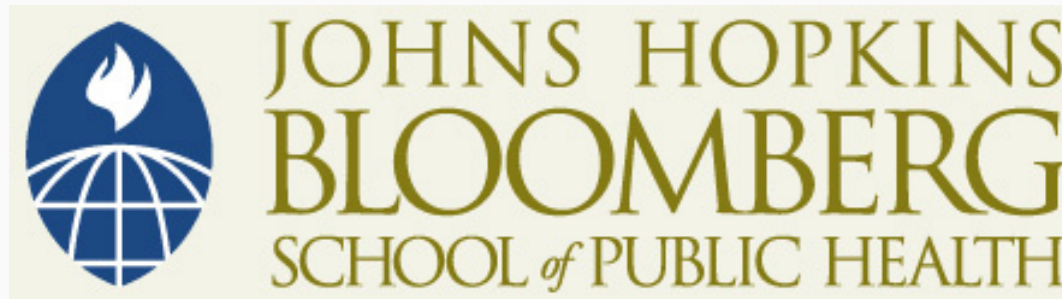


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Part 4 of 5

Food and Waterborne Microbial Threats

Question

- Why are specific microorganisms potential threats to our drinking water and food?
- To address this we need to divide the microorganisms into categories

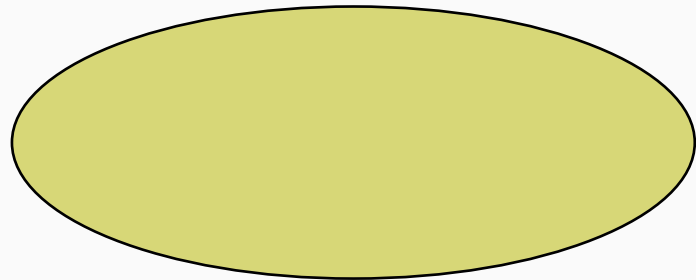
Groups of Microorganisms

- Bacteria
- Parasites
- Viruses
- Helminths
- Prions
- Two key concepts to keep in mind
 - Size of the microorganism
 - Resistance to environmental degradation and chemical inactivation

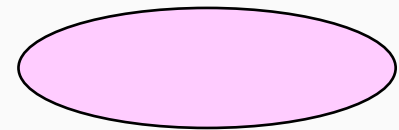
Relative Sizes of Pathogens



Red blood cell = 7 microns



Cryptosporidium = 3 microns



E. Coli = 0.5 – 2 microns



Norwalk virus = 0.03 microns

How Small is Small???

- A cryptosporidium is ~ 3 microns (μm) in length
 - 100 centimeters = 1 meter
 - 1,000 millimeters = 1 meter
 - 1,000,000 micrometers = 1 meter
 - 1,000,000,000 nanometers = 1 meter
- You could place 30,000 Cryptosporidium or 50,000,000 noroviruses on the head of a pin!!

- To see more about the relative size of cells, go to:
 - <http://www.cellsalive.com/howbig.htm>

Microorganisms

- Microorganism resistance to disinfection and environmental degradation

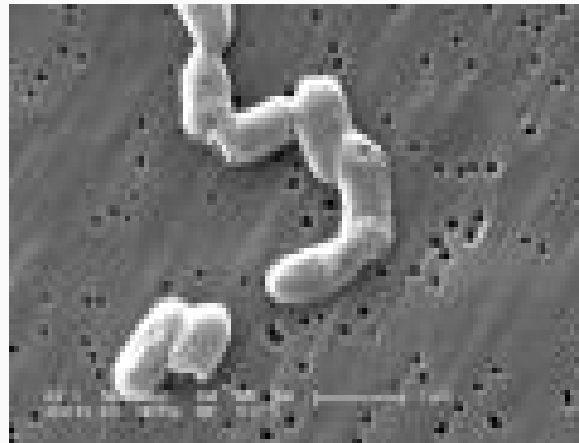
Prions > Parasites
Helminths > Viruses >> Bacteria

Specific Pathogens

- Others have reviewed the individual class A, B and C pathogens
- We will cover the group of food and waterborne pathogens

Salmonella

- http://www.cdc.gov/ncidod/dbmd/diseaseinfo/salmonellosis_t.htm



Source: CDC Public Health Image Library

Salmonella: Organism

- Gram-negative, motile, rod-shaped
- Can grow aerobically and anaerobically
- The *Salmonella* group consists of resilient microorganisms that readily adapt to extreme environmental conditions
- Although not spore-forming, they are resistant to drying
- Can survive at a pH as low as 4.5
- May survive for a long time in nutrient poor environment
 - 200 days in contaminated soil, 10 months in dust, 5 months in roach and rodent feces, 4 years in dried whole egg

Shigella

- http://www.cdc.gov/ncidod/dbmd/diseaseinfo/shigellosis_t.htm



Source: CDC Public Health Image Library

Shigella: Organism

- *Shigella*
 - *S. dysenteriae*, *S. flexneri*, *S. sonnei*, *S. boydii*
- Gram-negative, rod-shaped, non-spore forming
- Pathogenesis is related to its entero-invasive properties as well as its production of Shiga toxin

Shigella: Sources of Contamination and Transmission

- Highly host-adapted
 - Only natural hosts are humans and a few non-human primates
 - Therefore, 99% of all *Shigella* isolates in US are from humans
 - ▶ Route of transmission predominantly traceable to humans
 - ▶ Fecal-oral spread
 - ▶ Large numbers in stool of clinical cases (10⁵ to 10⁸/g stool)
 - ▶ Healthy carriers (~10²/g stool)

