Meet the Lab

Nervous System Engineers: Superpowered by Stem Cells

Educator Guide

PBS Wisconsin Education
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Table of Contents

Project Background: *Meet the Lab* and STEAM Identity

Meet the Lab is a series of learning media resources designed to introduce middle school students to scientific research through a human lens. This makes it different from many online science education resources that focus solely on science content learning (the "what" and "how" of science learning). Instead, *Meet the Lab* was created to focus on the "why" and the "who" of science learning, addressing two specific challenges in the science classroom:

As a science teacher, how do I:

- Connect science learning to the community at-large and to real-world problems in a way that resonates with my students?

- Connect science learning to my students' identities, and illuminate possible academic and career pathways for them to pursue?

Meet the Lab offers media resources and activities that we hope will serve you as you dig into these challenges. Each lab starts with a context-setting video that describes real-world problems that are relevant to student lives. We follow that with a second video and two activities that introduce students to multiple real-life scientists (as well as real lab content and practices), with a goal for students to relate to the scientists personally and to consider the possibilities of STEAM in their future.

A student's STEAM identity ("Who do I think I am, who can I be, where do I belong, and how do others see me?" in context of Science, Technology, Engineering, Arts, and Math) starts to develop very early on. Middle school is a critical time for students to actively construct their identities, and identify directions and possibilities for their lives. The science classroom is one place for students to develop an internal drive for science, and to see science and career pathways in science as relevant and accessible.

Meet the Lab features lab teams (rather than only featuring individual scientists), showing how diverse groups of people work together across disciplines to pursue answers to questions about our world. We hope this will support a parallel vision for student groups in your science classroom to work together as they enact scientific practices to answer relevant scientific questions.

Learning Goals

By using Meet the Lab resources, students will:

Learning Goal	**Project Component**
Make connections between lab research and why it matters in real life.	*Why Research Matters*
Identify scientific practices researchers use and apply these same practices to classroom experiments.	*Science Practices*
Identify strengths in science, and relate to people in science careers.	*Meet the Scientists*

Meet *This* Lab: Stem Cell Bioprocessing and Regenerative Biomaterials Lab

This set of education resources introduces students to the researchers at the Stem Cell Bioprocessing and Regenerative Biomaterials Lab at the Wisconsin Institute for Discovery, and helps students uncover some of the patterns researchers use to create new platforms for brain research. Researchers at the lab use stem cells and engineering tools to develop new platforms for the formation of neural tubes—like 2D and 3D tissues. The long-term goal for these platforms is to replace animal models as a drug discovery platform, by using patient cells to make these 2D and 3D tissues to develop new drugs and treatments for brain-related disorders (such as ALS, Parkinson's, Alzheimer's, and others).

Before using resources about this lab: Students should have prior knowledge of the body as a system. Organisms are made of cells and those cells can work together to form tissues which make up organs and connect into systems of the body. They should also have a basic familiarity with the parts of the human nervous system.

Founder and Principal Investigator: Randolph (Randy) Ashton

Randy's Education:

- Brookland Middle School (Henrico, VA)
- BS, Hampton University (Hampton, VA)
- PhD, Rensselaer Polytechnic Institute (Troy, NY)
- Post Doctoral Fellow, University of California-Berkeley (Berkeley, CA)

Randy says, "I founded this lab because I want to improve human health by moving my lab's stem cell-based bioengineering research into clinical and commercial settings."

Activating the *Why Research Matters* Content

This video features one young person's story of how a spinal cord injury impacted their life and what they did to get involved in helping others as a result. The story is meant to elicit discussion about the impact of nervous system injuries and diseases, and how science is a pathway to bring about a better understanding of what can go wrong in the nervous system. The video highlights how motivation and people drive the creativity necessary for science to look for ways to repair and treat nervous system injuries and disorders.

Watch the video, and then discuss it in small groups or as a class. Use the following questions (also featured next to the video) if helpful in promoting discussion.

1. Miranda's respect for her physical therapists inspired her to pursue a career in science. What interactions have you had with people in science careers? What did they do and how have they influenced you?

2. Miranda's injury prompted her to learn more about stem cells. What do you already know about stem cells? What do you want to know about how they work or what they can do?

Activating the *Science Practices* Content

This video focuses on the tools researchers at the lab use, the practices used to conduct investigations, and the crosscutting concept of patterns that is integral to the lab. In the video, researchers from the lab answer questions posed by middle school students. Watch the video as a class and then discuss it in small groups or together as a class. Use the questions below (also featured on the web page next to the video) to guide your discussion, if helpful.

- Researcher Carlos talks about how the lab grows stem cells inside molds, and that using different mold shapes can encourage stem cells to grow into entirely different types of tissues. Can you think of common items that are made of the same material, but have different functions due to the different molds they were made in?

- This lab's work is in the field of bioengineering. If you break down the word 'bioengineering' into its parts, what does that tell you about what the lab does? What do you know about engineering and the engineering design process?

The accompanying slide deck activity allows students to closely examine the images one of the researchers has taken as part of bioengineering neural tissue. All of the images students will use come from the lab and are involved in real research projects.

The companion data sheet allows students to record their answers to questions posed by the researcher, before they move on to the next slide, where they reveal their answers. Encourage students to defend their own interpretation of the images and use evidence they see in the images provided.

