Regenerative Medicine Minnesota
Progress Report
Due one month after your grant's end date or after payout of grant, whichever comes first.

Grant Title: Advancing Regenerative Medicine through Educating Minnesota K-8 Educators
Grant Number: RMM-2017-K12ED-01
Requester: Jilian Foxen, M.Ed.
Project Timeline: 6/1/2017 – 5/30/2018

Brief description of project:

Building on "Exploring the Body's Building Blocks" pilot program, which was RMM funded in 2016-2017, our team organized a one day program focused on teaching southern Minnesota teachers about building regenerative concepts into Science, Technology, Engineering, Art & Math (STEAM) curriculum.

To begin, the team obtained support from the Zumbro Education District (ZED) and Rochester Public and Private school's education leadership to reach out to current teaching faculty. Our recruitment efforts consisted of emailing an approved flyer to teaching staff in grades K-8. We then comprised a one day agenda (see figure 1) and secured key presenters for the program. The regenerative medicine education team, along with internal Mayo program managers from various facilities, took part in the day's agenda. Our external key note speaker was from the Rochester-Minnesota Children's Museum highlighting STEAM in state-wide initiatives.

Following the completion of the agenda planning, the grant team focused on identifying key teacher resources that would aid the dissemination of the curriculum in their classroom. The team developed a teacher facilitator's guide (see appendix) with all the lesson plans and key resources, using many materials developed in the pilot program. The production of this teacher's guide was contracted externally. The resources that were determined to have high learning impact included: 1) one 3D printed heart, 2) anatomical heart models, 3) one 3D cell model, 4) a book on science activities for teachers, and 5) a tote to store their learning aids. To supplement, a flash drive with the lesson plans, games, videos, and teacher tutorials was included. In addition, classroom sets of printed materials for executing the curriculum activities in the classroom (average class size is 30) were provided.

Figure 1: October 20, 2017 Program Agenda

Exploring the Body's Building Blocks: Through a Teach-the-Teacher Program
Friday, October 20, 2017 | Mayo Clinic

Program Agenda

7:30 AM	**Welcome Breakfast/Registration** Charter House, Floor 1, Room 158
8:00 AM	**Opening Remarks** *Speakers: Jilian Foxen, M.Ed., Course Director* *Amanda Golden, MLS, Planning Committee Member*
8:05 AM	**Why regenerative medicine?** *Speaker: Zach Resch, Ph.D., Program Manager Center for Regenerative Medicine Biotrust*
8:30 AM	**Undergraduate experience for a career in regenerative medicine** *Speakers: Cody Wyles, M.D., Resident, Department of Orthopedic Surgery* *Chris Livia, M.D., Ph.D. Candidate, Mayo Clinic Graduate School of Biomedical Sciences*
9:00 AM	**Break**
9:15 AM	**Getting started: Facilitator guide** *Speaker: Amanda Golden, MLS*
9:30 AM	**3rd Grade Curriculum** *Speakers: Jilian Foxen, M.Ed., Amanda Golden, MLS, and Henry Walker*
10:00 AM	**5th Grade Curriculum** *Speakers: Jilian Foxen, M.Ed., Amanda Golden, MLS, and Henry Walker*
10:30 AM	**Regenerative medicine in Minnesota: State-wide and local initiatives** *Speakers: Saranya Wyles, M.D., Ph.D., Regenerative Medicine Minnesota Grant Awardee and Clinical Resident at Mayo Clinic, and Alissa Cornell, Manager Research Operations, Center for Regenerative Medicine* *Heidi Mestad, Executive Director, Minnesota Children's Museum of Rochester*
11:00 AM	**7th Grade Curriculum** *Speakers: Jilian Foxen, M.Ed., Amanda Golden, MLS, and Henry Walker*
11:45 AM	**Lunch Break**
12:00 PM	**Inspiring the next-generation STEM workforce** *Speakers: Panel discussion facilitated by Dr. Saranya Wyles* *Alexandra J. Greenberg-Worisek, Ph.D. (WiSER), Jon Ninas (HS Mentorship), and Sinibaldo Romero Arocha, PREP Student (Student experience)*
1:00 PM	**Putting it all together: Tools for classroom engagement** *Speakers: Jilian Foxen, M.Ed., Amanda Golden, MLS, and Henry Walker*
1:30 PM	**Program closing remarks and questions**
1:45 PM optional session	**Regenerative medicine in discovery, translation, and application** Optional Mayo Clinic Laboratory Tours *Brandon Tefft, Ph.D- 3Dprinting, Raman Takhter, Ph.D.-beating cardiomyocytes, Henry Walker-manufacturing for clinical use, Alexandra J. Greenberg-Worisek, Ph.D. -science project demonstrations*
3:00 PM	**Program adjourns**

*Agenda and speakers subject to change based on availability

This program aimed to educate up to 50 self-identified teachers/educators from grades K-8 and provide them with enough resources so that they could facilitate the educational curriculum independently. A teach-the-teacher approach was designed to ensure wide dissemination and sustainability in the years to come. In addition, this program aimed to build long-term relationships with the community through its local teachers and work to ensure that subject matter experts were engaged in reviewing and updating the content to reduce biases, stigmas, and scarcity of factual information in this evolving field.

Where did this project take place?

October, 20th, 2017
The full-day teach-the-teacher event was held at the Mayo Clinic-Rochester Campus in one of our large meeting rooms (Charter House) commonly used for educational programs. Scientific laboratories that are currently engaged in activities such as 3D-printing, growing of cells, and restoring function to damaged organs were toured and small didactic lectures followed by some hands-on instruction and learning took place.

Additional site visits in the community: April 2018-May 2018
Teachers who were unable to attend the October 20th, 2017 session were approached for in-classroom outreach opportunities that engaged the regenerative medicine team and area classrooms with the regenerative medicine curriculum. Sites visited during this grant cycle included Friedell Middle School, St. Francis of Assisi School, Pine Island Elementary, and John Adams Middle School.

People impacted by project and where they are from:

The event attracted 11 teachers who registered for the event from the southern Minnesota area. In addition, to expand our reach for teachers to participate, we added additional outreach sessions. Sixteen classroom teachers and 2 school nursing staff received on site educational curriculum. A total of 5 educators attended the October 20th 2017 event, and an additional 15 teachers and 2 school nursing staff were reached for a total of 22 educators.

Disseminating the curriculum to the school districts allowed current and future students the opportunity to engage with the regenerative curriculum developed from our previous grant funding. *The estimated number of potential students reached by connecting with the teaching staff is approximately 3,939 students in grades K-8 for the academic year of 2017-2018.*[1,2] Having teachers in the school with regenerative medicine toolkits will allow them to carry forward the thoughts and ideas for future students.

Schools that had teaching staff registered for the October 20th, 2017 event included:

School	District	Student Enrollment[1,2] 2018
Lincoln K-8	Rochester Public Schools	
John Adams Middle School*+	Rochester Public Schools	1148
Friedell Middle School*	Rochester Public Schools	461
Bear Cave Intermediate School	Zumbro Education District (Stewartville)	
Sunset Terrace*+	Rochester Public Schools	691
Willow Creek Middle School	Rochester Public Schools	
St. John the Evangelist	Rochester Private Schools	
Folwell*	Rochester Public Schools	365
Holy Spirit *	Rochester Private Schools	292 (data from 2016)

*Educators in attendance + Repeat Representation from last year's pilot program

Additional outreach to teachers who were unable to attend the October 20th, 2017 event included:

