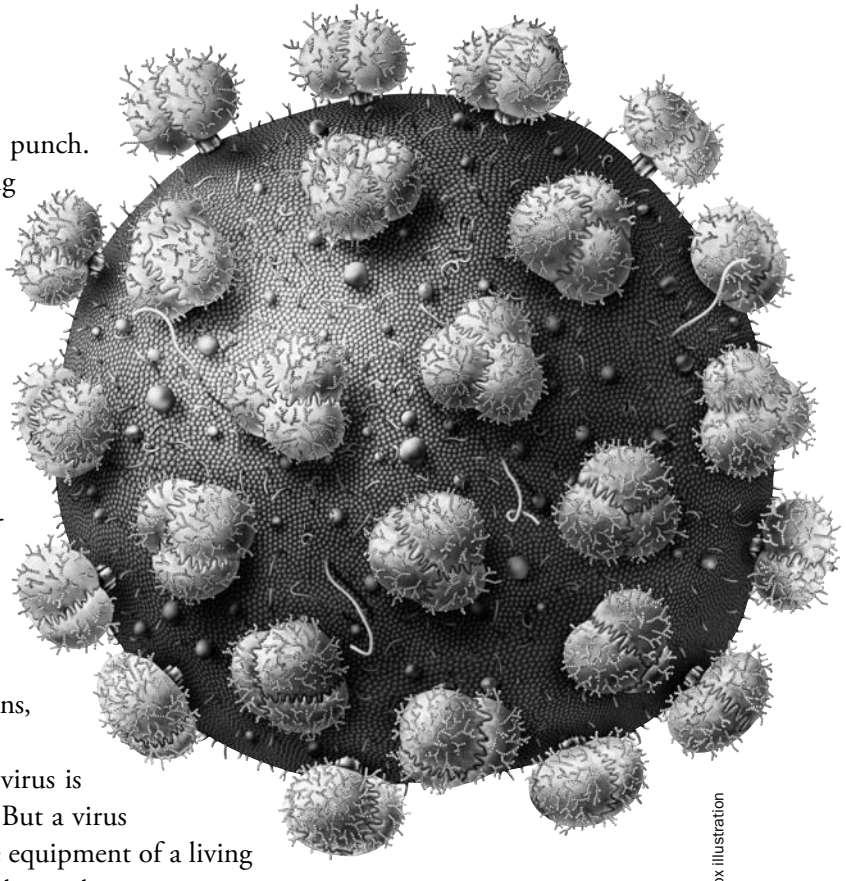
Activity 1

HIV: Evolving Menace



UNSM Angie Fox illustration

Viruses are tiny, but they pack a big punch. Viruses spread and multiply fast, causing some of the most common and contagious diseases in the world. If you've ever had a rash, flu, or warts, you've probably hosted a few viruses. Actually, you've hosted a few billion. Once a virus sets up residence in an organism, it doesn't stay solo for long. One type of virus, HIV, can make 10 billion new viruses in a single day.

A virus consists of a small amount of genetic material inside a protein case. The genetic material of some viruses, such as herpes viruses, is DNA, while the genetic material of other viruses, like HIV, is RNA. DNA and RNA store information for making proteins, which in turn build a complete organism.

Whether it contains DNA or RNA, a virus is basically a recipe for making more viruses. But a virus can't make new copies by itself; it needs the equipment of a living cell. Viruses attach themselves to cells and dump their genetic material inside. The virus takes over the cell's machinery, which then starts turning out copies of viruses instead of its own products. The new viruses bud from the cell and go on to infect other cells. To viruses, your cells are nothing more than giant copy machines for making more viruses.

Luckily, your body is equipped with an infection-fighting army called the immune system. The immune system is made up of many different kinds of cells. There are T cells that alert the body to viruses and organize an attack, and other T cells that kill off the infected cells. There are B cells that produce proteins—called antibodies—that lock on to the virus and prevent it from attaching to a cell. And there are

cells that clean up the mess. Your immune army is able to recognize and respond to virus invasions almost as fast as the viruses multiply. For example, it takes only a few days to recover from colds or flu. It happens naturally.

Some viruses, however, are so dangerous or deadly it isn't safe to let the immune system attack them naturally. You've probably received vaccines (usually shots) to protect you against highly contagious childhood diseases like polio, measles, mumps, and whooping cough. These vaccines are made of dead or weakened viruses. They boost the immune system by stimulating your cells to create antibodies that can recognize and block the viruses before they attach to a cell. The vaccine prepares your body to recognize the infection if it should recur. In other words, your body becomes immunized against that particular virus.

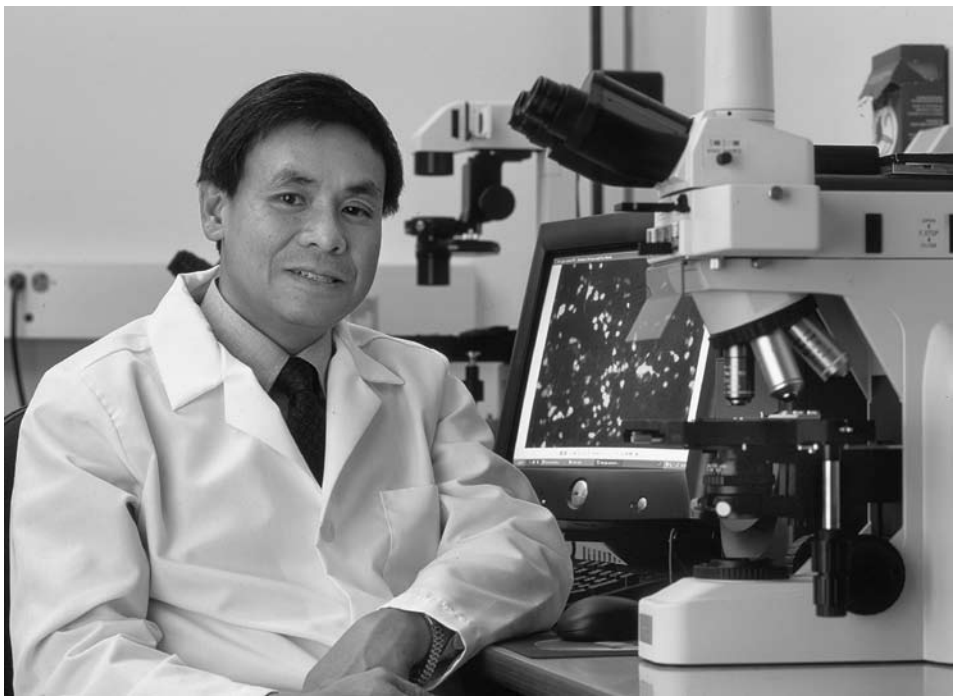
But not all viruses are "vaccine friendly." For example, there are more than 200 types of cold viruses, too many for a single vaccine to handle. Other viruses, such as influenza, quickly evolve into new versions that may be resistant to last year's vaccine. Every year scientists need to predict the type of flu that will be widespread that year and develop a flu vaccine that targets that particular version. And you're likely to need a different vaccine the following year.

