Welcome to our first lecture in Module 2, Lecture 6. This is our first lecture on the bacterial pathogens. You will find that the bacterial food pathogens are split into two lectures because there are so many of them. The bacteria are presented in alphabetical order rather than order of importance. Please don’t assume those presented first are more important. The picture is of raw milk because in the following slides we will discuss a number of pathogens that can be spread in raw milk. I want you to keep this lecture in mind if you see various media sources telling you that raw milk is beneficial for your health. Do you think something that has this many bacteria that could potentially kill you is beneficial for your health?

In this lecture we will describe in detail the bacterial pathogens which contaminate food in the United States. As mentioned, this will continue in Lecture 7. We will identify the food groups and the route of spread usually associated with these bacterial pathogens. If you have an interest in healthcare, this particular part should be of great interest to you. If you have a patient with suspected foodborne disease, you will want to ask them about the history of the foods they may have eaten. Knowing which pathogens are associated with which foods can guide your questions. We will then determine the diseases which result from these pathogens. And of course we will discuss control and prevention where available.

Occasionally in this lecture I will give you the current recommended antibiotic treatment for certain infections. However, please note that antibiotics change frequently and in the future these treatments may no longer be effective. When you go out to work in the field, the guidelines given here may no longer apply. The reason for this is that many microorganisms, and especially bacteria, can mutate. They can acquire resistance to antibiotics. In addition, sometimes new drugs are found to be more effective. Take the antibiotic information given here with a grain of salt, knowing that they may change. It is very important to note that antibiotics may only be used to treat bacterial and some protozoal infections. They are NOT effective against viruses, worms, and fungi. We will talk about appropriate treatments for these last three types of microorganisms.
Our first pathogen of interest is the *Bacillus cereus*. It causes two types of disease; intoxication due to pre-formed toxin, and a toxin-mediated disease which is due to toxin which forms after the infection is established. You can review these terms in your Module 1 lectures. The different diseases depend on which genes the *B. cereus* is carrying. [note added: strains typically carry genes for one or the other type of disease]. Symptoms will differ depending on the types of toxins the bacteria can produce. If diarrheal type toxins are present, obviously you see diarrhea and the accompanying abdominal cramps. However, if vomiting toxin is present, symptoms include vomiting, diarrhea, and abdominal cramps. Just to illustrate that this pathogen is involved in real food safety recalls. The FSA (the UK equivalent of the FDA) issued a recall for tofu linked to *Bacillus cereus*.

*Bacillus cereus* is frequently associated with contaminated rice as shown in the picture on right. But it can also be found in meats, milk, and vegetables. Milk is an interesting case because the live microorganism is killed by pasteurization but the spores survive. You may have noticed if you leave milk at room temperature, it will begin to spoil and you can smell a difference. This occurs because the *B. cereus* spores germinated at room temperature and begin to grow the microorganism. This is one of the reasons in the US, we like to keep milk cold as it prevents germinations of *B. cereus* spores. If you are interested, go to your grocery store and look for milk that is on a shelf [not in a refrigerator]. These can be found near hot cocoa and chocolate milk powders. These are found in boxes and note on the package that these are not pasteurized in the normal way but instead use ultrahigh temperature pasteurization (UHT). This treatment kills *Bacillus cereus* spores allowing these products to be sold in a box at room temperature. The spores of *Bacillus cereus*, which originate in soil, germinate when the food is improperly heated, cooled, and reheated. Prevention requires proper hold temperatures. The treatment for this is vancomycin. Keep in mind that vancomycin is a very expensive drug so you may see changes in this antibiotic if a better options comes along. Infections again are commonly linked to foods containing rice. I show you the picture on right to illustrate that often these diseases are caused by large preparations of food being placed in the refrigerator. The middle of the food stays warm (temperature danger zone!) allowing sporulation to occur.
Unfortunately, *Bacillus cereus* infections can be fatal. Shown here is a case report of a fatal outbreak of *Bacillus cereus* associated with food poisoning. I would ask you to take a minute to look at this outbreak and see if you can figure out the cause. Think of those three major causes discussed in Module 1. Was this a time/temperature abuse? Was this a personal hygiene issue? Or was this a case of cross-contamination? Again, take a minute to look at this slide before moving on and see if you can identify the cause.

