Yersinia pestis and plague

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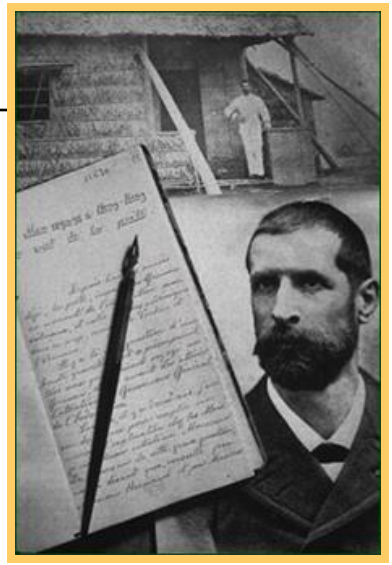
Discovery

- 1894: Hong Kong epidemic
- Alexander Yersin
  - Gram negative
  - Bacillus
- 1896
  - Developed antiserum



Historical Impacts

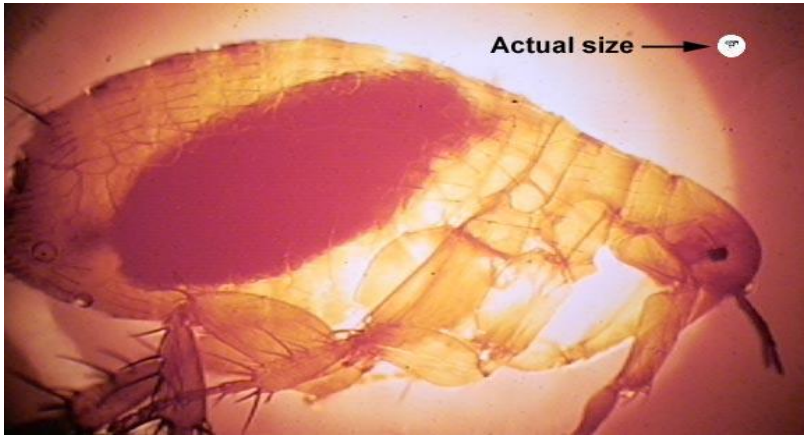
- The first plague was in 542 E.C. and lasted almost 60 years.
- The second and most severe pandemic was in the 14th century, also known as the Black Death. 24 million die in “the Black Death” plague
- The final and most recent pandemic occurred in 1894.

Yersinia pestis

- Family Enterobacteria
  - Gram negative small rods, pleomorphic
  - Aerobic, facultative anaerobic?, and facultative intracellular?
  - Most have animals as their hosts but they can cause disease in man
  - Grow better in blood agar, does not heamolyze blood
  - Bipolar staining when stained with leishman's stain
  - Ferment glucose and mannitol with the production of acid only
- It is pathogenic to mice, white rat and pigs

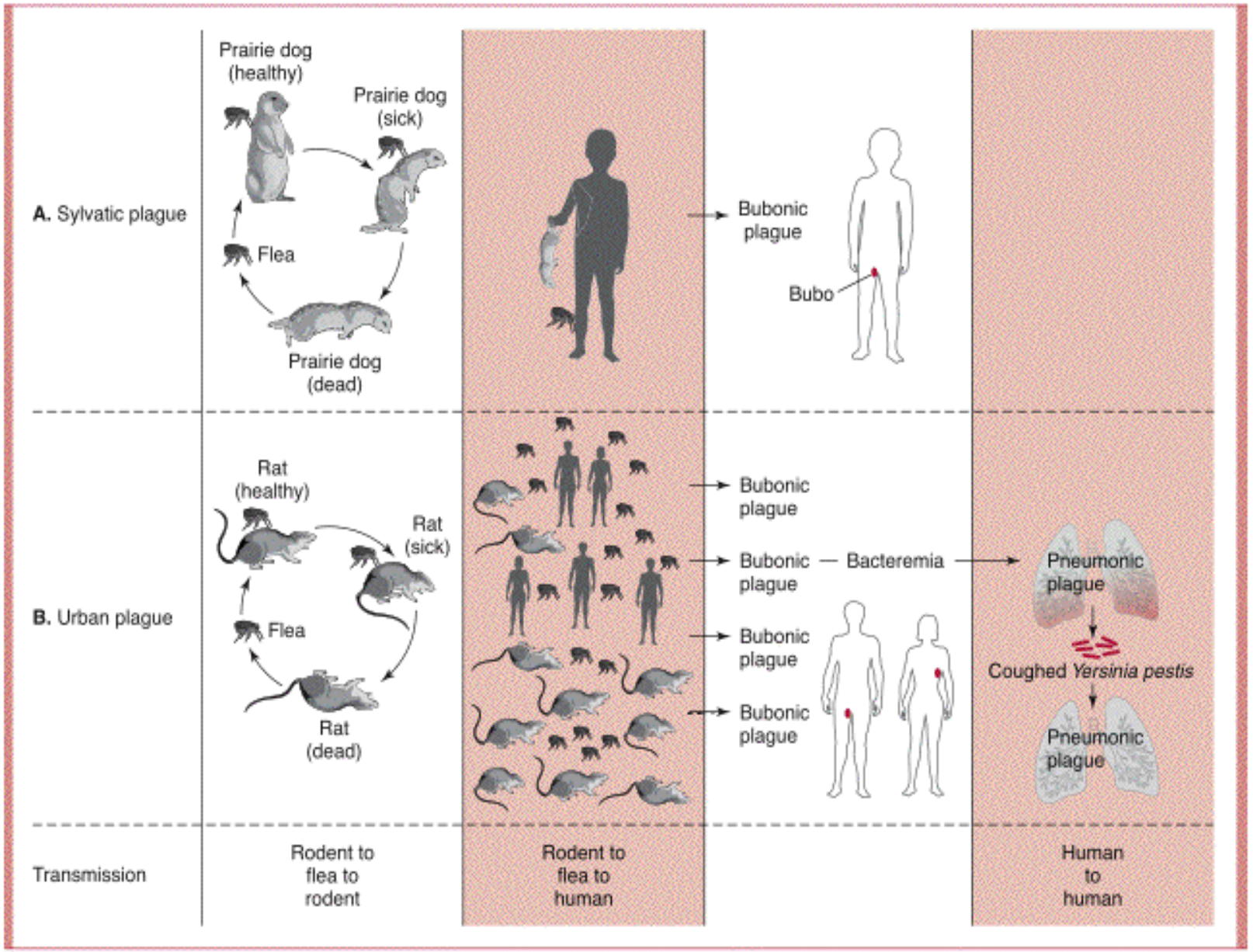
- Several plasmids and virulence factors
  - Anti-phagocytic V and F1 antigens
  - Type 3 secretion sys. To inject proteins that are pore forming and inhibit phagocytosis and signaling inside innate immune cells
  - Adhesins to invade the epithelial cells, plasminogen activator to dissolve clot for systemic invasion

