Lecture 14

BT 632
Stem Cells, Cancer and Therapy
(3-0-0-6)

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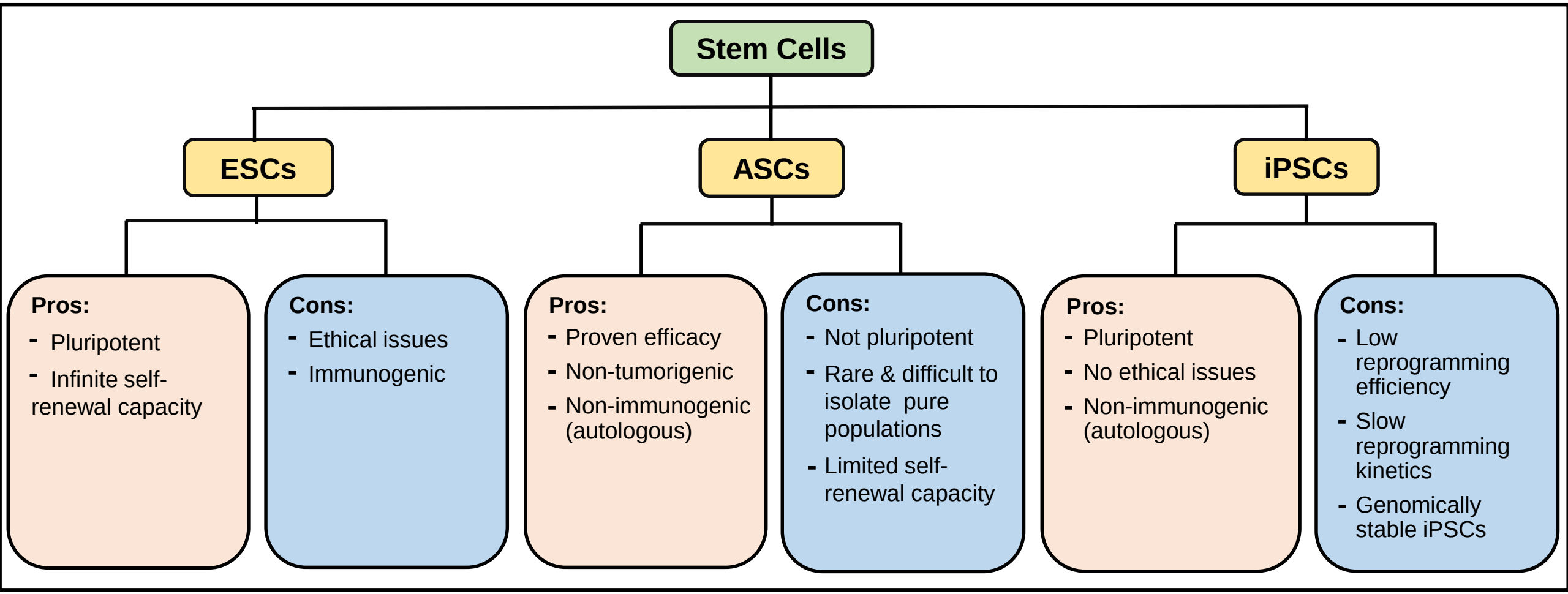
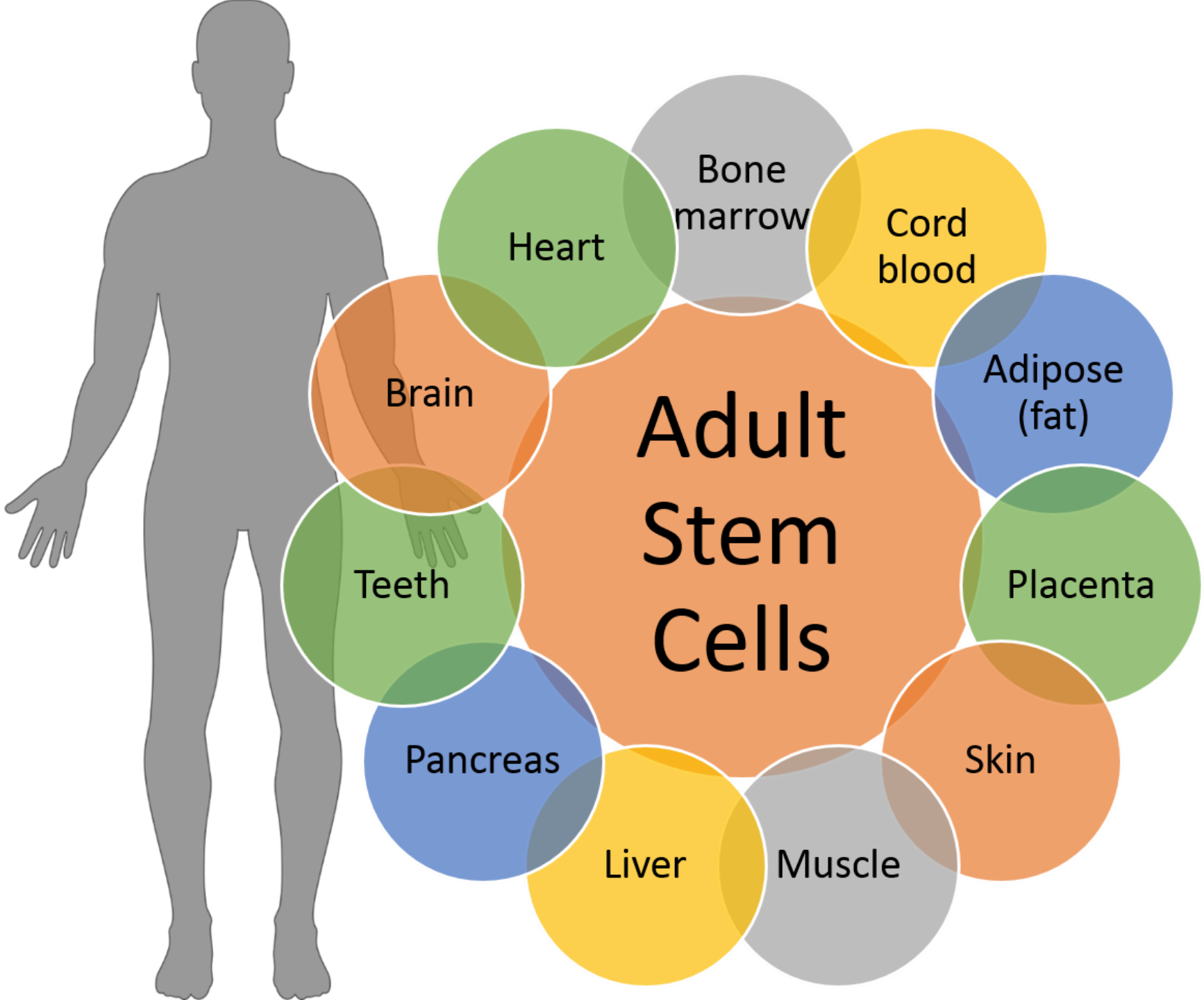
Types of stem cells

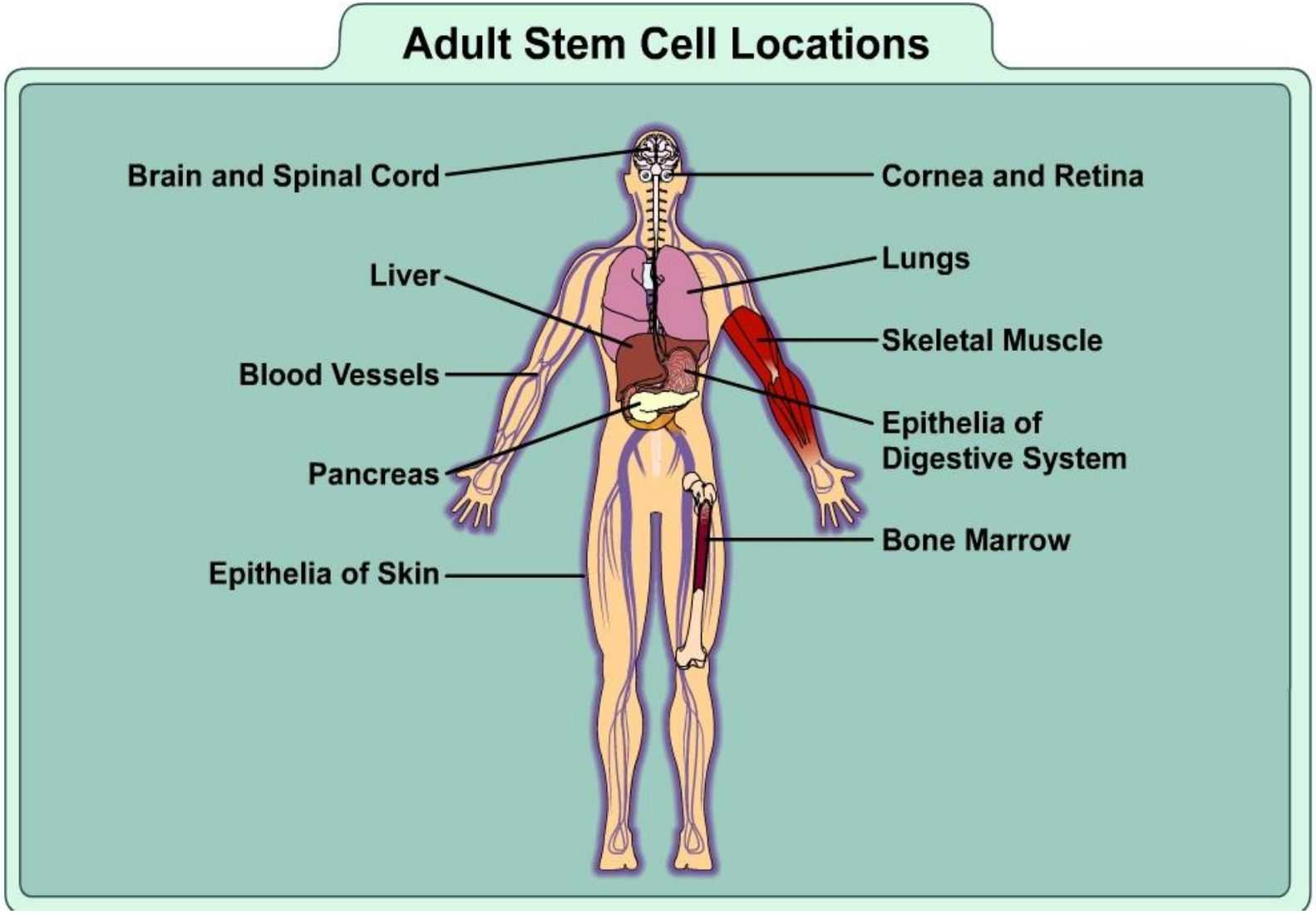


Saha B, …, **Thummer RP** (**2018**) Prospective applications of Induced Pluripotent Stem Cells in Military Medicine. Med J Armed Forces India. 74(4): 313-320.

