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PRODUCER
Cochran Communications

DIRECTOR
Peter Cochran

PROGRAM CONSULTANT
Frank Lowy, M.D.

TEACHER'S RESOURCE BOOK
Jennifer Wallace

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TABLE OF CONTENTS

Introduction	1
Learning Objectives	2
Program Summary	3

STUDENT ACTIVITIES

1: Virus Metaphors	5
2: Computer Virus	6
3. Viruses in the Movies	7
4: “Spanish” Influenza	8
5: Mad Cow Disease	9
6: Create a Virus Chart	10
7: The Virus as Parasite	11

FACT SHEETS

1: Glossary	12
2: Bibliography	15
Other Biology Programs	16

“The single biggest threat to man’s continued dominance on the planet is the virus.”

—**Joshua Lederberg, Nobel laureate and bacteriologist**

Microscopic viruses—far tinier than the smallest bacteria—have puzzled scientists since their discovery in 1930. Viruses are unique among microbes. They do not need food, cannot reproduce on their own and do not need oxygen as do other living things. They are neither truly living or dead.

Viral illnesses have plagued humans for centuries. Hundreds of millions of people have died in outbreaks of the viruses that cause small pox and influenza. On a smaller scale, almost everyone has suffered from the common cold, another viral affliction. Some viruses—like polio or measles—are more powerful. Thankfully, scientists have developed vaccines that boost our body’s ability to fight these diseases. Other viruses, such as HIV and Ebola, weaken the human immune system itself, making treatment difficult if not impossible.

The emergence and persistence of AIDS has proven that scientists have not won the war against viruses. This program investigates the history of medical science’s discovery of viruses and the efforts to combat their deadly effects. It investigates different types of viruses, their structures and the diseases they cause. The program concludes with a discussion of how the study of viruses has helped us to understand more about disease, the immune system and the relationships between humans and the global ecosystem.

LEARNING OBJECTIVES

After watching the video *Exploring Viruses* and participating in the activities in this Teacher's Resource Book, your students will be able to:

- describe how viruses are similar to and different from other living things
- describe the structure of viruses
- explain how viruses replicate
- explain how viruses cause disease
- describe different types of viruses

The video opens with a quick series of images and facts which summarize several viral epidemics of the 20th century: influenza, polio, AIDS and Ebola. A brief history follows, beginning with the discovery of bacteria by Anton van Leeuwenhoek (1632-1723).

Research continued for almost 200 years before the German doctor Robert Koch's experiments in the 1870's linked different kinds of bacteria to different diseases. Sixteen years later, chemist Adolf Mayer deduced (while studying the tobacco mosaic virus) that there must be a disease-causing agent different than bacteria. While scientists suspected the existence of viruses, they had no way of seeing them or understanding how they functioned until the invention of the electron microscope in 1930. Finally, we were able to see the wide variety of viruses with which we share the planet.

Round, rod-like or many sided, viruses do not have living cells. Instead, they have genetic material coded on a core of DNA or RNA. A protein coat (capsid and capsomeres) surrounds the core. Some viruses are also surrounded by a lipid or fatty envelope. Others have filaments extending outward from the envelope.

Viruses challenge our usual assumptions about what constitutes life. For instance:

- Like all living things, they interact with their environment.
- All other living things are comprised of cells; viruses are not.
- Other living things contain their genetic information in molecules of DNA. Many viruses contain their genetic information in DNA, but some, such as HIV, contain their genetic information in RNA.
- Living things can reproduce. Viruses reproduce too but they can't do this by themselves. In order to make more viruses they must take command of the reproductive machinery in the cells of other living things.

The program describes several other viral reproductive strategies including the budding process in HIV and lysogeny. In lysogeny, viral DNA combines with the DNA of the host cell. Viral reproduction occurs only when the host cell divides.

Disease occurs as viruses damage and kill the cells they invade. However, the body isn't defenseless against viruses. In some cases our immune system recognizes foreign invaders and manufactures antibodies to attack them. Scientists discovered they could fight certain viral infections by boosting the natural workings of our immune system. Vaccines were created which contain a weakened strain of certain viruses. The vaccine is injected and, in response, the immune system is stimulated to manufacture antibodies that remain in the

blood to attack subsequent invasions. Vaccines have been effective against viruses like polio and small pox.

Some viruses, however, can evade our defenses. Ebola multiplies so rapidly the immune system doesn't have time to kick in. Herpes lays dormant in nervous system cells to which the immune system doesn't respond. Influenza changes too quickly, making vaccines ineffective in a matter of years. Perhaps the most dangerous are viruses like HIV which attack the immune system itself, weakening the body so other diseases can take over.

