Vaccines and Immunity

Combating Old and New Diseases, from Smallpox to AIDS

The Wistar Institute’s Cutting-Edge Research

Classroom Experiment: Antigens and Antibodies
Vaccines: Shortcut to Immunity

Defending the Body Against Foreign Invaders

Imitating the Immune Response

Early Vaccines: Smallpox and Polio

The Next Wave: Recombinant Vaccines

Into the Future: Working on an AIDS Vaccine

The Wistar Institute: A Leader in Biomedical Research

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"Anti-idiotypne Antibody": Big Words to Fight a Big Disease - Cancer

Experiment

Fighting Diseases by Matching Antibodies to Antigens

Cover photo: Terry Wild Studio

About inset photo:
Scientists at The Wistar Institute in Philadelphia created this image of an adenovirus by combining the images from X-ray crystallography and an electron microscope using computer graphics. You can read more about this photograph on page 13.

Credits:
Dr. Dorothee Herlyn & Phoebe L. Stewart, The Wistar Institute, Philadelphia and Dr. Stephan D. Puller, European Molecular Biology Laboratory.
Each year, millions of people around the world are vaccinated against disease.

VACCINES: SHORTCUT TO IMMUNITY

When was the last time one of your classmates got whooping cough or diphtheria, or died from polio or smallpox? Probably never, but when your grandparents were children, these “childhood” diseases were very common, and parents lived in fear that their children would get them. Many children died, but those who survived a childhood disease would never get the same disease again. That’s because in fighting off the disease, the children had developed permanent immunity (protection against getting the disease again).

Today, most deadly childhood diseases are extremely rare in the United States, thanks to a series of shots you probably received as a tiny baby. These shots are vaccines. A vaccine activates your body’s immune system, which gives you the ability to fight off germs that cause disease.

Until recently, no one knew why or how people developed immunity. Even after the first vaccine succeeded in giving people immunity to smallpox, we did not understand how it worked. We did not know that until we began to understand our immune system. Today we can use vaccines to control many deadly diseases.

Our current vaccines, however, are not enough to rid the world of all horrible diseases and epidemics. In this issue of Your World/Our World, you will read about how research scientists — immunologists, molecular biologists, biochemists, and others — are constantly at work trying to unfold the mysteries of the immune system. You will also read about how biotechnology (using biological processes to make products or perform jobs) and genetic engineering (recombinant DNA technology) may hold the key to new vaccines that will make the world a healthier place.
When you get sick, your body becomes a battleground between your own cells and an invading virus or bacterium. The invaders destroy your cells or turn them into traitors, making them do harmful things. Fortunately, some of your cells act like sentries, staying on the lookout for suspicious foreigners. They can tell if a cell is an invader because every cell wears a kind of identification badge: a small part of the protein on the surface of the cell wall. When a sentry notices a cell without the “this is me” badge, it sounds an alarm and calls up an army of defending cells.

Special white blood cells called macrophages create the first line of defense. When they find an invading microorganism, they engulf it and break it down into pieces. Then they display the tell-tale badge of the invader for other immune cells to see. The badge of a foreign cell is called an antigen. The word “antigen” comes from the words “antibody generator.” Antigens cause other cells in the immune system to create antibodies. Antibodies are molecules that combine with the invading virus or bacterium and deactivate it. The cells that make these antibodies are called B cells. Every strain of bacterium or virus has a unique surface antigen, and the B cells use this antigen as a blueprint to make a custom-designed antibody. B cells, thus, make up the body's second line of defense.

T cells support the body's defense by giving the body's other cells immunity to the invading microorganism. They send and receive signals from other immune cells, destroy the foreign cells, and call more immune cells to the site of an infection.

The Immune System's Response to Invaders

MACROPHAGE: This immune cell takes the antigen from a virus or bacterium and holds it up for other immune cells to see.

ANTIGEN: This section of the surface protein of a virus or bacterium identifies it as an enemy.

T CELL: This immune cell makes many other T Cells that will recognize the enemy antigen.

