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## **The Flow of Food: An Introduction**

# University Outbreak

An outbreak of *Salmonella* sickened 32 visitors to a university located in the northeastern United States. The sickened guests had attended a luncheon during graduation weekend. Reports of illness flooded the local media, the university's on-campus clinic, and the local regulatory authority. Symptoms included stomach pain, nausea, diarrhea, chills, and vomiting.

It was determined that a new food handler at the dining facility had cross-contaminated romaine lettuce used for a chicken Caesar salad served at the luncheon. In her haste to catch up during a busy shift, the food handler chopped the lettuce on a cutting board that had been used to prep raw chicken for the salad. The cutting board had not been cleaned and sanitized between uses.

The university's contractor for foodservice announced that they would work closely with the local inspector to correct the problem. They would also immediately implement a program and provide training that would prevent cross-contamination in the future.

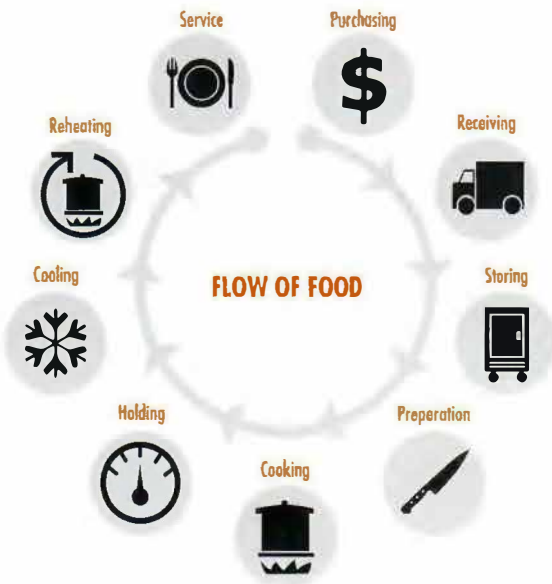
## You Can Prevent This

As you can see in the story above, preventing cross-contamination is critical for keeping food safe. But you must also control time and temperature when handling food. In this chapter, you will learn some general practices for keeping food safe throughout the flow of food in your operation. You will also learn about some tools to help with this.

## Study Questions

- How can you prevent cross-contamination?
- How can you prevent time-temperature abuse?
- What is the correct way to use and maintain thermometers?





## Hazards in the Flow of Food

To keep food safe, you must apply what you learn in the ServSafe program throughout the **flow of food**. This is the path that food takes through your operation, as shown in the image at left. It begins when you buy the food and ends when you serve it. Detailed practices for each phase are covered in later chapters.

You are responsible for the safety of the food at every point in this flow—and many things can happen to it.

For example, a frozen food might be safe when it leaves the processor's plant. However, on the way to the supplier's warehouse, the food might thaw. Once in your operation, the food might not be stored correctly, or it might not be cooked to the correct internal temperature. These mistakes can add up and cause a foodborne illness. That is why it is important to understand how to prevent time-temperature abuse and cross-contamination.

## Cross-Contamination

Pathogens can move around easily in your operation. They can be spread from food or unwashed hands to prep areas, equipment, utensils, or other food.

Cross-contamination can happen at almost any point in the flow of food. When you know how and where it can happen, it is fairly easy to prevent. The most basic way is to keep raw and ready-to-eat food away from each other. Table 4.1 shows some guidelines for doing this.

## Time-Temperature Control

Most foodborne illnesses happen because TCS food has been time-temperature abused. Remember, TCS food has been time-temperature abused any time it remains between 41°F and 135°F (5°C and 57°C). This is called the temperature danger zone because pathogens grow in this range. But most pathogens grow much faster between 70°F and 125°F (21°C and 52°C). These ranges are shown in the image at left. Food is being temperature abused whenever it is handled in the following ways:

- Cooked to the wrong internal temperature
- Held at the wrong temperature
- Cooled or reheated incorrectly

The longer food stays in the temperature danger zone, the more time pathogens have to grow. To keep food safe, you must reduce the time it spends in this temperature range. If food is held in this range for four or more hours, you must throw it out.

