

Stem Cells

Origen, Uses, and Controversy

Review of Reading

- Cell Differentiation
 - Involves the expression of certain genes in a cell's genome
 - Stem Cells are undifferentiated* (to varying degrees)
- The capacity of Stem cells to divide and differentiate along different pathways is necessary in embryonic development. It also makes stem cells suitable for therapeutic uses.
- Therapeutic Uses of Stem Cells
 - Stargardt's
 - Leukemia

- Clarification of Leukemia:
 - Cancerous precursors to WBCs in bone marrow
 - Over production of WBC precursors (immature)
 - Do not mature, but exit the bone marrow into blood
- Types of Stem Cells: Embryonic & Adult
 - Commonly From bone marrow, embryos, cord blood
- Our work with stem cells is largely experimental
- Ethics? Differing policy by nation?

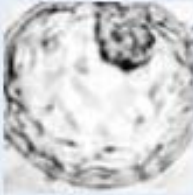
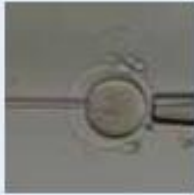
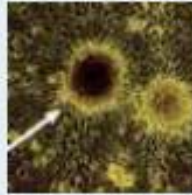
What are stem cells?

- Stem cells have two important characteristics that distinguish them from other types of cells:
 - First, ***Self-renewal*** - the ability to go through numerous cycles of cell division while maintaining an undifferentiated state.
 - Second, under certain physiologic or experimental conditions, they can be induced to become cells with special functions such as the beating heart muscle cells or the insulin-producing pancreas cells.
- Scientists primarily work with two kinds of stem cells from animals and humans: embryonic stem cells and adult stem cells, which have different functions and characteristics.

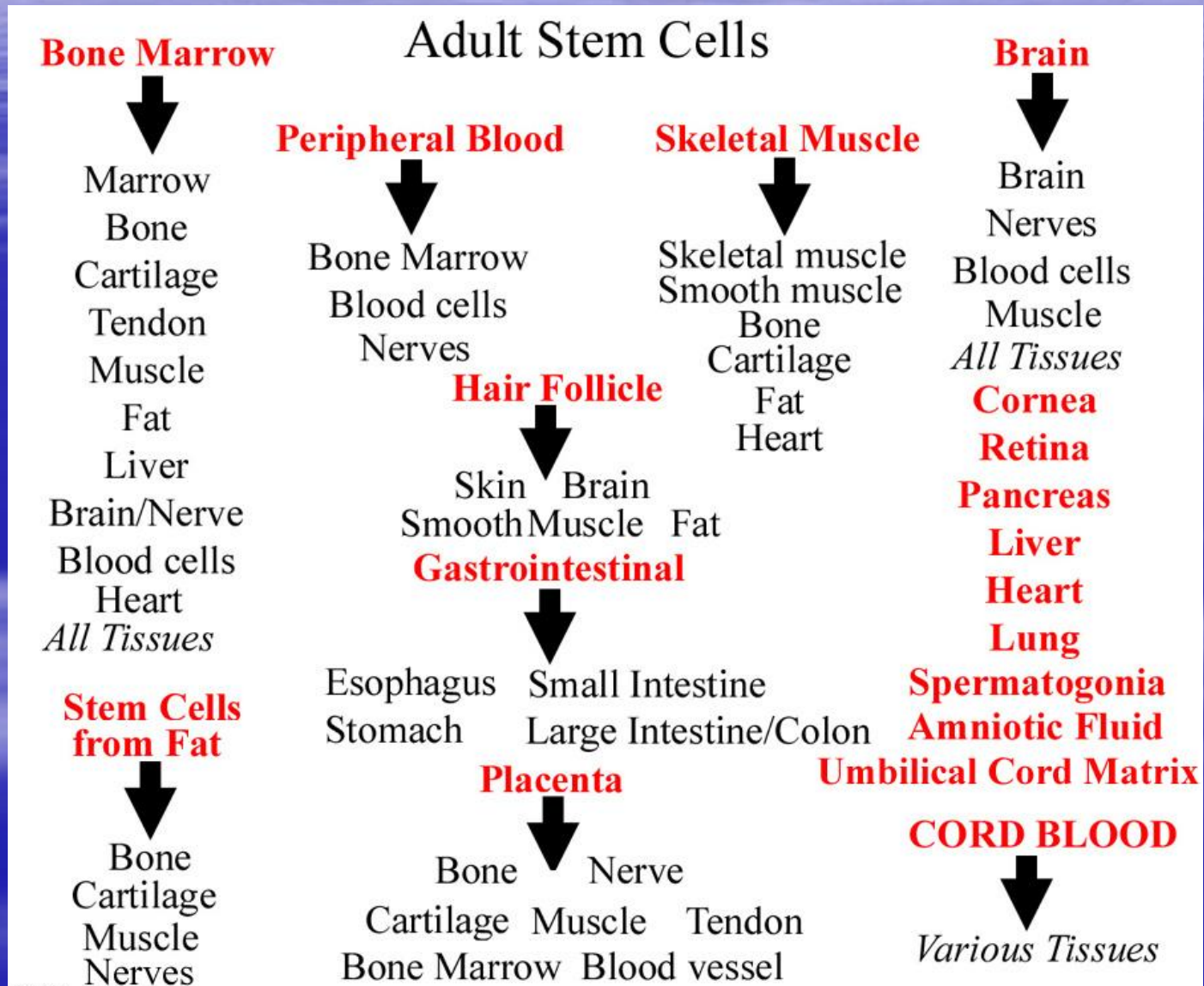
Embryonic vs. Adult Stem Cells?

