

A brief Note on Stem Cells

by

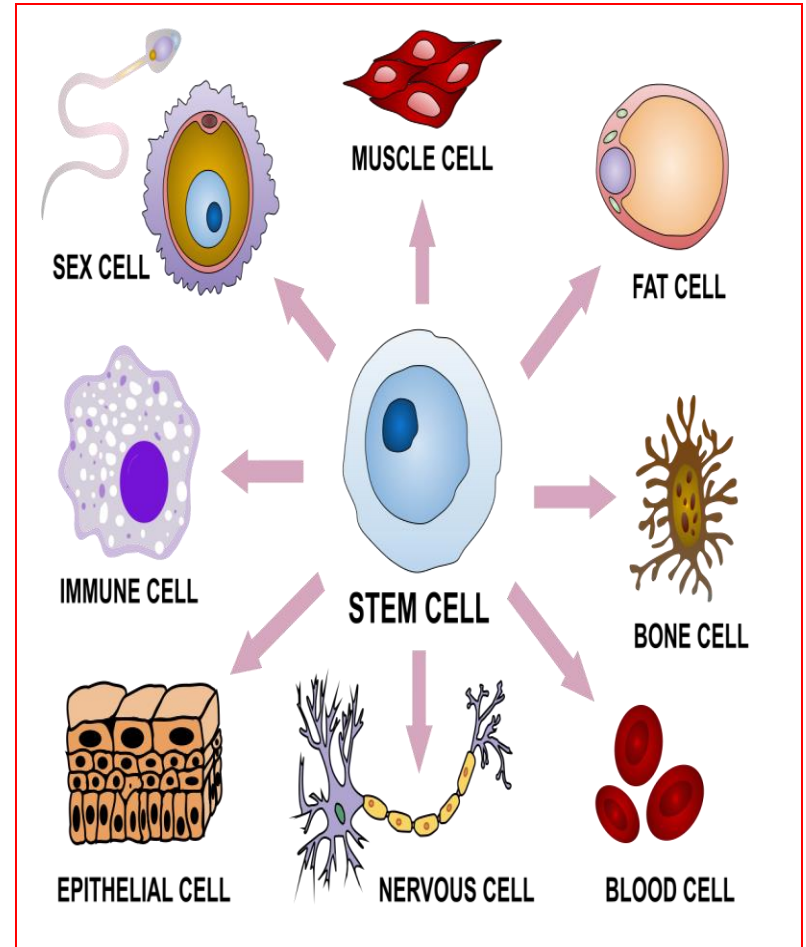
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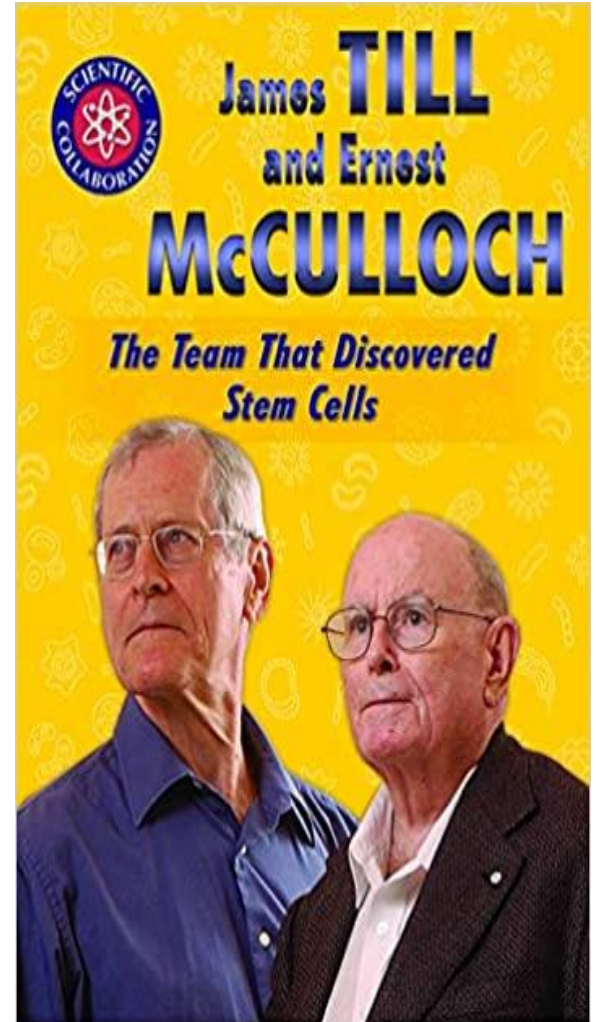
• What are the stem cells?

