

Stem Cells and Stem Cell Therapy

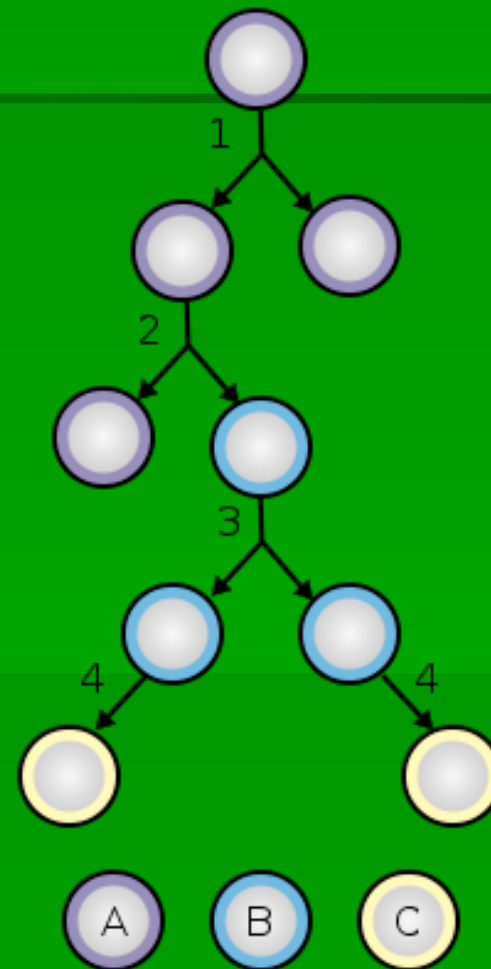
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Biochemistry 118

December 1, 2008

Stem Cell Characteristics

- Undifferentiated, unspecialized
- self-renewal through mitotic cell division
- Depending on physiological or experimental conditions (growth factors), they can be induced to differentiate into specialized cell types
- Symmetric: two daughter stem cells
- Asymmetric: 1 stem cell, 1 progenitor cell

