Are You Teaching Your Students about Stem Cells?

James Concannon, Patrick L. Brown, and Trisha Brandt

Abstract. This activity targets students' misconceptions about embryonic and adult stem cells while also addressing an important grades 9–12 science content standard. The authors designed the activity to provide students an opportunity to explore differences between embryonic and adult stem cells prior to formal explanation. The overarching goal of this activity is for students to understand stem cells because they will continue to encounter this topic throughout their lives.

Keywords: adult, cells, embryonic, specialization, stem

Students have several misconceptions about stem cells, stem cell research, and cloning (Freyermuth et al. 2008). The topics of these misconceptions range from the location to the purposes of stem cells. Many students believe that adult stem cells come from adults and that embryonic stem cells come from children and infants. Students may also believe that stem cells can be implanted into a woman's uterus to produce a baby and that all stem cells come from placenta or embryonic cells (Freyermuth et al. 2008). This activity was designed to address such misconceptions about embryonic and adult stem cells while also addressing a science content standard for grades 9–12 (National Research Council [NRC] 1996).

JAMES CONCANNON *is a science teacher educator at Westminster College in Fulton, Missouri. He received his PhD in science education from the University of Missouri. E-mail: jim.concannon@westminster-mo.edu*

PATRICK L. BROWN *is a science educator at Washington University in St. Louis, Missouri. He received his PhD in science education from the University of Missouri. E-mail: pbrown@wuchem.wustl.edu*

TRISHA BRANDT *is a 2009 graduate of Westminster College's Department of Education. She recently finished her student teaching experience to complete the requirements for elementary certification in Missouri. E-mail: brandttr@westminster-mo.edu*

National Science Education Standards

This activity addresses Life Science Content Standard C: As a result of their activities in grades 9–12, all students should develop an understanding of the cell.

> Cells differentiate, and complex multicellular organisms are formed as a highly organized arrangement of differentiated cells. In the development of these multicellular organisms, the progeny from a single cell form an embryo in which the cells multiply and differentiate to form the many specialized cells, tissues, and organs that comprise the final organism. (NRC 1996, 185)

Materials

- Six Styrofoam balls, each with a diameter of 6.35 cm
- Scissors
- Scotch tape
- Two 100-g skeins of white yarn
- One 100-g skein of red yarn
- One 100-g skein of blue yarn
- One 100-g skein of green yarn
- One 100-g skein of yellow yarn
- Construction paper
- Markers

Teacher Preparation

Before class, the teacher should divide the six Styrofoam balls into two groups of three. One group represents adult stem cells. Follow these instructions to create the adult stem cells:

1. Wrap three Styrofoam balls in different lengths of red yarn. For example, the first Styrofoam ball could be

wrapped with 10 m, the second with 16 m, and the third with 24 m (see Figure 1).
2. Tie white yarn to the red yarn.
3. Wrap each ball with approximately 20 m of white yarn. At this point, the balls should look nearly identical—all white.
4. All three adult stem cells will produce only one type of tissue. In this lesson, all adult stem cells produce cardiovascular tissue.

The remaining three Styrofoam balls represent embryonic stem cells. Each embryonic stem cell is made of a Styrofoam ball, a strand of white yarn, and a strand of colored yarn. The first ball should have white and green yarn, the second white and blue yarn, and the third white and yellow yarn. The different colors represent the type of tissue each embryonic stem cell will produce. Follow these instructions to create the embryonic stem cells:

1. For all three Styrofoam balls, begin by taping the colored yarn and wrapping it around the ball (see Figures 2 and 3). Wrap 30–40 m of the colored yarn around each ball (see Figure 4).
2. Tie white yarn to the colored yarn (see Figure 5).
3. Wrap 15 m of the white yarn over the colored yarn (see Figure 6). After all the yarn is bound, the embryonic stem cells will all look white (see Figure 7).

In addition to preparing the adult and embryonic stem cells, we also created a tissue chart (Table 1). This chart identifies the type of tissues represented by the colors of yarn. In this example, white and red yarn represents cardiovascular tissue, white and green hepatic tissue, white and blue renal tissue, and white and yellow gastrointestinal tissue. The tissue chart could be presented as a PowerPoint slide or on a large piece of construction paper posted on the board.