- A class of undifferentiated cells that have the potential to differentiate into any cell type in the body.
- Exist in both **embryos** and **adults**.

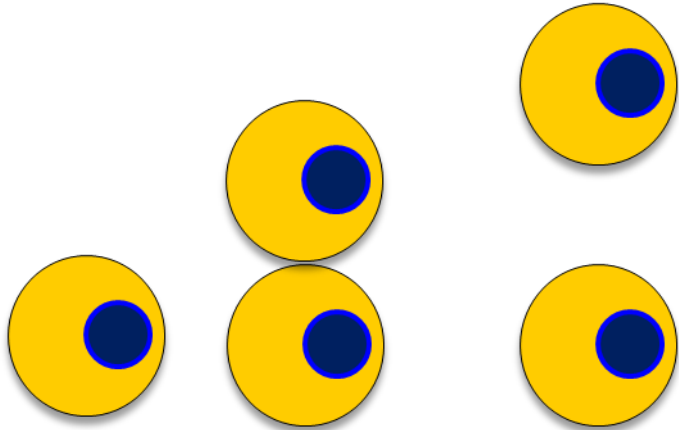


• Brief historical background?

- It is hard to pinpoint **when** or by **whom** "stem cells" were first discovered.
- However, it is thought that **Ernest McCulloch** and **James Till** were the first scientists defined the **key properties** of stem cells in **1960s**.
- They discovered **hematopoietic stem cell**, the **blood-forming stem cell**.

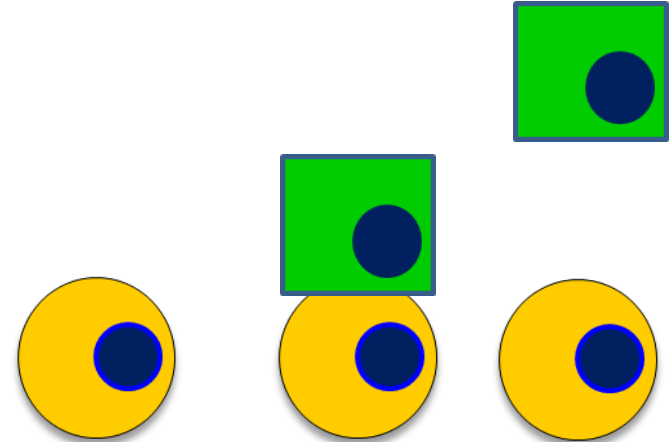


- Unique characters of stem cells:



