UNESCO HARARE CLUSTER OFFICE
in collaboration with the National Universities Commission, Nigeria
Virtual Institute for Higher Education in Africa

HIV/AIDS EDUCATION

...a training programme for teachers involved in the delivery of basic and higher education in Africa

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...without a vaccine, a major pathway to HIV/AIDS prevention is through education

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Lesson 1

Lesson Objectives

After completing this lesson, you will be able to:

- give the full meanings of HIV and AIDS;
- explain what a virus is;
- name two types of HIV; and
- state how HIV is contracted.

Basic Content

HIV is the shortened form for **H**uman **I**mmunodeficiency **V**irus. It is a virus, such as the virus that causes the flu or cold. A virus is a minute particle that lives as a parasite in plants, animals, and bacteria. It consists of an inside (core) made of a substance known as **nucleic acid** and an outside (sheath) made of **protein**. Viruses can only replicate within living cells and are not considered to be independent living organisms.

In order to make more viruses (and to do all of the other nasty things that viruses do), a virus has to infect a cell. HIV mostly infects the white blood cells of the body's immune system. These cells are known as T-cells or CD4 cells. Once inside the T-cell or CD4 cell, HIV starts producing millions of little viruses, which eventually kill the cell and

then go out to infect other cells. All of the drugs marketed to treat HIV work by interfering with this process

If one is infected with HIV, the body will try to fight the infection. It will make "antibodies", special molecules that are supposed to fight HIV. When you get a blood test for HIV, the test looks for these antibodies. If a person has them in the blood, it means that the person has HIV infection. People who have the HIV antibodies are called "HIV-Positive".

Infection with HIV does not necessarily mean that a person has AIDS. Some people who have HIV infection may not develop any of the clinical illnesses that define the full-blown disease of AIDS for ten years or more. Physicians prefer to use the term *AIDS* for cases where a person has reached the final, life-threatening stage of HIV infection.

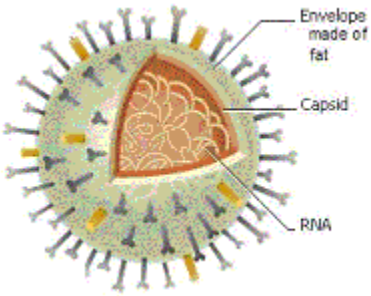
What about AIDS? AIDS is a shortened form for **A**cquired **I**mmune **D**eficiency **S**yndrome. It is a condition caused by HIV. This virus, as stated earlier, attacks the immune system, the body's "security force" that fights off infections. When the immune system breaks down, this protection is lost and can lead to the development of many serious, often deadly infections and cancers. These are called "opportunistic infections (OIs)" because they take advantage of the body's weakened defenses. You have heard it said that someone "died of AIDS." This is not entirely accurate, since it is the opportunistic infections that cause death. AIDS is the condition that lets the OIs take hold.

There are some specific criteria for determining when a person living with HIV progresses to AIDS. One thing they look at is T-cell counts: if a person falls below 200 T4 cells, then they have officially progressed to AIDS. Another thing they look for are OIs: if an HIV+ individual is diagnosed with an opportunistic infection the list of over two dozen possible HIV-related OIs, then they are diagnosed with AIDS.

What is a Virus?

A virus is an infectious agent that is found in virtually all life forms, including humans, animals, plants, fungi, and bacteria. Viruses consist of two major parts- an outer protective coat called a **capsid** which is

made of protein; and an inside which consists of genetic material. The genetic material is either of two substances with rather long names. These names have been abbreviated as **DNA** and **RNA**. DNA stands for **d**eoxyribo**n**ucleic **a**cid while RNA stands for **r**ibo**n**ucleic **a**cid. It is also worth noting that the capsid may or may not have an outer envelope made of fat.



Viruses are between 20 and 100 times smaller than bacteria and hence are too small to be seen by the light microscope. Viruses vary in size from the largest poxviruses of about 450 nanometre in length to the smallest polioviruses of about 30 nanometres. (Note: 1 nanometre is a billionth of a metre) Viruses are not considered free-living, since they cannot reproduce outside of a living cell; they have evolved to transmit their genetic information from one cell to another for the purpose of replication.

Viruses often damage or kill the cells that they infect, causing disease in infected organisms. A few viruses stimulate cells to grow uncontrollably and produce cancers.

Types of HIV

There are two types of this virus: HIV-1, which is the primary cause of AIDS worldwide, and HIV-2, found mostly in West Africa. On its surface, HIV carries a protein structure that recognizes and binds only with a specific structure found on the outer surface of certain cells. HIV attacks any cell that has this binding structure. However, white blood cells of the immune system known as T cells, which orchestrate a wide variety of disease-fighting mechanisms, are especially vulnerable to HIV attack. Particularly vulnerable are certain T cells known as CD4 cells. When HIV infects a CD4 cell, it commandeers the genetic tools within the cell to manufacture new HIV virus. The newly formed HIV virus then leaves the cell, destroying the CD4 cell in the process. No

existing medical treatment can completely eradicate HIV from the body once it has integrated into human cells.

The loss of CD4 cells endangers health because these immune cells help other types of immune cells respond to invading organisms. The average healthy person has over 1,000 CD4 cells per microlitre of blood. In a person infected with HIV, the virus steadily destroys CD4 cells over a period of years, diminishing the cells' protective ability and weakening the immune system. When the density of CD4 cells drops to 200 cells per microlitre of blood, the infected person becomes vulnerable to any of about 26 opportunistic infections and rare cancers, which take advantage of the weakened immune defences to cause disease.

HOW DO YOU GET AIDS?

You don't actually "get" AIDS. You might get infected with HIV, and later you might develop AIDS.

You can get infected with HIV from anyone who is infected, even if they don't look sick, and even if they haven't tested HIV-positive yet. The blood, vaginal fluid, semen, and breast milk of people infected with HIV has enough of the virus in it to infect other people. Most people get HIV by:

- Having sex with an infected person.
- Sharing a needle with someone who's infected.
- Being born when the mother is infected, or drinking the breast milk of an infected woman.
- Using unsterilised instruments in some traditional practices such as circumcision, tattooing, manicure, pedicure, and using unsterilised clippers in barbing saloons.

Getting a transfusion of infected blood used to be a way people got AIDS, but now the blood supply is screened very carefully and the risk is extremely low.

There are no documented cases of HIV being transmitted by tears or saliva, but it is possible to be infected with HIV through oral sex or in rare cases through deep kissing, especially if you have open sores in your mouth or bleeding gums.

IS THERE A CURE FOR AIDS?

Currently, there is no cure for AIDS. There are drugs that can slow down the HIV virus, and slow down the damage to your immune system. But there is no way to get all the HIV out of your body.
There are other drugs that you can take to prevent or to treat opportunistic infections (OIs). In most cases, these drugs work very well. The newer, stronger anti-HIV drugs have also helped reduce the rates of most OIs. A few OIs, however, are still very difficult to treat.

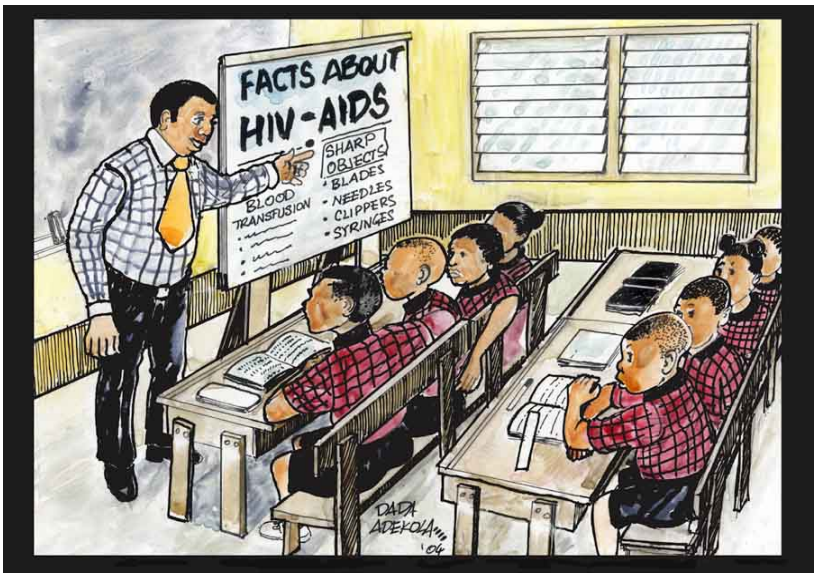
Resources: Three charts: (A) showing the expansion of HIV as Human Immunodeficiency Virus; and AIDS as Acquired Immune Deficiency Syndrome; (B) showing two diagrams- one of the virus – HIV, the other of an AIDS patient; and (C) listing ways of contracting the disease with relevant illustrative sketches.

Procedure: Using chart A, lead pupils to give the full meanings of HIV and AIDS. Remove the chart and call pupils randomly to give the meanings.

Using chart B, explain to the pupils that a virus is an infectious agent that is found in virtually all life forms, including humans, animals, plants, fungi, and bacteria. Viruses are not considered free-living,

since they cannot reproduce outside of a living cell; they have evolved to transmit their genetic information from one cell to another for the purpose of replication. Viruses often damage or kill the cells that they infect, causing disease in infected organisms. A few viruses stimulate cells to grow uncontrollably and produce cancers.

Name the two types of HIV as HIV-1, which is the primary cause of AIDS worldwide, and HIV-2, found mostly in West Africa. Emphasise that the virus attacks the immune system, the body's "security force" that fights off infections. When the immune system breaks down, this protection is lost and can lead to the development of many serious, often deadly infections and cancers. The infections are called "opportunistic infections (OIs)" because they take advantage of the body's weakened defenses. You have heard it said that someone "died of AIDS." This is not entirely accurate, since it is the opportunistic infections that cause death. AIDS is the condition that lets the OIs take hold.



