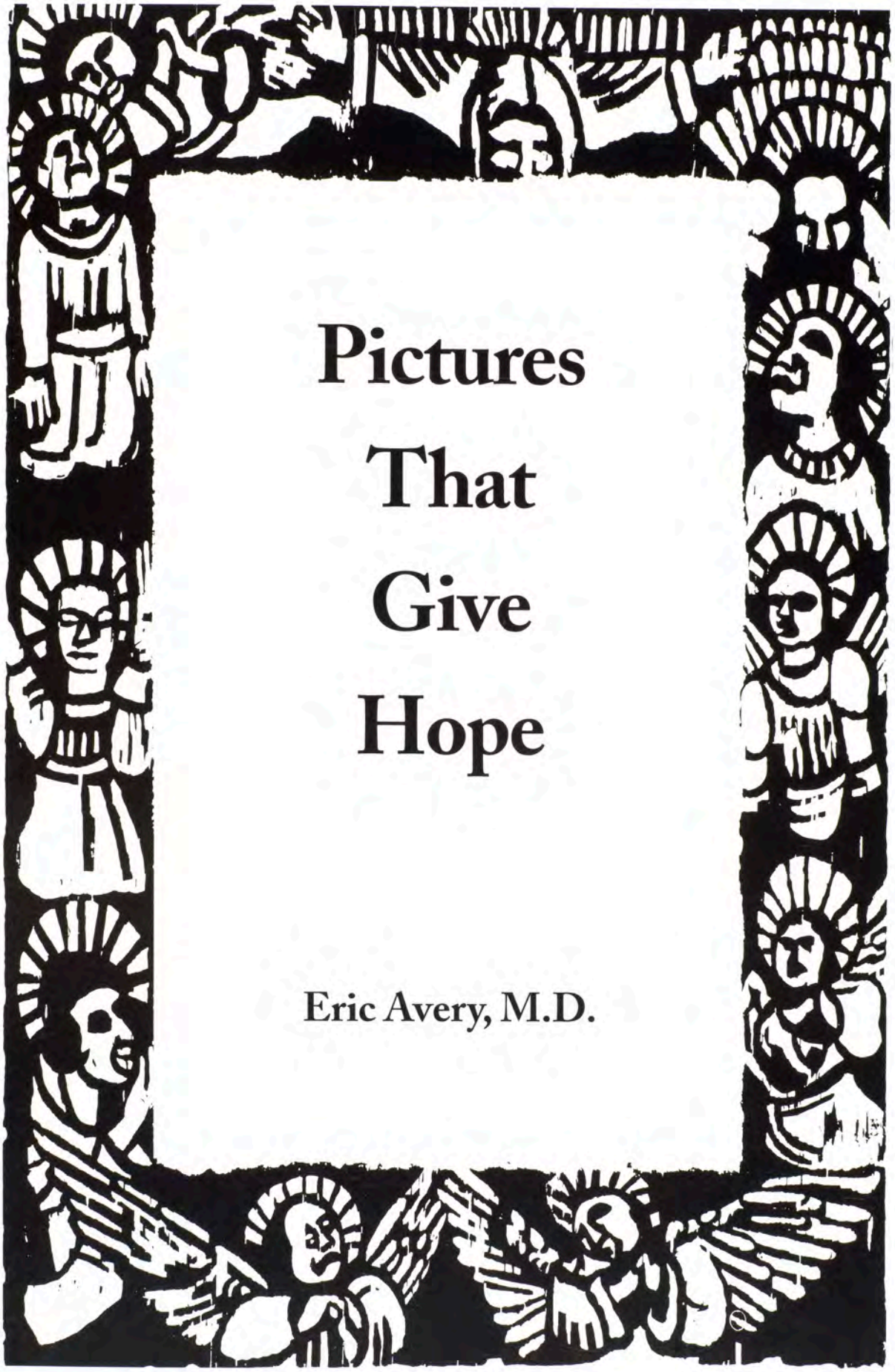

Pictures That Give Hope

Eric Avery, M.D.