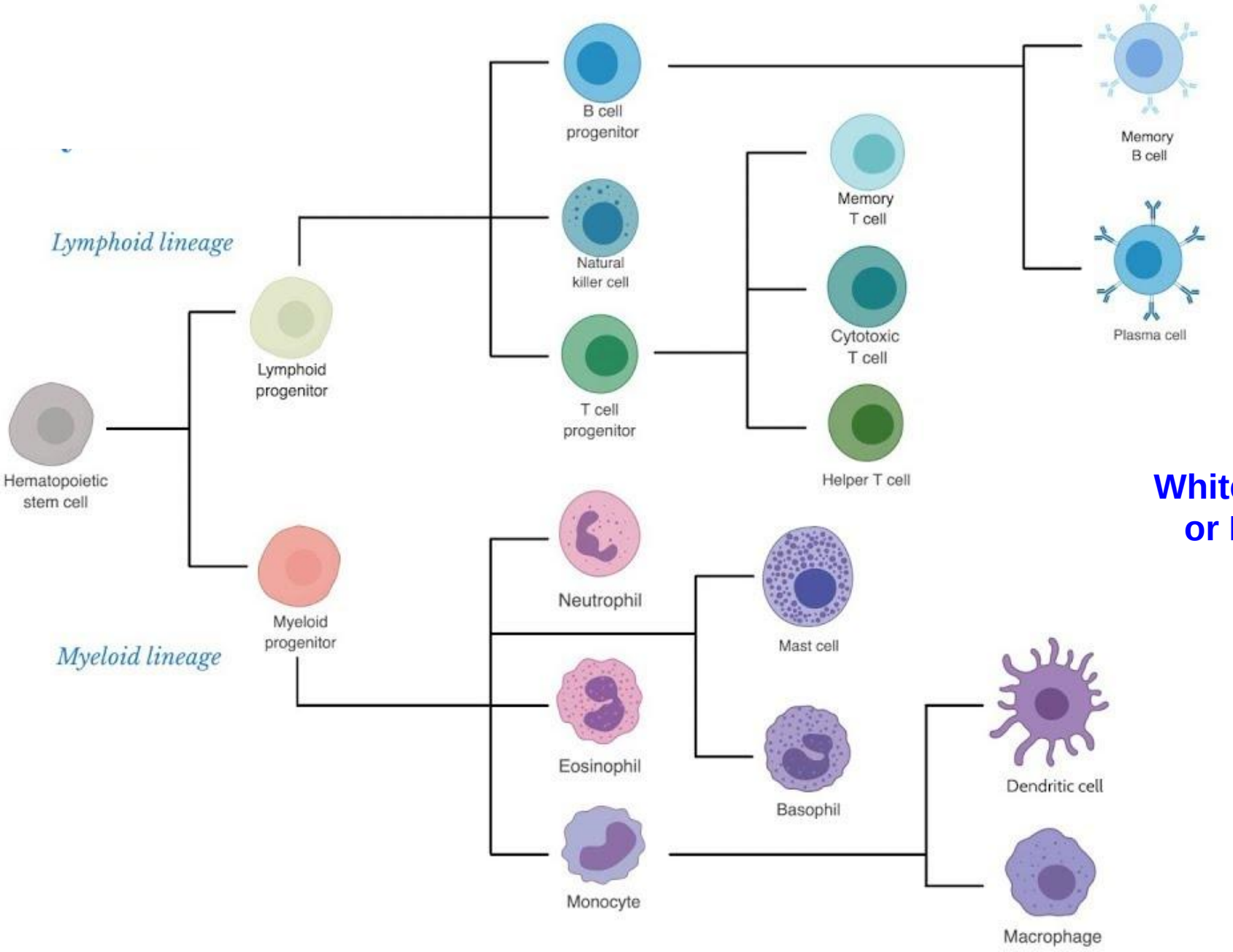
Adult Stem Cells


Bone marrow
Heart
Cord blood
Brain
Adipose (fat)
Adult Stem Cells
Teeth
Placenta
Pancreas
Skin
Liver
Muscle

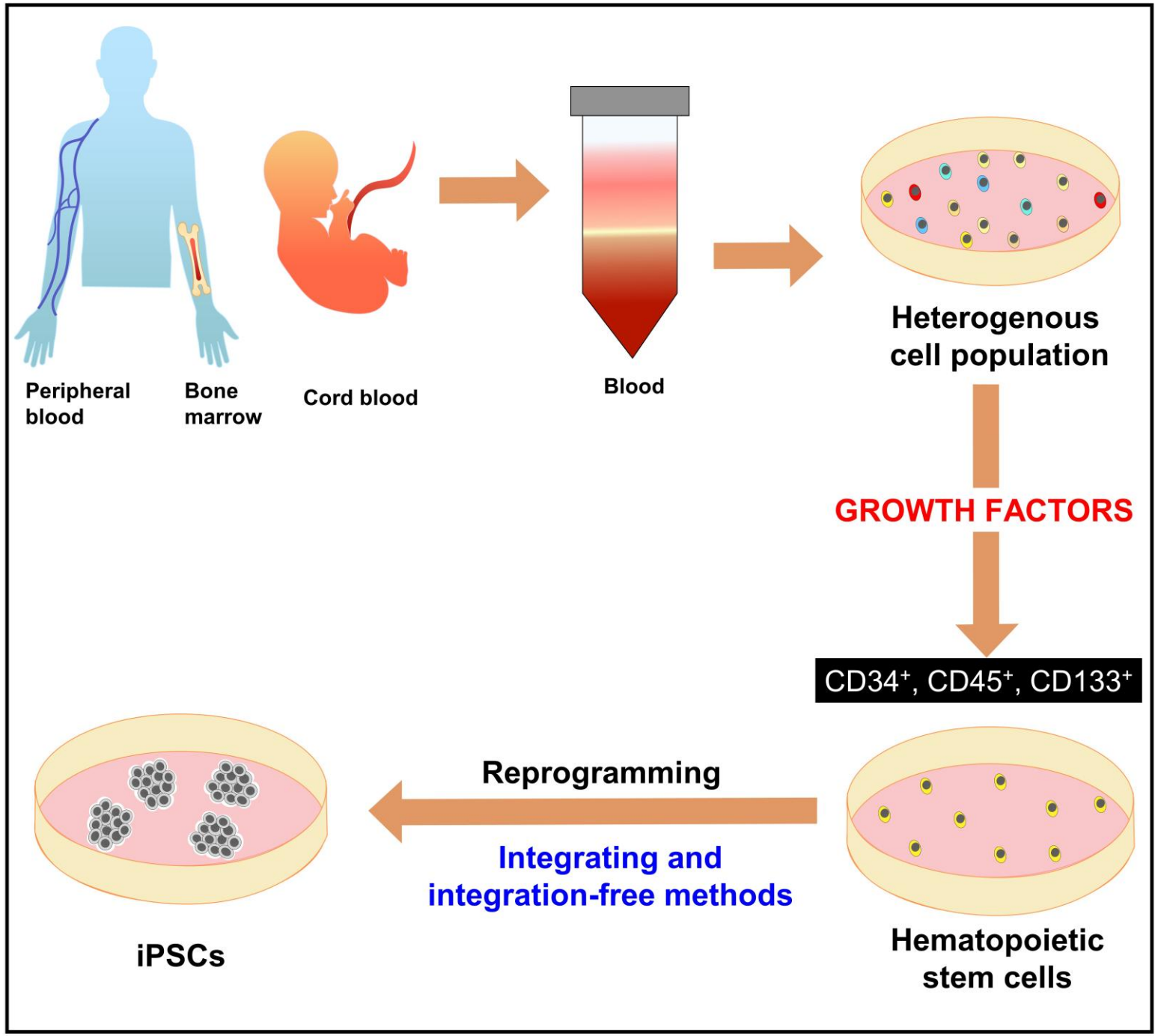
Adult stem cells
(most common)



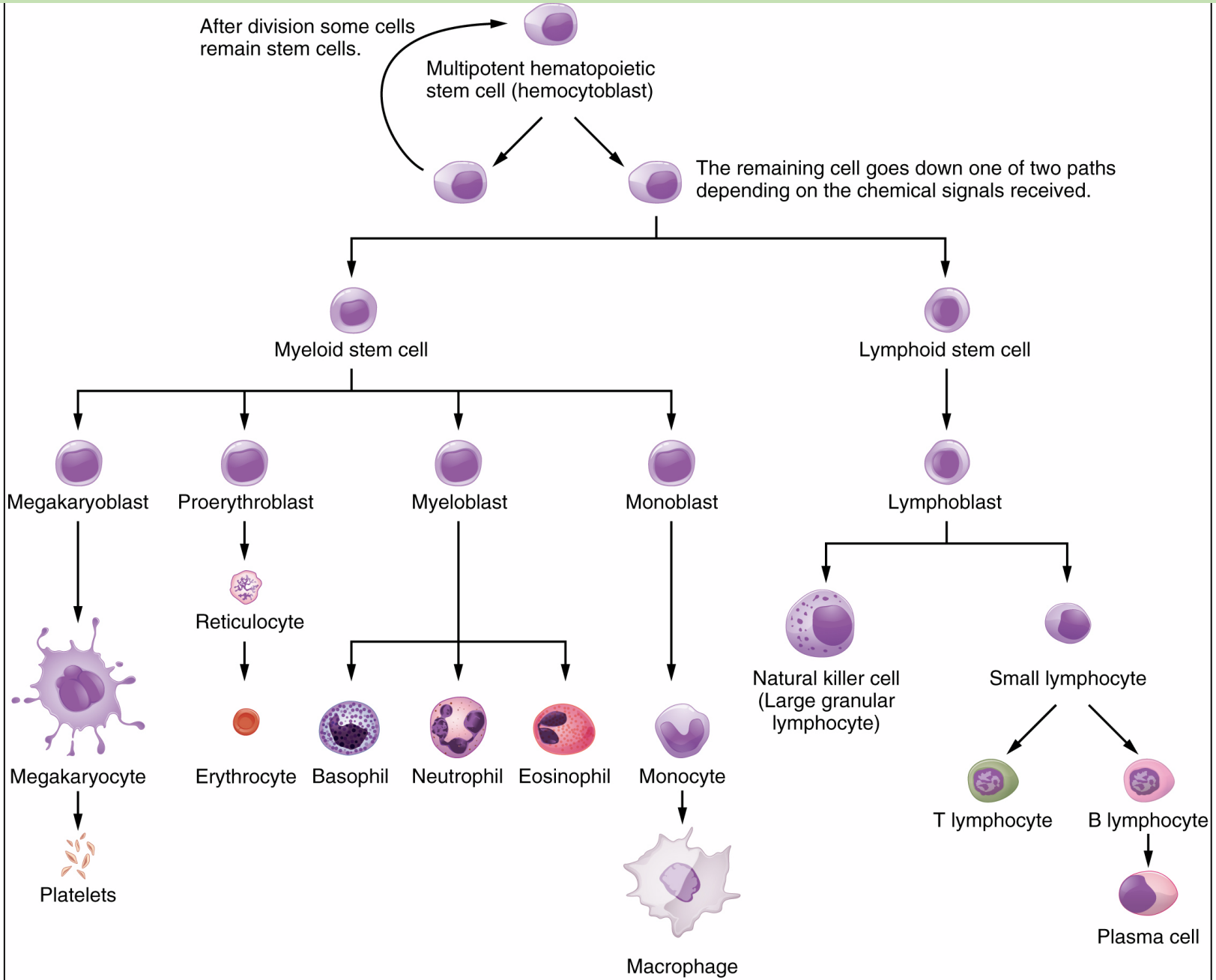
Hematopoietic Stem Cells (HSCs) Differentiation