Here we have another pathogens which causes a disease known as brucellosis (or undulant fever) caused by the bacterium *Brucella*. *Brucella* is primarily a disease of animals and humans are infected by consumption of meat and milk products from infected animals. Looking at the picture on right we see that the *Brucella* organism is usually transmitted by contact with infected farm animals. Not surprisingly, this is a hazard for those who do direct work with animals. In humans brucellosis can cause a range of symptoms similar to the flu and may include fever, sweats, headaches, back pains, and physical weakness. If you were the diagnosing medical professional, you would be presented with a very nonspecific set of symptoms. So again, it is very important to get a history on your patient especially concerning their profession and other factors that would help you identify *Brucella*. *Brucella* is a select agent and may possibly be used for bioterrorism. As I mentioned earlier, I have many years of experience working with biothreat agents and we had concerns over the possible use of this agent.

Unfortunately, a large number of cases of *Brucella* can be linked to the consumption of raw milk. So far, we have discussed only two pathogens and both can be spread in raw milk. *Brucella* can also be spread in raw meat. Proper food preparation can prevent these cases. Contact with infected animals should be avoided. It can be treated but remember that diagnosis is complicated. The current treatments are doxycycline and rifampin. [Note added: one or the other, not both].
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If you have lived in Florida for a while you are probably familiar with this guy in the picture here. This is a wild boar. You can find these all over Florida and in fact we have a hunting season during which people can shoot these. [Note added: a hunting season is necessary to keep the numbers of this nuisance species low]. Unfortunately, wild boar carry *Brucella* and cases often occur in people who hunt and field dress these animals. Wild boar are food animals, they can be eaten, and many people claim that they are delicious! They are hunted for food and occasionally cases are related to the consumption of meats or blood. In this case the blood may accidentally enter mucus membranes or make be ingested on purpose. It is important to remember boar carry *Brucella* and *Brucella* is a concern in Florida.

### Slide 10

**Campylobacter jejuni**

- 3 major foods are associated with *Campylobacter* infection:
  1. Raw chicken
  2. Raw milk
  3. Raw meat
- Disease is mild including nausea and diarrhea.
- 4th leading cause of foodborne illness (9% overall).
- 3rd leading cause of hospitalization (15% overall).

“Campy” - *Campylobacter*.

Our next pathogen is one of the most important pathogens in the US food supply and most people have never heard of it. This pathogen is *Campylobacter jejuni* but is often referred to as “Campy”. You can see the picture of the organism on the right [note added: those of you in microbiology, what would you call the shape of this organism?]. There are three major foods associated with *Campylobacter* infection; raw chicken, raw milk, and raw meat. [Note added: if you are asking yourself isn’t chicken meat, the answer in the food industry is no, chicken is poultry]. That is the third pathogen in raw milk. *Campylobacter* caused several outbreaks in raw milk while the audio was being recorded for this lecture. The disease is mild usually resulting in no more than nausea and diarrhea. This is why many people have never heard of *Campylobacter*, and it rarely gets reported. Would you go to your doctor with nausea and diarrhea? *Campylobacter* is the 4th leading cause of foodborne illness and the 3rd leading cause of hospitalization.
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The route of spread of *Campylobacter* is through undercooked foods or through foods which have become infected as a result of cross-contamination. We know that cross-contamination plays a major role in the spread of this pathogen. The picture shows raw poultry because it is commonly contaminated with *Campylobacter*. I also show red cutting boards/knives that we would assume would be used only to cut meat/poultry. However, if we then turn around and put lettuce on here, we would have the spread of *Campylobacter* (or other pathogens). The mild symptoms result in very few cases of *Campylobacter* being reported. Usually not reported unless it is part of an outbreak. This is why we know about the raw milk cases reported recently, they were part of an outbreak. In one of these outbreaks, raw milk was fed to a high school athletic team and they were not aware that the milk was raw and it was contaminated with *Campylobacter*. Treatment is usually not necessary. Prevention involves proper cooking and use of designated food preparation utensils.

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Here we see a report from the CDC known as the Morbidity and Mortality Weekly Report (MMWR). These reports are released weekly and you can check them to see what diseases are occurring and where. Here we see Notes from the Field: Recurrent Outbreak of *Campylobacter jejuni* Infections Associated with a Raw Milk Dairy in Pennsylvania. I can tell you that there a large number of people who consume raw milk in Pennsylvania. It is a very contentious subject in that state and legislators have tried to prevent the sale of raw milk but have been unsuccessful. As you can see underlined in the test, that outbreak was the largest raw-milk outbreak in Pennsylvania in the past 2 decades. In other words, this particular dairy has a history of *Campylobacter* infections.
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**Clostridium botulinum**

- Clostridium botulinum causes a bacterial intoxication primarily from improperly canned foods.
- Spores from C. botulinum can also infect infants who are fed honey (adults are immune).
- Intestinal symptoms include nausea and vomiting.
- Other symptoms include dizziness, double vision, difficulty swallowing and breathing.
- Intoxication can be fatal.

