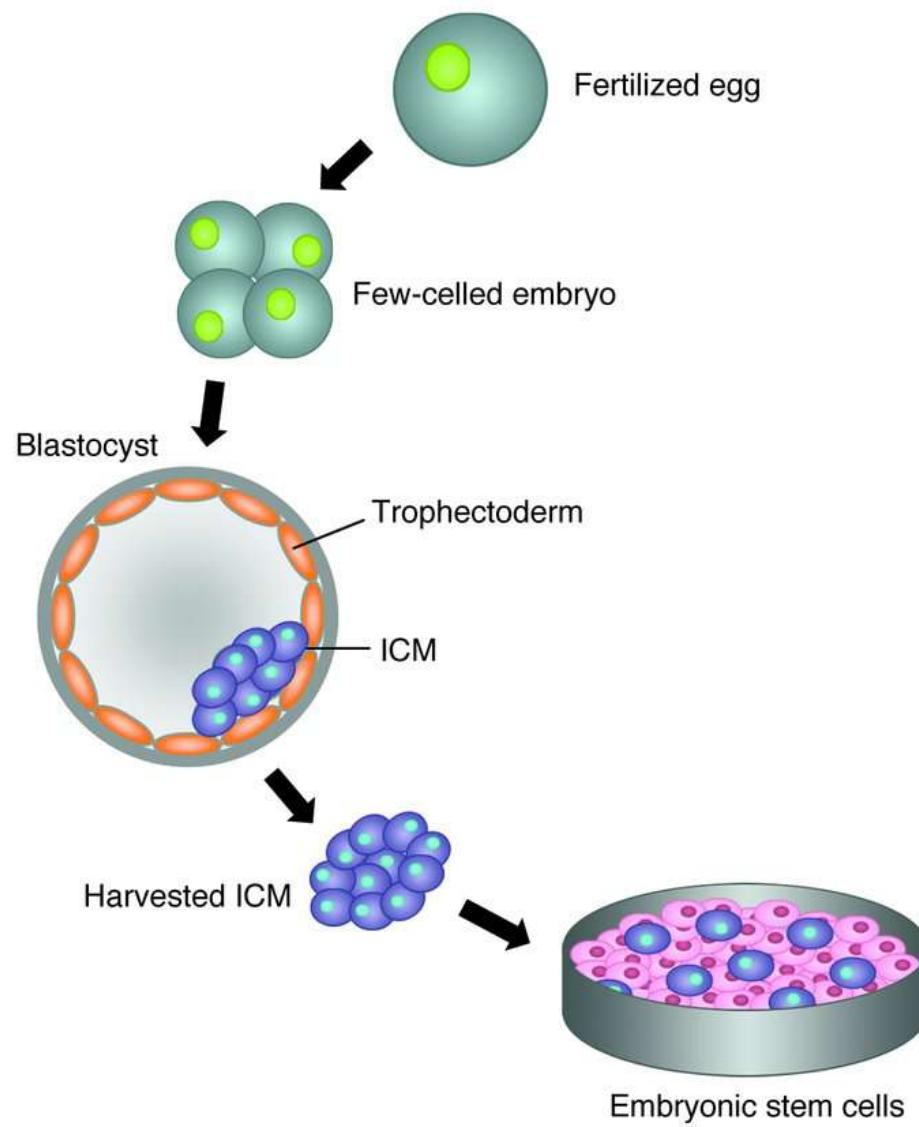


Nobel Prize – 2007 Physiology and Medicine

Embryonic stem cells – vehicles to the mouse germ line

For the discoveries of principles for introducing specific gene modifications in mice by the use of **embryonic stem cells**

