
Amp It Up! Engineering/Technology and Industry Lesson Extension

Teacher Name(s), School and District: Cheryl George, Danvers High School

Course Name: 9th grade Biology

Lesson/Unit Name: Trouble-shooting in Cell Signaling Research

Science or Education Topic(s): Engineering Technology Industry Related Field/Activity:

This lesson focuses on how CST antibodies are used in the research of diseases such as cancer and Alzheimers and how researchers use technology to troubleshoot inconclusive tests in their research of these diseases.

The following standards are addressed in this lesson:

English Language Arts - Common Core Standards

CCS.ELA-LITERACY.WHST.9-10.2A Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

CCS.ELA-LITERACY.WHST.9-10.2D Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

CCS.ELA-LITERACY.WHST.9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CCS.ELA-LITERACY.WHST.9-10.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

CCS.ELA-LITERACY.WHST.9-10.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Next Generation Science Standards

HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

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Massachusetts Curriculum Frameworks

Engineering Design:

1.1 Identify and explain the steps of the engineering design process: identify the problem, research the problem, develop possible solutions, select the best possible solution(s), construct prototypes and/or models, test and evaluate, communicate the solutions, and redesign.

Scientific Inquiry Skills Standards

SIS1. Make observations, raise questions, and formulate hypotheses.

SIS4. Communicate and apply the results of scientific investigations.

Biology Standards HS

Chemistry of Life:

1.2 Describe the basic molecular structures and primary functions of the four major categories of organic molecules (carbohydrates, lipids, proteins, nucleic acids).

Anatomy & Physiology:

4.7 Recognize that communication among cells is required for coordination of body functions. The nerves communicate with electrochemical signals, hormones circulate through the blood, and some cells produce signals to communicate only with nearby cells.

4.8 Recognize that the body's systems interact to maintain homeostasis. Describe the basic function of a physiological feedback loop.

When Taught: June 2015

Abstract: In 200 words or less, please provide a summary of your objectives, implementation, and the results of your implementation.

1. Prior to the lesson, students complete a web quest on the Immune System, learning how antibodies are made in the body, and investigate **monoclonal antibodies**, which are the type made by Cell Signaling Technologies.
2. Students will explore what a Western Blot test is and how and why it is used in the detection of antigens and antibodies in research and diagnoses of diseases.
3. Students use the information from their web quest and the western blotting protocol to help them as they explore the CST website. Students will investigate the role of antibodies in disease research in which they will investigate specific monoclonal antibodies made for use in microbiology research of different diseases as part of a research team.
4. Students will act as part of a research team to investigate a specific disease that CST makes antibodies for.
5. Students groups will then have an opportunity to play the part of the quality control team at Cell Signaling Technologies and be given a series of technical problems from "researchers" who are having trouble getting the correct Western Blot results for their on-going research.

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Objectives and assessment: Using the table below, identify at least 3-5 learning objectives (content and/or pedagogical) and describe how each will be assessed.

Objectives <i>By the end of this lesson/unit, the students will be able to:</i>	Assessment <i>How was the objective assessed? List the example of formative or summative assessment.</i>
Explain what an antibody is and its role in the Immune System and its special role in research.	Webquest (formative)
Teach their fellow scientists about the disease that they are investigating using CST antibodies	Visual and oral presentation to class (summative)
As a Quality Control team problem, solve a fellow researchers' poor Western Blot results and offer suggestions on how to get better results.	Write up w/ template & class discussion (formative)

Engineering/Technology Link: Please check the appropriate box(es) in question 1. And provide a brief answer to question 2.:

- How did you *introduce* engineering/ technology concepts or the company/industry focus in your course? Check the appropriate box(es) or choose Other.
 - X Defined terms (science, engineering, technology)**
 - Described the engineering design process
 - Engineering design challenge related to industry
 - X Overview of the company**
 - X Challenge based on 'industry specific' area of focus (manufacturing process, quality control, measurement, development, teamwork etc.)**
 - Other: _____

- After introducing the concepts, what did/will the students do to explore and apply the engineering/technology and industry specific concepts? (include information about the actual activity students did, discussions they had, or instructional strategies you used)

Students groups will be given a technical problem from a researcher who is having trouble getting the correct Western Blot results for their on-going research.

