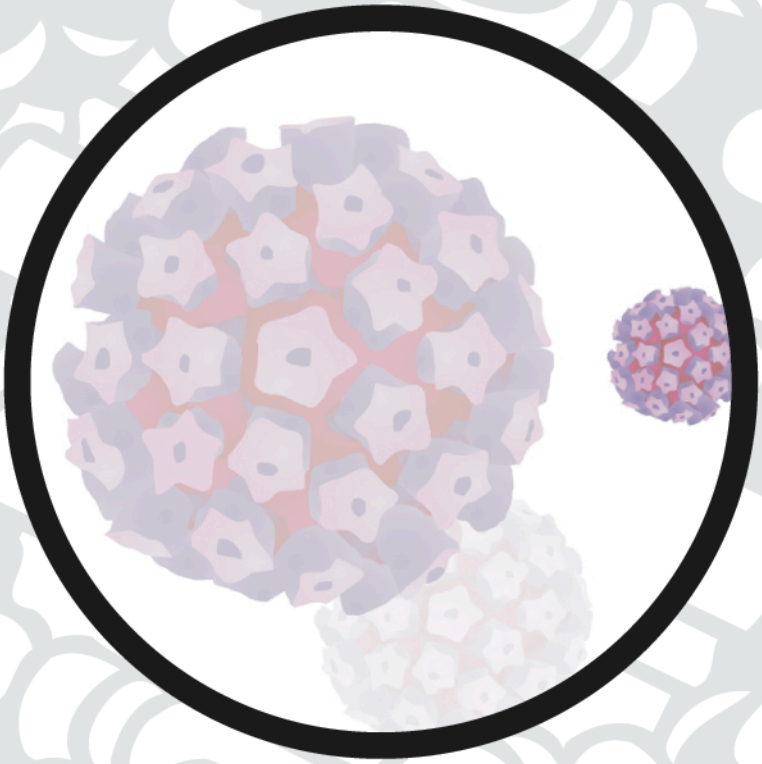
Dolan
DNA Learning Center
www.dnalc.org

# Viral Infection



**Background**

**History**

Edward Jenner was a doctor and researcher who lived in England during the late 19th century. He is remembered today as "the father of immunology". One of his greatest accomplishments was discovering and naming the first vaccine for smallpox. Smallpox was the most feared and greatest killer of Jenner's time. In today's terms it was as deadly as cancer or heart disease. Smallpox is caused by the virus *variola*. It enters the body through the lungs and is carried in the blood to the internal organs, which it infects. The virus then spreads to the skin where it multiplies, causing a rash. In severe cases patients die of blood poisoning, secondary infections or internal bleeding. There is no effective treatment once infection has taken place. Jenner called it the Speckled Monster.

Like any other doctor of the time, Edward Jenner carried out variolation to protect his patients from smallpox. This process of scratching into the skin scab material from someone with a mild form of smallpox was not a precise science and deaths from variolation were not uncommon. However, from the early days of his career Edward Jenner had been intrigued by country-lore, which said that people who caught cowpox from their cows could not catch smallpox. This and his own experience of variolation as a boy and the risks that accompanied it led him to undertake the most important research of his life.

Cowpox is a mild viral infection of cows. It causes a few pocks on their udders, but little discomfort. Milkmaids occasionally caught cowpox from the cows. Although they felt rather ill for a few days and developed a small number of pocks, usually on the hand, the disease did not trouble them. In May 1796 a dairymaid, Sarah Nelmes, consulted Jenner about a rash on her hand. He diagnosed cowpox rather than smallpox and Sarah confirmed that one of her cows, a Gloucester cow called Blossom, had recently had cowpox. Edward Jenner realized that this was his opportunity to test the protective properties of cowpox by giving it to someone who had not yet suffered smallpox. He chose James Phipps, the eight-year old son of his gardener. On May 14th he made a few scratches on one of James' arms and rubbed into them some material from one of the pocks on Sarah's hand. A few days later James became mildly ill with cowpox but was well again a week later. So Jenner knew that cowpox could pass from person to person as well as from cow to person. The next step was to test whether the cowpox would now protect James from smallpox. On July 1st Jenner variolated the boy. As Jenner anticipated, and undoubtedly to his great relief, James did not develop smallpox, either on this occasion or on the many subsequent ones when his immunity was tested again. Edward Jenner was the first to coin the term *vaccine*, which has its roots in the Latin term for cow, *vacca*.

Jenner followed up this experiment with many others. In 1798 he published all his research into smallpox in a book entitled *'An Inquiry into the Causes and Effects of the Variolae Vaccinae; a Disease Discovered in some of the Western Counties of England, Particularly Gloucestershire, and Known by the Name of The Cow Pox'*. In each of the next two years he published the results of further experiments, which confirmed his original theory that cowpox did indeed protect against smallpox.