Mario R. Capecchi, Martin J. Evans and Oliver Smithies

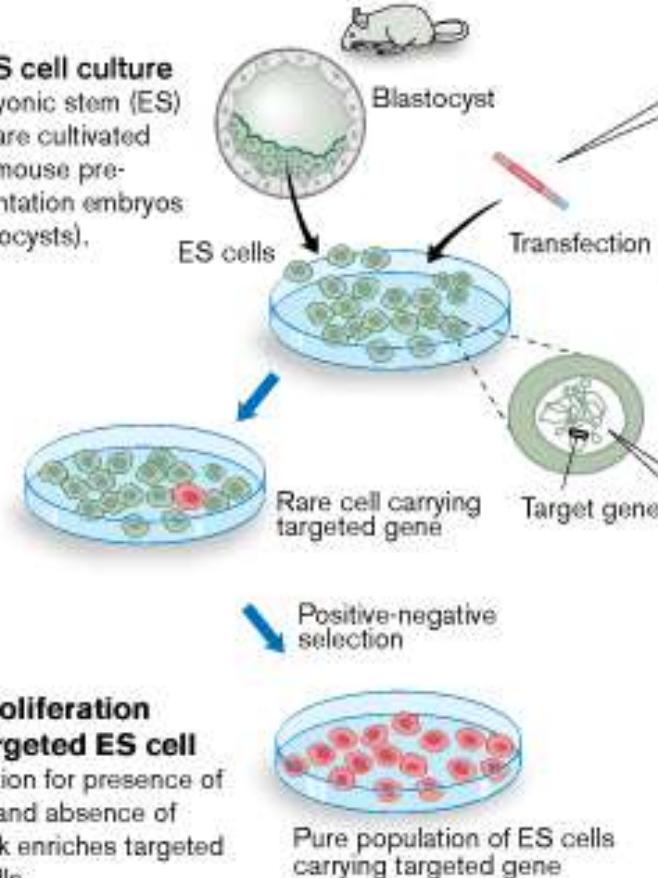


General strategy for gene targeting in mice

Step 1 Gene targeting in ES cells

1. ES cell culture

Embryonic stem (ES) cells are cultivated from mouse pre-implantation embryos (blastocysts).

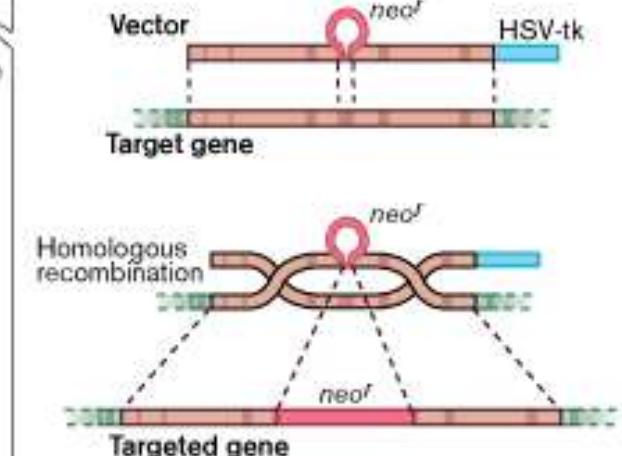


2. Construction of targeting vector

The vector contains pieces of DNA that are homologous to the target gene, as well as inserted DNA which changes the target gene and allows for positive-negative selection.

3. ES cell transfection

The cellular machinery for homologous recombination allows the targeting vector to find and recombine with the target gene.



Mario R. Capecchi, Martin J. Evans and Oliver Smithies

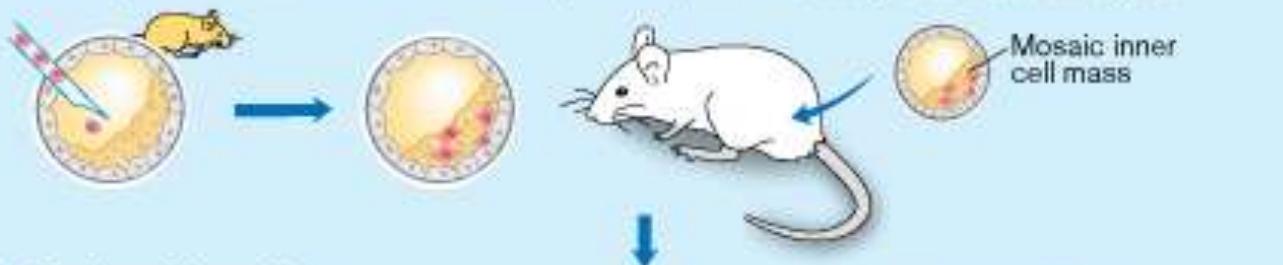
Step 2 From gene targeted ES cells to gene targeted mice

5. Injection of ES cells into blastocysts

The targeted ES cells are injected into blastocysts...