The Activity

The purpose of this activity is for students to be able to explain differences between embryonic and adult stem cells. However, before beginning the activity it is necessary to assess students' misconceptions about adult and embryonic stem cells. This can be accomplished by simply asking students to write down their ideas about how they think embryonic and adult stem cells are similar and different. Students can discuss their ideas about this question in groups.

After group discussion, students can explore their conceptions using the Styrofoam ball stem cells and the tissue chart. Show the class the six stem cells, making sure the students understand that three are adult and the other three are embryonic. Separate the class into six groups; ideally, each group will consist of five to six students. Each group will get its own stem cell. The students need an open area

FIGURE 1. The three Styrofoam balls representing adult stem cells should contain different lengths of red yarn. All of the adult stem cells will divide and differentiate into cardiovascular tissue.

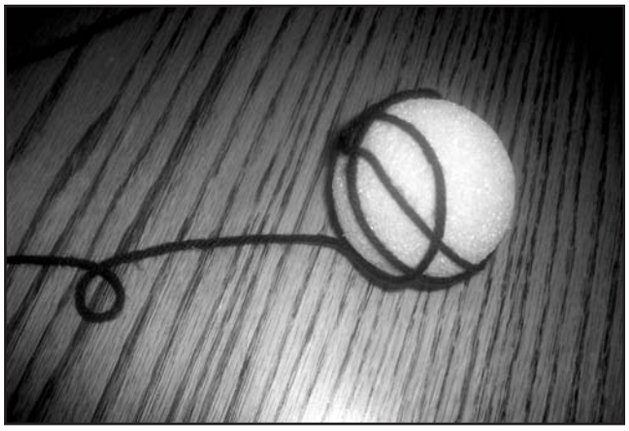

FIGURE 2. Each embryonic stem cell will divide and differentiate into a different type of tissue. This stem cell will differentiate into renal tissue.

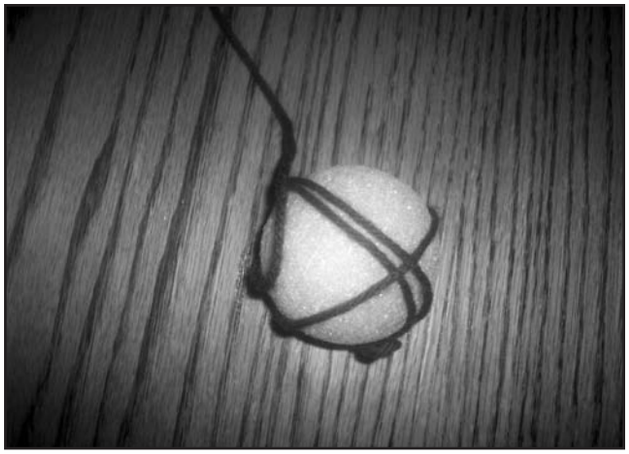

FIGURE 3. This embryonic stem cell will divide and differentiate into hepatic tissue.

FIGURE 4. Approximately 30–40 m of colored yarn should be wrapped around the Styrofoam ball.

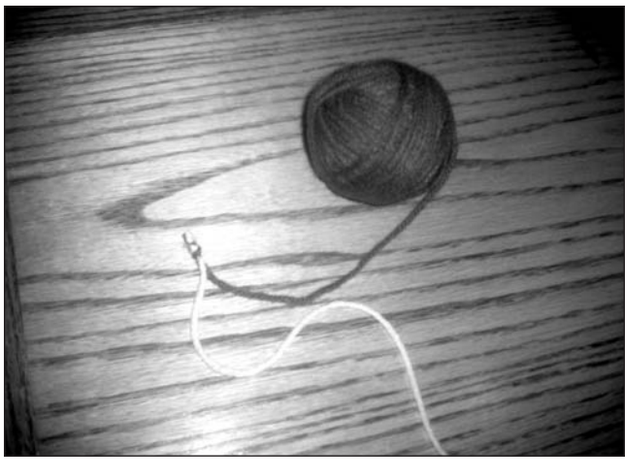

FIGURE 5. White yarn is tied to the green yarn.

FIGURE 6. White yarn is wrapped around the ball.

FIGURE 7. The embryonic stem cell is complete. All three embryonic stem cells appear white, but each will differentiate into a different type of tissue.

