Biotechnology and AIDS
A few dozen cases of a mysterious new disease appeared in Africa in the 1950s. By the early 80s, an epidemic (widespread outbreak) emerged in the United States. By the 1990s, it became a pandemic (a worldwide epidemic). It is fatal and incurable. It has killed 2.6 million people, leaving 11 million orphans under the age of 15. It has entire nations under siege, causing more human devastation than war and plague.

This horrible disease is AIDS, and the virus that causes it is HIV. People may not show signs of disease for up to ten years after becoming infected. Many people infected with HIV do not know it, and they infect more people.

New drugs can slow the progress of HIV from a silent disease to the deadly symptoms of AIDS. Yet even in industrialized countries, many people cannot afford these expensive drugs. Worse, scientists suspect that HIV will soon overcome even our most advanced combinations of drugs.

Meanwhile, every hour two U.S. teenagers become infected with HIV. AIDS kills more men between the ages of 25 and 44 in the U.S. than any other cause. In the U.S. alone, more than one million people have HIV.

Worldwide, more than 47 million people are HIV-infected and 11 more...
become infected every minute. AIDS is destroying entire communities in Africa and Asia. People in these countries have no access to drugs that treat HIV, and people die rapidly of AIDS. Twenty-three million people in Sub-Saharan Africa are HIV-infected, and 13.7 million have died.

There are two major weapons against AIDS: education and biotechnology. Education helps prevent the behavior that leads to HIV infection. As the 1999 World AIDS Day slogan stated, “Listen, Learn, Live!” In the early 1980s, biotechnology helped scientists identify HIV as the cause of AIDS, diagnose HIV infection, and clear the blood supply of contaminated blood. In the 1990s, new biotechnology techniques allowed scientists to study the virus’ life cycle and design drugs that can interrupt that life cycle. Now scientists are using biotechnology to develop new drugs and vaccines that may eventually cure the disease or prevent new infection.
Dr. Paul Volberding had never seen the disease his otherwise healthy young patient had. It was cryptosporidiosis, a disease that affects sheep. This patient was one of many who were getting bizarre diseases and rare cancers.

By 1981 scientists realized they were dealing with a new disease. It crippled the immune system and left patients vulnerable to cancers and other diseases that killed them. Scientists called the new disease AIDS, for Acquired ImmunoDeficiency Syndrome, and they began desperately searching for its cause.

Looking for Clues

Their first clue was how AIDS was spread. It was not spread by casual contact like colds, chicken pox, and measles. It was transmitted sexually and from pregnant women to babies. It appeared in intravenous drug users and in people who received blood transfusions. It followed the pattern of Hepatitis B, a blood-borne virus.

Thus, scientists studied AIDS blood samples to look for an infectious organism. First, they ran infected blood through filters that screened out “large” bacteria. The blood was still infectious, so they knew they were dealing with a tiny virus. Scientists eventually called that virus HIV, for Human Immunodeficiency Virus.

The next step was to learn what kind of virus. Scientists broke the virus down into its proteins and analyzed the molecular sequences. The virus belonged to a family called retroviruses. This was not good news.

Bad News in a Retrovirus

Retroviruses were identified as a cause of human disease in the 1970s. All viruses are parasites: small packages of genes in a protein shell. They have the genetic instructions for making new viruses, but none of the cellular machinery to do so. Instead, they hijack a host cell’s equipment to reproduce and grow. A retrovirus is a type of virus whose genes are written in RNA instead of DNA. It is “retro” because it reverses the direction of transcribing genes to proteins used by all other organisms.

There are two chilling facts about retroviruses. First, some may not cause symptoms for many years, so infected people could infect others unknowingly. That meant the known AIDS cases were just the tip of the iceberg; many more people were “silently” infected. Second, retroviruses insert their genes directly into the host cell’s DNA. That means there is no way to get rid of a retrovirus once it infects the body. For something as lethal as HIV, that was a horrible realization.

Diagnosing HIV

Meanwhile, more people were dying of AIDS. Scientists around the world desperately searched for a way to diagnose HIV infection. If the AIDS epidemic had emerged before the 1980s, there would have been no way to test for HIV. By the 1980s however, several new technologies came to the rescue.