Using chart C, explain to the pupils how HIV can be contracted. Most people get HIV by:

- Having sex with an infected person.
- Sharing a needle with someone who's infected.
- Being born when the mother is infected, or drinking the breast milk of an infected woman.
- Using unsterilised instruments in some traditional practices such as circumcision, tattooing, manicure, pedicure, and using unsterilised clippers in barbing saloons.

Let pupils know that there are no documented cases of HIV being transmitted by tears or saliva, but it is possible to be infected with HIV through oral sex or in rare cases through deep kissing, especially if you have open sores in your mouth or bleeding gums.

Conclude with the discussion on the cure for AIDS that currently, there is no cure for AIDS. There are drugs that can slow down the HIV virus, and slow down the damage to the immune system. But there is no way to get all the HIV out of the body.

Assist pupils to develop a simple concept map of the lesson. An example is given below.

In this lesson, we learned that

- HIV is the shortened form for **H**uman **I**mmunodeficiency **V**irus.
- A virus is an infectious agent that is found in virtually all life forms consisting of two major parts- an outer protective coat called a **capsid** which is made of protein; and an inside which consists of genetic material- **DNA** or **RNA**.
- HIV mostly infects T-cells, also known as CD4+ cells, or T-helper cells. These cells are white blood cells that turn the immune system on to fight disease. Once inside the cell, HIV starts producing millions of little viruses, which eventually kill the cell and then go out to infect other cells.
- There are two types of this virus: HIV-1, which is the primary cause of AIDS worldwide, and HIV-2, found mostly in West Africa.
- AIDS is a shortened form for **A**cquired **I**mmune **D**eficiency **S**yndrome). It is a condition caused by HIV.
- Most people get the HIV virus by having sex with an infected person; sharing a needle or sharp instruments with someone who's infected; and being born when the mother is infected, or drinking the breast milk of an infected woman.

We also learned how to teach the lesson to our pupils using three charts and a concept map.

Lesson 2

Lesson Objectives

After completing this lesson, you will be able to:

- give a brief narrative of the history of HIV/AIDS;
- describe the global picture of the prevalence of the disease; and
- share your knowledge on the topic with your pupils, friends and relations.

Basic Content

AIDS was first identified in 1981 among homosexual men and intravenous drug users in the United States in New York and California. Shortly after its detection in the United States, evidence of AIDS epidemics grew among heterosexual men, women, and children in sub-Saharan Africa. AIDS quickly developed into a worldwide epidemic, affecting virtually every nation. By 2003 over 40 million adults and 4 million children worldwide were living with HIV infection or AIDS. The World Health Organization (WHO), a specialised agency of the United Nations (UN), estimates that from 1981 to the end of 2002 about 20 million people died as a result of AIDS. About 4.5 million of those who died were children under the age of 15. In the short time since the first cases of the AIDS epidemic were reported in 1981, scientists have identified the viral cause of the illness, the basic modes of transmission, accurate tests for the presence of infection, and effective drugs that slow or halt the progression of the disease. During that same period, governments and grassroots organisations

around the world were spurred into action to meet the growing need for AIDS education, counselling, patients' rights, and clinical research. Despite these advances, critics observe that many governments were slow to respond to the crisis.

History of the Virus

There is a raging controversy about the origin of HIV. Using computer technology to study the structure of HIV, some scientists have claimed that HIV originated around 1930 in rural areas of Central Africa, where the virus may have been present for many years in isolated communities. According to this theory which is contested by African scientists, the virus probably did not spread because members of these rural communities had limited contact with people from other areas. But in the 1960s and 1970s, political upheaval, wars, drought, and famine forced many people from these rural areas to migrate to cities to find jobs. During this time, the incidence of sexually transmitted infections, including HIV infection, accelerated and quickly spread throughout Africa. As world travel became more prevalent, HIV infection developed into a worldwide epidemic. Studies of stored blood from the United States suggest that HIV infection was well established there by 1978. Many scientists from Africa have argued that HIV originated from North America.

Beginning in June 1981 reports were published on clusters of gay men (homosexuals) in New York and California who had been diagnosed with pneumocystic pneumonia or Kaposi's sarcoma. These two rare illnesses had previously been observed only in people whose immune systems had been damaged by drugs or disease. These reports triggered concern that a disease of the immune systems was spreading quickly in the homosexual community. Initially called gay-related immunodeficiency disease (GRID), the new illness soon was identified in population groups outside the gay community, including users of intravenous drugs, recipients of blood transfusions, and heterosexual partners of infected people. In 1982 the name for the new illness was changed to acquired immunodeficiency syndrome, or AIDS.

While the disease was making headlines for the speed with which it was spreading around the world, the cause of AIDS remained

unidentified. Fear of AIDS and ignorance of its causes resulted in some outlandish theories. Some thought the disease was God's punishment for behaviours that they considered immoral. These early theories created a social stigma surrounding the disease that still lingers.

Scientists quickly identified the primary modes of transmission—sexual contact with an infected person, contact with infected blood products, and mother-to-child transmission. From these modes of transmission it was clear that the new illness was spread in a specific manner that matched the profile of a viral infection. In 1983 French cancer specialist Luc Montagnier and his colleagues isolated what appeared to be a new human retrovirus from AIDS patients. They named it lymphadenopathy virus (LAV). Eight months later Gallo and his colleagues isolated the same virus in AIDS patients, naming the virus HTLV-III. Eventually, scientists agreed to call the infectious agent human immunodeficiency virus (HIV). In 1985 a new AIDS-causing virus was discovered in West Africa. Named HIV-2, the new virus is closely related to the first HIV, but it appears to be less harmful to cells of the immune systems and reproduces more slowly than HIV-1.

Research leading to the development of the ELISA test was conducted simultaneously by teams led by Gallo in the United States and Montagnier in France. In 1985 the ELISA test to identify HIV in blood became available, followed by the development of the Western Blot test. These tests were first employed to screen blood for the presence of HIV before the blood was used in medical procedures. The tests were later used to identify HIV-infected people, many of whom did not know they were infected. These diagnostic tests also helped scientists study the course of HIV infection in populations.

In 1970, American molecular biologist David Baltimore and American virologist Howard Temin independently discovered the enzyme called reverse transcriptase, which could be used to identify retroviruses. Over the next ten years, many retroviruses were identified in animals. But not until 1980, shortly before the first AIDS cases were recognized in the United States, did American virologist Robert Gallo identify the first human retroviruses, HTLV-I and HTLV-II (HTLV stands for human T cell lymphotropic virus).

Other studies demonstrated that these human retroviruses were more closely related to a retrovirus found in African chimpanzees than to each other. This discovery suggests that the human retroviruses may have evolved from retroviruses that originally infected chimpanzees. The chimpanzee retrovirus likely infected people and underwent

mutations to form the human retrovirus. In 1999 some scientists found that HIV spread from chimpanzees to humans on at least three separate occasions in Central Africa, probably beginning in the 1940s or 1950s.

Diagnosing Illness as AIDS

Physicians diagnose AIDS if a person has an illness known to be caused by immune deficiency, as long as there is no known cause for this immune deficiency (people who undergo radiation therapy or who take certain drugs may impair their immune systems). As more information became known about the course of HIV infection and the nature of the virus itself, this definition of AIDS was revised repeatedly to expand the list of illnesses considered diagnostic indicators of the disease. Early definitions were based on the opportunistic infections commonly found in HIV-infected men. As a result, many women who did not have symptoms covered in the official AIDS definition were denied disability benefits and AIDS-related drug therapies.

The current definition of AIDS was created in 1993 and includes 26 opportunistic infections and cancers, known as diagnostic indicators, that affect both men and women. The definition also emphasizes the importance of the level of CD4 cells in the blood. Today doctors make the diagnosis of AIDS in anyone with a CD4 count below 200 cells per microlitre of blood, regardless of the associated illnesses they may have.

Prevalence of HIV/AIDS: The Global Picture

The global HIV/AIDS epidemic killed more than 3 million people in 2003, and an estimated 5 million acquired the human immunodeficiency virus (HIV)—bringing to 40 million the number of people living with the virus around the world.

