Activity 1: Multiple Choice

Based on video and online text content

15 minutes (10 minutes before and 5 minutes after the video)

Setup

We hear so many statistics and read so much information about HIV and AIDS, it is difficult to keep the facts straight. Sometimes we even hear conflicting information. As a warm-up to this unit, go through the following multiple choice questions. Don't think about them too much—just check your first impulse. The answer you are expecting might not be there because you may have read or heard something different. As you watch the video or read the text, watch for information that is relevant to these questions. After the video, look at the Multiple Choice Answers sheet, which has answers from the video. We often hear conflicting numbers about HIV and AIDS, so are there any answers for which you have heard other information?

Materials

- One copy of the Multiple Choice Questions per person (master copy provided)
- Transparency of the Multiple Choice Answers (master copy provided)

Multiple Choice Questions

Note: Data are from 2003.

1. Each day, how many people die from AIDS, worldwide?
    a. 125 million
    b. 75 million
    c. 8,000
    d. 400
2. Each day, how many new HIV infections are there, worldwide?
    a. 15,000
    b. 6,000
    c. 2,000
    d. 150
3. How many people, worldwide, are infected with HIV?
    a. 500 million
    b. 65 million
    c. 5 million
    d. 300,000
4. How many people in sub-Saharan Africa are infected with HIV?
    a. 100 million
    b. 25 million
    c. 2 million
    d. 500,000
5. In what year were HIV DNA vaccines first tested in people?
    a. 1982
    b. 1991
    c. 1999
    d. 2002
6. In parts of Africa, what is the highest proportion of the adult population that is infected with HIV?
    a. nearly one in five
    b. approximately one-third
    c. up to one-half
    d. three-fourths
7. What percent of Russians are projected to be infected with HIV by 2010?
    a. 50%
    b. 30%
    c. 20%
    d. 12%

8. What kind of virus is HIV?
    a. rotavirus
    b. retrovirus
    c. rhinovirus
    d. coronavirus
9. Which of the following is NOT one of HIV's enzymes?
    a. reverse transcriptase
    b. ribosome
    c. integrase
    d. protease
10. What cells carry out the "humoral" immune response?
    a. macrophages
    b. neutrophils
    c. T cells
    d. B cells

Multiple Choice Answers

1. Each day, how many people die from AIDS, worldwide?
   c. 8,000
2. Each day, how many new HIV infections are there, worldwide?
   a. 15,000
3. How many people, worldwide, are infected with HIV?
   b. 65 million
4. How many people in sub-Saharan Africa are infected with HIV?
   b. 25 million
5. In what year were HIV DNA vaccines first tested in people?
   c. 1999
6. In parts of Africa, what is the highest proportion of the adult population that is infected with HIV?
   c. up to one-half
7. What percent of Russians are projected to be infected with HIV by 2010?
   d. 12%
8. What kind of virus is HIV?
   b. retrovirus
9. Which of the following is NOT one of HIV's enzymes?
   b. ribosome
10. What cells carry out the "humoral" immune response?
    d. B cells

Activity 2: According to WHO?

(An alternate to Activity 1)

Based on video and online text content

15 minutes (10 minutes before and 5 minutes after the video)

Setup

The World Health Organization's (WHO) 2002 document "The World Health Report" lists 10 risk factors for health. The WHO believes that, together, these factors account for more than one-third of all deaths worldwide. Risk factors associated with genetic diseases or infectious diseases, like the existence of pathogenic viruses and bacteria, are not included, although some of the risk factors are associated with the transmission of pathogens. Everything on the list is a risk factor that could, in principle, be reduced, and if it were reduced; the expected life span of the population would increase.

What do you think is on the list of global top 10 health risks? Make a list of the 10 largest health risk factors you can think of. One starting point is to think of the greatest global risk factor for HIV transmission. What are some other health problems and what is the greatest risk factor for these diseases? After you have made your list, compare it to the list from the 2002 World Health Report and discuss the discussion questions.

Materials

- Transparency of the list of Top 10 Risks for Health from The World Health Report 2002 (master copy provided)

Top 10 Risks for Health (The World Health Report, 2002)

According to the report, these are "real risks to health—for which the means to reduce them are known."

