

# Viruses

Section 2.1

## Viruses can make our lives miserable...

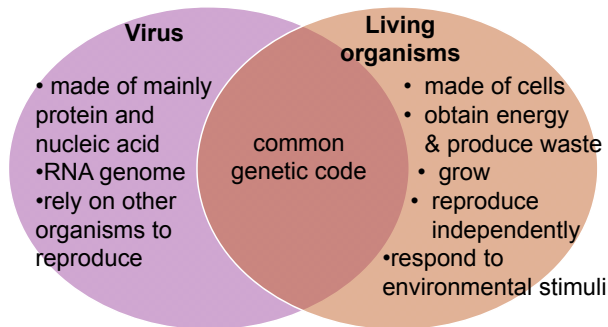
...but are viruses alive??

[Are viruses alive?](#) (2:57)



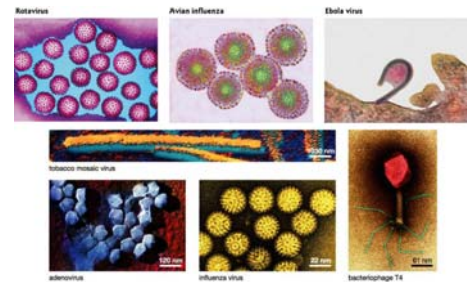
## Viruses straddle a strange world between “living” and “non-living”.

Considered by biologists to be non-living.



## What is a virus?

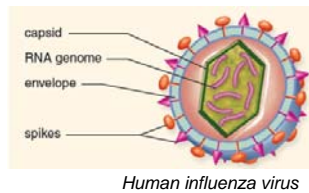
- small particle
- infects living cells in order to replicate
  - animals, plants, fungi, bacteria



## Viral structure

Two major components:

- genome:**
  - usually one chromosome
  - variations:
    - DNA or RNA
    - double or single-stranded
    - linear or circular
- capsid:** protein coat surrounding genome
  - some: membranous **envelope**, outside capsid
    - protein “spikes” allow recognition of host cell

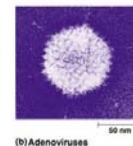


## Variations in viral structure

**Helical**  
rod-shaped capsid



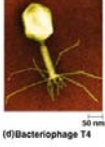
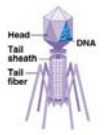
**Icosahedral**  
polyhedral capsid with 20 triangular faces



**Spherical**  
surrounded by membrane envelope

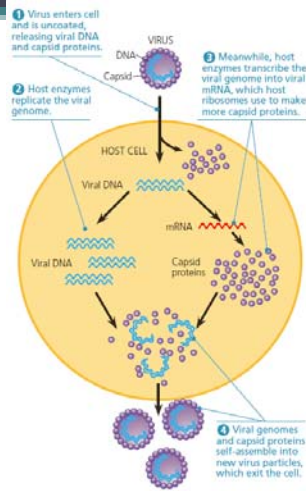


**Bacteriophage**  
icosahedral “head” & protein “tail”



# Viral Replication

- virus enters cell
- forces infected cell to use its own energy and resources to build new viruses
  - DNA replication
  - protein synthesis for capsid
- viruses assemble inside infected cell
- release into environment