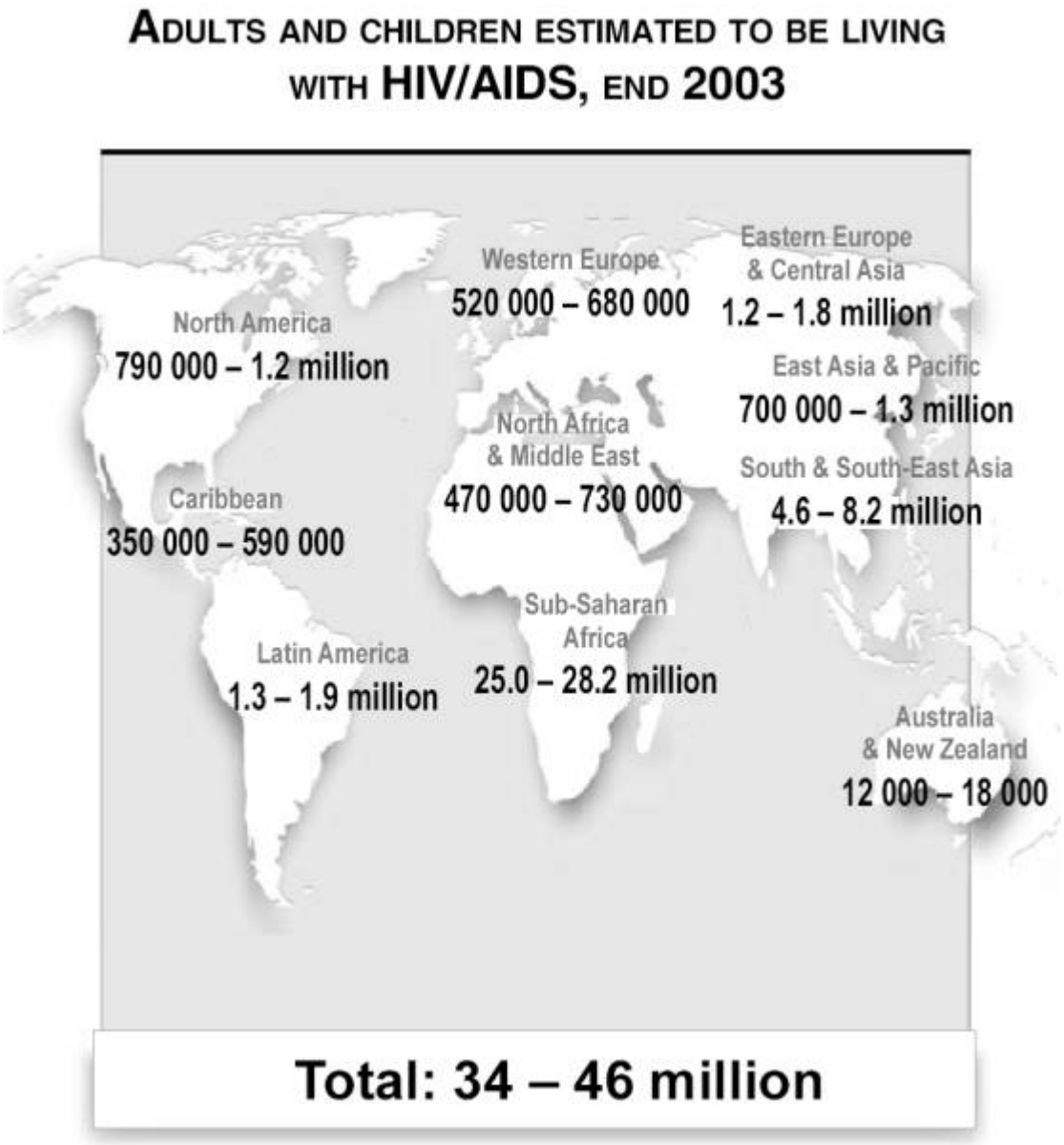
REGIONAL HIV/AIDS STATISTICS AND FEATURES, END OF 2003

Region	Adults and children living with HIV/AIDS	Adults and children newly infected with HIV	Adult prevalence (%)*	Adult & child deaths due to AIDS
Sub-Saharan Africa	25.0 – 28.2 million	3.0 – 3.4 million	7.5 – 8.5	2.2 – 2.4 million
North Africa & Middle East	470 000 – 730 000	43 000 – 67 000	0.2 – 0.4	35 000 – 50 000
South & South-East Asia	4.6 – 8.2 million	610 000 – 1.1 million	0.4 – 0.8	330 000 – 590 000
East Asia & Pacific	700 000 – 1.3 million	150 000 – 270 000	0.1 – 0.1	32 000 – 58 000
Latin America	1.3 – 1.9 million	120 000 – 180 000	0.5 – 0.7	49 000 – 70 000
Caribbean	350 000 – 590 000	45 000 – 80 000	1.9 – 3.1	30 000 – 50 000
Eastern Europe & Central Asia	1.2 – 1.8 million	180 000 – 280 000	0.5 – 0.9	23 000 – 37 000
Western Europe	520 000 – 680 000	30 000 – 40 000	0.3 – 0.3	2 600 – 3 400
North America	790 000 – 1.2 million	36 000 – 54 000	0.5 – 0.7	12 000 – 18 000
Australia & New Zealand	12 000 – 18 000	700 – 1 000	0.1 – 0.1	<100
TOTAL	**40 million (34 – 46 million)**	**5 million (4.2 – 5.8 million)**	**1.1% (0.9 – 1.3%)**	**3 million (2.5 – 3.5 million)**

* The proportion of adults (15 to 49 years of age) living with HIV/AIDS in 2003, using 2003 population numbers.

The ranges around the estimates in this table define the boundaries within which the actual numbers lie, based on the best available information. These ranges are more precise than those of previous years, and work is under way to increase even further the precision of the estimates that will be published mid-2004.

Source: UNAIDS, 2003



How Do I Teach Students?

Resources: Guest teacher and map of the world showing regional HIV/AIDS statistics.

Procedure: Invite a teacher in your school or from another school to lead discussions on the history of HIV/AIDS. Share the contents of this lesson with the guest teacher to enable him/her prepare for the lesson. Invite 3-4 students who will serve as group leaders for a briefing on the topic. After the presentation by the guest teacher, the class will break into groups (3 to 4) for follow-up round-table group

discussions. The group leaders will summarise the main points made by each group. With the aid of the map of the world, lead pupils to discuss the distribution of HIV/AIDS afflicted persons by region. Call on a random selection of pupils to describe, using the map of the world displayed in front of the class, sub-regional and national distribution of adults and children estimated to be living with HIV and AIDS in Africa.

In this lesson, we learned that:

- AIDS was first identified in 1981 among homosexual men and intravenous drug users in the United States in New York and California.
- AIDS quickly developed into a worldwide epidemic, affecting virtually every nation. By 2003 over 40 million adults and 4 million children worldwide were living with HIV infection or AIDS.
- Some scientists have claimed that HIV originated around 1930 in rural areas of Central Africa, where the virus may have been present for many years in isolated communities.
- Studies of stored blood from the United States suggest that HIV infection was well established there by 1978. Many scientists from Africa have argued that HIV originated from North America.
- In 1985 a new AIDS-causing virus was discovered in West Africa. Named HIV-2, the new virus is closely related to the first HIV, but it appears to be less harmful to cells of the immune systems and reproduces more slowly than HIV-1.
- In 1999 some scientists found that HIV spread from chimpanzees to humans on at least three separate occasions in Central Africa, probably beginning in the 1940s or 1950s.
- The global HIV/AIDS epidemic killed more than 3 million people in 2003, and an estimated 5 million acquired the human immunodeficiency virus (HIV)—bringing to 40 million the number of people living with the virus around the world.

Lesson 3

Lesson Objectives

After completing this lesson, you will be able to:

- describe the basic structure of the immune system of the human body;
- outline the activities of the immune system
- define immune deficiency; and
- identify the role of HIV in human immune deficiency;

Basic Content

Every minute of every day wars rage within our bodies. The combatants are too tiny to see. Some, like the infamous virus that causes AIDS, or acquired immune deficiency syndrome, are so small that 200 million would fit on the tip of a needle. Yet they employ tactics that can kill much larger cells they swarm upon.

Usually we never even notice the battles in the incessant wars within us. We have evolved legions of defenders, specialised cells that silently rout the unseen enemy. Sometimes these warriors mistake harmless invaders, such as pollen, for deadly foes, and they mount an allergic reaction. Sometimes our defenders are caught unprepared, and we

develop a cold, the flu, or worse. Occasionally some of our own cells begin the mutinous proliferation of cancer and manage to evade the surveillance of our body's defence forces. But for every successful penetration of our defences, thousands of attempts are repelled. We sleep securely, trusting the invisible vigilantes of our immune system.

The **immune system** of the human body is made up of group of cells, molecules, and organs that act together to defend the body against foreign invaders that may cause disease. The health of the body is dependent on the immune system's ability to recognise and then repel or destroy these invaders.

In humans the immune system consists of about a trillion (10^{12}) cells called lymphocytes and about 100 million trillion (10^{20}) molecules called antibodies that are produced and secreted by the lymphocytes. The special capability of the immune system is pattern recognition and its assignment is to patrol the body and guard its identity.

White blood cells are the mainstay of the immune system. Some white blood cells, known as *macrophages,* play a function in innate immunity by surrounding, ingesting, and destroying invading bacteria and other foreign organisms. *Lymphocytes* are specialised white blood cells whose function is to identify and destroy invading antigens. All lymphocytes begin as "stem cells" in the *bone marrow,* the soft tissue that fills most bone cavities, but they mature in two different places. Some lymphocytes mature in the bone marrow and are called B lymphocytes. *B lymphocytes,* or *B cells,* make *antibodies,* which circulate through the blood and other body fluids, binding to antigens and helping to destroy them. Other lymphocytes, called *T lymphocytes,* or *T cells,* mature in the thymus, a small glandular organ located behind the breastbone. Mature lymphocytes constantly travel through the blood to the lymphoid organs and then back to the blood again. This recirculation ensures that the body is continuously monitored for invading substances.

Immune Deficiency

Deficiencies in immune function may be either inherited or acquired. ***Inherited immune deficiencies*** usually reflect the failure of a gene important to the generation or function of immune system components. DiGeorge syndrome is an inherited immune disorder in

which a person has no thymus and, therefore, cannot produce mature T lymphocytes. People with this disorder can mount only limited humoral immune responses, and their cell-mediated immune responses are severely limited. The most extreme example of a hereditary immune deficiency is severe combined immunodeficiency (SCID). Individuals with this disease completely lack both T and B lymphocytes and thus have no adaptive immune responses. People with SCID must live in a completely sterile environment, or else they will quickly die from infections.

Acquired immune deficiencies can be caused by infections and also other agents. For example, radiation therapy and some kinds of drugs used in treating disease reduce lymphocyte production, resulting in damaged immune function. People undergoing such therapies must be carefully monitored for lowered immune function and susceptibility to infections. Environmental and lifestyle factors, such as poor nutrition or stress, can also affect the immune system's general status.

An infectious agent resulting in fatal immune deficiency is the human immunodeficiency virus (HIV). This virus causes acquired immunodeficiency syndrome (AIDS) by infecting and eventually destroying helper T cells. Because helper T cells regulate all immune responses, their loss results in an inability to make adaptive immune responses. This complete lack of immune function makes individuals with AIDS highly susceptible to all infectious agents.