- underweight
- unsafe sex
- high blood pressure
- tobacco consumption
- alcohol consumption
- unsafe water, sanitation, and hygiene
- iron deficiency
- indoor smoke from solid fuels
- high cholesterol
- obesity

Discussion Questions

Because this unit is about HIV, concentrate on unsafe sex as a risk factor.

1. What might be some effective strategies for reducing this risk in developing countries?

2. What might be some effective strategies for reducing this risk in developed countries?

Activity 3: The Mighty Immune System

(An activity for those who want a better understanding of the basic immune system)

Based on video and online text content

45 minutes

Setup

The key to understanding HIV is understanding the immune system—but our defense against diseases is one of the most complex systems in biology. Although it is a bit artificial, sometimes it helps to divide and conquer; that is, categorize and organize the parts of a complex system and think about them separately.

Working in pairs, follow the activity instructions to make diagrams and tables that organize the immune system parts. Use the HIV and AIDS online text chapter and the beginning of Dr. Jay Levy's interview transcript as references. Then make a big picture diagram that integrates the parts. If time permits, use the diagrams and tables to talk about one or more of the diseases in the discussion questions at the bottom of the activity instructions sheet.

Materials

- One copy of the Activity Instructions per person (master copy provided)
- One copy of the HIV and AIDS online text chapter per two people (available online at http://www.learner.org/channel/courses/biology)
- One copy of Dr. Jay Levy's interview transcript per two people (to approximate marker 11:20:55; available online at http://www.learner.org/channel/courses/biology)

Activity Instructions

Step 1: Make a Non-Specific/Innate vs. Specific List

a. Make two columns so two long lists can be made. Label one column "non-specific/innate" and the other "specific." Start by listing all the mechanical defenses in the "non-specific/innate" column. For each, write a sentence or two about how it works (e.g., "Ciliated cells keep mucus moving so bacteria and viruses that are inhaled can't hold fast to cells, or can't infect them.")

b. Next, list the cells that are involved in the non-specific response. Again, write a sentence or two about what they do (e.g., "Phagocytes engulf foreign cells and particles.")

c. Next, list the general types of cells of the specific immune system, with a sentence about what they do.

d. Finally, draw lines between cells of the non-specific immune system that interact with, or stimulate, the specific immune system cells.

Step 2: Make a Specific Immune System List

a. Make two columns. Label one "B lymphocytes/humoral" and the other "T lymphocytes/cellular." List the types of B lymphocytes and their functions. (Which are involved in short-term response and which are involved in long-term response?)

b. List the types of T lymphocytes, giving a short description of the job of each one. Mark those that are CD4 and those that are CD8. Which are infected by HIV?

c. Finally, draw lines between cells that interact with each other.

Step 3: Make a Big Picture Diagram

a. Divide a paper, section of the blackboard, or a transparency into three parts. Label them "non-specific," "specific B lymphocytes," and "specific T lymphocytes." Put all the cell types from Steps 1 and 2 into the diagram and draw lines to show interactions between cell types.

b. Draw arrows from one cell to a cell that it stimulates. Draw a line that ends in a short perpendicular line from one cell to a cell that it inhibits or down-regulates.

Step 4: Discussion Questions

Choose one or more of the following diseases, and describe its encounter(s) with the non-specific defenses and specific immune systems.

- common cold
- *Staphylococcus* skin infection
- cancer
- influenza
- malaria
- tuberculosis
- lupus
- pollen, in an allergy

Activity 4: Miracle Drugs?

(An activity for those who want to focus on HIV)

Based on video and online text content

45 minutes

Setup

When HIV infections begin to progress to AIDS, they are treated with a combination of sophisticated anti-HIV drugs. New drugs and new treatments are continuously being developed, so this exercise will focus on the types of drugs that are available or are in development. In pairs, do a brief presentation on one type of anti-HIV treatment. Your sources of information will be the video, the online text, transcripts from scientists interviewed for the video, and transparencies of helpful figures that are available for your presentations.

Start by spending a few minutes reviewing the immune system, because some of the drugs do not target the virus but manipulate the immune system. Especially note the roles of cytokines, interferon, and interleukins. Then review the mechanism of HIV infection. Focus especially on the proteins of HIV, because any protein is a potential drug target for a drug. Then each pair will choose one or more of the drugs to explain to the rest of the group. If time permits, discuss the additional discussion questions.

