Unit 4 Foodborne Illness and Disease
Lesson 1: What You Eat Can Make You Sick

The problem of economic loss due to sickness...a very serious matter for many families with and without incomes, and therefore, an unfair burden upon the medical profession. Franklin D. Roosevelt (1882-1945) U.S. Democratic President. Address on the problems of Economic and Social Security 14 Nov 1934

Food poisoning, food infection and food-borne illness are terms used to describe conditions related to the ingestion of contaminated food products. For example, the *C. botulinum* spores are responsible for infection related to improperly canned food (Frank, 2008, page 262, ¶3).

Whitney and Rolfes point out that the Food and Drug Administration (FDA) “…lists food-borne illness as the leading food safety concern because episodes of food poisoning far outnumber episodes of any other kind of food contamination” (2002, page 645, ¶3). However, proper precautions related to food handling and preparation can reduced the risk to consumers of contracting food-borne illness.

Food Poisoning and Food Infection

There are several different types of microorganisms and parasites which can cause illness when ingested. When the illness is caused by the growth of the organism itself, the illness is called food infection. When the illness is caused by the toxins produced by the microorganisms present in food, the illness is called food poisoning. There are a number of common types of food infection and poisoning and their symptoms according to Purdue University and the University of Minnesota (2008).

Major Bacterial Food-Borne Illnesses

The following information is from the University of Minnesota, Department of Food and Science (2008). The first chart below explains the three actual causes of symptoms associated with bacterial food-borne illnesses. The second chart classifies these illnesses according to these causes. (2)

<table>
<thead>
<tr>
<th>Causes of Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toxin Ingestion Ingestion of toxin previously</td>
</tr>
<tr>
<td>Infection Bacteria invade or infect the</td>
</tr>
<tr>
<td>Infection Followed by Toxin Production</td>
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</tbody>
</table>

6. Ibid.
produced by the bacteria. intestinal membrane(s) or lining where they multiply and may move to other organs through the blood stream. Bacteria multiply in the intestine and produce an enterotoxin which causes the gastrointestinal disturbance.

### Classification of Illnesses by Cause

<table>
<thead>
<tr>
<th>Toxin Ingestion</th>
<th>Infection</th>
<th>Infection Followed by Toxin Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Staphylococcal poisoning</td>
<td>a) Salmonellosis</td>
<td>a) Clostridium perfringens gastroenteritis</td>
</tr>
<tr>
<td>b) Botulism</td>
<td>b) Shigellosis</td>
<td>b) Cholera</td>
</tr>
<tr>
<td>c) <em>Bacillus cereus</em> gastroenteritis</td>
<td>c) <em>Vibrio parahaemolyticus</em> gastroenteritis</td>
<td>c) Enterotoxigenic <em>Escherichia coli</em> gastroenteritis</td>
</tr>
</tbody>
</table>

These illnesses are listed by these classifications in Table 1. This table details symptoms, illness characteristics, examples of foods involved and prevention. Treatment of the illnesses is not given, however. This should be obtained from a family physician or other health care professional. It should be noted that not all people who eat contaminated food will become ill and not all who become ill will have the same symptoms. The intensity of the symptoms and the seriousness of the illness may vary with concentration of organisms or toxins, quantity of food consumed and susceptibility of the individual to the disease. Infants, the elderly and people with altered immune systems due to medication or disease may be more susceptible to these diseases (University of Minnesota, 2008).

