



Image source:
http://biology.kenyon.edu/Microbial_Biorealm/eukaryotes/giardia/giardia.html

BAD BUGS

Presented by
The Groundwater Foundation



Image source:
<http://www.wisc.edu/foodsafety/meatresearch/images/ecoli.jpg>

E. Coli O157:H7

Giardia lamblia

COMMON WATERBORNE PATHOGENS

- *E. coli* (notably serotype O157:H7)
- *Legionella*
- *Cryptosporidium*
- *Giardia*
- Noroviruses (Norwalk-like viruses)



Image source:
<http://www.nih.gov/niid/para/atlas/images/giardia-trph.jpg>

Giardia lamblia

BAD BUGS AND THEIR GANGS



- Bacteria
 - *E. coli*
 - *Legionella*
 - *Campylobacter*
- Protozoa
 - *Cryptosporidium*
 - *Giardia*
- Viruses
 - Noroviruses (Norwalk-Like Viruses (NLVs))
 - (also Hepatitis-A, though no major documented cases of waterborne outbreaks in recent history)

BAD BUGS = BAD NEWS



- *E. coli* O157:H7
 - Bloody diarrhea without fever
 - Extreme cases may lead to hemolytic uremic syndrome (HUS) which may cause kidney failure
 - Note: serotype O157:H7 is just one strain of large family of *E. coli* bacteria, several others also pathogenic
- *Legionella*
 - Diseases called Pontiac Fever, Legionnaire's Disease
 - Respiratory infection
 - Pontiac Fever is less severe form of disease
 - Legionnaire's Disease is marked by development of respiratory infection into pneumonia

BAD BUGS = BAD NEWS



- *Campylobacter jejuni*
 - Diarrhea (may be bloody), cramping, abdominal pain, nausea, vomiting
 - In immune-compromised patients, may lead to life-threatening blood infection; may also lead to Guillain-Barre syndrome which may cause temporary paralysis
 - *C. jejuni* causes most human illnesses; however, other species of *Campylobacter* cause about 1% of documented illnesses

BAD BUGS = BAD NEWS



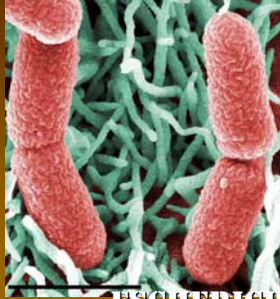
- *Cryptosporidium*
 - Diarrhea
 - Abdominal discomfort
- *Giardia*
 - Diarrhea
 - Abdominal discomfort

BAD BUGS = BAD NEWS

- Noroviruses (Norwalk-Like Viruses (NLVs))
 - Fever
 - Headache
 - Gastrointestinal discomfort
 - Diarrhea

BAD BUG PROFILES

Image source: www.microscopyconsulting.com/



NAME:
ESCHERICHIA COLI
0157:H7
(AKA E. COLI 0157:H7)

CRIMINAL HISTORY:
CAUSED ILLNESS IN 781 PEOPLE
AND 2 DEATHS IN
WASHINGTON CO., NY IN
1999; CAUSED ILLNESS IN
600 PEOPLE AND 7 DEATHS
IN WALKERTON, ONTARIO IN
2000

M.O.:
CAUSES BLOODY
DIARRHEA, OFTEN
WITHOUT FEVER, IN
VICTIM

IDENTIFICATION

NOTES:
PRODUCES "SHIGA-LIKE"
(SIMILAR TO SHIGELLA)
TOXIN WHICH MAY LEAD
TO HEMOLYTIC UREMIC
SYNDROME IN VICTIM.
KNOWN TO HANG OUT IN
UNDERCOOKED BEEF.

- **FIRST IDENTIFIED AS PATHOGEN IN 1982 WHEN OUTBREAK OF DIARRHEA WAS TRACED TO UNDERCOOKED HAMBURGERS**
- **MOST INFECTIONS OCCUR FROM CONSUMPTION OF UNDERCOOKED BEEF**
- **SYMPTOMS BEGIN 3-9 DAYS AFTER EXPOSURE, THOUGH SHORTER INCUBATIONS NOT UNCOMMON**
- **ILLNESS LASTS 5-10 DAYS**
- **ANTIBIOTICS AND ANTI-DIARRHEAL MEDICATIONS ARE NOT RECOMMENDED**
- **2-7% OF INFECTIONS LEAD TO HUS, OF WHICH 1/3 MAY EXPERIENCE LONG-TERM KIDNEY MALFUNCTION, AND 8% MAY HAVE LIFELONG COMPLICATIONS LIKE HIGH BLOOD PRESSURE, SEIZURES, BLINDNESS, PARALYSIS**
- **E. COLI 0157:H7 IS PRESENT IN GASTROINTESTINAL TRACT OF HEALTHY CATTLE AND INFECTED ANIMALS**
- **FIRST LINE OF DEFENSE: PREVENTING ANIMAL WASTE FROM ENTERING DRINKING WATER SOURCE**

