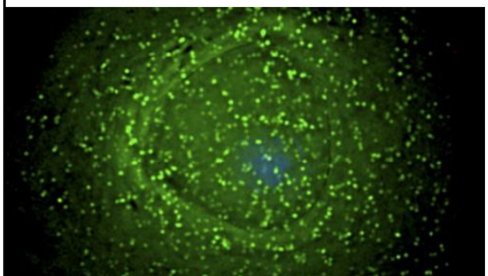

For HIV infection to take hold, a virus particle must first attach to a cell to gain entry. Shown above are HIV-1 particles assembling at the surface of an infected cell.

The Science of HIV/AIDS

Gregory L. Vogt, EdD.
Nancy P. Moreno, PhD.

Center for Educational Outreach

Baylor College of Medicine

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The Science of HIV/AIDS

The Science of HIV/AIDS: The Virus, the Epidemic and the World is a supplementary curriculum unit on the HIV/AIDS pandemic. The Human Immunodeficiency Virus (HIV) that leads to AIDS, or Acquired Immunodeficiency Syndrome, has spread across the globe. More than 30 million people have died of AIDS-related diseases, and a similar number of individuals are living with the infection. Nearly 6,000 new people are infected with HIV every day.

Content Advisory
This curriculum unit consists of essays and activities. The essays tell a small part of the HIV/AIDS story. Some present stark facts that may be difficult to absorb. Depending upon students' grade and maturity levels, the unit's essays may be used as teacher background information or student reading assignments. They are especially effective when read aloud.

See the following resources for additional information about HIV/AIDS and advice for discussing HIV/AIDS with students.

•National Institute of Allergy and Infectious Diseases, National Institutes of Health (NIH), offers resources on understanding HIV/AIDS: niaid.nih.gov/topics/hivaids/and aidsinfo.nih.gov.

•National Institute on Drug Abuse, NIH, offers facts about drug abuse and the link between it and HIV/AIDS: hiv.drugabuse.gov.
•The Centers for Disease Control and Prevention provides up-to-date information on HIV/AIDS prevention: cdc.gov/hiv/topics.

For complete instructions for conducting activities in this slide set, including materials needed, setup instructions and student sheets, download *The Science of HIV/AIDS Teacher's Guide*, free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/hivaids/.

Reference
Vogt, G., and Moreno, N. (2012) *The Science of HIV/AIDS Teacher's Guide*. Baylor College of Medicine: Houston. ISBN: 978-1-888997-62-0

Image Reference
Gross, L. (2006) Reconfirming the Traditional Model of HIV Particle Assembly. PLoS Biol 4(12): e445. doi:10.1371/journal.pbio.0040445. Image © 2006 Public Library of Science, CC-BY-SA.
http://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.0040445

Key Words
HIV, AIDS, HIV/AIDS, epidemic, pandemic, virus, retrovirus, T-cell, immune system, RNA, DNA, infection, disease, illness, pathogen, microbe, blood, white blood cell, virion, capsid, replication cycle, viral assembly, epidemiology, epidemiologist, microbiology, SEM TEM, microscope, CDC, WHO,

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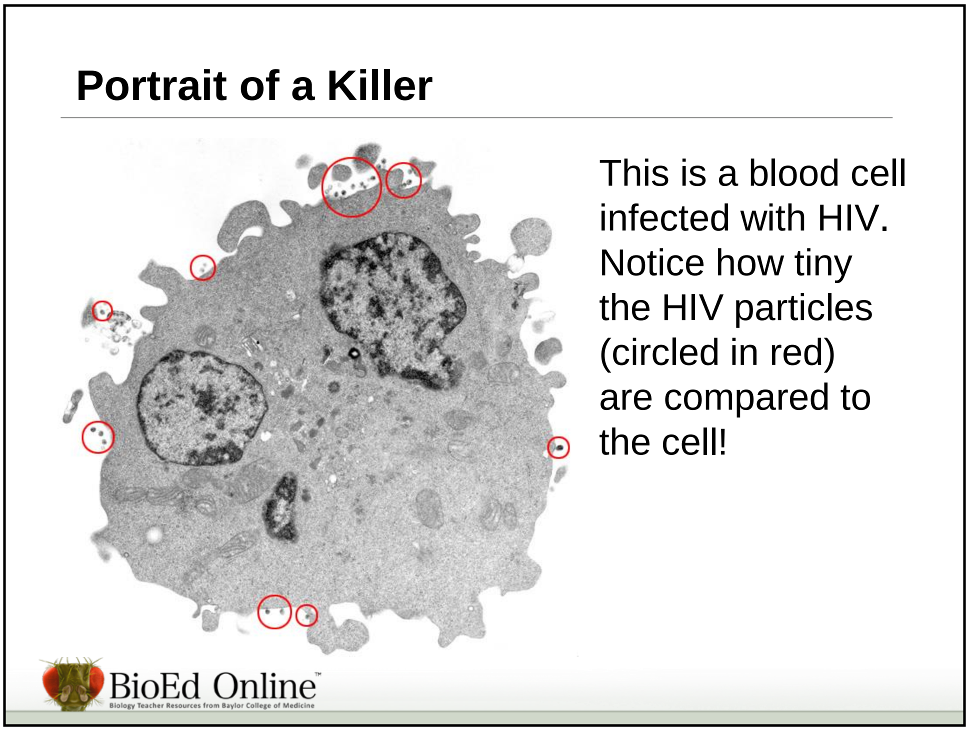

Portrait of a Killer (Essay 1)

For complete instructions for conducting activities in this slide set, including materials needed, setup instructions and student sheets, download *The Science of HIV/AIDS Teacher's Guide*, free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/hivaids/.

Content Advisory

Depending upon students' grade and maturity levels, the essay, "Portrait of a Killer," may be used as teacher background information or as a student reading assignment. It is especially effective when read aloud.

Essay

Imagine you are a doctor…

A young man arrives at your hospital in a very weak, deteriorated condition. His body resembles that of a concentration camp survivor. After running a few tests, you determine the patient is suffering from pneumocystis pneumonia, a very rare lung infection, especially in people with healthy immune systems. As a doctor, you refer to the infection as PCP. Over the coming weeks, several more patients arrive at your hospital, suffering from the same condition. All eventually die. You infer that every recent PCP patient had a weakened immune system.

A cluster of patients with the same rare condition raises a medical "red flag." Something new may be happening.

Across the country, other doctors encounter larger than the usual numbers of PCP patients, and other people with a different rare disease, Kaposi's sarcoma (or KS). KS is a form of cancer. It causes purple, red, brown and black skin lesions (sores) to appear over the entire body and in the mouth. The lesions are painful and disfiguring. They make eating difficult, and often are accompanied by unrelenting headaches. Ultimately, the KS patients die. Like PCP, Kaposi's sarcoma is exceedingly rare in people with healthy immune systems. Doctors treating KS patients infer that these people had weakened immune systems.

This really happened. The first recognized cases of the syndrome we today call AIDS, or acquired immunodeficiency syndrome, appeared in homosexual men in California in 1981. Soon after, similar clusters of AIDS cases occurred in New York. Then, men and women of Haitian origin began checking into Miami hospitals with symptoms of both PCP and KS. They, too, had AIDS, which was spreading across the country. It is estimated that by the time of its discovery, the new virus called HIV already had infected hundreds of thousands of men, women and children in the United States, and millions more people around the world.

What is HIV?

In the strictest sense, HIV, the Human Immunodeficiency Virus, is not a life form. Until it invades a human host, it's just a protein-coated mass of genetic material, no more alive than a grain of sand. Under a microscope, HIV appears insignificant, approximately 120 times smaller than the white blood cells it invades. But it is frighteningly powerful. Once inside a cell, HIV's genetic material serves as a biological "how-to" manual. The virus replicates itself hundreds of thousands of times, until the cell can no longer contain all the individual viruses. The new viruses push out, or "bud," through the cell wall. In the process, they steal part of the cell's outer envelope (cell membrane), which they use to create an outer protective layer.

Over a period of years, new HIV copies spread through the host body to infect more and more cells.

Gradually, the body's white blood cells, the "backbone" of a person's immune system, are destroyed. When the immune system is working, it attacks and fights off invading diseases. But when it is weakened or destroyed, it can no longer protect the body. Ultimately, HIV infection leads to a condition called AIDS, or acquired immunodeficiency syndrome. Untreated, AIDS opens the body to progressively rare and devastating illnesses until death results.