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2001

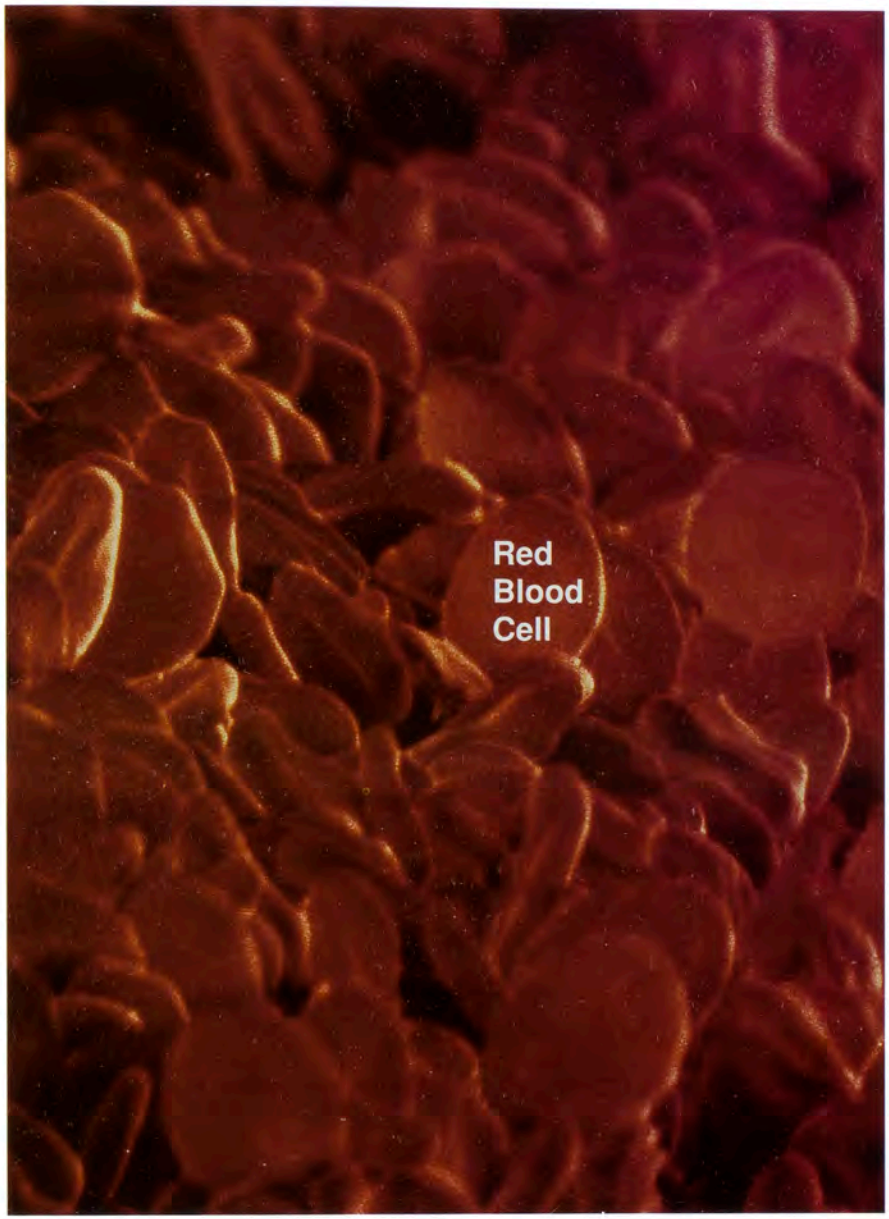
This book has been written to teach people about blood and the Human Immunodeficiency virus (HIV). The pictures that have been added will also help to explain what is being taught. I call them, "Pictures That Give Hope." I am a psychiatrist and part of my job is to keep hope alive for the HIV-positive people that I teach in the HIV clinic at UTMB at Galveston and at a minimum-security prison for women serving time in TDCJ. Therefore, I decided to put this book together so that you could read AND SEE that having HIV does not mean that there is no hope.

