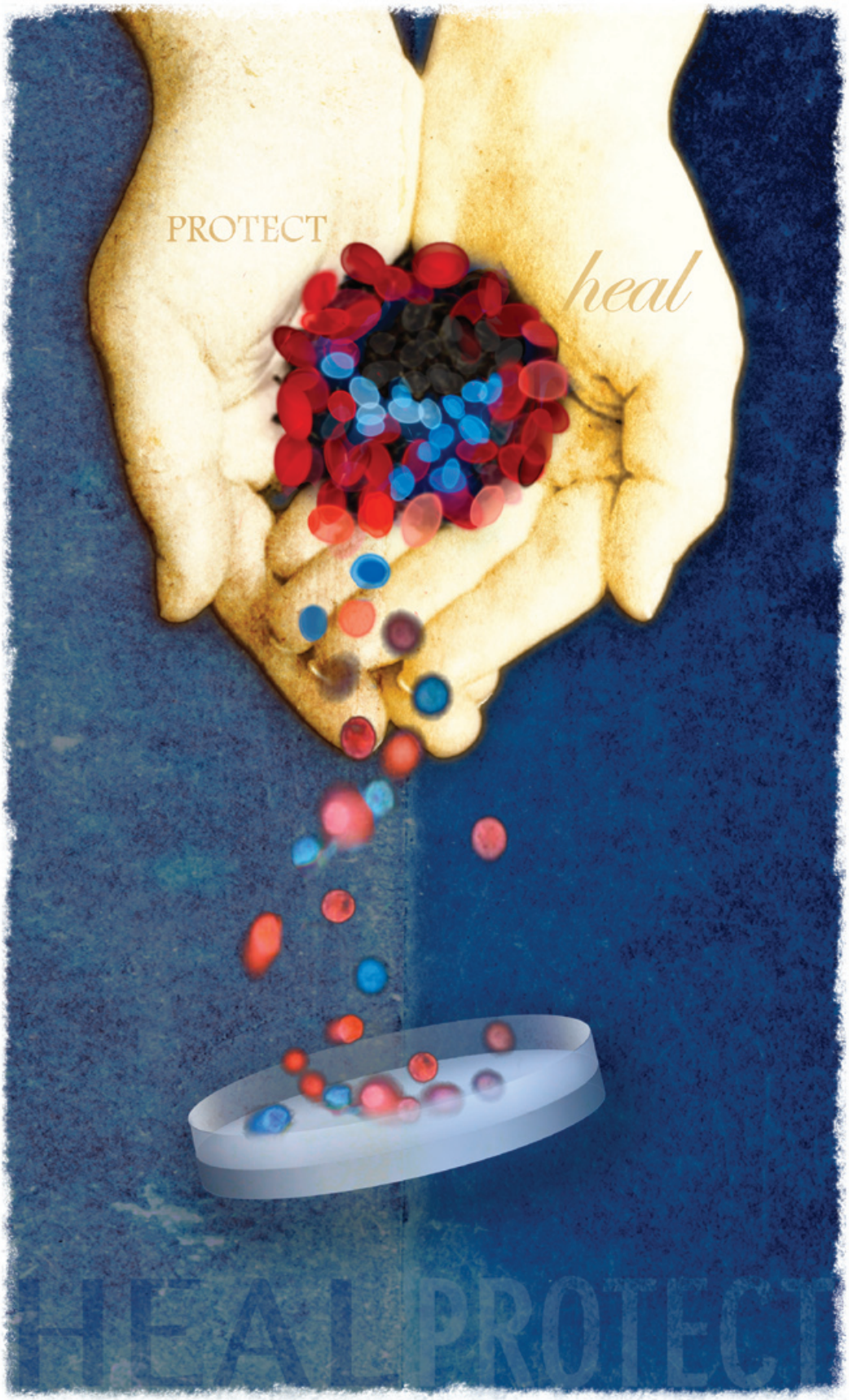
The Science and Ethics of Stem Cell Research



Third Edition

Curriculum Guide
Grades 7-12

Northwest Association for Biomedical Research
www.nwabr.org

Stem Cell Research

This curriculum is available on the NWABR website,
http://www.nwabr.org/education/stemcellrequest.html

The Science and Ethics of Stem Cell Research

Overview

This unit explores the scientific and ethical issues involved in stem cell research. Students are introduced to fundamental stem cell concepts by using planaria as a model organism in a laboratory investigation. Students then identify stages in the development of human embryos by modeling early growth with play-dough. Using their models, they are then able to compare the types and potency of human stem cells. A variety of techniques for obtaining stem cells are introduced to students though written descriptions, diagrams and news articles. Students learn the type of stem cells produced by each technique as well as some history of stem cell research. By introducing students to the major principles of biomedical ethics, students are able to develop an awareness of the many shades of gray that exist among positions of stakeholders in the debate about the use of stem cells in research. Students are also provided an opportunity to become familiar with the history of federal policy and regulation in regard to embryonic stem cell research, the ethical debate which has shaped this policy, and the implications for treatment of disease and advancement of scientific knowledge. The unit culminates with students developing a position on embryonic stem cell research through the use of a Decision-Making Framework. Two culminating assessments are offered: In the individual assessment, students write a letter to the President or the President's Council on Bioethics describing his or her position and recommendations; In the group assessment, students develop a proposal for NIH funding to research treatment for a chosen disease using either embryonic or adult stem cells.

Instructional Components

Length:

A Planaria lab, 5 lessons, and a selection of culminating assessments span approximately 2 weeks, depending on the number of activities and/or extensions used.

Target Audience: Grades 7-12

Washington State Standards Targeted

Systems	1.1.6 Characteristics of Living Matter
	1.2.6 Structure and Organization of Living System
	1.2.7 Molecular Basis of Heredity
	1.2.8 Human Biology
Inquiry	2.1.1 Questioning
	2.2.2 Limitations of Science and Technology
Design	3.1.1 Identifying Problems
	3.1.2 Designing and Testing Solutions
	3.1.3 Evaluating Potential Solutions
	3.2.1 All Peoples Contribute to Science and Technology
	3.2.2 Relationship of Science and Technology

Correlation to National Science Standards: Grades 5-12

Unifying Concepts and Processes	Planaria Lab	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Assessment
Systems, order, and organization	•	•					•
Evidence, models, and explanation	•	•	•	•	•	•	•
Constancy, change, and measurement	•	•	•		•	•	•
Evolution and equilibrium	•						•
Form and Function	•	•					•

Correlation to the National Science Standards: Grades 9-12

	Planaria Lab	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Assessment
Science as Inquiry							
Abilities necessary to do scientific inquiry	•						•
Understandings about scientific inquiry	•		•			•	•
Physical Science							
Structure and properties of matter			•				
Chemical Reactions							
Life Science							
The cell	•	•	•	•	•	•	•
Molecular basis of heredity	•	•	•				•
Biological Evolution		•					
Interdependence of organisms							
Matter, energy, and organizations in living systems		•	•				•
Behavior of organisms	•						
Science and Technology							
Abilities of technological design				•			•
Understandings about science and technology				•	•	•	•
Science in Personal and Social Perspectives							
Personal health and community health		•	•	•	•	•	•
Science and technology in local, national, and global challenges		•	•	•	•	•	•
History and Nature of Science							
Science as human endeavor	•	•	•	•	•	•	•
Nature of scientific knowledge	•	•	•	•	•	•	•
Historical Perspectives			•		•	•	•

Essential Questions:

1. What are the defining characteristics of different types of stem cells and how can each type be used in research?
2. Who should be allowed to make decisions regarding research related to moral and ethical issues that affect our quality of life?
3. How do we decide what to do, individually and collectively, when there are so many valid and conflicting viewpoints about stem cell research?
4. What are the various ethical perspectives concerning research on embryonic stem cells?
5. Will embryonic stem cells live up to their promise of providing life-saving health benefits?

Unit Objectives:

The student will be able to:

1. Explain what stem cells are, where they are located, how they develop, and how they function.
2. Explain the different methods of obtaining stem cells, the potential use of the types obtained, and how the source relates to the controversy over stem cell research.
3. Analyze the economic, social, legal, and ethical factors influencing stem cell research.
4. Describe the range of positions taken by individuals/organization/countries with respect to stem cells, and identify how a particular position relates to an ethical theory.
5. Evaluate policy options identified by the scientific community and the U.S. government, and become familiar with the ethical debate which has shaped this policy.
6. Integrate and apply understandings about stem cells, disease, and policy issues to develop an informed, personal position expressed either by writing a letter to a policy maker/advisory committee, or creating a research proposal for funding.

Enduring Understandings:

1. Because stem cells are undifferentiated cells with the ability to develop into a variety of cell types, they have many potential medical uses to regenerate tissues and act as a model for exploring cell processes, disease mechanisms, and treatment.
2. Research has given scientists tools and techniques for investigating the potential uses and limitations of stem cells from various sources (embryonic, adult, umbilical, fetal) and with different potencies.
3. Stem cell research (and scientific research in general) is determined by many factors, including public policy and laws, economic and funding issues, analysis of potential risks and benefits, and advocacy by groups and individuals.
4. Policy, advancement of research, and decision-making regarding stem cells varies between states and between countries, due to ethical considerations, economic concerns, cultural concerns, religious beliefs, and personal values of their citizens.
5. Stem cell research is controversial because there are many different and sometimes contradictory viewpoints that need to be considered when making decisions about which stem cells should be used and the ways in which experiments should be ethically conducted.

The Science and Ethics of Stem Cell Research

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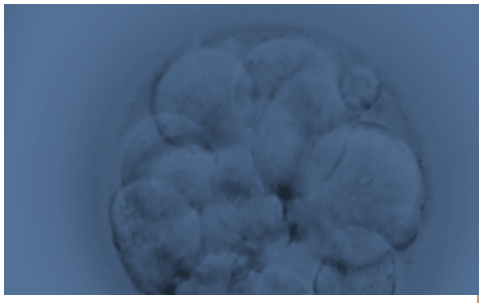


Lesson Overview

The lessons support students in writing and presenting a proposal for NIH funding to research treatment for a chosen disease using stem cells based upon knowledge of regeneration, types and potencies of stem cells, stakeholder positions on stem cell research, and current policies and regulations on stem cell research.

Laboratory Investigation — *Plenty of Planaria*

Students engage in a laboratory investigation designed to introduce fundamental stem cell concepts using Planaria as a model organism. This model works well for demonstrating stem cell function and complexity of tissue regeneration. The investigation functions as a starting point for students to begin thinking about the concept of regeneration and stem cells in other organisms. It also introduces the concept of stem cell potency.

Lesson One — *Stem Cell Development*

This lesson focuses on identifying stages in the development of human embryos and comparing the types and potency of stem cells. Using student-made play dough models, students visualize where stem cells come from, and learn that stem cells are totipotent, pluripotent, or multipotent at different stages of development.

Lesson Two — *Techniques for Obtaining Stem Cells*

Students gain an understanding of the variety of techniques used for obtaining stem cells, and learn if a given technique produces embryonic or adult stem cells. Students read articles from the news in which these different techniques are used and engage in small group discussions.

Lesson Three — *Case Study: One Family's Dilemma*

In this lesson, students are introduced to some major principles of biomedical ethics; respect for persons, beneficence / nonmaleficence, and justice. Next, they examine a case study in which the parents of two children born with the help of *in vitro* fertilization techniques are asked to decide the fate of their remaining frozen embryos. In small groups, students evaluate the options available to the parents in light of the bioethical principles, applying their understanding of ethical concepts to the case.

Lesson Four – *Shades of Gray*

Students develop an awareness of the many shades of gray that exist in the stakeholders of the stem cell research debate. In this lesson students participate in an activity where they take the role of a stakeholder and make inferences about that stakeholder's beliefs with respect to embryonic stem cell research. Later, an actual biographical example of such a stakeholder is provided to them. In several cases, the stakeholders do not fit the 'stereotype' of the particular group they belong to, reinforcing the idea that there are many 'shades of gray' in considering the perspectives on stem cell research.

Lesson Five – *Ethics and Policy*

This lesson provides students with the opportunity to consider how underlying ethical considerations influence the direction of public policy and advancement of scientific knowledge. Using a Socratic Seminar format, students consider fundamental ethical considerations underlying the use of embryos in research.

Culminating Project

Students complete a Decision-Making Framework to consider the larger moral and ethical issues behind the use of *in vitro* fertilized embryos in developing stem cell lines. The framework document serves as a basis for the final assessment.

For the culminating project, teachers may choose a group assessment, an individual assessment, or both;

As an individual assessment, each student expresses his or her personal view on the stem cell debate by writing a letter to the President or President's Bioethics Commission recommending future regulations and funding criteria.

The group culminating assessment allows students to simulate the real-life process of writing and presenting proposals for obtaining NIH funding to research treatment for a chosen disease using stem cells. In addition, the students participate on a review panel to evaluate proposal presentations in order to determine which proposals should be funded.

The Science and Ethics of Stem Cell Research

Plenty of Planaria Teacher Overview

Objectives

Students will be able to:

- Distinguish between types of stem cell potency (totipotent, pluripotent, and multipotent).
- Compare planaria stem cells to human stem cells.
- Design unique questions to test planaria regeneration, and analyze their data in support of a conclusion.
- Synthesize and evaluate trends in class data.

Class Time

- 1 class period for initial laboratory.
- 10-15 minutes each day over the course of the next week or two to record observations.
- 1 class period for data results and analysis.

Prior Knowledge Needed

Basic lab techniques, inquiry skills, basic understanding of cell biology.

Common Misconceptions

- Planaria will die when you cut them up.
- All stem cells are the same.

Purpose

The purpose of this lesson is to introduce students to fundamental stem cell concepts using brown planaria (*Dugesia tigrina*) as a model organism. This model works well for demonstrating stem cell function, development, and the complexity of tissue regeneration. This lesson also functions as a starting point for students to begin thinking about the concept of regeneration and stem cells in other organisms.

Key Concepts

- Stem cells are undifferentiated cells that can make more of themselves (self-renew) and can develop into specific cell types (differentiate).
- TOTIPOTENT stem cells are capable of regenerating ALL cells present in the organism, in contrast to PLURIPOTENT stem cells (which can make most cells) and MULTIPOTENT stem cells (which can make cells within a tissue type).
- Totipotent cells begin as non-differentiated cells and then commit to a developmental pathway to become differentiated. Alternatively, they can divide to make more totipotent cells.
- Planaria are capable of regeneration of a wide range of tissue structures due to the presence of totipotent cells – the 'neoblasts' – which divide by mitosis.
- Human totipotent cells are present only in the early divisions of the embryo (before 3 days). Human totipotent cells are not referred to as neoblasts.
- Pluripotent cells are used to create human embryonic stem cell lines.

Materials

Planaria

The brown planaria, *Dugesia tigrina*, and black planaria, *Dugesia dorotocephala,* can be purchased from commercial supply houses, such as **WARDS** and **Boreal/Science Kits**.
http://www.wardsci.com
http://www.sciencekit.com

The brown planaria are smaller than the black planaria, but they are usually able to regenerate fully in about two weeks. Although small, they can still be seen without magnification. The black planaria are heartier and larger than the brown planaria, but may take up to four weeks to fully regenerate. Teachers experience a lot of variability in the time it takes for full regeneration.

Planaria lab materials (per lab group)

- enough small Petri dishes and planaria for each student in class (three planaria per lab group)
- microscope slides
- lens paper
- 1 scalpel
- 1 pipet
- camels hair brush or small paint brush
- dissecting microscope or magnifying glass
- wax pencil or sharpie
- rulers (clear)

Teacher Resource Sheets

- Planaria Illustrations
- Care and Feeding of Planaria
- Animals in Research
- Potential Extensions

Student Handouts

- Handout 1—*Student Background*
- Handout 2—*Animals in Research*
- Handout 3—*Research Proposal Form*
- Handout 4—*Investigation*

An accompanying PowerPoint presentation on Planaria is available from the Northwest Association for Biomedical Research website (nwabr.org).

A free, helpful video from the Howard Hughes Medical Institute (HHMI) about stem cells and regeneration can be found at: **http://www.hhmi.org/biointeractive/stemcells/index.html**. Included on the video is a short interview with Dr. Sánchez Alvarado and his lab members about planaria, their ability to regenerate, and their ties to stem cell research.

Timeline

Prep Time:

Two to three weeks prior to beginning the lab, order planaria and supplies

Read over 'The Care and Feeding of Planaria'

Planaria do better when they have been fed/acclimated before cutting so give yourself enough time to do that!

This lab is designed to be finished before the stem cell unit begins. This allows students to develop concepts of totipotency, pluripotency, and multipotency before the names for these concepts are introduced. However, some teachers begin the lab right before the first day of the unit, do the unit while the planaria are growing, and then conclude the unit and the lab at the same time. If you choose this latter option, develop the ideas of totipotency, multipotency and pluripotency at the beginning of the lab.

Arrange for use of microscopes, if available

Prepare food for planaria

1-2 hours to read through lesson plan, make copies, and prepare lab materials.

CLASSROOM IMPLEMENTATION

A. Invitation to Learn

Ask students, **"How do identical twins form? Why can't that same process occur later in development?"**

Students will realize that the early embryo is capable of splitting into two genetically identical individuals. However, once differentiation of cells has occurred the cells ordinarily 'commit' to a fate.

Stress to students that some cells are capable of making all the cells in the human body and the placenta. In humans, they occur only in the first few cell divisions (before 3 days). [While these are the TOTIPOTENT cells, it is best to develop the concept first and provide the vocabulary later on in the lesson].

After the first few divisions, some human cells still retain the ability to make a great variety of cell types, but they cannot regenerate the whole human organism in the uterus [PLURIPOTENT cells, which can make most cell types, and MULTIPOTENT cells, which can make cells of a specific tissue type such as blood].

This can be demonstrated to students by asking them, **"If red blood cells last only four months and white blood cells only a few days, how can your circulatory system keep making all the blood you need? How can providing new bone marrow to a person with leukemia help cure them?"**

Develop the idea of stem cells as undifferentiated cells that can make more of themselves as well as develop into a variety of different cell types.

Some organisms, such as planaria, have tremendous flexibility in regeneration. A planaria fragment 1/279th the size of the fully grown planaria can regenerate into a new planaria!

Planaria are used as a model organism in this lab, and by researchers studying stem cells, because of their ability to regenerate. These seemingly simple organisms are actually quite complex—they are capable of regenerating a wide range of tissue structures which make up different organ systems. The only dividing cell in the planaria is the neoblast. This means the neoblast is capable of differentiating into any cell type the planaria requires for regeneration, whether it be a flame cell, photoreceptor cell, nerve cell, or excretory cell. For this reason, the neoblast is considered TOTIPOTENT.

In the wild, planaria reproduce both sexually and asexually. When they reproduce asexually, the bottom portion will attach to a rock or solid surface, and the top will pull away. Hence, the cutting of planaria will be similar to a process that occurs naturally. Still, as with any animal used in laboratories, respect and careful handling must be stressed.

B. Planaria Inquiry Lab

Day One

Introduce the Lab.

Let students become more familiar with the planaria through observation, research and/or the PowerPoint presentation available at nwabr.org.

Have student teams complete the 'Research Proposal' and 'Animals in Research' forms and submit them for approval.

Day Two

1. Lab teams receive three planaria.
   For one, they should make a horizontal cut.
   For the second, they should make a cut of their choosing, predicting the results. The third will be a control.
2. Over the course of the next 7-14 days, students should record data. Students draw their planaria, attempt to measure them, and make behavioral observations (light responses, eating, touch responses). It might be hard to measure the planaria – use this as an opportunity to discuss how challenging it sometimes is to make scientific measurements. They can decide, for example, to measure the planaria only when fully extended, or they can try to make several individual measurements and then average them.
3. In the final debriefing, student groups provide their summaries to the class. Each student will record the class data.
4. As a large group, the students will discuss trends and conclusions. Direct the discussion towards the idea of POTENCY.

Address key concepts in the debriefing:

Planaria represent regeneration "experts." Very small segments from vertical, horizontal or diagonal cuts can regenerate complete organisms within 7-14 days. (There are two exceptions – the tip of the nose and the pharynx cannot regenerate a new organism.) When a horizontal cut is made, each cut end knows whether to become a head or tail.

Stem cells are undifferentiated cells that can make more of themselves (self-renew) and can develop into specific cell types (differentiate).

TOTIPOTENT cells are capable of regenerating ALL cells present in the organism, and of making an entire organism.

PLURIPOTENT cells can make most cells, except placenta (in mammals), and thus cannot begin a new organism.

MULTIPOTENT cells can make cells within a tissue type, such as blood.

Planaria have totipotent cells – the 'neoblasts' – which divide by mitosis. Human totipotent cells are present *only* in the early divisions of the embryo (before 3 days). Human totipotent cells are not referred to as neoblasts.

Pluripotent cells are used to create human embryonic stem cell lines.

Adaptations

Simplify/modify written responses.

Have students only conduct the cutting in half experiment.

Conduct the experiment as a demonstration.

Assessment Suggestions

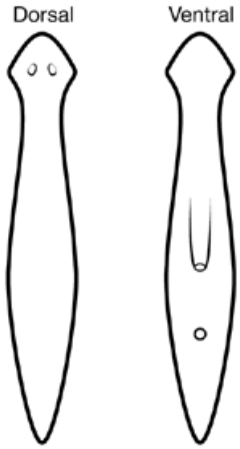
Monitor discussions and review written responses.

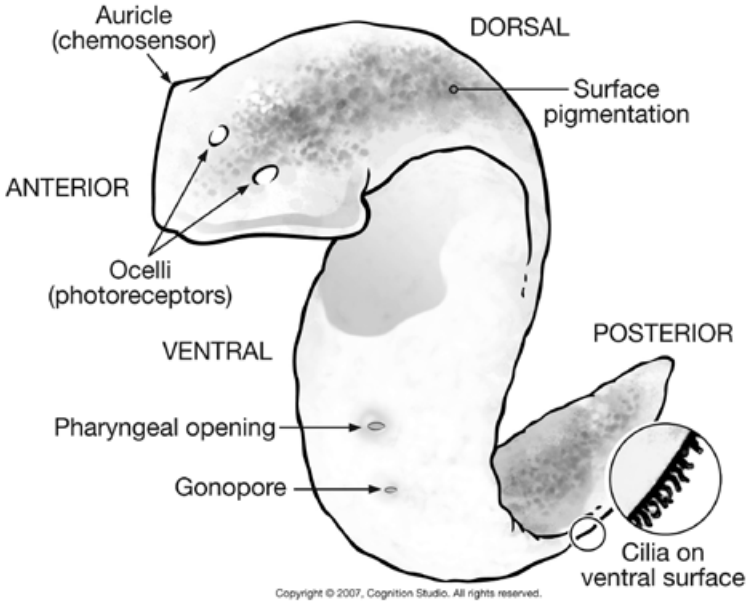
References

1. Newmark, Phillip, and A. Sánchez Alvarado, Not Your Father's Planarian: A Classic Model Enters the Era of Functional Genomics, 3, 210-220 (2002).
2. Davenport, J, What Controls Organ Regeneration, from Science, 309, 84 (2005).

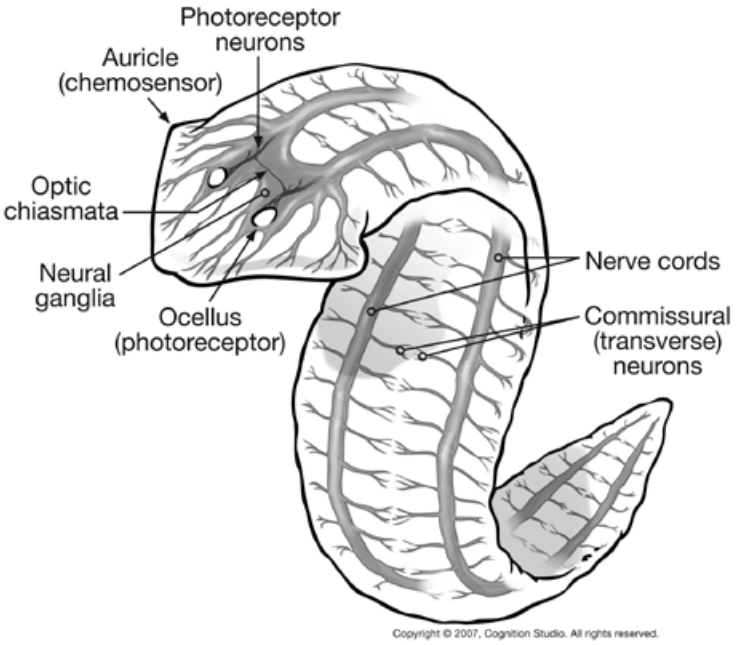
Planaria Illustrations

Planaria Overview

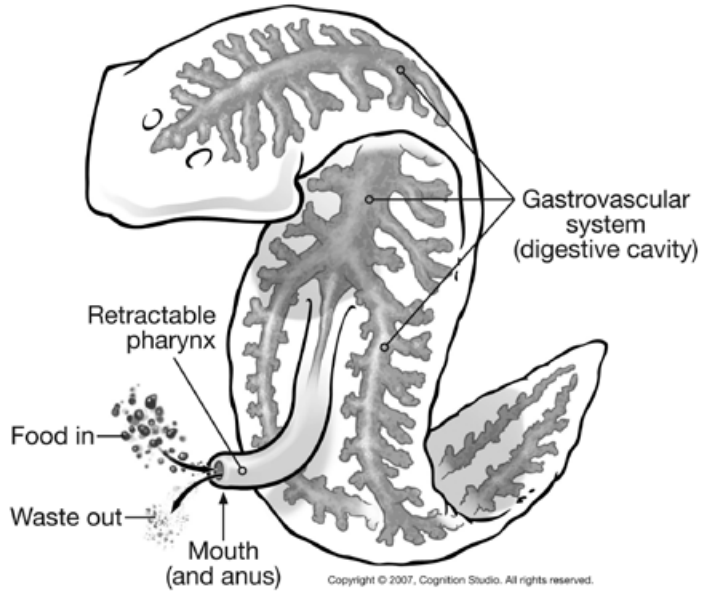




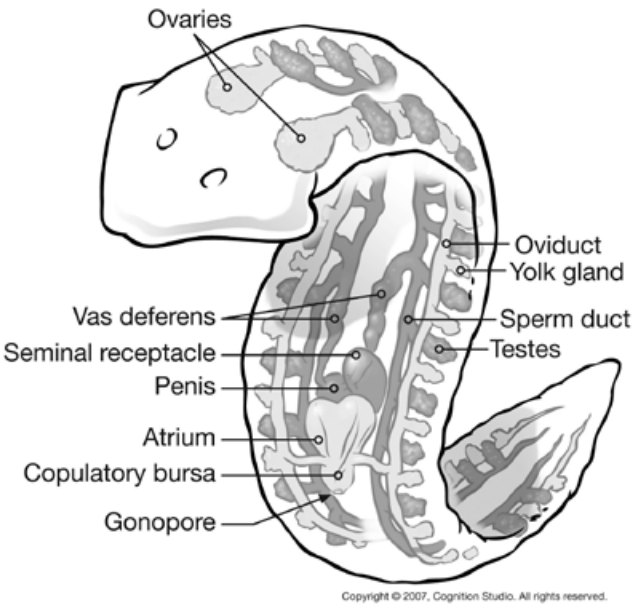
Nervous System



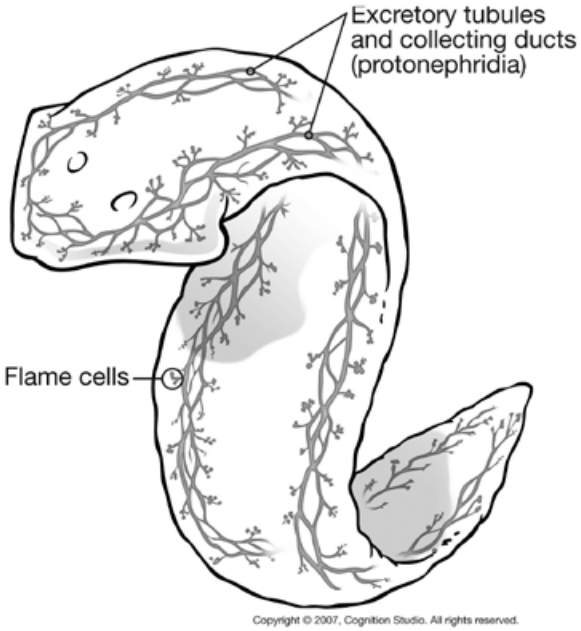
Gastrovascular System



Reproductive System



Excretory/ Osmoregulatory System



Care and Feeding of Planaria

1. The WATER is MOST important!

Planaria survive best in unpolluted pond, stream or lake freshwater (not saltwater). Bottled spring water also works for culturing.

Fresh tap water is not recommended, and distilled water lacks the minerals and nutrients that planaria need to survive.

2. Acclimation Period

Before using planaria in a dissection experiment, we recommended that they have 1-2 weeks of acclimation in your classroom. This will give you time to be feed them and test your water. A container with shallow water having a large surface area (better oxygen exchange) is better than a container of deep water with little surface area. During this period, observations and functional experiments can be done (e.g., movement in response to touch or light; feeding observations). Students may take turns doing the feeding and changing the water.

3. Water Changing

The water should be changed at least twice a week. It must be changed 1-4 hours after feeding to prevent the growth of bacteria. There are three methods of changing the water.

a. The old water can be carefully poured off the planaria. Some planaria may be floating on or near the surface of the water. Be sure that they are not poured out!

b. Using an eyedropper, the planaria may be individually transferred to containers of aged tap water or spring water. You must transfer them quickly so that they don't attach to the inside of the dropper.

c. Use an eye dropper or pipette to remove old water, being careful not to remove any planaria. Refill with aged tap water or spring water.

Never use a hard or sharp instrument to scrape the planaria into a container.

4. Feeding

Feed planaria small bits of liver once a week.. Chop the liver into small pieces and freeze. Planaria may also eat egg yolk. Some teachers have had success with Beta fish food.

Let them eat for up to 4 hours (until no longer feeding).

Change the water after feeding to prevent uneaten food from decaying in the water. Pouring off the water afterwards is usually easiest. A paper towel may be used to clean the bottom of the container before adding in more water.

5. Living Conditions

Planaria are sensitive to extremes of light, temperature, and pH.

Keep planaria at a reasonable room temperature (68-72 degrees F). Do not refrigerate them.

Do not expose to harsh light. Keep them in the dark most of the time – in a closed cupboard or drawer.

Lids on containers should be loosely closed.

6. Dissection Suggestions

Because of the small size of the planaria, vertical cuts can be difficult.

To slow down or immobilize planaria, try putting them on wet lens paper wrapped around a glass slide, or try a glass slide placed over ice. Water that has been frozen in a Petri dish can make a good platform for cutting planaria.

