CARTER COUNTY MUSEUM
EKALAKA, MONTANA

MUSEUM OF THE ROCKIES
MONTANA STATE UNIVERSITY

HILLEMAN & VACCINES:

Connecting Culture to Scientific Curiosity

Educator's Guide K-6

INTRODUCTION
HILLEMAN & VACCINES

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Cover image by Jenn Hall
Border graphics by Claire Jorgensen

We thank the following schools and institutions for their assistance in the evaluation and testing of the educational materials contained herein:

Ekalaka Elementary School, Ekalaka, Montana
Carter County High School, Ekalaka, Montana
Carter County Museum, Ekalaka, Montana

INTRODUCTION
HILLEMAN & VACCINES

WELCOME LETTER

Dear Educators,

Welcome to "Hilleman & Vaccines: Connecting Culture to Scientific Curiosity"!

Funded by a Montana State University Outreach and Engagement SEED grant, this curriculum promotes educational learning through math, science, and critical thinking.

The curriculum is organized around the life of Maurice Hilleman, groundbreaking microbiologist and vaccine developer. Dr. Hilleman was born and raised in rural Montana, so these lessons will inspire curiosity in Montana's rural students as well as spark interest in global public health. The project links photographs from Hilleman's life -- recently donated to the Museum of the Rockies -- that expand student knowledge of scientific concepts. The lessons were designed by a group of teachers from the elementary and high school level, who piloted the curriculum in their classrooms in Ekalaka, Montana during the month of May 2021. Content background was provided by Carter County Museum in consultation with Montana State University and Museum of the Rockies.

This guide is broken into two units, one for Elementary K-6 grades and the other for High School grades 9-12. The elementary guide is geared toward third grade students, lessons are easily adapted for younger students and there are notations on how to adapt for grades 4-6. Indian Education For All connecting resources are included for all ages.

We welcome educators to use the entire curriculum or just one lesson that applies most to their current studies. The lessons are strongest when taught in sequential order. For those communities that choose to host the companion exhibition, "Shots Felt 'Round the World: Maurice Hilleman and the Montana Origins of the Fight Against Pandemics," an educational DVD will be included with a copy of this curriculum. Otherwise, lessons contain links to relevant clips and the background material can be used to introduce the high school lessons.

Join us in exploring and celebrating the life of Maurice Hilleman and inspiring students to engage in scientific inquiry!

Sincerely,

Sabre Moore, Carter County Museum
Angela Weikert, Museum of the Rockies
Sharon Carroll, Carter County High School
Mardee Guyer, Ekalaka Elementary
Chioko Hammell, CCM Teacher Advisory Council

MUSEUM OF THE ROCKIES, MONTANA STATE UNIVERSITY

Museum of the Rockies (MOR) is an independent 501(c)(3) non-profit organization, a college-level division of Montana State University, a Smithsonian Affiliate, and a repository for state and federal fossils. MOR is recognized as one of the world's finest research and natural history museums. It is renowned for displaying an extensive collection of dinosaur fossils, including the fully-mounted Montana's T. rex skeleton!

MOR delights members and visitors with changing exhibits from around the world, regional and natural history exhibits, planetarium shows, educational programs and camps, insightful lectures, benefit events, and a museum store.

Accredited by the American Alliance of Museums, MOR is one of 1,083 museums to hold this distinction from the more than 35,000 museums nationwide. The museum is also a member of The Association of Science-Technology Centers (ASTC) Travel Passport Program and the Montana Dinosaur Trail.

The museum is proud to have sister-museum relationships with the Carter County Museum, Mifune Dinosaur Museum, Aso Volcano Museum, Fukui Prefectural Dinosaur Museum, and the Burke Museum of Natural History and Culture.

CARTER COUNTY MUSEUM

Located in Ekalaka, Montana, the Carter County Museum (CCM) was the first county museum in the state and the first to display fossils. It was founded in 1936 by the Carter County Geological Society, a group of amateur archaeologists and paleontologists who wanted to preserve and share the world-class dinosaur fossils found in southeastern Montana.

Exhibits cover a comprehensive 90 million year history of the region, from fossil dinosaurs from the Western Interior Seaway through the extinction event in the K-Pg boundary of the Hell Creek Formation, Ice Age hunting techniques of paleoindian tribes, and homesteading in the West. Exhibits include fully mounted skeletons of Anatotitan copei and T. rex, a complete skull of Triceratops, mounts and casts of pachycephalosaur, mosasaur, and a pterosaur as well as displays on the enduring cultures of American Indian nations in the area, natural history, ranching, rodeo, and the story of life on the Plains.

The CCM is a repository for BLM fossils, a sister museum to the Museum of the Rockies, and a member of the Kumamoto Montana Natural Science Museum Association and the Montana Dinosaur Trail.