- Individuals will argue if the use of embryonic stem cells is necessary or even wise for both ethical and practical reasons.
 - Embryonic stem cells may be totipotent, but do they have the chance of being “rejected”?
 - Will anti rejection drugs be needed?
 - Are embryonic stem cells less stable? Can they cause tumors?
 - Adult stem cells may be more difficult to maintain in culture and are generally unable to fully differentiate.
 - Is embryo “destruction” ethical?
- (These arguments may help you develop good questions to ask researchers.)

COMPARISON OF THE DIFFERENT SOURCES OF STEM CELLS

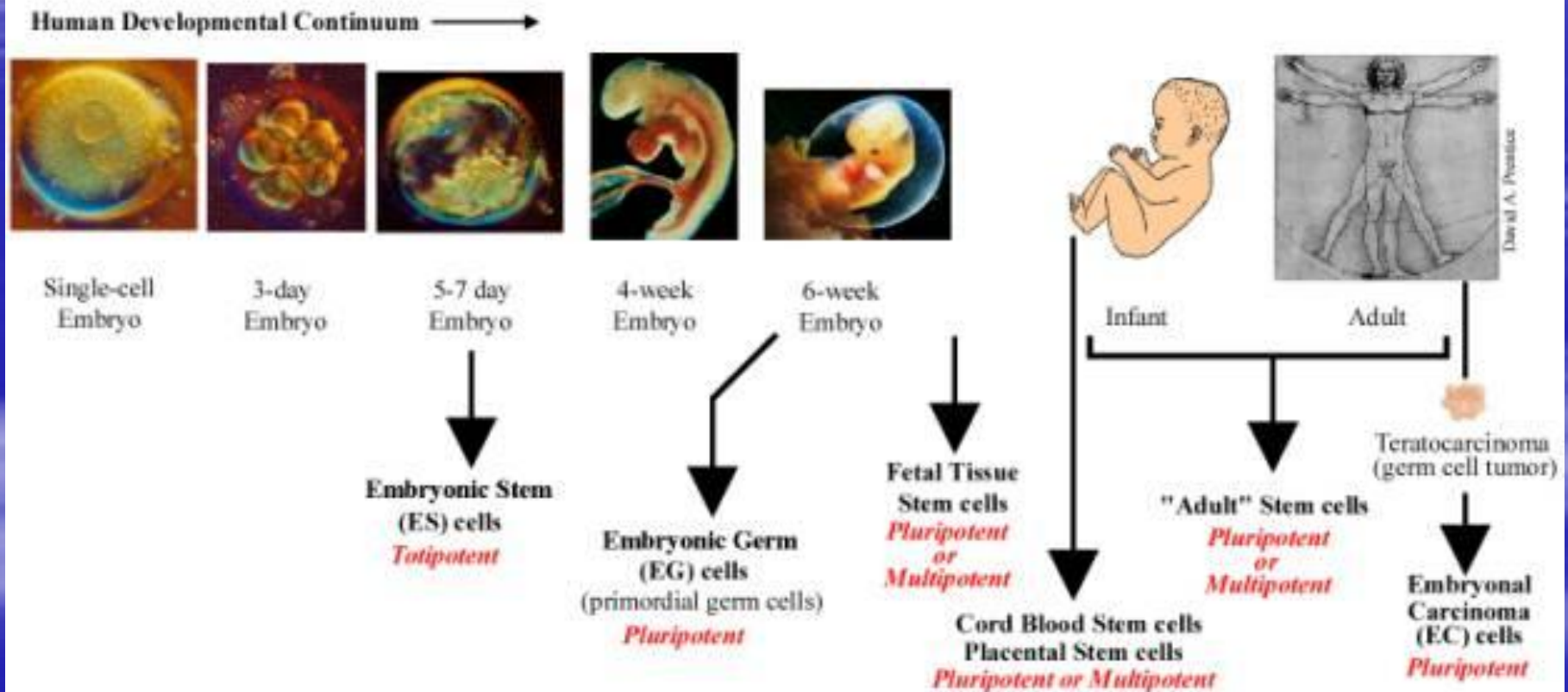
	Embryonic Stem Cells		Adult Stem Cells
Attributes	 <p>In Vitro Fertilization</p> <ul style="list-style-type: none"> • can produce all cell types • relatively easy to identify, isolate, maintain, and grow in the laboratory • large source of "excess" blastocysts from IVF clinics 	 <p>Nuclear Transfer</p> <ul style="list-style-type: none"> • can produce all cell types • relatively easy to identify, isolate, maintain, and grow in the laboratory • stem cells may be genetically matched to patient 	 <p>Adult Tissues</p> <ul style="list-style-type: none"> • demonstrated success in some treatments • stem cells may be genetically matched to patient
	<p>Limitations</p> <ul style="list-style-type: none"> • limited number of cell lines available for federally funded research • risk of creating teratomas (tumors) from implanting undifferentiated stem cells 	<ul style="list-style-type: none"> • not yet achieved with human cells • risk of creating teratomas (tumors) from implanting undifferentiated stem cells 	<ul style="list-style-type: none"> • produce limited number of cell types • not found in all tissues • difficult to identify, isolate, maintain, and grow in the laboratory
Ethical Concerns	<ul style="list-style-type: none"> • destruction of human blastocysts • donation of blastocysts requires informed consent 	<ul style="list-style-type: none"> • destruction of human blastocysts • donation of eggs requires informed consent • concern about misapplication for reproductive cloning 	<ul style="list-style-type: none"> • no major ethical concerns have been raised

Where do Adult Stem Cells Come From?



How are Stem Cells obtained?