Image source: <http://www.chemistryquestion.com/images/Question/legionella.jpg>



**NAME:
LEGIONELLA
PNEUMOPHILA
(AKA LEGIONELLA)**

M.O.:

**CAUSES RESPIRATORY
ILLNESS WITH HIGH
FEVER SOMETIMES
LEADING TO
PNEUMONIA. MAY ACT
MILDLY, CAUSING
PONTIAC FEVER**

CRIMINAL HISTORY:

**CAUSED OUTBREAK OF
LEGIONNAIRE'S
DISEASE IN TORONTO
NURSING HOME, 2005;
RESULTED IN 127
ILLNESSES AND 21
DEATHS**

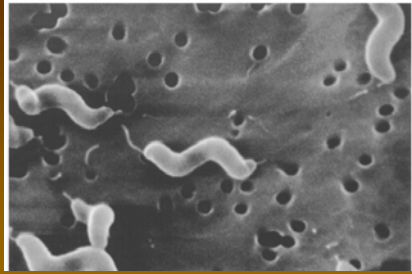
IDENTIFICATION

NOTES:

**MOSTLY OPERATES AS
AIRBORNE DROPLETS
THROUGH VENTILATION
SYSTEMS; IDEAL
HIDEOUT IS IN
SWIMMING POOLS AND
HOT TUBS**

- **FIRST IDENTIFIED
OUTBREAK IN 1976 AT
AMERICAN LEGION
CONVENTION IN
PENNSYLVANIA**
- **LEGIONNAIRE'S
DISEASE (MORE SEVERE
FORM, LEADS TO
PNEUMONIA) MAY
CAUSE DEATH IN UP TO
5-30% OF PATIENTS**
- **SYMPTOMS BEGIN TO
OCCUR 2-14 DAYS AFTER
EXPOSURE**
- **PONTIAC FEVER (LESS
SEVERE FORM) LASTS 2-
5 DAYS, NO TREATMENT
USU. NECESSARY**
- **LEGIONNAIRE'S
DISEASE TREATED WITH
ANTIBIOTIC**
- **VICTIMS WHO SURVIVE
MAY SUFFER
PERMANENT PHYSICAL
OR MENTAL
IMPAIRMENT**
- **MOST OUTBREAKS ARE
NOT LARGE, AFFECTING
1-2 VICTIMS AT A TIME**
- **CDC ESTIMATES 10,000
TO 15,000 CASES IN THE
US ANNUALLY**
- **COMMON LONG TERM
EFFECTS INCLUDE
FATIGUE AND LACK OF
ENERGY, MAY LAST
MONTHS**

Image source: <http://www.cdc.gov/ncidod/eid/vol5no1/altek2b.jpg>



M.O.:

CAUSES (POTENTIALLY BLOODY) DIARRHEA, CRAMPING, ABDOMINAL PAIN, NAUSEA AND VOMITING IN VICTIM; MAY LEAD TO LIFE-THREATENING BLOOD INFECTION OR PARALYSIS

NAME:

CAMPYLOBACTER JEJUNI (AKA CAMPYLOBACTER)

CRIMINAL HISTORY:

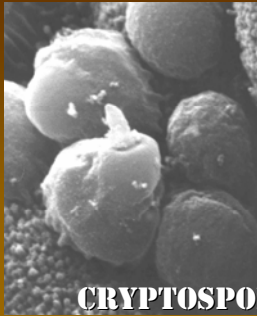
ACCOMPLICE TO WALKERTON, ONTARIO E. COLI OUTBREAK IN 2000; IDENTIFIED IN SOUTH BASS ISLAND, OHIO, OUTBREAK IN AUGUST 2004

IDENTIFICATION NOTES:

COMMONLY OPERATES IN SMALL, ISOLATED OUTBREAKS AND/OR ASSOCIATES WITH OTHER BAD BUGS; COMMONLY HANGS OUT IN UNDERCOOKED POULTRY