TABLE 1. Tissue Chart

Tissue type	Color
Cardiovascular	Red/White
Gastrointestinal	Yellow/White
Hepatic	Green/White
Renal	Blue/White

to do this activity. Have them push desks out of the way, if possible, so each group can form a circle free of obstructions. Tell the students that they are going to create a tissue. Explain that a tissue is a group of cells that perform a common function. Before starting the activity, make sure that the students in each group know whether they have an adult or embryonic stem cell.

Give the stem cell to one student in each group (see Figure 8). Have the student hold the end of the yarn in one hand and the ball of yarn in the other. Tell the class that the ball of yarn is one stem cell. Instruct the students who have the balls of yarn to keep holding the end of the yarn and throw the ball to another student in the same group. All groups do this activity simultaneously. After the first throw, stop the activity and explain that the line of yarn running from the first person to the second represents a new cell. Then ask the second person to hold onto the yarn and throw it to a third individual in the group. Explain to the class that this second line of yarn, running from the second to the third person, represents one of the daughter cells created from the cell division of the first line.

Allow each group to continue throwing the ball from person to person until no more yarn is left on the Styrofoam ball. Each new line represents one of the new daughter cells

produced from a previous cell division, and each throw represents a cell division (see Figure 9). At this point, a large spider web–like object has been formed (see Figure 10), which represents a tissue. As the students hold up this tissue, have them look at the tissue chart to determine the type of tissue that was formed from the division of the adult stem cell. All three adult stem cells will produce cardiovascular tissue. The embryonic stem cells will produce different types of tissues. After the activity, have the class regroup to share their findings. Ask one member of each group to identify the type of stem cell they had, adult or embryonic, and what type of tissue was formed. For future reference, record on the board each group's type of stem cell and the type of tissue it produced.

Ask the class to explain the differences in the types of tissues that were formed by the adult stem cells and the embryonic stem cells. On the basis of the activity, students should note that the adult stem cells all produced the same tissue type. However, the embryonic stem cells produced several different tissue types. It is important to guide students into thinking about not only the tissue types but also the variety of tissues that each type of stem cell produced. After students understand that adult stem cells are limited in their ability to produce different kinds of tissue, the terms *specialized* and *unspecialized* can be introduced. (See the glossary in the Appendix for additional basic terms and definitions.) Embryonic stem cells are unspecialized, whereas adult stem cells are specialized. Why are adult stem cells specialized? In the next part of the activity, students will answer this question as they further explore the differences and similarities between embryonic and adult stem cells.

The day after the initial activity, have students work in groups of three to do research online about differences and similarities between embryonic and adult stem cells. A good source for this research can be found on the National Institutes of Health (NIH) Web page (2006). Students should review the seven short chapters about stem cells and the highlighted words linked to the glossary on this Web site. Using this Web site, students will be introduced to key terms such as *pluripotent*, *multipotent*, and *totipotent*. As they do their research, students should record their findings in two columns: one of similarities and the other of differences.

After allowing 30 min for online research, ask students to write a short explanation about why they think adult stem cells are specialized. (This should be relatively easy to answer with information from the NIH Web site.) Adult stem cells are already specialized because they were obtained from specific tissues, whereas embryonic stem cells are obtained from the inner cell mass of a blastocyst. An adult stem cell can only become the kind of tissue from which it was originally obtained. In addition to asking students why adult stem cells are specialized, ask students to

FIGURE 8. A student beginning the activity.

FIGURE 9. Students holding onto the string and getting ready to throw it to the next person.

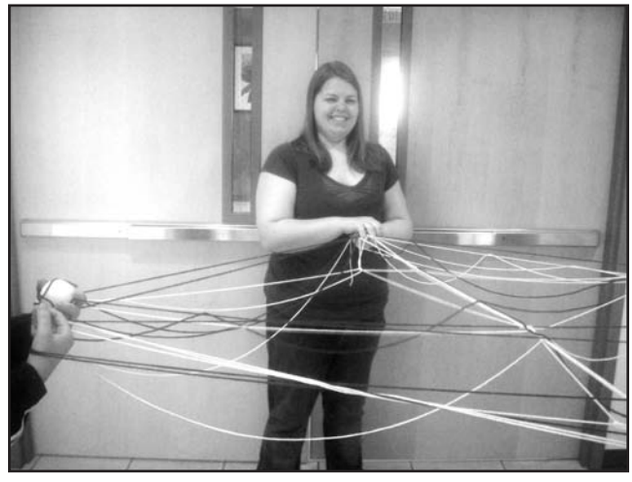

FIGURE 10. Students creating hepatic tissue.

write an explanation about the relationship between types of stem cells, their specialization ability, and their medical potential. Using the NIH Web page, students should be able to complete the task within one 50-min period.

