

## VIRUSES

Viruses are not classified in any kingdom yet because they are not really alive. They only show signs of life after they infect a host cell.

Virus: lifeless particle that does not carry out any METABOLIC functions on its own and CANNOT REPRODUCE on its own until it invades a living HOST cell

### Viral history:

Viral history is relatively short. It begins with the isolation of the human influenza virus in the 1930s and crystallization of the tobacco mosaic virus in 1933, and moves through the identification of HIV as the cause of AIDS in 1983 and the mapping of the structure of the common cold virus in 1985. It continues today with the discovery of the corona virus as the causative agent in severe acute respiratory syndrome (SARS) in 2003. None of the emerging and re-emerging infectious diseases of the past 25 years, from HIV/AIDS and hepatitis C to Sin Nombre (Hantavirus) and West Nile, is close to eradication or control. Experts predict that the diseases will spread and grow more virulent.

Viruses constantly mutate and change, and for this reason, infectious disease experts worry about a new flu pandemic. The worst pandemic in history, the Spanish Flu of 1918–1919, killed at least 20 million people, including about 30 000 Canadians. The Asian Flu of 1957, and the milder Hong Kong Flu in 1968, killed hundreds of thousands worldwide. Pandemic influenza viruses are more infectious than the regular variety because people have no immunity to them. These viruses seem to arise where people handle domestic ducks, chickens, and pigs. These interconnections provide an ideal environment for viruses to mix, mutate, and spread. When an animal flu virus infects a person who already has the flu, genetic material from the two viruses may mix or rearrange to create a new virus. This mixing is exactly what scientists think happened with the normally benign corona virus. The source of the common cold in humans, this virus causes major illness in cats, dogs, chickens, pigs, and cattle. Experts say the new human corona virus arose when it incorporated similar but foreign RNA into its genetic code. SARS may be caused by a combination of a new strain of corona virus and a meta-pneumovirus, which infects the lungs and triggers an immune reaction that can be so overwhelming that victims suffocate or die of organ failure. At the time of this publication (September 2003) researchers at the B.C. Cancer Agency had drafted the first sequence of the corona virus genome for development of a diagnostic test, but many questions about the causative agent have yet to be answered.

<http://www.ucmp.berkeley.edu/allife/virus.html>

<http://www.virology.net/garryfavweb.html>

<http://medicine.wustl.edu/%7Evirology/timeline.htm>

[http://www.virology.net/Big\\_Virology/BVHomePage.html](http://www.virology.net/Big_Virology/BVHomePage.html)

## Characteristics of Viruses

Comparing viruses to living cells:

Viruses have no metabolic apparatus and do not digest, respire, and so on.

- They are not made of cells. They have no cell membrane, nucleus, or cytoplasm.
- They are crystalline. Solutions of viruses leave behind crystals when evaporated.
- They can reproduce but only inside a host.
- They contain genes made of either DNA or RNA.
- They can take over the cell activity of hosts they invade, not just kill them.
- They can cause transmittable (contagious) diseases.

1. Microscopic: very small – measured in nanometers (nm)

1m = 1 billion nm	1m = 1 million $\mu\text{m}$
or 1nm = $1 \times 10^{-9}$ m	1 $\mu\text{m}$ = $1 \times 10^{-6}$ m (micrometer)

virus	bacteria	animal
200-500 nm	1000 nm ( 1 $\mu\text{m}$ )	8000 nm ( 8 $\mu\text{m}$ )

Ex. 5000 flu viruses can fit on the head of a pin

2. Design: very specific

- two parts: a) inner nucleic acid core or strand  
(either DNA or RNA, but not both)
- b) protective coat made of protein  
- called a CAPSID

3. Shapes: three (3) types – depends on capsid  
see book page 104

a) envelope-flu      b) helical-TMV      c) polyhedral-adenovirus

4. Host range: viruses are selective (specific virus enters only specific cells)  
def'n: the limited number of host species, tissues, or cells  
that can be infected by a virus or other parasite

ex. swine flu – hogs and humans      rabies – rodents ,dogs ,humans  
human cold virus – only affects cells of the upper respiratory tract  
HIV – only attacks human WHITE blood cells

## BACTERIOPHAGE

- also known as PHAGES : eaters of bacteria
- definition : a virus that infects bacteria
- structure : complicated , see picture page 104
  - tadpole shape: head - polyhedral capsid contains DNA
  - tail : long spikes for attachment