**Infectious Diseases vs. Genetic Diseases**

An infectious disease can be passed between humans and animals. It can be caused by a variety of microbes, known as pathogens, such as bacteria, viruses, and parasites that are transmitted via a host. A pathogen technically does not have to be an organism or virus. A pathogen can be any component of the physical environment, including adverse climate, soil, or air relations. While an infectious disease can be "caught" and is caused by foreign matter entering our bodies, a genetic disease is the result of a mutation or a change in the sequence of DNA, which encodes a gene. These mutations are inherited, or passed on through generations, and are not contagious.

**Viruses and Bacteria**

While bacteria and viruses can both cause infectious diseases, they are two very different types of pathogens. All bacteria are members of the kingdom *Monera* and share certain characteristics but they live in a variety of environments. All bacteria are prokaryotic. Prokaryotic organisms do not have a nucleus surrounding their DNA. It floats freely in the cytoplasm of the cell. All bacteria are also unicellular, or only comprised of one cell and microscopic in size. A single bacteria cell is referred to as a bacterium. The size of a single bacterium can range from one to ten micrometers. There are three basic shapes common among bacteria. A spherical shape is called a **coccus** (plural cocci, from a word meaning berries). A rod shape is a **bacillus** (plural, bacilli, meaning small staffs). A cell body with one or more twists is a **spirillum** (plural, spirilla). All bacteria can reproduce on their own through either a process known as budding or through prokaryotic fission. Prokaryotic fission results in two identical daughter cells formed from one parent cell.

Not all bacteria are considered dangerous. About ninety five percent of known bacteria are harmless to humans. Many that are considered beneficial are used in the production of dairy products as well as other food products. Butter is made from pasteurized (sterilized) cream, to which a lactic acid starter has been added. The starter contains, for example, *Streptococcus cremoris* or *S. lactis*, but requires *Lactobacillus diacetylactis* to give it its characteristic flavor and odor. Cheese is often made with *Streptococcus* and *Lactobacillus* bacteria. Fermentation lowers the pH, thus helping in the initial coagulation of the milk protein, as well as giving characteristic flavors. In such Swiss cheeses as Emmentaler and Gruyere, the typical flavor is the result of the use of Propionibacterium. Yogurt usually requires the addition of *Lactobacillus bulgaricus*, *Lactococcus thermophilus*, and/or *Streptococcus thermophilus* to the milk. Meat products, like salami and bologna sausages, require some fermentation with *Pediococcus cerevisiae*, *Lactobacillus plantarum* and some members of the genus *Bacillus*. Country cured hams use fungi of the genus *Aspergillus* and the genus *Penicillium* in their fermentation process. Izushi (sushi), a Japanese delicacy made from a mixture of fish, rice, and other vegetables is produced by fermentation with lactobacilli.

*Escherichia coli*, abbreviated *E. coli*, is a bacterium that is normally found in the large intestine of humans. Most *E. coli* strains are harmless and even beneficial to us because they serve a useful function in the body by stopping the growth of other harmful bacteria species and by making necessary vitamins for us.

About five percent of all known bacteria are considered harmful and can enter our bodies through different pathways. Cuts and abrasions on our skin, our mouths, noses and eyes are all doorways for invaders.

Viruses can be between hundredth and thousandth the size of a bacterium and are defined as non-cellular infectious agents that have two major characteristics. First, a viral particle consists of a protein coat, called a capsid, wrapped around a core of genetic material (either DNA or RNA). A virus that contains only RNA as its genetic material is called a retrovirus. Second, a virus is unable to reproduce itself on its own. It can be reproduced only after it lands on a host cell and injects its genetic material into it.

Viruses appear in several different shapes referred to as **icosahedrons.** These shapes fit specific cell receptors. Viruses can infect virtually all types of cells and each kind of virus can multiply only in certain hosts. The virus that causes the common cold is a type of **rhinovirus** (rhin is Greek for nose) and only infects cells that make up our sinus walls. Some viruses only infect plant cells. One example is the harmless tulip mosaic virus, which causes "color breaking" in tulips by affecting pigment forming cells, giving them a beautiful, "paint-splashed" appearance. **Bacteriophage** (phage meaning to eat in ancient Greek) are viruses that only infect bacteria cells. These complex viruses, such as T-even bacteriophage, have additional structures attached to their protein coats, which act like "landing gear" for when they land on a bacteria cell and attach to the cell receptors on the outer surface of its membrane. Some other diseases that are caused by viruses are chicken pox, measles, flu and mumps.