Conclusion

Stem cells are a subject with which all people should be familiar. However, most students will enter the science classroom with many misconceptions regarding this topic. The teacher has the responsibility to address these misconceptions to help students become scientifically literate in today's society. Teachers may use inquiry-based activities such as this one to help address student misconceptions. This activity provides students with a scenario and questions intended to drive their thinking. Given sufficient time, appropriate materials, and targeted questions, students can address their misconceptions and develop a better understanding of stem cells.

References

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Additional Resource

Bioscience Network. StemCellResources.org: The science of education. http://www.stemcellresources.org/teach_lessons.html (accessed March 13, 2009).

Appendix
Glossary

Adult stem cell: A stem cell that is located in the tissues of a living organism. It is already specialized and is limited in its ability to differentiate. Adult stem cells are difficult to isolate because of their low percentage in tissue.

Blastocyst: A bundle of 70–100 cells developed from a zygote.

Clone: An organism with the same genotype as the donor parent.

Embryonic stem cell: A cell obtained from the inner cell mass of a blastocyst. An embryonic stem cell can differentiate into any type of tissue.

Reproductive cloning: A process leading to a live organism genetically identical to the parent.

Somatic cell: A diploid (non-sex) cell obtained from any tissue in the body.

Somatic cell nuclear transfer: The process of cloning. This process involves taking a somatic cell nucleus, containing all pairs of chromosomes, from a somatic cell and transferring it to an enucleated egg cell. The cell is then shocked to make it begin dividing.

Therapeutic cloning: Halting the cellular division at the blastula stage to harvest embryonic stem cells. Such stem cells can give rise to tissues identical to the parent's, thus decreasing the probability of tissue rejection.

PHOTO RELEASE FORM

Lake Gibson High School
Lakeland, Florida, 33809

September 26, 2011

Dear Parents and Students:

Mrs. de Meza is in the process of working toward a Certificate in Biotechnology from the University of Florida. As part of her course work, she has designed an Action Research Project on Stem Cells for her Biotechnology students. This will involve pre and post tests, an attitude survey, Web Quests, labs, and a poster or brochure to highlight each student's research. The object of this Action Research Project is to educate students about stem cells, the types of stem cells, their value in research and to make them better educated to discuss the pros and cons of stem cell research, and thus, better informed citizens.

Student data on all the above activities will be gathered and analyzed. Along with this data, she is expected to take photographs of her students in action, performing the lab activities, and photos of posters ,etc. Some of these photos will be incorporated into a Power Point Presentation to be made at the University of Florida as part of the Junior Science, Engineering, and Humanities Symposium which will be held sometime in January or February, 2012.

In light of this, she is requesting permission to use photos of your son/daughter in her Presentation. Names will not be associated with any classroom photos. The presentation will be shown to other teachers who are also in the class and faculty of the University of Florida . Presentations will also be shared with the sponsors of the UF Program: Bench to Bedside. The sponsors are part of the National Institutes of Health.

Please check the appropriate box below and sign and return this form to Mrs. de Meza this week.

