

Chapter 5:

Danger Zone Ahead

Learning Objectives

After completing this chapter, you will be able to:

- Define the terms 'potentially hazardous' and 'non-hazardous' food
- Describe the factors that support the growth of disease causing microorganisms
- Describe the danger zone temperatures
- Explain the significance of the time/temperature rule in relation to foodborne illness

Chapter 5: Danger Zone Ahead

The material in this chapter will provide an overview of the general factors that contribute to foodborne illness. It answers the broad question of how to prevent the bad bugs from flourishing.



Cream Pies Get the Cold Shoulder

Heidi is very interested in expanding her business and her pie line because of the growing demand. She has never had a problem with any of her products, but one of the other vendors at the market mentioned that pumpkin, meringue and cream pies aren't allowed at the market. Heidi decides to meet with the market manager and the public health inspector to discuss the rules and regulations.

The manager confirms that these pies aren't allowed at the market for food safety reasons and that Heidi should talk to the public health inspector for details. The public health inspector informs Heidi that pumpkin, meringue and cream pies are potentially hazardous foods. These are foods that will support the growth of pathogenic microorganisms. Heidi is told that this regional health authority does not allow these foods to be produced in a home kitchen; to produce her pies she will need to use a permitted facility and handle them carefully.

The biological hazards associated with pumpkin and cream pies will significantly impact how she produces and markets them. The pathogens may also reduce the shelf life of her pies.





Plastic Totes Make the Grade with Pam and Liane



Pam and Liane are very conscious of food safety issues. They grow their fruits and vegetables following good agricultural practices recommended by their industry association. They also hand out an information sheet to their customers advising them of safe produce handling practices in the kitchen.

They decided to pack their products in plastic containers instead of wooden crates or cardboard boxes. Pam and Liane learned that plastic totes can be reused because they are easily cleaned and sanitized. They don't create physical hazards as readily as wooden crates or cardboard boxes. Crates splinter with use; cardboard disintegrates when wet exposing the contents to cross contamination from soil, dirty water, etc.

The plastic containers are also easier to stack in the back of their vehicles. The use of covers reduces contamination during transport.



Bad Bug Sparks Operations Review



Mike and Elizabeth are registered in the Start Clean, Stay Clean program which is the on-farm food safety program for the chicken industry. In working through the program they realized that the bacterium Salmonella is a concern in their poultry production. As a result, they assess their entire operation. They identify the risks of microbial contamination in their pork and the potential for cross contamination between their poultry and pork products.

Mike and Elizabeth want to provide their customers with safe food and realize the importance of this to the success of their farm direct operation. They are evaluating which marketing activities expose their products to various hazards.

Not All Foods Are Created Equal

Different foods present different food safety hazards. How you prepare the food, the facility you're required to prepare it in and how you must handle it depends on the food safety risks. Some foods are intrinsically safer than others. Some are perishable and spoil easily. Some support rapid bacterial growth and can quickly cause foodborne illness if not handled properly. Others are shelf stable and can last for years under proper storage conditions without a change in quality or food safety risk.

Non-Hazardous Foods

Non-hazardous foods present less of a food safety risk. These foods are low in moisture and generally not susceptible to deterioration at room temperature. These foods can be prepared at home and sold at most Alberta Approved Farmers' Markets. Some examples include:

- Dry goods (unconstituted dehydrated foods, dry cereals, crackers, plain breads and buns, dried legumes)
- Acidic (pickles)
- Sweet (containing 50 – 60% sugar such as jams, jellies, syrups, cinnamon buns, brownies and fruit pies)
- Salted (20% salt or more)

All foods sold in Alberta, with the exception of some foods sold at Alberta Approved Farmers' Markets, must be prepared in a facility permitted by the local regional health authority.

Perishable – any food product or ingredient that is susceptible to deterioration or loss of quality when subjected to temperature abuse. Perishable foods have a shelf life of less than 90 days at room temperature.

Permitted facility – facility licensed by the regional health authority under the authority of the Food and Food Establishments Regulation of the *Public Health Act*.

