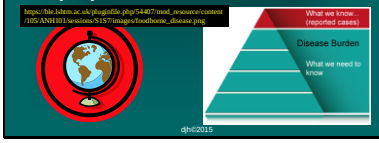
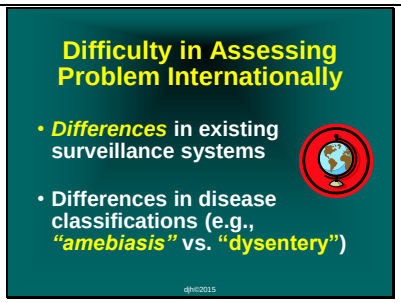
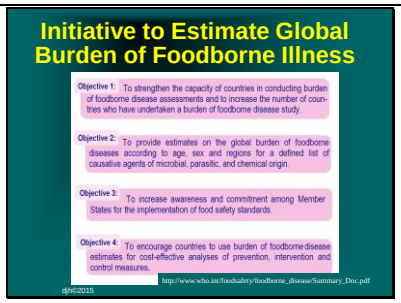
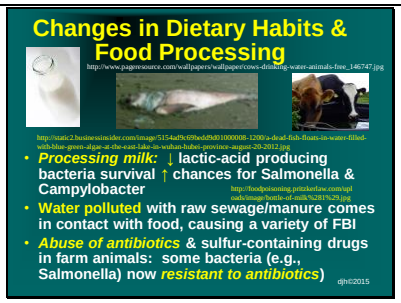
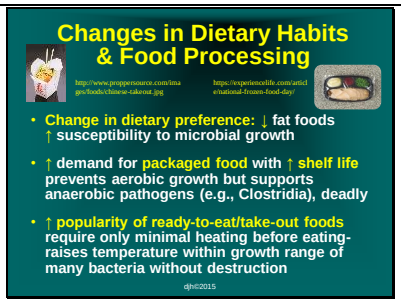
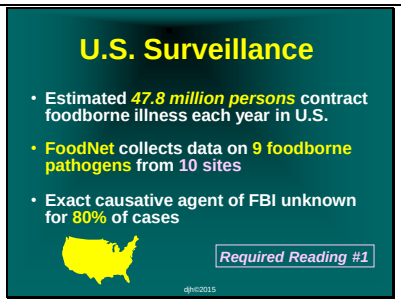
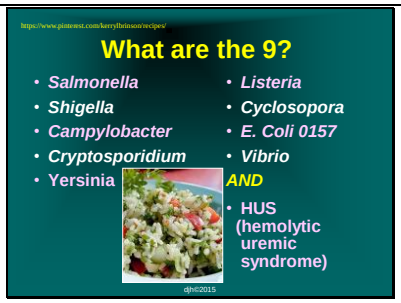
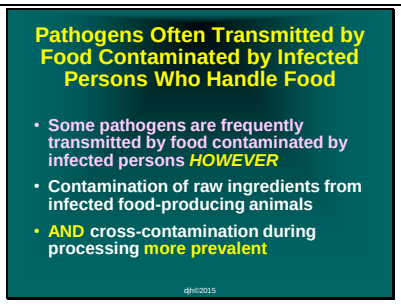
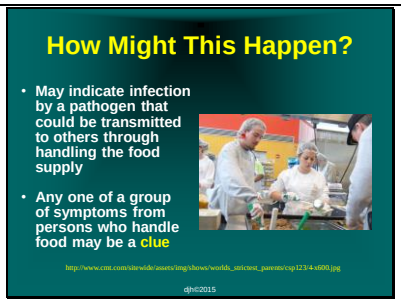
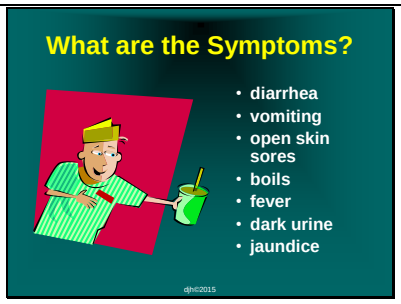
Slide 1	**Prevention of Foodborne Illness: A Global Perspective** **Part I**  http://www.theluxuryspot.com/wp-content/uploads/2011/11/turkey1.jpg ***Donna Haiduven, PhD, RN, CIC*** djh©2015	Welcome to the lectures entitled "Prevention of Foodborne Illness: A Global Perspective", covered in two parts. This is Part I. By the time you start reviewing these lecture notes, you should have completed the Required Readings. Part I of this lecture contains sections A & B.
Slide 2	**Section A: Epidemiology of Foodborne Illness & Reasons for Food Protection Programs**  djh©2015	This is section A: Epidemiology of Foodborne Illness & Reasons for Food Protection Programs.
Slide 3	**Acronyms/Abbreviations** • **FBI** = Foodborne Illness • **CAST**= Council for Agricultural Science & Technology • **CDC**= Centers for Disease Control & Prevention • **MD** = physicians • **Labs** = laboratories djh©2015	On this slide, commonly used acronyms and abbreviations in this unit's lectures are provided.
Slide 4	**The Global Problem** • **760,000 children <5 die from diarrheal illness each year (2.2 million total)** • **> proportion from FBI**  djh©2015	Worldwide, it is estimated that 2.2 million people, of which 760,000 *(Source: http://www.who.int/mediacentre/factsheets/fs330/en/)* are children under the age of 5, die from diarrheal illness each year. Because many of these deaths occur in developing countries, data about the exact agent responsible for the diarrheal illness are often unknown. However, it is believed that a large proportion is due to foodborne illness.
Slide 5	**Factors Accounting for Difference in Prevalence of FBI** • ***Climate:* Colder ↓ growth pathogens, warmer growth of some pathogens** • **Populations with *elderly/infants* will have rates of illness** • **Population with healthy diet: competent immune system & ↓ chance of FBI** • ***Cultural aspects* may be most important factor in determining risk factors for disease *(knowledge, attitudes, stress [illness, loss of S.O., poor living conditions])*** djh©2015	Differences in the prevalence of foodborne illness that may appear among the various regions of the world are due to the following: • Climate influences lifecycles and growth patterns for foodborne pathogens. A colder climate may impede the growth of certain pathogens. A warmer climate will promote the spread of some pathogens. • Populations with amplified numbers of elderly or infants, which are more susceptible to disease, will have higher rates of illness. • The nutritional status of a culture plays an integral part in determining the health status of a population. A population with a healthy diet will most likely possess a competent immune system and will be capable of fending off potential health threats. 4. **Cultural aspects**, like the knowledge, attitudes, stress (e.g., illness, loss of a significant other, or poor living conditions) and practices of individuals may be the **most important**

