



**The Science
and Ethics of
Stem Cell
Research**

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The Science and Ethics of Stem Cell Research

Classroom Discussion of Ethics

It is important to find a way to structure discussions related to ethics and science and keep them manageable in the classroom. An additional element that supports successful discussions is the setting of class discussion norms. Ideally, if time permits, students can derive these themselves with facilitation from teachers. If not, possible discussion norms are included in this section. Additionally, suggestions for conducting classroom discussions are offered, along with a rubric that can be used to evaluate such discussions.

Generation of Discussion Norms

- Allow students some quiet reflection time.
- Gather ideas from the group in a brainstorming session.
- Clarify and consolidate norms as necessary.
- Post norms where they can be seen by all and revisit them often.

Possible Student Discussion Norms

- A bioethics discussion is not a competition or a debate with a winner and a loser.
- Everyone will respect the different viewpoints expressed.
- If conflicts arise during discussion, they must be resolved in a manner that retains everyone's dignity.
- Everyone has an equal voice.
- Interruptions are not allowed and no one person is allowed to dominate the discussion.
- All are responsible for following and reinforcing the rules
- Critique ideas, not people.

Suggestions for Conducting Classroom Discussions

- Listen carefully to what students are saying when they argue a particular issue. Be patient and allow students to express their views fully.
- Take notice of the words that students use in arguing their positions. Often the choice of words will reveal a bias or an unquestioned assumption.
- Ask clarifying questions. Many students will express important ideas that are rough or unclear. Asking students to define their terms or to reword their statements may help students hone their ideas.
- Make distinctions that will further the analysis. For example, if students are discussing duties, ask them what kinds of duties they want to include or emphasize (legal, professional, ethical)?
- Look for logical inconsistencies or fallacies in the students' arguments.
- Ask yourself whether a student's comment is supportive of an ethical theory.
- Challenge them to consider the shortcomings of that theory and how an alternate theory might address the issue.
- Challenge students to take an opposing view or to be critical of their own view. Ask them to consider the weaknesses of their arguments. What, if anything, makes them uneasy about their own views?
- Ask students to justify their views or the statements they make. If the response is 'I just feel that way' or 'I just know it's right', ask them to explain why. Many times students will refer to principles or values to justify their views, and these provide more justificatory power than do feelings or intuitions.
- If no principle or value emerges, challenge students to consider whether their emotive responses or intuitions are wrong.
- Provide balance. Play the devil's advocate. Don't let the argument be decided by the strength or a student's personality or by the loudness of the argument.
- Check whether this is a redundant view. Keep the analysis simple.
- Be on the lookout for frustration. If you sense a student is becoming frustrated, ask him or her to express this frustration. Many times this will lead to interesting and important ideas.
- Stick to the case. While departing from the case may sometimes be useful, letting the discussion wander can be dangerous. You may create a discussion that is difficult to direct. Stick to the facts of the case. Many of the facts will limit the number of the issues that need to be considered.

Ethics Discussion Evaluation

	4 Exemplary	3 Proficient	2 Partially Proficient	1 Developing
Recognizes and Understands Multiple Perspectives	Beyond recognition and understanding, student is able to empathize with others' perspectives. Student's own thinking becomes more complex and thorough with added perspectives.	Student demonstrates recognition and understanding of multiple perspectives through reflection and paraphrasing.	Student recognizes and understands some alternate perspectives through reflection and paraphrasing.	Student struggles to reflect and paraphrase alternate perspectives accurately.
Participates in a Civil and Democratic Discussion	Beyond meeting discussion guidelines, student is a discussion leader, soliciting others' viewpoints and enforcing discussion guidelines in a respectful manner.	Meets all discussion guidelines.	Meets some discussion guidelines, but some areas need development.	Several areas of discussion guidelines need development.
Communicates Ideas Using Supporting Evidence	Student states ideas with relevant supporting evidence from several of the following: content presented in class, experience, legitimate sources.	Student states ideas with relevant supporting evidence from content presented in class, experience, or legitimate sources.	Student sometimes states ideas using relevant supporting evidence from content presented in class, experience, or legitimate sources.	Student rarely or never states ideas using relevant supporting evidence from content presented in class, experience, or legitimate sources.
Demonstrates Understanding and Application of Science Content	Student consistently uses ample content vocabulary appropriately. Scientific statements are factual and thorough. Student is able to apply scientific concepts through examples and integration, even to areas outside the original content.	Student uses content vocabulary appropriately. Scientific statements are factual. Student applies scientific concepts accurately through examples and integration of different concepts.	Student is at times able to use vocabulary appropriately. Some facts are incorrect. Student shows limited ability to apply scientific concepts through examples and integration.	Student rarely uses vocabulary appropriately. Facts are often incorrect. Student struggles to apply scientific concepts through examples and integration.

