**Siphonaptera: fleas**
- Endopterygota
- 1st mammalian ectoparasites
- Annoy, bite, cause allergies
- Hind legs adapted for jumping
- Adults: blood suckers
- Unfed adults live a long time
- Somewhat host specific

**Flea Vectors**
- Can live off host for months
- Many species are vectors
- *Oropsylla montana*
  - Rock and California ground squirrels, prairie dogs
  - Most important flea vector in US
- *Xenopsylla cheopis* (oriental rat flea)
  - 1st vector in epidemics in Asia, Africa, S.A.
  - Male engorged with blood

**Plague**

**Plague transmission**
- Flea bite (78%)
- Direct animal contact (20%)
  - Tissues, body fluids, scratches, bites
  - Enters through break in skin
- Aerosol (2%)
- Human cases
  - April-November (93%)
  - Increased activity of fleas and hosts

**Flea Transmission**
- \( \leq 27^\circ C \) (80°F)
  - Blood clots in gut of flea
  - *Y. pestis* trapped
  - Transmission occurs more readily
- \( > 27^\circ C \)
  - Blood clot in gut of flea dissolves
  - Organism passes through
  - Transmission less likely

**Types of plague**
- Bubonic (80-90% of cases)
  - Bubo: swollen, painful lymph node
  - Mortality (untreated): 50-60%
- Septicemic
  - Similar to bubonic, + septicemia, organ failure, hemorrhage, necrosis
  - Mortality (untreated): 100%
- Pneumonic
  - 1st - *Y. pestis* inhaled
  - 2nd - septicemic form spreads
  - Respiratory distress, hemoptysis
Plague spreads rapidly from endemic areas during wars and catastrophes. Epidemics still occur.

http://www.cdc.gov/ncidod/dvbid/plague/world98.htm

Transmission cycle
- Sylvatic
- Urban
- Reservoirs
  - Rock squirrels
  - Ground squirrels
  - Prairie dogs
  - Mice, Voles
  - Others

Transmission cycle
- Enzootic
  - Steady level in rodent populations
  - Low death rates
- Epizootic
  - Large die-offs ➔ fleas change hosts (e.g., rats)
  - Amplifying hosts
    - Prairie dog, ground squirrels, rock squirrels, woodrats, chipmunks
  - Expansion into human areas
    - Facilitated by poverty, homelessness

Animal Sources of Human Infection in U.S.
(319 cases) 1970 - 1993
- Undetermined
- Carnivores
- Rabbits
- Antelope
- Prairie Dogs
- Rock Squirrels
- CA Ground Sq.
- Other Squirrels

Plague in western US

FigURE: Number of plague cases, by county — western United States, 1970–2002
History

- Importance
  - 1 of 3 WHO quarantinable diseases
  - Estimated 200 million deaths recorded
- Three pandemics
  - Justinian 541 AD
  - Black Death 1346
  - China 1855

From where did the black death come?

- Black Plague came to shore of Black Sea
- Italian sailors infected
- It arrived in Europe October of 1347

Medieval cures

- The swellings should be softened with figs and cooked onions. Mix onions with yeast and butter. Then open the swellings with a knife.
- Take a live frog and put its belly on the plague sore. The frog will swell up and burst. Keep doing this with further frogs until they stop bursting. Can use a dried toad, too.

Medieval and contemporary art & the plague

- "Ring Around The Rosy
  A Pocket Full Of Posies
  Ashes, Ashes
  All Fall Down"

Plague and the Middle Ages

- 35% - 70% mortality
- 25,000,000 dead

Plague as a Biological Weapon

- One of top 6 agents identified by CDC
- Known attempted uses
  - Japanese in WWII; infected fleas released over China
  - A microbiologist with suspect motives obtained sample thru mail
- 1970 WHO simulation of 50 kg in city of 5 million
  - 80,000-100,000 hospitalized
  - 500,000 secondary cases
  - Up to 100,000 deaths
- Weapons programs
  - U.S. terminated 1970
  - Russia – prior program’s status unknown
Prevention and Control

- Education/awareness
- Isolate infected animals
  - Limit contact
  - Personal protection
- Flea control
  - Spring to fall
- Prevent roaming or hunting of pets
- Rodent control
  - Eliminate rodent habitat around home
- Insect repellents for skin & clothes
- Insecticide in epizootic areas

Tick Classification

- P. Arthropoda, sP Chelicerata, C. Arachnida, sC. Acari,
  - Order Ixodida
  - 860 spp. in 22 genera and 3 families
  - F. Ixodidae: the hard ticks
- Can transmit protozoans, viruses, and bacteria

Tick Classification

- Palps & Chelicerae protect barbed hypostome. Most hard ticks also secrete a cement from salivary glands.

Dorsal view of mouthparts of hard tick

Ticks, Lyme disease, and ecology

- Ticks are ectoparasites and vectors
- Spirochete bacterium is the pathogen
- What are the ecological drivers of disease emergence?

Ticks that cause Lyme disease

- Black-legged Tick
- Lone Star Tick
- Rocky Mountain Tick

Black-legged Ticks (Deer Ticks)

- Nymph
- Larva
- Adult (female)

Three life stages
Immature blacklegged ticks can be infected by feeding on mice that are carrying Lyme disease bacteria. Transmission can also occur from the ticks to mice.

Figure 1.3. Lyme disease is caused by the spirochete bacterium Borrelia burgdorferi. The bacterium is transmitted by several species of ticks, including the deer tick, hard tick, and others. The life cycle of the tick is shown. The deer tick (Dermacentor variabilis) and the black-legged tick (Ixodes scapularis) are two of the most prevalent tick species. Lyme disease is now spreading into southern Canada, Mexico, and several countries in Europe.
Symptoms and Treatment of Lyme Disease

- Can lead to cardiac; musculoskeletal; neurological problems
  - Headaches; fatigue; pain; insomnia; loss of memory
- An imitator of other conditions
  - Confused with flu; MS; seizure; arthritis; Gulf war syndrome; ADHD; fibromyalgia; other neurologic conditions
- Treated with antibiotics
  - Prompt treatment is most effective
  - No known cure for chronic Lyme disease