For example, scientists could now make monoclonal antibodies, which are identical (“mono”) copies (“clones”) of antibodies. Antibodies are Y-shaped molecules that latch onto invading microbes and signal immune cells to attack. Each antibody has a specific shape that matches just one type of protein on a microbe. Doctors can tell what organism is making you sick by identifying the antibodies in your blood.

Thus, scientists looked for antibodies that immune cells produce in response to HIV proteins. Finally, researchers found such a protein (called p24), which was then used to make a test kit (an “ELISA assay”) for HIV infection. This kit is similar to the rapid strep test you may have had. The HIV kit changes color when exposed to HIV-infected blood. Another new technology, called a Western blot analysis, could confirm a positive ELISA test.

The ability to diagnose was a breakthrough. Doctors could diagnose HIV in patients before they developed symptoms. Patients could take care not to infect others, and they could begin treatment to slow down the disease.

The ELISA test also allowed the Red Cross to screen the blood supply and prevent new infections. Because of this development the United States now has a blood supply free of HIV.

Measuring Infection Levels

Scientists also needed to measure the level of HIV infection to understand how the disease advances from a silent infection to the deadly symptoms of AIDS. They focused on the T4 helper immune cell. T4 cells are supposed to
orchestrate an attack on the virus, but instead HIV attacks and eventually kills T4 cells. Falling T4 counts are an early sign of HIV infection. Healthy people have T4 levels above 800. People with AIDS have levels below 200. At that level there are not enough immune cells to fend off the other infections or cancers that will eventually kill them.

In the mid 1980s a more specific tool burst on the scene: **PCR** (polymerase chain reaction). PCR allows scientists to study tiny amounts of DNA or RNA by “amplifying” (making millions of copies of) them. PCR can detect traces of HIV in people who have not yet made HIV antibodies. It measures the **viral load** in the blood, and this measurement would help scientists analyze the effectiveness of the new drugs that would soon be developed.

### Stage 1: ELISA Assay (tests for the presence of HIV antibody to p24 protein)

1) Blood is exposed to a layer of HIV p24 proteins.
2) If the blood contains HIV antibodies, as in the lower diagram, they latch onto the p24 proteins. If the blood is not infected, as in the upper diagram, nothing latches on.
3) Monoclonal antibodies with a signal attached latch on to the HIV antibodies captured in step 2, signaling a positive result.

### Stage 2: Western Blot Analysis (confirms positive ELISA result)

1) HIV proteins are broken apart and separated on a gel strip. Smaller proteins move farther through the gel, forming a ladder based on size. Blood from the person with a positive ELISA test is exposed to the strip.
2) HIV antibodies in the blood will grab the proteins along the bands of the ladder.
3) If the blood is infected, the antibodies show up as bands when treated with chemicals, confirming the HIV positive result.
4) If the blood is not infected with HIV, no bands appear.

### Stages of the HIV Disease

<table>
<thead>
<tr>
<th>Stage</th>
<th>Duration</th>
<th>T4 Cell Count</th>
<th>Viral Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Infection: flu-like symptoms</td>
<td>1-2 weeks</td>
<td>1,500</td>
<td>0 – 10,000,000</td>
</tr>
<tr>
<td>2) Asymptomatic “Clinical Latency:” no visible symptoms</td>
<td>1/2 - 10 years</td>
<td>800</td>
<td>~10,000</td>
</tr>
<tr>
<td>3) Swollen lymph nodes (glands)</td>
<td>up to 6 months</td>
<td>400-800</td>
<td>~10,000</td>
</tr>
<tr>
<td>4) Chronic: symptoms (opportunistic infections) appear</td>
<td>months to years</td>
<td>400</td>
<td>~100,000</td>
</tr>
<tr>
<td>5) AIDS and eventual death</td>
<td>years</td>
<td>200</td>
<td>1,000,000</td>
</tr>
</tbody>
</table>
Imagine you were a doctor and had a patient with a new disease. What information would you need before you could treat the disease?

Before scientists could treat AIDS, they had to understand the life cycle of HIV and how it infects cells. Viruses are tiny, efficient packages of genes. They don’t waste space on genes to make proteins if they can use their host’s equipment. Also, all other organisms have one gene for each kind of protein they make. But viruses make several proteins from one gene, cutting one long protein chain into several proteins.

Here’s what scientists learned about how HIV uses its compact genetic package to cause so much damage. You can follow the HIV life cycle on the diagram.