Ethics Discussion Evaluation

	4 Exemplary	3 Proficient	2 Partially Proficient	1 Developing
Identifies Ethical Processes and Theories Used	Beyond meeting discussion guidelines, student is a discussion leader, soliciting others' viewpoints and enforcing discussion guidelines in a respectful manner.	Meets all discussion guidelines.	Meets some discussion guidelines, but some areas need development.	Several areas of discussion guidelines need development.
COMMENTS:				

DISCUSSION GUIDELINES:

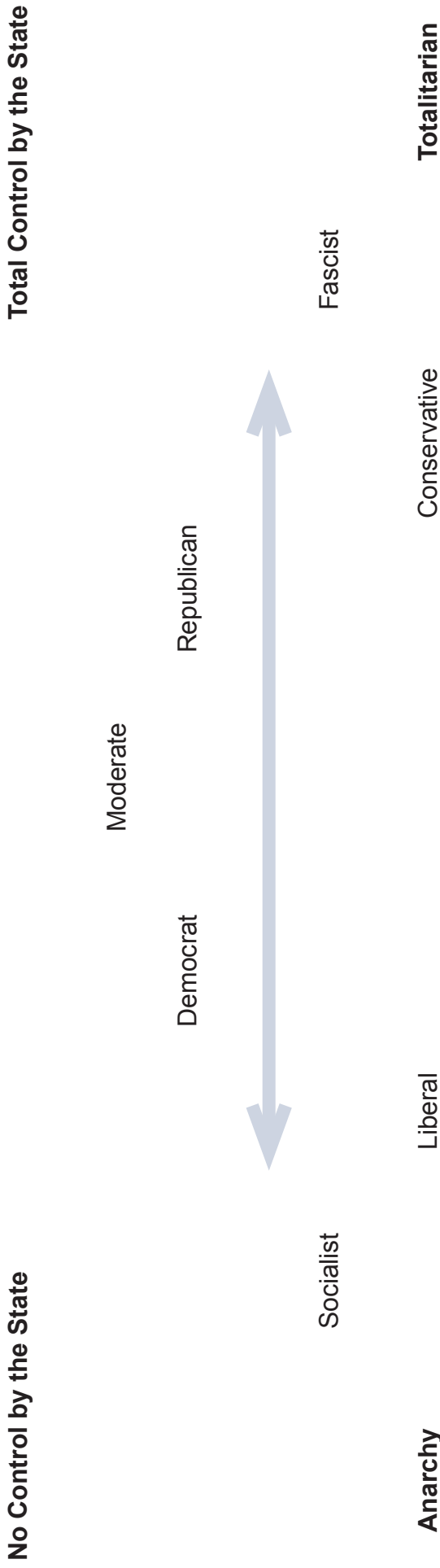
- Student's tone of voice and body posture implies discourse and discussion rather than a debate or competition.
- Student acknowledges and respects different viewpoints.
- Student tries to resolve conflicts that arise in a manner that retains everyone's dignity.
- Student advocates for own voice, as well as treats others' voices with equal importance.
- Student does not interrupt others.
- Student does not dominate the conversation.
- Student critiques ideas rather than people.
- Student is attentive.
- Student contributes to enforcing above rules when appropriate.

SUGGESTED MODES OF EVALUATION:

- Student sees rubric before participating in a discussion that will be evaluated.
- Self assessment based on rubric.
- Peer assessment based on rubric.

Lesson 4

A Simplified View of the American Political Spectrum



A Note to Teachers...