**Viral Infection of Cells**

When a virus injects its genetic material into a host cell, a series of events follows. The genetic material instructs the cell's machinery to replicate and synthesize new virus parts. New viruses are assembled within the host cell. Then, the host cell undergoes lysis, bursts open, and the new viruses are released to infect surrounding cells. This cycle of infection is called the **lytic pathway**. Another cycle known as the **lysogenic pathway**, includes a period of latency in which the virus does not kill its host cell outright. Instead, the viral genes are integrated into the host's chromosomes. When the host cell divides, the viral genes are passed onto the daughter cells. The cells may divide millions of times, essentially creating a time bomb effect. At some point, a molecular signal or some other environmental stimulus reactivates the cycle and lysis occurs. The human immunodeficiency virus (HIV) is an example of a virus that undergoes the lysogenic pathway. It targets white blood cells, which function as part of our immune system. The virus may remain dormant for years with the host unaware of the infection unless he or she is tested. If left unchecked, HIV can lead to acquired immune deficiency syndrome (AIDS) and is characterized by a severely impaired immune system and its related opportunistic infections. In essence, a virus has to "hijack" a cell to carry out its reproduction. This along with the fact that viruses don't eat, grow, or move, and are not made of cells, has led scientists to the conclusion that they are not living organisms.

**The Immune System**

The human body has a complex system of physical, chemical, and cellular defenses against pathogens that can damage it. This is the immune system. It provides several lines of defense against invaders. Foreign matter that enters our bodies referred to as an antigen. Antigens are can sometimes cause an immune response in our bodies. Our first line of defense is our skin. Our skin cells make a thick dead cell layer. It is impossible for germs to penetrate it. The cells that are found in our noses and down our lungs are lined with microscopic hairs called cilia that can sweep away pathogens. Another example of a physical defense is when a cold virus infects our inner nose cells, they make sticky mucus to trap these invaders and flush them out. The body has an immune response to the virus and tries to flush it out with mucus. There are several other physical means for blocking pathogens. When a pathogen gets through our physical defense mechanisms and enters our bodies they have to deal with our second line of defense, our white blood cells. White blood cells are made in our bone marrow.

There are three main categories of white blood cells. The first are fast-acting cells called neutrophils. Neutrophils are found throughout the blood stream. They have a non-specific response to anything perceived as an invader. They stick to the walls of the blood vessel nearest to the invader. Then they squeeze their way between the blood vessel cells and move towards the antigen. They quickly engulf and destroy the antigen and in the process, destroy themselves as well. Because of this, they are sometimes called "kamikazes".

The second category of white blood cells is also non-specific in their targets. They are called macrophages. Macrophages are sometimes called "big eaters" because they engulf and digest any foreign invader through a process called phagocytosis. Macrophages usually don't die when they engulf an antigen and are able to continue the process.

The third group of white blood cells, called lymphocytes, only targets specific pathogens. Lymphocytes can be broken down into two groups called B-cells and T-cells. B-cells produce molecular "markers" called antibodies that bind to the surface receptors of specific antigens "tagging" them as invaders. Once the antigen is tagged with antibodies it is unable to infect our cells. All of our body's cells are covered with their own molecular markers so that macrophages and neutrophils recognize them as "self" (our own cells). Invading cells, antigens, don't have these markers and are recognized as "non-self". When lymphocytes recognize cells that are "non-self", our T-cells are stimulated to divide through mitosis, forming an army. These cells signal the other cells that make up our immune system to attack the antigen. Once our lymphocytes have made antibodies for a specific antigen, our bodies always have them ready in the event that it invades us again.

Viruses and bacteria are not the only things that our bodies recognize as invaders. Many allergic reactions are caused by harmless particles of dust or pollen entering the body through the nose. The sneezing, itching, and watery eyes that some people get during allergy season are caused by the immune system treating the harmless foreign matter as if it is a bacterium or a virus.

Some people are born an immune system that doesn't work properly. SCIDS (severe combined immunodeficiency syndrome) is an example of a genetic disease that hinders your immune system. It is usually characterized by a severe defect in both the T-cell & B-cell lymphocyte systems. Children born with SCIDS are in danger of contracting serious infections within the first few months of their lives. These infections are usually life threatening. In recent years, treatments have been developed for children living with SCIDS. It usually involves weekly injections that deliver genetically modified versions of their own bone marrow cells. This boosts their immune system's ability to combat disease and allows them to lead normal healthy lives.

# Viral Infection

## Description of Activity

In this one-hour activity for students in grades 5-8, children are provided with the opportunity to learn about the reproductive cycle of viruses by infecting harmless *E.coli* bacteria with the T4 bacteriophage and observing the results. This is also an opportunity to discuss with students the difference between genetic and infectious disease.

## Learning Outcomes

Students will:

- describe the difference between genetic and infectious disease.
- describe how and why viruses infect cells.
- discuss the history of vaccines and their role in disease prevention.
- explain the function of major components of the immune system.
- compare and contrast the structure and function of bacteria and viruses.
- work collaboratively to infect E.coli cells with the T4 bacteriophage and observe the results.