		factor in determining the risk factors for disease. For example, African indigenous populations retain the custom of eating raw meat or pork which puts them at risk of consuming viable *Trichinella spiralis* (roundworm) or Taenia spp. (tapeworm) organisms.
Slide 6		Foodborne illness is a major health and economic problem in the U.S. and abroad. In the U.S., surveillance systems (which you will learn about in PHC 6251 Disease Surveillance & Monitoring) have been put in place to monitor the incidence and impact of important foodborne pathogens such as *Campylobacter jejuni, Clostridium perfringens, Escherichia coli 0157:H7*, Salmonella spp. and *Staphylococcus aureus.* Internationally, it is difficult to accurately assess the prevalence of foodborne disease because of the differences in existing surveillance systems, if they exist at all. When comparing statistics among countries, differences in disease classification often make it difficult to find data on specific diseases. For example, amebiasis may be classified according to disease "amebiasis" or as a symptom under "dysentery".
Slide 7		The list of notifiable diseases also varies among countries. While some countries report all identified cases, others report only cases associated with outbreaks, leaving the sporadic cases unaccounted for. Lesser developed countries often lack the infrastructure and resources necessary to monitor many of the causative agents of foodborne disease, and it may be in the best interest of some governments to minimize reports of foodborne illness to protect the food export and tourism industries. Unfortunately, it is these countries that may suffer most from foodborne illness.
Slide 8		In January of 2002, the World Health Organization endorsed the Initiative to Estimate the Global Burden of Foodborne Illness. The Initiative has 3 goals: 1) to advocate risk-based food safety systems (such as HACCP which we will discuss later in these lectures), 2) to develop science-based measures to prevent exposures to hazards through food, and 3) to assess and communicate foodborne risks. W.H.O. also set specific goals by date: **By 2009:** Foodborne disease burden estimates will have been available for at least ten selected microbial, parasitic and chemical causes. **By 2011:** 1) A global report and global interactive atlas on foodborne disease morbidity, disability and mortality will have been published, 2) A peer-reviewed journal series describing global foodborne disease morbidity, disability and mortality as well as their policy implications will have been published with at

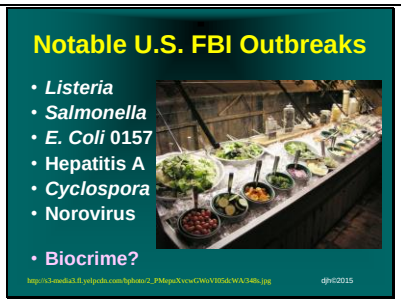
		least 50% of authors from developing countries, and 3) Foodborne disease burden studies will have been completed in all six WHO regions of the world.
Slide 9		The W.H.O. reports that the majority of the burden of mortality and morbidity due to foodborne illness occurs in developing countries, although estimates of incidence are unavailable. Persons in developing countries are apt to use unsafe water to clean and prepare food, engage in risky food production processes and handling, and lack access to adequate food storage. The countries are unlikely to have adequate food storage infrastructure or adequate or properly enforced regulatory standards. These factors contribute to a high risk environment for foodborne illness. Photos from this page are available for education purposes at the following link: http://www.who.int/mediacentre/multimedia/2002/eth_nutrition/en/index1.html
Slide 10		W.H.O.'s Initiative has these four objectives which will be carried out by the Foodborne Disease Burden Epidemiology Reference Group (FERG) and in-depth studies at the individual country level.
Slide 11		Changes in dietary habits and food processing may contribute to the surfacing of new pathogens and an increase in the number of illnesses due to traditional pathogens. Several of these are listed here. First, a decrease in lactic-acid producing bacteria as a result of processing mil increases the chances of survival of Salmonella or Campylobacter, as their competition has been removed. Second, water polluted with raw sewage or manure containing harmful numbers of microbes comes into contact with food, causing a variety of illnesses. A third example is that due to the abuse of antibiotics and sulfur-containing drugs in farm animals, some bacteria (e.g., Salmonella) have acquired resistance to antibiotics.
Slide 12		In an attempt to eat healthier, foods that are lower in fat are being consumed, but this makes the food more susceptible to microbial growth. The increase in demand for packaged food with a longer shelf life prevents aerobic growth but supports anaerobic pathogens like *Clostridia*, which can be deadly. Finally, ready-to-eat and take-out foods require only minimal heating before consumption. This contributes to food that is within the ideal growth range of many bacteria that are not destroyed by high enough temperatures before consumption.