Non-hazardous food – food that does not normally support the growth of disease causing bacteria and does not usually need to be refrigerated.

Potentially hazardous foods are capable of supporting the rapid and progressive growth of pathogenic microorganisms or the production of toxins. They pose an increased food safety risk.

Potentially Hazardous Foods

Potentially hazardous foods present the greatest food safety risk. They are foods that are normally rich in protein, moist, non acidic and readily support bacterial growth. They must be refrigerated or frozen and pose a food safety risk when left at room temperature for even short periods of time. They are frequently linked to foodborne illness because they can support the growth of pathogens.

Potentially hazardous foods include:

- Most animal products
- Eggs and egg products
- Dairy products
- Seafood products
- Cooked cereals, fruits and vegetables
- Many processed foods



For a more detailed list of potentially hazardous and non-hazardous foods see Appendix D: Potentially Hazardous Foods.

Potentially hazardous food – food capable of supporting the rapid and progressive growth of pathogenic microorganisms or the production of toxins, has a pH greater than 4.6 and a water activity (A_w) of 0.85 or more.

Pathogen – any bacteria, virus, mould or other form of life too small to be seen by the naked eye and capable of causing disease, illness or injury. Pathogens require moisture, temperature, proper pH and food source to grow. They can double every 10 – 20 minutes and do not necessarily change the look, smell or taste of food.

Foodborne illness – sickness caused by the ingestion of food containing microbiological, chemical or physical hazards; any illness that results from ingesting food or beverages.

You may be surprised to learn that cooked produce and cereals present a food safety risk. Cooking breaks down the starches and proteins in produce and cereals, and the protective outer layer of fruits and vegetables. This makes these foods more available for bacterial growth. These foods **must** be refrigerated once cooked.

Table 5.1 **Some Common Potentially Hazardous Foods**

Food Type	Comments
Meat, fish, shellfish and poultry	High protein foods that spoil rapidly. Prevent from contaminating other foods.
Milk and dairy products	Pasteurize.
Eggs	Includes all foods with eggs as an ingredient – cheesecake, custards, lemon meringue pie, pumpkin pie, etc. <i>Staphylococcus aureus</i> has been found under meringue when it was added to a cold filling.
Processed foods containing potentially hazardous ingredients	Includes processed meat products, sausage rolls, perogies, potato salad, mayonnaise salads and home canned antipasto and salsa, cabbage rolls, etc. Foods that have been processed and contain moisture are considered potentially hazardous and are more at risk from the growth of pathogens. The only exception is commercially canned potentially hazardous foods as they are sterilized during the commercial canning process.
Gravies, sauces, cream based soups	These low acid, moist, protein foods support the growth of disease causing organisms.
Cooked fruits, vegetables and cereals	Will support bacterial growth after cooking.

Some regional health authorities require that potentially hazardous foods sold at Alberta Approved Farmers' Markets be prepared in a facility permitted by the local health authority. Contact the public health inspector responsible for the specific Alberta Approved Farmers' Market for details.

Numerous hazards are associated with handling potentially hazardous foods, therefore:

- They must be refrigerated or frozen at all times
- They must be handled with considerable care since the potential for cross contamination with other products is greater
- When sampling these products, the length of time the samples are at room temperature must be carefully monitored so that the time/temperature rule is not abused

Potentially hazardous foods may be allowed for sale at some market venues and not others. It's important to check with the regional health authority responsible for each of your markets to determine their policy on selling potentially hazardous foods.



For more information on the regulations that pertain to selling food see Chapter 5: It's The Law and Chapter 6: It's the Law II.

Factors Contributing to Foodborne Illness

As you learned in Chapter 3: Bad Bugs, pathogenic bacteria are the most important biological foodborne hazard for you because they create the most serious problems.

Pathogens are disease causing microorganisms. The term bacterial or pathogenic growth means the organisms are multiplying and increasing in number. Pathogens thrive in warm, moist foods and can double their number every 20 minutes. A single pathogenic bacterium can multiply to more than 2 million in seven hours when the temperature is between 35°C and 45°C. The presence of pathogenic microorganisms usually does not change the look, smell or taste of food.

