MedMyst Magazine

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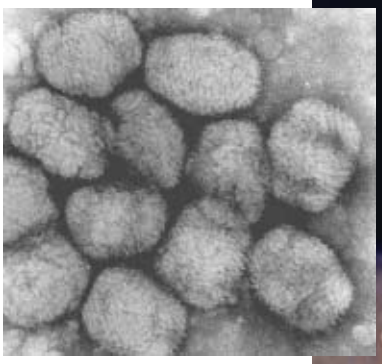
1.2 **Poxes**



SMALL VIRUSES CAUSE BIG PROBLEMS

INSIDE

Infectious Diseases

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Lynn Lauterbach, B.S.
Science Teacher and Curriculum Coordinator
Erwin Middle School
Thompson School District, Loveland, CO

Joseph B. McCormick, M.D.
Assistant Dean and James H. Steele Professor
Regional Campus at Brownsville/Regional Academic Health Center
The University of Texas Health Science Center at Houston
School of Public Health
Houston, TX

C. J. Peters, M.D.
Professor of Microbiology
Professor of Immunology and Pathology
Director, Center for Biodefense
University of Texas Medical Branch
Galveston, TX

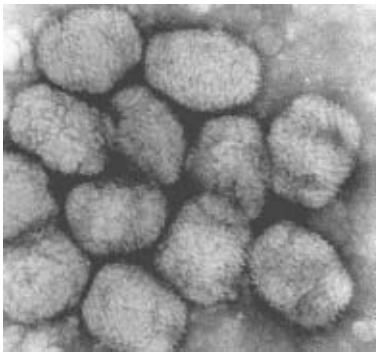
Liliana F. Rodriguez, M.P.H., R.M. (AAM)
The University of Texas Health Science Center
Office of Community and Educational Outreach
Houston, TX

medmyst@rice.edu http://medmyst.rice.edu

Cover photos courtesy of the CDC

ARE ALL PATHOGENS ALIKE?

The pathogens (germs) that cause poxes are viruses. They are very different from bacteria. For one thing, viruses are much smaller. Scientists can see bacteria with an ordinary light microscope, but they need special electron microscopes to see most viruses.



Electron micrograph of a *Variola major* virus
Brick-like shape is typical of Smallpox
Courtesy of the CDC

Bacteria are living organisms. Viruses are not. Viruses are simply bundles of DNA or RNA wrapped up inside a protein coat. Viruses cannot reproduce without a host cell. Viruses can enter living cells in an organism. Once inside, they take over the cell machinery and force the cell to make more viruses. This often damages or kills the cells, causing us to get sick.

Many other diseases besides poxes are caused by viruses. The one most often seen is the common cold, but other viral infections include influenza (flu), hepatitis, and human immunodeficiency virus (HIV).

POX PRODUCES POCKS

Smallpox is a highly contagious and often deadly disease. It has been one of the most dreaded infectious diseases. It gets its name from the many small fluid-filled blisters (also called pustules or pocks) that develop on the skin. These can leave pockmarks (scars) all over the body.

Smallpox sores are most numerous on the face and ends of arms and legs
Courtesy of the CDC

The specific virus that causes smallpox is ***Variola*** (var-e-ola) ***major***. Smallpox is extremely contagious and can move from person to person very quickly. It can spread through the air from an infected person's coughing or sneezing, or by contact with the fluid from the pustules.

Once a person is exposed to smallpox, it takes about two weeks before any symptoms appear. The first symptoms are flu-like:

- fever
- tiredness
- severe headaches and backache

A few days later these first symptoms, the rash begins to appear. First it appears on the face, hands, and arms, and then later on the rest of the body. Before widespread vaccination programs eliminated the disease, three out of every ten people who contracted smallpox would die.

CHICKENPOX: Don't let the name fool you!