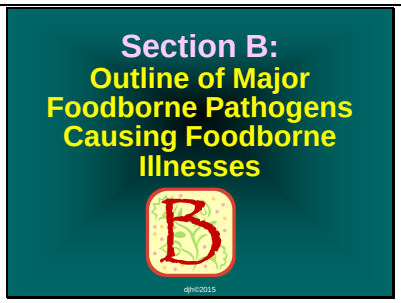
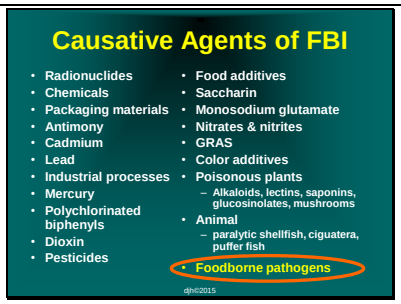
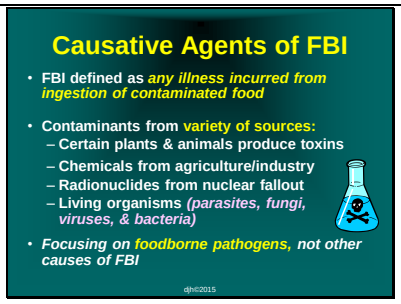
Slide 13		An outbreak of foodborne illness is almost always accompanied by a cost that reflects the amplitude of the outbreak. Medical costs incurred during the treatment of an illness, and the loss of wages for those who must stay home from work, are examples of expenses encountered by individuals with a foodborne illness. Upon identifying a food product as the origin of illness, the industries responsible for producing, processing or distributing the foodstuff suffer losses reaching into the millions of dollars as they halt production, recall the contaminated product for disposal, lose sales, and increase marketing efforts to compensate for losses. Other costs result from investigations searching for the source of the contamination, increased quality assurance measures to produce safer products, litigation fees from lawsuits, and the loss of trade.
Slide 14		An outbreak of foodborne illness occurs when a group of people consume the same contaminated food and two or more of them come down with the same illness. It may be a group that ate a meal together somewhere, or it may be a group of people who do not know each other at all, but who all happened to buy and eat the same contaminated item from a grocery store or restaurant. For an outbreak to occur, something must have happened to contaminate a batch of food that was eaten by a group of people. Often, a combination of events contributes to the outbreak. A contaminated food may be left out a room temperature for many hours, allowing the bacteria to multiply to high numbers, and then be insufficiently cooked to kill the bacteria. Many outbreaks are local in nature. They are recognized when a group of people realize that they all became ill after a common meal, and someone calls the local health department. This classic local outbreak might follow a catered meal at a reception, a pot-luck supper, or eating a meal at an understaffed restaurant on a particularly busy day. However, outbreaks are increasingly being recognized that are more widespread, that affect persons in many different places, and that are spread out over several weeks. For example, a recent outbreak of salmonellosis was traced to persons eating a breakfast cereal produced at a factory in Minnesota, and marketed under several different brand names in many different states. No one county or state had very many cases and the cases did not know each other. The outbreaks was recognized because it was caused by an unusual strain of *Salmonella*, and because state public health laboratories that type *Salmonella* strains noticed a sudden increase in this one rare strain. In another recent outbreak, a particular peanut snack food caused the same illness in Israel, Europe and North America. Again, this was recognized as an increase in infections caused by a rare strain of *Salmonella*. The vast majority of reported cases of foodborne illness are not part of recognized outbreaks, but occur as individual or "sporadic" cases. It may be that many of these cases are actually part of unrecognized widespread or diffuse outbreaks. Detecting and investigating such widespread outbreaks is a major challenge to our public health system. This is the reason that new and more sophisticated laboratory methods are being used at CDC and in state public health department laboratories.

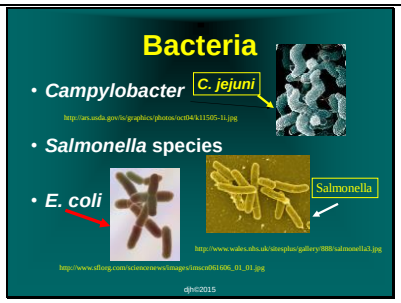
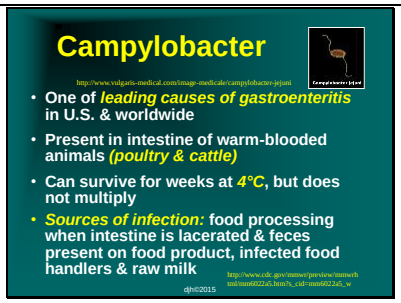
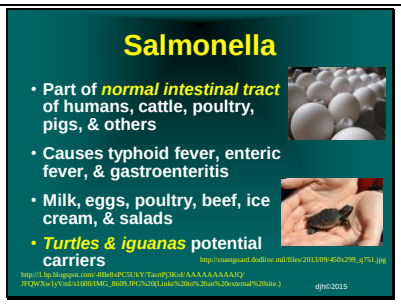
Slide 15		Some persons at particularly high risk from contaminated food should take more precautions. That includes all of those listed on this slide. Pregnant women, the elderly, and those with weakened immune systems are at higher risk for severe infections such as *Listeria* and should be particularly careful not to consume undercooked animal products. They should avoid soft French style cheeses, pates, uncooked hot dogs and sliced deli meats, which have been sources of *Listeria* infections. Persons at high risk should also avoid alfalfa sprouts and unpasteurized juices. A bottle-fed infant is at higher risk for severe infections with *Salmonella* or other bacteria that can grow in a bottle of warm formula if it is left at room temperature for many hours. Particular care is needed to be sure the baby's bottle is cleaned and disinfected and that leftover milk formula or juice is not held in the bottle for too long. Persons with liver disease are susceptible to infections with a rare but dangerous microbe called *Vibrio vulnificus*, found in oysters. They should avoid eating raw oysters. *Supplemental Reading #3 provides more specific information on why children are disproportionately affected by foodborne illness.*
Slide 16		The Centers for Disease Control & Prevention (CDC) estimate that 47.8 million persons in the U.S. contract foodborne illnesses each year. The Foodborne Diseases Active Surveillance Network (FoodNet) is the principal foodborne disease component of CDC's Emerging Infections Program (EIP). FoodNet is a collaborative project of the CDC, ten EIP sites, the U.S. Department of Agriculture (USDA), and the Food and Drug Administration (FDA). The project consists of active surveillance for foodborne diseases and related epidemiologic studies designed to help public health officials better understand the epidemiology of foodborne diseases in the United States. FoodNet collects data on 9 foodborne pathogens from 10 sites. Required Reading #1 is a journal article where the authors estimate numbers regarding foodborne illness data from several surveillance sources, and that *explains why their numbers may differ from those on this slide.* In the United States, 2011 reports from the Centers for Disease Control and Prevention estimate that of these almost 48 million people, 128,000 are hospitalized, and 3,000 die from foodborne illness each year. Despite the established surveillance for foodborne illness in the U.S., the exact causative agent is still unknown up to 80% of cases of foodborne illness.