Activity of the Immune System

Of the one hundred trillion cells that make up a human body, one in every hundred is there to defend us. They are the white blood cells that are born in the bone marrow. When they emerge, they form three distinct regiments of warriors—the ***phagocytes*** and two kinds of lymphocytes, the ***T cells*** and ***B cells***. Each has its own strategies of defence. The first defenders to arrive would be the phagocytes—the scavengers of the system. Phagocytes constantly scour the territories of our bodies, alert to anything that seems out of place. What they find, they engulf and consume.

Phagocytes are not choosy. They will eat anything suspicious that they find in the bloodstream, tissues, or lymphatic system. In the lungs, for instance, they consume particles of dust and other pollutants that

enter with each breath. They can cleanse lungs that have been blackened with the contaminants of cigarette smoke, provided the smoking stops. Too much cigarette smoking, over too long a time, destroys phagocytes faster than they can be replenished. Environmental pollutants like silica and asbestos also overwhelm them.

We can watch phagocytes at work when our skin is injured. The skin is our first defence line—until a cut allows bacteria and other micro-organisms to invade. Immediately cells near the wound release substances that stimulate nearby blood vessels to dilate, causing swelling and reddening around the cut. Phagocytes flow in through the distended blood vessels, devouring the invaders. In time the body weaves threads of fibrin across the wound to restore the skin's barrier.

There is a special kind of phagocyte called a macrophage. As the macrophage engulfs a stray virus, it plucks a special piece, an antigen, from the invader. It displays that small piece on its own cell surface like a captured banner of war. That flag plays a critical role in the immune system's response: It alerts a highly specialised class of lymphocytes, the T cells. All our lives a small contingent of those lymphocytes has circulated through our bodies, waiting for this particular virus. They recognise it, as the virus identified its victim among the cells, by shape. The antigens on the surface of the virus fit exactly into these T cells' receptors.

How did that particular group of T cells know the shape of the antigen? Their training takes place in the thymus, a mysterious pale grey gland that sits behind the breastbone, above the heart. (The “T” in T cell stands for thymus-derived.) This unsung little gland swells in size from birth to puberty and then begins to shrink. Somehow, as the T cells mature in the thymus, one learns to recognise the antigens of, say, the hepatitis virus, another to identify a strain of flu antigens, a third to detect rhinovirus 14, and so on.

Most T cells die in the thymus, We do not know why. A guess is that the thymus is selecting only the best T cells, those with the sharpest powers of recognition. And what a staggering task the thymus confronts. Nature can create antigens in hundreds of millions of different shapes. The thymus must turn out a group of T cells that recognises each one. Remarkably, we have T cells trained to recognise even artificial antigens created in the lab—antigens the body has never encountered in its millions of years of evolution.

The thymus pumps out T cells by the tens of millions. Even though only a few of them may recognize any one antigen, the collective scouting force is vast enough to identify the almost infinite variety of antigens nature produces.

So diligent are our T cells that even desirable cells transplanted from one person to another are quickly recognised as foreign and destroyed. The process, called rejection, can defeat a lifesaving heart or kidney transplant unless surgeons use drugs to keep the immune system at bay.

The T cells that first detect antigens, known as ***helper T's***, carry no weapons. Rather they send urgent chemical signals to a small squadron of allies in the body—the ***killer T cells***. The message: Multiply fast!

Like all T cells, killer T's are trained to recognise one specific enemy. When alerted by the helper T's, the squadron reproduces into an army. The killer T's are lethal. They can trigger a chemical process that punctures the cell membranes of bacteria or destroys infected cells before viruses inside have time to multiply.

Besides summoning the killer T's, helper T cells call more phagocytes into the battle. They also rush toward the spleen and the lymph nodes. There they will alert the last major regiment of the immune system, the B cells.

B cells migrate after their birth in the bone marrow, with many of them concentrating in our lymph nodes. These small bean-shaped capsules are scattered along the intricate branching of the lymph system. We are aware of them only during certain infections, when they become swollen and sometimes painful to the touch. Our lymph nodes are small munitions factories, staffed by the B cells. Their product: the chemical weapons called antibodies.

By sticking to the surface of unwelcome cells, antibody molecules slow them down, making them easier targets—as well as more attractive ones—for phagocytes. Antibodies can also kill. Locking on to the enemy's antigens, which they precisely mirror in shape, the antibodies collect substances in the bloodstream called complement. When this complement comes together in the right sequence, it detonates like a bomb, blasting through the invader's cell membrane. At the peak of operation, each B cell can churn out thousands of antibodies a second. As the immune defences gather, the tide of battle turns. Normally

within a week or so the invader is in retreat. Then the third member of the T-cell family takes over—the ***suppressor T***, the peacemaker.

Suppressor T's release substances that turn off B cells. They order killer cells to stop the fight. Suppressor T's even command helper T's to cease and desist. The battle is won. In the aftermath phagocytes range over the area, cleaning up the litter of dead cells and spent substances. Tissue damage is repaired. The threat is over—but not forgotten. Most of the T and B cells recruited for battle die off within days of an infection.

There is one simple reason why the AIDS virus is so deadly. It kills the one lymphocyte most critical to the immune response: the helper T cell. Like Greeks hidden inside the Trojan horse, the AIDS virus enters the body concealed inside a helper T cell from an infected host. Almost always it arrives as a passenger in blood or semen. In the invaded victim, helper T's immediately detect the foreign T cell. But as the two T's meet, the virus slips through the cell membrane into the defending cell. Before the defending T cell can mobilise the troops, the virus disables it.

Some researchers believe the AIDS virus also may change the surface of helper T cells in such a way that they fuse together. That strategy makes it even easier for the virus to pass from cell to cell undetected.

Once inside an inactive T cell, the virus may lie dormant for months, even years. Then, perhaps when another, unrelated infection triggers the invaded T cells to divide, the AIDS virus also begins to multiply. One by one, its clones emerge to infect nearby T cells. Slowly but inexorably the body loses the very sentinels that should be alerting the rest of the immune system. Phagocytes and killer cells receive no call to arms. B cells are not alerted to produce antibodies. The enemy can run free!

By the late 1960s, it had become clear that stem cells give rise to two broad lineages of lymphocytes (as well as the other blood cells). One consists of the *B* cells, which originate in the bone marrow and produce antibodies that bind to foreign proteins and mark them for attack by other cells. They act against extra-cellular pathogens such as bacteria. The other, the *T* cells, arises in the thymus. *T* cells handle such intracellular pathogens as viruses in addition to such intracellular parasites as tuberculosis. *T* cells also secrete molecules known as lymphokines, which direct the activity of *B* cells, other *T* cells and other parts of the immune system.

Once formed, cells of both types migrate to the spleen, lymph nodes and intestinal lymphoid tissues. There they can encounter antigen, the molecular signature of microbial or viral invaders, and be called into action. Lymphocytes continuously circulate through the body's vascular and lymphatic systems, stopping periodically in the lymphoid organs as they patrol for foreign antigens.

Use the drama method to teach this lesson. Pupils should be assigned roles as invading germs and white blood cells. Let pupils act their roles based on a script developed from the basic content of this lesson.

In this lesson, we learned that

- The **immune system** of the human body is made up of group of cells, molecules, and organs that act together to defend the body against foreign invaders that may cause disease.
- The system consists of about a trillion (10^{12}) cells called lymphocytes and about 100 million trillion (10^{20}) molecules called antibodies that are produced and secreted by the lymphocytes.
- White blood cells also called lymphocytes are the mainstay of the immune system.
- Some lymphocytes mature in the bone marrow and are called B lymphocytes. Other lymphocytes, called *T lymphocytes,* or *T cells,* mature in the thymus, a small glandular organ located behind the breastbone.
- Deficiencies in immune function may be either inherited or acquired. ***Inherited immune deficiencies*** usually reflect the failure of a gene important to the generation or function of immune system components. ***Acquired immune deficiencies*** can be caused by infections and also other agents.
- An infectious agent resulting in fatal immune deficiency is the human immunodeficiency virus (HIV). This virus causes acquired immunodeficiency syndrome (AIDS) by infecting and eventually destroying helper T cells. Because helper T cells regulate all immune responses, their loss results in an inability to make adaptive immune responses. This complete lack of immune function makes individuals with AIDS highly susceptible to all infectious agents.
- Once inside an inactive T cell, the virus may lie dormant for months, even years. Then, perhaps when another, unrelated infection triggers the invaded T cells to divide, the AIDS virus

also begins to multiply. One by one, its clones emerge to infect nearby T cells. Slowly but inexorably the body loses the very sentinels that should be alerting the rest of the immune system. Phagocytes and killer cells receive no call to arms. B cells are not alerted to produce antibodies. The enemy can run free!

Lesson 4

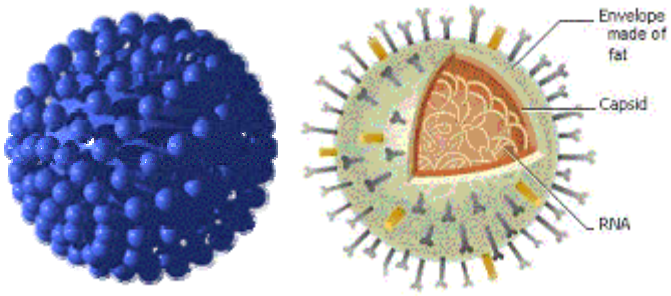
Lesson Objectives

After completing this lesson, you will be able to:

- describe the life cycle of HIV;
- identify stages in the life cycle targeted by antiretroviral drugs; and
- teach pupils the simplified form of the life cycle of HIV.

Basic Content

In this lesson, we shall describe the life cycle of HIV as a series of steps. Six steps are commonly seen. These are binding; reverse transcription, integration, transcription, translation, and viral assembly. Before we begin, let us review what we learned in lesson 1 about the structure of HIV. In that lesson, we learned that viruses consist of two major parts- an outer protective coat called a **capsid** which is made of protein; and an inside which consists of genetic material. The genetic material is either of two substances with rather long names. These names have been abbreviated as **DNA** and **RNA**. DNA stands for **d**eoxyribo**n**ucleic **a**cid while RNA stands for **r**ibo**n**ucleic **a**cid. It is also worth noting that the capsid may or may not have an outer envelope made of fat.

