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E-Content

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Stem Cells and Regenerative Biology

Stem Cells:

Stem Cells are extraordinary cells because they have property of self-renewal. In 1998, U. Wisconsin research team isolates stem cells from IVF-blastocysts. They have no specific function, remain unspecialized but become specialized or differentiated with the potential to produce more than hundred of different types of cells in the body. They serve as the body's repair system, renew itself and replenish other cells. ESCs have distinguished potential to form the entire three lineages (endoderm, ectoderm and mesoderm).

Two Major Types of Stem Cells:

A. Embryonic Stem Cells

- From blastocysts
- From fetuses

B. Adult Stem Cells

- Stem cells have been found in different tissues and organs like blood, bone marrow, liver, kidney, cornea, dental pulp, umbilical cord, brain, skin, muscle, salivary gland etc.

Characteristics of Embryonic stem cells:

- Embryonic stem cells are *pluripotent*.
- Retain the special ability to develop into nearly any cell type.

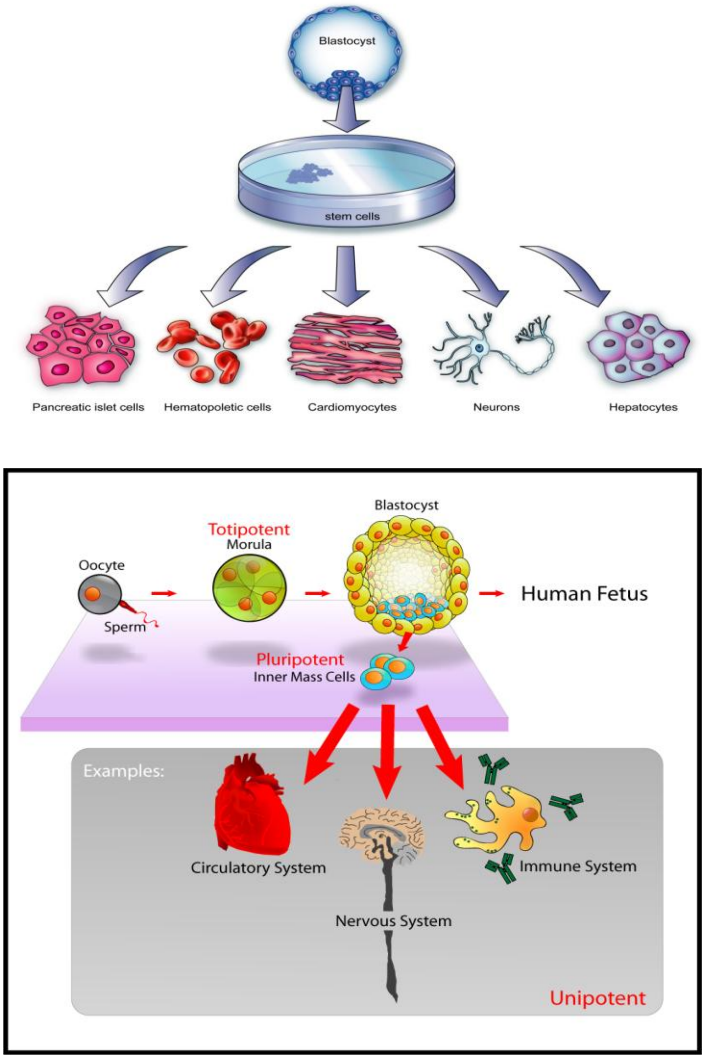

Figure 1: Differentiation of blastocysts into different type of cells.

http://commons.wikimedia.org/wiki/Image:Stem_cells_diagram.png

Characteristics of Adult Stem Cells:

- Adult stem cells are the cells which are derived from particular organs such as adult bone marrow, brain, skeletal muscle, liver, pancreas, fat, and skin (B. Nick et al., 2010).
- Bone marrow derived mesenchymal stem cells have the highest multilineage differentiation capacity (R. Passier & C. Mummery, 2003).
- Hematopoietic stem cells (HSC) within the bone marrow give rise to all mature blood cell lineages while retaining their self-renewal capacity. Human Hematopoisis produces 10^{12} cells per day (S. Doulatov et al., 2012).