## Assumptions of Prior Knowledge

Students should have a basic understanding of genetics and inheritance, as well as, the life cycle of the prokaryotic cell. An introduction to the reproductive cycles of viruses is also helpful.

## Misconceptions

It may be difficult for students to distinguish the difference between genetic and infectious diseases. A disease that can be "caught" is an infectious disease. Genetic diseases are not contagious.

Possible misconception question: Are viruses living things like bacteria? Viruses have genetic material, but it is enclosed in a protein coat and not in a cell. The only way a virus can reproduce is by infecting living cells, because a virus lacks the cellular machinery necessary to replicate itself.

## Lesson

### Materials and Equipment (for every student pair)

- Petri dishes with LB agar (2 per group)
- Sterile plastic spreaders
- Clear, empty 1.5ml eppendorf tubes (1 per group)
- Temperature controlled water bath (for the whole class)
- Plastic beakers (1 per group)
- Small tube racks (1 per group)
- 100-1000µl micropipettors (1 per group)*
- Pipette tips (1 box per group)*
- Permanent markers (1 per group)
- Masking tape (1 per group)

If micropipettors are unavailable, plastic transfer pipettes (droppers) can be substituted

### Reagents

- 200ul aliquots of E.coli B (2 per group)
- 12uL aliquots of T4 bacteriophage (1 per group)

### Recipes

#### Luria-Bertani (LB) Broth (1L)

- 10g Tryptone
- 5g-yeast extract
- 10g NaCl
- 875µl 4N NaOH (4g NaOH /100ml of $dH_2O$)
- Mix ingredients into 1L of $dH_2O$.
- Pour into glass bottles (100ml each).
- Autoclave for 25 minutes.

#### Basic *E.coli B* overnight culture

- Aliquot 2ml of sterile LB broth into a 15ml "snap-cap" tube.
- Use a sterile, medium-size pipette tip to pluck a colony from a fresh plate of desired bacteria.
- Eject tip directly into LB aliquot.
- Incubate tube overnight at 37°C in a SHAKING incubator. Make sure tube caps are loose so that cells can aerate.

**Luria-Bertani Agar**

- 10g Tryptone
- 5g yeast extract
- 10g NaCl
- 875µl 4N NaOH (4g NaOH /100ml of $dH_2O$)
- 15g Bacto-agar
- Mix ingredients into 1 liter of $dH_2O$
- Autoclave for 25 minutes
- Let solution cool to 55°C and pour into sterile petri plates.
- After agar cools and solidifies, store upside-down in the refrigerator.

**Purchasing Information**

- Eppendorf tubes (various colors) - USA Scientific
- Petri plates - Fisher Scientific
- Transfer pipettes -VWR International
- Sterile plastic spreaders - USA Scientific
- E. Coli B - Carolina Biological Company
- T4 Phage - Carolina Biological Company
- Miscellaneous chemicals – Fisher scientific

**Before Class**

- Photocopy the corresponding student worksheets.
- Grow overnight cultures ( 8mL) of E.coli B in a shaking incubator at 37° C.
- Prepare aliquots of *E.coli* B and T4 bacteriophage.
- Set water bath to 37°C.
- Distribute the beakers, tube racks, markers, tape, pipettes, and pipette tips to each student station.

**During Class**

- Provide each student pair with a protocol.
- Review the history of viruses and vaccination. Focus on the work done by Edward Jenner.
- Discuss the components of the immune system and the different invaders it defends against. Make sure to impress upon students that any foreign body is considered an antigen (mold, bacteria, viruses, protists).
- Explain to students why viruses are not considered living organisms. It is helpful to draw a chart on the board comparing and contrasting viruses and bacteria.
- Discuss how different viruses infect different kinds of cells. For example, some might only infect plant cells while others only infect human cells, but all viruses use a host for the same purpose: reproduction. Point out that the *E.coli* B strain is harmless, not the strain that causes food poisoning. Also, the virus used in this experiment can only infect this strain of bacteria. It too, is harmless to humans.
- Explain to students that bacteriophage infect bacteria by "hijacking" an individual cell. The virus can then go through two different "life" cycles, the lytic cycle and the lysogenic cycle. Sometimes when viral DNA is inserted into a host cell it can be incorporated into the host genome for a period of time, before viral replication begins.
- Before beginning the experiment, discuss sterile technique with the students. Describe AND demonstrate clam-shelling petri plates to prevent contamination.
- Ask students to read steps 1-3 out loud, and demonstrate. When the bacteria and virus are combined, make sure to gently tap the tube to mix, label with your initials and place in the 37°C water bath. Ask students why the tubes are placed in the water bath.
- For the experiment, divide students into groups of two. Give each group copies of the handouts. Direct students to follow the instructions on their worksheets
- When handing out the plates to each group, place them on the table upside down. Tell the students not to open them, but to label the bottom of each plate with their initials, their partner's initials and the date. Also, label one plate + virus and the other plate - Virus. The plus plate will be the experiment and the minus plate will be the control.
- After incubation, students can use the clam-shelling technique to plate the "+" tube onto the "+" plate, and the "-" tube onto the "-" plate. Make sure that students use sterile spreaders to evenly disperse the bacteria over the entire agar surface inside each dish.
- Ask students to tape both plates together using masking tape, and store plates upside down in a 37°C incubator overnight. If an incubator is unavailable, store pates upside down at room temperature for 24-48 hours.
- On the results worksheet, have students predict what they think each plate will look like once the bacteria have grown.