HELPER T CELL: This "educator" helps B Cells make antibodies to attack the enemy virus or bacterium.
Together, these immune cells help us recover from an infection, but they also do something even more remarkable. They make memory cells that prevent us from getting that particular disease again. Memory cells remember what the foreign invader looks like and how to fight it. They keep the antibodies in the body’s arsenal, and keep the battle strategy in the immune system’s files. If that microorganism invades again, the immune cells immediately overwhelm the invaders before they can infect the body.

MOST DISEASES ARE ONCE-IN-A-LIFETIME EVENTS
Thanks to the immune system’s memory, most diseases never strike the same person twice. That is true for serious diseases like measles and smallpox, as well as for the common cold. Some winters you may feel like you are getting the same cold over and over again, but you are really getting different colds from among the 100 different types of rhinovirus, the medical name for the family of cold-causing viruses.

Allergic Reactions: Confusion in the Immune System
The immune system sometimes goes off. This happens when the immune cells think the body has been attacked by a pathogen but really they have just detected a harmless substance such as cat fur or ragweed pollen. Not knowing that the substance is harmless, they attack anyway and produce their antibodies against the imagined invaders. Since there are no invaders to destroy, the body is left with a large dose of antibodies that irritates the body itself, causing sneezing, coughing, swelling and itching. We call this reaction an allergic reaction.

Where is the immune system?
We can’t draw a diagram of the immune system the way we can of the circulatory system or nervous system. The cells of the immune system start in the white blood cells of bone marrow, the soft red substance inside the bones. These cells then develop their specialized functions. They circulate throughout the body as if they were on patrol, but they often gather in the lymph nodes, which are located in your neck, armpits and groin. You often have “swollen glands” when you are fighting off a cold or flu because immune cells wage war on the infectious microorganisms in the lymph nodes.
Many diseases are so serious we don't want to risk getting sick from them. We have learned to avoid them by using a trick called a 
vaccine. Vaccines intentionally trigger the body's immune 
system and set up an immune response. This response can 
benefit people in two ways. It can result in immunity so the vacci-
cinated person will not get the disease, as in the case of small-
pox or rubella, or it can help the immune system fight off an 
invader and thus "cure" a disease, as in the case of rabies or 
cancer.

Vaccines work by imitating the invader, showing the immune 
system what the "bug" looks like and how to kill it. There are several strategies for creating vaccines:

1) Live, "Attenuated" (Weakened):
Attenuated vaccines actually contain the living virus or bacte-
rium, but in a weakened form. The germ is too weak to cause 
disease, but it still activates the immune 
response. The first vaccine ever developed prevented smallpox by using the naturally attenuated cow-
pox virus. (See page 8.)

In the first half of the twentieth century, scientists learned how to 
make their own attenuated vaccines by growing viruses in cultured cells. 
Growing a virus in a non-human 
cell, such as the cell of a chicken 
egg, for example, can make it too 
weak to cause disease, but leave it 
strong enough to give immunity.

2) Inactivated or Killed: Sometimes we can use a killed virus or 
bacterium to train the immune 
system. Scientists grow the organ-
ism, and then kill it by using chemi-
cals that do not destroy its surface 
antigens. The body's immune cells 
can then react to the dead germ in 
the same way they would if it were 
living. The first successful killed 
virus vaccine was an influenza 
("flu") vaccine developed in response to a horrible flu epidemic that killed 
20 million people during World 
World I.

3) Recombinant DNA-Based:
Some viruses refuse to grow in cul-
tured cells, so it has been impossible 
to develop either live or inactivated 
vaccines. Now, molecular biologists 
are learning to use a portion of the 
virus, called a subunit, to create the 
vaccine.

Imagine that you were allergic to 
strawberries. Then you discovered 
that you were really only allergic to 
the seeds, not the fruit. If you could 
get berries without seeds, you could 
eat them and not have an allergic
reaction. The seeds would be the "subunits" of the strawberry that cause your allergy.