One of the deadliest viruses to emerge in recent years is HIV. It causes the disease called AIDS. HIV stands for Human Immunodeficiency (im-YOU-no-Dee-FISH-in-see) Virus. HIV invades the body's immune system, the very system that protects you from viruses and other invaders. Specifically, HIV targets the immune system's T cells. T cells organize the immune system response team. HIV is able to attach to a T cell through the interaction of its surface proteins with the T cell's receptor, like a key in a lock. Once the virus attaches to the cell, it fuses with the cell to deliver its genes inside.

People whose T cells become infected with HIV may not know it at first, but their immune system is gradually being destroyed, leaving them defenseless against deadly diseases such as pneumonia and tuberculosis. Even normally mild diseases like colds and flu may become deadly as the immune system collapses from HIV infection. This weakened condition is called AIDS (Acquired Immune Deficiency Syndrome). AIDS is always fatal. But with the proper drugs, people can live for many years with HIV infection.

HIV was discovered in the 1980s. In 20 years, the virus has spread to people in every country in the world. Today, about 40 million adults and children are infected with HIV, over 20 million have died from the disease, and the numbers keep rising. Increasingly, the victims are young women in their childbearing years. They often pass the virus to their babies.

As HIV races around the world, scientists are racing to stop it. One of these scientists is Charles Wood, a virologist (virus expert) at the University of Nebraska. Wood heads a team of scientists that is tracking the evolution of HIV in mothers and their infants. The team investigates how the virus evolves as it passes from mother to child, and how it changes in response to the immune system. Charles Wood studies



Charles Wood is the director of the Nebraska Center for Virology at the University of Nebraska. He studies how HIV is transmittted from mothers to infants.
Photo courtesy David Fitzgibbon University of Nebraska-Lincoln

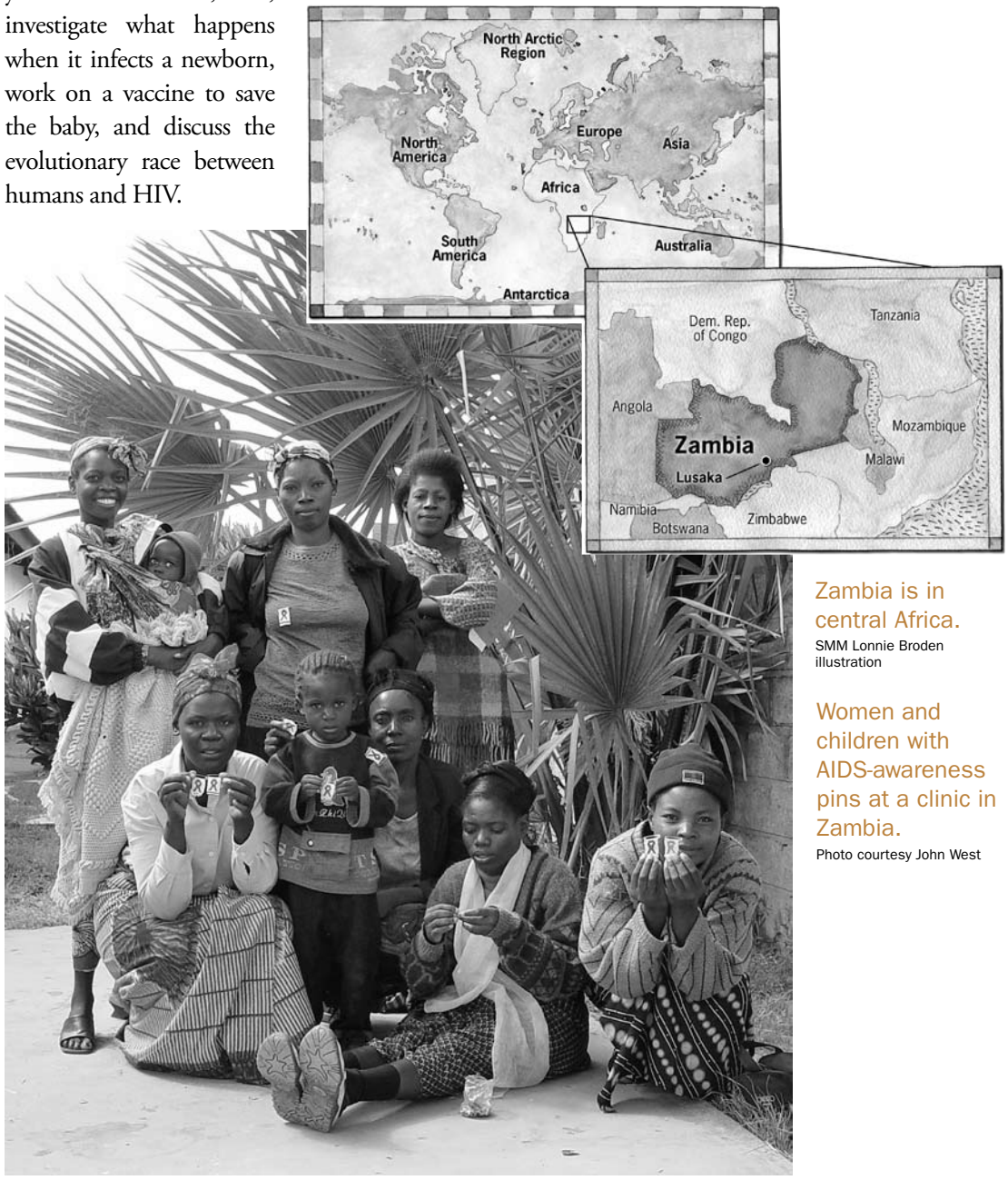
these things to try to understand effective ways to block HIV's spread. It's not clear yet who will win this race, HIV or us. Read on and find out why.