When making a partial cut that does not completely separate a body part, hold the blade in the cut for at least five seconds to prevent the pieces from fusing back together. (The first 30 minutes may be critical for keeping the "parts" separated so that they don't fuse back together.)

7. After Dissection

The planaria will show regeneration after 1-2 weeks. It may take 4 weeks to get complete regeneration. During that time, do not feed the planaria. Disturb them as little as possible – for water changes, it is best to pour off water, rather than move them with an eye dropper.

After horizontal cuts, the "head portions" may move normally. The "tail portions" will adhere to the container.

After partial vertical cuts, the cuts should be observed daily and may require re-cutting during the first three days.

Potential Extensions

In addition to observing the regeneration of the flatworm **appearance**, students can better appreciate the regeneration of internal organs and neural connections by observing the regeneration of **function**.

1. Regeneration of Photoreceptor Function

Planaria will avoid or swim away from light. After cutting the planaria, students should record their observations of appearance AND test for the re-establishment of neural connections to the photoreceptors ("eye"). If the planaria containers can be kept in dim light, a flashlight can be used to direct intense light onto the planaria. Students should record the numbers of days of growth after cutting that is required before they see an avoidance response to the light. The distance that the planaria moves from the light will be greatest when the photoreceptors are functioning. Students should note the difference in time between when they see the photoreceptors and when the photoreceptors appear to be functioning.

2. Faster Regeneration near the Head

It has been observed that there is faster regeneration if a cut is made nearer the head because of a higher concentration of growth factors near the head. Have students make horizontal cuts on three different planaria. The cuts should be at different distances from the head, such as ¼, ½, and ¾ body length from the head. Students should observe regeneration and record the difference in speed of regeneration.

3. Digestive Track Function

The digestive system can be studied by feeding planaria a colored substance such as carmine powder or carbon black. It may be possible, but more difficult, to see "yellow" in the gut after feeding them cooked egg yolk. After cutting planaria, students can observe regeneration and note when the re-generated flatworms begin to eat and have a functioning gut.

4. "Wild" vs. "Purchased" Planaria

"Wild" planaria can be collected by dangling cooked meat or egg yolk in a cheesecloth bag at the edge of a freshwater stream or pond for 15-30 minutes. The planaria can then be carefully removed from the side of the cheesecloth and grown in the lab in the usual growing conditions. It could be beneficial to grow the wild planaria in water from their original source.

Students should observe the differences in appearance, feeding behavior, and regeneration time between "wild" and "purchased" lab planaria. There are many different families of planaria and it is unknown if there will be observable differences.

Plenty of Planaria

Student Background

Planaria are freshwater flatworms. Although they seem simple, they are actual quite COMPLEX! They have muscles that they use to move, assisted by cilia on their underside. They have a digestive system, but it is incomplete (partially open). While they lack circulatory and respiratory systems, they do possess a specialized excretory system.

Planaria have a rudimentary 'brain' consisting of two groups of neurons (ganglions) located in the anterior (front) end. Two nerve cords run along the side towards the back of the animal, giving the nervous system a ladder appearance. This system gives planaria the ability to have varied behaviors. Planaria have the ability to respond to their environment by moving towards or away from stimuli. A positive and negative response to environmental cues is called a 'taxis'. So, moving towards light is called 'positive phototaxis'.

Planaria have a special capability. They are famous for being able to regenerate parts of themselves! In this lab, we will use them as a MODEL ORGANISM for understanding the REGENERATION process and the cells involved. Only one type of cell in a planaria—the 'neoblast'—is capable of dividing. It must, therefore, be able to differentiate into any type of complex tissue the planaria requires for regeneration.

During this investigation you will conduct an experiment to learn more about the ability of planaria to regenerate.

Whenever scientists use animals, they need to carefully consider the ethical and legal guidelines in addition to the benefits that the research may provide. In your proposal, you will need to address ethical guidelines.

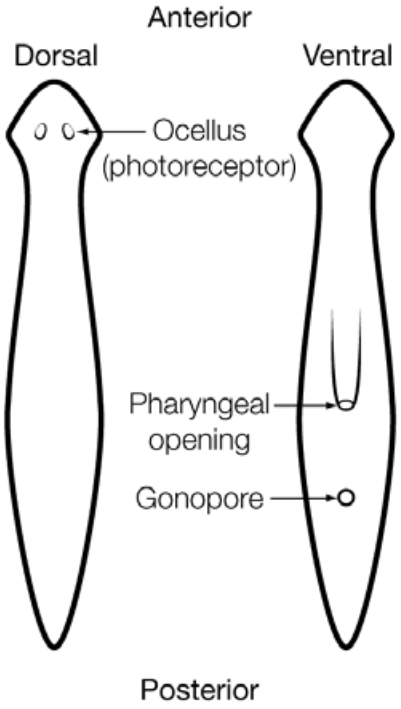
You will have three planaria per team

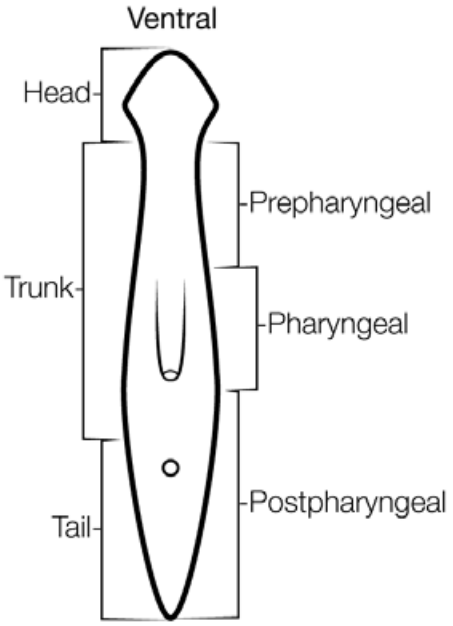
1) Two "experimental" planaria
    a. Experimental planaria #1 will be cut into half, with a front (anterior) and rear section (posterior). Every team in the class will do the same! (Why is it important to have experiments repeated in order to generate more data?)
    b. Experimental planaria #2 will be cut in a manner determined by your team.
2) A "control" planaria which will not be cut

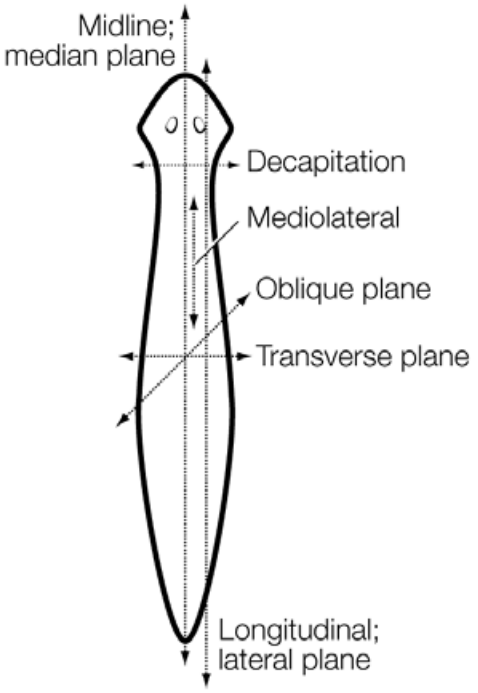
Review the Planaria anatomy on the other side of this sheet, then complete the **Research Proposal Form** with your team and receive approval from your teacher before proceeding.

Plenty of Planaria

Student Background







Animals in Research

When animals are used in biomedical research, laws, regulations and guidelines govern their care.

These include requirements that:

- procedures involving animals be relevant to human or animal health
- the minimum number of animals be used to obtain valid results
- alternatives to animals be considered
- animal pain or distress be avoided or minimized
- living conditions for animals be appropriate for their species
- research scientists and those caring for the animals be properly trained and qualified

These requirements are sometimes summarized as the **3R's:**

1. **Replacement**-using other models when appropriate
2. **Reduction**-using the minimum number of animals necessary
3. **Refinement**-enhancing animal welfare and ensuring the best conditions possible, minimizing pain and distress

Groups that review research involving animals ('Institutional Animal Care and Use Committees'- IACUCs) suggest ways to minimize pain and distress, and work directly with researchers before experiments have started. The IACUCs use the 3R's as principles that underlie the humane treatment of animals in biological research. A fourth R – Respect for the organism– is often added. These requirements are based on the idea that good science evolves with, and as a result of, humane science.

Background on laws:

Animal Welfare Act (AWA)

The Animal Welfare Act sets federal standards for all aspects of care for laboratory animals. It was enacted into law in 1966 and has been amended by the U.S. Congress several times. The act applies to all public and private research facilities in this country. Facilities must be registered by the US Department of Agriculture and comply with their regulations, including unannounced annual inspections. Also, all facilities must establish an Institutional Animal Care and Use Committee (IACUC). The committee ensures that applicable federal, state, and local laws and regulations are met, reviews and approves procedures involving animals before they take place, and inspects facilities twice a year for compliance with the AWA.

Health Research Extension Act.

This 1985 federal law applies to facilities that receive funding to do research from the federal government, in contrast to the Animal Welfare Act, which applies to all facilities regardless of the source of funds. The legal and regulatory requirements of the act are very similar to those of the Animal Welfare Act, and they apply to all research supported by the U.S. Public Health Service (PHS) involving vertebrate animals, including rats, mice and birds, which are not covered under the AWA.

http://www.nwabr.org/research/regulations.html

http://caat.jhsph.edu/programs/workshops/20th/locke.htm

Name _____ Date _____ Period _____

Using the 3 R's in Animal Research

Replacement – Please indicate if *alternative procedures* (that do not require animals) exist that might meet the project's needs. If alternative procedures exist, please explain why you feel that animals must still be used:

Reduction - Please provide an explanation why you feel that the number of these animals to be used on the project represents the *minimum number required*:

Refinement - Please explain the methods and techniques that will be used to *minimize distress to these animals.*

Investigator Certification:
We certify that we will adhere to the guidelines contained in this proposal, and will not deviate from any of the procedures contained unless they are formally approved by the Institutional Animal Care and Use Committee (IACUC). We certify that the studies performed under this project are not unnecessarily duplicating research that has already been done before, that all personnel working on this pr oject are appropriately trained in a manner approved by the IACUC, and that the scientific requirements of the project and the welfare of the animals used for the project will be maintained.

Signed **Date**

Student Handout 3

Name _____ Date _____ Period _____

Plenty of Planaria

Research Proposal Form

Team Name

Team Members

Project Proposal Title

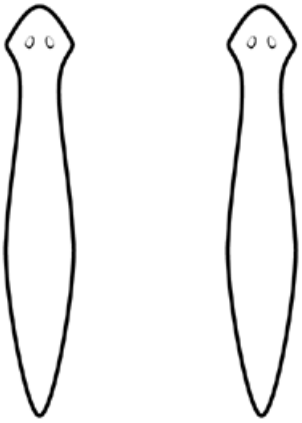
Please summarize the purpose and goals of the project.

What species are you using? How many animals are you using?

PROCEDURES ***Diagram your cuts, and your expected results***

Experimental Planaria #1

Original Draw Cut ➔ Prediction



What hypothesis are you testing with Planaria #1?

If your hypothesis is supported, what do you predict you will see?

What is your 'manipulated' (independent variable)?

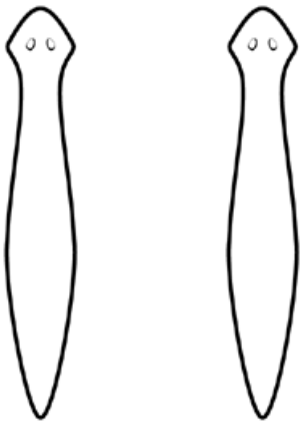
What is your 'responding' (dependent variable)?

What measurements could you make?

PROCEDURES ***Diagram your cuts, and your expected results***

Experimental Planaria #2

Original Draw Cut → Prediction



What hypothesis are you testing with Planaria #2?

If your hypothesis is supported, what do you predict you will see?

What is your 'manipulated' (independent variable)?

What is your 'responding' (dependent variable)?

What measurements could you make?

PROCEDURES ***Diagram your control, and your expected results***

Control Planaria

Initial → Final

Student Handout 4

Name _____ Date _____ Period _____

Plenty of Planaria

Investigation

Collect the following materials.

Observe a planaria and sketch it.

Create your cuts and collect your initial data.

Materials (per group)

- small petri dish containing 3 Planaria
- microscope slides
- lens paper
- 1 scalpel
- 1 pipet
- camel's hair brush or small paintbrush
- dissecting microscope or magnifying glass
- wax pencil or sharpie
- ruler (clear)

Procedure

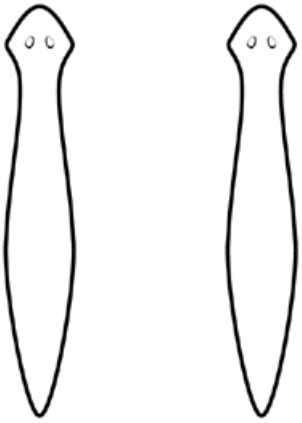
1) Using a pipet, put a planaria on a microscope slide with a drop of water (if the planaria gets stuck in the pipet, flush out using water).
2) Observe the planaria under the dissecting microscope or with a magnifying glass.
3) Sketch a planaria and label the following structural components
   - head
   - tail
   - photoreceptors (eye spots)
   - pharynx
4) Label your petri dish with your name and group.
5) Wrap a piece of lens paper around a second microscope slide. This will form a cutting surface.
6) Using the pipet and/or camels hair brush, place experimental planaria #1 on the microscope slide that is wrapped in lens paper. Allow the planaria to become fully extended on the slide.
7) Put the slide under the microscope or magnifying glass.
8) Use the scalpel to make your cut for experimental planaria #1.
9) Measure and record the length of the front (anterior) and the rear (posterior) pieces.
10) Gently place the separated or cut planaria back in the Petri dish using the pipet or camels hair brush.
11) Repeat numbers 6 through 11 for experimental planaria #2, making cuts and measurements according to your group's plan.
12) Measure the length of your control planaria without making any cuts. Gently place it back in the Petri dish.
13) Make sure there is water in the Petri dish. Cover the Petri dish and place it in a shady area at room temperature.
14) Clean up your lab area and return all materials

SKETCH:

Experimental Planaria #1

Cut in half into front (anterior) and rear (posterior)

Original ➔ Cut ➔ Prediction ➔ Final Observation (last day)



- ***Record the length of the front (anterior) section just AFTER you cut. This is your INITIAL front length:*** _____
- ***Record the length of the rear (posterior) section just AFTER you cut. This is your INITIAL rear length:*** _____

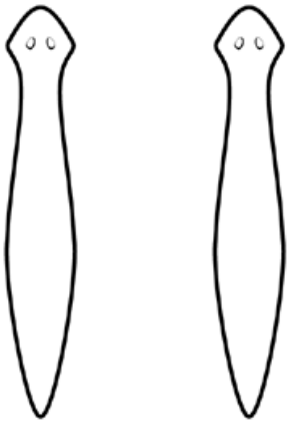
Date	Sketch	Front/Rear Length(s)	Behavioral	Other
Initial				

- ***Record the FINAL length of the front (anterior) section:*** _____
- ***Record the FINAL length of the rear (posterior) section:*** _____

Experimental Planaria #2

Your Choice of Cut

Original ➔ Cut ➔ Prediction ➔ Final Observation (last day)



■ ***Record your team's measurement of choice just AFTER you cut. This is your INITIAL length:*** _____

■ ***If your team has more than one segment to measure, record the second measurement just AFTER you cut.*** _____

Date	Sketch	Measurement of Choice Length(s)	Behavioral	Other
Initial				

■ ***Record the FINAL measurement of choice for your team's cut:*** _____

■ ***If your team has more than one segment to measure, record the second FINAL measurement of choice.*** _____

Control Planaria

Original ➔ Final Observation (last day)

■ ***Record the INITIAL length:*** _____

Date	Sketch	Length(s)	Behavioral	Other
Initial				

■ ***Record the FINAL length:*** _____

Planaria Data Analysis – Team Project

1. Calculate the % change in length for experimental planaria #1 that was cut in half, for each piece. Show your work below. *Express your answer as a percent.*

$$\% \text{ Change in length of front piece} = \left[\frac{\text{Final front length} - \text{Initial front length}}{\text{Initial front length}} \right] \times 100 =$$

$$\% \text{ Change in length of rear piece} = \left[\frac{\text{Final rear length} - \text{Initial rear length}}{\text{Initial rear length}} \right] \times 100 =$$

2. Describe what happened to planaria #2 over time, using your actual measurements.

3. Calculate the % change in length of your control planaria over time.
Express your answer as a percent.

$$\% \text{ Change in length} = \left[\frac{\text{Final length} - \text{Initial length}}{\text{Initial length}} \right] \times 100 =$$

4. If your planaria (or sections of your planaria) died, please speculate as to why they died. What would you do differently next time?

5. How does this experiment account for multiple trials?

Conclusions – Team Project

1. Did your planaria that was cut in half (experimental planaria #1) regenerate? Refer to your % change in length figures in supporting your statement.

   Was your hypothesis supported, refuted, or were your results inconclusive?

2. Did experimental planarian #2 regenerate? What happened?

   Was your hypothesis supported, refuted, or were your results inconclusive?

3. Did the control planaria get smaller? Larger? Stay the same? Refer to the % change in length. What does this mean for your analysis of your other planaria?

Planaria Data Sheet – Class Results and Conclusions

1. Regeneration of experimental planaria #1 cut in half:

Group	% change in length Anterior	% change in length Posterior
Average		

2. Regeneration of experimental planaria cut in various ways #2

Group	Cut Made	Results

Conclusions – Group Results

What trends did you see? Was there a difference between anterior and posterior?

Refer specifically to the data, mentioning the averages as well as the range of numbers (highest/lowest) and the number of planaria that were used total. What can you conclude about planaria that are cut in half?

What can you conclude from the results of the 'free choice cuts'? Again, refer to specific examples.

Overall, what conclusions can you draw from this investigation regarding the ability of planaria to regenerate?

How do you think planaria actually DO the regeneration? What might be happening to their cells? How might regeneration be possible?

Last Thoughts

A university lab studying planaria conducted the following research. Use what they learned to answer the questions:

Part I:

- Planaria were exposed to irradiation, which killed all the dividing cells in the organism.
- The irradiated planaria lost their capacity to regenerate any type of tissue when cut.
- The irradiated planaria survived for several weeks on the virtue of their already-differentiated, non-dividing cells.
- The planaria eventually died.

Part II:

- Neoblasts were isolated from wild-type animals and injected into the irradiated host planaria.
- The hosts regained their capacity to regenerate all types of tissues.
- The host planaria survived.

What special function does the neoblast have?

Would neoblasts be considered totipotent, pluripotent or multipotent? Why?

What would humans need for regeneration to occur? (hint: humans don't have neoblasts)

Are there limits to human regeneration? Explain.

Planaria serve as a MODEL organism for understanding human stem cells. How might our understanding of planaria regeneration be applied to help humans?

Lesson 1 Stem Cell Development

Objectives

Students will be able to:

- Identify stages of early embryonic development.
- Compare and contrast embryonic developmental stages in terms of the potency of their cells (totipotent, pluripotent, and multipotent).
- Distinguish between 'adult' and 'embryonic' stem cells.
- Understand where cells used to create stem cell lines come from.

Class Time

1 class period

Prior Knowledge Needed

- Stem cells differentiate to give rise to different types of cells.
- Each type of cell has a unique look and function, (bone cells vs muscle cells for example).

Common Misconceptions

- Embryos are fetuses.
- Embryonic stem cells come from a woman's uterus, a baby, or umbilical cords.
- Adult stem cells are only found in adults.

Introduction

In this activity, students make play dough models of an embryo through the early stages of development. They use their models to visualize where stem cells come from, and to understand that stem cells are totipotent, pluripotent and multipotent at different stages of development. Students fill out Student Handout 1.1 as they make their models. Students can work individually, or in groups of 2-3. Review/homework sheets and procedures for lesson extensions are also included.

Key Concepts

- Stem cells are totipotent, pluripotent or multipotent at different stages of development.
- Embryonic stem cells come from the inner cell mass of the blastula stage and are pluripotent. Removing the inner cell mass from the blastula destroys the blastula.
- Adult stem cells are multipotent and are already committed to one of the three tissue layers developed during the gastrula stage.

Materials

- 4 tubs of different colors of modeling clay or play dough (at least 3 tablespoons) per student or group
- Paper plates to represent Petri dishes
- Paper clips
- Straws
- If making play dough from scratch (see adaptations), you will need flour, salt, water, cream of tartar, oil and food coloring
- Student Handouts
  1.1 –*Modeling Stem Cell Development*
  1.2 –*Review: Stem Cell Notes*
  1.3 –*Stem Cell Comparison Charts*
  1.4 –*Sea Star Stem Cells Extension*
- Teacher Guides for Student Handouts 1.1 and 1.2
- A PowerPoint presentation to accompany this lesson can be found at nwabr.org.

Internet Resources

Pictures of each early stage of development (as well as pictures of *in vitro* fertilization) can be found through the Florida Institute for Reproductive Sciences and Technologies:
http://www.firstivf.net/laboratory_tour.htm#ICSI_Pictures

More sources for pictures of early development can be found in the "Additional Sources" section at the end of this lesson.

Introduce the Lesson:

Refer back to the planaria's ability to regenerate. This regeneration depends on a type of cell that can

1. Self-renew (make more of themselves by dividing) and
2. Differentiate (give rise to daughter cells that can develop into many types of cells).

Stress that **these two characteristics are the hallmarks of a stem cell**.

In this lesson, students will learn where embryonic stem cells are found and how their potential to develop into different types of cells changes over time.

Procedure:

The students receive Student Handout 1.1 and fill it in as they are they directed by the teacher. **The teacher will demonstrate each step along the way** as the students make their own clay models. Ideally each student will have at least 3 tablespoons of each color. They can also work in teams of 2-3. Instruct students that they will need to divide up their clay and save some for later stages.

1. **Zygote (zye**-goht): To build the zygote model, use a single color to make both an egg (about the size of a ping pong ball) and a much smaller sperm cell. Mix them together to form a zygote. (The 'tail' of the sperm drops off and does not enter the egg). Place it on the "Petri dish" (paper plate) to represent in-vitro fertilization. The zygote is totipotent; this single cell will give rise to every cell type in the body and the placenta.
2. **Early Cell Divisions:** Divide the single-cell zygote in half, making two spheres. Divide each of those two cells in half, then each of those in half again, until there are 16 cells.
3. **Morula** (**mor**-yoo-la): Push the 16 cells together to form a sphere. This represents the morula stage. Have the students set this aside on the Petri dish (paper plate) to compare to the stages which will follow.
4. From the one-celled zygote to the 16-celled morula, the cells are considered totipotent. That means that any of the cells the students have just made could differentiate into any tissue in the body or placenta. In fact, identical twins arise from this stage of development; one or more cells from the morula (or earlier) can split off and become a separate, new organism.
5. Fill in the totipotent column on Student Handout 1.1
6. **Blastula (blast**-yoo-la): Explain that the cells will continue to divide and we will "fast forward" through the blastula stage, which occurs from the 3rd through the 14th day after fertilization. At this point some cells have differentiated into cells which will become the placenta. The pre-placental cells will form a hollow ball surrounding the embryonic cells.

7. To build the blastula model, pick a new color and make a sphere the size of a ping pong ball. The goal is to make a hollow ball, but since this will be difficult students can make the shape of a bowl. This will represent the cells that will become the placenta. Students can use the end of a straw or a pen cap to make indentations in the bowl that look like cells.

8. Use fresh clay or dough in the color used in the original zygote model, and make many small spheres (about the size of a pea or smaller) to represent the cells growing inside the hollow ball, or bowl. These represent the inner cell mass, or embryonic stem cells. Place these in a pile inside the bowl. Be sure to reinforce that the pre-placental cells (the 'trophoectoderm') would really form a "hollow ball" (trophoblast) completely surrounding the embryo, and that **even though they are now represented in a different color, they also originated from the morula**.

9. The cells of the blastula are pluripotent. The cells have already gone through one "fate decision"; the hollow ball can only become placenta, and the inner cell mass can become any type of cell in the body *except* placenta. The inner cell mass is the source of **embryonic stem cells**. If the inner cell mass is removed from the blastula, the blastula is destroyed and cannot continue to develop.

10. At this point, an **embryonic stem cell line** can be made. Cells from the inner cell mass of a four- to five-day old blastula are transferred into a plastic laboratory culture dish and grown in a medium that provides support and nutrients. When kept in this way, the inner cell mass (or embryonic stem cells) can continue to divide and proliferate for long periods of time without differentiating or losing pluripotency. A stem cell line, directed to differentiate into specific cell types, offers the possibility of treating diseases including Parkinson's and Alzheimer's diseases, spinal cord injury, stroke, burns, heart disease, diabetes, osteoarthritis, and rheumatoid arthritis. *(Note: Many of the early embryonic stem cell lines that have been used for research in the last decade have been grown on mouse feeder cells and would be inappropriate for therapeutic uses in humans.)*

11. Set the blastula in the Petri dish (paper plate), and tell the students that in real life, the embryo would go into a freezer if not implanted immediately in a woman using *in vitro* fertilization techniques to become pregnant.

12. Fill in the pluripotent column on Student Handout 1.1

13. **Gastrula (gass**-troo-la)**:** Explain that we are fast forwarding in time again and that the embryonic cells have continued to divide. At about 14 days after fertilization, the cells will begin to differentiate and form three layers (endoderm, mesoderm, and ectoderm). The differentiation is triggered in part by the attachment of the pre-placental cells to the uterine wall.

14. To build the gastrula model, make a new early placenta "bowl" in the same color as the previous one, using roughly a ping-pong ball sized sphere. Take a small bit more of the original embryo color and form a ball about the size of a small pea. Flatten a marble-sized piece of a new color and wrap that around the ball. Then add another layer in a new color around the outside. Now open

a paper clip, and use it to cut through the center of the gastrula. The three different tissue layers will be clearly visible on the inside. The three-layered ball can be somewhat flattened before cutting through it with the paper clip, if desired. This would more accurately represent the shape of the embryonic disc, from which the three tissue layers form. Place the gastrula on the Petri dish next to the morula and blastula. Optional: Have students bring their blastulas in their Petri dishes and place them in the freezer, where they will be stored indefinitely!

15. The gastrula is multipotent. The early placenta cells can still only become placenta. The inner cell mass has undergone another "fate decision" and has differentiated into three layers, the endoderm, mesoderm and ectoderm. The endoderm cells will become, in part, the digestive and respiratory tracts; the mesoderm will become bones, blood cells and the heart; the ectoderm cells will become the skin and central nervous system. Once the cells have differentiated into three layers, they are considered "adult" stem cells and can only make the type of cell determined by that layer.
16. Fill in the multipotent column on Student Handout 1.1.
17. Although the three layers of the embryo will be difficult to separate, students can take apart the remainder of the model and store the clay for further use.

Discussion

Clarify any questions that the students might have regarding the handout, models or terminology.

Discuss the LIMITATIONS of the model. These limitations can include:

- The simulation shows only discrete points in time rather than continuous development.
- The different colors may give the wrong idea about origins of cells—all of the "colors" originate from the original zygote.
- Students cannot see the spherical nature of trophoblast.
- Any other limitations students may suggest.

Important terms to emphasize include:

Totipotent, pluripotent, multipotent, zygote, blastula/blastocyst, embryonic stem cell, adult stem cell.

Suggested Extension—viewing of Sea Star Stem Cells

Working independently, students observe prepared slides of developing Sea Star embryos. Sea Urchin embryo slides can also be used. Students draw and label the zygote, morula, blastula and gastrula stages, reinforcing their understanding of early development.

Procedure:

Using microscopes, students examine prepared slides of the sea star embryos. They will sketch and label various stages of development, as described in Student Handout 1.4.

Materials:

Class set of Sea Star embryology slides (fertilized egg, early cleavage, morula, blastula, gastrula) available from various biological supply houses.

- Student Handout 1.4
- Microscopes

More Extensions

The play dough can also be used to model "Therapeutic Cloning", also known as Somatic Cell Nuclear Transfer (SCNT). Use two colors of dough, to make an unfertilized egg cell. The nucleus would be one color inside the cytoplasm of another color (it might look a bit like a fried egg). Have the students inscribe the number 23 in the nucleus using an open paper clip to represent the number of chromosomes. Then have them build another cell to represent a somatic (body) cell with a different colored nucleus, and the number 46 inscribed on it. Have the students cut out both nuclei with the paper clip. The nucleus removed from the egg cell will be destroyed, and the nucleus from the somatic cell will replace the egg's nucleus. Explain that since the egg now has 46 chromosomes, it will behave as if it had been fertilized, and begin to divide and grow. This is how cloning is done!

Adaptations

An excellent way to show continuous differentiation of the embryo, is to use homemade play dough, and add food coloring at each appropriate step. Recipe makes about 1 ½ cups of play dough.

1 cup flour

1 cup warm water

2 teaspoons cream of tartar

1 teaspoon oil

¼ cup salt

Mix in saucepan. Stir over medium heat until thick.
Remove, kneed until smooth.

In this version of the activity, the students will use the same play dough from beginning to end. They will take part of the dough from the morula stage, and add food coloring to the part which will become the placenta. The embryo will then differentiate inside the placenta, and can be divided into three layers, each a different color to form the gastrula.

Homework

The Student Handout 1.3 *Review: Stem Cell Notes* can be assigned as homework. Students can use their notes from the play dough activity as well as from the background information sheet Student Handout 1.4 *Stem Cell Comparison Charts* to guide them in completing this summary.