There are poxes like **plumpox** that affect plants and **cowpox**, **monkeypox**, **fowlpox**, and **swinepox** that affect animals. Following this same logic, one might be tempted to assume that **chickenpox** is a disease in chickens. Actually, it has nothing to do with chickens and it is NOT a pox virus. It is in the herpes virus family.. The name chickenpox came from the similarity of the red spots on the skin to chick peas.

Chickenpox is caused by the ***Varicella zoster*** (var-ih-sell-luh zohs-ter) virus. It is not nearly as serious as smallpox. Some of the ways to detect the difference between the two diseases are:

- the pustules look different
- the location of the pustules on the body are different

A typical case of chickenpox
Courtesy of the CDC

When chickenpox blisters break open, they cause a lot of itching. Scratching the blisters can cause an infection and scars. The best thing to do to help stop the itching is take a bath with oatmeal, cornstarch, or baking soda. Sounds weird, but it works. For most children, chickenpox is no more than a few days of discomfort. Contracting chickenpox past the age of 15 can be more serious.

While many people in the United States are vaccinated as infants to prevent chickenpox, about four million (non-vaccinated) Americans contract chickenpox each year.

THE BODY DEFENDS ITSELF

Courtesy of the NIH

The body is able to fight viruses it has encountered before, which is why people don't get chickenpox more than once. It's the job of our immune system to identify and remember invading pathogens, then be prepared to fight them if they come back again. Special white blood cells produce antibodies that recognize the chickenpox antigen and target it for destruction. The chickenpox virus is then unable to infect the person again.

This is how vaccines are supposed to work. They help prepare the body to combat a particular known pathogen. However, there are many viruses that constantly mutate (change). So it is possible for someone to get a flu vaccination against specific flu viruses and still catch another form of the flu. Also, vaccinations don't last forever, and that's why many of them require boosters.

If a disease like smallpox starts to infect people whose immune systems have never confronted the virus, it spreads quickly. When explorers carried the smallpox virus to new regions where it had not been, epidemics broke out among the local people. The early European settlers of the New World were responsible for smallpox epidemics that killed many Native Americans. In Mexico, so many Aztecs died from smallpox that it helped Hernando Cortez conquer the entire empire with only a small number of soldiers.

PREVENTING POX

Pages from History

Lady Montagu
Courtesy of the National Library of Medicine

In 1717 Lady Mary Wortley Montagu, the wife of the English ambassador to Turkey, watched Turkish women gather fluid from the blisters of smallpox victims. The women coated needles with this fluid and then used the needles to scratch young children. They were inserting some of the virus into the skin. A child scratched by one of these needles would get smallpox, but usually only a mild case. The purpose was to protect these children from smallpox for life.

Having smallpox as a child and having a brother who died from smallpox, Lady Montagu wanted to protect her children from the dread disease. Upon learning of the Turkish practice of preventing smallpox, she had her son scratched (variolated) with a smallpox-coated needle. Lady Mary's son was not harmed, and was safe from smallpox after that.

When they returned to England, Lady Montagu and her husband urged people to have themselves and their children inoculated. Because of their prominent social status, many people in England listened to them. In 1722, the heir to the British throne (the Prince of Wales) had himself and his entire family inoculated. A few years before another heir to the British throne had died of smallpox. Wanting to follow the example of the royal family, many mothers had themselves and their children inoculated.

DID YOU KNOW?

In 1965 Benjamin Rubin redesigned the eyelet of a sewing machine needle to make it into a fork shape. His invention is the now-familiar bifurcated (fork-shaped) needle. It is still the preferred method of delivering the vaccine today. The small space between the tines holds enough vaccine to inoculate a person with a just a few jabs.