Reference

Vogt, G., and Moreno, N. (2012) *The Science of HIV/AIDS Teacher's Guide*. Baylor College of Medicine: Houston. ISBN: 978-1-888997-62-0

Image Reference

Transmission electron microscopic image courtesy of Charles P. Daghlian, Ph.D., and Louisa Howard © Dartmouth College.
http://www.dartmouth.edu/~emlab/gallery/

Key Words

HIV, AIDS, HIV/AIDS, epidemic, pandemic, virus, retrovirus, T-cell, immune system, RNA, DNA, infection, disease, illness, pathogen, microbe, blood, white blood cell, virion, capsid, replication cycle, viral assembly, epidemiology, epidemiologist, TEM, SEM, microscope, microbiology, CDC, WHO,

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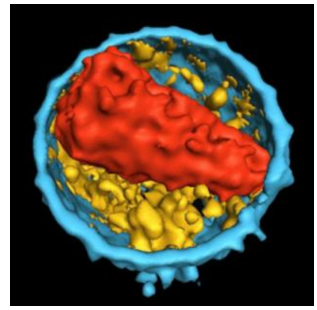
Modeling an HIV Particle

- Viruses are small infectious agents that require living cells to make copies of themselves (replicate) and invade other cells.
- Most viruses are too small to see with a light microscope.
- Viruses are responsible for different diseases, including the cold, flu, small pox and HIV/AIDS.



Cryo-Electron Tomography image of an HIV particle. The RNA-containing core is shown in red.

- All viruses consist of genetic material (RNA or DNA) surrounded by a protective coat.

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Modeling an HIV Particle (Activity 1)

For complete instructions for conducting activities in this slide set, including materials needed, setup instructions and student sheets, download *The Science of HIV/AIDS Teacher's Guide*, free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/hivaids/.

Background

This activity helps students visualize the Human Immunodeficiency Virus (HIV) by having them construct 3D HIV particle models from paper. The model to be used represents a complete viral particle. It is a 20-sided polyhedron, called an icosahedron, which approximates the shape of the virus. The completed, three-piece model is about 500,000 times larger than an actual HIV virus particle. Students will combine their finished models into one mass in a first step toward estimating how many HIV particles could be contained inside a white blood cell before being released into the blood stream to attack new cells.

Note: Viral particles, also known as virions, consist of the genetic material (DNA or RNA, shown in red in the image on the slide), a protein coat called the capsid (yellow), which surrounds and protects the genetic material, and sometimes an envelope of lipids (blue) that surrounds the protein coat.

Procedure

1.Ask students, *Have you ever seen a virus?* [It is not possible to observe viruses directly, because they are extremely small.] Encourage students to share what they already know about viruses. List their ideas on the board. Make sure that the facts on the slide are included.

- Viruses are small infectious agents that require living cells to make copies of themselves (replicate).
- Viruses replicate by invading living cells.
- Most viruses are too small to see with a microscope.
- Viruses are responsible for many different diseases, including the common cold, flu, small pox, and HIV/AIDS.
- All viruses consist of genetic material (DNA or RNA) surrounded by a protective coat.

1.Discuss the purpose of the activity with your students. They will learn about the Human Immunodeficiency Virus (HIV) by constructing a paper model that enables them to visualize a single HIV particle. The model will show both the exterior and interior of the particle and serve as a starting point to learn about the virus's function.

Reference

Vogt, G., and Moreno, N. (2012) *The Science of HIV/AIDS Teacher's Guide*. Baylor College of Medicine: Houston. ISBN: 978-1-888997-62-0

Image Reference

Stephen Fuller © Wellcome Images\B0006824. http://wellcomeimages.org/

Key Words

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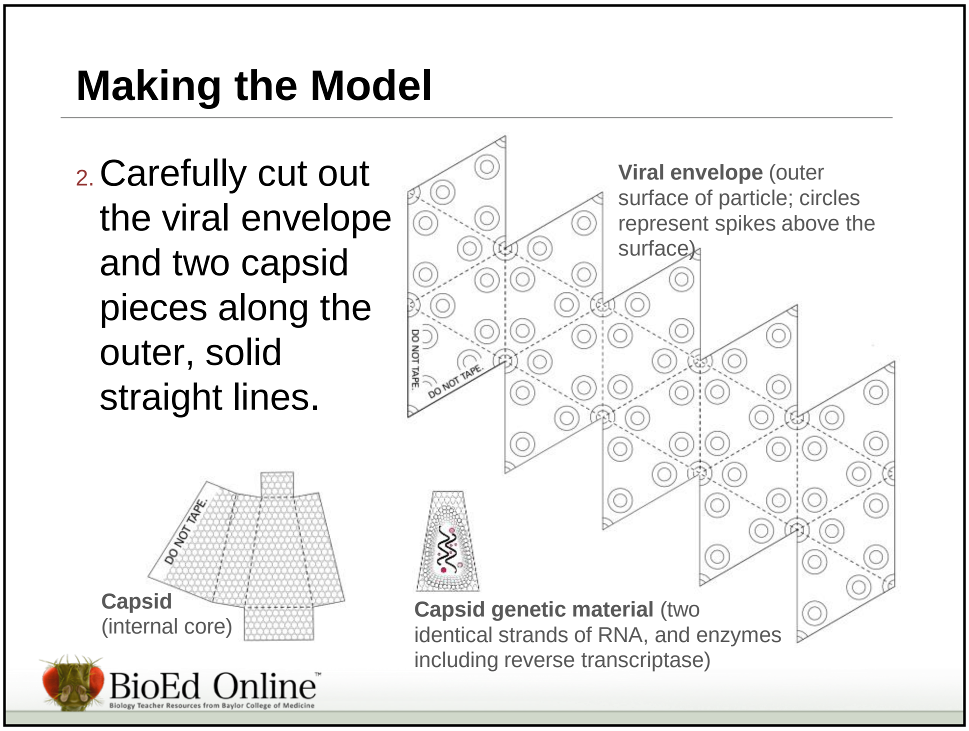

Making the Model

For complete instructions for conducting activities in this slide set, including materials needed, setup instructions and student sheets, download *The Science of HIV/AIDS Teacher's Guide*, free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/hivaids/.

Procedure *(cont.)*
3.Demonstrate how to cut and fold the model. Stress that the more carefully students cut out their models and score the folds, the better the models will look. Students should cut along the solid lines and use the ruler straight edge and ballpoint pen to score the dashed fold lines. Pressing the pen tip into the paper produces a crease that makes accurate folding easy.

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Image Reference

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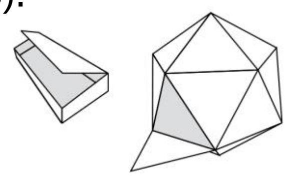
Making the Model *(cont.)*

3. Use markers or pencils to color the pieces.
4. Score and fold the viral envelope and capsid piece along the dotted lines and tape together EXCEPT where indicated (flap).
5. Insert the capsid genetic material piece into the capsid. Close the flap.



6. Insert the capsid into the large viral envelope and close the triangular flap.

Making the Model

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Procedure *(cont.)*

4.Have students color their models prior to assembly. While virus particles do not have color, researchers often create colored models to emphasize certain structures. [See the presentation "Viruses (NCMI)" on BioEd Online, www.bioedonline.org, for examples of virus models.]

5.Demonstrate how the virus envelope is formed. Start by creasing along the edges of each triangle, and then reopening the creases. Begin taping with two adjacent triangles. Bring their adjoining straight edges together and hold with a small piece of tape. Continue taping triangles until the model gradually forms a spherical shape. Repeat until all triangles but one are taped together. The remaining triangle serves as a "door" to the inside of the virus.

6.Have students follow the same cutting, folding, and taping procedures for the HIV capsid. They also should press the capsid insert into the capsid. If the insert is loose, a small dab of glue or a small reversed tape ring will hold it in place. Temporarily slip the capsid inside the completed viral envelope.

7.Discuss the model's appearance and structures as a class. Explain that the model is approximately 500,000 times bigger than an actual HIV particle. Ask, *How big do you think the actual HIV particle is?* [about 120 nanometers] List a few comparisons, measured in nanometers, for visualization (see "Note," below). A nanometer is one one-billionth of a meter (approximately 0.04 billionths of an inch). Ask, *How tall are you in nanometers?* [Your height in meters times one billion.]

8.Have each student measure the diameter of his/her virus model. Ask, *Since the model is not a sphere, what is the best way to measure it?* Discuss different ways to measure the model's diameter (point to point, point to side, edge to edge, side to side).

9.Tell students that the white blood cell invaded by the HIV particle is 120 times larger than the particle. Ask, *Compared to the HIV model, how big is a white blood cell?*

10.Have all students place their HIV models into a pile to see how large the mass of models becomes. Count the number of particles in the pile. Then ask, *How many HIV particles do you think it would take to fill a white blood cell? How could you find out?* (It would take about 1.7 million HIV particles to fill one white blood cell completely. This calculation is based on a comparison of the volume of an HIV particle with that of a white blood cell. To compute these values with students, use the equation, volume=$4/3\pi$ radius^3.