_____ I give permission to use photos that may include my child _____.

_____ I do not give permission to use photos that may include my child _____.

_____
Parent Name

_____
Parent Signature

SCIENCE FAIR BOARD DISPLAY

STEM CELL PROJECT

DUE: FRIDAY, OCTOBER 21, 2011

1. Choose a stem cell topic: Embryonic, adult, or cord blood

2. Divide up the areas below so each person on the team has somewhat equally shared responsibility.

3. Research your topic, looking for new information.

4. Include essential definitions of related vocabulary.

5. Identify specific uses in research.

6. List the Pros and Cons of using these cells.

7. Describe at least one case of a successful cure or treatment.

8. Include pictures and/ or diagrams.

9. List all references used – at least 3.

10. Make it colorful, attractive, accurate, professional in appearance.

Name_____Date_____Class period_____

Point values for Stem Cell Project

	Points	Earned points
1. Title is prominently and attractively displayed.	__10____	_____
2. Key information about the topic is well addressed	__20_____	_____
3. Vocabulary is listed and defined	__10____	_____
4. Pros and Cons are listed.	__20____	_____
5. Uses in research are explained.	__10____	_____
6. At least one success story is included, explained	_ 20____	_____
7. Pictures and/or diagrams are included	_ 20____	_____
8. Includes at least 3 well documented references	_ 20____	_____
9. Evidence of equal participation	_ 20____	_____
10. All information is typed or word processed	_ 10____	_____
11. Appearance, design is attractive, professional	_10____	_____
Total point	170____	_____

Stem Cell Lab Activity

Teacher Preparation:

Before class, the teacher should divide the six Styrofoam balls into two groups of three. One group represents adult stem cells . Follow these instructions to create adult stem cells.

1. Wrap three Styrofoam balls in different lengths of red yarn. For example, the first Styrofoam ball could be wrapped with 10m, the second with 16m and the third with 24m.

2. Tie white yarn to the red yarn. Wrap each ball with approximately 20m of white yarn. At this point, the balls should look nearly identical – all white.

3. All three adult stem cells will produce only one type of tissue. In this lesson, all adult stem cells produce cardiovascular tissue.

The three remaining Styrofoam balls represent embryonic stem cells.

1. For all three Styrofoam balls, begin by taping the colored yarn (green on one, blue on another, and yellow on the third) and wrapping it around the ball. Wrap 30-40 m of the colored yarn around each ball.

2. Tie white yarn to the colored yarn.

3. Wrap 15 m of the white yarn over the colored yarn. After all the yarn is bound, the embryonic stem cells will all look white. Each embryonic stem cell will produce different tissues: white and green hepatic tissue, white and blue renal tissue, and white and yellow gastrointestinal tissue.

	I can define and explain stem cells.		I can distinguish between diferent kinds of stem cells.		I support any stell cell research.		I support embryonic stem cell research.		I support adult stem cell research.		Stem cell research is the answer to curing many diseases.		Federal funds should be used for stem cell research.		TOTAL POINTS		DIFFERENCE
STUDENT	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	**PRE**	**POST**	
Alex	4	5	3	4	4	4	4	4	5	5	4	4	4	5	**28**	**31**	**3**
Ambar	1	4	1	3	1	5	1	5	1	5	3	2	4	3	**12**	**27**	**15**
Cayman	1	4	2	5	5	2	5	1	5	5	3	5	1	2	**22**	**24**	**2**
Devin	3	3	2	4	5	4	4	3	4	4	3	5	4	4	**25**	**27**	**2**
Jazmin	3	4	3	4	3	4	3	4	3	4	3	5	3	3	**21**	**28**	**7**
Matthew	4	5	2	5	1	1	1	1	1	1	1	1	1	1	**11**	**15**	**4**
Seth	1	5	1	5	4	4	3	4	3	5	3	4	4	4	**19**	**31**	**12**
Vincent	2	5	1	5	4	5	4	5	4	5	4	4	4	2	**23**	**31**	**8**
Wendy	3	5	2	4	4	4	4	4	5	5	4	5	4	4	**26**	**31**	**5**

5 - Strongly Agree; 4 - Agree; 3 - Undecided; 2 - Disagree; 1 - Strongly Disagree

What's It All About? A Study of the Impact of Instruction about Stem Cells on Biotech Students' Knowledge and Attitudes

Marcia B. de Meza

Lake Gibson High School

Author Note

Marcia B. de Meza, Director of Industrial Biotechnology Academy

Correspondence concerning this article should be addressed to

Marcia de Meza

Lake Gibson High School, 7007 N. Socrum Loop Road, Lakeland, FL 33809.

Contact: marcia.demeza@polk-fl.net

Abstract

The purpose of this project was to help educate my students about stem cells and to correct any misconceptions they had about them. I wanted to present them with enough information to convey knowledge and affect attitudes related to the use of stem cells in research. In this process, students did become quite literate in stem cell terminology and learned about methods of developing stem cell lines for research.