Additional Sources

A series of pictures showing early sea urchin embryo development from the 1-cell stage through to the late blastula stage:
http://www.luc.edu/faculty/wwasser/dev/urchindv.htm

Drawings of early human development:
http://www.biology.iupui.edu/biocourses/n100/2k4ch39repronotes.html

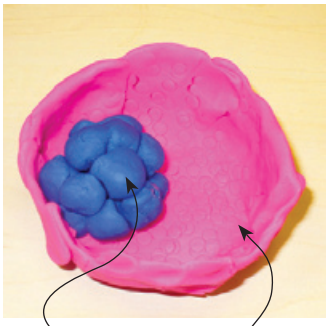
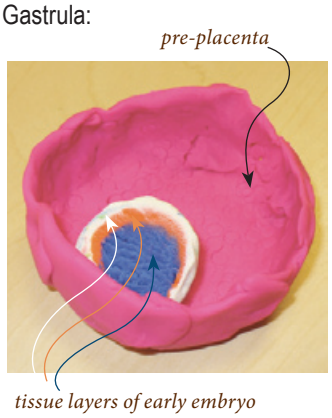
The Visible Embryo is a visual guide through fetal development from fertilization through pregnancy to birth: **http://www.visembryo.com/baby/index.html**

Name _____ Date _____ Period _____

Modeling Stem Cell Development

	Totipotent Stem Cells	Pluripotent Stem Cells	Multipotent Stem Cells
Diagrams of play-dough creations	Zygote: Morula:	Blastula/Blastocyst: Label pre-placenta and early embryo ('inner cell mass')	Gastrula: Label early placenta and three tissue layers of early embryo
Approximate days cell division occurs			
Approximate number of cells			
Definitions of important terms	Totipotent: Zygote: Morula:	Pluripotent: Blastula/Blastocyst: Embryonic stem cell: Embryonic Stem cell line:	Multipotent: Gastrula: Adult stem cell:

Modeling Stem Cell Development

	Totipotent Stem Cells	Pluripotent Stem Cells	Multipotent Stem Cells
Diagrams of play-dough creations	Zygote:  Morula: 	Blastula/Blastocyst:  	Gastrula: 
Approximate days cell division occurs	Before 3 days	3-14 days	After 14 days
Approximate number of cells	1-16	Up to several hundred	Several hundred and more
Definitions of important terms	**Totipotent**: Stem cells that can differentiate into any type of cell. **Zygote**: Single cell formed when sperm cell fertilizes the egg. **Morula:** The mass of up to 16 undifferentiated cells produced by the first four divisions after fertilization. (Teacher note: Some researchers have proposed using cells from early cleavage/morula stages to create stem cell lines, allowing the embryo to continue to develop.)	**Pluripotent**: Stem cells that can differentiate into most types of cells. (Here, the embryonic cells can become anything except a placenta). **Blastula**: The "hollow ball" stage where the pre-placental cells form the ball with the early embryo inside. This is also referred to as the **Blastocyst** stage. **Embryonic stem cell**: Stem cell taken from blastocyst (or earlier stages). Currently, researchers use cells from the inner cell mass at the blastocyst stage. **Embryonic Stem cell line**: Embryonic stem cells, which have been cultured under *in vitro* conditions that allow proliferation without differentiation for months to years.	**Multipotent**: Stem cells that can differentiate into a limited range of cell types. **Gastrula**: The embryo develops three cell layers. Stem cells are limited to forming tissues only from that layer. **Adult stem cell**: Any stem cells taken after the three cell layers have formed. Stem cells taken from umbilical cord blood, and from anyone after birth are considered adult stem cells. (Teacher note: the three layers are ectoderm – which becomes skin/nervous system, mesoderm – which becomes muscle/bone, and endoderm, which becomes lining of gut and internal organs)
Other Notes:	Totipotent cells are used for Pre-Implantation Genetic Diagnosis	Pluripotent cells from the inner cell mass are used to make embryonic stem cell lines	Multipotent ('Adult') cells are already committed to a certain tissue layer

Name _____ Date _____ Period _____

Review: Stem Cell Notes

What are two main characteristics of stem cells?

1)

2)

What is the major difference between adult and embryonic stem cells?

Embryonic stem cells:

"Adult" stem cells:

Describe what each of these terms means in reference to stem cells and their capabilities:

Totipotent-

Pluripotent-

Multipotent-

Terms associated with development:

Zygote-

Blastula/Blastocyst-

Embryo-

Fetus-

Stem Cell Notes

What are two main characteristics of stem cells?

1)

Self-renew (make more of themselves by dividing)

2)

Differentiate (give rise to daughter cells that can develop into many types of cells)

What is the major difference between adult and embryonic stem cells?

Embryonic stem cells:

Embryonic stem cells: Can become any type of cell in the body

"Adult" stem cells:

"Adult" stem cells: Current research indicates that these cells can become cells of a particular tissue type (i.e. blood)

Describe what each of these terms means in reference to stem cells and their capabilities:

Totipotent-

Capable of becoming any cell in the body or placenta. Capable of regenerating an entire new organism

Pluripotent-

Capable of becoming almost any cell in the body (except placental tissue).
Not capable of regenerating an entire new organism. ("Embryonic stem cells")

Multipotent-

Capable of becoming a cell of a particular tissue type. (see "Adult" stem cells)

Terms associated with development

Zygote-

Fertilized egg

Blastula/Blastocyst-

Hollow ball stage where some cells begin to differentiate from others.
Cells from the 'inner mass' of this stage are used to make embryonic stem cell lines

Embryo-

Early stages of development, prior to 8 weeks

Fetus-

Later stages of development, from 8 weeks to birth

Name _____ Date _____ Period _____

Stem Cell Comparison Charts

Stem Cells and Potency

Potency	What can they become?	When do they occur?	Where do they come from?	What are they referred to?
Totipotent (Toti=total)	Able to make all the cells in the human body and the placenta	Before 3 days	From cells of first few cell divisions	Early embryonic cells (blastomeres)
Pluripotent (Pluri=more)	Able to make most of the cells in the human body, with the exception of placental tissues	3-14 days (before 'gastrulation', the development of 3 germ layers in the embryo)	From inner cell mass of blastula	Embryonic stem cells (if cultured *in vitro*) Pluripotent stem cells (cells within the inner cell mass)
Multipotent (Multi=many, much)	Able to make a range of cells within a particular tissue type (such as blood)	After 14 days	From cells of the developing individual as well as adult	Cord blood stem cells Adult stem cells

Adult vs. Embryonic Stem Cells

Type	Where are they obtained?	How flexible are they?	Advantages	Disadvantages
Embryonic	From inner cell mass of blastocyst of: Donated fertilized eggs (IVF) or donated eggs fertilized by researchers Product of " Somatic Cell Nuclear Transfer" (genetically identical to donor nucleus)	Pluripotent* *very early embryonic cells are totipotent, but these are not used to make stem cell lines	Can become most cells/tissues of the body Easier to culture in lab Great potential for developing future therapies to cure diseases	Potentially ethically problematic: blastocyst must be destroyed when cells are removed, egg donation also an issue
Adult	Often from adult tissues/organs (note: this term is also often used for multipotent cells found in fetuses or younger individuals, including newborns and children)	Multipotent* *some studies suggest certain adult stem cells may be able to be reprogrammed to become pluripotent	Less ethically problematic - no destruction of blastula involved Already used in therapies (bone marrow transplants)	Hard to culture in lab Most are limited to become specific tissue types

Name _____ Date _____ Period _____

Sea Star Stem Cells Extension

Using the prepared slides of sea star or sea urchin embryonic development, find the following stages of development. **Draw and label** at least one example from each stage in the space provided.

---

1. Zygote or fertilized egg. The fertilized egg can be distinguished by the presence of a fertilization membrane surrounding the cell. Also, the nucleus in a fertilized egg is quite indistinct.

---

2. Early cell divisions ("cleavage")**.** Find two-cell, four-cell, and eight-cell stages. Note that the appearance of the embryo in each case will depend on its orientation with respect to the surface of the slide. Some embryos may be seen in end view, other in a side view at various angles.

---

3. Morula. Find one or more 16-cell stages. (You may be able to count the number of cells by careful focusing at different levels. Even if you are unable to count the exact number of cells, you can make a rough estimate.) Look for a cluster **without** a central cavity. This is the morula. (Some 16-cell clusters might already show the beginnings of a blastocoel, the central cavity.)

---

4. Blastula. 32-cell, 64-cell and later stages will usually show a central cavity, the blastocoel. The cells can be referred to as **'blastocysts'.**

---

5. Gastrula. In the early gastrula, cells have just begun to push in from one end. In the middle gastrula stage, cells have pushed in sufficiently to produce an opening to the outside (archenteron – a primitive gut) by means of a wide blastopore. The formation of the archenteron is completed in the late gastrula.

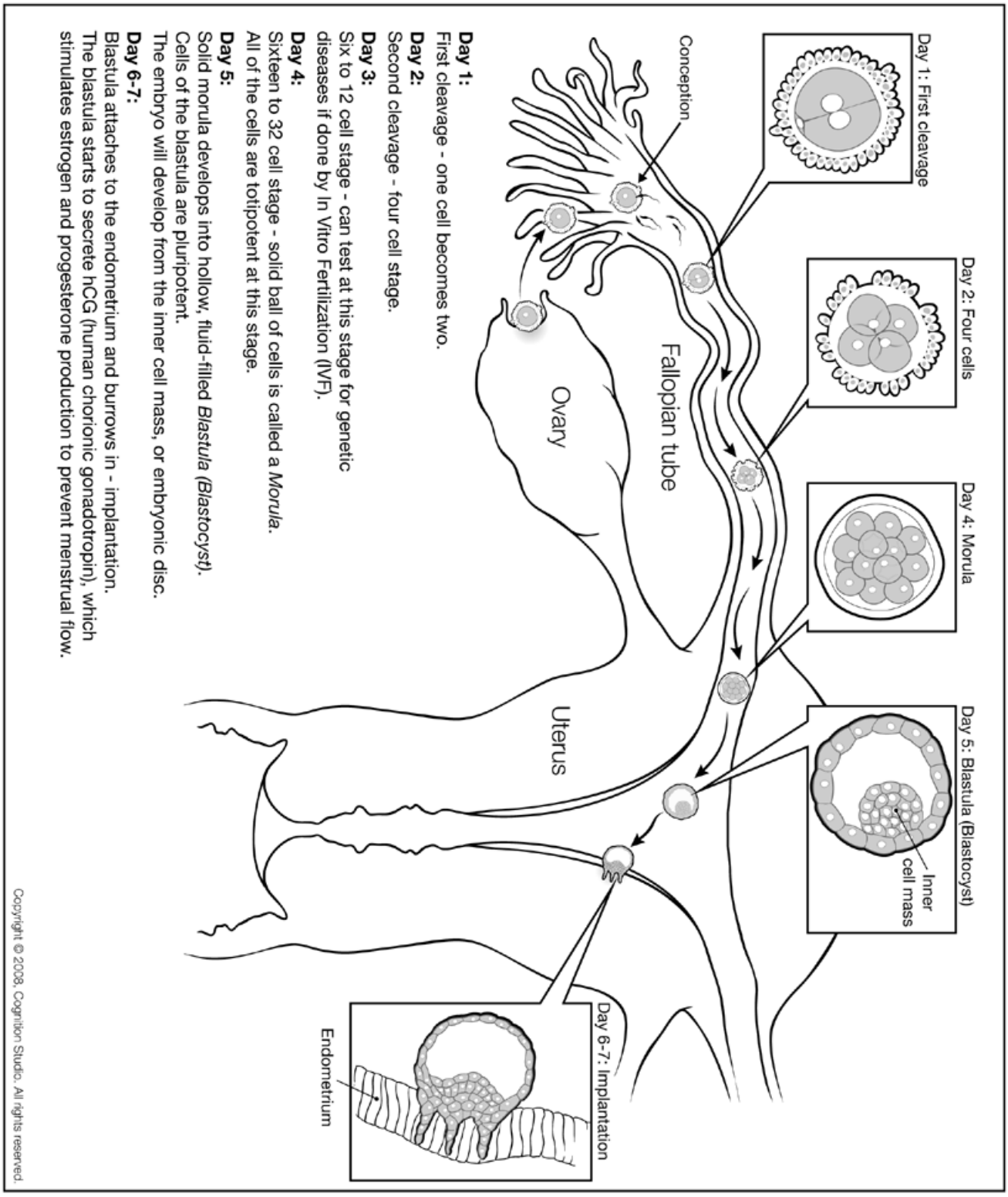
---

6. Circle the stages at which the embryonic cells are totipotent, and underline the stages at which the embryonic cells are pluripotent:

Zygote – Early Cell Divisions – Morula – Blastula – Gastrula

Early Development

In the first days and weeks after conceptions, mitotic cell divisions begin, converting the one-celled zygote to a multicellular early embryo.



Day 1:
First cleavage - one cell becomes two.

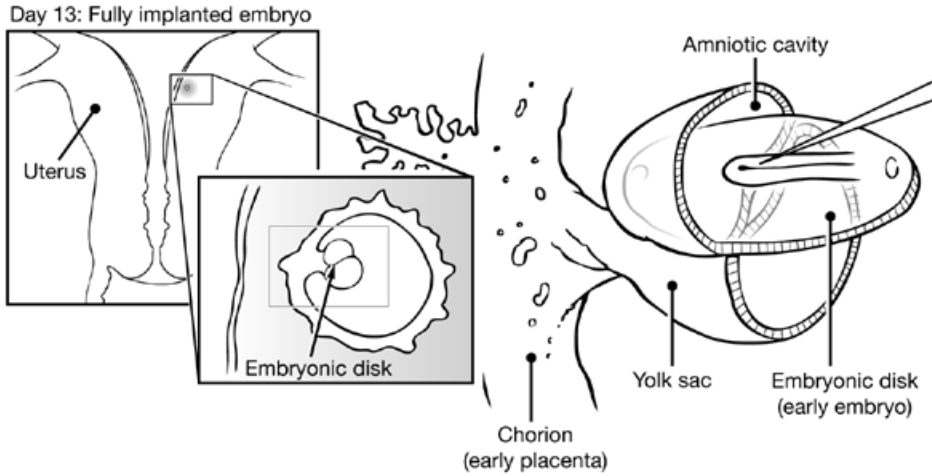
Day 2:
Second cleavage - four cell stage.

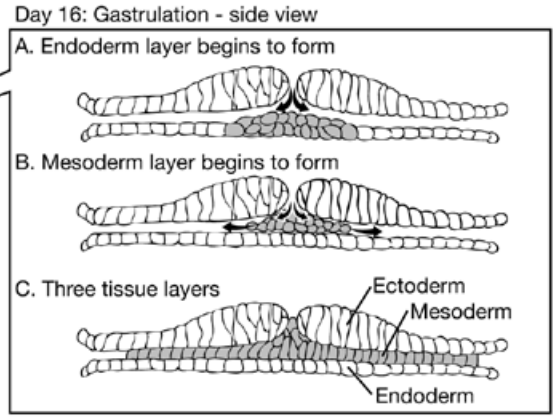
Day 3:
Six to 12 cell stage - can test at this stage for genetic diseases if done by In Vitro Fertilization (IVF).

Day 4:
Sixteen to 32 cell stage - solid ball of cells is called a *Morula*.
All of the cells are totipotent at this stage.

Day 5:
Solid morula develops into hollow, fluid-filled *Blastula (Blastocyst)*.
Cells of the blastula are pluripotent.
The embryo will develop from the inner cell mass, or embryonic disc.

Day 6-7:
Blastula attaches to the endometrium and burrows in - implantation.
The blastula starts to secrete hCG (human chorionic gonadotropin), which stimulates estrogen and progesterone production to prevent menstrual flow.



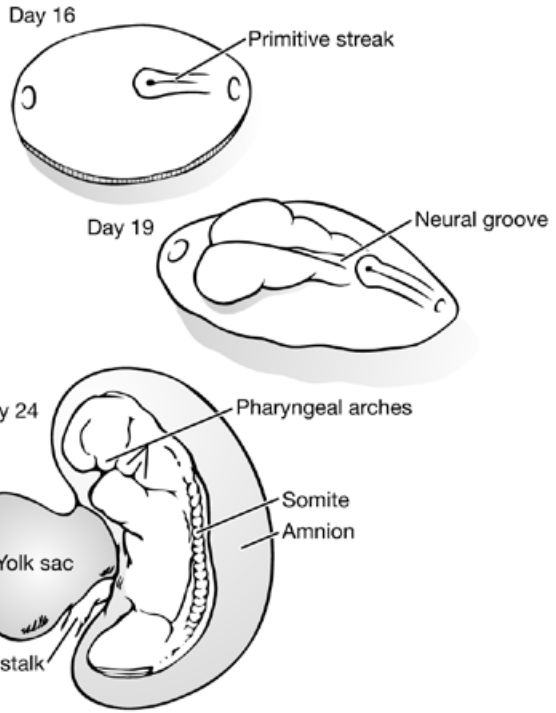


Day 7-14:
Pregnancy becomes established - the embryo is completely implanted in the uterine endometrium.
The following structures begin to form:
Amniotic cavity
Yolk sac
Chorion (placenta)
Embryo starts to form from *embryonic disc.*

Day 14-21:
Emergence of the vertebrate body plan.
Primitive streak starts to form - this is the site of gastrulation.
Gastrulation - major cellular reorganization into three tissue layers:
Ectoderm - (outer) skin, nervous system
Mesoderm - (middle) muscles, bones, heart
Endoderm - (inner) gut lining and internal organs
Neural groove begins to form - future spinal cord and brain.
Somites begin to form - bands of tissue that will become muscles and bones.
Cells at this stage are multipotent.

Day 21-24:
Pharyngeal arches begin to form - future face, neck, mouth and nose.

Week 3 – Week 8:
Embryo - development of all organ systems.



Lesson 2 Techniques for Obtaining Stem Cells

Objectives

Students will be able to:

- Describe scientific techniques (IVF, therapeutic cloning, using cord blood and bone marrow, inducing pluripotent stem cells) used for producing stem cells.
- Identify the type of stem cell (adult, embryonic) each technique yields.
- Provide an example of each technique.
- Describe how stem cells are currently used in research.

Class Time

One class period; homework assignment may be done in class if periods are longer.

Prior Knowledge Needed

- Definition and significance of stem cells.
- Sources of stem cells.
- Embryonic development.
- Potencies of stem cells from different sources.

Common Misconceptions

- The foremost purpose of cloning (SCNT) is to create genetically identical individuals, such as for reproductive use.
- New techniques using adult stem cells indicate embryonic stem cells are no longer needed in research.
- Embryos look like little tiny fetuses.

Introduction

In this lesson students learn about the variety of techniques used for obtaining stem cells, and find out if a given technique produces embryonic (pluripotent) or adult (multipotent) stem cells. Background news articles are included for each of the following techniques: *In Vitro* Fertilization (IVF), "Therapeutic Cloning", utilizing Umbilical Cord Blood and Bone Marrow, and inducing Pluripotent Stem Cells.

Key Concepts

- There are a number of methods for obtaining stem cells.
- Different techniques produce different types of stem cells—IVF procedures and 'Therapeutic Cloning' produce embryonic stem cells, umbilical cord blood and bone marrow produce adult stem cells, and the iPS technique produces pluripotent cells that behave like embryonic stem cells.
- The uses of these techniques have societal implications.
- Stem cells are currently being used for
  - regenerative medicine
  - drug development and testing
  - illustrating early growth and differentiation
  - understanding development of diseases.

Materials

Student Handouts:

2.1 – *What is IVF?*

2.2 – *What is "Therapeutic Cloning"?*

2.3 – *How are Umbilical Cord Blood and Bone Marrow Used?*

2.4 – *How do Differentiated Adult Cells become induced Pluripotent Stem Cells (iPS)?*

2.5 – *Summary of Newsflash! Information*

2.6 – *Overview: How Do We Get Stem Cells?*

2.7 – *How are Embryonic Stem Cells used?*

2.8 – *Current Stem Cell Research Article Review*

Internet Resources

An animated tutorial showing some stem cell techniques from the University of Michigan can be found at: **http://www.lifesciences.umich.edu/research/featured/tutorial.html**

The 15-minute video "The Cloning Process" from NOVA ScienceNOW reviews stem cells and touches upon different techniques. The video can be found at: **www.pbs.org/wgbh/nova/sciencenow/3209/04.html**

Student Handout 2.7 directs students to these two websites:

http://www.isscr.org/public/selected_topics.htm

http://www.pbs.org/wgbh/nova/sciencenow/3209/04-related.html

Procedure

An **embryonic stem cell line** *can be made from the inner cell mass of the blastula. These cells are transferred into a plastic laboratory culture dish and grown in a medium that provides support and nutrients.*

When kept in this way, the inner cell mass (or embryonic stem cells) can continue to divide and proliferate for long periods of time without differentiating or losing pluripotency. When coaxed to differentiate, they can then become any cell in the body.

Begin by asking students: "How do you think scientists get different types of stem cells for research and medical therapies?", and "Are scientists now using stem cells for therapies?"

- Brainstorm any ideas students have about obtaining stem cells.
- Tell students that they will read about some of the major techniques currently used for both adult and embryonic stem cell research and potential therapies.

News Flash! – Jigsaw activity

1. Students count off by fours, and then break into groups based on their number. Distribute copies of Student Handouts 2.1-2.4 to groups, so that each group is reading one article. Each two-sided handout has a description and a diagram of a technique used for obtaining stem cells on one side, and a news story about that technique on the other side.
2. Student should read quietly for approximately 7 minutes, until all members of their group are finished. Students use Student Handout 2.5 to summarize the information.
3. Once everyone has finished reading, the group should discuss the article and each student should take notes on his or her summary sheet.
4. Rearrange groups, so that there are groups of four with a student who has read each article. Each student should spend 2-3 minutes sharing the information in his or her article with the students who read a different article. Students should summarize the story they read and the answers to the questions from Handout 2.5.

5. Distribute Student Handout 2.6 "Overview: How Do We Get Stem Cells?" to each student.
   - Students work in groups to complete the table using information from the articles.
   - Students should diagram/flowchart the basic ideas from each technique on the back of this handout.

Discussion

1. Review tables with entire class. Students should fill in any missing information and correct any errors as you proceed.
2. Make sure students are clear about how embryonic versus adult stem cells are derived.
3. Of the four techniques described, reinforce to students that the clinical applications of "Therapeutic Cloning" and using iPS (induced pluripotent stem cells) have not yet been realized in humans.
4. Many animals have been cloned using the technique of "Therapeutic Cloning" (including Dolly the sheep) even though there have not yet been any human clinical applications. Therapeutic cloning remains the most controversial of the techniques.

"Therapeutic Cloning" is also referred to as Somatic Cell Nuclear Transfer, or SCNT.

How are Embryonic Stem Cells used?

1. Ask students: "When scientists get stem cells through one of these techniques, how are those stem cells used?
2. Brainstorm any ideas that students may have.
3. Distribute Student Handout 2.7 "How are Embryonic Stem Cells Used?" to each student.
4. Give students enough time to read about the uses of stem cells detailed on the handout.
5. Discuss the handout. Pose questions such as:
   - Which of these uses might be the most beneficial? Why?
   - Do any of these uses seem problematic? Why?

Homework

Student Handout 2.8

Student are directed to the following two websites and asked to find articles about stem cells. Handout 2.8 provides questions about stem cell research to help students summarize their findings.

http://www.isscr.org/public/selected_topics.htm

http://www.pbs.org/wgbh/nova/sciencenow/3209/04-related.html

The case study from Lesson 3 (Student Handout 3.1) can be given as homework the night before beginning Lesson 3.

Extensions

- Create a timeline with the major advances in stem cell technology. Students can use *Key moments in the Stem Cell Debate* from Lesson 5 (Student Handout 5.1) as a reference.
- Read the article "A Law's Fetal Flaw" by Nell Boyce from US News and World Report aloud to the class while students read along and discuss the issues raised by the story It can be found at: **http://health.usnews.com/usnews/health/articles/030721/21cure.htm**.
- Brainstorm other diseases that involve the degeneration or irreparable damage of cells. Possible ideas include Parkinson's Disease, Diabetes Type 1, Alzheimer's Disease, spinal cord injuries, heart disease, organ transplants, and blindness.
- Have students look for news articles that illustrate one or more of the embryonic stem cell uses described in Student Handout 2.7. Students can also research other ways in which embryonic stem cells are being used.

Adaptations

After learning the four techniques introduced in this lesson, students could do their own internet search to find current articles to summarize. The table on handout 2.6 could be completed as a class.

Assessment Suggestions

- Check for accuracy on handouts
- Students reasoning on whether techniques should be used for different purposes
- Class discussion

Source Information for Federal Policies

- National Institutes of Health Guidelines on Human Stem Cell Research, 2009. **http://stemcells.nih.gov/policy/2009guidelines.html**

Name _____ Date _____ Period _____

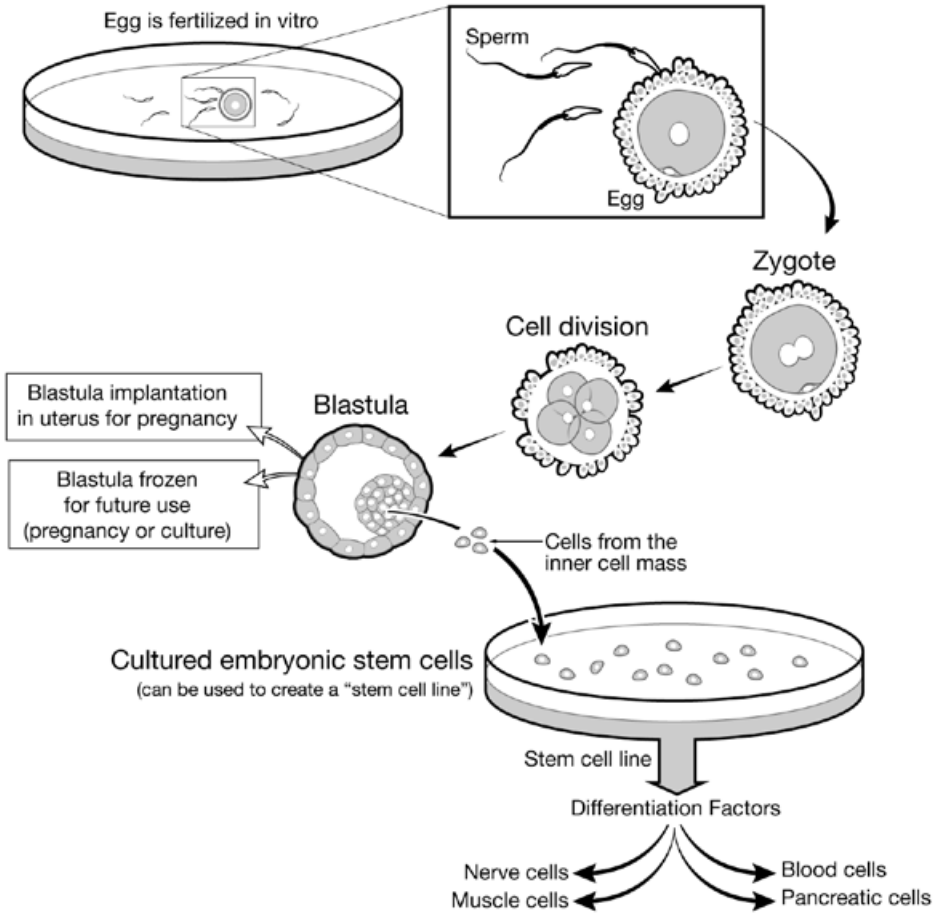
What is *In vitro* Fertilization (IVF)?

Vitro is Latin for "glass". In vitro means "in glass" referring to a test tube or Petri dish.

In Vitro Fertilization is a technique that has been used for nearly thirty years for fertility purposes. A woman is given fertility medications designed to trigger the release several mature eggs from the ovaries which are collected and fertilized with sperm "*in vitro*" or in a lab, outside of her body. The fertilized eggs, or embryos, are then grown to the blastula stage. Some are placed into her uterus and if successful, will result in a healthy pregnancy. The remaining embryos are frozen for later use if she chooses to attempt another pregnancy. Embryos for which she no longer has use will remain frozen. There are currently over 400,000 embryos stored in the U.S. by IVF clinics, the majority of which will never be used for reproduction.

To be used for stem cell research, the frozen embryos are thawed and cells from the pluripotent inner cell mass is removed and grown in a Petri dish in a research laboratory. Under the right conditions, these embryonic stem cells can self-renew (make more of themselves by dividing) indefinitely. By differentiating the embryonic cell lines into various cell and tissue types, researchers can generate new tissue to repair or replace damaged tissue, or investigate diseases such as diabetes, Parkinson's, Alzheimer's and others. Embryos created for IVF are the source of all embryonic stem cell lines currently used in federally funded research in the U.S. As of July 2009, federal funds cannot be used for research in which an embryo is created only to be destroyed for research purposes.

Pluripotent cells from the inner cell mass of the blastula are referred to as "embryonic" stem cells.



Stem Cell Research May Benefit Couples Using IVF

The origins of embryonic stem cells used in research are the IVF clinics that derive them for reproductive uses. Many couples chose to donate their unused embryos for research after a team of researchers in Wisconsin first isolated stem cells from embryos in 1998. Now this research is producing information that may ultimately result in more successful IVF pregnancies using fewer embryos. Fertility specialists are partnering with stem cell scientists in the hope that a clearer understanding of human development in these early stages will improve IVF rates. "If we can find the best way to grow embryos to get stem cells, and understand the best techniques to nurture them, then we can do studies to see if it might make a difference in our standard culture lines for things we are indeed going to place into patients," said Dr. David Smotrich, medical director and founder of La Jolla IVF.

Smotrich has teamed up with Evan Snyder, a biologist at the Burnham Institute in San Diego. The two are working on improving embryo handling methods such as freezing and thawing embryos to decrease damage. IVF methods are much more successful than they were in 1978 when the first *in vitro* baby was born, but many couples still fail to conceive after multiple attempts and it isn't always clear why. "You are dealing with a biological system whose signals we just don't understand, by and large," Snyder said.

Another example of how stem cell research has benefited couples hoping to conceive comes from Susan Fisher at UCSF. Dr. Fisher has been growing embryonic stem cells on a bed of human placental cells instead of the usual feeder mouse cell layer to reduce contamination by non-human proteins. This approach is now being experimented with at IVF clinics for use with the more difficult infertility cases. IVF clinics usually use a nutrient media that works well enough to keep embryos healthy enough to implant, but in some cases, embryos need the extra rich nutrients placental cells provide.

Many people disapprove of embryonic stem cell research because it destroys the human embryo. This research is showing that some of the first results of stem cell studies may improve IVF, reducing the number of embryos necessary to produce a successful pregnancy and ultimately increasing the number of babies born.

