

Part 2: So, What's Changed?

Then and now

As you can see, things are a lot better than they used to be—at least for most people in the United States and other industrialized countries. Of course, the world is far from perfect. But many of the health problems we face today are relatively minor compared with those of our ancestors. What's more, when faced with serious health challenges, we have a lot more power to fight against them than we used to have. We can cure many diseases that once killed people by the dozens, and although some new diseases (such as **AIDS**) have emerged that cannot be cured, in many cases we understand at least how these diseases are transmitted and how they can be prevented. In fact, it would be reasonable to argue that we have gained more power over our health in the past 150 years than we did in the thousand years prior to that period.

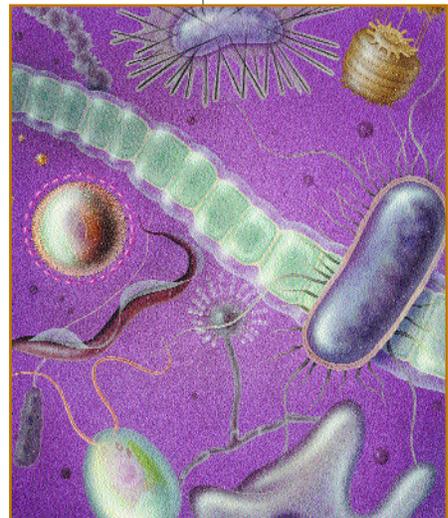
What happened over the last 150 years that has brought us to this new place in human history? The next section will provide some answers to this important question.

THE FIGHT AGAINST CONTAGIOUS DISEASES

Understanding the role of germs

Many kinds of illnesses are caused by **microbes**—tiny life-forms that are too small to be seen with the naked eye. There are many kinds of microbes, including **bacteria**, **protozoa**, and **fungi**. Bacteria are simple one-celled creatures. Two kinds of bacteria are *Salmonella*, a common cause of food poisoning, and *Streptococcus*, the cause of

Microbes are tiny life-forms that can cause illnesses.



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Viruses: Living, Nonliving, or in Between?

Is a dog or a cat a living thing? Sure. A tree? Absolutely. A rock? Of course not.

But a virus? That's a much trickier question.

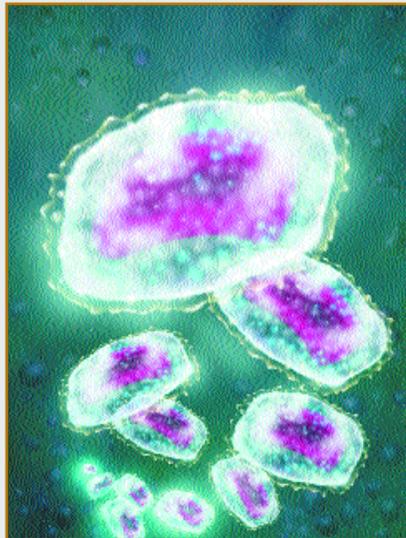
Viruses—which cause illnesses and conditions such as the common cold, influenza, herpes, and rabies—are unlike living things in several important ways. First of all, they do not even have a single **cell**—the basic building block of life. Instead, they are mostly a strand of genetic material curled up inside a tiny bag made of protein. Second, viruses cannot grow or reproduce on their own.

Viruses also can't take in energy: Unlike animals, they don't eat, and unlike plants, they don't use sunlight to make their own food. They can't move on their own, so they have to be carried along in air, water, food, or body fluids, or passed around from one surface to another.

However, viruses do share some characteristics with living things. They contain **DNA** (or a similar chemical called **RNA**), the genetic code for life. They can reproduce with the help of a living cell. (They do this by injecting their DNA into the cell and "hijacking" the cell's own reproductive system, forcing it to make new viruses.) And over time, they can evolve—for example, by developing a resistance to a drug. Some viruses that cause human diseases are rhinoviruses, which cause colds; herpesviruses, which can cause cold sores and blisters; and the **human immunodeficiency virus (HIV)**, which causes AIDS.

Some scientists classify viruses as living things. Others classify them as non-living. Still others believe that they belong to their own unique category. But even if they're not alive themselves, viruses definitely play a big role in life on Earth.