HIV not only multiplies rapidly, it also mutates rapidly. This means that new viruses are not exact copies. They have genetic variations, or mutations. Scientists call these different viruses "strains." The strains are like a swarm of bees, each slightly different. The body's immune system (or a drug treatment) blocks many of the new strains and greatly reduces the number of viruses. But some of the viruses escape and produce new strains. Each time the immune system or treatment tries to eliminate the viruses, some of the new viruses escape, and the different strains build up into another swarm. This is typical behavior for viruses. What is unusual about HIV is that it infects the immune cells themselves. With each new swarm, HIV is simultaneously destroying the immune system, leaving the body defenseless against all kinds of disease.

Charles Wood's research takes him to a laboratory in Zambia, a country in Africa. HIV is one of the greatest threats to women and children in Zambia and in the rest of the developing world. In tracking the evolution of HIV from mother to child, Wood first identifies the strains of HIV in the mother on the day she has her baby. He then looks at what happens when the virus travels to its new host, the newborn baby.

To stay ahead of the evolving virus, scientists need to predict which parts of the virus are likely to change and evade recognition by the body's immune system, and which parts are likely to remain unchanged. Wood is hopeful: "If we can understand the evolution of HIV, where the virus is going, and why it is going there, we'll win." Wood and his team are collaborating with other scientists on a vaccine to give HIV-infected mothers before they give birth. The vaccine is designed to create antibodies that tie up all the viruses so that none are able to infect the baby.

But what about a vaccine for the baby? Try your hand at creating one that works. In this activity you'll meet the virus, HIV, investigate what happens when it infects a newborn, work on a vaccine to save the baby, and discuss the evolutionary race between humans and HIV.



Zambia is in central Africa.
SMM Lonnie Broden illustration

Women and children with AIDS-awareness pins at a clinic in Zambia.
Photo courtesy John West

PART ONE
Inside the invader

A virus has been called "a piece of bad news wrapped in a protein." Meet HIV, then make a flip book movie to watch the action of a virus attack.

Work with a partner

Each team of two will need:

- Virus Flip Book sheets 1, 2, and 3
- clip or stapler
- marker
- colored pencils
- scissors

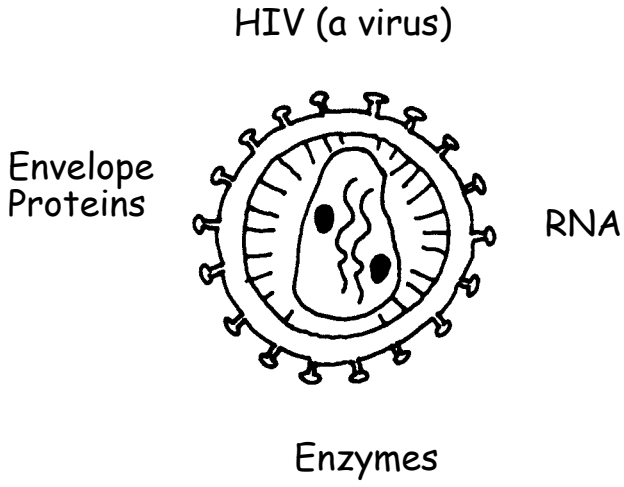
1 Map a Virus

A virus is essentially a recipe for making itself, packaged in a protein overcoat. HIV targets one kind of human immune cell, called T cells, and then breaks in. Once inside it pirates the cell's control center, takes over the cell and makes thousands of copies of itself. Check out the virus parts. Draw lines connecting the labels to the features on the HIV diagram:

a Find the virus envelope proteins. They are the spikes or keys on the surface that the virus uses to break into living T cells.

b Find the two long thin strands of RNA located inside the virus. RNA is a genetic code for making more of this type of virus.

c Find the enzymes. They are chemicals (represented by dots) that help the virus reproduce.



2 Explore a T Cell

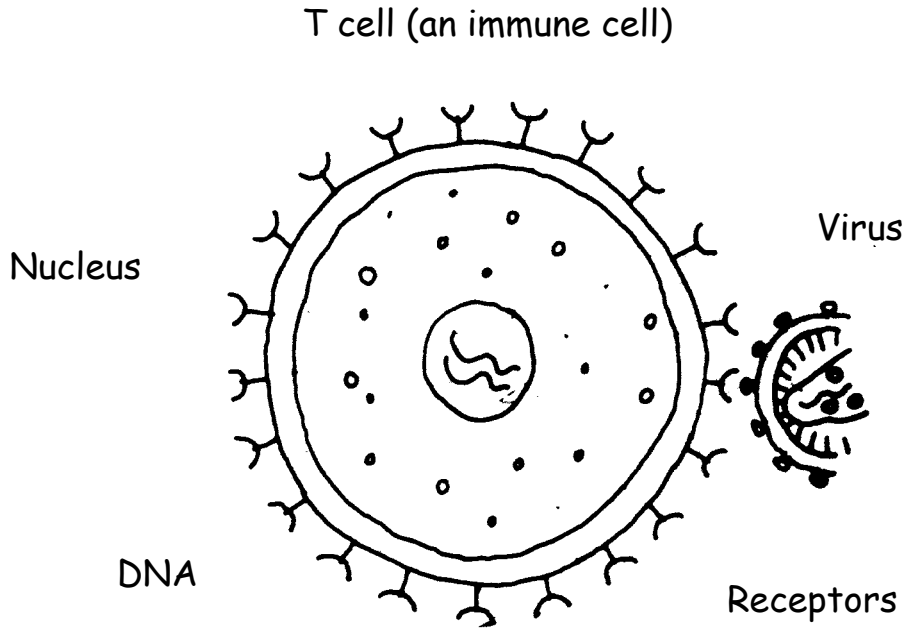
T cells are one kind of the body's defense cells. They respond to an infection by identifying the invader and signaling the rest of the body's immune system to get busy defending against the attack.