Adapted from:

Stem cell research may be boon to fertility clinics by Carl T. Hall ***San Francisco Chronicle***, February 21, 2005

Reduce multiple IVF births, experts urge by Patricia Reaney, ***Reuters.com*** Jun 18, 2006

Name _____ Date _____ Period _____

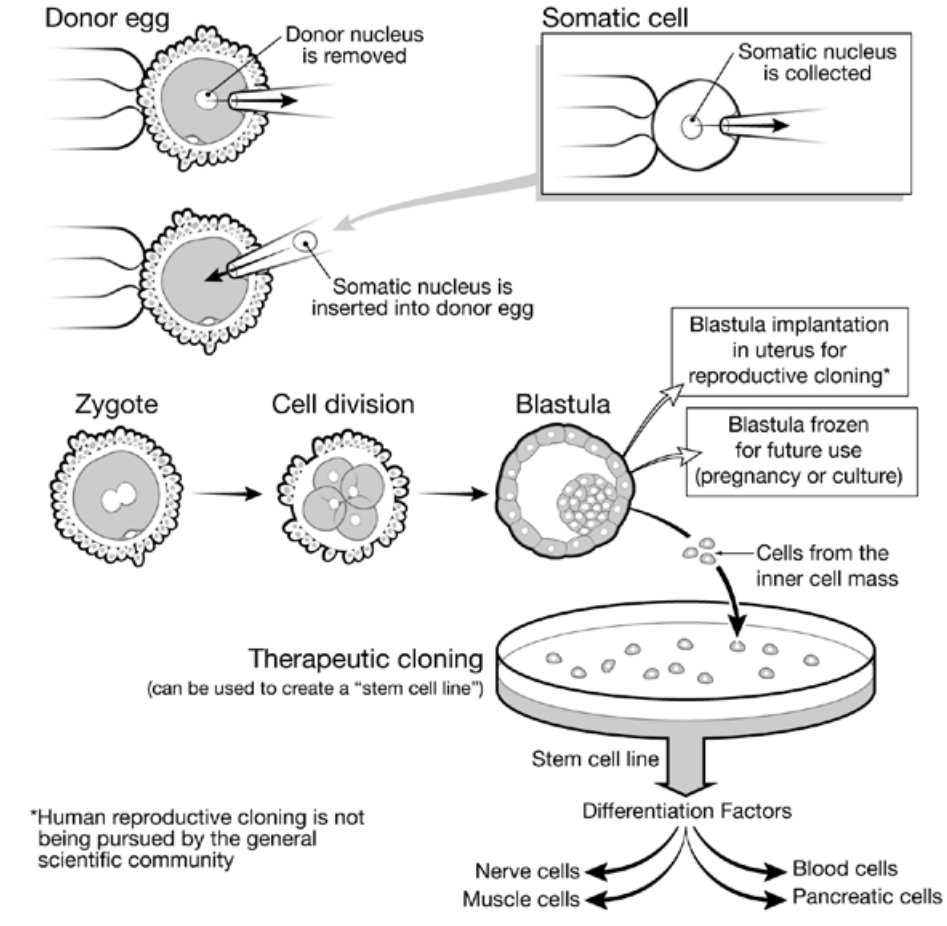
Therapeutic Cloning

"Therapeutic Cloning" is a technique used to create stem cells that are a genetic match to a donor. It has been used to clone non-human animals, the most famous being the sheep Dolly. Therapeutic cloning has been negatively associated with the idea of human reproductive cloning but the majority of scientists do not support the reproductive uses of this procedure in humans.

A somatic cell is any cell in the body not involved in gamete production or the gametes. Skin cells, bone cells, liver cells or cheek cells are all examples of somatic cells. In therapeutic cloning, the nucleus of a donated egg cell is removed and the nucleus from a patient's somatic cell is inserted. After receiving electric and chemical signals to stimulate it, the egg then behaves as if it has been fertilized and it begins to mitotically divide through the stages of zygote, morula, and blastula. In the center of the blastocyst, is an inner mass of cells. This inner mass is removed and grown in the lab in a Petri dish. These pluripotent embryonic stem cells (ESC) are genetically identical to the original somatic cell from the patient. This means that ESCs derived from the therapeutic cloning method may be used in treatments *without the risk of rejection by the patient's immune response*.

Another potential use for these ESCs is in the research of specific diseases. ESCs made from a patient with a specific disease could be used to follow the disease mechanisms in the search for possible treatments. Therapeutic cloning is also known as *somatic cell nuclear transfer (SCNT)* or *patient specific stem cells* because of these uses. As of July 2009, no human stem cell lines have been produced using this technique, and the federal government will not fund research that uses therapeutic cloning to derive stem cell lines.

Pluripotent cells from the inner cell mass of the blastula are referred to as "embryonic" stem cells.



Harvard Recruiting Egg Donors For Stem Cell Research

Harvard Stem Cell Institute (HSCI) became the second academic institute in the country to begin work on human therapeutic cloning when it announced Tuesday that HSCI will recruit women as egg donors. Therapeutic cloning, also referred to as somatic cell nuclear transfer, can be used to create stem cell lines which are genetically identical to patients. Experts believe such stem cell lines could be very valuable tools for studying diseases such as Alzheimer's and Parkinson's. However, the process of creating then destroying an embryo is controversial and opposed by some. South Korean scientists claimed to have created almost a dozen stem cell lines using therapeutic cloning but this year admitted that their results were made up.

The procedure for recruiting egg donors required significant thought and consideration. Because women will not be paid, aside for expenses associated with the donation process (travel, hotel, etc.), they are considered "compassionate" donors. The expenses that are paid, like all funding for the projects, must come from private donations because of the federal ban of such research. In order to harvest eggs, women are given hormones which stimulate them to release more eggs. In South Korea, this caused considerable health problems for donors. As a result, Harvard researchers will limit the amount of hormonal stimulation and the number of eggs harvested from each woman. Finally, women who agree to donate will sign a detailed informed consent form.

One project that has been given the go-ahead requires scientists to remove the nuclei of skin cells taken from diabetes patients. These would then be inserted into donated eggs to create disease-specific stem cell lines. "We're excited using SCNT [Somatic Cell Nuclear Transfer, or "Therapeutic Cloning"] as a way forward where in essence we can move the study of disease from patients to Petri dish," said Douglas Melton, co-director of the Harvard Stem Cell Institute. Melton's son has been diagnosed with juvenile diabetes.

Adapted from:

Harvard Embarks on Research Cloning by Constance Holden ***ScienceNOW*** Daily News 6 June 2006

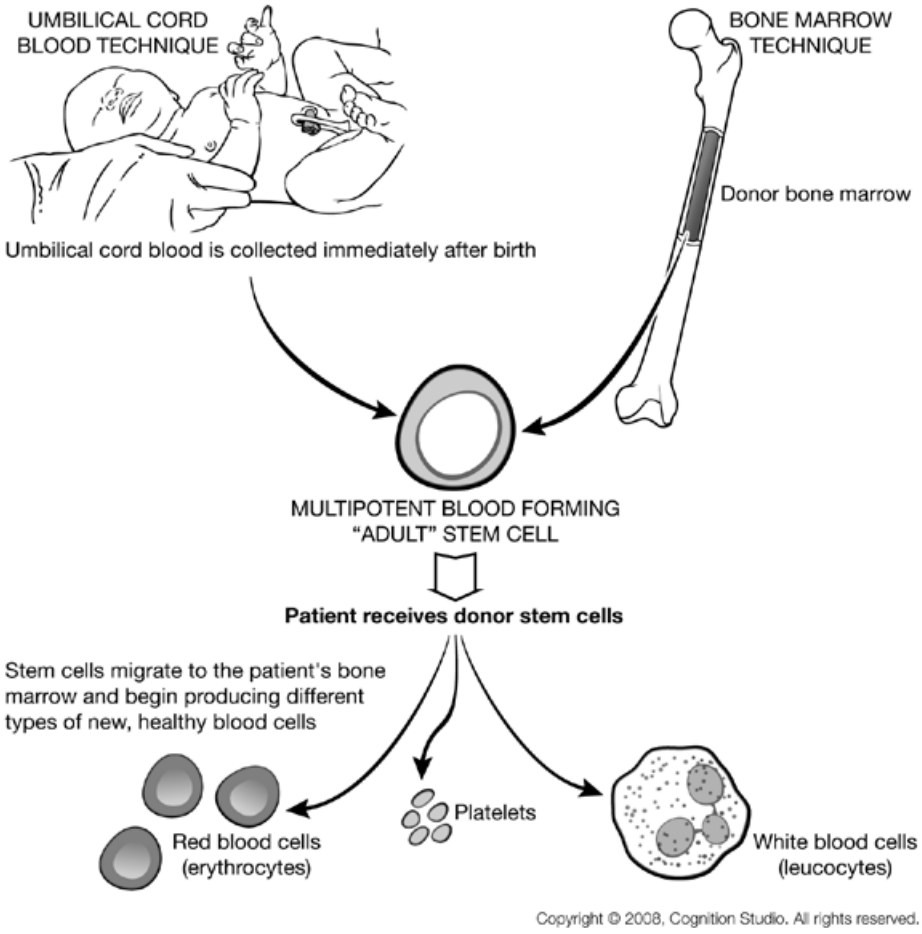
Why Harvard is recruiting stem cell donors by Alice Park ***Time*** June 6, 2006

Name _____ Date _____ Period _____

How are Umbilical Cord Blood and Bone Marrow Used?

There are three main types of blood cells; erythrocytes (red blood cells), leucocytes (white blood cells) and platelets. Each cell type has specific functions related to oxygen exchange, the immune system and clotting and requires constant replenishment as cells age or are destroyed as part of the immune response. New blood cells are produced in the bone marrow by multipotent blood forming adult stem cells. These adult stem cells can also be found in umbilical cord blood and in small amounts in the blood stream. Both umbilical cord blood and bone marrow transplant procedures are used to treat blood cancers such as leukemia and genetic blood disorders such as sickle cell anemia. First, a patient's diseased cells are usually destroyed and removed through chemotherapy and radiation. Healthy cells from either a genetically matched bone marrow donor or an umbilical cord blood donor are then given through the central venous catheter into the bloodstream. The stem cells make their way to the patient's own bone marrow and if the procedure is successful, begin making healthy new blood cells.

A bone marrow transplant is the best-known and oldest stem cell therapy, with the first successful transplant (between identical twins) taking place in 1956. Cord blood transplantation is still relatively new and the umbilical cord has typically been thrown away after birth. However, doctors now commonly ask parents if they would like to preserve it. Rejection is less common with umbilical cord blood transplants, because the cells have not developed features that the patient's immune system might recognize as foreign.



The multipotent cells found in umbilical cord blood and bone marrow are already committed to only making different types of blood cells. They are considered "adult" stem cells.

Source: Genetic Science Learning Center

Saving Blood Saves Lives

Susan Orr was six months pregnant when her 2 year old son Brandyn was diagnosed with leukemia. She and her then-husband, Bob, had never heard of cord blood when an oncologist suggested they save the umbilical cord blood from the birth of their second son, Kaelyn. Willing to do anything that might help Brandyn, they agreed without even thinking about the cost.

The blood remaining in the umbilical cord and placenta after a woman gives birth is rich in adult stem cells that have the ability to develop into many types of blood cells. Beginning in 1988, cord-blood transplants have been used to treat blood disorders and regenerate immune cells following chemotherapy. The Orrs signed on with a private cord-blood bank and paid a $1,000 fee to have the blood collected and stored. They did the same when two more sons, Devyn and Jadyn were born in the next few years.

Meanwhile, Brandyn continued treatment, and after three difficult years, his cancer went into remission. It seemed the cord blood wasn't needed after all.

Brandyn's parents didn't think much of his complaints about feeling tired and sore during a family vacation to Florida. But when he fell down on the playground and couldn't get up, they rushed him to the hospital. Their worst fear was confirmed – the leukemia had returned. The only hope this time was a transplant, and there was not time to wait for a donor. They asked to have the banked cord-blood tested. Kaelyn's blood was not a match, but to everyone's relief, Devyn's was.

Before the transplant could be performed, 6-year-old Brandyn had to endure weeks of radiation and chemotherapy in order to destroy the cancerous cells. After the treatment, a syringe containing his brother's cord blood cells was pushed into an intravenous tube. The transplant took five minutes. Brandyn was required to stay in the hospital for five weeks after the procedure, then return for weekly check ups and treatments.

Today, Brandyn has been cancer free for nearly 6 years. He plans to be a computer programmer, or a repairman, or even an artist. Since his parent's divorce, he's the man of the house and helps out by doing everything from installing a new ceiling fan to fixing the VCR. He's glad his past with leukemia is over and now spends his time dreaming about the future.

Adapted from:

"Umbilical cord blood provides a lifesaving solution" Christina Vanoverbeke, East Valley Tribune, June 25, 2006

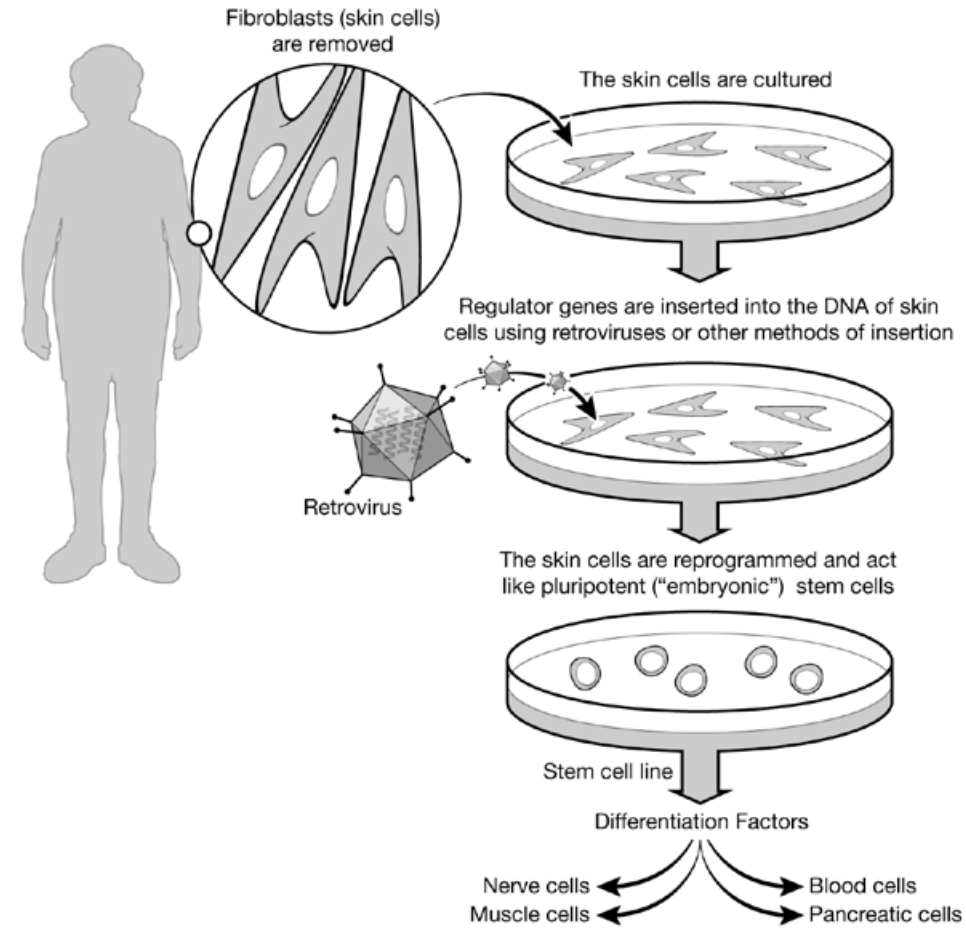
Name _____ Date _____ Period _____

How do Differentiated Adult Cells become induced Pluripotent Stem Cells (iPS)?

Although each team of researchers inserted four master regulator genes into skin cells, the teams used different combinations of genes; only two of the four genes were the same in both groups.

Scientists have shown that differentiated adult cells can be reprogrammed to behave like undifferentiated human embryonic stem cells, producing *induced pluripotent stem* cells, or iPS cells. Pluripotent cells are able to develop into any of the hundreds of cell types in the human body, such as muscle, nerves, cartilage, blood or bone. To make iPS cells, four or more master regulator genes are inserted into the DNA of an adult cell such as a fibroblast skin cell. These regulator genes act like a reset button, returning the cell to a 'blank' state. This reprogramming allows the former skin cell to behave like an embryonic (pluripotent) stem cell, and give rise to different types of tissue. Though promising, this new technique is not yet ready to be used to treat diseases in humans. Researchers are working to find the best way to insert the master regulator genes into the DNA of the adult cell. Retroviruses have been used but are problematic because the inserted genes are spliced into the DNA at random places and can cause tumors. Recent work using transposons ('jumping genes') to insert the master regulators genes shows potential, but requires further study.

Using skin cells or other adult tissue to produce iPS cells is less ethically objectionable to some people since no embryos are destroyed in the process. Most scientists believe that it will be necessary to continue studying embryonic stem cells through traditional means, as they serve as the "gold standard" and as a basis for evaluation and comparison. Earlier studies on embryonic stem cells also identified the genes chosen to reprogram the skin cells.



Induced Pluripotent Stem Cells *Newsflash!*

Skin Cells fix Sickle Cell Anemia in Mice

Using a new technique to turn skin cells into stem cells, scientists have corrected sickle cell anemia in mice. The advance provides "proof of principle" that stem cells made without embryos can treat disease, at least in lab animals, says Rudolf Jaenisch, the biologist who led the work at the Whitehead Institute for Biomedical Research in Cambridge, Mass. Jaenisch and his team caution, however, that the technique is not yet suitable for use in humans because it may cause tumors.

Still, Jaenisch says that embryofree stem cells now "have the same potential for therapy as embryonic stem cells, without the ethical and practical issues." Embryonic stem cells are difficult to obtain, and some people oppose such research because it destroys discarded embryos.

The Whitehead researchers obtained mice engineered to carry a defective version of the human hemoglobin gene. That flaw distorts red blood cells into the characteristic sickle shape. To fix the flaw, the researchers induced skin cells plucked from the tails of the mice to become iPS [induced pluripotent stem] cells, and corrected the genetic defect.

Next, the Whitehead team prodded the corrected cells into becoming blood stem cells, which can produce red and white blood cells. The team used a recipe originally developed for embryonic stem cells and found that it also made iPS cells grow into blood stem cells.

"We wanted to compare the embryonic stem cells versus the iPS cells," says Whitehead researcher Jacob Hanna. "They behaved similarly."

Finally, the researchers performed a procedure akin to a bone marrow transplant. They transfused a million of the corrected blood stem cells into each of three mice whose bone marrow—which harbored the mice's original defective blood stem cells—had been obliterated by radiation. The corrected blood stem cells soon began producing healthy red blood cells. Because the same animal was both donor and recipient, the infused cells were not rejected, as commonly occurs in human bone marrow transplants. After this treatment, the formerly lethargic mice made swift recoveries. "The improvement was profound," says Hanna. "There was a clear sign of reduction of destruction of red blood cells, which is actually the main problem in sickle cell anemia."

Mark Walters, a bone marrow transplant specialist at Children's Hospital and Research Center in Oakland, Calif., says the procedure surmounts the biggest obstacle in performing such transplants in children—finding a genetically matched donor. Worldwide, only 300 to 400 children with sickle cell anemia have received bone marrow transplants because matched siblings are rare. "But the results are outstanding, with a cure rate between 85 and 90 percent," Walters says.

Before the procedure can advance to human trials, though, researchers must find a more benign way to make iPS cells, because the viruses currently used can trigger cancer. "We'd have to have some information that these are not preleukemic or premalignant cells, that they're safe in the long term," says Walters.

Source: Brian Vastag, From ***Science News***, Vol. 172, No. 23, Dec. 8, 2007, p. 355.

Name _____ Date _____ Period _____

Summary of *News Flash!* Information

Name of article: _____

1. What is the name of the technique used in the article?

2. What is the purpose of the technique in the article?

3. What steps are used in this technique?

4. What type of stem cells could be produced using this technique?

5. What are the possible points of controversy with this technique?

Name _____ Date _____ Period _____

Overview: How do we get stem cells?

Technique	How is it done?	Origin of stem cell (adult or embryonic?)	Points of controversy
"Therapeutic Cloning"			
In vitro fertilization (IVF)			
Umbilical Cord Blood/ Bone Marrow Transplantation			
Induced Pluripotent Stem Cells (iPS)			

Diagram the technique in each space below.

"Therapeutic Cloning"	*In vitro* ***Fertilization (IVF)***
Umbilical Cord Blood/Bone Marrow Transplant	***Induced Pluripotent Stem Cells (iPS)***

Overview: How do we get stem cells?

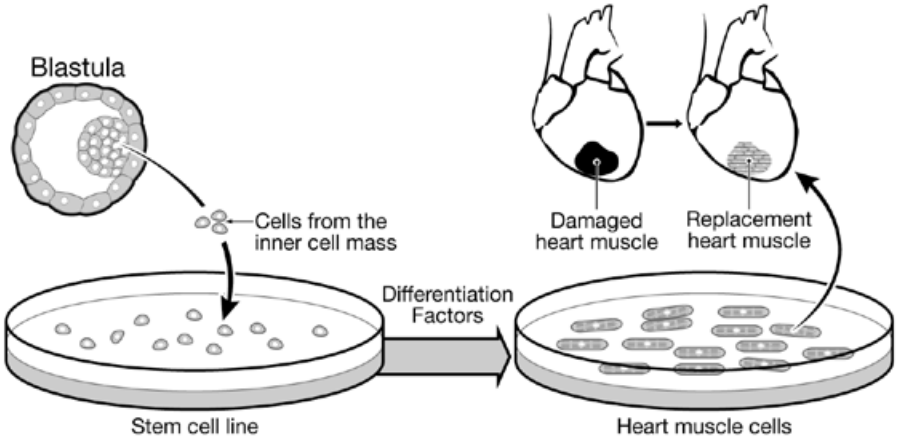
Technique	How is it done?	Origin of stem cell (adult or embryonic?)	Points of controversy
"Therapeutic Cloning"	The nucleus of a donated egg cell is removed and replaced with the nucleus from a patient's somatic cell, such as a skin cell or liver cell. The egg, now having a full set of chromosomes, is stimulated to divide. At the blastula stage, the inner cell mass is cultured and coaxed into eventually becoming the type of tissue the patient needs, such as insulin-producing cells to treat diabetics.	Embryonic	Could this lead to reproductive cloning? Should women be paid for donating eggs? Is it better to use cells from a blastula that was never intended to become a baby?
***In vitro* fertilization (IVF)**	Several eggs are fertilized with sperm *in vitro*. At the blastula stage, some of the fertilized eggs are implanted into the uterus. If successful, pregnancy results. The remaining embryos are frozen for future use by the couple, if needed. The inner cell mass from the "leftover" blastulas can be cultured and coaxed into eventually becoming the type of tissue the patient needs, such as insulin-producing cells to treat diabetics.	Embryonic	The blastula was originally created by an infertile couple wanting to have children—does the original purpose for creating the blastula matter? Should "leftover" embryos from IVF be used in this way? How else might they be used? Should donor have to give consent to donate their blastulas?
Umbilical Cord Blood/ Bone Marrow Transplantation	Patients with blood cancers (such as leukemia) have their diseased blood cells destroyed and replaced with healthy, genetically-matched cord blood or bone marrow donor cells. The multipotent stem cells from the cord blood or the bone marrow can develop into any type of blood cell.	Adult	Should a couple with a child with leukemia try to have another baby, in hopes of being able to use the cord blood to help the older child? Who should pay for saved cord blood? Should bone marrow donors be paid?
Induced Pluripotent Stem Cells (iPS)	With the introduction of 4 'master regulator genes', an adult fibroblast skin cell can be coaxed into reverting to a pluripotent state, thus having the ability to become any type of cell in the body.	Adult	Does this mean blastulas are not needed as sources of embryonic (pluripotent) stem cells? Does this really sidestep the controversy of using embryonic stem cells from other sources?

Name _____ Date _____ Period _____

How are Embryonic Stem Cells used?

Regenerative medicine. Regenerative medicine uses stem cells to regenerate, or re-grow, new cells, tissues or organs in order to repair or replace diseased tissues and organs. Human embryonic stems cells can be directed to develop into any of the hundreds of specific cell types in the body. For a person with Type I Diabetes, for example, this could mean re-growing the insulin-producing cells that the body has lost over time. For a person living with heart disease or who has had a heart-attack, this could mean growing a patch of heart muscle that would replace damaged tissue. Future therapies will likely include using stem cells to grow an entire organ for transplantation that would be genetically matched with a patient. This type of medicine offers the possibility of growing cells and tissues to treat diseases such as Parkinson's and Alzheimer's disease, spinal cord injury, stroke, burns, and arthritis. See figure 1.

Figure 1 – Using embryonic stem cells for regenerative medicine



Early Human Development. This research uses cells from the inner cell mass of the blastocyst (blastula) embryo to grow human embryonic stem cells in cultures. Because the cells can mimic normal development even though they are outside of the body, scientists are better able to understand the complex events that unfold as undifferentiated stem cells become differentiated cells and tissues. What genes are central to this process? What signals turn those genes on and off? When this process goes awry and cells divide abnormally or do not differentiate correctly, loss of pregnancy and serious medical conditions such as cancer and birth defects can result. Many cancers, for example, result from uncontrolled cell division. Using human embryonic stem cell cultures to better understand the factors that control early cell division and differentiation will eventually allow researchers to devise better treatments and therapies.

Sources:

Stem Cell Basics, National Institutes of Health. **http://stemcells.nih.gov/staticresources/info/basics/SCprimer2009.pdf**

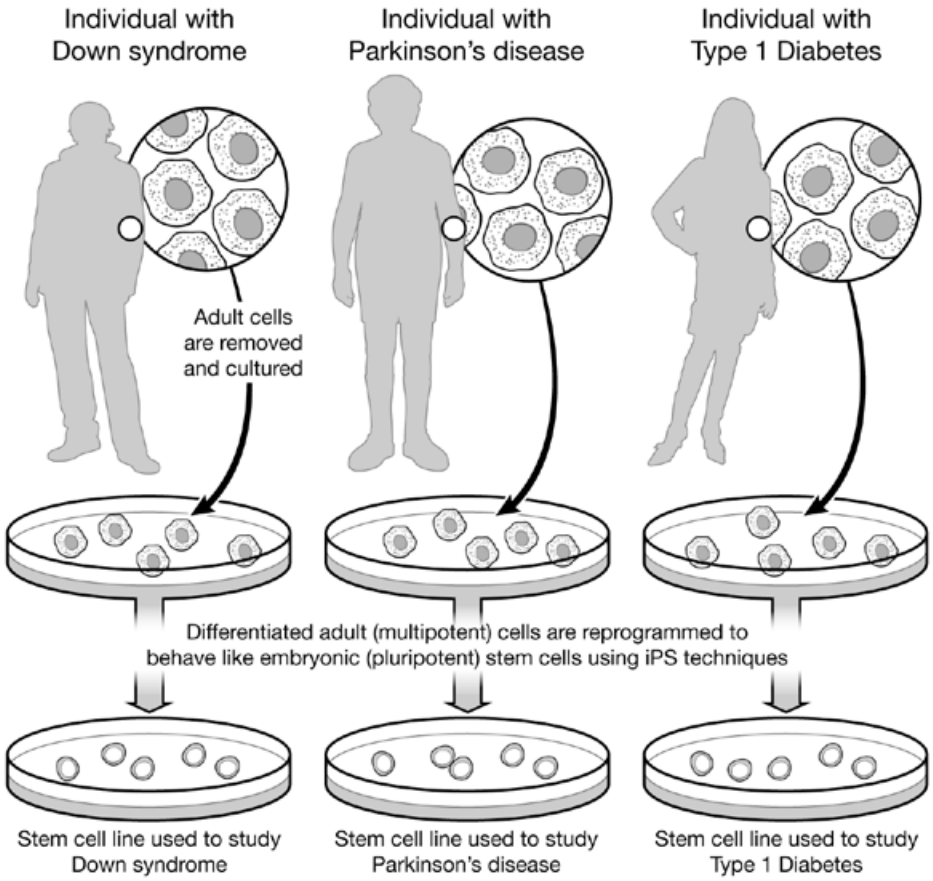
Wadman, Meredith, "New Tools for Drug Screening" Science Magazine, December 20, 2007. **http://www.nature.com/stemcells/2007/0712/071220/full/stemcells.2007.130.html**

Colen, B.D., "Daley and colleagues create 20 disease-specific stem cell lines" Harvard Science, August 7, 2008. **http://www.harvardscience.harvard.edu/foundations/articles/daley-and-colleagues-create-20-disease-specific-stem-cell-lines**

Drug Development and Testing. Getting a new drug into the marketplace can cost billions of dollars and require decades of research. In early rounds of drug development, chemical compounds are tested on various cell types in the laboratory. In later rounds of safety testing, before any tests with human subjects, drugs are tested on more specific tissues types that may be affected by the drug. The liver, for example, can be harmed by the drugs it breaks down; liver tissue is therefore an important component for many drug safety studies. Currently, scientists rely on animal tissues, animal toxicity studies and scarce, often diseased, human liver tissue samples for safety testing. Human embryonic stem cells that have been coaxed to make liver tissue would offer tremendous advantage to the drug development and testing process. Likewise, stem cells that have differentiated into heart, nerve or other tissue types could be used in the same way. This use of stem cells could also eventually reduce the need for animals in research.

Understanding Disease. Creating disease-specific stem cell lines allows researchers to watch the development of a disease in a Petri dish, outside of the human body. Cell lines have been made from embryonic stem cells carrying the mutation that causes cystic fibrosis, for example. Using the Induced Pluripotent Stem Cell (iPS) technique, researchers have also created cell lines that carry the version of the genes (or genetic components) that cause Parkinson's disease, Type I Diabetes, Down syndrome, Huntington's disease, two forms of Muscular Dystrophy, and others. Although in the early stages of research, these cell lines will likely be valuable tools for understanding the development of disease. They will also aid in creating treatments, therapies, and new drugs that would attack the root cause of the disease. See Figure 2

Figure 2 – Using embryonic stem cells to better understand disease



Name _____ Date _____ Period _____

Current Stem Cell Research Article Review

Find one article related to stem cell research and disease treatment and summarize the type of research using the guide below. You can use one of the links, below, or find your own.

http://www.isscr.org/public/selected_topics.htm

http://www.pbs.org/wgbh/nova/sciencenow/3209/04-related.html

1. How are stem cells being used in this article?

2. What type of stem cell (adult, embryonic, or both) is used in the research?

3. What is the source of the stem cell?

4. Summarize techniques used in the research:

5. Does this research show potential? Explain.

Lesson 3 Case Study: One Family's Dilemma

Objectives

Students will be able to:

- Describe major biomedical ethical principles.
- Analyze how a particular position relates to the principles.

Class Time

About 1 class period, depending on the amount of discussion and how much is given as homework before the lesson.

Prior Knowledge Needed

- An understanding of *in vitro* fertilization techniques.
- How to have a discussion in which it is safe to have different opinions from classmates.

Introduction

In this lesson, students are introduced to the major principles of biomedical ethics: respect for persons, beneficence / nonmaleficence, and justice (definitions are provided on the next page). Next, they examine a case study in which the parents of two children born with the help of *in vitro* fertilization techniques are asked to decide the fate of their remaining frozen embryos. Students identify the bioethical principle given priority in their own solution to the dilemma posed in the case study.

Key Concepts

- Ethics is a discipline, or organized system of thought, concerned with questions about what is right and wrong and what kind of person each individual should strive to be.
- Bioethical dilemmas can be evaluated using various ethical perspectives. The bioethical principles introduced are:
  - Respect for Persons (Autonomy)
  - Beneficence (Do good)
  - Nonmaleficence (Do no harm)
  - Justice (Be fair)
- It is important to provide a sound justification and argument for choosing an ethical perspective when options in a bioethical dilemma are identified.