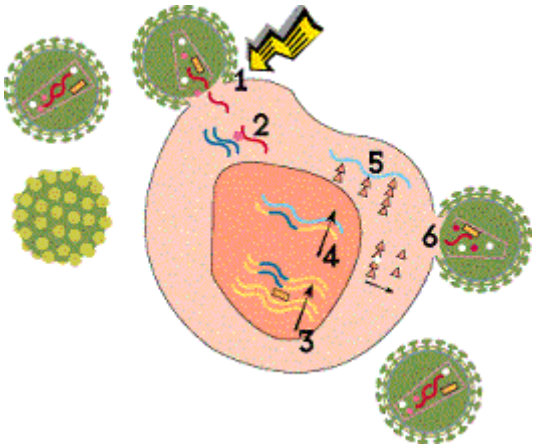


Representation of HIV Structure of the virus

In lesson 3, we also learned that the body's immune system is made up of white blood cells (otherwise known as lymphocytes). One type of lymphocyte is called T-lymphocytes or T-cells with surface receptors known as CD4+. Let us now examine the stages in the life cycle of HIV. As stated earlier, six stages will be described.

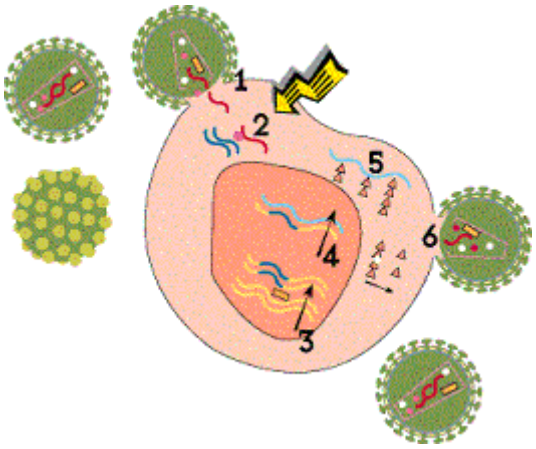
Step 1: Binding

HIV binds to a CD4+ surface receptor, it activates other proteins on the cell's surface, allowing the HIV envelope to fuse to the outside of the cell.



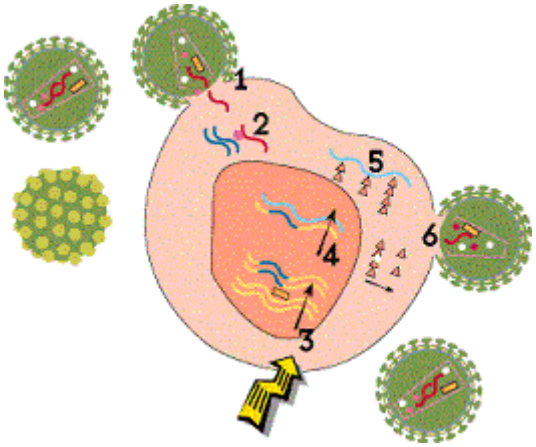
Step 2: Reverse Transcription

The virus infects the cell- a process called "reverse transcription" takes place. At the end of the process the cell makes a DNA copy of the virus's RNA. After the binding process, the inside of the virus which contains the RNA and important enzymes is released into the host cell. A viral enzyme called reverse transcriptase makes a DNA copy of the RNA. This new DNA is called "proviral DNA."



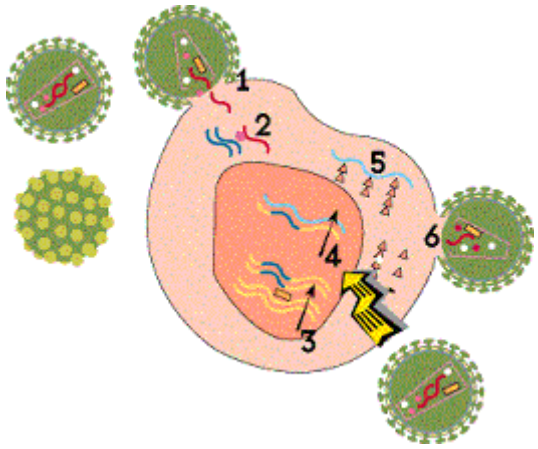
Step 3: Integration

The HIV DNA is then carried to the cell's nucleus, where the cell's DNA is kept. Then, another viral enzyme called integrase hides the proviral DNA into the cell's DNA. When the cell tries to make new proteins, it can accidentally make new HIVs. Integration can be blocked by integrase inhibitors, a new class of drugs that are in the earliest stage of research.



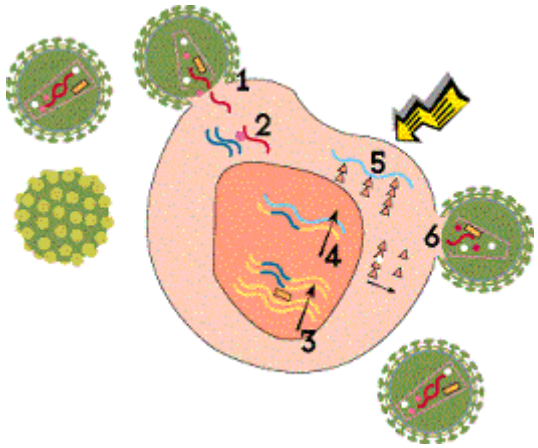
Step 4: Transcription

Once HIV's genetic material is inside the cell's nucleus, it directs the cell to produce new HIV. The strands of viral DNA in the nucleus separate, and special enzymes create a complementary strand of genetic material called messenger RNA or mRNA (instructions for making new HIV). Transcription can be blocked by antisense antivirals or transcription inhibitors (TIs), new classes of drugs that are in the earliest stage of research.



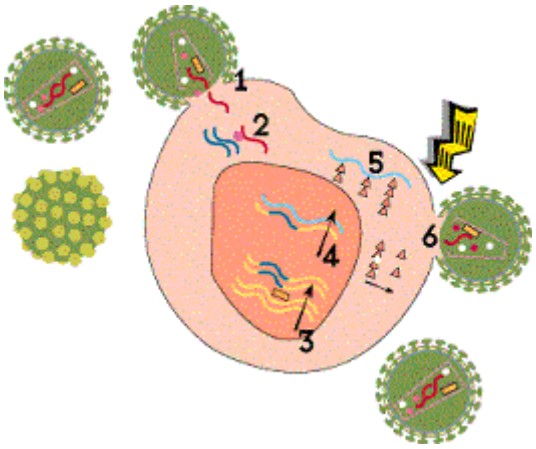
Step 5: Translation

The mRNA carries instructions for making new viral proteins from the nucleus to a kind of workshop in the cell. Each section of the mRNA corresponds to a protein building block for making a part of HIV. As each mRNA strand is processed, a corresponding string of proteins is made. This process continues until the mRNA strand has been transformed or "translated" into new viral proteins needed to make a new virus.



Step 6: Viral Assembly

Finally, a new virus is assembled. Long strings of proteins are cut up by a viral enzyme called protease into smaller proteins. These proteins serve a variety of functions; some become structural elements of new HIV, while others become enzymes, such as reverse transcriptase. Once the new viral particles are assembled, they bud off the host cell, and create a new virus. This virus is then able to infect new cells. Each infected cell can produce a lot of new viruses.



How Do I Teach Students?

Resources: Chart showing six stages in the life cycle of HIV.

Procedure: Using the chart showing the life cycle of HIV, lead a class discussion to describe the different stages in the life cycle of HIV. As the lesson progresses, call on pupils to describe what they see in the chart, stage by stage. Explain at each stage what role(s) antiviral drugs play in slowing down the process. Pupils to stage a drama to illustrate the stages.

In Summary

In this lesson, we learned about six stages in the life cycle of HIV as follows:

Step 1: Binding
HIV binds to a CD4+ surface receptor, it activates other proteins on the cell's surface, allowing the HIV envelope to fuse to the outside of the cell.

Step 2: Reverse Transcription
The infected cell makes a DNA copy of the virus's RNA.

Step 3: Integration
A viral enzyme called integrase hides the proviral DNA into the cell's DNA. Then, when the cell tries to make new proteins, it accidentally make new HIVs.

Step 4: Transcription
Once HIV's genetic material is inside the cell's nucleus, it directs the cell to produce new HIV.
The strands of viral DNA in the nucleus separate, and special enzymes create a complementary strand of genetic material called messenger RNA or mRNA (instructions for making new HIV).

Step 5: Translation
The mRNA carries instructions for making new viral proteins from the nucleus to a kind of workshop in the cell. As each mRNA strand is processed, a corresponding string of proteins is made. This process continues until the mRNA strand has been transformed or "translated" into new viral proteins needed to make a new virus.

Step 6: Viral Assembly
Finally, a new virus is assembled. Once the new viral particles are assembled, they bud off the host cell, and create a new virus. This virus is then able to infect new cells. Each infected cell can produce a lot of new viruses.

Lesson 5

Lesson Objectives

At the end of this lesson, you should be able to

- identify three ways by which HIV is transmitted;
- dispel misconceptions about HIV transmission; and
- learn how to teach your students the topic *"How HIV is Transmitted"*

Basic Content

HIV is passed on in the sexual fluids or blood of an infected person. This usually happens by either having sexual intercourse with an infected person or by sharing needles or sharp objects that had come in contact with the blood of an infected person. People can also become infected by being born to a mother who has HIV. A very small number of people become infected by having medical treatment using infected blood transfusions.