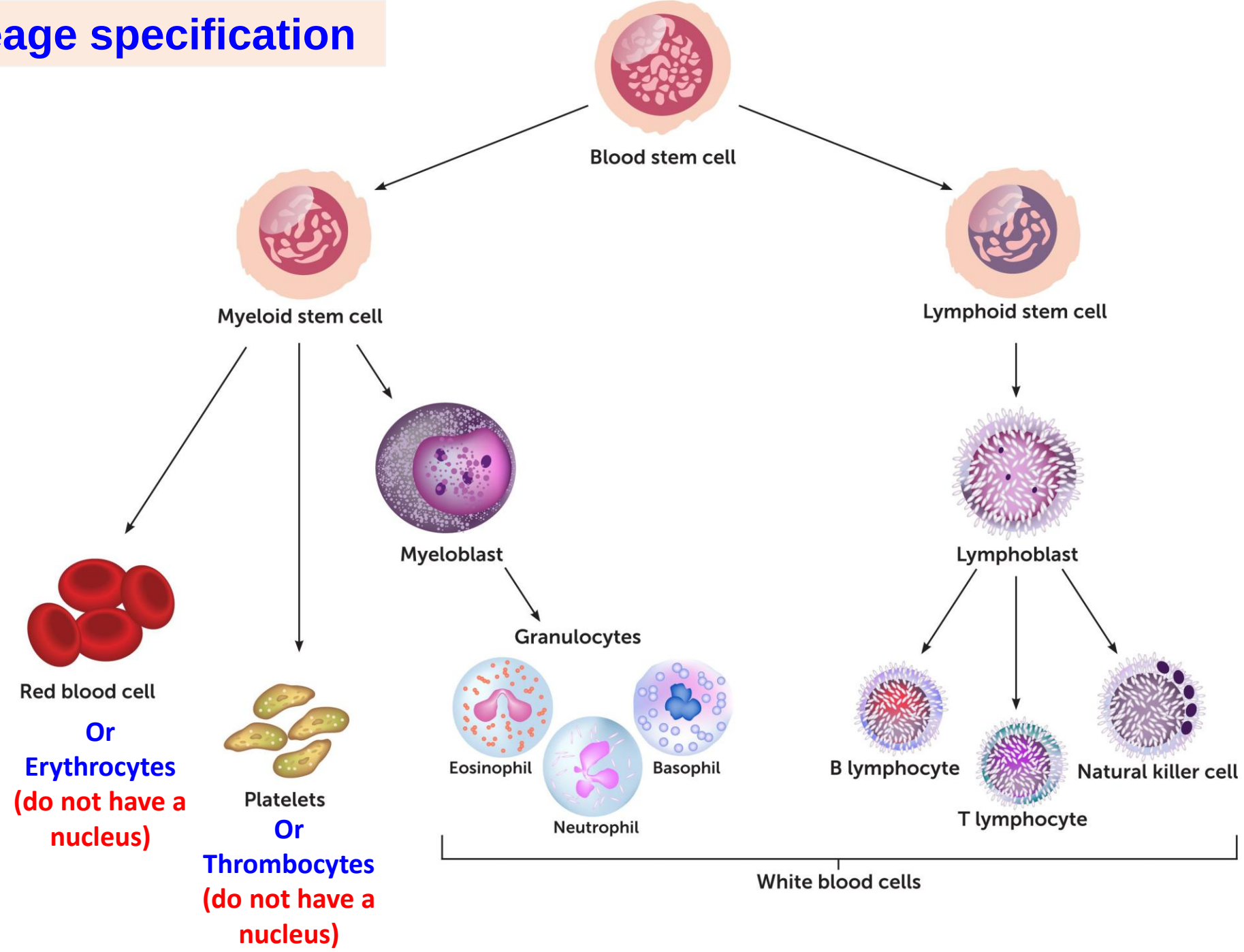
White Blood Cells or Leuckocyte


Peripheral blood
Bone marrow
Cord blood
Blood
Heterogenous cell population
GROWTH FACTORS
CD34+, CD45+, CD133+
Hematopoietic stem cells
Reprogramming
Integrating and integration-free methods
iPSCs