**The HIV Life Cycle**

**Entry Stage**

HIV lives in the blood, saliva, or mucus. The virus is transmitted when it infects a cell, frequently an immune cell called a T4 cell. The HIV’s surface is studded with gp120 proteins. To dock onto a T4 cell, one of these “studs” grips the T4’s binding site: a CD4 protein and a nearby co-receptor. (See #1 on diagram.) The HIV’s fuses into the cell (#2) and deposits its contents – two strands of RNA containing the HIV genome and several enzymes (#3).

Inside the cell, an enzyme unique to retroviruses called the reverse transcriptase (RT) goes to work. All other organisms have
their genes written in DNA and they copy the DNA into an RNA template to build a protein. Retroviruses, however, carry their genetic instructions in RNA. The reverse transcriptase copies this RNA into

a single strand of DNA (#4a).

Then it reverses its direction, makes a second copy (#4b) to produce a double strand – the same format as the host’s DNA (#5).

Now HIV uses its integrase enzyme to insert or “integrate” that double stranded DNA – containing HIV’s genes – right into the host’s DNA (#6). Then the host cell’s protein-making machinery copies the HIV’s genes into RNA templates (#7) and produces the HIV proteins (#8).

**The Assembly Stage**

One of the HIV proteins, gp160, belongs to a group of “env” (envelop or surface) proteins. As it is, gp160 isn’t functional; it needs to be cut into two smaller proteins. The HIV uses the host’s protease, a “cutting” enzyme, to snip gp160 into gp120 and gp41 (#9). These two proteins form the surface of the new virus and they eventually help it attach to a CD4 protein to enter a new cell (#1).

Meanwhile, one of the newly made proteins called gag groups the other proteins together and shuttles them to the host’s outer membrane (#10), where they bud out of the host cell (#11). Once outside, the HIV is still an immature virus without all of its working parts. To complete the process, the

HIV protease cuts a long protein chain into the proteins that make up the internal core and the key enzymes: reverse transcriptase, protease, and integrase (#12). The virus changes shape and becomes a mature HIV at the end of the life cycle, about 1 to 2 days after the virus first entered the cell (#13).

**The Spreading Stage**

The host cell continues to make new viruses until it dies. The newly made HIVs fan out, looking for new cells to infect.

**The Collapse of the Immune System**

The T4 cell directs all the other immune cells in the body, including two important types: the B cell that makes antibodies and the killer T8 cell that destroys infected cells in the body. Normally the B and T8 cells are resting, waiting for signals from the T4 cell to rev up their function. Yet as HIV kills off the T4 cells, the immune system can’t rev up. It works too slowly and HIV makes more copies than the immune system can destroy. Eventually the immune system loses the battle. Since the T4 cells are needed to fight all types of infections, HIV patients lose the ability to fight off any infection. They become immunodeficient and eventually die of both common and rare cancers and diseases such as the cryptosporidiosis in Dr. Volberding’s patient.

**Prevention is the Best Plan**

HIV is spread by unprotected sex (including oral sex and deep kissing), contaminated needles, and unscreened blood supplies. To protect yourself: abstain! (otherwise use latex condoms!) and don’t do intravenous drugs! Don’t share razors for shaving. HIV is not spread by casual contact or through food, utensils, towels, swimming pools, toilet seats, telephones, or insect bites. You can hug, cuddle, and hold hands. An HIV positive woman can infect a baby during pregnancy, birth, and nursing. She should take the drug AZT (see next page) during pregnancy and should bottle-feed the baby.

**Think about it!**

Which of the HIV proteins could scientists target to derail this life cycle?

What strategy could they use?

**Career Connection:** Counseling and Patient Support–Help people understand test results and treatment options.
The new diagnostic tools and knowledge about the HIV life cycle were a huge advance, but doctors still urgently needed new drugs to battle the disease itself.

Scientists worldwide undertook diverse research efforts, like a full-court press in basketball. Just as a team will go for the ball, break up passes, and weaken the defense, scientists targeted key stages in the HIV life cycle to break up its winning streak.

Reverse Transcriptase Inhibitors

One obvious target for a drug was the enzyme unique to retroviruses: the reverse transcriptase. Scientists looked for a molecule that could stop or “inhibit” the RT enzyme. They found their first reverse transcriptase inhibitor – AZT (zidovudine) – already “on the shelf.”