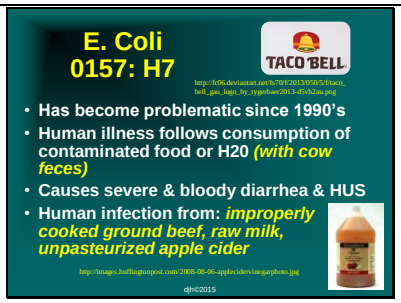
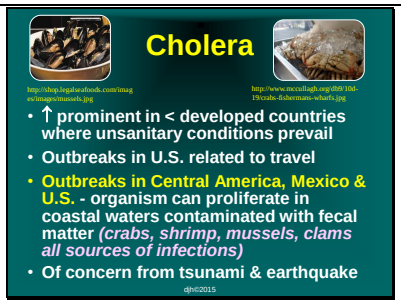
Slide 17		Food Net conducted population-based active surveillance for clinical laboratory isolations of *Campylobacter, Cryptosporidiosis, Cyclospora, E. coli 0157, Listeria monocytogenes, Salmonella, Shigella, Vibrio and Yersinia enterocolitica.* This surveillance was conducted in California, Connecticut, Colorado, Georgia, Maryland, Minnesota, New Mexico, New York, Oregon, and Tennessee (total population: 44.5 million). A case was identified as isolation (for bacteria) or identification (for parasites) of an organism from a clinical specimen. Food Net also conducts surveillance for foodborne disease outbreaks and hemolytic uremic syndrome (HUS), the latter principally through reports from pediatric nephrologists. *(We will cover more about the surveillance methods used by FoodNet in the fall PHC 6251 Disease Surveillance & Monitoring class).*
Slide 18		The contamination of raw ingredients from infected food-producing animals and cross-contamination during processing are more prevalent causes of foodborne diseases than is contamination of foods by persons with contagious or infectious diseases. However, some pathogens ARE frequently transmitted by infected persons.
Slide 19		This could happen when a person who is ill handles food and contaminates it.
Slide 20		The presence of any one of the following signs or symptoms on this slide, in persons who handle food, may indicate infection by a pathogen that could be transmitted to others through handling the food supply
Slide 21		Sneezing on or near food can cause infections with organisms such as *Staphylococcus aureus.* On the right half of this slide is a picture of two sneeze guards, which are used in many restaurants and other food establishments to protect food from contact with secretions of consumers.

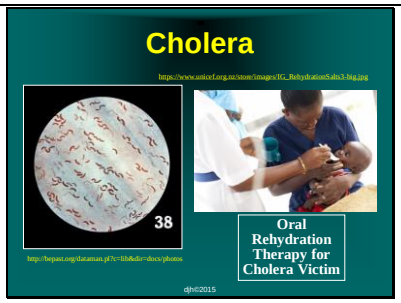
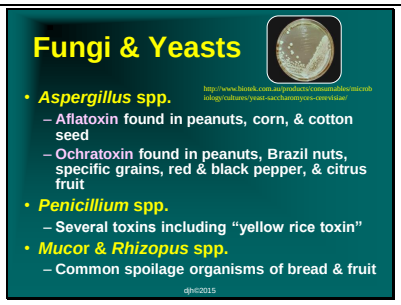
Slide 22	**What Other Clues?** • *Failure of food handlers to:* – Wash hands *(e.g., after bathroom, handling raw meat, cleaning spills, carrying garbage)* – Wear clean gloves – Use clean utensils  djh©2015	The failure of food handlers to wash hands (in situations such as after using the toilet, handling raw meat, cleaning spills, or carrying garbage); failure to wear clean gloves; or use clean utensils are responsible for the transmission of these pathogens.
Slide 23	**Pathogens Causing Disease by *Infected Food Handler*:** • Noroviruses • Hepatitis A virus • *Salmonella typhi* • *Shigella* species • *Staphylococcus aureus* • *Streptococcus pyogenes*  djh©2015	Pathogens that can cause diseases after an infected person handles food are all those listed on this slide: Noroviruses, Hepatitis A virus, *Salmonella typhi, Shigella* species, *Staphylococcus aureus and Streptococcus pyogenes.*
Slide 24	**How to Prevent Them?** Prevent food contact by persons who have an acute diarrheal illness  djh©2015	This slide reinforces the strategy of decreasing the risk of foodborne illness by limiting food contact with persons who have a diarrheal illness.
Slide 25	**Pathogens Occasionally Transmitted by Food Contaminated by Infected Persons who Handle Food**  djh©2015	Other pathogens are ***occasionally*** transmitted by infected persons who handle food.
Slide 26	**What About This Group?** • Occasionally transmitted this way • Pathogens in this category often require period of temperature abuse to permit multiplication to infectious dose • *Usually transmitted by:* – contamination at food source – in food – by non-foodborne routes  djh©2015	Bacterial pathogens in this category often require a period of temperature abuse to permit their multiplication to an infectious dose before they will cause disease in consumers. These pathogens usually cause disease when food is intrinsically contaminated or cross-contaminated during processing or preparation.
Slide 27	**What are these diseases?** • *Campylobacter jejuni* • *Crptosporidium parvum* • *Entamoeba histolytica* • Enterohemorrhagic *Escherichia coli* • Enterotoxogenic *E. coli* • *Giardia lamblia* • Non-typhoidal *Salmonella* • *Taenia solium* • *Vibrio cholerae* 01 • *Yersinia enterocolitica*  djh©2015	Preventing food contact by persons who have an acute diarrheal illness will decrease the risk of transmitting the pathogens listed on this slide.