Bifurcated needles for smallpox vaccination
Courtesy of the CDC

Modern day vaccination with a bifurcated needle is a derivative of the early Turkish method
Courtesy of the CDC

DISEASE DETECTIVES

JENNER'S GENIUS

Edward Jenner 1749-1823
Courtesy of the National Library of Medicine

Edward Jenner was born in England. He began his medical education as an apprentice to a local apothecary (pharmacist). Although they were not doctors, apothecaries often treated minor illnesses, so this was a good way to start a medical career. Jenner saw many different pox diseases, including smallpox, cowpox, and swinepox. Cowpox and swinepox were mainly cow and pig diseases, but people working around these animals sometimes caught the diseases, too. Fortunately, both were mild illnesses in humans. Jenner took special interest when local people told him that a person who had once had cowpox or swinepox would never get smallpox.

Could another pox disease provide immunity to smallpox? If so, why? How does it work?

After Jenner got his medical degree he served in the British army. He forgot all about poxes until he returned home to practice medicine, and an epidemic of smallpox broke out. Jenner watched closely to see who got smallpox and who did not. He found that no one who had ever had cowpox or swinepox caught smallpox.

We now know that cowpox and swinepox are caused by viruses that are from the same family as smallpox. They are so similar to smallpox that immunity to either cowpox or swinepox will work against smallpox as well.

Early attempts to transfer immunity involved getting fluid from the pustules of people with smallpox and scratching it into the skin of healthy people. This practice of inoculating with the *Variola* virus was called **variolation**.

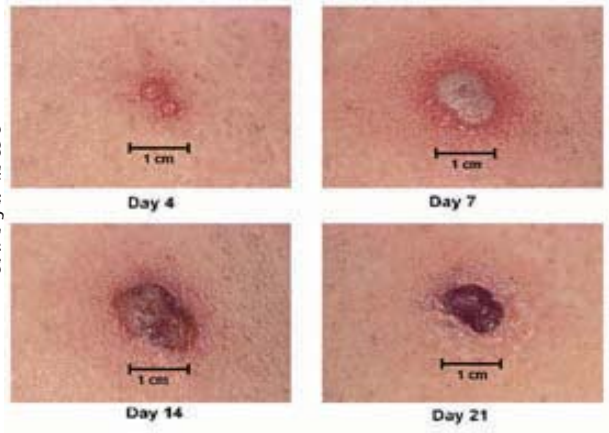
While attempts were made to weaken the virus before variolation, there was always a chance of actually giving the subject a full-blown case of smallpox or of starting a smallpox epidemic. Jenner hypothesized that cowpox fluid might work to provide immunity, yet do it more safely.

Later, a milkmaid came to him to be treated for cowpox. Jenner took some of the fluid from her pustules and inoculated his gardener's son so that the child would deliberately catch cowpox. After a mild case of cowpox, he soon recovered. Then Jenner inoculated the boy with smallpox, believing that his cowpox infection had made him immune to other poxes . Fortunately, Jenner was right, and the boy did not catch smallpox.

When Jenner presented his findings, he met with a bit of opposition. Many people just did not believe that one disease could make you immune to another. However, by the time Jenner died, support for his findings had grown. Since the inoculation used the cowpox (*Vaccinia*) virus, this new method of preventing smallpox by inoculating with cowpox was called **vaccination**. The term comes from *vacca*, the Latin word for cow.

Vaccination using the *Vaccinia* virus was less dangerous than variolation, which used real smallpox virus *(Variola major)*. In 1840, the British government, declaring Jenner's method a success, forbade variolation with smallpox and made vaccination the only legal method to protect people against smallpox. The country doctor had triumphed.

Normal reaction to smallpox vaccine at the site of vaccination, Day 4 - Day 21



Courtesy of the CDC

After the vaccine is given, it is very important to follow instructions to care for the site of the vaccination. Because the virus is live, it can spread to other parts of your body, or even to other people.

DID YOU KNOW?

In earlier times, if a person really wanted to express their anger at some one, he or she might say "A pox on your house!" How scary to have smallpox infect your household. It was a serious curse to wish a pox on someone.