11.Have students collect their HIV virus particle models and save them for use in the activity, "Making Copies of an HIV Particle."

Note: To compare the size of an HIV particle to other objects, divide the size of each object below by 120 nm (the size of one HIV particle).

- Visible light wavelength: 400 to 700 nm
- Human hair: 100,000 nm wide
- Period on a page: 500,000 nm
- Penny: 19,000,000 nm wide
- Basketball: 239,506,000 nm wide

Reference

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Image Reference
Illustrations by G.L. Vogt and M.S. Young © Baylor College of Medicine.

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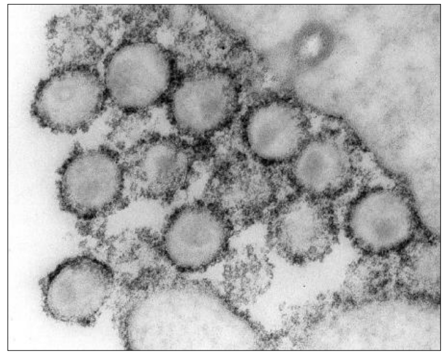
Glycoprotein Spikes

- In this transmission electron microscopic image of HIV-1 virions, glycoprotein spikes on the outer surface of the particles appear darkest gray.



- TEM instruments can reveal interior structures and components of extremely tiny particles.

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Glycoprotein Spikes

Glycoprotein spikes jut out from the surface of each virion.

Reference

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Image Reference

Image courtesy of the CDC\949 Edwin P. Ewing, Jr., PhD.
http://phil.cdc.gov/phil/home.asp

Key Words

HIV, AIDS, HIV/AIDS, epidemic, pandemic, virus, retrovirus, T-cell, immune system, RNA, DNA, infection, disease, illness, pathogen, microbe, blood, white blood cell, virion, capsid, glycoprotein, replication cycle, viral assembly, microscope, TEM, SEM, science, research, microbiology, CDC, WHO,

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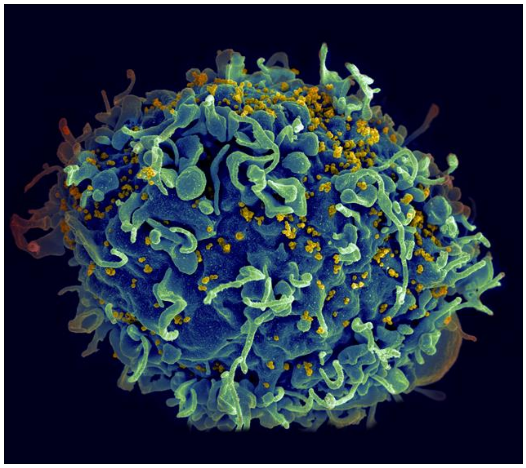
The Deadly Cycle



- In this false-color scanning electron microscope image, HIV particles (yellow) are shown erupting out of a single white blood cell (blue).
- SEM's reveal surface details cells, viruses, and even tiny animals!

The Deadly Cycle (Essay 2)

For complete instructions for conducting activities in this slide set, including materials needed, setup instructions and student sheets, download *The Science of HIV/AIDS Teacher's Guide*, free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/hivaids/.

Content Advisory

Depending upon students' grade and maturity levels, the essay, "The Deadly Cycle," may be used as teacher background information or as a student reading assignment. It is especially effective when read aloud.

Essay

An HIV virus particle is far too small to be seen with an ordinary light microscope. More than one hundred times smaller than the white blood cells they invade, HIV virus particles look like miniature cells—but they are not cells. Rather, HIV particles, like all viruses, are best described as containers of genetic material.

The HIV particle is surrounded by an envelope of cell membrane material, taken from the cell from which it emerged. Inside, the HIV virus contains enough genetic material (in the form of RNA molecules) to direct a host cell to make new virus copies. Viruses cannot live, grow and reproduce on their own. Instead, they must invade the cells of living organisms and force those cells to produce more viruses. This is how viruses cause disease. The term, “virus particle” (or “virion”) usually refers to the infectious version of the virus, as it exists outside a host cell.

The surface of an HIV particle typically has between 14 to 73 small projections, referred to as glycoprotein spikes. Glycoproteins (gp) are protein molecules with carbohydrates incorporated into their structure. They are represented by concentric circles on the outside of the paper model used in the previous activity. Two different glycoproteins, gp120 and gp41, comprise each spike on an HIV particle. The numbers, 120 and 41, refer to each protein’s molecular weight (an indicator of a molecule’s size). The gp120 glycoproteins allow the HIV virus particles to attach to, or “dock” with certain kinds of white blood cells.

HIV cannot survive for long outside the body, and only can be transmitted to another person through body fluids from someone who already has the infection. Once inside the body, HIV particles enter the blood stream and make contact with leukocytes, or white blood cells, the body’s chief defenders against infectious diseases. There are five different kinds of leukocytes. However, HIV most often attacks one kind, called a CD4+ cell. CD4+ cells get their name from a particular protein, called CD4, found on the outside cell surface (in other words, these cells are “positive” for the presence of a CD4 protein). CD4+ cells sometimes are referred to as T-cells.

HIV particles—specifically the exterior glycoprotein spikes—attach to CD4 molecules on the surface of CD4+ cells. This connection is similar to that between a lock and key. Once attached, the virus particle fuses with the cell membrane and releases its contents into the cell. After this stage in the infection process, the HIV particle and white blood cell together can begin to reproduce more HIV particles.

Inside the fatty envelope of an HIV particle is a bullet-shaped core, called the capsid. Made of proteins, the capsid holds the virus’s genetic material and triggering enzymes. HIV’s genetic material consists of two single-stranded RNA molecules (or ribonucleic acid). The viral RNA strands contain just nine genes, compared to the 20,000 or 25,000 genes in humans. Once HIV RNA is inserted into a cell, an enzyme called reverse transcriptase transcribes, or changes the RNA strands into double-stranded DNA. The viral DNA then integrates with the host DNA in one chromosome within the cell’s nucleus. From this point, the virus may remain inactive for many years. Eventually, though, the viral DNA is activated and the cell begins replicating the parts required to make new HIV virus particles—by the hundreds of thousands. In essence, HIV hijacks the cell’s functions and turns the cell into a kind of virus factory. Raw materials inside the cell are reworked into new strands of RNA, proteins, and enzymes, which gather just inside the cell wall. Then, the new HIV virus particles bud from the wall of the host cell into the bloodstream.

The HIV replication process eventually overwhelms the host cell until it dies. New HIV particles, millions of them, pass through the blood stream to attach and insert themselves into other leukocytes and begin the replication process again. Over time, the number of white blood cells declines to the point where they can no longer provide protection. Other components of the immune system, such as the lymph nodes, also are affected, and the host body becomes less and less able to defend itself against diseases. A person infected with HIV is diagnosed with AIDS when he or she has one or more serious illnesses associated with HIV, such as pneumonia or tuberculosis, and has dangerously low numbers of infection-fighting white blood cells.

Reference

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Image Reference

Scanning electron microscope image courtesy of the National Institute of Allergy and Infectious Diseases, NIH. http://www.niaid.nih.gov/

Key Words

HIV, AIDS, HIV/AIDS, epidemic, pandemic, virus, retrovirus, T-cell, immune system, RNA, DNA, infection, disease, illness, pathogen, microbe, blood, white blood cell, virion, glycoprotein, reverse transcriptase, viral envelope, capsid, replication cycle, viral assembly, structural biology, microbiology, TEM, SEM, CDC, WHO,

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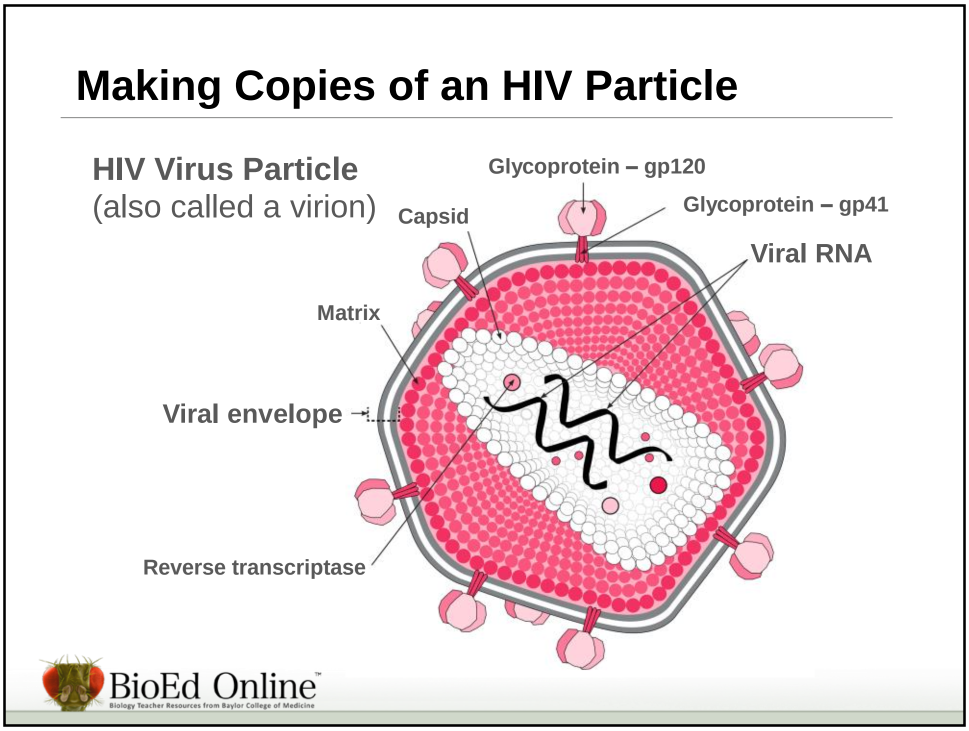

Making Copies of an HIV Particle (Activity 2)

For complete instructions for conducting activities in this slide set, including materials needed, setup instructions and student sheets, download *The Science of HIV/AIDS Teacher's Guide*, free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/hivaids/.

