

STEM CELL RESEARCH

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- **The Stem Cell debate and the impact of the induced pluripotent stem cell procedure**

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Why Is Vocabulary Important?

- Key terms frame the debate
 - “Mature” versus “adult” stem cells
 - “Early” versus “embryonic” stem cells
 - “Therapeutic” versus “reproductive” cloning
- Definitions
 - Multipotent — Give rise to multiple **but limited cell types**
 - Pluripotent — Flexible, give rise to **any cell type in the body**

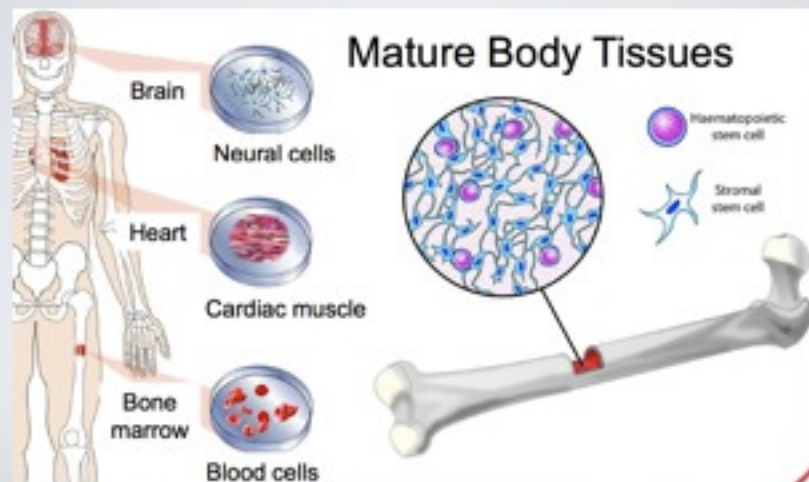
What Is a Stem Cell?

- Unspecialized cells
- Give rise to **more than 250 specialized cells** in the body
- Serve as the body’s repair system
 - Renew itself
 - Replenish other cells

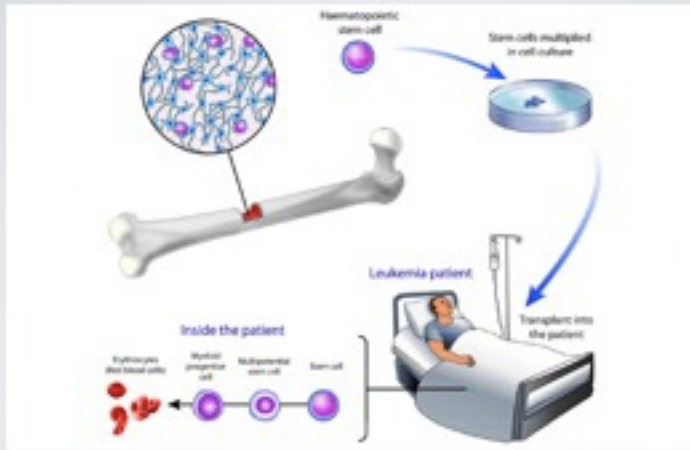


Mature Stem Cells (MSC)

What Are the Sources of Mature Stem Cells?



What Is a Treatment Example?



Umbilical Cord & Placenta SC Research

•Isolated immediately following birth

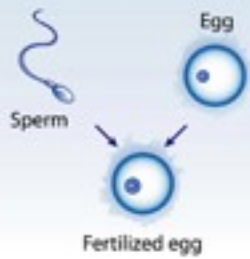
- Wharton's Jelly showing promise as a source
- More flexibility = some **pluripotent** characteristics
- Research is limited but growing



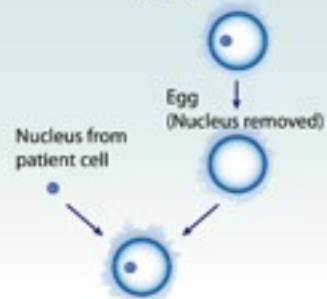
Early Stem Cells (ESC)

What Are the Sources of Early Stem Cells?

In vitro fertilization



SCNT



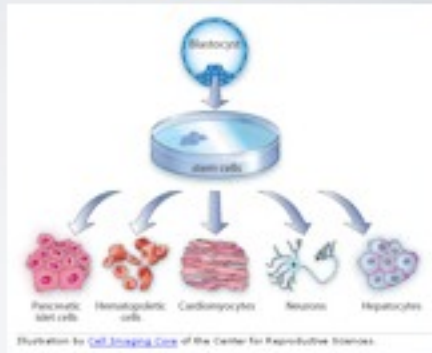
Where Are Early Stem Cells Found?