Smallpox virus



“strep” throat. Protozoa are also one-celled creatures, but unlike bacteria, protozoa have a **nucleus** inside them. In this way, they are more like animals or people than they are like bacteria. Protozoa are known to cause only a few human diseases, of which two of the most common are **malaria** and **dysentery**. Fungi can grow on or in the body and live by breaking down dead cells or body fluids. Examples of common fungal infections include athlete's foot and yeast infections. Fungal infections can also occur inside the lungs. People with weakened immune systems, including elderly people and patients with AIDS, are especially vulnerable to some kinds of fungal infections.

Some scientists say that microbes include **viruses**, which cause many human diseases, from the common cold to AIDS. Viruses are extremely simple life-forms—so simple that many scientists argue that they are not life-forms at all. Others put them in a class by themselves, somewhere between living and nonliving things. For the purposes of this book, it is easier to lump viruses in with microbes.

The world is full of microbes, and so is your body. A great many of them are harmless to people. Some are even helpful. (For exam-



Garlic has long been used to fight off illness, but it is only recently that scientists learned it can kill germs.

ple, the bacteria in your intestines help you digest food.) But other microbes have the potential to cause illness in the human body. We call these disease-causing microbes **germs**. Germs can be spread through food, water, the air, or the environment. They can also be spread by physical contact between two people. Sometimes germs can be spread by physical contact with animals, although many germs that infect animals are slightly different from the ones that make people sick.

Before people knew about germs, they didn't understand how diseases started and spread.

Sometimes they blamed diseases on evil spirits—or, later, on “bad blood,” an idea without any medical source. They would come up with treatments based on these ideas, such as performing exorcisms or deliberately cutting people to drain the “bad” blood. These treatments often failed, and even when they worked, doctors didn't fully understand why. For example, garlic was used for medical purposes in many ancient cultures, but only recently have scientists discovered that it can kill germs.

One of the earliest known suggestions that germs cause disease came from the Italian

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LOUIS PASTEUR



Louis Pasteur (1822–1895), a French chemist, was one of the most important scientists in history. Many of his accomplishments and insights set the stage for modern medicine.

Pasteur increased our understanding of disease by proving the theory of **spontaneous generation**—the belief that some life-forms, such as insects and microbes, could suddenly materialize from nonliving matter—wasn't true. For example, it was thought that the mold that grew on spoiled milk just appeared there from nothing.

People had believed in spontaneous generation since ancient times, and although others before Pasteur had raised objec-

tions, Pasteur's experiments were the most convincing. He proved that molds, fungi, and bacteria were actually present in the air and that they wouldn't grow on anything they couldn't touch.

Not only did Pasteur show that germs were present everywhere, but he also pioneered ways to get rid of them. He proved that boiling liquids like wine and milk killed any germs that were present, and then he demonstrated that quickly sealing them off from air kept new germs from growing. This process is called **pasteurization**, and it's still used today. He also suggested that surgeons boil their instruments before doing surgery, but the idea didn't catch on until later.

Pasteur's work helped to convince other scientists that germs were the cause of contagious diseases. Among his many accomplishments, Pasteur pioneered vaccines for chicken pox, cholera, diphtheria, anthrax, and rabies.

physician Girolamo Fracastoro in the year 1546. But his idea didn't catch on. For one thing, nobody could see these germs—the microscope hadn't been invented yet! And by the time scientists finally began to study bacteria and viruses, Fracastoro's work had been mostly forgotten.

The “germ theory” of disease was really popularized by the French chemist Louis Pasteur in the 19th century. By then, Pasteur was able to show that the presence of germs was linked to certain illnesses. Once this idea was established, scientists started identifying the bacteria and viruses that cause common diseases. As technology improved, so did our ability to find, categorize, and study these microscopic creatures.

Today, scientists have identified many of the germs that cause known human diseases—even the ones that we can't cure. Obviously, knowing what causes an illness is incredibly important to doctors and patients who are trying to fight it, and scientists are working very hard to figure out the nature of more illnesses—like **multiple sclerosis**—so they can identify and help eliminate the viruses that may cause them.

Curbing the spread of disease

Once people came to understand that germs cause many diseases, they started identifying and blocking the paths along which the germs travel. In many cases, doing this was possible before anyone had any detailed knowledge of the actual germs involved.