Transmission
Vector of the Plague



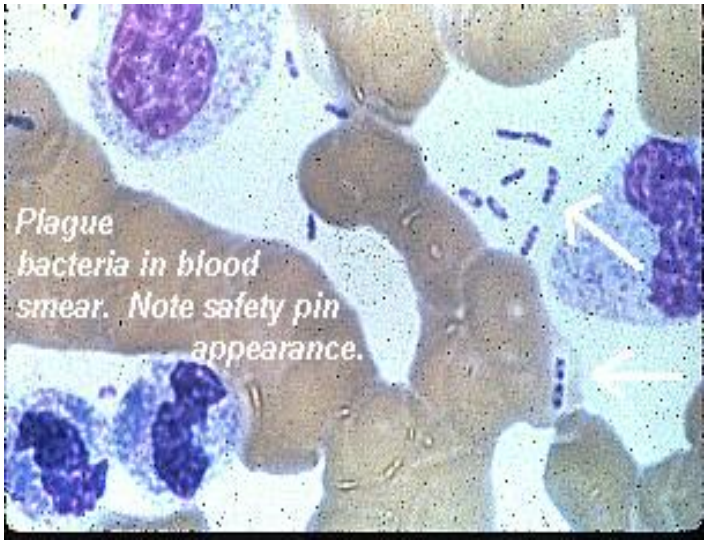
- From animals; By Fleas bite (fleas found on rodents may carry disease 78%, or direct contact with the infected animal
- From human to human
  - droplet contact - coughing or sneezing on another person
  - direct physical contact - touching an infected person, including sexual contact
  - airborne transmission - the microorganism can remain in the air for long periods
  - fecal-oral transmission - usually from contaminated food or water sources

The epidemiology of plague



- Contrary to popular belief, rats did not directly start the spread of the plague mainly bubonic. It is mainly a disease in the fleas that infested the rats and dogs, making the rats and dogs themselves the first victims of the plague. Infection in a human occurs when a person is bitten by a flea or come in contact with infected rat or dog
- Several proteins contribute to the maintenance of the bacteria in the flea digestive tract, among them the hemin storage (Hms) system. Using the Hms sys. the bacteria stick together to form a plug that blocks its stomach and causes it to starve. The flea then bites a host and continues to feed, and consequently the flea vomits blood tainted with the bacteria back into the bite wound.