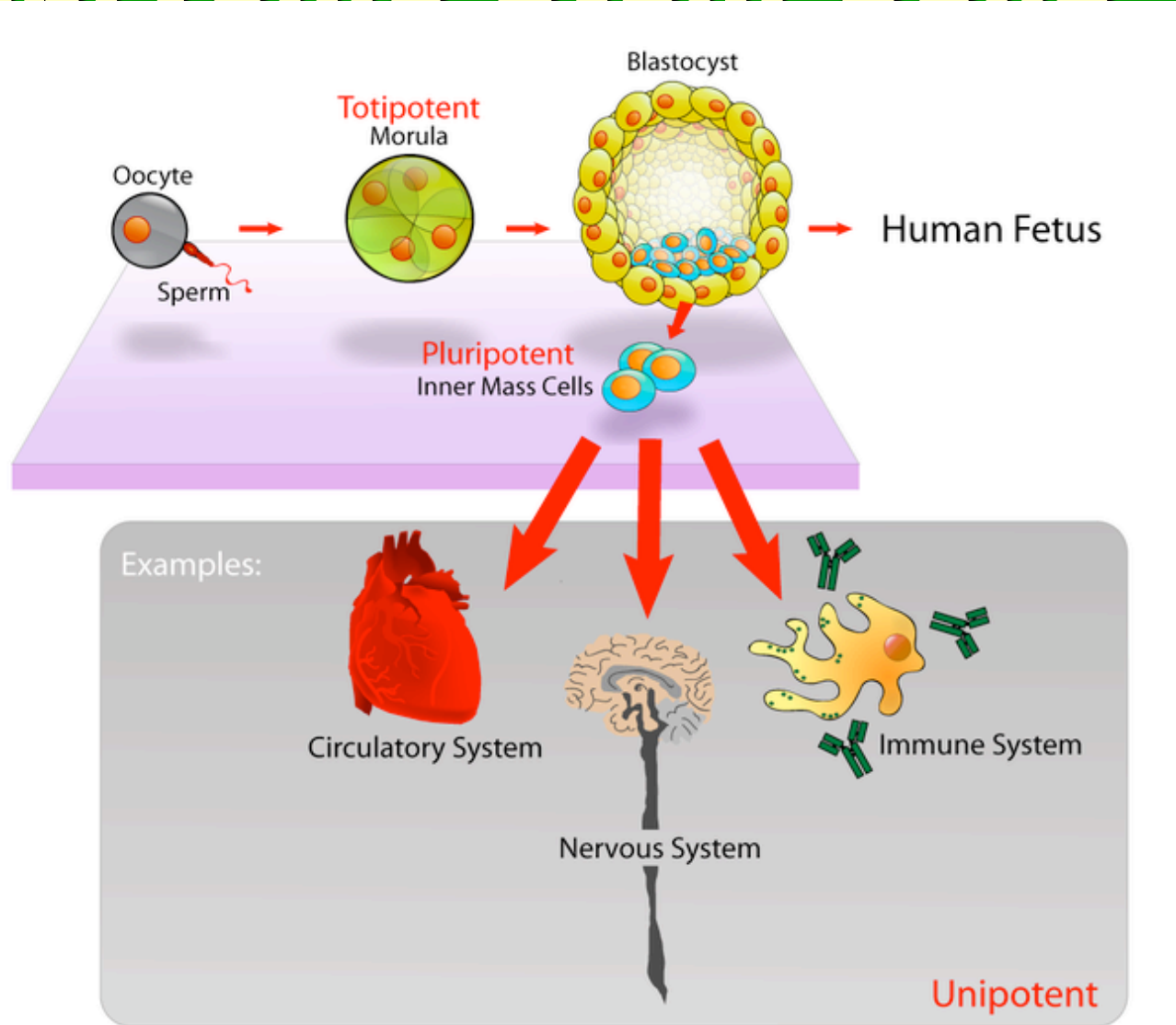


http://en.wikipedia.org/wiki/Image:Stem_cell_division_and_differentiation.svg

Characteristics (cont'd)

- Genes characteristic in stem cells: Oct-3/4, SOX2, c-Myc, Klf4, NANOG
- Yamanaka and Takahashi: iPSC
- Differentiate into ectoderm, mesoderm, endoderm, and germ cells- Pluripotency
- Most stem cell therapy uses embryonic stem cells and adult stem cells

