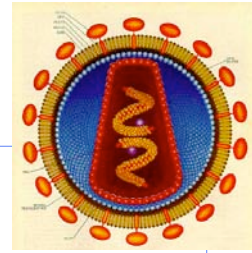


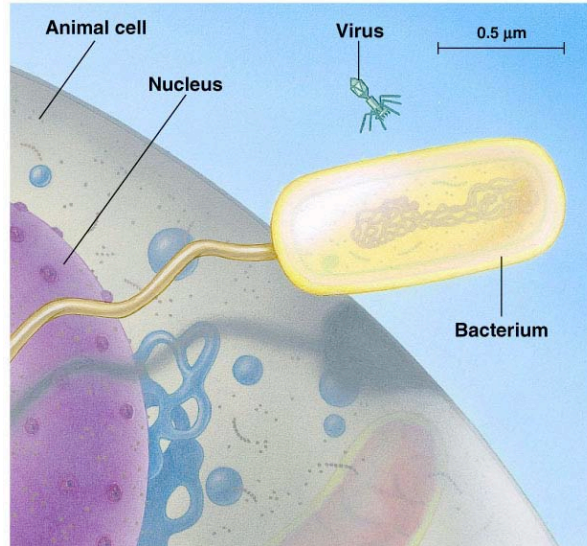
Chapter 18.

Viral Genetics



A sense of size

- Comparing
- eukaryote
 - bacterium
 - virus



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What is a virus? Is it alive?

- DNA or RNA enclosed in a protein coat
- Viruses are not cells
- Extremely tiny
 - ◆ electron microscope size
 - ◆ smaller than ribosomes
 - ◆ ~20–50 nm

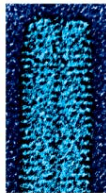
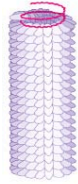
1st discovered in plants (1800s)

- tobacco mosaic virus
- couldn't filter out
- couldn't reproduce on media like bacteria



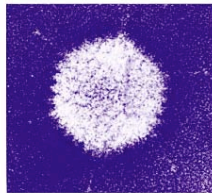
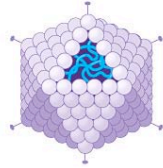
Variation in viruses

plant virus



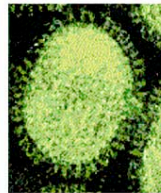
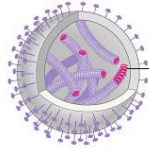
10 nm

pink eye



50 nm

influenza



50 nm

bacteriophage



50 nm

a package of genes in transit from 1 host cell to another

Viral genomes

Viral nucleic acid varies

- ◆ double-stranded DNA (dsDNA)
- ◆ single-stranded DNA (ssDNA)
- ◆ double-stranded RNA (dsRNA)
- ◆ single-stranded RNA (ssRNA)

Linear or circular molecule of nucleic acid

- ◆ smallest viruses have only 4 genes, while largest have several hundred

Table 18.1 Classes of Animal Viruses, Grouped by Type of Nucleic Acid

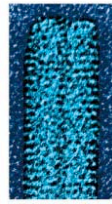
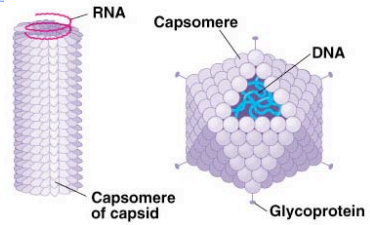
Class*	Examples/Diseases
I. dsDNA**	
Papovavirus	Papilloma (human warts, cervical cancer); polyoma (tumors in certain animals)
Adenovirus	Respiratory diseases; some cause tumors in certain animals
Herpesvirus	Herpes simplex I (cold sores), herpes simplex II (genital sores); varicella zoster (chicken pox, shingles); Epstein-Barr virus (mononucleosis, Burkitt's lymphoma)
Poxvirus	Smallpox; vaccinia, cowpox
II. ssDNA	
Parvovirus	Roseola; most parvoviruses depend on co-infection with adenoviruses for growth
III. dsRNA	
Reovirus	Diarrhea; mild respiratory diseases
IV. ssRNA that can serve as mRNA	
Picornavirus	Poliovirus; rhinovirus (common cold); enteric (intestinal) viruses
Togavirus	Rubella virus; yellow fever virus; encephalitis viruses
V. ssRNA that is a template for mRNA	
Rhabdovirus	Rabies
Paramyxovirus	Measles; mumps
Orthomyxovirus	Influenza viruses
VI. ssRNA that is a template for DNA synthesis	
Retrovirus	RNA tumor viruses (e.g., leukemia viruses); HIV (AIDS virus)