Stem Cells



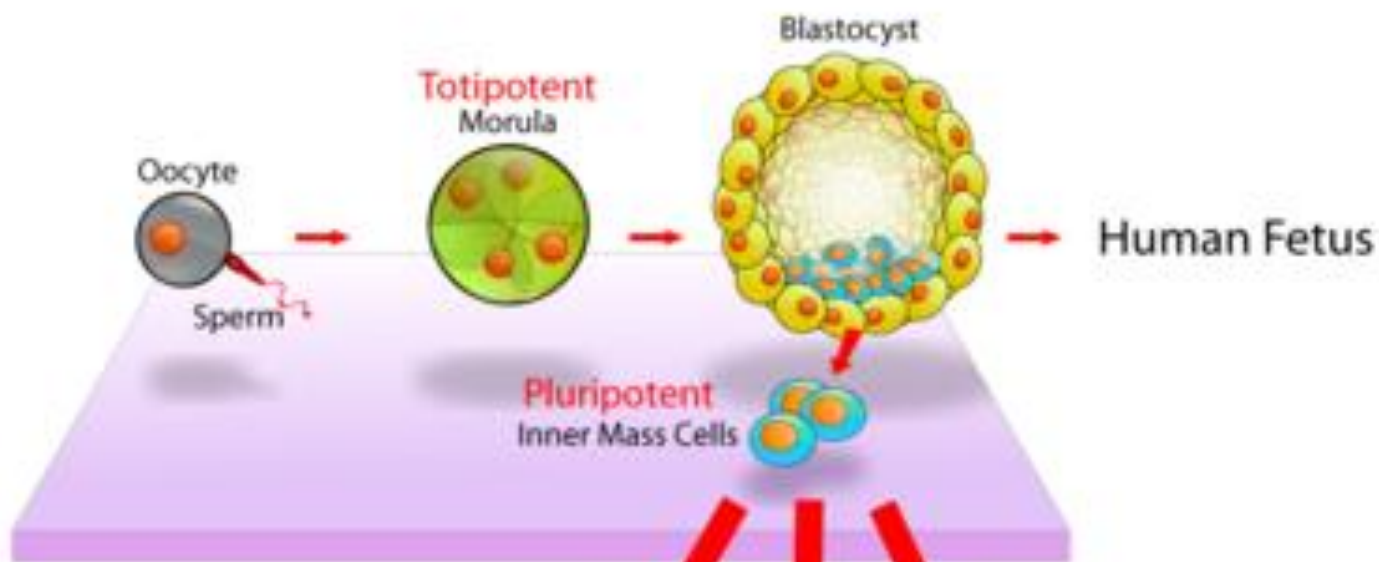
Potency?

- **Potency** - the capacity to differentiate into specialized cell types.
- **Potency** specifies the differentiation potential (the potential to differentiate into different cell types) of the stem cell:
- **Totipotent** stem cells are produced from the fusion of an egg and sperm cell. Cells produced by the first few divisions of the fertilized egg (the Morula) are also totipotent. These cells can differentiate into embryonic and extraembryonic (placental) cell types.
- **Pluripotent** stem cells are the descendants of totipotent cells, they originate as inner mass cells within a blastocyst, and can differentiate into cells derived from any of the three germ layers.

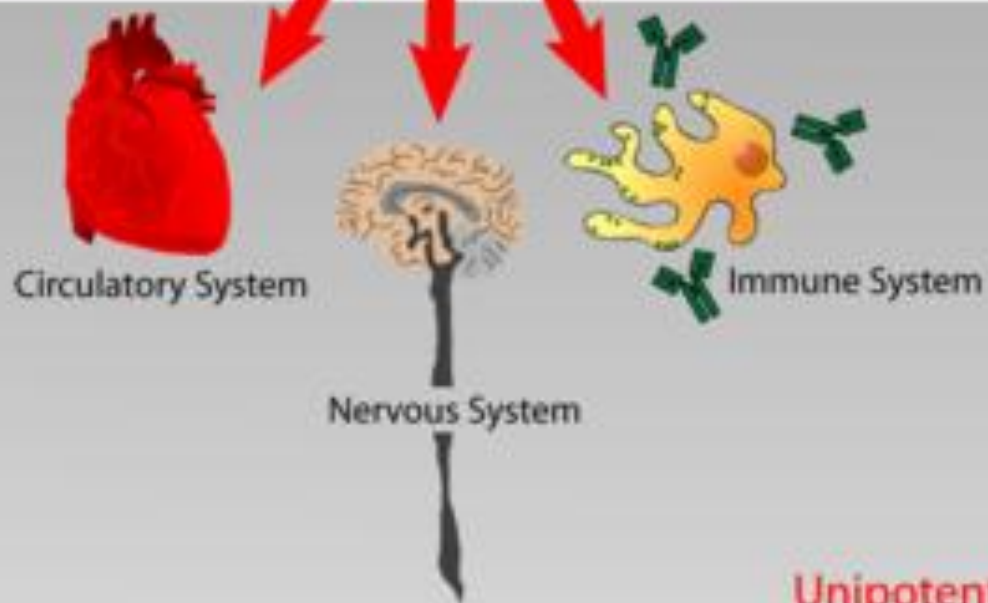
Potency (cont'd)