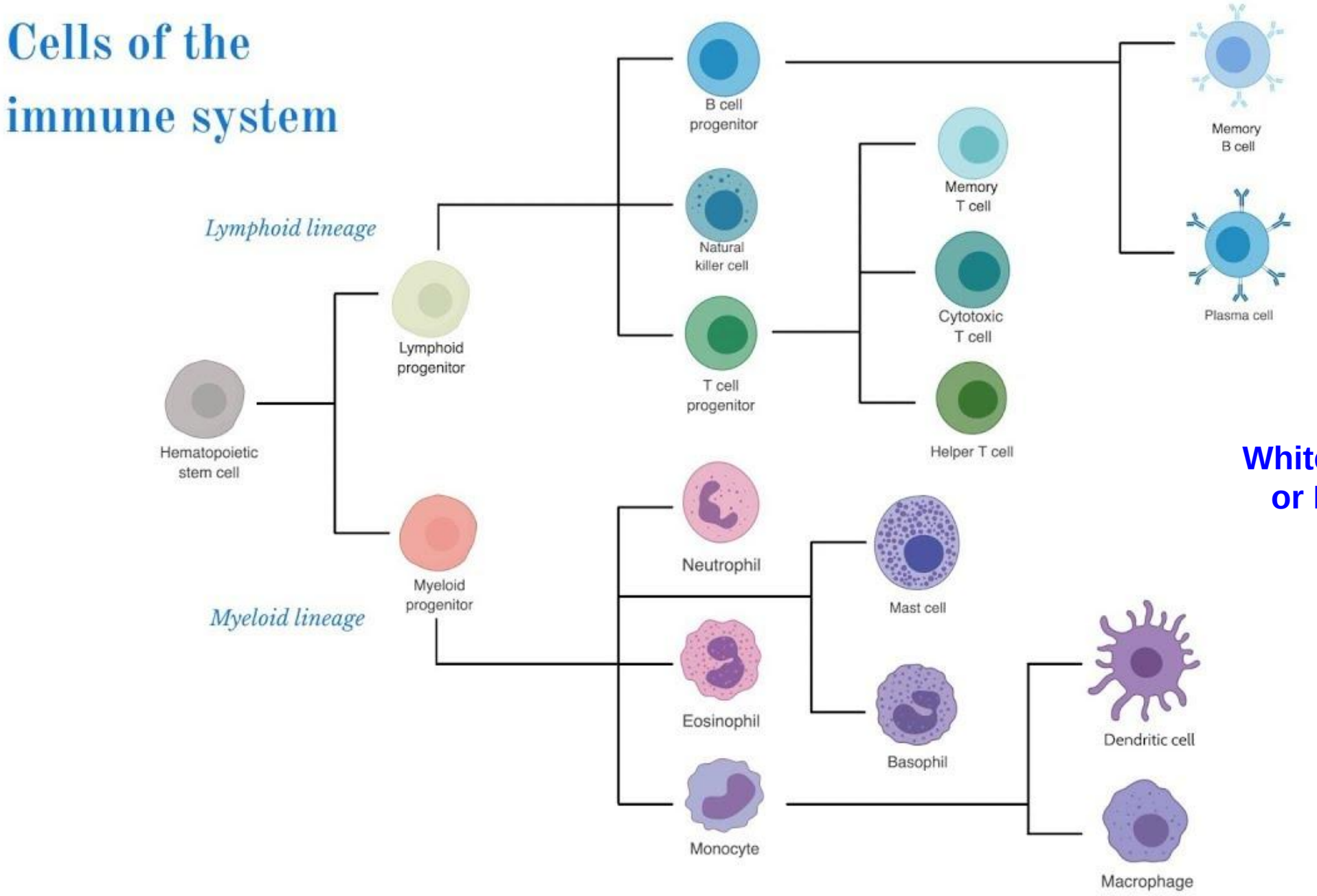
Isolation of adult stem cells



Blood lineage specification

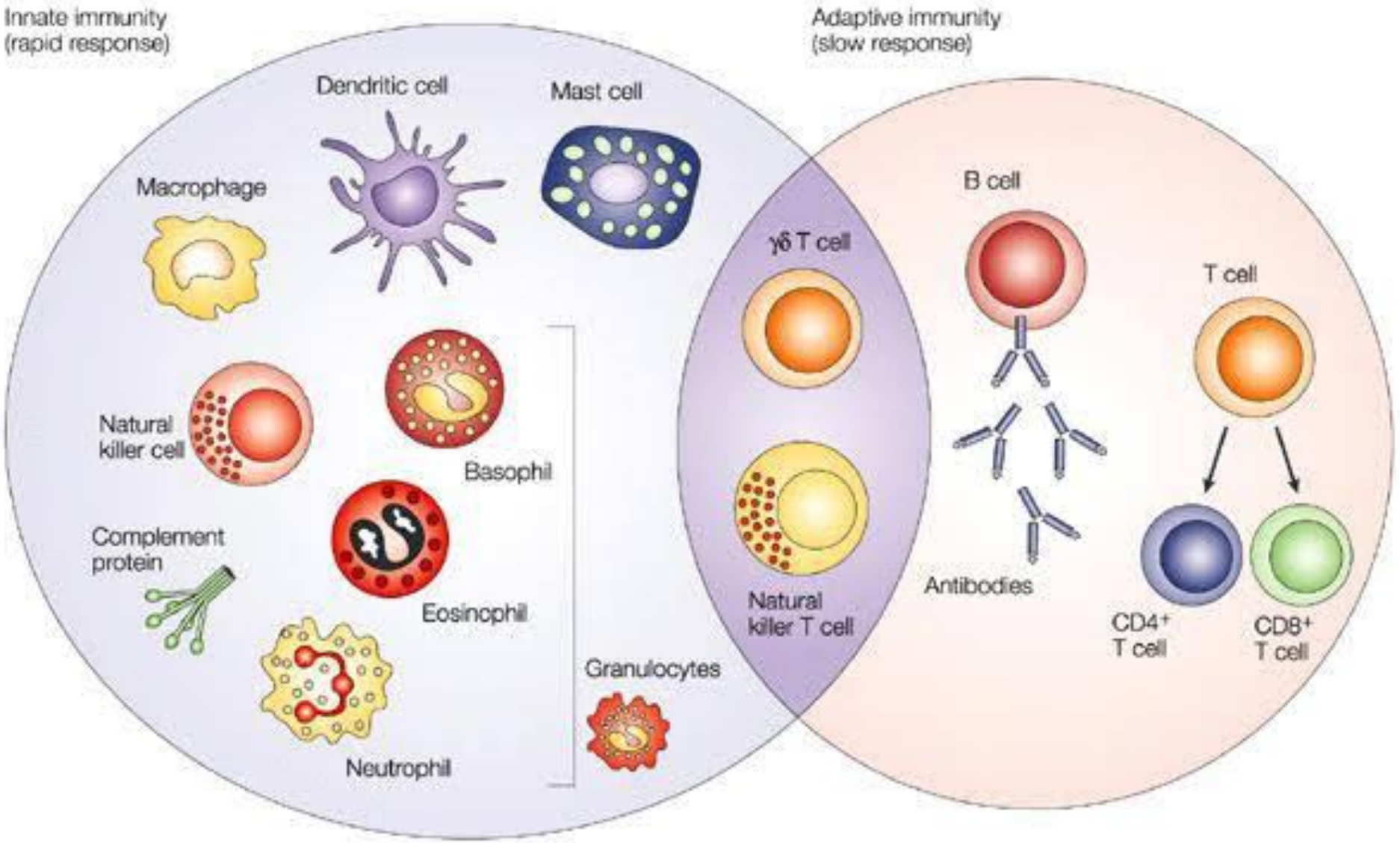


Components of the Immune System – Immune Cells

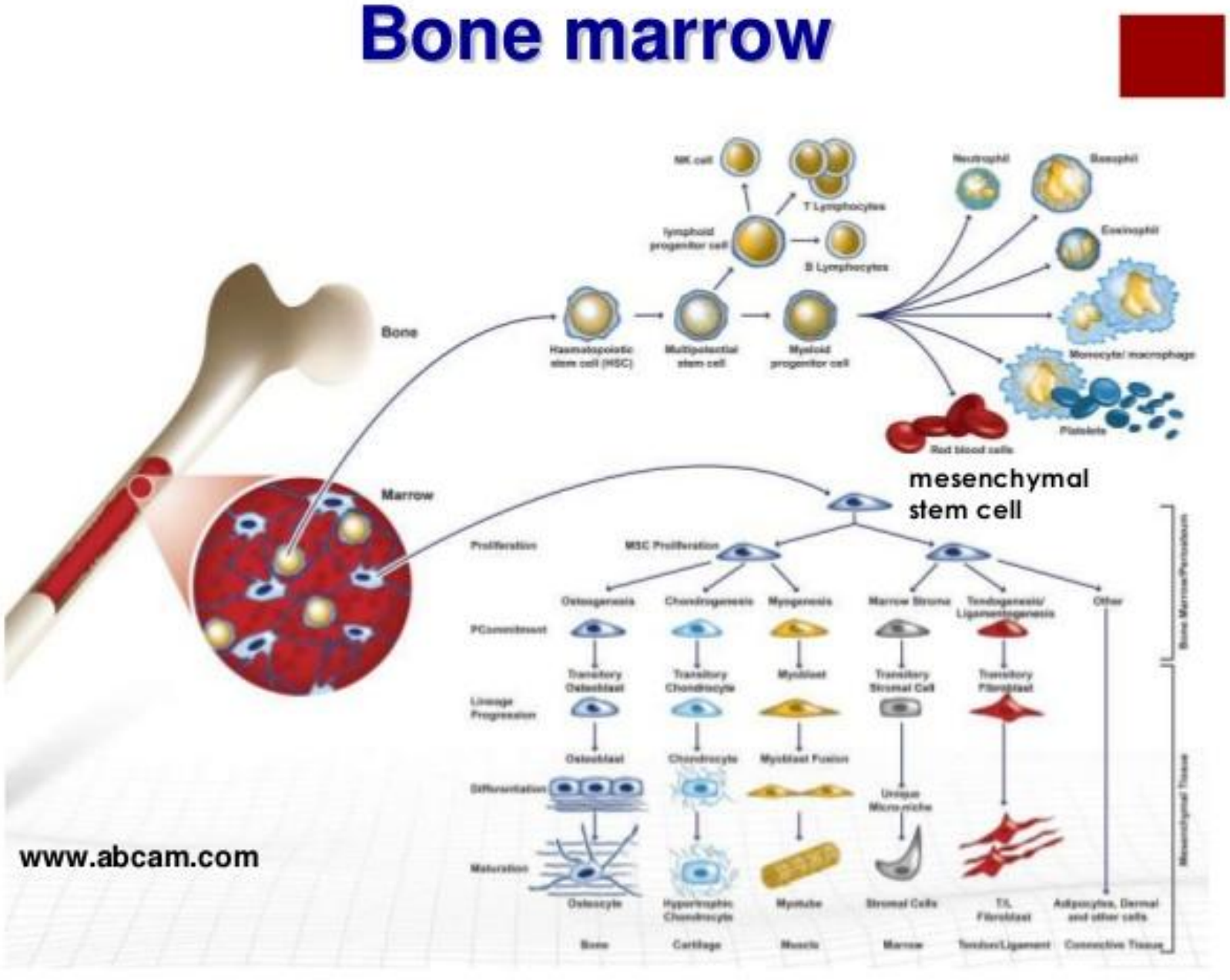


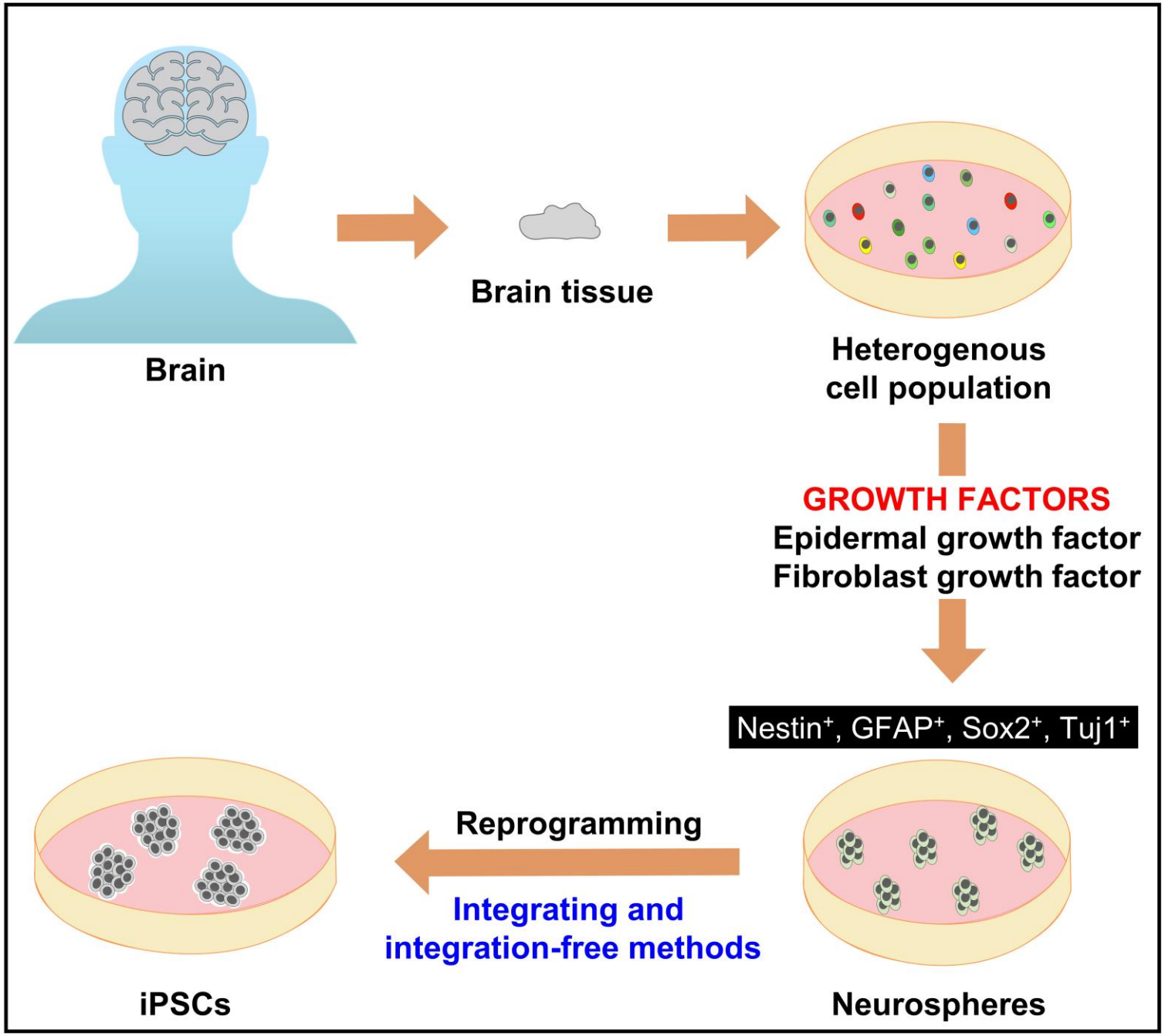
White Blood Cells or Leuckocyte

Innate vs Adaptive Immunity

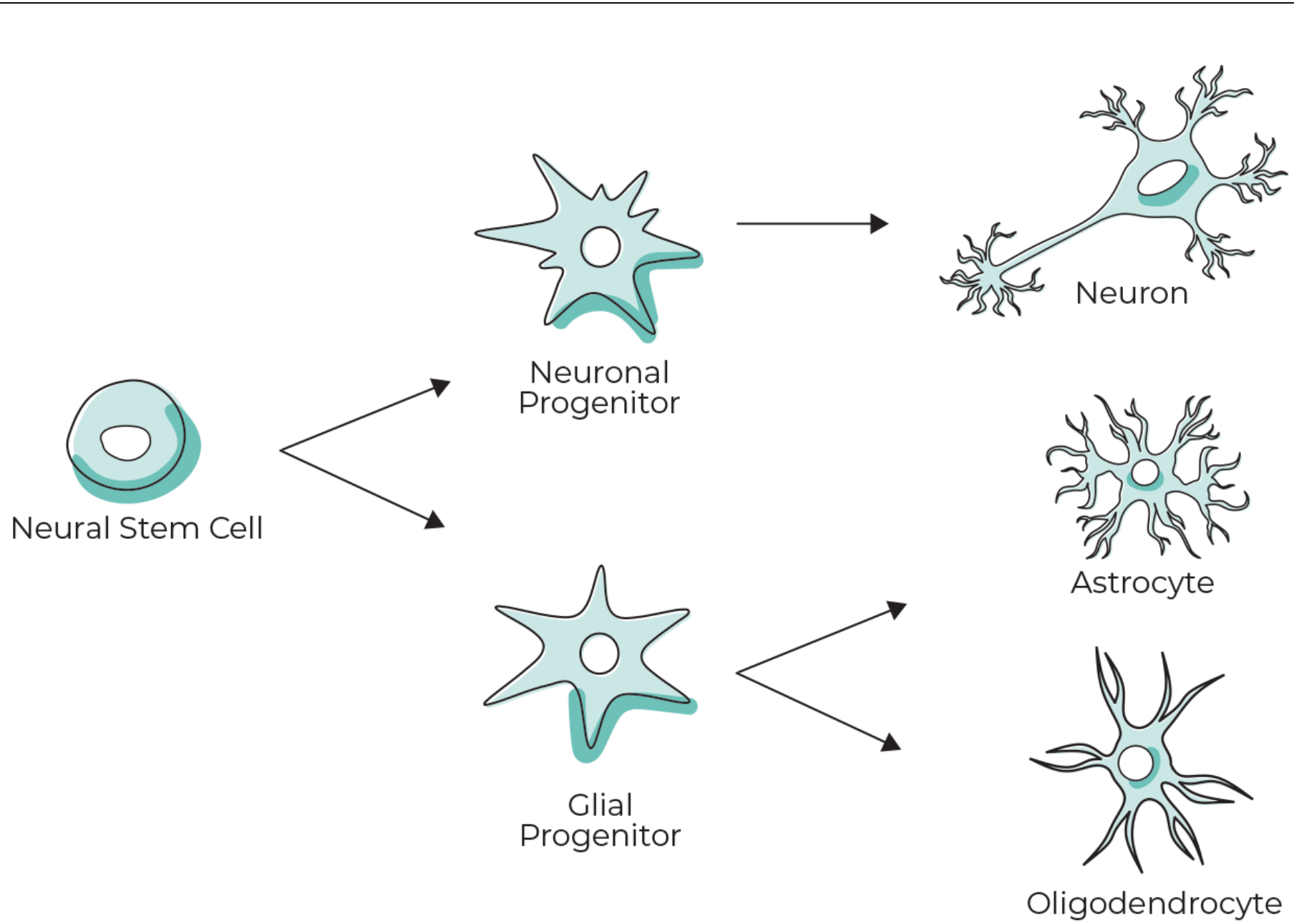


Isolation of adult stem cells

