

The Effect of Teaching About Stem Cells on the Education and Attitudes of High School Biology Students

**By Jennifer Guillard
Mandarin High School
4831 Greenland Road
Jacksonville, FL 32258
guillardj@duvalschools.org**

Abstract: The purpose of this action research is to educate my students on the facts of stem cells and how they can be used to fix many medical problems. Stem cells have gotten a bad rap with the initial source being embryonic tissue, and it is a very hot political topic. Students inherit many opinions and views from their parents, and my goal is to educate them on the facts, show them the potential, and change their attitudes toward stem cell research and use in medical fields. This research starts with both student and parent attitude surveys and a student discussion to assess and compare initial feelings on the issue. Instruction begins with a class rotation of 7 stem cell case studies and proceeds through an informational webquest on the science behind stem cell use, short video clips on stem use and 3D printing, and an activity on decellularization of liver.

Rationale: I chose the area of stem cell research and use in medicine because I believe there are a lot of misconceptions and negative feelings toward stem cell use. Early on, stem cells were extracted exclusively from embryonic tissue, and the general public became very against this practice as it also went along with abortions. However, we have come a long way from those days, and stem cells hold the promise to “fix” many problems we have these days with tissues and organs that do not function due to accident or disease. My goal is to educate my students on the different ways that we can obtain stem cells and what they can do to help us in an effort to eradicate those misconceptions and open their eyes to the potential of stem cell use. A secondary goal is to provide my students with a “hot topic” that they may wish to pursue in further educational endeavors. In addition, stem cells are a topic of current political debate, and my students will need to understand them in order to make informed political decisions as they get older and as this field develops further. My research area of focus will be to determine if these proposed activities in stem cell education will change both the attitudes and knowledge base in my students.

Action Research Intervention: The interventions that I will be implementing with three levels of classes (freshman Standard Biology, freshman Pre-AICE Biology, and senior AICE Biology) include pre and post surveys and quizzes, Socratic seminars, group rotations, a webquest, small video clips, and liver decellularization in the following time schedule:

Day One:

- Pre-Quiz
- Pre-Survey (students)
- Pre-survey (parents)
- Socratic Seminar (Before)

Day Two:

- Rotations (7 case studies with stem cells)

Day Three:

- Socratic Seminar (After)
- WebQuest (find one or make my own)
- TedMed: Regenerative Medicine & Bioengineering

Day Four:

- Decellularization Info

- Liver Decellularization

Day Five:

- Post-survey (students)
- Post-Quiz

The pre survey will give me information on incoming attitudes about the topic and will include both student and parent surveys. I will compare the two groups to see if there is a correlation in attitudes. The post survey will give me information on how attitudes have changed after learning about stem cells and will only involve the student groups. The pre quiz will assess incoming knowledge base while the post quiz will assess knowledge gained during the intervention. I will have two Socratic seminars: the first will be before students learn about stem cells to discuss baseline knowledge and misconceptions as well as to spark interest in learning about it. The second Socratic seminar will be after the students do the group rotations. The group rotations will be case studies on the use of stem cells. Students will be placed in groups of four and will visit 7 different case study stations of how stem cells are currently used in medicine. They will discuss these studies with their group and answer some questions on them. Students will then do a webquest individually to learn about the science behind how stem cells are collected and used in medicine. I will show them some video clips to help them understand and visualize the processes involved in stem cell use. Finally, students will decellularize liver to help them understand how current tissue can be used and “reseeded” with stem cells to produce functioning tissues and organs. At the conclusion of the intervention, students will take a post survey to assess their resulting attitudes toward stem cells as well as a post quiz to determine their increase in stem cell knowledge.

Connections to Bench to Bedside Summer Institute: I learned specific information about stem cells and how far we have come with this technology at Bench to Bedside. Learning about it made me realize how important it is to make my students understand this topic and how fast the field is expanding. They will not be able to avoid the topic in the future. In addition, at B2B I learned how to decellularize liver to show how to keep the extracellular matrix while removing all cellular material.