To change pathogens again, you have probably heard of *Clostridium botulinum* before. You may be familiar with botox, a chemical derived from this microorganism, that is used to smooth out wrinkles. You can see this in the cartoon on right. *Clostridium botulinum* causes an intoxication. Remember that word, underline intoxication if you need to, this is a toxin that causes most of the problems. *C. botulinum* intoxications occur primarily from improperly canned foods. During the recording of this audio, an outbreak of *C. botulinum* was occurring cause by improperly canned foods served at a church potluck. One person has died. Spores from *C. botulinum* can also infect infants who are fed honey (adults are immune to this). Adults have been challenged with *C. botulinum* spores enough time that our immune systems can easily handle the pathogen (but not the toxin). In infants botulism can be fatal. Intestinal symptoms include nausea and vomiting but as the toxin spreads through the body other symptoms include dizziness, double vision, difficulty swallowing, and breathing. As I mentioned earlier, intoxication can be fatal.

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**Clostridium botulinum (continued)**

- Botulinum toxin causes flaccid paralysis by blocking motor nerves, it is extremely useful in both cosmetics and neurology. However, it can be deadly due to problems with breathing. The flaccid paralysis progresses symmetrically downward, usually starting with the eyes and face, to the throat, chest and extremities. When the diaphragm and chest muscles become fully involved, respiration is inhibited and death from asphyxia results. The treatment is an anti-toxin. You should know that an anti-toxin and a toxoid are not the same thing. An anti-toxin is an antibody against a toxin. Prevention is properly canning foods and never feed honey to infants. If you were to look on the internet right now, you would find a lot of claims about the benefits of raw honey, none of which are supported by real science. You will also hear many people claim that they fed honey to their infants and there was no problem. Remember that anecdotal stories do not trump science. You can see the picture here on the right where this baby was in the hospital due to botulism. In the middle you can see “Baby BIG arrived” what they mean is antibody against botulism toxin has arrived and they are now giving it to this baby. If they didn’t do this, this child would have lost its life. It is very important to remember that botulism is serious and no one should ignore the rules about honey. It is also important to note that anti-toxin is not available at all hospitals. Oftentimes it has to be flown in from another place. Here in Tampa our hospitals...
are large enough that we might have anti-toxin in stock, if not, it can be flown here from CDC and other places.

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In this case, honey was added to an infant’s bottle. The infant of course ended up with botulism poisoning. So please be highly suspicious of raw honey claims and do not give honey to infants. [Note added: this includes honey from the grocery store, no honey should be given to infants ever]

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We are going to switch gears here and talk about a different Clostridium. Please be careful that you distinguish the two. This is Clostridium perfringens which causes a toxin-mediated infection. Meats and poultry products are most likely to be contaminated. Hygiene issues also contribute to illnesses. Symptoms include intense abdominal pain, severe diarrhea, and nausea. This is the third leading cause of foodborne illness.

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Clostridium perfringens infections are usually attributed to foods that have undergone temperature abuse, which is of course one of our major causes of illnesses. In this case it is usually undercooked meats. C. perfringens is often found in spices, gravy, and undercooked meats. Prevention is proper holding temperatures and cooking. There is no recommended treatment as most disease is self-limiting. Looking at the picture at right, do you feel this meat is properly cooked? It is very common to find tenderloins of pork and other meats where the meat is still pink in the center. You want to be sure that the meat is cooked all the way through. The easiest way to do this is to use a thermometer. The color, pink or not, is not a great indicator in this case as the meat can sometimes reach the correct temperature. However, it can in some cases be a sign that meats are rare. In other words, it is always best to default to using the thermometer!
Here we have another MMWR report because I wanted to demonstrate to you that a fatal *C. perfringens* outbreak did occur. It is interesting to note that this occurred at a state psychiatric hospital. Interestingly, the 3 people who died in the outbreak were all taking pills that impair intestinal motility. These are very common drugs, most of which are available over the counter, and include many “purple” pills such as Prilosec, Prevacid, Nexium, and those drugs we use to treat gastrointestinal reflux. These are known to contribute to *Clostridium* diseases [Note added: including *C. difficile* or “C. diff” as disease you will come to hate as a healthcare provider]. The growth of *Clostridia* will be affected by the drugs a patient is taking, think about the spores. You will not be surprised to learn that this outbreak was caused by temperature abuse.