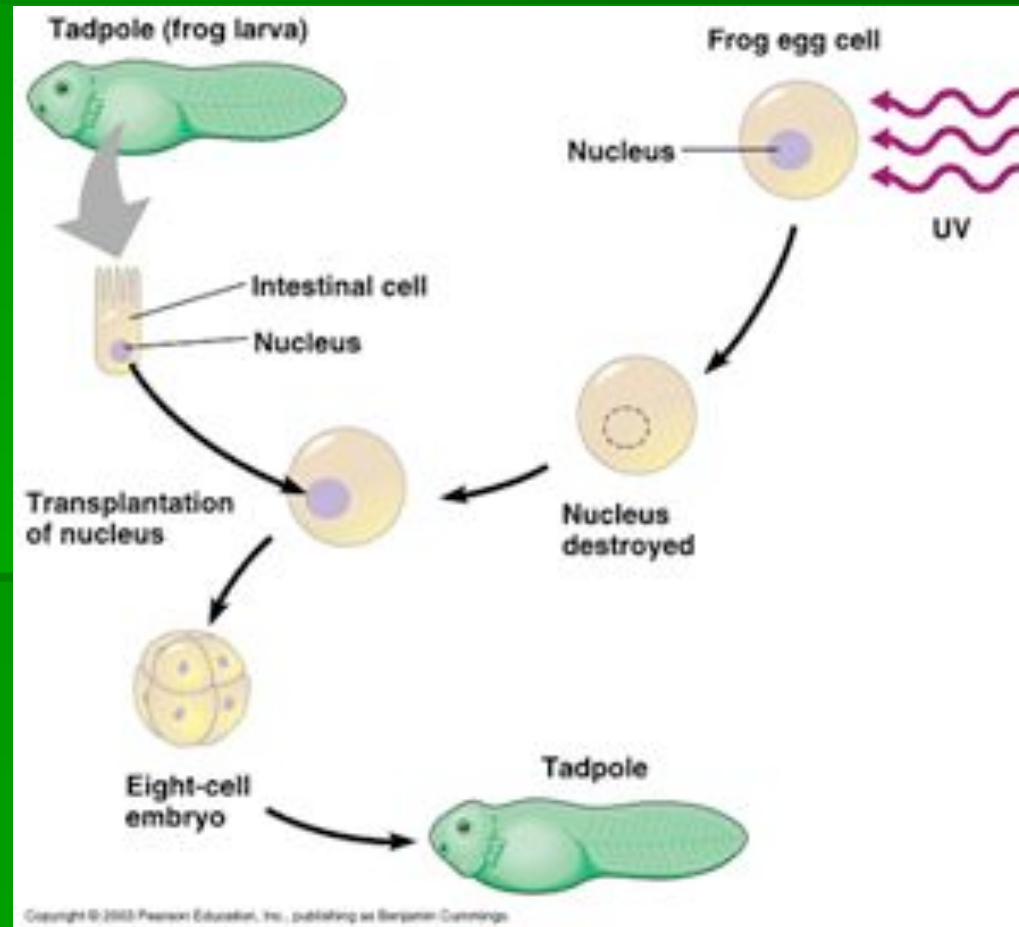
Embryonic Stem Cells



Stem Cell Therapy

- Form of regenerative medicine in which adult or embryonic stem cells are used to repair damaged tissue and treat diseases
- Stem cells are often used alongside nuclear transplantation
 - Involves transplanting the nucleus of adult somatic cell into an egg cell, which generates embryonic stem cells with the same DNA as the donor of the adult cell
 - Reduces or eliminates risk of immune rejection