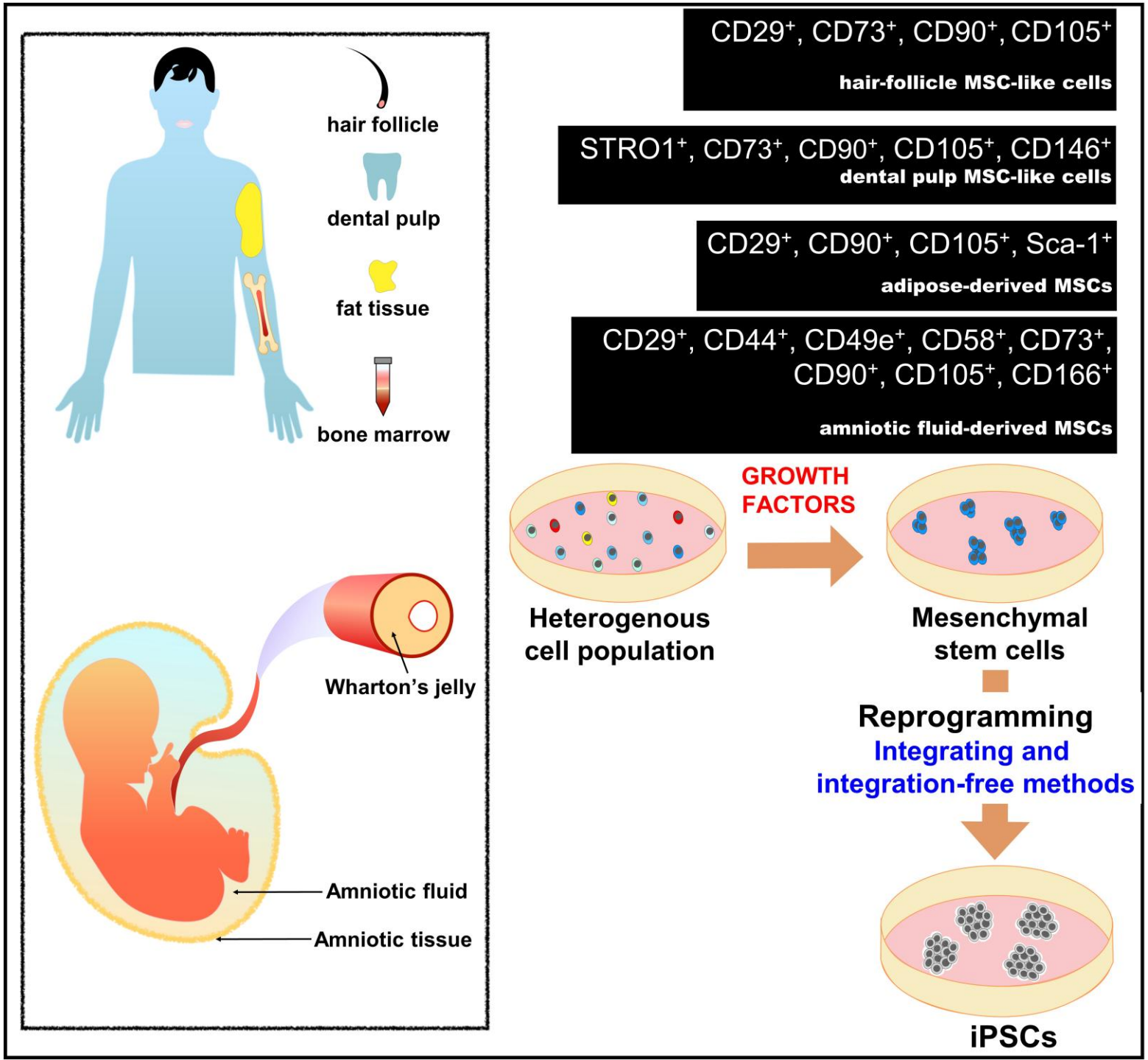



Brain
Brain tissue
Heterogenous
cell population
GROWTH FACTORS
Epidermal growth factor
Fibroblast growth factor
Nestin+, GFAP+, Sox2+, Tuj1+
Neurospheres
Reprogramming
Integrating and
integration-free methods
iPSCs

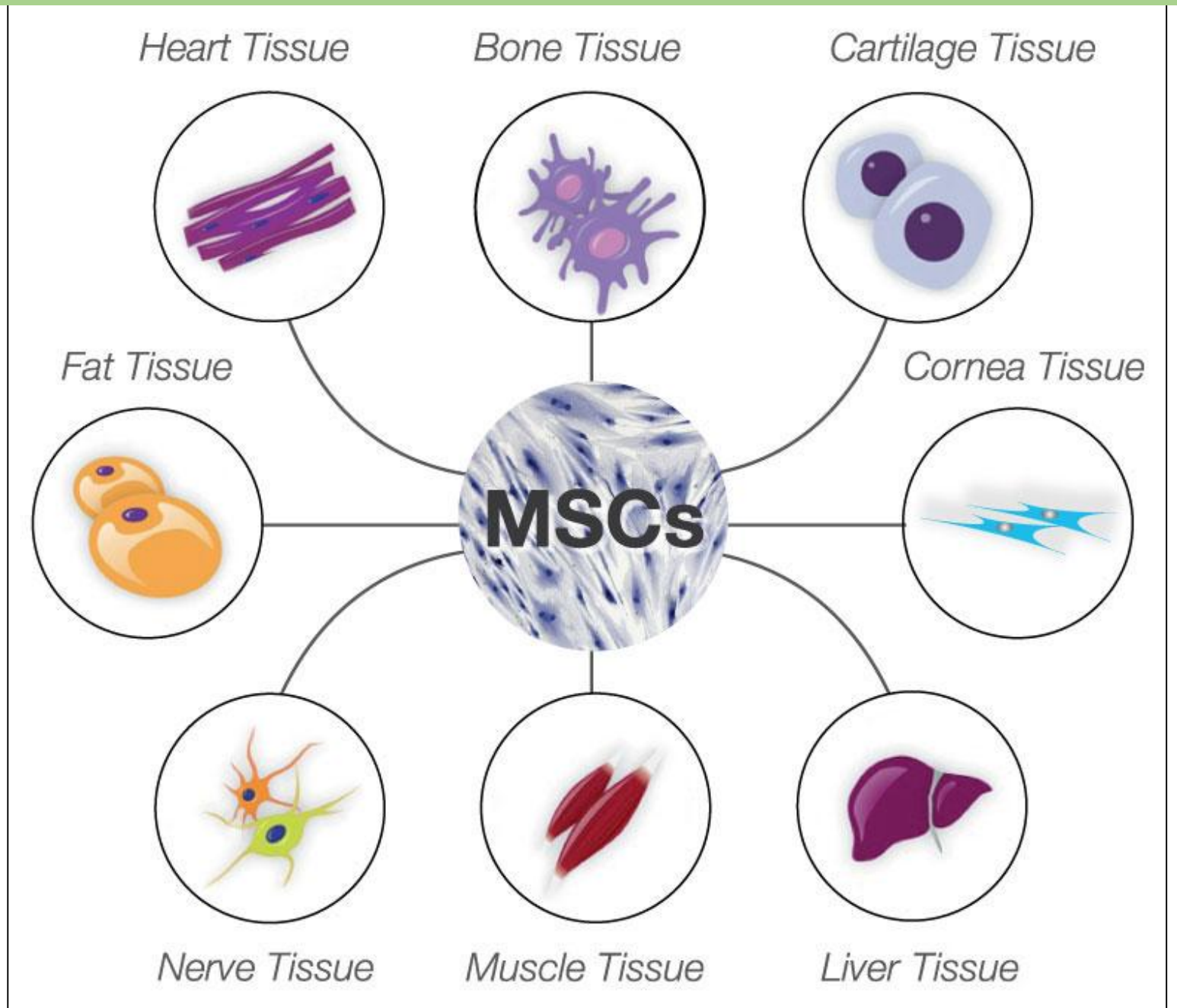
Neural Stem Cells (NSCs) Differentiation



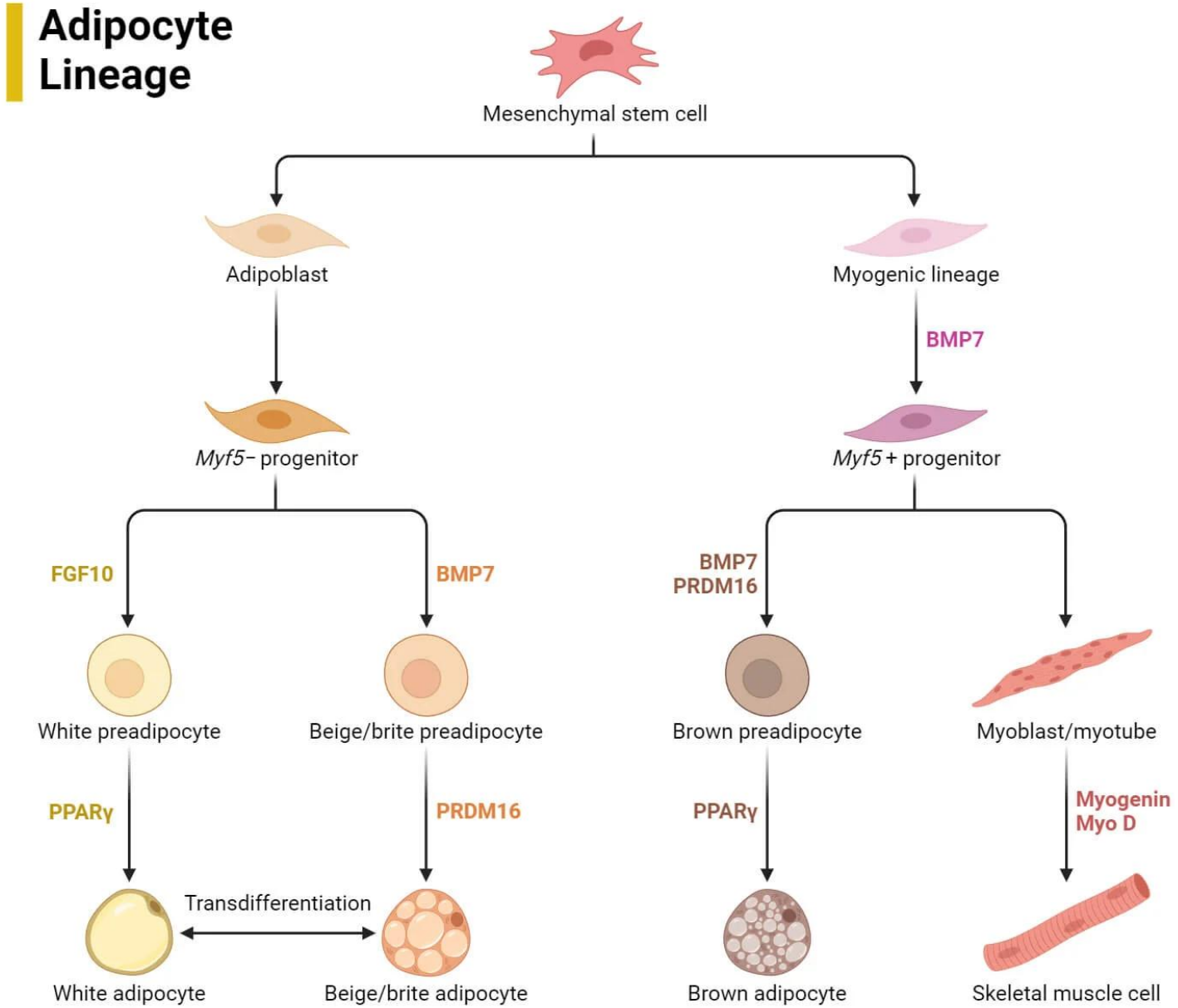
https://captivatebio.com/what-are-neural-stem-cells/