#### TABLE 1 BACTERIAL FOOD-BORNE ILLNESSES

<table>
<thead>
<tr>
<th>ILLNESS</th>
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</thead>
<tbody>
<tr>
<td><strong>I. TOXIN INGESTION</strong> (Caused by ingestion of toxin formed by bacteria)</td>
<td><strong>Botulism</strong></td>
<td><strong>Bacillus cereus gastroenteritis</strong></td>
</tr>
<tr>
<td><strong>FOODS INVOLVED</strong></td>
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<td><strong>FOODS INVOLVED</strong></td>
</tr>
<tr>
<td>Custards, egg salad, potato salad, chicken salad, macaroni salad, ham, salami, cheese.</td>
<td>Canned low-acid foods, smoked fish, perishable vacuum-packed foods.</td>
<td>Vegetables, salads, meat dishes, casseroles, puddings, sauces, soups, rice, and macaroni and cheese.</td>
</tr>
<tr>
<td><strong>SYMPTOMS</strong></td>
<td><strong>SYMPTOMS</strong></td>
<td><strong>SYMPTOMS</strong></td>
</tr>
<tr>
<td>Vomiting, diarrhea, prostration, abdominal cramps. Generally mild and often attributed to other causes.</td>
<td>Double vision, inability to swallow, speech difficulty, progressive respiratory paralysis. Fatality rate is high, in the United States about 65 percent.</td>
<td>Diarrhea or vomiting</td>
</tr>
<tr>
<td><strong>CHARACTERISTICS</strong></td>
<td><strong>CHARACTERISTICS</strong></td>
<td><strong>CHARACTERISTICS</strong></td>
</tr>
<tr>
<td>Transmitted by food handlers</td>
<td></td>
<td>Transmitted by eating food containing the toxin. <em>Diarrheal form</em></td>
</tr>
</tbody>
</table>

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who carry the bacteria and by eating food containing the toxin. Onset: Usually within 3 to 8 hours Duration: 1 to 2 days;

**PREVENTION**
Growth of bacteria that produce toxin is inhibited by keeping hot foods above 140° F and cold foods at or below 40° F.

Onset: Usually within 3 to 8 hours Duration: 1 to 2 days;  
Duration: 3 to 6 days

**PREVENTION**
Growth of bacteria that produce toxin is inhibited by keeping hot foods above 140° F and cold foods at or below 40° F.

**II. INFECTIONS** (Caused when pathogenic bacteria invade and multiply in intestinal tract)

**ILLNESS**

**Salmonellosis**

**FOODS INVOLVED**
Poultry, red meats, eggs, dried foods, dairy products.

**SYMPTOMS**
Severe headache followed by vomiting, diarrhea, abdominal cramps, and fever. Infants, elderly, and persons with low resistance are most susceptible. Severe infections cause high fever and may even cause death.

**CHARACTERISTICS**
Transmitted by eating contaminated and undercooked food, or by contact with infected persons or carriers of the infection. Also transmitted by insects, rodents, and pets. Onset: Usually within 12 to 36 hours Duration: 2 to 7 days

**Shigellosis**

**FOODS INVOLVED**
Salads (potato, tuna, shrimp, macaroni, chicken), and cut, diced or chopped and mixed foods.

**SYMPTOMS**
Diarrhea, abdominal pain and fever. Vomiting, chills and headache may also occur. Feces may contain blood, mucus or pus.

**CHARACTERISTICS**
Transmitted by food handlers (symptomless carriers or persons recovering from the disease). Food is contaminated by hand manipulation or mixing. Onset: 1 to 7 days Duration: 12 hours to 3 weeks (5-6 days average)

**Vibrio parahaemolyticus gastroenteritis**

**FOODS INVOLVED**
Raw fish, clams, oysters, raw crab, crab salad, lobster and shrimp.

**SYMPTOMS**
Severe abdominal cramps, diarrhea, nausea, vomiting, headache, chills and prostration.

**CHARACTERISTICS**
Transmitted by ingestion offish and shell fish which were contaminated in their aquatic environment or cross-contamination of cooked foods with raw products. Onset: 2 to 48 hours Duration: 2 hours to 10 days (2-3 days av.)

**PREVENTION**
Cook seafood thoroughly,
**PREVENTION**  
Destroy by heating the food to 140° F and holding for 10 minutes or to higher temperatures for less time; for instance, 155° F, for a few seconds. Refrigeration at 40° F inhibits the increase of Salmonellae, but they remain alive in foods in the refrigerator or freezer, and even in dried foods.  

