



**Did you get your vaccinations when you were younger? Why do you have to get vaccinated? It hurts. But the hurt is minor compared to the diseases you might get if you weren't vaccinated. Vaccinations can help you resist infections.**

**Have you heard about smallpox? Smallpox is a viral disease like chickenpox, which you probably have heard of. Maybe you or some of your friends even got infected with chicken pox.**

**Smallpox is caused by a virus that is both highly infectious (infects readily) and very contagious (spreads easily). Smallpox once was a major worldwide scourge for many centuries. You are about to read the story of how vaccination eliminated smallpox from the entire world.**

**For centuries, people around the world lived in dread of smallpox because there was no treatment and the disease was so deadly. About 30% of those infected with smallpox died.**

**Until Edward Jenner came along, the idea of vaccination against diseases like smallpox was unknown. Many people recognized that those who recovered from some diseases seemed resistant to infection a second time (acquired immunity). However, few people had no concept of vaccination.**

**Because smallpox was so common and deadly, once a vaccine was developed, a worldwide campaign to eliminate the disease began. A smallpox vaccine was initially developed in**



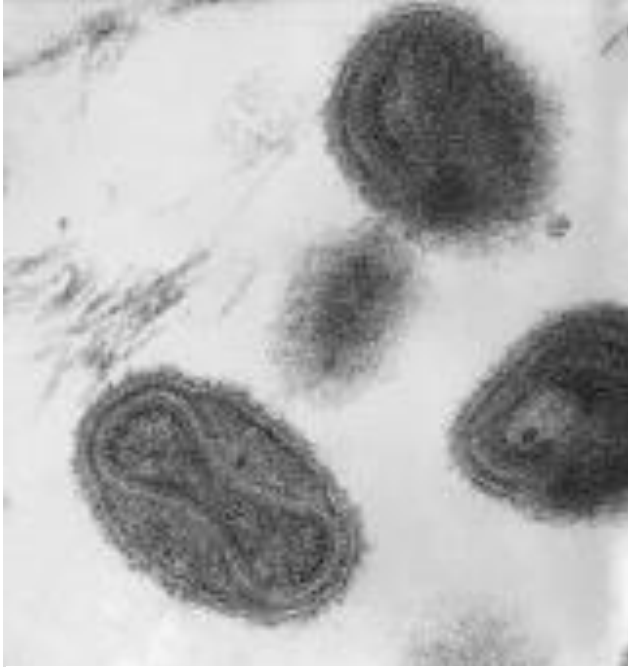


Figure 1. Electron micrograph of smallpox viral particle. The inner core, appearing as a bow-tie shape, contains DNA. Once a particle infects a human cell, it replicates its DNA to make new particles. Photo from [microbewikin.Kenyon.edu](http://microbewikin.Kenyon.edu).

**1796. Because almost everybody was vaccinated, smallpox was eliminated worldwide by 1972.**

**In this “Meet the Scientist” segment, you will read the story of this deadly disease and how a physician, Edward Jenner discovered a vaccine against it.**

## Edward Jenner 1749-1823

By the late 1700s, a British physician named Edward Jenner (Figure 1) discovered a way to prevent smallpox infections. The prevention involved inventing the principle of vaccination. This earned Jenner the title of “father of immunology.” Still, despite his important discovery, Jenner had no way of knowing just how vaccinations work. Those mechanisms were only discovered in the 20<sup>th</sup> century!

Edward Jenner was born in Gloucestershire, England on May 17, 1749, the son of the pastor of a local church. As a boy Edward became interested in medicine. At the age of 14, he was apprenticed to a local surgeon and later trained in London. Nine years later in 1772, he returned to his hometown, where he spent most the rest of his career as a physician.

Gloucestershire was a small rural town surrounded by farms. Dairy farmers in the area noticed that their cows sometimes caught a disease known as “cowpox.” Jenner, sometimes serving as a veterinarian, saw many cases of cowpox and even noticed that sometimes milk maids got cowpox on their hands. This disease caused pox-like lesions in cows, especially on their udders and teats (Fig. 3). Many decades later, scientists discovered that cowpox was a virus related to smallpox.

Of course, in that era, no one knew about viruses. Even the idea that germs could cause disease had not yet been established. That came about 100 years later from the work of Louis Pasteur. Even so, doctors in the 1700s knew there were diseases that could be spread from animals to animals, from animals to humans, and from humans to humans. Cowpox and smallpox were among such diseases.

Human smallpox was common in Jenner’s era. Physicians in those days recognized that survivors of smallpox infections could become forever resistant to reinfection. They also knew from the work of a Dutch physiologist, Jan Ingenhaus, that pressing a small amount of pus from a smallpox lesion into a small wound of a healthy person conferred later resistance in those that it did not kill. Dr. Jenner knew from local folklore that milkmaids who had been infected by cowpox never seemed to become infected with smallpox.