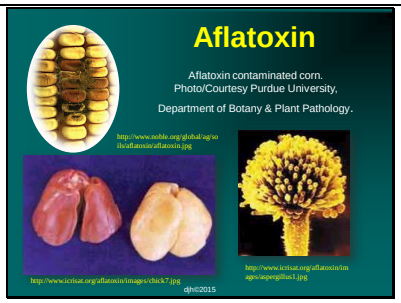
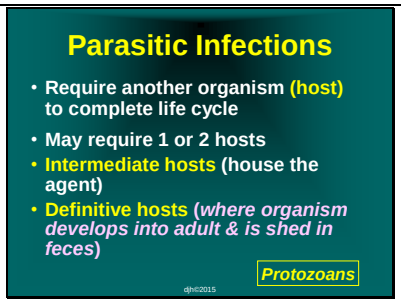
Slide 28		Raw foods of animal origin are the most likely to be contaminated; that is, raw meat and poultry, raw eggs, unpasteurized milk, and raw shellfish. Because filter-feeding shellfish strain microbes from the sea over many months, they are particularly likely to be contaminated if there are any pathogens in the seawater. Foods that mingle the products of many individual animals, such as bulk raw milk, pooled raw eggs, or ground beef, are particularly hazardous because a pathogen present in any one of the animals may contaminate the whole batch. A single hamburger may contain meat from hundreds of animals. A single restaurant omelet may contain eggs from hundreds of chickens. A glass of raw milk may contain milk from hundreds of cows. A broiler chicken carcass can be exposed to the drippings and juices of many thousands of other birds that went through the same cold water tank after slaughter. Fruits and vegetables consumed raw are a particular concern. Washing can decrease but not eliminate contamination, so the consumers can do little to protect themselves. Recently, a number of outbreaks have been traced to fresh fruits and vegetables that were processed under less than sanitary conditions. These outbreaks show that the quality of the water used for washing and chilling the produce after it is harvested is critical. Using water that is not clean can contaminate many boxes of produce. Fresh manure used to fertilize vegetables can also contaminate them. Alfalfa sprouts and other raw sprouts pose a particular challenge, as the conditions under which they are sprouted are ideal for growing microbes as well as sprouts, and because they are eaten without further cooking. That means that a few bacteria present on the seeds can grow to high numbers of pathogens on the sprouts. Unpasteurized fruit juice can also be contaminated if there are pathogens in or on the fruit that is used to make it.
Slide 29		For the last slide in section A, several notable outbreaks of foodborne illness have occurred in the U.S. The *Listeria* outbreak in 2011 caused by contaminated cantaloupe, with 29 deaths, has been called the most deadly foodborne illness in recent U.S. history. In 2008-2009, a multi-state outbreak of *Salmonella* serotype *Tennessee* infections resulted in association with peanut butter in the U.S., affecting nearly every state. Also in 2009, an outbreak of the unusual *Salmonella* serotype SaintPaul encompassed 13 states and 228 identified cases. This outbreak was linked to alfalfa sprouts. In 2008, a multi-state outbreak of *E. coli* 0157 was traced back to beef (both intact and ground) from a single slaughter facility. In 2006, there were two outbreaks of *E. coli*, one from a taco restaurant and another traced to bagged lettuce and spinach from California. Hepatitis A was the causative organism in an outbreak in Pennsylvania in 2003, traced to consumption of green onions. In 1996, the parasite *Cyclospora* suddenly appeared as a cause of diarrheal illness related to Guatemalan raspberries. These berries had just started to be grown commercially in Guatemala, and somehow became contaminated in the field with this unusual parasite. Several recent outbreaks of Norovirus on cruise ships have resulted in hundreds of cases in each situation. In 1984, there was a little-known outbreak of *Salmonella* that was not determined to be a purposeful biocrime until several years after it occurred. This

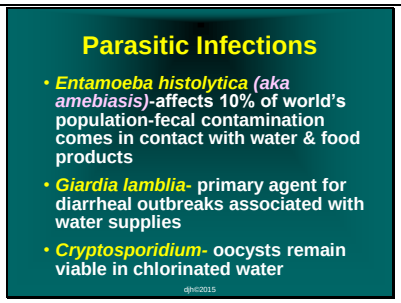
		situation resulted in 730 cases of *Salmonella* infection but luckily no deaths. *(This was covered in Week 2).* These are just a few of the notable foodborne outbreaks that have occurred in the U.S.
Slide 30		In Section B, we will outline the major foodborne pathogens causing foodborne illnesses (FBI).
Slide 31		As you can see from this slide, foodborne pathogens, which by themselves make up a very large category, are only ONE of the causative agents of foodborne illness.
Slide 32		Foodborne illness (FBI) is defined as any illness incurred from the consumption of contaminated food. Food contaminants come from a variety of sources. Certain plants and animals produce substances that are toxic to humans. Chemicals such as arsenic and lead may contaminate food through agricultural or industrial processes. Radionuclides from nuclear fallout are present in food products cultivated at or near testing sites. Parasites, viruses, fungi and bacteria are all examples of living organisms that have the potential to contaminate a food supply and are called "foodborne pathogens". In this lecture, we are focusing on foodborne pathogens. It is not possible to cover all of the foodborne pathogens, but we will emphasize several of the most common ones and those which are epidemiologically important.
Slide 33		Foodborne pathogens include those caused by bacteria, fungi, parasites, toxins, and viruses. The 4 tables that comprise Required Reading #4 for this set of lectures are excellent resources for determining causative agents of bacterial, viral, parasitic and non-infectious conditions.