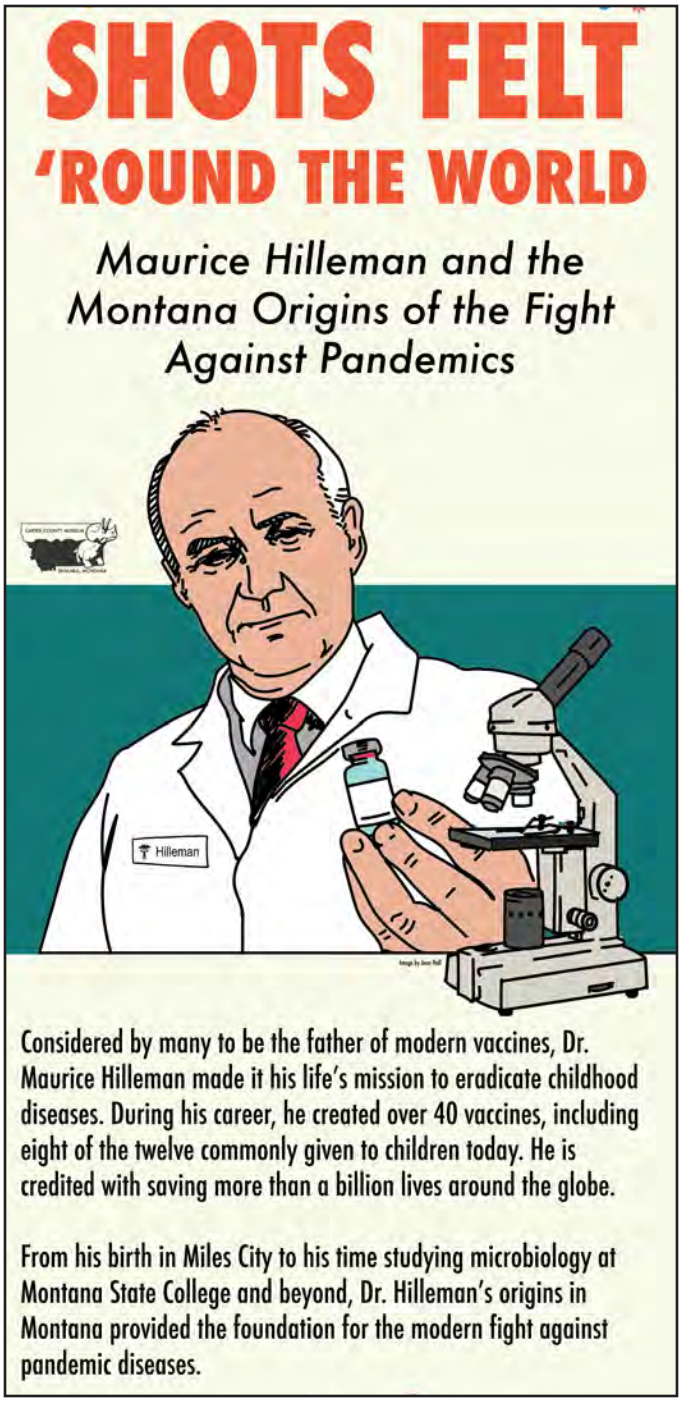
INTRODUCTION
HILLEMAN & VACCINES

Companion Exhibition

Designed and produced on-site at the Carter County Museum in Ekalaka, Montana, the exhibition "Shots Felt 'Round the World: Maurice Hilleman and the Montana Origins of the Fight Against Pandemics" provides historical context for the subjects of vaccines, infectious disease, and healthcare. Visitors are invited to discover the process of scientific inquiry and vaccine development through the inspiring life of Dr. Maurice Hilleman, who was born in Miles City, and laid the foundation for the modern fight against pandemic disease.

The exhibition consists of 16 pop-up display panels, including two that are specific to the Carter County area. It went on display in May 2021 in the Central Schoolhouse Gallery at Carter County Museum and the Carter County Healthcare Facility critical access hospital.

In the future, the exhibition will travel to other rural communities in the state, enhancing public understanding of the role viruses play in human health. Communities that choose to host the exhibition are invited to create background information about infectious disease and healthcare that is local to their region, so that students may better connect with the material. Teachers are encouraged to have their students visit the exhibition as part of the overall lesson plan.



Exhibition by Sabre Moore
Hilleman Image by Jenn Hall

INTRODUCTION
HILLEMAN & VACCINES

Vaccine Development in Montana

Rocky Mountain Labs

Founded in response to the outbreak of spotted fever in the Bitterroot Valley in 1900, Rocky Mountain Labs is now a National Institute of Health biomedical research facility located in Hamilton, Montana. For the first two decades of its existence, scientists traveled to the valley to investigate the cause, treatment and prevention of spotted fever. Initially, they lived in tents and worked out of cabins and farmhouses. In fact, Dr. Ralph Parker even performed research on ticks in an old woodshed before renting an abandoned schoolhouse in 1921. Dubbed the Schoolhouse Lab, this building would become the site of the creation of the first effective vaccine against spotted fever.

Front exterior view of the Canyon Creek Schoolhouse Laboratory

In 1927, the Montana State Legislature appropriated $60,000 for the construction of an entomological laboratory, and Hamilton was chosen as the site. This inspired protests, as residents were worried that ticks might escape and widespread infection would occur. Construction was completed in 1928 and the Public Health Service rented space within the building for continued research on vaccine production. In February 1932, the federal government purchased the facility for $68,757 from the state of Montana. Rocky Mountain Labs became part of the National Institute of Health in 1937, manufactured the United States' supply of yellow fever vaccines during World War II, and helped develop the Ebola vaccine in 2014 for use in West Africa.

Innoculating a tray of eggs for vaccine production

Today, the facility is one of nine federal facilities in the country with a biosafety Level 4 capacity, the highest such rating, and scientists there are responsible for investigating a wide variety of infectious diseases.

COVID-19

Scientists at Rocky Mountain Labs began running experiments on the novel coronavirus before the first cases were confirmed in January 2020 and soon shifted all research efforts to the Covid-19 illness. Called "the center of the universe" in regards to Covid-19 research by a May 2020 New York Times article, the lab's five research teams conducted vaccine trials, built reliable animal models to grow the coronavirus in cell cultures, submitted research on effective ultraviolet light disinfection methods for N95 masks, and even provided the microscope images of the spiked coronavirus that accompanied all the articles on the disease during the pandemic.

Photography section of the graphic arts department at Rocky Mountain Labs (1960)

Scientists at RML partnered with a team in Austin, Texas and were able to define the structure of the SARS-CoV-2 protein and go to work on a vaccine using messenger RNA (mRNA). The team based their work on their earlier research on the MERS virus, which first appeared in 2012. Through a partnership with Moderna pharmaceutical company, the vaccine was developed and approved for emergency production in late 2020 by the U. S. Food and Drug Administration.

Infectious Disease in Carter County

Smallpox

In Carter County, smallpox afflicted the Russell family, among them Ijkalaka, for whom the town was named. Ben, the oldest son of the family, had gone to boarding school on the Cheyenne River Indian Reservation in the fall of 1900. Smallpox struck the reservation and Ben broke quarantine to return home. He soon became sick, as did his brother and mother.

Ben and his brother Thomas passed away that spring. Mrs. Russell died May 16, 1901. That same year, the Montana State Board of Health issued a mandatory vaccination order for children attending school, resulting in a dramatic lowering of smallpox cases, though outbreaks continued.

During our stay in Ekalaka, Mrs. David Russel (Ijkalaka) was sick with smallpox. My mother helped two other ladies make gowns so that each day the doctor had a new one for her and he burned the one she had worn. This way he kept the disease from spreading. (Anita Ewalt Rose, Shifting Scenes Vol. 1, p. 236)

1918 Flu

In the winter of 1918, Dr. B. B. Sandy traveled from home to home in his sleigh caring for individuals stricken by the flu pandemic.

Approximately 21 members of the community died from the disease, including an individual who had contracted the disease while serving in World War I.