Who did it first?

- In 1998, U. Wisconsin research team isolates stem cells from IVF-blastocysts

What Are the Characteristics?

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



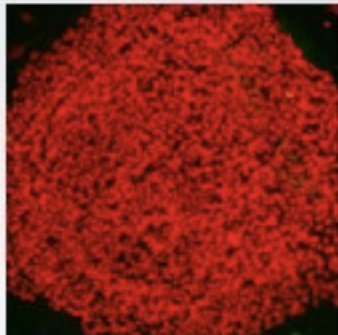
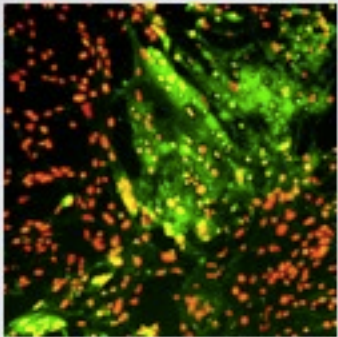
How many types of stem cells are there?

The easiest way to categorize stem cells is by dividing them into two types: mature and early. Mature stem cells are found in specific mature body tissues as well as the umbilical cord and placenta after birth. Early stem cells, often called embryonic stem cells, are found in the **inner cell mass** of a **blastocyst** after approximately five days of development. See the below tables for more details on the characteristics of mature and early stem cells.

Somatic Cell Nuclear Transfer (SCNT)

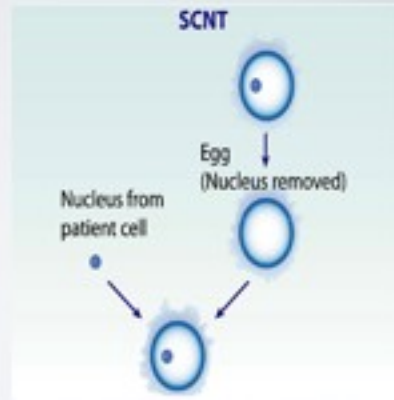
- Sometimes referred to as "**therapeutic cloning**"

What do stem cells look like under the microscope?

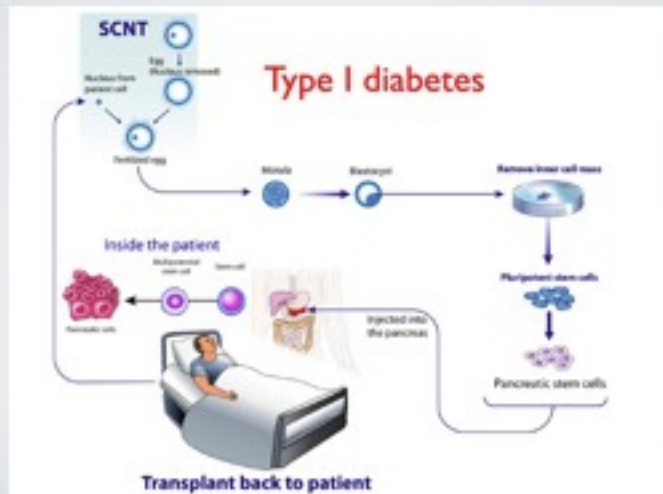


SCNT: Asexual Reproduction

- 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



How Would SCNT Treat Disease?



What Should You Know About SCNT?

•Purpose:

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

•Potential Results:

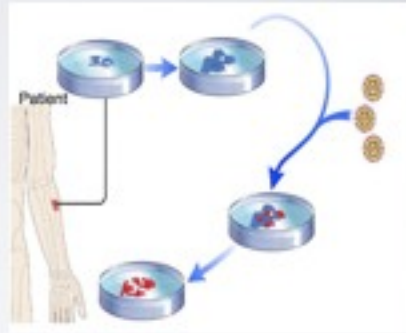
- ⇒**Patients will receive own stem cells to treat disease**
- ⇒**No need for donor match**
- Like transplantation, **but without rejection**

What Should You Know About SCNT?