Most of my patients do not know very much about the tiny world of blood and cells, bacteria and viruses. They are often scared because they have heard things about HIV from other people that are not true. This may sometimes rob them of their hope and even cause them to stop taking their medication. That is a big mistake and in the pages ahead you will learn that it doesn't have to be that way.

One picture can be worth a thousand words when teaching my patients how HIV attacks and destroys the body's immune system so it cannot fight off disease. That's the bad side, but these pictures also show how medications are helping us to fight back. For example, the graph at the end of the book shows how protease inhibitors, one of the medications used to fight HIV, is helping people to live longer lives. Now that's news you can use!

All blood cells are made from "mother" stem cells, cells that make other cells. This happens inside our bones in the bone marrow. After RED BLOOD CELLS are made they enter the bloodstream. Every minute that we are alive our bodies produce 120 million new red blood cells.

Red blood cells are very small and, as you can see from the picture, they look like compact discs that can be bent. They travel through our arteries and veins, giving us oxygen and taking away carbon dioxide, and make their way through our entire body 3,000 times a day. This is like a long and miserable ride on a chain bus only to stop long enough each day to work in the hoe squad because each red blood cell survives a tough trip and works non-stop for four months. When they wear out, they are gobbled up by a blood cell called a MACROPHAGE, which is simply the blood's version of a "tank boss" or a bully preying on the weak cells. Right now your body has about 25 trillion red blood cells and before the day is over with it will make 200 billion more to replace the ones that wore out. Six types of WHITE BLOOD CELLS are also made in the bone marrow. They also travel in the bloodstream and are very important to my patients because they are the soldiers of the immune system, fighting infections caused by germs and keeping our bodies healthy.

