

BACTERIA CAUSING FOODBORNE ILLNESS

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I.	FOOD INTOXICATIONS	
A.	<i>Bacillus cereus</i>	2
B.	<i>Clostridium botulinum</i>	2
C.	<i>Clostridium perfringens</i>	2
D.	<i>Staphylococcus aureus</i>	3
II.	FOOD INFECTIONS	
A.	<i>Aeromonas hydrophila</i>	3
B.	<i>Campylobacter jejuni</i>	3
C.	<i>Escherichia coli</i>	4
	1. Enterotoxigenic <i>E. coli</i> ("Travelers' diarrhea")	4
	2. Enteroinvasive <i>E. coli</i>	4
	3. Hemorrhagic <i>E. coli</i> 0157:H7	4
	4. Enteropathogenic <i>E. coli</i>	4
D.	<i>Listeria monocytogenes</i>	4
E.	<i>Plesiomonas shigelloides</i>	5
F.	<i>Salmonella</i>	5
G.	<i>Shigella</i>	5
H.	<i>Vibrio</i>	5
	1. <i>Vibrio cholerae</i> 01 (cholera)	5
	2. <i>Vibrio cholerae</i> non-01 (mild food poisoning)	6
	3. <i>Vibrio parahaemolyticus</i>	6
	4. <i>Vibrio vulnificus</i>	6
I.	<i>Yersinia</i>	6
	1. <i>Yersinia enterocolitica</i>	6
	2. <i>Yersinia pseudotuberculosis</i>	6
	REFERENCES	6

The authors are Robert J. Price, Ph.D., Extension Seafood Technology Specialist, and
 Pamela D. Tom, Staff Research Associate
 Department of Food Science & Technology, University of California, Davis, California 95616-8598

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I. FOOD INTOXICATIONS

A. *Bacillus cereus*

SOURCE:	Soil, vegetation, human intestines, dairy products, meats, spices, dried products, cereals
1. Diarrheal syndrome	
FOODS INVOLVED:	Meat products, soups, vegetables, puddings, sauces
INCUBATION:	8-16 hours
SYMPTOMS:	diarrhea, abdominal cramps
DURATION:	12-24 hours
2. Emetic syndrome	
FOODS INVOLVED:	ethnic rice and cereal dishes, pasta
INCUBATION:	1-5 hours
SYMPTOMS:	nausea, vomiting
DURATION:	6-24 hours
TOXIC DOSE:	500,000 cells/gram
GROWTH:	41°F - 122°F
INCIDENCE:	84,000 cases/year
CAUSES:	<ol style="list-style-type: none">1. Holding cooked foods at room temperature for long periods of time prior to reheating or serving them.2. Cooling foods at temperatures that allow the germination and growth of <i>B. cereus</i>.3. Failure of foodservice personnel to use good personal hygiene when working in foodservice facilities. People can be carriers of this bacteria. If they do not wash their hands and under their fingernails after defecating, they can transmit this bacteria to anything they touch or handle.

D. *Clostridium botulinum*

SOURCE:	Proteolytic types: soil, water, vegetables, meats, dairy products Non-proteolytic types: soil, water, fish and seafood products
FOODS INVOLVED:	Vegetables, fish and seafood products, meat products, condiments, dairy products
TOXIC DOSE:	Unknown
INCUBATION:	12-72 hours
SYMPTOMS:	Nausea, vomiting, fatigue, dizziness, headache, skin dryness, dryness of the mouth and throat, constipation, paralysis of muscles, double vision, difficulty in breathing, respiratory failure, cardiac arrest
DURATION:	6-8 months (35-65% fatal in 3-10 days)
GROWTH:	Proteolytic types: 50°F - 118°F Non-proteolytic types: 38°F - 113°F
INCIDENCE:	Infant botulism: 60-100 cases/year (6-10 deaths) Adult botulism: 100 cases per year (2-3 deaths)
CAUSES:	<ol style="list-style-type: none">1. Insufficient processing of home-canned or commercially canned low-acid foods (most vegetables, meat, poultry and fish products) with storage at room temperature.2. Failure to maintain proper storage conditions below 38°F for refrigerated, vacuum packaged foods, such as smoked fish and sous vide items.3. Packing fresh vegetables (e.g., mushrooms) in airtight packages and displaying them in supermarkets at temperatures above 50°F.