This brings us to the *E. coli*. I have included some extra slides here on *E. coli* because their classification can get somewhat confusing. Please do not memorize what you see on the right hand side of this slide. I included this in case you were interested in how the *E. coli* were assigned their unique names. *E. coli* is normal flora of the gut. Normal flora *E. coli* usually do not cause GI disease. However, they are the leading cause of urinary tract infections. Normal flora *E. coli* do not form toxins and therefore do not cause GI distress. They can cause urinary tract infections because they are introduced to the urinary tract from the GI tract accidentally. Usually this occurs because someone wipes in the wrong direction. Remember the rule, front to back, not back to front! Consider that this may also occur in persons wearing a diaper, including young children and an elderly person with incontinence. When we are talking about *E. coli* in foodborne disease, we are not talking about normal flora *E. coli*, but rather true pathogens. GI disease is due to toxin-producing strains of *E. coli*. 
So how do we get those weird names for *E. coli*? And by the way, this isn’t all of them, just those important for food. EHEC are the enterohemorrhagic *E. coli* and when you see hemorrhagic you should think about blood. These guys cause bloody diarrhea. They are sometimes also called STEC which is Shiga-toxin producing *E. coli*. This includes the previously mentioned *E. coli* 0157:H7, one of the EHECs which got a toxin from *Shigella*. We also have the ETEC or enterotoxigenic *E. coli* which cause traveler’s diarrhea. And then we have a group I have lumped together because they cause similar disease and have similar symptoms and these are the enteropathogenic, the enteroinvasive, and the enteroaggregative *E. coli*. They generally do not cause serious disease but there are some exceptions.

This brings us to a quick note about serotypes. *E. coli* and *Salmonella* are commonly classified by proteins found on their surface. This is a process known as serotyping. *E. coli* is classified by two proteins O and H and a number denoting with O or H antigen is present. For example, *E. coli* 0157:H7 refers to a strain expressing O antigen number 157 and H antigen number 7 on its bacterial structures. You may be asking yourself why we care about serotypes but this is one way to link cases together. When I told you the number of cases involved in the Jack in the Box outbreak, serotyping was a quick way to know these cases were related. We can get more information by doing DNA fingerprinting but this takes much longer, up to 3 days for *E. coli* in contrast to serotyping which is faster. Those of you who are interested in molecular epidemiology please take note here that serotypes and genotypes are NOT the same thing. We will not discuss this further in this case but in your other classes be sure to note that these are different.
This brings us to our first type of *E. coli*, the EHEC or enterohemorrhagic *E. coli*. Outbreaks of this particular organism have been traced to a number of different foods. Unfortunately, EHEC originates in feces and feces have found their way into meats, produce, and dairy. EHEC has been found in undercooked hamburger, contaminated milk, sprouts, and other foods. This includes the *E. coli* O157:H7 but please remember that there are other serotypes that are enterohemorrhagic. The symptoms include watery and then bloody diarrhea, severe abdominal cramping, and possibly kidney failure due to HUS (hemolytic uremic syndrome) which we have mentioned before. Remember that Jack-in-the-Box and other outbreaks were linked to *E. coli* O157:H7.

Continuing with EHEC, it usually contaminates foods from infected animal feces. Prevention involves proper cooking for meats and pasteurization for milk and fruit juices. Note that this is another organism that can be found in raw milk. We will return to the idea of EHEC in fruit juices because later on we will cover an outbreak in which EHEC contaminated cider. And of course washing of produce can help prevent EHEC. Treatment is complicated as antibiotics may contribute to HUS, causing kidney failure, and therefore antibiotics should not be used. The treatments for EHEC are fluid replacement and dialysis. Those have shown some success. On the right you can see an outbreak of *E. coli* O157:H7 which was linked to ready-to-eat salads. Recall that ready-to-eat salads are truly ready to eat, they should not require washing before eating. Unfortunately, this was contaminated with *E. coli*. 
EHEC – Enterohemorrhagic E. coli
Other than O157:H7
• Serotypes other than O157:H7 have in the past been largely ignored.
• A huge outbreak in Germany was due to E. coli 0104:H4 and resulted in several deaths due to kidney failure.
• Note: 852 patients with HUS and 32 deaths!

