Overview of Activity
The purpose of this activity is to engage students in studying the HIV viral infection pathway in a human cell. Students will be introduced to the concepts of the HIV life cycle, HIV immunity, and drugs as inhibitors of the spread of disease in the human body.

This activity can be paired with a general exploration of the Koshland Science Museum’s online exhibit *Infectious Disease: Evolving Challenges to Human Health*. It can also be used as a warmup activity to the Koshland’s Infectious Disease webquest.

_HIV/AIDS is not curable with the drugs currently available. Why is this the case?_

HIV is a retrovirus. Retroviruses are a group of viruses that cause AIDS and some types of cancer. They carry their genetic information in the form of RNA and then copy it into DNA to be integrated into the cell’s nucleus. Unfortunately, there is no cure for HIV at this time. There are only ways to control HIV and attempts to keep it from progressing into AIDS. In this activity, you will learn what challenges exist to develop drugs to cure HIV.

Part of your assignment will be to discover – the same way scientists do – how to treat HIV/AIDS. You will present your findings to the class through diagrams and descriptions and compare your deductions to those of actual scientists.

Part 1: HIV Immunity


1. What is the benefit of studying the extreme situations in a viral infection?

2. How does HIV infect a cell?
3. What are some possible ways people can be resistant to HIV?

4. Why is it useful to learn about how people can become immune to HIV?

Part 2: Mystery of the Black Death

Read the Clues and Evidence article and respond to the questions below.

1. How is studying a virus different from studying a bacteria?

2. What evidence indicates that there is a relationship between individuals with ancestors who survived the plague and those resistant to HIV?
3. What is a type of drug mentioned in the article that is used to inhibit HIV from affecting a cell? How does it work?

Part 3: Studying the Life Cycle of HIV

Looking at “The HIV Life Cycle” document, identify at least three more stages in the lifecycle, in addition to the one identified in the article. Propose a drug that can be developed to prevent HIV at each of the three stages. Develop a hypothesis about how this drug would work and discuss how you could test your hypothesis. Think about what you would look for to indicate that the drug was effective in blocking HIV at a particular stage.

Explain your group’s response below, using diagrams if necessary. You will share your findings with the class, so be sure to explain in a clear and well-supported manner.
Part 4: How do Antiretroviral Drugs Work?

Watch the *How do Antiretroviral Drugs Work* video from the Koshland Science Museum’s *Infectious Disease* exhibit. In your group compare your findings about how antiretroviral drugs can interrupt the life cycle of HIV to the information from the video, and then respond to the questions below. [https://www.koshland-science-museum.org/explore-the-science/interactives/infectioushttps://new.koshlandscience.org/sites/all/exhibits/exhib_infectious/hiv_antivirals_movie1.jsp](https://www.koshland-science-museum.org/explore-the-science/interactives/infectioushttps://new.koshlandscience.org/sites/all/exhibits/exhib_infectious/hiv_antivirals_movie1.jsp)

1. How do your findings compare to those of scientists? How close were you in identifying stages in the infection pathway targeted by current drugs?

2. Currently, what is the standard way to treat an HIV infection with medicine? Why is this the case?

3. You have seen how people develop a natural immunity to certain infectious diseases through vaccines. Why don’t we have a vaccine for HIV? *Think about why HIV is effective at spreading so quickly throughout the body.*
The HIV Life Cycle

1 Binding and Fusion: HIV begins its life cycle when it binds to a CD4 receptor and one of two co-receptors on the surface of a CD4+ T-lymphocyte. The virus then fuses with the host cell. After fusion, the virus releases RNA, its genetic material, into the host cell.

2 Reverse Transcription: An HIV enzyme called reverse transcriptase converts the single-stranded HIV RNA to double-stranded HIV DNA.

3 Integration: The newly formed HIV DNA enters the host cell's nucleus, where an HIV enzyme called integrase "hides" the HIV DNA within the host cell's own DNA. The integrated HIV DNA is called provirus. The provirus may remain inactive for several years, producing few or no new copies of HIV.

4 Transcription: When the host cell receives a signal to become active, the provirus uses a host enzyme called RNA polymerase to create copies of the HIV genomic material, as well as shorter strands of RNA called messenger RNA (mRNA). The mRNA is used as a blueprint to make long chains of HIV proteins.

5 Assembly: An HIV enzyme called protease cuts the long chains of HIV proteins into smaller individual proteins. As the smaller HIV proteins come together with copies of HIV's RNA genetic material, a new virus particle is assembled.

6 Budding: The newly assembled virus pushes out ("buds") from the host cell. During budding, the new virus steals part of the cell's outer envelope. This envelope, which acts as a covering, is studded with protein/sugar combinations called HIV glycoproteins. These HIV glycoproteins are necessary for the virus to bind CD4 and co-receptors. The new copies of HIV can now move on to infect other cells.

Terms Used in This Fact Sheet:

CD4 receptor: A protein present on the outside of infection-fighting white blood cells. CD4 receptors allow HIV to bind to and enter cells.

Co-receptor: In addition to binding a CD4 receptor, HIV must also bind either a CCR5 or CXCR4 co-receptor protein to get into a cell.

T-lymphocyte: A type of white blood cell that detects and fights foreign invaders of the body.

For more information:
Contact your doctor or an AIDSinfo Health Information Specialist at 1-800-448-0440 or http://aidsinfo.nih.gov.