In a similar way, a subunit of a virus or bacterium can trigger the immune response. If scientists can identify the right subunit, they can use recombinant DNA technology to produce it. The subunits would activate the body's immune response, but not cause disease. The new vaccine for hepatitis B uses this technique, and many people hope that recombinant DNA technology can help develop a vaccine for AIDS.

4) Experimental Vaccines: Biotechnology has opened the doors to many new kinds of vaccines. For example, engineered viruses and bacteria could have certain genes deleted so they give immunity without causing disease. They could also carry the antigens for several diseases, making a kind of super vaccine. Scientists are working on ways to create new antigens that form antibodies to trigger specific immune responses to fight cancer. Scientists are also experimenting with growing plants that produce the antigens for a disease. These antigens would activate the immune response when people eat the plant. Such a vaccine would make it easier to vaccinate people in the developing world where the lack of refrigeration makes it difficult for many people to receive vaccinations.

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<tr>
<th>Vaccination Schedule for U.S. Children</th>
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Foreign Travel:
If you travel the world, you may need other vaccinations before you go, such as yellow fever, malaria, typhoid fever, rabies, and bacterial meningitis.
EARTH VACCINES

You may be surprised to learn that diseases like the plague, smallpox, typhoid fever and polio have killed more people than all the wars in history. For example, in the six years between 1346 and 1352, the black plague wiped out one-fourth of Europe’s population! Between 1492 and 1618, almost 95% of the native inhabitants of the Americas died of new diseases brought by the Europeans, such as smallpox and measles. From World War I until the early 1960s, millions of American children died or became permanently crippled by polio. Today, these diseases have been either eliminated or controlled by vaccines.

Smallpox: Beginner’s “Luck”

In 1776, the year of the American Revolution, an English doctor named Edward Jenner unknowingly started a medical revolution. He’d heard that milkmaids and farmers who caught cowpox never got sick with smallpox. Then he did something he could never have done today — experimented directly on a human being. He infected a young boy with cowpox, and the boy got sick. (His illness was not bad, though, because cowpox is a very mild disease.) When the boy recovered, Jenner infected him with smallpox, and this time the boy did not get sick at all.

Without even knowing what a virus was, Jenner had found a relative of the smallpox virus that acted like an attenuated, weakened virus. He called his potion vaccinia, which is the Latin word for “cow.” To this day, we use the word vaccine in honor of Jenner’s discovery, and up until recently we continued to use the cowpox virus to vaccinate against smallpox. Today, smallpox has been completely eliminated throughout the entire world, so people no longer need to be vaccinated. So far, it is the only disease to have been completely wiped out.

The Polio Vaccine: A Long, Hard Struggle

The polio virus is very contagious, and many of your parents may remember the fear of catching polio in the summers of their youth. People who caught polio felt at first like they had the flu, but soon their limbs would ache unbearably. If the virus infected their spinal fluid, it might paralyze them, and some people were so badly paralyzed they could not breathe on their own. They needed to lie in big “iron lungs” that helped them breathe and stay alive. The polio epidemic killed or paralyzed millions of people between its outbreak in 1916 and the mid 1950s, and most of the victims were children.

Developing a vaccine for polio took longer than everyone had hoped, and it required many people around the world working together to solve different parts of the problem. First, researchers had to determine how many types of
the polio virus existed. After they determined there were three types, they had to develop a vaccine that protected against all of them. Some groups of researchers focused their efforts on developing a killed virus vaccine. Other groups worked on an attenuated virus vaccine.

In the early 1950s, Dr. Jonas Salk's research group introduced the first killed virus vaccine to the nation. Everyone was ecstatic when it proved effective. Dr. Salk was hailed as a hero and people named the vaccine after him. He was embarrassed by this fame, and always stressed that the vaccine was the result of group efforts. He wanted to call the vaccine the "Pitt vaccine" for the University of Pittsburgh, where he conducted much of the research.

In 1961, Dr. Albert Sabin's research group introduced an attenuated virus vaccine. It soon became the polio vaccine of choice in most of the world, because it could be taken orally instead of injected. This improvement has been especially important in the developing world where it is very difficult to sterilize needles reliably.