- Please note that this is a highly simplified graphic and does not accurately represent the gradations of the U.S. political spectrum.
- If your students are having a difficult time understanding the U.S. political spectrum and are not familiar with words like “conservative” and “liberal”, this graphic (though simplified) may be helpful.
- For students who have some familiarity with the political vocabulary, however, it is NOT recommended that they be instructed in the terminology before the Four Corners Activity in Lesson 4. Students often work out amongst themselves the meaning of the words, and have a better appreciation for the complexity involved.
- Though a useful tool in some cases, this graphic serves to further stereotype stakeholder positions. The object of Lesson 4 is to reinforce the idea that there are many ‘shades of gray’ in considering the perspectives on stem cell research.





The Science and Ethics of Stem Cell Research

Teacher Background

What are stem cells, and why are they important?

Stem cells have two important characteristics that distinguish them from other types of cells. First, they are unspecialized cells that renew themselves for long periods through cell division. The second is that under certain physiologic or experimental conditions, they can be induced to become cells with special functions such as the beating cells of the heart muscle or the insulin-producing cells of the pancreas.

What are embryonic stem cells?

Embryonic stem cells, as their name suggests, are derived from embryos. Specifically, embryonic stem cells are derived from embryos that develop from eggs that have been fertilized *in vitro*—in an *in vitro* **fertilization** clinic—and then donated for research purposes with informed consent of the donors. They are *not* derived from eggs fertilized in a woman's body. The **embryos** from which **human embryonic stem cells** are derived are typically four or five days old and are a hollow microscopic ball of cells called the **blastocyst**. Growing cells in the laboratory is known as **cell culture**. Human embryonic stem cells are isolated by transferring the **inner cell mass of a blastocyst** into a plastic laboratory culture dish that contains a nutrient broth known as **culture medium**. The cells divide and spread over the surface of the dish after six months or more, the original 30 cells of the inner cell mass yield millions of embryonic stem cells. Embryonic stem cells that have proliferated in cell culture for six or more months without differentiating, are **pluripotent**, and appear genetically normal are referred to as an **embryonic stem cell line**. The source of embryonic stem cells is the inner cell mass from the blastocyst. Removing these cells prevents further development of the embryo.

What are adult stem cells?

An adult stem cell is an **undifferentiated** cell found among differentiated cells in a tissue or organ, can renew itself, and can differentiate to yield the major specialized cell types of the tissue or organ. The primary roles of **adult stem cells** in a living organism are to maintain and repair the tissue in which they are found. Adult stem cells sounds like they come only from adult humans. Actually, this term refers to cells taken from cells that are multipotent—cells that are committed to a cell lineage—including those from newborns and children.

Where are adult stem cells found and what do they normally do?

Adult stem cells have been identified in many organs and tissues. One important point to understand about adult stem cells is that there are a very small number of stem cells in each tissue. Stem cells are thought to reside in a specific area of each tissue where they may remain quiescent (non-dividing) for many years until they are activated by disease or tissue injury. The adult tissues reported to contain stem cells include brain, bone marrow, peripheral blood, blood vessels, skeletal muscle, skin and liver.

What is the difference between stem cells from an adult, and stem cells from an embryo?

Totipotent stem cells—such as the product of fertilization of an ovum and its progeny—are stem cells that have total potency, which means that they have the ability to form an entire mature organism, e.g., a human being, although only if placed in a woman's uterus.

Stem cells from the blastocyst stage of an embryo are **pluripotent stem cells**, and give rise to almost all of the cell types of the body, such as muscle, nerve, heart, and blood. They hold great promise for both research and health care.

Adult stem cells are **multipotent stem cells**. These are undifferentiated cells formed after gastrulation, (during which the three tissue layers: ectoderm, mesoderm, and endoderm form). These are true stem cells but can only differentiate into a limited number of types. For example, the bone marrow contains multipotent stem cells that give rise to all the cells of the blood but not to other types of cells

What are the potential uses of human stem cells?

There has been one study in which scientists claim to have discovered a stem cell in adults that can turn into every single tissue in the body. This has yet to be replicated.