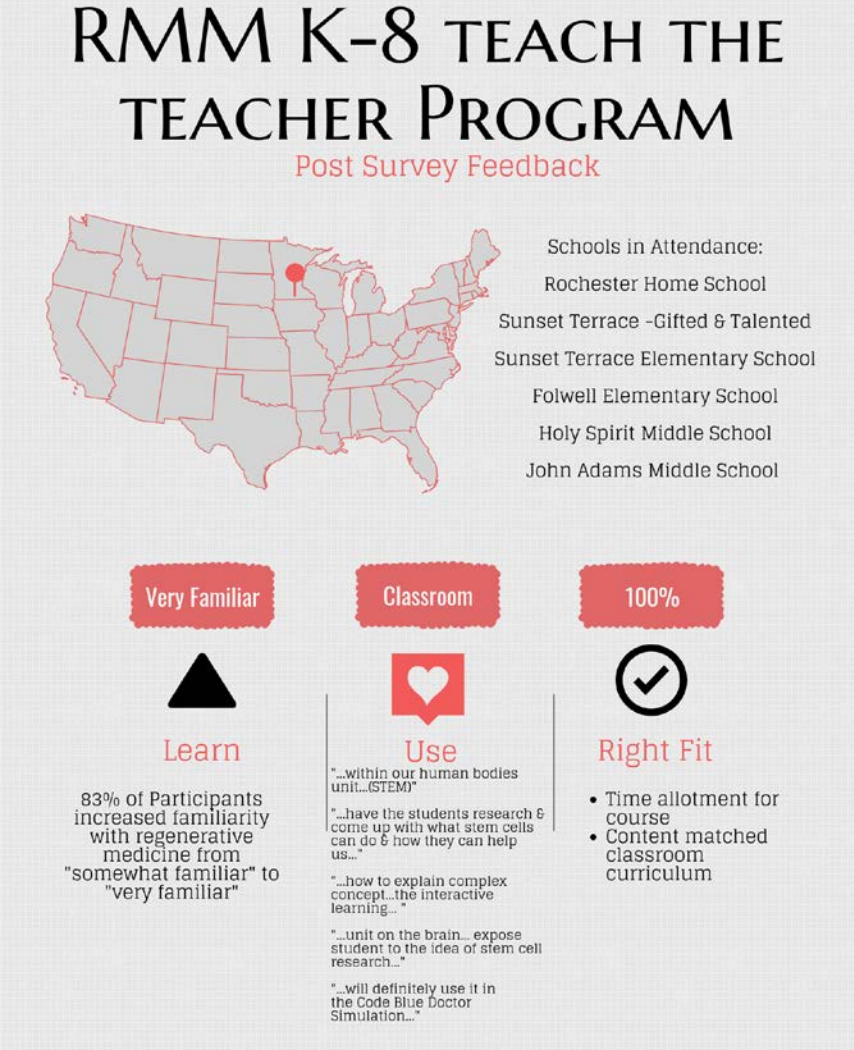
School	District	Student Enrollment[1,2] 2018
St. Francis of Assisi*	Rochester Private Schools	409 (data from 2016)
Pine Island Elementary*+	Zumbro Education District (Pine Island)	573

*Educators in attendance + Repeat Representation from last year's pilot program

What was the outcome of the project? (Did the project work the way you expected it to? What were the successes? What were the failures? How did it impact regenerative medicine in Minnesota?)

The program and content were highly valuable to the students and the teachers. We conducted a pretest and posttest assessment for the October 20th, 2017 event and results of the survey showed an increase in understanding for the post-teacher program. A summary of the key takeaways can be found in figure 2.

Figure 2: Teacher Post Survey Feedback



In addition, while we were unable to offer the pretest, we did survey the teachers of the outreach program to get their feedback regarding onsite visits and the response was overwhelmingly positive. Some key teacher responses regarding the outreach session included specific details on how our curriculum matched what they were currently focusing on in the classroom and this program enhanced the learning with regenerative concepts and fun games. They also commented on how they planned to build regeneration into future curriculum in their classes.

"This (human body) is covered in our science curriculum. We could definitely have some research time for regeneration and work it into the curriculum."

"I will be incorporating regenerative topics, including cell growth and repair, into the 7th grade curriculum. Cell differentiation and stem cells are topics that will be given more time and focus as they are part of cell research now and in the future."

While the October 20th, 2017 event proposed some challenges which included overlap with the state-wide Minnesota Education Academy professional development days, the teachers who attended the program were all invested in the topic, believed the curriculum to be strong, and enjoyed the large amount of classroom teaching aids and resources. In addition, being on the Mayo Clinic campus allowed them to "see and demystify" Mayo Clinic and view it as a community partner. The teaching staff appreciated the facility tours and engaging with the scientists. Although we had hoped for a larger attendance, the teachers present appreciated the special attention and intimate exposures to the science they received by being a small group.

Lessons learned and opportunities for future events focus on:

- Date selection so that our program is not competing with school requirements or other teacher learning opportunities.
- Developing, engaging new content, such as
    - Expanding to concepts of regenerating the whole person and wellness concepts,
    - Offering opportunities for teachers to be part of projects in the summer to gain further understanding and skillsets to bring back to their classrooms.

The impact this grant award had on regenerative medicine in Minnesota can best be highlighted in terms of engaging the student body for years to come and the teachers of southeastern Minnesota's interest in adding regenerative medicine concepts to their existing classroom curriculum in years to come. In addition, this grant has met its goals of 1) expanding the curriculum to additional classrooms in southeastern Minnesota, and 2) building a model of sustainability by partnering regional school systems with subject matter experts in regenerative medicine from Mayo Clinic.

Please list any of the following that have resulted from your Regenerative Medicine Minnesota grant funding:

☐ Publications and/or manuscripts submitted for publication

None.

☐ Disclosures/patents

None.

X Other grant applications and/or awards

As a result of the successful pilot program and feedback from this current grant cycle, a third grant application was submitted that focused on building pathways with high school students and mentoring

them toward STEM and regenerative medicine career opportunities. This grant was recently funded by Regenerative Medicine Minnesota and is currently underway.

Responsible Spending:
Please let us know how you spent the money. Any unspent funds must be returned.

The funds for this grant went to support teaching aims such as cell models, books and other classroom learning visual aids. A portion of the funding was spent on the professional design and content creation of the teacher facilitator's guide. We partnered with Mayo Clinic and an external designer to complete this portion of the grant. Finally, a small portion of funds were spent on operationalizing the event such as signage, honorarium for guest speaker, parking arrangements for attendees, and food and beverage for the one day program.

Description	**Final cost**
Total Direct Cost	$12,578
Classroom materials & cost to administer the program	$6494
Indirect Cost	$3831
Total	$10,325

Reference:

1) Minnesota Report Card: https://rc.education.state.mn.us/#
2) Rochester Public Schools. http://www.rochester.k12.mn.us/UserFiles/Servers/Server_3083669/File/Finance/Attachment%20A%20-Enrollment%20Projection%202016-2017.pdf

Appendix

1. Regenerative Medicine in the classroom: A teacher's guide for children in grades 3, 5 and 7.

MAYO CLINIC

REGENERATIVE MEDICINE CURRICULUM

REGENERATIVE MEDICINE IN THE CLASSROOM

A Teachers Guide for Children in Grades 3, 5 and 7

ABOUT THIS CURRICULUM

Recent advances in stem cell biology have contributed to the evolving field of science with new developmental concepts and methodologies. Given the continually expanding knowledge of stem cell science, it is vital to involve younger generations in understanding current fundamental concepts and current fact-based information. The motivation for addressing this knowledge gap stemmed from the recognition that there is opportunity in improving upon the national documents on science content for grades K-12 in regards to stem cell biology.

TABLE OF CONTENTS

INTRODUCTION TO REGENERATIVE MEDICINE

About "Exploring the Body's Regenerative Building Blocks"

In 2016, a team of medical school students, scientists, and business professionals working in the field of regenerative medicine noticed a gap in the education system. The absence of regenerative concepts in school curricula was evident from primary schools through medical schools. The field of regenerative medicine is a fairly new field and it's advancing quickly, but biases from the early days of stem cell research and misinformation threaten the future of the field.

To fulfill this information gap and to inspire a future workforce in regenerative medicine, a pilot education program was designed to bring awareness of regenerative medicine into 3rd-8th grade classrooms. This education program was fully funded through a grant from Regenerative Medicine Minnesota in mid-2016. One objective of the grant was to provide outreach programming to 12 classrooms within southeast Minnesota, reaching approximately 300 students. When the pilot program ended in June 2017, the *Exploring the Body's Regenerative Building Blocks* team provided outreach programs to 24 classrooms and just over 600 students in the target area [Figure 1].

The program curricula were built using the Understanding by Design® framework[1]. The Understanding by Design® framework is used to build lesson plans in a backwards style – with the students' end learning goals or "enduring understandings" at the forefront when developing lesson plans[2]. In tandem, we mapped our learning goals with Minnesota Science Standards[3] and Next Generation Science Standards[4].