Table 5.2 Bacteria Growth Over Time

Time (hours)	Number of Bacteria
0.5	2
1.0	4
1.5	8
2.0	16
2.5	32
3.0	64
3.5	128
4.0	256
4.5	512
5.0	1024
5.5	2048
6.0	4096
6.5	8192
7.0	16 384
7.5	32 768
8.0	65 536
8.5	131 072
9.0	262 144
9.5	524 288
10.0	1 048 576

Table 5.2 illustrates the rapid growth of microorganisms. Within ten hours, two bacteria can develop into 1,048,576 – more than enough to cause foodborne illness.

Bacterial growth – an increase in the number of bacteria through division. Pathogens thrive in warm, moist foods and can double their number as quickly as every 20 minutes. A single pathogenic bacterium can multiply to more than 2 million in seven hours when the temperature is between 35°C and 45°C.

FAT TOM Grows Pathogens

Potentially hazardous foods held at warm temperatures provide ideal conditions for pathogen growth. They provide the nutrients as well as the low acid, oxygen rich, warm, moist environment that the pathogenic bacteria need. These conditions that pathogens require to grow are commonly referred to by the acronym FAT TOM which stands for: **F**ood, **A**cid, **T**ime, **T**emperature, **O**xygen and **M**oisture. Remove one or more of these factors and pathogen growth is significantly slowed or suspended.

Pathogens require several conditions to grow. They need a **F**ood source such as potentially hazardous or perishable foods. These foods contain the nutrients pathogens require to multiply.

Adequate Acidity or pH is critical. Microbes prefer neutral or slightly acid conditions. Pickling reduces the pH to a level unacceptable for microbial growth.

Pathogens need enough **T**ime to reproduce. The presence of a single bacterium will not make you ill. There needs to be a sufficient number of microorganisms present, the threshold level, in food to cause food poisoning.

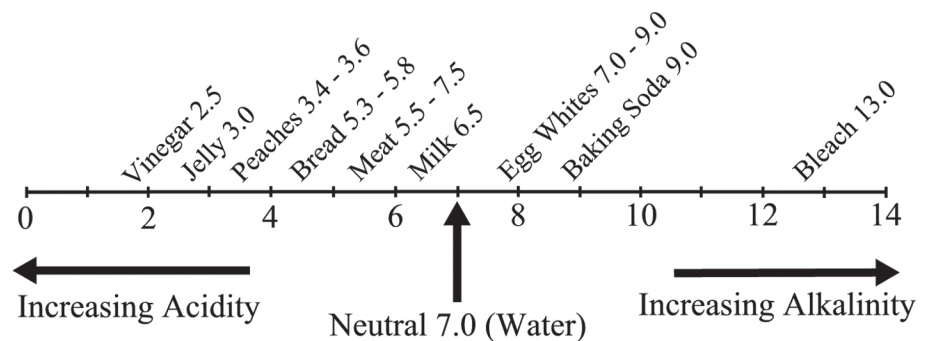


Figure 5.1 **pH Scale Showing the pH Levels of Some Common Foods**

Warm **T**emperatures are preferred. The danger zone includes those temperatures between 4°C and 60°C because at these temperatures pathogens grow and multiply rapidly. Failure to thaw frozen potentially hazardous foods at refrigerator temperatures, thoroughly cook potentially hazardous foods, cool cooked foods quickly and hold hot foods above 60°C or cold foods below 4°C are major causes of foodborne illness due to temperature abuse.

Most pathogens need sufficient **Oxygen**. Replacing oxygen with a vacuum or another gas stops the growth of many bacteria. However, a few such as the bacteria that cause botulism grow in the absence of oxygen.

Moisture is crucial. Microbes need moisture to absorb nourishment. The amount of water available to pathogens is known as water activity (A_w). The lower the water activity, the drier the food. Without an adequate supply of moisture, pathogens will not reproduce. Bacteria can grow in fluid milk but cannot grow in powdered milk because of its lower water activity. Drying food is one way to stop microbial growth. Dry herbs will last for months in the cupboard whereas fresh herbs will begin to deteriorate in days, even in the refrigerator. The high sugar content of jams and jellies ties up available moisture in these foods, thus limiting bacterial growth.