VICTORY OVER THE SMALLPOX VIRUS: Several Strategies

Mass Vaccination

The World Health Organization (WHO) is a branch of the United Nations that works to improve the health of the world population. In 1967, the WHO set a goal to eliminate smallpox throughout the world. Some countries, such as the U.S., had tackled smallpox by requiring vaccinations; however, many poor nations did not have funds available to vaccinate their entire population.

Ring Vaccination

The WHO developed a plan called "ring" vaccination. When a case of smallpox was reported, health workers would vaccinate everyone who had been in contact with the patient. This approach created a "ring" of vaccinated people around the people who were infected with smallpox and stopped the spread of the disease. Scientists knew that the smallpox virus would not live very long without a human host. In the end, it was this strategy of "ring" vaccination that eliminated the naturally occurring instances of the disease.

Even after the disease was eliminated, some scientists thought it was important to keep samples of live smallpox viruses for future study. The Centers for Disease Control in Atlanta and the Research Institute of Viral Preparations in Moscow are the two official sites where the virus is kept. There is suspicion that other nations may also have secretly acquired the virus. Because smallpox is so highly contagious and can be spread through the air, it poses a threat for use as a biological weapon.

A DISEASE AS A WEAPON?

- Could some unfriendly and dangerous nations have this virus in their possession?
- Would they be willing to use it against other people?
- How should we protect against this possibility?
- What should be done about this risk?

These are the questions that are being asked all across the world today.

Courtesy of the U.S. Department of State

A WEAPON FROM HISTORY

Smallpox was used as a secret weapon during the French and Indian War. The war was fought between Great Britain and its two enemies, the French and the Indians, in what is now Canada and the United States. In the 1750s, Lord Jeffrey Amherst, a British General, was involved in the fight for territory. Knowing that smallpox was contagious, he intentionally infected a group of Native Americans. To do this, he obtained scabs from smallpox victims, ground them into blankets, and gave the blankets to his enemies. The Native Americans had never encountered the virus before and had no immunity to it, so the disease spread quickly with deadly results.

RISKS VERSUS BENEFITS

Elements of a vaccination kit
Courtesy of the CDC

The fact that smallpox can be used as a weapon has many people concerned. Some people think the best safety plan would be to make the entire country immune to the disease by vaccinating everyone, the way it has been done in the past. A problem with this idea is that sometimes the smallpox vaccine has serious or deadly effects. A small number of people could be hurt or even die by the vaccine. If an attack does not happen, is it worth the risk?

The government has taken several options under consideration. One possibility is mass vaccination. Another strategy is ring vaccination, which has been effective, but would have limitations. Only AFTER someone contracts smallpox would the vaccinations begin. Some advisors have recommended that medical healthcare workers be vaccinated first, since they will be called upon to treat anyone who becomes infected. Analyze the risks versus the benefits of mass vaccination against smallpox. What would you decide?

INCREDIBLE EDIBLE VACCINES

Scientists are working on ways to use FOOD as a method of delivering vaccines against diseases. In some underdeveloped areas of the world, vaccination by injection is difficult and expensive. People who now die because they do not have access to traditional vaccines could be reached with food-based ones. In the future, it may be possible to eat a specially engineered banana or potato that would provide immunity for specific diseases.

You could be part of this quest with a career in biotechnology!

To learn more about vaccines, check out the booklet on UNDERSTANDING VACCINES by the National Institute on Allergies and Infectious Diseases at http://www.niaid.nih.gov/publications/vaccine/undvacc.htm

TREATING VIRAL DISEASES

Viral diseases can be very difficult to treat because viruses live inside the body's cells where they are protected from medicines in the blood stream. Researchers developed the first antiviral drug in the late 20th century. The drug, acyclovir, was first approved by the U.S. Food and Drug Administration to treat herpes simplex virus infections. Only a few other medicines are available to prevent and treat viral infections and diseases.

Acyclovir 200 mg capsules
Courtesy of the NIH

Health care professionals treat human immunodeficiency virus (HIV) infection with a group of powerful medicines which can keep the virus in check. Known as highly active antiretroviral therapy, or HAART, the new treatment has improved the lives of many who suffer from this deadly infection.