Once lesson plans and mapping was complete, it was clear that introducing regenerative medicine concepts to the students was most complimentary for 3rd, 5th, and 7th grades' curricula.

The Science, Technology, Engineering, and Math, or STEM, -based outreach program we developed was limited to one classroom session and featured a mini-lecture with discussion, grade-appropriate activities, and hands-on exploration of a 3D printed organ. A pre-and post-assessment using a "talking drawing"[5, 6] was used to gauge the effectiveness of our program and teaching.

The successes from this pilot work led to additional grant funding by Regenerative Medicine Minnesota in mid-2017. This new grant centers on developing a teach-the-teacher event to broadly disseminate the information we developed in the pilot grant. By sharing foundational concepts and knowledge on regenerative medicine with southeast Minnesota educators, our intent is that you can incorporate, share, and shape this information to best suit the learning needs of your students.

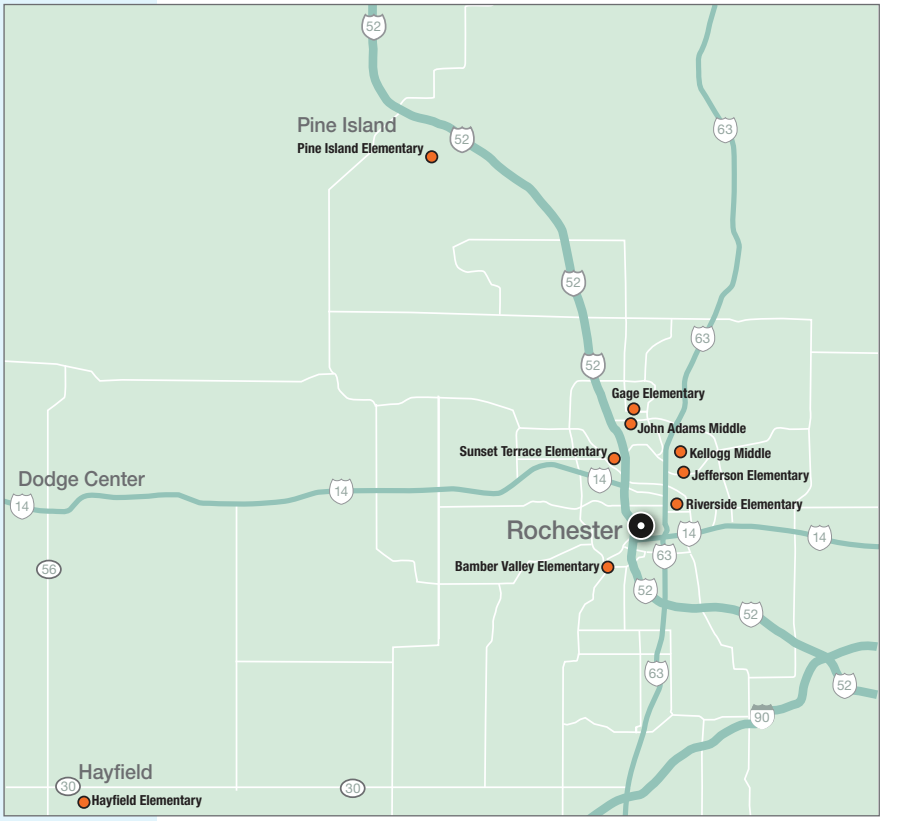


Figure 1. *24 classrooms in southeast Minnesota participated in the program for a total of 604 students reached.*

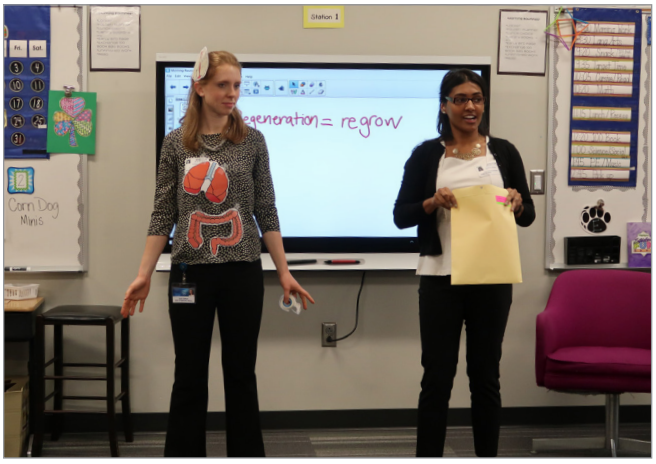
WHY REGENERATIVE MEDICINE?

Regenerative medicine is used to:

- Repair the body's ability to heal itself
- Replace damaged tissue by transplanting healthy tissue
- Restore damaged or diseased tissue with stem cell therapies or acellular therapies

Undergraduate Experience
For A Career In Regenerative Medicine

Regenerative medicine as a field of science is in its infancy. Over the past 15 or so years, regenerative concepts such as stem cells, cloning organs, and other new experimental treatments have been explored and investigated to restore, rejuvenate and replace one's body function and structure.



Relevant course work that might help undergraduate students prepare for graduate and medical school includes:
Mayo Clinic School of Medicine Prerequisites (example)

- One year of biology and/or zoology (with one year of lab)
- One year of inorganic chemistry (with one year of lab)
- One year of organic chemistry (with one year of lab)
- One year of physics (with one year of lab)
- One course in biochemistry
- One year Calculus or Statistics
- Sometimes AP or CLEP credits cannot be used to fulfill these requirements (school dependent)

Optional Courses

- Human Anatomy
- Human Physiology
- Computer Science/Programming
- Ethics
- Behavioral and Social Sciences
- Statistics
- Genetics
- Microbiology
- Immunology
- Cell and Molecular Biology

In the end it does not matter the specific degree pursued for undergraduate studies so long as the minimum prerequisites of the schools are met. Commonly, students will major in biology or chemistry since the medical school requirements overlap with those of their undergraduate studies.

Key resources at Mayo Clinic for students wishing to pursue a career in regenerative medicine may include:

- Mayo Clinic College of Medicine and Science
  - Graduate School of Biomedical Science
- Regenerative Sciences Training Program
  - A unique program supported by the Center for Regenerative Medicine in the School of Biomedical Sciences that aims to enhance trans-disciplinary Ph.D. training in the field of regenerative science.
  - The program aims to prepare next generation scientists with discovery, translation and ethical application of clinically relevant regenerative therapies.
- Ph.D. program
- Medical Scientist Training Program (MSTP)
- Initiative for Maximizing Student Development (IMSD)
- Post-baccalaureate Research Education Program (PREP)
  - Graduate School of Medicine
- M.D. program
- Medical Scientist Training Program (MSTP)
- Oral and Maxillofacial Surgery Residency M.D., .M.S.
- Visiting Medical Student Clerkship (Electives)
  - Graduate School of Education
  - School of Health Sciences

TEACHING REGENERATIVE MEDICINE IN THE CLASSROOM

ABOUT THE CURRICULUM

Recent advances in stem cell biology have contributed to the evolving field of science with new developmental concepts and methodologies. Given the continually expanding knowledge of stem cell science, it is vital to involve younger generations in understanding current fundamental concepts and current fact-based information. The motivation for addressing this knowledge gap stemmed from the recognition that there is opportunity in improving upon the national documents on science content for grades K-12 in regards to stem cell biology.

MAYO CLINIC

Mayo Clinic
200 First Street SW
Rochester, Minnesota 55905

MC7092-45

3RD GRADE: WHAT IS REGENERATION?

The primary goal of this lesson plan is: *"What is regeneration?"* We hope to illustrate how regeneration can help the body heal with the objective of understanding the concept of regeneration. Students can be initially engaged with videos of salamander, starfish, or newt regeneration and prompted to explain what regeneration is in their own words. The discussion can continue with questions about which parts of the human body can regrow (hair, skin, nails, etc.). Teachers can also utilize the sorting game where students can sort pictures of various items that *can* and *cannot* regenerate. Group discussion can include EuroStem's, *Where are my Stem Cells* activity where students can learn that cells in different organs look different and begin to understand basic concepts of regeneration. Consider inviting guest speakers (if appropriate) and/or writing in questions for scientists at Mayo Clinic can also help facilitate discussion.