Today, polio is very rare in much of the world. In parts of the developing world, though, clinics still do not have refrigeration, so the vaccines cannot be stored and polio still exists. We may never completely eliminate polio worldwide, but the work of these great biological researchers has certainly been one of medicine's true successes.

Franklin Delano Roosevelt, photographed here with his wife, Eleanor, was our longest-serving president. He served in the White House for four terms, from 1933 to 1945. He helped bring the nation out of the Great Depression and led us through World War II. He was also a victim of polio, and he helped form the March of Dimes to raise money for polio victims and research.
RECOMBINANT VACCINES

Scientists are proud to have developed so many successful vaccines, and they hope to be able to bring even more diseases under control. Some of these diseases are new, like AIDS and Lyme disease. Some, like tuberculosis, were almost under control and are now reaching epidemic levels again. Others, like cancer, are claiming thousands of lives each day. Yet others affect people in specific parts of the world, such as malaria in tropical climates. To tackle these diseases, researchers are turning to molecular biology and recombinant DNA techniques.

HEPATITIS B: THE FIRST BIOENGINEERED VACCINE

The hepatitis B virus attacks the liver, sometimes so severely that it causes death. Other times it is so mild that people do not even know they have it. In mild cases, people usually recover within six months. In about 10% of mild cases, however, the immune system does not defeat the virus and the virus stays in the blood. These people become "chronic carriers" who can infect other people. There are about one million hepatitis carriers in the United States.

To protect people who might be exposed to the hepatitis B virus, researchers tried to develop a vaccine. Unfortunately, the virus would not grow in a cultured animal cell the way the polio virus does, so they could not make a live or killed virus vaccine. Then research showed that exposing laboratory animals to just the surface antigen of the virus caused them to make enough antibodies to become immune. Biomedical researchers found the genes that encode the makeup of the antigen in the virus, and using recombinant DNA technology, they cloned those genes. Next, they used a plasmid to insert these genes into the DNA of a yeast cell. As the yeast cell grew, it produced the antigen, which could then be made into a vaccine. Because the vaccine contains only a small portion of the virus, it is called a sub-

unit viral vaccine. When injected into a human body, the surface antigen alerts the immune system and causes it to produce antibodies against the hepatitis B virus.

The recombinant hepatitis B vaccine is the first vaccine to be made with ordinary baker’s yeast. It is also the first subunit viral vaccine in the world, but it definitely won’t be the last.
LYME DISEASE: CURING THE CARRIER, TOO

As diseases go, Lyme disease is quite new. A doctor near Lyme, Connecticut first diagnosed the strange symptoms, including crippling arthritis and heart problems, among area children in 1975. He found that victims had been bitten by tiny deer ticks that were infected with a bacterium called *Borrelia burgdorferi*. The infected ticks slowly spread this disease. It is now found in most of the continental U.S., and every year almost 10,000 people get Lyme disease.

Diagnosing and treating Lyme disease is very difficult, so researchers are working hard to develop a vaccine. They found that injecting laboratory mice with a subunit of the bacterium's protein caused the mice to make antibodies against Lyme disease. These vaccinated mice did not get infected when bitten by infected deer ticks.

The vaccine did even more than protect the mice: after ingesting the mice's blood, the ticks themselves were no longer infected! The researchers believe the antibodies in the mice's blood were strong enough to fight off the disease in the tick's body. Thus, the vaccine not only prevents infection in the mice, it also cures the tick! Once this experimental vaccine gets federal approval, we could vaccinate animals in the wild by placing the vaccine in food baits and these vaccinated animals could actually help stop the spread of Lyme disease among deer ticks.

TUBERCULOSIS: THE COMEBACK DISEASE

*Mycobacterium tuberculosis*, the bacterium that causes TB.

Literature from the 18th and 19th centuries is full of references to people dying of "consumption," which is what they called tuberculosis, or TB. In those days, there was no cure for the highly contagious disease, so people who had it were isolated in "TB sanatoriums."