One strategy for blocking the spread of infectious disease is **quarantine**, which involves identifying the people who have a contagious disease and separating them from healthy people so that the disease doesn't spread. Quarantines have been used for thousands of years. More recently,

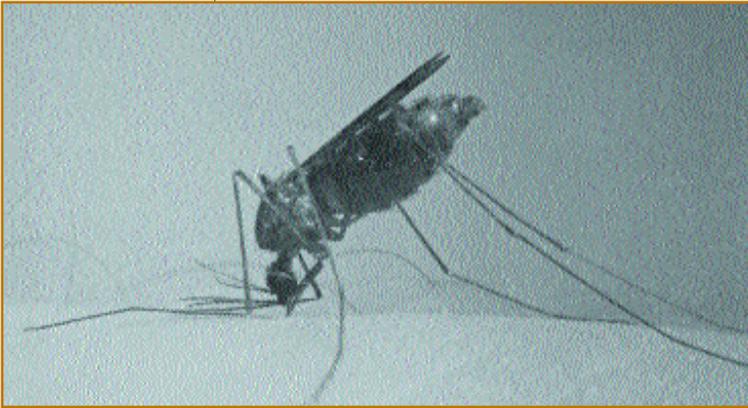
quarantines have helped control diseases like the supercontagious and deadly **Ebola** virus, which has devastated several villages in Africa over the past few decades, and **SARS** (severe acute respiratory syndrome).

Quarantines can be effective in controlling some contagious diseases. But there are several big drawbacks. For one thing, it can be hard to identify all the sick people. In many cases, a person might be infected and still be able to spread the disease for quite a while before developing any **symptoms** of the disease. Second, some infected people never get sick at all. But in either case, a person who looks healthy



A woman in Hong Kong wears a mask to avoid breathing in the SARS virus, which is passed on by close person-to-person contact. Using quarantines helped to contain the disease in 2003.

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Mosquitos are the main vectors for malaria, which is caused by a parasite spread through their bites.

might still be able to pass on his or her germs to others. Quarantines also can't always block other ways that germs might spread—for example, through infected water, food, animals, or insects. Finally, quarantines can mean separating sick people from their jobs, friends, and family, and that can be very hard to do. Today, big quarantines involving lots of people are rare and are used mainly in emergencies.

Another way to control the spread of disease is by controlling the **vectors** that help it spread. A vector is a kind of middleman: a creature which carries a germ that infects people. For example, mosquitoes are the main vectors for malaria (a deadly disease common in the tropics). For centuries, European explorers assumed that the disease was caused by something in the tropical air (in fact, the word “malaria” translates to

“bad air”). But in 1895, the British biologist Ronald Ross discovered that a tiny **parasite** (an organism that lives off another organism) really causes the disease. Three years later, a team of Italian scientists figured out that the parasite was carried by mosquitoes and was spread through their bites. Once people understood this, people in tropical cities were able to reduce the threat of malaria by draining nearby swamps where mosquitoes bred.

The spread of disease can also be controlled through **sanitation**—in other words, keeping our food, water, and environment clean. Many diseases, including **cholera** and **typhoid fever**, which have killed countless people throughout history, are spread through infect-



Using antiseptics and sterile tools and rooms help make surgery safer than it once was.

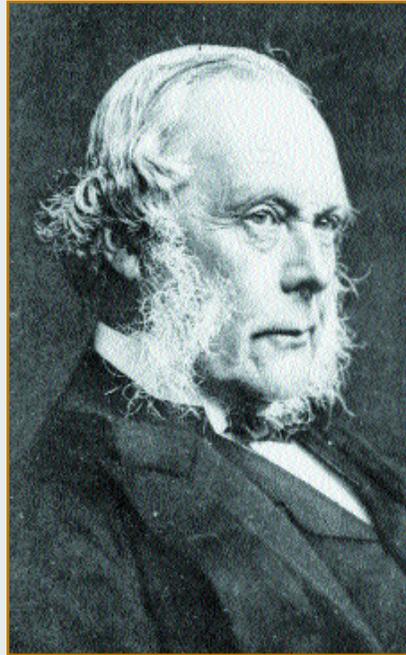
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ed drinking water. Other germs and parasites spread through food that's unclean, spoiled, or improperly cooked. Over the past century, humans have learned a lot about preparing and storing food safely and treating public water supplies, and the health payoff has been extraordinary.

Surgery, dentistry, and medicine have also been made much safer, thanks to the use of **antiseptics** (chemicals that kill germs). Antiseptics are used to make a doctor's tools sterile (germfree). Before antiseptics became popular, many patients died from infections that were spread on unclean surgical instruments. In some cases, having surgery was actually more dangerous than the disease itself!