Disease types



Compliments of CDC

- Bubonic plague: based on the lymphatic system.
- Septicemic plague: Centers in the bloodstream.
- Pneumonic Plague: Centers in the lungs,may be primary(earosol) or secondary from blood
- Plague meningitis, cutaneous plague, pharyngitis

Bubonic Plague

- 80-90% of cases
- Incubation: 2-6 days
- Clinical signs
  - Fever, malaise, chills, headache
  - Bubo: swollen, painful lymph node (hemorrhagic inflammatory response)
  - ± vomiting, abdominal pain, nausea,
- Mortality (untreated): 50-60%

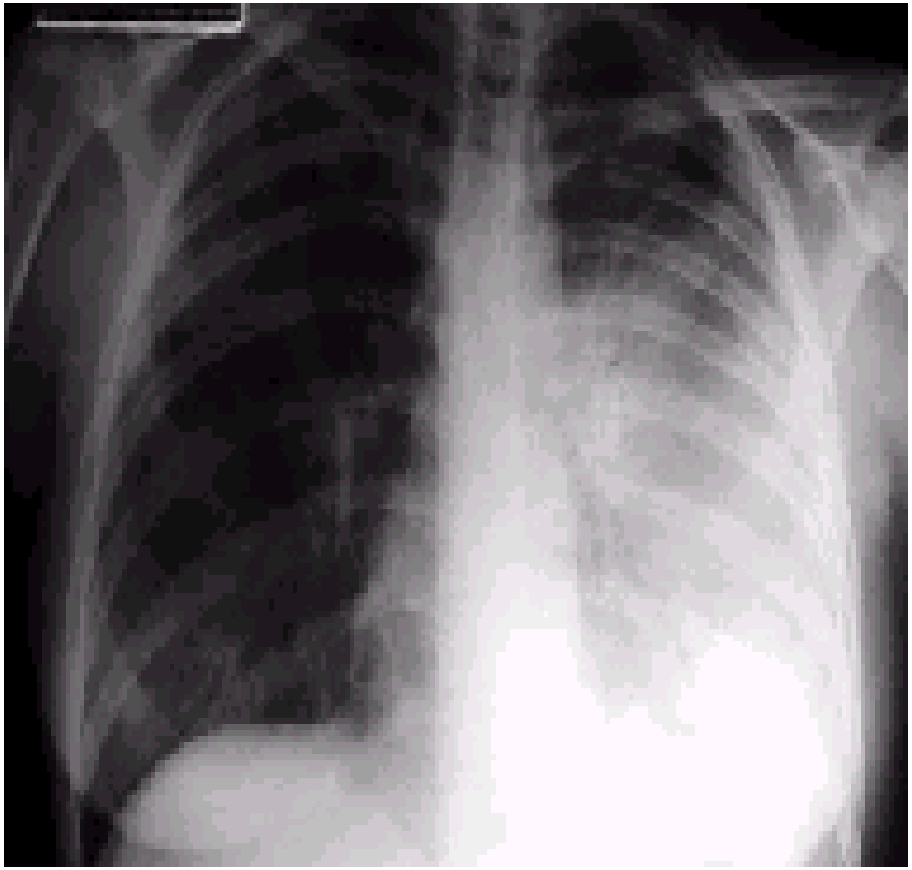
Septicemic Plague

- blood spread
- Clinical signs
  - Similar to bubonic, plus circulatory collapse, septic shock, organ failure, hemorrhage, DIC
  - Necrosis of extremities
    - Microthrombi blocking capillaries (black death??)
- Mortality (untreated): 100%

Pneumonic Plague

- Incubation: 1-6 days
- If this transmitted by aerosols from infected human, this is considered primary, while secondary occurs after symptoms of bubonic or septicemic infection.
- Clinical signs
  - Purulent pneumonia
  - Fever, chills, headache, septicemia
  - Respiratory distress, hemoptysis
  - Highly fatal
- Person-to-person possible
- Mortality 100% with in 24 hours

Pneumonic Plague



Diagnosis

- Isolation of organism Culture of blood, sputum, CSF as indicated
  Gram's stains can confirm the presence of gram-negative rods, and in some cases the leishman's stain
- Serology Fourfold rise in antibody titer An anti-F1 serology test can differentiate between different species of *Yersinia*
  - Single titer of >1:128 is positive
- Others: leukocytosis;
- PCR

Treatment

- With early treatment – Survival ~100%
- Supportive
- Antibiotics
  - Aminoglycosides
    - Streptomycin, kanamycin
  - Doxycycline, tetracycline, chloramphenicol
  - Penicillins and cephalosporins are NOT effective

- The main mechanisms of resistance of pathogenic bacteria to β-lactams are :
  - (i) changes in the target sites of the drug (penicillin-binding proteins),
  - (ii) the activity of hydrolysing enzymes produced by the bacteria (B-lactamases),
  - (iii) the reduced accessibility of the target sites to the drug (permeability barrier). The latter barrier in Gram-negative bacteria consists of the outer membrane (OM)

Plague
Prophylaxis

- Flea, rodent control (kill fleas before redents)
- Isolation for the suspected patients
- Killed vaccine and living attenuated given to travelers and workers with the bacteria and in disaster areas, to prevents bubonic plague
  - Primary vaccination: 0, 1-3, & 5-6 months
  - Boosters: 12, 18, & 24 mo., then every 1-2 years

- Preferred post-exposure prophylaxis:
  - Doxycycline
  - Ciprofloxacin
  - Duration of prophylaxis: 7 days