AZT was a leftover from earlier cancer research. Retroviruses were once called RNA tumor viruses because some of them cause certain cancers. In the late 1960s, two researchers hypothesized that RNA tumor viruses copy their genetic instructions from RNA to DNA – against all current understanding that genetic instructions are carried only in DNA. Their idea seemed outrageous at the time, but it proved to be true. Those scientists, Howard Temin and David Baltimore, received the Nobel Prize in 1975 for their discovery of reverse transcriptase.

“Nukes”

Cancer researchers then looked for ways to stop the RT enzyme in order to stop the cancer virus from spreading. They found that a host cell strings together DNA bases to make an RNA-to-DNA copy of the virus. They created AZT as a decoy DNA base and nicknamed this decoy a “nuke.” It is similar to a real base, but it lacks a critical attachment point, so the cell can’t link any more DNA bases. Since the reverse transcription stops, the HIV can’t reproduce – theoretically. (See diagram 1.) Unfortunately, AZT didn’t stop most cancer cells from multiplying.

Fortunately, AZT does a better job stopping HIV from reproducing – for a while at least. All too soon, drug-resistant strains of HIV appear that can override AZT. (See box on page 11.) Scientists realized that no single drug would do. They turned to the concept of combination therapy. If several drugs were mixed in a “cocktail,” there was less chance that HIV could escape all of them.

“Non – Nukes”

A second class of RT inhibitors uses different chemicals to mimic the action of nukes. Scientists screened thousands of molecules and found some that bind to the RT enzyme and prevent it from linking DNA bases into new DNA chains. (See diagram 2.) They nicknamed these molecules “non-nukes.” Because nukes and non-nukes work in different ways, together they keep RT from making a working DNA copy.

Protease Inhibitors

Scientists also targeted another key HIV enzyme for drug action – the protease. Viral proteins are made of long strands, which the HIV protease cuts up to assemble a working virus. Without the protease’s scissor action, the virus could not make several proteins needed to build new viruses. Again, when scientists looked for a molecule to inhibit the HIV protease, they found their first model ready-made.
While reverse transcriptase enzymes are unique to retroviruses, protease enzymes are common to all organisms. They perform many functions in the body and are common digestive enzymes. They are used in meat tenderizers, laundry whiteners, and drugs that prevent blood from clotting.

Scientists had designed inhibitors to stop unwanted enzyme activity. One inhibitor targeted the enzyme renin, which plays a role in high blood pressure. Amazingly, researchers realized that the structure and function of renin is very similar to the HIV protease enzyme. Furthermore, the renin inhibitor fit into the HIV protease scissors and stopped it from cutting. (See diagram 3.)

Soon, new molecular modeling techniques helped custom-design a new generation of protease inhibitors. Molecular models show the three-dimensional structure of enzymes and molecules. By analyzing the shapes of different molecules, scientists could identify and even custom-build new molecules that would prevent the scissor action in different ways.

The Cocktail

Scientists combined the two reverse transcription inhibitors and the protease inhibitor to make a “combination drug cocktail” called HAART (highly active antiretroviral therapy). The cocktail made a huge difference for HIV infected people. In the United States, deaths from AIDS sank by 44% from 1996-97, and hospitalizations declined as well. People on their deathbeds returned to work and recreation. But by 1999, several patients on the cocktail were regressing into AIDS. HIV was becoming resistant even to HAART. Scientists looked for new targets to stop HIV’s progression.

HAART is HARD!

Taking the combination drug cocktail isn’t easy. People must take 16 or more pills a day in a specific sequence, even getting up in the middle of the night. The drugs have such unpleasant side effects that some people stop taking them. Then, they might infect other people with an already drug-resistant strain. People who have a support system have more success staying on this difficult drug program. People who have the least success are intravenous drug users – and they are the most likely to pass HIV on to others.
At first the combination drug cocktail seemed to work miracles. But it still can’t clear the virus from the body. To actually cure HIV infection, scientists need to stop the virus from reproducing completely until the cell it is hiding in dies.

One of many new strategies focuses on blocking the virus from entering the cells in the first place. That strategy would be like keeping the opposing basketball team from even getting on to the court. To do that, scientists need to learn more about how viruses manage to enter their host cells.