Materials

- Video available for people to review
- One copy of the HIV and AIDS online text chapter per two people (available online at http://www.learner.org/channel/courses/biology)
- One copy of the interview transcript with Dr. Jay Levy per two people (available online at http://www. learner.org/channel/courses/biology)
- One copy of the interview transcript with Dr. David Weiner per two people (available online at http://www.learner.org/channel/courses/biology)
- One copy of the Guide to the Presentations plus Discussion Questions per person (master copy provided)
- Tips and Suggested Answers
- Transparency of the HIV infection cycle (master copy provided)
- Transparencies of the HIV drugs and the molecules they resemble to use for presentations (optional, master copies provided)

Guide to the Presentations plus Discussion Questions

Guide to the Presentations

Here is a list of drugs or treatments that could be investigated and presented:

- protease inhibitors
- nucleoside reverse transcriptase inhibitors
- non-nucleoside reverse transcriptase inhibitors
- integrase inhibitors
- interferons and interleukin
- CAF and other cytokines
- anti-HIV vaccines
- presentations could also be made on the innate/non-specific immune system, the specific immune system, and the replication and infection cycle of HIV

Here are some questions to try to answer in the presentations:

1. Does the treatment inhibit the virus or does it boost the infected person's immune response?

    a. If it targets the virus, which step in replication and which viral protein does it target?

    b. If it targets the virus, does it prevent the virus from becoming established in the cell, or does it inhibit its replication once it is integrated?

    c. If it targets a viral protein, is it a "competitive inhibitor" that looks like a molecule the protein normally interacts with, like a substrate of an enzyme? If not, what is its mechanism of action?

    d. If it targets the immune system, does it affect the innate (nonspecific) or the specific response? What kind of cells does it affect and how does it affect them?

2. Is the treatment currently available?

    a. If so, how long has it been available and how effective is it?

    b. What are the side effects?

    c. If it is not yet available, what is the state of research and development on this therapy?

Discussion Questions

1. Why are drugs taken in combination with each other? (Note: See the Tips and Suggested Answers.)

2. What points in the HIV replication cycle are not being targeted yet?

After discussing the above questions, read the following:

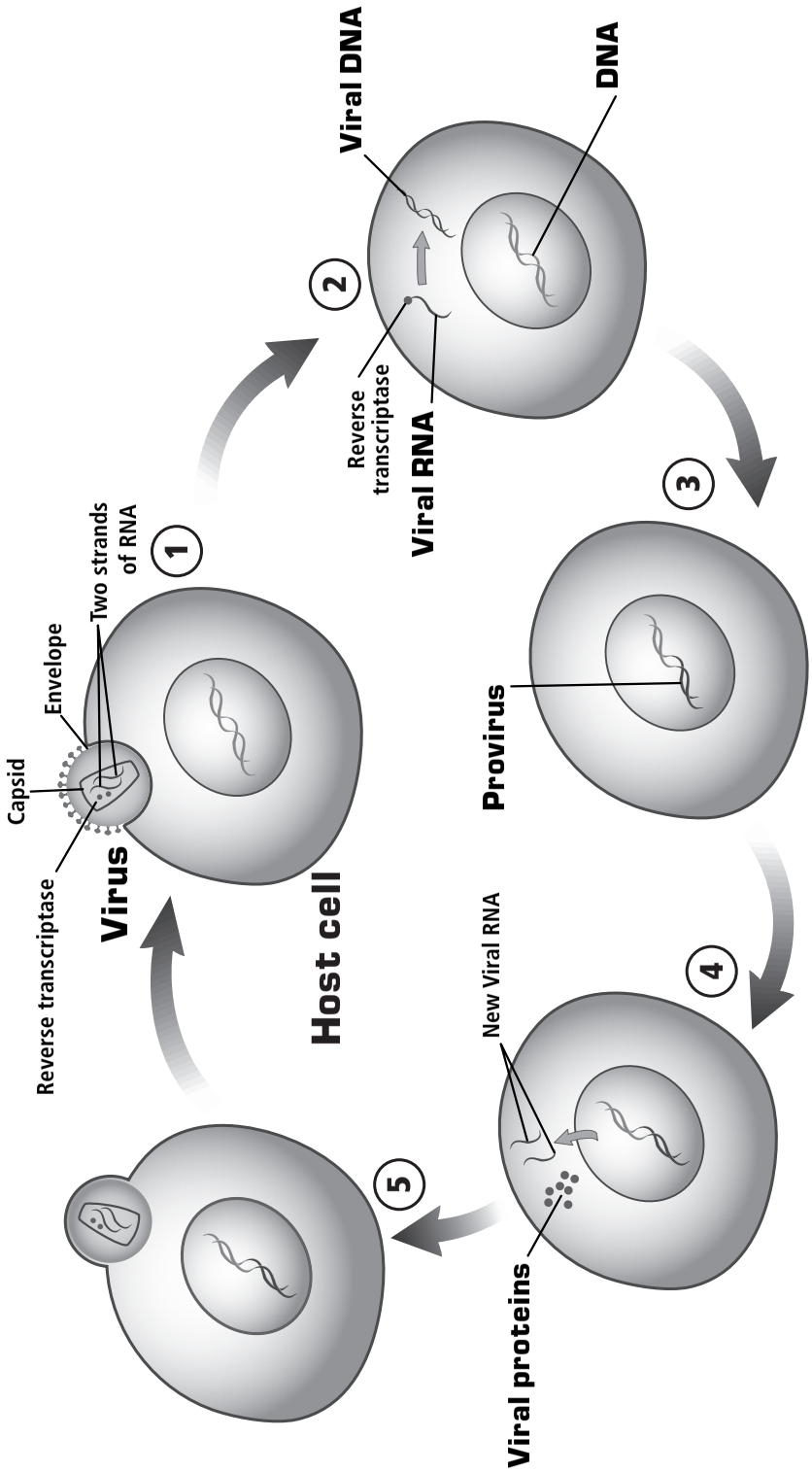
> HIV encodes a protein called viral infectivity factor (Vif), which is absolutely required for HIV-1 to infect certain cell types. These cells express a protein, called APOBEC3G, that is a viral defense mechanism. APOBEC3G works on unusual, viral DNA, like the RNA-DNA intermediate that forms while reverse transcriptase is converting the HIV RNA chromosome into double-stranded DNA. It deaminates cytosine (C) residues in the unusual DNA, converting them to uracil (U), which does not belong in DNA. The U residue in DNA can cause it to be destroyed (or impairs its ability to be replicated) or cause the introduction of many deleterious mutations.
>
> Source: *Nature*. 2003. Jul 3; 424(6944):21–2.