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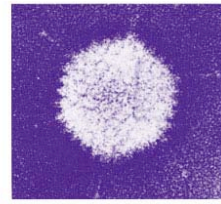
Viral protein coat

■ Capsid

- ◆ crystal-like protein shell
- ◆ 1-2 types of proteins
- ◆ many copies of same protein = capsomere



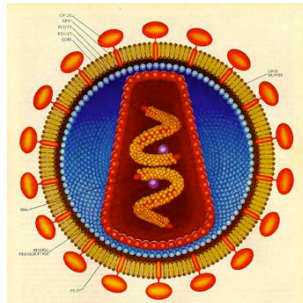
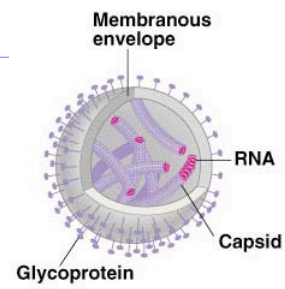
(a) Tobacco mosaic virus



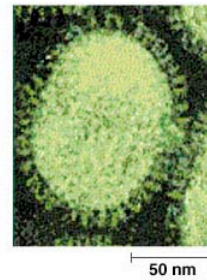
(b) Adenoviruses

Viral envelope

- Lipid bilayer membranes cloaking viral capsid
 - ◆ envelopes are derived from host cell membrane
 - glycoproteins on surface



HIV

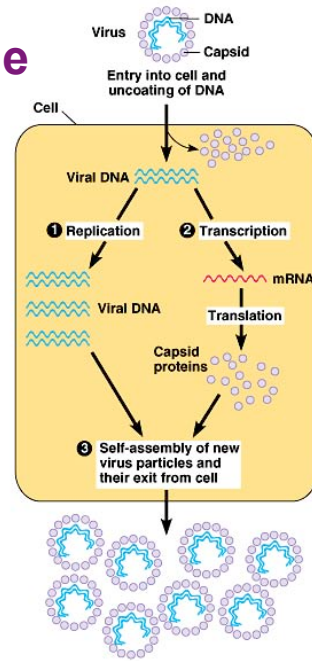


(c) Influenza viruses

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Generalized viral lifecycle

- **Parasites**
 - ◆ lack enzymes for metabolism
 - ◆ lack ribosomes for protein synthesis
 - ◆ need host “machinery”
- **Entry**
 - ◆ virus DNA/RNA enters host cell
- **Assimilation**
 - ◆ viral DNA/RNA takes over host
 - ◆ reprograms host cell to copy viral nucleic acid & build viral proteins
- **Self assembly**
 - ◆ nucleic acid molecules & capsomeres then self-assemble into viral particles
 - ◆ exit cell

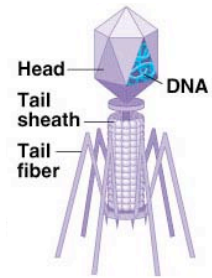


AP

Bacteriophages

- **Viruses that infect bacteria**

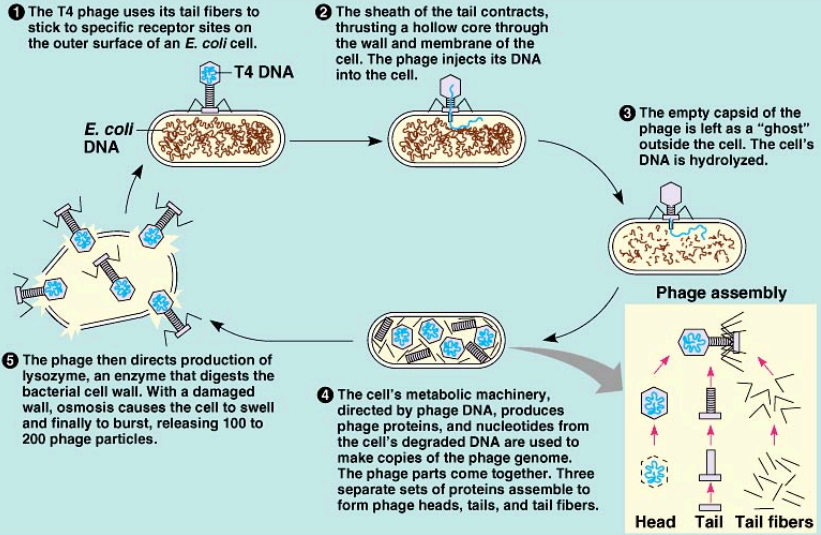
- ◆ **ex. phages that infect *E. coli***
- ◆ **20-sided capsid head encloses DNA**
- ◆ **protein tail attaches phage to host & injects phage DNA inside**



