10B-3 Viral Diseases

10B-3 Objectives

- Describe two methods of controlling viral diseases
- Compare and contrast attenuated and inactivated vaccines
- Describe three viral diseases that affect man

Most viruses are highly specific regarding their host cells. It appears that a virus particle in contact with the wrong type of cell either lacks the mechanisms for entering the cell or, once inside the cell, lacks the mechanisms for affecting the cell's metabolism. This virus would most likely be destroyed by the cell or released as a waste product.

Most viruses are thus limited not only to one type of organism but also to one cell type in that organism. Smallpox, chicken pox, and measles usually affect skin cells. Rabies and polio attack cells in the nervous system. Influenza and the common cold are usually viral infections of the respiratory system. A few viral diseases, however, like rabies and cowpox, can affect similar cells in different organisms.

The blood can carry various poisons released by virus-infected cells to other areas of the body. These transported poisons often cause the symptoms of the disease to be widespread, even though the actual infection may be in a limited area. Thus flu viruses in cells of the respiratory system can cause muscle soreness, headaches, and nausea, even though the cells of these areas are not infected with virus. The blood can also carry many types of viral particles from one area to another. A viral infection, therefore, is often found in areas of the same type of tissue throughout the body.

Control of Viral Diseases

Once a virus is inside a cell, it is virtually impossible to destroy the virus without harming the host cell. For this reason, developing medications to fight viral infections has been quite difficult. In addition, viruses are able to mutate quite rapidly, causing medications to lose their effectiveness. The control of viral diseases has two major components—prevention by vaccination and antiviral drugs to halt the progression of the disease.

Vaccination Programs

The purpose of any vaccine is to activate the body's immune system so that it can readily recognize and rapidly respond to a virus, or other organism, and prevent disease. There are two basic types of vaccines against viruses—inactivated and attenuated.

10B.11
Vaccines have prevented many serious childhood diseases.

Table 10B-1 **Other Viral Diseases**

In man	
• Ebola	• Mumps
• Hepatitis A, B, C, and D	• Severe Acute Respiratory Syndrome (SARS)
• Herpes simplex (fever blisters, cold sores)	• Warts
• Mononucleosis, infectious	• Yellow fever
In animals	
• Cowpox	• Hog cholera
• Distemper (in dogs)	• Monkeypox
• Foot-and-mouth disease	• Sacbrood (in bees)
• Fowl leukemia	• Sheep pox
In plants	
• "Breaking" diseases (as in Rembrandt tulips)	• Mosaic diseases (in cabbage, cucumbers, potatoes, sugar cane, and tobacco)

To make an **inactivated vaccine**, researchers alter the virus so that it cannot replicate in a host cell; however, enough identifying characteristics of the virus remain so that the body can recognize and store the information in its immune system. Most inactivated vaccines do not require special handling, such as refrigeration, making them easier to use in rural or isolated areas and in mobile vaccination programs. Unfortunately, the immune response created by inactivated vaccines is relatively weak and may have to be repeated.

An **attenuated vaccine** is made from "live" viruses that can still replicate in a host cell. Unlike Jenner's vaccine that was made from unaltered cowpox virus, attenuated vaccines are made from viruses that are grown under special conditions or genetically altered so that they are nonvirulent. One advantage of attenuated vaccines is a stronger immune response than an inactivated vaccine. As with any vaccine or medication, there are possible side effects. Attenuated vaccines should not be given to those who have a compromised immune system, such as those taking immune-suppressing drugs, cancer patients, or people diagnosed with HIV. Also, there is a slight possibility that the virus could revert to a virulent form and actually cause the disease it was developed to prevent.

10B.12
Some antiviral drugs are administered by nasal spray rather than injections or pills.

Antiviral Drugs

Once someone has a viral disease, the treatment must shift from prevention to control. Whereas antibiotics are quite effective in treating bacterial infections, they are ineffective in the treatment of viral disease. Researchers and physicians had to look elsewhere for effective medications.

In the 1950s, chemicals called **interferons*** (IN tur FEHR ahnz) were discovered. An interferon is a protein that is produced by an infected host cell and released when the cell bursts. It then binds to receptors on other cells, causing them to produce enzymes that inhibit viral replication. Researchers thought that a cure for viral diseases was close at hand; however, interferons were difficult to produce in large quantities and did not live up to initial antiviral expectations. Although today interferons are produced by recombinant DNA technology and are used for some viral diseases such as hepatitis B, interferons' effectiveness is still somewhat limited.

The identification of the human immunodeficiency virus in the 1980s prompted a renewed effort to develop antiviral medications. As the specifics of virus life cycles have been discovered, scientists have directed their efforts at blocking viral metabolism and enzymes. Drugs such as acyclovir and azidothymidine (AZT) are called **retroviral drugs** and are designed to stop the production of viral nucleic acids in retroviruses by inhibiting the reverse transcriptase enzyme.

Protease inhibitors are another class of antiviral drugs that attack a different aspect of viral metabolism—protein synthesis. Without the proteins needed for its capsid, the virus is inactivated.

Interferons, retrovirals, and protease inhibitors all work after the virus has infected the cell. In early 2003, the FDA approved a new class of drugs—**fusion inhibitors**. These drugs prevent viral infection by blocking HIV from entering a cell. Although these drugs are quite expensive (over $20 400 per year) and must be given as injections (shots), these medications offer some hope since HIV is rapidly developing resistance to other medications.

interferon: inter- (L. INTER, between or among) + -feron (FERIER, to strike)

Advances in Vaccine Technology

In 1997, scientists discovered a new way to make vaccines. They are called mRNA vaccines. mRNA vaccines contain the genetic code for a small protein in a virus. It does not contain the whole virus, like older vaccines do. The genetic code allows a person's cells to make the protein fragment found in the virus. When a person's body detects the foreign protein, it makes antibodies to destroy it. If the person is ever exposed to the actual virus, his body will already know how to fight it, and his body can quickly destroy the virus before it multiplies.

mRNA vaccines have been used to treat cancer, the flu, and Ebola. They have also been used to stop infectious disease, such as rabies, in animals. mRNA is fragile, so after it delivers the instructions to a person's cells, it breaks down and disappears from their body in about 72 hours. Because the mRNA in the vaccine is fragile, the vaccine must be stored at very cold temperatures to keep them from breaking down.

There are several advantages of using mRNA vaccines. They don't contain an active virus, so they are not infectious. Also, new mRNA vaccines can be designed and manufactured swiftly. Scientists don't have to grow the virus in a lab and then weaken it; they just need the genetic code of the virus and, in a few days, they can produce a vaccine. Viruses that are grown in the lab are grown on a material that contains eggs. If a person is allergic to eggs, they cannot receive some traditional vaccines. The new mRNA vaccines do not contain egg, so they are safe for people with egg allergies.