(1) Can renew

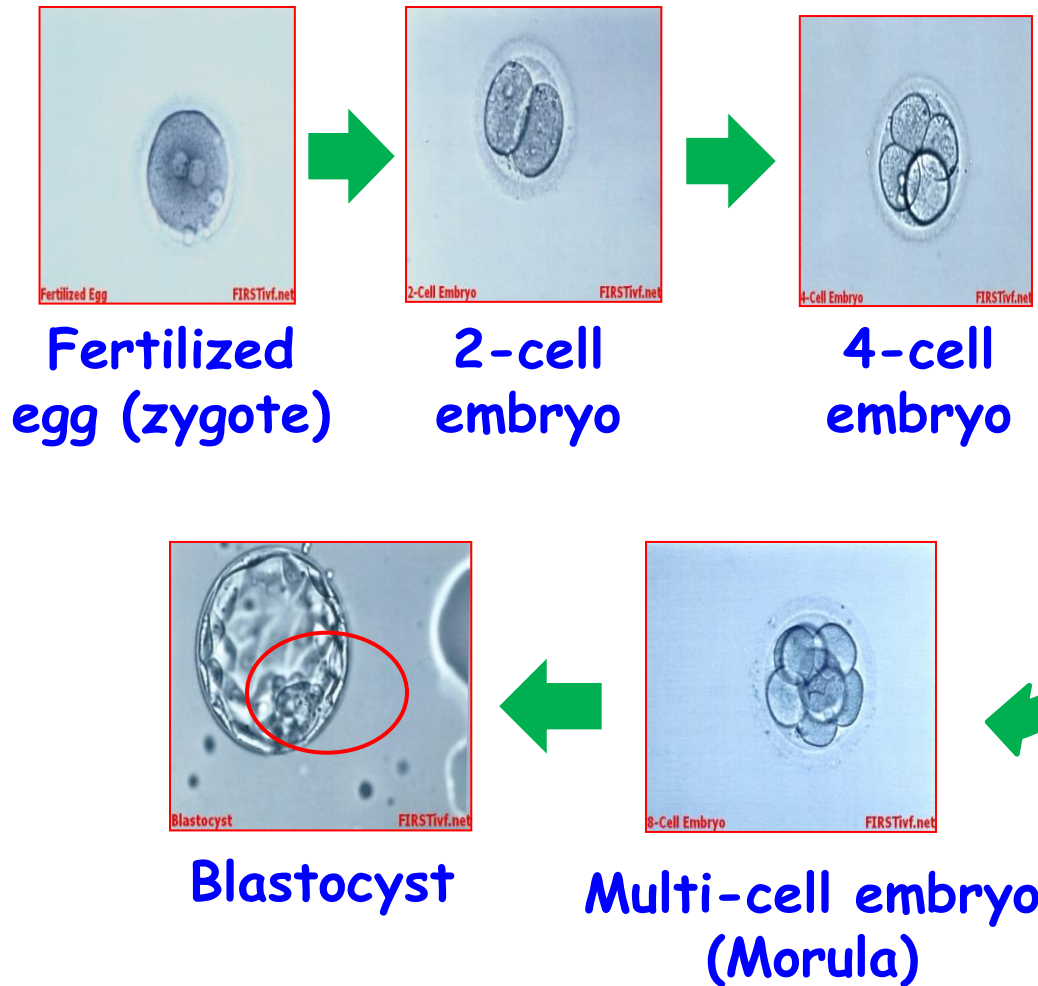
"Divide and generate more similar cells"



(2) Can specialize

"Turn into mature, specialized cells"