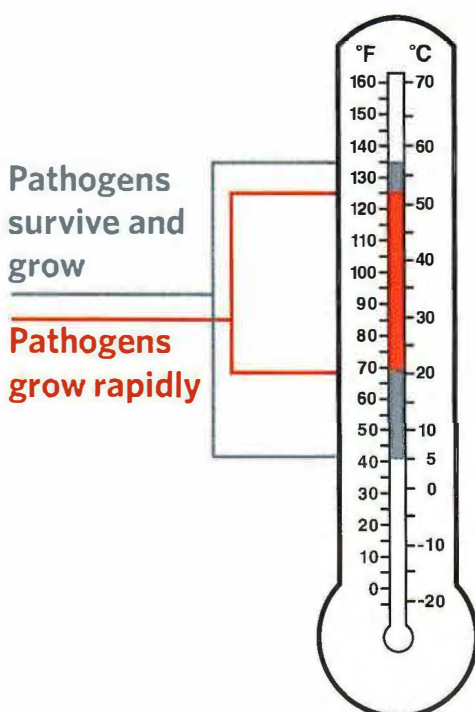


Table 4.1: Guidelines for Preventing Cross-Contamination between Food

Guideline	Description
	<p><b>Use separate equipment for raw and ready-to-eat food</b></p> <p>Each type of food should have separate equipment. For example, use one set of cutting boards, utensils, and containers for raw poultry. Use another set for raw meat. Use a third set for produce.</p> <p>Colored cutting boards and utensil handles can help keep equipment separate. The color tells food handlers which equipment to use with each food item. You might use yellow for raw chicken, red for raw meat, and green for produce.</p>
	<p><b>Clean and sanitize before and after tasks</b></p> <p>Clean and sanitize all work surfaces, equipment, and utensils before and after each task. When you cut up raw chicken, for example, you cannot get by with just rinsing the equipment. Pathogens such as nontyphoidal <i>Salmonella</i> can contaminate food through cross-contamination. To prevent this, you must wash, rinse, and sanitize equipment. See chapter 10 for more information on cleaning and sanitizing.</p>
	<p><b>Prep raw and ready-to-eat food at different times</b></p> <p>If you need to use the same prep table for different types of food, prep raw meat, fish, and poultry at a different time than ready-to-eat food. You must clean and sanitize work surfaces and utensils between each type of food. Also, by prepping ready-to-eat food before raw food, you can reduce the chance for cross-contamination.</p>
	<p><b>Buy prepared food</b></p> <p>Buy food that does not require much prepping or handling. For example, you could buy precooked chicken breasts or chopped lettuce.</p>



Food handlers should avoid time-temperature abuse by following good policies and procedures. These should address the areas in Table 4.2.

Table 4.2: Avoiding Time-Temperature Abuse

Guideline	Description
	<p><b>Monitoring</b></p> <p>Learn which food items should be checked, how often, and by whom. Make sure food handlers understand what to do, how to do it, and why it is important.</p>
	<p><b>Tools</b></p> <p>Make sure the correct kinds of thermometers are available. Give food handlers their own thermometers. Have them use timers in prep areas to check how long food is in the temperature danger zone.</p>
	<p><b>Recording</b></p> <p>Have food handlers record temperatures regularly. Make sure they write down when the temperatures were taken. Print simple forms for recording this information. Post them on clipboards outside of coolers and freezers, near prep areas, and next to cooking and holding equipment.</p>
	<p><b>Time and temperature control</b></p> <p>Have procedures to limit the time TCS food spends in the temperature danger zone. This might include limiting the amount of food that can be removed from a cooler when prepping the food.</p>
	<p><b>Corrective actions</b></p> <p>Make sure food handlers know what to do when time and temperature standards are not met. For example, if you hold soup on a steam table and its temperature falls below 135°F (57°C) after two hours, you might reheat it to the correct temperature or throw it out.</p>

## Something to Think About

A *Salmonella* outbreak linked to pastries claimed the lives of two people and sickened dozens of others. The bakery that made the pastries was cited for many violations during the investigation. One was for leaving a 5-gallon bucket of pastry cream to cool at room temperature. This kept the cream in the temperature danger zone for hours. Workers also stored ready-to-eat pastry shells in used egg crates. The egg crates later tested positive for *Salmonella*.