3. How might this information be used to generate new anti-HIV drugs?

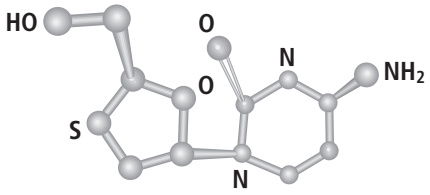
4. With what you've seen so far, do you have an opinion on what kind of drugs seem more promising for long-term management of HIV infection: drugs that interfere with viral replication or drugs that regulate the innate immune system? Why?

5. Developing new drugs takes millions of dollars, and years of research and development time. Who should pay for this? Do you think most people would be willing to pay an extra dollar for a bottle of aspirin if it would lower the cost of anti-HIV drugs? What strategies could a pharmaceutical company use to raise money for this kind of drug development?

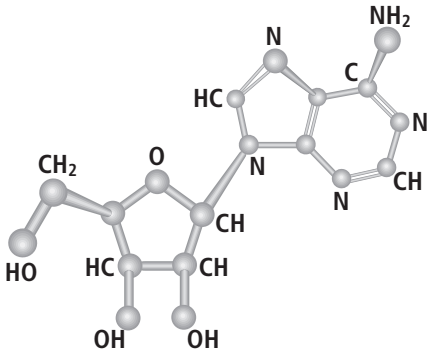
The HIV Infection Cycle



Nucleoside Reverse Transcriptase Inhibitor (3TC)
(from 2003 Web site http://www.medicine.mcgill.ca/mjm/issues/v05n01/v05p060/v05p060main.htm)