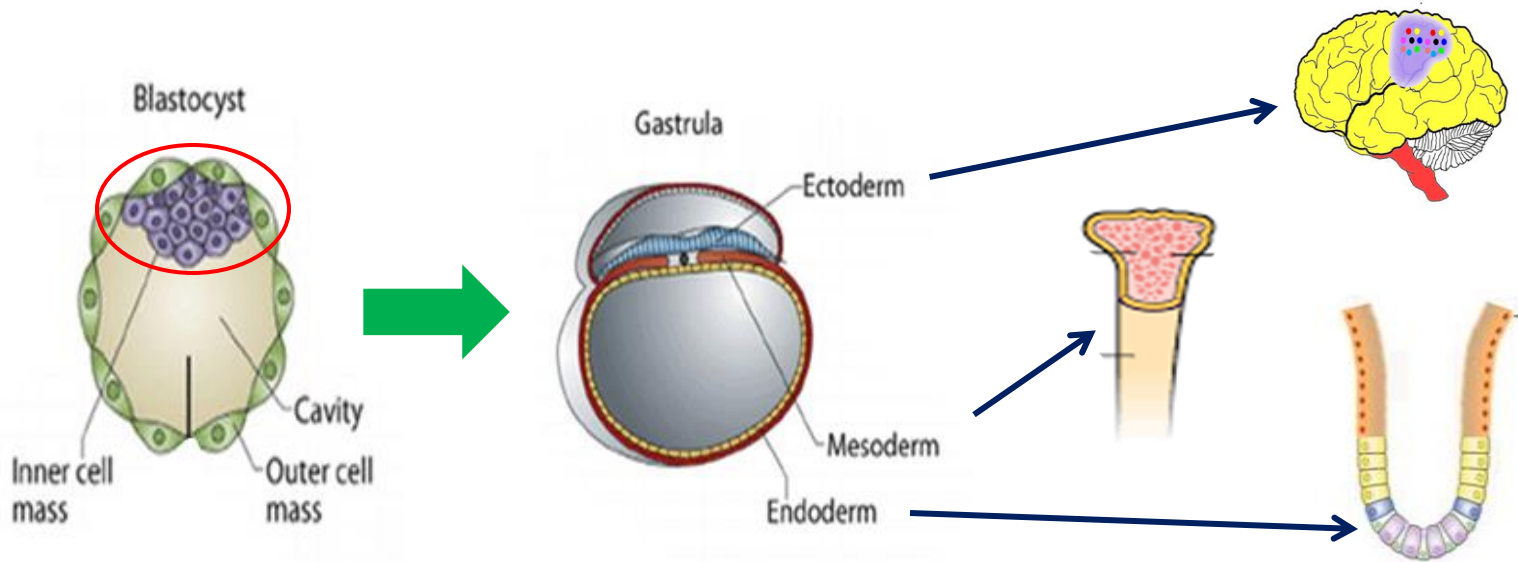
• Formation of stem cells and their types:



The zygote to cells of the morula



(1) Totipotent Stem Cells



Inner cell mass



(2) Pluripotent Stem Cells
(Embryonic Stem Cell, ES)

Cells of germ layers

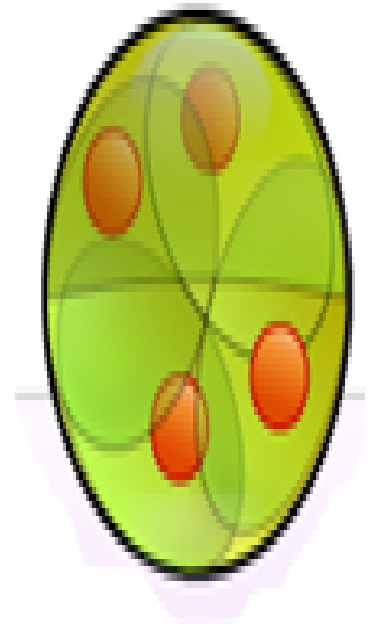


(3) Multipotent Stem Cells
(Adult Stem Cell, somatic)

Totipotent Stem Cells

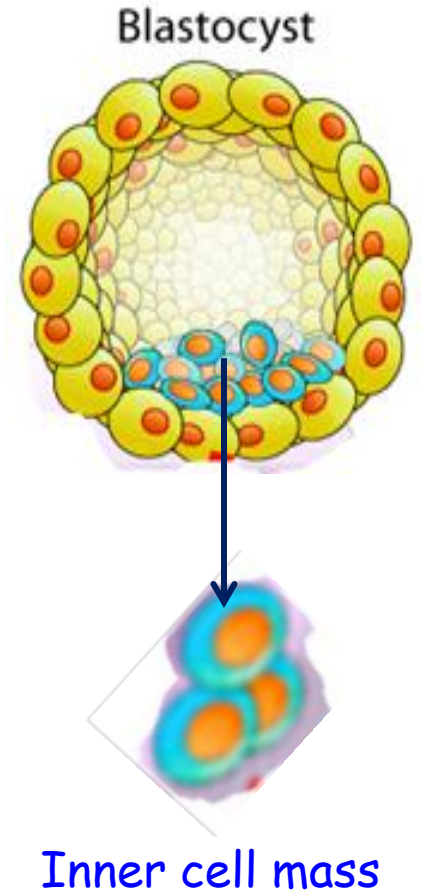
- Derived from the zygote to cells of morula.
- Each cell can develop into a **new organism**.
- Studies using **totipotent stem cells** is limited by **ethical** and **practical** considerations.

