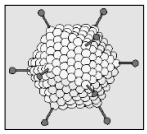
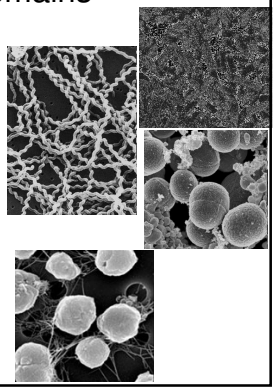


Diversity of Bacteria, Archaea, and Viruses

Chapter 19

The prokaryotic domains

- Bacteria
  - ❖Three types of structure
    - ➢Spherical, rod-shaped, and spiral
- Archaea
  - ❖Many are extremophilic
    - ➢Prefer to live in very extreme environments.



Prokayotes (bacteria)

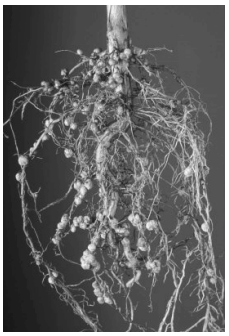
- Differences between species include
  - ❖Size (range from 0.2 mm to 700 mm).
  - ❖Shape (rod, spherical, spiral)
  - ❖Gram stain results
    - ➢Gram negative
    - ➢Gram positive
  - ❖Presence or absence of flagellum.
  - ❖Anaerobic vs aerobic

Prokaryotes and animals

- Prokaryotes are important for animal nutrition
  - ❖Herbivores need bacteria to digest cellulose
  - ❖Humans need bacteria to make Vitamin K & vitamin B12.
  - ❖Termites need bacteria to digest wood.

Bacteria and plants

- Nitrogen fixing bacteria
  - ❖Live in the soil
  - ❖Help legumes (beans) trap nitrogen



Bacteria are recyclers

- Decompose organic matter
  - ❖Releases nutrients back into the environment
- Clean up pollution (bioremediation)
  - ❖Break down a lot of chemicals
  - ❖A hot area of research for oil spills.

Pathogenic bacteria

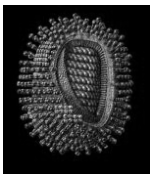
- Pathogenic: produces disease.
  - ❖Many anaerobic bacteria cause disease
    - ➢Botulism, tetanus
  - ❖Bubonic plague (black death)
  - ❖Leprosy
  - ❖Tuberculosis

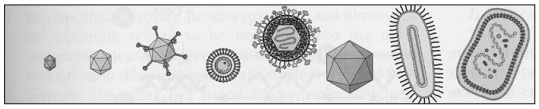
A virus is a nucleic acid molecule with a protein coat.

A. Structure of Viruses:

Infectious particles consisting of:

- ❖ Nucleic acid genome (DNA or RNA)
- ❖ Protein coat = capsid
- ❖ Lipid bilayer = envelope

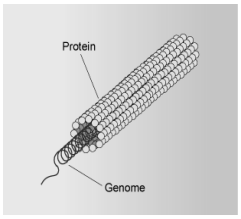


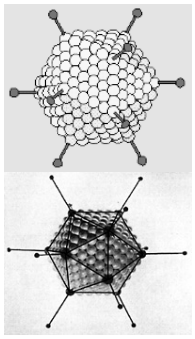


Capsids and Envelopes

Main capsid types:

- Polyhedrons
- Helical (rods)



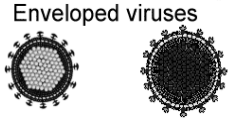


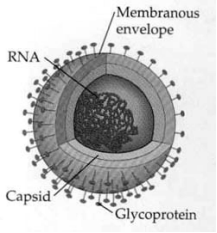
Envelopes

Contain membrane glycoproteins:
Bind to specific host cell protein = "viral receptor"

❖remember that glycoproteins act as identifying signals.

Enveloped viruses





Features of viral reproductive cycles

Parasite: an organism (?) that benefits by living in or on another organism (its host) at the expense of that organism.