Data Collection and Analysis: I will be collecting data by comparing student pre and post surveys on stem cell attitudes, comparing student pre surveys with parent pre surveys, and comparing student knowledge base acquisition with pre and post quizzes. This data will be quantitative as I will assign numbers to survey questions with lower numbers representing negative feelings toward stem cells and higher numbers being positive feelings. I will also compare surveys and quizzes across my three levels of classes: freshman Standard Biology, freshman Pre-AICE Biology, and senior AICE Biology. In addition to comparing attitude and knowledge changes between the three groups as a result of the activities, I will also collect data on ease of comprehension and differences in time needed for activities among the two freshman groups and one senior group.

Budget and Budget Justification: The necessary resources and costs associated with these activities, not including materials normally present in a biology laboratory, are as follows:

- Beef or chicken liver (around \$5.00)
- Triton X solution (Sigma Aldrich, 2 bottles, 93443-100ML, \$86.10 x 2)
- SDS solution (Sigma Aldrich, 71736-100ML, \$55.00)

TOTAL: \$232.20

Permissions: No permissions are required to my knowledge.

Literature Cited:

Cells4life, Look, no embryos! The future of ethical stem cells
<http://www.cells4life.co.uk/news-events/look-no-embryos-future-ethical-stem-cells>, accessed **6/23/2015**.

Cells4life, Wheelchair-bound MS Patients Given "Miraculous" Stem Cell Treatment
<http://www.cells4life.co.uk/news-events/wheelchair-bound-ms-patients-miraculous-stem-cell-treatment>, accessed **6/23/2015**.

Coghland, Andy. April 2014. Stem cell timeline: The history of a medical sensation.
<http://www.newscientist.com/article/dn24970-stem-cell-timeline-the-history-of-a-medical-sensation.html#.VYtoYflViko>, accessed 6/23/2015.

Fingrut, Warren. Top of the World Stem Cell Drive: A Case Study in Rural Stem Cell Donor Recruitment, Vancouver Fraser Medical Program, University of British Columbia, 2015.
http://www.ubcmj.com/pdf/ubcmj_6_1_2014_41-43.pdf, accessed **6/23/2015**.

International Society for Stem Cell Research, 2011, Stem Cell Fact Sheets, http://cri.utsw.edu/wp-content/uploads/2013/07/ISSCR_Stem_Cell_Facts.pdf, accessed **6/23/2015**.

McGowan Institute for Regenerative Medicine, www.mirm.pitt.edu, accessed 6/25/2015.

NHS, Hope and Hype, NHS November 2011
http://www.nhs.uk/news/2011/11November/Documents/hope_and_hype_1.0.pdf, accessed **6/23/2015**.

Palmiera Sarmiento, Carlos Alberto, M.N. Rodrigues, R.Z. Bocabello, A.M. Mess, and M.A. Miglino. Pilot Study: Bone Marrow Stem Cells as a Treatment for Dogs with Chronic Spinal Cord Injury, Regenerative Medicine Research 2014, 2:9 <http://www.regenmedres.com/content/pdf/2050-490X-2-9.pdf>, accessed **6/23/2015**.

Pearce Stevens, Alison. Stem Cells: The Secret to Change. April 10, 2013. <https://student.societyforscience.org/article/stem-cells-secret-change>, accessed 6/23/2015.

Rutgers University, Ethics
http://rutchem.rutgers.edu/sites/default/files/coursefiles/Courses_f09/127/stemcellcasestudy09.pdf, accessed **6/23/2015**.

Sciencewise, Stem Cell Dialogue: A Public Dialogue Around the Science, and Social and Ethical Issues, Sciencewise <http://www.sciencewise-erc.org.uk/cms/assets/Uploads/Publications/Stemcells-FINAL.pdf>, accessed 6/23/2015.