## Analysis and Discussion

- When bacterial growth is visible, it should appear as a lawn, covering the entire agar surface. The control plate ("-") should have an uninterrupted lawn. The experiment plate ("+") should have a lawn with small pinhole sized areas of inhibited growth called plaques. Plaques are areas where the bacterial cells

died due to viral infection. If the plaques are difficult to see, hold the plate up to a light.

- Ask students if there is any way to mathematically quantitate how many bacterial cells have died. Theoretically, each plaque is an area where an infected cell produced viruses, which spread outward to infect surrounding cells.
- Ask students to hypothesize what might happen if the experiment plates were left for a few more days. Would there be any change in the plaques, and if so, why? What might have happened if the tubes weren't incubated before they were spread over the agar surface?
- Discuss the possible use of bacteriophage in the treatment of bacterial infections. Some researchers believe that doctors might some day use these viruses to combat the growing number of antibiotic resistant strains of bacteria. Are there any problems that might be encountered if this were tested in an animal with a functional immune system?

## Further Explorations

Students can learn about the use of viruses in genetic research using the DNA Interactive Internet site. Using viruses, scientists were able to learn a great deal about the DNA molecule and how it functions.
Go to: www.dnai.org/timeline/index.html < Hershey and Chase, to learn about a famous blender experiment.
Go to: www.dnai.org/timeline/index.html < Baltimore and Temin, to learn about retroviruses.

Encourage students to think of other antigens that may cause immune responses in the body. Viruses and bacteria are not the only things that our bodies recognize as invaders. Many allergic reactions are caused by harmless particles of dust or pollen entering the body through the nose or mouth. The sneezing, itching, and watery eyes that some people have during allergy season are caused by the immune system!

Students can individually research different viral infections from chicken pox to the common cold, and present their findings to the class. What does each virus look like? How does this virus infect a host cell? What kind of host cell will the virus infect? Is there a vaccine for this viral infection? Why or why not?

After studying viral reproduction and specificity, ask students to propose treatments and/or cures for viral infections such as HIV, which currently are incurable and/or fatal.

Discuss the recent smallpox scare in the United States. There are two known samples of the smallpox virus left in the world. Many believe that they should have been destroyed with the worldwide eradication of smallpox, while others disagree. Ask students to debate the pros and cons of such a decision.

## Resources

### Internet Sites

www.dnai.org/timeline/index.html
A Dolan DNA Learning Center Internet site. This is a timeline of important discoveries in DNA science.

www.seyet.com/t4phage/leiman-et-al.movie-2.mov
A great 3-D animation of bacteriophage infection.

http://www.virology.net
*The Big Picture Book of Viruses*
This site has some great electron micrographs of viruses.

### Films

"Understanding: Bacteria"
Discovery Channel School (1997), Discovery Communications Inc.
http://school.discovery.com

"Understanding: Viruses"
Discovery Channel School (1997), Discovery Communications Inc.
http://school.dicovery.com

### Books

Cell Wars. Dr. Fran Balkwill. Carolrhoda Books, Inc., 1993.

Germ Zappers. Fran Balkwill and Mic Rolph. Cold Spring Harbor Laboratory Press, 2002.

Microbes Bugs and Wonder Drugs. Fran Balkwill and Mic Rolph. Cambridge University Press, 1995.

Viruses. Arnold J. Levine. Scientific American Library.1992

## Correlations

**New York State**
NYS Standard 4: The Living Environment

- Living things are both similar to and different from each other and nonliving things.
- Individual organisms and species change over time.

**National**
Content Standard C: Life Sciences
Diversity and Adaptations of Organisms

- Millions of species of animals, plants, and microorganisms are alive today. Although different species might look dissimilar, the unity among organisms becomes apparent from an analysis of internal structures, the similarities of their chemical processes, and the evidence of common ancestry.
- Biological evolution accounts for the diversity of species developed through gradual processes over many generations. Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations. Biological adaptations include changes in structures, behaviors, or physiology that enhance survival and reproductive success in a particular environment.
- Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival. Fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on earth no longer exist.