- No reputable scientist wants to clone human beings
- **SCNT stem cells are alive in a Petri dish**
- Unless implanted in uterus, you can not generate a fetus
- Evidence suggests that SCNT stem cells **may never develop into a human even when implanted**

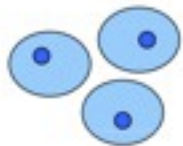
Most Recent Discovery

- 2006/2007 - mouse and human induced pluripotent stem cells were produced.
- Introduce 3/4 genes found in stem cells into adult fibroblast cells
- Ethical concerns eliminated, but therapeutic concerns remain

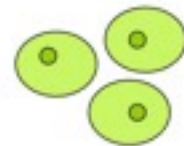


Most Recent Discovery

Adult/Mature
(skin) Cells

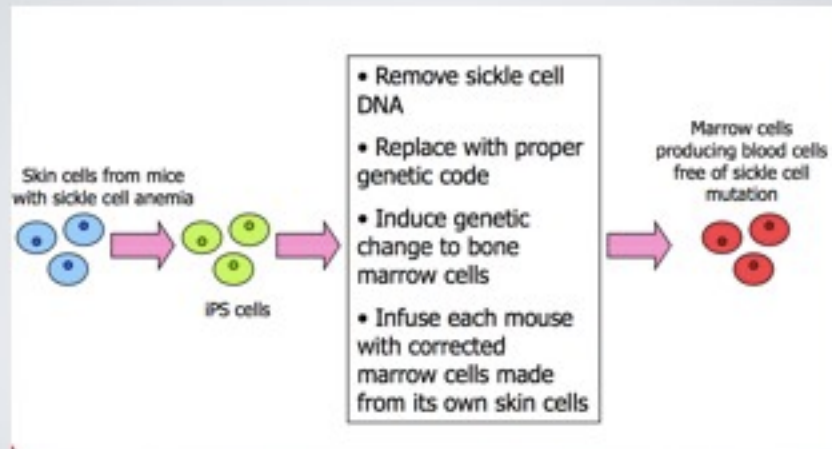


"Embryonic" Stem Cells
(Induced Pluripotent
Stem – iPS)



→
*Addition of
Genes*

Curing Mice of Sickle Cell Anemia



Both Kinds of SCR are Needed

Comparison of Mature and Early Stem Cells

Mature Stem Cells	Early Stem Cells
a.k.a. adult, somatic	a.k.a., embryonic, blastocystic
Obtained from mature body tissues, and umbilical cord and placenta after birth	Obtained from the <u>inner cell mass</u> of a blastocyst
Primarily <u>multipotent</u> : give rise to limited cell types	<u>Pluripotent</u> : give rise to all cell types (except the cells of the <u>placenta</u>)
First isolated in the 1960s	First isolated in 1998 by researchers at the <u>University of Wisconsin</u>
Federal funding (FY 1999-2004): \$2.24B	Federal funding (FY 2002-2004): \$55M
Results: 50+ human therapies	Results: Only in animal trials, no human trials to date

What are the advantages and disadvantages of mature and early human stem cells?

We still have a great deal to learn about both mature and early human stem cells and their potential for treating and hopefully curing disease. Both have distinct advantages and disadvantages associated with them and each offer important insight into how cells rejuvenate the body and cause disease. See the below table for more information:

Mature	Advantages	Disadvantages
	Immune response is unlikely because patients are using their own cells	Limited longevity; difficult to maintain in cell culture for long periods
	Some availability (e.g., blood stem cells)	Difficult to find and extract from mature tissues
	Partly specialised; require less coaxing to create specialised cells	Many unknowns; not all mature stem cell types have been identified yet
		Multipotent ; limited flexibility; cannot become any cell type to date
		Uncommon and growing more scarce with age
		Questionable quality due to genetic defects; targeted disease may still be present in stem cell genes
Early	Advantages	Disadvantages
	Immortal; cell lines remain intact for long periods of time and produce endless numbers of cells	Immune rejection is possible if stem cells are derived from an blastocyst created through in vitro fertilisation (IVF)
	Easy to extract in a laboratory	Difficult to control; may require many steps to coax into desired cell type
	Pluripotent ; very flexible; can make any body cell	
	Readily available; many blastocysts created by in vitro fertilisation are available for research purposes; new methods like SCNT are opening up new potential sources	
	With somatic cell nuclear transfer (SCNT), immune rejection is not an issue because the patients are using their own cells	