How HIV Damages The Immune System

Introduction

The basic structure of HIV is similar to other viruses (Figure 1). HIV has a core of genetic material surrounded by a protective sheath, called a capsid. The genetic material in the core is RNA, ribonucleic acid, which contains the information that the virus needs to reproduce and perform other functions. You can think of RNA as the set of rules the virus follows in order to live.

In HIV, viral RNA has a protein called "reverse transcriptase" that is crucial for viral replication inside of T-cells. The function of reverse transcriptase, which means "writing backwards," will be explained later when we explain how HIV infects the T-cell.

HIV, like all other viruses, has proteins that are particular to itself. These proteins are called antigens. Antigens have diverse functions in viral replication. In the case of HIV, a combination of two antigens, the gp120 and the gp41, allow the virus to hook onto T-cells and infect them. These antigens are located on the surface of the virus. (Another HIV antigen is the p24, an antigen of the core of the virus that is measured to estimate the amount of active free-floating virus in the blood of HIV positive people).

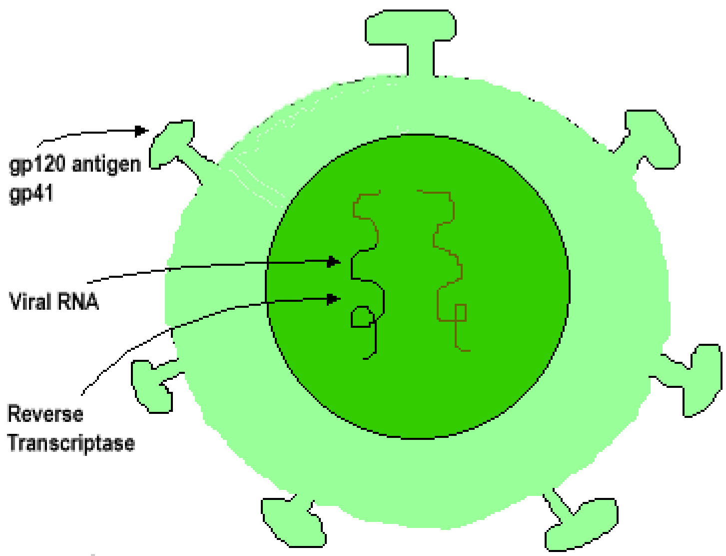

Figure 1

HIV Targets T-Cells

Let's look at the structure of the T-cell. T-cells are the main target of HIV in the blood, and act as the host that the virus needs to replicate. (However, macrophages, B-cells, monocytes, and other body cells can also be infected by HIV.) The T-cell has a nucleus that contains genetic material in the form of DNA (deoxyribonucleic acid) (Figure 2). The cell's DNA has all the information that the cell needs to function. The difference between RNA and DNA is that the former is a single strand of genetic material, while the latter is a double strand (Figure 3). This difference is crucial in the process of T-cell infection by HIV.