Segura-Totten, Miriam. Jim and the Forgotten Embryos: A Case on Stem Cell-Based Therapy. North Georgia College & State University, http://sciencecases.lib.buffalo.edu/cs/collection/detail.asp?case_id=628&id=628, accessed 6/23/2015.

Stem Cell Foundation, Following Through: Realizing the Promise of Stem Cells (Canadian Action Plan), 2015 <http://stemcellfoundation.ca/wp-content/uploads/2014/07/Following-Through-Realizing-The-Promise-of-Stem-Cells.pdf>, accessed 6/23/2015.

Sullivan, D, Mirmalek-Sani, S, Deegan, B. Decellularization methods of porcine kidneys for whole organ engineering using a high-throughput system. Biomaterials 2012; 33:7756-7764.

University of Alberta, What You Need to Know About Stem Cell Therapies,. 2014. http://oirm.ca/sites/default/files/about-orim/sc_patient_booklet_feb_2014.pdf, accessed 6/23/2015.

Wake Forest Institute for Regenerative Medicine, www.wakehealth.edu/WFIRM/, accessed 6/25/2015.

Welham, Holly. How to Teach Stem Cell Research. 2014. <http://www.theguardian.com/teacher-network/teacher-blog/2014/feb/02/how-to-teach-stem-cell-research-resources-news>, accessed 6/23/2015.

Need to Do:

- **Find legal limitations of stem cell stuff**
- **Find/make survey**
- **Find/make webquest**
- **Find case studies**
- **Find animations/video clips**

SINGLE LESSON PLAN

Teacher: Jennifer Guilard

Content Area/Grade: Biology, 9/12

Date: 7/14/15

Unit Name: BioMedicine and Stem Cells

Unit Goal

What unit goal does this daily lesson address?

The use of stem cells in biomedicine is a very effective “cure” for many problems in medicine.

Standard(s)/Benchmark(s)

What standard(s)/benchmark(s) does this daily lesson address?

SC.912.N. – 1.1, 1.2, 1.3, 1.5, 1.6, 1.7, 14.6

Students will understand that...

What should the students understand by the end of today’s lesson?

That stem cells can be used to “fix” a wide array of medical issues.

Essential Questions

What essential question(s) does this lesson address?

What can stem cells be used to do?
Where are stem cells normally found?

Connecting Concepts

How will you review yesterday’s content and connect today’s lesson to it?

We will have a Socratic seminar prior to this lesson.

Organizing Students for Learning

How will students be organized today for the lessons activities?

Students will be heterogeneously arranged according to class rank, sex, and personality.

LEARNING EXPERIENCES, INSTRUCTION AND RESOURCES

What activities or experiences (from your Unit Plan) will students engage in today?

Lesson Sequence**Activating Prior Knowledge**

Pre survey
Pre quiz
Socratic seminar

- ABC Brainstorming
- KWL
- Anticipation Guide
- Card Sort
- Think-Pair-Share

Explicit Instruction

Directions on group rotations procedure.