In the years since viruses were first seen under the magnification of the electron microscope, we have learned much about our "tiniest and perhaps most complicated foe." Viruses have taught us how genes affect cell division, about the subtleties of our immune system, about the effects of human actions in the global ecosystem and, since viruses straddle the line between living and non-living, about life itself.

As Robin Henzig says in her 1993 book, [A Dancing Matrix: Voyages Along the Viral Frontier](#), "Maybe we are not the most favored (life form), but we're still among nature's most creative creatures. The challenge facing us in the next century will be to apply what we have learned about the basic blueprint of viral emergence..."

STUDENT ACTIVITIES

Name: _____

Science writer Peter Radetsky has described viruses as:

“...minute, wayward, and unruly parts of ourselves—something like adventurous teenagers who have fled the nest but just can’t resist coming back home at every opportunity...sometimes to overstay their welcome, sometimes to wreak absolute havoc, sometimes to make us better through their mere presence. And like loving parents, for better or for worse, we almost always leave them the key to the front door.”

From your understanding of viruses after watching this program, discuss the aptness of Radetsky’s analogy. Analyze the appropriateness of other metaphors used to describe viruses: *pirates of the cell, submicroscopic hijackers, a piece of bad news wrapped up in protein, or tropical punch.*

Create your own metaphors.

Name: _____

Analyze several contemporary treatments of infectious disease:

The movie *Outbreak*

The movie *The Andromeda Strain*

How are human attitudes toward disease portrayed?

What approach do they take to illustrate the cause of infectious disease?

Is there any discussion of our ethical responsibility for developing policies that might prevent epidemics?

Name: _____

Between 1918 and 1919, “Spanish” influenza was responsible for killing, by conservative estimate, more than twenty million people world-wide. In the United States, it killed more Americans than died in battle during all of World War I.

Compare Ellen Bryant Voight’s poem about the epidemic (below) to these lines from Sinclair Lewis’ Arrowsmith, in which Dr. Almus Pickerbaugh says,

*Sell your hammer and buy a horn,
But hang onto the old fly-swatter.
If you don’t want disease
sneaking into the Home
Then kill the fly you gotter!*

“Kyrie,” by Ellen Bryant Voight

*How we survived: we locked the doors
and let nobody in. Each night we sang.
Ate only bread in a bowl of buttermilk.
Boiled the drinking water from the well,
clipped our hair to the scalp, slept in steam.
Rubbed our chests with camphor, backs
with mustard, legs and thighs with fatback
and buried the rind. Since we had no lambs
I cut the cat’s throat, Xed the door
and put the carcass out to draw the flies.
I raised an upstairs window and watched them go—
swollen, shiny, black, green-backed, green-eyed—
fleeing the house, taking the sickness with them.*

On a separate sheet of paper, write your own poems from several points of view: someone who is ill with an infectious disease, a family member, a loved one, a doctor, a research scientist, or a reporter.

Name: _____

Mad cow disease, a viral illness found mostly in British live-stock, emerged as part of the agricultural industry's response to certain economic pressures. For many years, cattle food was mixed with protein derived from sheep. The protein was obtained as a by-product of another process used to obtain fat from sheep. This fat was used to manufacture wax. When prices for wax were high, expensive solvents were used to process the sheep carcasses. This solvent apparently killed a naturally-occurring virus that had co-existed with sheep without causing disease. After wax prices fell, expensive solvents were no longer used. As a consequence, the virus was not killed and made its way into the cattle feed, infecting thousands of cows with a disease that attacks brain cells. This is an example of the transfer of a virus that once co-existed with one species but then leaped to another species with disastrous effects.

What does the emergence of mad cow disease illustrate about the consequences of human actions?

Can you think of other examples where the economic demands of human manufacturing needs have changed the balance in an ecosystem resulting in the emergence of disease?

Name: _____

On a separate sheet of paper, make a chart of the following viruses and identify the following facts for each:

1. how the disease is caused
2. the way(s) that it is spread
3. which organ systems are attacked
4. physical symptoms
5. available vaccine
6. treatment
7. usual outcome

VIRUS LIST:

Adenoviruses

Influenza

HIV

Rubella

Mumps

Herpes

Smallpox

Rabies

Polio

Hepatitis A

Hepatitis B

Hepatitis C

FACT SHEETS

Name: _____

Adenovirus: Belonging to the group of DNA Tumor viruses which neutralize a cell's suppressor genes, resulting in cancer.