Totipotent
Morula



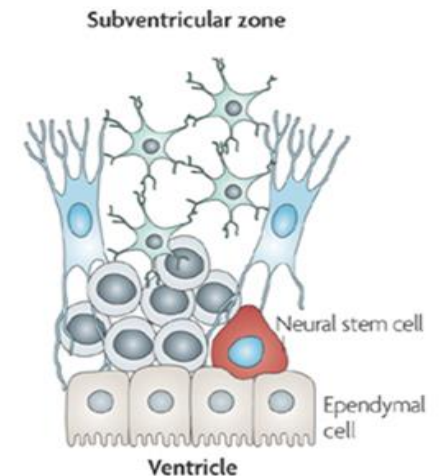
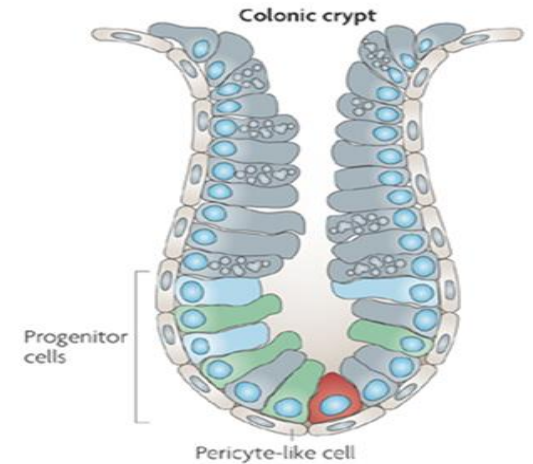
Pluripotent (Embryonic) Stem Cells

- Derived from the inner cell mass of the blastocyst.
- Form cells of the three germ layers.
- Able to give rise to all cells of the tissues of the body.
- Their medical use is ethically restricted.



Multipotent (Adult, Somatic) Stem Cells

- Undifferentiated cells found among differentiated cells in many organs in the body.
- Able to renew and differentiate into a specific cell lineage (narrower spectrum of differentiation than PSCs).
- Enable replacement of lost cells, growth and healing.



Replacement



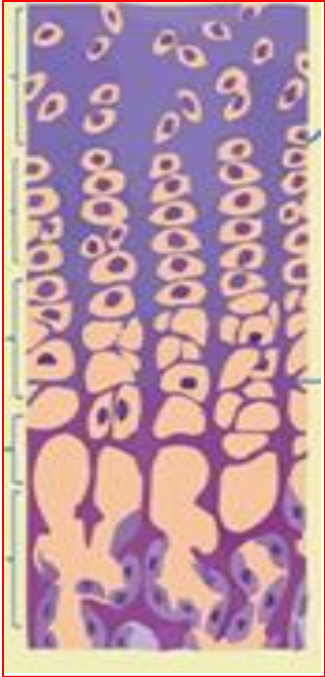
Epidermal stem cell

Growth

Epichondrium



Epiphyseal plate



Healing



- Types of adult stem cells:

- Mesenchymal stem cells
- Hematopoietic stem cells
- Neural stem cells
- Testicular stem cells
- Endothelial stem cells
- Olfactory stem cells

- Oligopotent stem cells:

Can differentiate into several cell type (e.g. Myeloid stem cells).

