

## The Science of Foodborne Illness: Register of Foodborne Illness — part 1

Pathogen	Host Range	Common Sources	Epidemiology	Mode of Transmission	Optimum Growth Temperature	Infectious Dose	Illness Symptoms	Incubation Period	Duration of Illness	Number of Cases	Deaths	Preventative Measures
<b>Aeromonas hydrophila</b>	Humans, amphibians, fish, reptiles, birds	Fresh water fish, oysters and other seafood	Worldwide; especially near freshwater sources; incidence of serious human disease is increasing and many isolates are probably misdiagnosed as coliforms	Fecal-oral transmission; contact with contaminated water and food; improper food handling	35° (min=10° max =40°)	Not known	Gastroenteritis	Not clearly identified	24-48 hours; on rare occasions the syndrome is severe and may last for several weeks	The relative frequency of illness in the US. is unknown	Rare	Proper handwashing
<b>Bacillus cereus</b>	Soil, dust and spices	Starchy foods	Worldwide; especially in Europe	By ingestion of foods kept at ambient conditions after cooking; contaminated food handlers hands	30-35° (min=4° max=48°)	Greater than 106 organisms by ingestion (>105 organisms/g of food)	Two forms: an emetic form with severe nausea and vomiting and a diarrheal form with abdominal cramps and diarrhea; both forms are usually mild and self-limiting	Emetic form 1-6 hours, average 4 hours; diarrheal from 6-24 hours, average 17 hours	Duration of symptoms is generally less than 24 hours	Difficult to determine and often mis-diagnosed	Rare	Proper handwashing
<b>Campylobacter jejuni</b>	Animal reservoirs and foods of animal origins	Meat, poultry, milk and mushrooms	Cause of diarrheal illness worldwide in all age groups (5-14% of diarrhea in world); common source outbreaks most often associated with foods, unpasteurized milk and unchlorinated water	Ingestion of organisms in undercooked food or in unpasteurized milk or water; cross-contamination from these sources to foods eaten	42° (min=37° max =47°)	500 organisms or less (by ingestion)	Diarrhea, abdominal pain, malaise, fever, nausea and vomiting; blood in association with mucus and WCBs present in liquid of foul smelling stools	2-5 days, with a range of 1-10 days; dose-dependent	Illness generally lasts 7-10 days, but relapses are not uncommon (about 25% of cases). Most infections are self-limiting	Estimated 2 to 4,000,000 cases a year in the US (leading cause of)	Estimated at 0.1% of cases	Proper handwashing (especially after handling raw foods)
<b>Clostridium botulinum</b>	Soils, plants, marine sediments and fish	Canned foods, meat products, smoked meats	Sporadic or family-grouped cases occur worldwide; in association with food products prepared or preserved to permit toxin production	By ingestion of contaminated food containing toxin	37°C (min=10° max=50°)	Cells/spores not normally toxic to adults; toxin is extremely potent	Acute flaccid paralysis involving the muscles of the face, head and pharynx, down to the thorax and extremities	12 - 36 hours after ingestion of toxin	Variable	30-50 cases a year in the US annually	Fatality rate of cases reported is high	Proper food sterilization; proper handwashing
<b>Clostridium perfringens</b>	Dust, soil and gastrointestinal tracts of animals and humans	Meat and poultry dishes, sauces and gravies	Widespread and relatively frequent in countries with cooking practices that favor multiplication of Clostridia	Ingestion of food contaminated by soil or feces, held under conditions which permit multiplication	43-45° (min=15° max=50°)	105 organisms/g food	Sudden onset of colic followed by diarrhea, nausea, but vomiting and fever is usually absent	From 6-24 hours; usually 10-12 hours	The illness is usually over within 24 hours but less severe symptoms may persist in some individuals	Estimated about 10,000 actual cases occur annually in the US.	Rare	Proper handwashing especially after toilet visits
<b>Cryptosporidium parvum</b>	Vertebrates including humans, poultry, fish, reptile, small and large mammals	Daycare centers; beverages and salads	Worldwide; rate of infection ranges from 1 to 4.5% in developed countries and from 3 to 20% in developing countries; higher infection rates reported in AIDS patients (3-20% in US, 50-60% in Africa and Haiti); frequent outbreaks in daycare centers	Fecal-oral route (person-to-person, animal-to-person, food and waterborne transmission)	35°	ID50=132 organisms	Profuse, watery diarrhea, cramping, abdominal pains, weight loss, anorexia, flatulence and malaise; nausea, vomiting, fever and myalgias may also be present	1 to 12 days; average is 7 days	1 or 2 weeks in healthy individuals	Sporadic outbreaks that when occur, affect large numbers	Rare, increased in children, elderly and immunocompromised individuals	Proper handwashing imperative
