Lesson 2 – Animal Research and Vaccines

These lessons were developed in collaboration with the Pennsylvania Society for Biomedical Research (PSBR). For additional information about animal research and PSBR programming, visit www.psbr.org.

LESSON QUESTIONS

- What role does animal research play in vaccine development?
- What are some limitations of animal research?

LESSON OBJECTIVES

- Cite evidence for how animal research supports vaccine development with specific examples.
- Construct an argument for the necessity of animal research in the development of vaccines.

DOK 2 – 4

OVERVIEW

Animal research and vaccines have contributed significantly to human health and continue to do so. This lesson provides students with the foundation for explaining how animal research is related to vaccine development. Students also analyze the limitations of animal models in research.

LENGTH

One 45-minute session

GLOSSARY TERMS

animal model, clinical trial, Edward Jenner, eradication, Louis Pasteur, rabies, smallpox, vaccine efficacy, vaccine safety

STANDARDS

- **Next Generation Science Standards**
    - HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
    - HS-LS1-2.2.1 Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.

- HS-LS1-2.4.1 Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions— including energy, matter, and information flows—within and between systems at different scales.
- HS-LS1-2.LS1.A.1 Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.
- HS-LS4-6.LS4.D: Biodiversity and Humans – Humans depend on the living world for the resources and other benefits provided by biodiversity.

- **Common Core State Standards**
  - RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context.
  - RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
  - WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
  - WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research.
  - WHST.9-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
  - HSS.IC.A Understand and evaluate random processes underlying statistical experiments.
  - HSS.IC.B Make inferences and justify conclusions from sample surveys, experiments, and observational studies.
  - HSS.ID.A Summarize, represent, and interpret data on a single count or measurement variable.

MATERIALS

- Computer with internet access
- Sticky notes

BACKGROUND FOR TEACHER

In this lesson, students investigate the role that animal research plays in vaccine development. There's no doubt that millions of lives have been saved by vaccines. In turn, most vaccines have relied on animal research to evaluate their safety and efficacy. For example, physicians used monkeys to prove that polio was infectious. This advance led to the ability to grow the polio virus in cultures of mouse brain cells. After decades of research, scientists developed the polio vaccine leading to a nearly worldwide eradication of the disease. In 2016, 37 cases were reported, compared with 350,000 in 1988. Students should understand that there are alternatives to working with animals for research. However, these are limited in scope and efficacy. Computer modelling and histological studies can lay the groundwork for developing new vaccines (as well as drugs and surgical procedures). But living systems are too complex for these methods to account for all of the variables. For example, subtle genetic differences can result in differences related to how individuals respond to vaccines or treatments. Today, we enjoy relative freedom from infectious diseases. That is, in large part, because of vaccines. In turn, the success of vaccines has been in large part because of animal research. This lesson provides a foundation for students to explain how animal research has contributed to the development and success of vaccines. The lesson provides a learning pathway for students to construct an argument for the necessity of animal research in developing vaccines. Students will learn how scientists have relied on animal research to develop many modern vaccines. This learning occurs in the context of understanding why animal models are necessary to advance scientific and medical knowledge.

TEACHER NOTES

Be aware that some students may be sensitive regarding the use of animals for biomedical research. Explain that the aim of this lesson is to evaluate the facts related to working with animals for biomedical research. Emphasize that students are encouraged to employ critical thinking skills about this topic. Encourage students to weigh the costs and benefits objectively based on the evidence.

You may wish to organize struggling or ESL students in pairs throughout the lesson since some of the vocabulary may be beyond grade level.

LESSON RESOURCES

- Lesson video
  - *How are Animals Used in Vaccine Development Research?* https://vimeo.com/245457950

- Reading Passage:
  - *Preventing Disease: How do Animals Help?*

- Other resources that may be helpful:
  - The History of Vaccines, The College of Physicians of Philadelphia, https://www.historyofvaccines.org/

ENGAGE

1. Ask students to think about influenza (aka, the flu).
2. Students write one or two sentences describing their knowledge. If needed, guide students to describe prevention, symptoms and treatments.
3. Ask the class for a show of hands to indicate who wrote that an influenza vaccine could prevent or minimize flu symptoms. (Note: if students wrote "flu vaccine" you may accept that as an answer since it will be something most of them will likely have experienced. However, point out that "influenza vaccine" is technically correct, and that the word "flu" is often used by society incorrectly to describe illnesses other than those caused by influenza.)
4. Divide the class into small groups. (Pairs will also work.)
5. Each group discusses and brainstorms their knowledge about the influenza vaccine.
6. Explain to the class that they will learn how vaccines are developed. Emphasize that they will learn about the essential role of animal research in creating new vaccines. (At this stage, struggling or ESL students may benefit from using a K-W-L chart to guide their learning.)