Background

Many biologists do not consider viruses to be "living" organisms, because they cannot carry out many of the functions that define life. For example, viruses cannot use food; nor are they able or make copies of themselves ("reproduce") without invading a living cell and redirecting the cell's internal mechanisms to make new virus copies. Outside cells, viruses exist as genetic material (DNA or RNA) surrounded by a protective coat of protein, called a capsid. HIV's capsid contains two strands of RNA.

Some viruses also wrap themselves in a modified form of the cell membranes from which they emerge. This modified membrane, called an envelope, is studded with proteins that enable the virus to latch onto and infect other cells. HIV and the influenza (flu) virus are examples of viruses that are surrounded by an envelope. The complete, assembled viral package—consisting of the genetic material, capsid and envelope (when present)—is referred to as a "virus particle" (or virion) to distinguish it from the virus components present inside host cells.

Procedure

1.Use the student-constructed models as a basis for a class discussion about the structure and function of the HIV particle. For example, ask*, What is contained inside the particle?* [capsid and genetic material] *What does the capsid do?* [contain and protect genetic material] *Why might some virus particles also have an envelope?* [provides a way to dock with certain kinds of cells and fuse with the cell membrane]

2.Discuss the main parts of the HIV particle, and their functions.

- Glycoprotein gp120: Identifies and initially docks with host cell.
- Glycoprotein gp41: Completes docking and assists in fusion with host cell.
- Viral envelope: Two-layer lipid membrane
- Capsid: Protein shell
- Matrix: Protein shell
- Viral RNA: Two identical strands of genetic material
- Reverse transcriptase: Uses viral RNA as a template to produce DNA once the particle is inside a cell.

3.Project microscopic images of the HIV particle and have students compare the outsides of their models to the images. Mention that the double circles on the exterior of the envelope on their models represent the glycoprotein spikes needed by the virus particle to attach to the CD4+ white blood cells.

4.Have students remove their capsid models from the inside of the viral envelope. Ask them to examine the inside of the capsid. Point out the RNA strands and discuss their function: to transmit genetic information to the host cell. Describe the RNA strands as an instruction manual that directs the cell to make virus components. Also mention the reverse transcriptase enzyme and its function, which is to transform the genetic information on the RNA strands into DNA, the genetic code within each host cell.

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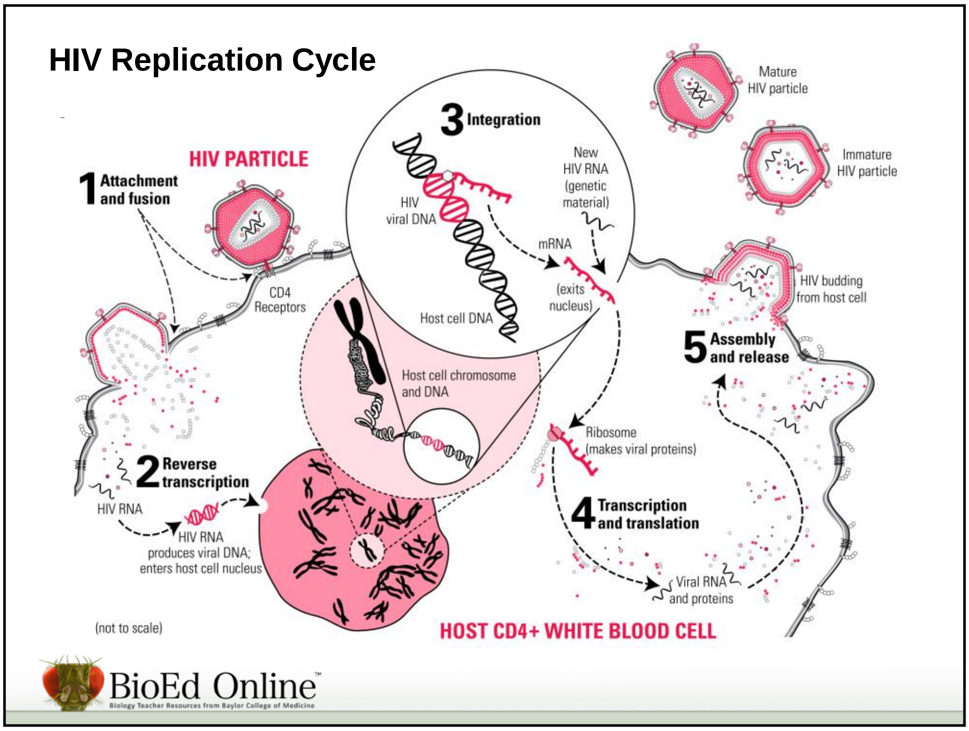


HIV Replication Cycle

For complete instructions for conducting activities in this slide set, including materials needed, setup instructions and student sheets, download *The Science of HIV/AIDS Teacher's Guide*, free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/hivaids/.

Procedure *(cont.)*

5.Depending on the ages of your students, you may want to examine the HIV life cycle in more detail. Use the "HIV Replication Cycle" sheet as a guide. Following are the steps involved in HIV infection of a cell.

1) **Attachment and entry.** The HIV virus bumps into a CD4+ white blood cell, attaches to it, and injects the capsid and its contents into the cell.

2) **Reverse transcriptase.** Once inside the cell, HIV genetic material (in the form of RNA) is converted into a form that is compatible with the cell's genetic information (DNA). In cells, DNA usually is used to produce new RNA through a process called transcription. When RNA is used as a template to produce DNA, as is the case with HIV infection, the process is referred to as "reverse" transcription.

3) **Integration.** The newly formed viral DNA moves into the cell nucleus, where it is spliced into the cell's human DNA. The HIV genetic material may remain dormant or inactive for many years. In this state, HIV is able to "hide" from the immune system and is unaffected by antiviral treatments.

4) **Transcription and translation.** The viral DNA becomes active and directs the cell's machinery to produce the virus components: viral RNA, viral envelope and capsid. This activation can occur many years after initial infection with HIV, and is not yet completely understood.

5) **Assembly and release.** The viral particle is assembled, fuses to the cell membrane and is released by "budding" off the surface of the cell. During the budding process, the new particle wraps itself in part of the host cell's membrane to create the viral envelope. The new virus particles now circulate within the body and are able to invade other cells.

Notes

Viruses cannot live, grow and reproduce on their own. Instead, they must invade cells of living organisms and force these cells to produce more viruses. This invasion of healthy cells is how viruses cause disease.

HIV is one of a handful of viruses known to reverse the normal pathway through which genetic information is transmitted within cells. Usually, DNA is used to produce RNA, which then directs the assembly of proteins in cells. HIV, however, is able to use its own RNA as a template to produce viral DNA that can be spliced into the DNA of the human host cell.

Reference

Vogt, G., and Moreno, N. (2012) *The Science of HIV/AIDS Teacher's Guide*. Baylor College of Medicine: Houston. ISBN: 978-1-888997-62-0

Image Reference

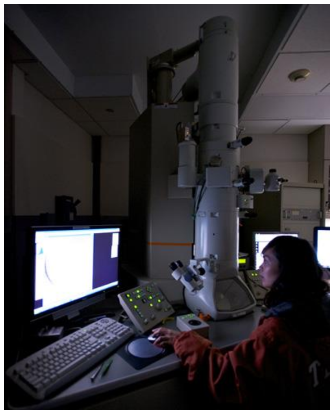
Illustration by G.L. Vogt and M.S. Young © Baylor College of Medicine.