Even the simple practice of washing one's hands has made an enormous difference in the overall health of the public, since it keeps germs from spreading to everything—and everyone—a person touches. Frequent hand washing has become a widespread practice only within the past century or so. While it's especially important for health care workers and food preparers, all people can benefit from washing their hands on a regular basis.

JOSEPH LISTER



By the middle of the 19th century, surgeons had become fairly skilled at their craft. However, even though the operations themselves went well, half of the patients died in the days or weeks after surgery. The cause was usually some kind of inflammation around the surgical wounds. Nobody quite knew what caused it. Some people thought it was a kind of chemical reaction between open wounds and the oxygen in the air.

British surgeon Joseph Lister (1827–1912) had a different idea. He

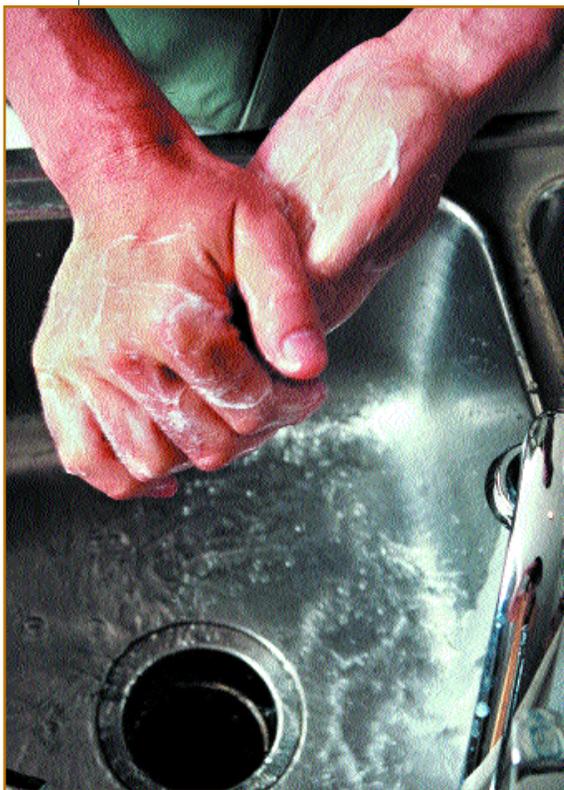
believed that the inflammations were caused, not by the air itself, but by some kind of particle carried in it. When he heard about Louis Pasteur's research, he connected it to his own observations. He became convinced that the wounds were being infected by germs that lived in the air.

The problem now was how to get rid of the germs. He had already tried cleaning the wounds, with little success. Finally, he used a chemical called **carbolic acid**, which had been used to treat sewage in a nearby town. After he began cleaning his patients' wounds with carbolic acid, they remained free of infections.

Many people didn't trust Lister's techniques at first, but within a few decades they had caught on. In 1878, his work inspired the German surgeon Robert Koch to sterilize his surgical tools with steam.

Today, surgery is conducted under antiseptic conditions, which means that everything possible is done to keep the patient and the surgical tools free of germs. Without antiseptic surgery, even the simplest operation would still be a very dangerous gamble.

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Washing your hands is an easy way to prevent the spread of germs.

The role of antibiotics and vaccines

The last century also saw a revolution in the tools that we have available to fight contagious diseases. Two of the most important are **antibiotics** and **vaccines**.

Antibiotics are a class of drugs that kill germs (usually bacteria) that are in your body. Antibiotics come in many forms: pills or liquids that you swallow, powerful

solutions that a doctor can inject with a needle, and lotions, liquids, and creams that can be applied to your skin or an open wound. There are many different kinds of antibiotics; each one works best against only certain kinds of germs.

Doctors had long searched for ways to fight disease-causing germs directly, rather than just treating the symptoms of the illness. By the early 20th century, several possibilities were being explored, including **sulfa drugs**, which fight bacteria by blocking a chemical they need in order to reproduce. Sulfa drugs were effective against some infections, but weak or useless against others. Another potential treatment was **bacteriophage** therapy.

Bacteriophages are viruses that kill harmful bacteria. To fight an infection, doctors would inject bacteriophages into a patient's bloodstream. But because each kind of bacteriophage kills only certain bacteria, the treatments were very limited.