Draw lines connecting the labels to the features on the T cell diagram:

a Find the nucleus. This is the control center of the cell.

b Inside the nucleus, find the two strands of DNA. This is the genetic material that contains the recipe for making a new cell.

c Find the receptors on the cell membrane. These are the locks that the virus must open to gain entrance into the T cell.



3 What's the Difference?

How is a virus similar to and different from a T cell?

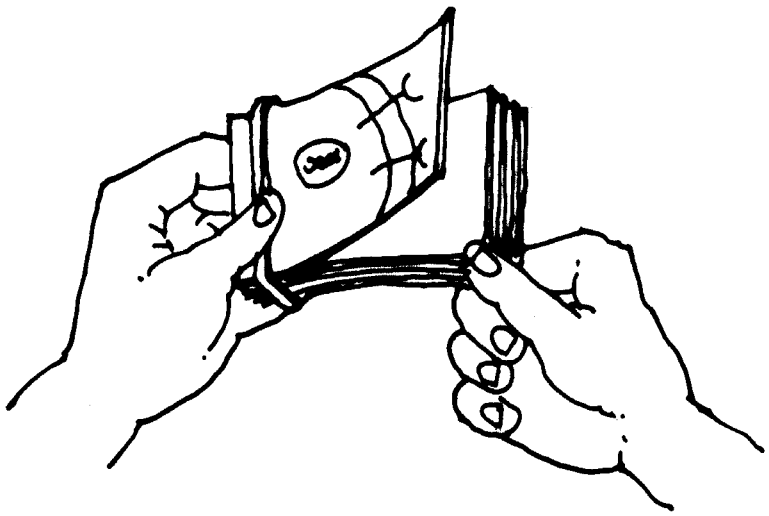
4 Make a Flip Book Movie: Virus Attacks

a First cut out all the flip book pages. The movie will work better if you are exact in your cutting. Put the pages in order, starting with page one.

b Color the pages if you like. Be sure to keep the colors the same on each page.

c Line up the outside edges without the numbers by tapping them on a flat surface.

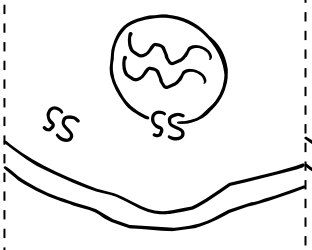
d Test flip your movie. When you are sure your pages are in good flipping order, bind the pages with a staple, clip, or rubber band. Be sure to bind the flip book pages on the side with the number.



Cut on dashed lines.

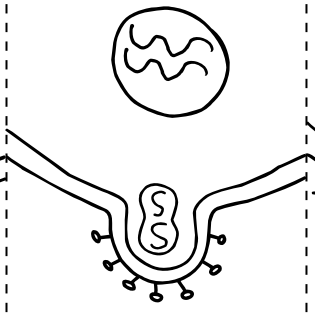
VIRUS FLIP BOOK SHEET 1

10



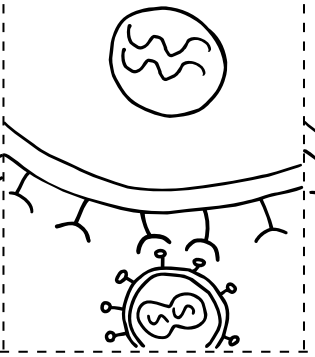
7

The virus spills its contents into the T-cell.



4

HIV virus attaches to T-cell's surface.



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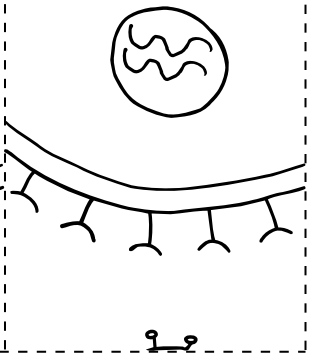
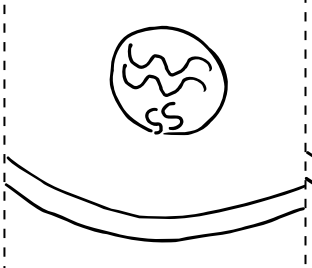


11

The virus' genetic code enters the cell's nucleus.



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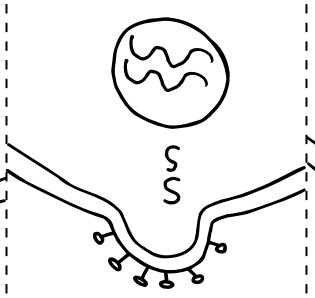

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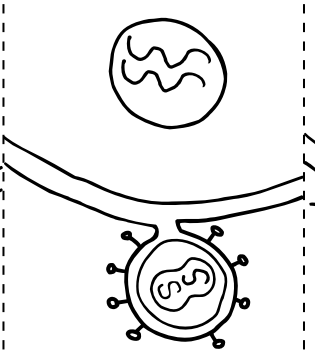
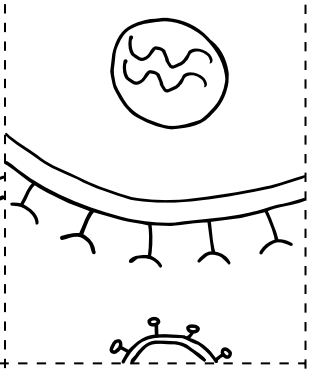
The virus breaks into the T-cell with its keys.



2

T-cell minding its own business.