Content Standard G: History and Nature of Science
History of Science

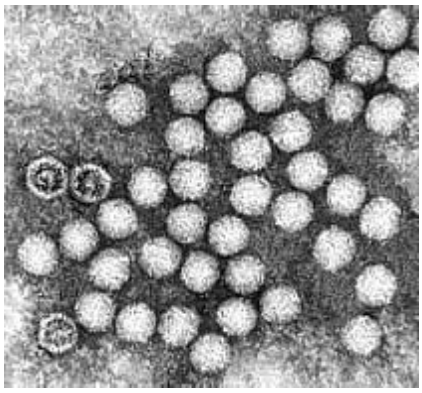
- Many individuals have contributed to the traditions of science. Studying some of these individuals provides further understanding of scientific inquiry, science as a human endeavor, the nature of science, and the relationships between science and society.
- In historical perspective, different individuals in different cultures have practiced science. In looking at the history of many peoples, one finds that scientists and engineers of high achievement are considered to be among the most valued contributors to their culture.
- Tracing the history of science can show how difficult it was for scientific innovators to break through the accepted ideas of their time to reach the conclusions that we currently take for granted.

**AAAS Benchmarks**
Chapter 10. Historical Perspectives
Standard I: Discovering Germs

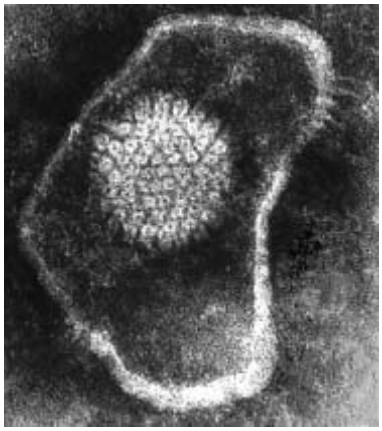
- Throughout history, people have created explanations for disease. Some have held that disease has spiritual causes, but the most persistent biological theory over the centuries was that illness resulted from an imbalance in the body fluids. The introduction of germ theory by Louis Pasteur and others in the 19th century led to the modern belief that many diseases are caused by microorganisms-bacteria, viruses, yeasts, and parasites.
- Pasteur wanted to find out what causes milk and wine to spoil. He demonstrated that spoilage and fermentation occur when microorganisms enter from the air, multiply rapidly, and produce waste products. After showing that spoilage could be avoided by keeping germs out or by destroying them with heat, he investigated animal diseases and showed that microorganisms were involved. Other investigators later showed that specific kinds of germs caused specific diseases.
- Pasteur found that infection by disease organisms-germs-caused the body to build up immunity against subsequent infection by the same organisms. He then demonstrated that it was possible to produce vaccines that would induce the body to build immunity to a disease without actually causing the disease itself.
- Changes in health practices have resulted from the acceptance of the germ theory of disease. Before germ theory, illness was treated by appeals to supernatural powers or by trying to adjust body fluids through induced vomiting, bleeding, or purging. The modern approach emphasizes sanitation, the safe handling of food and water, the pasteurization of milk, quarantine, and aseptic surgical techniques to keep germs out of the body; vaccinations to strengthen the body's immune system against subsequent infection by the same kind of microorganisms; and antibiotics and other chemicals and processes to destroy microorganisms.
- In medicine, as in other fields of science, discoveries are sometimes made unexpectedly, even by accident.

# What's A Virus?

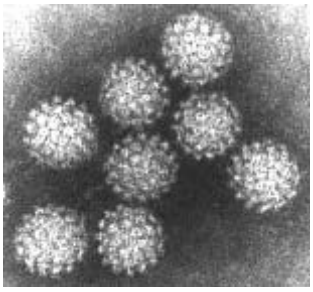
A virus is a protein package containing genetic material, either in the form of DNA or RNA. Viruses don't eat, grow or move and are not made of cells. For these reasons viruses are considered non-living. A virus is only able to reproduce by infecting another cell host. When a virus infects a host cell, it transfers its DNA or RNA. The host then becomes a virus factory. Different viruses can infect different types of cells, such as plant, animal (including humans) and bacterial cells. Notice that different viruses have very different shapes.