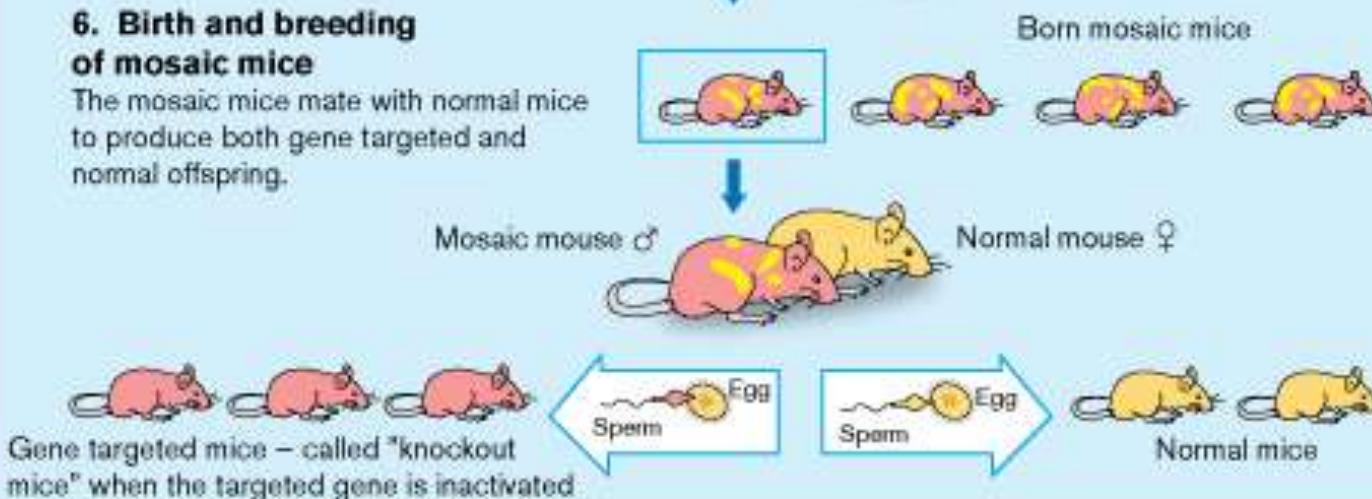
...where they mix and form a mosaic with the cells of the inner cell mass from which the embryo develops.

The injected blastocysts are implanted into a surrogate mother where they develop into mosaic embryos.



6. Birth and breeding of mosaic mice

The mosaic mice mate with normal mice to produce both gene targeted and normal offspring.