"Willard was born in 1912 in Wisconsin. He was orphaned at the age of six when the Spanish influenza swept the country following World War I. Willard lost his father, mother, two sisters and one brother within two days to this dread disease. (Willard Mathwig entry, Shifting Scenes Vol. II, p. 558)

"The "killer flu" epidemic of 1918-19 was hard on everyone it hit. It struck Frank and Lottie and his parents just at potato digging time, but old timers didn't quit. Lottie not only had the flu, she was expecting their baby in January and being too sick to stand up to pick her share of the potatoes, she crawled down the row--her four year old daughter lugging the buckets along and emptying them often. (Frank Ray Heckathorn entry, Shifting Scenes Vol. 1, p. 327)

"In the fall of 1918 influenza was prevalent and several people died. At one time the undertaker had trouble keeping caskets on hand. My sister passed away at that time. She had the flu and her baby was born prematurely. (Christie G. Bush entry by Emma Kortum Bush, Shifting Scenes Vol. 1, p. 103)

"People in town, five and six in a family were down with flu. Twyla was in school and each day I would drive to town to see what help I could be [...] At night I would kill and cook a chicken to make a gallon or more of broth. I also churned butter to have buttermilk for those who were desperately sick. I drove this big, wild team to a top buggy, on a high run. I built fires for people, fed people, emptied slop jars, changed beds, and ran to the next house to do the same thing again." (Elizabeth Julia Sacht entry, Shifting Scenes Vol. II, p. 758)

Measles & Mumps

On April 16, 1935, a small delegation came from Billings to inform Relief Administrator Oscar Dahl that a Civilian Conservation Corps camp would be built 5 miles south of Ekalaka, near the Needmore ranger station.

With nearly 200 recruits, the camp was a prime spot for disease, where mumps and scarlet fever warranted quarantines. In June 1935, the camp was quarantined with three cases of measles and eight cases of mumps. After Christmas 1935, there was another outbreak of mumps, this time affecting 12 recruits, and many young men were down with scarlet fever. They were quarantined in the Baker hospital.

Ekalaka Eagle, Ekalaka Mont. (November 11, 1921)

Doctor B. B. Sandy at Montana State Legislature (1923)

Exhibition by Sabre Moore

MAURICE R. HILLEMAN

Harold (left) and Maurice (right) on Hillside Ranch (MT, 1931)
Image Courtesy Museum of the Rockies

Maurice Ralph Hilleman was born August 30, 1919 in Miles City, Montana during the second phase of the so-called Spanish Influenza Pandemic. His mother, along with his twin sister became sick and died soon after his birth. Her dying wish was that Maurice would be raised by his aunt and uncle who lived nearby and had no children. From a young age, Maurice was interested in science and became a fan of the writings of Charles Darwin. He graduated from Custer County High School in 1937.

Maurice Hilleman was awarded a scholarship and attended Montana State College, now known as Montana State University-Bozeman. While at MSC, Hilleman was a member of several honors societies, including Phi Kappa Phi and Phi Eta Sigma, and earned the coveted "A Flush" perfect record. In 1941, he graduated first in his class and went to the University of Chicago for his doctorate in Microbiology. In June 1966, after developing several vaccines including one that reduces respiratory illness, Hilleman received an honorary Doctor of Science degree from Montana State University.

Upon graduation from Montana State, Maurice Hilleman received fellowship offers from10 universities and decided to attend the University of Chicago, where he studied microbiology and graduated with his PhD in 1944. His prize-winning dissertation on chlamydia determined the disease was actually caused by a bacteria and not a virus, which meant it could be treated with antibiotics.

Against the recommendations of his advisors, who wanted him to pursue a career in academic research, Hilleman chose to work in the pharmaceutical industry. Hilleman recognized that viruses can be used to stimulate antibodies in a vaccinated person and developed his first vaccine, against Japanese B encephalitis, which was put into immediate use to immunize troops at the Pacific front during World War II.

In 1954, Hilleman joined Merck Laboratories, where he directed the research and development of vaccines against Measles, Mumps, Rubella, Meningococci, Pneumococci, Hepatitis B, Hepatitis A, Polio, and Chickenpox.

Hilleman created these vaccines and others through critical thinking, use of the resources at Merck including rapid movement to clinical trials, and having a thorough, well-researched plan in place, which he presented to regulatory authorities.

BACKGROUND
Hilleman & Vaccines

In 1999, Dr. Maurice Hilleman was invited to contribute something of science to the National Millennium Time Capsule under the theme "Honor the Past -- Imagine the Future."

As a past recipient of the National Medal of Science, Hilleman proposed the topic of recognizing major contributions of 20th century vaccines for preventing disease, disability and death among the peoples of the 21st century.

US Army Medical Officer Training (Spring 1943)
Image courtesy Museum of the Rockies

Hilleman chose six vaccines and embedded them in a special clear plastic box. He gave the following speech at the December 31, 1999 National Millennium Time Capsule Ceremony in Washington, DC:

"The pediatric vaccines prevent more than four million deaths per year worldwide. Other vaccines prevent respiratory illness, hepatitis A and B, and even cancer. The principal diseases of children are no longer significant in the USA and in much of the developed world.

My contribution consists of eight vaccines of the Twentieth Century which prevent illness, disability and death and have changed the face of the world!"

Dr. Hilleman retired from Merck in 1984 at the age of 65 per the mandated company rule. He continued to keep busy and worked as a consultant, including serving as an advisor to the World Health Organization (WHO). In 1998, President Regan awarded him the National Medal of Science, the highest science award given in the U. S. Maurice Hilleman passed away on April 11, 2005.

Hilleman Scholars Program

Did you know there is a scholarship program at Montana State University named in honor of Dr. Hilleman? This program is open to Montana residents and is based on evidence of significant academic, leadership, and career potential.

Approximately 50 Hilleman Scholars are selected each year and are eligible to receive up to $6,500 in tuition assistance for their first year and $4,000 per year for the following three years. Students who maintain an exceptional record may then be eligible at the end of their Junior Year for an additional $3,000 to apply toward a study abroad experience.

There is a heavy emphasis on leadership training and career planning and Hilleman Scholars are expected to graduate in four years. For more information and to apply to the program, visit this website: https://www.montana.edu/hillemanscholars/.

A FEW OF DR. HILLEMAN'S VACCINES

INFLUENZA

More than 5,000 Montanans, or 1 percent of the population, died of influenza during the 1918-19 pandemic. This was a time when medical science and public health were ill equipped to deal with the Pandemic as a vaccine for influenza had not been developed, which was the case for other diseases at the time, such as measles, diphtheria, typhoid and scarlet fever.