AIDS: Acquired Immune Deficiency Syndrome. A fatal sexually transmitted virus infection caused by HIV. The virus slowly destroys the function of the body's immune protective system, leading to uncontrollable infections, brain damage and other destructive body processes.

Antibodies: Special molecules formed by our bodies to help fight off foreign invaders such as viruses.

Antigens: Chemical "markers" on the surface of a virus which the immune system recognizes as "foreign." In response, antibodies are created which destroy or immobilize the antigens.

Bacteria: One-celled plantlike microorganisms often classified by shape (spherical, spiral, rod-like, or comma shaped). Some bacteria perform essential decomposition functions within ecosystems. Others can enter the body and cause infections and diseases.

Bacteriophage: Viruses that attack bacteria.

Bubonic Plague: An infectious disease transmitted by bacteria carried by fleas; it wiped out one-third of Europe's population between 1346 and 1350.

Budding: Process of the cell membrane forming an envelope that surrounds the capsid; occurs as HIV exits a cell.

Cancer: Uncontrollable cell growth producing tumors that invade normal tissues.

Capsid: A coat of protein surrounding the core genetic material of a virus.

Capsomeres: Smaller bits of protein making up a capsid.

Cells: The smallest self-contained unit of life. Our bodies are made up of billions of cells grouped together to form organs and body tissues.

DNA: Deoxyribonucleic acid. A complex substance found in every cell of the body, containing all the genetic material necessary for guiding all gene-directed processes in a living thing.

Name: _____

DNA Tumor viruses: A group of viruses attacking a cell's suppressor genes, resulting in cancer.

Ebola: A virus attacking the body's tissues and organs.

Electron microscope: An instrument using a beam of electrons rather than light for magnification, enabled scientists to see and decipher the structure of viruses.

Epidemic: An outbreak of disease spreading rapidly and affecting a large portion of a population at one time.

Filterable virus: A term used in the late 1800's to describe disease-causing microorganisms capable of passing through a bacteria-trapping filter; too small to be seen with ordinary light microscopes.

Gene: Portions of DNA molecules which carry a "code" of information passed on from one generation of the cell to the next.

Genetic code: All the coded information carried by a DNA molecule that directs the form, size, shape, function and behavior of a species.

Helical: Spiral shaped; like the tobacco mosaic virus.

Icosohedral: A virus with a twenty-sided shape.

HIV: Human Immunodeficiency Virus; the virus that causes AIDS.

Immune System: A system of the body composed of various white blood cells, proteins, antibodies and other chemicals that recognize foreign substances in the body and attack them to immobilize or destroy them; the body's first and main line defense against infections.

Influenza: A quickly changing virus for which vaccinations are not effective in the long-term; responsible for killing as many as ten million people in the world-wide epidemic of 1918-19.

Lipid Envelope: Coating on some viruses of fatty organic compound (oils, fats, waxes, steroids) which make up cell membranes and store energy as well as control body functions.

Lysis: Rupturing of the cell wall by the bacteriophage virus, resulting in the cell's death.

Name: _____

Lysogeny: The process through which viral DNA may be incorporated into the host's DNA.

Mutation: An inheritable change in a cell or virus caused spontaneously or by known outside influences.

Polio: The virus causing paralytic poliomyelitis, a disease of the spinal cord causing paralysis (most common in children) resulting from damage to the nervous system.

Protein: Large, nitrogen-containing organic compounds forming the major building blocks of cells and tissues in all living organisms.

Reverse transcriptase: An enzyme common to retroviruses enabling the transcription of viral RNA to a cell's DNA; it later directs a cell's production of new viral proteins, causing cell death and crippling the immune system.

Retrovirus: A group of viruses of which HIV is a member; it does not have DNA but has two strands of RNA capable of copying genetic information and forming a new viral DNA from the host's DNA.

RNA: Ribonucleic acid, a form of nucleoprotein found in all living cells where it controls protein synthesis and the transmission of genetic information.

Suppressor genes: Prevent cells from dividing uncontrollably; DNA tumor viruses (adenovirus) can neutralize these genes, resulting in cancerous uncontrolled cell division.

T-cells: Cells playing an important role in the immune system; these are cells attacked by the HIV virus.

Vaccine: A fluid containing a weakened form of a particular virus, which is injected into the body to give immunity from disease caused by that virus.

Virus: The simplest living organisms, tiny particles lacking cell structure and consisting only of genetic material encased in protein. Viruses can only reproduce inside a host cell and are capable of manipulating the host cell to promote their own reproduction. Many infectious diseases—AIDS, polio, rabies and smallpox—are caused by viruses.

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