© The Nobel Committee for Physiology or Medicine. Illustration: Annika Röhl

Mario R. Capecchi, Martin J. Evans and Oliver Smithies

Nuclear Transfer in Mammals

Took ~40 years, 1996



Dolly – Finn Dorset Eve
Egg donor - Scotting
Black Face

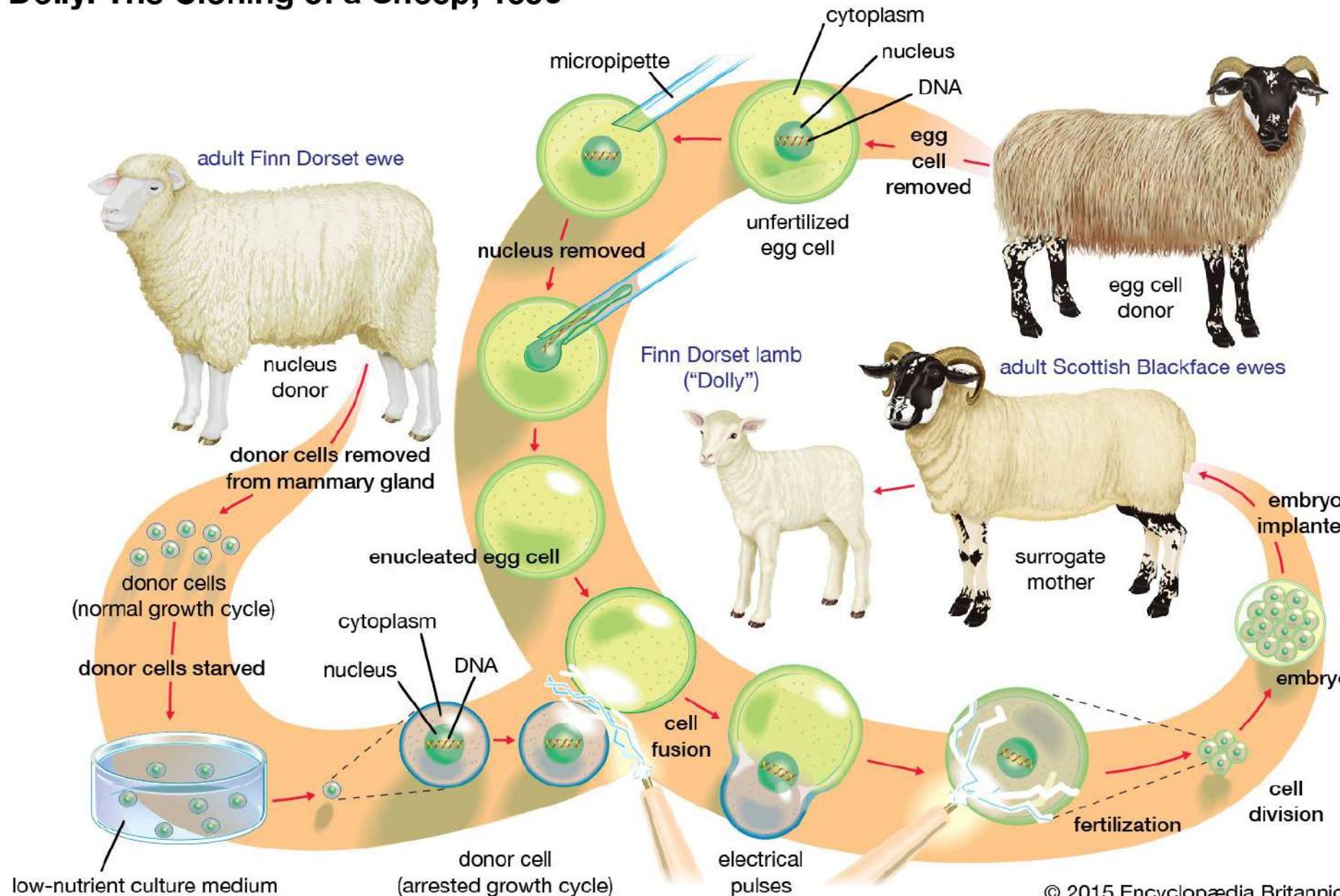


Sir Ian Wilmut



Roslin Institute 22 Feb 1997
3000 Phone Calls

Dolly: The Cloning of a Sheep, 1996

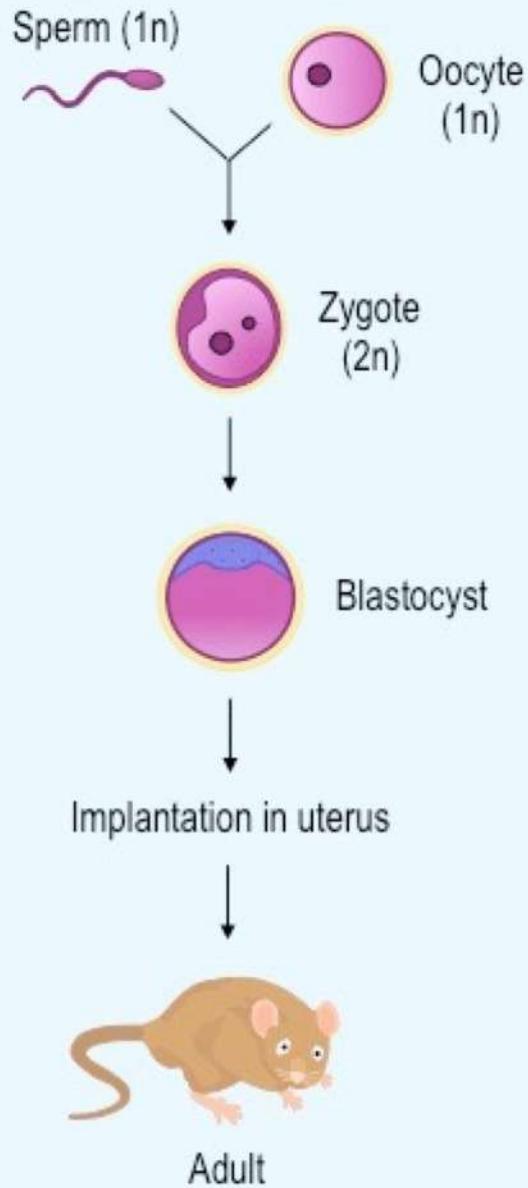