In the 1930s, scientists isolated the influenza virus and developed vaccines. Among these scientists was Dr. Hilleman, who found the influenza A viruses underwent gradual and progressive changes in antigenic characteristics called "drift and shift." Drift is a result of slow continuous changes and what vaccines are generally made against. Shift is an abrupt, major change in an influenza A virus, which cannot be predicted. However, vaccines can rapidly be made to the shift versions once they are detected in the population.

Dr. Hilleman actually predicted the next influenza pandemic. After noticing a report in the April 17, 1957 edition of the New York Times regarding a respiratory disease in Hong Kong, Hilleman was able to get a sample of the virus and lead the development of the H2N2 Asian Influenza vaccine in just 4 months.

MEASLES

Children with the measles develop high fever, a red rash and pink eye. The virus can also infect the lungs, causing pneumonia, and the brain, causing permanent damage. Dr. Hilleman used a technique where the virus is grown inside a chicken egg and weakened by passing it through the embryo cells 40 times to make the vaccine.

During the 1960s, about 20 percent of chickens in the United States carried a chicken leukemia virus. Dr. Hilleman would have to find chickens that did not have this strain in order to make a vaccine he felt would be completely safe from passing the cancer on to humans. Hilleman's friend Wendell Stanley directed him to Kimber Farms in Fremont, California, which had managed to breed a flock of virus-free chickens.

John Kimber founded the farm in the early 1930s, and developed disease-free eggs, disease-resistant chickens, and hens that could lay 250 eggs per year through scientific breeding. After arriving at Kimber Farms, Dr. Hilleman asked to meet with the director of poultry research, W. F. Lamoreaux. At first, he refused to sell the disease free chickens, but after finding out that Hilleman was from Miles City, Lamoreaux, who was from Helena, told him to "take them all." Hilleman set up the flock of chickens at Merck and used them to make the Moraten strain measles vaccine, which brought the number of measles cases down from 4 million to fewer than 50.

Today, vaccines at Merck are still made from the descendants of the Kimber flock.

BACKGROUND
Hilleman & Vaccines

Mumps

In 1963, Dr. Hilleman's daughter, Jeryl Lynn, came down with the mumps. By weakening the mumps virus he had obtained from swabs of her throat, he was able to make a safe and effective mumps vaccine. The same strain of mumps virus is used to make the mumps vaccine today. It is called the Jeryl Lynn strain.

Prior to the vaccine, mumps was the most common cause of meningitis (swelling of the lining of the brain and spinal cord in children). It was the leading cause of acquired deafness among children in the United States.

Rubella

Children infected with the rubella virus suffered from a mild rash and swelling of the glands behind the ear. Rubella can pass from mother to child in the womb and cause birth defects, including blindness and deafness, heart defects or mental deficits.

In Montana, women are asked to get a blood test for Rubella before a marriage certificate is issued to the couple. In 2007, this law was modified to offer a waiver option, and further legislation was introduced against it in 2019 because widespread use of the MMR vaccine has nearly eradicated this disease.

Dr. Hilleman developed the combined MMR (measles, mumps, and rubella) vaccine in 1971.

Noon Extract

TUESDAY
December 17, 1991

Vaccination value: A family tradition

June 1966: Eight-year-old Jeryl Lynn Hilleman, at left of photo, comforts her sister, Kirsten, while she receives the mumps vaccine. Their father, Merck's Dr. Maurice Hilleman, developed the vaccine using a strain isolated from his eldest daughter in 1963. Dr. R. Weibel of the University of Pennsylvania administered the vaccine.

July 1991: Now a mother, Jeryl Lynn's son, Colin, was vaccinated against the disease with the strain of mumps that came from her father's lab 25 years ago and bears her name. She is shown with Colin's pediatrician, Dr. R. Buchta of La Jolla, Calif.

The next issue of MERCK WORLD will include a report on the new Merck Vaccine Division and an interview with the president of the division, Dr. Gordon Douglas. Look for it in your mail at home in January.

The new productivity challenge

"The single greatest challenge facing managers in the developed countries of the world is to raise the productivity of knowledge and service workers," says business management expert and author Peter Drucker in the Nov./Dec. issue of Harvard Business Review. "This challenge, which will dominate the management agenda for the next several decades, will ultimately determine the competitive performance of companies."

As defined by Drucker, knowledge and service workers include research scientists, salespeople, engineers, machine operators, data-entry operators and janitors. Yet for all their diversity in knowledge, skill and responsibility, he contends, these workers are remarkably alike in two crucial respects: what works in raising their productivity and what does not.

"The first thing we have learned – and it came as a rude shock – is about what does not work. Capital cannot be substituted for labor. Nor will new technology by itself generate higher productivity. The key to the new productivity revolution is 'working smarter.' As applied to knowledge and service work, working smarter requires five distinct steps:

1. Define the task. Ask about each job not only "What are we trying to accomplish?" but also "Must we do it at all?" The easiest productivity gains come from eliminating what does not need to be done.

2. Concentrate on the task. Ask the questions, "What value is this job supposed to add?" and "What are we paying for?" Many workers carry a steadily growing load of busywork that contributes little, if any, value and has little to do with what these professionals are qualified and paid for.

3. Define performance. For some jobs, performance means quality (for example, a physician's diagnosis, developing a new packaging design or editing a magazine). For others, quality and quantity constitute performance (the work or engineers, sales reps and claims adjusters.) Finally, some service jobs are "production" jobs (for example, clerical filing), in which performance is largely defined by the quantity of work accomplished and quality is a matter of external criteria.