Sex with an infected person

HIV transmission occurs most commonly during intimate sexual contact with an infected person, including genital, anal, and oral sex. The virus is present in the infected person's semen or vaginal fluids. During sexual intercourse, the virus gains access to the bloodstream of

the uninfected person by passing through openings in the mucous membrane—the protective tissue layer that lines the mouth, vagina, and rectum—and through breaks in the skin of the penis. In some parts of the world especially the United States and Canada, HIV is most commonly transmitted during sex between homosexual men, but the incidence of HIV transmission between heterosexual men and women has rapidly increased. In most other parts of the world, HIV is most commonly transmitted through heterosexual sex.

Contact with infected blood

Someone can get infected with HIV when transfused with infected blood. Also, infected blood occurs when people who use heroin or other injected drugs, share hypodermic needles or syringes contaminated with infected blood. Sharing of contaminated needles among intravenous drug users is the primary cause of HIV infection in many countries. Less frequently, HIV infection results when health professionals accidentally stick themselves with needles or other sharp objects containing HIV-infected blood or expose an open cut to contaminated blood. To combat this, government regulations have required that all donated blood and body tissues be screened for the presence of HIV before being used in medical procedures. As a result of these regulations, HIV transmission caused by contaminated blood transfusion or organ donations have reduced. However, the problem continues to concern health officials in sub-Saharan Africa. Less than half of the 46 nations in this region have blood-screening policies. By some estimates only 25 percent of blood transfusions are screened for the presence of HIV. The World Health Organisation (WHO) had hoped to establish blood safety programmes in more than 80 percent of sub-Saharan countries by 2003.

Parent-to-Child Transmission

HIV can be transmitted from an infected mother to her baby while the baby is still in the woman's uterus or, more commonly, during childbirth. The virus can also be transmitted through the mother's breast milk during breastfeeding. Mother-to-child transmission accounts for 90 percent of all cases of AIDS in children. Mother-to-child transmission is particularly prevalent in Africa, where the number of women infected with HIV is ten times the rate found in other

regions. Studies conducted in several cities in southern Africa in 1998 indicate that up to 45 percent of pregnant women in these cities carry HIV.

Misconceptions about HIV Transmission

The routes of HIV transmission are well documented by scientists, but health officials continually grapple with the public's unfounded fears concerning the potential for HIV transmission by other means. HIV differs from other infectious viruses in that it dies quickly if exposed to the environment. No evidence has linked HIV transmission to casual contact with an infected person, such as a handshake, hugging, or kissing, or even sharing dishes or bathroom facilities. Studies have been unable to identify HIV transmission from modes common to other infectious diseases, such as an insect bite or inhaling virus-infected droplets from an infected person's sneeze or cough.

Resources: Four posters: Poster A showing HIV transmission through sexual contact with an infected person; Poster B showing HIV transmission through contact with infected blood; Poster C showing mother-to-child HIV transmission; and Poster D showing that HIV cannot be transmitted through hand shake, hugging or sharing dishes and bathrooms facilities.

Procedure: Using charts A, B, and C, lead pupils in interactive discussions on the three major ways of contracting HIV; viz: having sexual intercourse with an infected person; by sharing needles or sharp objects that had come in contact with the blood of an infected person; and being born to a mother who has HIV. Using chart C, dispel misconceptions about HIV transmission. Each pupil to draw a concept map of what he/she learned. Ask pupils to share what they learned in class with family and friends.

In Summary

In this lesson, we learned that HIV

- is transmitted by having sexual intercourse with an infected person; by sharing needles or sharp objects that had come in contact with the blood of an infected person; and being born to a mother who has HIV.

- is NOT transmitted through casual contact with an infected person, such as a handshake, hugging, or kissing, or even sharing dishes or bathroom facilities. Studies have been unable to identify HIV transmission from modes common to other infectious diseases, such as an insect bite or inhaling virus-infected droplets from an infected person's sneeze or cough.

Lesson 6

Lesson Objectives

After completing this lesson, you will be able to:

- describe the symptoms of infection with HIV in adults and children;
- suggest some therapies for HIV infection; and
- share with your pupils the characteristics of persons infected with HIV.

Basic Content

Symptoms in Adults

In the period immediately after infection with HIV, no specific symptoms are noticeable. However, within one to three weeks after infection, most people experience the following:

- flu-like symptoms, such as fever, sore throat, headache;
- skin rash;
- tender lymph nodes; and
- a vague feeling of discomfort.

These symptoms usually go away after a week or two. Often, if they occur at all, they are so mild they are hardly noticeable, although for some people they are severe enough to warrant calling a doctor. *It is important to keep in mind that these symptoms are almost identical to those of many other illnesses.* **That is why testing is so important.**

Very often people who have the symptoms are worrying unnecessarily. Only by taking the HIV test can someone reliably know their HIV status. Everything else is just guessing and HIV is too important an issue to merely guess about.

The symptoms last one to four weeks. During this phase, known as ***acute retroviral syndrome,*** HIV reproduces rapidly in the blood. The virus circulates in the blood throughout the body, particularly concentrating in organs of the lymphatic system. The normal immune defenses against viral infections eventually activate to battle HIV in the body, reducing but not eliminating HIV in the blood. Infected individuals typically enter a prolonged asymptomatic phase, a symptom-free period that can last ten years or more. While persons who have HIV may remain in good health during this period, HIV continues to replicate, progressively destroying the immune system. Often an infected person remains unaware that he or she carries HIV and unknowingly transmits the virus to others during this phase of the infection.

When HIV infection reduces the number of CD4 cells to around 200 per microlitre of blood, the infected individual enters an ***early symptomatic phase*** that may last a few months to several years. HIV-infected persons in this stage may experience a variety of symptoms that are not life-threatening but may be debilitating. These symptoms include:

- extensive weight loss and fatigue (wasting syndrome);
- periodic fever;
- recurring diarrhea;
- and thrush, a fungal mouth infection.

An early symptom of HIV infection in women is a recurring vaginal yeast infection. Unlike earlier stages of the disease, in this early symptomatic phase the symptoms that develop are severe enough to cause people to seek medical treatment. Many may first learn of their infection in this phase.

If CD4 cell levels drop below 200 cells per microlitre of blood, the ***late symptomatic phase*** develops. This phase is characterised by the appearance of any of 26 opportunistic infections and rare cancers. The onset of these illnesses, sometimes referred to as ***AIDS-defining complications***, is one sign that an HIV-infected person has developed full-blown AIDS. Without medical treatment, this stage may last from

several months to years. The cumulative effects of these illnesses usually cause death.

Symptoms in Children

HIV infection in children progresses more rapidly than in adults, most likely because the immune system in children have not yet built up immunity to many infectious agents. The disease is particularly aggressive in infants—more than half of infants born with an HIV infection die before age two. Once a child is infected, the child's undeveloped immune system cannot prevent the virus from multiplying quickly in the blood. This extensive virus burden speeds the progression of the disease. In contrast, when adults become infected with HIV, their immune system generally fights the infection. Therefore, HIV levels in adults remain lower for an extended period, delaying the progression of the disease.

Children develop many of the opportunistic infections that befall adults but also exhibit symptoms not observed in older patients. Among infants and children, HIV infection produces wasting syndrome and slows growth (generally referred to as failure to thrive). HIV typically infects a child's brain early in the course of the disease, impairing intellectual development and coordination skills. While HIV can infect the brains of adults, it usually does so toward the later stages of the disease and produces different symptoms.

Children show a susceptibility to more bacterial and viral infections than adults. More than 20 percent of HIV-infected children develop serious, recurring bacterial infections, including meningitis and pneumonia. Some children suffer from repeated bouts of viral infections, such as chicken pox. Healthy children generally develop immunity to these viral illnesses after an initial infection.

Wasting Syndrome and Weight Loss

Weight loss and wasting syndrome are two AIDS-related complications that, if not adequately treated, can be life threatening. Even though anti-HIV therapies have helped reduce the risk of weight loss and wasting syndrome, both problems still occur. Is there a difference between weight loss and wasting? Yes. As its name implies, weight loss refers to a loss of body weight. Wasting syndrome refers to a loss of body mass or size, most notably muscle mass (sometimes referred to as "lean body mass"). Very often, both occur at the same time. However, this is not always the case. It is possible that someone who is losing weight might not lose muscle mass. It is also possible that someone losing muscle mass might not lose a lot of weight. For

example, some HIV-positive people lose a lot of muscle. Yet they may experience an increase in fat. This can cause weight to stay the same, even though muscle wasting is going on. In people who do not have HIV, weight loss is not usually a serious problem. For example, someone who goes on a diet will eventually lose weight. To make up for the lack of food being eaten, the body will naturally burn fat – either in the blood or stored in cells – to help meet its energy needs. At the same time, the body works to protect protein during periods of dieting or physical activity. Protein is needed to build muscle, cells, and organs in the body. In other words, most people can afford to lose fat. They cannot afford to lose protein.

In people with HIV, especially during periods of illness (e.g., MAC or tuberculosis), the energy demands of the body increase. Turning fat into energy also requires a lot of work in the body. To help save energy, the body may go after protein to fuel its energy needs. This is because protein is much easier to convert into energy than fat. Also, protein is needed to help repair damaged organs and to replace immune system cells lost during periods of illness.

Figuring out the underlying cause of weight loss is very important. In some cases, the cause of weight loss or wasting is obvious, particularly when an opportunistic infection (OI) that is known to cause weight loss has been diagnosed. Other times, weight loss or wasting can be a symptom of an underlying OI that has not yet been diagnosed. Thus, weight loss that cannot be easily explained often requires that doctors examine their HIV-positive patients carefully, especially if they are losing weight.

There are a number of treatment strategies that have been proven effective in terms of weight gain and, in some cases, muscle growth and maintenance:

Diet Improvements: Diet improvement is crucial for virtually all HIV-infected individuals suffering from mild to severe forms of weight loss. Forms of dietary improvement include nutritional counselling and oral nutrition supplements. In terms of counselling, a registered dietitian can help identify weaknesses in an existing diet and make suggestions regarding dietary needs and how best to tailor them to meet individual tastes, schedules, and tolerances. Nutritional supplementation can also be extremely useful.