Suggested Additional Classroom Discussion:

- Why do we want our bodies to regenerate?
- What career might have a role and /or impact in regenerative medicine?
- What superheroes have regenerative abilities? Would you want that super power for yourself?
- What are other animals or plant systems that naturally regenerate?
- Research a project that demonstrates regeneration with the class.

3rd Grade Lesson Plan

Essential question/goal: What is regeneration and how can it help the body heal?

Enduring understanding: The concept of regeneration.

I. *0-2 mins* – Introduction

II. *2-5 mins* – *[2-3 people. Introduction only from one person.]* We're here today to talk to you about some cool new things happening in medicine these days that you might be interested in, in the area of regenerative medicine. Then, we'll have some activities and at the end, you'll be able to show us what you know about this new information in a picture. [3.1.3.2.2]

III. *5-10 mins* – Ok, let's pretend we're all scientists today. Let's take a moment to watch an organism in nature that naturally heals itself and let's watch what's interesting about this animal. [Video regeneration] [3.4.1.1]

a. What happened to the newt after it was injured?
b. Why do you think a doctor or scientist studies newts?
c. Can our body heal the same way?

IV. *10-13 mins* – Well, researchers at Mayo Clinic and around the world are interested in finding the answers to how our bodies heal similarly or differently from newts. We work in a field of science called regenerative medicine. This scientific field is called regenerative medicine and it's full of doctors and scientists trying to answer this question of how to heal body parts that can't or don't heal. Let's try a little exercise: If you've ever broken a bone, raise your hand. If you've cut your skin, put your hand on your head. If you've been to the hospital overnight, snap. [3.4.1.1]

V. *13-23 mins* – Let's go back to the newt. Did your cuts or broken bones heal or grow back or *regenerate* the way a newt does?

a. Regenerate means to grow (as a lost body part) once more or "regrow" (from Merriam-Webster's Dictionary for Children)
    1. For those of you who had a cut or a broken bone, what happened to it?
    2. Maybe you didn't grow a new limb, but I bet that the cut went away and all that's left is a scar.
    3. So, even though it's not as big of a change as growing a new limb, your cut went away because new skin grew around that cut.
b. Our bodies do have a way to help you heal that's similar, but different, from the newt.
    1. What are other things that can regrow or heal like the newt? (Examples for teasing out: fingernails, hair, skin). Now, we're going to work with a buddy to play a little sorting game. As the game is being passed around, we want you to decide what you think can/cannot regenerate. Please sort the pictures into 2 piles: 1) things that can regenerate and 2) things that cannot regenerate.
        — 3 mins for sorting.
    2. Show what can regenerate and place those organs on the body for kids to see.
        — Pin the organ on the body activity.

VI. *23-33 mins* – Let's get back to our seats. Now I want you to show me on your piece of paper in front of you "What is regeneration?" Use your writing instrument to answer "What is regeneration?" Please work by yourself.

VII. *33-45 mins* – Revisit newt. Tie back into restoration and renewal and why we're doing what we're doing. Explain that Mayo Clinic researchers, and around the world, are working on finding ways to fix organs that have been damaged so that they function better.

VIII. Conclusion

a. Question and answer
b. Thank you

5TH GRADE: WHAT ARE EXAMPLES OF ORGANS THAT CAN USE STEM CELLS TO REGENERATE?

The primary goal of this lesson plan is: *"What are examples of organs that can use stem cells to regenerate?"* The objective is to understand the various types of stem cells and how they differentiate from each other. Students can be initially engaged by an open-ended questions like "Has anyone ever broken a bone?" The discussion can continue with answers on how our bodies heal, which can serve as an introduction to definitions of regeneration, cell, stem cell, and differentiation. Teachers can tailor this lesson plan to specific organ systems such as the heart. Group discussions can center on organ systems and current options for restoring or regenerating tissue. Consider inviting guest speakers (if appropriate) and/or writing in questions for scientists at Mayo Clinic can also help facilitate discussion.

Suggested Additional Classroom Discussion

- Utilize Jeopardy PPT for classroom interactive activity and discussion.
- How do cells fight infection?
- Discuss how cells are impacted by disease.
- Using technology available in your classroom, what interactive models could your class build or design (i.e. using 3-D printer technology or other manipulatives)
- Have a discussion of how technology can impact the healthcare system, what might it look like in the future?

5th Grade Teaching Plan

Essential question/goal: What are examples of organs that can use stem cells to regenerate?
Enduring understanding: The types of stem cells and how they differentiate.
Appoint someone to facilitate playing videos (on flash drive)
Appoint someone to help write definitions on the white board, if desired

I. *0-2 mins* – *[Introduce ourselves]*

II. *2-5 mins* – *[2-3 people. Intro only from one person.]*
We're here today to talk to you about some cool new things happening in medicine these days that you might be interested in. Then, we'll have some activities and at the end, you'll be able to show us what you know about this new information in a picture.

III. *15 mins* – **Activity 1: Introduction**

a. Has anyone ever had a cut or a broken bone?
    1. Let's try a little exercise: If you've ever broken a bone, raise your hand. If you've cut your skin, put your hand on your head. If you've been to the hospital overnight, snap. Are those bones still broken? Is that cut still there? Or did your bone and skin … regrow?!

b. We're interested in finding the answers to how our bodies heal and especially in finding ways to help people whose bodies can't heal. This scientific field is called regenerative medicine and it's full of doctors and scientists trying to answer this question of how to heal body parts that can't or don't heal.
    1. Does anyone know what regeneration means?
        — *Define Regeneration*
    2. Let's talk about what our bodies need in order to regenerate.
    3. Who knows what a cell is?
        — *Define Cell*
    4. Our bodies also have special cells - these are known as stem cells.
        — *Define Stem Cell*

c. Our body's cells undergo a process called "differentiation" which helps them decide what role they will have.
    1. *Define Differentiation*
    2. Talk about the ability to reprogram and give direction or instructions to cells if we want them to become cardiac cells or muscle cells
    3. Show cells differentiating into other organs (show video of cell differentiation)
        — Enforce that these are adult stem cells (all found within our own bodies right now)

d. Let's talk about your heart. It is one of your body's organs. Did you know it's made of cells too?
    1. Would anyone like to see real heart cells beating? *[Show video of beating cardiomyocytes.pptx]*
        — Let's look at a video of these cells that was taken while the cells were beating under a very powerful microscope.
    2. Do you see that these cells can grow and beat all on their own – just like the heart in your body is growing and beating all on its own?
        — Have you ever thought about how these tiny little cells become an organ? Explain how cells come together to build tissue to form organs, like a heart, based on their innate instructions.
        — Talk about analogy of a building with blueprint plans, framing, rooms, etc. and its similarity to human body with bones, muscle and other organs.

e. *What do other stem cells look like? Let's take a look at the various tissues of specific stem cells*
    1. Here we will look at staining of various stem cells.
        — *[Show cards of various cells]* from "where are my stem cells game"
        — Students will observe the different cell compositions from various tissues that make up our tissues (skin, pancreas, muscle, etc.) [Use "pin the organ" activity]

5TH GRADE: WHAT ARE EXAMPLES OF ORGANS THAT CAN USE STEM CELLS TO REGENERATE? - continued

IV. ***15 mins*** – **Activity 2: Group Discussions:** By studying the way a heart functions and by watching heart cells grow and develop, scientists are questioning what tools can help regenerate a whole heart. Or parts of a heart. There are different types of tools. 1) Those that come from our body such as B cells and T cell that help fight infection, and 2) tools that man have created such as 3D printers. Let's learn a bit more about these tools in our small group stations!

a. *Organs and 3D bioprinting*
    1. Discuss the current options for restoring or regenerating tissue.
    2. We're learning about ways that we can help them too. Did you know scientists are trying to figure out how to print organs that might be used in bodies one day? Special equipment called a 3D printer makes organs like these for scientists to study. Is everyone familiar with a 3D printer? Let's look at 3D printing in action by watching a short video. 3D printers are being used as a tool to support the body's natural building and regeneration and can create custom individual size and shape organs to replace/transplant. Let's look at one 3D printed organ up close.