**HIV Fusion**

From the perspective of a virus, a cell’s membrane is a forbidding barrier. It is made of several tightly packed, protective layers.

A T4 cell’s CD4 protein recognizes HIV’s gp120, which grips onto the CD4. A co-receptor on the T4 cell then tightly binds to gp120.

The co-receptor moves the gp120 out of the way and exposes the gp41, which jack-knifes open.

The fusion peptide pierces the cell membrane and draws the HIV close enough to fuse into the T4 cell.
In addition, when a virus attaches to a surface protein such as the CD4, it is held at arm’s length and can’t pierce the membrane. How do viruses get close enough to break through the membrane? Scientists found out how the influenza (flu) virus does it, and later they learned that HIV performs a very similar trick.

The key player for these viruses is a surface protein with a section called a **fusion peptide**. A peptide is a small fragment of a protein, and a fusion peptide helps the virus melt into the host cells membrane. Scientists modeled the three-dimensional structure of the surface protein and saw that it is a tightly bound bundle of three identical proteins, each with an upper and lower section.

In HIV, the upper part is the gp120 protein and the lower section is the gp41 protein with a fusion peptide at the end. These proteins change shape several times upon contact with the CD4 protein. At first, the upper gp120 sticks outward like a cup on a spike. The lower gp41 section is dropped like an anchor into the virus’s surface and the fusion peptide is buried in the virus. This lower section is doubled over and “spring loaded,” but it is held back by the gp120. When the gp120’s cup binds to the CD4, the gp41 jack-knifes open, exposes the fusion peptide, and throws it like a harpoon into the host cell’s membrane. This action pulls the virus close to the cell’s membrane, and the viral contents ooze into the cell.

### Fusion Inhibitors

Seeing the spring-loaded mechanism of the gp120 and gp41 proteins suggested an interesting experiment. Scientists hypothesized that they could prevent this fusion if they could keep the lower gp41 “jackknife” protein from being released. They screened over 60 thousand synthetic (non-natural) peptides to find some that would lock up the gp41 and keep it from springing open. They found one candidate, called a T-20 peptide, that seemed to work. However, the T-20 peptide can’t be given as an oral drug. Because it is made up of proteins, the digestive system thinks it’s a food and digests it. Scientists are looking for a molecule that will perform the same duty and can be given orally.

### Resisting Drug Resistance?

Fusion inhibitors may have an advantage over reverse transcriptase and protease inhibitors. The structure of the fusion peptide changes very little among the different strains of HIV. Scientists hypothesize that this spring-loaded mechanism is not a hot spot for mutation. Thus, HIV may not become drug resistant to fusion inhibitors as it has to other antiretroviral drugs.

There is more good news. This research on fusion inhibitors will apply to a number of viruses, including influenza and Ebola. This is just one instance of the way HIV research is advancing the diagnosis and treatment of a variety of infectious diseases.
Even the best HIV drugs will be too expensive for the massive numbers of people who need them. How can we stop the rapidly spreading worldwide infection? Historically, the best way to stop an infectious disease is through a vaccine.

A vaccine works by imitating a key feature of a disease-causing virus. It shows the immune system what the virus looks like and gives your body practice killing it. Then, the immune system can mount an effective defense when it meets the real enemy. Some vaccines use a live but weakened virus that can’t cause disease but still activates the immune response. The smallpox vaccine (see box on page 13) was the first live virus vaccine. Other vaccines use a killed virus whose antigens trigger the immune system.

Scientists cannot use either live or killed HIV in a vaccine. A weakened HIV could mutate into a lethal form and cause the disease. Likewise, if a killed HIV vaccine were not completely disabled, it could revive and become infectious. Thus, researchers are turning to new vaccine models made possible by biotechnology.

Recombinant Vaccines

Some AIDS researchers are using the smallpox model to develop a recombinant live virus vaccine for HIV. (“Recombinant” means that scientists have recombined DNA by inserting a gene from one species into another species that will produce the foreign proteins.) Scientists are inserting genes for harmless HIV proteins into other viruses that don’t cause disease in humans. When the virus “infects” us, it won’t make us sick but it will produce an HIV protein that safely tricks our immune system into fighting HIV.