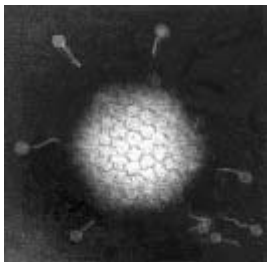
Enteroviruses - cause intestinal infections



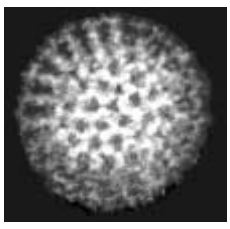
Herpes Virus - causes cold sores



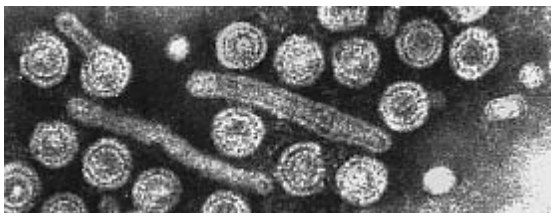
Papillomavirus - causes warts



Adenovirus - causes the common cold

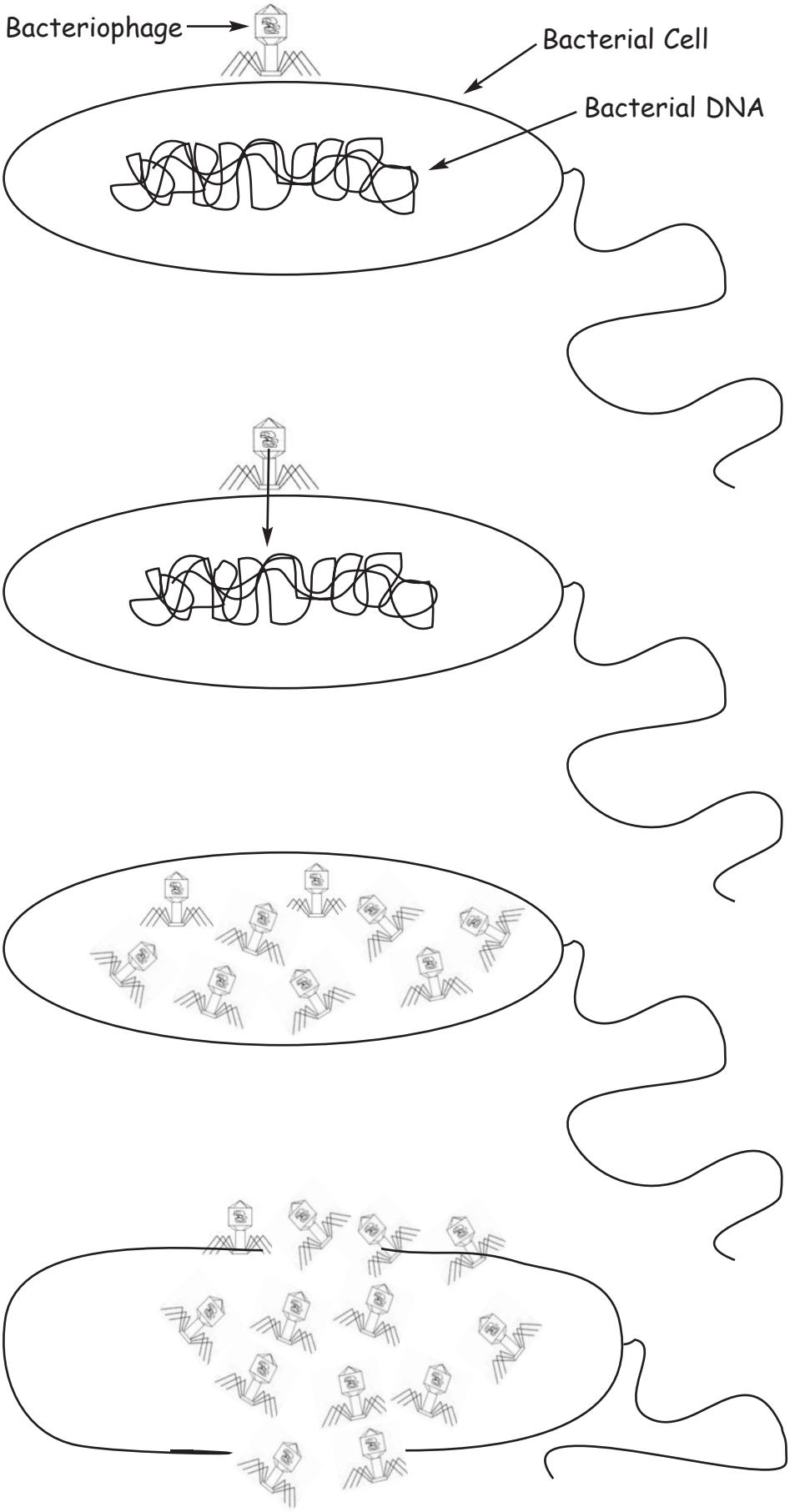


Rotavirus - causes intestinal infections



Hepatitis B virus - causes liver infections

# How Can Bacteriophage Reproduce?




**The Lytic Cycle**

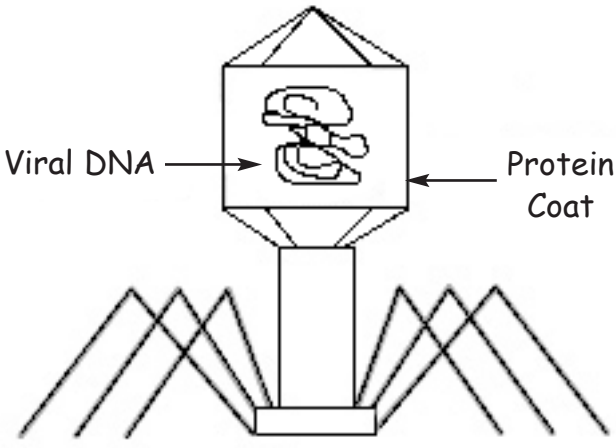
The bacteriophage lands and "docks" on the bacterial cell membrane.

After docking on the cell, the bacteriophage inserts its DNA into the bacterial cell. This DNA contains the instructions for the bacterial cell to make more bacteriophage.

When the cell receives the DNA instructions it starts to make thousands of new bacteriophage.

Eventually the cell fills up with bacteriophage and bursts. This is called **lysis**. The newly produced bacteriophage can now infect other cells.

# Viral Infection




A bacteriophage is a virus that infects bacteria.

In this experiment you will be infecting bacterial cells with a virus called a **bacteriophage** ("bacteria eater"). "Bacterio" refers to bacteria and "phage" means to eat, so a bacteriophage