Materials

Poster Paper and Marker

Student Handouts:

3.1 – *Case Study: One Family's Dilemma*

3.2 – *Decisions, Decisions*

3.3 – *My Perspective*

3.4 – *Bioethical Principles and Embryonic Stem Cells*

Teacher Resources:

Sample answers for Handout 3.2 and 3.4

Skit Improvisation List

Procedure

A. Introduction to the Principles of Bioethics through Skits

1 Up to this point, we have been focusing on the science behind the use of stem cells for research. As we enlarge our view to include societal issues and examine the debate over the use of stem cells, students will be exposed to many valid and conflicting viewpoints. Tell students that many bioethical dilemmas are evaluated using various ethical perspectives. Introduce ethics as a discipline or organized system of thought that reflects on and studies the moral life. It is concerned with questions about what is right and wrong and what kind of person each individual should strive to be.

2 As students are exposed to conflicting points of view, it is important to find a way to keep discussions manageable in the classroom. Some suggestions for conducting classroom discussions and setting norms can be found in the Appendix.

3. In this activity, students perform skits first, then derive the ideas underlying the Principles of Bioethics taught in this unit during a teacher-led discussion. The skits provide a way for students to show their awareness of concepts supporting the Principles of Bioethics even though they may not have the precise vocabulary to explain it as such. The teacher will know which bioethical principle is being introduced (in parentheses after 1-6, below) but the students will not. After each set of skits and class discussion, the teacher should name the principle and write it down for the class to see.

   a. Choose 6 pairs of students to come to the front of the class to improvise 30-second role-plays of interactions between a parent and child. These are groups 1-6. Groups 5 and 6 can choose a third student to act as the sibling, if desired.

   b. Give each group of students one of the scenarios 1-6, found below in 'c', and as a Teacher Resource.

   c. Give the students about 2 minutes to prepare to simulate the following interactions between a parent and child. Tell students that it is helpful for them to 'give voice' to the ideas inside a person's head by saying them out loud.

      The skits (also found in as a Teacher Resource) are:

      1. Parent respecting the child's career choice
         (respect for persons, or autonomy)
      2. Parent NOT respecting the child's career choice.
         (respect for persons, or autonomy)
      3. Parent helping child with her homework
         (maximizing benefits/minimizing harms)
      4. Parent NOT helping child with her homework
         (maximizing benefits/minimizing harms)
      5. Parent being fair between siblings
         (justice)
      6. Parent NOT being fair between siblings
         (justice)

d. Have students from groups 1 and 2 present their skits. Ask students, "What code or standard is being honored (or not)?" Students may say 'respect' or 'right to choose for him/herself'. Tell students that one of the bioethical principles is called **Respect for Persons** and that it emphasizes the inherent worth and dignity of each individual, and acknowledges a person's right to make his or her own choices.

e. Write the principle on a poster paper for all to see. This is your class Principles Poster.

f. Have students from groups 3 and 4 present their skits. Ask students, "What code or standard is being honored (or not)?" Students may say 'helping' or 'being good'. Tell students that another of the bioethical principles relates to **Doing Good/Doing no Harm**. It asks how we can maximize benefits and minimize harms.

g. Add this principle to the poster.

h. Have students from groups 5 and 6 present their skits. Ask students, "What code or standard is being honored (or not)?" Students may say 'fairness' or 'equality'. Tell students that the third bioethical principle is called **Justice**. It considers how we can treat people fairly and equitably.

i. Add this principle to the poster.

j. Leave the Principles Poster with the three bioethical principles up for the remainder of the unit.

4. Introduce these principles to the students:

'Respect for Persons'

This principle focuses on respect for individuals and their **autonomy**. It acknowledges a person's right to make choices, to hold views, and to take actions based on personal values and beliefs. It emphasizes the responsibility individuals have for their own lives and the right to self-determination. The rules for informed consent in medicine are derived from the principle of respect for individuals and their autonomy. In medicine, there is also a special emphasis on respecting individuals from vulnerable populations.

Some ethicists also add:

Care – *Focus on the maintenance of healthy, caring relationships between individuals and within a community. The principle of care adds context to the traditional principles and can be used in a complimentary way alongside them.*

'Do Good' / 'Do no harm'

'Do Good" (beneficence) stresses directly helping others, acting in their best interests, and being a benefit to them. It requires positive action.

'Do No Harm' (nonmaleficence) relates to one of the most traditional medical guidelines, the Hippocratic Oath (*First of all, do no harm*). The Hippocratic Oath requires that physicians at least do no harm—even if they cannot help their patients.

Justice- 'Be Fair'

This principle relates to '*Giving to each that which is his due*' (Aristotle). It dictates that persons who are equals should qualify for equal treatment, and that resources, risks, and costs should be distributed equitably.

B. Case Study: One Family's Dilemma

1. Ask students to read Handout 3.1 — *Case Study: One Family's Dilemma.* This can be given as homework the night before.
2. Using Handout 3.2, students can list the various options Kathleen and Tom have, and tie these to an ethical principle.

   List the options and complete the first column of Handout 3.2 together as a class. Then divide the class into small groups and have each group brainstorm the ethical principle given the most weight for each option, as well as the reason they chose that principle.

   Provide an example for illustration. A sound justification and argument is more important than the selection of a particular principle for any one option. The sheet can be completed in small groups, individually in class, or as homework.

Homework

Have students complete Handout 3.3, My Perspective: Embryonic Stem Cells. This allows students to reflect more deeply on their particular perspective and allows for reinforcement of the principles discussed in class. Students may want to keep their own position private – writing about their position as homework allows them to do so.

Handout 3.4, Bioethical Principles and Embryonic Stem Cells, can also be used as homework. Students complete a chart practicing the application of the principles to the overall question of the use of embryonic stem cell research. This is suitable for advanced classes or those with background in bioethics.

More about the Lesson

Ethicists defend (or justify) their positions using different ethical perspectives and theories. The three principles introduced in this lesson (Respect, Do Good/Do No Harm and Justice) fall under the umbrella of the "Biomedical Principles" ethical perspective. For more information on this ethical theory and others, *An Ethics Primer* is available to download from the Northwest Association for Biomedical Research. It can be found at: **http://www.nwabr.org/education/ethicslessons.html**

In addition, an on-line ethics training course from Family Health International can be found here: **http://www.fhi.org/en/RH/Training/trainmat/ethicscurr/RETCCREn/pr/Contents/SectionIV/b4sl32.htm**

Kathleen and Tom's story is based on an actual story written for the Boston Globe in 2004. In that case, the couple involved in the decision-making process decided to donate their excess embryos for research. This information should not be revealed to students until they have finished the lesson.

Extensions

Provide students with opinion pieces (articles, letters to the editor, etc…) that they can analyze in order to identify individual positions on stem cell research, and to identify which ethical theory they may be using.

Skit Improvisation List

Cut out the following interactions between a parent and child. Choose 6 pairs of students to improvise 30-second role-plays. Students in groups 5 and 6 can choose a third student to be the sibling, if desired. Give the students about 2 minutes to prepare their scenes.

Skits 1 and 2 relate to *Respect for Persons* (autonomy), skits 3 and 4 relate to '*Do Good'/Do No Harm*, skits 5 and 6 relate to *Justice*.

1. Parent respecting a child's career choice
2. Parent NOT respecting the child's career choice
3. Parent helping child with her homework
4. Parent NOT helping child with her homework
5. Parent being fair between siblings
6. Parent NOT being fair between siblings

One Family's Dilemma

Kathleen knew that there was quite a bit of controversy regarding stem cell research in the news, but it didn't occur to her that it really affected her in any way. Then again, she had never thought the word 'infertility' would apply to her either. Kathleen and Tom were both raised in conservative religious households. She and Tom both came from large families; their parents now have 27 grandchildren. It wouldn't appear that there are any problems with reproduction. How could there be?

Kathleen and Tom made careful plans before their marriage so that they would be prepared for a family: researched career choices, accepted positions with growing software companies in the Seattle area, purchased a house in an area where the schools were highly recommended. Why couldn't she get pregnant? Two years passed, then three before they were able to bring themselves to discuss their apparent infertility and learn about the mind-boggling possibilities in fertility treatments, none of which they wanted to discuss with their seemingly problem-free siblings.

After a long journey through tests and research, Kathleen and Tom had two children through *in vitro* fertilization. The process was lengthy and expensive. After months of painful injections to boost her egg production, Kathleen underwent procedures to have 6-8 eggs removed. The eggs were then fertilized with her husband's sperm in a Petri dish, and the resulting embryos were incubated for several days in a carefully controlled environment.

Four blastocysts (embryos with about 150 cells) were implanted back into Kathleen. They were each smaller than a period at the end of a sentence, had no heartbeat and could not develop into a person without successfully implanting in a womb. Statistically, one out of every four implanted embryos results in a full-term pregnancy, but the first time none of Kathleen's embryos developed into a fetus. They had to repeat the procedure two more times. There were six potentially good embryos remaining when Kathleen became officially pregnant. The excess embryos were frozen and stored in a special tank.

At holiday gatherings no one would ever know that Kathleen and Tom's children had been conceived any differently than any other cousin running around the back yard. Yet the path to parenthood had put them at odds with their faith, which does not approve of *in vitro* fertilization (IVF) because of the risk to potential embryos and because of the use of technology for procreation. However Kathleen and Tom felt sure that they were meant to have children. Although there is more initial uncertainty with IVF than with a regular pregnancy (*What if the embryo doesn't implant? What if all four of them do?*), once the pregnancy is advanced it is no different than any other. Occasionally Kathleen and Tom remembered the excess embryos and were glad: if they decided to have a third child it would be possible. Then Kathleen learned that she was pregnant, after the years of fertility treatments she didn't even know to recognize the signs. Her doctor told her that it is not uncommon for women with infertility problems to be somewhat "cured" by having children. Their family is now complete. Their older children are five and three years old now, and the baby has just been born.

But they still have these excess embryos and the insurance company has notified them that the $500/year storage is no longer covered. The notification letter came in the same mail with an invitation to yet another school fundraiser. However, the insurance company also included a letter from a research institute citing a desperate need for embryos. That's when Kathleen learned that the debate over stem cell research involves her family, and also the family of her best friend.

The letter stated that there are potential medical breakthroughs that can be made on virtually every disease known if researchers are able to use stem cells in their research. According to the information (from Harvard's Stem Cell Center, no less) the only source of human embryonic stem cells available for federally-funded research are those left over from IVF clinics. There are an estimated 400,000 unused embryos in storage tanks throughout the United States. The older stem cell lines used for research have been grown on feeder cells derived from mice. The paper cites the need for more human embryonic stem cell lines. In the letter, one researcher wrote about his personal stake in creating more stem cell lines for research. His son and daughter have diabetes and his son is insulin-dependent. He believes that scientists will be able to cure diabetes, perhaps using stem cells to grow insulin. Kathleen's best friend Clare has three children, and her oldest was diagnosed with Type I diabetes when she was just two years old. Clare practically devotes her life to raising money for diabetes research, in addition to trying to make her daughter's life seem as normal as possible. Kathleen knows that if Clare had embryos to donate she would do it in a heartbeat.

Kathleen and Tom find time to sit down together to discuss their options. The embryos belong to them, but they do not plan to use them. The storage cost is $500 per year, which would pay for a lot of new shoes. They hate the idea of their embryos, the embryos similar to the ones that became Caitlin and Tom Jr., being discarded as medical waste. They believe those embryos have the possibility of life, even if they do not have heartbeats. Yet Kathleen also feels torn about donating the embryos to an infertile couple. How would she feel, letting somebody else raise their children? The position of their religion is that these stem cells are sacred and should not be used for research. The Stem Cell Center states that all embryo donations are voluntary and the donors would need to sign an informed consent document. The informed consent states that the donors understand that their embryos would be destroyed for research, and the donors would receive no payment for the donation. The Center also notes that they will make the stem cell lines available to any scientist in the field. They estimate that from 350 donated embryos they could significantly impact the number of stem cell lines available for research.

Kathleen makes a list of possible actions to take, and then they read over the page again that gives specifics about research. It says that the embryos have been frozen for varying amounts of time; they do not always survive thawing. Those that survive may not develop into a stem cell line. The letter states that cells generated by the embryos cannot be identified with the donors. Kathleen and Tom talk about their own children and how they would feel if they were diagnosed with a disease. In the past they have talked about whether they would donate their organs if anything happened to them. They believe that life is sacred and that it begins at conception. Tom suggests that they pay the $500 for another year, while they learn more, but Kathleen feels strongly that it is time for them to decide how they feel about stem cell research. Her children are like miracles, exhausting, but miracles. What research led to *in vitro* fertilization breakthroughs that allowed them to be born? She thinks to herself, "the embryos don't have heartbeats and they could help to save lives. But don't we have a duty to protect them? What should we do?"

Selected Sources:

Cook, Gareth, "After 2 Children Via IVF, Pair Faced Stem Cell Issue" The Boston Globe, April 4, 2004.
(This case study was based loosely on the Dooley story)

Dreifus, Claudia, "At Harvard's Stem Cell Center the Barriers Run Deep and Wide"
New York Times, January 24, 2006.

Wade, Nicholas, "Stem Cell News Could Intensify Political Debate" New York Times, July 24, 2006.

Name _____ Date _____ Period _____

Decisions, Decisions

Options for Kathleen and Tom	Which ethical principle is given priority?	How does the option relate to the ethical principle?
1.		
2.		
3.		
4.		
5.		

Decisions, Decisions

Options for Kathleen and Tom	Which ethical principle is given priority?	How does the option relate to the ethical principle?
1. Continue to pay	Do No Harm Respect for Persons	The embryos will not be harmed if they are not taken out of storage In some views, embryos are granted full personhood and should be respected as such.
2. Donate embryos to research	Do Good	The research could benefit society
3. Donate embryos to other infertile couple	Do Good *or* Justice	Benefits somebody else Couple may not be able to afford IVF
4.Discard the Embryos	Respect for Persons	The embryos belong to Kathleen and Tom—they can choose to discard them
5. Use embryos to have more children	Respect for Persons	The embryos could grow to be children and have the right to self-determination

Name _____ Date _____ Period _____

My Perspective: Embryonic Stem Cells

1. Does the source of the embryo matter? For example, is it okay to use stem cells from IVF if:

	Yes/No	Reason why or why not
• the embryo is left over from IVF and will be discarded • the embryo was produced solely for research and was not intended to become a baby • Genetic testing reveals a serious genetic flaw and the embryo will not be implanted.		

2. Does the potential benefit of the research matter? For example is it okay to use embryonic stem cells if:

	Yes/No	Reason why or why not
• research could save ***some*** human lives (i.e. hundreds) • research could save ***many*** human lives (i.e. thousands or more) • research could reduce the suffering of ***some*** • research could reduce the suffering of ***many*** • research could decrease medical costs for ***some*** • research could decrease medical costs for ***many***		

1. Refer to the Case Study, “One Family’s Dilemma’. What do you think Kathleen and Tom should do with the excess fertilized eggs?

2. Why?

3. Which bioethical principle (Respect for Persons, Do Good/Do No Harm, or Justice) is given the most weight in your solution?

4. Explain why you chose that ethical principle.

Name _____ Date _____ Period _____

Bioethical Principles and Embryonic Stem Cells

	Respect for Persons	Do Good/Do No Harm	Justice
Description	Respect an individual's right to make self-determining choices	Doing good (beneficence) and not doing harm (nonmaleficence)	Treat others equitably, distribute benefits/burdens fairly
A person who DOES support embryonic stem cell research and who argues from this approach might say…..?			
A person who DOES NOT support embryonic stem cell research and who argues from this approach might say…?			

OVER

Bioethical Principles and Embryonic Stem Cells

	Respect for Persons	Do Good/Do No Harm	Justice
Description	Respect an individual's right to make self-determining choices	Doing good (beneficence) and not doing harm (nonmaleficence)	Treat others equitably, distribute benefits/burdens fairly
A person who DOES support embryonic stem cell research and who argues from this approach might say…..?	Individuals should be able to choose for themselves what happens with their fertilized eggs. Our duty is to always try to help those individuals who are suffering with diseases. Although embryos should be accorded respect, we should give more respect to fully formed humans.	Sometimes, to achieve a greater good we must sacrifice some human life to benefit the lives of many other living and future human beings. If frozen IVF embryos are going to be thrown out anyway, we should use them for something good.	It is only fair to use stem cells to try to improve better health care for all.
A person who DOES NOT support embryonic stem cell research and who argues from this approach might say…?	Embryos deserve special protections, because they have the potential to become humans. We should not destroy human life, even if that life is at the embryonic stage.	The consequences of destroying human embryos are not outweighed by the health benefits that may be achieved through their use.	I am concerned that the benefits of embryonic stem cell research will not be available equally to all persons.

Lesson 4 Shades of Gray

Objectives

Students will be able to:

- Consider, analyze and represent viewpoints different from their own.
- Describe the range of positions taken by individuals, organizations, and countries with respect to embryonic stem cells.

Class Time

1 to 2 class periods.

Prior Knowledge Needed

- An understanding of different ethical perspectives.
- Some understanding of the liberal/conservative political spectrum is helpful.

Common Misconceptions:

- An individual's position on stem cell research can be predicted by his or her political party or religious affiliation.
- Members within a political party or religious group have a singular, united view of stem cell research.

Introduction

Students develop an awareness of the many shades of gray that exist in the stakeholders of the stem cell research debate. In this lesson students participate in an activity where they take the role of a stakeholder and make inferences about that stakeholder's beliefs with respect to embryonic stem cell research. Later, an actual biographical example of such a stakeholder is provided to them. In several cases, the stakeholders do not fit the 'stereotype' of the particular group they belong to, reinforcing the idea that there are many 'shades of gray' in considering the perspectives on stem cell research.

Key Concepts

- There is a range of positions in society with respect to embryonic stem cell research.
- An individual's position cannot always be predicted by his or her political party or religious affiliation.
- The consideration of the "moral status of the embryo" is at the center of the stem cell debate, and different stakeholders have different views on this central question.
- Bioethical principles can be associated with different stakeholder positions.

Materials

Who am I? Stakeholder Biography Cards

Shades of Gray Position Cards

Ethical Issues Statements for Four Corners

Four large signs for each corner of the room reading:

Strongly Agree, Agree, Disagree, Strongly Disagree

Student Handout 4.1 – *My Stakeholder Thinks…*

A PowerPoint presentation with additional background and pictures of stakeholders can be found at **http://nwabr.org/education/stemcell.html**.

Background

In *Bioethics and the New Embryology*, Gilbert, Tyler & Zackin (2005) write:

> Embryonic stem cell research and therapeutic cloning hold out the promise of medical treatments that could alleviate or even eliminate conditions including Parkinson's and Alzheimer's diseases, multiple sclerosis, diabetes, certain heart conditions and traumatic spinal cord injury (as cited by the National Institute of Health 2000). Research universities, biotechnology companies, and medical institutions generally are anxious to push the field forward; the public at large has been more cautious as they slowly become aware of the positive implications and potential hazards of the work**. Does the destruction of a human embryo at the very earliest stages of development constitute harm that is morally unacceptable when weighed against the potentially monumental gains in the war against human suffering?** (p. 159)

Moral Status of the Embryo

An important concept considered by ethicists in the stem cell debate is the "moral status of the embryo", which leads to questions such as these: When does the embryo acquire "personhood"? How should we treat the embryo? What rights does it have? What responsibilities do we have towards it? How do we balance our attitudes towards the embryo with our responsibilities to help others?

Advocates and opponents of embryonic stem cell research both want the same thing – the preservation of human life. The "ethics of embryonic stem cell research" is often about the values we assign to different stages of human development or to cells with the potential to become human beings. One of the challenges in defining when an embryo acquires "personhood" is that human development is a gradual process, but assigning moral standing is based on an "all-or-nothing" model. Attempting to define the moment life begins blurs the lines between science, society and religion.

When Does Life Begin?

Consider the following four perspectives to this question. Each view has its supporters and detractors.

- **At fertilization:** At conception, a new and unique genome is created by the union of the genes from two parents. Once this genetic blueprint for a new human being is formed, personhood is acquired.
- **At gastrulation:** About day 14, the embryo's cells begin to differentiate into specific cell types. At this point, twins can no longer be formed and the embryo continues on the path to become an *individual*. Some feel that personhood cannot be bestowed before gastrulation since each twin is a distinct person.
- **When an EEG pattern is detected**: Between 24 and 27 weeks, the fetal neurons link to display conscious brain activity. In the United States, death is defined by the *lack* of an EEG (electroencephalogram); this view considers the acquisition of an EEG as the corresponding definition of life.
- **At or near birth:** Some feel that a fetus acquires personhood when it can survive on its own (as early as 22 weeks, with technological assistance) or has gone to full term (40 weeks) and can be seen as an indisputable, distinct individual. For much of human history, it was not uncommon for infants to die shortly after birth; many cultures therefore waited until birth or after to bestow personhood.

Source: Gilbert et al. 2005

Relevance to Stakeholder Positions

Each individual's view on when life begins and the moral status of the embryo inform his or her position on stem cell research. The stakeholders in the following activity have diverse views on this subject; some of the general themes are below.

- *"Embryos are human individuals and should not be used or destroyed for human research"* – This view places the status of the embryo, at any stage of development, above the potential benefits of research. It has been the basis for federal funding policy since 2001 although research on stem cell lines created prior to 2001 has been permitted.
- *"Embryos do not have the same status as a baby or fetus and can be used in research"* – In this view, the rights of patients or potential benefits of research are given priority.
- *"Embryos should not be created for research, but excess IVF embryos could be used if they would otherwise be discarded."* – In this view, nothing is lost if research is allowed.
- *"Embryos are a cluster of cells (with no heart, nervous system, etc.) that can be created for research."* If 'personhood' does not pertain to the blastocysts stage, this view holds that it does not matter if the embryos are created for research or left over from IVF.

The PowerPoint presentation that accompanies this lesson (found at http://nwabr.org/education/stemcell.html) contains slides that can be used to help present this background to students.

Procedure

A. Before Class

1. Print and cut out the *Who Am I?* stakeholder cards with an individual's biographical sketch and position statement on stem cell research.
2. Cut each card in half along the dotted line, separating the biography portion of the card from the position portion.
3. Attach the **biography** to the **outside** of an envelope. Put the corresponding position statement inside the envelope.
4. Close the envelope (seal it if you are doing this lesson with only one class, otherwise close the envelope but caution students to not look inside and read the biography until given permission to do so).
5. Put up the four signs (Strongly Agree, Agree, Disagree, and Strongly Disagree) in each corner of the room.
6. Make a copy of the Student Handout 4.1 for each student.

B. Four Corners Activity

1. Ask students, "Who are the stakeholders in the stem cell debate?" (Which individuals and/or institutions have a stake in the outcome of the debate? What do they care about? What are their concerns?). Brainstorm a number of answers.
2. Tell students that they are going to role-play the views of an individual stakeholder, based on a brief biography of that person.
3. Hand out (or let students choose) a *Who Am I?* stakeholder envelope with the biography card attached to the outside.
4. Depending on the students, it may be helpful to define some of the vocabulary (i.e. liberal, conservative, democrat, ethicist, moderate) used on the cards.
5. Read the first statement on Student Handout 4.1, *My Stakeholder Thinks…* ("**It is ethically acceptable to use human embryonic stem cells for medical research**"). Ask students to go to the corner of the room that they think best represents the position of their stakeholder. They can stand in between signs, if needed.
6. Ask students to discuss their position with two or three others near them and to appoint a representative from their group to share the discussion with the class.
7. Probe students with additional clarifying questions and allow them to change positions if necessary.
8. **Repeat** the activity with other statements from Student Handout 4.1. Students may have difficulty knowing where their stakeholder would stand based on the brief biography, but encourage them to make an educated guess.

C. Shades of Gray

1. After students have had practice representing their stakeholders, re-read the first statement on Student Handout 4.1 and have students go to the corresponding corner. This will align the students/stakeholders into the key groups that are perceived to be for or against embryonic stem cell research.
2. Have students open their envelopes and read the position of the person whose view they have been representing.
3. If the actual position of the person is different from the presumed position, have the students move to the corner of the room which best represents the actual view of that person.
4. Are there any surprising outcomes? Have students read their cards out loud, either in small groups or for the whole class.
5. Debrief and make explicit the nuances in a person's commitments in reaching a position on stem cells -- there are many shades of gray (for example, being a conservative about other issues in society doesn't automatically mean that the individual would be against stem cell research).
6. Point out that the corners of the room may be quite heterogeneous at this time—people with diverse views may still agree on unexpected things. It is also important to point out that, even though it's useful to think about the range of positions a stakeholder might take, students can't always predict a stakeholder's position on a subject.

An important concept considered by ethicists in the stem cell debate is the "moral status of the embryo", which leads to questions such as these: How should we treat the embryo? What rights does it have? What responsibilities do we have towards it? How do we balance our attitudes towards the embryo with our responsibilities to help others? Point out that different stakeholders have different views on the moral status of the embryo, and the governmental policies that are enacted reflect these differences.

D. Stakeholders and Ethical Principles

- Have students meet in small groups of 3-4. Using the biography/position cards, have each group try to identify the ethical principle (respect for persons, beneficence/nonmaleficence, justice) most clearly associated with the 3 or 4 stakeholder positions present in their group.
- To debrief as a class, ask if any group had a very clear example of a stakeholder position related to an ethical principle. Debrief some of the most compelling examples as a class. (For example, David Prentice invokes the principle of nonmaleficence, while Orrin Hatch stresses beneficence).
- Next, ask if any student had a stakeholder whose ethical position was harder to determine. Guide the class in trying to discern which principle is most clearly emphasized in the ambiguous cases.

Extensions and Adaptations

- Have students research their *Who Am I?* cards before beginning the lesson, or for homework after using Student Handout 4.1 but before using Handout 4.2.
- A diagram of the American Political Spectrum (and notes about using it) can be found in the Appendix.
- Shades of Gray can be played as a game:

  Have students identify different groups represented by the stakeholders, and brainstorm positions usually associated with each group, especially perceived stances on embryonic stem cell research. It may be helpful to define the terms used on the biography cards (i.e. democratic, conservative, ethicist) before playing the game. Some teachers use a class-generated list of stereotypes to "define" these terms, only the have the stereotypes dispelled as the game is played.

  a. Divide the class into 3-4 teams of 5-10 students facing each other.
  b. Each team receives a packet in which each person's biography and position statement is on one piece of paper. These papers are then dealt out to each player until they are gone, and kept face down until in use.
  c. The person to the right of the dealer reads a biography.
  d. The other members of the team decide whether the person is "for" or "against" stem cell research, based on the bio.
  e. The person to the right of the reader is the team spokesman, and listens to the team members, then states out loud the team's position.
  f. The player who read the biography now reads the position statement on the card.

g. If the team got it right – have a scorekeeper write down 1 point. Each team is competing against the other teams in the class for the most correct answers.

h. Play continues to the right – the team spokesman is now the reader, and this continues until all of the cards have been read aloud.

i. The team with the most points wins.

Homework

- Students can further research their stakeholders, and fill out any portion of Student Handout 4.1 not covered during the four-corners activity.
- If students would like to express their own views in a non-public way, Student Handout 4.1 can be completed from each student's perspective as homework. Since members of the general public are considered stakeholders, students can fill in their own names when asked for the name of their stakeholder.
- Students can also plot some or all of the stakeholder cards along a line showing the range of perspectives about embryonic stem cell research, with FOR and AGAINST at either end of the line.

Sources:
Gilbert, S. F., A. L. Tyler, E. J. Zackin. 2005. *Bioethics and the New Embryology.* Sinauer Associates, Sunderland, MA.
National Institutes of Health. 2000. Stem cells: A primer. **http://www.nih.gov/news/stemcells/primer.htm**

Shades of Gray

Stakeholder and Position Cards

Directions:
Cut each *Who Am I?* stakeholder card below to form strips of paper. Cut the card in half along the dotted lines, separating the "Biography" from the "Position" portion of the card. Attach each **Biography** strip of paper to the **outside** of an envelope. Put the corresponding Position statement inside the envelope. Close or seal the envelope. Participants select a role and assume that point of view for the "Four-Corners" activity.

Who Am I? President of the United States

Barack Obama

Biography: My name is Barack Obama and I was elected President of the United States in November 2008. I was born in Honolulu, Hawaii, obtained early education in Jakarta, Indonesia, and Hawaii; continued education at Occidental College, Los Angeles, Calif., and Columbia University, New York City; and studied law at Harvard University, where I became the first African American president of the Harvard Law Review.

Position: On March 9, 2009, I issued Executive Order 13505 titled, "Removing Barriers to Responsible Scientific Research Involving Human Stem Cells." It states that the federal government may support and conduct responsible, scientifically worthy human stem cell research, including human embryonic stem cell research, to the extent permitted by law.

Source: http://stemcells.nih.gov/policy/2009guidelines.html

Who Am I? A Republican Politician

Mitt Romney

Biography: I am former Republican Governor Mitt Romney of Massachusetts, home to Harvard University which has one of the largest stem cell research facilities in the U.S. I received my B.A. from Brigham Young University, then an MBA from Harvard University. I am also a member of The Church of Jesus Christ of Latter-day Saints (Mormon). I have been in the news because I was heavily involved in national and statewide attempts to block the Massachusetts' Supreme Court's ruling which legalized same-sex marriage. I have stated that I want to keep abortion "safe and legal in this country." I ran for the Republican nomination for President in 2008.

Position: Former Governor Mitt Romney has condemned stem cell research that destroys embryos and urged the U.S. Senate to oppose legislation to provide federal funds for such experimentation. Governor Mitt Romney has said that he will reject the state legislature's bill supporting stem cell research, urging lawmakers to rewrite the measure to prohibit scientists from cloning and to remove a passage that redefines when life begins.

Source: http://www.boston.com/news/local/articles/2005/05/12/romney_urges_changes_to_stem_cell_bill/; May, 2005

Who Am I? A Democratic Politician

Rubén Díaz

Biography: I am Rubén Díaz and I was elected as a Democrat to the New York State Senate in November 2002. I was born in Puerto Rico and joined the U.S. Armed Forces and proudly served in the Army until completing my tour of duty with an honorable discharge. I've made New York City my home since 1965. I obtained a Bachelor's Degree, and then in 1978 became an ordained Minister of the Church of God

Position: Democrat Rubén Diaz has made his position on stem cell research very clear, writing: "embryonic stem cell research is another and more sophisticated way for the continued killing of unborn babies in America. I oppose the direct destruction of innocent human life for any purpose, including research. As I said before, embryonic research is simply another form of abortion in America."

Source: http://newyork.democratsforlife.org/diaz/diazstemcellspeech.htm

Who Am I? A Republican Politician

Orrin Hatch

Biography: My Name is Orrin Hatch and I am a Conservative Republican Senator from Utah. I am Mormon, and I graduated from Brigham Young University. I am the most senior Republican member of the Senate Judiciary Committee. I also take an active role in the confirmation of all judicial nominations, including justices of the Supreme Court, and have a direct impact on such issues as civil rights, immigration, antitrust and consumer protection, and issues related to the Constitution. In addition, I have the honor of serving on the Board of Directors for the Holocaust Memorial Museum; I am a poet and lyricist and have produced several albums of patriotic and religious music.