Sometimes a person with a viral disease will develop a bacterial disease as a complication of the initial viral infection. For example, children with chickenpox often scratch the skin sores caused by the viral infection. Bacteria can enter those lesions and cause a bacterial infection. The doctor may then prescribe an antibiotic to destroy the bacteria. The antibiotic, however, will not work on the chickenpox virus. As with most antibiotics, it will work only against bacteria not viruses.

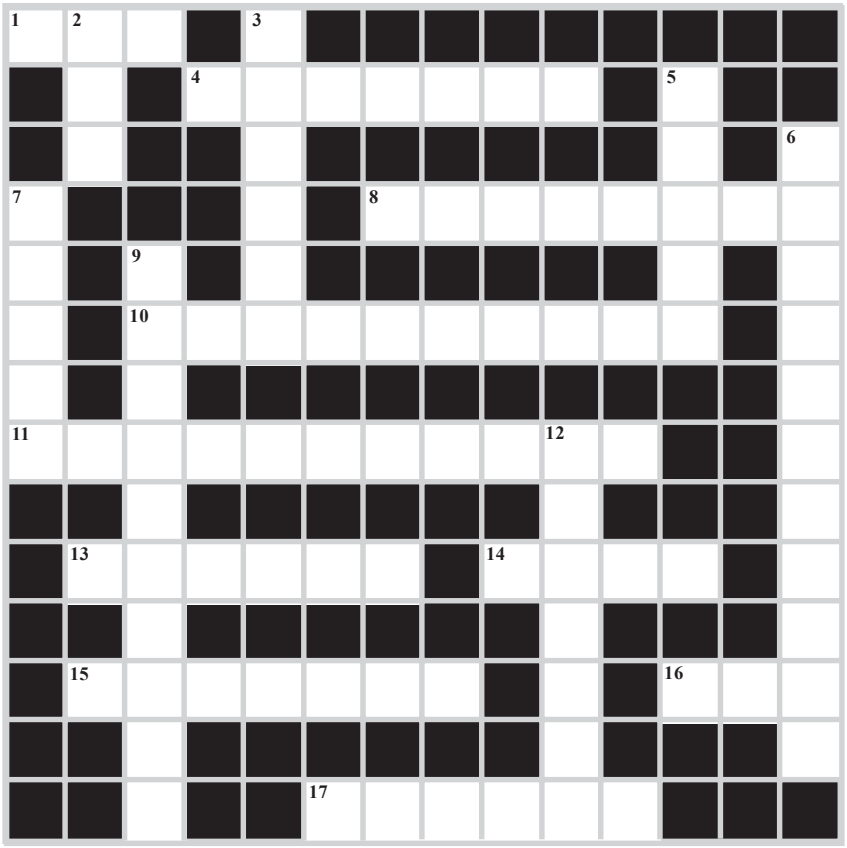
Although treatments and cures for all viral diseases have not yet been discovered, there are already many vaccines available to protect you from certain types of viral infections.

PREVENTING VIRAL DISEASES

Examples of viral diseases with vaccines are:

Measles	Measles is caused by a virus that attacks many organs in the body, and usually makes a red skin rash. Measles can cause blindness, brain damage, and death.
Mumps	The mumps virus infects the salivary glands and causes the neck to swell. It can sometimes move to the brain. If pregnant mothers catch mumps during the first three months of pregnancy, it can cause birth defects in the baby.
German Measles	German measles (also known as rubella) is a rather minor infection, but if caught by pregnant mothers, it can also cause birth defects in the baby.
Polio	The Polio virus attacks nerve endings and causes varying amounts of paralysis in victims.

