Lecture Highlights- Wednesday, January 16, 2002 – Anthrax

1) Biology studies nature at hierarchical levels: genes, cells, organs/systems, individuals, populations and landscapes.

2) Although researchers work at one of these levels, to solve a complicated problem such as anthrax bioterrorism attacks, we need integration across several levels:
   a. Need to know about DNA to track samples
   b. Need cell biology to understand what anthrax is (and how to weaponize/kill it)
   c. Need to know what happens at individual level to treat people (cutaneous vs. inhalation)
   d. Need to know immune system to treat later stages or prevent with vaccine
   e. Need to know the population and landscape to know about disease spread and risks

3) Anthrax – big questions
   a. Where did strains come from?
      i. How can we tell anthrax strains apart? Or which ones are similar?
      ii. With DNA analysis: example Variable number tandem repeat loci
      iii. Mutations in DNA cause different fragment lengths among different anthrax strains
      iv. When DNA is extracted from strains and run through a gel with electrical current, they separate based on length – longer stay near top, shorter move further down through gel
      v. Differences or similarity among banding patterns tell us whether strains were different or similar
   b. What is it?
      i. Bacterium – Bacillus anthracis (name “anthrax” came from Latin root)
      ii. 2 life stages:
         1. Spore (resting stage)
         2. Rod shaped cell (vegetative stage)
      iii. How weaponize?
         1. Spores are very resilient
         2. They are dried, chemicals are added, ground into fine powder that can be aerosolized
   c. What does it do?
      i. Cutaneous anthrax
         1. 95% of anthrax cases in US
         2. Easily treated with antibiotics
         3. 3-5 days after exposure – blister
         4. Then, turns into black open sores
         5. Later, if untreated, will cause:
         6. Necrosis (tissue death)
         7. Bloodstream infection (fatal- 5% of people)
      ii. Inhalation anthrax
         1. Rare and very deadly
         2. 2,500-55,000 spores lethal to 50% of people
         3. 1 ml (20 drops) could kill 100-1,000 people!
         4. First stage – flu like
         5. Fever, coughing, weakness, chest pain
         6. Next stage - lung damage
         7. Cuts off oxygen -> shock -> death within days
   iii. Gastrointestinal anthrax
      1. Even less common- often fatal
      2. Eating infected meat
      3. Death due to toxin entering bloodstream
d. How treat it?
   i. Antibiotics – kill bacterial cells
      1. 60 day course of Cipro (although, if susceptible, other antibiotics are recommended – we’ll discuss this next week)
   ii. But, anthrax also produces a toxin
   iii. Experimental: Immune globulin treatment
        1. IG: immune system protein formed in blood of vaccinated people
        2. IG could neutralize toxin
        3. Might help treat more advanced stages
        4. Worked for other diseases

e. How spread?
   i. Case study – Sverderlovsk, USSR
   ii. Lessons from raccoons and rabies

f. Who did it?: Ongoing detective story
   i. 22 total cases; 11 inhalational (5 died), 11 cutaneous
   ii. 9 of 11 inhalational–likely exposure to envelopes
      1. Think all mailed from NJ
   iii. Some whole genomes sequenced: FL strain almost identical to one from Ames, IA
   iv. Genetics (e.g., VNTR), narrowed source to ~7 domestic labs & 1 from England
   v. Powdered form very similar to that created by US military
   vi. So, think threat is domestic

g. How worried should we be?
   i. Highly treatable – especially when detected early
   ii. NOT contagious
   iii. Infection only by inhaling spores or skin contact with bacteria
   iv. 5 people have died from this wave of “bioterrorism” anthrax so far
   v. For more information go to www.cdc.gov
   vi. More people die from:
      1. Dog bites
      2. Being struck by lightning
      3. Falling in holes
      4. People have died from:

a. Tipping over vending machines!