

Lesson 2: Meet the Heroes

Teacher's Guide

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Lesson Questions:

- What is the history of the first scientifically recorded administration of a vaccine?
- Who have been the leading people to develop vaccines?
- How is the scientific method used in the development of vaccines?

Lesson Objectives:

- Construct a timeline of vaccine development.
- Compare the histories of different people who have developed vaccines.
- Explain how the scientific method is used in the development of vaccines.

DOK: 1 – 2

Overview: In this lesson, students learn stories about the human side of vaccine development. The aim is for students to understand that numerous scientists have contributed to developing vaccines. Students read a passage about Edward Jenner, an English doctor who first published scientific research and procedures that led to the smallpox vaccine. Students then research different vaccine heroes, using their information to compile a list of five heroes they would invite to a party. This learning is reinforced by group work in which students create a timeline for selected guests and include information about the guests' contributions to vaccine success. Finally, students write a brief essay about which of their guests would be the guest of honor and why. The lesson offers an extension option for class work.

Length: Up to two 45-minute sessions

Materials:

- Computer with Internet access
- Roll of paper (if whiteboard is unavailable)
- Card stock
- Adhesive tape
- Ruler

Glossary terms: cowpox, disease, eradication, hypothesis, infection, inoculation, smallpox, vaccination, variolation, virus

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Standards: Science standards are aligned to NGSS Grade 3. Language and math standards are aligned to Common Core State Standards (CCSS) Grade 4 (ELA/Literacy) and Grade 3 (Mathematics). However, parallel standards for other grade bands are readily applicable to this lesson for Grades 3-5.

Science Standards (NGSS)

	Standard	Connections to Classroom Activity
Next Generation Science Standards (NGSS)	Science and Engineering Practice	
	Obtaining, Evaluating and Communicating Information <ul style="list-style-type: none"> • Combine information in written text with that contained in corresponding tables, diagrams, and/or charts to support the engagement in other scientific and/or engineering practices. • Communicate scientific and/or technical information orally and/or in written formats, including various forms of media and may include tables, diagrams and charts. 	<ul style="list-style-type: none"> • create a timeline that combines information about vaccine researchers and scientists
	Crosscutting Concept	
	Scale, Proportion and Quantity <ul style="list-style-type: none"> • Standard units are used to measure and describe physical quantities such as weight, time, temperature and volume. 	<ul style="list-style-type: none"> • determine how dates fit proportionally on a timeline

Common Core State Standards (CCSS)

	Standard	Connections to Classroom Activity
ELA/Literacy	Key Ideas and Details	
	RI.4.1 Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.	<ul style="list-style-type: none"> • read about scientists and summarize information in flash cards
	Craft and Structure	
	RI.4.4 Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a grade 4 topic or subject area.	<ul style="list-style-type: none"> • study the meanings of glossary words related to history of vaccines
	RI.4.5 Describe the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts or information in a text or part of a text.	<ul style="list-style-type: none"> • interpret the story of how vaccines were created in the context of the scientific method
	Integration of Knowledge and Ideas	
	RI.4.7 Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.	<ul style="list-style-type: none"> • create flash cards and a time line to organize information about scientists who developed vaccines
	Range of Reading and Level of Text Complexity	
RI.4.10 By the end of year, read and comprehend informational texts, including history/social studies, science and technical texts, in the grades 4-5 text complexity band proficiently, with scaffolding as needed at the high end of the range.	<ul style="list-style-type: none"> • read a text about the history of how the first vaccine was created 	

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Mathematics	Solve Problems Involving Measurement and Estimation	
	3.MD.A.1 Tell and write time to the nearest minute and measure time intervals in minutes. Solve word problems involving addition and subtraction of time intervals in minutes, e.g., by representing the problem on a number line diagram.	<ul style="list-style-type: none">represent time intervals proportionally on a number line diagram (time line)
	Represent and Interpret Data	
	3.MD.B.4 Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units — whole numbers, halves, or quarters.	<ul style="list-style-type: none">measure lengths using rulers to show data on a time line

BACKGROUND FOR TEACHER

The goal of this lesson is for students to understand that vaccine development relies on the hard work and ingenuity of dedicated, compassionate people. To engage students, they read about Edward Jenner. While Jenner was not the first to realize that inoculation could prevent disease, he was the first to record and document his procedures and results. In this sense, Jenner served to bring scientific rigor to the development of vaccines. As students research the Vax Pack Hero “Vaccine Heroes” section, their learning will be enhanced if they review the basic principles of the scientific method and the historical context in which the scientists were working. The lesson resources include a 3-5 grade level passage about Edward Jenner. The Vax Pack Hero website also has brief biographies on 50 scientists and researchers. The information will enable students to compile their lists of Vaccine Party invitees. If needed, students can also research online to learn more about the human stories behind their selected invitees. At a minimum, student learning should include the data in the heroes’ biographies:

- Years Lived
- Country
- Years of Discovery
- Summary of Discovery

TEACHER NOTES

The over-arching question of this lesson is “What are the human stories behind vaccines?” Most students will have received vaccinations and will understand that these protect from disease. However, students may not know any history related to vaccine development or how the scientific method is applied to developing vaccines. In this lesson, students choose five leading vaccine “heroes” to learn how individual people or teams have created life-saving vaccines. Specifically, students conduct research to learn the historical context in which vaccines have developed. For example, smallpox was a deadly disease that killed almost a third of unvaccinated people. By 1980, the World Health Assembly declared that smallpox was globally eradicated. In another example, a bite from a rabid dog was an inevitable death sentence, with practically no chance of surviving the disease. In 1885, French scientist Louis Pasteur produced the first successful rabies vaccine. Today, the rabies vaccine saves an estimated quarter of a million lives per year. These are just two examples of the types of stories students can learn about during their research. The framework for the research provides students the opportunity to formulate connections with the heroes as they choose five people they would invite to an imaginary party. As a summative exercise, students work as a class to synthesize information on a timeline with all 50 scientists.