50 nm

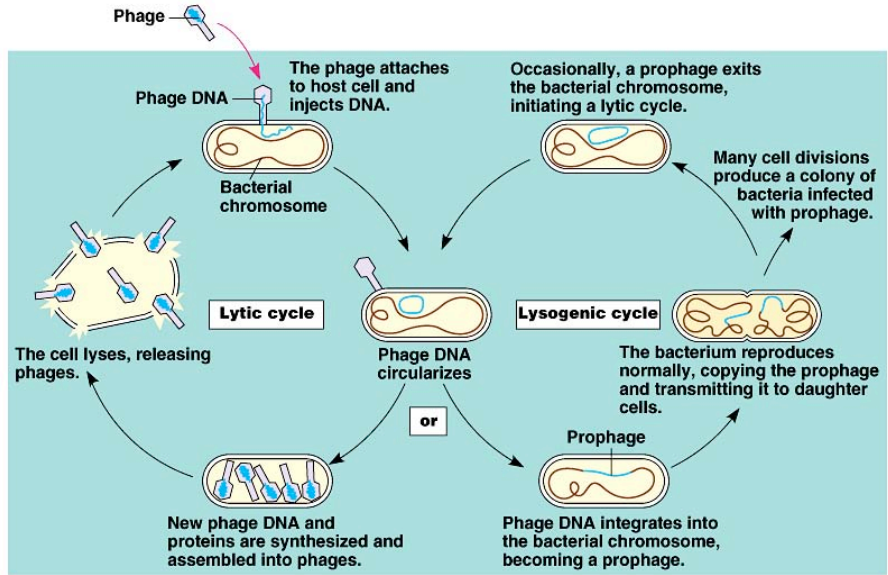
(d) Bacteriophage T4

Lytic lifecycle of phages



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Lysogenic lifecycle of phages



Viral hosts

- **Host range**
 - ◆ each type of virus can infect & parasitize only a limited range of host cells
 - ◆ identify host cells via “lock & key” fit
 - between proteins on viral coat & receptors on host cell surface
 - ◆ broad host range
 - rabies = can infect all mammals
 - ◆ narrow host range
 - human cold virus = only cells lining upper respiratory tract of humans
 - AIDS virus = binds only to specific white blood cells

Defense against viruses

- **Bacteria have defenses against phages**
 - ◆ natural selection favors bacterial mutants with receptors sites that are no longer recognized by a particular type of phage
 - ◆ bacteria produce **restriction enzymes** that recognize & cut up foreign DNA
 - modifications to bacteria's own DNA prevent its destruction by restriction enzymes
- **It's an escalating war!**
 - ◆ natural selection favors phage mutants resistant to the bacterial defenses

RNA viruses

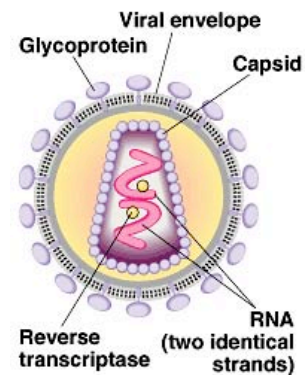
- **Retroviruses**

- ◆ use an enzyme = **reverse transcriptase**
- ◆ copies viral RNA into DNA in host
 - viral DNA can be integrated into host chromosome
 - can be passed on to other cells
- ◆ host's RNA polymerase now transcribes viral DNA into viral RNA molecules
 - produces viral components

Retroviruses

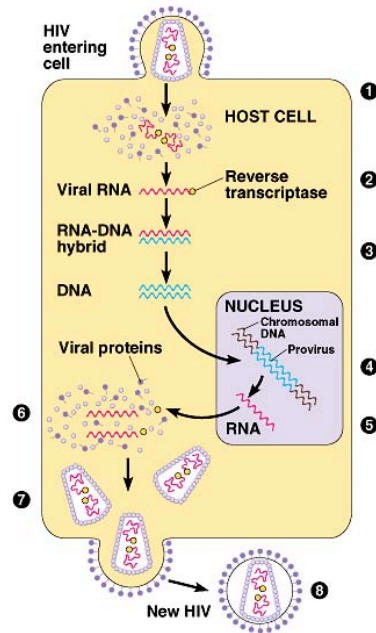
■ HIV

- ◆ human immunodeficiency virus
- ◆ causes AIDS
 - acquired immunodeficiency syndrome
- ◆ envelope with glyco-proteins for binding to specific WBC
- ◆ capsid containing 2 RNA strands & 2 copies of reverse transcriptase



HIV infection

- HIV enters host cell
 - ◆ reverse transcriptase synthesizes double stranded DNA from viral RNA
- Transcription produces more copies of viral RNA
 - ◆ translated into viral proteins
 - ◆ proteins & vRNA self-assemble into virus particles & leave host