Position: Orrin Hatch announced: "I am proud to be here today with all these incredible people who are in support of stem cell research. Leading scientists have told us time and time again that stem cell research, including and especially embryonic stem cell research, holds great promise in uncovering the mysteries of human health and disease and in potentially developing diagnostic tests and therapeutic agents for a multitude of conditions including cancer, heart disease, diabetes, Alzheimer's, Parkinson's and many, many others. I am supportive of all forms of stem cell research that can be conducted in an ethical manner. This includes adult stem cell research. This includes embryonic stem cell research conducted through the technology of somatic cell nuclear transfer. This includes cord blood stem cell research."

Source: http://www.lifesciences.umich.edu/research/featured/orrinhatch.pdf July 2005

Who Am I? A Person who is Hindu

Swami B.V. Tripurari

Biography: I am Swami B.V. Tripurari. I have spent over 30 years as a Hindu monastic. I was awarded the sannyasa order in 1975, and have studied under several spiritual masters in the Gaudiya lineage. I currently run a Vaisnava monastery in the redwoods of Northern California. I am also the author of several books, including "Bhagavad-Gita; Its Feeling and Philosophy" (March 2002).

Position: According to Hindu scripture, human life begins when the male semen fertilizes the female egg. So there is no debate within Hinduism as to when life begins. Thus abortion involves killing, which in most cases is not acceptable. Although I have not studied the argument, it is likely that on similar grounds Hinduism would oppose stem cell research.

Source: http://www.beliefnet.com/story/104/story_10493_1.html

Who Am I? A Conservative Christian

Anne Graham Lotz

Biography: I am Anne Graham Lotz, the daughter of Rev. Billy Graham. I am the President and Executive Director of Angel Ministries, a non-profit organization offering Christian outreach. My husband Daniel and I reside in Raleigh, North Carolina. My father has Parkinson's disease. I have a son who has cancer, a mother who has degenerative arthritis and I have a husband who has diabetes. And those are four very close family members, each one of whom has a disease that I have read, anyway, could be possibly affected by stem cell research.

Position: Anne Graham Lotz has stated "I would not want any one of my family members to benefit from the willful destruction of another human life…An embryo, as tiny as it is, is still a human life, created in the image of God, with the capacity and the maturity to know the creator. And to destroy that human life willingly, for any reason, is abhorrent to me. It comes close to thumbing our nose in God's face."

Source: http://abcnews.go.com/ThisWeek/TheList/story?id=780096; May, 2005

Who Am I? An Ethicist

Ron Green

Biography: My name is Ronald M. Green and I am faculty director of the Ethics Institute at Dartmouth College. I have written over eighty articles and five books in the fields of ethical theory, religious ethics, and applied ethics, including medical ethics and business ethics. I am a member of the Bioethics Committee of the March of Dimes Birth Defects Foundation. I serve on the Ethics Advisory Board of Advanced Cell Technology, a biotechnology company.

Position: I served on the National Institute of Health Human Embryo Research Panel along with 18 other scientists, bioethicists, lawyers and specialists in the area of reproductive medicine. Our report recommended funding for stem-cell research. We permitted the deliberate creation of human embryos for research "potentially of outstanding scientific and therapeutic value".

Source: http://www.beliefnet.com/story/153/story_15349_1.html Sept. 2004

Who Am I? An Ethicist

C. Ben Mitchell

Biography: My name is C. Ben Mitchell and I am an Associate Professor of Bioethics and Contemporary Culture, at Trinity Evangelical Divinity School, in Deerfield, Illinois. I serve as editor of the journal *Ethics and Medicine* and Bioethics Consultant to the Ethics and Religious Liberty Commission of the Southern Baptist Convention. My Ph.D. is in philosophy with a concentration in medical ethics, and my dissertation focused on the ethical issues in patenting human life. I also serve as a consultant for the Genetics & Public Policy Center of Johns Hopkins University.

Position: In response to a study where Virginia scientists created blastocysts solely for embryonic stem cell research, I said, "Once we begin to approve embryonic stem cell research, all bets are off. Establishing boundaries becomes nearly impossible." I called the work "immoral and unconscionable" and said any research based on embryonic stem cells is "morally tainted."

Source: http://www.health24.com/medical/Condition_centres/777-792-1987-1999,13320.asp

Who Am I? A Diabetes Patient Advocate

Mary Tyler Moore

Biography: My name is Mary Tyler Moore. I was born in Brooklyn, New York in 1937. I began a television career as a "Happy Hotpoint" dancing performer in appliance commercials in 1955. I co-starred in *The Dick Van Dyke Show* from 1961-1966 and have made many television guest appearances. I have received 3 Emmy Awards, a Golden Globe Award, and was named to the Academy of Television Arts and Sciences Hall of Fame in 1987.

Position: Actress Mary Tyler Moore says she opposes abortion, but she also doesn't like President George W. Bush's reluctance to expand research using stem cells from human embryos to achieve medical breakthroughs.
Moore, diagnosed more than 30 years ago with juvenile diabetes, likened the harvesting of stem cells from unused, donated fertilized eggs to organ donations.
"It is the true pinnacle of charity," she said, appearing Wednesday with House of Representatives members who want new lines of stem cells made available for research. "Federal support for stem cell research . . . is the best way to ensure it is undertaken with the highest of ethical standards," she said.

Source: April 2004 http://www.jdrf.org/index.cfm?page_id=101204

Who Am I? A Liberal Christian

Rev. Dr. Joanne C. Sizoo

Biography: My name is Rev. Dr. Joanne C. Sizoo and I am a pastor of the Norwood Presbyterian Church in Cincinnati, OH. I am also the chair of the General Assembly's Advocacy Committee for Women's Concerns. I served for a number of years on the board of More Light Presbyterians. I am also known for my advocacy of Gay Lesbian Bisexual Transgender issues.

Position: Excerpts of a letter from clergy written to Republican Senator Frist. Dr. Joanne C. Sizoo was one of the many clergy who signed this letter.
…We believe that as a nation, it is far better to pursue a path where there is common moral ground. One place of agreement is the shared belief among major religions that we have an obligation to relieve suffering and heal the sick. **The enormous potential of embryonic stem-cell research to treat the sick and injured is, in our view, an embodiment of this religious view.**
Moreover, the proposed legislation limits federal funding to embryos that remain frozen in fertility clinics and would otherwise be destroyed. Couples who no longer need these embryos for reproductive purposes should be allowed to donate them for research and treatment of disease, to relieve suffering and promote healing. Such an act, through informed consent, lies within the well-developed ethics and tradition of organ donation, which is also supported by major religions…

Source: June 2005. http://theocracywatch.org/stem_cell_letter.htm

Who Am I? A Moderate Christian

Barb Edwards

Biography: My name is Barb Edwards, and I consider myself to be pro life. I am a member of The United Methodist Church (as is President Bush). The United Methodist Church has no formal position on research involving human stem cells. However, the denomination's Board of Church and Society supports a ban on embryonic stem cell research based on the church's opposition to any procedure that creates waste embryos. I have a son Alex, who was paralyzed from the chest down after a car accident on September 11, 1999, due to a spinal cord injury.

Position: "I'm pro life - my child's life," says Barb Edwards. "Cells are sitting in dishes doing nothing and they could help my son," she says, referring to extra embryos at fertility centers that are no longer needed after a couple conceives a child through *in vitro* fertilization.

Source: http://www.interpretermagazine.org/umns/news_archive2002.asp?ptid=&story=%7B1B0CBD36-A605-4D88-89F7-1FF039C14DD4%7D&mid=2399; August, 2002.

Who Am I? A Democratic Politician

John F. Kerry

Biography: My name is John Kerry and I am a United States senator from Massachusetts. I was the Democratic candidate for president in 2004. I graduated from Yale University in 1966 and joined the U.S. Navy during the Vietnam War. I attended Boston College Law School and worked as a prosecuting attorney before jumping into politics. After two years as Lieutenant Governor, I was elected to the U.S. Senate for the first time in 1984, and I've been there ever since.

Position: I think we can do ethically guided embryonic stem cell research. We have 100,000 to 200,000 embryos that are frozen in nitrogen today from fertility clinics. These weren't taken from abortion or something like that, they're from a fertility clinic, and they're either going to be destroyed or left frozen. It is respecting life to reach for that cure. It is respecting life to do it in an ethical way. Bush's chosen a policy that makes it impossible for our scientists to do that. I want the future, and I think we have to grab it.

Source: Second Bush-Kerry Debate, in St. Louis MO Oct 8, 2004

Who Am I? An Advocate for Aging Americans

Daniel Perry

Biography: My name is Daniel Perry, and I am the President and CEO of the Alliance for Aging Research, a non-profit organization dedicated to improving the health and independence of aging Americans through public and private funding of medical research. I was appointed during the first Bush Administration to the Federal Task Force on Aging Research. I was also named by President Clinton to the Advisory Board of the White House Conference on Aging and served as a delegate to the 1995 and 2005 White House Conferences on Aging.

Position: Our organization agrees with the 80 Nobel Laureates who wrote to President Bush urging him not to halt federal funding of embryonic stem cell research. "It would be tragic to waste this opportunity to pursue the work that could potentially alleviate human suffering." Shutting off federal funds for university research would still allow the research to go on in private labs and biotechnology companies in other countries. This would eliminate the matter of public accountability and oversight that is the best protection against abuses in the use, sale, and transfer of human embryonic tissues.

Source: http://www.npr.org/programs/specials/stemcells/viewpoints.perry.html

Who am I? A Parkinson's Disease Patient Advocate

Michael J. Fox

Biography: My name is Michael J. Fox. I was born in Edmonton, Alberta, Canada in 1961 and attended high school in Vancouver, Canada. I dropped out of school in the 12th grade and received my GED in 1995. I married Tracy Pollan in 1988. I began acting professionally at age 15. Though I would not share the news with the public for another seven years, I was diagnosed with young-onset Parkinson's disease in 1991. Upon disclosing my condition in 1998, I committed myself to the campaign for increased Parkinson's research.

Position: In an article in the New York Times about the presidential race, Michael J. Fox who suffers from Parkinson's disease, wrote: "The outcome is likely to have a dramatic bearing on my prognosis — and that of millions of Americans whose lives have been touched by Parkinson's, amyotrophic lateral sclerosis, spinal cord injury, Huntington's disease, Alzheimer's disease and other devastating illnesses. That's because one question that may be decided on Tuesday is whether stem cell research — which holds the best hope of a cure for such diseases — will be permitted to go forward. Campaign aides to George W. Bush, who has not publicly addressed the issue, stated on several occasions that a Bush administration would overturn current National Institutes of Health guidelines and ban federal funding for stem cell research...Mr. Bush favors a ban on stem cell research, one aide said, 'because of his pro-life views.' "

Source: November 2005; http://www.religioustolerance.org/res_stem3.htm

Who Am I? A Spinal Cord Injury Patient Advocate

Christopher Reeve

Biography: My name is Christopher Reeve and I was born on September 25, 1952, in New York. I studied at Cornell University, while at the same time working as a professional actor. In my final year of Cornell, Robin Williams and I, who became a life-long friend, were selected to study at the Julliard School of Performing Arts. I've since appeared in many feature films (most notably Superman), TV movies and some 150 plays. In May, 1995, I was thrown from my horse during a riding event, and, landing on my head, broke the top two vertebrae in my spine. Left paralyzed from the neck down, I became an active advocate for bringing greater public awareness to the needs of those with spinal cord injuries. My wife and I created a fundraising foundation called the Christopher and Dana Reeve Foundation to raise research money and provide grants to local agencies that focus on quality of life for the disabled. (Note: Christopher Reeve died in 2004 and his wife, Dana, died in 2006, but their foundation continues to be active)

Position: Christopher Reeve's testimony on the topic of NIH funding and stem cell research:

We must pursue research on embryonic stem cells. With the life expectancy of average Americans heading as high as 85 to 90 years, it is our responsibility to do everything possible to protect the quality of life of the present and future generations. A critical factor will be what we do with human embryonic stem cells. These cells have the potential to cure diseases and conditions ranging from Parkinson's and multiple sclerosis to diabetes and heart disease, Alzheimer's, Lou Gehrig's disease, even spinal-cord injuries like my own. They have been called the body's self-repair kit…

…Fortunately, stem cells are readily available and easily harvested. In fertility clinics, women are given a choice of what to do with unused fertilized embryos: they can be discarded, donated to research or frozen for future use. Under NIH supervision, scientists should be allowed to take cells only from women who freely consent to their use for research. This process would not be open ended; within one to two years a sufficient number could be gathered and made available to investigators. For those reasons, the ban on federally funded human embryonic stem cell research should be lifted as quickly as possible.

Source: April, 2000 http://www.chrisreevehomepage.com/testimony-nih.html

Who Am I? A Citizen/Taxpayer who is Conservative

Judie Brown

Biography: My name is Judie Brown and I am President of the American Life League, which I cofounded in 1979. It is a pro-life organization in the United States and is committed to the protection of all innocent human beings from the moment of creation to natural death. I live in Stafford, VA. I attended St. Mary's Academy from 1958-1962, El Camino Junior College from 1962-1963, and the University of California – Los Angeles from 1963-1965.

Position: "As deeply concerned as we are about the treatment and cure of disease, we don't believe the average American wants to see tiny embryonic boys and girls, little children, used as experimental material," said Judie Brown, a spokeswoman for the American Life League. "The problem we have with this particular type of research," said Brown, "is that you have to kill a person to get these stem cells. That's unethical."

Source: March 2001 http://transcripts.cnn.com/TRANSCRIPTS/0103/08/i_ins.00.html

Who Am I? A University Science Professor

David A. Prentice

Biography: I am David Prentice, and I spent nearly 20 years as a Professor of Life Sciences at Indiana State University, and as an Adjunct Professor of Medical and Molecular Genetics at Indiana University School of Medicine. I am now a Senior Fellow for Life Sciences at Family Research Council.. I am a founding member of the organization Do No Harm: The Coalition of Americans for Research Ethics, a national coalition of researchers, health care professionals, bioethicists, legal professionals, and others.

Position: Funding for human embryonic stem cell research is illegal, unethical and unnecessary. Destroying living human embryos for research violates the basic tenet of the healing arts: "first do no harm." There is ample published scientific evidence showing that adult stem cells can and do provide an adequate alternative to using embryonic stem cells.

Source: http://www.npr.org/programs/specials/stemcells/viewpoints.prentice.html

Who Am I? A Former First Lady who is Conservative

Nancy Reagan

Biography: I am Nancy Reagan. I am a republican and was first lady when my husband Ronald Reagan was President. Soon after graduating from high school I became a professional actress. I met Ronald Reagan in 1951, when he was president of the Screen Actors Guild. The following year we were married in a simple ceremony in Los Angeles in the Little Brown Church in the Valley. I soon retired from making movies so I could be the wife I wanted to be...A woman's real happiness and real fulfillment come from within the home with her husband and children. We have a daughter, Patricia Ann, and a son, Ronald Prescott.

Position: She said she believed stem cell research "may provide our scientists with many answers that for so long have been beyond our grasp". I believe the research could lead to a cure for Alzheimer's disease, which afflicted my husband, Ronald Reagan. The Bush administration has blocked public funding of this type of research because of his party's ethical reservations about embryo research. At a fundraising dinner for the Juvenile Diabetes Research Foundation in Hollywood, I said my husband was now in "a distant place where I can no longer reach him. I just don't see how we can turn our backs on this... We have lost so much time already. I just really can't bear to lose any more."

Source: http://www.kansascures.com/quotes.php; May, 2004

Who Am I? A Biotechnology CEO in the U.S.

Dr. William Haseltine

Biography: My name is Dr. William Haseltine and I founded the company Human Genome Sciences, Inc. located in Rockville Maryland in 1992. Human Genome Sciences, Inc. is a company with the mission to develop products to predict, prevent, detect, treat and cure disease based on its leadership in the discovery and understanding of human genes. I have a doctorate from Harvard University in Biophysics and was a Professor at Dana-Farber Cancer Institute, Harvard Medical School and Harvard School of Public Health from 1976-1993 before joining Human Genome Sciences. I have had many years of experience with biotechnology companies. Since 1981, I have founded seven companies, each in a different area of medicine. In 1996 I was the recipient of the American Academy of Achievement Golden Plate Award and was also chosen by Ernst & Young as the Greater Washington (D.C.) Entrepreneur of the Year.

Position: People who want government to fund ES cell research are expecting taxpayers to pay for science projects that knowledgeable investors will not. William Haseltine, ES cell research advocate and CEO of Human Genome Sciences said, "The routine utilization of human embryonic stem cells for medicine is 20 to 30 years hence. The timeline to commercialization is so long that I simply would not invest. You may notice that our company has not made such investments."

Source: http://www.maclaurin.org/article_detail.php?a_id=62 July 2005

Who Am I? A High School Student

Heather Hanson

Biography:
My name is Heather Hanson. I was born on June 3, 1990 and I am a junior at Eastside Catholic High School in Bellevue, Washington. History and English are my favorite subjects in school. I have played soccer since I was in elementary school, and I now play on a year-round select team. I also like to ski and hang out with my friends. I am active with the Youth Group at my church in Seattle. I have been on three mission trips with this group; one to Arkansas, one to Florida and one to the US/Mexican border. I have an older sister in college and I live with my mother and my father.

Position: Heather wrote in a school paper: "It [using blastocysts from *in vitro* fertilization clinics] is not the 'taking of human life,' but the use of resources which would otherwise be thrown away. With the couples' consent, they could be used for this cutting edge research and provide hope and healing to millions of people. These embryos would not be wasted. A great amount of use would come from them, and the quality of life for people currently suffering from various neuro-related ailments would improve." Healther was skiing with her father on March 7, 2001, when, on the last run of the day, he fell and broke his neck. He is now partially paralyzed and has gone through therapy to learn to walk with some aid. Heather and her parents have lobbied in Washington, DC for a bill that would allow some embryos to be used in federally funded stem-cell research to cure paralysis. Heather's church, The United Church of Christ, doesn't object to research on blastocysts, as long as it's conducted with respect and not done for reproductive purposes.

Source: Phone interview, June 17, 2007

Who Am I? A Conservative Columnist

Ann Coulter

Biography: I am Ann Coulter. I graduated with honors from Cornell University School of Arts & Sciences, and received my J.D. from University of Michigan Law School. After practicing law in private practice in New York City, I worked for the Senate Judiciary Committee. From there, I became a litigator with the Center For Individual Rights in Washington, D.C., a public interest law firm dedicated to the defense of individual rights with particular emphasis on freedom of speech, civil rights, and the free exercise of religion. I am now a New York Times best selling author of books such as ***Slander: Liberal Lies About the American Right*** (June 2002). I am a frequent guest on many TV shows, including Hannity and Colmes, Scarborough Country, HBO's Real Time with Bill Maher, The O'Reilly Factor, and Good Morning America; and I have been profiled in numerous publications.

Position: Ann Coulter wrote in her column: "So what great advance are we to expect from experimentation on human embryos? They don't know. It's just a theory. But they definitely need to start slaughtering the unborn. Stem-cell research on embryos is an even worse excuse for the slaughter of life than abortion. It's either a life or it's not a life, and it's not much of an argument to say the embryo is going to die anyway. What kind of principle is that? Prisoners on death row are going to die anyway; the homeless are going to die anyway, prisoners in Nazi death camps were going to die anyway. Why not start disemboweling prisoners for these elusive "cures"?

Source: http://www.jewishworldreview.com/cols/coulter072601.asp; July, 2001

Who Am I? A Person involved in Biomedical Research

Alfred E. Mann

Biography: I am Alfred Mann, and I am the chairman of three companies:
- Advanced Bionics Corporation which develops, manufactures and markets systems for neuromuscular electrostimulation systems and at this time sells cochlear stimulators to restore hearing for the profoundly deaf.
- Second Sight is an early stage company developing a visual prosthesis to restore sight to the blind.
- AlleCure is developing vaccines for eliminating allergies.

Position: The Alfred E. Mann Institute for Biomedical Engineering at USC is a nonprofit corporation engaged in biomedical research and development. Its mission is to conduct biomedical research and to foster the development and commercialization of biomedical devices and other biomedical technologies. AMI-USC collaborates with the USC faculty to identify, validate, develop and transition to private industry new concepts for use in promoting public health. Its aim is to move promising new technology from the idea stage to successful commercialization in a short period of time. This requires the use of stem cells.

Source: http://bme.usc.edu/research/ami-usc.htm

Who Am I? A Person who is Jewish

Elliot Dorff

Biography: I am Elliot N. Dorff a Conservative rabbi, a professor of Jewish theology at the University of Judaism in California, author, and a bio-ethicist. I am considered to be an expert in the philosophy of Conservative Judaism, Bioethics, and acknowledged within the Conservative community as an expert in Jewish law. I was ordained as a rabbi from the Jewish Theological Seminary in 1970, and earned a PhD in philosophy from Columbia University in 1971.

Position: According to Elliot Dorff, "In light of our divine mandate to seek to maintain life and health, one might even argue that from a Jewish perspective we have a duty to proceed with that research." Under Jewish Law, genetic materials outside the womb are morally neutral. Even in the womb during the first 40 days, the status of genetic materials is "as if they were simply water."

Source: http://www.uscj.org/Embryonic_Stem_Cell_5809.html Spring, 2002

Who Am I? A Person who is Catholic

Pope Benedict XVI

Biography: I am Pope Benedict XVI. I was born Joseph Cardinal Ratzinger in Bavaria Germany in 1927. After spending a few months as a POW near the end of WWII, I entered the seminary and became in ordained priest in 1951. Prior to the death of Pope John Paul II, I served as a member of the Congregation of Bishops, the Congregation for Divine Worship and the Discipline of the Sacraments, the Congregation for Catholic Education, the Congregation for the Evangelization of Peoples, the Congregation for the Oriental Churches, the Council for Christian Unity, the Council for Culture, the Commission Ecclesia Dei, and the Commission for Latin America.

Position: The Roman Catholic Church is opposed to all Embryonic Stem Cell Research. All life is sacred from the moment of conception. Adult Stem Cell Research is approved when no embryo is harmed. The Pope has said, "Experience is already showing how a tragic coarsening of consciences accompanies the assault on innocent human life in the womb, leading to accommodation and acquiescence in the face of other related evils such as euthanasia, infanticide and, most recently, proposals for the creation for research purposes of human embryos, destined to be destroyed in the process."

Source: http://www.vermontcatholic.org/FamilyLife/StemCell.htm
http://www.americancatholic.org/newsletters/CU/ac0102.asp

Who Am I? A Former Member of the President's Council on Bioethics

Leon Kass

Biography: My name is Leon Kass and I was Chairman of the President's Council on Bioethics from 2002 to 2005. I am a native of Chicago and earned both my B.S. and M.D. degrees at the University of Chicago. I then got a Ph.D. in biochemistry at Harvard. I have written many popular essays about biomedical ethics and have dealt with issues raised by *in vitro* fertilization, cloning, genetic screening and genetic technology, organ transplantation, aging research, euthanasia and assisted suicide, and the moral nature of the medical profession. My wife and I have two married daughters and four young granddaughters.

Position: Leon Kass opposes *in vitro* fertilization, and all types of cloning, including therapeutic cloning. When speaking about a new technique for establishing embryonic stem cell lines from an early human embryo without destroying it he said, "I do not think that this is the sought-for, morally unproblematic and practically useful approach we need." He has also said, "It would be better to derive human stem cell lines from the body's mature cells, a method researchers are still working on."

Source: http://www.iht.com/articles/2006/08/24/healthscience/web.0824stem.php

Who Am I? A Professor of Law and Medical Ethics

Alta Charo

Biography: I am Alta Charo and I was born in 1958 in Brooklyn, NY. I am a Professor of Law and Bioethics at the University of Wisconsin at Madison. I offer courses on health law, bioethics and biotechnology law, food & drug law, medical ethics, reproductive rights, torts, and legislative drafting. In addition, I have also served on the UW Hospital clinical ethics committee, the University's Institutional Review Board for the protection of human subjects in medical research, and the University's Bioethics Advisory Committee. In 1994 I served on the NIH Human Embryo Research Panel, and from 1996-2001, I was a member of President Clinton's National Bioethics Advisory Commission. I am fond of poker, foreign language study, cats, home renovation, Harry Potter books, old movies, roller coasters, salsa music, Jane Austen novels and Star Trek.

Position: When speaking about a new technique for embryonic stem cell research, Alta Charo said, "Anything that makes it possible for science to advance in this area is to be applauded." She also said, "But this [new technique] should not be used as an excuse not to finance the most promising forms of research we already know about," referring to work done on blastocysts already slated for destruction at fertility clinics.

Source: http://www.washingtonpost.com/wp-dyn/content/article/2006/09/22/AR2006092201377.html

Who Am I? A Person who is Muslim

Dr. Gamal Serour

Biography: I am Dr. Gamal Serour, an Egyptian Muslim. I am currently a Professor at Al-Azhar University and Consultant in Obstetrics and Gynecology, specializing in infertility treatment. I developed the bioethics curriculum and oversee its implementation in the medical school. I am also the Director of the International Islamic Center For Population Studies and Research. In addition, I am the clinical director of the Egyptian *in vitro* fertilization clinic in Cairo.

Position: Dr. Serour argues that excess early embryos (less than 14 days old) are not yet human beings. "Instead of leaving them to perish, why not use them for research for the benefit of human beings?" Some Islamic scholars hold favorable views toward embryonic stem-cell research from the perspective of sharia (Islamic law). Most of these scholars believe ensoulment of the embryo occurs on the 120th day of the pregnancy, and that is the point when it gains its moral status or rights as a legal person. Other Islamic scholars, however, say ensoulment occurs on the 40th day. In broad terms, Islam tends to favor stem cell research because of its potential to promote human healing.

Source: http://www.csmonitor.com/2005/0622/p15s02-wogi.html June 2005

Name _____ Date _____ Period _____

My Stakeholder Thinks...

Read each of the following statements. Circle the letter(s) that you think represent how the stakeholder you stand for feels. You can't know for sure, so *use your best judgment.*

My Stakeholder:_____

SA = Strongly Agree A = Agree D= Disagree SD = Strongly Disagree

SA A D SD	1. It is ethically acceptable to use human embryonic stem cells for medical research.
SA A D SD	2. It is ethically acceptable to use adult stem cells for disease treatments, such as those involving bone marrow transplants.
SA A D SD	3. The federal government should use taxpayer money to pay for research using human embryonic stem cells.
SA A D SD	4. Conducting research using human embryonic stem cell is immoral and unconscionable.
SA A D SD	5. The embryo at the blastocyst stage is a human being and should be considered equal to a fully formed human being.
SA A D SD	6. New stem cells lines should be created for the purpose of research.
SA A D SD	7. Blastulas left over from IVF clinics are still human lives and should not be willfully destroyed.
SA A D SD	8. It is possible to do ethically-guided human embryonic stem cell research.
SA A D SD	9. Life begins at conception.
SA A D SD	10. It would be tragic to waste the opportunity to pursue research that could potentially alleviate human suffering.

Lesson 5 Ethics and Policy

Objectives

Students will be able to:

- Identify ethical issues around policy and use of stem cells.
- Compare and contrast opposing views with respect to the ethics of embryonic stem cell research.
- Engage in a discussion of the ethical and policy issues surrounding stem cell research.

Class Time

Approximately 75 minutes; if the articles are read for homework, class time would be decreased by 15-20 minutes.

Prior Knowledge Needed

- A basic understanding of stem cell types and potencies, as well as the techniques for using stem cells.
- An understanding of the ethical perspectives.
- How to have a classroom discussion in a way that is respectful of others.

Common Misconceptions:

- Privately funded stem cell research is federally regulated.

Introduction

This lesson provides students with the opportunity to become familiar with the history of federal policy and regulation with respect to embryonic stem cell research, and the ethical debate which has shaped this policy. Students discuss issues regarding private and public funding, and the implications for treatment of disease and advancement of scientific knowledge.

Students read articles with opposing viewpoints surrounding the ethics of embryonic stem cell research. The class then participates in a **Socratic Seminar Fishbowl Discussion**. This activity provides students with the opportunity to have a structured discussion and achieve a deeper understanding about the ideas and values in the articles.

Students use a "Critical Reasoning Analysis Form" to examine the articles and create a set of open-ended questions about public policy and embryonic stem cell research.

Key Concepts

- Federal regulations apply only to research institutes that receive federal funding.
- Private research institutes and companies are virtually unregulated by the federal government.
- The national debate over embryonic stem cell research policy is shaped by issues of faith, politics, values and science.

Materials

Student Handouts:

- 5.1 – *Key moments in the Stem Cell Debate*
- 5.2 – *Opposing Views: Arguing FOR Embryonic Stem Cell Research*
- 5.3 – *Opposing Views: Arguing AGAINST Embryonic Stem Cell Research*
- 5.4 – *Critical Reasoning Analysis Form*
- 5.5 – *Open-Ended Questions for a Socratic Seminar*
- 5.6 – *Socratic Seminar Fishbowl Discussion Partner Evaluation* (optional adaptation)

Teacher Background

- —Socratic Seminar Assessment Rubric
- —Private vs. Public Funding for Stem Cell Research

As an option to the Opposing Views essays, students can read a letter from eighty Nobel laureates in support of embryonic stem cell research and President George W. Bush's 2001 policy-defining speech regulating embryonic stem cell research. These documents can be found at the end of this lesson.

The Opposing Views essays can be found at:
http://www.npr.org/takingissue/takingissue_stemcells.html

A more complete timeline, up to 2007, can be found at:
http://www.npr.org/templates/story/story.php?storyId=5252449

Additional information about the purpose, structure and key elements of a Socratic Seminar can be found in An Ethics Primer, available at:
http://nwabr.org/education/ethicslessons.html#PR

Background on Federal Policies and Regulations

Many students ask, "**Is embryonic stem cell research legal?**" The answer is, "Yes." The derivation of new stem cell lines and work with existing lines has always been legal, even under President Bush's restrictive policies. Federal law does not prevent research using embryonic stem cells. Federal law can, however, strictly enforce the use of federal funds. Most research institutions and public universities receive grants from the federal government to support their research. If federal funds (money from taxpayers) are not allowed to be spent on certain types of research, the institutions either have to forgo the research, or find ways to fund it outside of the federal government.

Reinforce that federal funding restrictions only apply to research institutions that receive money from the federal government.

There are virtually no restrictions on the kind of stem-cell research that may be done with private money.

Also note that individual states have created sources of money to fund embryonic stem cell research without relying on federal funds. In 2004, California voters passed Proposition 71 which approved $350 million annually for embryonic stem cell research. In 2007, California spent more than the federal government and many other nations on human embryonic stem cell research. Students can become familiar with the history of embryonic stem cell research in the U.S. by reading *Key moments in the Stem Cell Debate* (Handout 5.1).

