

Case Study: Smallpox—The First Vaccine

In England, a country doctor named Edward Jenner developed the first modern vaccine. His technique of injecting a less harmful virus into the body to stimulate the immune system was truly remarkable. This vaccine for smallpox was developed nearly 150 years before the virus could be seen with the electron microscope. The action of white blood cells was not understood until nearly 100 years after the administration of the first smallpox vaccine.

Despite a lack of information on how the disease spread, Jenner developed a successful vaccine in 1796. Noticing that rural townsfolk seemed less susceptible to the deadly smallpox, Jenner formed a hypothesis. He believed that their immunity must be related to their environment. He noted that dairymaids had a particularly low incidence of smallpox but a high incidence of a much less harmful disease called cowpox. Cowpox had many of the same symptoms as smallpox, but they were milder.

- (a) Dairymaids often had cowpox sores on their hands. Suggest a possible source of the virus.

- (b) Assuming that the virus is contagious, would you expect cowpox to infect people other than dairymaids? Give your reasons.

Jenner reasoned that cowpox must provide some immunity to the more dangerous and faster growing smallpox virus. To test his theory, he injected the pus from a festering wound on the arm of a dairymaid into a young boy named James Phipps. James developed cowpox but quickly recovered from the mild infection. Two months later, Jenner inoculated James with smallpox. When James failed to develop smallpox, Jenner declared that he had developed a successful vaccine.

- (c) What dangers did Jenner's untried procedure hold for James?

- (d) Why do you think using humans as a first test subject is no longer accepted?

White blood cells identify cowpox antigens and signal other white blood cells to produce antibodies against them. Fortunately, the antibodies for cowpox work against smallpox because the viral surface antigens are very similar.

- (e) What makes the cowpox virus less virulent than smallpox?

- (f) Explain why cowpox antibodies stop the spread of smallpox in the human body.

A coordinated international vaccination program against smallpox during the twentieth century has eliminated this disease.