In another strategy, scientists are identifying a specific portion or subunit of harmless HIV proteins that act as blueprints for antibodies. These subunits could make an inexpensive vaccine that can be transported easily to remote regions of the world.

A Tricky Vaccine Test

One such vaccine is being tested in Thailand. Researchers used human volunteers, since no other animal gets AIDS when infected with HIV. They gave the vaccine to 50% of the volunteers and a placebo to the rest. The study was “blind,” so no one knew which version they received. Can you think of ethical objections to this method? The researchers could, so they provided counseling to all volunteers; they explained how HIV is transmitted and how to protect against infection. After 1.5 years, the infection rate dropped from 8% to 0.1%.

Researchers realized the counseling itself greatly reduced the infection rate by changing behavior. This realization was a great advance in AIDS prevention. To see if the vaccine itself is effective, they are turning to a group of volunteers who don’t respond well to counseling: intravenous drug users. This group may practice safe sex but still share contaminated needles. If their infection rates go down with vaccine, then the vaccine probably protected them.

AIDS patients crowd hospital wards in northern Thailand. Ninety five percent of the 47 million people infected with HIV live in Asia and Africa.
DNA Vaccines

Several years ago, scientists were surprised to learn that naked DNA could produce an immune response. Naked DNA refers to a gene that is spliced into a circular piece of bacterial DNA called a plasmid, without the cover of a virus. The gene-bearing plasmids are injected into the body. The body’s cells take up the gene and produce whatever protein it instructs. Scientists first used this concept in gene therapy experiments in the 1980s, and they were disappointed. They wanted the gene to produce a healing protein to treat a genetic disease. The gene did produce the protein, but the body’s immune system reacted to the foreign antigens of the protein and destroyed it. In the 1990s, scientists realized they could make use of this immune response for vaccines.

There may be something about plasmids that make a DNA vaccine doubly effective. Since plasmids come from bacteria and bacteria are common infectious enemies, our immune system might recognize them as a danger sign. If so, this recognition would prime the immune system for a vigorous response against the protein that plasmid encodes. Several genes safely designed to activate antibodies and killer T cells may be combined on one plasmid to fight HIV on several fronts. (See illustration below.)

The Smallpox Model

During the first half of the 20th century, the world grappled with an epidemic even greater than AIDS is now — smallpox. Between 1919 and 1945, more people died of smallpox than were killed during both World War I and II. In response, the World Health Organization helped distribute the smallpox vaccine worldwide. This vaccine, discovered by an English doctor named Edward Jenner in 1776, uses a harmless relative of smallpox called cowpox. Smallpox was finally eradicated in 1978 — at a cost of $300 million. That amount of money pays for one commercial airliner. How much does a fighter plane cost? A space shuttle flight? How much would we spend on an AIDS vaccine?

Hope and Challenge

Many see vaccines as the only hope for stopping the relentless spread of HIV, yet vaccines present one of the greatest scientific challenges in AIDS research. Perhaps you or your classmates will make a scientific discovery down the road that will save the world from this horrible pandemic.
Colonel Debbi Birx, M.D., is director of the U.S. Military HIV Research Program that is developing vaccines and new treatments for HIV infection. She’s active in AIDS advocacy and research organization, and has written more than 100 journal articles.

Debbi Birx grew up in a family of scientists. For Christmas, she and her brothers received radio or TV kits to put together, and they were the first family on the block to get calculators. “While other families discussed long hair and the Vietnam War,” Debbi recalls, “we talked about how transistors were revolutionizing the planet.” In high school, Debbi participated in the Westinghouse Talent Search for Science. She played sports, including varsity field hockey at Houghton College, where she majored in physical chemistry and math. “I thought I would work for Kodak, but one day I realized I didn’t want to just make better dyes for photos. Instead, I went to medical school after college.”

In medical school, she married a man who was on the military’s Health Professional Scholarship. “For us to be in medical school together, I had to join the Army,” she explains. “And I’ve stayed in the Army for 20 years because of the terrific research opportunities.”