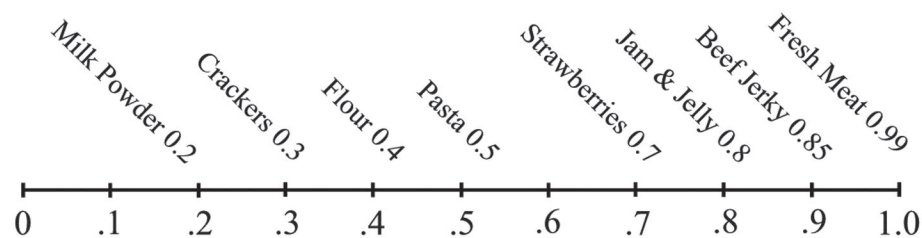


Figure 5.2 **Water Activity Scale Depicting the A_w of Some Common Foods**

pH – scale by which the acidity and/or alkalinity of a food is measured. The lower the pH number, the more acid is in the product. pH values range from 0 to 14. Potentially hazardous foods have a pH greater than 4.6 which favors growth of food poisoning organisms. The value for pure distilled water is 7, which is considered neutral.

Water activity – the amount of free water in the food that is available to pathogens. It is denoted by the symbol A_w . Pure water has a water activity of 1.0.

Table 5.3 **FAT TOM**

Food	All organisms need a source of energy to grow
Acidity	Pathogens grow in pH ranging from 4.6 to 9.0; very acid (sour) foods discourage bacterial growth
Time	Bacteria can double in number every 15 to 20 minutes
Temperature	The <i>Danger Zone</i> is 4°C - 60°C as pathogens grow fastest at these temperatures
Oxygen	The presence or absence of oxygen limits bacterial growth. Anaerobic bacteria cannot grow in the presence of oxygen while aerobic bacteria require oxygen to multiply
Moisture	As water becomes unavailable, bacteria cease to grow

Factors required for the growth of pathogens:

Food

Acidity

Time

Temperature

Oxygen

Moisture

These factors are necessary for bacterial growth. Eliminate one or more of these conditions and you can control pathogen growth.

Each food has its own pH or acidity. Within a food category such as fruit and specific food type, for instance lemons, there are pH ranges. Depending on the variety, lemons usually have a pH ranging from 2.0 to 2.2 while other fruits might have a pH closer to 5.0. Antipasto and salsas are categorized as potentially hazardous because the pH of the finished product is not in the low acid range even though these products contain higher acid ingredients such as vinegar and tomatoes. Potato salad is considered potentially hazardous for the same reason. The acidity of the commercial mayonnaise is not sufficient to bring the pH of the potato salad below 4.6.

Table 5.4 pH of Some Common Foods

pH	Food	Acidity
2.2	Lemons, limes and their juices	ACIDIC
3.5	Raspberries, strawberries	
4.0	Commercial mayonnaise, yogurt, jams, jellies, syrups, salad dressings	
5.0	Cheese, buttermilk	Pathogens grow best at pH levels above 4.6
5.5	Most vegetables, chili, bread	
6.3	Most meat, poultry, fish, butter	
6.4	Egg yolk	
7.0	Distilled water, milk, shrimp	NEUTRAL
8.5	Egg white, black olives	
10.5	Milk of magnesia	ALKALINE
13.0	Strong detergents, strippers	

Potentially hazardous foods such as meat, fish, poultry and dairy products are the most common sources of foodborne illness. Bacteria found on the animals and in their digestive tract can be transferred to the food products during slaughter and processing. Animal products are also rich in protein which is an important nutrient source for some bacteria. It **must** always be assumed that raw, potentially hazardous foods are contaminated with pathogens or disease causing microorganisms. The control of these pathogens usually occurs when the potentially hazardous foods are heat treated by cooking or pasteurization.

*Hazard + Right Conditions
= Foodborne Illness*

The danger zone represents the temperature range, from 4°C to 60°C, at which bacteria multiply rapidly. Foods should not be allowed to stay in this temperature zone for more than 2 hours.