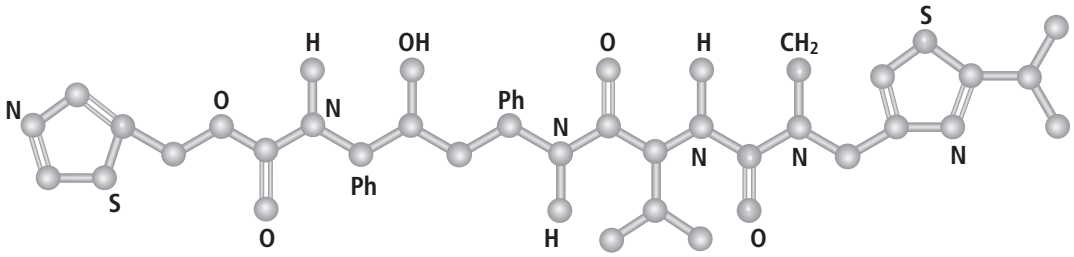


Nucleoside
(from 2003 Web site http://www.web-books.com/MoBio/Free/Ch3A4.htm)

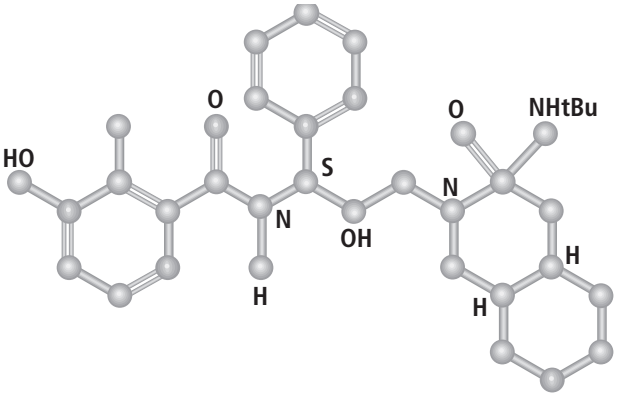


Protease Inhibitors
(from 2003 Web site NEJM via http://cmgm.stanford.edu/biochem118/Projects/2002/ro.pdf)

Ritonavir

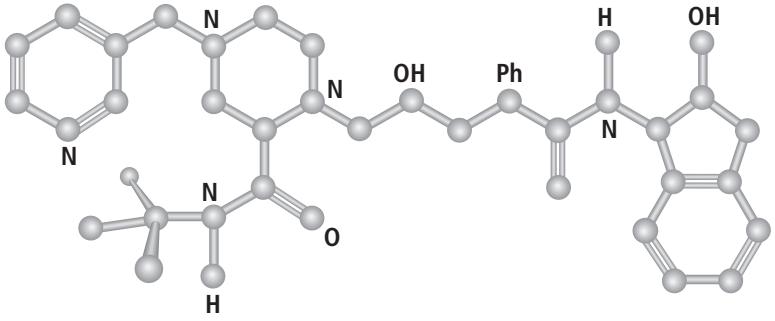


Nelfinavir

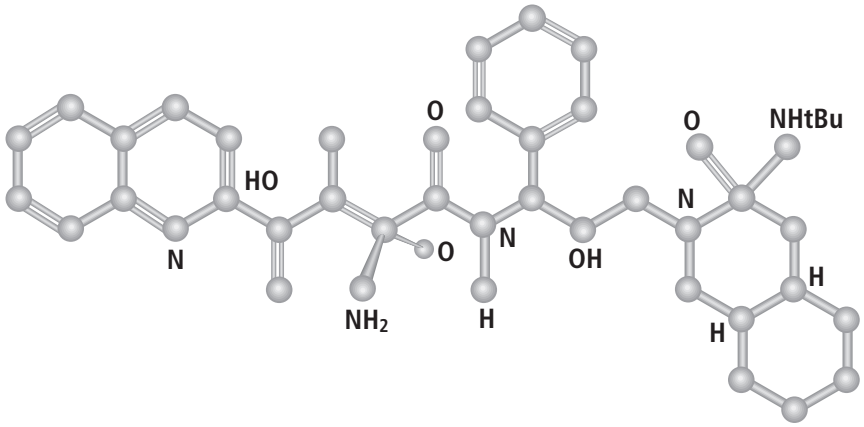


Protease Inhibitors (continued)
(from 2003 Web site NEJM via http://cmgm.stanford.edu/biochem118/Projects/2002/ro.pdf)