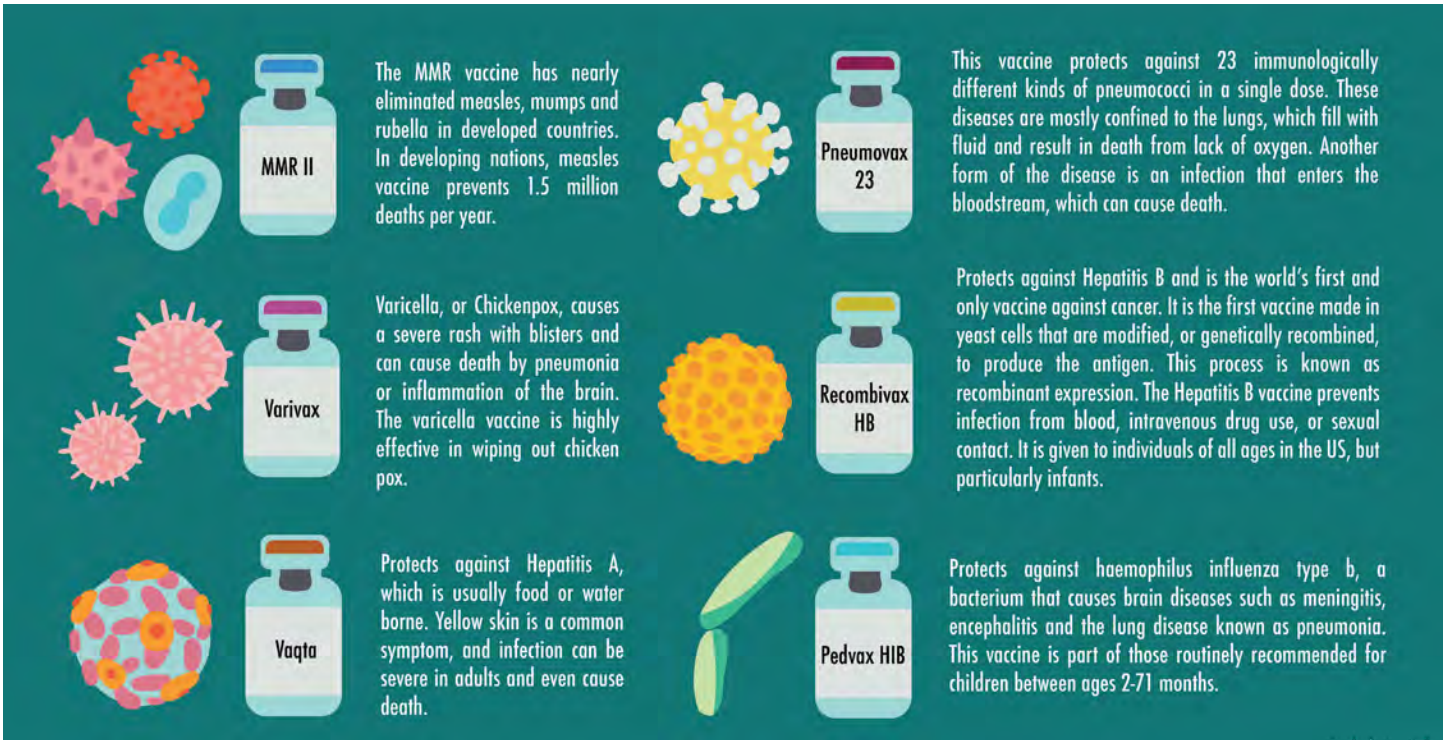
4. Ask the people who do the work how they think their productivity can be improved. Today's managers have to work in partnership with employees.

5. Build continuous learning into the organization through training and by asking the best performers to become teachers for the rest. As the Japanese can teach us, the greatest benefit of training comes not from learning something new but from doing better what we already do well.

Merck World Magazine Feature (1991)
Image Courtesy Museum of the Rockies

VACCINE SPOTLIGHTS

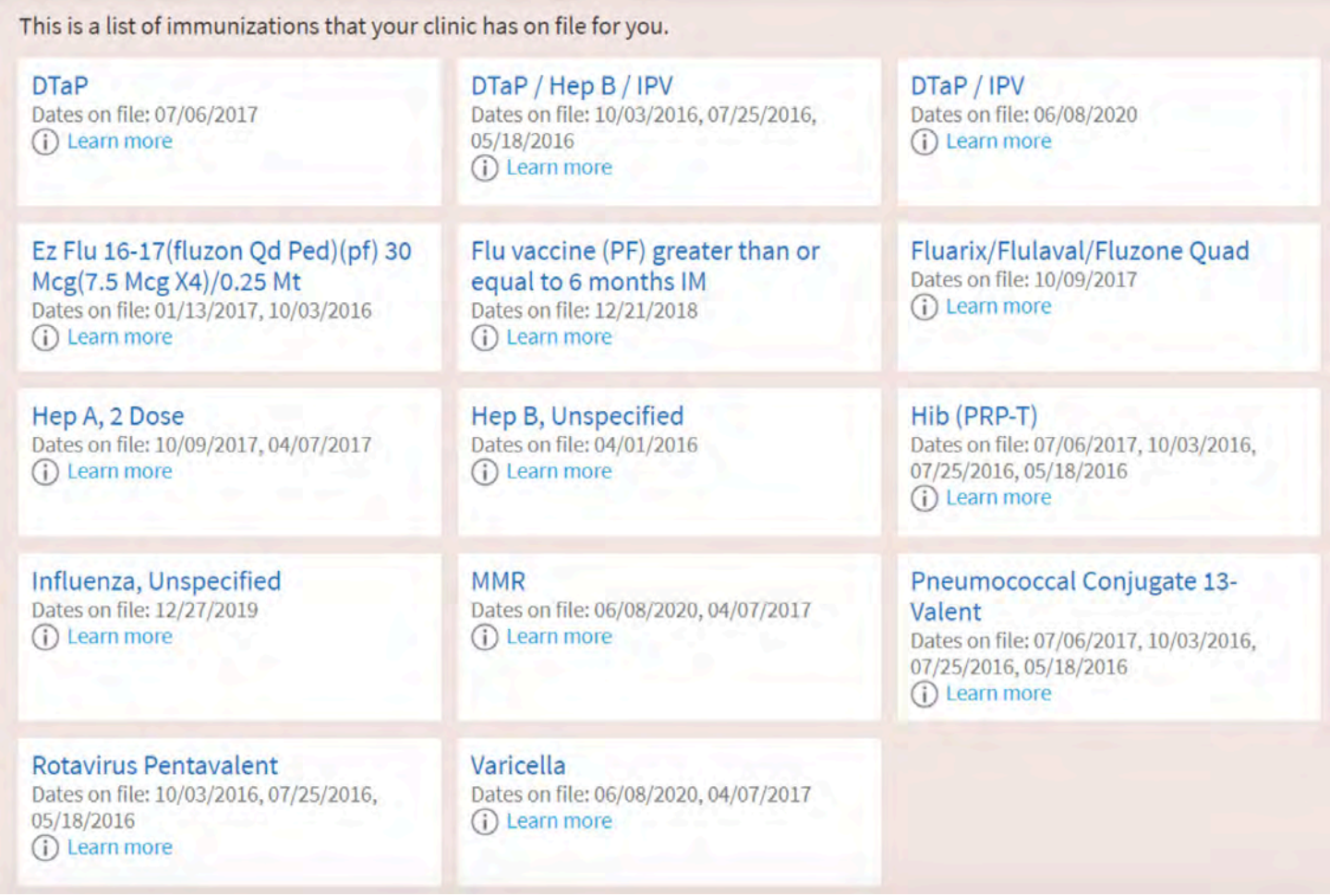
During his lifetime, Dr. Hilleman developed over 40 vaccines, including eight of the 14 vaccines commonly recommended for children. The pediatric vaccines prevent more than four million deaths per year worldwide. Other vaccines prevent respiratory illness, hepatitis A and B, and even cancer. Thanks to these vaccines, the principal diseases of children are no longer significant in the USA and in much of the developed world. Some of these vaccines and their associated diseases are described in the infographic below.