Background on the Socratic Seminar

"A Socratic discussion is a text-based discussion in which an individual sets their own interpretations of the text alongside those of other participants. The aim is a mutual search for a clearer, wider and deeper ('enlarged') understanding of the ideas, issues, and values in the test at hand. It is shared inquiry, not debate; there is no opponent save the perplexity all persons face when they try to understand something that is both difficult and important."

— *Walter Parker, PhD, University of Washington*

In a Socratic Seminar Discussion, the participants carry the burden of responsibility for the quality of the discussion. Good discussions occur when participants study the text closely in advance, listen actively, share their ideas and questions in response to the ideas and questions of others, and search for evidence in the text to support their ideas. The discussion is not about right answers; it is not a debate. Students are encouraged to think out loud and to exchange ideas openly while examining ideas in a rigorous, thoughtful manner.

In a Socratic seminar, there are several basic elements:

- A text containing important and powerful ideas (it could be an article, film clip, etc.) that is shared by all participants. It is helpful to number the paragraphs in a text so that participants can easily refer to passages.
- A distinctive classroom environment; seating students in a circle and using name cards helps to facilitate discussion. The students should have a clear understanding of the discussion norms, which should be prominently posted.

- An opening question that requires interpretation of the text and is genuine (one where there is not an easy, predetermined answer). For example, 'What is the most important passage?' or 'What is the author driving at in the text? Recommended questions can be found in the Procedure section.

Procedure

Before the Socratic Seminar

1. Introduce the seminar and its purpose (to facilitate a deeper understanding of the ideas and values in the text through shared discussion).
2. Have students read the articles from Student Handouts 5.2 and 5.3 with opposing viewpoints. It is important that every student reads the text, since the quality of the discussion depends on contributions from each participant. It may be helpful to allow time in class for students to read the articles.
3. Students may use one of several formats to process the information. The Critical Reasoning Analysis Sheet (Handout 5.4) and/or the Open-Ended Questions (Handout 5.5) can be used to help students understand the content. If students have been given the reading as homework, the completed handouts can be used as the 'ticket' to participate in the seminar. Some teachers give students the guiding question (described below) for them to consider as they read the text.
4. In addition to the classroom discussion norms you may have already set, it is important to include the following norms:
   - Don't raise hands
   - Listen carefully
   - Address one another respectfully
   - Base any opinions on the text

During the Socratic Seminar Fishbowl Discussion

1. To create the discussion groups, divide the class in half and form two circles (an inner circle and an outer circle). The inner circle is engaged in the discussion, and the students in the outer circle are listening to the inner circle discussion. Students in the outer circle take notes and write down ideas or comments on what they hear in the inner circle discussion. After approximately 10 minutes (or another appropriate time period) the circles flip so that students in the inner circle and outer circle trade places. Teachers can use Student Handout 5.6 to help focus students during the discussion, if needed (see "adaptations.")
2. Teachers may choose to have the inner circle complete a Socratic seminar using only one of the articles (either the FOR or the AGAINST Embryonic Stem Cell Research argument). When the inner and outer circle trade places, a new Socratic seminar can begin with the second article, using the same guiding question.

3. To begin the discussion, the teacher/facilitator may pose the guiding question(s) or the participants may agree upon questions to begin the discussion.

   Recommended guiding questions:

   - What values are most important to each author, based on his or her viewpoint and position?
   - Which ethical principles (respect, beneficience/nonmaleficience, justice) does each author rely on to support his or her reasoning?
   - In what way would the underlying values of each author guide future federal policy?

   Additional questions could include:

   - What, according to the authors, does this research mean?
   - What are the implications of each text?
   - What is the most important sentence in each article?

   Sample questions to move the discussion along:

   - Where do you find evidence for that in the text?
   - Who has not yet had a chance to speak?
   - Is there something in the text that is unclear to you?

4. If students completed sheet 5.5, many of these questions generated could be used as guiding questions for the discussion.

   1. The teacher can choose to facilitate the discussion by asking clarifying questions, summarizing comments, and highlighting understandings and misunderstandings. Teachers can restate the opening question if the conversation gets off track, or ask for different ideas if it stalls.
   2. Later on in the discussion, questions that refer to the experiences of the students and their own judgments can also be used. For example, 'Is it right that….?' or 'Do you agree with the author?' or 'Has anyone changed his or her mind?' These do not require reference to the text to be answered.

After the Seminar

1. Ask everyone questions such as:

   "Do you feel like you understand the texts at a deeper level?" and,

   "What was one thing you noticed about the seminar?"

2. Share your experience with the seminar as a facilitator.

Based on materials shared by Walter Parker, PhD, University of Washington, Paula Fraser, Bellevue PRISM program, Bellevue, WA, Jodie Mathwig and Dianne Massey, Kent Meridian High School, Kent, WA. We also gratefully acknowledge the influence of the Coalition of Essential Schools and the National Paideia Center.

Homework

Before the lesson, students can read *Key Moments in the Stem Cell Debate* (Handout 5.1) and the opposing essays (Handouts 5.2 and 5.3) as homework. Because the quality of the discussion is dependent on the students having read the essays, some teachers also give out *The Critical Reasoning Analysis Form* (Handout 5.4) and/or the *Open-Ended Questions* (Handout 5.5) for student to complete as they read the essays. The completed analysis sheets can be used as a 'ticket' to participate in the seminar.

After the lesson, students may wish to express their own opinions about embryonic stem cell research. Students can be assigned a short essay in which they detail their own views and beliefs on the subject and tie these beliefs back to one or more of the ethical perspectives they have studied.

The *Critical Reasoning Analysis Form* (Handout 5.4) can also be used as homework after the seminar.

Extensions

Students can investigate embryonic stem cell research policy in different states and countries, and discuss the similarities, differences, and implications for scientists/ scientific advancement.

Adaptations

To help engage students in the Socratic Seminar Fishbowl discussion you can have them evaluate another student's participation behaviors. This can be done by pairing each student in the inner circle with a student in the outer circle, or using Student Handout 5.6 to help students evaluate each other.

Assessment Suggestions

The students' Critical Reasoning Analysis Forms can be used as formative assessment to prepare for the Socratic Seminar.

The teacher may choose to require students to make a specific number of meaningful contributions to the discussion (for example – requiring the student to contribute 3 times to the discussion).

The teacher may choose to evaluate students in the discussion using the Rubric for Evaluating Classroom Discussions, found in the Appendix of this curriculum.

Sources

http://www.npr.org/takingissue/takingissue_stemcells.html

http://www.npr.org/templates/story/story.php?storyId=5252449

http://nwabr.org/education/ethicslessons.html#PR

http://newsroom.stemcells.wisc.edu/

Student Handout 5.1

Name _____ *Date* _____ *Period* _____

Key Moments in the Stem Cell Debate

The first embryonic stem cells were isolated in mice in 1981. But it wasn't until 1998 that researchers managed to derive stem cells from human embryos. That kicked into full gear an ethical debate that continues to this day. Here's a look at key moments in the controversy so far:

1981: Embryonic stem cells are first isolated in mice

1995: Researchers isolate the first embryonic stem cells in primates — rhesus macaque monkeys. The research shows it's possible to derive embryonic stem cells from primates, including humans.

1996: The first cloned animal, Dolly the sheep, is born in Scotland.

1998: Researchers report isolating human embryonic stem cells. The cells have the potential to become any type of cell in the body and might one day be used to replace damaged or cancerous cells. But the process is controversial: One team derived their stem cells from the tissue of aborted fetuses; the other from embryos created in the laboratory for couples seeking to get pregnant by *in vitro* fertilization.

2000: The National Institutes of Health issue guidelines that allow federal funding of embryonic stem-cell research. Former President Bill Clinton supports the guidelines.

February 2001: The month after taking office, President George W. Bush puts a hold on federal funds for stem-cell research.

August, 2001: President Bush announces his decision to limit funding to a few dozen lines of embryonic stem cells in existence at that date. Many of the approved lines later prove to be contaminated, and some contain genetic mutations, making them unsuitable for research.

November, 2001: Scientists at a private company in Massachusetts which receives no federal funding, claim to have cloned a human embryo. However, the evidence proves controversial and not conclusive.

February, 2004: South Korean scientists led by Hwang Woo-suk, announce the world's first successfully cloned human embryo using therapeutic cloning (SCNT) techniques. Unlike other past cloning claims, the scientists report their work in a prestigious, peer-reviewed journal, *Science.* The embryos were cloned not for reproductive purposes but as a source of stem cells.

September, 2005: Scientists in California report that injecting human neural stem cells appeared to repair spinal cords in mice. The therapy helped partially paralyzed mice walk again.

January, 2006: The Seoul National University investigation concludes that Hwang Woo-suk's 2004 landmark paper published in *Science* (see Feb. 12, 2004) was fabricated. He is later charged with fraud, embezzlement and violating the country's laws on bioethics.

July 2006: The Senate considers a bill that expands federal funding of embryonic stem-cell research. Among Senate sponsors of the bill are two prominent Republicans, Sen. Arlen Specter of Pennsylvania and Sen. Orrin Hatch of Utah.

July, 2006: President Bush vetoes the bill — the first use of his veto power in his presidency.

OVER

January, 2007: The House of Representatives is expected to pass a bill that would expand federal funding for embryonic stem-cell research, but the bill won't carry enough votes to override a threatened presidential veto.

April, 2007: Again, the Senate passes a bill that would expand federal funding for embryonic stem-cell research. The bill passes 63-34, just shy of the two-thirds majority needed to protect the legislation from President Bush's promised veto.

June, 2007: Researchers succeed in modifying a skin cell so that it behaves like an embryonic stem cell using iPS techniques. This eases some ethical concerns since it does not require the destruction of an embryo.

June, 2007: The House approves legislation to ease restrictions on federally funded embryonic stem-cell research. The bill would authorize federal support for research on stem cells from spare embryos that fertility clinics would otherwise discard. But the House is still 35 votes short of what it needs to override a presidential veto.

June, 2007: President Bush vetoes legislation that would have eased restraints on stem-cell research. This marks the second time the president has used his veto power against federally funded embryonic stem-cell research.

November, 2007: Scientists for the first time successfully clone embryos from the cells of an adult monkey and derive stem cells from those cloned embryos using therapeutic cloning (SCNT) techniques.

November, 2007: Two independent teams of scientists report on a method for making induced pluripotent stem cells (iPS) without destroying a human embryo. The researchers caution there are many steps before these cells are useful for human therapies but the work is being hailed as a critical step forward, both scientifically and ethically.

November, 2008: Barack Obama, a supporter of embryonic stem cell research, is elected President of the U.S.

February, 2009: Researchers create induced pluripotent stem (iPS)cells without using problematic retroviruses to insert the master regulator genes.

March, 2009: President Obama issues an executive order to remove barriers to responsible scientific research involving human stem cells.

July, 2009: The National Institutes of Health issue guidelines that detail how federal funds can be used for embryonic stem cell research.

During the time period when federal funding for stem cell research is more limited (between 2001 and 2008) New Jersey, California, Connecticut, Illinois, Florida, Maryland, Missouri and Iowa all find ways to fund embryonic stem cell research within the states' budgets, without relying on federal funds.

Reporting by Maria Godoy, Joe Palca and Beth Novey.

Source:
http://www.npr.org/templates/story/story.php?storyId=5252449
http://www.nature.com/news/2009/090227/full/458019a.html

Name _____ Date _____ Period _____

Opposing Views: Arguing FOR Embryonic Stem Cell Research

What Does it Mean to Be Human? *Laurie Zoloth*

Laurie Zoloth is a professor of medical ethics and humanities and of religion at Northwestern University. She is the past president of the American Society for Bioethics and Humanities.

November 22, 2005 — Of all the mysteries that surprise and delight us, surely the process by which a human being is created is the most ordinary and the most mesmerizing. In the last three decades, this process has also raised ethical questions that have defined and divided Americans: When does human life begin? What does it mean to be human?

Our answers to these questions shape the debate over the use of human embryonic stem cells to understand and hopefully to cure human diseases. If life begins at the instant of conception, then any act to end that life would be wrongful killing. But if human life is a contingent matter, a slow and complex process that unfolds temporally, physically and spiritually — as I believe — then it is possible to speak of times and manners and reasons why other moral appeals may matter more.

We are more than our DNA maps, for we are our love, our chance for duty. Careful use of the human blastocyst may be seen as a basic human duty in the face of significant suffering. These are the reasons why people of the deepest faith all over the globe support and defend stem cell research.

For most of human history, pregnancy was understood as prelude. Life was understood to begin in stages, the most important one being the birth itself, when a person becomes fully human, accepting the blessing of human family and community and attaining moral status for the Greek philosophers such as Aristotle.

For the writers of the first texts and laws of Western religions — Christian, Jewish and Muslim — pregnancy became actual when it was tangible, visible or palpable to the outside world. For them, the soul — God's participation in human beings — needed a form.

It was only after microscopes could reveal egg and sperm that such a concept as "life begins at conception" could alter theological and legal traditions, and in part, this is why the Vatican changed its idea about when life began. Prior to the mid-1800s, the Roman Catholic tradition, like Jewish and Muslim law, followed the science of Aristotle — that the first 40 days after conception was "formless" or "like water." Catholic canon law changed to reflect this new policy and the new science in 1917.

We know now that much has to occur for fertilization to take place. The egg must be released, it must accept the sperm, the cell wall and the nuclear wall have to be breached, the DNA correctly assembled. Even more has to occur before we can claim a woman is pregnant: The fertilized egg — a blastocyst — must maneuver the fallopian tube, get to the womb and be implanted. Only then can a pregnancy test confirm the event.

All along the way to birth, there are critical biological events, a universe of chance and contingency. That is why we greet each child as a miracle. That is also why we question the fate of the hundreds of thousands of human blastocysts created to treat infertility and then left in labs around the world.

Beyond the question of life's biological beginning, we need also to decide when our moral obligations to others begin — in this case, to others who suffer and whose own lives are at stake.

As a society, in our treatment of infertility, we have already made the decision that it is just and right to treat serious disease by researching and then creating human blastocysts. We allow physicians to experiment on human sperm and human eggs to find the best way to make blastocysts, to make far more than the couple will be able to use, to implant them knowing that only one or two can be carried to term.

We have been making blastocysts in the lab for more than two decades, knowing that most will be destroyed routinely. At stake is whether we can use blastocysts made in this way to treat other diseases, like diabetes, Parkinson's or spinal cord injury by using them to make stem cells.

We have our duties toward all of life, to be certain. We have duties toward the uncertain microscopic world, duties toward the blastocysts we create. But we have duties as well toward the millions of patients who might be cured by regenerative medicine, just as we did toward infertile women.

It is the strong belief in many religious and philosophic traditions that the ethical appeal for healing the suffering neighbor is far more important than the appeal for the blastocyst.

Source: **http://www.npr.org/takingissue/takingissue_stemcells.html**

Name _____ Date _____ Period _____

Opposing Views: Arguing AGAINST Embryonic Stem Cell Research

A Distinct Human Organism *Robert P. George*

Robert P. George is a former member of the President's Council on Bioethics. He is also a professor of jurisprudence and director of the James Madison Program in American Ideals and Institutions at Princeton University.

November 22, 2005 — The key question in the debate over stem cell research that involves the destruction of human embryos is: When does the life of a human being begin? To answer this question is to decide whether human embryos are, in fact, human beings and, as such, possessors of inherent human dignity.

Where do we go to find the answer? Not, in my opinion, to the Bible, Talmud or other religious writings, even if we regard these texts as sources of moral wisdom and even divine revelation. Nor should we be satisfied to consult our "moral intuitions."

Rather, the answer is to be found in the works of modern human embryology and developmental biology. In these texts, we find little or nothing in the way of scientific uncertainty: "…human development begins at fertilization…" write embryologists Keith Moore and T.V. N. Persaud in *The Developing Human* (7th edition, 2003), the most widely used textbook on human embryology.

A human embryo is a whole living member of the species *Homo sapiens* in the earliest stage of development. Unless severely damaged or deprived of nutrition or a suitable environment, the embryonic human will develop himself or herself by an internally directed process to the next more mature developmental stage, i.e., the fetal stage.

The embryonic, fetal, infant, child and adolescent stages are *stages of development* of a determinate and enduring entity — a human being — who comes into existence as a zygote and develops by a gradual and gapless process into adulthood many years later.

Whether produced by fertilization or cloning, the human embryo is a complete and distinct human organism possessing all of the genetic material needed to inform and organize its growth, as well as an active disposition to develop itself using that information. The direction of its growth *is not extrinsically determined*, but is in accord with the genetic information within it.

The human embryo is not something different in kind from a human being, nor is it merely a "potential human being," whatever that might mean. Rather the human embryo is a human being in the embryonic stage.

The adult that is you is the same human being who, at an earlier stage of your life, was an adolescent, and before that a child, an infant, a fetus and an embryo. Even in the embryonic stage, you were a whole, living member of the species *Homo sapiens*. You were then, as you are now, a distinct and complete — though, of course, immature — human organism.

Unlike the embryo, the sperm and egg whose union brings a human being into existence are not complete organisms. They are both functionally and genetically identifiable as *parts* of the male or female parents. Each has only half the genetic material needed to guide the development of a new human being toward maturity. They are destined either to combine to generate a new and distinct organism or simply die.

Even when fertilization occurs, the gametes do not survive: Their genetic material enters into the composition of a new organism. (A somatic cell that might be used to produce a human being by cloning is analogous not to a human embryo, but to gametes.) The difference between human gametes and a human being is a difference *in kind*, not a difference in stage of development. The difference between an embryonic human being (or a human fetus or infant) and an adult is merely a difference *in stage of development*.

Some today deny the moral premise of my position, namely, that human beings possess inherent dignity and a right to life simply by virtue of their humanity. They claim that some, but not all, human beings have dignity and rights. To have such rights, they say, human beings must possess some quality or set of qualities (sentience, self-consciousness, the immediately exercisable capacity for human mental functions, etc.) that other human beings do not possess or do not yet possess, or no longer possess.

I reject the idea that human beings at certain stages of development (embryos, fetuses, infants) or in certain conditions (the severely handicapped or mentally retarded, those suffering dementia) are not "persons" who possess dignity and a right to life. And no person may legitimately be destroyed in biomedical research or for other reasons.

Source: **www.npr.org/takingissue/takingissue_stemcells.html**

Name _____ Date _____ Period _____

Critical Reasoning Analysis Form

	For Embryonic Stem Cell Research	Against Embryonic Stem Cell Research
Point of View What is the point of view, and how does the particular perspective show through?		
Purpose Why was this material written?		
Questions What questions are addressed by the author? What questions do you have about the material?		
Information What are some of the most important facts included?		

Student Handout 5.4

Name _____ *Date* _____ *Period* _____

Critical Reasoning Analysis Form

	For Embryonic Stem Cell Research	Against Embryonic Stem Cell Research
Concepts What are the main ideas and concepts addressed?		
Implications What is the larger meaning? What are the consequences of the decision to be made?		
Assumptions What is the author assuming that might be subject to question?		
Inferences What can you infer and conclude based on the material?		

From the Foundation for Critical Thinking, **www.criticalthinking.org**, and Paula Fraser, Bellevue School District PRISM Program.

Name _____ Date _____ Period _____

Open-Ended Questions for a Socratic Seminar

When preparing for a Socratic Seminar, write questions using these sentence frames to stimulate your thinking about the article(s) you read. Choose and complete 5 of the following:

What puzzles me is…

I'd like to talk with people about…

I'm confused about…

Don't you think this is similar to…

Do you agree that the big ideas seem to be…

I have questions about…

Another point of view is…

I think it means…

Do you think…

What does it mean when the author says…

Do you agree that…

Name _____ Date _____ Period _____

Socratic Seminar Fishbowl Discussion Partner Evaluation

Name of person you are observing _____ Topic: _____

1) Record a check for each time your partner contributed in a meaningful way:

_____ _____ _____ _____ _____

2) On a scale of 1-5, with 5 being the highest, how well did your partner do at the following?

_____ **Analysis and Reasoning**

Did your partner….
Cite reasons and evidence for his/her statements with support from the text?
Demonstrate that they had given thoughtful consideration to the topic?
Provide relevant and insightful comments?
Demonstrate organized thinking?
Move the discussion to a deeper level?

Notes/Comments:

_____**Discussion Skills**

Did your partner…
Speak loudly and clearly?
Stay on topic?
Talk directly to other students rather than the teacher?
Stay focused on the discussion?
Invite other people into the discussion?
Share air time equally with others (didn't talk more than was fair to others)?

Notes/Comments:

_____ **Civility**

Did your partner…
Listen to others respectfully?
Enter the discussion in a polite manner?
Avoid inappropriate language (slang, swearing)?
Avoid hostile exchanges?
Question others in a civil manner?

Notes/Comments:

Socratic Seminar Rubric

	Exemplary	Proficient	Partially Proficient	Developing	Comments
Analysis and Reasoning	Clearly references text to support reasoning. Demonstrates thoughtful consideration of the topic. Provides relevant and insightful comments, makes new connections. Demonstrates exceptionally logical and organized thinking. Moves the discussion to a deeper level	Occasionally references text to support reasoning. Demonstrates consideration of the topic. Provides relevant comments. Thinking is clear and organized.	Rarely references text, may reference text incorrectly. Demonstrates awareness of the topic but little reflection on it. Comments are mostly relevant. Thinking is mostly clear and organized.	Does not reference text. Demonstrates little or no consideration of the topic. Comments are off-topic or irrelevant. Thinking is confused, disorganized, or stays at a very superficial level.	
Discussion Skills	Speaks loudly and clearly. Stays on topic and brings discussion back on topic if necessary. Talks directly to other students (rather than the teacher). Stays focused on the discussion. Invites other people into the discussion. Shares 'air time' equally with others. References the remarks of others.	Speaks at an appropriate level to be heard. Stays on topic and focused on the discussion. Aware of sharing 'air time' with others and may invite them into the conversation. May occasionally direct comments to teacher.	Mostly speaks at an appropriate level but may need to be coached. Sometimes strays from topic. Occasionally dominates the conversation.	Cannot be heard, or may dominate the conversation. Demonstrates inappropriate discussion skills.	

Socratic Seminar Rubric

	Exemplary	Proficient	Partially Proficient	Developing	Comments
Civility	Listens to others respectfully by making eye contact with the speaker, and waiting their turn to speak. Remarks are polite and demonstrate a high level of concern for the feelings of others. Addresses others in a civil manner, using a collegial and friendly tone.	Listens to others respectfully. Uses appropriate language and tone. Remarks demonstrate a concern for the feelings of others.	Listens to others respectfully, but may not always look at the speaker or may sometimes interrupt. Remarks demonstrate an awareness of feelings of others.	May be distracted or not focused on the conversation. Interrupts frequently. Remarks demonstrate little awareness or sensitivity to the feelings of others. Uses an aggressive, threatening, or otherwise inappropriate tone.	

Private vs. Public Funding for Stem Cell Research

Private Funding	Public Funding
No tax money used	Tax money used
May only benefit those who can pay	Possible benefit to a wider range of people
No governmental regulation specific to stem cells	Government regulation specific to stem cells is necessary
Able to use any stem cell lines and develop their own	Must abide by the National Institutes of Health Guidelines on Human Stem Cell Research.
Intellectual information can be patented and available only at a price	Any research findings are public domain and there are regulations about how they must be published
No oversight as to whether scientists are using ethical procedures	Government oversight and accountability is necessary

What do the 2009 National Institutes of Health (NIH) Guidelines on Human Stem Cell Research say?

The guidelines are based on the following principles:

1. Responsible research with human embryonic stem cells has the potential to improve our understanding of human health and illness and discover new ways to prevent and/or treat illness.
2. Individuals donating embryos for research purposes should do so freely, with voluntary and informed consent.

ELIGIBLE for Federal Funding

Research with human embryonic stem cells is eligible for federal funding if the embryos:

- are created using in vitro fertilization techniques for reproduction and are no longer needed for this purpose
- are donated voluntarily with adequate informed consent, including a statement that no payments of any kind are offered for the embryos.

NOT ELIGIBLE for Federal Funding

Research with human embryonic stem cells is NOT eligible for federal funding if the research involves:

- introducing human embryonic stem cells into non-human primate blastocysts.
- the breeding of animals where embryonic stem cells may contribute to the germ line.
- embryonic stem cells derived from other sources including therapeutic cloning (SCNT), embryos created solely for research purposes, or parthenogenesis.

The Dickey Amendment (an annual appropriations act) adds a twist in that federal funds may not be used for the actual destruction of the embryo, even though federal funds may be used to establish a stem cell line resulting from the destruction of the embryo.

With the exception of a few specific circumstances, the NIH Guidelines do not pertain to research using induced pluripotent stem (iPS) cells since their formation does not involve the destruction of a human embryo.

Source:

Stem Cell Information [World Wide Web]. Bethesda, MD: National Institutes of Health, U.S. Department of Health and Human Services, 2009. **http://stemcells.nih.gov/policy/2009guidelines**

Lesson 5

Opposing Views: President Bush Speaks

President Bush Discusses Stem Cell Research

August 9, 2001 8:01 P.M. CDT

1 THE PRESIDENT: Good evening. I appreciate you giving me a few minutes of your time tonight so I can discuss with you a complex and difficult issue, an issue that is one of the most profound of our time.

2 The issue of research involving stem cells derived from human embryos is increasingly the subject of a national debate and dinner table discussions. The issue is confronted every day in laboratories as scientists ponder the ethical ramifications of their work. It is agonized over by parents and many couples as they try to have children, or to save children already born.

3 The issue is debated within the church, with people of different faiths, even many of the same faith coming to different conclusions. Many people are finding that the more they know about stem cell research, the less certain they are about the right ethical and moral conclusions.

4 My administration must decide whether to allow federal funds, your tax dollars, to be used for scientific research on stem cells derived from human embryos. A large number of these embryos already exist. They are the product of a process called *in vitro* fertilization, which helps so many couples conceive children. When doctors match sperm and egg to create life outside the womb, they usually produce more embryos than are planted in the mother. Once a couple successfully has children, or if they are unsuccessful, the additional embryos remain frozen in laboratories.

5 Some will not survive during long storage; others are destroyed. A number have been donated to science and used to create privately funded stem cell lines. And a few have been implanted in an adoptive mother and born, and are today healthy children.

6 Based on preliminary work that has been privately funded, scientists believe further research using stem cells offers great promise that could help improve the lives of those who suffer from many terrible diseases — from juvenile diabetes to Alzheimer's, from Parkinson's to spinal cord injuries. And while scientists admit they are not yet certain, they believe stem cells derived from embryos have unique potential.

7 You should also know that stem cells can be derived from sources other than embryos — from adult cells, from umbilical cords that are discarded after babies are born, from human placenta. And many scientists feel research on these type of stem cells is also promising. Many patients suffering from a range of diseases are already being helped with treatments developed from adult stem cells.

8 However, most scientists, at least today, believe that research on embryonic stem cells offer the most promise because these cells have the potential to develop in all of the tissues in the body.

9 Scientists further believe that rapid progress in this research will come only with federal funds. Federal dollars help attract the best and brightest scientists. They ensure new discoveries are widely shared at the largest number of research facilities and that the research is directed toward the greatest public good.

10 The United States has a long and proud record of leading the world toward advances in science and medicine that improve human life. And the United States has a long and proud record of upholding the highest standards of ethics as we expand the limits of science and knowledge. Research on embryonic stem cells raises profound ethical questions, because extracting the stem cell destroys the embryo, and thus destroys its potential for life. Like a snowflake, each of these embryos is unique, with the unique genetic potential of an individual human being.

11 As I thought through this issue, I kept returning to two fundamental questions: First, are these frozen embryos human life, and therefore, something precious to be protected? And second, if they're going to be destroyed anyway, shouldn't they be used for a greater good, for research that has the potential to save and improve other lives?

12 I've asked those questions and others of scientists, scholars, bioethicists, religious leaders, doctors, researchers, members of Congress, my Cabinet, and my friends. I have read heartfelt letters from many Americans. I have given this issue a great deal of thought, prayer and considerable reflection. And I have found widespread disagreement.

13 On the first issue, are these embryos human life — well, one researcher told me he believes this five-day-old cluster of cells is not an embryo, not yet an individual, but a pre-embryo. He argued that it has the potential for life, but it is not a life because it cannot develop on its own.

14 An ethicist dismissed that as a callous attempt at rationalization. Make no mistake, he told me, that cluster of cells is the same way you and I, and all the rest of us, started our lives. One goes with a heavy heart if we use these, he said, because we are dealing with the seeds of the next generation.

And to the other crucial question, if these are going to be destroyed anyway, why not use them for good purpose — I also found different answers. Many argue these embryos are byproducts of a process that helps create life, and we should allow
15 couples to donate them to science so they can be used for good purpose instead of wasting their potential. Others will argue there's no such thing as excess life, and the fact that a living being is going to die does not justify experimenting on it or exploiting it as a natural resource.

At its core, this issue forces us to confront fundamental questions about the beginnings of life
16 and the ends of science. It lies at a difficult moral intersection, juxtaposing the need to protect life in all its phases with the prospect of saving and improving life in all its stages.

As the discoveries of modern science create tremendous hope, they also lay vast ethical mine fields. As the genius of science extends the horizons of what we can do, we increasingly
17 confront complex questions about what we should do. We have arrived at that brave new world that seemed so distant in 1932, when Aldous Huxley wrote about human beings created in test tubes in what he called a "hatchery."

In recent weeks, we learned that scientists have created human embryos in test tubes solely to
18 experiment on them. This is deeply troubling, and a warning sign that should prompt all of us to think through these issues very carefully.

Embryonic stem cell research is at the leading edge of a series of moral hazards. The initial stem cell researcher was at first reluctant to begin his research, fearing it might be used for
19 human cloning. Scientists have already cloned a sheep. Researchers are telling us the next step could be to clone human beings to create individual designer stem cells, essentially to grow another you, to be available in case you need another heart or lung or liver.

I strongly oppose human cloning, as do most Americans. We recoil at the idea of growing human beings for spare body parts, or creating life for our convenience. And while we must
20 devote enormous energy to conquering disease, it is equally important that we pay attention to the moral concerns raised by the new frontier of human embryo stem cell research. Even the most noble ends do not justify any means.

My position on these issues is shaped by deeply held beliefs. I'm a strong supporter of science and technology, and believe they have the potential for incredible good — to improve lives, to save life, to conquer disease. Research offers hope that millions
21 of our loved ones may be cured of a disease and rid of their suffering. I have friends whose children suffer from juvenile diabetes. Nancy Reagan has written me about President Reagan's struggle with Alzheimer's. My own family has confronted the tragedy of childhood leukemia. And, like all Americans, I have great hope for cures.

I also believe human life is a sacred gift from our Creator. I worry about a culture that devalues life, and believe as your President I have an important obligation to foster and encourage respect for
22 life in America and throughout the world. And while we're all hopeful about the potential of this research, no one can be certain that the science will live up to the hope it has generated.