<b>Escherichia coli O157:H7</b>	Feces of infected humans	Meat and soft cheeses	Sporadic and in outbreaks of bloody diarrhea; associated with 15-30% of patients where no other pathogen has been identified	Ingestion of contaminated food; fecal-oral transmission; person-to-person transmission extremely high	37° (min=10° max=45°)	10 organisms by ingestion	Hemorrhagic colitis, intestinal disease accompanied by cramps and abdominal pain; initially watery, followed by bloody diarrhea; low grade fever; 5-10% of hemorrhagic colitis victims may develop hemolytic uremic syndrome (HUS)	2-8 days (median of 3-4 days)	Normally 5-10 days	Estimated 73,000 cases of infection per year in the US	61 deaths in the US annually	Proper handwashing is extremely important
<b>Giardia lamblia</b>	Humans; wild (beavers and bears) and domestic animals (dogs)	Water, salads and fruit washed with contaminated water and foods handled by contaminated individuals	Worldwide; prevalent in areas with poor sanitation; water-borne outbreaks are common where unfiltered waters are routinely contaminated by human and animal feces; daycare centers and cause of travellers diarrhea	Person-to-person, faecal-oral route is most important (hand to mouth transfer of cysts); infected food handlers; fecally-contaminated water & food	35°	Less than 10 cysts when given orally, may even be as low as 1 cyst	Sudden onset of diarrhea with foul-smelling, greasy-looking stool that lacks mucus and blood; associated with abdominal cramps, bloating, fatigue and weight loss; restricted to upper small intestine with no invasion	From 3 - 25 days, usually 7 - 10 days	Normally illness lasts 1-6 weeks; chronic infections can last months to years	Estimated 40,000 reported cases annually in the US	0.2% fatality of reported cases	Proper handwashing
<b>Hepatitis A virus</b>	Humans, marmosets (experimentally infected), chimpanzees, macaque monkeys, owl monkeys	Shellfish (especially raw shellfish) and salads	Worldwide, sporadic and epidemic, cyclic recurrences; outbreaks in institutions, housing projects, day-care centers; where environmental sanitation is poor infection occurs at an early age; commonly	Person-to-person, faecal-oral route; ingestion of contaminated food (i.e., shell fish) and water	33°	Not known, however presumed to be 10-100 virus particles	Many infections are asymptomatic; abrupt onset with fever, malaise, anorexia, nausea and abdominal discomfort, followed within a few days by jaundice	From 10-50 days, depending on dose; average 28-30 days	Mild illness (1-2 weeks) to severely disabling (6-9 months period)	Estimated 20,000 cases per year in the US	Average 4.1% fatality rate (dependent on age of host)	Proper handwashing and vaccination
<b>Hepatitis E virus</b>	Humans, primates (infection of chimpanzees, macaques, African Green monkeys, marmosets, owl monkeys), pigs, rodents and domestic chickens	Water, salads, shellfish	Cases of HEV have occurred over a large geographic area, most notably in regions with poor sanitation; there have been several food-borne epidemics; HEV infections epidemics; HEV infections have been associated with the consumption of fecally contaminated water. Most notably in regions with poor sanitation; there have been several foodborne epidemics	Faecal-oral route; ingestion of contaminated water; potential exists for food-borne transmission	33°	Not known	Symptoms include: jaundice, anorexia, hepatomegaly, abdominal pain and tenderness, nausea and vomiting and fever; mortality of HEV infection has been reported to be as high as 1%; in pregnant women may reach 20%; mortality rate may reach 20%;	Two to 9 weeks, mean 26-42 days	Host dependent	Current estimates in the US not available (not yet significant)	1 to 2% of cases; in pregnancy it kills up to 35% of women/fetuses	Proper water sanitation; proper handwashing
<b>Listeria monocytogenes</b>	Soil, vegetation and water	Milk, soft cheeses, vegetables fertilized with manure, cold meats	Recent outbreaks associated with food; nosocomial acquisition; 40% of clinical cases occur in infants; in adults infection occurs mainly after age 40; European studies have disclosed large numbers of human carriers; case fatality rate in newborns is 50%	Ingestion of contaminated food	30-37° (min=1° max =45°)	Not known	Meningoencephalitis and/or septicemia in the elderly, in neonates and among immunocompromised individuals; infection at all ages with consequence only during pregnancy	Variable, outbreak cases have occurred 3-70 days following a single exposure to an implicated product, median incubation is about 3 weeks	Varying, dependent on health of host	Estimated to be 1600 cases of listeriosis per year in the US	415 deaths in the US annually	Proper handwashing especially after handling raw food and unwashed fruits and vegetables

Your ability to wage the war against foodborne illness begins with an appreciation of the strength and resilience of the enemy. With microbes being an important part of our immune system, how do we identify the pathogens? How do we harness the constructive power of science?