The first effective antibiotic was discovered, partly by accident, by the Scottish biologist Alexander Fleming, who was searching for something to fight bacteria, which he studied in little culture plates. Fleming also wasn't the neatest person in the world, and one day

he came back from a long vacation to find that some of his culture plates had gotten moldy. Like countless scientists before him, Fleming threw the moldy plates away. But a former colleague, who happened to be visiting Fleming's lab, saved some of the plates and noticed something interesting: No bacteria were growing near the patches of mold. He pointed this out to Fleming, who did some more experiments and isolated a bacteria-killing chemical from the mold that he called **penicillin**.

Fleming published his results in a journal, or scientific magazine, and suggested that penicillin might be useful if it could be mass produced. More than a decade would pass before another scientist, Howard Florey, developed a technique for making penicillin in large quantities.

Penicillin became a “break-through drug,” because it was cheap to make, was generally safe, and worked against a wide variety of infections. It is still used today all over the world. Many more antibiotics were discovered because of it, and, by the middle of the 20th century, antibiotics had become the treatment of choice for diseases caused by infections. It is no exaggeration to say that millions of people are

ALLERGIES TO ANTIBIOTICS

Not all antibiotics are right for everyone. Some people have allergies to certain antibiotics. For example, about 2 to 5 percent of Americans are allergic to penicillin, one of the most common and inexpensive antibiotics. People can have allergies to other antibiotics as well.

Allergic reactions to antibiotics range from mild rashes to severe hives, tight airways, and difficulty breathing. In some cases, an allergic reaction can be deadly.

However, many unpleasant reactions to antibiotics—such as nausea, rashes, and diarrhea—are not really allergies, only side effects. For example, penicillin and drugs like it can sometimes cause fever, itching, hives, or joint pain. Side effects of more powerful antibiotics like ciprofloxacin (which was used to treat people exposed to anthrax in the fall of 2001) include diarrhea, drowsiness, strange dreams, and blurry vision. Most side effects are uncomfortable, but not life threatening. Also, people sometimes mistake the symptoms of their illness for a reaction to an antibiotic. They may stop taking the antibiotic because they feel sick, when in fact the antibiotic is their best chance to feel better. In fact, recent studies suggest that 80 percent of people who believe they are allergic to penicillin are not really allergic at all.

If you're not sure if you're allergic to penicillin or any other antibiotic, ask your doctor. A simple skin test can give you the answer. If you are allergic, it's important to mention this whenever you get a new prescription or medical treatment. Usually, another antibiotic will be available for you.

alive today only because they received antibiotics at some point in their lives.

Another important weapon against contagious diseases is the use of vaccines. Vaccines are different from antibiotics, because they prevent disease rather than treat it. Vaccines work by stimu-

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A child gets a polio vaccine, which will prevent his getting the disease, at an inoculation clinic.

lating your **immune system** (your body's natural defense against disease). When you get exposed to a new, harmful germ, your body develops cells called **antibodies** that are custom-made to fight that germ. It's a good system, and it works a lot better than you probably realize (since it's often kept you from getting sick in the first place!). But making those antibodies takes time, and if an infection

is powerful enough, the germs can take advantage of that "lag time" to do a lot of damage or to multiply and spread so much that they're difficult or impossible to defeat.

Vaccines give your body a head start. Usually, a vaccine contains a killed or weakened form of the germ that causes a disease, or just a few important pieces of it.

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Whatever the case, it's enough to make your body produce antibodies to the germ, without getting you sick. So in the future, if you're ever infected with the germ, those antibodies are ready to attack it right away, before it gets out of control. Some vaccines, such as the one for **tetanus**, require **booster shots** every so often to keep the antibodies primed and ready. Others last a whole lifetime from just one dose.

Sometimes, the use of vaccines can even protect people who aren't vaccinated. If a lot of people in an area are vaccinated against a particular germ, the germ won't be able to live and grow inside very many people. As a result, the disease-causing germs start to die off.

The earliest form of vaccination was **variolation**, which was practiced in China as early as the 10th century. It was used as a way to prevent the deadly disease **smallpox**. In variolation, healthy people were exposed to powdered smallpox scabs, often by sticking them up their noses! Variolation often caused mild sickness and sometimes resulted in death, but overall it was thought to lower the rates of full-blown smallpox.

COMMON VACCINATIONS

The Centers for Disease Control recommends a number of different vaccines for children. Different vaccines work best at different ages. Some vaccines can be given to very young infants. Others work better when given to children who are a year old or more.

Some vaccines require only one shot. Others are given in several shots, months or years apart.