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**BACTERIAL FOOD-BORNE ILLNESSES**

### II. INFECTIONS (continued)

#### ILLNESS

**Vibrio vulnificus septicemia**  
**FOODS INVOLVED**  
Raw or undercooked seafood, particularly oysters and clams.  

**SYMPTOMS**  
Malaise followed by chills, fever and prostration. Vomiting and diarrhea are uncommon, but sometimes occur after chills and fever.

**CHARACTERISTICS**  
*V. vulnificus* is widespread in the estuarine waters of most U.S. coastal states. The organism penetrates the intestinal tract and produces a primary septicemia. The infection is rare in healthy people, usually being associated with liver disease, malignancy, and renal disease. However, it has been reported to cause death in 40-60% of the infected patients. Onset: 16-48 hours

**PREVENTION**  
Cook seafood thoroughly, eliminate cross-contamination and properly refrigerate cooked seafood.

#### ILLNESS

**Yersiniosis**

**FOODS INVOLVED**  
Dairy products, raw or rare meats, seafood, fresh vegetables.

**SYMPTOMS**  
Abdominal pain, fever and diarrhea. Vomiting and skin rashes may also occur.

**CHARACTERISTICS**  
*Yersinia enterocolitica* are found in the intestinal tracts and feces of animals, raw foods of animal origin, non-chlorinated water supplies and wells, lakes, streams and rivers. Transmission may be by animal to food/water to human or human to human. Yersinia can grow at refrigerated temperatures but are killed at 140° F. Not all strains cause the illness.  
Onset: 24 to 36 hours  
Duration: 3 to 7 days (Appears most often in children and teenagers.)

**PREVENTION**  
Cook foods thoroughly; avoid contamination during processing and preparation.

#### ILLNESS

**Campylobacter enteritis**

**FOODS INVOLVED**  
Raw meat and poultry.

**SYMPTOMS**  
Vary widely but may include abdominal pain and cramping, diarrhea, fever and prostration. Blood may appear in feces after 1 -3 days of diarrhea. Other symptoms that may occur are headache, malaise, muscle pain, dizziness and delirium.

**CHARACTERISTICS**  
*Campylobacter jejuni* is found in great numbers in the intestinal tracts of healthy cattle, sheep, swine and poultry. Fecal material may contaminate the animal carcasses with the bacteria during slaughtering or other food (milk, eggs) with which it comes in contact.

**PREVENTION**  
Avoid contamination during handling and
ILLNESS

Listeriosis

FOODS INVOLVED
Milk, cole slaw (from manure contaminated cabbage) and Mexican-style cheese.

SYMPTOMS
In a healthy person, influenza-like symptoms and fever may occur. Infection in pregnant women may result in infection of fetus and interrupted pregnancy. Persons debilitated by alcoholism diabetes, cardiovascular disease, and immunocompromised individuals are at the most risk. Meningitis or meningoencephalitis (inflammation of the brain and surrounding membranes) are common manifestations of the disease in adults.

CHARACTERISTICS
Listeria monocytogenes is found in soil, decaying vegetation and the intestines of domestic and wild animals, stream water, mud, sewage and silage. Consumption of contaminated food is one mode; others or exact means are unknown.

PREVENTION
Avoid raw meats, unpasteurized milk and foods made with contaminated ingredients

BACTERIAL FOOD-BORNE ILLNESSES

III. INFECTION FOLLOWED BY TOXIN PRODUCTION (Bacteria invade and multiply in intestinal tract and produce an enterotoxin which causes the gastrointestinal disturbance)

<table>
<thead>
<tr>
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<tr>
<td>gastroenteritis</td>
<td></td>
<td>coli</td>
</tr>
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</table>
FOODS INVOLVED
Stews, soups, or gravies made from poultry or red meat.

SYMPTOMS
Nausea without vomiting, diarrhea, acute inflammation of stomach and intestines.