- Motivational Hook
- Lecture
- Demonstration
- Note-taking Guide

Lesson Sequence				Resources and Materials
Group Processing of New Information	Group rotations of stem cell case studies. Socratic seminar.	<input type="checkbox"/> Jigsaw <input type="checkbox"/> Reciprocal Teaching <input type="checkbox"/> Concept Attainment <input type="checkbox"/> Think-Pair-Share	<input type="checkbox"/> Lab / Inquiry Activity	<input type="checkbox"/> Computer <input type="checkbox"/> LCD Projector <input type="checkbox"/> Paper <input type="checkbox"/> Pencils <input type="checkbox"/> Whiteboards <input type="checkbox"/> Markers <input type="checkbox"/> Butcher Paper <input type="checkbox"/> Response Cards <input type="checkbox"/> Post-it Notes <input type="checkbox"/> Video Clip(s): <input type="checkbox"/> Website(s): <input type="checkbox"/> Lab Materials:
Elaborative Questioning	Socratic seminar.	<input type="checkbox"/> Inferential Questions <input type="checkbox"/> Analytic Questions <input type="checkbox"/> Philosophical Chairs		
Demonstrating Understanding	Completion of case study worksheet.	<input type="checkbox"/> Graphic Organizers <input type="checkbox"/> Picture Notes <input type="checkbox"/> Flow Charts <input type="checkbox"/> Concept Maps <input type="checkbox"/> Mnemonics <input type="checkbox"/> Graffiti		
Reflection	Reflective journaling.	<input type="checkbox"/> Reflective Journals <input type="checkbox"/> Think Logs <input type="checkbox"/> Exit Ticket (Student Learning)		
Daily Progress Monitoring Assessment	Journal entry.	<input type="checkbox"/> Quiz <input type="checkbox"/> Journal <input type="checkbox"/> Exit Ticket (for Content) <input type="checkbox"/> Response Cards		
Based in the results from your Daily Progress Monitoring Assessment, what concepts need to be revisited in the next lesson?				Homework

UNIT PLAN	
Unit Title: BioMedicine and Stem Cells	Content Area/Grade: Biology/9 th and 12th
Teacher: Jennifer Guillard	Implementation Time Frame: 6 class days
STAGE 1: THE DESIRED RESULTS What are my learning goals?	
Unit Goal Students will understand that...	Standard(s)/Benchmark(s) What standard(s)/benchmark(s) does this daily lesson address?
The use of stem cells in biomedicine is a very effective “cure” for many problems in medicine.	SC.912.N. – 1.1, 1.2, 1.3, 1.5, 1.6, 1.7, 14.6
Related Misconceptions What misconceptions are predictable?	Students will know... Vocabulary, terminology, definitions
Students believe stem cells only come from aborted fetuses. Students believe stem cell use is unethical. Students believe stem cell use should be banned and is illegal.	Adult stem cell: Stem cells taken from umbilical cord blood, bone marrow, or some organs. Bioengineering: Using biology, chemistry and physics to come up with real world applications for biological problems. Bioprinting: The use of 3D printers to produce molds using biological materials like collagen. Decellularization: The process of treating organs with detergents to remove all the cells, leaving behind the extracellular matrix (ECM). Differentiation: Process an unspecialized cell takes to become specialized, changes form and function. Embryonic stem cell: Stem cell taken from an embryo. Extracellular Matrix (ECM): The non-living material that is between the cells that gives the organ its shape, mostly of collagen. Sometimes referred to as a scaffold for bioengineering organs. Growth factor: Proteins that turn genes on /off to promote specialization. Induced pluripotent stem cell: An adult cell that has undergone a process to turn it into a stem cell. Lysis: Breaking apart a cell. Perfused: To permeate an organ with a fluid. Protocol: A set of procedures or steps to be followed. Regenerate: The ability to regrow and function. The liver is the only internal organ that can regrow. Regenerative Medicine: Branch of medicine that seeks to replace defective body parts with new bioengineered parts. Scaffold: The non-living architectural component of an organ, consisting primarily of ECM. SDS: Sodium dodecyl sulfate, a detergent used to cause cell lysis. Stem Cell: A cell that can differentiate/change into many different types of cells. Triton X 100: A non-ionic detergent used to cause cell lysis. Zygote: The first stage of development when the sperm joins the egg.
Essential Questions What questions will foster inquiry, understanding and transfer of learning?	
Where do stem cells come from? What can stem cells be used to do? How do stem cells know how to do the job of a certain tissue?	