Figure 2. Edward Jenner.  
Photo: National Library of Medicine



Figure 3. Left: depiction of British milkmaids during the time of Edward Jenner's medical practice (Courtesy Wellcome Library, London). Right: cowpox lesions on cow teat (Courtesy Merck Veterinary Manual).



## Think About It!

In your notebook, state:

- Why Jenner might have thought there was something different in people who recovered from smallpox and those that did not.
- Why his observations of milkmaids who had cowpox were important for figuring out what might be going on.

Jenner must surely have asked himself, “Is cowpox actually smallpox, some kind of disease that is not as deadly in cows as it is in people?” This was not true, but he had no way to know. He may also have thought to himself, “Whatever cowpox is, maybe it protects people from the similar seeming smallpox. It certainly seems to protect milkmaids.” The obvious conclusion was that deliberately infecting humans with cowpox might protect them from smallpox.

It would be easy to infect people with cowpox. All that was needed was to take scrapings from cowpox lesions and rub it into the skin of a human. In 1796, Jenner did just that—on an eight-year-old boy.

We do not know how Jenner talked the boy into letting him test his smallpox preventive theory on him. We assume Jenner got his parents' permission through persuasive argument. A likely factor in obtaining permission might have been that a major epidemic of smallpox had just broken out in his community. Smallpox was so deadly and so feared that it is possible that nearly everyone was willing to take any reasonable risk to protect themselves from it.

Maybe Dr. Jenner chose a boy for the experiment, because many youngsters who got infected with smallpox had their lives snuffed out his life before they had a chance to live a full life. Jenner made a small incision in the boy's arm and smeared in it pus taken from a cowpox pustule on a milkmaid. After several months, Jenner tried to infect the boy with smallpox using pus from the pustules of human smallpox patients. The boy never developed smallpox.

In 1797, Dr Jenner described this experiment in a research report to the Royal Society. Their journal editors rejected the report because only one subject was tested, and the whole idea of vaccination was still unknown at that time. Therefore, Jenner repeated the experiment in other children, including his own 11-month-old son. Again, his subjects never developed smallpox.

Now his evidence was much stronger. Jenner resubmitted his report on his multiple subject experiment. The Royal Society accepted his report and published it in 1798. Dr. Jenner labeled his new procedure as "vaccination" from the Latin word "vacca" meaning cow. Jenner spent much of the rest of his career perfecting the vaccination process and advising other physicians on the merits of vaccination.

Jenner conducted other types of medical research too and published many useful papers on heart disease. Jenner even formed a local medical society. He and fellow physicians frequently dined together and discussed medical research papers. He also spent much time pursuing his hobbies of involving collecting fossils and horticulture.

Though his vaccination idea started to gain acceptance among scientists, Jenner encountered religious objections in communities. Some clergymen objected to the practice because they found it repulsive and ungodly to put material from a diseased animal into a human.

Because most people were poorly educated, it took years for vaccination to become an accepted practice. Its acceptance was also slowed because poor and rural communities had limited access to Jenner's vaccine. The governments of England and Wales ordered everyone to be vaccinated, but much of the public protested.

In 1967, World Health Organization mobilized a worldwide effort to eradicate smallpox. At that time, there were many unvaccinated people in the world, particularly in South America, Africa, and India. Health workers went to even the most remote villages across the globe to vaccinate



Figure 4. Smallpox vaccination scar. Source: Pauline, Flickr

entire populations in an effort to stamp out smallpox. By 1980, there were no more cases of smallpox anywhere in the world! None have occurred since.

Wonder what that scar looked like? Ask to see the upper arm of one of your older relatives (someone born before 1972). They will likely have a small visible smallpox vaccination scar, because nearly everyone born before 1972

received the smallpox vaccination. (See upper left arm in Figure 4 for an example of the smallpox vaccination scar.)

## **Vaccination Today**

Over years of smallpox vaccination, it is clear that this vaccination is safe and effective. Most people around the world now accept vaccination as a valid and important part of preventive medicine. However, even in recent years, some opposition to vaccination was generated by a false, and now retracted, research claim that measles vaccination causes autism. Some parents have refused to allow vaccination of their children for common childhood diseases like measles. Now have many localized epidemics of measles. A recent World Health Organization bulletin announced that an outbreak of a potent strain of measles has occurred in the Democratic Republic of Congo in Africa. In the first six months of 2019, measles has infected nearly 100,000 people, and thousands of children have died.

We came close to eliminating measles with vaccination, just as was done with smallpox. It is still not too late. But we need for people to get their vaccinations.

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