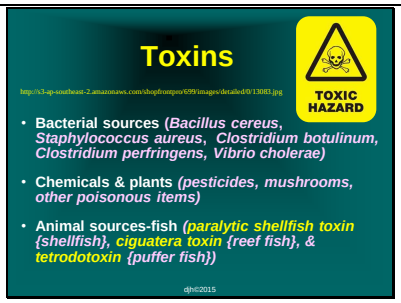
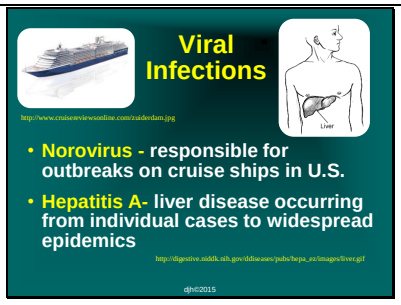
Slide 34		The most commonly recognized bacterial foodborne infections are those caused by *Campylobacter*, *Salmonella*, and *E. coli* O157:H7. Although there are numerous other bacterial pathogens, it is not possible to cover every one. Thus, the next several slides will focus on these three bacteria. A microscopic view of each of these three are located on this slide.
Slide 35		*Campylobacter* is a bacterial pathogen that causes fever, diarrhea, and abdominal cramps. It is the most commonly identified bacterial cause of diarrheal illness in the world. These bacteria live in the intestines of healthy birds, and most raw poultry meat has *Campylobacter* on it. In fact, *Campylobacter* species are part of the normal intestinal tract of warm-blooded animals. Of primary concern are poultry and cattle. Eating undercooked chicken, or other food that has been contaminated with juices dripping from raw chicken are the most frequent sources of this infection. *Campylobacter* can survive for weeks at 4° C but even though it does not multiply at this temperature, it can still infect with ingestion of with a few hundred organisms. Contamination with this organism occurs primarily during food processing when the intestinal tract is lacerated, allowing feces to contaminate the food product. Infected food handlers and raw milk are also significant sources of infection. The FoodNet surveillance system reported that there were 6621 cases of *Campylobacter,* 13.82 illnesses per 100,000 persons in 2013. *The links for this ire in the transcript (Source: 2013 FoodNet report.)* Food Net Charts: *Cases:* http://www.cdc.gov/foodnet/data/trends/tables/2013/table2a-b.html#table-2a *Incidence:* http://www.cdc.gov/foodnet/data/trends/tables/2013/table2a-b.html#table-2b
Slide 36		*Salmonella* species are part of the normal intestinal tract of humans, cattle, poultry, pigs & many other animals. *Salmonella* causes three syndromes: typhoid fever, enteric fever and gastroenteritis. The symptoms of gastroenteritis typically include fever, diarrhea and abdominal cramps. The disease is transmitted by food and water, putting every person at risk. It can spread to humans via a variety of different foods of animal origin. *Salmonella* stems from a wide variety of sources, including milk, eggs, ice cream, poultry, beef & salads infected with such species as *S. typhimurium, S*. *enteriditis*, and *S. montivideo.* In persons with poor underlying health or weakened immune systems, it can invade the bloodstream and cause life-threatening infections. The FoodNet surveillance system reported that there were 7277 reported cases of *Salmonella* and 15.19 infections per 100,000 U.S. population in 2013. Finally, domestic animals such as turtles and iguanas should be considered potential carriers and handled accordingly. *Food Net Source: Cases:* http://www.cdc.gov/foodnet/data/trends/tables/2013/table2a-b.html#table-2a

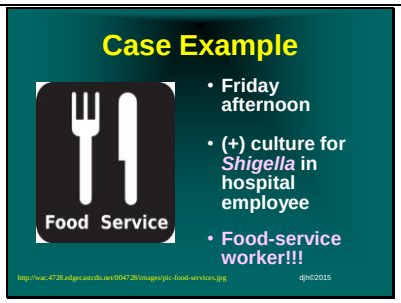
		Incidence: http://www.cdc.gov/foodnet/data/trends/tables/2013/table2a-b.html#table-2b
Slide 37		One particular type of *E. coli* , 0157: H7, has become one of the more problematic foodborne pathogens since the 1990's. *E. coli* O157: H7 is a bacterial pathogen that has a reservoir in cattle and other similar animals. Human illness typically follows consumption of food or water that has been contaminated with microscopic amounts of cow feces. The illness it causes is often severe with bloody diarrhea and painful abdominal cramps, without much fever. In 3 to 5% of cases, a complication called hemolytic uremic syndrome (HUS) can occur several weeks after the initial symptoms. This severe complication includes temporary anemia, profuse bleeding, and kidney failure. Cattle are the major reservoir for this organism, and human infection is the result of consuming improperly cooked ground beef, raw milk, or unpasteurized apple cider. The Pacific Northwest experienced a large outbreak of this pathogen in the 1990's, which was traced to contaminated meat from Taco Bell. More recently, outbreaks have been traced to Taco Bell in the northeast, spinach from California, and beef from a single slaughter facility. The FoodNet surveillance system reported that there were 552 cases of Shiga toxin-producing *E. coli* 0157:H7 (STEC 0157) and 1.15 cases per 100,000 U.S. population in 2013. *Food Net Sources: Cases:* *http://www.cdc.gov/foodnet/data/trends/tables/2013/table2a-b.html#table-2a* *Incidence:* *http://www.cdc.gov/foodnet/data/trends/tables/2013/table2a-b.html#table-2b*
Slide 38		Cholera is an acute, diarrheal illness caused by infection of the intestine with the bacterium *Vibrio cholerae*. This disease is most prevalent in lesser developed countries where unsanitary conditions may prevail. In the U.S., most cases are associated with international travelers who either become infected while abroad or who bring contaminated food items back to the U.S., where the infection might occur. In the 1990's , there was an outbreak of cholera beginning in Peru and spreading throughout most of South America, Central America and then into Mexico and the U.S. (an estimated 645,030 cases). This gram negative organism can proliferate in temperatures between 15° and 42°C, in a PH range of 6-10 and in solutions of up to 6% sodium chloride. Hence, it can be found in coastal waters contaminated with fecal matter, (e.g., Gulf of Mexico for the U.S.). Crabs, shrimp, mussels, and clams may harbor the organism for long periods of time and have all been implicated as sources of infection. After the tsunami in 2004, concern for cholera outbreaks was extremely high. In a later lecture in this class, we will discuss the recent cholera outbreak during the aftermath of the earthquake in Haiti.