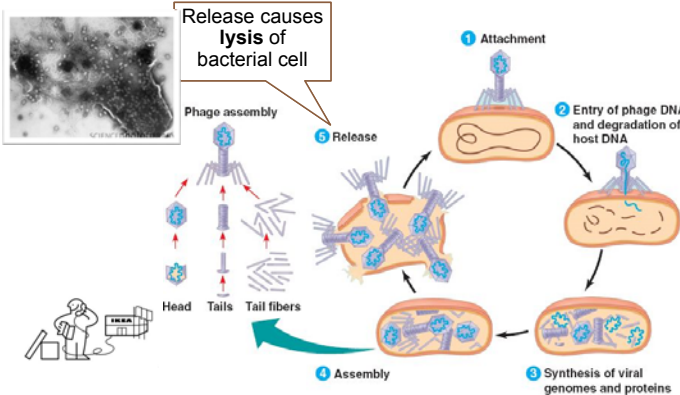
# Modes of Viral Replication

Two modes – Depends on virus & environment

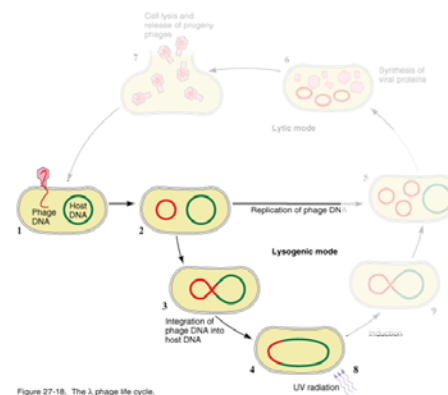
1. lytic
2. lysogenic

Both cycles were first studied and characterized in **bacteriophages** (viruses that infect bacteria).

# Lytic Cycle: Bacteriophage Example



# Lysogenic Cycle: Bacteriophage Example



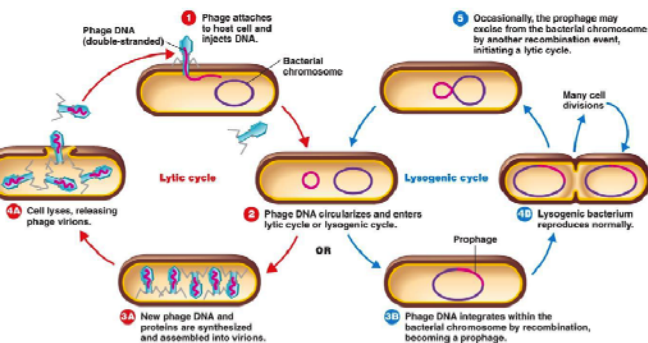
Phage DNA is incorporated into host genome.
 

- replicates with it
- forms a "prophage"

Environmental stress triggers **induction**:
 

1. **excision** of viral DNA
2. entry into **lytic** phase (rapid reproduction)

Figure 27-18. The λ phage life cycle. Copyright 2005 John Wiley and Sons, Inc. All rights reserved.



# Comparison of life cycles

	Lytic Cycle	Lysogenic Cycle
speed	immediate, short-term	period of dormancy (long-term), followed by active lytic period
symptoms	appear quickly	may not appear until much later
virus type	"virulent" e.g., T4 phage	"temperate" e.g., lambda phage

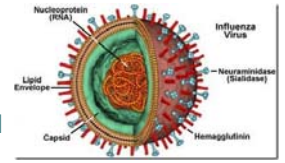




## Learning Checkpoint

- Viruses are small infectious particles made of nucleic acid (RNA or DNA) and a protein coat.
- Viruses are not considered alive, because they rely on a host cell in order to replicate.
- There are two major viral replication cycles: the lytic and lysogenic cycles. Part of the lysogenic replication mode includes a lytic period.

## Viruses in Animals



- most have an envelope
  - viral **proteins** on outside
  - bind to **receptors** on host cell
  - allows entry to cell
- envelope proteins are specific for certain types of cells:
  - common cold (adenovirus) – respiratory tissues
  - poliovirus – nerve cells

### Examples

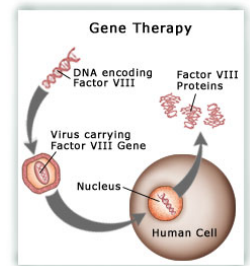
- **lytic**: common cold, flu, SARS, rabies
- **lysogenic**: herpes, HPV, hepatitis B, chicken pox
- lysogenic viruses are characterized by asymptomatic periods with occasional flare-ups



## Some viruses are helpful to humans.

... but most are harmful.