CHARACTERISTICS
Transmitted by eating food contaminated with abnormally large numbers of the bacteria. Onset: Usually within 8 to 20 hours 
Duration: May persist for 24 hours

PREVENTION
To prevent growth of surviving bacteria in cooked meats, gravies, and meat casseroles that are to be eaten later, cool foods rapidly and refrigerate promptly at 40°F or below, or hold them above 140°F.

FOODS INVOLVED
Water, raw and undercooked fish and shellfish from polluted water, contaminated food.

SYMPTOMS
Vomiting (without nausea) and painless watery diarrhea. Rapid dehydration may result in circulatory collapse.

CHARACTERISTICS
Humans carry Vibrio cholerae which may survive in the environment and contaminate water and food. Onset: 1 - 5 days

PREVENTION
Avoid consuming fish and shellfish from polluted water; ensure sanitary sewage disposal and safe water supplies; wash hands after using the toilet and before handling food.

FOODS INVOLVED
Contaminated foods not subsequently heat processed.

SYMPTOMS
Mild to severe diarrhea with severe dehydration and shock. No fever.

CHARACTERISTICS
Transmission is by fecal contamination of foods. Due to presence in animal and human intestines, feces may contaminate soil, water, animal carcasses used for food and shellfish from waters with sewage. Onset: 8 to 44 hours Duration: Diarrhea usually stops after 30 hours

PREVENTION
Avoid consuming fish and shellfish from polluted water; ensure sanitary sewage disposal and safe water supplies; wash hands after using the toilet and before handling food.

According to Purdue University, Animal Sciences the following information concerns identification and transmission of major food-borne illnesses

**Botulism**

Botulism is food poisoning caused by the toxin produced by the bacterium Clostridium botulism. The toxin is extremely dangerous as it affects the nervous system and is often fatal. Botulism is usually found in low-acid, canned foods such as canned meat and seafood, smoked and processed fish. Botulism can be prevented by cooking to destroy the toxins, proper refrigeration and sanitation. Canned foods which show evidence of swelling should

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not be eaten. The illness causing toxin can be inactivated by cooking for 15 minutes at 185°F.\(^9\)

**Campylobacter Enterocolitis**

Poultry and other types of meats can be contaminated with Campylobacter jejuni and Campylobacter coli. Ingestion of as few as 500 bacteria can cause food infection with severe abdominal pain and diarrhea. Fortunately, these bacteria are easily controlled as they are killed at normal cooking temperatures and do not multiply at temperatures below 86 °F.\(^{10}\)

Source: University of California Davis, E. coli 0157:H7 \(^{11}\)
[http://usd.edu/~qlightni/page1.htm](http://usd.edu/~qlightni/page1.htm)
2008. Compiled by K. Cavanaugh

**E. coli 0157:H7** is another pathogen that has a reservoir in cattle and other similar animals. Human illness usually follows utilization of food or water that has been contaminated with microscopic amounts of cow feces. The illness it causes is a severe bloody diarrhea with painful abdominal cramps on the side, and without much of a fever. This illness can lead to a complication called hemolytic uremic syndrome, it occurs several weeks after the initial symptoms. The complication includes temporary anemia, profuse bleeding, and kidney failure (University of California, Davis, n.d.).\(^{12}\)

_E. coli_ 0157:H7 is a mutated version of a bacterium found abundantly in the human digestive system. Most _E. coli_ bacteria help us digest food, synthesize vitamins, and guard against dangerous organisms. _E. coli_ 0157:H7 on the other hand, can release a powerful toxin—called a “verotoxin” or a “Shiga toxin” —that attacks the lining of the intestine. In about four percent of reported _E. coli_ cases, the Shiga toxin enter the bloodstream, causing hemolytic uremic syndrome (HUS), which can lead to kidney failure, anemia, internal bleeding, and the destruction of vital organs. The Shiga toxins can cause seizures, neurological damage, and strokes (Schlosser, 2007, page 199, ¶3-4).\(^{13}\)