Poxes



Poxes Crossword Puzzle

ACROSS

1 Scientists are working to put vaccines into the things that we _____.

4 Lady Mary Wortley _____ brought back inoculation from Turkey.

8 Powerful instruments called _____ microscopes finally allowed us to see viruses.

10 Smallpox is a member of this family of diseases.

11 These medicines are often effective against bacteria but don't work against viruses.

13 Edward _____ discovered vaccination.

14 This type of vaccination is when you only vaccinate the close contacts of a patient.

15 The virus that causes smallpox.

16 This organization led the campaign to rid the world of smallpox.

17 If you once had smallpox, you are now _____ to it and cannot catch it again.

DOWN

2 Many viruses can spread through the _____.

3 A person who works around cattle might catch _____.

5 The common cold is caused by a _____.

6 The technical term for inserting small amounts of virus into the skin.

7 Vaccination comes from this word, Latin for "cow."

9 In earlier times, a person who dispensed medical assistance without the aid of a doctor.

12 _____ pox is caused by the *Varicella zoster* virus and is less serious than smallpox.

Need a HINT?
Answers on back page!

VIRUS HUNTERS in ACTION

Susan Fisher-Hoch, M.D.
Used with permission

There are many modern virus hunters. Joseph McCormick, M.D., and Susan Fisher-Hoch, M.D. ,are two people who have worked with some of the most dangerous viral diseases ever discovered.

Many of the so-called new viruses that doctors discover have actually been present for a long time, sometimes living in unpopulated regions, or uncommonly infecting humans. It is only when humans change their behavior or disturb ecological areas and upset the balance of the natural habitat that the viruses may infect humans even when humans are not normally their target hosts. Many are naturally present in certain monkey and rodent populations. Monkeypox can jump from rodents to humans. AIDS apparently jumped across species from monkeys to humans, and Ebola virus infects humans from yet an unknown ecological source.

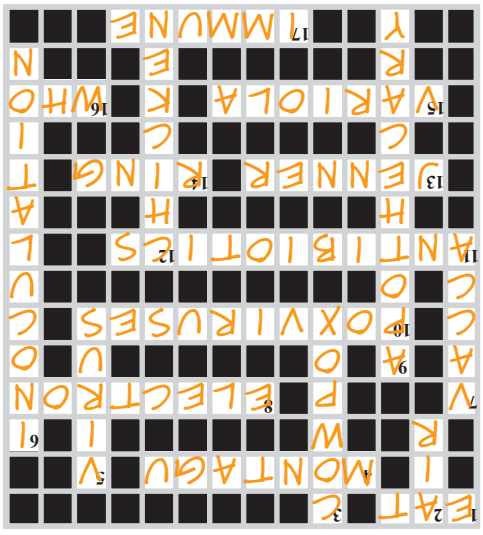
Joseph B. McCormick, M.D.
Used with permission

In their virus hunting, Drs. McCormick and Fisher-Hoch have traveled to remote areas to help the local people treat and contain dangerous outbreaks of disease. Read their first hand accounts in the book, LEVEL 4: Virus Hunters of the CDC.

C.J. Peters, M.D. ,is a virus hunter who shares his quests to track down "hot" viruses in VIRUS HUNTERS: Thirty Years of Battling Hot Viruses Around the World. He was the commander of the Army virology unit that battled Ebola in Africa and the Hantavirus in New Mexico. A number of newly identified viruses are gruesome and have no known cures. The progression of Ebola is particularly chilling with bleeding (hemorrhaging) from the eyes and eventually the entire body. Patients can experience a fever, vomiting, diarrhea, and a serious drop in blood pressure. Some viruses may result in fluid filling up the lungs; others can cause the brain to swell. They are often fatal. Examples of some these hemorrhagic viruses are Marburg, Ebola, Lassa Fever, and Hantavirus.

VIRUS HUNTERS ON THE BIG SCREEN

The movie, OUTBREAK, brings a Hollywood twist to an unknown disease. Although there are some deviations from facts in the movie, it makes for a chilling tale. Watch it and see if you can use your analytical skills and science knowledge to separate the scientific fact from fiction.



Crossword Puzzle Answers