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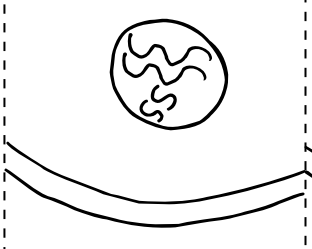
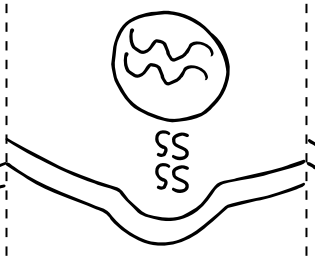


9

The virus copies its genetic code.



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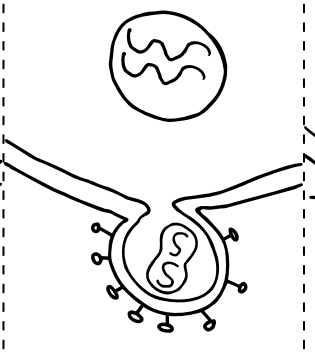

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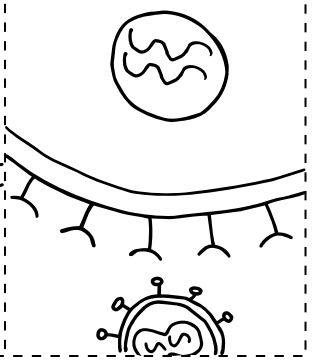
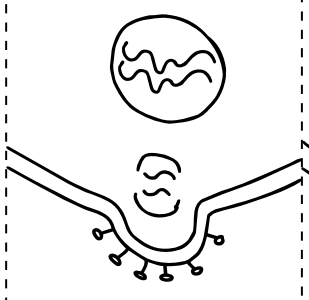


Cut on dashed lines.

VIRUS FLIP BOOK SHEET 2

22

New virus forms inside the T-cell.



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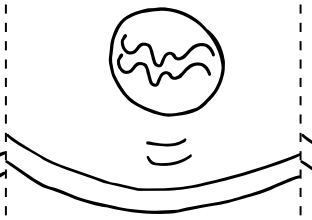
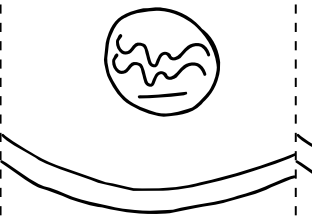


16

The virus code directs the T-cell to make virus.



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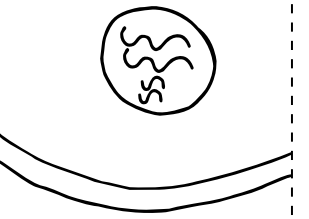

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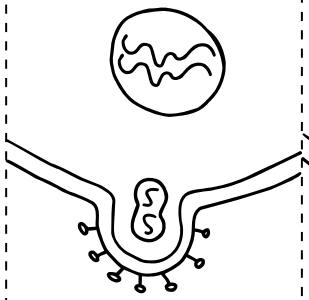

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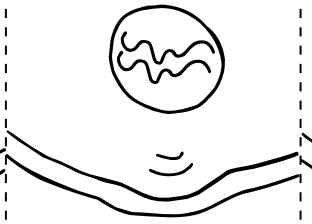

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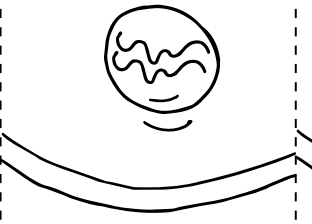
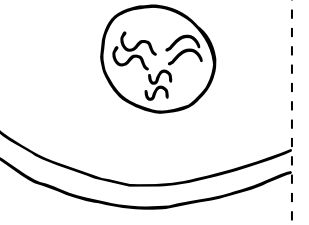


14

The virus splices into the T-cell's DNA.



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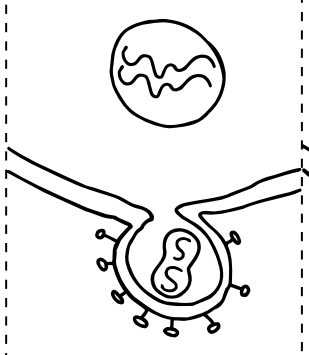

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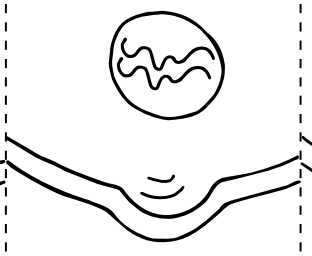

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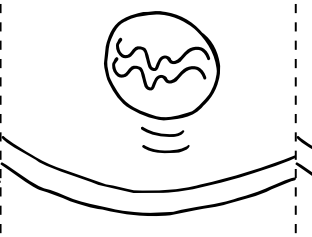
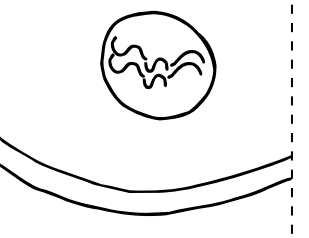


15

The virus inserts its genetic code into the T-cell's DNA.



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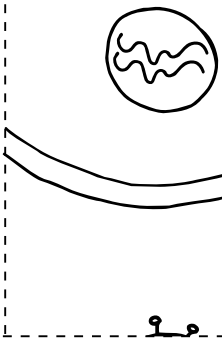
VIRUS FLIP BOOK SHEET 3

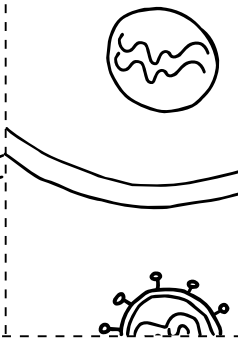
31

Each new virus searches for a new T-cell to attack.



28

Each infected T-cell makes a swarm of new viruses.