Level of Inquiry: Which of the following best describes the level of inquiry (adapted from Bell 2005) you used for this lesson/unit? Check the appropriate level.

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Structured inquiry: Instructor provides question and procedure. Students determine the results based on given procedures.

Lesson Extension Plan: Problem-Solving For Scientists

Title/Topic: When Western Blots Go Bad! How can an OTS production team help a researcher with bad results?
Time (minutes): 2-3 class periods, and outside class time to perform web quest on antibodies.
Company Name and brief Description: Cell Signaling Technologies, Beverly, MA The OTS Production Development Team. The responsibilities for the OTS team are production of new antibody products, performing and improving the quality of existing products, and managing a number of technical support cases.
Overview of the Lesson: Student groups will now play the role of an OTS (Off The Shelf) production team at CST. Students groups will be given a series of technical problems from researchers who are having trouble getting the correct Western Blot results for their on-going research.
Standard(s)/Unit Goal(s) to be addressed in this lesson: <i>SIS1. Make observations, raise questions, and formulate hypotheses.</i> <i>SIS4. Communicate and apply the results of scientific investigations</i> <i>HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</i>
Essential Question(s) addressed in this lesson: How do production development scientists assure quality control of their antibody products?
Objectives: <ol style="list-style-type: none">1. Identify some commonly researched diseases when given an antibody2. Discover the role of the Western Blot test in research.3. Problem-solve with a group when given a poor Western Blot result scenario4. Present their findings to a group of peers
Link to Industry: <ol style="list-style-type: none">1. Students will become aware of the role Cell Signaling Technologies plays in disease research and antibody production2. Students will learn what a production development scientist, and their role in assisting researchers who buy their products for researching diseases.
What students should know and be able to do before starting this lesson <ol style="list-style-type: none">1. Be able to navigate the Internet2. Work collaboratively3. Present their findings to the teacher and their peers
Instructional Materials/Resources/Tools <ol style="list-style-type: none">1. Laptop carts and Internet access2. All worksheets will be shared electronically with students

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Lesson Delivery
Lesson Opening Students complete a web quest on the Immune System, and investigate monoclonal antibodies , the type of antibody that CST produces for the use of microbiology research of different diseases.
During the Lesson (activities/labs/challenges) <ol style="list-style-type: none">1. Students will act as part of a research team of 3 to investigate a specific disease that CST makes antibodies for. Students will be randomly assigned an antibody and must complete research to determine the disease that the antibody is associated with. Students will complete a template to help them organize their thoughts.2. Research teams will present their findings to their fellow researchers in a multimedia or poster presentation.3. Students will explore what a Western Blot test is and how it is used in the detection of antigens and antibodies. As a class, students will watch the CST protocol on Western Blots. Over one thousand Western Blots are performed daily at CST and are used as quality control to validate thousands of manufactured antibodies. https://www.youtube.com/watch?v=yUstng0npaY.4. Students groups will then be given a series of technical problems from researchers who are having trouble getting the correct Western Blot results for their on-going research. Students will investigate where the researcher may have made a mistake in their testing, and how to fix the problem.5. Students will report their findings to the other researchers in the class.
Lesson Closing Students will present their disease research to the class either by poster or Powerpoint presentation.
Assessment
Student Assessment: Students will complete a visual and oral presentation of their disease research as well as their solving of the technical problems
Delivery Assessment: Students will be assessed by their ability to work collaboratively, on their visual presentation, and oral presentation by a rubric

Additional resources and assessments: List the attachments here.

Attachments should include handouts, readings (with references), lab write-ups, rubrics, exams/quizzes, and/or other similar materials.

Web Quest For the Immune System (Pre-lesson homework activity)

In this activity, You will learn about the immune response and the role of antibodies in the body

Website: <https://www.niaid.nih.gov/topics/immunesystem/Pages/default.aspx>

Select **Overview Of The Immune System**

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What is the function of the immune system?

What are DAMPS?

What are PAMPS?

Now, read **The First Line of defense**.

What is a pathogen? List three pathogens.

Any substance that stimulates an immune response is known as an _____

Read through **The First Line of defense- non-specific barriers**.

List the six body parts that represent the first line of defense.