V. 5 mins – **Talking Drawing**

a. Now I want you to show me on your piece of paper in front of you "What are examples of organs that can use stem cells to regenerate?" Use your writing instrument to answer "What are examples of organs that can use stem cells to regenerate?" Please work by yourself.

VI. *Optional: Ask a question to a scientist*

a. As a class, think of a question you would like one of our scientists to answer about regenerative medicine.
    1. Class works together to come up with a classroom question.
    2. Teacher emails Building Blocks facilitator (Teacher emails REGENMED@mayo.edu) the class's question
    3. Building Blocks facilitator will work with Mayo Clinic subject matter experts to record a video or alternate response to email back to the teacher.

VII. Conclusion

a. Thank you to all the students and teachers for participating!

7TH GRADE: WHY DO WE WANT OUR BODIES TO REGENERATE?

The primary goal of this lesson plan is: *"Why do we want our bodies to regenerate?"* with the objective of understanding the current state of regenerative science and career options. Students can be initially engaged by videos of starfish, salamander, or newt regeneration and prompted with the question of whether the human body can heal the same way. This can serve as an introduction to definitions of regeneration, cell, stem cell, and differentiation. Teachers can tailor this lesson plan to group activities such as how stem cells can differentiate into various types of cells in the body. Group discussions can center on organ systems and current options for restoring or regenerating tissue. Job opportunities to become involved in the field of regenerative medicine can also be discussed (scientist, doctor, business entrepreneur, medical writer, etc.). Consider inviting guest speakers (if appropriate) and/or writing in questions for scientists at Mayo Clinic can also help facilitate discussion.

Suggested Additional Classroom Discussion

- Have your student make small clip video/movie of stop-motion cell division and multiplication.
- Have students make a scientific poster on how regenerative medicine can impact a specific disease,
- Taking a student's career interest have them map out how that career could impact regenerative medicine or the STEAM field (ex: librarian, computer programmer, marketing manager)

7th Grade Lesson Plan

Enduring Understanding: Current state of regenerative science and career options

Essential Question: Why do we want our bodies to regenerate?

I. 0-2 mins – *[Introduce ourselves]*

II. 2-5 mins – *[2-3 people. Intro only from one person.]* We're here today to talk to you about some cool new things happening in medicine these days that you might be interested in. We will discuss, show videos, play a game and ask you to participate in expressing what you learned at the end. Our goal for this visit is to teach you basics about regenerative medicine and highlight future career possibilities in the field.

III. 5-10 mins – Ok, let's pretend we're all scientists today. Let's take a moment to watch an organism in nature that naturally heals itself and let's watch what's interesting about this animal. [Video regeneration]

a. What happened to the newt after it was injured?
b. Why do you think a doctor or scientist studies newt?
c. Can our body heal the same way?
d. Why do we want our bodies to regenerate?

IV. 10-13 mins – Well, researchers at Mayo Clinic and around the world are interested in finding the answers to how our bodies heal similarly or differently from newt. This scientific field is called regenerative medicine and it's full of doctors and scientists trying to answer this question of how to heal body parts that can't or don't heal.

a. This scientific field is called regenerative medicine and it's full of doctors and scientists trying to answer this question of how to heal body parts that can't or don't heal.
    1. Does anyone know what regenerative medicine means?
        — *Define Regenerative Medicine*
    2. Let's talk about what do our bodies need in order to regenerate?
        — Who knows what a cell is?
            • *Define Cell*
        — Our bodies also have special cells — these are known as stem cells.
            • *Define Stem Cell*
    3. Our body's cells undergo a process called "differentiation" which helps them decide what role they will have.
        — *Define Differentiation*
        — Talk about the ability to reprogram and give direction or instructions to cells if we want them to become cardiac cells or muscle cells

V. 13 – 20 mins – Group Activity

a. Student simulation of differentiation. I have an injury. I need I need help.
    1. All students cluster into one large group
        — Students are given cards with a stem cell or a growth factor on the front of the card
        — One student receives the skateboard card and reads the scenario to the class
        — Group facilitator tells students to look at their colored stem cell cards or growth factor

a. Then, students read a message that tells them they're a _____ cell
    1. Heart cell
    2. Neuron (brain) cell
    3. Bone cell
    4. Skin cell

b. Facilitator now tells student read their growth factor card
    1. These students will represent the solution to repair/rebuild the damaged heart tissue

c. Facilitator now tells all students to find their matching growth factor or cell and move to the large organ poster they are building

7th GRADE: WHY DO WE WANT OUR BODIES TO REGENERATE? - continued

d. Now you're recovering and back on the path to health, thanks to regenerative medicine.
    1. Facilitator asks skateboarding student how their life was impacted by the accident. How did they feel, what did they miss or were unable to do? Etc.

VI. 20 – 25 min – Pull students back to their seats. Explain to them the activity they just went through – that they all received signals to differentiate one stem cell into another; that some were damaging organs; and that others were special therapeutics, growth factors, that can rebuild/ regrow/regenerate organs.

a. Show cells differentiating into other organs (video)
    1. Enforce that these are adult stem cells (all found within our own bodies right now)

VII. 25-35 mins – As organs, why do we need regenerative medicine? What diseases can you think of that are currently damaging organs?

a. Let's look at examples of diseases that could benefit from regen therapies
    1. Sonia Sotomayor ⇨ Type I Diabetes
    2. Muhammad Ali ⇨ Parkinson's disease

VIII. 35-40 mins – Although we referenced celebrities with diseases, you may know family or friends who also suffer from these conditions as well. While we're researching cures for these unmet needs, we'll need your help in the future to help develop regenerative therapies too.

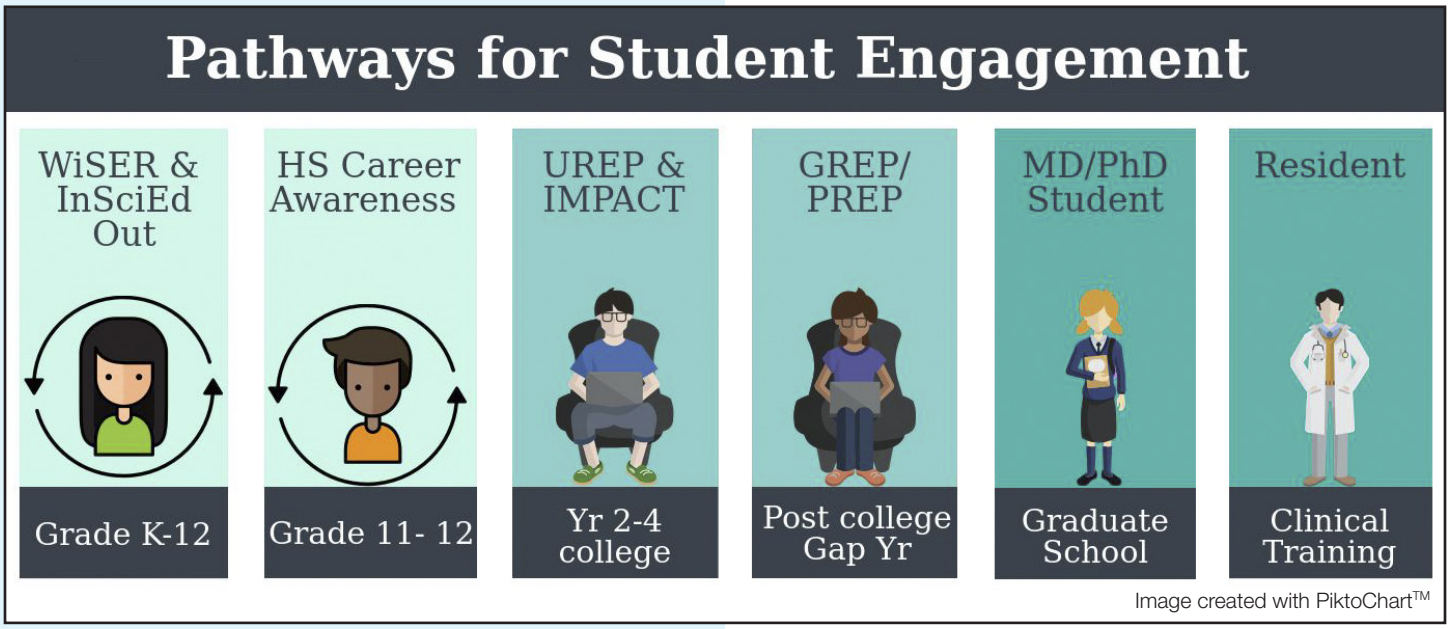
a. What jobs are available in the field of regenerative medicine? You don't have to be a scientist or a doctor! It's about being part of a collaborative team.