E. *Clostridium perfringens*

SOURCE:	Soil, sewage, manure, water, dust, human intestines, animal intestines, raw meats and vegetables
FOODS INVOLVED:	Usually high protein foods - meats, poultry, soups, gravies, sauces, stews, casseroles
TOXIC DOSE:	≥ 500,000 cells/gram
INCUBATION:	8-24 hours
SYMPTOMS:	Diarrhea, severe abdominal pain
DURATION:	12-24 hours
GROWTH:	59°F - 127.5°F
INCIDENCE:	650,000 cases/year (6-7 deaths)
CAUSES:	<ol style="list-style-type: none">1. Failure to use cooking methods which ensure that food products heat rapidly enough to control the multiplication of this pathogen.2. Failure to hold hot protein items above 130°F because hot holding equipment thermostats are not accurate.

3. Failure to use rapid cooling methods that prevent the multiplication of *C. perfringens*.
4. Failure of foodservice personnel to use good personal hygiene and proper methods of hand washing when handling food products.
5. Failure to use clean, sanitized equipment to penetrate meat and poultry.
6. Failure of refrigeration makers to design refrigeration systems that have the capacity to cool food safely and rapidly.

F. *Staphylococcus aureus*

SOURCE:	Human and animal - throat, hair, feces, skin, sores, skin lesions
FOODS INVOLVED:	Processed meats, cooked poultry, meat and fish products, egg salads, potato salad, sauces, dairy products, custard or cream-filled baked products, canned mushrooms
TOXIC DOSE:	> 1 million cells/gram
INCUBATION:	2-6 hours
SYMPTOMS:	Vomiting, severe abdominal cramps, diarrhea
DURATION:	24 hours
GROWTH:	43.8°F - 122°F
INCIDENCE:	1,155,000 cases/year (5-8 deaths)
CAUSES:	<ol style="list-style-type: none"> 1. Animals that have staphylococcal infections at time of slaughter and are the source of contamination of raw meat products. 2. Foodservice personnel who work in foodservice facilities with infected cuts and abrasions, boils, and pimples. They do not disinfect and cover these areas. As a result, <i>S. aureus</i> is spread into food. If the food is allowed to remain at temperatures between 50°F and 115°F, <i>S. aureus</i> will multiply and produce toxin. 3. Managers who do not check employees for infections and allow foodservice personnel with skin infections to continue working in foodservice facilities. 4. Allowing buffet food to remain at <i>S. aureus</i> multiplication temperatures for many hours because of lack of adequate knowledge and equipment.

II. FOOD INFECTIONS

A. *Aeromonas hydrophila*

SOURCE:	Fresh and ocean waters, animal and human intestines, raw milk
FOODS INVOLVED:	Undercooked or raw - meat, poultry, fish, shellfish, milk; dairy products, fruits and vegetables, prepared food products
INFECTIVE DOSE:	Unknown
INCUBATION:	Unknown
SYMPTOMS:	Diarrhea, abdominal pain, fever, vomiting (under 2 years of age), blood and mucous in fecal material, large losses of body fluid
DURATION:	Unknown
GROWTH:	38°F - 107°F
INCIDENCE:	Unknown
CAUSES:	<ol style="list-style-type: none"> 1. Environmental contamination of most foods from human and animal sources. 2. Transmission and cross-contamination of <i>A. hydrophila</i> during slaughtering, processing, transport and distribution, and food preparation. 3. Multiplication of the microorganism at the approved, government "safe" storage temperature of 45°F.

B. *Campylobacter jejuni*

SOURCE:	Intestinal tract of poultry, livestock and warm blooded domestic animals.
FOODS INVOLVED:	Raw milk, undercooked poultry, eggs, beef, contaminated water
INFECTIVE DOSE:	10 - 500 microorganisms
INCUBATION:	2-5 days
SYMPTOMS:	Diarrhea (may be severe and bloody), fever, headache, nausea, severe abdominal pain; may be a relapse when recovery seems imminent; can sometimes lead to a form of reactive arthritis
DURATION:	1-2 weeks
GROWTH:	86°F - 113°F
INCIDENCE:	2,100,000 cases/year (2,100 deaths)
CAUSES:	<ol style="list-style-type: none"> 1. Government reluctance to set microbial standards on raw food. 2. Unsanitary food handling procedures in retail food operations. 3. Insufficient heat during cooking to destroy <i>Campylobacter</i>.

