# High School

## MATH & SCIENCE LESSON 1

Hilleman & Vaccines

## LEARNING GOALS

This series of lessons will allow students to use mathematics to improve scientific and mathematical literacy, and combine the two to help students understand where humans are in the context of a pandemic, especially during the development of an entirely new vaccine. Students will understand the development and use of a variety of vaccines.

## WHERE DOES THIS FIT INTO YOUR CURRICULUM?

### MATH

Using simulations as models and then applying computational thinking to understand processes

Using probability and statistics to understand population dynamics

### SCIENCE

Understanding the spread of diseases in populations

Understanding the development and use of a variety of vaccines and the process of achieving herd immunity to stabilize the human population during a pandemic

Understanding how genetic mutations occur and their effect on organisms and the stability of a system

## MATHEMATICAL PRACTICES

- Make sense of problems and persevere in solving them.
- Reason abstractly and quantitatively.
- Construct viable arguments and critique the reasoning of others.
- Model with mathematics.
- Use appropriate tools strategically.
- Attend to precision.
- Look for and make use of structure.
- Look for and express regularity in repeated reasoning.

## MATHEMATICAL STANDARDS

- Statistics and Probability: Interpreting Categorical and Quantitative Data (S.ID1,2,3, 5, 6a,6b, 6c).
- Conditional Probability and the Rules of Probability (S.CP 1,2,3,4,5,6,7,8).
- Making Inferences and Justifying Conclusions (S.IC, 1,2,3,4,5,6).
- Using Probability to Make Decisions: (S.MD 6,7 ).

## NEXT GENERATION SCIENCE STANDARDS ALIGNMENT

***HS-LS2-1*: Interdependent Relationships in Ecosystems**

Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

***HS-LS3-2* Inheritance and Variation of Traits**

Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.

***HS-LS3-3* Inheritance and Variation of Traits**

Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

## MONTANA SCIENCE STANDARDS

***Crosscutting Concepts***: Cause and effect; proportion and quantity, and systems and system models.

***Science and Engineering Practices:*** Developing and using models; analyzing and interpreting data; using mathematics and computational thinking, constructing explanations as it applies to science.

***LS2. A:*** Use mathematical or computational representations to support arguments about environmental factors that affect carrying capacity, biodiversity, and populations in ecosystems.

***LS3.B:*** Make and defend a claim based on evidence from multiple sources that inheritable genetic variation may result from:

- New genetic combinations through meiosis
- Viable errors occurring during replication
- Mutations caused by environmental factors

***LS3. B:*** Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

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# LESSON 1

## Hilleman Film

Hilleman & Vaccines

# HILLEMAN: A PERILOUS QUEST TO SAVE THE WORLD'S CHILDREN

## OBJECTIVES

Students will learn about the life of Dr. Maurice Hilleman and his contributions to science. Hilleman was born in Miles City, Montana, which will help establish the Montana connection to the curriculum.

## MATERIALS

- Documentary DVD, HILLEMAN: A Perilous Quest to Save the World's Children
- Film screening kit (pages 149-150)

## PREPARATION

- Review HILLEMAN FAQ guide
- Make copies of the discussion guide, one per student
- Preview and load the documentary for classroom viewing

## INSTRUCTIONS

1. Introduce the film and lesson series. Here are a few reference points:

   - HILLEMAN - A Perilous Quest to Save the World's Children tells the inspiring story of Dr. Maurice Hilleman, a man with a singular focus: to eliminate the diseases of children.

   - The film was produced by Medical History Pictures as part of The Vaccine Makers Project.

# HILLEMAN Frequently Asked Questions (FAQ)

- **Why was Jonas Salk so well-known and Hilleman virtually unknown?**
  The differences in notoriety between these two men occurred for a few reasons:
  - Where they worked – Salk worked in academia and Hilleman worked in industry. People who work in industry tend not to be in the public eye as much as those in academia.
  - Their personalities – Although Dr. Hilleman had a forceful personality, he was humble. None of his discoveries are named after him. Although Salk did not name his vaccine, he was in the media, so his name was always associated with it.
  - Timing and marketing – People were scared of polio and desperate for a vaccine. Many children participated in the well-publicized trials as "polio pioneers," and the National Foundation for Infantile Paralysis (present day March of Dimes) did vigorous fundraising which included celebrity endorsements. As a result, Salk became a new kind of celebrity — a celebrity scientist! When the vaccine worked, Salk became an instant hero.

- **Why didn't Dr. Hilleman win a Nobel Prize?**
  The Nobel Prize is awarded for basic research, not practical applications. Some people felt Dr. Hilleman should have won for his work on interferon, but the award is not given after death and the Nobel committee did not want to give it to an industry scientist. Hilleman was not alone in being passed over for the Nobel Prize in his field; neither Jonas Salk nor Albert Sabin were ever awarded a Nobel.

- **Why does it take so much longer to develop a vaccine today?**
  Vaccines are regulated by the Food and Drug Administration (FDA). Although the FDA was founded in 1906, over the years regulatory protocols have become more stringent and time consuming not only for vaccines, but for all drugs and products that fall within the purview of FDA regulation.

- **Why was Dr. Hilleman able to do so much?**
  Dr. Hilleman had extraordinary intelligence and remarkable drive. At Merck, he had ample resources and autonomy to develop vaccines. These factors, combined with the faster regulatory process of the era, provided the perfect setting for him to develop a large number of vaccines.

- **Why didn't Hilleman take another position when Merck forced him to retire at age 65?**
  Dr. Hilleman was settled at Merck. To set up a lab in another place would have been an enormous undertaking, and he likely would not have had the resources he had at Merck.

- **Where can I get a copy of the film?**
  Order DVDs, Blu-rays, or a streaming link through the Vaccine Makers website (vaccinemakers.org). You can also sign up for the mailing list or review educational materials on the site.

- **How can I share this film?**
  You can connect with the Vaccine Makers team on social media, and if you are interested in hosting a screening, please contact: vacinfo@email.chop.edu.

the vaccine makers project

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# HILLEMAN Community Discussion Guide

Use this guide to facilitate a book-club style audience conversation. Questions can help focus the conversation on the wonder of scientific discovery and the positive impact of vaccines on public health.

- What surprised you the most about the film?

- Were you already familiar with all of the different diseases and their effects that were shown in the film? If not, which diseases did you not know much about and why do you think you didn't know about them?

- What were some moments in the film that stood out to you? Why?

- What moments in Dr. Hillman's life do you think were most pivotal for him? How do you think the story of his life would have changed had those episodes or events not taken place?

- How important is the setting and time period to the story of Dr. Hilleman's life and work? Do you think his story would have played out the same way in a different setting or time period?

- How important a role do you think Dr. Hilleman's personality played in his ability to achieve his goals?

- Were you surprised by the way that Dr. Hilleman and other scientists in the film talked about vaccine safety? What struck you about their behaviors concerning vaccine safety?

- Dr. Hilleman expressed his belief that some vaccine preventable diseases would have to make a resurgence for people to realize how dangerous they are. Do you agree or do you think there are other ways to help people realize how dangerous the diseases can be?

To keep the discussion focused on the film, questions about vaccines or vaccine safety can be directed to the Vaccine Education Center (VEC) website which provides complete, up-to-date and reliable information about vaccines and the diseases they prevent.

**vaccine.chop.edu**

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