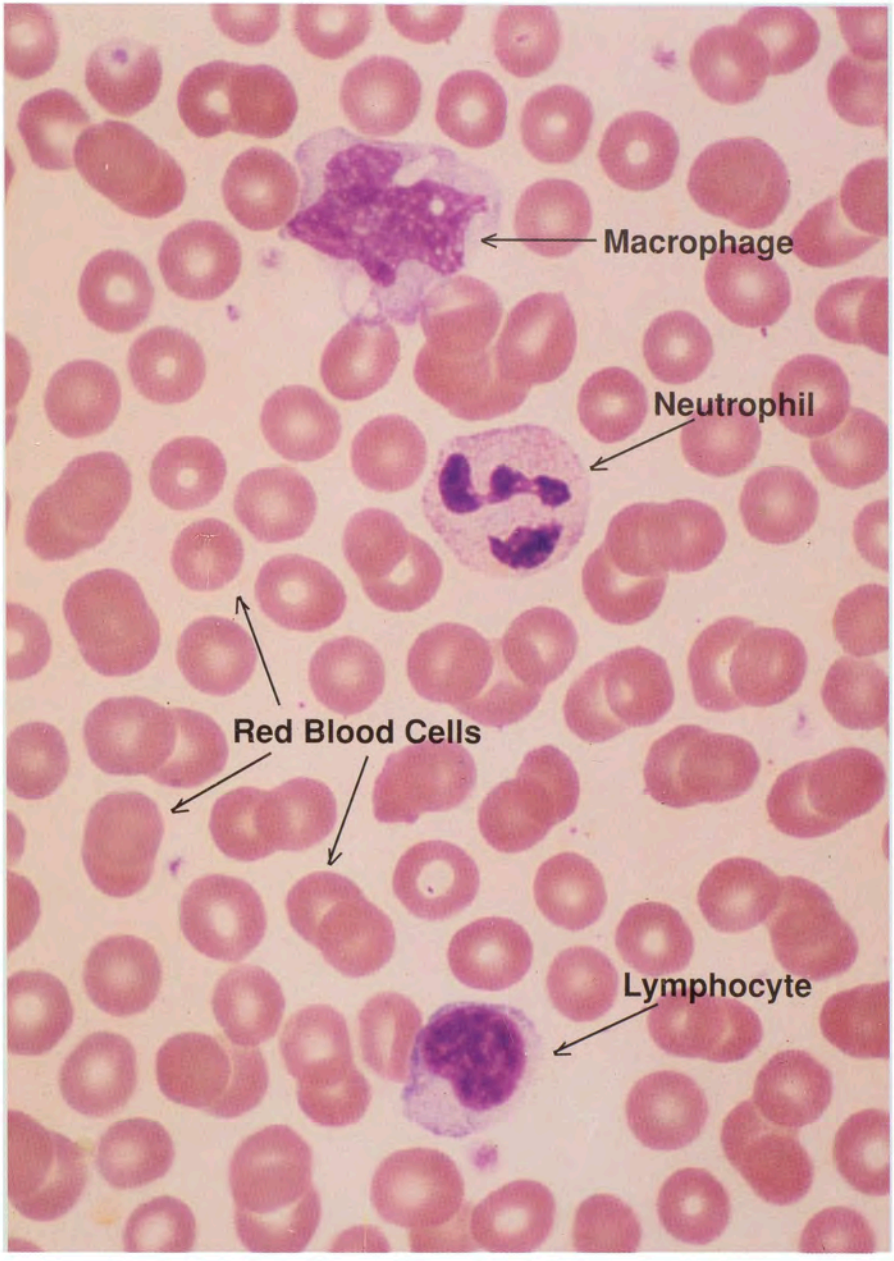


In the picture of my own blood on the right there are 3 types of larger white blood cells. The first on the scene when a germ enters the body is a NEUTROPHIL. It swallows germs and "snitches," so to speak, by sending out messages to the other cells telling them where to show up for the fight.

Then, the bully MACROPHAGE arrives to gobble up the dead germs and whatever else is left. After the meal, these bullies also send out a message that causes other white blood cells to show up and help fight the threat to the body.

Finally, the LYMPHOCYTES begin to arrive. One type of lymphocyte, the CD4 cell, is the "shot caller" or master cell of the immune system. It gives orders to the other white blood cells during the body's battle with germs.