4. Cross-contamination of food by foodservice personnel.

C. *Escherichia coli*

1. Enterotoxigenic *E. coli* ("Travelers' diarrhea")

SOURCE: Human intestinal tract
FOODS INVOLVED: Any food (meat, vegetables, and dairy products) or water can become contaminated
INFECTIVE DOSE: 100,000,000-10,000,000,000 cells
INCUBATION: 8-44 hours
SYMPTOMS: Watery diarrhea, low-grade fever, abdominal cramps, malaise, nausea
DURATION: 3-19 days

2. Enteroinvasive *E. Coli*

SOURCE: Human intestinal tract
FOODS INVOLVED: Any food product (meat, vegetables, and dairy products) can become contaminated
INFECTIVE DOSE: 1,000,000-100,000,000 cells
INCUBATION: 8-24 hours
SYMPTOMS: Chills, fever, headache, muscular pain, abdominal cramps, profuse diarrhea or dysentery
DURATION: Unknown

3. Hemorrhagic *E. coli* O157:H7

SOURCE: Animal intestinal tract
FOODS INVOLVED: Under-cooked ground beef products; any food product (meat, vegetables, and dairy products) can become contaminated
INFECTIVE DOSE: 1,000,000-100,000,000 cells
INCUBATION: Unknown
SYMPTOMS: Bloody diarrhea, severe abdominal pain, cramps, hemolytic uremic syndrome
DURATION: Unknown

4. Enteropathogenic *E. coli*

SOURCE: Human and animal intestinal tracts, untreated water
FOODS INVOLVED: Any food product (meat, vegetables, and dairy products) can become contaminated
INFECTIVE DOSE: Unknown
INCUBATION: 17-72 hours
SYMPTOMS: Severe diarrhea, nausea, vomiting, abdominal cramps, headache, fever, chills
DURATION: 6 hours - 3 days
GROWTH: 36.5°F - 114°F
INCIDENCE: > 200,000 cases/year (400 deaths)
CAUSES:

1. Animal feedlot practices which allow some animals to become colonized.
2. The spreading of the organisms during slaughtering, processing, food preparation, and poor personal hygiene.
3. Improper sewage treatment and disposal; use of improperly treated animal and human wastes to fertilize crops.
4. Allowing food products to remain above 36°F which enables this microorganism to multiply during distribution and service.

D. *Listeria monocytogenes*

SOURCE: Human and animal intestines, soil, plants, water, raw and treated sewage, vegetables, fish and seafood
FOODS INVOLVED: Coleslaw, raw milk, soft "Mexican-style" cheese
INFECTIVE DOSE: 100-1,000 microorganisms
INCUBATION: 1 day - few weeks
SYMPTOMS: Fever, chills, headache, backache, abdominal pain, diarrhea, meningitis, septicemia, endocarditis, abortion
DURATION: Unknown
GROWTH: 35°F - 115°F
INCIDENCE: 25,000 cases/year (1,000 deaths)
CAUSES:

1. Environmental contamination from infected animal wastes and other sources.
2. Unsanitary food production and storage practices.
3. Spread of pathogen during slaughtering.
4. *L. monocytogenes* multiplies at temperatures of 35°F and above.