EXPLORE

1. Students watch the video *How are Animals Used in Vaccine Development Research?*
2. Use a Sweet Tweet strategy to reinforce learning from the video.
3. Students briefly discuss the elements of a tweet including the user name and 240-character message. If needed, remind students that hashtags are a useful way to organize information on a topic.
4. Give students three or four sticky notes.
5. Students write a "username" on the top of each note.
6. Students create "tweets" to describe facts or interesting points they learned from the video, and write their tweets on individual sticky notes. (Using real devices may be distracting.)
7. Students share their "tweets" with other students.
8. Students place the notes they were given on the whiteboard. As students place the notes, they organize each one according to the information on them (or by hashtag, if utilized).
9. Students can photograph the organized notes for later reference and discussion.
10. Ask students individually to read the reading passage: *Preventing disease: How do animals help?*
11. Ask each student to write in their own words a summary of their understanding of the passage.
12. Divide the class into small groups.

13. Share a list of vaccines with the groups:

- Influenza ("flu")
- Rabies
- Polio
- HPV (Human papillomavirus)
- Diphtheria
- Mumps
- Typhus
- Tetanus
- Cholera
- Pertussis (whooping cough)
- Yellow fever

14. Each group chooses one vaccine to research. If needed, you can assign the groups a specific vaccine to ensure that each group in the class is assigned a different vaccine.
15. Groups research their chosen (or assigned) vaccine and complete the table on page 1 of the student worksheet.
16. Using the information they gathered, each group creates a graphic organizer. If needed, guide students toward a specific type of organizer such as a concept map, timeline or chart. Ensure that the graphic organizers show how animals were involved in the origin, development and (or) testing of their vaccine, and in particular the justification for why researchers worked with animals during the development of their vaccine.

EXPLAIN

1. Student groups present the information in their graphic organizers. Individual students take turns explaining their information including:
    a. A description of the disease and its history.
    b. A description of the research undertaken to develop the vaccine including:
        i. Why it was necessary to work with animals to develop the vaccine.
        ii. The methods the scientist(s) used during vaccine development and specifically when working with animals.
        iii. Additional information about the vaccine, such as the benefits, recognition of the scientist(s) involved and so on.

ELABORATE

1. To extend the lesson, groups create a resource from their work during Explore. The resource should target a specific audience (such as the public, younger students, or non-experts with an interest in animal research or vaccines). The aim of the resource is to show the target audience:
    a. How animal research supports vaccine development, with specific examples.
    b. Why animal research is necessary for the development of vaccines or medical treatments.
2. Allow students to choose the appropriate resource. Possible formats for the resource include a flyer, brochure, web page, presentation or app. If needed, guide students toward an appropriate format.

EVALUATE

1. Students self-evaluate by comparing their own graphic organizer (from Explore) and resource (from Elaborate) with those of another group.
2. For summative assessment students complete the quiz. Struggling or ESL students who used the K-W-L chart in Engage can complete the "L" section as an alternate summative assessment.

EXTENSION

As a lesson follow-up, students can contact a researcher at a local university, hospital or biotech lab and ask the expert to review their resource and offer feedback. Alternatively, you can invite such an individual to visit the class to have a discussion related to these topics and answer student questions.

RUBRIC: STUDENT WORKSHEET

Vaccine Research Assignment

- Ensure that in their graphic organizers and presentations the student groups articulate the role animals played in the origin, development and (or) testing of the vaccine they researched and understand why researchers worked with animals.

Summative Assessment Quiz

1. What are two advantages of using smaller animals for vaccine development?

- A. Shorter life spans, cheaper to care for

2. Correct order for steps in creating a vaccine:

3. A. Determine how to test hypothesis
2. B. Generate hypothesis
4. C. Test vaccine on animals
1. D. Determine need for vaccine
5. E. Conduct clinical trials on people

3. Correct order for groups tested in clinical trials of the rotavirus vaccine, starting with initial trials.

5. A. Babies
3. B. Adolescents
4. C. Grade school children
1. D. Laboratory mice
2. E. Adult humans

4. What was the role of cows in the development of the smallpox vaccine invented by Edward Jenner?

- B. He obtained cowpox virus from them to test on humans.

5. Why did Louis Pasteur use dogs to test the rabies vaccine?

- C. Rabbits were unsuitable for testing the vaccine.

6. Write a short passage with a balanced analysis on the ethics of using animal research to develop vaccines.

- Answers may vary. Sample answer: Animals are our fellow creatures. We should, therefore, use them wisely and humanely. In some cases, we must balance the need to use animals with the needs of society and humans. While it is true that sentient animals feel pain, society must strive to alleviate human suffering. Vaccines have helped to eliminate the pain, suffering and deaths of millions of human beings. On that basis, there is a strong argument for the use and development of vaccines. A balanced view would suggest that alleviating human suffering is a high priority, and in that view, animal research to develop vaccines is ethically acceptable.