Dolly's Life

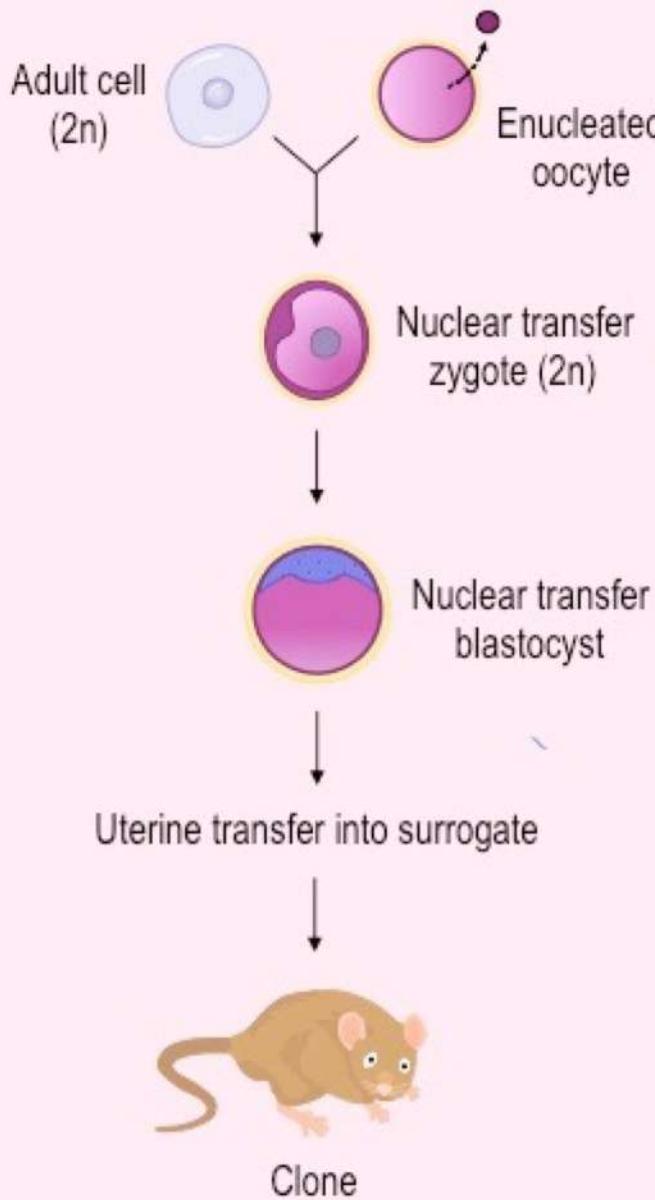
- When Dolly was 1 year Old – Analysis of her DNA showed that her telomeres were shorter than would be expected of that age.
- Dolly could conceive and gave birth to 6 lambs.
- In 2000, lung infection (viral infection)
 - Jaagsiekte Sheep Retrovirus
- 2001 – Diagnosed with arthritis
- 2003 – Tumor in the lungs
- Dolly's body was donated to National Museum Of Scotland Edinburgh