## Apply Your Knowledge

**An Ounce of Prevention** Write an X next to the practice if it helps prevent cross-contamination.

- 1 \_\_\_\_\_ Use separate cutting boards for prepping raw meat and raw vegetables.
- 2 \_\_\_\_\_ Wash and rinse a cutting board after prepping raw fish.
- 3 \_\_\_\_\_ Buy diced onions instead of dicing them in the operation.
- 4 \_\_\_\_\_ Prep salads before prepping raw meat on the same prep table.
- 5 \_\_\_\_\_ Use green-handled knives to prep produce and yellow-handled knives to prep raw poultry.
- 6 \_\_\_\_\_ Wipe down prep tables with a wiping cloth between different tasks.
- 7 \_\_\_\_\_ Cook chicken in-house instead of buying precooked chicken.

For answers, please turn to page 4.16.

## Apply Your Knowledge

**Is It Safe?** Read each story and decide if the food handler handled the food safely. Explain why or why not in the space provided.

- 1** Leah had to prepare six chicken salad sandwiches. She went to the cooler and pulled out a large hotel pan of chicken salad and put it on the prep table. She was interrupted several times to help with other tasks. After assembling the sandwiches, she covered the pan of chicken salad, dated it, and put it back in the cooler.

**Did Leah handle the food safely? Why or why not?**

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- 2** Greg filleted raw salmon on a cutting board on the prep table. Then he washed and rinsed the table and equipment he used. After that, he sliced onions and peppers on the same cutting board on the prep table. Before he left for the day, he washed, rinsed, and sanitized the prep table and equipment.

**Did Greg handle the food safely? Why or why not?**

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For answers, please turn to page 4.16.

## Monitoring Time and Temperature

To keep food safe, you must control the amount of time it spends in the temperature danger zone. This requires monitoring. The most important tool you have to monitor temperature is the thermometer. Three types are commonly used in operations:

- Bimetallic stemmed thermometers
- Thermocouples
- Thermistors



## Bimetallic Stemmed Thermometer

A bimetallic stemmed thermometer, shown in the photo at right, can check temperatures from 0°F to 220°F (–18°C to 104°C). This makes it useful for checking temperatures during the flow of food. For example, you can use it to check food temperatures during receiving. You can also use it to check food in a hot- or cold-holding unit.

A bimetallic stemmed thermometer measures temperature through its metal stem. When checking temperatures, insert the stem into the food up to the dimple. You must do this because the sensing area of the thermometer goes from the tip of the stem to the dimple. This trait makes this thermometer useful for checking the temperature of large or thick food. It is usually not practical for thin food, such as hamburger patties.

If you buy these thermometers for your operation, make sure they have these features.

**Calibration nut** You can adjust the thermometer to make it accurate by using its calibration nut.

**Easy-to-read markings** Clear markings reduce the chance that someone will misread the thermometer. The thermometer must be scaled in at least two-degree increments.

**Dimple** The dimple is the mark on the stem that shows the end of the temperature-sensing area.



## Thermocouples and Thermistors

Thermocouples, such as the one in the photo at right, and thermistors are also common types of thermometers in operations. These tools are similar. The difference between them is the technology inside.

Thermocouples and thermistors measure temperatures through a metal probe. Temperatures are displayed digitally. The sensing area on thermocouples and thermistors is on the tip of their probe. This means you do not have to insert them into the food as far as bimetallic stemmed thermometers to get a correct reading. Thermocouples and thermistors are good for checking the temperature of both thick and thin food.





Thermocouples and thermistors come in several styles and sizes. Many come with different types of probes. The following are some basic types.

Table 4.3: Types of Probes

	<p><b>Immersion probes</b></p> <p>Use these to check the temperature of liquids. This could include soups, sauces, and frying oil.</p>
	<p><b>Surface probes</b></p> <p>Use these to check the temperature of flat cooking equipment, such as griddles.</p>
	<p><b>Penetration probes</b></p> <p>Use these to check the internal temperature of food. They are especially useful for checking the temperature of thin food, such as hamburger patties or fish fillets.</p>
	<p><b>Air probes</b></p> <p>Use these to check the temperature inside coolers and ovens.</p>

## Infrared (Laser) Thermometers

Infrared thermometers measure the temperature of food and equipment surfaces. These thermometers are quick and easy to use.