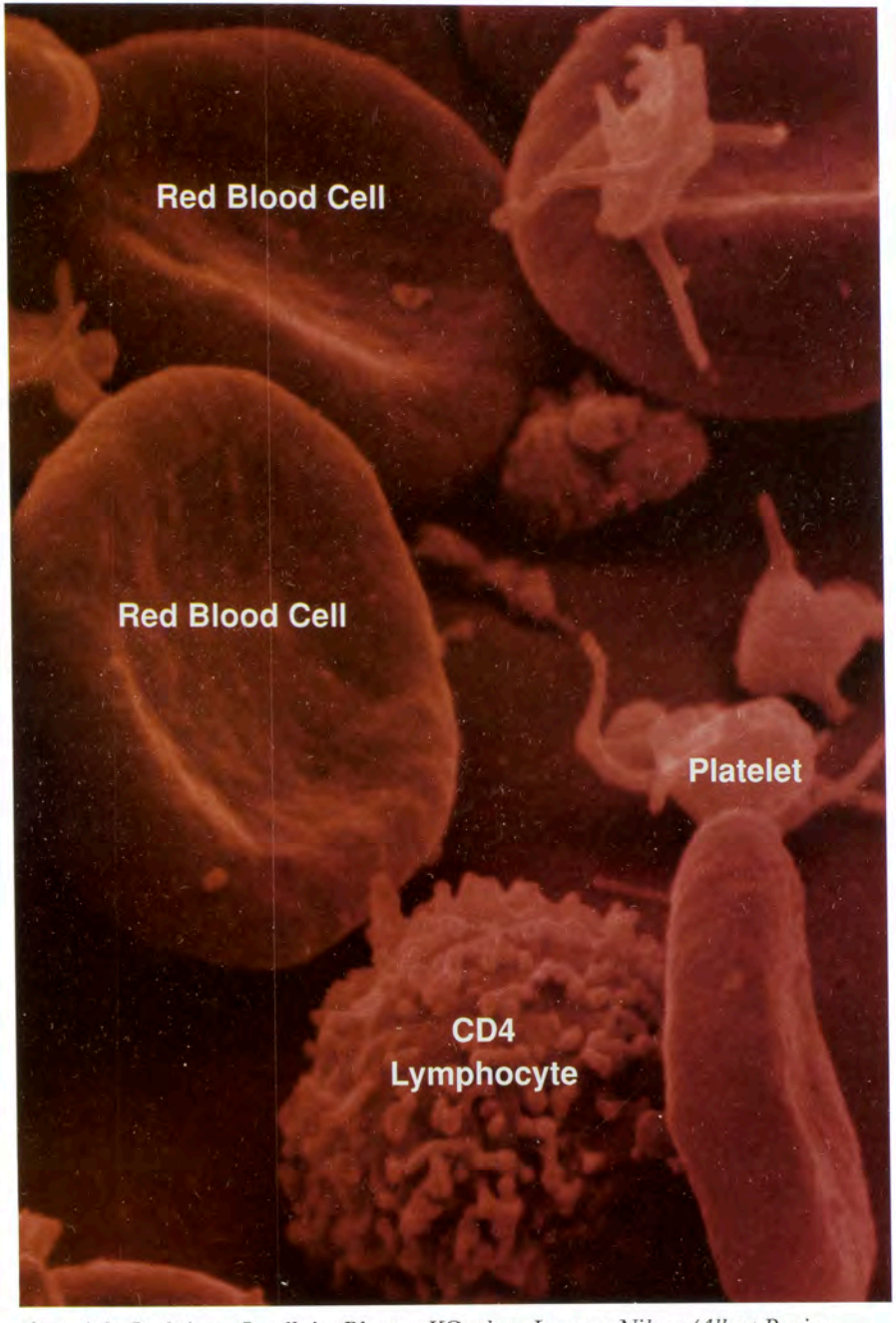
When HIV enters the body and gets into the blood, it attacks the shot caller CD4 cell and damages the body's immune system. HIV is a tiny germ. In fact, it is so small that you could fit 10 million of them on the tip of a pencil!



This photograph shows a closer view of some RED BLOOD CELLS and a LYMPHOCYTE with nubs on its surface. You can also see PLATELETS, which happen to be what helps you to stop bleeding when you have a wound.

When HIV enters the bloodstream, it attaches to the shot caller CD4 lymphocytes and the bully macrophage because they are covered with a protein material called CD4. HIV needs this protein to clamp onto and then it uses it to enter the cells. Now that these cells are infected they carry HIV to all parts of the body, even the brain. HIV can either rest in infected CD4 cells for a long time or it can turn into factories for making HIV. Eventually, HIV kills the CD4 cell.

In someone that does not have HIV there are 500–1000 CD4 cells per cubic millimeter of blood (1/5 of a teaspoon). In HIV positive people this count, also known as a T-cell count, is very important because if this number drops below 200, then they are said to have AIDS; same virus, just a different name and level of seriousness.