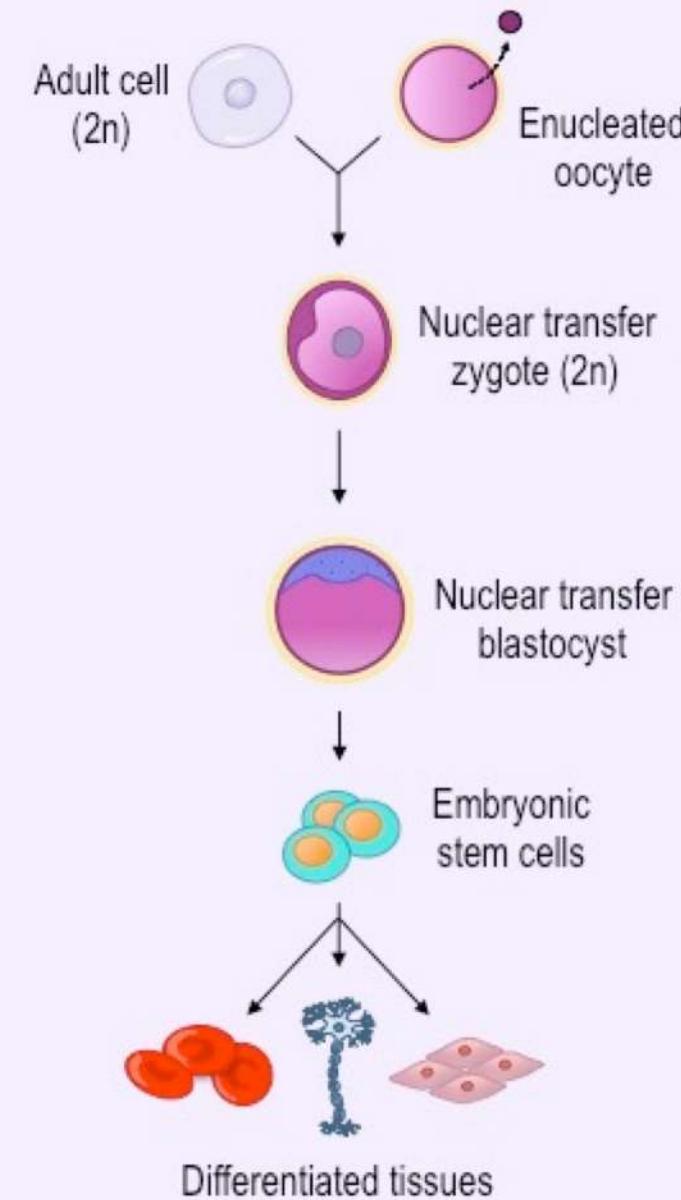
Normal Development



Reproductive Cloning



Therapeutic Cloning



- Stem cells pose a bright future for the therapeutic world by promising treatment options for diseases which are considered as non-curable.
- Holds hope for curing or improving treatments for 70+ diseases

Is Stem Cell Research Ethical?

Embryonic Stem Cells - morally objectionable, because the human embryo must be destroyed during harvest.

Embryonic Germ Cells - morally objectionable when utilizing fetal tissue derived from elective abortions.

Umbilical Cord Stem Cells - morally acceptable, since the umbilical cord is no longer required once the delivery has been completed.

Placentally-derived Stem Cells - morally acceptable, since the afterbirth is no longer required after the delivery has been completed.

Adult Stem Cells - morally acceptable.

Should stem cell research continue?

- If the government doesn't fund research in this area, private sectors will certainly pursue stem cell research. Private sector research is market driven and not government-regulated.

Ethical arguments The use of human embryos

43

IS AN EMBRYO HUMAN?



'Lines that Divide'



Ethical Arguments....

46

- Is it morally right?
 - Why do the embryos have to be destroyed for stem cell research? Isn't this the same as taking a life?
 - Will embryo farms will be around the corner?
 - Will organs be produced as per your specification?
 - Why do we need to keep using embryos in research when we have new IPS cells?
 - Could women be forced to sell eggs/ embryos for research?
 - Won't doing therapeutic cloning lead to cloning humans?
- ARE HUMAN PLAYING GOD?



Are human playing as God?



Ethics



How far can we go with this?

Is it morally right?

The two of us?
There'll always be
Just you and me—
The two of us!



RELIGIOUS ISSUES

"Only God has the power to create human life." *Human cloning*

"Playing God"

Some people believe that cloning is similar to playing God. They believe that God should be the creator of all living and natural things.



"Reverence for life"

It is believed that a human has the right for the full human development in a natural environment and that the human embryo should be left alone after the 14th day of fertilization.

God is the Creator of all life. Period.
and His alone!!!!!! *Human cloning*

"Not Unique"

People believe human cloning takes away from an individual being unique and stresses psychological and social development *Human cloning*

"No Soul"

Some religious people believe that if you clone a human being it has no soul. *Human cloning*

"The breath of life is given to us by God - not by scientists splicing genes in a lab."

"Human cloning is wrong to play God."

References:

- Essentials of Stem Cell Biology, 2013, Edt: Robert Lanza, Anthony Atala, Academic Press.
- Stem Cells: From Basic Research to Therapy, Federico Calegari, Claudia Waskow, CRC Press, 2014.
- Stem Cells and Cloning (2nd Edition): Kelly M Hogan, Michael A. Palladino

<http://www.nature.com/news/human-stem-cells-created-by-cloning-1.12983>

<http://www.eurostemcell.org/films>

Publications

Reviews and Papers (will be cited on the slide)