# Public Health Microbiology

CE421/521

Lecture 10-03-06

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# Pathogens and parasites

- Epidemiology
  - Definitions
    - epidemiology = study of spread of d_____ in populations
    - infectious disease = disease that are spread from one h_____ to another
    - incidence = number of i_____ with the disease in a population
    - prevalence = the p_____ of a population with the disease at a given time
    - epidemic = disease outbreak with a high i_____
    - endemic = disease outbreak with a l_____ incidence
    - pandemic = disease outbreak across c_____

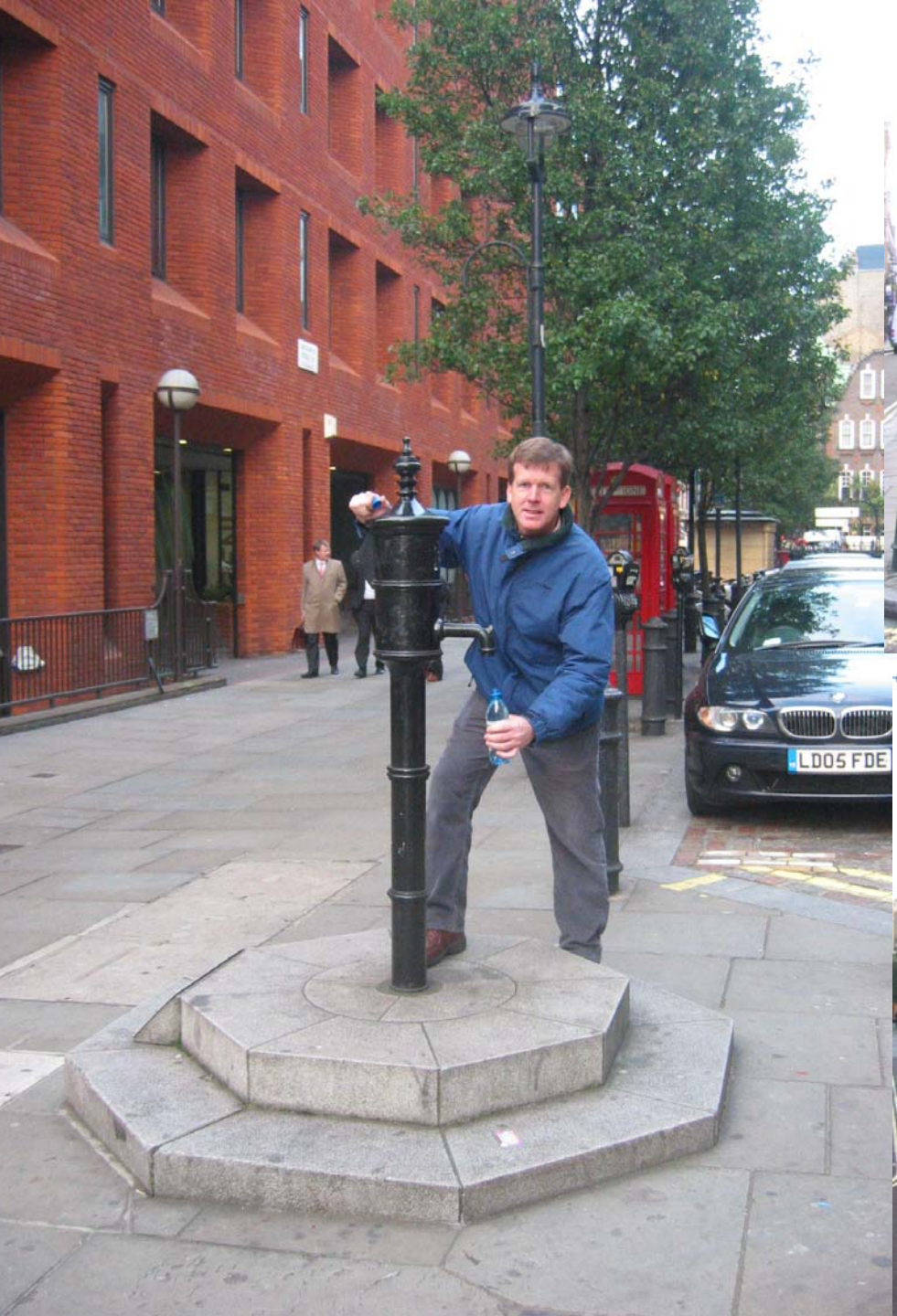
# History of Epidemiology

- one of the early theories was that disease was caused by b_____ a_____ (malaria actually means "bad air")
- microorganisms weren't s_____ until Antonie van Leewenhoek - a 17th Century native of Holland devised the first m_____ with sufficient magnification to see protozoa and bacteria
- wasn't until the middle of the 19th Century that s_____ and disease were linked - cities that cleaned up their filth and rubbish had lower i_____ of disease

# History of Epidemiology

- J_____ S_____ and the Broad Street pump in 1854
  - he was able to show that 59 of the 77 c_____ victims used the pump on Broad Street
  - There was a w_____ in the vicinity where cholera was endemic but nobody at this workhouse got cholera. This particular workhouse had its own w_____.