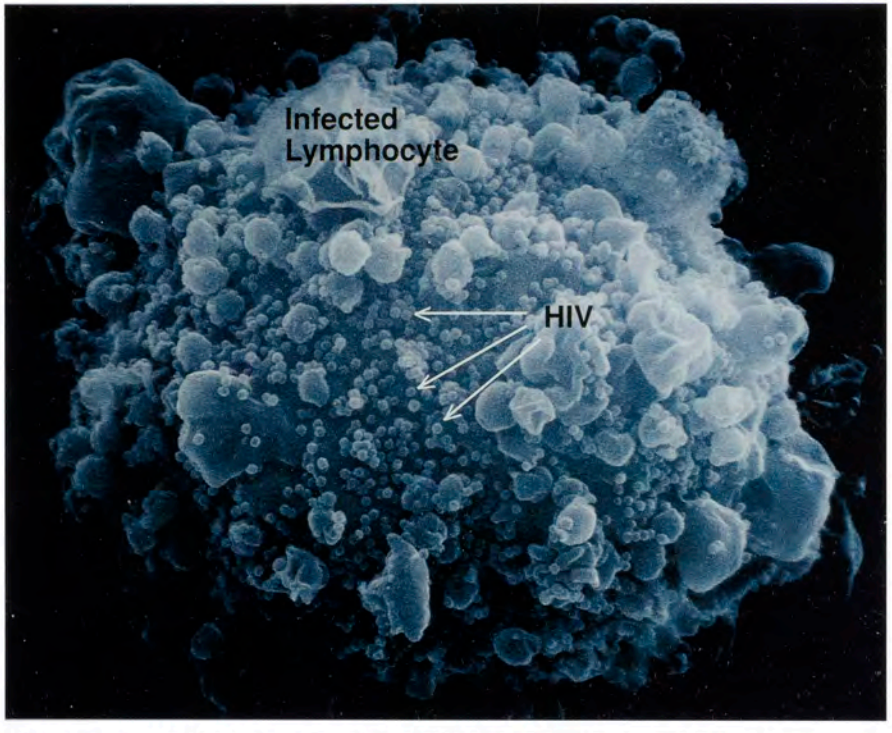
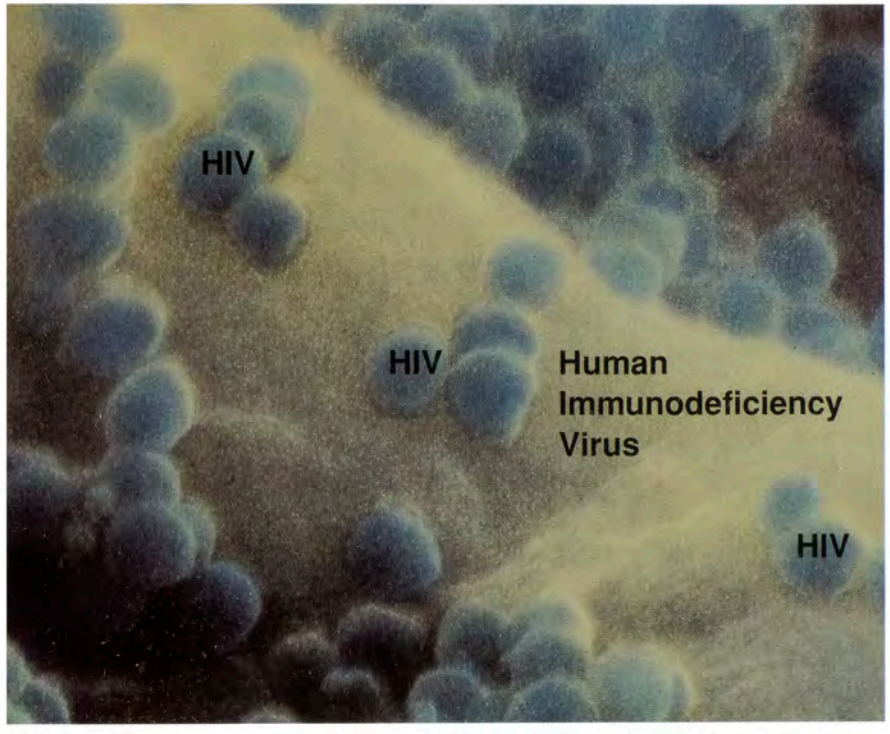


Photo courtesy of the National Institute for Biological Standards and Control.

HIV enters the CD4 cell in a process called FUSION. This allows HIV's genetic material, called RNA, and its proteins, called enzymes, to enter the white blood cell. Now, once the RNA and enzymes are inside, the infected cell can become a factory for making more HIV. In this picture, the tiny round balls on the infected CD4 cell are HIV attached to or budding out of the surface of the infected cell.