## The Science of Foodborne Illness: Register of Foodborne Illness — part 2

Pathogen	Host Range	Common Sources	Epidemiology	Mode of Transmission	Optimum Growth Temperature	Infectious Dose	Illness Symptoms	Incubation Period	Duration of Illness	Number of Cases	Deaths	Preventative Measures
<b>Norwalk virus</b>	Humans	Shellfish, salads	Worldwide and common; affects mainly older children and adults; frequent outbreaks in camps, schools, nursing homes, cruise ships and areas with contaminated drinking and swimming water	Principally by fecal-oral route; documented sources include water and food	37°	Not known	Abrupt onset of diarrhea, vomiting, non-bloody diarrhea and abdominal cramps; 25-50% of affected persons report myalgias, malaise, headache, nausea and low-grade fever; fatality is associated with electrolyte imbalance;	From 10-60 hours; usually 24-48 hours	Usually resolves within 24-48 hours; symptoms can persist for up to several weeks	Estimated at 40 million cases a year in the US	Rare	Proper handwashing is very important
<b>Salmonella spp.</b>	Intestinal tracts of animals and humans	High protein foods - meat, poultry, fish and eggs	Worldwide, more extensively in North America and Europe; higher incidence rate for infants and young children; small outbreaks in general population; large outbreaks in hospitals, institutions, nursing homes, restaurants	By ingestion of directly or indirectly; contaminated food, infected animals, or food by infected animal or person; fecal-oral trans-mission from person to person	37°C (min=5° max=47°)	100 - 1,000 organisms - ingestion	Sudden onset of abdominal pain, diarrhea, nausea and vomiting	Six to 72 hours, usually about 12-36 hours	Days to several weeks; 1% of infected adults and 5% of infected children excrete organism for over 1 year	It is estimated that from 2 to 4 million cases of salmonellosis occur in the US	1% of cases (up to 15% in elderly populations)	Proper handwashing (especially after raw meat handling)
<b>Salmonella typhi</b>	Humans	Raw meats, poultry, eggs, milk and dairy products, and fish	Worldwide; sporadic cases in North America; most cases represent importation from endemic areas; multi-drug resistant strains have appeared in several areas of the world	Person-to-person; by contaminated food or water; by food contaminated by food handlers hands of carriers	35-37° (min=7° max =45°)	100,000 organisms - ingestion; variable with gastric acidity and size of inoculum	Generalized systemic enteric fever, headache, malaise, anorexia, enlarged spleen, and constipation followed by more severe abdominal symptoms; rose spots on trunk in 25% of Caucasian patients	Depends on size of infecting dose; usually 1-3 weeks	Variable depending on host	Approximately 400 cases of typhoid fever are reported per year. More than two thirds of cases are acquired from	10% of cases	Proper handwashing is important
<b>Shigella spp.</b>	Humans, primates	Salads (potato, tuna, shrimp, macaroni, and chicken), raw vegetables, milk and dairy products, and poultry	Worldwide; 2/3 of cases and most deaths are children under 10 years; common during weaning period; outbreaks under conditions of crowding and poor sanitation; endemic in tropical and temperate climates	By direct or indirect fecal-oral transmission from a patient or carrier; poor hygiene practices spread infection to others by direct physical contact or indirectly by contaminating food	35-37° (min=10° max =45°)	10-200 organisms by ingestion	Acute disease of large and small intestine; diarrhea, fever, nausea; sometimes toxemia, vomiting, cramps and tenesmus; stools contain blood, mucus and pus; alterations in consciousness may occur; mild infections occur; dependent on host, dose and serotype	One to 7 days, usually 1-3 days	Variable depending on host	An estimated 300,000 cases of shigellosis occur annually in the U.S. The number attributable to food is unknown, but is probably substantial	Fatality may be as high as 10-15% of cases	Proper handwashing is extremely important
<b>Staphylococcus aureus</b>	Nose and throat of 30 to 50 percent of healthy population; skin and superficial wounds	Meat and seafood salads, sandwich spreads, high salt foods	Occurs worldwide; particularly in areas where personal hygiene is suboptimal	Ingestion of food containing staphylococcal enterotoxin contaminated by food handlers hands	30-37° (min=10° max=45°)	Virulence of strains varies greatly	Nausea, projectile vomiting, diarrhea, no fever	4 to 6 hours	6 to 24 hours	Hard to determine, figures estimate between 1,500 and 7,000 cases annually in the US	Death from staphylococcal food poisoning is very rare, cases have occurred among the elderly, infants, and severely debilitated persons	Proper handwashing is essential