Treating Side Effects or General Symptoms of HIV: There are a number of treatments available to control symptoms, including drug side effects that make eating undesirable. Drugs to control nausea and vomiting (anti-emetics), diarrhea (anti-diarrheals), and decreased appetite (appetite stimulants) are widely available.

Treating the Opportunistic Infection (OI): Treating an active opportunistic infection, especially one that causes malabsorption, can halt and possibly reverse weight loss. Unfortunately, there are no effective treatments for intestinal diseases such as cryptosporidiosis and microsporidiosis, however a number of recent reports have suggested that anti-HIV may be extremely helpful in terms of boosting the immune response against these chronic infections and ultimately increasing weight. But, like appetite stimulants, treatments for OIs associated with weight gain usually contribute to fat accumulation, not muscle.

Hormonal Therapy: Treating metabolic disorders associated with wasting has been a large focus of research over the past few years. In particular, results from clinical trials of anabolic therapies have suggested that certain agents can increase and protect muscle mass in HIV-positive people with wasting and weight loss.

Immune-Based and Anti-HIV Therapies: In terms of treating immune system disorders, promising results have been seen using the drug thalidomide (Synovir), a drug that was once banned because of its ability to cause birth defects in pregnant women taking the drug. Yet, the most promising therapy in terms of stabilizing the immune system has been taking the anti-HIV drug combinations currently recommended. By drastically reducing the amount of virus circulating in the body, anti-HIV therapy allows the immune system to recover from the damage of HIV. In fact, a large number of studies have demonstrated that people receiving anti-HIV therapy, especially those with wasting, gain a great deal of weight while on therapy.

Lesson 7

When we hear about the percentage of people in our country who are HIV positive, we may become anxious about our HIV status. Also, when we hear about the death from AIDS complications of a neighbour, relation or friend, we get worried as to whether or not we have HIV. In order to get our worries allayed, we need to do a test for HIV.

Lesson Objectives

After completing this lesson, you should be able to

- state reasons why a person should test for HIV;
- describe commonly used tests for HIV;
- interpret results of an HIV test; and
- share knowledge with your students about HIV testing.

Basic Content

Need for HIV testing

Getting tested for HIV is a smart thing to do. Yet many people refuse to get tested. They find the idea of getting tested so frightening they just do not want to do it, even though they will often continue to be stressed and worried about whether they are infected. Others think of

testing as unnecessary because they want to believe that they cannot be infected with HIV.

Many times when someone gets tested, they happily find out their concern about being infected was unfounded. Getting the assurance of that negative test result can provide an enormous relief. For others, getting tested and learning they are HIV positive is the first important step towards staying healthy.

Being unaware of HIV status also makes it more likely for a person to unknowingly pass the HIV virus to others. One of the most basic truths about HIV is that gender, age, race and economic status are irrelevant when it comes to vulnerability to HIV. Anyone can become infected.

Who Should Be Tested?

Testing is recommended for those who:

- have multiple sexual partners (2 or more sexual partners in the last 12 months)
- have received a blood transfusion recently in a place where blood is not screened before transfusion, or if a sexual partner received a transfusion and later tested positive for HIV.
- are uncertain about their sexual partner's risk behaviours.
- are homosexuals
- have used street drugs by injection especially when sharing needles and/or other equipment.
- have a sexually transmitted disease (STD), including pelvic inflammatory disease (PID).
- are health care workers with direct exposure to blood on the job.
- want to make sure they are not infected with HIV before getting pregnant.
- are infected with tuberculosis.

Even if you have no risk factors for HIV infection, you may still want to get tested to ease your own mind. This also encourages everyone to be more responsible about HIV transmission.

HIV Tests

Since HIV was first identified as the cause of AIDS in 1983, a variety of tests have been developed for diagnosing HIV infection as well as determine how far the infection has progressed. Doctors determine if HIV is present in the body by identifying HIV antibodies, specialised

proteins created by the immune system to destroy HIV. The presence of the antibodies indicates HIV infection because these antibodies form in the body only when HIV is present. HIV antibodies form anywhere from five weeks to three months after HIV infection occurs, depending upon the individual's immune system. The antibodies are produced continually throughout the course of the infection. There is a "window period" which is the time it takes the body to produce antibodies after HIV infection has begun. For the vast majority of those who will test positive, antibodies to HIV will develop within 4-6 weeks after exposure. Thus, to receive a reliable test result, it is necessary to wait at least three months (13 weeks) after the last possible exposure to the virus before being tested.

Getting tested before three months may result in an unclear result or a false negative. Some testing centres may recommend testing again at six months. All but less than 1% of those who are going to seroconvert will do so within three months (*seroconversion is the development of detectable antibodies to HIV in the blood as a result of infection*.) It is extremely rare for seroconversion to take more than six months to develop detectable antibodies.

There are a number of tests for the presence of the HIV virus. Generally speaking, these tests yield conclusive results within 48 to 72 hours after infection has occurred. However, in some cases, it can take as long as 28 days for results to be considered accurate. Some of these tests are described below.

The ELISA AND WESTERN BLOT TEST

The standard test for detecting HIV antibodies in the blood is the **e**nzyme-**l**inked **i**mmuno**s**orbent **a**ssay (**ELISA**). In this test, a blood sample is mixed with proteins from HIV. If the blood contains HIV antibodies, they attach to the HIV proteins, producing a telltale colour change in the mixture. This test is highly reliable when performed two to three months after infection with HIV. The test is less reliable when used in the very early stage of HIV infection, before detectable levels of antibodies have had a chance to form. Doctors routinely confirm a positive result from an ELISA test by using the **Western Blot test**, which can detect lower levels of HIV antibodies. In this test a blood sample is applied to a paper strip containing HIV proteins. If HIV antibodies are present in the blood, they bind to the HIV proteins, producing a color change on the paper. The combination of the ELISA and the Western Blot test is more than 99.9 percent accurate in detecting HIV infection within 12 weeks following exposure.

P24 Antigen Test: This test uses ELISA technology to look directly for key pieces of the HIV virus – the p24 protein found on HIV's outer coat. This test can reduce the chance of a false-negative in standard (antibody) ELISA testing if it is done too early (i.e., less than 13 weeks after exposure). The p24 antigen test may be ordered if there is a very recent risky exposure to HIV, such as a healthcare work-related incident. Blood banks also use it for screening donations. The test is valuable in detecting HIV infection early in the window period after exposure, this test is only useful for a period of approximately three weeks after exposure, before the production of antibodies begins. A p24 test result should be confirmed by antibody testing once the window period has passed.

Viral Load Test

Viral load testing measures the amount of new virus being produced and released into the bloodstream. Several studies have shown that higher levels of viral load are associated with more rapid disease progression and a greater risk of death. Lower levels are associated with stability and reduced risk of progression, infection, or death. Ideally, an HIV infected person should have no detectable level of virus, which means that the level of virus activity is too low to be measured. Currently available tests measure down as low as 200 to 500 copies of virus, the lowest amount presently measurable. This is associated with the best possible clinical outcome. Higher levels, ranging from several hundred upwards of millions of copies of virus, are associated with higher rates of disease progression. In short, the higher the number, the more rapid the rate of disease progression.

The viral load test gives a more accurate picture of the *rate* of disease progression. There are two commonly available tests for measuring viral load. One is called "quantitative PCR" (or "Q-PCR"), the other "branched DNA" (or "b-DNA"). Though there are small differences between the two tests, they are for practical purposes one and the same.

> **The Quantitative Polymerase Chain Reaction (QPCR):** is considered to be highly reliable for someone who may have recently been exposed to the virus, particularly in a high-risk situation. If the virus is present, the quantitative PCR will reveal how much virus is in a person's bloodstream (the viral load). In most cases, a quantitative PCR is highly accurate within 48 to 72 hours. However, a small number of people do not have viral loads that are high enough to confirm a diagnosis until 28 days

after exposure. The standard recommendation is that a negative PCR result be confirmed with an ELISA test at 13 weeks.

Qualitative PCR: The qualitative PCR, also known as the PCR-DNA test, looks for DNA in cells that suggest that HIV infection has taken place. It is not a viral load test, meaning that it will only determine if the virus is present, not how much virus is present. This test is frequently used to determine if an infant born to an HIV-positive is infected with the virus, given that it can detect virus before viral load becomes detectable. However, it is not at all clear if the qualitative PCR test has any advantages over the quantitative PCR test, which appears to be just as reliable, more widely available, and cheaper to perform.

Clinical trials of new drugs use these tests to measure the effect of drugs. A good antiviral drug can quickly reduce the level of virus at least ten fold and often as much as a thousand fold. The goal of therapy is to reduce the viral load to the lowest level detected by the test, usually below 200-500 viral copies.

HIV infected people and their physicians use these tests to make decisions about when and if to use antiviral drugs, and to determine if a drug is working on not. When the virus levels begin to rise again while using a drug, most physicians believe it is time to switch to another drug or combination of drugs.

Knowing the viral load helps doctors estimate an infected person's survival time. For example, studies show that without treatment, the average survival time for people with an HIV viral load greater than 30,000 per microlitre of blood is 4.4 years, while those with a viral load below 10,000 per microlitre of blood live for an average of ten years.

CD4+ Testing

For many years, testing the number of CD4+ cells was the most common way to measure the effects of HIV disease. Low numbers of these cells (below 200) accurately predicts the risk of major infections. The meaning of test results in between this critical level of 200 and the normal level of 1000 is unclear. Physicians once typically started treatment for people when the CD4+ was below 500, but this was always an arbitrary number simply selected from clinical trials. By itself, this number does not tell us enough about the state of disease. It only shows that the level of CD4+ cells is below normal, to varying

degrees. Getting the full picture of HIV disease requires additional tests, especially the Viral Load Test.