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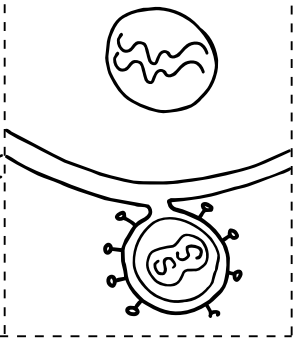
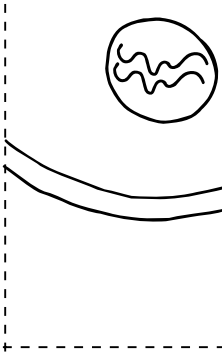


32

The invaded T-cell dies.



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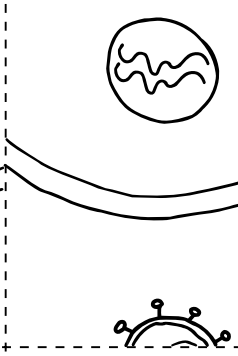
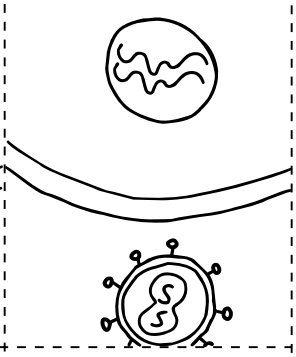


26

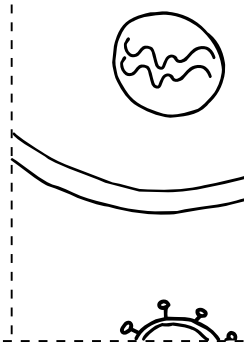
A new killer HIV virus bursts out of the T-cell.



Optional first page: Create your own title page here.

30

Deadly new viruses are loose inside the body.



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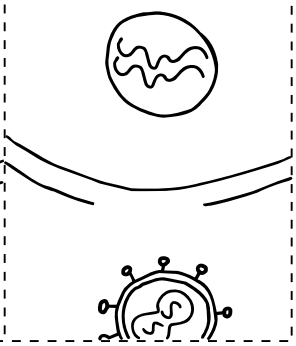


e Read the script of what is happening in the movie on the pages. Use these as clues to caption the movie characters in the next step.

f The characters in your movie need labels. Write the following label names on the flip book pages where they first appear:

- T cell
- T cell nucleus
- T cell genetic code
- HIV
- HIV genetic code
- New virus

g Write a title for this movie. Put it on the first page of the flip book.

5 Consider This

If you had to write an epilogue (comment about what will happen next) for this script, what would it say?

PART TWO
Evolution of the mutants

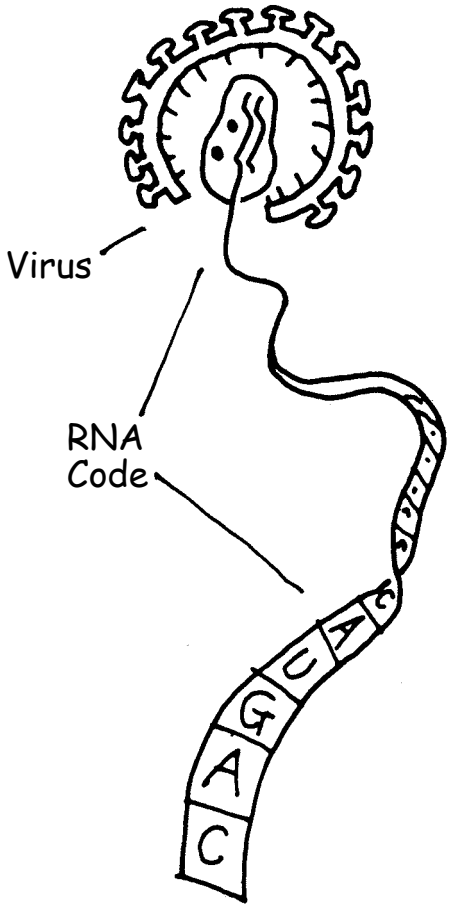
In this section you will investigate how HIV from a mother can evolve into new strains when it is passed on to her baby. You will look closely at a section of the virus RNA code as it changes over generations.

DNA and RNA store information for making proteins, which in turn build a complete organism. Your challenge is to create a "vaccine" that can disable all the virus strains and save the baby's life. In this activity the vaccine will work on the viral RNA. In real life, vaccines work directly on the proteins made by the virus.

Work with a partner

Each team of two will need:

- Virus Mutation Tracker sheet
- Available "Vaccine" (see page 58)
- Your "Vaccine" (see page 58)
- scissors
- coin
- colored pencils: yellow, red, blue, green



1 Tracking Mutations

Take a look at the Virus Mutation Tracker sheet. The columns on the sheet represent a short segment of the HIV RNA code. A real virus has about 10,000 sites. You will work with only 10 sites of code.

VIRUS MUTATION TRACKER

Mother's Virus Strain	Infant Virus Strain 1	Infant Virus Strain 2	Infant Virus Strain 3	Infant Virus Strain 4	Infant Virus Strain 5
Site 1 A	Site 1 A	Site 1 A	Site 1 A	Site 1 A	Site 1 A
Site 2 U	Site 2 U	Site 2 U	Site 2 U	Site 2 U	Site 2 U
Site 3 U	Site 3 U	Site 3	Site 3	Site 3	Site 3
Site 4 G	Site 4 G	Site 4 G	Site 4 G	Site 4 G	Site 4 G
Site 5 C	Site 5 C	Site 5 C	Site 5 C	Site 5 C	Site 5 C
Site 6 C	Site 6 C	Site 6	Site 6	Site 6	Site 6
Site 7 A	Site 7 A	Site 7 A	Site 7 A	Site 7 A	Site 7 A
Site 8 C	Site 8 C	Site 8 C	Site 8 C	Site 8 C	Site 8 C
Site 9 G	Site 9 G	Site 9	Site 9	Site 9	Site 9
Site 10 C	Site 10 C	Site 10 C	Site 10 C	Site 10 C	Site 10 C

Color Key A=red/Adenine U=blue/Uracil C=yellow/Cytosine G=green/Guanine

2 Create a Virus Strain

a On the Virus Mutation Tracker sheet, notice the column on the left called Mother's Virus Strain. It is made up of a string of letters: A-U-C-G. Those letters represent the nucleotides Adenine, Uracil, Cytosine, and Guanine.