Students pursued WebQuests and case studies to make the science concepts more relevant and to develop higher order thinking skills. They participated in activities that involved them in basic skills in scientific inquiry. They found the activities interesting and were able to adequately communicate the information to each other. Each team of 2-3 students designed a science fair board based on a particular category of stem cell – embryonic, cord blood, and adult. They presented these to the class and shared them at a public open house for academies in Polk County. They will also be passing on their knowledge to Biotechnology 1 students as they develop a lesson about their category of stem cell.

What's It All About? A Study of the Impact of Instruction about Stem Cells on Biotech Students' Knowledge and Attitudes

RATIONALE:

My Biotechnology 2 class is composed of a group of nine primarily honors students. They have had earth-space science, biology, chemistry, and Biotechnology 1. The Biotechnology 2 curriculum involves the nature of science, an understanding of bioethics, the proper use of scientific terminology, application of basic skills in scientific inquiry, cellular structure and function, gene selection and connections between biotechnology and careers. These are just some of the topics in their curriculum.

In my class, these students had not yet tackled a large research project, nor had they investigated any controversial subjects. With this in mind, and my peaked interest in some of the latest research on stem cells, I questioned how much my students really understood about stem cells. It is doubtful that the average high school student can voice an educated opinion about stem cell types, their use in research, and true benefits. According to Concannon (2009), students have many misconceptions about this topic. He feels that the teacher has the "responsibility to help students become scientifically literate in today's society."

Much of the hype has been about embryonic stem cells, but I want students to become literate in the knowledge of both embryonic and adult stem cells. According to an article written by Guzzetti and Bang (p. 56) on literacy based science instruction, they say:

> "This study provides insights into the ways in which incorporating literacy-based activities into science education can influence adolescents' achievement in and engagement with scientific concepts and processes and offers implications for instruction.

> These three recommendations for instruction include emphasizing interactivity and collaboration in literacy activity; relating content concepts to ordinary life through a variety of textual forms and forums; and providing opportunities for learning and practicing higher-order thinking/reading skills."

I helped my students achieve these goals through reading about the topic using Webquests, writing about the topic by answering questions and designing their display board, and allowing them time to discuss content concepts and share research highlights in various stem cell experiments.

Due to my experiences in the Bench to Bedside workshops, I learned about some of the truths in current stem cell research, the trials and tribulations of the research , and some of the successes. I wanted to share this information with my students. I also began listening to some of the HHMI Holiday Lectures, particularly the one on Potent Biology (NOVA, 2006). I found that I could help my students better understand some of these concepts and research methods by showing them animations from the presentations.

This action research project purposed to determine the impact of instruction about stem cells on my biotechnology's students' knowledge and attitudes with the expectation of improved literacy, attitudes and overall achievement in the class.

I approached this Action Research Project using various methods with my Biotech 2 class. These eleventh graders have had both Biology Honors and Chemistry Honors classes and Biotechnology 1. They are a small group who typically work well together but circumstances beyond our control hampered us regarding time and the project occupied almost four weeks.

Learning objectives were to gain knowledge about the nature of science and biotechnology by advancing through lessons about stem cells and stem cell research leading to a more comprehensive understanding of the technologies involved and specific scientific terminology. Students were to learn about types of stem cells and how they are used in scientific research to help cure human diseases.

To meet these goals, I wrote a pretest/posttest as an introductory lesson. I was testing for their familiarity with some basic stem cell terminology and their perception of stem cell research. I also designed a Likert scale pre/post survey for the students to take that sought their views on the need of stem cell research and funding to support it.

Using the HHMI Holiday Lecture Series on Potent Biology, I showed the students two animations, since they included Human Embryonic Development and cellular differentiation. These students were not familiar with the terminology or the developmental process of an embryo so these animations were significant learning opportunities.

To help develop a visual idea of the differences between embryonic and adult stem cells, the students participated in an activity that clearly showed differences between embryonic and adult stem cells . They used styrofoam balls and yarn to simulate tissue development from the two types of stem cells and could see the greater variety of tissue types from embryonic stem cells.

The students then pursued two WebQuests: one to learn about basic stem cell information and one to explore some practical applications of stem cell research. This helped students explore the origins of stem cells, the pros and cons of embryonic versus adult stem cells, and the practical applications of stem cell therapy.