With the development of antibiotics in the early twentieth century, it appeared that a cure had finally been found. By the middle of the century, it seemed that TB might be left behind along with horse-drawn carriages and tin lizzies. By 1984, in fact, there were so few cases of TB in the United States that public health officials no longer worried about it.

Then, suddenly, there was a new epidemic. It resulted from the fact that *Mycobacterium tuberculosis*, the bacterium that causes TB, grows very slowly, so people with the disease must take antibiotics for a long time - even after they feel well again. Regrettfully, some people stop taking the antibiotics as soon as they feel better. At that point, they are still infectious, and the TB bacterium is resistant to the medication, so it is harder and harder to cure.

With new, resistant strains of TB, it may be more effective to prevent the disease through vaccines than to treat it, but the existing TB vaccine is not very effective. As a result, immunologists are working to understand the disease better so they can make a better vaccine. In the past five years, scientists have learned that TB is a disease of the immune system, like AIDS. (TB infiltrates the macrophages, the infection-fighting white blood cells.) They are also using techniques of biotechnology to work more easily with the bacterium's hard-to-handle DNA.

Immunologists hope this knowledge will lead to a new, improved TB vaccine in the near future. Currently, about 1.7 billion people around the world are infected with TB, and 3 million die each year. Since TB is so infectious, a new vaccine could not come too soon!
AIDS, or Acquired Immune Deficiency Syndrome, is our newest and fastest growing epidemic. It first appeared in the early 1980s and now infects 14 million adults and 1 million children worldwide. It is spreading so fast that 120 million people may have it by the year 2000. Unlike other epidemics, no one has ever recovered from AIDS, so no one has developed life-long immunity. Since immunization rests on preventing infection, how can you immunize someone against an infection from which no one ever recovers?

AIDS is caused by a retrovirus called Human Immunodeficiency Virus (HIV). A retrovirus contains RNA, rather than DNA like other viruses. (In recombinant DNA technology, genetic engineers use retroviruses to sneak into cells and rearrange the DNA.) HIV is so devious and subversive that we are only beginning to learn how it works.

What we know so far about HIV is scary. It sneaks past the macrophages, the sentry cells of the immune system. Then it infiltrates the lymph nodes, the hub of the immune cells’ activity. (This feat is sort of like a foreign spy infiltrating CIA headquarters.) HIV can hide in the lymph nodes for years, infecting the helper T cells — the very immune cells that ought to be combating it. When the immune system finally does respond to the invader, other cells kill the body’s own T cells along with the HIV, so the immune system seems to be destroying itself. It becomes so weakened that the body falls prey to other deadly infections, such as tuberculosis or pneumonia.

Because HIV is so sneaky, destructive and changeable, immunologists are afraid to use the standard weapons of a vaccine — attenuated or killed viruses. No one knows if, over the long term, an attenuated (weakened) retrovirus could regain its deadly strength. No one wants to risk the small chance that a killed retrovirus vaccine might contain a live virus by mistake.

Most of the work on an AIDS vaccine involves cloning the genes for the surface antigen of the HIV. None of the fifteen HIV antigens tested so far, however, is strong enough to fight off the infection. Since HIV can sneak around so easily during the second phase of the immune system’s response, a vaccine may have to focus on the first phase of the immune reaction. One strategy, therefore, may be to fortify macrophages so they can block the entry of HIV right from the very start.

Many difficult questions remain. Which of the many HIV strains should we use? Will a vaccine that protects the blood from infection (blood transfusions, operations, contaminated needles) also fight the infection when it enters through mucous membranes, where the infection often starts? Once these technical problems are solved, social questions remain. How will we get the vaccine to all the people most at risk? Who will pay for poor people’s vaccinations? Truly, the AIDS epidemic is testing the limits of both our medical expertise and our social systems.
The Wistar Institute: A Leader in Biomedical Research

This building on the campus of the University of Pennsylvania has housed The Wistar Institute since it opened in 1894.