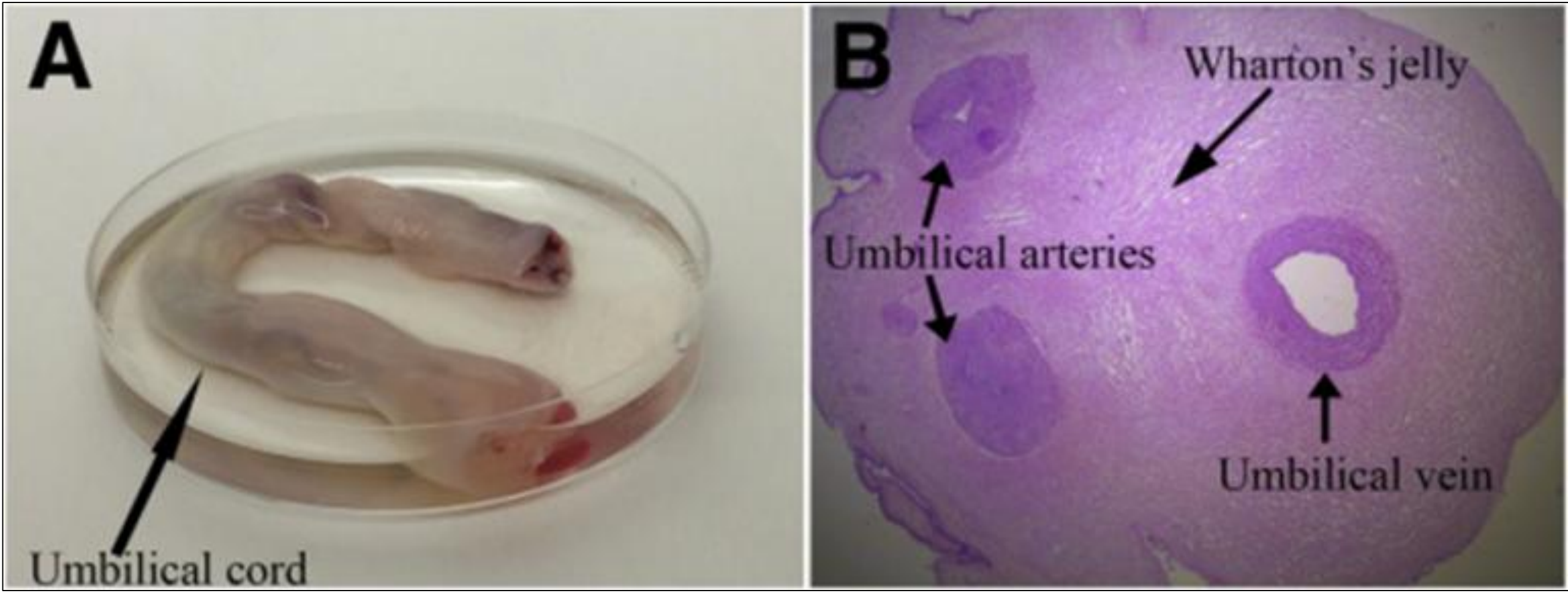

hair follicle
dental pulp
fat tissue
bone marrow
Wharton's jelly
Amniotic fluid
Amniotic tissue
CD29+, CD73+, CD90+, CD105+
hair-follicle MSC-like cells
STRO1+, CD73+, CD90+, CD105+, CD146+
dental pulp MSC-like cells
CD29+, CD90+, CD105+, Sca-1+
adipose-derived MSCs
CD29+, CD44+, CD49e+, CD58+, CD73+, CD90+, CD105+, CD166+
amniotic fluid-derived MSCs
GROWTH FACTORS
Heterogenous cell population
Mesenchymal stem cells
Reprogramming
Integrating and integration-free methods
iPSCs

Mesenchymal Stem Cells (MSCs) Differentiation



Mesenchymal Stem Cells (MSCs) Differentiation




A
Umbilical cord
B
Wharton's jelly
Umbilical arteries
Umbilical vein

Article | Full-text available

July 2012 · Bio-medical Materials and Engineeri... 22(4):243-54

DOI: 10.3233/BME-2012-0714

Source · PubMed

Mesenchymal stem cells derived from Wharton's jelly: Comparative phenotype analysis between tissue and in vitro expansion

Talar Margossian · Loic Reppel · Nehman Makdissy · Show all 6 authors · Céline Huselstein

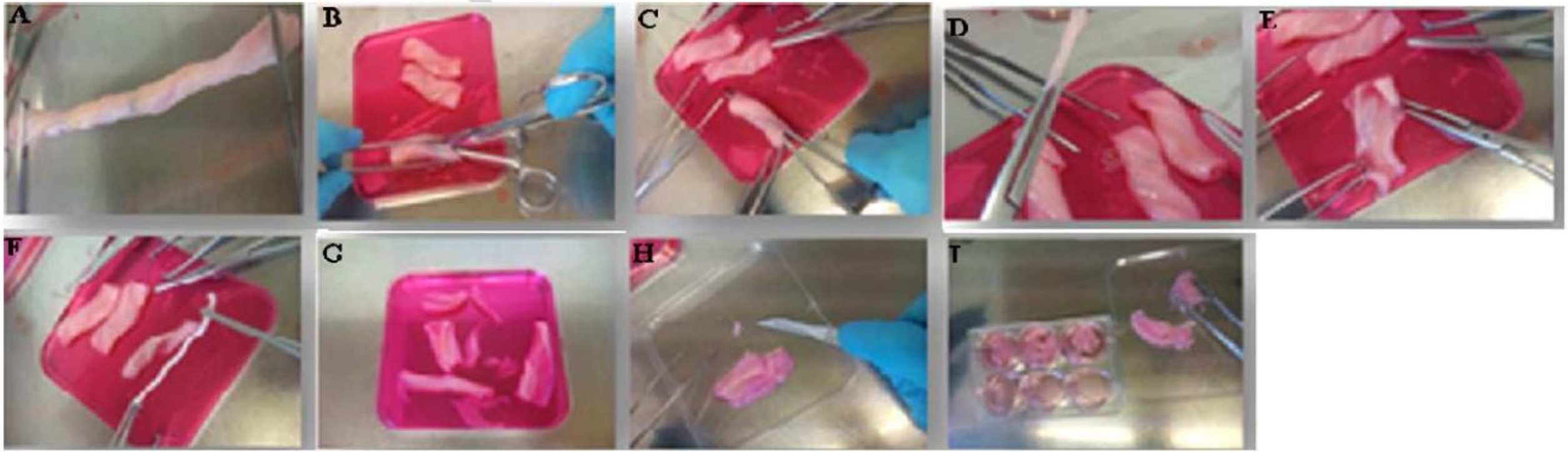
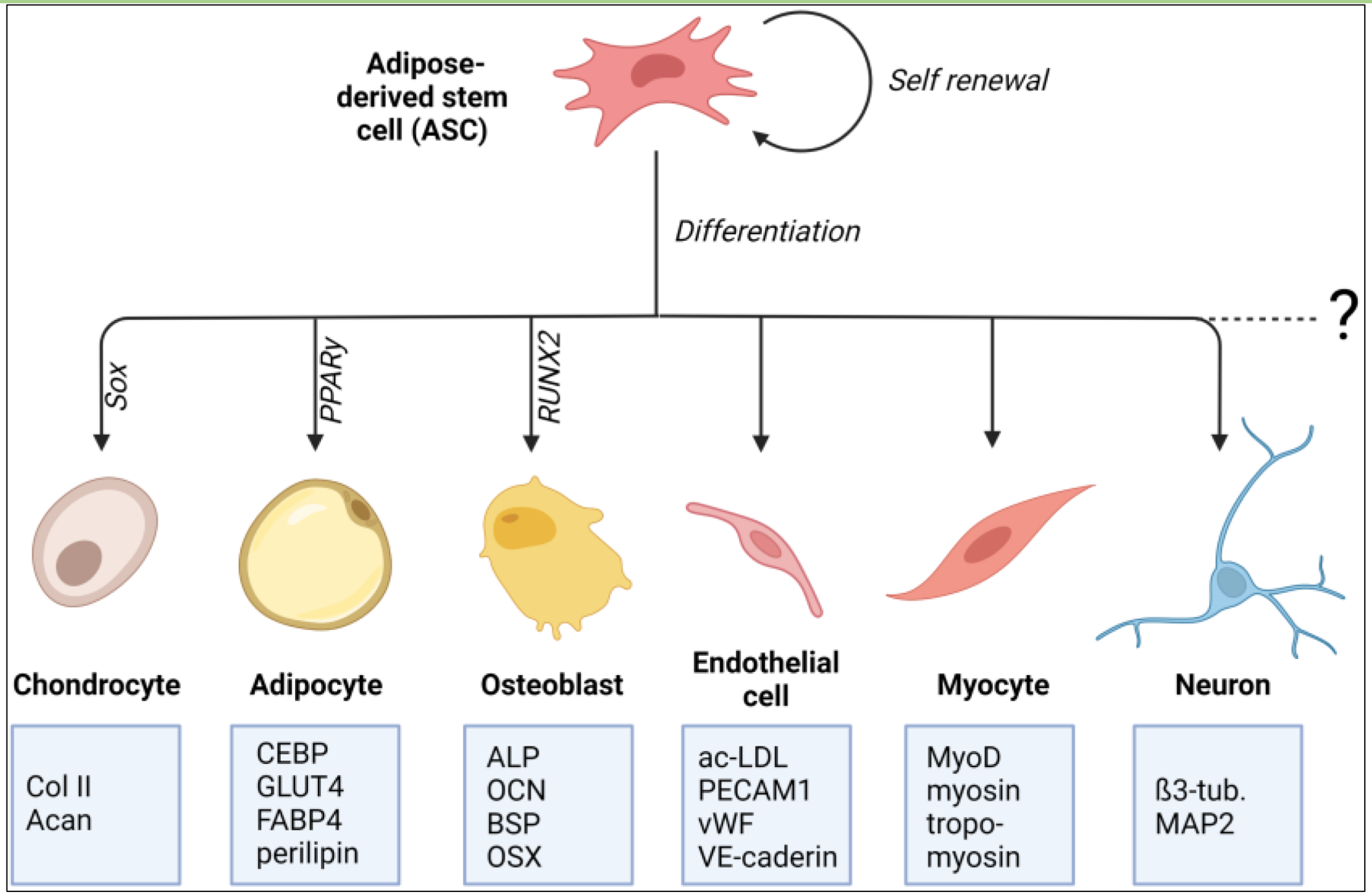
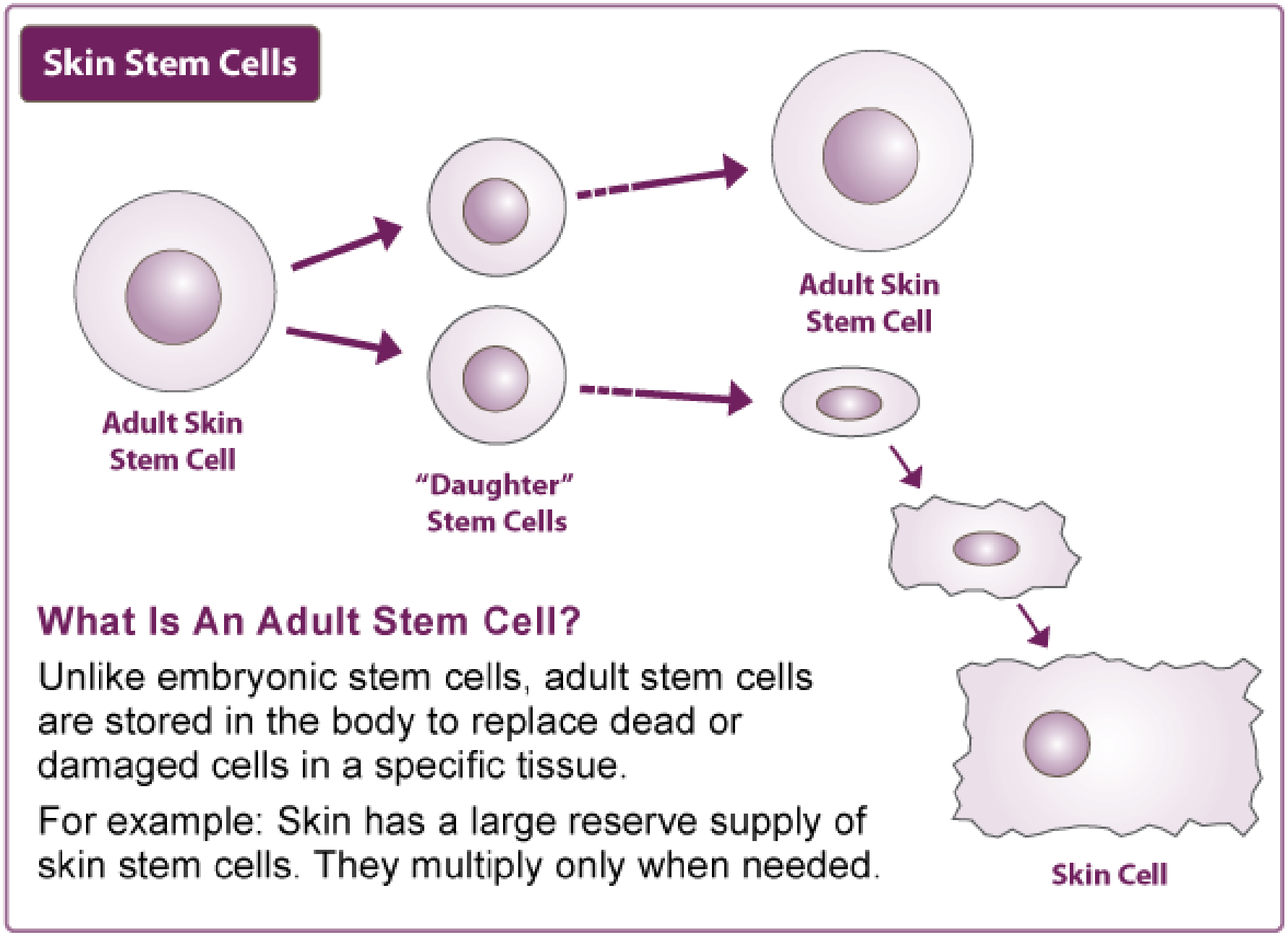


