

**Understanding Vaccines and the Immune System  
Is This Really “New” Science?  
A Unit for Middle School Students**

Mary Janelle Low, M.S. Edu  
McCord Junior High  
4304 N. McCord Rd.  
Sylvania Ohio, 43560  
[mjlow@sylvaniaschools.org](mailto:mjlow@sylvaniaschools.org)

Mentor: Dr. Ritu Chakravarti, Ph. D  
Department of Physiology and Pharmacology, University of Toledo  
Funded through The American Association of Immunologists

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**Abstract:** This unit has been designed to introduce middle school aged students to the history of vaccinations and their development and help demystify the research and development of vaccinations by increasing their understanding of viruses, the immune system, and the immune response.

### **I. Science Background**

- a. Basic understanding of the innate and adaptive immune system.

### **II. Student Outcomes (Middle School)**

- a. History of vaccines and variolations.
- b. Students will understand that the study of viruses, vaccinations, and immunology has been ongoing for centuries.
- c. Students will have a basic understanding of the innate and adaptive immune systems, and how the understanding of how the immune system works has aided in the development of vaccines to prevent diseases.
- d. NGSS Standards:
  - i. MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
  - ii. MS-LS1-2. Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.
  - iii. MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
  - iv. MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
  - v. MS-LS1-1. Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.

### **III. Learning Objectives**

- a. Students will create a Google Slides class presentation on the History of Vaccines and be able to identify influential cultures and individuals involved in vaccine research and development using the class created timeline.
- b. Students will have a general understanding of the innate and adaptive immune responses and be able to identify which immune response is involved in various different scenarios.
- c. Students will understand how the immune system works to help them understand the benefit of vaccines to society.

### **IV. Time Requirements**

- a. Timeline for the History of Vaccinations should take 2-2.5 class period depending on how much research time is assigned as out of class work.
- b. 1 class period to introduce the immune system and its major components.

- c. 2-3 class period to discuss the innate immune response and complete the activity and questions associated with the Immune System Analogy Poster Project and have group presentations.
- d. 1 class period to discuss vaccinations and how they work and discuss Unit Review.
- e. 1 class period for Unit Review and Kahoot Review Game (assessment).
- f. Final class period for group discussion with reflection of how their understanding of vaccinations and the immune system has changed since the beginning the unit.

#### **V. Advance Preparation**

- a. Materials for the project should be readily available.
- b. Create group assignments beforehand to allow for best overall outcomes with comprehension and participation.

#### **VI. Materials and Equipment**

- a. Computer access
- b. Poster Paper with crayons, colored pencils, markers
- c. Whiteboards with dry erase markers

#### **VII. Student Prior Knowledge and Skills**

- a. No in-depth knowledge is required for this unit. Basic cell parts can be reviewed if necessary.

#### **VIII. Daily Unit Plans**

- a. Daily Lesson Plans

#### **IX. Summative Assessment**

- a. No summative assessment is given with this unit, although we will play a Kahoot Unit Review game after reflecting on how their understanding of vaccines and the immune system has changed since we started the unit. The Kahoot Review will serve as a formative assessment to allow me to get a basic understanding of comprehension and retention.

#### **X. Appendix**

- a. History of Vaccines Timeline Activity
- b. Daily Lesson Plans

## Google Slides

### History of Vaccinations Interactive Timeline Activity

#### Lesson Questions

- Are vaccines really “new” science?
- What societies and people have been involved in the development of vaccines?
- How has society benefited from the development of vaccines for diseases such as smallpox?

#### Lesson Objectives

- Students will work in groups to research the history of vaccinations and then as a class combine their research to create a timeline on the history of vaccinations using Google Slides.
- Students will understand that vaccination development is not a recent development but has been happening throughout different cultures and societies for hundreds of years.
- Students will research and analyze possible ethical issues within the history of vaccine development.