IX. 40-45 mins – Now, I want you to show me on your piece of paper in front of you, "Why do we want our bodies to regenerate?" Use your writing instrument to answer this question and please work quietly by yourself.

NEXT GENERATION CAREER PATHWAYS

The three shields of the Mayo Clinic emblem represent Research, Education, and Clinical Practice. Building on Mayo Clinic's commitment to each of these shields, there is a robust education and training environment that supports building our next generation workforce.

We encourage the local community and others to consider these existing pathways for engagement when preparing student for college preparation and career planning.



Women in Science & Engineering Research – WiSER

Our mission is to create and foster interest, excitement, and curiosity about science and engineering research in young women, and allow early exposure to the fields of science and engineering.

- Applicable for grades K-12
- Contact: Alexandra J. Greenberg-Worisek, Ph.D., MPH: *greenberg.alexandra@mayo.edu*
  Amanda Huff, Ph.D. Student: *huff.amanda@mayo.edu*

Integrated Science Education Outreach (InSciEd Out)

InSciEd Out is a collaborative partnership committed to rebuilding science education curricula for Pre-K-12 students, and providing opportunities for in-service teachers to grow themselves as scientists, engineers, and educators. Our mission is to engage students and empower teachers through research-based experiential learning rooted in real science and connected to the local communities to close the achievement gap.

- Applicable for grades Pre-K-12
- Webpage: http://www.insciedout.org

Career Awareness High School Mentorship Program

- Applicable for grade 11 &12
- Webpage: https://careerawareness.mayoclinic.org
- Contact: Jon Ninas, Career Awareness Program: *Ninas.Jonathon@mayo.edu* or Misty Cockram, Administrative Assistant: *cockram.misty@mayo.edu*

Career Awareness Programs for High School Students

Mayo Clinic's campus in Rochester, Minnesota offers several Career Awareness tools designed to support students in career exploration as well as to assist high school counselors and educators in advising students.

- High School Mentorship
- Career Observation Program
- Exploring - Learning for Life
- HOSA (Health Occupations Students of America)
- Health Care Career Festival
- High School Educational Visit
- Project SEARCH
- Teacher Externship
- Youth Apprenticeship

Undergraduate Research Employment Program (UREP)

This is a summer employment opportunity offered as a temporary paid research position in a research or clinical laboratory environment. Open to students who have completed at least one year of college and are returning in the fall.

- Applicable for college students who have completed one year of college
- Must have 2.5 GPA
- Pursuing an undergraduate degree in Science, Technology, Engineering or Math
- Website: http://www.mayoclinic.org/jobs

Innovative Minds Partnering to Advance Curative Therapies (IMPACT)

This program focuses on exploring creative solution for critical health questions by working in multidisciplinary teams. Undergraduates from various backgrounds work together to generate hypothesis and solve real-world health questions with science and physician leaders.

- Applicable for college students at any stage with any major
- Website: http://www.mayo.edu/research/centers-programs/center-regenerative-medicine/about/education-training/innovative-minds-partnering-advance-curative-therapies-impact?_ga=1.185153385.1319122817.1438700029
- Contact: *IMPACT@mayo.edu*

Key resources at Mayo Clinic for students wishing to pursue a career in regenerative medicine may include:

Mayo Clinic College of Medicine and Science – Graduate School of Biomedical Science

Regenerative Sciences Training Program

- A unique program supported by the Center for Regenerative Medicine in the School of Biomedical Sciences that aims to enhance trans-disciplinary Ph.D. training in the field of regenerative science.
- The program aims to prepare next generation scientists with discovery, translation and ethical application of clinically relevant regenerative therapies.

- Ph.D. program
- Medical Scientist Training Program (MSTP)
- Initiative for Maximizing Student Development (IMSD)
- Post-baccalaureate Research Education Program (PREP)
    - — Graduate School of Medicine
- M.D. program
- Medical Scientist Training Program (MSTP)
- Oral and Maxillofacial Surgery Residency M.D., M.S.
- Visiting Medical Student Clerkship (Electives)
    - — Graduate School of Education
    - — School of Health Sciences
- Website: http://www.mayo.edu/mayo-clinic-college-of-medicine-and-science
- Contact: Jolene Young: *mccm@mayo.edu*

Graduate Research Employment Program (GREP)

The Graduate Research Employment Program aims to provide up to two-years of post-baccalaureate laboratory research for students interested in basic or translational research. Students in this program are welcomed to participate in graduate-level courses through the Mayo Graduate School.

- Applicable for medical school or Ph.D. bound students
- Must have Overall GPA of 2.5 or higher
- Bachelor's degree in Science, Technology, Engineering or Math
- Website: http://www.mayoclinic.org/jobs

Post-baccalaureate Research Employment Program (PREP)

A program developed to diversify the biomedical research workforce. The PREP program offers unique opportunity for underrepresented students to competitively apply to Ph.D. or M.D., Ph.D. programs.

- Applicable for Mayo Clinic College of Medicine and Science underrepresented groups
    - — Black/African-American
    - — Hispanic or Latino
    - — American Indian or Alaska Native
    - — Native Hawaiian or U.S. Pacific Islander
    - — Members of other racial and ethnic groups considered to be underrepresented in medicine and biomedical research (eligibility based on a disadvantaged background)
    - — Individuals with a life-altering disability
- Must have earned a bachelor's degree within the past three years, or open to seniors about to graduate in a biomedical science discipline
- Planning to pursue a Ph.D. degree in biomedical science
- Website: http://www.mayo.edu/mayo-clinic-graduate-school-of-biomedical-sciences/programs/postbaccalaureate-research-education-program-prep
- Contact: Dennis Mays Ph.D.: *mays.dennis@mayo.edu*

Medical Residency

Website: http://www.mayo.edu/mayo-clinic-school-of-graduate-medical-education/residencies-fellowships?_ga=2.221146012.548819923.1506373119-222486115.1497446847

ETHICAL CONSIDERATIONS

The melting pot of expectations, hope, responsibility, idealism, and realism in the field of stem cell research need to be carefully considered.

Is government-funded stem cell research carried out ethically?

Stem cell research, like any field within biomedicine, poses social and ethical concerns. As a funding agency, the National Institutes of Health (NIH) has comprehensive policies to govern research. NIH-funded researchers must comply with a comprehensive set of regulations that have been carefully developed and are in accordance with national and international standards.

- Policies on the conduct of stem cell research: http://nas-sites.org/stemcells/

What is stem cell tourism?

International (and even domestic) clinics have begun advertising unproven therapies at great cost to the patient and at great profit to the clinic—this is referred to as stem cell tourism. A closer look will often reveal no information about what type of stem cells are being used. These sites also rely on video testimonials from patients soon after the stem cell injections, but little information provided about how those people fared long-term.

Patient Advisory for Stem Cell Therapy and Medical Tourism

Advancement of clinical therapies is best done in the setting of rigorous and formal clinical trials. To ensure safety and proper management of patient's rights, physicians, patients and family members can look for specific things in a clinical trial, such as:

- Approval from FDA or similar country-specific regulatory agencies.
- Peer-reviewed publications demonstrating pre-clinical safety and efficacy in support of the clinical trial. Peer reviewed publications are articles in professional journals that are only accepted after appropriate review by expert professionals in the same field.
- Review and approval by an independent Ethics Committee or Institutional Review Board (IRB). A copy of this approval should be available to patients. Ethics Committees or IRBs review clinical trial research on humans at a treating facility, clinic, or hospital setting to assure that the research is ethical and that patients are protected.
- Disclosure of the investigator or person offering the treatment. This disclosure should include any possible conflicts of interest or financial benefit.