is a virus which "eats" bacteria. When bacterial cells are infected with this virus they will manufacture new viruses until they fill up and eventually burst. The bacterial cell is destroyed, and the new viruses go on to infect more bacterial cells.

## Procedure

1. Label two tubes containing *E.coli B* "+" and "-". Write your initials and your partner's initials on both tubes.

2. Use a micropipettor to add **10 ul** of bacteriophage to the "+" tube. Shake well to mix the virus with the bacteria.

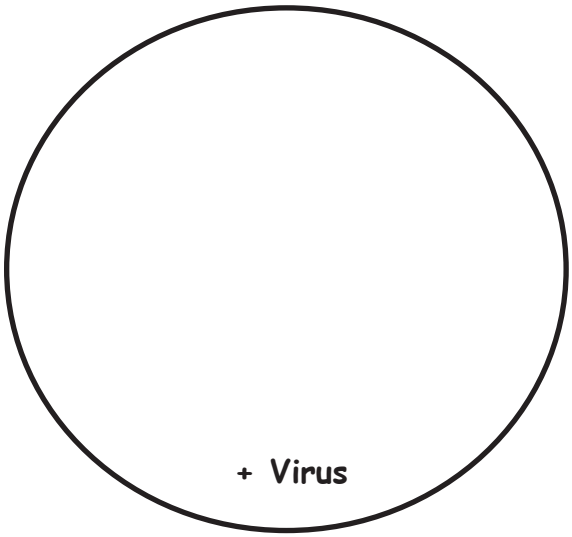
3. Place both tubes in a 37°C (98.6°F) water bath for 10 minutes.

4. Use a permanent marker to label one Petri plate " **+ Virus** " and the other " **- Virus** ". Be sure to label both plates with your partner's initials & your own.

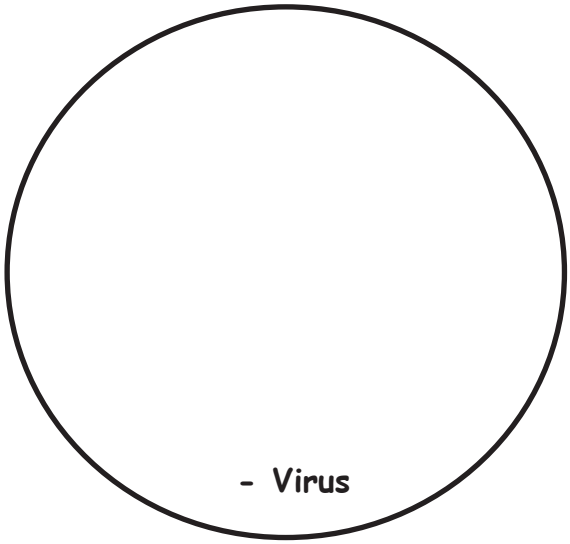
5. Transfer the bacteria & virus from the "+" tube onto the Petri plate labelled " + Virus". Transfer the bacteria from the "-" tube onto the plate labelled " - Virus ". Remember to **clamshell** your plate.

6. Gently spread the bacteria and virus mixtures over the Petri plates using a sterilized spreader. Remember to **clamshell** your plate.

# What results do you expect?




*E.coli B* with virus




*E.coli B* with NO virus