Key Words

HIV, AIDS, HIV/AIDS, epidemic, pandemic, virus, retrovirus, T-cell, immune system, RNA, DNA, infection, disease, illness, pathogen, microbe, blood, white blood cell, virion, glycoprotein, reverse transcriptase, viral envelope, capsid, replication cycle, viral assembly, structural biology, microbiology, CDC, WHO,

The Science of HIV/AIDS Teacher's Guide © Baylor College of Medicine, was developed with support from a Science Education Partnership, National Institutes of Health (NIH), grant number 5R25 RR018605, and in partnership with the Baylor-UT Houston Center for AIDS Research, an NIH-funded program, AI036211.

How Do Researchers See Viruses?



Researcher Jenelyn Ramos, with Baylor College of Medicine, uses a transmission electron microscope to isolate and examine virus particles.

- An HIV virus particle is about 120 nm across. As such, it is too small to be seen using a normal optical microscope.
- Scientists use special instruments to see and study the viruses on a computer screen.

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How Do Researchers See Viruses?

Though 800 times smaller across than a human hair, the HIV particle is larger than most other viruses. Even so, it was very challenging to discover what the HIV virus looks like and how it is constructed. You cannot observe a virus particle on the stage of a normal optical microscope, which works with visible light and has a practical limit for magnification.

An optical microscope's diffraction limit, or resolution (ability to separate two closely spaced objects) is based on the wavelengths of visible light, which range from about 400 to 700 nm (violet to red). The minimum practical resolution (or distance between two objects) is less, about 200 nm. Any specimens closer together than 200 nm appear as a single object under an optical microscope. Consequently, the useful magnification power of optical microscopes is limited to approximately 1,500x. Pushing to a magnification power higher than that leads to hopelessly fuzzy images that are impossible to resolve clearly. Thus, an HIV particle, which measures 120 nm across, is smaller than optical microscopes will allow us to view, even at maximum resolution.

Because virologists (scientists who study viruses) must be able to "see" objects as small as a single nanometer, they require microscopes with much greater magnification power. However, “seeing” is not quite what they do. Rather, they employ a variety of sophisticated microscopes that create images on a computer screen.

One such instrument is the transmission electron microscope, or TEM, which directs a beam of electrons through a very thin specimen. The electrons interact with the specimen and are shifted slightly as they pass through. Then, they fall onto a fluorescent screen or a detector, similar to a CCD chip in a digital camera, where the TEM’s image is created. Typically, electron microscopes are able to produce useful magnifications one million times the actual size. But under special circumstances, 50 million times magnification has been achieved.

Reference

Vogt, G., and Moreno, N. (2012) *The Science of HIV/AIDS Teacher’s Guide*. Baylor College of Medicine: Houston. ISBN: 978-1-888997-62-0

Image Reference

Photo courtesy of the National Center for Macromolecular Imaging © Baylor College of Medicine.

Key Words
HIV, AIDS, HIV/AIDS, epidemic, pandemic, virus, retrovirus, research, microscopes, microbiology, SEM, TEM, CDC, WHO,

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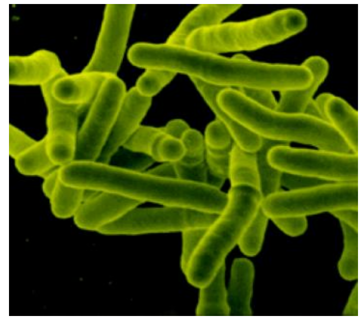
It’s All In the Numbers

- People usually don’t die directly from HIV. With compromised immune systems, AIDS patients tend to suffer from chronic illnesses, such as TB and cancer.
- The rate of HIV viral replication is so enormous, that particles overwhelm the immune system, weakening it to the point that it can no longer fight off infectious diseases.



TB is caused by the bacterium called *Mycobacterium tuberculosis*. The disease mostly affects the lungs.

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It’s All In the Numbers (Essay 3)

For complete instructions for conducting activities in this slide set, including materials needed, setup instructions and student sheets, download *The Science of HIV/AIDS Teacher’s Guide*, free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/hivaids/.

Content Advisory

Depending upon students' grade and maturity levels, the essay, ”It’s All In the Numbers," may be used as teacher background information or as a student reading assignment. It is especially effective when read aloud.

Essay

Acquired Immunodeficiency Syndrome (AIDS) is not a disease like the measles or flu, and there is no cure. It is the result of a long-term viral infection. A person with AIDS no longer has natural body protections against many diseases that circulate through the human population. People usually don’t die directly from HIV infection; rather, AIDS patients tend to suffer from chronic illnesses that accumulate one after another. Invading diseases gang up to waste away their bodies and cause great suffering until they no longer can survive. Once a person has AIDS, treatment options are mostly reactive. If a person with AIDS has pneumonia or cancer, doctors employ pneumonia or cancer treatments. Often, AIDS patients have multiple illnesses, challenging doctors to find treatments that are effective and compatible. Regardless, over time the battle will be lost.

Because there is no cure or vaccine, worldwide efforts are focused on preventing AIDS from spreading from one person to the next. As noted earlier, AIDS results from infection by the Human Immunodeficiency Virus (HIV), an almost unimaginably small particle of genetic material more than 800 times smaller across than a human hair. HIV is passed from human to human only through body fluid transfer. Blood transfusions, breastfeeding, and sharing of needles among drug users are common routes of transfer of HIV virus particles.

HIV/AIDS: A Numbers Game

Once inside the bloodstream, the virus particle attaches itself to cells that have a particular kind of molecule, called CD4, on their surface. T cells, the white blood cells responsible for directing the body's defense against invaders, have CD4 receptor molecules. In fact, T cells also are referred to as CD4+ cells. After attaching, the HIV virus particle injects its contents into the cell. The viral material may lay dormant for years but, eventually, it begins to multiply. Actually, the host cell does the multiplying. The particle simply provides the cell with a genetic "how-to" manual for creating copies of the virus. Each new virus particle triggers the formation of more particles. Their numbers grow until millions of HIV particles are released into the bloodstream to interact with (infect) more CD4+ cells. Once infected, CD4+ cells are less able to defend the body against disease; sometimes, they are simply overwhelmed and die. As the immune system gradually fails, the disease known as AIDS results.

Treatment

Anti-HIV treatments usually rely on a combination of three different medications that target the HIV virus itself. Because HIV is capable of rapid genetic change (mutations), it can become resistant to the treatment drugs if medications are not taken on schedule as prescribed. HIV also is difficult to treat because its genetic material becomes incorporated into the DNA of cells within the human immune system. Once inside the nucleus of a CD4+ cell, for example, HIV can remain inactive and unaffected by drugs for years. HIV's ability to "hide" within cells makes it impossible to eliminate completely. If treatment is stopped or disrupted for any reason, HIV is able to emerge from hiding and multiply within the body again.

Reference

Vogt, G., and Moreno, N. (2012) *The Science of HIV/AIDS Teacher's Guide*. Baylor College of Medicine: Houston. ISBN: 978-1-888997-62-0

Image Reference
Scanning electron microscopic image courtesy of the National Institute of Allergy and Infectious Diseases, NIH. http://www.niaid.nih.gov/

Key Words
HIV, AIDS, HIV/AIDS, epidemic, pandemic, virus, retrovirus, exponential growth, population, statistics, reproduction, replication, epidemiology, epidemiologist, microbiology, CDC, WHO,

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Calculating Exponential Growth

- If an HIV particle reproduces itself every minute, at the end of one minute, there will be two particles.
- After two minutes, there will be four particles; and after 10 minutes, the number will have grown to 1,024.

- In 20 minutes, there will be more than one million particles, and after 30 minutes, the population will have increased to more than one billion. This is “exponential” growth.

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Calculating Exponential Growth (Activity 3)

For complete instructions for conducting activities in this slide set, including materials needed, setup instructions and student sheets, download *The Science of HIV/AIDS Teacher’s Guide*, free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/hivaids/.

Background

Under favorable conditions and with sufficient time and resources, populations of all organisms, including infectious agents like viruses, have the potential to increase dramatically over time. Even slow-growing organisms can reach astounding population sizes if reproduction is unchecked. Charles Darwin used elephants, which breed very slowly, as a hypothetical example. Beginning with two elephants, which generally produce only six offspring during a reproductive span of 60 years, an elephant population would number only 54 individuals after 200 years. However, after 1,000 years, the population would have grown to 86,000,000 elephants!

Now consider another example, in which a parent cell divides into two daughter cells every 10 minutes. After 10 minutes, there would be two cells; after 20 minutes, four cells; after 30 minutes, eight cells, and so on. After three hours, there would be close to one million cells. When quantity increases by a fixed percentage at regular time intervals, we have what is referred to as exponential growth. On a graph, exponential growth is represented by an upward curve, not a straight line. In addition to the example of cell division, exponential growth can be observed in the accumulation of compound interest, and in the increasing levels of CO_2 in the atmosphere. Untreated, HIV also is capable of exponential growth once it begins to replicate and spread within the human body.