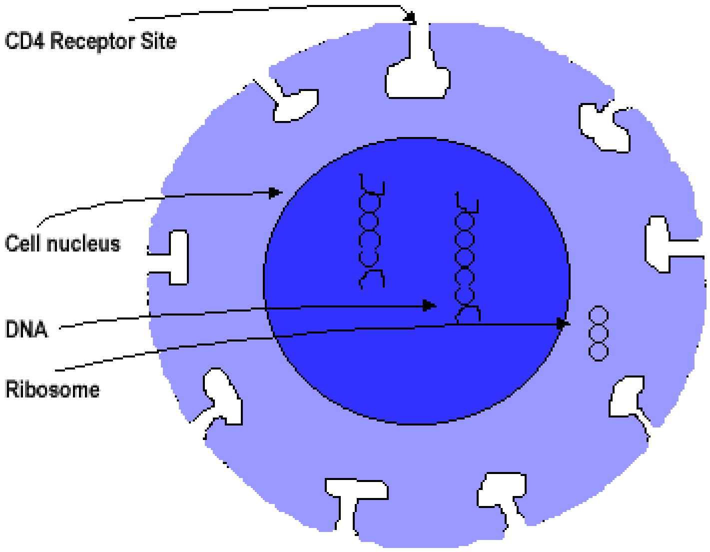

Figure 2

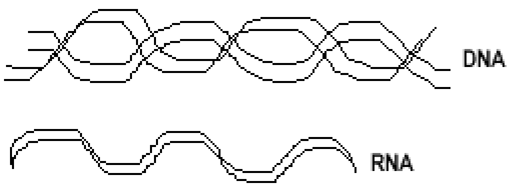

Figure 3

One important feature in the T-cell's structure is the CD4 receptor site (Figure 2). The CD4 is a protein on the surface of the cells. HIV's gp120 is a mirror image of the CD4. If HIV bumps into the right place on the cell's surface, the gp120 of the virus will lock onto the CD4 site of the T-cell (Figure 4). Because of that, the CD4 is called the receptor site or docking port for HIV.

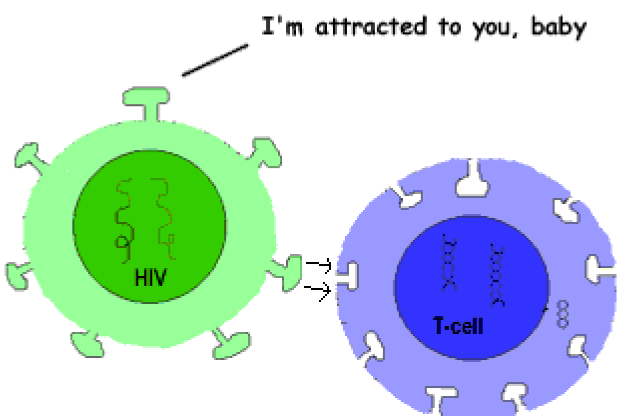

Figure 4
Virus attaches to healthy T-cell

When HIV successfully latches onto a T-cell, the next step will be to inject its core with the viral RNA and the reverse transcriptase (Figure 5).

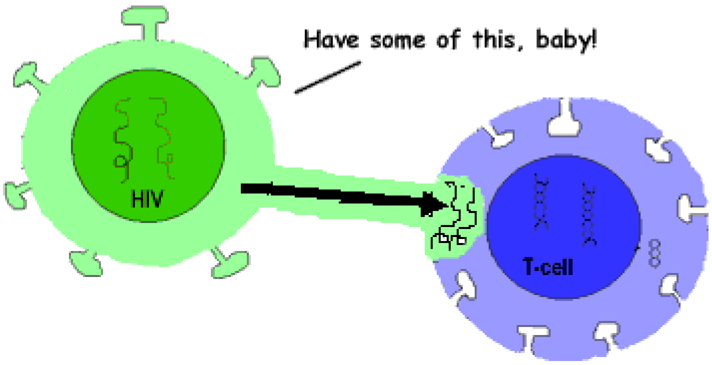

Figure 5
Virus injects its core (viral RNA and reverse transcriptase)

HIV Takes Control Of T-Cells

Once in the cell, the capsid protective sheath will be dissolved, liberating the viral RNA and the reverse transcriptase. Now, in order to effectively infect the cell, the viral RNA needs to travel into the cell's nucleus (where it can change the T-cell's rules and convert it into a virus factory). However, for that to happen, an important transformation needs to take place.

Normally, the T-cell's nucleus communicates with the rest of the cell by transforming DNA into RNA and sending it out of the nucleus. (In all the cells of our body, RNA acts as a messenger between the nucleus and the rest of the cell. The DNA makes RNA and sends it out to convey orders.) The genetic material's passport to leave the nucleus is to be transformed into a single-stranded RNA. In the same fashion, the passport to enter the nucleus is to be transformed into double-stranded DNA.

Viral RNA needs to become DNA in order to reach its final destiny. Reverse transcriptase allows the RNA to borrow material from the cell and to "write backwards" a chain of viral DNA.