Graphic by Jenn Hall,
Words by Sabre Moore
"Shots Felt 'Round The World" Exhibition by Carter County Museum (2021).

List of specific, current vaccinations for Ages 0 mo. - Kindergarten: Date of Birth 04/26/2016

Numerous immunizations are recommended for children starting at birth. This immunization report from a child born on April 26, 2016 in Spearfish, South Dakota shows a fully vaccinated child according to recommendations in 2021. For a list of Montana's requirements, please visit https://dphhs.mt.gov/publichealth/immunization/childcareandschoolresources



This is a list of immunizations that your clinic has on file for you.

DTaP
Dates on file: 07/06/2017
Learn more

DTaP / Hep B / IPV
Dates on file: 10/03/2016, 07/25/2016, 05/18/2016
Learn more

DTaP / IPV
Dates on file: 06/08/2020
Learn more

Ez Flu 16-17(fluzon Qd Ped)(pf) 30 Mcg(7.5 Mcg X4)/0.25 Mt
Dates on file: 01/13/2017, 10/03/2016
Learn more

Flu vaccine (PF) greater than or equal to 6 months IM
Dates on file: 12/21/2018
Learn more

Fluarix/Flulaval/Fluzone Quad
Dates on file: 10/09/2017
Learn more

Hep A, 2 Dose
Dates on file: 10/09/2017, 04/07/2017
Learn more

Hep B, Unspecified
Dates on file: 04/01/2016
Learn more

Hib (PRP-T)
Dates on file: 07/06/2017, 10/03/2016, 07/25/2016, 05/18/2016
Learn more

Influenza, Unspecified
Dates on file: 12/27/2019
Learn more

MMR
Dates on file: 06/08/2020, 04/07/2017
Learn more

Pneumococcal Conjugate 13-Valent
Dates on file: 07/06/2017, 10/03/2016, 07/25/2016, 05/18/2016
Learn more

Rotavirus Pentavalent
Dates on file: 10/03/2016, 07/25/2016, 05/18/2016
Learn more

Varicella
Dates on file: 06/08/2020, 04/07/2017
Learn more

VACCINES & INFECTIOUS DISEASE

Infectious diseases have been around for thousands of years and have plagued humanity across the globe. As early as 1000 CE, people in China, India, Africa and Turkey used variolation to immunize people against smallpox. This method involved inoculating people with material taken from an infected patient in the hope that a mild infection would result and cause immunity. The practice spread to Europe where it caught the attention of Edward Jenner, who used cowpox pustules to inoculate patients successfully against smallpox in 1796, laying the foundation for the modern concept of vaccines. In the late 1800s, Louis Pasteur proposed the Germ Theory of Disease and created the first live attenuated bacterial vaccine in 1879 against chicken cholera, followed by rabies in 1884, which he used in humans in 1885.

Brought by sick individuals who traveled across the Atlantic Ocean to America, smallpox killed over 90 percent of Native Americans. Outbreaks occurred along the Missouri River, killing 17,000 indigenous peoples, including half of the Arikara tribe, in what would be called the 1837 Great Plains Smallpox Epidemic. Others occurred in Butte, Missoula, Anaconda and Great Falls throughout the late 1880s-90s, prompting the creation of the Montana State Board of Health in 1901. The board was authorized to "make sanitary investigations and inquiries respecting the causes of disease, and especially epidemics, the causes of mortality and the influence of locality, employment habits, and other circumstances and conditions, upon the health of the people."

One of the first actions taken by the Montana State Board of Health was to require children to be vaccinated before attending school. As a result of this campaign, fewer children became infected with the disease. There was some opposition to this campaign on the grounds of cost or perceived violation of personal liberty. To the former, vaccinations were free to the public and it was proven cheaper than funding the care of infected persons. In the latter, these individuals would change their minds when they or those close to them caught the disease.

Similar vaccination campaigns were enacted throughout the United States. In 1980, the World Health Assembly declared smallpox eradicated, making it one of the biggest achievements in international public health.

Vaccine research and development saw exponential expansion in the mid-20th century through the efforts of Dr. Maurice Hilleman, Dr. Jonas Salk (polio), Dr. Charles Mérieux (vaccine mass production), and others.

VACCINE SAFETY

Today, vaccines are credited with saving millions of lives. Their regulation, development and use are organized around mandates, research and testing, informed consent and disparities in access.

Vaccine mandates, particularly in schools, seek to protect the greatest number of people. Research and testing ensure that vaccines must pass rigorous safety and efficacy standards. The inclusion of diverse experts of scientific and social disciplines invites ethical discussions that prioritize safety and communication. Informed consent is part of the transparency process. Access issues remain a challenge as access can depend on socioeconomic and ethnic status. There is a need for continued efforts to ensure equal opportunity for people to benefit from vaccination.

Throughout his life, Dr. Hilleman was obsessed about vaccine safety. He rigorously tested all of his vaccines and led by

example. In developing his hepatitis B vaccine in the late 1970s, Dr. Hilleman used human blood and developed a chemical process to kill any possible contamination. Convinced of its safety, Dr. Hilleman first tested the vaccine on himself, then conducted a successful trial among Merck employees and executives. In the case of the mumps vaccine, he vaccinated his second daughter, Kirsten, with the vaccine he had named for his first child, Jeryl Lynn.