Students then viewed an animation on Somatic Cell Nuclear Transfer to better understand In Vitro Fertilization. This was followed by a stem cell simulation activity developed by the University of Rochester in which they were to develop a stem cell line from both embryonic and adult stem cells. In this activity, In Vitro fertilization was addressed and that is why showing the animation was appropriate and necessary for student comprehension. This activity connected to biotechnology skills and the application of scientific inquiry. Students recorded data and answered analysis questions.

I then assigned a different case study to each of my students in which they had to pursue a web site to study real applications of stem cell research that have led to cures for a number of people. They each presented their case to the class highlighting the body system the research was used to help and the resulting success of the stem cell therapy. Students were able to discuss these cases and incorporate some bioethical principles.

Since I have a small class, I asked them about wanting to design a poster or brochure as a final project. They wanted to do science fair boards, so I developed my requirements and a rubric based on this type of presentation. The students worked in small groups to choose adult, embryonic or cord blood as their topic. They had to divide up the labor, gather pieces of information and pictures and bring them into class. They then assembled their display boards in class. I was able to see them discuss the information they had gathered and select specific

articles or modify and gather new material. I was also able to see how well they worked together as a team and each team member's input. They then had to present their project to the class. This highlighted each member's specific knowledge about their topic, their presentation skills, and their ease of speaking to the group.

This unit was completed when students took the posttest and the survey I had made regarding their attitudes toward stem cell research and funding for this research. The students seemed to enjoy the project and showed positive gains in knowledge and attitudes.

CONNECTIONS TO BENCH TO BEDSIDE SUMMER INSTITUTE:

This institute addressed several opportunities to learn about stem cells, their categories, development of stem cell lines, and current research being done with different types of stem cells. It also introduced the participants to a variety of websites for information and lab activities, like the development of stem cell lines using Science Take Out simulation activities.

DATA COLLECTION AND ANALYSIS:

Qualitative Data

This included a Likert scale to assess their attitudes about stem cell research before and after the unit. It consisted of about 10 statements that students respond to as a scale of five choices ranging from "totally agree" to "totally disagree". I made a display of the scale and indicated the number of responses for each statement with tally marks written in blue. At the end of the stem cell unit, I tallied the responses in red. As a culminating display, the responses were totaled on a bar graph in two colors for pre/post survey attitudes.

Quantitative Data involved:

1. A participation grade for an activity designed to drive student thinking about a differentiation between embryonic and adult stem cells (Concannon, 2009).
2. A grade for correctly answering WebQuest questions and completing all parts of the WebQuest.
3. A grade designed to address the stem cell line simulation activity. It included following directions, completion, and accuracy.
4. A rubric to evaluate the poster or brochure based on appearance, design, accuracy, and completion.
5. Grades for the pretest and posttest related to student acquisition of knowledge about stem cells, types, procedures, and practical application.

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BUDGET

ITEM	UNIT	QTY	PRICE EACH	TOTAL COST	VENDOR
Are You Teaching Your Students about Stem Cells? Activity	each	1	$49.00	$ 49.00	pubget.com
Aprons		on hand		$ -	
Bromothymol blue	100 mL	1	$4.45	$ 4.45	Fisher Scientific Ed
Computers		on hand		$ -	
Construction paper		on hand		$ -	
Droppers (8/lab group)		on hand		$ -	
Gloves		on hand		$ -	
Goggles		on hand		$ -	
India ink	2 oz.	1		$ -	Michael's
Markers		on hand		$ -	
Methyl red	25 mg	1	$19.00	$ 19.00	Fisher Scientific Ed
Microtubes (8/lab group)		on hand		$ -	
pH 10 buffer	500 mL	1	$29.25	$ 29.25	Fisher Scientific Ed
pH 3 buffer	500 mL	1	$38.72	$ 38.72	Fisher Scientific Ed
pH 7 buffer	100 mL	1	$19.78	$ 19.78	Fisher Scientific Ed
Poster board		on hand		$ -	
Scissors		on hand		$ -	
Scotch tape		on hand		$ -	
Six Styrofoam balls (6.35 cm diameter ea.)	6/pack	2	$3.00	$ 6.00	
Yarn - blue	100-g skeins	1	$7.00	$ 7.00	Wool2dye4.com
Yarn - green	100-g skeins	1	$7.00	$ 7.00	Wool2dye4.com
Yarn - red	100-g skeins	1	$7.00	$ 7.00	Wool2dye4.com
Yarn - white	100-g skeins	2	$7.00	$ 14.00	Wool2dye4.com
Yarn - yellow	100-g skeins	1	$7.00	$ 7.00	Wool2dye4.com
Yellow food coloring		on hand		$ -	
TOTAL COST				**$208.20**	