Certain kinds of stem cells have the ability to differentiate into a number of different cell types, given the right conditions. If this differentiation of adult stem cells can be controlled in the laboratory, these cells may become the basis of therapies for many serious common diseases. Some examples of potential treatments include replacing the dopamine-producing cells in the brains of Parkinson's patients, developing insulin-producing cells for type I diabetes and repairing damaged heart muscle following a heart attack with cardiac muscle cells. This advance in human biology continues to generate enthusiasm among scientists, patients suffering from a broad range of diseases, including cancer, heart disease and diabetes, and their families. For example, further research using human pluripotent stem cells may help:

- Generate cells and tissue for transplantation. Pluripotent stem cells have the potential to develop into specialized cells that could be used as replacement cells and tissues to treat many diseases and conditions, including Parkinson's disease, spinal cord injury, stroke, burns, heart disease, diabetes, osteoarthritis, and rheumatoid arthritis.
- Improve our understanding of the complex events that occur during normal human development and also help us understand what causes birth defects and cancer.
- Change the way we develop drugs and test them for safety. Rather than evaluating the safety of candidate drugs in an animal model, drugs might be initially tested on cells developed from pluripotent stem cells and only the safest candidate drugs would advance to animal and then human testing.

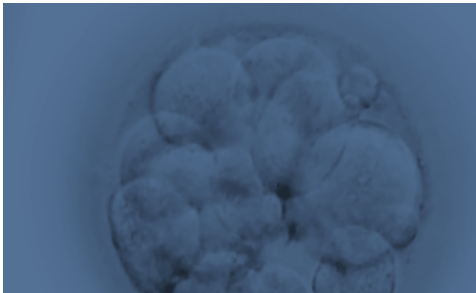
Have human embryonic stem cells been used successfully to treat any human diseases yet?

Scientists have only been able to do experiments with human embryonic stem cells (ESC) since 1998, when a group led by Dr. James Thomson at the University of Wisconsin developed a technique to isolate and grow the cells. Moreover, federal funds to support ESC research have only been available since August 9, 2001, when President Bush announced his decision on federal funding for ESC research. Because many academic researchers rely on federal funds to support their laboratories, they are just beginning to learn how to grow and use the cells. Thus, although ESC are thought to offer potential cures and therapies for many devastating diseases, research using them is still in its early stages.

In late January 2009, the California-based company Geron received FDA clearance to begin the first human clinical trial of cells derived from human embryonic stem cells. Adult stem cells such as blood-forming stem cells in bone marrow (called hematopoietic stem cells, or HSCs) are currently the only type of stem cell commonly used to treat human diseases. Doctors have been transferring HSCs in bone marrow transplants for over 40 years. More advanced techniques of collecting, or “harvesting”, HSCs are now used in order to treat leukemia, lymphoma and several inherited blood disorders.

The clinical potential of adult stem cells has also been demonstrated in the treatment of other human diseases that include diabetes and advanced kidney cancer. However, these newer uses have involved studies with a very limited number of patients.

Source: National Institution of Health; <http://stemcells.nih.gov/info/faqs.asp>



Selected Stem Cell Online Resources

General Background

HHMI Potent Biology: Stem Cells, Cloning and Regeneration

http://www.hhmi.org/biointeractive/hl/2006_summaries.html

This free 2006 Holiday Lectures on Science video contains lectures aimed at high school students, animations, and interviews with scientists. There is also a helpful section about planaria.

Bioscience Network

<http://www.stemcellresources.org/>

This comprehensive source has links to everything from case studies to animations to policy issues.

University of Wisconsin Stem Cell Site

<http://www.news.wisc.edu/packages/stemcells/>

Written for general audiences, includes some graphics

Scientific American Article: *The Stem Cell Challenge*, June 2004 (Lanza and Rosenthal)

<http://www.sciam.com/article.cfm?articleID=000DFA43-04B1-10AA-84B183414B7F0000&sc=I100322>

Scientific American article on Stem Cell Research

Stem Cells and the Future of Regenerative Medicine Online Book (2002)

<http://www.nap.edu/books/0309076307/html/>

National Academies Press

Animations/Video

Stem Cells in the Spotlight includes animations (geared at younger audiences) <http://gslc.genetics.utah.edu/units/stemcells/>

Animation from the University of Michigan

<http://www.lifesciences.umich.edu/research/featured/tutorial.html>

PBS Newshour Stem Cell Online Animation

http://www.pbs.org/newshour/health/stem_cell_animation.html

Similar to the Stem Cell Research Animation

PBS Online Newshour: Growing Stem Cells, 2004 (Streaming Video and RealAudio)

http://www.pbs.org/newshour/bb/health/july-dec04/stemcell_8-10.html

Lehrer Newshour feature on Stem Cells, including footage from the 2004 Democratic National Convention