Infrared thermometers do not need to touch a surface to check its temperature. This means there is less chance for cross-contamination and damage to food. However, these thermometers cannot measure air temperature or the internal temperature of food.

Follow these guidelines for using infrared thermometers.

**Distance** Hold the thermometer as close to the food or equipment as you can without touching it as seen in the photo on the right.

**Barriers** Remove anything between the thermometer and the food, food package, or equipment. Do **NOT** take readings through metal, such as stainless steel or aluminum. Do **NOT** take readings through glass.

**Manufacturer's directions** Always follow the manufacturer's guidelines. This should give you the most accurate readings.



## Other Temperature-Recording Devices

Other tools are available that can help you monitor temperature. A maximum registering thermometer is one type. This thermometer indicates the highest temperature reached during use and is used where temperature readings cannot be continuously observed. It works well for checking the final rinse temperature of dishwashing machines.

Some devices monitor both time and temperature. The time-temperature indicator (TTI), shown in the photo at right, is an example. These tags are attached to packaging by the supplier. A color change appears in the window if the food has been time-temperature abused during shipment or storage. This color change is not reversible, so you know if the food has been abused.

Some suppliers place temperature-recording devices inside their delivery trucks. These devices constantly check and record temperatures. You can check the device during receiving to make sure food was at safe temperatures while it was being shipped.



## General Thermometer Guidelines

You should know how to use and care for each type of thermometer in your operation. In general, follow the guidelines below. However, you should always follow manufacturers' directions.

**Cleaning and sanitizing** Thermometers must be washed, rinsed, sanitized (as seen in the photo at right), and air-dried. Keep storage cases clean, too. Do these things before and after using thermometers to prevent cross-contamination. Be sure the sanitizing solution you use is for food-contact surfaces. Always have plenty of clean and sanitized thermometers on hand.





**Calibration** Thermometers can lose their accuracy. When this happens, the thermometer must be calibrated, or adjusted, to give a correct reading. Make sure your thermometers are accurate by calibrating them regularly. Calibrate thermometers at these times:

- After they have been bumped or dropped.
- After they have been exposed to extreme temperature changes.
- Before deliveries arrive.
- Before each shift.

Keep in mind:

- Some thermometers cannot be calibrated and must be replaced.
- Others will need to be sent back to the manufacturer for calibration.
- Always follow the manufacturer's directions regarding calibration.

**Accuracy** Thermometers used to measure the temperature of food must be accurate to within  $\pm 2^{\circ}\text{F}$  or  $\pm 1^{\circ}\text{C}$ . Thermometers used to measure air temperature in food-storage equipment must be accurate to within  $\pm 3^{\circ}\text{F}$  or  $\pm 1.5^{\circ}\text{C}$ . A hanging thermometer in a walk-in cooler is an example.

**Glass thermometers** Glass thermometers, such as candy thermometers, can be a physical contaminant if they break. They can only be used when enclosed in a shatterproof casing.

**Checking temperatures** When checking the temperature of food:

- Insert the probe into the thickest part of the food, as shown in the photo at left. This is usually in the center.
- Take another reading in a different spot. The temperature may vary in different areas.

Before recording a temperature, wait for the thermometer reading to steady. While digital thermometers are capable of displaying the temperature instantly, bimetallic stemmed thermometers will take more time. Allow at least 15 seconds after you insert the thermometer stem into the food.



## Calibrating Thermometers

There are two ways to calibrate a thermometer:

- The **boiling-point method** involves adjusting the thermometer to the temperature at which water boils (212°F [100°C], depending on your elevation).
- The **ice-point method** involves adjusting the thermometer to the temperature at which water freezes (32°F [0°C]).

The ice-point method, detailed below, is easier and safer.



- 1** Fill a large container with ice. Use crushed ice if you have it. Add tap water until the container is full.

*Note: Stir the mixture well.*



- 2** Put the thermometer stem or probe into the ice water. Make sure the sensing area is submerged.

Wait 30 seconds or until the indicator stops moving.

*Note: Do not let the stem or probe touch the container.*



- 3** Adjust the thermometer so it reads 32°F (0°C).

*Note: To calibrate a bimetallic stemmed thermometer, adjust it by holding the calibration nut with a wrench or other tool.*

To calibrate a thermocouple or thermistor, follow the manufacturer's directions.