    The cause of contamination turned out to be the d_____ of an infected person that was within three feet of the well.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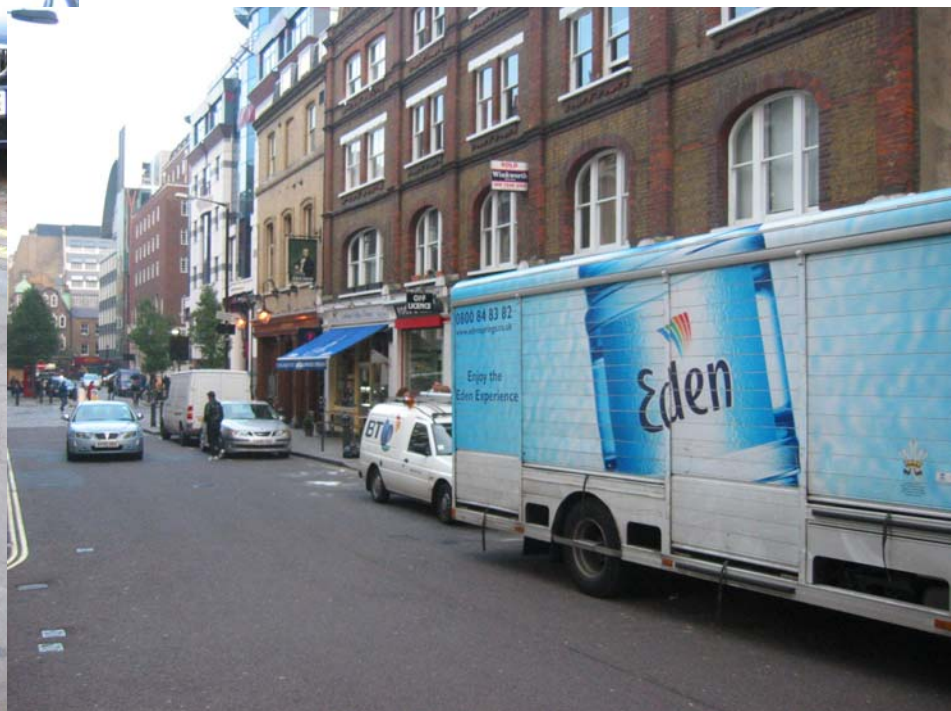
JOHN SNOW
SALOON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# Background

- many if not most pathogens are w_____ and are therefore a concern to environmental engineers
- need to be familiar with l_____ c_____ of pathogens: some can stay infective for periods longer than one year, some less than one day, some have a l_____ period greater than one year
- almost all pathogens can be spread by a s_____ carrier - makes detection difficult
- usually the very young, very old, and those with w_____ i_____ systems are affected the most

# Chain of infection

- Infectious agent - m_____ i_____ dose (MID) varies widely
  - b_____
  - v_____
  - p_____
  - h_____
- frank pathogen versus o_____ pathogens

# Reservoirs

- required for pathogen to s_____ and m_____
- Can be l_____: humans, animals, plants
- or non-living: s_____, w_____, w_____

# Mode of transmission

- Person to p_____ - most common (STDs, hands, coughing, sneezing fall into this category)
- W_____ - intestinal illnesses (gastroenteritis), giadiasis, cryptosporidiosis (Milwaukee, Wisconsin , 1993: 400,000 affected, 47 deaths - animal runoff suspected)
- F_____
  - irrigation water, handling, preparation, shellfish
- A_____
  - legionaires disease
- V_____
  - Malaria
- F_____
  - clothing, toys, etc.