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Symptoms of viral infection

- **Link between infection & symptoms varies**
 - ◆ kill cells by lysis
 - ◆ cause infected cell to produce toxins
 - ◆ viral components, such as envelope proteins, may be toxic
- **Damage?**
 - ◆ depends...
 - lung epithelium after the flu is repaired
 - nerve cell damage from polio is permanent

Cancer viruses

- **Viruses appear to cause certain human cancers**
 - ◆ **hepatitis B virus**
 - linked to liver cancer
 - ◆ **Epstein-Barr virus = infectious mononucleosis**
 - linked to Burkitt's lymphoma
 - ◆ **Papilloma viruses**
 - linked with cervical cancers
 - ◆ **HTLV-1 retrovirus**
 - linked to type of adult leukemia

Cancer viruses

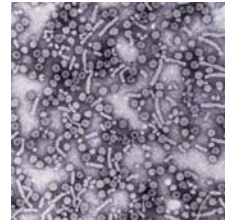
- Transform cells into cancer cells after integration of viral DNA into host DNA
 - ◆ carry **oncogenes** that trigger cancerous characteristics in cells
 - ◆ version of human gene that normally controls cell cycle or cell growth
- Most tumor viruses probably cause cancer only in combination with other mutagenic events

Viral diseases

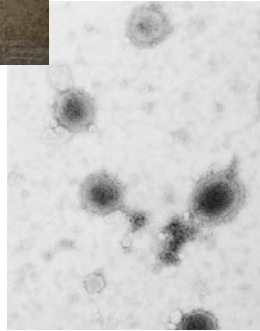


Polio

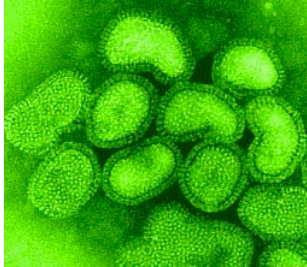
Hepatitis



Measles



Influenza: 1918 epidemic



30-40 million deaths world-wide

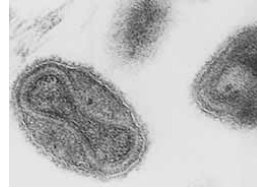
RNA virus



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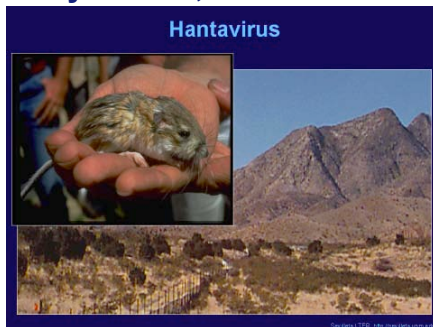
Smallpox

- Eradicated in 1976
 - ◆ vaccinations ceased in 1980
 - ◆ at risk population?



Emerging viruses

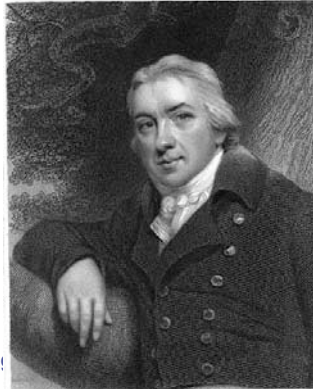
- Viruses that mutate & “jump” host
 - ◆ Hanta virus
 - ◆ Ebola virus
 - digests human body & every opening in body bleeds, no matter how small



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Vaccines

- Injections of harmless variants of virus
 - ◆ stimulate immune system to mount rapid defense against future attack



Edward Jenner
1st vaccine



AP Biolo

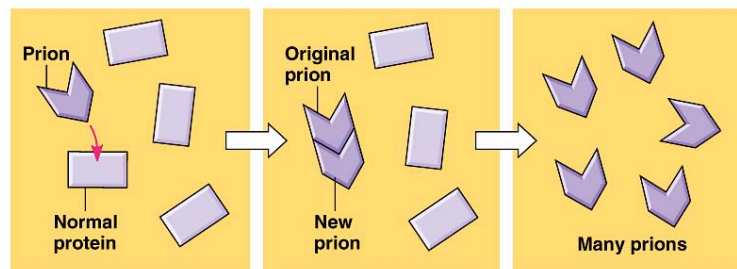
And there's more....



Prions

- **Spongiform encephalopathies**

- ◆ **misfolded versions of normal brain proteins**
 - induce normal proteins to take on abnormal shape
 - destroy brain cell & brain function
 - mad cow disease
 - Creutzfeldt-Jakob disease



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2004-2005