## Apply Your Knowledge

**Pick the Correct Thermometer** For each situation, choose the best thermometer or thermometers. Some thermometers may be chosen more than once. Write the letter or letters in the space provided.

- \_\_\_\_\_ Internal temperature of a fish fillet
- \_\_\_\_\_ Internal temperature of a roast
- \_\_\_\_\_ Internal temperature of fryer oil
- \_\_\_\_\_ Surface temperature of a griddle
- \_\_\_\_\_ Air temperature of a cooler

- Bimetallic stemmed thermometer
- Thermocouple with immersion probe
- Thermocouple with surface probe
- Thermocouple with penetration probe
- Thermocouple with air probe
- Infrared thermometer



## Chapter Summary

- The flow of food is the path food takes in your operation from purchasing to service. Many things can happen to food in its flow through the operation. Two major concerns are cross-contamination and time-temperature abuse.
- To prevent cross-contamination, keep ready-to-eat and raw food separated. When possible, use separate equipment for each type of food. Clean and sanitize all work surfaces, equipment, and utensils before and after each task. When separate equipment cannot be used, prep ready-to-eat food and raw meat, poultry, and fish at different times. Prepping ready-to-eat food first minimizes the chance for contamination. Similarly, you can buy food items that do not require much preparation or handling.
- Time-temperature abuse happens any time food remains between 41°F and 135°F (5°C and 57°C). This range is called the temperature danger zone. You must try to keep food out of this range.
- Have policies and procedures to avoid time-temperature abuse. They should include monitoring food and recording temperatures and times. Also make sure the correct types of thermometers are available. Use timers to check how long food is in the temperature danger zone. Make sure food handlers know what to do if time and temperature standards are not met.
- A thermometer is the most important tool you can use to prevent time-temperature abuse. Different types of thermometers are suited to different tasks. Use the correct type for the food or equipment being checked. Clean and sanitize thermometers before and after each use.
- When checking food temperatures, put the thermometer stem or probe into the thickest part of the food. Then take another reading in a different spot. Before you record the temperature, wait for the thermometer reading to steady. If using a bimetallic stemmed thermometer, put it into the food from the tip to the end of the sensing area. Never use glass thermometers with food items unless they are enclosed in a shatterproof casing.
- Thermometers should be calibrated regularly to keep them accurate. Two methods for calibrating are the ice-point method and the boiling-point method. Follow the manufacturer's directions for calibration.

## Chapter Review Case Study

To keep food safe, you must prevent cross-contamination; prevent time-temperature abuse; check food temperatures using the correct kinds of thermometers; and keep your thermometers accurate.

**Now, take what you have learned in this chapter and apply it to the following case study.**

At 6:00 a.m., Annie started her workday at The Little Bistro. After a quick meeting with the chef, her first task was to make the broccoli quiches for the lunch special. By 6:15 a.m., she had collected all the ingredients. She set salt, eggs, cream, butter, and cheese on the prep table. On her last trip to the cooler, she got the broccoli. It took over an hour to wash and chop it. Finally, Annie was able to make the quiche filling. Leaving the leftover eggs and cream on the table, she got out the premade quiche crusts from the freezer and poured the filling. By the time she got the quiches in the oven, it was 10:45 a.m.

Twenty-five minutes later, Annie checked the quiches. They were supposed to bake for around 30 minutes. However, she did not want to overcook them. The chef said their internal temperature needed to be 155°F (68°C). Annie used an infrared thermometer to check the temperature of one quiche in two places. The readings were in the correct range. She took the quiches out of the oven and set them on a table to cool.

While the quiches cooled, Annie went to work making fruit salad. She washed her hands and put on gloves. As she headed back to the prep table with the melon, strawberries, and grapes, she noticed the eggs and cream she left out. She quickly put them back in the cooler. Then she wiped down the table and started prepping the melon.

**What did Annie do wrong?**

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For answers, please turn to page 4.16.



## Study Questions

Circle the best answer to each question.

- 1 A food handler has finished trimming raw chicken on a cutting board and needs the board to prep vegetables. What must be done to the cutting board?**
  - A It must be dried with a paper towel.
  - B It must be turned over to the other side.
  - C It must be washed, rinsed, and sanitized.
  - D It must be rinsed in hot water and air-dried.
  