# Portal of Entry

- Gastrointestinal t_____
- R_____ tract
- S_____

Host susceptibility

- A_____
- Natural or acquired i_____
- H_____ (mental and physical)

# Pathogens in Wastewater

- Bacteria
  - F_____ material contains approximately 1012 bacteria per gram
  - B_____ content is approximately 9% of the weight (wet basis)
  - Most cause gastroenteritis (d_____ - inflammation of the intestines and loss of blood) or d_____ (typhoid fever is a notable exception)
  - Important groups:
    - *Salmonella* - most p_____ (over 2000 types)
      - primarily a f_____ contaminant, but transmission by _____ water possible
      - causes gastroenteritis

# Bacterial Pathogens

- *Salmonella typhi* produces t_____ causing typhoid fever
- *Shigella*
  - causal agent of bacillary d_____
  - small i_____ dose (as low as 10 organisms)
  - mode of t_____: primarily person to person, but f_____ and waterborne possible (outbreak in Florida of 1200 people)
  - difficult to e_____ in laboratory (viable but not culturable)

# Bacterial Pathogens

- *Vibrio cholera* - causative agent of c_____ - profuse diarrhea, r_____loss of fluid, causing death in short time period
  - e_____ in various parts of Asia (Bengal state of India, Bangladesh)
  - documented outbreaks linked to s_____ contaminated v_____
- *Escherichia coli (E. Coli)*
  - found in gastrointestinal tract of humans and w_____ blooded animals
  - many are harmless, some p_____
  - 2-8% have been found to be enteropathogenic (EPEC) causing t_____ diarrhea
  - infective d_____ is relatively high - 106 to 109 organisms
  - several outbreaks have been associated with water d_____ systems
    - Scotland (1990)
    - Cabool, Missouri (1990) 243 documented cases of diarrhea and four d_____

# Bacterial Pathogens

- *Yersinia* - a_____ gastroenteritis
  - s _____are a major reservoir
  - waterborne incidence was suspected as cause of some o_____
  - psychotrophic - t_____ at low temperatures (~ 4°C)
  - poorly c_____ with bacterial indicator organisms
- *Campylobacter*
  - a_____ gastroenteritis
  - municipal water supplies and m_____ streams implicated for outbreaks:
    - V_____ (1978) 2,000 out of a population of 10,000 infected
    - high recovery of organisms in s_____ water in Fall (55% of samples positive) and Winter (39% of samples positive)
    - poorly correlated with bacterial i_____ organisms
- *Legionella pneumophilia* - causative bacteria in Legionaire's disease
  - first encountered in P_____ in 1976
  - found in natural habitats such as l_____ and r_____
  - acute pneumonia (respiratory distress) with high f_____ rat
  - organism is s_____ by aerosolization
  - microbial a_____ from evaporative condensers, humidifiers and cooling towers
  - also affects gastrointestinal, u_____, and nervous system
  - can be persistent in local water distribution systems (e.g. h_____)
- Other opportunistic bacterial pathogens -
  - *Pseudomonas*
  - *Aeromonas*
  - *Kleibsiella*
  - *Flavobacterium*
  - hospitals can harbor a_____ resistant strains

# Viral Pathogens

- 140 known v_____ pathogens
- Smallest "living" unit, but are they alive? Require a h_____ c_____to reproduce
- Invade cells and take over their m_____ functions
- Infect h_____, animals, plants, bacteria, protozoa, etc.
- Weren't identified until 1931 with advent of e_____ microscope
- Viruses are ingested, m_____ in intestines and are excreted in large numbers
- Usually present in small numbers overall therefore need to be c_____ in order to detect
  - Adsorption to m_____ filters
  - D_____ using animal tissue culture, immunological testing (ELISA) or gene probes
- Most probable transmission is p_____ to person or foodborne, but w_____ transmission also possible
- Infection depends on MID and host s__
- MID is s_____ compared to bacterial pathogens (tens of plaque forming units, PFUs)
- Viruses can cause f_____, diarrhea, respiratory infection, meningitis, or paralysis
- Difficult because can't treat with a_____ (can use antibiotics to prevent secondary infection)
- Some v_____ available

# Major Viruses of Concern

- Hepatitis A (i_____ Hepatitis - HAV) oral/fecal route
  - short i_____ period (2-6 weeks)
  - oral/fecal route of transmission (water borne, foodborne, or person to person)
  - causes l_____ damage, nausea, fatigue, jaundice (yellowing of eyes), loss of appetite
  - p_____ worldwide
  - s_____ contamination of particular concern
  - c_____ shellfish in 1988 in Shanghai was responsible for 292,000 cases
- Hepatitis B (s_____ Hepatitis - HBV)
  - transmitted by infected b_____ or sexual contact
  - higher m_____ than HAV (1-4%)