Why are we using Uracil? The DNA in humans and some viruses uses four nucleotides as building blocks: Adenine, Thymine, Cytosine, and Guanine. But HIV belongs to a group of viruses that has RNA instead of DNA. RNA uses building blocks: Adenine, Uracil, Cytosine, and Guanine.

b Color each site of the Mother's Virus Strain according to this chart:

Nucleotide Color Chart

LETTER CODE	COLOR IT	NUCLEOTIDE
A	Red	Adenine
U	Blue	Uracil
C	Yellow	Cytosine
G	Green	Guanine

c Now color each site of the next column, Infant Virus Strain 1, according to the Nucleotide Color Chart. How does it compare to the mother's strain?

When this infant was born the mother infected her infant with her virus, Strain 1.

3 Create a Mutant Strain

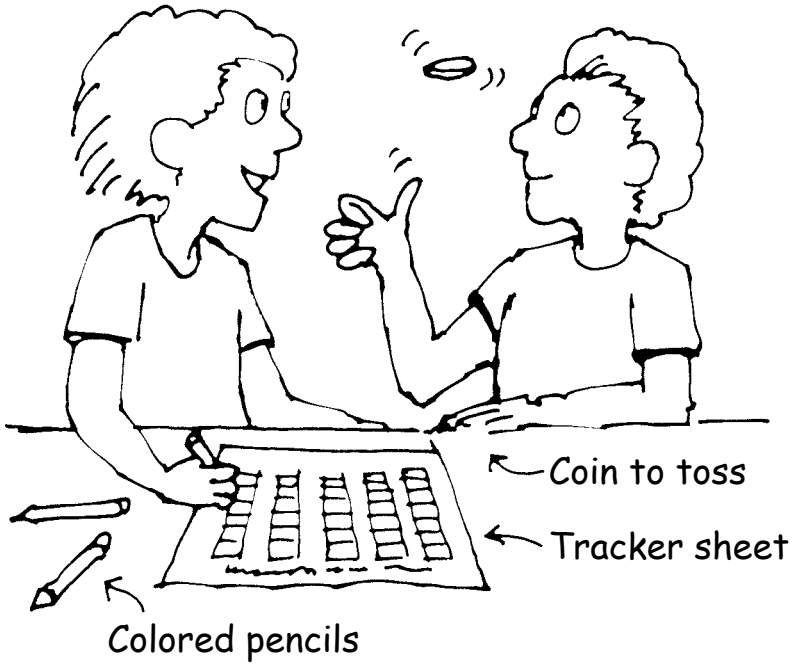
a Inside the baby, the virus invades cells and reproduces. HIV often makes mistakes when it copies itself. Instead of a perfect copy, certain sites in the code tend to switch nucleotides.

b To create Infant Virus Strain 2, find the third column from the left, Infant Virus Strain 2. First color each site of Strain 2 according to the Nucleotide Color Chart, except for sites 3, 6, and 9. These sites switch letters at random. Use the information in the Coin Toss Chart to fill in the random letter.

Coin Toss Chart

COIN TOSS	LETTER CODE	COLOR IT
Heads/Heads	A	Red
Heads/Tails	U	Blue
Tails/Heads	C	Yellow
Tails/Tails	G	Green

- Flip a coin two times to decide if an A, U, C, or G will fill site 3. Then flip twice again for site 6, and again for site 9. Then finish coloring the code. Congratulations, your virus has replicated!



4 Make More Mutants

To make more virus strains, repeat the above process three more times to create Strains 3, 4, and 5. The infant now has five different strains of viruses replicating inside its body. Your next challenge is to make a vaccine before the baby's immune system is overwhelmed by virus attacks.

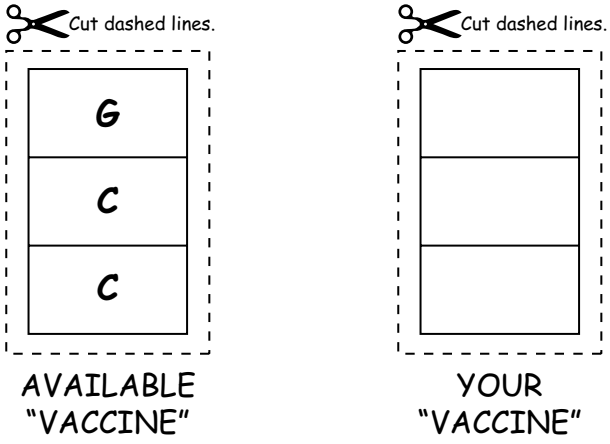
5 Discover a Vaccine

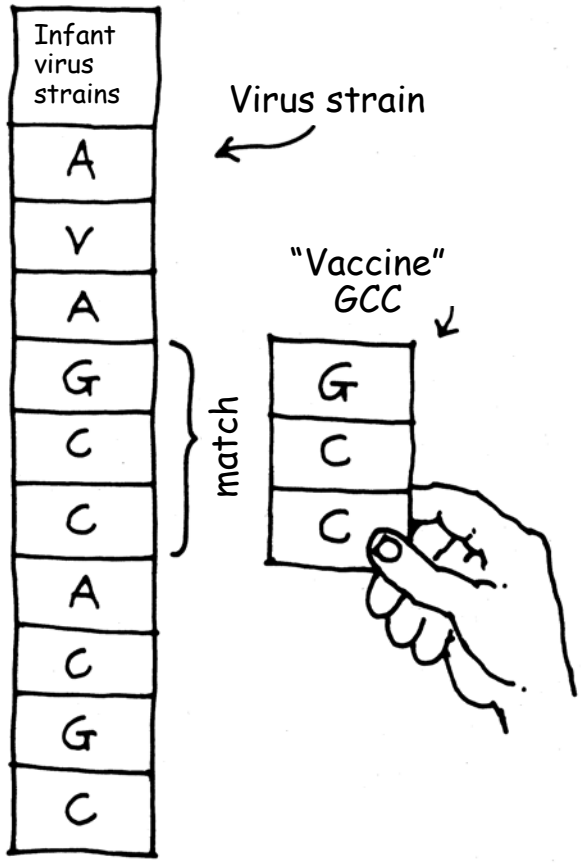
Your infant is now host to a number of different virus strains having different genetic codes (sequences of A,U,C,G). Your job is to discover a "vaccine" with a three-letter sequence that can kill all the infant's viruses.