Fig. 1. Isolation of Wharton's jelly from human umbilical cord. (A) Cord removed from T75 flask and washed with alcohol. (B) Insertion of the clamp into the umbilical vein. (C) Longitudinal incision in the wall of the cord. (D and E) Detachment of the umbilical vein. (F) Withdraw of umbilical arteries. (G) Pieces of Wharton's jelly after removal of arteries and vein. (H) Cut into small pieces of 2–3 mm. (I) Distribution of pieces in six well plates. (Colors are visible in the online version of the article; http://dx.doi.org/10.3233/BME-2012-0714.)

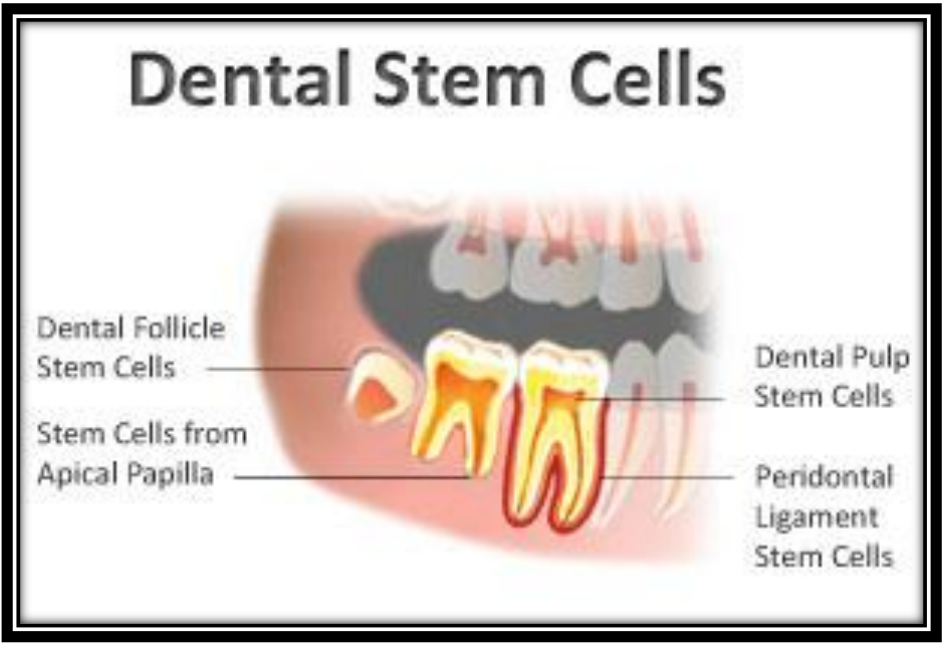
Adipose-derived Stem Cells (ADSCs) Differentiation