- **ONE OF THE MOST COMMON CAUSES OF DIARRHEAL ILLNESS IN THE U.S.**
- **OCCURS MORE FREQUENTLY IN SUMMER THAN WINTER**
- **CAMPYLOBACTER IS FRAGILE AND CANNOT TOLERATE COLD TEMPERATURES, DRYING (MAY EVEN BE KILLED BY OXYGEN)**
- **DOES NOT COMMONLY CAUSE DEATH, BUT MAY CAUSE UP TO 100 DEATHS PER YEAR**
- **MOST VICTIMS CAN RECOVER WITHOUT TREATMENT, THOUGH IN SOME CASES, ANTIBIOTICS MAY BE USED**
- **VICTIMS SHOULD DRINK PLENTY OF FLUIDS TO AVOID DEHYDRATION**
- **ILLNESS BEGINS 2-5 DAYS AFTER CONTACT AND LASTS 2-5 DAYS, SOMETIMES UP TO 10 DAYS**
- **SEVERE LONG-TERM EFFECTS INCLUDE BLOOD INFECTION IN IMMUNE-COMPROMISED VICTIMS, AND GUILLAIN-BARRE SYNDROME (TEMPORARY PARALYSIS REQUIRING INTENSIVE CARE) IN RARE CASES**

Image source: <http://www.k-state.edu/parasitology/625tutorials/FIGbaileyi06.jpg>



NAME:
CRYPTOSPORIDIUM
PARVUM
(AKA CRYPTOSPORIDIUM)

CRIMINAL
HISTORY:
CAUSE OF CRYPTOSPORIDIOSIS
OUTBREAK IN MILWAUKEE,
WISCONSIN IN 1993; OVER
400,000 PEOPLE ILL

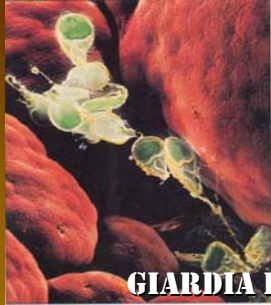
M.O.:
CAUSES DIARRHEA,
ABDOMINAL
DISCOMFORT IN VICTIM

IDENTIFICATION
NOTES:
PROTOZOAN, DEVELOPS
OOCYST (FUNCTIONS
LIKE BULLET-PROOF
VEST) WHICH AIDS
PERPETRATOR IN
RESISTING
INACTIVATION FROM
CONVENTIONAL
DISINFECTION
METHODS

- **CRYPTOSPORIDIUM NOW IDENTIFIED AS ONE OF THE MOST COMMON PATHOGENS IN DRINKING WATER AND RECREATIONAL WATER**
- **ILLNESS OCCURS APPROXIMATELY 2-10 DAYS AFTER EXPOSURE (AVERAGE 7 DAYS)**
- **SYMPTOMS LAST 1-2 WEEKS; MAY SEEM TO GET BETTER AND THEN WORSEN**

- **SOME PRESCRIPTION DRUGS AVAILABLE FOR TREATMENT, THOUGH INDIVIDUALS WITH HEALTHY IMMUNE SYSTEMS USUALLY RECOVER WITHOUT TREATMENT**
- **EFFECTS OF PRESCRIPTION DRUGS ON THOSE WITH COMPROMISED IMMUNITY (AIDS, CANCER PATIENTS, ELDERLY AND YOUNG) IS UNCLEAR**
- **CRYPTOSPORIDIUM LIVES IN INTESTINES OF WARM-BLOODED ANIMALS, INCLUDING CATTLE, SHEEP, DEER AND BEAVERS**
- **FIRST LINE OF DEFENSE: PREVENTING ANIMAL WASTE FROM ENTERING DRINKING WATER SOURCE**

Image source: http://biology.kenyon.edu/Microbial_Biorealm/eukaryotes/giardia/giardia.html



NAME:
GIARDIA LAMBLIA
(AKA GIARDIA, GIARDIA
INTESTINALIS)

CRIMINAL HISTORY:
CAUSED ILLNESS 324
PEOPLE IN RENO,
NEVADA IN 1982

M.O.:
CAUSES DIARRHEA,
ABDOMINAL
DISCOMFORT IN VICTIM

IDENTIFICATION
NOTES:
PERPETRATOR MAY CAUSE
ILLNESS FOR 2 WEEKS
UP TO 2 MONTHS. LIKE
CRYPTOSPORIDIUM,
FORMS PROTECTIVE
OUTER BARRIER LIKE
BULLET-PROOF VEST