She was specializing in immunology at the Walter Reed Army Medical Center when she was recruited for a new Division on HIV in 1987. “I left a big office and lab for a cubby and a tiny lab,” Debbi laughs, “but it was an exciting opportunity!” She now directs a lab of 30 dedicated researchers and 80 technicians. Their work involves trials with volunteers in the USA, Uganda, and Thailand, using vaccines that express HIV proteins to stimulate the immune response. (See pages 12-13.) Debbi is excited about the future of HIV vaccines. “We are evaluating many vaccine ‘candidates’, some of which may also help us fight diseases like malaria and dengue fever. It’s a privilege to work with these committed scientists. I come back from Asia and Africa feeling like I should work all day and night to match everyone’s commitment to solving the AIDS crisis.”

Debbi has two teenagers, so she thinks a lot about how students make career decisions. “I say do what you love, but don’t burn any bridges. Take a variety of courses and in college do summer internships in different areas so you can see what you really like. There are incredible resources available in every field and your work will be so exciting as the technology moves forward. No field is off-limits to anyone. The most important quality we look for is not brute intelligence but the ability to work with people and form a team. Success is not measured by individual achievements but by the achievement of the group and the success of the whole project.”

If Debbi’s group project – an HIV vaccine – is successful, the world will truly be a better place to live. What a great way to live, and to earn a living!
Simulating The Spread of AIDS

Your class can simulate how HIV is transmitted from one person to many people.* One of you will have an “HIV infected” test tube of “body fluids,” but you won’t know who. (The infected fluid really contains a harmless chemical.) You won’t know until the end if you have “shared body fluids” with an infected person.

Set-up
1. Form groups of four students each.
2. Obtain from your teacher a numbered test tube containing 6 ml of a simulated “body fluid.”
3. Using a pipette, transfer 1 ml of the fluid into an empty “control” tube with the number matching your vial. Set this control tube aside.

Transmission
4. Choose a partner in your group and exchange fluids. One of you will pour his or her solution into the other’s test tube. Then pour half the solution back into the first tube. This exchange represents your first potential contact with the virus.
5. Record the number on your test tube (“Me”) and record the number on your partner’s vial as the “1st Contact.”
   
   Me    1st Contact    2nd Contact    3rd Contact
   #_____ #_____ #_____ #_____  

6. Two students leave your group, taking their test tubes with them, and join a group with two other students. Two students from another group join the remaining two students.
7. Choose a new partner in your new group and exchange fluids, as in Step 4. Record your new partner’s number under “2nd Contact.”
8. The two original members in each lab group move to different groups that, if possible, don’t contain any of their original members. Choose a new partner and exchange fluids. Record this partner’s number as “3rd Contact.”

Testing
9. If you are using a “virus detection solution,” use a pipette to place 5 drops of the solution into your test tube. If the fluid turns pink or red, the test is positive for HIV; you have been infected. If it remains clear or milky, the test is negative; you are not infected. If you are using litmus paper, dip the paper into your fluid. If it turns blue, the test is positive (infected). If it turns red, you are not infected.
10. Test your “control” test tube to see who was the first person infected.

Results
11. How many students were infected at the end of this activity?
12. What is the rate of infection in your classroom?
13. What would happen if you exchanged fluids for more rounds?

Conclusion
14. Why is it important to understand how HIV spreads through a population?
15. How can you use this understanding to protect yourself from infection?

*Activity based on “How Viruses Travel!” developed by NeoSci. To purchase the HIV Simulation Kit please call:
NeoSci: 800-526-6689, Kit # 10-20-1133
Fisher Scientific: 800-955-1177, Kit #532008

Career Connection: Biotechnology Education—Help people understand new scientific discoveries.
Kids can do many things to help people with AIDS and to fight the disease. Volunteer to care for AIDS patients in your community. Organize or participate in events to raise money for medical research or to support a local AIDS clinic. Lobby your politicians and local media to pay more attention to the AIDS crisis worldwide. Talk to other kids about preventing HIV infection. Your actions can make a difference!

Reading Room

Center for Disease Control: http://www.cdc.gov/
National Institutes of Health: http://www.nih.gov
AIDS hotline: 800-342-AIDS
World AIDS Campaign for Young People:
http://www.unaidsof.org/wac/1999/index.html
World Health Organization (WHO):
http://www.who.int/aid/aids/
UNAIDS: http://www.unaids.org/Revised/Cube_frame.html
Cells Alive HIV Drug Animation:
http://www.cellsalive.com/hiv0.htm
The Science, Spread, and Therapy of HIV Disease, by Michael A. Dispezio