Procedure

1.Lead a class discussion about the meaning of exponential growth, as it relates to HIV. Due to exponential growth, the greater the number of HIV particles present, the faster they will increase in number. Use the following example.

> If an HIV particle reproduces itself every minute, at the end of one minute, there will be two particles. After two minutes, there will be four particles; and after 10 minutes, the number will have grown to 1,024. In 20 minutes, there will be more than one million particles, and after 30 minutes, the population will have increased to more than one billion. This is “exponential” growth.

1.Tell students that there are many examples of exponential growth. Pose the following scenario to the class.

> Imagine you have applied for a job. Your future employer offers a temporary position lasting just 30 days. Then, something amazing happens: you’re asked to decide if you’d rather be paid in dollars or pennies.
>
> If you choose to be paid in dollars, you will earn $1,000 on the first day of work, $2,000 on your second day, $3,000 on the third, and so on. For each of your 30 days of employment, your salary will be increased by $1,000.
>
> If you choose to be paid in pennies, you will earn one cent on the first day of work, two cents on your second day, four cents on the third day, and so on. Each day, your will salary will be exactly double the salary you earned the day before. *Which payment plan will you select?*

1.Give each student group the “Dollars or Cents” page, which includes the challenge just described. Allow time for students to discuss the options and select one of the job’s two possible “pay schedules.” Have students calculate their daily salaries, total income earned so far at the end of each day, and the amount of money they will earn for the full 30-day period.

1.Compare the final balances accrued by each salary schedule. If required for clarification, share the following information with students (also see the answer sheet at the end of this activity).

> Being paid in dollars certainly seems like the smart choice. In just five days, you will earn $15,000. By the end of the next five days, your salary will reach $55,000. Adding $1,000 to your salary each day quickly builds up to a 30-day grand total of $465,000! Not bad for a temporary job.
>
> On the other hand, it takes a lot of discipline (and quick calculations!) to choose to be paid in pennies. Initially, the pay will be dismal. By day 10, you will have only earned a total of only $10.23. It takes three weeks before your salary begins to pick up. On day 20, you will have earned $10.485.75. And from that point on, salary growth becomes spectacular. Just five days later, your salary will pass $335,000. By day 30, you will have earned $10,737,417.61!

1.Revisit your previous discussion of HIV replication. Ask students to explain how the salary analogy applies to virus multiplication within cells in the body. Or, ask each group of students to summarize what they learned about exponential growth by writing a paragraph in their science notebooks or as a homework assignment.

Reference

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Image Reference

Key Words

HIV, AIDS, HIV/AIDS, epidemic, pandemic, virus, retrovirus, exponential growth, population, statistics, reproduction, replication, epidemiology, epidemiologist, microbiology, CDC, WHO,

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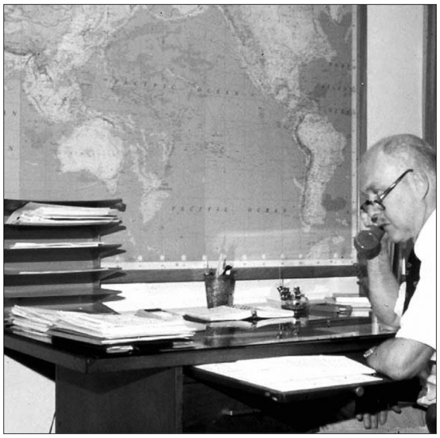
Trailing the Pandemic



- In 1981, Dr. Michael B. Gregg published a report about five cases of the then-rare disease, PCP, among young men in Los Angeles. It was a precursor of the AIDS epidemic.

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Trailing the Pandemic (Essay 4)

For complete instructions for conducting activities in this slide set, including materials needed, setup instructions and student sheets, download *The Science of HIV/AIDS Teacher's Guide*, free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/hivaids/.

Content Advisory

Depending upon students' grade and maturity levels, the essay, "Trailing the Pandemic," may be used as teacher background information or as a student reading assignment. It is especially effective when read aloud.

Essay

Each week on television, police investigators race to the latest crime scene and dazzle viewers by solving the "who done-it" using sophisticated laboratory tests and computer wizardry. While some of the techniques shown are scientific nonsense, occasionally real crime scene investigation techniques, such as "mapping the evidence," are shown. Brightly colored markers are placed next to evidence or clues, photographed and logged on a scene map. Like following footprints in snow or mud, the sequence of events in a crime sometimes can be deduced from this "map."

In the 1980s, when AIDS cases first began to appear, the affliction was thought to be restricted to homosexual men. But as more cases emerged among different populations, the relationship of the disease to the community became unclear. No longer limited only to gay men, HIV was infecting heterosexual men and women, as well as children, of all races and many countries.

The origins of AIDS were very difficult to trace, because most people infected with HIV show no symptoms for many years. During this time, infected individuals can unknowingly pass HIV particles to others through bodily fluids. While many scientists sought to find cures or treatments for AIDS, others sought to determine the origin of the HIV virus. Knowing where it came from and how it spread could help explain how the virus infects people—and how to combat it. Research agencies, including the World Health Organization and the U.S. Centers for Disease Control and Prevention began tracking the prevalence of infection, country by country.

As hoped, mapping HIV/AIDS populations around the world provided important clues. Epidemiologists (scientists who study factors that affect the health of populations) found that countries with the highest incidence rates were among the earliest to report HIV/AIDS infections. Mapping also confirmed that HIV/AIDS had become a pandemic (Greek: pan = “all” + demos = “people”), an infectious disease epidemic that has spread through human populations across continents, or even the entire world.

By tracking back to the earliest reported HIV outbreaks, researchers determined the virus originated in Africa. The first known case of HIV infection was detected in a blood sample collected in 1959 from a man in Kinshasa, Democratic Republic of Congo. However, investigators believe HIV may have existed since the 1930s. And still today, there is an astoundingly high percentage of adults living with HIV/AIDS in central and southern Africa.

It has been established that HIV arose from a related virus found in chimpanzees once common in west-central Africa. A subgroup of chimpanzees still living there was found to have simian immunodeficiency virus (SIV). Researchers confirmed the presence of SIV and its close relationship to HIV by collecting and studying chimpanzee feces from ten forest sites in southern Cameroon. SIV was found in five of the sites. Genetic analysis then enabled scientists to trace the virus to individual chimpanzees.

It is not known exactly how the virus transferred to humans, but cultural evidence indicates that it might have occurred in a single incident. Chimpanzees long have been hunted in Africa as a food source. It is probable that the virus was transferred to a human who was butchering an infected chimpanzee. Perhaps the butcher had an open sore or a cut that provided a pathway for the virus contained in the animal's blood. Regardless, somewhere in the viral transference process, SIV mutated into HIV, a virus that causes infection and disease in humans.

From the 1930s to 2009, HIV/AIDS grew from a single case to a global pandemic, with approximately 34 million people now infected by HIV. This number does not include the estimated 30 million people worldwide who have died from AIDS. Due to improved treatments, the infection rate is dropping in some countries. However, these gains are being offset by the rise of infections in other regions, where HIV/AIDS care is minimal. Worldwide, there are approximately 2.7 million new HIV infections (including 53,000 in the U.S.) and about two million HIV-related deaths each year.

Reference

Vogt, G., and Moreno, N. (2012) *The Science of HIV/AIDS Teacher's Guide*. Baylor College of Medicine: Houston. ISBN: 978-1-888997-62-0

Image Reference

Photo courtesy of the CDC\Steve Thacker.
http://wwwnc.cdc.gov/eid/article/14/9/08-0952-f1

Key Words

HIV, AIDS, HIV/AIDS, disease, epidemic, pandemic, virus, retrovirus, infection rates, PCP, statistics, epidemiology, epidemiologist, microbiology, mapping, world, WHO, CDC, Michael B. Gregg,

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Mapping the Spread of HIV/AIDS

- Epidemiologists study outbreaks of disease in human populations.
- Most people who choose this career have a keen interest in science, medicine and mathematics.
- They also like solving mysteries and puzzles.

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Mapping the Spread of HIV/AIDS (Activity 4)

For complete instructions for conducting activities in this slide set, including materials needed, setup instructions and student sheets, download *The Science of HIV/AIDS Teacher's Guide*, free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/hivaids/.

Background

Diseases have haunted the human race throughout history. With the continued expansion of the world's population, international travel and global trade, diseases are able to spread more rapidly now than ever before. Since its origination in the 1930s, HIV has reached every coun¬try in the world and killed 30 million people. It is estimated that another 34 million people currently are living and struggling with HIV/AIDS.