Differences between Embryonic and Adult Stem Cells:

Embryonic S.C.	Adult S.C.
"Pluripotent" ("can become any cell")	**"Multipotent" ("can become many but not any")**
More Stable - Can undergo many cell divisions.	**Less Stable- have capacity for self-renewal is limited.**
Easy to obtain from blastocysts.	**Technically more difficult to isolate in adult tissue.**
Possibility of rejection	**Host rejection minimized**

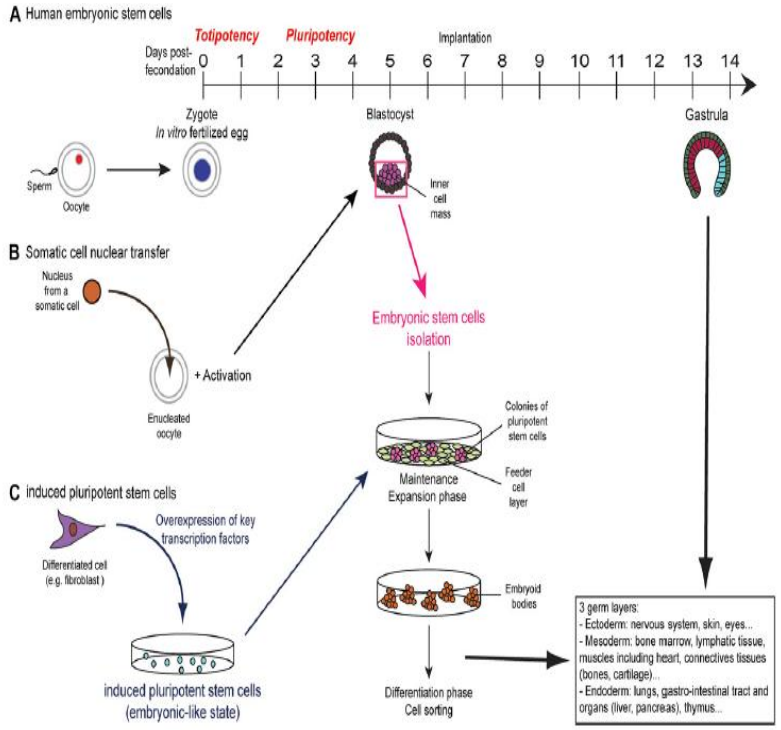

Figure 2: Isolation, generation and culture of pluripotent stem cells:

(Anne C. Brignier, et al., 2010)

Somatic Cell Nuclear Transfer (SCNT)

(Sometimes referred to as "*therapeutic cloning"*

- No sperm involved.
- Transfers nucleus from a mature cell into a donor egg.
- Requires electric or chemical stimulus to begin dividing.
- Functionally different from regular fertilized egg.

Purpose:

- Find cures and therapies for diseases.
- Awaken the natural capacity for self-repair that resides in our genes.

Potential Results:

- Patients will receive own stem cells to treat disease.
- No need for donor match as in case of organ- transplantation.

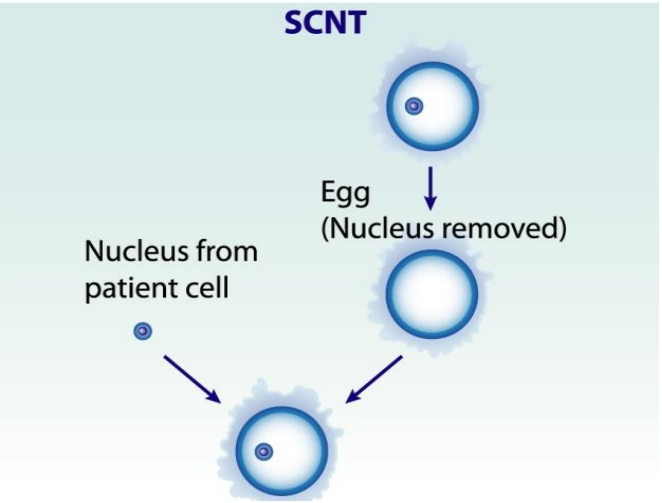

Figure 3: Somatic Cell Nuclear Transfer (SCNT)

Importance of Stem Cell Research

- Stem cells allow us to study how organisms grow and develop over time.
- Stem cells can replace diseased or damaged cells that cannot heal or renew themselves.
- We can test different substances (drugs and chemicals) on stem cells.
- We can get a better understanding of our "genetic machinery."

Examples of diseases being treated with Stem Cells

- Parkinson's Disease
- Leukemia (Bone Marrow Transplants)
- Skin Grafts resulting from severe burns

Potential of Stem Cell Therapy

- To regenerate tissues/organs.
- To cure diseases like diabetes, multiple sclerosis, etc.

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