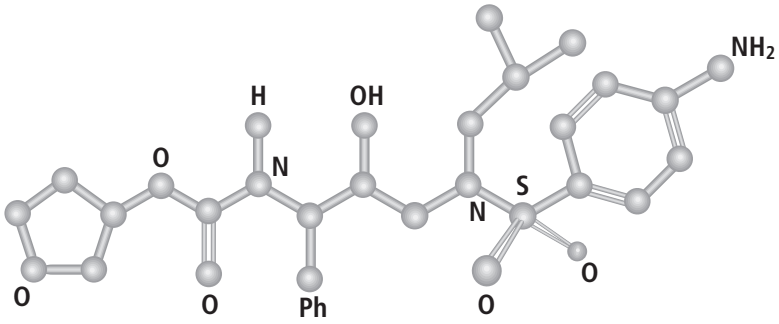
Indinavir



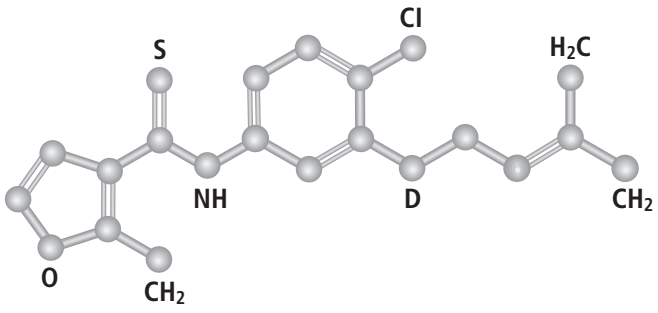
Saquinavir



Amprenavir



Non-Nucleoside Inhibitor (UC781)
(from 2003 Web site http://aidscience.org/Articles/aidscience010.asp)



Answer to the Discussion Question

1. Why are drugs taken in combination with each other?

   When HIV is exposed to just one drug, resistant viral strains quickly appear. Much more time is required for resistance to multiple drugs.

   If two drugs separately can slow HIV, together they can have an even greater impact on slowing the replication.

   HIV can infect many different cells. The drugs differ in their abilities to reach different types of cells, so a combination is more likely to reach all the types of infected cells.

Activity 5: DNA Vaccines

Based on video and online text content

10 minutes

Setup

DNA vaccines are a relatively new technology. Compare them to traditional vaccines by answering the following questions.

Materials

- One copy of the Discussion Questions per person (master copy provided)

Discussion Questions

1. A person who receives the oral polio vaccine is actually infected and produces virus, although they should not get polio. A person who receives the polio vaccine as a shot is not infected and does not produce the virus. Which one of the polio viruses is a "live" but "attenuated" (weakened) virus? Which is an intact but chemically "killed" virus? How does each vaccine stimulate an immune response and protect against the virus? How is the antigenic protein for this vaccine produced: by the virus, in a cell outside the vaccinated person, or in the cells of the vaccinated person?

2. The Hepatitis B vaccine is a viral protein produced in, and then purified from yeast cells. How does this vaccine stimulate an immune response and protect against the virus? How is the antigenic protein for this vaccine produced: by the virus, in a cell outside the vaccinated person, or in the cells of the vaccinated person?

3. What is injected in a vaccination with a DNA vaccine? How does this vaccine stimulate an immune response and protect against the virus? How is the antigenic protein for this vaccine produced: by the virus, in a cell outside the vaccinated person, or in the cells of the vaccinated person?

Activity 6: Lesson Plans

Based on video and online text content

20 minutes

Setup

Many of us have discussed HIV and AIDS in a biology class. All of us have presented information that had both academic and practical value to students. The goal of this unit is to learn more about HIV and AIDS. The goal of this exercise is to focus especially on academic and practical information about HIV and AIDS that you would like students to know.

Work in pairs to come up with five facts or pieces of information about HIV and AIDS that you have presented to a high school class, or have considered presenting. If you have not covered HIV and AIDS in your classes, think of other information related to this topic that you have covered. Next, write down five new ideas that you have gained from the video, online text, or activities of this unit that you might present to a high school class.

As a group share ideas, with a word or two about whether this is something you want students to know for practical (meaning health and safety) reasons, or something you want them to know because it is a good example of a biological principle. If time permits, discuss the additional discussion questions.

Materials

- Transparency of the Activity Instructions and Discussion Questions

Activity Instructions and Discussion Questions

Activity Instructions

- List five facts or points related to HIV and AIDS that you *have* or *have considered* presenting to a high school class.
- List five facts or points from this unit that you might present to a class.
- Are these points important for practical reasons or as an example of a basic biological principle?