Which was most surprising to you?

Click on: Second line of defense

Fill in the table with a brief description of each type of immune cell and provide a brief sketch of each

granulocytes	cell sketch	definition
neutrophil		
eosinophil		
basophil		
agranulocytes	cell sketch	definition
lymphocyte		
monocyte		

What is the major difference between granulocytes and agranulocytes?

Read: **The third line of defense**

Describe a specific immune response

What is the difference between a self-antigen and a non-self antigen?

Watch the movie Antibody Production: <https://www.youtube.com/watch?v=KpNFAEbLcvk>

What is an antibody? What type of cell produces antibodies?

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How does the shape of an antibody allow it to do its job?

How Lymphocytes produce antibodies Cells Alive! site: <http://www.cellsalive.com/antibody.htm>

What type of “big eater” responds when an antigen infects the body?

Monoclonal Antibodies video: <https://www.youtube.com/watch?v=0A99pk6kpS4>

What is a monoclonal antibody?

Skip to 2:51 and watch. What was Muromonab used for?

Watch the video to 3:48. What are two other diseases that are treated with monoclonal antibodies?

What is the source of Muromonab?

Monoclonal antibody production:

<http://www.dnatube.com/video/27678/Explanation-of-Monoclonal-Antibody-Production>

What type of cell is the source of a monoclonal antibody?

Describe two uses for monoclonal antibodies.

What is a hybridoma?

What two types of cells are hybridomas made from?

What are the conditions that the cells are cultured in?

Disease Research and Antibody Use

You are part of a research team that is tasked with investigating a mystery disease. You are given a clue, and that is an antibody that is routinely used in the research of this disease. This antibody is made at Cell Signaling Technologies. Please choose ONE antibody from the list that follows:

Neurofilament L rabbit mAb
LRRK rabbit mAb
BRCA1 antibody

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Go to the CST website: <http://www.cellsignal.com/product/productListing.jsp?N=102236> and enter the antibody in the product search area.

Look under the **Product** section and look for the disease that this antibody is used for in research.

Research template

Chosen antibody _____
Animal source of antibody _____
Name of disease _____

Now, each member of your research team will use the Internet to investigate ONE of the following:

Symptoms of the disease	
Treatment Options	
3 other antibodies used in the research of this disease	

You will first share your findings with your team members, and then present your findings to the class with a visual presentation as well as an oral presentation.

Options for visual presentation: Choose ONE:

- Poster
- Power Point presentation

Worksheet For Quality Control in Western Blots Activity

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When Western Blots Go Bad!

The scenario

You are part of a *OTS (off The Shelf)* production team of scientists at Cell Signaling technologies. Part of your job is to produce and validate the antibodies made by Cell Signaling Technologies. Another part of your job is to respond to researchers who are having technical problems getting the correct Western Blot results for their on-going research. Your team of three will be given a description and images of invalid Western Blot results, and based on your research and discussion will decide what the researcher may have done wrong in their protocol, and how they can fix it.

Instructions: Watch Western Blots protocol <https://www.youtube.com/watch?v=yUstng0npaY> and answer these questions:

1. What is a Western Blot?
2. What is CST's recommendations with regard to their antibody use in Western Blot protocols?
3. Why does CST recommend both a positive and negative control when performing Western Blots?
4. How often are Western Blots performed each day at CST?

Your team will be randomly assigned a scenario of a poor Western Blot result. Use the following websites to assist you. Problems can include: no signal, high background, or multiple bands shown on the gel plate.

<http://www.cellsignal.com/common/content/content.jsp?id=western-trouble> CST trouble-shooting guide

<http://bitesizebio.com/19799/the-top-10-western-blotting-mistakes-and-solutions/> top 10 Western Blotting mistakes

<http://www.abcam.com/protocols/western-blot-troubleshooting-tips> Western Blot troubleshooting tips

Template

Customer reports invalid result on Western Blot- What are they experiencing? What is the definition of the problem?	
Possible causes for invalid test- how did the customer perform the test? What reagents did they use, etc...	
What will you tell the customer? Possible solutions to fix the problem	

Each member of the student team will investigate one of these parts of the scenario, and brief the other team members on their findings. Research groups will then present to the teacher and other student groups in an informal class discussion.