One of the biggest enterohemorrhagic E. coli outbreaks was NOT caused by E. coli O157:H7 and I wanted to stress that by showing you this slide. In the past, serotypes other than O157:H7 have largely been ignored. In Germany, there was a huge outbreak of E. coli which was due to E. coli O104:H4, another enterohemorrhagic strain. It resulted in several deaths due to kidney failure. Note in this outbreak there were 852 patients with HUS and 32 deaths. Thinking about that real quickly, how would you provide dialysis services to 852 people? This is obviously a huge public health problem and this outbreak was traced to produce.

ETEC - Enterotoxigenic E. coli
• Also known as Traveler’s diarrhea (and Montezuma’s revenge).
• Transmitted by contaminated food and water.
• Produces 2 toxins that result in symptoms of watery diarrhea, nausea, vomiting, fever, chills, and cramps.

This brings us the enterotoxigenic E. coli which you may have heard referred to as traveler’s diarrhea or Montezuma’s revenge. In the picture at right we see a person with diarrhea and a sign indicating that diarrhea is very dangerous. You may see warning signs in a number of countries as diarrhea can be deadly. It is transmitted by contaminated food and water. The enterotoxigenic E. coli produce two toxins that result in the symptoms. Symptoms include watery diarrhea, nausea, vomiting, fever, chills, and cramps. When we see cases of enterotoxigenic E. coli in the US, they are usually imported or occurring in people who were on cruise ships.

ETEC - Enterotoxigenic E. coli (continued)
• Disease is mild and can be prevented by avoiding water (and ice), seafood, and produce in countries with contaminated water supplies.
• Note: most cases in the US are the result of travel to Mexico.
• Rx: Peptol-bismol, Bactrim in severe cases.
• Note: some travelers will take Bactrim during their trip and eat/drink whatever they like. Why do people take Pepto? So they can have margaritas mostly!

The disease caused by ETEC is usually very mild. It can be prevented by avoiding contaminated water but it is important to note that you have to avoid contaminated ice as well. In other words, if you are going to take the cruise to Mexico or other places where ETEC occurs, you cannot have that margarita! You also have to avoid seafood and produce from countries that have contaminated water supplies. Most cases in the US are the result of travel to Mexico. There are treatments, you can treat over the counter, and they will often resolve on their own. Usually you can treat this with Peptol-bismol but severe cases may require Bactrim. Some people will just go ahead and take Bactrim the entire length of their trip because it is relatively cheap and has few side effects. This way when they travel in other countries, they can eat and drink whatever they want. What do you think about this? Could that have an impact on antibiotic resistance to Bactrim? Think about these public health issues before going on to the next slide.
Travelers Beware – Enterotoxigenic E. coli

If you are planning on traveling and wonder what countries have ETEC, this is a good resource. The map shows low, intermediate, and high risk countries for ETEC. Please note that ETEC is found in places that also have problems with clean water supplies and hygiene. Please beware if you plan to travel to any of these countries.

As I mentioned earlier, we often see enterotoxigenic E. coli on cruise ships. Keep in mind that it is spread by fecal-oral route. On cruise ships there are a number of opportunities for these to be spread. Buffets have been implicated and sometimes items like pool equipment and gym equipment have become contaminated. Unfortunately, norovirus which is discussed in a later lecture, spreads by the same route. It is also fecal-oral route of spread. Both organisms spread by fecal-oral route so it is common to find both norovirus and ETEC circulating on the same ship. As you can imagine, this is a pretty miserable experience for the people on the cruise. Please pay attention to media reports as you go through this course as there may be reports of cruise ships with large numbers of people with diarrheal diseases. We will talk later about how cruise ships are regulated by the CDC vessel sanitation program and the regulation that occurs.

As I mentioned, there are other E. coli that cause diarrhea, known as diarrheagenic E. coli. They include the enteropathogenic E. coli, the enteroinvasive E. coli, and the enteroaggregative E. coli. All there result in diarrhea from contaminated foods. The disease is rarely serious and prevention is the same as the other E. coli strains.

It is very hard to find data on those last three E. coli because very few labs have the capacity to identify them. The study shown here states that the true incidence of these diseases is largely unknown. It is possible that when a cruise ship for example has both ETEC and norovirus, one of these may also be present. However, because no one checks the samples for these strains, we really don’t know.
This brings us to the pathogen known as *Listeria monocytogenes*. You will recall in the last module I told you that *Listeria* was responsible for the deadliest foodborne outbreak in the past 25 years. That was the Jensen Farms cantaloupe outbreak which resulted in 33 deaths. The symptoms of *Listeria* are very similar to influenza and we will look at those on the next slide. *Listeria* can be transmitted to infants from infected mothers. If a fetus becomes infected with *Listeria*, the CFR (case fatality rate) can be as high as 50%. *Listeria* is the 3rd leading cause of foodborne death.