Nuclear Transplantation



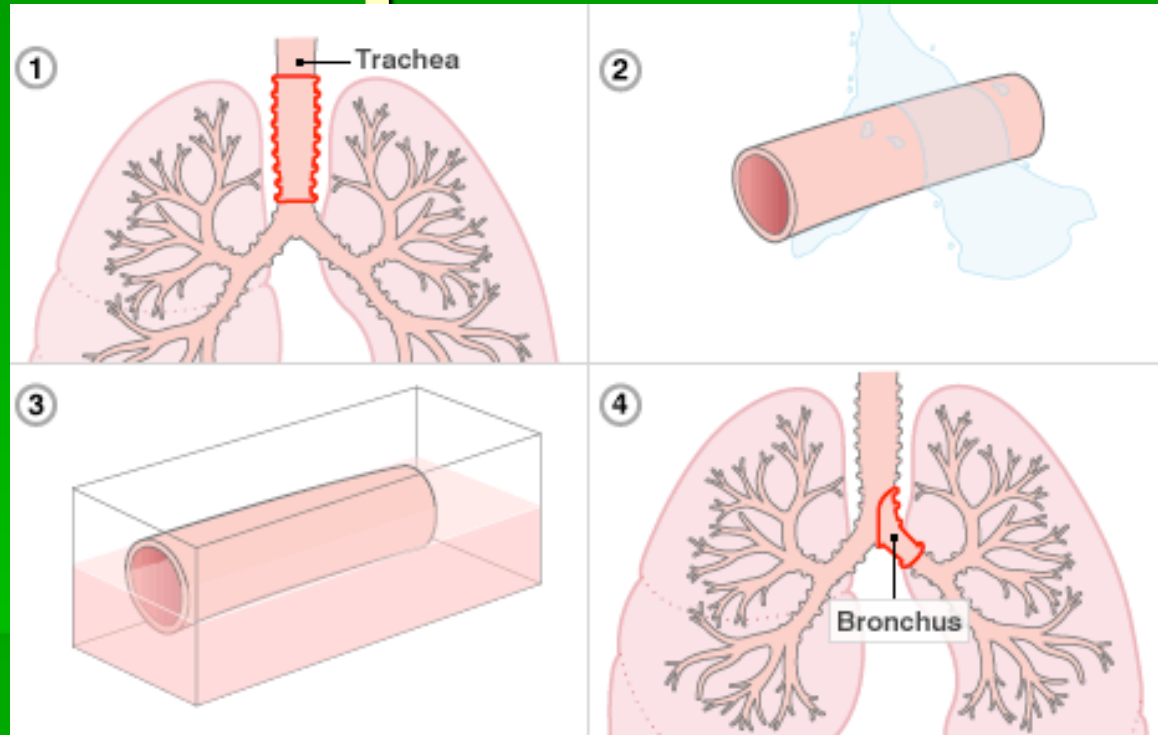
Established forms of SC Therapy

- **Hematopoietic stem cell transplantation**
 - Leukemia patients receive bone marrow transplants after chemotherapy
 - If successful, stem cells will migrate to bone marrow and produce healthy leukocytes
- **Retinal stem cell transplantation**
 - In 2005, a trial at Queen Victoria Hospital restored eyesight to 40 people
 - Stem cells are used to redevelop the cornea- film at the front of eye that lets in light
 - ESC are grown as a thin sheet in vitro, then transplanted

New SC Therapies

- Nov. 19, 2008- Doctors in Spain were able to carry out world's first tissue-engineered whole organ transplant
 - Rebuilt a whole bronchial tube using the patient's own stem cells
 - First tissue transplant without the need of anti-rejection drugs

Diagram of Windpipe Transplant



- 1 Trachea is removed from dead donor patient
- 2 It is flushed with chemicals to remove all existing cells
- 3 Donor trachea "scaffold" coated with stem cells from the patient's hip bone marrow. Cells from the airway lining added
- 4 Once cells have grown (after about four days) donor trachea is inserted into patient's bronchus

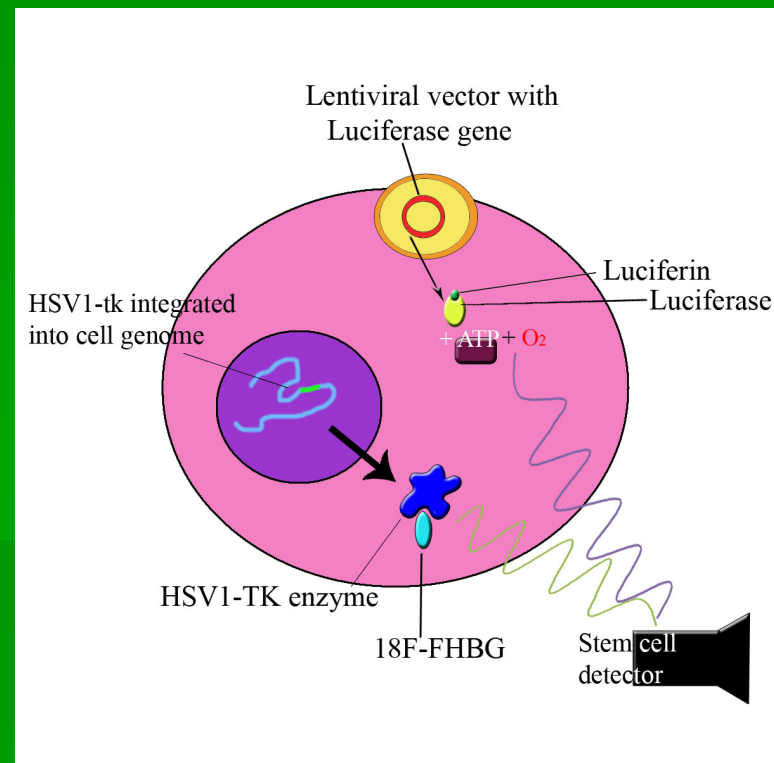
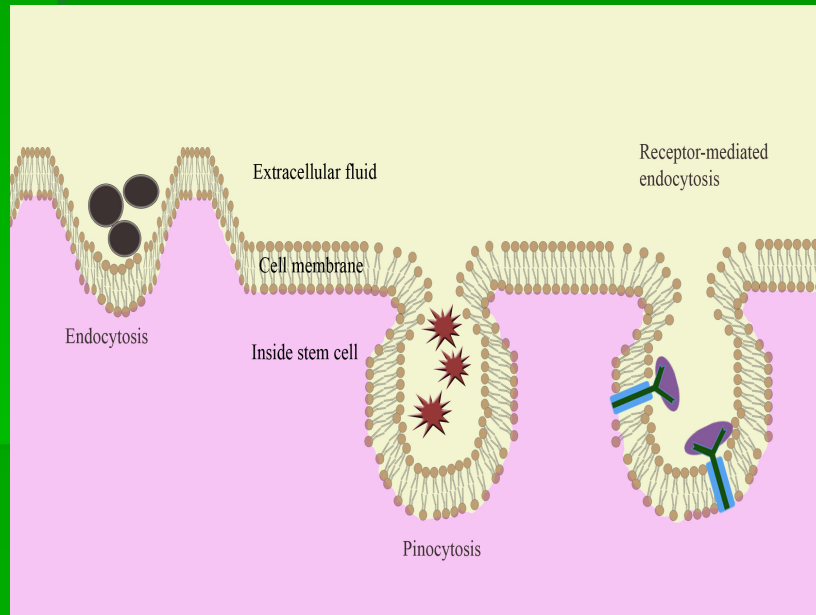
Current Topics of Stem Cell Research