- Bacteriophages – Prevalent in mucus
  - kill harmful bacteria
- Biotechnology
  - gene therapy
  - vaccines
  - biocontrol



## Case Study: HIV/AIDS

- Human Immunodeficiency Virus
- target: CD4 white blood cells (part of immune system)
- transmitted through body fluids:
  - exposure to a mucous membrane
  - exposure to damaged tissue
  - direct injection

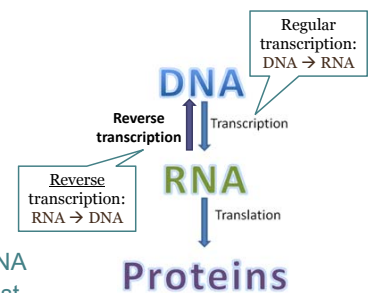


### HIV is a retrovirus.

Retroviruses have a special structure and life cycle – the

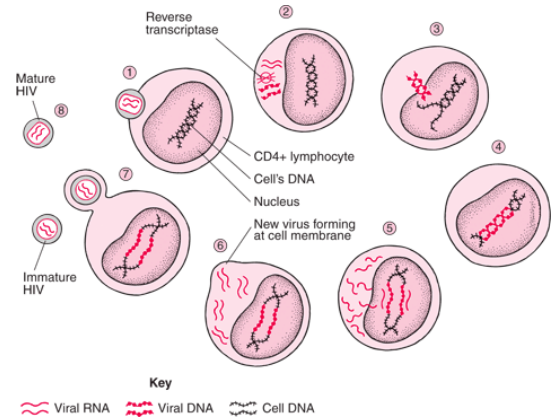
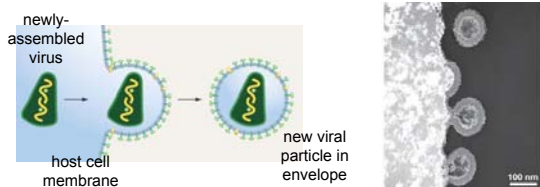
#### Retroviral cycle:

- genome made of RNA
- inside host, RNA is **reverse transcribed** → DNA
- DNA incorporates into host genome (as a **provirus**)

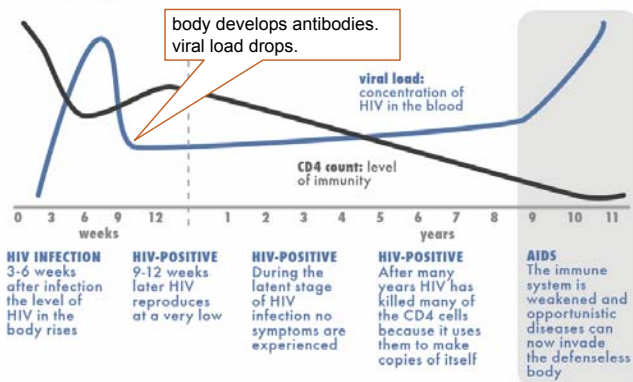


## Once integrated into the host genome...

- directs the synthesis of new viruses, without being excised from genome.
  - unique to **retroviral cycle**
- new viral particles are "budded" off from the host cell; they do not kill the host.
  - different from lysogenic cycle



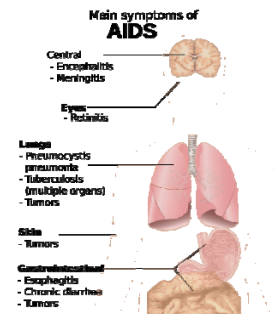
## HIV progression, CD4 count and viral load



- Primary infection is followed by period of latency

- HIV infection can lead to AIDS if untreated:

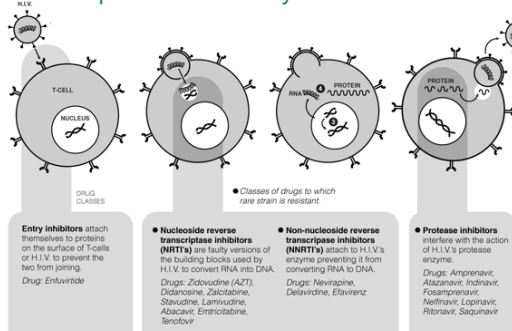
- **Acquired Immunodeficiency Syndrome**
- syndrome = combination of symptoms/diseases
  - extreme susceptibility to *opportunistic infections*



- progression can take 9-11 years if untreated

## HIV antiretroviral drug targets:

- prevention of binding to CD4 cells
- inhibition of reverse transcription
- interference with protein assembly