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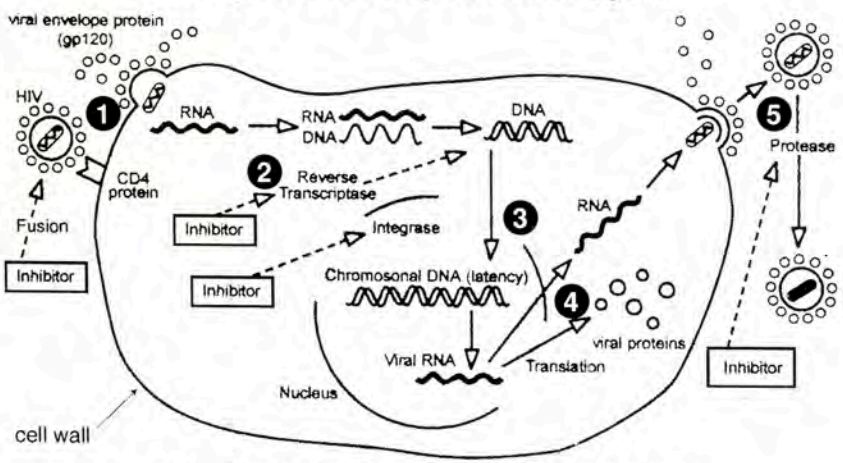
Here is an even closer view of HIV on the CD4 cell surface. In a silent battle, your body makes billions of new CD4 cells a day just to replace the ones killed by HIV. The body can keep this up for years, but it eventually starts to lose the fight and can no longer replace them. When this happens, the CD4 count we talked about earlier drops, the immune system is weakened, and with time, AIDS develops. You start to feel sick and get opportunistic infections, which are illnesses that can also move you into the AIDS category.

Now I want to show how HIV makes copies of itself. There are 5 steps. In the diagram below where you see a "1" is the place where HIV attaches to the CD4 cell wall and injects RNA and its proteins into the cell. That is step 1. Once inside, reverse transcriptase, a fancy name for an enzyme, changes RNA into DNA, which is step 2. This is important because if you look at the diagram you will see that RNA is just one strand of genetic material, but DNA is double stranded. So, you could say that RNA is not complete until it becomes HIV DNA. Once this HIV DNA gets into the cells "healthy" or non-infected DNA, you have step 3. It is here that HIV can rest quietly for years or start the HIV factory. These new proteins that make up HIV then move to the surface and then bud out of the infected cell like we saw on the picture earlier. That is step 5, and that means that there are new viruses that can find other CD4 cells and macrophages to infect.