When a vaccine works, the disease does not manifest. People often forget the devastating effects of past pandemics when millions died. When asked about the growing levels of vaccine skepticism in the documentary Hilleman: A Perilous Quest to Save the World's Children, Dr. Hilleman lamented, "I think the only way we're actually going to get people to understand the importance of these vaccines is to watch children suffer again."

Vaccines undergo a rigorous safety process, including review of every study, phase and trial by an independent safety board of experts and the FDA, before a vaccine is authorized for use in the United States public. People concerned about the safety of vaccines are invited to visit cdc.gov/vaccine safety/index.html for more information.

Vaccine Development in Montana

Founded in response to the outbreak of spotted fever in the Bitterroot Valley in 1900, Rocky Mountain Labs is now a National Institute of Health biomedical research facility located in Hamilton, Montana. For the first two decades of its existence, scientists traveled to the valley to investigate the cause, treatment and prevention of spotted fever. Initially, they lived in tents and worked out of cabins and farmhouses. In fact, Dr. Ralph Parker even performed research on ticks in an old woodshed before renting an abandoned schoolhouse in 1921. Dubbed the Schoolhouse Lab, this building would become the site of the creation of the first effective vaccine against spotted fever.

In 1927, the Montana state legislature appropriated $60,000 for the construction of an entomological laboratory and Hamilton was chosen as the site. This inspired protests, as residents were worried that ticks might escape and widespread infection would occur. Construction was completed in 1928 and the Public Health Service rented space within the building for continued research on vaccine production. In February 1932, the federal government purchased the facility for $68,757 from the state of Montana. Rocky Mountain Labs became part of the National Institute of Health in 1937, manufactured the United States' supply of yellow fever vaccines during World War II, and helped develop the Ebola vaccine in 2014 for use in West Africa.

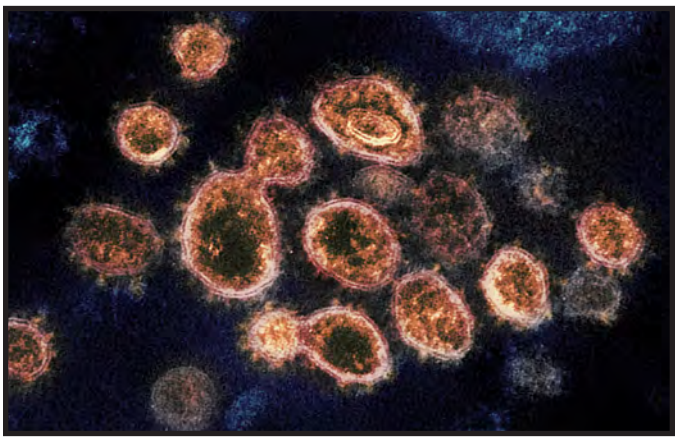
Today, the facility is one of nine federal facilities in the country with a biosafety Level 4 capacity, the highest such rating, and scientists there are responsible for investigating a wide variety of infectious diseases.

Front exterior view of the Canyon Creek Schoolhouse Laboratory in Hamilton, Mont.
Image Courtesy Rocky Mountain Labs Historical Collection, Montana Memory Project

COVID-19 VACCINES

COVID-19 is caused by a coronavirus first identified in Wuhan, China in December 2019. The disease frequently carries mild symptoms but can cause severe illness and death. Individuals who have underlying conditions are at greater risk of developing severe illness from the virus. Coronaviruses are common in people and several different species of animals and some cause mild upper-respiratory tract illnesses.

'CO' stands for 'corona', VI for 'virus' and D for disease. The 19 comes from the year it was first recorded. The formal name for the virus is SARS-CoV-2 and it is similar to other beta coronaviruses like MERS-CoV and SARS-CoV. Like these other viruses, it likely developed from an animal host, but the source has not yet been conclusively identified.



This transmission electron microscope image shows SARS-CoV-2, the virus that causes COVID-19, isolated from a patient in the U.S. Virus particles are shown emerging from the surface of the cells cultured in the lab. The spikes on the outer edges of the virus particles give coronaviruses their name, crown-like. Image captured and colorized at NIAID's Rocky Mountain Laboratories (RML) in Hamilton, Mont.

Image courtesy NIAID

The first reported cases of COVID-19 in the United States occurred in January 2020. In March 2020, state and local governments began enforcing widespread public health orders such as social distancing and sanitation. Many businesses were closed and airlines were grounded in an effort to contain the virus. Regulations fell primarily to the state level and were developed by public health authorities.

By March 2021, the United States listed over 29 million cases and over 500,000 deaths. In Montana, there have been over 101,000 cumulative cases and 1,392 reported deaths.

TRIBAL SOVEREIGNTY

As sovereign nations with the authority to legislate policy within their borders, Montana's tribes instigated several measures to mitigate the spread of COVID-19 on their reservations. They created unified task forces with county governments, closed roads to non-essential travel, instituted checkpoints, and closed recreational areas.

According to the Indian Health Service, infection rates for American Indian and Alaska Native populations are more than 3.5 times higher than non-hispanic whites, and Indigenous peoples are four times likely to be hospitalized from COVID-19. A November 2019 Public Health and Human Services report stated that, in Montana, indigenous peoples comprise 16 percent of the state's COVID-19 cases and 12 percent of the state's total deaths from the virus.

BACKGROUND
Hilleman & Vaccines

Montana's urban Indian health centers and Indian Health Service (IHS) sites chose to receive their vaccines from the IHS. Other tribal health centers are working with the state.

Vaccines

Scientists at Rocky Mountain Labs began running experiments on the novel coronavirus before the first cases were confirmed in January 2020 and soon shifted all research efforts to the Covid-19 illness. Called "the center of the universe" in regards to Covid-19 research by a May 2020 New York Times article, the lab's five research teams conducted vaccine trials, built reliable animal models to grow the coronavirus in cell cultures, submitted research on effective ultraviolet light disinfection methods for N95 masks, and even provided the microscope images of the spiked coronavirus that accompanied all the articles on the disease during the pandemic.

Scientists at RML partnered with a team in Austin, Texas and were able to define the structure of the SARS-CoV-2 protein and go to work on a vaccine using messenger RNA (mRNA). The team based their work on their earlier research on the MERS virus, which first appeared in 2012. Through a partnership with Moderna pharmaceutical company, the vaccine was developed and approved for emergency production in late 2020 by the U. S. Food and Drug Administration.

The Moderna and Pfizer mRNA vaccines require two doses, the first of which starts building protection and the second, which boosts efficacy. In early 2021, a third vaccine was added to the FDA emergency approval list, requiring a single dose.