- **IDENTIFIED AS ONE OF MOST COMMON PATHOGENS IN DRINKING WATER AND RECREATIONAL WATER**
- **SYMPTOMS BEGIN TO OCCUR 1-2 WEEKS AFTER EXPOSURE (7 DAYS AVERAGE)**
- **ILLNESS LASTS 2-6 WEEKS, OCCASIONALLY LONGER**

- **PRESCRIPTION DRUGS ARE AVAILABLE FOR TREATMENT**
- **CHILDREN AND PREGNANT WOMEN ESPECIALLY SHOULD DRINK PLENTY OF FLUIDS TO AVOID DEHYDRATION DURING ILLNESS**

Image source: <http://www.extension.iastate.edu/foodsafety/images/norwalk.jpg>



**NAME:
NOROVIRUS**

(AKA NORWALK-LIKE VIRUS)

**CRIMINAL HISTORY:
CAUSED RELATIVELY SMALL
OUTBREAK AT WYOMING
SNOWMOBILE LODGE IN
FEBRUARY 2001; LARGE
OUTBREAK AT ITALIAN
RESORT (344 ILL) IN JULY
2000**

M.O.:

**CAUSES FEVER,
HEADACHE,
GASTROINTESTINAL
DISCOMFORT,
DIARRHEA IN VICTIM**

**IDENTIFICATION
NOTES:**

**ORIGINAL STRAIN WAS
NORWALK, FIRST NOTED
CRIMINAL ACTIVITY IN
1968; SINCE THEN,
SEVERAL OTHER
STRAINS IDENTIFIED
AND ARE COLLECTIVELY
CALLED NOROVIRUSES**

- **NORWALK VIRUS FIRST IDENTIFIED IN 1972, FROM 1968 OUTBREAK OF GASTROENTERITIS IN SCHOOL CHILDREN AND TEACHERS IN NORWALK, OHIO**
- **SINCE 1972, SEVERAL SIMILAR STRAINS IDENTIFIED AND COLLECTIVELY CALLED 'NORWALK-LIKE VIRUSES,' RECENTLY OFFICIALLY CALLED NOROVIRUSES**
- **SYMPTOMS OCCUR WITHIN 24-48 HOURS OF EXPOSURE, SOMETIMES AS LITTLE AS 12 HOURS**
- **ILLNESS LASTS 1-2 DAYS**
- **NO ANTIVIRAL MEDICATION OR VACCINATION AT PRESENT**
- **INFECTED PERSONS ARE CONTAGIOUS FROM ONSET OF SYMPTOMS, TO UP TO 2 WEEKS AFTER RECOVERY**
- **VIRUS IS HIGHLY CONTAGIOUS, PRESENT IN STOOL AND VOMIT OF VICTIM**

GETTING RID OF BAD BUGS

- Chemical treatment
 - Chlorination: Most common form of treatment
 - Effective against bacteria, but not as effective against viruses or protozoa cysts
 - Disinfection byproducts are a growing concern
 - Water chemistry must be assessed/altered
- Non-chemical treatment
 - Ultraviolet
 - Effective against bacteria and viruses, but will not deactivate protozoa cysts
 - Water quality must be assessed/altered

PREVENTING BAD BUG ACTIVITY

- Virtually all bad bugs found in human or animal fecal matter
- Preventing bad bugs from entering drinking water sources includes:
 - Proper onsite waste management
 - Runoff prevention/interception
 - Fencing around surface water sources
 - Proper well construction (including well casing extension in floodplains)
 - Placing wells away from potential sources

ONSITE WASTE MANAGEMENT, RUNOFF PREVENTION/INTERCEPTION, FENCING

- Proper placement of septic systems
- Regular pumping and inspection of septic systems
- Proper containment of animal waste (lagoons)
- Filter strips around surface water sources – effectiveness assessments are mixed
 - Slow runoff and filter out sediments (including attached pathogens); but create habitat for wildlife at shore/bank
- Fencing around surface water sources to keep large animals out

WELL CONSTRUCTION AND PLACEMENT

- Well should be located 'uphill' (up-stream) of potential contamination sources
- Wells should be cased with impervious (steel or plastic) material
 - Nebraska standards dictate this, though older wells may have clay/brick casing
 - Older wells should be abandoned properly and new up-to-standard wells should be constructed
- Top of well casing should be at least 12 inches above ground
 - May need to be taller in floodplain areas (so that top of casing is above flood waters)
 - Area around casing should slope away from well