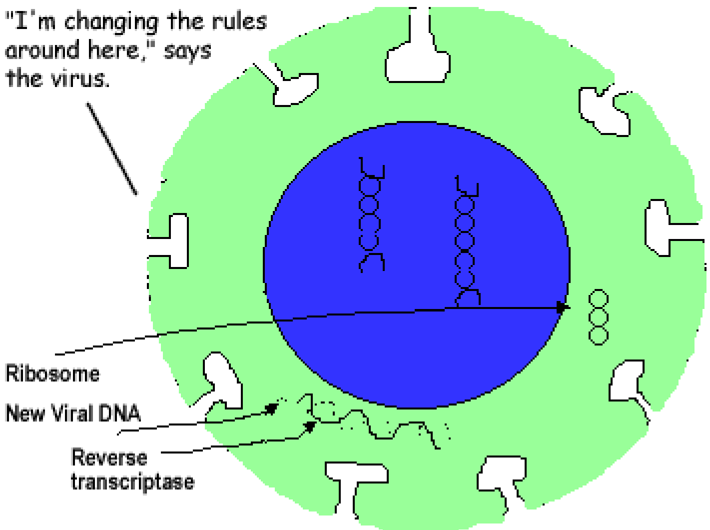

Figure 6
The viral RNA and the reverse transcriptase change the T-cell, giving it a new set of codes/info

HIV is a retrovirus because of its capacity to transform RNA into DNA, *reversing* the natural process that takes place in cells. This is accomplished by a substance called reverse transcriptase. Retroviruses are a special family of viruses to which only a few known viruses belong (although many others might yet be discovered).

HIV Replicates

Once transformed, the viral DNA will travel into the T-cell's nucleus and sew itself to the cell's genetic material (a process similar to placing a "bug" in a computer software program). At this point, if the T-cell is activated, instead of performing T-cell functions, it will start producing and shedding new virus.

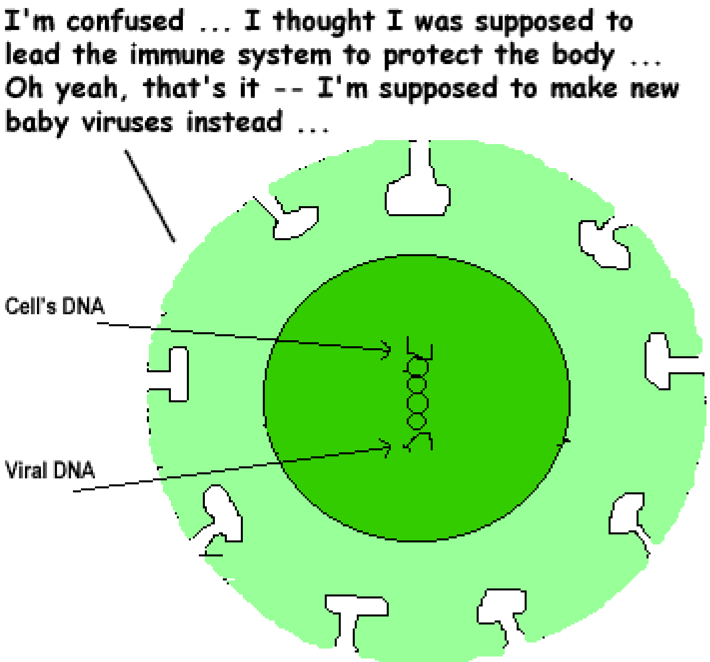

Figure 7

At this stage, several things can happen. The new virus ("provirus") can remain inactive for a long time without triggering the reproduction of virus, or it can divide into two proviruses (mitosis), or it can start producing new virus that will bud off from the T-cell wall, eventually destroying the T-cell.

Due to its method of reproduction, HIV is particularly devastating to the immune system. In the process of reproducing, the virus destroys increasing numbers of T-cells. The coordinator cells of an important part of the immune system are annihilated, leaving the body open to opportunistic infections.