Shigella: Sources of Contamination and Transmission

- One of the most communicable causes of bacterial diarrhea
 - As few as 10 to 200 viable organisms will produce illness
 - Commonly spread in
 - ▶ Family settings
 - ▶ Confined populations
 - Day care centers
 - Prisons
 - Residential institutions
 - Cruise ships

Escherichia coli O157:H7

- http://www.cdc.gov/ncidod/dbmd/diseaseinfo/escherichiacoli_t.htm



Source: CDC Public Health Image Library

Escherichia coli O157:H7

- Eating meat, especially ground beef, that has not been cooked sufficiently to kill *E. coli* O157:H7 can cause infection. Contaminated meat looks and smells normal.
- In many instances, very few organisms are required to cause disease (<10).
- Other known sources of infection are consumption of sprouts, lettuce, salami, unpasteurized milk and juice, and swimming in or drinking sewage-contaminated water.
- Bacteria in diarrheal stools of infected persons can be passed from one person to another if hygiene or handwashing habits are inadequate.

Escherichia coli O157:H7 Sequelae

- Hemolytic uremic syndrome (HUS): Persons with this illness have kidney failure and often require dialysis and transfusions. Some develop chronic kidney failure or neurologic impairment (e.g., seizures or stroke). Some have surgery to remove part of the bowel.

Vibrio cholerae

- http://www.cdc.gov/ncidod/dbmd/diseaseinfo/cholera_g.htm



Source: CDC Public Health Image Library

Cholera

- Acute epidemic dehydrating diarrhea
- Usually sudden in onset and if not properly treated is fatal in approximately half of those infected
- One of the most dramatic of all diseases

Cholera: Sources of Contamination

- Feces from people acutely infected constitute by far the most important source of infection in cholera epidemics
 - Excrete ~ 10^7 vibrios/ml of rice-water stool with a total volume of 10 –20 liters /day
 - ▶ 10^{11} (100,000,000,000) organisms in 10 liters
- Infected crustaceans also a significant source of infection

Cholera: Clinical Syndromes

- The severe fluid and electrolyte loss can lead to dehydration
 - Bicarbonate and potassium loss
- Cardiac arrhythmia and renal failure
- Mortality ~60% in untreated patients but <1% in patients promptly treated with fluids and electrolyte replacement
- Cholera will spontaneously resolve after a few days after symptoms

Cryptosporidium

- <http://www.cdc.gov/ncidod/dpd/parasites/cryptosporidiosis/default.htm>

Cryptosporidium

- Prior to 1976, recognized exclusively as a veterinary pathogen of young farm animals
- Later, was associated with sporadic zoonotic infection in humans
- 1982 – linked to disabling sometimes fatal diarrhea in AIDS patients
- 1993 – Milwaukee waterborne outbreak
 - 403,000 ill
 - ~100 deaths

Cryptosporidium parvum

- Complex life cycle involving both sexual and asexual stages
- Oocysts are spherical or oval, 3-6 microns in size

Cryptosporidium Epidemiology

- Worldwide distribution
- Wide variety of animal reservoirs
 - Mammals, reptiles, fish
- Transmission
 - Zoonotic spread from animal reservoirs to humans
 - Most common: person-to-person spread by fecal-oral and anal-oral routes
 - Potential transmission by food-handlers who are excreting oocysts

Cryptosporidium Clinical Syndrome

- Oocysts are very infectious
- 3-11 day incubation (average is 7 days)
- May result in asymptomatic carriage
- Self-limiting in healthy individuals
 - Watery diarrhea without blood
 - illness lasts 10-14 days
- no medical treatment and the disease is self-limiting
- Immunocompromised patients
 - >50 stools/day with tremendous fluid loss
 - Can be severe and last for months
 - 10-15% of AIDS patients die of complications related to cryptosporidiosis

Noroviruses

- <http://www.cdc.gov/ncidod/dvrd/revb/gastro/norovirus-factsheet.htm>
- <http://www.cdc.gov/ncidod/dpd/healthywater/factsheets/norovirus.htm>

Norovirus Disease

- Gastroenteritis outbreaks associated with diverse settings including banquets, cruise-ships, schools, military maneuvers, nursing homes, summer camps, families
- Adults, children, elderly
- Most common cause of waterborne and foodborne disease (uncooked shellfish, cake icing, cold food such as salads, sandwiches)
- 23 million cases in the US / yr

NoV Illness

- Very rapid onset following 8-48 hr incubation
- Self limiting, lasting 24-48 hrs
- Vomiting and diarrhea most common symptoms
- Individuals are highly infectious during illness
- High secondary transmission

Clostridium botulinum

- http://www.cdc.gov/ncidod/dbmd/diseaseinfo/botulism_t.htm



Source: CDC Public Health Image Library

Clostridium botulinum

- Botulism is a rare but serious paralytic illness caused by a nerve toxin that is produced by the bacterium *Clostridium botulinum*

Botulism

- Botulism illness is characterized by symmetric, descending flaccid paralysis of motor and autonomic nerves, always beginning with the cranial nerves.
- Symptoms include
 - double vision, blurred vision, drooping eyelids, slurred speech, difficulty swallowing, dry mouth, and muscle weakness.
- If untreated, illness might progress to cause descending paralysis of respiratory muscles, arms and legs.

Botulism

- All forms of botulism can be fatal and are considered medical emergencies. Foodborne botulism can be especially dangerous because many people can be poisoned by eating a contaminated food.