If you walked by The Wistar Institute on the Philadelphia campus of the University of Pennsylvania, you might not suspect that this quiet Victorian building houses some of the most pathbreaking research in the world! Founded in 1892, The Wistar Institute is this country's oldest independent, non-profit biomedical research institute. Wistar's 400 staff members are involved in vaccine research, as well as research on cancer, AIDS, cystic fibrosis, rheumatoid arthritis, rabies and many other diseases.

Wistar's scientists have had hundreds of successes, such as the widely used rabies vaccine for wildlife, which was the first genetically altered vaccine to be released into the environment. (You can read more about this rabies vaccine in an article entitled "Stopping Rabies Among Wild Animals" in Volume 1, Number 1 of Your World/Our World.) Another success is a vaccine for rotavirus, a virus that causes stomach cramping and diarrhea. (You've probably had this virus and recovered, but for malnourished children around the world, it can be a killer.) Yet another success came with the polio vaccine. A Wistar researcher and former director, Dr. Hilary Koprowski, worked on a polio vaccine at the same time as Dr. Salk, and his was the first vaccine to be tested in Africa and Eastern Europe.

Wistar has devoted much effort to cancer research, and this research has taken some unexpected turns. Until the late 1950s, for example, no one could grow normal human cells in a laboratory, only cancerous human cells. Wistar researchers tried to grow normal human cells, hoping they could then find cancer-causing viruses. They succeeded in growing the normal human cells, but failed in finding the viruses. Their efforts did not advance cancer research in the way they had hoped, but they did advance vaccine research in a way they had not foreseen.

Until then, vaccines could only be produced using animal cells (usually chicken embryos), but some people are allergic to animal protein and so cannot take the vaccine. Wistar scientists realized they could use the normal human cells to produce vaccines that cause fewer allergic reactions in people than vaccines made from animal tissue cells. This research led to a new, safer rubella (German measles) vaccine and a rabies vaccine for humans that was much less painful and more effective than the previous vaccine.

This success illustrates a common path of scientific research: even if research fails to meet one goal, it may still yield very important information. You can read more about Wistar's cancer research on page 14.

Putting a Picture to Good Use.

The adenovirus causes respiratory infections, dysentery and conjunctivitis in humans, and it is responsible for half of all infant deaths in developing countries. Wistar has developed a 3-D imaging technology that gives scientists a good look at this common enemy. They combined the images from X-ray crystallography and an electron microscope using computer graphics. The colors in the picture show the different kinds of viral surface proteins, any of which might be attacked by a vaccine or drug to disable the virus. This new imaging technology lets scientists see how disease-causing microorganisms are constructed, which can help them develop methods to combat different viruses and bacteria.
Dorothee Herlyn grew up in Germany, where she earned an undergraduate degree in Veterinary Science and a doctor's degree in Endocrinology from the University of Munich. Since 1976 she has worked at The Wistar Institute in Philadelphia in immunology and cancer research.

As a Wistar researcher, Dorothee works with a team of other scientists and technicians. "We could not achieve anything if we worked in isolation," Dorothee explains. "We all know our own capacity is limited. For example, my field is immunology, and I need the help of experts in other fields, such as molecular biology, biochemistry or medicine."

Wistar's team approach to research also involves scientists from around the world. Dorothee often travels to give talks and attend meetings to learn about other research findings. In addition, she oversees clinical trials with patients who are trying new drugs developed as part of her research. "Of course," Dorothee adds, "much of the work I do is funded by grants, so I also write grant proposals and research papers."

Dorothee and her research team are working on vaccines to fight cancers like colon cancer and melanoma (skin cancer). Their anti-idiotypic cancer vaccine (see below) has already been given to about fifty cancer patients in trial experiments, and Dorothee is encouraged by the initial results.

The vaccine Dorothee ultimately hopes to develop will treat a cancer tumor once it has started growing: it will not actually prevent cancer. For that reason, Dorothee believes scientists must continue developing ways to diagnose cancer as early as possible.

She likes being at Wistar where she can concentrate on research, but she also pursues outside interests. Dorothee is an accomplished pianist, and she and her husband—who is also a scientist at Wistar—have two young children. She hopes that each year, more and more students will enter the field of scientific research.