This certainly is not the first disease calamity to strike humans. The Spanish Flu pandemic of 1918–19 resulted in the death of an estimated 50 million people, either directly from the disease or from its complications. Before that, yellow fever, small pox and the black plague ravaged populations around the world. Another old killer, malaria, still plays a deadly role in many nations.

Disease detectives, called epidemiologists, help us to understand and defeat these awful illnesses. Epidemiologists study factors that affect the health of populations. Their work is a colossal investigation being conducted in remote natural settings and high-tech laboratories around the world. Epidemiologists collect data to identify outbreaks of old and new diseases, analyze samples, make computer projections, and evaluate possible cures and strategies. Their goal is to identify the cause of disease and determine what to do about it.

The following classroom activity places students in the role of disease detectives, as they investigate trends in HIV infection worldwide. Students will discover that many countries with high HIV infection rates have low levels of per capita income and education, two characteristics often linked with disease. For example, malnutrition and insufficient protection against parasites, often found in economically deprived nations and communities, can limit the immune system's ability to fight off infections. Under these circumstances, individuals are more susceptible to infection by HIV and other pathogens (disease causing organisms). HIV/AIDS treatments are expensive, and are less available in economically disadvantaged countries. Poor children have an increased likelihood of contracting HIV/AIDS from an infected mother during pregnancy or while nursing, because HIV treatments to reduce the chances of HIV transmission are expensive and may not be an option, or even available.

HIV/AIDS also depletes household resources and income. Medical care is expensive and family members who care for the sick may not be able to work. Children may be left to fend for themselves or even become orphaned. And poverty sometimes leads people to participate in risky activities that increase their chances of being exposed to disease. Sustainable economic development, improved standards of living, and better education are essential to combating the global HIV/AIDS pandemic.

Procedure

1.Ask students, *Does anyone know what "CSI" stands for?* [crime scene investigation] *Have any of you watched one of the different CSI programs on television? How do the investigators on these programs gather information?* Mention that students will apply problem-solving strategies and scientific techniques like those used on CSI to collect clues and explain a mystery. Discuss the topic of mapping a crime scene and help students understand how the mapping process informs investigators. Ask, *What does a crime scene map tell the investigators?* [It helps them determine the sequence of events.]

2.Divide the class into 10 HIV/AIDS mapping teams. Provide each team with one of the ten “Adult HIV/ AIDS Prevalence Rate, by Country” tables. If you have fewer than ten teams, give some groups two tables or divide the remaining countries among all teams.

3.Explain that each table lists 16 or 17 different countries for which HIV/AIDS data are available (data are not available for all countries). The number to the right of each country name is the percentage of the adult population in that country living with HIV/AIDS. (For this activity, an “adult” is defined as a person aged 15 to 49.) The data were collected from *The World Factbook* produced by the U.S. Central Intelligence Agency. They are from the year 2009. The percentage of infected adults in each country was calculated by dividing the total adult population by the number of adults living with HIV/ AIDS, whether or not they exhibited AIDS symptoms.

4.Create a color legend for the map, or assign one or more students to create the legend. The table below provides suggested percentage ranges to be represented by each color of map pin or adhesive dot. However, you may adjust the legend on your class map to match the colors available.

Suggested Legend

*<0.1% Purple

0.1% – <0.5% Blue

0.5% – <1% Green

1% – <5% Yellow

5% – <15% Orange

15% – <26% Red

*< = less than

5.Have each student team locate its assigned countries on the world map. Then, have students place an appropriately-colored pin or dot in the center of each country to represent the percentage of adults in that country who are living with HIV/AIDS. Some countries may be difficult to locate. A world atlas or access to geography websites will be helpful.

6.When all teams have plotted their countries, have them use the questions on the student page to analyze the total map display.

7.Lead a class discussion of the results. Ask, *Do you see any trends? Where is HIV/AIDS most prevalent?* [central and southern Africa.] *Which country has the highest percentage of adults living with HIV/AIDS?* [Swaziland: 26.1%.] *What are the numbers worldwide?* [34 million people are living with HIV/AIDS.]

Note: Though the CDC estimates have changed over time, the numbers used in this lesson remain useful.

Reference

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Image Reference

Key Words

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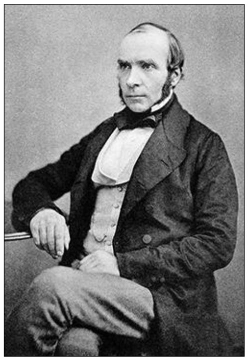
The Birth of Epidemiology



Dr. John Snow (1813–1858)

- Dr. John Snow is considered the father of epidemiology. In 1854, he solved the mystery of a deadly cholera epidemic in London.
- By studying patterns of outbreak and talking to local residents, he traced cholera outbreaks to human sewage leaking into a public water pump.
- He also used a map that revealed clusters of cholera cases in specific areas of the city.

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The Birth of Epidemiology

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Extension

Have each student "adopt" one country from his/her table and research that country's resources, people, politics, and other conditions that may contribute to the spread of HIV/AIDS and/or other health problems.

Reference

Vogt, G., and Moreno, N. (2012) *The Science of HIV/AIDS Teacher's Guide*. Baylor College of Medicine: Houston. ISBN: 978-1-888997-62-0

Image Reference

Photo of Dr. John Snow (1813-1858), British physician. Public domain.

https://en.wikipedia.org/wiki/John_Snow_%28physician%29#/media/File:John_Snow.jpg

Key Words
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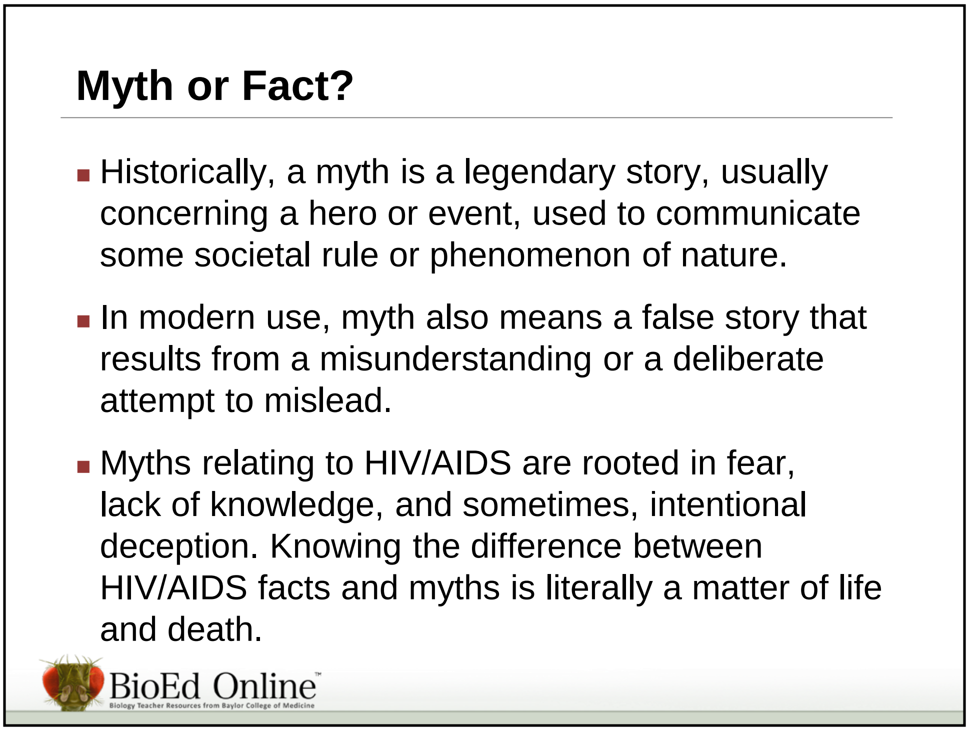

Myth or Fact? (Essay 5)

For complete instructions for conducting activities in this slide set, including materials needed, setup instructions and student sheets, download *The Science of HIV/AIDS Teacher's Guide*, free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/hivaids/.

Content Advisory

Depending upon students' grade and maturity levels, the essay, ”Myth or Fact?" may be used as teacher background information or as a student reading assignment. It is especially effective when read aloud.

Essay

When bad things happen, people naturally search for answers, explanations, and something or someone to blame. This can be helpful. If we know the cause of a tragedy, such as the HIV/AIDS pandemic, we can try to prevent it from happening again, or at least minimize its harmful effects. For example, knowledge of HIV's origins, and means of transmission has helped researchers to find effective treatments and preventative measures.

Unfortunately, the long process of discovery and development also has produced an abundance of misinformation that is very difficult to correct. Especially these days, when technology allows almost instantaneous global distribution of Internet content—both true and untrue—it can be difficult to tell reliable information from pure fabrication.