- Unipotent stem cell:

Able only to form one cell type (e.g. Epidermal stem cell).

Stem Cell Hierarchy

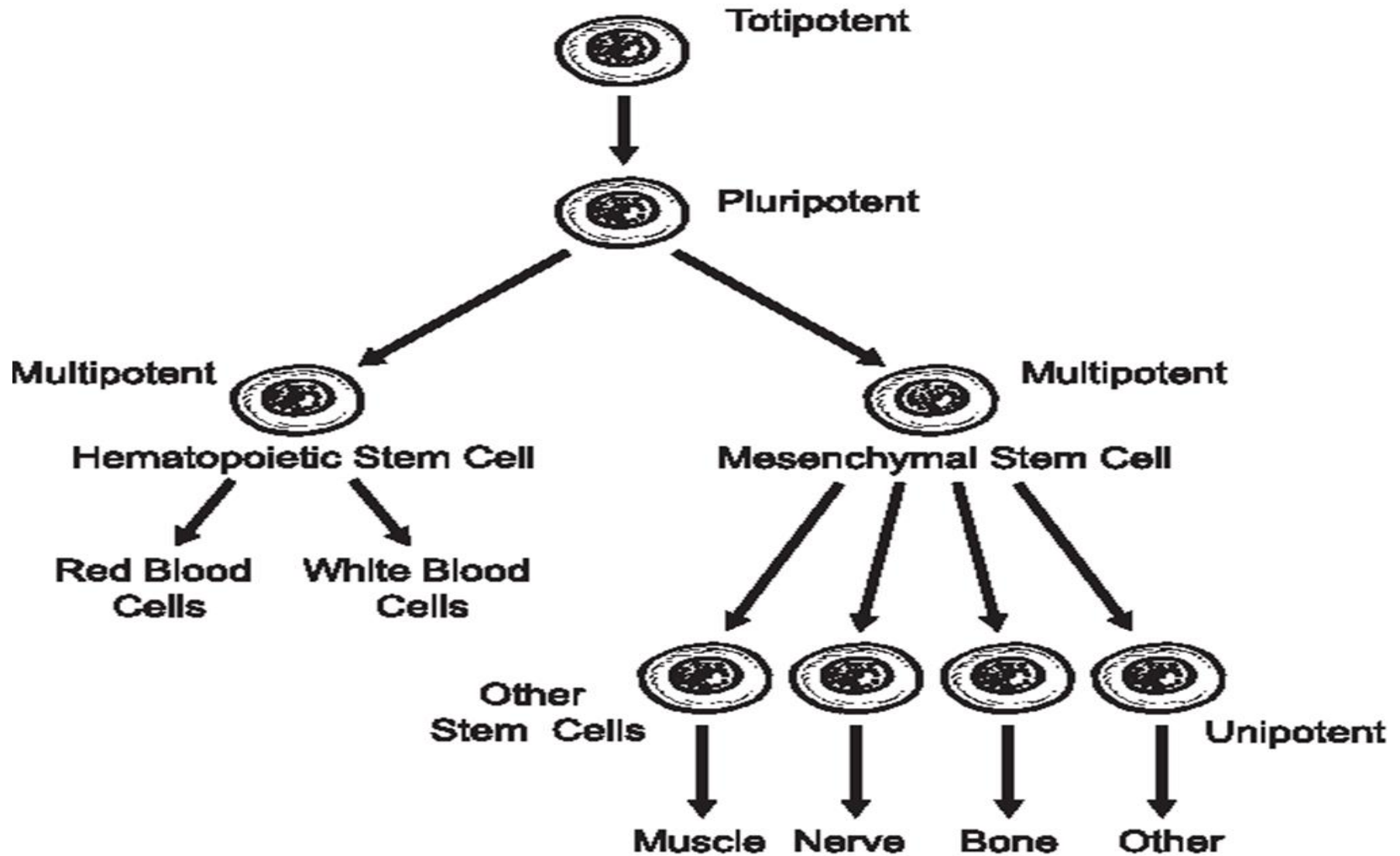
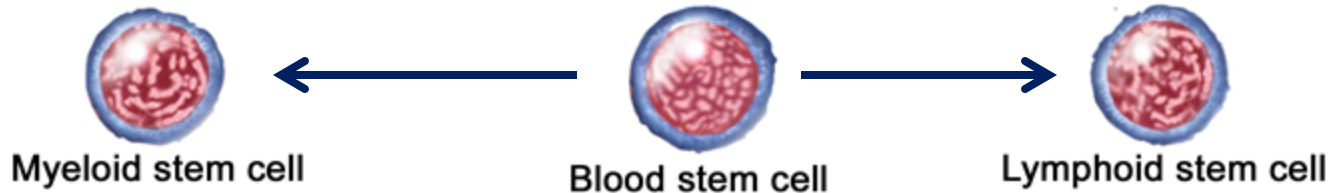