I have given you here the symptoms of *Listeria* from the CDC. The reason I wanted to give you the symptoms on its own slide is to illustrate how it can be difficult to diagnose *Listeria* initially. *Listeria* can be mistaken for the flu, especially if the infections occur during flu season. A person with listeriosis has fever, muscle aches, and sometimes gastrointestinal symptoms such as nausea or diarrhea. If infection spreads to the nervous system, symptoms such as headache, stiff neck, confusion, loss of balance, or convulsions can occur.

Despite our big outbreak that occurred in produce, *Listeria* is most often spread in contaminated meats and dairy products. Ready-to-eat foods and raw milk are also at risk for infection. Prevention is proper storage and cooking and the treatment is penicillin. Again remember this treatment may change. So I want you to think about hot dogs. Raw hot dogs in particular are not a ready-to-eat food. The exceptions are those that are fully cooked. In case you were not aware, there are quite a lot of people who like to eat hot dogs raw, especially kids. Given what I just told you about *Listeria*, do you think it is safe to eat uncooked hot dogs?
Listeria Outbreak - Queso Fresco

Remember how I told you that the outbreak in cantaloupe was the deadliest outbreak in 25 years? Before that outbreak was one that was deadlier, this was also Listeria, and it was caused by queso fresco or fresh cheese. The picture below shows the DNA fingerprint of Listeria strains isolated from patients who ingested Listeria from contaminated queso fresco. In each case where you see the word neonate, that is a child who died. The queso fresco was purchased at an outdoor market and it was not refrigerated. Note the cities in the data, Houston, McAllen, this occurred in Texas. The cheese was imported from Mexico and sold at an outdoor market in Texas in summer. You can imagine how hot it was outside at the time. The queso fresco was contaminated with Listeria which was multiplying like mad! [temperature danger zone!]. The four neonates represented below all died due to this infection.

As a result of the outbreak I told you about on the last slide, it is now illegal to import queso fresco. This doesn’t mean you can’t get it, several sources sell it here in the US. Because it is harder to get and people like to make their own, it is still illegally imported. At first glance, you might think the picture on left is a cocaine bust, when in fact, it is a cheese bust! A large amount of queso fresco illegally entered the country and this food was detained. Unfortunately, a number of people have tried to make queso fresco in their bathtubs. The tub serves as a very large reservoir in which you can make the cheese. Needless to say, it is not safe to do so. Unfortunately, as you can see in the picture on right, this person attempted to make queso fresco in a coffin! Please note that Listeria has caused some of the deadliest outbreaks of foodborne illnesses. Be careful where you get your queso fresco. And recall that pregnant women should never eat deli meats and soft cheese, also true for other immunocompromised persons.
This brings us to our last bacterial pathogen in this lecture and that is *Mycobacterium bovis*. Foodborne *M. bovis* is usually spread in unpasteurized milk as the pathogen is a zoonosis. Recall that a zoonosis is an animal disease that can spread to humans. Disease is relatively rare and should not be confused with tuberculosis caused by *Mycobacterium tuberculosis*. *M. bovis* can cause a disease similar to *M. tuberculosis* but *M. tuberculosis* is NOT foodborne. Please take a look at the food safety news story on right. This story comes from a debate on a Louisiana food bill that was designed to restrict the sale of raw milk. During the debate, one of the senators said that if a child died of foodborne illness due to drinking raw milk, they could just go to heaven. Do you think this comment is responsible? Are we protecting children from raw milk? Take a minute to think about that. I hope in the future if you encounter claims about the benefits of raw milk, you will remember this lecture and that raw milk is not safe.

As mentioned previously, you can see a human tuberculosis disease due to *Mycobacterium bovis* in the United States. Again, please don’t confuse the two organisms, both *Mycobacterium bovis* and *Mycobacterium tuberculosis* cause a tuberculosis disease in humans. But only *M. bovis* is foodborne.

To summarize our lecture, Bacterial Pathogen I. Bacterial pathogens commonly cause disease via contaminated meats, produce, dairy, and water. Disease can range from mild diarrhea to debilitating conditions and death. Understanding the common causes of contamination which are; time and temperature abuse, poor personal hygiene, and cross contamination are key to preventing these diseases.