CD4+ Cell Ranges

Low	Medium	High
(under 300)	(300-500)	(500 plus)

High Range:

In general, a CD4+ count above 500 suggests no immediate danger, even though it may represent a loss of half the normal CD4+ cell count (1000). The 500 level is sometimes cited as the bottom of the "normal" range, but this can be misleading. While an occasional drop to 500 may be normal, a steady or falling count of 500 or even 600 is not normal and indicates suppressed immunity. At the very least, dietary counselling, nutritional supplements, CD4+ cell monitoring, and periodic use of other tests are recommended in this range, whether or not treatments are used.

Medium Range:

CD4+ counts in this range indicate significant decline of the immune system. However, serious symptoms are uncommon in this range. Some researchers believe this is the optimum time to begin treatment, especially if the viral load test also indicates significant viral activity.

Low Range:

CD4+ counts below 300 indicate the greatest risk of infections and according to the 1993 definition of AIDS, a CD4+ count of 200 or less constitutes an AIDS diagnosis. A person with counts below 300 CD4+ may remain stable for many years, especially with careful health management. While some people have warning signs in the form of symptoms before major infections occur, this is not always the case.

How Testing is Done

Rapid Testing: A blood sample is obtained through finger stick and analyzed using the ELISA test. The results are usually available within ten to sixty minutes. If the result is positive, a follow-up test is required, usually by drawing blood and sending the sample to a laboratory for Western blot testing. If the result is negative, there is no need for additional testing and the result can be considered conclusive. Convenient and faster, this method is often used in healthcare settings, particularly where urgency is an issue such as with someone

who is pregnant or about to give birth. Because it provides a result so quickly, this is an increasingly popular method for testing.

Oral Fluid Test: A device is used to collect oral (mouth) fluid (i.e. saliva). Oral fluids can contain antibodies to HIV, which can be detected using the ELISA and Western blot tests. Typically, it takes one to two weeks to get a result. Because it is so easy and comfortable to accomplish, this test is often used in clinics, doctors' offices, hospitals, and school-based and university health centres.

Urine-Based Test: A urine sample, collected in a cup, is used for the ELISA/Western blot tests. The results of this non-invasive and non-technical method can be obtained typically in one to two weeks. It is commonly used in community-based and outreach settings, adolescent, school and university-based settings. Anyone with a positive urine result must have a confirmatory test.

What Do My Test Results Mean?

A negative test result means:

- If you have not engaged in any risky behaviours for the last 6 months, you are not currently infected with HIV. If you have had unprotected sex or shared needles or have other risk factors in the last 6 months, you should be tested again. You could still be HIV positive, and pass the HIV on to other people, even though your test is negative.
- A negative test does not mean that you are immune to HIV.
- Some people who have a negative test may be tempted to continue risk behaviours, believing "It can't happen to me." If you continue unsafe behaviours, you are still at risk.

A positive test result means:

- The person is infected with HIV. This does not necessarily mean that he/she has AIDS.
- A person with HIV is infected for life. He or she can pass the virus to others by having unprotected sex, or by sharing drug use needles or equipment. To protect yourself and others, you need to avoid doing these things. A woman who has HIV can pass it on to her unborn or breast feeding baby. Those carrying the HIV should not donate blood, plasma, semen, body organs, or other tissue.

- One should get a doctor to monitor the progression of HIV in the body, and advise on when it is appropriate to begin treatment. There are differing opinions about how early to begin treatment, but it is clearly much better to begin treatment long before symptoms of AIDS develop.
- If one's HIV test is positive, sexual partners and anyone with whom one has shared drug injection equipment may also be infected. They should be told they have been exposed to HIV and advised to seek HIV counselling and antibody testing.

Need for periodic testing

Many people continue to engage in some degree of risky behaviour, and choose to be tested for HIV periodically (every six months, every year, or every other year.). Since the window period for developing a positive test result can be as long as six months, it would rarely make sense to be tested more often than this. There are clear benefits to early medical attention for infection with the HIV virus. There is little agreement on how early this must be. But if you wait longer than two years, treatment of the disease may be less effective. If you are beyond the six month window period from a possible HIV transmission event and were reported HIV negative by an accurate HIV test (and you are not subsequently put at risk for HIV), you can consider yourself HIV negative. There is no need to retest. However if it eases your anxiety, you may wish to take the test again periodically.

Resources: Chart A showing (i) a person having his blood drawn preparatory to being tested for HIV and (ii) a person pricking self ready to test for HIV using HIV testing kit; Chart B listing different types of HIV test; and Chart C showing low, medium and high viral loads.

Procedure:

Step 1: In small groups, ask students to discuss why people should test for HIV and the procedure commonly adopted. Request a member of each group to present the summary of the group's discussion to the whole class. List the summaries on the board.

Step 2: Engage pupils in interactive discussion on the class summaries, giving further explanation on why people should be tested for HIV. Request pupils to consider taking the HIV test and in turn, to encourage member of their family and friends to take the test at the nearest clinic where such facility exists.

Step 3: Using Charts A and B, discuss with pupils the following HIV tests:

The ELISA and Western Blot Test

The standard test for detecting HIV antibodies in the blood is the **e**nzyme-**l**inked **i**mmuno**s**orbent **a**ssay (**ELISA**). In this test, a blood sample is mixed with proteins from HIV. If the blood contains HIV antibodies, they attach to the HIV proteins, producing a telltale colour change in the mixture. This test is highly reliable when performed two to three months after infection with HIV. Doctors routinely confirm a positive result from an ELISA test by using the **Western Blot test**, which can detect lower levels of HIV antibodies.

Viral Load Test

Viral load testing measures the amount of new virus being produced and released into the bloodstream. Higher levels, ranging from several hundred upwards of millions of copies of virus, are associated with higher rates of disease progression. In short, the higher the number, the more rapid the rate of disease progression.

Using Chart C, explain to the pupils the meanings of the results of HIV tests. Let pupils lead the discussion on what should be done when the result is (a) positive; and (b) negative. Contribute the following to the discussion.

If the result is negative:

- you are not currently infected with HIV if you have not engaged in any risky behaviours for the last 6 months,. If you have had unprotected sex or shared needles or have other risk factors in the last 6 months, you should be tested again. You could still be HIV positive, and pass the HIV on to other people, even though your test is negative.
- A negative test does not mean that you are immune to HIV.

- Some people who have a negative test may be tempted to continue risk behaviours, believing "It can't happen to me." If you continue unsafe behaviours, you are still at risk.

A positive test result means:

- The person is infected with HIV. This does not necessarily mean that he/she has AIDS.
- A person with HIV is infected for life. He or she can pass the virus to others by having unprotected sex, or by sharing drug use needles or equipment. To protect yourself and others, you need to avoid doing these things. A woman who has HIV can pass it on to her unborn or breast feeding baby. Those carrying the HIV should not donate blood, plasma, semen, body organs, or other tissue.
- One should get a doctor to monitor the progression of HIV in the body, and advise on when it is appropriate to begin treatment. There are differing opinions about how early to begin treatment, but it is clearly much better to begin treatment long before symptoms of AIDS develop.
- If one's HIV test is positive, sexual partners and anyone with whom one has shared drug injection equipment may also be infected. They should be told they have been exposed to HIV and advised to seek HIV counselling and antibody testing.

Step 4: Close the lesson with a summary and review questions.

In this lesson, we learned the following:

Testing is recommended for those who:

- have multiple sexual partners (2 or more sexual partners in the last 12 months)
- have received a blood transfusion recently in a place where blood is not screened before transfusion, or if a sexual partner received a transfusion and later tested positive for HIV.
- are uncertain about their sexual partner's risk behaviours.

- are homosexuals
- have used street drugs by injection especially when sharing needles and/or other equipment.
- have a sexually transmitted disease (STD), including pelvic inflammatory disease (PID).
- are health care workers with direct exposure to blood on the job.
- wants to make sure they are not infected with HIV before getting pregnant.

The standard test for detecting HIV antibodies in the blood is the **e**nzyme-**l**inked **i**mmuno**s**orbent **a**ssay (**ELISA**). In this test, a blood sample is mixed with proteins from HIV. If the blood contains HIV antibodies, they attach to the HIV proteins, producing a telltale colour change in the mixture. This test is highly reliable when performed two to three months after infection with HIV. The test is less reliable when used in the very early stage of HIV infection, before detectable levels of antibodies have had a chance to form. Doctors routinely confirm a positive result from an ELISA test by using the **Western Blot test**, which can detect lower levels of HIV antibodies.

The P24 Antigen Test uses ELISA technology to look directly for key

pieces of the HIV virus – the p24 protein found on HIV's outer coat. This test can reduce the chance of a false-negative in standard (antibody) ELISA testing if it is done too early (i.e., less than 13 weeks after exposure).

Viral load testing measures the amount of new virus being produced and released into the bloodstream.

In general, a CD4+ count above 500 suggests no immediate danger, even though it may represent a loss of half the normal CD4+ cell count (1000). The 500 level is sometimes cited as the bottom of the "normal" range, but this can be misleading. While an occasional drop to 500 may be normal, a steady or falling count of 500 or even 600 is not normal and indicates suppressed immunity.

Testing methods include (a) Rapid Testing**:** A blood sample is obtained through finger stick and analyzed using the ELISA test; (b) Oral Fluid Test**:** A device is used to collect oral (mouth) fluid (i.e. saliva). Oral fluids can contain antibodies to HIV, which can be detected using the ELISA and Western blot tests; and (c) Urine-Based Test: A urine sample, collected in a cup, is used for the ELISA/Western blot tests. The results of this non-invasive and non-technical method can be

obtained typically in one to two weeks. It is commonly used in community-based and outreach settings, adolescent, school and university-based settings. Anyone with a positive urine result must have a confirmatory test.