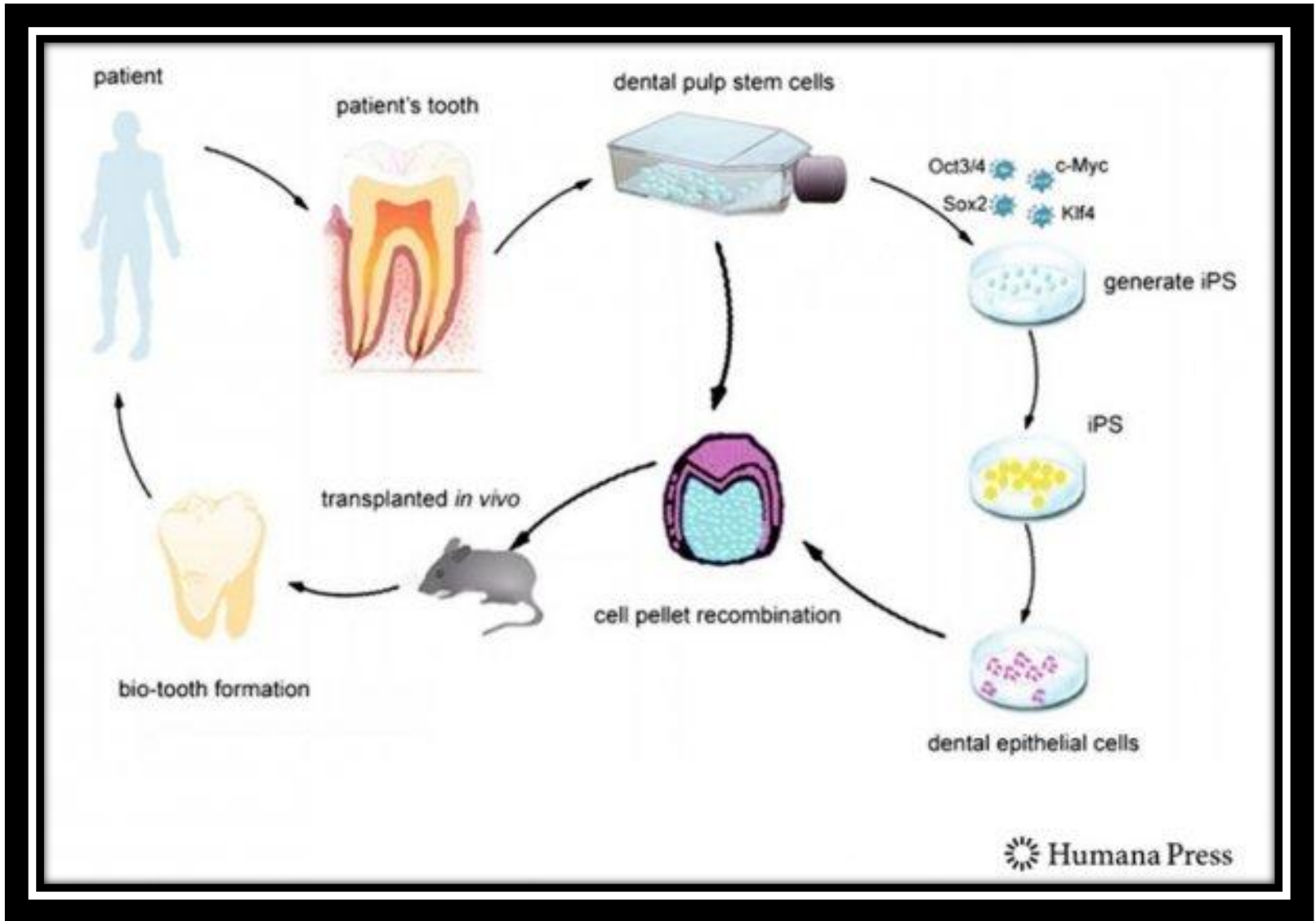


Isolation of adult stem cells

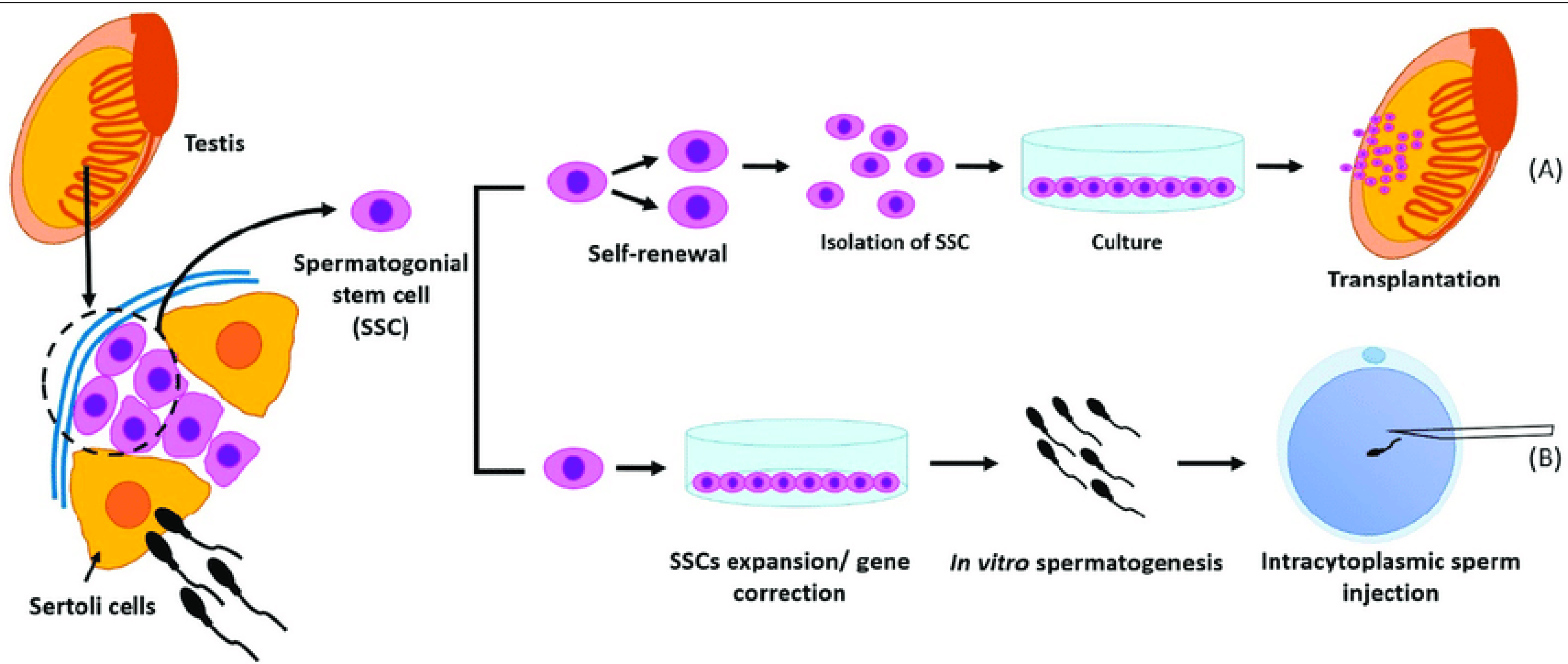


Isolation of adult stem cells

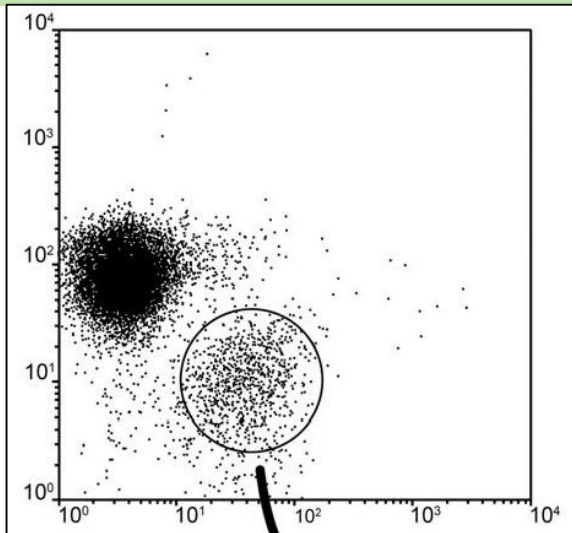


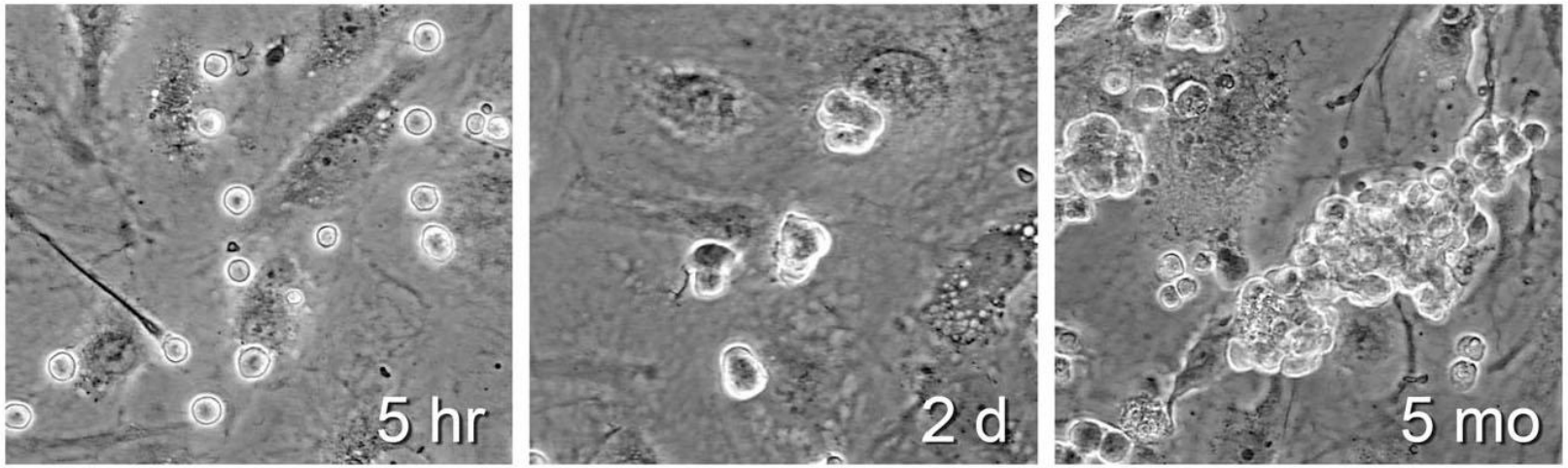


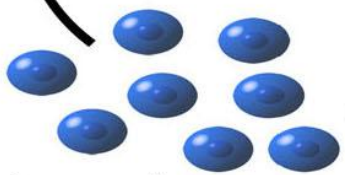
Isolation of spermatogonial stem cells



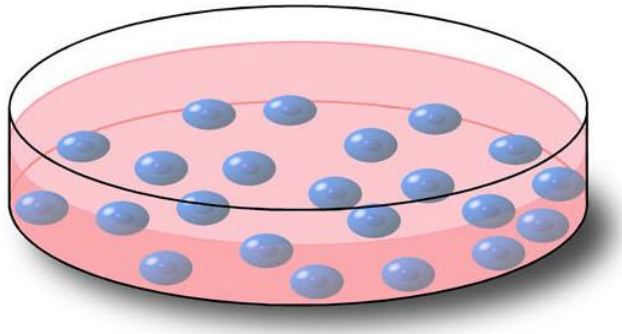
Isolation of spermatogonial stem cells

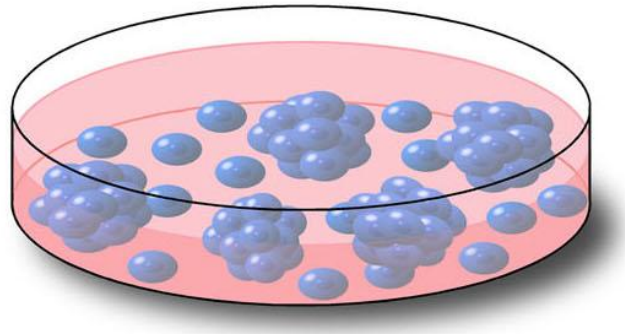






THY1$^+$ spermatogonia





SSC-enriched population
- FACS
- MACS
- Differential plating
- Density-gradient centrifugation

Serum-free medium
- Minimum compounds

Appropriate feeder cells
- STO embryonic fibroblasts
- C166 embryonic endothelial cells

Self-renewal promoting factors
- GDNF
  - GFRA1
- FGF2

Limitations of multipotent (adult/tissue) stem cells

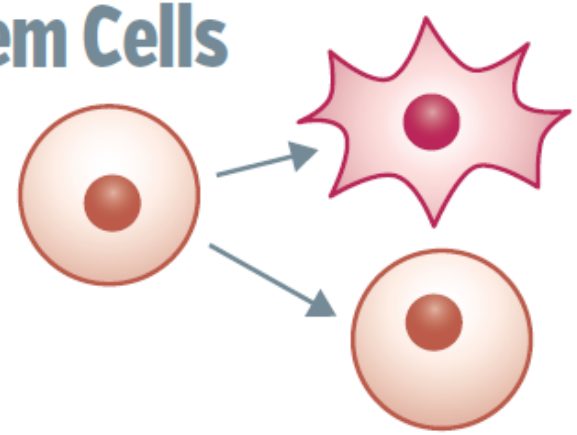
- ❑ **No ethical issues (consent required)**
- ❑ **Immune rejection (only when transplanted from different patient)**
- ❑ **Multipotent**
- ❑ **are scarce**
- ❑ **difficult to obtain pure populations**
- ❑ **difficult to maintain these pure population of cells indefinitely in culture; limited life-span**

Pluripotent stem cell vs Multipotent Stem Cell

	Pluripotent Stem Cell (PSCs) Embryonic Stem Cell (ESC) Induced Pluritpotent Stem Cell (iPSC)	Multipotent Stem Cell (MSC) Adult Stem Cells (Hematopoietic Stem Cells; Mesenchymal Stem Cells, Neural Stem Cells, etc.
Potency	Pluripotent (differentiates into all cell types)	Multipotent (differentiates into limited number of cell types)
Biomedical Potential	Vast	Limited
Proliferation capacity	Unlimited (immortal)	Limited Life-span
Proliferation rate	Fast (symmetric division)	Slow compared to PSC (asymmetric division)
Derived from	Embryo or Artificially reprogrammed	Adult human body
Availability	Grown relatively easily in culture … one requires large amount of cells for cell therapy	Are scarce and difficult to obtain pure populations
Ethics … Cancerous	-ESCs are controversial as destruction of embryo is involved (but not in case of iPSCs) -can be cancerous	-Non-controversial … -Mostly non-cancerous

Three Key Facts About Stem Cells

1. The defining characteristic of a stem cell is that it can self-renew or differentiate.
2. Stem cells enable the body to grow, repair and renew.
3. There are three types of stem cells:



Differentiation (Specializing)

Specialized cell
(e.g. muscle cell, nerve cell)

Self-Renewal (Copying)

Stem cell

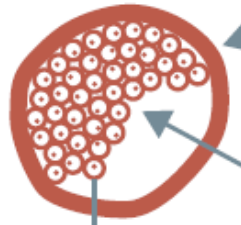
Tissue Stem Cells

In the fetus, baby and throughout life.

Found throughout the body, each type gives rise to at least one type of more specialized cell.

For example, blood stem cells are found in the bone marrow.

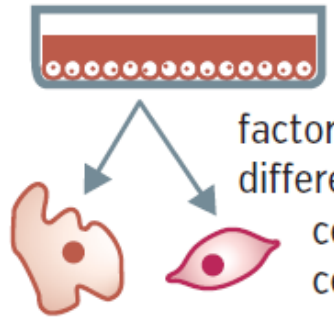
Embryonic Stem Cells



A *blastocyst*

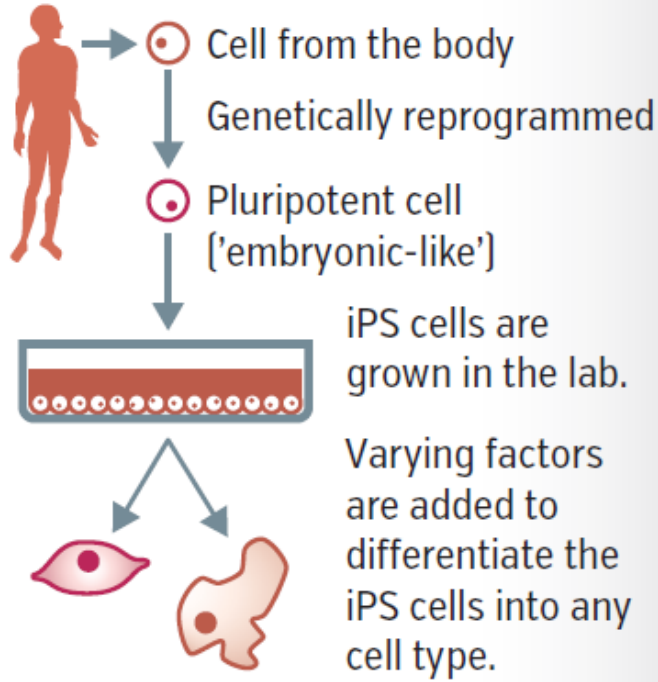
The cells inside are the *inner cell mass.*

These cells, then grown in the lab, are called *embryonic stem cells.*



Varying factors are added to differentiate the ES cells into any cell type.

Induced Pluripotent Stem Cells (iPS)



Cell from the body

Genetically reprogrammed

Pluripotent cell ('embryonic-like')

iPS cells are grown in the lab.

Varying factors are added to differentiate the iPS cells into any cell type.

Embryonic stem cells and iPS cells are *pluripotent;* they can generate all the specialized cells of the body.