### Reproduction in viruses:

Viruses replicate inside living cells. They rely on a HOST cell to replicate. To do this, they first must INFECT a living cell. Once inside, a virus sets out on one of three different paths:

- a) lytic cycle
- b) lysogenic cycle
- c) retroviruses

Lytic cycle	Lysogenic cycle	Retroviruses
<ul style="list-style-type: none"> <li>- virus injects its genetic material into the host cell</li> <li>- genetic material enters the nucleus and is inserted into host's DNA, reprogramming its nucleus</li> <li>- cell immediately uses its machinery to produce the parts of future viroids</li> <li>- parts are assembled and the cell explodes (lysis), releasing more harmful viroids</li> <li>"Virulent" viruses undergo a lytic cycle</li> </ul>	<ul style="list-style-type: none"> <li>- viral genes do not go into action immediately; viral genetic material simply makes a circle and sits quietly</li> <li>- each time the cell divides, its daughter contains the dormant viral material called a PROVIRUS</li> <li>"Temperate" viruses undergo a lysogenic cycle. At some point, the lytic cycle is triggered , probably due to environmental changes</li> </ul>	<ul style="list-style-type: none"> <li>-virus contains RNA as its genetic material</li> <li>-virus contains an enzyme called reverse transcriptase, which it uses to make DNA from an RNA template (this never occurs in cellular organisms)</li> <li>- cell then follows the directions found in the new DNA code and the lytic cycle is triggered</li> <li>Retroviruses include rhinovirus and HIV.</li> </ul>

See book page 105 – viral replication

## Viruses and Human Health

Viruses are pathogens and have caused many different diseases, some of which are difficult to treat, and therefore very dangerous.

### WHY?

1. Viruses are not living, therefore are not destroyed by ANTIBIOTICS.
2. When viruses are LYSOGENIC, a person may not know he is infected and as a CARRIER, may infect many more.
3. Certain viruses (retroviruses) change the host DNA turning the cell into a CANCEROUS CELL which begins to multiply out of control

### SOLUTIONS

VACCINES: liquid preparations of DEAD or WEAKENED PATHOGENS like bacterial cells or viruses that stimulate the body's immune system to fight back

- some viral diseases can be prevented by vaccines  
ex. polio ,smallpox, Hepatitis A and B ,
- vaccines can be administered ORALLY or by INJECTION ( inoculation )

### IMPORTANT VIRUS – INFLUENZA

Reportable diseases in Ontario since 1923, types A and B influenza continue to be a major cause of preventable illness and death in Ontario. On average, 70 000 to 75 000 hospitalizations and 500 to 1500 deaths in Canada yearly are influenza-related. Annual infection rates in Canada range from 10% to 20% and can be considerably higher in epidemics. Current control measures in Canada include vaccination and treatment with anti-viral medication. New influenza vaccines are developed yearly to reflect the antigenic characteristics of the circulating strains.

Killer influenza strains are identified by year, not a five-year span or a decade (e.g., Spanish Flu of 1918–1919, Asian Flu of 1957, Hong Kong Flu of 1968). Humans have no immunity to a new virus, so the spread and severity of the disease are often greatest during that first entry into a population. If this agent goes through a population and then re-enters it the next year, it will encounter people who were previously infected and are now immune. That immunity often reduces the activity and severity of the disease.

Influenza: first identified in 1930's, structure – electron microscope – 1943

Structure: RNA inside a protein coat (capsid)

Three (3) main types –      A                      B                      C

Described by:      a) protein coat  
                            b) year of isolation  
                            c) geographic location

Transmission: (how disease is spread) – DIRECT CONTACT

Point of infection:      virus enters RESPIRATORY tract and destroys  
                                    CILIATED cells lining the passage to the lungs  
                                    - results in sore throat

Symptoms:      chills, fever (40°C), muscle aches, sweating, fatigue, nausea,  
                            congested lungs due to mucus build up, difficulty breathing

Complications:      bronchitis, sinus infections, pneumonia may develop

Treatment:      NONE, antibiotics do not work  
                            - cannot kill something that is not alive

Can only treat the symptoms: rest, liquids, medication to relieve symptoms

Prevention:      flu vaccines  
                            - new vaccines made yearly because viruses always mutating , creating a  
                            new capsid coat