Figure 1



What are the kinds of these stem cells?



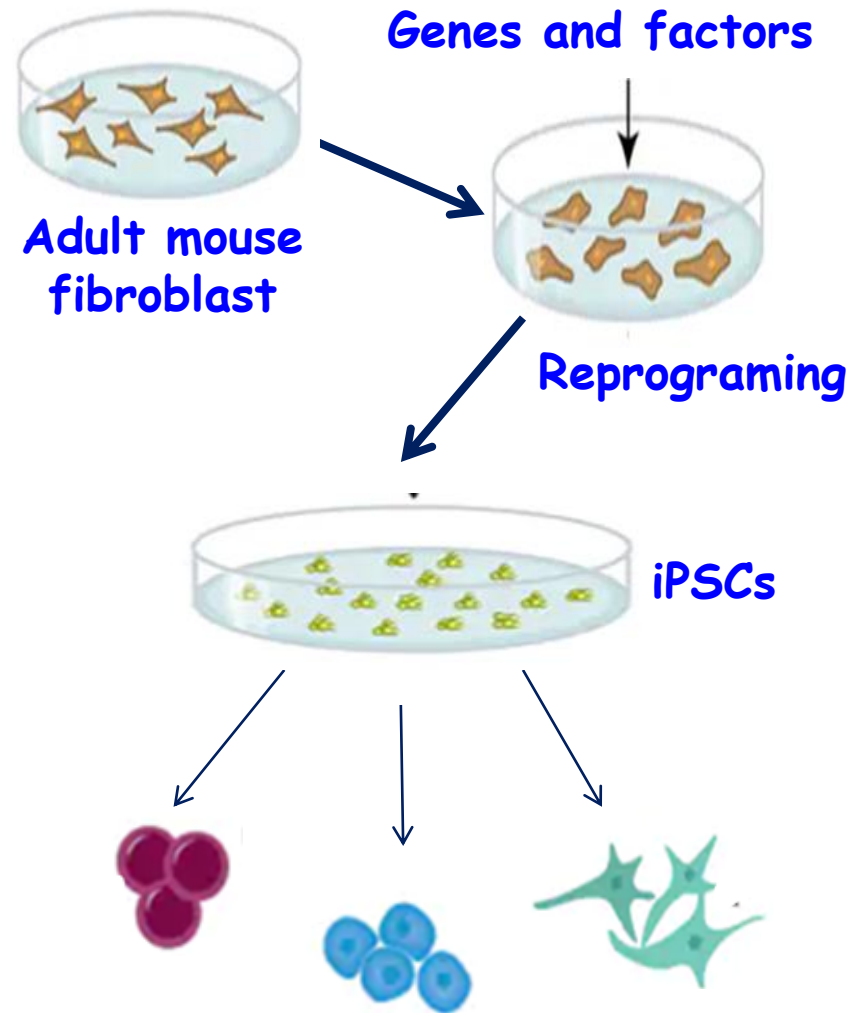
Mention a feature that counts for each of the pluripotent and multipotent stem cells?