Obligate intracellular parasites

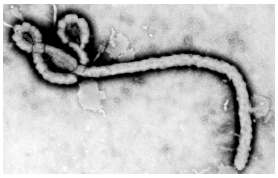
Viruses cannot reproduce without a host cell.

No way to undergo mitosis or meiosis.

Viruses require from hosts:

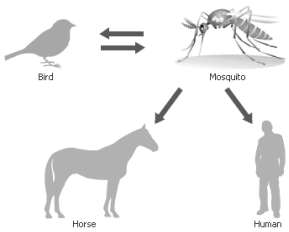
- enzymes
- ATP
- ribosomes, etc.
- monomers (NTs, amino acids)

Rabies virus

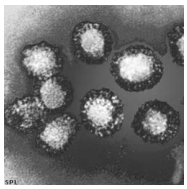


Ebola virus

Host Range: the limited group of organisms / cell types that can be infected by a particular virus

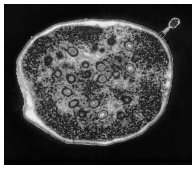


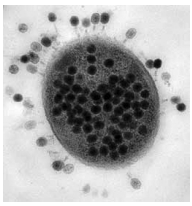
e.g., West Nile Virus



Bacteriophage: virus that infects bacteria

- Can be beneficial to humans if it targets a pathogenic bacteria.
- Phages will destroy bacteria during reproduction.





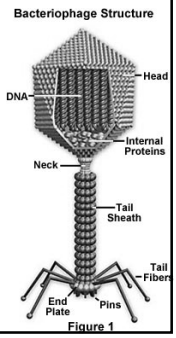
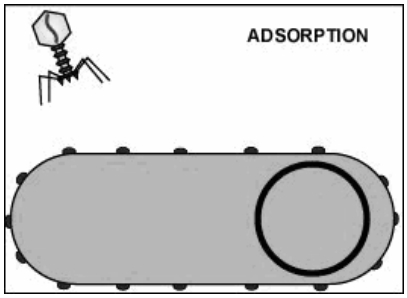


Figure 1

Bacteriophage life cycle



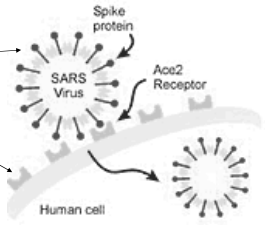
What dictates host range?

Ability of virus to gain entry (most important)

Glycoproteins that aren't recognized are rejected by the cell.

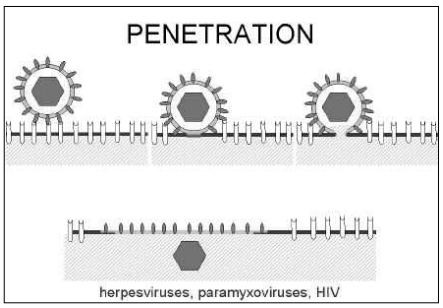
viral surface protein

viral receptor

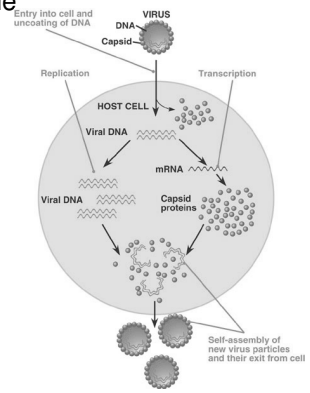


SARS virus enters cell via Ace2 receptor.

2. Fusion of viral envelope with plasma membrane

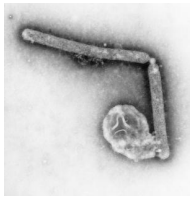


Viral reproductive cycle (DNA virus)



Concept 18.2 - Viruses, viroids and prions are formidable pathogens

A. Viral diseases in animals / emerging viruses.



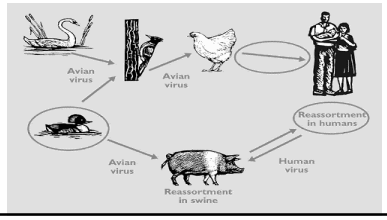
Pathogenic virus: a disease-causing virus

Emerging viruses: sudden appearance (or sudden medical importance)

Examples: Avian bird flu

Where do emerging viruses come from?