a A "vaccine" is available that targets Infant Virus Strain 1. It will disable any virus that has the three-letter sequence, G,C,C (reading from top down). Color the "vaccine" according to the Nucleotide Color Chart (A=red, U=Blue, C=Yellow, and G=Green). Then cut it out.

b Use the GCC "vaccine" to scan the other virus strains. If the GCC sequence matches, it will disable that strain. The infant will be saved when all the strains are disabled. How many strains is this vaccine effective against?

c Try creating your own three-letter vaccine with any three-letter sequence of A,U,C,G's. Use your new "vaccine" to scan all of the virus strains. How many strains is your new vaccine effective against?





6 Consider This

Is it possible to create a vaccine that disables all the infant's virus strains? Why or why not?

PART THREE
HIV, information please

It takes a lot of effort, money, and time to develop a drug for HIV. Because the virus evolves so quickly, constantly creating new strains, no drug is effective for long. In North America, drugs that help someone stay alive with HIV cost thousands of dollars a year. In Africa, until recently, an average person in a country like Zambia could not afford these drugs. Getting people information about how HIV works and how it spreads is one cheap and effective way to help prevent this deadly disease. But even after decades of research, there is still confusion and fear about HIV and AIDS. Read the HIV fact cards. Then turn some of the information that you learned into a poster to inform others.

Work with a partner

Each team of two will need:

- HIV Fact Cards 1 and 2
- poster-sized paper, collage materials, or magazines
- glue stick
- markers or colored pencils
- scissors

1 HIV Cards: just the facts

a Cut the HIV Fact Cards apart.

b Deal the cards out equally between you and your partner.

c Read the cards. Report back to the group a summary of what you read.

2 Display Your Knowledge: create a poster

a Pick one fact from the cards that you think is the most useful or most interesting to know. Use that fact to make an HIV Information Poster.

b First design the poster's text. (Short and simple is best.)

c Then create an illustration using a drawing or collage. Share your poster ideas with the other groups.

3 Consider This

What do you think is the most important thing your friends or family need to know about HIV and AIDS?

Cut on dashed lines.

HIV Fact Cards 1

AIDS APPEARS

Doctors first recognized AIDS in the early 1980s when they noticed a growing number of patients who were dying from diseases that rarely harmed healthy people. It was not until 1983 that French scientists isolated HIV, the virus that causes AIDS.

HIV HISTORY

Scientists believe that HIV first emerged in Africa in the early 1900s. It evolved from viruses that infect chimpanzees and monkeys. As hunters killed these primates for food, they sometimes became infected with the virus. Over time, they began to spread the virus to other people.

HIV TAKES OFF

Scientists suspect that HIV may have first emerged in the 1930s and for decades was restricted to central Africa.

Gradually people in the region became more mobile, moving to growing cities, spreading the virus. Increasing air traffic allowed the virus to reach other continents. By 1980 it was rapidly spreading in Europe, the Caribbean, and North America.

HIV: YOU CAN'T GET IT BY...

HIV virus travels in body fluids of infected people.
You can't get it from:

- Hugging
- Shaking hands
- Just being close
- Coughs or sneezes
- Sweat
- Mosquito bites
- Towels, telephones, swimming pools

VERY VARIED VIRUSES

The variation found in viruses such as HIV is enormous compared to the variation found in animals or plants. One scientist describes them this way: The number of potential variants of HIV in one person per day can be as many as 1,000,000,000.

HIV vs. AIDS

People who get infected with HIV virus may not know that they are infected for years. They feel fine and look no different than before.

The only way to know if people have HIV at this stage is to give them a special blood test. But after several years, most people who carry HIV become very sick. At this stage the condition is called AIDS (Acquired Immunodeficiency Syndrome).

Linda Allison illustration.

Cut on dashed lines.

HIV Fact Cards 2

HIV: HOW IT SPREADS

People can only become infected with HIV if they come into direct contact with body fluids of an infected person.This can happen through sexual contact, contaminated blood transfusions, or sharing needles. Pregnant women can pass HIV to their unborn children, because their bloodstreams are connected. HIV can be passed to a baby through mother's milk.

FINDING A CURE

HIV stands for human immunodeficiency virus. Currently, there is no effective vaccine for HIV. It is possible, however, to keep the virus in check with a combination of drugs. If people with HIV stop taking the drugs, they will get sick again.

HIV's KILLER RESISTANCE

As HIV spreads, it also evolves. The virus has experienced natural selection as it has been attacked by the immune systems of its human hosts. Over thirty drugs and treatments have been developed to fight HIV. In every case the virus has evolved resistance.

HIV FIGHTERS

A series of HIV-fighting drugs has been introduced since 1987. The most effective treatment so far is a combination of drugs that interfere with the virus's ability to copy itself.

The drugs are very expensive to produce and to dispense. The vast majority of people in the world infected with HIV cannot afford to take them.

HIV DEATHS

More than 20 million people worldwide have died of AIDS since 1981. AIDS experts worry that the toll will climb even faster if new epidemics break out in countries such as China and India.

HIV ATTACK

HIV (human immunodeficiency virus) gradually destroys the immune system. Infected people may feel and look fine for many years while this happens. Eventually their immune systems collapse, and they fall victim to other diseases like pneumonia. At this point the condition is called AIDS (Acquired Immune Deficiency Syndrome).

PART FOUR

Be a science reporter

Write a short news story about HIV. Tell your readers about how a baby who is born with HIV carries exactly the same strains of the virus as the mother. Within six months, the baby can have millions of new strains. Based on what you have learned, explain how you think the baby gets new strains of HIV.

P.S. Don't forget the headline.