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Resources for Lesson 2:

- Vax Pack Hero: Vaccine Heroes
<http://vaxpackhero.com/vaccine-heroes/>
- The History of Vaccines
<http://www.historyofvaccines.org/>

GLOSSARY

The following glossary terms are recommended vocabulary for this lesson. It is not necessary for students to recall all the details, but these terms will help students to understand the material introduced in the activities.

- **Cowpox** – a type of virus in the same family as smallpox but causing milder symptoms. Used by Jenner for the first vaccination.
- **Disease** – a condition resulting in the disruption of an organism's normal function and typically causing symptoms of illness.
- **Eradication** – the complete removal or elimination of something.
- **Hypothesis** – an educated guess based on an observation that might explain a phenomenon; experimentation is designed to prove whether this informed guess is accurate or not.
- **Infection** – a condition caused when a germ, such as a virus or bacteria, invades an organism and reproduces; may or may not cause illness.
- **Inoculation** – introduction of a foreign agent into an organism, usually with the intent of protecting from infectious disease, as in vaccination.
- **Smallpox** – a type of virus in the same family as cowpox, but producing severe symptoms; about 3 of every 10 people (30%) died from their infections.
- **Vaccination** – a method of protecting an individual from an infectious disease by introducing a weakened, dead or partial version of the virus or bacteria that causes the disease.
- **Variolation** – inoculation of a healthy person with dried material from the scabs of another person who was infected with smallpox to protect the healthy person from getting smallpox. This technique carried significant risk of contracting the disease and was later replaced with vaccination.
- **Virus** – a type of germ or microorganism that contains either DNA or RNA and makes copies of itself by taking over host cells so the cell produces more virions.

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ENGAGE

1. Ask students to list any diseases they know are caused by viruses. If needed, lead students to understand that illnesses they know of, such as the common cold and influenza (“flu”) are caused by viruses. They may have heard of AIDS, and that it is caused by a virus.
2. Ask students if they have heard of a disease called smallpox. Explain that this disease is caused by a virus and would kill around a third of infected people, but today that disease has been eradicated.
3. Ask students to write in their notebooks the question: “How was smallpox eradicated?” Explain that they will read a passage to answer this question.
4. Students individually read the story about Edward Jenner. (Consider allowing younger students to role play in a mini-skits to act out Jenner’s story.)
5. Ask students to write an answer to the questions written in step 3 in their notebooks.

Teacher note: For Step 5, if needed, guide students to answer the question in terms of their reading, including the main points:

- Jenner was a doctor who had to deal with smallpox.
- He heard about a similar disease that was much less serious.
- He hypothesized that this other disease, cowpox, would protect people from smallpox.
- He used cowpox to create a vaccine.
- He tested his hypothesis by administering the vaccine and then infecting his subject, James Phipps, with smallpox.
- Jenner’s hypothesis was confirmed when Phipps failed to show any smallpox symptoms.
- Governments and health agencies worked together to vaccinate people worldwide, leading to smallpox eradication.

EXPLORE

1. Students work online in small groups to review the “Vaccine Heroes” section of the Vax Pack Hero website.
2. If needed, review the glossary items to assist student understanding of the material.
3. Imagining that they would invite them to a party, groups choose five vaccine heroes to research in more detail.
4. As students work, encourage them to take notes, paying attention to the data in the heroes’ biographies.
5. If needed, students can use The History of Vaccines website’s timeline to explore their invitees’ biographies in more detail.
6. Tell students that they will use their information in the next part of the lesson.

Teacher note: Student studies during Explore can include library work and group discussion as well as online research.

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EXPLAIN

1. Groups make invitations (flashcards) for five heroes they would like to invite to a dinner party.
2. Ask students to identify three important facts about each guest to include on their flashcards.
3. If time allows, students can choose a hero to role-play within the group to imagine a conversation between invitees (e.g., an imaginary conversation between Jenner and Pasteur).
4. Ask students to write a short passage about differences and similarities between each of their heroes.

Teacher note: For Step 2, ensure that students include information about the guests' contributions to vaccine success. If needed, post the steps of the scientific method to assist them with aligning vaccine contributions to the scientific method. If time allows, ask students to choose one of their "guests" and then assess how steps of the scientific method were applied to make their discoveries.

ELABORATE

1. Ask groups to organize their flashcards in a time sequence.
2. Use your whiteboard (or roll of paper) to create a timeline from 1600 to 2000.
3. Ensure that students scale the time between years according to the distance on the timeline.
4. Each student in the group tapes one of the flashcards on the timeline.
5. If time allows, students can copy the information from the timeline into their notebooks.

Teacher note: You may need to guide students on information-gathering and organization strategies. For example, they could make index cards with disease information including: type of germ, areas of infection, symptoms and scientists who studied the disease. To ensure accuracy, ask students to compare information on the class timeline with the timeline on the History of Vaccines website.

EVALUATE

1. Allow time for students to choose a "Guest of Honor" either from their original five guests or from the timeline.
2. Students write a brief essay about which of their guests would be the guest of honor and why.

EXTENSION

To reinforce learning with an engaging activity, students plan a party and attend the party, role-playing as one of the heroes (see *Explain*, Step 3.)

Students can research additional ways in which the scientific method was applied by other selected "guests" (see *Explain*, Teacher notes).