

Exploring the Body's Building Blocks: a Regenerative Medicine Curriculum for 3rd – 8th Grades



Amanda K. Golden, MLS¹, Jilian L. Foxen, M.Ed.¹, Henry J. Walker¹, Katherine M. Cafilisch¹, Christopher Livia^{1,4},
Alissa R. Cornell¹, Christopher K. Pierret, Ph.D.², Atta Behfar M.D., Ph.D.^{1,3}, Andre Terzic M.D., Ph.D.^{1,3}, Saranya Wyles M.D., Ph.D.¹
¹Center for Regenerative Medicine, ²Department of Biochemistry and Molecular Biology, ³Department of Cardiovascular Diseases, ⁴Mayo Clinic School of Medicine
Mayo Clinic, Rochester, MN

Abstract

Problem: The lack of formal STEM curricula in elementary and middle schools, along with stem cell biases, stigmas, and paucity of factual information, are some of the impediments that may prevent schools from integrating regenerative medicine fundamentals into educational programs.

Background: Given the current impact of regenerative sciences on biomedicine and healthcare, it is important to involve and engage younger generations in understanding the fundamental concepts of regenerative medicine.

Hypothesis: By introducing regenerative medicine concepts, in 3rd – 8th grades, students will become more aware and informed about regeneration as measured through the assessment of taking drawings.

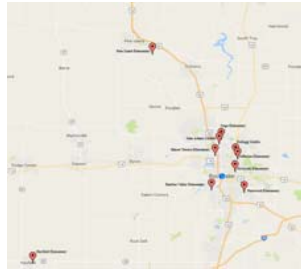
Research

The framework for our pilot program is as follows:

- 1) Recruit elementary and middle school teachers in southeastern Minnesota.
- 2) Write age appropriate curricula in partnership with Mayo Clinic subject matter experts and educators from the local school system.
- 3) Develop teacher feedback forms and student assessments.
- 4) Teach students in 3rd – 8th grades regenerative medicine concepts in a one-time outreach visit.
- 5) Analyze student assessments to measure the knowledge learned from the outreach program.*
- 6) Evaluate the teacher feedback forms for continuous improvement and teacher perceptions.*

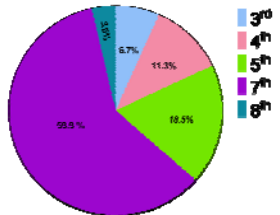
* Analysis and evaluation of the program are currently in progress.

Figure 1: Participants



13* teachers from 10 schools participated in the program. 556 students* were reached. Schools with high proportions of students receiving free/reduced lunch were included in the pilot program.
*Additional teacher and students from 2 sessions not yet included.

Figure 2: School grades represented



Total=556

Figure 3: Classroom activities

Basic concepts	Definitions, short videos, lecture
Activities	Sorting game, stem cells in the body, differentiation game, 3D printed heart
Assessments	Talking drawing

A variety of activities are used in the classroom setting to help reinforce the basic concepts.

Figure 4: Understanding By Design Template

Outreach program framework for grades 3, 5, & 7	
Stage 1: Desired Results	
Established Goals	
Enduring Understandings:	Essential Questions:
3rd: The concept of regeneration 5th: Stem cells are the building blocks of organs 7th: The basics of regenerative science including cell differentiation, disease applications, and career options	3rd: What is regeneration and how can it help the body heal? 5th: What are examples of organs that can regenerate? What tools help regenerate human organs? 7th: Why do we want our bodies to regenerate?
The student will know:	The student will be able to:
<ul style="list-style-type: none"> The possibilities of the body's own ability to heal itself What regenerative medicine is How regenerative medicine can impact their life Why some things regenerate and others do not 	<ul style="list-style-type: none"> Next Generation Science Standards <ul style="list-style-type: none"> 3-LS1-1: Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death. 3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. MN Academic Standards in Science <ul style="list-style-type: none"> 3.1.3.2.2: Recognize that the practice of science and/or engineering involves many different types of work and engages men and women of all ages and backgrounds. 3.4.1.1: Living things are diverse with many different characteristics that enable them to grow, reproduce and survive.
That cells are: One of the tiny units that are the basic building blocks of living things, that carry on the basic functions of life either alone or in groups, and that include a nucleus and are surrounded by a membrane	
<ul style="list-style-type: none"> Merriam Webster's Student Dictionary 	
That stem cells are: A simple cell that can become a cell (as a blood cell or skin cell) with a special function	
<ul style="list-style-type: none"> Merriam Webster's Student Dictionary 	
Stage 2: Assessment Evidence	
Performance Task:	Other Evidence:
Student provides drawings of regeneration	<ul style="list-style-type: none"> Oral or written responses to one of the essential questions Compare a healthy heart versus a heart damaged from infarction Display of language and concepts learned that weren't previously known through Talking Drawing activity
Stage 3: Learning Plan	
What teaching and learning experiences will equip students to demonstrate the targeted understandings?	
3rd: Watch regeneration in an animal model, learn basic terms, small group regeneration sorting activity where students learn about regeneration in the animal kingdom 5th: Introduce differentiation as a concept, basic terms, identify organs where stem cells have been found, watch beating cardiomyocytes, 3D printing 7th: Hands on experience with differentiation, key terms, disease discussion on regenerative targets, videos, 3D printing, facilitator's lab career path	

Figure 5: Outreach in action



3rd-grade students work in groups to decide what organisms in nature are capable of regeneration.

Figure 6: Outreach in action



5th-grade students investigate 3D heart models.

Figure 7: Outreach in action



7th-grade students work in groups to understand the process of differentiation.

Observations

In the early stages of developing our curricula, we learned that grades 3, 5, and 7 were better suited for this pilot program based on current science education. In these grades, regenerative medicine complements the life science concepts based on state and national academic standards. As a guide to develop our lesson plans, we used the Understanding By Design (UbD) educational planning framework. The curriculum was mapped to Minnesota Academic Standards as well as national Next Generation Science Standards.

Students were engaged and participatory throughout the outreach visit, asking thoughtful questions about regenerative medicine. The heart models and 3D printing discussions with the students appeared to be the most engaging topic. Using talking drawings as a tool to understand knowledge gained was difficult for some teachers who wanted to remind, prompt, and coach students into remembering the content covered. Students also had access to electronic devices connected to the internet which may have affected answers.

Conclusions

In this pilot program, we sought to administer 12 sessions of this outreach to approximately 300 students. Teacher registration indicated a high level of interest in an educational program focused on regenerative concepts. To date, we have offered 22 sessions of this program reaching over 550 students.

Students were provided foundational concepts to inspire the future regional and national regenerative medicine workforce. Next up, we will develop a teach-the-teacher course being designed as a more sustainable and larger dissemination vehicle for the curricula designed in this program.

Acknowledgements

Regenerative Medicine Minnesota education grant: RMM-2016-12ED-02
 Van Cleve Cardiac Regenerative Medicine Program
 Rochester Public Schools & Zumbro Education District
 Mayo Clinic Center for Regenerative Medicine
 Marriot Foundation