- **Multipotent** stem cells can produce only cells of a closely related family of cells (e.g. **hematopoietic stem cells** differentiate into red blood cells, white blood cells, platelets, etc.).
- **Unipotent** cells can produce only one cell type, but have the property of self-renewal which distinguishes them from non-stem cells (e.g. muscle stem cells)

In the strictest sense, “stem cells” are either **totipotent** or **pluripotent** – (to be able to give rise to any mature cell type) although **multipotent** or **unipotent** (progenitor cells) are sometimes referred to as stem cells.

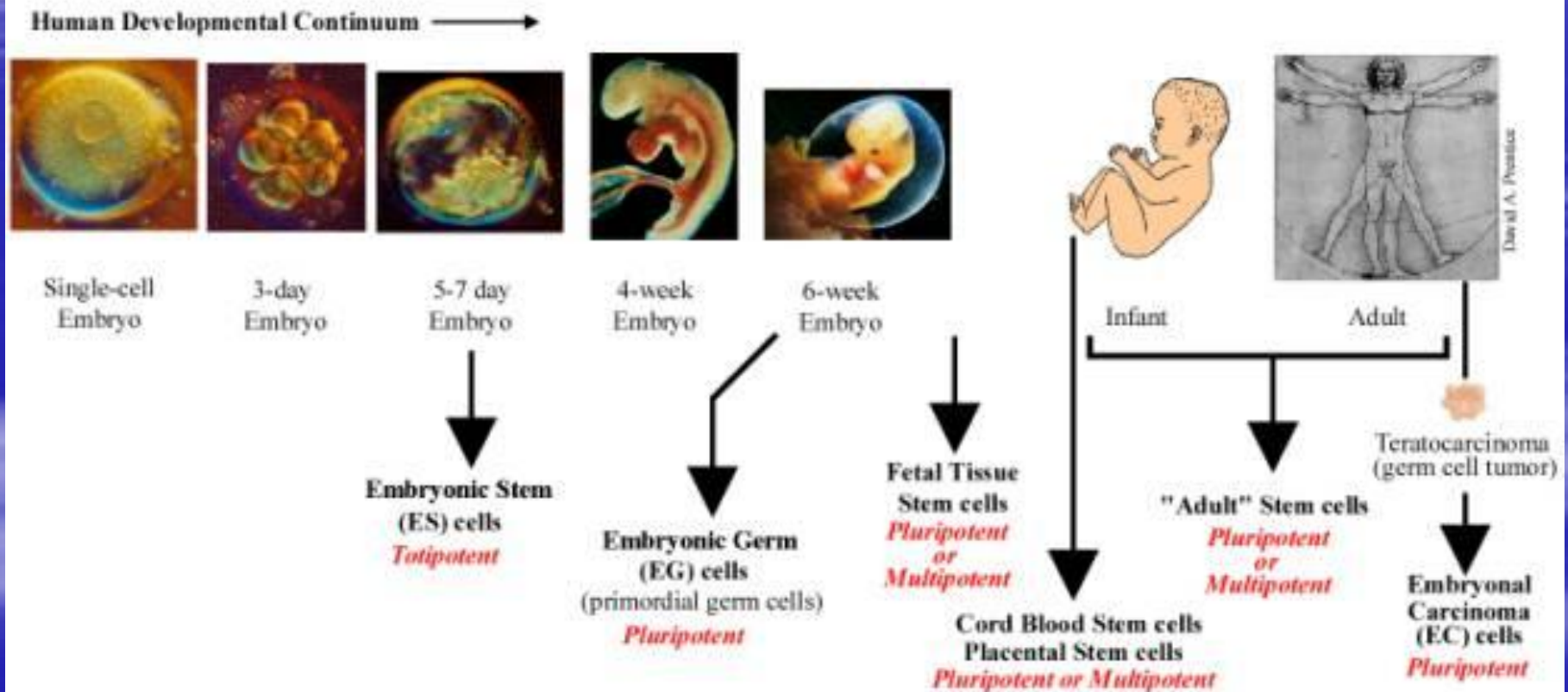


Examples:



How are they obtained?

Stem Cells



Review

- This video discusses stem cells and the differentiation of cells in the human embryo.

Applications of Stem Cell Technology?

- Scientists “create” a beating heart:
 - <http://www.youtube.com/watch?v=j9hEFUpTVP>
[A](#)
- Spinal Cord regeneration using “adult stem cells”
<http://www.youtube.com/watch?v=Fpw7xXF8XiE&NR=1>

Ethical Implications?

- There exists a widespread controversy over human embryonic stem cell research that emanates from the techniques used in the creation and usage of stem cells.
- Human embryonic stem cell research is controversial because, with the present state of technology, starting a stem cell line requires the destruction of a human embryo and/or therapeutic cloning.
- Recently, it has been shown in principle that adult stem cell lines can be manipulated to generate embryonic-like stem cell lines using a single-cell biopsy similar to that used in preimplantation genetic diagnosis that may allow stem cell creation without embryonic destruction.
- It is not the entire field of stem cell research, but the specific field of human embryonic stem cell research that is at the centre of an ethical debate.

- Opponents of the research argue that embryonic stem cell technologies are a slippery slope to reproductive cloning and can fundamentally devalue human life. Those in the pro-life movement argue that a human embryo is a human life and is therefore entitled to protection.
- Contrarily, supporters of embryonic stem cell research argue that such research should be pursued because the resultant treatments could have significant medical potential. It is also noted that excess embryos created for in vitro fertilization could be donated with consent and used for the research.
- The ensuing debate has prompted authorities around the world to seek regulatory frameworks and highlighted the fact that stem cell research represents a social and ethical challenge.

Legislation?