PERMISSIONS

A form was issued to all members of my Biotechnology 2 class for student and parental release so that student pictures can be used in my presentation.

MODIFICATIONS

The original proposal suggested I would have my Biotechnology 2 students do a lesson on stem cells to teach my Biotechnology 1 students. However, due to the pacing of a topic in which Biotechnology 1 students were involved in at the time and the extended time it took to complete the project for my Biotech 2 students, I chose to forego this aspect of the project. I am also led to believe that I may have to combine Biotech 2 and Biotech 3 next year and that would lend itself to the teaching aspect quite well.

WHAT I LEARNED FROM MY ACTION RESEARCH

My students were not acquainted with the processes of embryonic development, the terminology associated with these processes nor the process of In Vitro fertilization. They had heard of these processes, but showing them the animations was very helpful. I was happy to have some activities to accompany the instruction to highlight some of the differences between adult and embryonic stem cells. The students had some information about stem cells and some held definite beliefs about stem cell research. I found that, through factual information, some did alter their views of stem cell research and a few held staunchly to their original beliefs.

Most of the lessons, as originally planned, did work. However, recurrent problems with my laptop computers hindered our planned time for completion of the WebQuests. We were not usually able to use computers in the media center because of an exhaustive testing schedule for various student groups. I found that the students enjoyed doing the science fair boards. They researched materials at home, brought in pictures, scrapbooking supplies, typed information, and worked together well to make their boards attractive.

I hope to repeat the unit with classes in the future. I did get a better set of laptops and expect them to perform much better. I would like to look for some better WebQuests or design my own. As I work on this unit, I would also like to improve on my pretest-posttest to add objective questions and increase the information I want them to learn.

From the action research process, I learned more information about stem cells and stem cell research. I found some of my students had ingrained opinions and others seemed to soak in the information we were learning gaining new insights that helped change their points view. I saw that they could work well cooperatively and put forth real effort to complete their projects. I have done other projects that I thought were action research, but found that the instruction we received and the book we received opened my eyes to a more thorough approach that really was research. I am thankful to all our instructors throughout Bench to Bedside for the excellent work they did and the specific help given to us.

Coming back from the Summer Institute is always an exciting time. My enthusiasm spills over as I relate my experiences to my administrators, to the science department, and to a myriad of other teachers I met at three different workshops held at the UF Biotech Center in Alachua, and to teachers I met at the Pittcon Conference held at the Orange County Convention Center. I participated in an Expo held at the Lakeland Center for academies in our county and met a teacher from Polk State College, who became very interested in what I did at UF and I have continued to email her opportunities as I learn about them. I sent information about Biotech to a representative from Polk State College and this is an area they are investigating. As a P.R.I.S.M. finalist for Polk County, a summary of some of my UF experiences were read to the entire audience composed of teachers and district personnel from five central Florida counties.

At the Polk County Expo, I had a chance to share my experiences and the action research with parents and students. I had my student science fair boards on display to generate questions and conversation .I held a meeting for parents and prospective students to my Biotech Academy. There I shared my quest for more and more biotechnology, my goals for working toward graduate credits, and some of the wonderful information I had learned. I shared learnings from my UF experience with all my students and with all our ninth grade honors Earth Science students as I introduced them to my biotechnology academy. In my application for Polk County Teacher of the Year, I wrote about my biotech experiences to district level personnel. In earning a place as a county finalist, some of this information was announced to a very large audience that included many teacher nominees and school administrators plus our school board members.

I am always eager to share my UF experiences and learnings with other teachers. I might be interested in sharing at a conference or writing a journal article. I would certainly want someone to critique the article before being submitted, as I don’t think I am an excellent writer.