Although it is important to vaccinate your children as early as possible, it is never too late. So even if your child has fallen behind schedule, he or she will benefit from being vaccinated as soon as possible.

Here are the vaccinations every child should get and when they should be given:

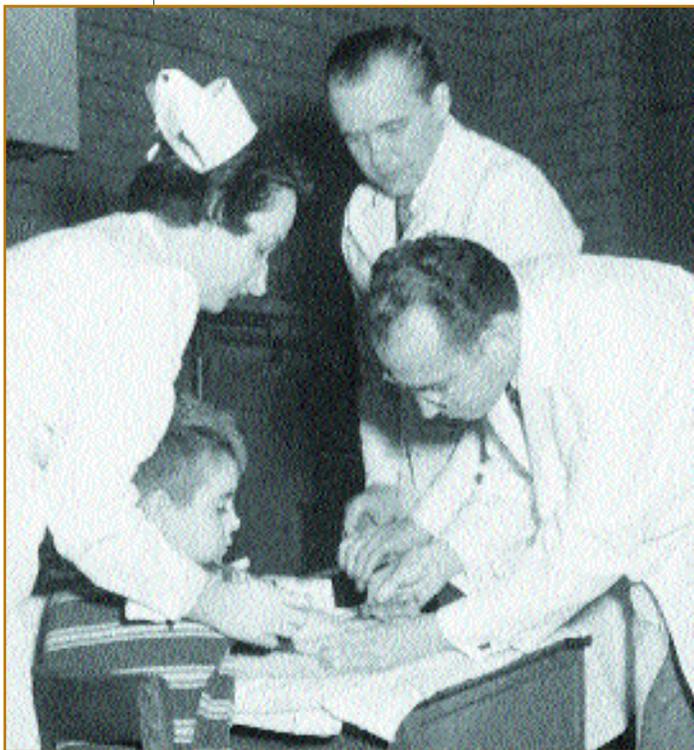
| Vaccine | Number of doses | Age for first dose | Other doses |
|---|-----------------|--------------------|--|
| Hepatitis B | 3 | Birth–2 mos. | 1–4 mos., 6–18 mos. |
| Hib (meningitis) | 4 | 2 mos. | 4 mos., 6 mos., 12 mos. |
| Polio | 4 | 2 mos. | 4 mos., 6–18 mos., 4–6 yrs. |
| DTaP (diphtheria, tetanus, and pertussis) | 5 | 2 mos. | 4 mos., 6 mos., 15–18 mos., 4–6 yrs. <i>Tetanus booster shots recommended every 10 years.</i> |
| PCV (Bacterial Meningitis) | 4 | 2 mos. | 4 mos., 6 mos., 12–15 mos. |
| MMR (measles, mumps, rubella) | 2 | 12–15 mos. | 4–6 yrs. |
| Varicella (chickenpox) | 1 | 12–18 mos. | |
| Hepatitis A* | 2 | 2+ yrs | At least six months later |

*Recommended in certain areas; ask your doctor.

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The first real vaccine is credited to an English country doctor named Edward Jenner. He had noticed similarities between smallpox and **cowpox**, a disease found in cows. Humans could catch it, too, but the disease was mild compared with smallpox.

Some of the villagers that Jenner treated claimed that catching cow-



Dr. Jonas Salk developed the polio vaccine, which he gives to a Pittsburgh boy in 1954.

pox kept a person from getting smallpox. Jenner began to take detailed notes on the subject and found that the story seemed to be

true. Finally, he decided to test it. In 1796, he deliberately vaccinated a young boy named James Phipps with cowpox. Sure enough, the boy didn't catch smallpox when he was exposed to it.

This kind of vaccination became popular throughout Europe and the United States in the 19th century. However, it wasn't universally accepted. Some people didn't believe it really worked. Others thought it was disgusting and unnatural to be infected with the blood of an animal. Still others objected to laws that made vaccination mandatory. And, of course, the vaccine still caused a sickness, so people had to accept *definitely* getting cowpox just to avoid the *possibility* of getting smallpox. Today, many effective vaccines use viruses that are weakened in some way, making it much less likely that the vaccines will cause disease.

One of the most successful modern vaccines was the one for **poliomyelitis** (or **polio**). This vaccine was invented by Dr. Jonas Salk in 1953. It used an inactivated form of the polio virus that couldn't make you sick.*

***In 1957, Dr. Albert Sabin began testing a live, but weakened, form of the virus as a vaccine to improve upon Salk's vaccine.**