Like all vaccines, these are designed to teach the body's immune system to recognize and fight off the virus. By March 2021, over 107 million vaccines were administered in the United States, with over 300,000 doses administered in Montana.

Developing a vaccine in the middle of a pandemic necessitates moving quickly, but the safety of these vaccines remained paramount. To increase speed, phases one and two of clinical trials were combined and vaccines batches were made while the clinical trials were being completed. Because of this process, there would be doses ready to ship when the vaccine was approved. If the vaccine was not approved, those doses would have been thrown away. Phase three trials, which include tens of thousands of participants, and the vaccine review process did not change. This process includes both the FDA and a special committee of independent investigators, known as the Vaccine and Related Biologics Product Advisory Committee. Extra monitoring for the COVID-19 vaccines was also added.

USEFUL LINKS

The Coronavirus Pandemic - Answering Your Questions: https://vaccinemakers.org/news-events/coronavirus-pandemic-answering-your-questions

Coronavirus Pandemic Questions: https://vaccinemakers.org/news-events/archived-coronavirus-pandemic-questions

Full charts of vaccinations we typically receive for ages 0-18 years:
https://www.cdc.gov/vaccines/schedules/easy-to-read/adolescent-easyread.html#vpd

Full charts of vaccinations we typically receive for ages 19+ (easy chart/list is toward the bottom):
https://www.cdc.gov/vaccines/schedules/hcp/imz/adult.html

Vaccine Information Statements where you can look deeper into each vaccine and why it is important:
https://www.cdc.gov/vaccines/hcp/vis/current-vis.html

A starting point for scholarly articles
https://pubmed.ncbi.nlm.nih.gov/?term=common+adult+vaccines&filter=simsearch2.ffrft

Great information on where to begin with vaccine efficacy and effectiveness:
https://www.who.int/influenza_vaccines_plan/resources/Session4_VEfficacy_VEffectiveness.PDF

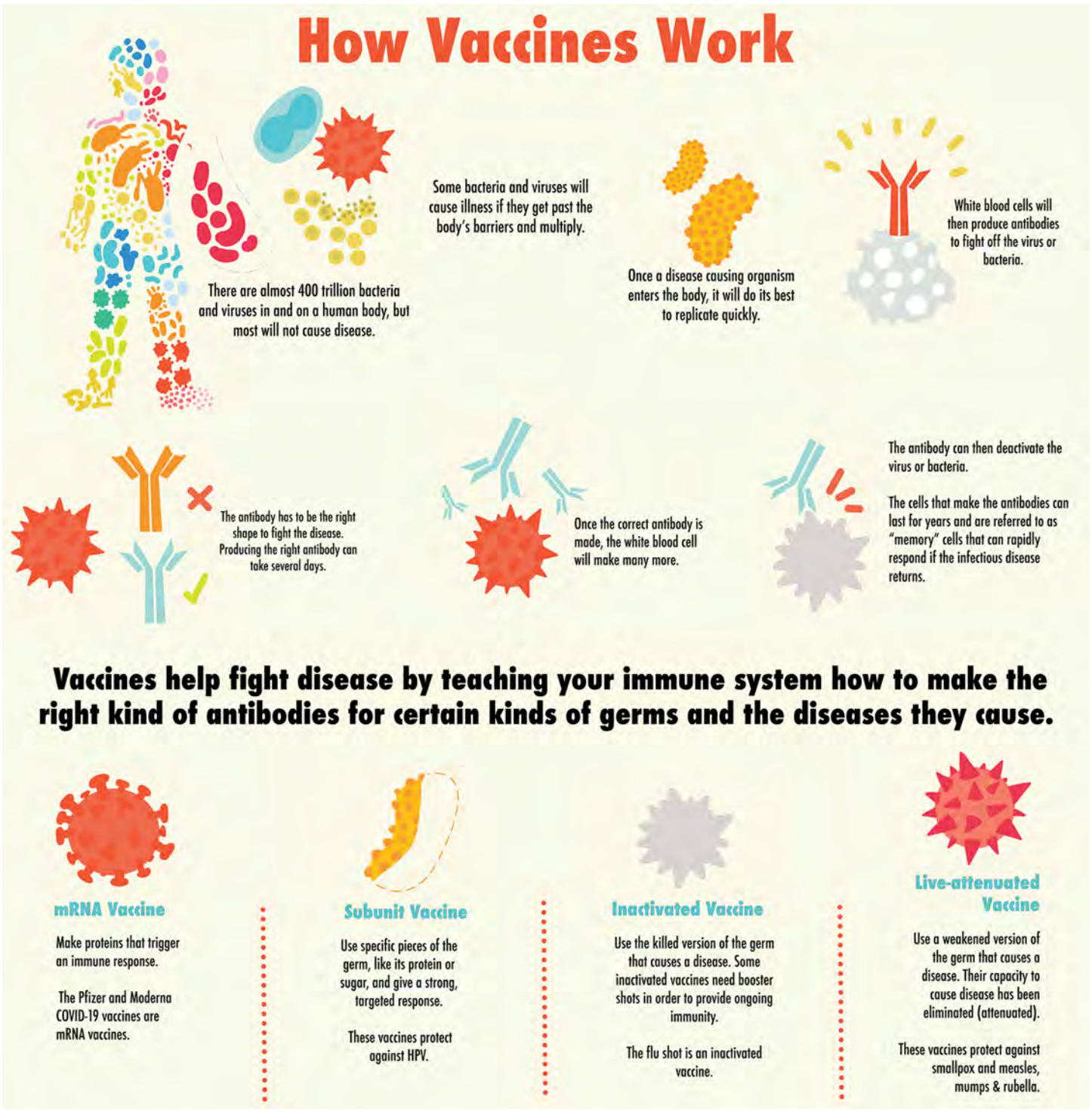
Difference between efficacy and effectiveness
https://www.immune.org.nz/vaccines/efficiency-effectiveness

All the different kinds of vaccines, intervals between doses, and FDA licensure (great list of sources at the bottom):
https://www.cdc.gov/vaccines/hcp/acip-recs/general-recs/timing.html

Vaccine history and different types of vaccines:
https://www.sciencedirect.com/topics/immunology-and-microbiology/virus-attenuation

State Mandated Vaccinations:
https://www.immunize.org/laws/polio.asp

BACKGROUND
Hilleman & Vaccines



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