Eight years ago, scientists believed fetal tissue research offered great hope for cures and treatments — yet, the progress to date has not lived
23 up to its initial expectations. Embryonic stem cell research offers both great promise and great peril. So I have decided we must proceed with great care.

As a result of private research, more than 60 genetically diverse stem cell lines already exist. They were created from embryos that have already been destroyed, and they have the ability to
24 regenerate themselves indefinitely, creating ongoing opportunities for research. I have concluded that we should allow federal funds to be used for research on these existing stem cell lines, where the life and death decision has already been made.

Leading scientists tell me research on these 60 lines has great promise that could lead to breakthrough therapies and cures. This allows us to explore the
25 promise and potential of stem cell research without crossing a fundamental moral line, by providing taxpayer funding that would sanction or encourage further destruction of human embryos that have at least the potential for life.

I also believe that great scientific progress can be made through aggressive federal funding of research on umbilical cord placenta, adult and
26 animal stem cells which do not involve the same moral dilemma. This year, your government will spend $250 million on this important research.

I will also name a President's council to monitor stem cell research, to recommend appropriate guidelines and regulations, and to consider all of the medical and ethical ramifications of
27 biomedical innovation. This council will consist of leading scientists, doctors, ethicists, lawyers, theologians and others, and will be chaired by Dr. Leon Kass, a leading biomedical ethicist from the University of Chicago.

This council will keep us apprised of new developments and give our nation a forum to continue to discuss and evaluate these important issues. As we go forward, I hope we will always be guided by both intellect and heart, by both our capabilities and our conscience.

28 I have made this decision with great care, and I pray it is the right one.

Thank you for listening. Good night, and God bless America.

END 8:12 P.M. CDT

Lesson 5

Opposing Views: Nobel Laureates Speak

Nobel Laureates' Letter to President Bush

Eighty Nobel laureates were among those who signed a letter to President Bush urging funding for research on human embryo cells.

**To the Honorable George W. Bush,
President of the United States**

1 We the undersigned urge you to support Federal funding for research using human pluripotent stem cells. We join with other research institutions and patient groups in our belief that the current National Institutes of Health (NIH) guidelines, which enable scientists to conduct stem cell research within the rigorous constraints of federal oversight and standards, should be permitted to remain in effect. The discovery of human pluripotent stem cells is a significant milestone in medical research. Federal support for the enormous creativity of the US biomedical community is essential to translate this discovery into novel therapies for a range of serious and currently intractable diseases.

2 The therapeutic potential of pluripotent stem-cells is remarkably broad. The cells have the unique potential to differentiate into any human cell type. Insulin-producing cells could be used to treat — or perhaps even cure — patients with diabetes, cardiomyocytes could be used to replace damaged heart tissue, chondrocytes could be used for arthritis, and neurons for Parkinson's, Alzheimer's, ALS and spinal cord injuries to name a few examples. There is also the possibility that these cells could be used to create more complex, vital organs, such as kidneys, livers, or even entire hearts.

3 Some have suggested that adult stem cells may be sufficient to pursue all treatments for human disease. It is premature to conclude that adult stem cells have the same potential as embryonic stem cells — and that potential will almost certainly vary from disease to disease. Current evidence suggests that adult stem cells have markedly restricted differentiation potential. Therefore, for disorders that prove not to be treatable with adult stem cells, impeding human pluripotent stem cell research risks unnecessary delay for millions of patients who may die or endure needless suffering while the effectiveness of adult stem cells is evaluated.

4 The therapeutic promise of pluripotent stem cells is based on more than two decades of research in mice and other animal models. This research confirms that pluripotent stem cells are capable of generating all of the cell types of the body. Most importantly, the therapeutic potential of these cells has already been demonstrated. Cardiomyocytes generated in the laboratory from these cells have been transplanted into the hearts of dystrophic mice where they formed stable intracardiac grafts. Nerve cells have successfully reversed the progression of the equivalent of multiple sclerosis in mice and have restored function to the limbs of partially paralyzed rats; and insulin-secreting cells have normalized blood glucose in diabetic mice. These findings suggest that therapies using these cells may one day provide important new strategies for the treatment for a host of currently untreatable disorders.

5 While we recognize the legitimate ethical issues raised by this research, it is important to understand that the cells being used in this research were destined to be discarded in any case. Under these circumstances, it would be tragic to waste this opportunity to pursue the work that could potentially alleviate human suffering. For the past 35 years many of the common human virus vaccines — such as measles, rubella, hepatitis A, rabies and poliovirus — have been produced in cells derived from a human fetus to the benefit of tens of millions of Americans. Thus precedent has been established for the use of fetal tissue that would otherwise be discarded.

6 We urge you to allow research on pluripotent stem cells to continue with Federal support, so that the tremendous scientific and medical benefits of their use may one day become available to the millions of American patients who so desperately need them.

Yours respectfully,

Kenneth J. Arrow*, Stanford University

Julius Axelrod*, National Institute of Mental Health, Education & Welfare

Baruj Benacerraf*, Dana-Farber Cancer Institute

Paul Berg*, Stanford University

J. Michael Bishop*, University of California, San Francisco

Nicolaas Bloembergen*, Harvard University

Herbert C. Brown*, Purdue University

Jose Cibelli, Advanced Cell Technology

Stanley Cohen*, Vanderbilt University School of Medicine

Leon N. Cooper*, Brown University

E. J. Corey*, Harvard University

James W. Cronin*, University of Chicago

Robert Curl, Jr.*, Rice University

Peter Doherty*, St. Jude Children's Research Hospital

Johann Deisenhofer*, University of Texas Southwestern Medical Center

Reneto Dulbecco*, Salk Institute

Edmond H. Fischer*, University of Washington

Val L. Fitch*, Princeton University

Robert Fogel*, University of Chicago

Jerome I. Friedman*, Massachusetts Institute of Technology

Milton Friedman*, Hoover Institute

Robert F. Furchgott*, State University of New York Health Sciences Center

Murray Gell-Mann*, Santa Fe, NM

Walter Gilbert*, Harvard University

Alfred Gilman*, University of Texas, Southwestern Medical Center

Donald Glaser*, University of California, Berkeley

Sheldon Lee Glashow*, Boston University

Ronald M. Green, Dartmouth College

Paul Greengard*, The Rockefeller University

Roger Guillemin*, The Salk Institute

Leonard Hayflick, University of California, San Francisco

Herbert A. Hauptman*, Hauptman-Woodward Medical Research

James J. Heckman*, University of Chicago

Alan Heeger*, University of California, Santa Barbara

Dudley Herschbach*, Harvard Medical School

David H. Hubel*, Harvard Medical School

Russell Hulse*, Plasma Physics Laboratory

Eric Kandel*, Columbia University

Jerome Karle*, Washington, D.C.

Lawrence R. Klein*, University of Pennsylvania

Walter Kohn*, University of California, Santa Barbara

Arthur Kornberg*, Stanford University School of Medicine

Edwin G. Krebs*, University of Washington

Robert P. Lanza+, Advanced Cell Technology

Robert Laughlin*, Stanford University

Leon Lederman*, Illinois Institute of Technology

David M. Lee*, Cornell University

Edward Lewis*, California Institute of Technology

William Lipscomb, Jr.*, Harvard University

Rudolph A. Marcus*, California Institute of Technology

Daniel McFadden*, University of California, Berkeley

R. Bruce Merrifield*, The Rockefeller University

Robert Merton*, Harvard University Graduate School of Business Administration

Franco Modigliani*, Massachusetts Institute of Technology

Mario J. Molina*, Massachusetts Institute of Technology

Ferid Murad*, University of Texas Medical School

Marshall W. Nirenberg*, NIH National Heart, Lung & Blood Institute

Douglass C. North*, Washington University

George A. Olah*, University of Southern California

Douglas Osheroff*, Stanford University

George E. Palade*, University of California, San Diego

Martin Perl*, Stanford University

Norman F. Ramsey*, Harvard University

Burton Richter*, Stanford University

Richard J. Roberts*, New England Biolabs

Paul A. Samuelson*, Massachusetts Institute of Technology

Melvin Schwartz*, Columbia University

Phillip A. Sharp*, Massachusetts Institute of Technology

Richard E. Smalley*, Rice University

Hamilton O. Smith*, Celera Genomics

Robert M. Solow*, Massachusetts Institute of Technology

Horst Stormer*, Columbia University

Henry Taube*, Stanford University

Richard Taylor*, Stanford University

E. Donnall Thomas*, University of Washington

James Tobin*, Yale University

Susumu Tonegawa*, Massachusetts Institute of Technology

Charles Townes*, University of California, Berkeley

James D. Watson*, Cold Spring Harbor Laboratory

Steven Weinberg*, University of Texas

Thomas H. Weller*, Harvard School of Public Health

Michael D. West+, Advanced Cell Technology

Eric F. Wieschaus*, Princeton University

Torsten N. Wiesel*, The Rockefeller University

Robert W. Wilson*, Harvard-Smithsonian Center for Astrophysics

* Nobel Laureate

+ Corresponding Author

Final Assessments

Introduction

Students complete a Decision-Making Framework to consider the larger moral and ethical issues behind the use of *in vitro* fertilized embryos in developing stem cell lines. In working through the framework, students integrate and apply their understanding of stem cell research, as well as clarify their own ethical position.

The framework document serves as a basis for the final assessment.

For the culminating project, teachers may choose one of the two options below, or both.

Option 1 – Individual Assessment

A Letter to the President or President's Council on Bioethics: Each student expresses his or her own personal views on the stem cell debate by writing a letter to the President or the President's Counsel on Bioethics recommending future regulations and funding criteria.

Option 2 – Group Assessment

A Grant Application

Students simulate the real-life process of writing and presenting proposals for obtaining NIH funding to research treatment for a chosen disease using stem cells. In addition, the students participate on a review panel to evaluate proposal presentations in order to determine which proposals should be funded.

Materials

Student Handouts:

6.1 – *Ethical Decision-Making Framework*

6.2 – *A Stem Cell Letter*

6.3 – *A Grant Application*

Scoring Guides:

Ethical Decision-Making Framework

A Stem Cell Letter

Grant Proposal Presentation

Final Assessment

Decision-Making Framework

Students will be able to:

- Integrate and apply understandings about stem cell science, ethics, and policy issues.
- Utilize a decision-making framework to help them clarify their own ethical position.

Class Time

1 class period.

Introduction

The use of a Decision-Making Framework allows students to integrate their learning from throughout the unit into a coherent whole. It provides them with a methodology for structuring their reasoning in a logical way.

Materials

Student Handout

6.1 –*Ethical Decision-Making Framework*

Scoring Guide

Ethical Decision-Making Framework

Procedure

1. Give students Handout 6.1 *Ethical Decision-Making Framework*. Explain that when examining an ethical question, it is helpful to have a structured way to reason through the dilemma. One possible ethical question could be: *Under what circumstances, if any, is it ethically acceptable to conduct embryonic stem cell research?*
2. Explain that this framework will integrate material from throughout the unit. Just as the unit started with an understanding of stem cell science, an ethical decision should be grounded in the factual information available. The framework also integrates the idea of stakeholders and their concerns, examines various options, and asks students to relate their chosen solution to a bioethical principle.
3. Students can work through the decision-making framework in small groups or individually. Individuals should complete the last section ('Decision') from their own, personal perspective. The key to sheet 3.4, Biomedical Ethical Principles and Embryonic Stem Cells, may be useful to students in completing the decision portion of their framework.
4. The completed Decision-Making Framework can serve as the basis for the individual or group culminating assessments. Students can complete the Decision-making Framework for homework if not completed in class.

Name _____ Date _____ Period _____

Ethical Decision-Making Framework

I. Question

What is the ETHICAL QUESTION?

II. Facts: Known and Unknown

KNOWN: What are the different types of stem cells? Where do they come from? How do they differ in terms of what they can become?

What other facts are relevant to this question?

UNKNOWN: What additional facts, information, or evidence would be useful in helping to make a decision?

Name _____ Date _____ Period _____

III. Stakeholders

WHO are the major stakeholders? Which individuals or groups have an important stake in the outcome? Identify the concerns and values associated with each stakeholder. What do they care about? What is important to them? Pick 6 of the most important stakeholders.

Stakeholder	Stakeholder	Stakeholder
Concerns/Values	Concerns/Values	Concerns/Values

Stakeholder	Stakeholder	Stakeholder
Concerns/Values	Concerns/Values	Concerns/Values

Name _____ Date _____ Period _____

IV. Options

What different options are available? (Try to identify at least 3)	What are the advantages/disadvantages of each?
1. 2. 3. 4. 5.	

Name _____ Date _____ Period _____

V. Decision

What is your decision?

Describe the reasons for your decision. Refer to the ethical concepts and principles (autonomy, beneficence, nonmaleficence, justice) in one or more of your reasons.

1.

2.

3.

Modified from the Hastings Center, 1990

Scoring Guide

Name _____ *Date* _____ *Period* _____

Ethical Decision-Making Model Scoring Guide	POINTS POSSIBLE	POINTS RECEIVED
Ethical question clearly identified 5 pts: Question that relates to an ethical dilemma clearly identified. 4 pts: Question suggests an ethical dilemma but is ambiguous, vague, or not clearly identified. 3 pts: Question does not clearly relate to an ethical dilemma or is inappropriate for topic. 0 pts: Question not identified.	5	
Sufficient factual information provided 25 pts: Different types of stem cells, their origin, and their potency are thoroughly discussed. Additional information relevant to the question is provided. 24-20 pts: Different types of stem cells, their origin, and their potency are discussed. Additional information relevant to the question is included. Most relevant information is presented, but some main ideas are missing. 20-10 pts: Different types of stem cells, their origin, and their potency are mentioned but the information is inaccurate or incomplete. 0 pts: Factual information is missing.	25	
Additional (unknown) information necessary for decision-making identified 5 pts: Additional information necessary for decision-making is thoroughly considered, clear explanation of what is lacking is provided. 4 pts: Additional information briefly considered, and explanation conveys what is lacking overall. 3 pts: An attempt to identify additional information is made, but explanation is unclear or not present. 0 pts: Additional information not considered.	5	
Stakeholders clearly identified 10 pts: Major stakeholders clearly identified, and their concerns and values are thoroughly explored. 8 pts: Major stakeholders clearly identified, but without corresponding clarification of their position. 6 pts: Major stakeholders not clearly identified, or irrelevant stakeholders mentioned. 0 pts: Description of stakeholders is missing.	10	
Minimum of 3 alternative options generated 10 pts: 3-5 alternative options described 8 pts: 2-3 alternative options described 6 pts: 1 option described 0 pts: Description of options is missing.	10	
Options 15 pts: Options thoroughly evaluated based on advantages and disadvantages. 14-13 pts: Evaluation of options is adequate, but certain aspects lack depth. The discussion of advantages/disadvantages would benefit from further exploration and development. 12-5: Evaluation of options is attempted, but important aspects may have been missed or are incorrectly interpreted. 0 pts: Options are not described.	15	
Decision clearly identified 10 pts: Final decision is readily identified. 8 pts: Final decision is identified, but may be unclear or vague 6 pts: Final decision is alluded to, but may be incomplete or fragmentary. 0 pts: Final decision is not identified.	10	

Scoring Guide

Name _____ *Date* _____ *Period* _____

Ethical Decision-Making Model Scoring Guide	POINTS POSSIBLE	POINTS RECEIVED
Justification 20 pts: Justification includes accurate reference to one or more ethical principles and is thoroughly and thoughtfully developed. The rationale behind the decision is clearly articulated. The explanation is logical and presents clear supporting examples. 18 pts: Justification includes accurate reference to at least one ethical principle and is well-developed. The rationale behind the decision is mostly complete. Explanation is logical and presents clear supporting examples. 16 pts: Justification may reference to ethical principles, but key concepts/ideas are inaccurately presented or incomplete. Partial reference is made to the consideration of perspectives, facts, and principles involved, but key points may be missing. The rationale behind the decision may be incomplete. The explanation may not follow logically, or less than 3 supporting examples are present. 14 pts: The consideration of perspectives, facts, and principles involved is incomplete. The rationale behind the decision is not clearly explained. Evidence of a logical justification for the decision reached is scant or absent, or less than 2 supporting examples are present. 12 pts or less: The consideration of perspectives, facts, and principles involved is attempted. Evidence of a logical justification for the decision reached is scant or absent. Supporting examples, if provided, are insufficiently developed or do not relate to the decision made. 0: Justification is missing.	20	
TOTAL	**100**	

ADDITIONAL COMMENTS:

Individual Culminating Project

A Letter to the President / President's Council on Bioethics

Students will be able to:

- Integrate and apply their understandings about stem cell science, ethics, and policy issues in developing a letter to the President or the President's Council on Bioethics.

Class Time

1-2 class periods.

Introduction

This culminating assessment allows students to write a letter to the President or President's Council on Bioethics.

Materials

Student Handout

6.2 –*A Stem Cell Letter*

Scoring Guide

A Stem Cell Letter

Procedure

1. Students reference their completed Decision-Making Framework as a basis for writing the letter.
2. Provide students with the Student Handout 6.2, Stem Cell Letter, and review the rubric. Students should work individually on completing their letters.
3. Some teachers choose to actually mail the students' letters to the intended recipients.

A policy recommendation letter-writing guide and scoring rubric can be found in An Ethics Primer, available to download from the Northwest Association for Biomedical Research (nwabr.org).

Name _____ Date _____ Period _____

A Stem Cell Letter

Your assignment is to write a letter, addressed to the President or the President's Council on Bioethics, with your recommendations for future federal policies concerning embryonic stem cell research. In your letter, there should be a clear statement as to whether you, 1) support the current policy or, 2) you believe there need to be changes to the policy, and state those changes. For either position, you need to support your reasoning and cite any sources used.

TASK: Write a policy recommendation letter containing the following:

PRE-WRITE: Use the decision-making model to organize your ideas.

1. Describe the ethical dilemma surrounding stem cell research.
2. Clearly explain your recommendation(s) concerning funding and regulations to address the ethical dilemma.
3. Provide two supporting ethical arguments. Include reference to the ethical principles.
4. Provide two supporting scientific arguments. Demonstrate your understanding of the science behind stem cell research by using terms and concepts from this unit accurately.
5. Cite your sources.
6. Conclude your letter by thanking the recipient for their time.

LENGTH: The paper should not be longer than 3 pages, 12pt font, 1.5 line spacing.

Use the evaluation rubric for additional guidelines for meeting criteria.

Scoring Guide

Name _____ Date _____ Period _____

A Stem Cell Letter for Policy Recommendation

	Exemplary	Proficient	Partially Proficient	Developing	Comments
Recognizes and Understands Multiple Perspectives	Student's own thinking becomes more complex and thorough with added perspectives.	Student demonstrates recognition and understanding of multiple perspectives.	Student recognizes and understands some alternate perspectives.	Student struggles to reflect and paraphrase alternate perspectives accurately.	
Communicates Ideas Using Supporting Evidence	2 Ethical arguments are provided. Student states ideas with **relevant** supporting evidence from several of the following: content presented in class, experience, legitimate sources that are cited in the body of the letter and works cited (at least 2 sources).	2 Ethical arguments are provided. Student states ideas with supporting evidence from content presented in class, experience, or legitimate sources cited in the body of the letter and works cited (at least 2 sources).	Fewer than 2 ethical arguments. Student sometimes states ideas using relevant supporting evidence from content presented in class, experience, or legitimate sources.	Fewer than 2 ethical arguments. 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	2 Scientific arguments provided. 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.	2 Scientific arguments provided. Student uses content vocabulary appropriately. Scientific statements are factual. Student applies scientific concepts accurately through examples and integration of different concepts.	Fewer than 2 scientific arguments provided. 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.	Fewer than 2 scientific arguments provided. Student rarely uses vocabulary appropriately. Facts are often incorrect. Student struggles to apply scientific concepts through examples and integration.	

A Stem Cell Letter for Policy Recommendation

	Exemplary	Proficient	Partially Proficient	Developing	Comments
Identifies and Addresses Ethical Dilemma	Student correctly identifies dilemma and clearly explains major viewpoints surrounding debate. Recommendations for policy show thoughtful reasoning incorporating both scientific and ethical ideas.	Student correctly identifies dilemma and can express some understanding of viewpoints. Recommendations for policy show thoughtful reasoning, incorporating both scientific and ethical theories.	Student shows limited understanding of dilemma and viewpoints surrounding debate. Recommendations for policy are poorly connected to scientific and ethical ideas.	Student incorrectly identifies dilemma and has not shown understanding of viewpoints surrounding debate. Recommendations are not clearly connected to scientific and ethical arguments.	
Timeliness and Thoroughness / Grammar and Spelling	Student met all deadlines. Work meets all guidelines. In-class time given is always used efficiently and thoughtfully. Evidence also demonstrates much time spent outside of class in writing and improving. No mistakes are made with sentence structure, grammar and spelling.	Student met all deadlines. Work meets all guidelines. In-class time given is often used efficiently and thoughtfully. It is clear that additional time outside of class was spent. Few grammar and spelling errors.	Student met some deadlines. Work meets some guidelines. In-class time given is sometimes used efficiently and thoughtfully. Work reflects some time spent outside of class. Few to many grammar and spelling mistakes.	Student did not meet either deadlines. Work meets only a few of the guidelines. In-class time given is rarely used efficiently and thoughtfully. Work done reflects little time spent outside of class. Many spelling and grammar mistakes	

Group Culminating Project

A Grant Application

Students will be able to:

- Integrate and apply understandings about stem cells, disease, and policy issues.
- Develop a research proposal for funding.

Class Time

- 1-2 class periods to allow students to work together in small groups.
- Providing time with internet access would be helpful.
- 1 class period to evaluate the research proposals.

Common Misconceptions

The NIH funds a majority of the grant applications it receives.

Introduction

The culminating assessment allows students to simulate the real life process of writing and presenting proposals for obtaining NIH funding to research treatment for a chosen disease using stem cells. In addition, the students participate on a review panel to evaluate proposal presentations in order to determine which proposals should be funded.

Materials

Student Handout

6.3 –*A Grant Application*

Scoring Guide

Grant Proposal Presentation

Procedure

1. Students work in small groups to develop a research proposal which uses stem cells to treat a disease of the group's choosing.
2. Teams write a Letter of Intent, and fill out a grant application (Student Handout 6.3).
3. Teams present their proposals to a funding panel made up of their peers.
4. Students participate in the funding panel to evaluate other proposals from their class. A scoring guide is also provided for them.
5. As a class, students decide which proposal(s) get funded, while recognizing only 15% of grant proposals received are funded by the National Institutes of Health.

Homework

Students can work on portions of the proposal individually at home.

Those with Internet access can do background research and carry out a literature search.

As an individual assessment each student can express personal views on the stem cell debate by writing a letter to a policy maker recommending future regulations and funding criteria.

Name _____ Date _____ Period _____

A Grant Application

REQUEST FOR APPLICATIONS

TITLE:
Research to Identify Possible Treatment for Disease Using Stem Cell Therapy

EXECUTIVE SUMMARY:

Purpose: This Request for Applications seeks to provide financial support to researchers interested in the treatment of disease by stem cell therapy. Stem cells have the remarkable potential to develop into many different cell types in the body. Serving as a sort of repair system for the body, they can theoretically divide without limit to replenish other cells as long as the person or animal is still alive. When a stem cell divides, each new cell has the potential to either remain a stem cell or become another type of cell with a more specialized function, such as a muscle cell, a red blood cell, or a brain cell. This potential may lead to the treatment and cure of several diseases requiring the replacement of ailing or destroyed tissue.

Assignment Objectives: Your research team is responsible for developing a research proposal to develop a treatment for a disease of your choosing. Your team must complete the following tasks:

1. LETTER OF INTENT: Submit the names of group members, disease of interest, and preliminary sources for research.
2. APPLICATION: Complete Grant Application including specific aim of project and research plan.
3. PRESENTATION: Present your proposal to the Funding Panel.
4. PANEL PARTICIPATION: You will be a member of the Funding Panel during the presentation of proposals by other groups. During this time you will evaluate the proposals using a rubric as a guide.

Funds Available: Due to a limited budget, approximately 15% of NIH grant applicants are approved for funding. There will only be 15% of proposals funded for this project. You will be evaluated by a panel of experts to decide which proposals are worthy of funding.

KEY DATES: Letter of Intent due:

Application due:

Presentation:

Name _____ Date _____ Period _____

Grant Application

Department of Health and Human Services Public Health Services

TITLE OF PROJECT:
RESEARCH PLAN
Specific aim of project
Background research significant to project
Laboratory Experience (Planaria Inquiry Lab) Include an explanation of how it relates to the project.

RESEARCH DESIGN

a) ***Source*** and ***potency*** of stem cells to be used in research:

b) ***Methods:*** *Describe the research techniques (IVF, SCNT, umbilical cord blood, bone marrow) you will be using to meet the specific aim of your project.*

c) ***Scientific justification*** of stem cell type and research technique to be used. You must include arguments to support your choice.

d) ***Ethical justification*** of stem cell type and research technique to be used. You must include arguments to support your choice.

LITERATURE CITED (list all resources used in your research).

Scoring Guide – A Grant Application

CATEGORY	5 EXCEEDS CRITERIA	3 MEETS CRITERIA	1 DOES NOT MEET CRITERIA	0 ABSENT	SCORE
AIM OF PROJECT	Disease is identified. Impact of disease on society is addressed. Result desired for cure and/or treatment of disease is clearly explained.	Disease is identified. Results desired for cure is clearly explained.	Disease is not clearly identified. Results desired for cure and/or treatment of disease is unclear.	No aim is presented.	
BACKGROUND RESEARCH	Explains three or more important studies previously conducted on disease. Shows clear understanding of how previous research connects to future studies including team's proposed research.	Explains at least three important studies previously conducted on disease. Explains how proposed project will advance scientific knowledge.	Explains less than three important studies previously conducted on disease.	Does not include summaries of previously conducted research.	
LABORATORY EXPERIENCE	Connects Planaria Inquiry Lab to understanding of stem cells and their potential to treat disease. Clear understanding of how neoblasts and stem cells compare and contrast and why stem cells are more complex.	Connects Planaria Inquiry Lab to understanding of stem cells and their potential to treat disease. Clearly understands differences between neoblasts and stem cells.	Connection to Planaria Inquiry Lab is unclear. Lacks understanding of how neoblasts and stem cells compare and contrast.	Does not include information concerning Planaria Inquiry Lab	
SOURCE AND POTENCY OF STEM CELLS	Source and potency of stem cells to be used in proposal is clearly identified. Shows clear understanding of related vocabulary by giving detailed examples.	Source and potency of stem cells to be used is clearly identified. Understands and uses stem cell vocabulary.	Source or potency of stem cells to be used in proposal is missing or unclear. Does not use stem cell vocabulary correctly.	Does not include source and potency of stem cells to be used in proposal.	
METHODS	Chosen methods are well developed and detailed. Techniques necessary from proposal are correctly identified and appropriate to the aims of the project. Alternatives techniques are considered and evaluated.	Methods are clearly explained. Techniques necessary for proposal are correctly identified and appropriate to the aims of the project.	Methods are not outlined clearly. Techniques are not defined and inappropriate to aims of the project.	Methods absent	
SCIENTIFIC JUSTIFICATION	Scientific justification for source of stem cells contains evidence from more than two pieces of research that they studied. More than three supporting facts are used.	Scientific justification for source of stem cells contains evidence from two pieces of research that they studied. Three supporting facts are used.	Scientific justification based on vague references to their research. Facts are not clearly connected to choice of stem cell source.	Scientific justification absent.	
ETHICAL JUSTIFICATION	Ethical justification uses correct vocabulary and clear expression of ethical ideas. Addresses status of the embryo. Lists more than one objection and responds with appropriate ethical argument.	Ethical justification for source of stem cells contains correct vocab. and clear expression of ethical ideas. Addresses status of embryo. Lists one objection and respond with appropriate ethical argument.	Ethical justification uses some vocabulary. Ethical arguments are unclear. Doesn't address status of embryo.	Ethical justification absent.	

The Science and Ethics of Stem Cell Research

Appendix

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:

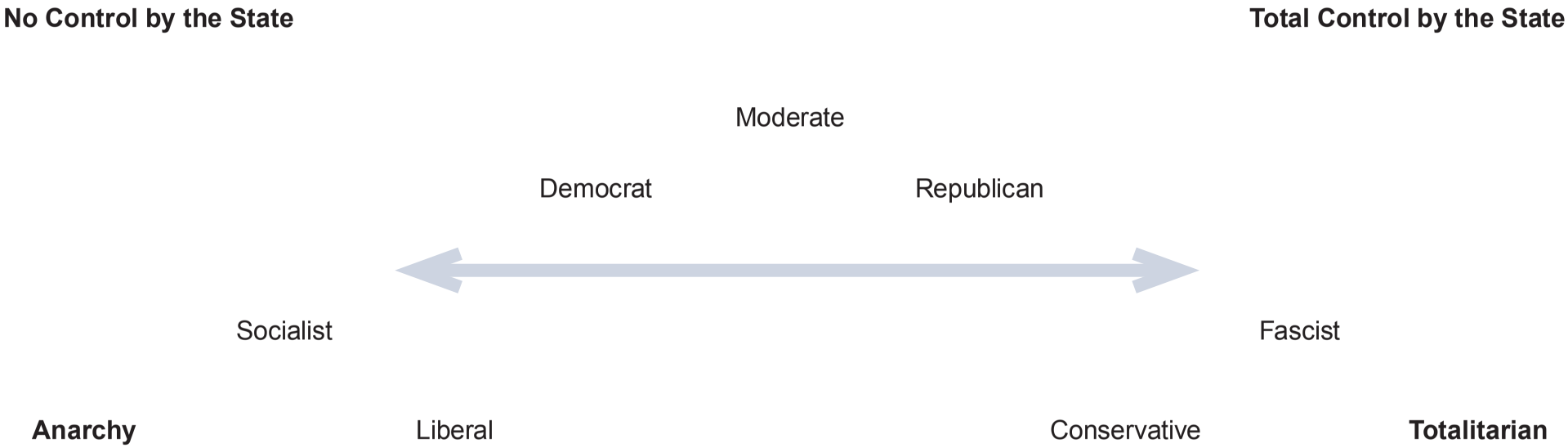
Student sees rubric before participating in a discussion that will be evaluated.

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.

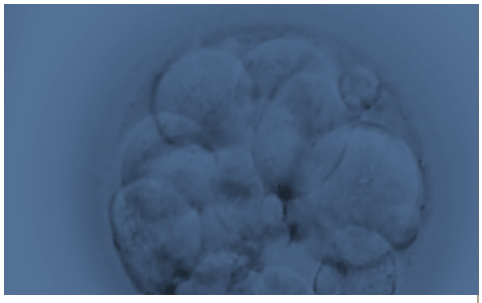
Have human embryonic stem cells been used successfully to treat any human diseases yet?

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 NationalConvention

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

NWABR.ORG
Northwest Association for Biomedical Research

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