# Major Viruses of Concern

- V_____ gastroenteritis
  - *rotavirus* -
    - 70-nm particles, d_____ stranded RNA
    - acute i_____ gastroenteritis
    - responsible for significant proportion of childhood mortality in d_____ countries (millions of deaths per year)
    - major c_____ of traveler's diarrhea
    - w_____ pathogen
    - fecal/oral route most l_____, but respiratory route also suspected
    - ELISA kits are available for d_____

# Major Viruses of Concern

- *Norwalk virus*
  - small 27 nm virus d_____ in Norwalk, Ohio
  - waterborne and f_____
  - difficult to detect in e_____ samples
  - gastroenteritis and traveler's diarrhea
  - 42% of n_____ gastroenteritis attributed to Norwalk virus in one study

# Major Viruses of Concern

- Other viruses
  - AIDS/HIV - not considered a waterborne pathogen, but may s_____ in water for a limited time
  - c_____ virus - not waterborne
  - adenovirus - can cause e_____ infections (conjunctivitis) in swimming pools and respiratory disease
  - poliovirus - can cause p_____, aseptic meningitis

# Protozoan Pathogens

- Most produce c_____ that are resistant to disinfection, can survive for long periods of time
- In 1991-1992 there were 34 disease o_____ associated with waterborne pathogens affecting about 17,000 people
  - five of 34 were c_____ water systems
  - 29 were c_____, resorts, recreation areas, restaurants, and private systems
  - in 11 of the outbreaks the cause was i_____
  - 7 of the 11 were p_____ parasites *Giardia* or *Cryptosporidium*
  - 4 were h_____ A, shigella, or specific chemicals

# Protozoan Pathogens

- *Giardia lamblia*
  - i_____ person can excrete 106 cysts per gram of feces
  - wild and domestic animals act as r_____
  - e_____ in mountain areas (beavers, muskrats, dogs, cats)
  - infection may last for months to y_____
  - MID is f_____ than 10 cysts
  - causes diarrhea, a_____ pain, nausea, fatigue, and weight loss (rarely fatal)
  - b_____ diarrhea
  - i_____ may last from months to years
  - first major outbreak occurred in Rome, NY in 1975 - 5,000 people (10% of the population) water had been c_____ but not f_____
  - major factor in waterborne outbreaks (as high as 50%)
  - i_____ organisms don't correlate well, cryptosporidium does
  - *Giardia* has been detected in 16% of p_____ water supplies at an average concentration of 3 cysts per 100 mL
  - prevalence may be as high as 80% of s_____ water supplies

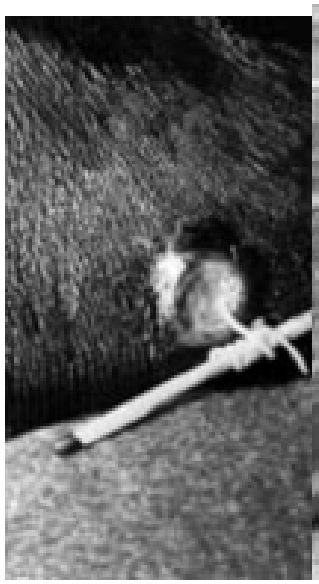
# *Cryptosporidium*

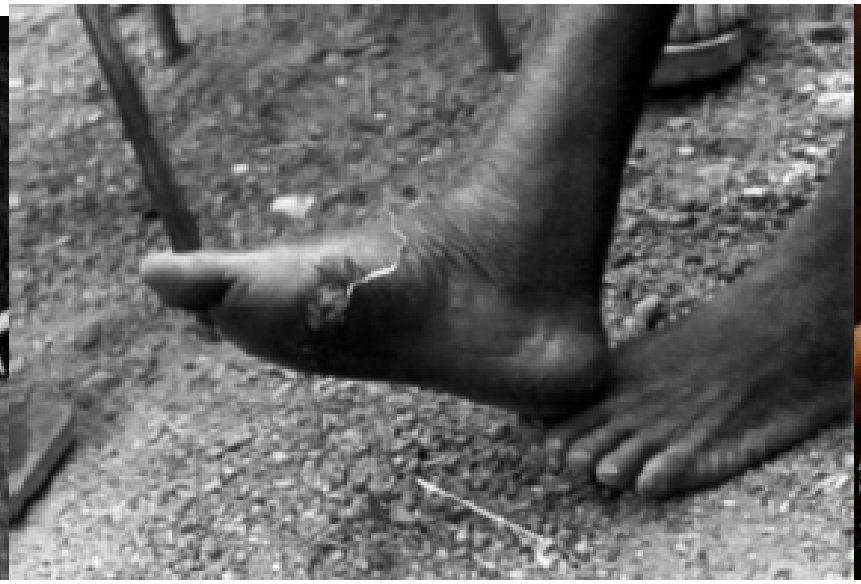
- prevalent in c_____ and sheep (billions of oocysts shed in feces every day)
- infections in h_____ not detected until 1970's
- incidence in w_____ outbreaks not identified until late 1980's
- cyst releases sporozoite after i_____
- l_____ MID (possibly as low as 1-10)
- p_____ diarrhea, rapid water loss, weight loss, nausea, vomiting, fever
- diarrhea lasts from 1-10 days usually, longer for immunodeficient p_____
- prevalence in population is approximately _____%
- person to person contamination most probable route, hygiene important - especially in d_____ c_____ c_____
- major waterborne outbreaks:
  - New Carrollton, Georgia
    - 1987 - 13,000 people infected
    - No indicator organisms identified
    - 39% of patients t_____ p_____ for crypto
    - Improper s_____ f_____ operation implicated
  - Milwaukee, Wisconsin
    - 1993 - 403,000 people infected, several deaths (#?)
    - Improper c_____ and sand filter operation implicated
- *Cryptosporidium* has been detected in _____% of potable water supplies at an average concentration of 43 cysts per 100 mL, prevalence may be higher in surface water supplies