Students will know... key facts, formulas, critical details, important events, important people, timelines
What stem cells are, how they are used, how their use has increased over the last 15 years (timeline), how politics have shaped their research and use in medicine, and how to prepare tissues for stem cells (decellularization).
Students will be able to... Specific skills students will acquire as a result of this unit
<ul style="list-style-type: none"> • Discuss the science behind stem cells with others. • Make informed decisions on what they believe should be allowed with stem cells rather than relying on their parents’ opinions. • Decellularize biological tissue.

STAGE 2: ASSESSMENT EVIDENCE

What evidence will show that my students have achieved the learning goals?

Performance tasks:

Through what specific “real-world” performance task(s) will students demonstrate their understanding of the learning goals?

Students will demonstrate their understanding of the learning goals through individual conversations, small group discussions, and whole class discussion with their peers. They will also take a piece of fully intact beef liver and follow a prescribed laboratory protocol to decellularize it.

Rubric

By what criteria will “performance of understanding” be judged?

- Anecdotal observations of individual conversations.
- Anecdotal observations of small group conversations.
- Anecdotal observations of large group discussion.
- Anecdotal observations of lab procedures during decellularization.

Other Evidence:

What other evidence needs to be collected in order to monitor student progress on these concepts and skills along the way?

- Pre survey
- Pre quiz
- Post survey
- Post quiz
- Webquest worksheet
- Case Study Rotations worksheet

Self-Assessment/Reflection

How will students reflect and self-assess their learning?

They will do a KWL the first day.
They will have daily journal reflective questions.

STAGE 3: LEARNING EXPERIENCES, INSTRUCTION, AND RESOURCES

What activities will help my students achieve the learning goals?

<p>What here</p>	<p>What is expected? How will you ensure that students are aware of the learning goals? Where are your students? How will you establish your students' prior knowledge?</p> <p>Learning objectives on the board. Pre quiz. Pre survey. Socratic seminar in the beginning</p>
<p>Hook old</p>	<p>How will you hook students at the beginning of the unit? How will you hold their attention throughout the units?</p> <p>Socratic seminar. Story of my experiences at UF B2B about decellularization.</p>
<p>Experience xplore quip</p>	<p>What critical input experience will help students explore the key ideas and essential questions? How will you equip your students with needed skills and knowledge?</p> <p>Group rotations with stem cell case studies. Stem cell webquest. Decellularization activity.</p>
<p>Reflect ethink ehearsi ng evising</p>	<p>How will you encourage students to reflect and rethink? How will you guide students in the process of rehearsing, revising, and refining their work?</p> <p>Daily journal reflections. Case study worksheet.</p>
<p>Exhibit valuate</p>	<p>How will you help students to exhibit and self-evaluate their developing skills, knowledge and understanding throughout the unit?</p> <p>Webquest worksheet. Daily journal reflections.</p>
<p>Tailor</p>	<p>How will you tailor your instruction to meet the different needs, interests and abilities of all learners in your classroom?</p> <p>I will circulate throughout the room while students are doing the webquest, case study group rotations, and decellularization to help and clarify as necessary.</p>
<p>Organize</p>	<p>How will you organize and sequence the learning activities to maximize the engagement and achievement of all students?</p> <p>Activities will be scaffolded starting with learning about ways that stem cells are used in medicine, then learning about the science behind them, and concluding with decellularizing an organ.</p>

Big Idea:		Standard(s)/Benchmark(s):
Unit:		Sample Activities
Grade:		
Score 4.0	In addition to Score 3.0, in-depth inferences and applications that go beyond what was taught.	
Score 3.0	<p>The student:</p> <p>The student exhibits no major errors or omissions</p>	
Score 2.0	<p>There are no major errors or omissions regarding the simpler details and processes as the student:</p> <ul style="list-style-type: none"> • Recognizes or recalls specific terminology • Performs basic processes, such as: <p>However, the student exhibits major errors or omissions regarding the more complex ideas and processes</p>	
Score 1.0	With help, a partial understanding of some of the simpler details and processes and some of the more complex ideas and processes.	
Score 0.0	Even with help, no understanding or skills demonstrated.	