<b>Streptococcus moniliformis</b>	Humans, rats, other animals; squirrels, weasels, gerbils	Milk and dairy products	Worldwide; uncommon in North and South America and most European countries	By direct contact with secretions of the mouth, nose, eye of an infected animal; animal bite; consumption of contaminated food or water	35°	Not known	Abrupt onset of fever, chills, vomiting, headache and severe pains in the joints; a maculo-papular, petichial, or purulent rash develops within the first 48 hours and involves the palms, soles & extremities;	Usually 3-10 days	Variable	Estimates hard to give; currently not reportable in the US; rare	10% of untreated cases	Proper handwashing (especially after contact with animals)
<b>Toxoplasma gondii</b>	Cats and other felines; most warm blooded animals and birds; humans	Raw or undercooked pork, lamb, or venison	Worldwide; 3-70% of healthy adults are seropositive; increased cases of cerebral toxoplasmosis in AIDS patients (up to 50%); higher incidence in the tropics and lower in cold, arid regions	Consuming under-cooked infected meats (pork, mutton, beef); ingestion of infective oocysts in milk food or water; may be transmitted to food by flies or cockroaches; at least one outbreak attributed to con-taminated water supply	35°	Not known	Most infections are asymptomatic; mild cases with a localized lymphadenopathy accompanied with fever, sore throat, rash, mimicking mononucleosis in some individuals; transplacental transmission causes brain damage, epilepsy, and vision problems	10-23 days - following ingestion of contaminated meat	10-13 days	Estimated to range from 400 to 9,500 cases per year	Rare; 2% of fetus death occurs in pregnant women	Proper cooking, proper handwashing (especially after contact with raw meat and domestic felines)
<b>Trichinella spp.</b>	Humans; domestic and wild animals; marine mammals	Pork and pork products, wild game	Worldwide with sporadic cases and localized outbreaks	By ingestion of encysted larvae in raw or undercooked flesh of mammals	35°	Not known	Symptoms variable depending on size of inoculum from inapparent infection to fatal disease; gastrointestinal symptoms may result; malaise, nausea, diarrhea, abdominal cramping; larvae may migrate and encapsulate in the muscles leading to muscle pain	Systemic symptoms develop in 2-4 weeks (may be longer depending on dose); gastrointestinal symptoms develop in a	1-8 weeks	Median of 12 cases annually in the US; incidence higher as asymptomatic cases go unreported; estimates unavailable	Zero reported deaths in the US	Proper handwashing (especially after handling raw meats)
<b>Vibrio cholerae</b>	Humans	Water, raw shellfish	Pandemic cholera spread from India throughout the world in 19th century; spread from Indonesia through Asia into Europe, Africa; some outbreaks in Japan and South Pacific; few sporadic cases in North America; recent outbreak in South America	Primarily through ingestion of water contaminated with feces or vomitus of patients; ingestion of food which had been contaminated by dirty water, feces, soiled hands or flies	37° (min=10° max =43°)	106-1011 organisms in healthy individual by ingestion route; varies with gastric acidity	Acute bacterial enteric disease with sudden onset, profuse watery stools, occasional vomiting, rapid dehydration, acidosis and circulatory collapse;	From a few hours to 5 days; usually 2-3 days	Variable depending on age and health of host	About 180 cases in the last five years in the US. Frequent outbreaks in third world countries and areas devastated by disaster	Rare	Proper handwashing and sanitation critical
<b>Vibrio parahaemolyticus</b>	Fish and shellfish	Raw and cooked seafood	Sporadic cases and common source outbreaks, particularly in Japan, Southeast Asia, and North America	By ingestion of raw or inadequately cooked seafood, or any food cross-contaminated by handling raw seafood in the same environment	15° (min=4° max=30°)	> 106 organisms	Watery diarrhea and abdominal cramps; sometimes nausea, vomiting, fever and headache; occasionally a dysentery-like illness with bloody or mucoid	Usually between 12-24 hours, but can range from 4-96 hours	The median duration of the illness is 2.5 days	Major outbreaks have occurred in the US during the warmer months of the year. Sporadic cases occur along all coasts of the US	Rare	Proper handwashing (especially after handling raw seafood)
<b>Yersinia enterocolitica</b>	Poultry, beef, swine	Milk, tofu, meats and fish	Worldwide; 2/3 of Y. enterocolitica cases occur among infants and small children; highest rate during cold season in temperate climates; epidemics associated with hospitals and schools as well as contaminated vehicles	Fecal-oral transmission by contact with infected persons or animals, or by eating and drinking fecally contaminated food and water	30-37° (min=2° max =40°)	106 organisms	Acute watery diarrhea, enterocolitis, acute mesenteric lymphadenitis mimicking appendicitis, fever, headache, pharyngitis, anorexia, vomiting, erythema nodosum, arthritis, iritis, cutaneous ulceration, hepatosplenic abscesses and osteomyelitis	3 to 7 days, generally under 10 days	Variable depending on host	Estimated 17,000 cases occur annually in the USA; yersiniosis is a far more common disease in Northern Europe, Scandinavia, and Japan	Rare	Proper hand washing