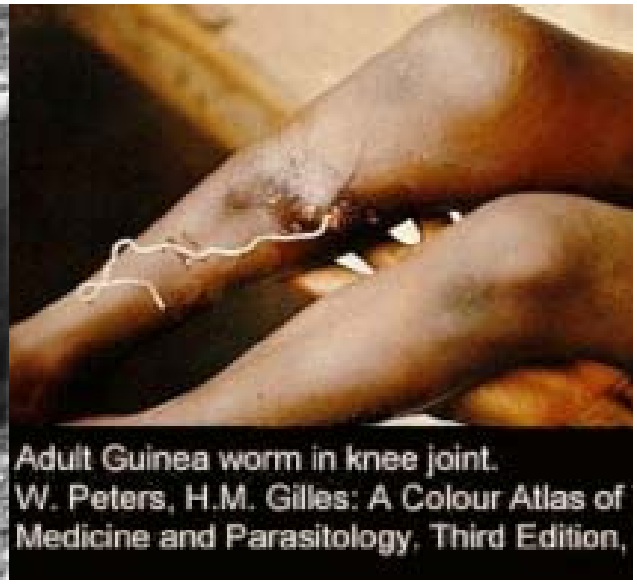
# Helminths

- Similar to protozoan o_____ in survivability and resistance to disinfection
- Parasitic w_____
- most are transmitted in contaminated f_____
- Some are transmitted by other routes: *Schistosoma* in u_____
- *Dracunciliasis* (guinea worm) - skin b_____

# Guninea Worm

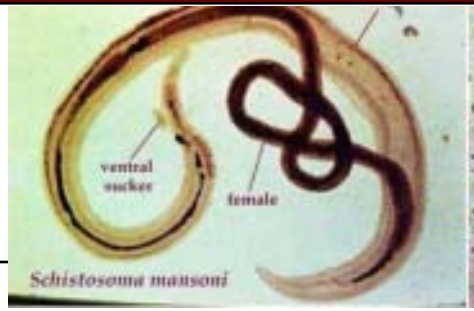






Adult Guinea worm in knee joint.
W. Peters, H.M. Gilles: A Colour Atlas of Medicine and Parasitology. Third Edition,

# *Schistosomiasis*





- Affects nearly _____ million
- Africa, South A_____, parts of Asia
- 200,000 d_____ per year
- Causes enlargement of l_____, diarrhea, anemia
- Free swimming l_____ in water called cercaria are emitted from s_____ which serve as intermediate hosts
- Cercaria attach to human s_____ and penetrate to the blood stream
- They mature in the l_____, eggs are passed in urine
- Eggs hatch in water into free swimming c_____ larvae and infect snails
- Milder form of schistosomiasis - s_____ i_____
- D_____ and irrigation projects in developing countries have created ideal conditions for the spread of the disease

# *Ascariasis* (roundworms)

- MID is a few infective e_____
- Each female can produce _____ eggs per day
- Resistant to disinfection, can survive 2-7 years in s_____
- High prevalence worldwide _____ million to __ billion (1983)
- 85% of infections are s_____
- Symptoms include pneumonia, nausea, abdominal pain, m_____
- A child that has _____ worms may lose 10% of his daily intake of p_____
- Vitamin ____ and ____ deficiencies possible
- part of life cycle spent in l_____