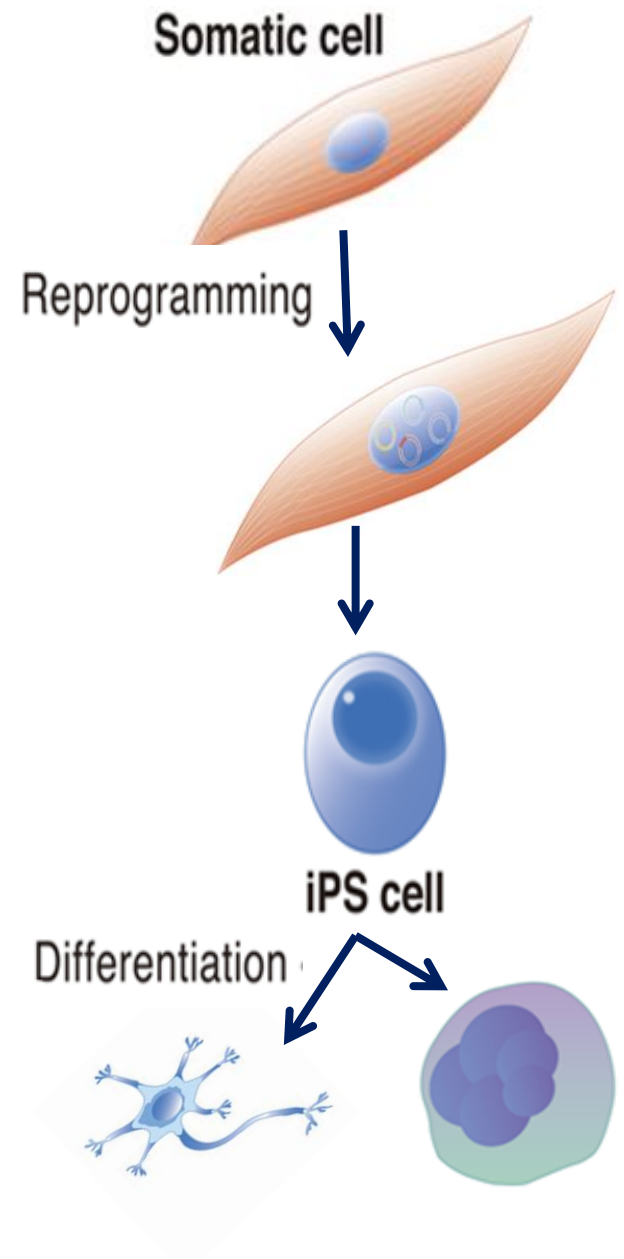
Mention a features for the hematopoietic and neural stem cells on regarding of their division?

Induced Pluripotent Stem Cells (iPSCs)

A type of pluripotent stem cell derived from adult somatic cells that genetically reprogramed to an ES cell-like through forced expression of genes and factors important for pluripotency.



- iPS cells from mouse fibroblasts were first prepared by Yamanaka lab at Kyoto University in 2006.
- iPS cells from human fibroblasts were first produced by Yamanaka's and Thomson's groups in late 2007.



• Characters of iPSCs:

Similar to ES cells in many aspects, for instance:

- Expression of ES cell markers.
- Pluripotency.
- Contribution to many different tissues in vitro.

 Why using iPSCs is advantageous over ESCs?

Tissue formed from iPSCs is compatible with the patients as the donor and recipient can be the same individual.

Differentiation vs Transdifferentiation of Adult Stem Cells

Differentiation

Adult stem cells differentiate into **mature** cell types similar to cells where they reside (e.g. **Hematopoietic** stem cells give rise to **blood** cells).

Transdifferentiation

Adult stem cells differentiate into **other cell types** (e.g. blood-forming cells give rise to cardiac muscle ... etc



Thank you for your interest