Stages of HIV Reproduction Cycle

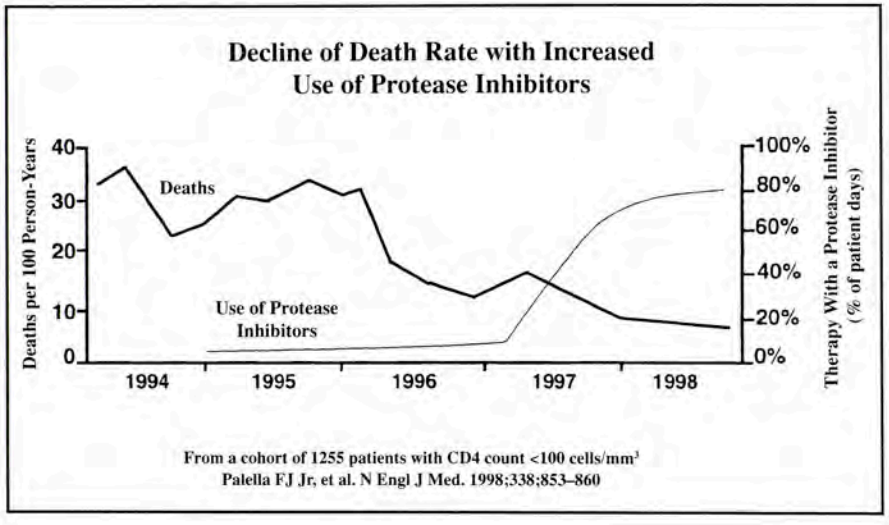


Showing Sites of Action of Medications

It is important to know, however, that this does not always happen to people at the same levels. The quicker the virus can reproduce, the more CD4 cells killed, and the faster the development of AIDS. A VIRAL LOAD TEST can measure virus reproduction, or the rate that this happens. This is another important number for my patients because your viral load is how many viruses are present in the one cubic millimeter (1/5 of a teaspoon) of blood that we talked about earlier. There can be from 1 to 1 million viruses in this small amount of blood. If you have HIV, of course it is better for this viral load number to be low and your CD4 cell count to be high.

The good news is that doctors have learned more about HIV in a short time than they have about any other germ ever! When doctors learned about these 5 steps they also learned how to interrupt them with medications. Two groups of medications, called NRTIs[1] and NNRTIs[2], prevent the "incomplete" RNA from turning into the "complete" HIV DNA that happens in step 2. Another group of medicine, the PROTEASE INHIBITORS, or PIs, stops the last part of the process (step 5) where HIV buds out of infected CD4 cells. There is now a new class of medicine called FUSION INHIBITORS that interferes with step 1. So, don't worry, we are all over HIV like a convict on a hot meal after a one-month lockdown!

[1]Nucleoside Reverse Transcriptase Inhibitor
[2]Non-Nucleoside Reverse Transcriptase Inhibitor



This graph shows that the increased use of PIs since 1995 has caused a huge drop off in deaths from AIDS. In other words, less people are dying and more people have hope. To stop HIV reproduction, all the 3 medications (PIs, NRTIs, and NNRTIs) are combined so that as many of the 5 steps is interfered with as possible. This treatment is called ANTIRETROVIRAL THERAPY or ART. As the anti-HIV medications work to stop the virus from making copies of itself, the amount of HIV in the blood goes way down. BUT, if you miss a dose of your NRTI, or NNRTI, HIV gets more chances to enter the new CD4 cells. If you miss a dose of your PI, the HIV can make some good copies of itself to attack more cells and then your viral load goes up. So, do not give HIV a better chance by missing you medicine!

For those that can afford these medications, treatment developments have saved their lives. These treatments during pregnancy and after the delivery of newborn babies have cut mother-to-child transmission of HIV in the U.S. to very low levels.

But these medications are not a cure for HIV. They help to control HIV disease, but do not remove it from the body. So, people on medications can still give HIV to others. The medications also cost a lot of money and some people have trouble with their side effects. Many others have trouble taking medication the right way because there are so many pills that have to be taken at different times. Therefore, the development of new and better ways to help as many people as possible to fight HIV is very important.

If you have HIV, you need to understand the information in this book about CD4 cells, HIV, viral reproduction, and viral load before starting ART. You also need to understand that there is always hope and I pray these pictures have given you just that.

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Eric Avery began this book in November 1999 in collaboration with students and faculty at the UTK Print Workshop, Department of Art, University of Tennessee, Knoxville. The first printing of ***Pictures That Give Hope*** was produced during the Southern Graphics Council Conference at the Department of Art, The University of Texas at Austin, March 2001. David Paar M.D. helped with the text. M.D. Williams helped with the digital layout of the book. Dr. Avery's reduced relief engraving of The Life Cycle of HIV Showing Sites of Action of Medications is attached to the back cover. In 2002, the peer educators at theTexas Department of Criminal Justice Central Unit revised the book for the inmate population. In 2003, the revised book was reprinted for TDCJ use under the supervision of Dennis W. Cook, HIV/AIDS Educator, The University of Texas Medical Branch at Galveston, with a special thank you to Boehringer Ingelheim Pharma KG, Lennart Nilsson/ Albert Boniers Forlag AB, and David Hockley at the National Institute for Biological Standards and Control, S. Mimms, U.K. for permission to use photographs.

Life Cycle of HIV Showing Sites of Action of Medications