## Viruses are not affected by antibiotics.

- antibiotics target life processes that are performed by bacteria; results in pathogen destruction
  - viruses don't have equivalent processes
- difficult to find **targets** for anti-viral medication
  - inhibit binding to/entering host cells
  - inhibit viral synthesis – genome, capsid assembly
  - inhibit release of virus

## Vaccination can prevent infection.

- vaccine made from weakened or killed forms of the virus
- exposure stimulates patient to produce antibodies
  - resistance or immunity to subsequent infection

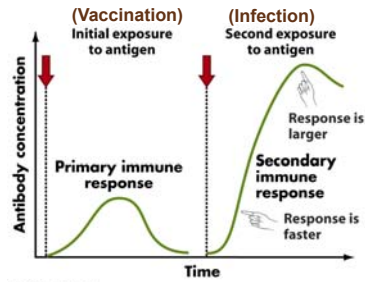
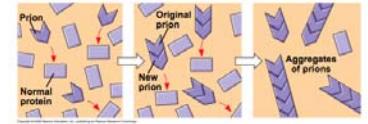


Figure 41.18 Biological Science, 2/e  
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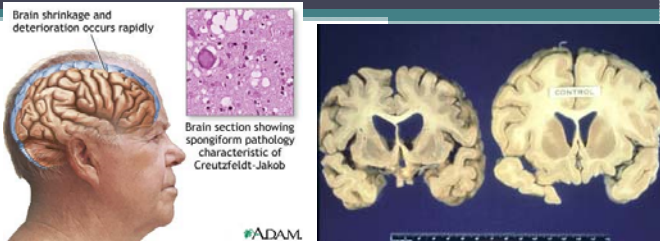
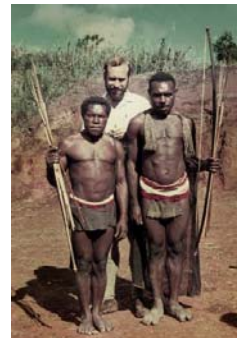
## Prions are another type of non-living pathogen.

- prion – infectious **protein**
- an abnormally folded form of normal brain protein
  - can convert normal proteins into abnormal forms
- causes degenerative brain disease:
  - scrapie, mad cow disease, Creutzfeldt-Jakob disease, kuru



## Case study: Kuru

- epidemic in 1960's
- tribal people of Papua New Guinea
- symptoms: muscle tremors, uncontrollable laughter, slurring of speech, inability to swallow
- women and children most affected
- genetic basis was ruled out



- incubation period of 10+ years
  - difficult to trace source of infection
- resists high temperatures and enzymatic digestion
  - thought to be transmitted through food

## Viroids are infectious RNA particles.

- pathogens of plants
- smallest infectious particles known; disc. 1971

example: potato spindle tuber viroid

- potatoes, tomatoes
- stunted growth, colour changes, elongated/cracked tubers



- anthropologists: funerary cannibalism was common practice



**Do you kuru?**



**Smart cannibals don't eat brains!**  
(A public service announcement from  
the Association for Behavioral Anthropology and the Chemical Anti-Defamation Society)

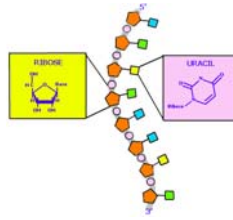
- transmitted by mechanical methods: contaminated machinery, tools, pruning, seed, pollen

*Like a virus...*

- short pieces of RNA
- use host cell to make copies

*Unlike a virus...*

- no protein coat**
- genes don't contain instructions to make any proteins



## Evolutionary significance?

- ancient relic of a world before DNA and protein
- precursor to viruses
- intermediate between inanimate matter, and life



## Summary

- Viruses are infectious particles composed of a DNA or RNA genome, surrounded by a protein capsid. They lack the basic characteristics of cellular, living organisms.
- Once they infect a cell, they replicate using either the lytic mode or the lysogenic mode.

- Retroviruses have a unique method of replication, due to their RNA genomes.
- Vaccination is an effective method for preventing some viral infections.
- Other, non-cellular infectious particles are prions and viroids.

## Homework

- Read 2.1
- Complete handout
- Pg. 58 #5, 6, 9, 10, 11, 14