The Danger Zone

As the number of pathogenic bacteria in the food increases, the risk of illness increases. Some of the bacteria may produce a toxin that if eaten can cause foodborne illness. Preventing pathogens from growing is a critical step in reducing the risk of foodborne illness.

The most powerful measure to inhibit growth of microbes is to control temperature. Usually this is done through proper refrigeration and cooking of potentially hazardous foods. Most pathogens are destroyed if the food reaches a high temperature for an adequate period of time which is generally one minute at 100°C. The centre of the food, not just the surface, must reach these high temperatures. If lower internal temperatures are recommended, a longer holding time at that temperature is required. It's essential to use a calibrated thermometer to ensure your food is cooked to the proper internal temperature. Potentially hazardous foods must be thawed, transported and stored out of the danger zone (between 4°C and 60°C).

Refrigeration and freezing do not kill pathogens in food; they only slow or stop microbial growth. It is crucial that you cool hot foods as quickly as possible to limit the amount of time spent in the danger zone.

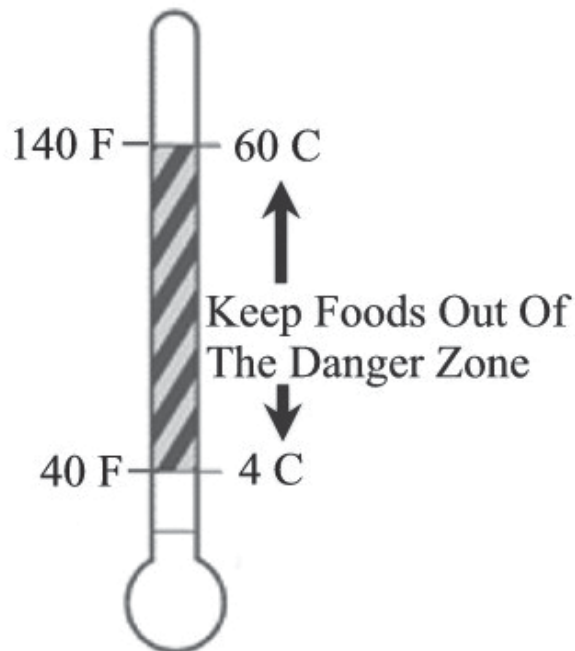


Figure 5.3 Keep Food out of the Danger Zone

Food is kept out of the danger zone temperatures to:

- Slow or stop microbial growth (4°C or colder)
- Destroy microbes present (60°C or hotter)

Time/Temperature Rule

Abuse of the time/temperature rule is the most likely condition to cause foodborne illness. Food can become unsafe quickly if held in the danger zone (above 4°C and below 60°C) for more than two hours. Remember the time food is held in the danger zone is cumulative so include all the time involved in purchasing, preparing, storing, transporting, serving and sampling your food.

You **must** store potentially hazardous foods at 4°C, displayed on ice or frozen. If potentially hazardous foods are stored on ice, ensure the temperature of the entire food item is below 4°C. Potentially hazardous foods intended for sampling may be held at room temperature but for no more than two hours, after which you **must** discard the samples.



It is important that freezers and refrigeration units are equipped with an accurate thermometer and the thermometer be calibrated as recommended. For more information see Chapter 12: Equipment.

Holding Temperatures

Freezers **must** operate at -18°C to ensure that the food is kept frozen. Refrigerators and coolers **must** be able to keep food out of the danger zone (4°C or below).

Use equipment with an accurate thermometer such as an electric fry pan, oven or toaster oven to cook and reheat food. Whole cuts of meat such as roasts, whole chickens or turkeys should be cooked at an oven temperature not less than 350°F in a conventional oven and 325°F in a convection oven. Cook poultry to an internal temperature of 74°C; all other meats should reach 71°C. Always reheat potentially hazardous food to a minimum temperature of 74°C. Once reheated, hot foods may be held at 60°C.

Refrigeration or freezing do not kill the pathogens that are present in food.