FEDERAL LEGISLATION

- **HHS Appropriations language (since 1996)**

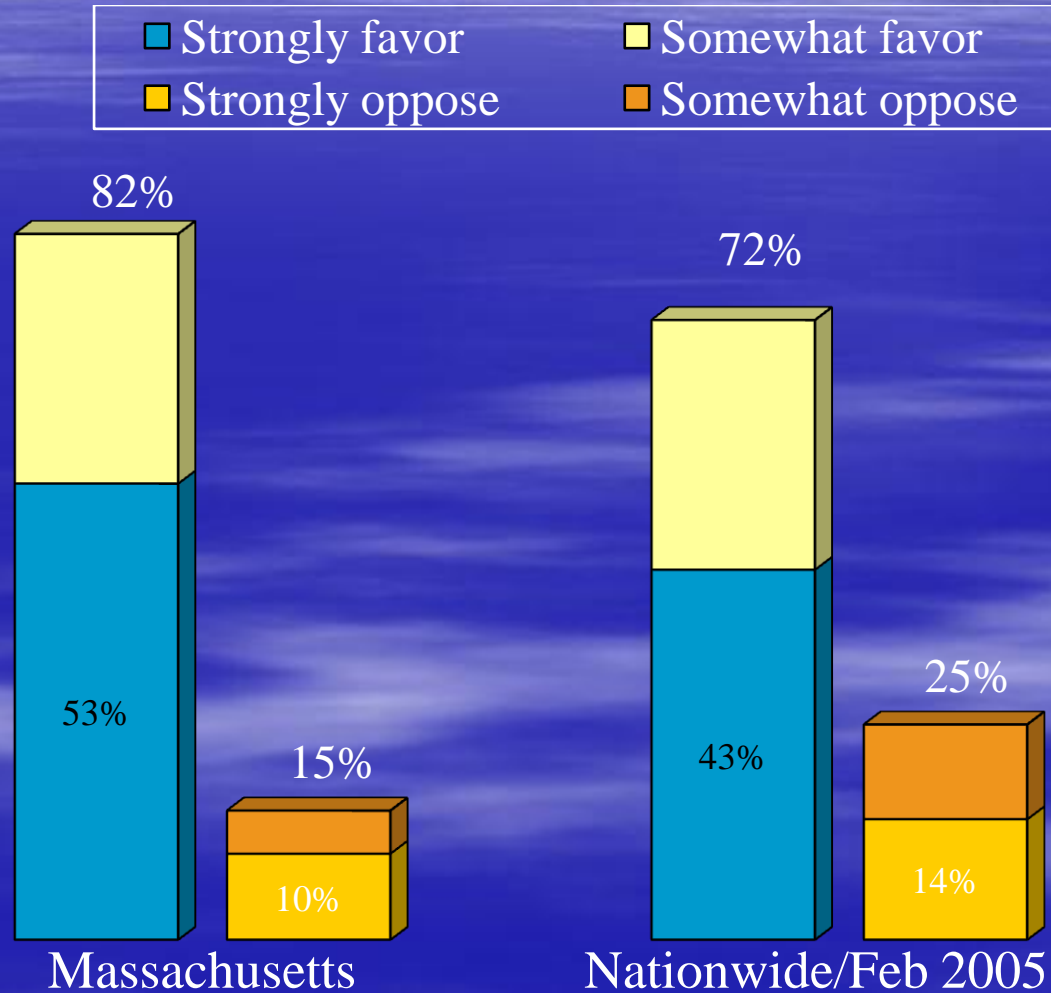
SEC. 510.

(a) None of the funds made available in this Act may be used for (1) the creation of a human embryo or embryos for research purposes; or (2) research in which a human embryo or embryos are destroyed, discarded, or knowingly subjected to risk of injury or death greater than that allowed for research on fetuses in utero under 45 CFR 46.208(a)(2) and section 498(b) of the Public Health Service Act (42 U.S.C. 289g(b)).

(b) For purposes of this section, the term “human embryo or embryos” includes any organism, not protected as a human subject under 45 CFR 46 as of the date of the enactment of this Act, that is derived by fertilization, parthenogenesis, cloning, or any other means from one or more human gametes or human diploid

Support For Stem Cell Research Increases With Explanation

“Embryonic stem cells are special cells that can develop into every type of cell in the human body. The stem cells are extracted from frozen embryos in fertility clinics, donated by couples who no longer intend to use the embryo to conceive a child. These embryos would therefore be discarded. The process destroys the embryo. These stem cells can then reproduce on their own, creating what is called a ‘line’ of stem cells that many researchers can work with. Scientists believe that there is a good chance that stem cells can be developed into cures or treatments for diseases such as cancer, Parkinson's, heart disease, juvenile diabetes, and spinal cord injuries.”



Writing questions for researchers

- Show your background knowledge.
- Do not shy away from ethical or political questions, knowing researchers may give you a more factual answer.
- Be specific; ask procedural questions
- Do not be afraid to ask about the researcher's educational or professional background.
- You are encouraged to ask specifics about what type of stem cell research and applications occur at the UW and other research institutions.

Nice Comprehensive Talk

- http://www.youtube.com/watch?v=mUcE1Y_bOQE

History at UW?