Additional Resources

- How are stem cells regulated? http://www.aabb.org/aabbcct/therapyfacts/Pages/regulated.aspx
- Cell therapy medical tourism: Time for action http://c.ymcdn.com/sites/www.celltherapysociety.org/resource/resmgr/uploads/files/Resources/Regulatory/CT_Medical_Tourism_ISCT_WP.pdf
- Nine things to know about stem cell treatments http://www.closerlookatstemcells.org/stem-cells-and-medicine/nine-things-to-know-about-stem-cell-treatments

Gene Editing

Recently developed techniques to easily modify DNA are bringing many new possibilities as well as dilemmas to the forefront of medicine and ethics. One technique in particular, referred to as "genome editing," has attracted much attention among scientists, policymakers, and the general public.

Genome editing allows scientists to make changes to specific "target" sites in the genome – almost like using a molecular scalpel to alter individual sections of genetic code. One of the tools for performing genome editing, known as Clustered Regularly Interspaced Short Palindromic Repeats or, "CRISPR" (pronounced like the word "crisper"), has generated the most excitement due to its efficiency and ease of use. Researchers have used CRISPR in plants, animals, and human cells; in fact, CRISPR has worked in all species examined to date. Much of the research on using CRISPR for treating disease is focused on introducing genetic changes in cells, such as those in blood, lungs, or brain, that would not affect the genome of the individual's future offspring.

Because such genetic changes could be passed on to future generations, germline editing has been the subject of particular concern and discussion by scientists, ethicists and the broader public.

CLASSROOM RESOURCES

Mayo Clinic Resources

Mayo Clinic Research Information Center

- Visit the Research Information Center to learn more about medical research at Mayo Clinic.
- The Research Information Center is located in the Gonda Building near the street-level information desk
- Learn more at: http://www.mayo.edu/research/about/information-center

MayoClinic.org

- For the most current consumer health information, search the www.mayoclinic.org website for:
  - "stem cells"
  - "regenerative medicine"

Regenerative Medicine Minnesota (RMM)

- RMM was established in May 2014 by the Minnesota State Legislature. State-wide financial support has been allocated for 10 years to fund research, education, patient care, and business development initiatives that advance regenerative medicine for all Minnesotans.
- Learn more at: http://www.regenmedmn.org/
- RMM awards several education grants each year. Education proposals are usually accepted in the spring. Learn more at: http://www.regenmedmn.org/apply-grant
- Tolar, J., Terzic. A. Regenerative Medicine Minnesota: Transforming the future of healthcare. Minnesota Physician. 2017; August:1. https://issuu.com/mppub/docs/mp_0817_web2. Accessed Sept 11, 2017.

Minnesota Children's Museum

- Learn more at: https://mcm.org/visit/rochester

The International Society For Stem Cell Research

- This independent non-profit organization aims to be the voice of the stem cell research community providing authoritative, up to date information.
- Learn more at: http://www.isscr.org/
- Check out their educational website, A Closer Look at Stem Cells for additional resources: http://www.closerlookatstemcells.org/

SweetRush Modules

The following online education modules, developed by Mayo Clinic and SweetRush, Inc., provide introductory information on regenerative medicine concepts.

Module 1: Regenerative Medicine Fundamentals http://www.mayo.edu/blackboard/2016/MSCPD/RegMed/RegMed_M1/story.html

Module 2: Stem Cell Fundamentals http://www.mayo.edu/blackboard/2016/MSCPD/RegMed/RegMed_M2/story.html

Module 3: Regenerative Medicine Ethical Considerations http://www.mayo.edu/blackboard/2016/MSCPD/RegMed/RegMed_M3/story.html

Module 4: Mayo Clinic: Advancing the Field of Regenerative Medicine http://www.mayo.edu/blackboard/2016/MSCPD/RegMed/RegMed_M4/story.html

Supplemental Videos

The videos listed in this section can be used, where appropriate, in your own classroom with your students.

A good introductory video for all students can be accessed through the Exploratorium: https://www.exploratorium.edu/video/stem-cells-cells-potential-scientists-view.

3rd grade lesson plan

"Newt Limb Regeneration." Howard Hughes Medical Institute Video. Online Video Clip. HHMI.org. Accessed on Sept 14, 2017. http://www.hhmi.org/biointeractive/newt-limb-regeneration.

5th grade lesson plan

"How do stem cells work? — Bang goes the theory." BBC Video. Online Video Clip. YouTube.com. Accessed on Sept 14, 2017. https://www.youtube.com/watch?v=cEB8656TCIE&feature=youtu.be. (Stop video at 1 minute, 17 seconds.)

"3D Printing 101." University of New England Video. Online Video Clip. YouTube.com. Accessed on Sept 14, 2017. https://www.youtube.com/watch?v=JygeEJqVvrY.

"Beating cardiomyocytes." Mayo Clinic. Van Cleve Cardiac Regenerative Medicine Program. 2016.

7th grade lesson plan

"How do stem cells work? - Bang goes the theory." BBC Video. Online Video Clip. YouTube.com. Accessed on Sept 14, 2017. https://www.youtube.com/watch?v=cEB8656TCIE&feature=youtu.be. (Stop video at 1 minute, 17 seconds.)

"3D Printing 101." University of New England Video. Online Video Clip. YouTube.com. Accessed on Sept 14, 2017. https://www.youtube.com/watch?v=JygeEJqVvrY.

SCIENCE PROJECTS

Check out the following resources for additional hands-on activities with your students.

Genetic Science Learning Center. Stem Cells. Learn. Genetics website. http://learn.genetics.utah.edu/content/stemcells/. Updated July 10, 2014. Accessed September 14, 2017.

Southworth C. Regenerate! Interactive classroom games and activities. EuroStemCell web site. http://www.eurostemcell.org/regenerate-interactive-classroom-games-and-activities. Updated April 1. 2012. Accessed September 14, 2017. "The set contains three fun, interactive activities that can be adapted for different ages and abilities from 11 year olds upwards."

Tinus D. Earthworm Science Projects. Sciencing web site. http://sciencing.com/earthworm-science-projects-7909412.html. Updated April 25, 2017. Accessed September 14, 2017. Regenerating Worms: "This project works best with higher elementary or middle school children and shows how worms can regenerate the parts of their bodies that are cut off."

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2. Introduction: What is the UbD framework [white paper]. Alexandria, VA: ASCD; March 2012. http://www.ascd.org/research-a-topic/understanding-by-design-resources.aspx. Accessed September 14, 2017.

3. Minnesota Department of Education. Minnesota K-12 Academic Standards in Science (2009) web site. http://education.state.mn.us/MDE/dse/stds/sci/. Accessed September 14, 2017.

4. Next Generation Science Standards. https://www.nextgenscience.org/, Accessed September 14, 2017.

5. McConnell, S. Talking drawings: A strategy for assisting learners. *Journal of Reading.* 1993; 36(4), 260–269.

6. Paquette KR, Fello SF, Renck Jalongo M. The Talking Drawings Strategy: Using Primary Children's Illustrations and Oral Language to Improve Comprehension of Expository Text. *Early Childhood Education Journal*. 2007; 35(1):65-73.

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This facilitator guide was crafted by the Exploring the Body's Regenerative Building Blocks team: Alissa Cornell, Jilian Foxen, M.Ed., Amanda Golden, M.L.S., Christopher Livia, M.D., Ph.D.-candidate, Joseph Taraba, Henry Walker, Saranya Wyles, M.D., Ph.D.

NOTES

Biographies

Alissa Cornell is an Operations Manager in the Center for Regenerative Medicine (CRM) at Mayo Clinic. In her role she provides the necessary support to researchers, clinicians and laboratory staff to strategically integrate regenerative medicine into new models of care. Ms. Cornell also provides support and oversight for CRM's educational initiatives that are collectively developing the regenerative workforce of the future. Ms. Cornell first joined Mayo Clinic in 2002 as a Supervisor for the Department of Linen & Central Services (LCS) managing workflow and functions related to disinfection, processing, sterilization, and distribution of sterile and non-sterile linen, patient care supplies and equipment. In 2006 she became the Quality Supervisor for LCS and was instrumental in establishing the department's quality management system and continuous improvement activities. In 2008, Ms. Cornell joined the Division of Management Engineering and Internal Consulting (MEIC) as a Senior Health Systems Engineer. As part of Mayo Clinic's internal business consulting and management engineering team, she leveraged robust systems, process, and management engineering methodologies, innovative knowledge-sharing tools, strategic management frameworks and advanced project management approaches to drive high value results for her clients. Prior to joining Mayo, Ms. Cornell worked in alternative education providing operational oversight and clinical services for a facility serving clients ages 12-17. She holds a BA in Psychology with a minor in Cell and Molecular Biology from Winona State University.