Dorothee Herlyn Explains "Anti-idiotypic Antibody"

Big Words to Fight a Big Disease — Cancer

A cell's antigen (surface protein) can trigger the production of antibodies in the immune system. Each antigen and antibody has a unique shape that fits the other like a hand in a glove. Think of the hand as the antigen and the glove as the antibody. The antibody fits neatly over the antigen. The shape of the antibody is called the idiotypic.

1. For most diseases the "hand" or antigen of the virus or bacterium stimulates the body to make a "glove" or antibody to fight the disease.

2. In cancer, however, the "hand" of a cancer cell looks like the hand of a regular cell to the immune system, so the immune cells do not make antibodies (gloves) to kill the cancer cell.
EXPERIMENT
Fighting Diseases by Matching Antibodies to Antigens

Background
Our bodies' immune systems consist of a very sophisticated army of attack cells whose job it is to detect and fight off foreign invaders. Specialized molecules, called antibodies, wait and watch for invaders that can signal them into action. These foreign invaders are antigens, or "antibody generators."

When a foreign cell invades, your immune system either produces new antibodies or calls existing antibodies into action. These antibodies exactly match the invading antigen. So when the immune system works as it should, the antibody and antigen fit together just like a lock and key. Of course, a lock needs the right key to be opened.

In this activity, you and your partner will make a matching antibody and antigen (or lock and key) from construction paper.

You will then try to match them to cure a disease.

Materials
• construction paper (two pieces per pair of students)
• felt tip markers
• scissors

Procedure
You and your partner should each have a sheet of construction paper. Without comparing your work to anyone else's in your class, one partner should use the marker to design a cell with a protruding surface protein (which is the antigen). Cut out your cell and put a mark on the part of your cell that is the antigen.

Give your antigen some bumps and irregularities; they can be any shape you want.

Label your cell with the name of a disease, either real or one you make up. After the name of the disease, write your initials, so your cell should have something written on it such as "polio kmw." The initials represent the strain of the disease.

The other partner should now trace the antigen on his or her paper and cut out a shape that will fit the antigen like a puzzle piece. This matching pattern is the "antibody." Do not write anything on the antibody. It should match only one antigen.

Your teacher will now collect all of the antigens and antibodies, mix them up, and pass out one antigen or antibody to each person in the class.

Once everyone has an antigen or antibody, go around the class until you find your match. You will see that antigens can have an unlimited number of shapes, but that each shape will find only one antibody.

3. The scientists at Wistar are making an anti-idiotypa vaccine - a "fake hand." It has the same shape (idiotype) as the cancer cell's hand (antigen), but the immune system sees it as being different from the body's own cells. The fake hand thus triggers an immune response.

4. The fake hand stimulates the immune system to make a glove (anti-idiotype or antibody) that fits the fake hand.

5. This glove will also fit the antigen of the cancer cell. As a result, the immune system has created an antibody that will attack the cancer cell.
It Takes More Than Vaccines to Make the World Healthy

The World Health Organization and UNICEF have set the noble goal of vaccinating every child against measles, polio, diphtheria, whooping cough, and tetanus by the year 2000. President Clinton wants every child in the United States to receive vaccinations. Even if we could vaccinate every child, though, we also need to improve the social conditions that lead to disease: poverty, homelessness, contaminated water and food, dangerous habits and war. Efforts to improve people's living conditions throughout the world must accompany the development and distribution of vaccines.

Dear Students:

We are pleased to provide you with this issue of Your World/Our World. We hope you find it an interesting way to learn more about biotechnology. Biotechnology can be important to you for two reasons:

1. During your lifetime there will be tremendous discoveries in this field, and you'll want to understand what those discoveries mean for you, your friends, and your family.

2. You can help make those discoveries if you decide to continue to study science and math.

Either way, we hope you join us in discovering the promise of biotechnology for our world. We are pleased to acknowledge the support of the companies listed. Their support makes this project possible.

Sincerely,

Jeff Davidson
Executive Director
Pennsylvania Biotechnology Association

Pennsylvania Biotechnology Association

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