Following simple food preparation best practices will help you prevent foodborne illness:

- *Cook products using the proper time/temperature combination*
- *Rapidly cool cooked food to 4°C*
- *Maintain proper temperatures*

Talk to your public health inspector about hot holding at the market. The potential for growth of pathogenic bacteria is greater in reheated foods than in raw foods.

Temperature Control:

- **Hot holding: 60°C or hotter**
- **Freezing: -18°C or colder**
- **Refrigeration: 4°C or colder**

Is hot holding allowed at your Alberta Approved Farmers' Market?

If you are considering hot holding potentially hazardous foods at the farmers' market for sampling throughout the market day, check with your public health inspector first. Some regional health authorities do not allow hot holding. If it is allowed, follow the Food Retail and Foodservices Code requirement which states that, "potentially hazardous foods that have been cooked, then cooled to 4°C must be reheated to 74°C or higher in a manner that they will pass through the danger zone, 4°C to 60°C, as quickly as possible."

Reheated foods have a higher food safety risk because the potential for growth of pathogenic bacteria is greater in reheated foods than in raw foods. This is because spoilage bacteria, which inhibit the growth of pathogens by competition on raw products, are killed during cooking. Subsequent recontamination will allow pathogens to grow without competition if temperature abuse occurs.

Use a calibrated thermometer to monitor correct temperatures. Make sure thermometers are used in the proper spot such as inserted in the thickest part of the food. Take the temperature in several different places to ensure the entire food is heated thoroughly.

Food Storage

Once cooked, food must be cooled rapidly so it moves through the danger zone quickly. Remember, pathogens grow best at those temperatures between 4°C to 60°C. Potentially hazardous foods left at room temperatures for more than two hours provides the ideal conditions for microorganisms to multiply rapidly.



Proper food handling and food storage are key components of keeping food safe at the market. For more information see Chapter 10: Storage and Chapter 14: Food Handling.



Word Scramble

Complete the word scramble below to help you review the principles in this chapter. You will find the answers at the end of this chapter.

rhlbepeias	-----	1) Foods that have a shelf life of less than 90 days at room temperature
negthoap	-----	2) Disease causing life form that is too small to be seen by the naked eye
netolpaityl sdrazauoh oodf	----- ----- -----	3) Foods capable of supporting rapid and progressive growth of pathogenic microorganisms
ourf ot yxist	----- -- -----	4) Danger zone temperatures in degrees Celsius
meit	-----	5) A very important factor to consider when potentially hazardous foods are held at room temperature
iprad lgoconi	----- -----	6) When cooling hot food this can be done to help keep the food safe
ameptrurete nloortc	----- -----	7) A very important aspect of food safety, especially when storing and transporting potentially hazardous foods
arilonge lhteha tyhrotuai	----- ----- -----	8) All managers of farmers' markets should check with this authority to ensure that provincial regulations are being adhered to
siytx	-----	9) Hot food must be held at or above this temperature

Foodborne illness is preventable. You have a responsibility to ensure that your food is as safe as possible.

Preventing Foodborne Illness is Your Responsibility

Preventing foodborne illness is everyone's responsibility. It is estimated that 60 percent of foodborne illnesses may occur because of improper food handling by the consumer at home, so it's important that you provide your customers with information on transporting, handling and preparing their food purchases safely.

You might be thinking "No one has ever become sick on my food. I don't need to worry." Unfortunately, past performance is no guarantee that an incident won't happen in the future. How certain are you that you are doing everything you can to ensure the safety of your products and your market operation?

It is not the role of the public health inspector, Alberta Health and Wellness, Alberta Agriculture, Food and Rural Development or the Canadian Food Inspection Agency staff to prevent foodborne illness. They enforce the legislation that is in place to reduce the risk of a foodborne illness outbreak. They can help you identify and reduce food safety risks in your operation and food handling practices but ultimately *you* are responsible for marketing food safely.

Summary

The primary factors that promote the growth of pathogens and lead to foodborne illness are FAT TOM – a Food source, adequate Acidity, sufficient Time, warm Temperature, presence or absence of Oxygen and enough Moisture. Remove one or more of the conditions and pathogen growth is significantly slowed or suspended.