1. Mutation of existing viruses
   RNA viruses: very high mutation rate
2. "Jumping" species
   - ❖Frequently involve swine or birds
3. Spread from small isolated populations

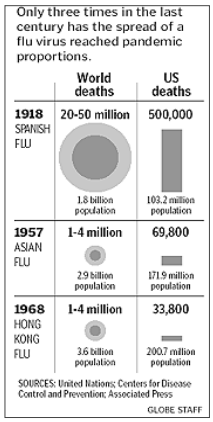


Viral vaccines

Viruses or viral components used to stimulate immune system defenses (without causing the disease).

- **Major types:**
  - ❖Live (weakened) virus
    - ➢Polio virus, measles, mumps
  - ❖Killed virus
    - ➢Flu shots, hepatitis A
  - ❖Viral protein(s)
    - ➢Human papilloma virus (HPV)

Humans:
H1N1 - 1918 "Spanish flu"
H2N2 - 1957 "Asian flu"
H3N2 - 1968 "Hong Kong flu"
H5N1 - 2005 "Avian flu"

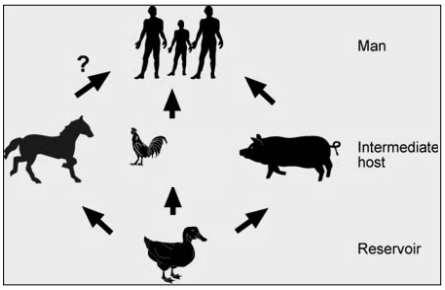

Only three times in the last century has the spread of a flu virus reached pandemic proportions.

	World deaths	US deaths
1918 SPANISH FLU	20-50 million	500,000
	1.8 billion population	103.2 million population
1957 ASIAN FLU	1-4 million	69,800
	2.9 billion population	171.9 million population
1968 HONG KONG FLU	1-4 million	33,800
	3.6 billion population	200.7 million population

SOURCES: United Nations; Centers for Disease Control and Prevention; Associated Press

GLOBE STAFF

Transmission of influenza A

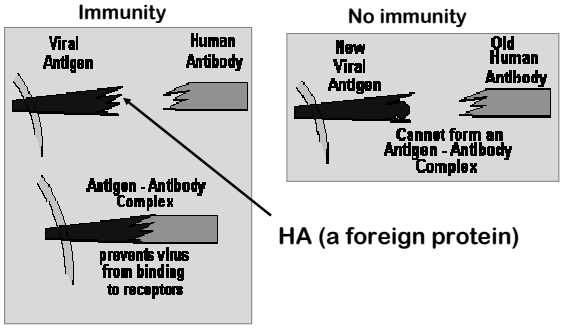


All flu viruses originate in aquatic birds (= reservoir)

Why are we fearful about H5N1 (avian flu)?

1. Avian H5N1 in humans is highly pathogenic.
   - ❖ But not easily transmitted:
     - ➢ Poultry to human
     - ➢ Human to human

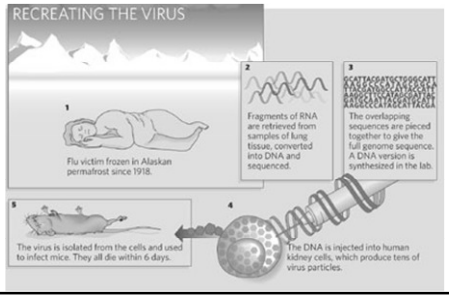
2. Humans would have little/no immunity to this strain.



What makes a particular strain pathogenic?

Unknown!