Discussion Questions

1. What are the three most important points to emphasize when teaching about HIV/AIDS to high school students?

2. What are the three most important points about the *biology* of HIV to emphasize to high school students?

3. What are the three most important points about *HIV infection and prevention* to stress to high school students?

Activity 7: Public Opinion, Public Policy

Based on video and online text content

20 minutes

Setup

HIV can be transmitted through unprotected sex or shared needles during intravenous drug use. This is one of the reasons for the stigma of being HIV-positive, and the stigma has had an impact on prevention programs and the distribution of treatment. As a group or in pairs, discuss the following questions about the public perception of HIV infection and how public opinion affects policy about HIV treatment.

Materials

- One copy of the Discussion Questions per person (master copy provided)

Discussion Questions

1. When an HIV vaccine is approved for general public use, it will probably be available in limited quantities at first.
    a. Who should be vaccinated first? Here are some suggestions:
        • children
        • adults who are at high risk for infection, like prostitutes and intravenous drug users
        • people who live in sub-Saharan African countries, where the infection rate can be as high as 30% and the availability of anti-HIV drugs is low
        • health care workers

    b. Who should decide who receives the first vaccinations? Here are some suggestions:
        • the World Health Organization or the Red Cross
        • the United Nations
        • the company that produces the vaccine

    c. Sometimes, post-infection vaccination can slow down or prevent the development of disease. If this turns out to be the case with the HIV vaccine, should we first vaccinate people who are already infected? If so, would it matter if they were infected "accidentally" (e.g., through blood transfusion) or if they were infected through sex or drug use?

2. Hepatitis B is transmitted the same way as HIV, yet a Hepatitis B infection does not have the same stigma as an HIV infection. Why?

3. Dr. Jay Levy from the University of California—San Francisco was interviewed for the *Rediscovering Biology* project (you can read a transcript of the entire interview at the Web site). In answer to questions about how to distribute treatments, he said:

    > I want to emphasize that we should not lose sight of prevention. And what's happening is all the funds are going for treatment, and we're saying, "Fine, we just treat, that's it." We aren't looking at blocking this epidemic. So I'm not sure how it can be done, but we must not lose sight of the fact that we need to prevent it through education, distribution of condoms, needle exchanges, and, of course, a vaccine.

    a. Do you agree or disagree with Dr. Levy's statement?

    b. The three suggestions that are possible as of 2003 are education, distribution of condoms, and needle exchanges. Given public sensibilities, are we doing all we can in these areas in the U.S.? If you think we could do more, how? If you think we are doing everything possible in these areas, do you think it is working to prevent HIV transmission?

4. Dr. Levy also said:

> Of course, the big question now—and it's vying groups against one another—is, do you encourage prevention or do you encourage treatment? There is no question that now that the world knows that there are drugs that can help people who advance to disease; we cannot deny them the drugs. There is evidence to suggest that if you give drugs to people, it lowers the amount of virus in their blood, and also in genital fluids, so you may actually reduce transmission. Doesn't mean that if you're on drugs you can go and not worry about transmitting it, but there is some evidence to suggest that. So we've got to do something worldwide, and it's being recognized. It's as if one says, "Yeah, we're slow, but it's going to happen." You can't look at the world and see what's happening with 15,000 new infections every day and 8,000 deaths every day—that we can just sit back and be oblivious and not respond. So that's a clear thing.
>
> Source: Sharon Lerner, "How To Advise Youth in the Age of AIDS," *International Herald Tribune*, 8 August 2003.

   a. Are we doing all that we can to prevent HIV transmission worldwide?

   b. Are we doing enough to treat HIV worldwide?

   c. How are prevention and treatment related? How might transmission of HIV be affected, either positively or negatively, if people in a community see that effective treatment is available?

5. At the 2003 National HIV Prevention Conference at the Center for Disease Control in Atlanta, Claude Allen, the deputy secretary for the U.S. Department of Health and Human Services, said, "encouraging young people and young adults to abstain is the only appropriate initial strategy" for controlling HIV infections in young people.

   a. What is your opinion about this policy?

   b. Are we implementing this policy in our schools? If so, is it effective? If not, what can we do to implement it?

   c. Two alternatives to "abstinence only" policies are "stand-alone" classes in safe sex; or intensive, individualized programs that integrate sex education with components that encourage self-expression in arts, sports, and other "above-the-waist" activities. Of these two alternatives, which seems the most practical? Which seems the most likely to work?