The initial discovery of AIDS in a group of homosexual men led to the belief that only homosexual men were at risk. But then, HIV/AIDS was found in intravenous drug users. Still later, HIV began to spread through minority groups and entire nations. Each new discovery led to new rumors and myths, some motivated by personal bias rather than an interest in the truth. Fear, denial, and misinformation have hindered education efforts and are partially are responsible for the rapid worldwide spread of the virus. HIV/AIDS causes approximately 2 million deaths per year. More than 34 million persons were living with HIV/AIDS as of 2009.

HIV/AIDS Myths

- AIDS is a punishment from God.
- An HIV diagnosis is a death sentence.
- HIV/AIDS was created for germ warfare.
- Only homosexual males and drug users are affected by HIV/AIDS.
- HIV/AIDS is no longer a problem in the United States.
- Women cannot give men HIV.
- You can get HIV from a kiss, a cough, a sneeze, tears, a toilet or shower, a swimming pool, a mosquito bite, contaminated ketchup bottles, or a hug.
- Drug companies are withholding an HIV/AIDS cure to make more money.
- HIV prevention does not work.
- You can tell if someone has HIV by his or her appearance.
- Since there are drugs to treat HIV/ AIDS, people no longer have to worry about being infected.
- HIV is the result of a government conspiracy to eliminate certain groups of people.
- If someone is taking HIV medications, they can’t spread the virus to others.

HIV/AIDS Facts

- Anyone can acquire HIV.
- HIV infections are preventable.
- HIV is transmitted through unprotected sex with a carrier of HIV.
- HIV is transmitted through contaminated blood transfusions and the sharing of needles among drug users.
- HIV can be transferred from mother to child during pregnancy and nursing.
- Though extremely rare, HIV can be transmitted accidentally to medical workers who are stuck with needles used with patients with HIV/AIDS.
- Modern drug therapies can hold HIV at bay indefinitely if administered

consistently.

- For treatments to be effective, HIV patients must take all of their medications exactly as prescribed, always on time and without missing doses.
- Birth control pills do not protect against HIV infection. Condoms, when used properly, reduce the transmission of HIV. Abstinence is 100% effective in preventing sexually transmitted HIV.
- Researchers have not yet developed a vaccine to prevent HIV infection.
- HIV is not a death sentence.
- Education is the best way to prevent HIV/AIDS.

Reference

Vogt, G., and Moreno, N. (2012) *The Science of HIV/AIDS Teacher's Guide*. Baylor College of Medicine: Houston. ISBN: 978-1-888997-62-0

Image Reference

Scanning electron microscopic image courtesy of the National Institute of Allergy and Infectious Diseases, NIH. http://www.niaid.nih.gov/

Key Words

HIV, AIDS, HIV/AIDS, disease, epidemic, pandemic, virus, retrovirus, HIV, HIV/AIDS, AIDS, statistics, epidemiology, epidemiologist, microbiology, U.S., CDC, WHO,

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HIV/AIDS in the United States

- Recent data on HIV diagnosis make it clear that HIV touches every corner of the United States.
- Let's participate in a classroom HIV/AIDS research conference.
- First, look at the data.

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HIV/AIDS in the United States (Activity 5)

For complete instructions for conducting activities in this slide set, including materials needed, setup instructions and student sheets, download *The Science of HIV/AIDS Teacher's Guide*, free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/hivaids/.

Background

The Centers for Disease Control and Prevention (CDC) estimate that more than one million people in the United States are living with HIV. About one in five (21%) of these people are unaware of their HIV-positive status. It is not surprising, then, that each year, upwards of 56,000 more Americans become infected with HIV. And despite improved medications, more than 18,000 people in the U.S. die each year from AIDS-related causes.

The burdens of HIV/AIDS are not distributed equally across all segments of the U.S. population. Among racial/ ethnic groups, African Americans face the highest rates of infection. Hispanics/Latinos also have a disproportionately large representation among the population of Americans living with HIV/AIDS.

Unfortunately, many young people do not understand how HIV is transmitted or treated. This lack of knowledge, when combined with alcohol and/or drug use, can be especially dangerous for adolescents, who are more likely to engage in high-risk behaviors, such as unprotected sex, when they are “under the influence.” Improving students’ basic knowledge, understanding of risks, and decision-making skills can help reduce rates of teen pregnancy and infection by STDs, including HIV. In this activity, students will discuss common misconceptions and truths about HIV/AIDS, and will examine authentic CDC data about the epidemic in our country.

Procedure

1.Announce to your students that they will be participating in a classroom HIV/AIDS research conference.

2.Divide the class into teams and provide each team with the HIV/AIDS data tables you have selected. The data describe the incidence of new HIV infections for the United States in the years 2006, 2009, and the prevalence of AIDS in the U.S. in the year 2007.

3.Challenge each team to review the data in the CDC tables and produce a graph, chart or some other document that illustrates the relationship between the data in two or more of the tables. Students should be careful to note whether a table is reporting data by percentage or raw number. Each team’s goal is to create a presentation on the HIV/AIDS pandemic as it relates to the U.S. Presentations should explain students’ observations clearly, in a way the entire class will be able to understand. If desired, the U.S. data can be related to worldwide numbers examined in the previous activity, “Mapping the Spread of HIV/AIDS.”

4.Discuss different ways to interpret and present the data through tables, graphs, diagrams etc. For example, students might elect to use graphs in the form of bar charts, pie charts, scatter plots, etc. Also, allow students to be creative in their choices of media used to communicate their findings (e.g., posters, flip-charts, PowerPoint® presentations, artwork, video, etc.).

5.Help students understand how to read and compare the different tables. They will see the abbreviation, “N,” used to refer to the total number of subjects represented in a table.

Because different statistical methods were used to derive information for the tables, some tables relating to the same topic have different “N” values. For example, in some tables, the numbers for Asian/Pacific Islander and American Indian/ Alaska Native groups are too small to allow for accurate estimates. Consequently, totals for those racial/ethnic groups are not included in some tables, which reduces the tables’ “N” value.

The table presenting the incidence of new HIV infections presents data as a rate per 100,000. This means, as an example, that for each 100,000 Hispanic/Latino persons in the United States, 40 individuals acquired a new HIV infection in 2009. (Note: some tables present data as percentages rather than raw numbers.)

1.Conduct a class “HIV/AIDS Research Conference,” during which students share their presentations, explain the data they used and present their conclusions.

2.Discuss each team’s findings with the entire class. Some of the questions below may help to promote student responses and learning.

- What do your data show?
- Based on the data, which groups are at greatest risk for contracting HIV?
- How do these totals relate to the population as a whole?
- Are males or females more likely to become infected with HIV?
- Is any age or racial/ethnic group untouched by HIV/AIDS?
- Why are HIV and AIDS reported separately in the tables?
- Is HIV transmission limited to homosexual contact?

Sample Conclusions

- The prevalence of HIV infection in the U.S. is well below that in some nations, but it is nevertheless a major health issue in our country.

- Although Black/African Americans make up only 13% of the total U.S. population, they accounted for a disproportionately high number (45%) of the new HIV infections in 2006.

- While males are more likely than females to become infected with HIV, the increase in the rate of infection among Black/ African American females is the highest for all racial/ethnic groups.

•HIV and AIDS are reported separately in the tables because a person infected with HIV may not have AIDS. Without diagnosis and consistent medical treatment, the virus, HIV, leads to the disease, AIDS. Due to improved HIV detection and treatment, and to the deadly effects of AIDS itself, the number of people liv¬ing with HIV is much greater than the number living with AIDS.

•The infection rate (per 100,000 people) for Black/African Americans is 7.5 times greater than the infection rate for white Americans. The rate of infection for Hispanic/Latino populations is 2.5 times greater than the rate for white Americans.

•Among all racial/ethnic groups in the U.S., Black/African American females currently are at greatest risk of becoming infected with HIV.

•Based on the final tables, homosexual activity still is the most common way for HIV to be transmitted. However, heterosexual contact and needle sharing among drug addicts also are major transmission routes.

Extensions

•Talk with your students about the ways to prevent HIV infection. The U.S. Centers for Disease Control and Prevention provide explicit information on prevention measures. Your school or school district may have specific recommendations about how to discuss this topic with students (http://cdc.gov/hiv/topics).

•Invite a public health medical professional to visit your class. Have student teams present their findings again, and discuss the results with this guest.

Note: Though the CDC estimates have changed over time, the numbers used in this lesson remain useful.

Reference

1.Vogt, G., and Moreno, N. (2012) *The Science of HIV/AIDS Teacher's Guide*.

Baylor College of Medicine: Houston. ISBN: 978-1-888997-62-0
2. Today's HIV/AIDS Epidemic. CDC. http://www.cdc.gov/nchhstp/newsroom/docs/HIVFactSheets/TodaysEpidemic-508.pdf

Image Reference

Graphic courtesy of AIDS.gov. https://www.aids.gov/hiv-aids-basics/hiv-aids-101/statistics/

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