Slide 39		This slide has s a picture of a cholera plate with organisms present. The infection is often mild or without symptoms, but sometimes it can be severe. Approximately 1 in 20 infected persons has severe disease characterized by profuse watery diarrhea, vomiting, and leg cramps. In these persons, rapid loss of body fluids leads to dehydration and shock. Without treatment, death can occur within hours. The other picture shows a child receiving oral rehydration therapy for cholera. Oral rehydration therapy, otherwise known as ORT, is an essential strategy to reduce dehydration and death in cholera cases. Oral Rehydration solution is a prepackaged mixture of sugar and salts to be mixed with water and drunk in large amounts. This solution is used throughout the world to treat diarrhea. Severe cases also require intravenous fluid replacement. With prompt rehydration, fewer than 1% of cholera patients die.
Slide 40		Fungi such as molds and yeasts grow on cereals, breads, fruit, vegetables, and cheese. For years man has used fungi for their beneficial purposes. Antibiotics such as penicillin and vitamin C, are derived from molds. *Aspergillus, Penicillium*, and Mucor are examples of 3 common molds. Two toxins produced by *Aspergillus* are aflatoxin and ochratoxin. Aflatoxins are found in corn, peanuts, and cotton seed. In the U.S., aflatoxin is of concern during the storage of corn, and in milk from cows that have consumed the aflatoxin. Aflatoxin causes hemorrhaging, anemia, ataxia, hematosis, cirrhosis of the liver, and is a very potent carcinogen. Techniques such as treating milk with ultraviolet light or soaking corn in bisulfite during processing are ways that the food industries eliminate the toxin. Ochratoxin is found in peanuts, Brazil nuts, grains, red and black pepper, and citrus fruit. The ochratoxin causes swelling of the liver and necrosis of the kidney tubules, leading to blockage. Members of the genus *Penicillium* are capable of producing several toxins, including rubratoxin, patulin and yellow rice toxin. Yellow rice toxins are produced by various species of *Penicillium* growing on rice during storage. The toxin causes the rice to turn yellow, hence it's name. Mucormycosis is the disease caused by fungi in the order Mucorales. Species of the genera *Mucor* and *Rhizopus* are the common species responsible for the disease. *Mucor* and *Rhizopus* species are found in the soil, and are common spoilage organisms of bread and fruit. Pathogenic strains, such as *Rhizopus oryzae*, are opportunistic organisms, infecting diabetics, leukemics, and those with suppressed immune systems.

Slide 41		This slide has pictures (bottom left) of a regular corn kernel and one affected by aflatoxin, the *Aspergillus* mold (bottom right), and a cob of corn affected by aflatoxin (top left).
Slide 42		Parasites are organisms that require another animal (host) to complete its life cycle. Organisms such as *Entamoeba histolytica or Crytosporidium parvum* require only one host, they are shed in the feces, and infection occurs by consuming water or food contaminated with these feces. *Trichinella spiralis*, on the other hand, causes infection in those who eat meat infested with the cyst of the organism. In the case of *Trichinella*, the organisms require two hosts, the intermediate host (pig) (which houses the cyst), and the definitive host, where the organism develops into an adult and is shed is the feces.
Slide 43		Species of *Trichinella spiralis* are found in warm-blooded animals such as bear, walrus, hogs, wild boar and rats. This organism causes trichinosis from warm-blooded animals containing viable larvae are consumed by humans. In the 1940s, there were an average of 400 cases of trichinosis per year. This number has decreased markedly to just 32 cases in 1994 as a result of improved cooking habits, greater access to home, and legislation that regulates the quality of feed intended for commercial hogs. *Trichinella* organisms can be destroyed by cooking meat until it turns a gray color or by freezing. In Idaho in 1995, an outbreak occurred from the ingestion of cougar jerky. The outbreak was contained to 10 people who displayed symptoms of eosinophilia, fever, rash, and overall weakness. The beef tapeworm *Taenia saginata* and the pork tapeworm *Taenia solium* infest humans through the ingestion of undercooked beef or pork that contains viable larvae. Although tapeworm infections are rare in the U.S., they are more prominent in areas where beef or pork are consumed raw. In healthy individuals symptoms often go unnoticed. In malnourished individuals multiple infections can occur, leading to blockage of the intestines. If the tapeworm leaves the intestine and infect organs such as the heart or brain, effects can be severe regardless of the health status of the individual. Tapeworms can be prevented by appropriately disposing of contaminated feces, cooking meat to an internal temperature of 57° C, or freezing it at –10 ° for 5 days.

Slide 44		Amebiasis, which is caused by *Entamoeba histolytica*, affects about 10% of the world's population. Outbreaks occur where sanitation is poor, where risky sexual habits are practiced, and in institutional facilities. In such settings, fecal material comes in contact with water and food products, increasing the likelihood of the organisms being ingested. While in the cyst stage of its life cycle, the organisms can survive in the external environment where it is transmitted by the fecal-oral route. Once ingested, the cysts are broken down by normal digestive action. Mobile trophozoites are then released, multiply and invade the large intestine, causing symptoms from mild to bloody diarrhea with numerous explosive liquid stools a day. This latter case is known as amoebic dysentery. *Giardia lamblia* is a protozoan flagellate found in areas with poor sanitation and in unfiltered surface water supplies. *Giardia* is considered to be the primary agent for diarrheal outbreaks associated with contaminated water supplies having a prevalence of 1.5 to 20%. In the U.S. giardiasis is most common among those who travel to endemic areas, men who have sex with men, and in child day-care centers where constant diaper changing facilitates the spread from one child to another. The organism is also found in surface waters used for drinking and recreational facilities. Symptoms usually manifest within one week of eating the contaminated food and consists of nausea, explosive diarrhea, and fatigue. Without treatment, symptoms linger and reinfection is possible. The first reported case of Cryptosporidiosis, which is caused by the parasite *Cryptosporidium*, occurred in 1976. Cases were prevalent primarily among immune compromised individuals, whose immune systems were unable to protect the body from infections. In 1993, the city of Milwaukee experienced the most comprehensive outbreak to date, which involved 400,000 inhabitants of the city who drank from the contaminated public water supply. Primarily a waterborne pathogen, *Cryptosporidium* is transmitted via water contaminated with feces from human and agricultural origins. In 1994, the first documented case of foodborne cryptosporidiosis stemmed from fresh-pressed apple cider. Foodborne transmission of this parasite occurs via the fecal-oral route, usually from food handlers shedding the oocysts and not using good hygiene. In healthy individuals, symptoms appear as mild diarrhea, nausea, cramps, and a low-grade fever. Immunocompromised patients, such as infants, the elderly and those with HIV infection, experience more severe symptoms. Cryptosporidium is of particular concern because the oocysts remain viable in the chlorinated water of swimming pools and can survive the water treatment processes through which drinking water passes. It can be expected that more outbreaks will continue to occur until researchers and regulators devise more adequate means to destroy the organism in our water supplies. The FoodNet surveillance system reported that there were 1,186 cases of *Cryptosporidium* and 2.48 cases per 100,000 U.S. population in 2013. *Food Net Sources:* *Cases:* http://www.cdc.gov/foodnet/data/trends/tables/2013/table2a-b.html#table-2a *Incidence:* http://www.cdc.gov/foodnet/data/trends/tables/2013/table2a-b.html#table-2b

