The HIV Life Cycle

Introduction
In order for viruses to reproduce, they must infect a cell. Viruses are not technically alive: they are sort of like a brain with no body. In order to make new viruses, they must hijack a cell, and use it to make new viruses. Just as your body is constantly making new skin cells, or new blood cells, each cell often makes new proteins in order to stay alive and to reproduce itself. Viruses hide their own DNA in the DNA of the cell, and then, when the cell tries to make new proteins, it accidentally makes new viruses as well. HIV mostly infects cells in the immune system.

Infection: Several different kinds of cells have proteins on their surface that are called CD4 receptors. HIV searches for cells that have CD4 surface receptors, because this particular protein enables the virus to bind to the cell. Although HIV infects a variety of cells, its main target is the T4-lymphocyte (also called the "T-helper cell"), a kind of white blood cell that has lots of CD4 receptors. The T4-cell is responsible for warning your immune system that there are invaders in the system.

Replication: Once HIV binds to a cell, it hides HIV DNA inside the cell's DNA: this turns the cell into a sort of HIV factory.

Definitions

There are a few things you need to know in order to understand HIV infection.

DNA: DNA is like the "blueprint" for building living cells.

Enzymes: Enzymes are like the workers of a cell. They build new proteins, transport materials around the cell, and carry out other important cellular functions.

RNA: RNA is like the construction boss. Cells use RNA to tell enzymes how to build a specific part of a cell. To make a new protein, enzymes will copy a specific part of the DNA into a piece of RNA. This RNA is then used by other enzymes to build a new protein or enzyme.

Proteins: The building blocks that are used to make living things.

Nucleus: A small package inside the cell where the genetic material is kept.
Step 1: Binding

A virus consists of an outer envelope of protein, fat and sugar wrapped around a set of genes (in the case of HIV, genetic information is carried as RNA instead of DNA) and special enzymes.

HIV has proteins on its envelope that are strongly attracted to the CD4+ surface receptor on the outside of the T4-cell. When 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.

Entry can be blocked by entry inhibitors.

Step 2: Reverse Transcription

HIV's genes are carried in two strands of RNA, while the genetic material of human cells is found in DNA. In order for the virus to infect the cell, a process called "reverse transcription" makes a DNA copy of the virus's RNA.

After the binding process, the viral capsid (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."

Reverse transcription can be blocked by: Nucleoside Reverse Transcriptase Inhibitors (NRTIs), and Non-Nucleoside Reverse Transcriptase Inhibitors (NNRTIs).
Step 3: Integration

The HIV DNA is then carried to the cell's nucleus (center), where the cell's DNA is kept. Then, another viral enzyme called integrase hides the proviral DNA into the cell's DNA. Then, when the cell tries to make new proteins, it can accidentally make new HIVs.

Integration can be blocked by integrase inhibitors.

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 and Maturation

The final step begins with the assembly of new virus. 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. The virus then enters the maturation stage, which involves the processing of viral proteins. Maturation is the final step in the process and is required for the virus to become infectious.

With viral assembly and maturation completed, the virus is able to infect new cells. Each infected cell can produce a lot of new viruses.

Viral assembly can be blocked by Protease Inhibitors (PIs). Maturation, a new target of companies developing anti-HIV drugs, may be blocked using Maturation Inhibitors.
colored scanning electron micrograph of a single HIV budding from a T4 cell

colored scanning electron micrograph of a T4 cell (green) infected with HIV (red).
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