Jilian L. Foxen, MEd, is Program Manager for the Cardiac Regeneration Program in the Center for Regenerative Medicine. She has been at Mayo Clinic ten years, supporting cardiovascular research encompassing basic, translational and clinical trials research. In her current capacity, she manages and participates in the breadth of research projects in the Cardiac Regeneration Program working with collaborators across the institution and externally. She holds the academic rank of Instructor of Medical Education in the College of Medicine at Mayo Clinic and is active in multiple efforts, including Regenerative Medicine education, education for medical students and community outreach, professional development courses for allied health staff, and design and development of patient education resources.

Amanda Golden, MLS is a Research Medical Writer within the Cardiac Regeneration Program. She has been at Mayo Clinic since 2006. She helps investigators in proposal writing and provides editorial support for abstracts and manuscripts. Prior to joining the Cardiac Regeneration Program, she was an editorial research librarian for Mayo Clinic consumer health publications. She received her MLIS from the University of Kentucky, and a BS in English Literature from Bellarmine University.

Alexandra Greenberg, PhD, is an Assistant Professor of Epidemiology and the Translational Integrator for the Biomaterials and Biomolecules cGMP Facility at the Mayo Clinic Center for Regenerative Medicine. She serves as one of the leaders for the educational programming in regulatory, translational, and team science being developed within the newly FDA-funded Yale University-Mayo Clinic Center for Excellence in Regulatory Science and Innovation (CERSI) and the Mayo Clinic Center for Clinical and Translational Science (CCaTS). Before joining Mayo Clinic in 2016, Dr. Greenberg completed the Cancer Prevention Fellowship Program at the National Cancer Institute in the Division of Cancer Control and Population Sciences. She received her PhD from Mayo Clinic Graduate School of Biomedical Sciences in Clinical and Translational Science and an MPH in Quantitative Methods from the Harvard TH Chan School of Public Health. Dr. Greenberg has published on a variety of different cancer- and translation-related topics, including rural-urban disparities in health technology utilization, barriers and challenges to clinical translation and the role of technology in oncology. She currently serves as an extramural consultant for the National Cancer Institute's Health Information National Trends Survey (HINTS).

Christopher Livia is a fourth year MD/ PhD student in the Medical Scientist Training Program. He is currently working in the Cardiac Regeneration Program, with his doctoral thesis concentrating on the study of non-cellular therapies or regeneration in the heart after ischemic injury. He is also developing new methods and strategies of organ preservation for heart transplantation. Christopher graduated from Florida International University summa cum laude with a BS in Biological Sciences with honors. Prior to joining the Cardiac Regeneration Program, he worked in a lab developing lentiviral based gene-therapies for glaucoma.

Adaheid (Heidi) Mestad's professional and educational background focuses on designing purposeful experiences for engagement, connection and experiential learning. Her graduate degrees are in Anthropology and Experience Design at George Washington University and has applied such social and business design practices cross industries; urban revitalization, museums, public space, patient/health care experience and community/cultural organizational growth. Her leadership continues to identify and design relevant organizational, systemic, place-based and programmatic opportunities to better a person's connection to space and self.
Heidi's portfolio includes, Smithsonian, Natural History, Meridian International Center, Science Museum of Minnesota, Rochester Downtown Alliance, Mayo Clinic Patient Experience Design, Destination Medical Center and Minnesota Children's Museum

Jon Ninas works in Recruitment Strategies at Mayo Clinic, developing and managing Mayo's long-term recruitment programming geared towards middle school, high school and college undergraduate students. His focus is exposing students to the wide breadth of career opportunities in healthcare, and offering them the tools and experiences to confirm a career choice. Jon has a Bachelor's Degree in Communication Studies from the University of Minnesota, and worked in the areas marketing and higher education prior to coming to Mayo Clinic in 2011.

Zachary Resch, PhD, is Assistant Professor of Medicine, Mayo Clinic College of Medicine and the Program Manager for the Center for Regenerative Medicine's Biotrust. As the cellular-based technical platform within the Center for Regenerative Medicine, the Biotrust provides end-to-end services for the generation and validation of adult-derived, induced pluripotent stem cells. These biomaterials serve several functions to internal and external collaborators including: disease in a dish modeling systems for determining pathophysiology of disease, optimized drug screening platform based on individualized genetic contributions as well as forms the functional unit of novel regenerative therapeutics. Dr. Resch attended Gustavus Adolphus College as an undergraduate, completed his doctoral work at the University of North Dakota School of Medicine and completed fellowship training at Mayo Clinic – Rochester in the Division of Endocrinology.

Sinibaldo Romero is a Post-Baccalaureate student in the PREP Program. He is currently working in the Cardiac Regeneration Program, focusing on stem cell therapies. His work focuses on characterizing and further developing the cardiopoietic stem cell phenotype, stem cells that help to regain heart function after an ischemic injury. Sinibaldo graduated from North Dakota State University cum laude with a BS in Biotechnology and Zoology. His undergraduate experience in stem cell biology and organismal development fostered his desired to pursue a scientific career with a focus in translational research. Prior to joining the Cardiac Regeneration Program, he worked as a research technician in the Department of Immunology at the Mayo Clinic using mouse models to understand T cell development and maturation.

Ramandeep Takhter, PhD, is an Assistant Professor of Biochemistry and Molecular Biology. His research focuses on cardiovascular protection and regeneration, including creating a cell-free platform to deliver genes of interest for targeted and temporally restricted genes therapy. The ultimate goal of Dr. Takhter's research activity is to revolutionize care for patients with heart attacks, as it could lessen or even stop the progression towards fatal heart disease.

Joe Taraba has over 15 years' experience in operations, project and program management and currently serves as a Project Manager within the Center for Regenerative Medicine at the Mayo Clinic. In his current role, Joe is working with physicians and Mayo staff to plan, organize and deliver strategic initiatives in the areas of Diabetes and regenerative medicine education. A native Texan, Joe joined Mayo Clinic in the spring of 2017. Prior to Mayo, Joe worked at various Fortune 500 companies in the financial and I.T. sectors where he created and implemented several business improvement processes which resulted in greater bottom line revenue and significant improvements within the customer experience. Joe received his BBA in Finance from Texas A&M University and is certified in Lean Six Sigma, Scrum Methodology and is pursuing his PMP certification.

Brandon Tefft, PhD, is a Research associate in cardiology. He received his PhD from Northwestern University and his research interests include vascular tissue engineering, organ printing and molecular dynamics.

Cody Wyles, MD, is currently a Resident in Orthopedic Surgery. He received his MD/MS from the Mayo Clinic School of Medicine. His research interests include understanding regenerative medicine applications in orthopedic surgery.

Saranya Wyles, MD, PhD is a Resident in Dermatology. She received her MD/PhD from the Mayo Clinic School of Medicine. Her research interests include regenerative medicine applications in dermatology, acting as the Program Director for Regenerative Medicine and Surgery Selective for Minnesota medical students.

Henry Walker manages Mayo Clinic's Advanced Product Incubator (API), which — while adhering closely to FDA regulation — is used to translate novel research ideas into value-added patient outcomes. As API's manager, Henry tries to ensure that Mayo Clinic patients receive safe, cutting-edge care as quickly as possible. Among other strategies, his team helps accomplish this task by building relationships with industry partners and designing process solutions for each new product. Since joining Mayo Clinic in 1993, Henry has engaged in virtually all aspects of bio-pharmaceutical manufacturing from the concept to patient pipeline. This includes knowing the underlying biological mechanisms of the human body, engineering tools to facilitate manufacturing, and managing facilities. Henry also has an in-depth understanding of FDA manufacturing regulations.