#### Overview

In this activity, students will be divided into groups to research the history of vaccination development via websites such as:

- [The History of Vaccines - An Educational Resource by the College of Physicians of Philadelphia](#) (The College of Physicians of Philadelphia)
- [Smallpox: The Threat and Terrible Scourge](#) (NIH)

Each group will be given a specific time period to research possible specific individuals, cultures, and terminology. Slides should contain links to sites used in research, including any video lessons used. After researching their time period the students will create 1-2 slides representing the time period or individual they researched, using Google Slides. At the end of the activity, all groups’ work will be consolidated into an interactive timeline using the Google Slides App.

#### Length (2-2.5 class periods)

- Engage student interest by asking the question: “What are vaccines, and are vaccines “new” science?” Have them record their answers in their science notebooks or on a sheet of paper and have them draw what think a scientist who studies vaccines and diseases looks like.
- After students record their answers and finish their drawings have those that are willing to share their ideas and pictures. Record common responses on a whiteboard.
- Finish the class period by introducing the research project on the History of Vaccinations:
  - Groups will be assigned time periods and specific individuals to research and create a shared document within their group allowing for sharing of researched questions and links to where information was found. This may be assigned as an out of class activity.
  - One class period to create 1-2 slides to present the information researched. Each slide should contain a picture or graphic.
  - 5 minutes for individual groups to present their timeline slides once all group slides are placed in chronological order on one presentation.
  - 20-minute interactive classroom discussion about the research and ethical concerns groups may have encountered during their research.

**NGSS Standards**

- **Science is a Way of Knowing:**
  - Science knowledge has a history that includes the refinement of, and changes to, theories, ideas, and beliefs over time.
- **Scientific Investigations Use a Variety of Methods:**
  - Science investigations use diverse methods and do not always use the same set of procedures to obtain data.
  - New technologies advance scientific knowledge.
  - Scientific investigations use a variety of methods, tools, and techniques to revise and produce new knowledge.
- **Science is a Human Endeavor:**
  - Scientific knowledge is a result of human endeavor, imagination, and creativity.
  - Individuals and teams from many nations and cultures have contributed to science and to advances in engineering.

**Materials**

- Chromebooks
- Group Research Topic Sheet with Rubric (printed and shared)

**Research Groups (2-3 students)**

Group	Time Period	Information that must be included in the presentation
1	Early Chinese	<ul style="list-style-type: none"> <li>● Possibly as early as?</li> <li>● Which disease were they trying to prevent?               <ul style="list-style-type: none"> <li>○ Describe the disease</li> </ul> </li> <li>● Procedure used</li> <li>● Define Inoculation</li> </ul>
2	Early India	<ul style="list-style-type: none"> <li>● Possibly as early as?</li> <li>● Which disease were they trying to prevent?               <ul style="list-style-type: none"> <li>○ Describe the disease</li> </ul> </li> <li>● Procedure used</li> <li>● Define Inoculation</li> </ul>
3	The 1500s	<ul style="list-style-type: none"> <li>● Epidemics during this time period - India, Paris</li> <li>● What practice was used to help prevent?</li> </ul>
4	The 1600s	<ul style="list-style-type: none"> <li>● Epidemics during this time period - Paris</li> <li>● What practice was used to help prevent?</li> </ul>
5	The 1700s	<ul style="list-style-type: none"> <li>● <u>Lady Mary Wortley Montague</u> - Biography               <ul style="list-style-type: none"> <li>○ History with smallpox</li> <li>○ Who did they test on?</li> </ul> </li> </ul>
6	The 1700s	<ul style="list-style-type: none"> <li>● American inoculation               <ul style="list-style-type: none"> <li>○ <u>Benjamin Franklin</u> <ul style="list-style-type: none"> <li>■ How was he affected by smallpox and his response?</li> </ul> </li> </ul> </li> </ul>