- Stroke and brain damage
- Cancer
 - cells had migrated into the cancerous area and produced *cytosine deaminase*, an enzyme that converts a non-toxic pro-drug into a chemotherapeutic agent. As a result, the injected substance was able to reduce tumor mass by 81%
- Spinal Cord Injury
- Parkinson's Disease
 - Strategies for producing dopamine neurons (improve motor function) from human stem cells in the laboratory for transplantation into humans with Parkinson's disease
- Heart reconstruction
 - Vincentelli et al tissue engineered heart valves in vitro

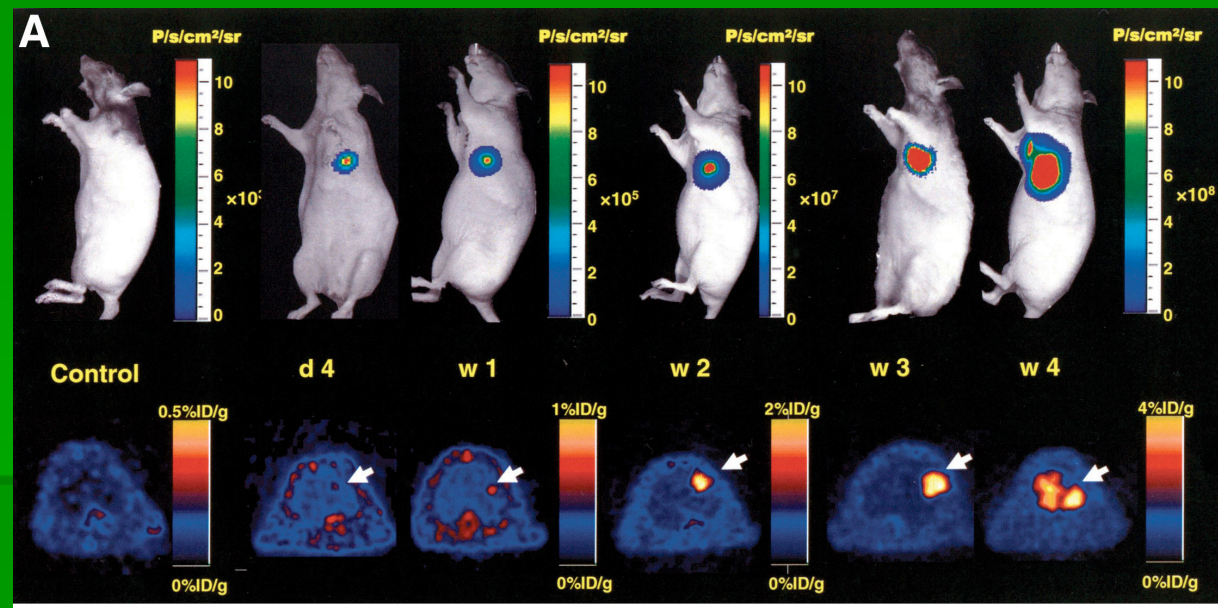
Labeling Stem Cells

- Stem cells need to be labeled in order to be tracked in vivo
 - MRI- superparamagnetic iron oxide particle
 - Bioluminescence- Luciferase/Luciferin
 - Positron Emission Tomography- Radioactive isotopes, HSV1-tk

Labeling SC



Images of SC In vivo



interactive.snm.org/docs/JNM.043299.pc.f4.jpg

Work Cited

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