Riken Center for Developmental Biology

<http://www.cdb.riken.jp/jp/stemcells/>

European Consortium for Stem Cell Research

http://www.eurostemcell.org/Outreach/Film/film_eng.htm

Korean Scandal

NY TIMES on Hwang Woo Suk and falsified data on human embryonic stem cell cloning

http://topics.nytimes.com/top/reference/timestopics/people/h/hwang_woo_suk/?inline=nyt-per

Special Science Magazine articles on Hwang Woo Suk, including original papers

<http://www.sciencemag.org/sciext/hwang2005/>

Additional Lesson Plans

PBS Newshour Extra Lesson Plan

(internet research and advocacy brochure)

<http://www.pbs.org/newshour/extra/teachers/lessonplans/august01/stemcells/>

PBS Newshour Extra Lesson Plan (students use a worksheet to find basic information on the internet, and then use a graphic organizer to collect and discuss information on adult vs. embryonic stem cell research)

http://www.pbs.org/newshour/extra/teachers/lessonplans/science/adult_stemcell.html

Genetic Science Learning Center at <http://teach.genetics.utah.edu/> Teacher Resources -> Classroom Activities -> Stem Cells in the Spotlight. Provides a variety of lessons related to Stem Cell Issues, including 'Meeting in Mutantville' (deciding whether to grant a business license to a stem cell company) and 'Embryos are Us' (a couple decides what to do with extra embryos from an *in vitro* fertilization procedure). A preassessment activity entitled 'What do you know about stem cells?' asks students to interview others about stem cell research.

NWABR Ethics in the Science Classroom Workshop
Teacher-Developed Stem Cell Lesson Plans.

<http://www.nwabr.org/education/ethicslessons.html>

This set of lessons uses some of the material from the Genetic Science Learning Center as well as from other sources (news articles, hypothetical scenarios) to investigate issues surrounding stem cell research.

Saving Superman: A Look into Stem Cell Research

http://sciencecases.org/superman/superman_notes.asp

This is an online case-study approach that uses the story of Christopher Reeves. Background materials are also included. From the National Center for Case Study Teaching in Science, SUNY Buffalo: <http://ublib.buffalo.edu/libraries/projects/cases/case.html>.

History of Stem Cell Research and Policy

<http://www.aaas.org/spp/cstc/briefs/stemcells/>

American Association for the Advancement of Science Brief (updated 2009)

National and International Policy

International Stem Cell Research Links from the NIH
<http://stemcells.nih.gov/research/intlresearch.asp>
Includes links to the International Stem Cell Forum and International Society for Stem Cell Research.

World Stem Cell Map

<http://mbbnet.umn.edu/scmap.html>

The map shows relative levels of permissive/flexible stem cell research policies across the globe.

Ethics

President's Council on Bioethics

http://www.bioethics.gov/topics/stemcells_index.html

Reports, transcripts, and background material

International Society for Stem Cell Research

<http://www.isscr.org/public/ethics.htm>

Remarks by the President on Stem Cell Research, by George W. Bush, August 9, 2001

<http://www.whitehouse.gov/news/releases/2001/08/20010809-2.html>

Embryo Ethics: The Moral Logic of Stem Cell Research, New England Journal of Medicine

<http://content.nejm.org/cgi/content/full/351/3/207>

Two members of the President's Council on Bioethics reflect on the use of embryonic stem cells from a moral perspective.

The National Reference Center for Bioethics Literature offers a free "ETHX on the Web" database containing citations and full-text

(when available) documents on ethical issues related to stem cell research, at: <http://bioethics.georgetown.edu>

Go to the above page, then SEARCH, and select ETHX on the Web. Enter keyword terms, e.g., stem cells or stem cell research or embryonic stem cell research or adult stem cells into the search box.

Advocacy Groups

Organization Promoting Adult Stem Cell Use

Do No Harm: The Coalition of Americans for Research Ethics

<http://www.stemcellresearch.org/>

Organization Promoting Embryonic Stem Cell Use

Coalition for the Advancement of Medical Research

<http://www.camradvocacy.org/>

Stem Cell Research News

http://www.stemcellresearchnews.com/Stem_Cell_News.htm

A commercial, online newsletter that features stories about stem cells of all types