		<ul style="list-style-type: none"> <li>● <u>John Adams</u></li> <li>● Colonial Army</li> </ul>
7	The 1700s	<ul style="list-style-type: none"> <li>● <u>Edward Jenner</u> - Biography <ul style="list-style-type: none"> <li>○ Research</li> <li>○ Where did the word “vaccine” come from?</li> </ul> </li> </ul>
8	The 1800s	<ul style="list-style-type: none"> <li>● Inoculations/Vaccinations throughout the world <ul style="list-style-type: none"> <li>○ Public Response</li> <li>○ What was happening with disease outbreaks?</li> </ul> </li> <li>● <u>Louis Pasteur</u></li> </ul>
9	The 1900s	<ul style="list-style-type: none"> <li>● <u>Maurice Hilleman</u></li> <li>● Two other influential scientists and their research</li> </ul>
10	The 1900s	<ul style="list-style-type: none"> <li>● <u>Jonas Salk</u></li> <li>● Two other influential scientists and their research</li> </ul>
11 & 12	Late 1970 - Present	<ul style="list-style-type: none"> <li>● Smallpox <ul style="list-style-type: none"> <li>○ Where is it now?</li> </ul> </li> <li>● Which diseases now have vaccines</li> <li>● Polio</li> <li>● Measles - What is it? <ul style="list-style-type: none"> <li>○ Outbreaks - Why?</li> </ul> </li> <li>● Whooping cough - What is it? <ul style="list-style-type: none"> <li>○ Why do we have outbreaks?</li> </ul> </li> <li>● Disease statistics since the introduction of vaccines</li> </ul>

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Daily Lesson Plans – 5E Instructional Model**

Day	Component	Description	Activity/Homework
1	<b>Engage</b>	In Science Notebooks answer: <ol style="list-style-type: none"> <li>1. What are vaccines?</li> <li>2. Are vaccines “new” in science?</li> <li>3. Draw a picture of what you think a scientist that studies diseases and vaccines looks like?</li> </ol> On the whiteboard record common answers. Compare students’ pictures of “scientists” and discuss similarities and differences.	
1	<b>Explore</b>	Discuss and assign “History of Vaccines Timeline” activity. Assign groups and discuss group responsibilities. Allow time to begin research	<a href="#">History of Vaccines Timeline Activity</a> Homework: Research topics and copy links into group shared document.
2-3	<b>Elaborate</b>          <b>Explain</b>	Groups finish research and create 1-2 Google Slides representing their assigned time period and individuals.  Organize shared slides into chronological order on Shared Class Timeline.  Groups present and explain their slides, followed by group discussion and reflection in science notebook. Questions: <ol style="list-style-type: none"> <li>1. Did you answer the question “Are vaccines “new” in science” correctly the first day?</li> <li>2. In your notebooks: List and describe 5 things that surprised you after researching and completing the timeline with the class.</li> </ol>	





	<p><b>Explain</b></p> <p><b>Elaborate</b></p>	<p>As a class: Discuss and describe the components of the innate immune system discussed in the video.</p> <p>In Groups of 4: If your immune system were a castle, which parts of the castle would represent the innate immune system? What other types of analogies could you make to the immune system?</p> <p>Discuss Immune System Poster Analogy Project</p> <p>Groups discuss what they would like to compare the immune system to. In middle school they may need a little guidance. Suggestions: Castle, country, island, sports arena</p>	<p>Immune System Poster Analogy Project</p>
<p>6</p>	<p><b>Evaluate</b></p> <p><b>Explain</b></p> <p><b>Elaborate</b></p>	<p>Science Notebook Questions: What were the components of the Innate Immune System? Which parts of your groups project represented the components of the innate immune system?</p> <p><a href="#"><u>Adaptive Immune System - Vaccine Makers Project</u></a></p> <p>As a class: Discuss and describe the components of the Adaptive Immune System discussed in the video: Dendritic Cells, Lymph nodes, Helper T cells, B cells, antibodies, (Memory T cells)</p> <p>What parts of your project could represent these components?</p> <p>Groups work on their projects. Move between groups to help with focus and understanding</p>	<p>Continue Immune System Poster Analogy project</p>



		Unit Review Sheet – Science Notebook and Google Slide Presentation	
9 -10	<b>Elaborate</b>	Unit Review – as a class  Science Notebooks: How has your understanding of vaccines and the immune system changed since the beginning of this unit?	
	<b>Evaluate</b>	Kahoot Review Game	