1918 strain (Spanish flu) - "resurrected"

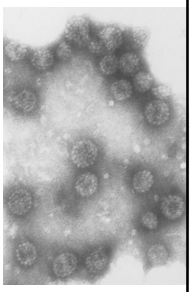


Pathogenic viruses

- **Smallpox**
  - ❖**Oldest known viral disease**
    - ➢**First records in 150 A.D.**
  - ❖Disastrous for North American natives
  - ❖**Why?**
- World-wide vaccination helped to nearly eradicate smallpox.
  - ❖**Two known repositories**
    - ➢**Atlanta, Georgia**
    - ➢**Russia**

Pathogenic viruses

- Human papilloma virus
  - ❖Almost all cases of cervical cancer is due to HPV.
  - ❖Cervical cancer survival rate has improved with pap smears and other screening.
    - ➢Stage 1: 80 – 90% survive
    - ➢Stage 2: 50 – 55% survive
    - ➢Stage 3: 15 – 25% survive
- HPV is sexually transmitted.

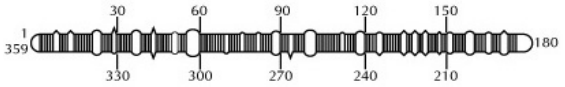


Pathogenic viruses

- Mumps and measles
  - ❖Mumps is not deadly
    - ➢But can cause sterility, especially in infected adult men.
  - ❖Measles is highly contagious
    - ➢90% of exposed people will develop measles.
    - ➢German measles (rubella) in pregnant women will cause serious birth defects in fetus

B. Viroids & Prions

1. **Viroids:** infectious agents in plants.
   - ❖ Small circular RNA molecules
   - ❖ Encode no proteins!

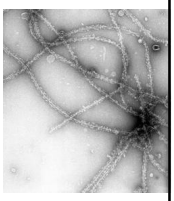


Pathogenic viroids

- **Potato spindle tuber viroid**
  - ❖Affects both potatoes and tomatoes
    - ➢Both are nightshade plants

2. Prions

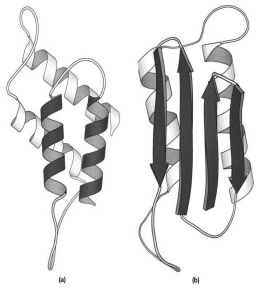
- Infectious agents in animals
  - **Pro**teinaceous **in**fectious particles.
- Cause degenerative brain diseases:
  - ❖ Kuru (humans)
  - ❖ Scrapie (sheep)
  - ❖ BSE ("mad cow disease")
  - ❖ Wasting disease (deer, elk)
  - ❖ Creutzfeld-Jacob disease (humans)



Agent is a protein (no genome!)

Misfolded form of a ***normal*** brain protein (PrP^c)

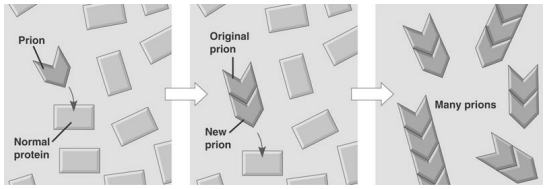
Cellular function unknown



PrP^c **Prion**

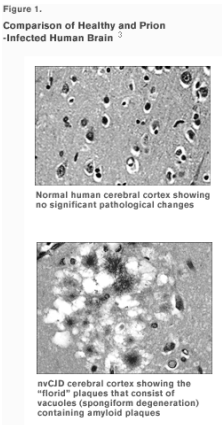
Disease mechanism

Fig 18.13



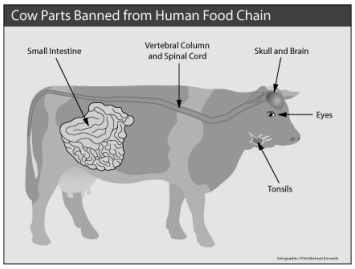
1. Prion binds to PrP^c → 2. PrP^c misfolding → **3. Chain reaction**

Effect of prions on brain morphology



Transmission of BSE

Consuming prion-infected tissue (mostly neural)



Prion disease transmission

- Kuru
  - ❖Occurred in New Guinea among the Fore tribe.
  - ❖Medical puzzle that stumped researchers because it affected mostly women and children.
  - ❖Mystery solved in the 1950s when it was discovered that the Fore tribe was cannibalistic, eating their dead relatives's brains as a funeral rite.