Slide 45		In addition to disease caused by direct infection, some foodborne diseases are caused by the presence of a toxin in the food that was produced by a microbe in the food. For example, the bacterium *Staphylococcus aureus* can grow in some foods and produce a toxin that causes intense vomiting. The rare but deadly disease botulism occurs when the bacterium *Clostridium botulinum* grows and produces a powerful paralytic toxin in foods. These toxins can produce illness even if the microbes that produced them are no longer there. Other bacteria that produce toxins include *Bacillus cereus*, *Clostridium perfringens*, and *Vibrio cholerae*. The toxins produced by bacteria vary in their sensitivity to heat. The Staphylococcal toxin which causes vomiting is not inactivated even if it is boiled. Fortunately, the potent toxin that causes botulism is completely inactivated by boiling. Other toxins and poisonous chemicals can cause foodborne illness. People can become ill if a pesticide is inadvertently added to a food, or if naturally poisonous substances are used to prepare a meal. Every year, people become ill after mistaking poisonous mushrooms for safe species, or after eating poisonous reef fishes. Toxins produced by fish include paralytic shellfish poisoning from shellfish, ciguatera toxin from a variety of reef fish, and tetrodotoxin from puffer fish.
Slide 46		Viruses are microscopic particles that usually contain a single strand of RNA. Although viral particles can exist outside a host cell, they require a host cell during transmission, for replication to occur. After invading and replicating within a cell, death or damage to the host cell is common, but this is not always the case. The two most prominent foodborne viruses of present day are hepatitis A and Noroviruses. **Noroviruses** (genus *Norovirus*, family *Caliciviridae*) are a group of related, single-stranded RNA, nonenveloped viruses that cause acute gastroenteritis in humans. Norovirus has been approved as the official genus name for the group of viruses provisionally described as “Norwalk-like viruses” (NLV). Norviruses are an extremely common cause of foodborne illness. It causes an acute gastrointestinal illness, usually with more vomiting than diarrhea, that resolves within two days. Unlike many foodborne pathogens that have animal reservoirs, it is believed that Noroviruses spread primarily from one infected person to another. Infected kitchen workers can contaminate a salad or sandwich as they prepare it, if they have the virus on their hands. Infected fishermen have contaminated oysters as they harvested them. There have been numerous outbreaks of Noroviruses on cruise ships.The Centers for Disease Control and Prevention reports 3 outbreaks of foodborne illness so far in 2014; two of which were confirmed to be from Norovirus. Hepatitis A is a liver disease caused by the hepatitis A virus. Hepatitis A occurs in epidemics both nationwide and in communities. Hepatitis A can affect anyone. In the United States, hepatitis A can occur in situations ranging from isolated cases of disease to widespread epidemics. During epidemic years, the number of reported cases reached 35,000. In the late 1990s, hepatitis A vaccine was more widely used and the number of cases reached historic lows. One-third of Americans have evidence of past infection (immunity). HAV is found in the stool (feces) of persons with hepatitis A. HAV is usually spread from

		person to person by putting something in the mouth (even though it may look clean) that has been contaminated with the stool of a person with hepatitis A.
Slide 47		To complete this section on foodborne pathogens, I'd like to share a real case example that I was involved with at my previous workplace, a large county hospital in San Jose, California. One Friday afternoon (*which is when all Infection Control problems happen*), our infection control office received a call from the laboratory of a positive culture for *Shigella*. It turns out that the case was a hospital employee. When this happens, it is imperative to find out where that employee works as soon a s possible, to make sure that he or she is not in a job category where food contamination could occur or patient care could be compromised. Unfortunately, we quickly found out that this person worked in the cafeteria. So we went to our director to find out if we were going to need to send out an exposure notice that afternoon. He half-jokingly said that as long as it was not the "guy who carved the roast beef that day", we probably did not need to, as all food service workers were required to wear gloves when handling food that was already cooked or would not be cooked further. We had noticed at lunch that day that the person carving the roast beef was wearing a glove on the hand using the knife and handling the roast beef with a bare hand. So that is why my supervisor made that comment.
Slide 48		Well guess what? If you can believe it, the person with the positive Shigella culture WAS the roast beef carver!!!! We had two goals to meet immediately-warn employees of a potential exposure and protect the confidentiality of the infected worker as much as possible. This was before e-mail and faxes, so we drafted a memo and distributed it hospital-wide by about 5 PM that day. The definition of an exposure was "eating roast beef". Employees were notified of potential symptoms to look out for and to call in to Employee Health if they occurred. In addition, all supervisors were asked to monitor the call-in logs to see if any diarrheal illnesses were reported. Luckily, there were no secondary cases as a result of this. This concludes "Prevention of Foodborne Illness: A Global Perspective", Part 1, Sections A & B.