The focus for students is to identify patterns of cells with different engineering frameworks to determine which version generates the best 'inner circle patterns of cells.' This is an NGSS crosscutting concept that should be made explicit as students are participating in the activity, that they are engaging in the same practice of bioengineering.

Activating the *Meet the Scientists* Cards

The researcher trading cards are meant to foster students' own STEAM identity by making a connection between themselves and a featured researcher.

Encourage students to review the trading cards from the scientists from the lab, keeping in mind the question “Who do you relate to the most and why?” and then have them discuss what they learned and their own answers to the question in small groups or as a class.

To extend the activity, share the list of superpowers (below) with your class, and ask students to identify which superpower(s) they have. Do they share a superpower with any of the scientists?

Sample superpowers:

Ambition
Compassion
Creativity and Originality
Deep Investigation
Dependability and Follow Through
Endurance and Perseverance
Enthusiasm
Flexibility
Heart and Passion
Imagination and Curiosity
Inclusive Communication
Organization and Order
Outgoing Optimism
Planning and Strategy
Precision and Attention to Detail
Sensitivity and Intuition
Spontaneity and Risk-taking
Super Helper Skills
Terrific Troubleshooting
Vision and Leadership

As an additional extension to the activity, invite students to create their own trading card using the downloadable PDF on the website.

To use the fillable PDF in the browser: Select “View” to open the PDF, fill in the text boxes, and use the “print” function to save as a new PDF (or to make a physical copy). To annotate the PDF in the browser you will need an extension (like Kami for Google Chrome), or you can download and print a physical copy to write on directly.

To use the fillable PDF in an application like Adobe Acrobat: Select the “Download” option. Open the file in your preferred program, fill in the text boxes, and use the “Save As...” function to save as a new PDF.

To use the PDF as a physical worksheet: Just download and print!

Curricular Connections

Are you teaching about cells (stem cells), the nervous system, or engineering? Consider having students create a model of what they think a stem cell is and how stem cells might be used as raw material to bioengineer tissues. Use the resources provided as a starting point to get ideas.

- Students can draw some of the things they think make a stem cell unique, write down their ideas and make connections between them.

- Once students have drawn and written their own ideas they could share ideas to make a team model. The tissues that are bioengineered in the activity with Carlos are more accurately referred to as organoids.

- Each team should share their ideas with the class. As a class see where one model addresses questions another model raises. What do we want to know as a class? What information do we need to improve our models? Create a list of questions the class has.

- If students watch the *Students Ask Scientists* video and/or complete the activity, return to these models after each to add and revise them. Check the class question list to see what students are learning to answer those questions on how the cross-cutting engineering practices interface with biology. Add more questions as necessary.

Standards Supported

Next Generation Science Standards (NGSS)
Disciplinary Core Ideas (DCI):

1. LS1.A: Structure and Function: All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). (MS-LS1-1) Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2) In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3)

NGSS Practice Standards

2. SCI.ETS1: Students use science and engineering practices, crosscutting concepts, and an understanding of engineering design to make sense of phenomena and solve problems.

3. SCI.ETS3: Students use science and engineering practices, crosscutting concepts, and an understanding of the nature of science and engineering to make sense of phenomena and solve problems.

Wisconsin Science Standards (WSS)
Disciplinary Core Ideas (DCI) — Life Science:

1. Learning Priority SCI.LS1.A.m: Structure and Function: All living things are made up of cells. In organisms, cells work together to form tissues and organs that are specialized for particular body functions.

    a. Example Three-Dimensional Performance Indicators: Conduct an investigation to provide evidence that living things are made of cells, either one cell or many different numbers and types of cells. (MS-LS1-1) Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function. (MS-LS1-2) Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. (MS-LS1-3)

Disciplinary Core Ideas (DCI) — Engineering, Technology, and the Application of Science:

2. Standard SCI.ETS1: Students use science and engineering practices, crosscutting concepts, and an understanding of engineering design to make sense of phenomena and solve problems.

3. Standard SCI.ETS3: Students use science and engineering practices, crosscutting concepts, and an understanding of the nature of science and engineering to make sense of phenomena and solve problems.

Meet the Lab resources will work with a Claims Evidence Reasoning and/or Conceptual Modeling approach to teaching. Support for implementing these frameworks can be found through the National Science Teaching Association.

Resources for More Information

On Modeling, Stem Cells, Bioengineering, and the Nervous System:

For information on the practice of modeling, go to the Wisconsin Department of Public Instruction website and search for "Science and Engineering Practices."
Link: https://dpi.wi.gov/science/standards/practices#model

Craig A. Kohn. TED video and curriculum produced in conjunction with the UW Stem Cell and Regenerative Medicine Center and the Morgridge Institute for Research.
Link: https://ed.ted.com/lessons/what-are-stem-cells-craig-a-kohn

For information on Bioengineering, go to PBS LearningMedia and search for the "Bioengineer" collection.
Link: https://wisconsin.pbslearningmedia.org/search/?q=bioengineer

The National Institutes of Health (NIH) have several resources for helping educators and students understand the Division of Discovery Science & Technology (Bioengineering).
Link: https://www.nibib.nih.gov/research-funding/division-discovery-science-technology-ddst

The nervous system is a complex network that regulates and coordinates your body's activities. Learn more about it here.
Link: https://www.pbs.org/video/d4k-nervous-system-video-short-wwbysl/

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