- E. *Plesiomonas shigelloides***
SOURCE: Human and animal intestines, fresh surface water, seawater
FOODS INVOLVED: Raw oysters, oysters, salted fish, crabs
INFECTIVE DOSE: Unknown
INCUBATION: 1-2 days
SYMPTOMS: Diarrhea, abdominal pain, nausea, chills, fever, headache, vomiting.
DURATION: A week or longer
GROWTH: 46.4°F - 113°F
INCIDENCE: Unknown
CAUSES:
 1. Government shellfish control programs do not include tests for *Plesiomonas shigelloides*
 2. Temperature control during wholesale distribution is unreliable.
 3. Foodservice operators do not have accurate temperature measuring devices to assure that correct temperatures are reached when seafood products are cooked.
- F. *Salmonella***
SOURCE: Raw - poultry, meat products, contaminated water
FOODS INVOLVED: Egg yolks, fish and seafood, cheese, chocolate candy
INFECTIVE DOSE: 10,000 cells
INCUBATION: 8-72 hours
SYMPTOMS: Abdominal cramps, diarrhea, fever, chills
DURATION: 1-7 days
GROWTH: 41°F - 114°F
INCIDENCE: 3 million cases/year (2,000 deaths)
CAUSES:
 1. The government sets no microbial standards or pasteurization specifications that can be used to control the presence of this microorganism in raw food in retail food operations.
 2. During transport and distribution, temperatures are often above 41°F, allowing *Salmonella* to multiply in food products.
 3. Food may not be heated sufficiently to destroy *Salmonella*.
 4. Post-cooking cross-contamination .
 5. In spite of regulations forbidding people to work when they are ill, people who are ill or carriers of *Salmonella* continue to work in food operations.
- G. *Shigella***
SOURCE: Human intestines, raw sewage
FOODS INVOLVED: Seafood, vegetables
INFECTIVE DOSE: 10-100 microorganisms
INCUBATION: 12 hours - 4 days
SYMPTOMS: Mild diarrhea, fever, abdominal cramps, severe fluid losses
DURATION: 4-14 days
GROWTH: 45°F - 115°F
INCIDENCE: 300,000 cases/year (600 deaths)
CAUSES:
 1. Use of human waste (both intentional and unintentional) to fertilize crops, particularly vegetables.
 2. Field workers who do not wash fecal material from their hands and fingertips when harvesting fruits and vegetables.
 3. Improper disposal of human waste products that result in contamination of water supplies.
 4. Food handlers who are ill or are carriers of *Shigella* and who contaminate food after using the toilet.
- H. *Vibrio***
SOURCE: Marine and estuarine environments, sewage-polluted water, seafood, shellfish
 1. *Vibrio cholerae* 01 (cholera)
FOODS INVOLVED: Contaminated cooked crabs, raw and partially cooked oysters and clams, raw seafood, raw vegetables
INFECTIVE DOSE: 1,000,000,000 cells in healthy adults; lower if gastric acidity is reduced
INCUBATION: 6 hours - 5 days
SYMPTOMS: Mild diarrhea, or profuse watery diarrhea (cholera gravis)
DURATION: 1-5 days

2. *Vibrio cholerae* non-01 (mild food poisoning)

FOODS INVOLVED: Raw oysters, egg and asparagus salad, potatoes

INFECTIVE DOSE: Unknown

INCUBATION: 6 hours - 3 days

SYMPTOMS: Mild diarrhea

DURATION: 2 - 12 days

3. *Vibrio parahaemolyticus*

FOODS INVOLVED: Seafood

INFECTIVE DOSE: 100,000-10,000,000 cells

INCUBATION: 9-25 hours

SYMPTOMS: Diarrhea, abdominal cramps, nausea, vomiting, headache, low-grade fever, chills

DURATION: 2½-3 days

4. *Vibrio vulnificus*

SYMPTOMS: Fever, chills, nausea, hypotension, septicemia in high risk individuals (liver disease, cirrhosis, AIDS, cancer, gastric disease, diabetes)

FOODS INVOLVED: Raw seafood (especially oysters)

INFECTIVE DOSE: Unknown

INCUBATION: 7-48 hours

DURATION: Rare in healthy individuals; 40-60% mortality in high risk individuals

GROWTH: 41°F - 111°F

INCIDENCE: *V. parahaemolyticus/cholerae*: 13,000 cases/year (2 deaths)

V. vulnificus: 10,000-30,000 cases/year (300 - 900 deaths)

CAUSES:

1. Government shellfish control programs do not include tests for *Vibrio*.
2. Temperature control during wholesale distribution is unreliable.
3. There is growth and cross-contamination of seafood products in retail display cases and in foodservice facilities at approved "safe" government temperatures of 45°F.
4. Foodservice operators do not have accurate temperature measuring devices to assure that correct temperatures are reached when seafood products are cooked.

I. *Yersinia*

1. *Yersinia enterocolitica*

SOURCE: Pork, shellfish, raw milk, meats, vegetables, water from unsafe sources

FOODS INVOLVED: Pasteurized milk, tofu, chocolate milk, milk powder, chow mein

INFECTIVE DOSE: > 10,000,000 cells/gram

INCUBATION: Unknown

SYMPTOMS: Severe abdominal pain

DURATION: 1-2 days

INCIDENCE: 5,000 - 20,000 cases/year (2-3 deaths)

2. *Yersinia pseudotuberculosis*

SOURCE: Domestic and free-living animals

FOODS INVOLVED: Unknown

INFECTIVE DOSE: Unknown

INCUBATION: Unknown

SYMPTOMS: Fever, abdominal pain, anorexia, nausea, vomiting

DURATION: Unknown

INCIDENCE: Unknown

GROWTH: 32°F - 111°F

CAUSES:

1. Environmental contamination from animal wastes and cross-contamination.
2. Poor food sanitation practices.

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