Most microbes multiply quickly under the right conditions. The longer potentially hazardous foods remain in the danger zone (4°C to 60°C), the greater the possibility that a food safety problem may occur.

You can prevent most foodborne illnesses by keeping potentially hazardous foods out of the danger zone and eliminating the FAT TOM factors that favor pathogen growth.

"I've had a long standing relationship with the same three inspectors over 15 years. They tell me what they need and I try to comply. I don't question what they tell me nor am I confrontational in any way. They are there to help us." Jackie Lacey, Millarville Farmers' Market

Market Manager Responsibilities

As a manager of an Alberta Approved Farmers' Market, you are responsible for the safety of the food sold at your market. You need to take measures to prevent food safety problems at your market.

Build a good working relationship with your public health inspector. Talk to the inspector on a regular basis and get to know new ones as soon as they are assigned to your market. Walk through the market with them and ask them to help you identify and reduce food safety risks in your market. Make sure your vendors understand and implement food safety best practices in their market operations. Remind them to use the Market Start Up and Weekly Food Safety Checklists for Market Vendors to identify areas requiring improvement.

In the words of a manager at an Alberta Approved Farmers' Market, "The manager needs to create and develop a strong cooperative and positive relationship between the regional health authority and the market. He needs a good understanding of the food regulations and legislative requirements. She should educate the vendors about the regulations and suggest actions for compliance where required. He should include these requirements in the general policies of the market and work with the committees of the market to make sure these standards are followed. Finally, the manager must police the implementation of market policies."



The Food Safety Checklist series for farmers' market vendors and managers can be found in Appendix M. Tear pads of the weekly and startup *Checklists* may be ordered from the AAFRD Farmers' Market Specialist. Call (780) 427-4514 to order. Dial 310-0000 for toll free access.

"As soon as I got the Food Safety Checklists I made sure each of my vendors had one. I told them that as an Alberta Approved Farmers' Market it's very important that we keep up the good reputation that the market has. We work together. My vendors use their checklists and when I go through the market with my own checklist, I help them as well." Sonia Meyer, Lethbridge Farmers' Market

What's Next

Do milk and farm cream sold from the farm or at a farmers' market need to be pasteurized? Do you as a farmers' market vendor need a food establishment permit? Ignorance is no excuse when it comes to food safety. Regulations are in place to reduce the risk of a foodborne illness outbreak. Do you know and follow the regulations for all your market practices? Turn to Chapter 6: It's the Law and Chapter 7: It's the Law II to answer these questions and more.



Resources

If you need more information or have food safety questions about this chapter contact:

Safe Food Systems
Agri-Food Systems Branch, Food Safety Division
Alberta Agriculture, Food and Rural Development
Phone: (780) 427-4054. Dial 310-0000 first for toll free access.

Answers to Word Scramble Exercise

- 1) Perishable
- 2) Pathogen
- 3) Potentially hazardous food
- 4) Four to sixty
- 5) Time
- 6) Rapid cooling
- 7) Temperature control
- 8) Regional health authority
- 9) Sixty



Chapter Review

Take a few minutes to review the chapter and answer True or False to the following statements.

1. The presence of pathogenic microorganisms changes the look, smell and taste of the food. _____
2. “Potentially hazardous” means any food that is capable of supporting the growth of pathogenic microorganisms or the production of toxins. _____
3. All pathogens require oxygen for growth. _____
4. Refrigeration kills pathogens. _____
5. A farmers’ market manager has no responsibility for the safety of the food at the market. _____
6. Food kept at temperatures from 4°C to 60°C is in the danger zone. _____

Answers to Chapter Review

- 1) **False**, pathogens have no effect on the appearance, taste, or smell of food. This is caused by spoilage organisms which affect quality not safety
- 2) **True**
- 3) **False**, the organism that causes botulism does not require oxygen to grow
- 4) **False**, refrigeration and freezing suspend or stop the growth of pathogens. The pathogens are still alive and will continue to grow again under the right temperature
- 5) **False**, the market manager has the responsibility to monitor vendors to ensure they are adhering to the legislation and handling foods safely
- 6) **True**