**Clostridium perfringens Food Infection**

This type of food infection is caused by an anaerobic spore forming bacteria that produces toxins and large amounts of gas during growth. While the bacteria is found in many foods, large amounts of it must be eaten for this type of food infection to occur. At greatest risk for

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\(^9\) Ibid.
\(^{10}\) Ibid.
\(^{11}\) University of California Davis. (n.d.) What are the most common food-borne diseases? Retrieved April 10, 2008 from [http://usd.edu/~qlightni/page1.htm](http://usd.edu/~qlightni/page1.htm)
\(^{12}\) Ibid.
growth of this type of bacteria are meat products which are cooked, allowed to cool slowly, and held for an extended period before serving.\textsuperscript{14}

This type of food infection can be prevented by rapidly cooling cooked and heat processed foods, proper refrigeration of foods, and good sanitation. Temperatures of foods on steam tables should be held above 140 °F. Leftovers should be thoroughly heated to destroy the bacteria and its toxins.\textsuperscript{15}

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{image.png}
\caption{Source: University of California Davis, Salmonella\textsuperscript{16}}
\end{figure}

\url{http://usd.edu/~qlightni/page1.htm}

2008. Compiled by K. Cavanaugh

\textbf{Salmonellosis}

There is a large variety of Salmonellae organisms that can cause the food infection Salmonellosis. These bacteria grow inside the host and produce a toxin which causes illness by irritating the intestinal walls. One million or more organisms must be ingested in order to cause illness. Most cases of salmonellosis are a result of contact of prepared foods with raw meet or its juices. Eating raw or rare meat is also a danger. Other cases result from insufficiently cooked poultry, eggs, and dairy products especially when kept unrefrigerated for longer periods of time. Salmonellae bacteria can be prevented by cleanliness and sanitation of food handlers and equipment, pasteurization, and refrigeration (Purdue University, 2008).\textsuperscript{17}

\begin{flushleft}
\textsuperscript{15} Ibid.
\textsuperscript{16} University of California Davis. (n.d.) What are the most common food-borne diseases? Retrieved April 10, 2008 from \url{http://usd.edu/~qlightni/page1.htm}
\end{flushleft}
Staphylococcal Food Poisoning

The bacteria Staphylococcus aureus produces enterotoxin which causes gastroenteritis (inflammation of the stomach and intestinal linings) and can also affect the nervous system. Although unpleasant, this type of food poisoning rarely results in death. Staphylococcal food poisoning is one of the most common foodborne illnesses in the United States. Foods most commonly affected by this type of bacteria are cream and custard filled pastries, potato salad, dairy products, and cooked meats (especially ham and poultry).

These bacteria can reproduce to very large numbers without changing the color, flavor, or smell of the food. Growth rate of Staphylococcus aureus is highest at temperatures above 68 ºF and in foods with little acidity. While the bacteria are easily destroyed by heat (151ºF for 12 minutes), the illness causing toxins produced by the bacteria are much more difficult to destroy (250 ºF for 30 minutes). This type of food poisoning can be prevented by pasteurization of susceptible foods, refrigeration, and sanitation.

Trichinosis

One of the most well known parasites which causes food infection is Trichinella spiralis. These small, wormlike organisms can be found in insufficiently cooked meat of carnivorous animals such as pigs. Ingested larvae mature in the upper part of the intestinal walls within five to seven days. The mature worms then reproduce in the intestine where new larvae are hatched. The larvae then migrate to the circulatory system and are carried to the muscles of the host where they burrow and become encysted causing muscle pain in the host. The most common way to prevent this type of food infection is by cooking pork to internal temperatures of at least 138 ºF.

Summary

Gail Frank discusses the role of bacteria in food-borne illness point out how “...90% of the cases of food-born illness... and variable ...symptoms” result from ingesting foods containing “...either a poison

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or toxin produced by bacteria, chemicals, or viruses” (2008, page 263, ¶2). How bacteria are transferred is a complex process and one which nutrition professionals must understand when educating others about how food-borne illnesses and diseases are transmitted to humans.