- 2 How far must a bimetallic stemmed thermometer be inserted into food to give an accurate reading?**
  - A Just past the tip of the thermometer stem
  - B Halfway between the tip of the thermometer stem and the dimple
  - C To the dimple in the thermometer stem
  - D Past the dimple of the thermometer stem
  
- 3 Which probe should be used to check the temperature of a chicken breast?**
  - A Air probe
  - B Immersion probe
  - C Penetration probe
  - D Surface probe
  
- 4 At what temperatures do most foodborne pathogens grow most quickly?**
  - A Between 0°F and 41°F (-17°C and 5°C)
  - B Between 45°F and 65°F (7°C and 18°C)
  - C Between 70°F and 125°F (21°C and 52°C)
  - D Between 130°F and 165°F (54°C and 74°C)
  
- 5 Which practice can help prevent time-temperature abuse?**
  - A Keeping records of employee schedules
  - B Cleaning and sanitizing equipment and work surfaces
  - C Making sure food handlers spend at least 30 seconds washing their hands
  - D Limiting the amount of food that can be removed from a cooler for prepping

## Study Questions

**6 Which thermometer is used to measure surface temperatures?**

- A Thermistor
- B Thermocouple
- C Infrared thermometer
- D Bimetallic stemmed thermometer

**7 A thermometer used to measure the temperature of food must be accurate to what temperature?**

- A  $\pm 2^{\circ}\text{F}$  or  $\pm 1^{\circ}\text{C}$
- B  $\pm 4^{\circ}\text{F}$  or  $\pm 3^{\circ}\text{C}$
- C  $\pm 6^{\circ}\text{F}$  or  $\pm 5^{\circ}\text{C}$
- D  $\pm 8^{\circ}\text{F}$  or  $\pm 7^{\circ}\text{C}$

**8 Which practice can help prevent cross-contamination?**

- A Using color-coded cutting boards
- B Rinsing cutting boards between use
- C Purchasing food requiring preparation
- D Prepping raw and ready-to-eat food at the same time

**9 What device can be used to monitor both time and temperature abuse during the shipment or storage of food?**

- A Infrared thermometer
- B Time-temperature indicator
- C Thermistor with an air probe
- D Bimetallic stemmed thermometer

**10 How long can food stay in the temperature danger zone before it must be thrown out?**

- A 1 hour
- B 2 hours
- C 3 hours
- D 4 hours

For answers, please turn to page 4.17.



# Answers

## 4.5 An Ounce of Prevention

1, 3, 4, and 5 should be marked.

## 4.6 Is It Safe?

- 1 No. Leah took out more chicken salad than she needed to make a small number of sandwiches. This exposed the chicken salad to time-temperature abuse, which was made worse by the many interruptions.
- 2 No. Greg did not sanitize the table and equipment after he filleted the salmon. The onions and peppers could have been contaminated by the salmon.

## 4.11 Pick the Correct Thermometer

- 1 A, D
- 2 A, D
- 3 B
- 4 C, F
- 5 E

## 4.13 Chapter Review Case Study

Annie did the following things wrong:

- She should have washed her hands before making the quiches.
- She left the eggs and dairy at room temperature for too long. The quiche filling was at room temperature for four hours and 30 minutes. The leftover eggs and dairy were at room temperature for five hours. She should have thrown away the leftover eggs and dairy.
- She used the wrong kind of thermometer to check the internal temperature of the quiches.
- She let the quiches cool at room temperature and did not store them correctly.
- She did not clean and sanitize the prep table after she finished preparing the quiches and before prepping the fruit.

# Answers

## 4.14 Study Questions

- 1 C
- 2 C
- 3 C
- 4 C
- 5 D
- 6 C
- 7 A
- 8 A
- 9 B
- 10 D

## Apply Your Knowledge

**Which Is It?** Write an X next to the food that needs time and temperature control to keep it safe.

1 \_\_\_\_\_ Chopped lettuce

2 \_\_\_\_\_ Sliced watermelon

3 \_\_\_\_\_ Dry rice

4 \_\_\_\_\_ Flour

5 \_\_\_\_\_ Cooked carrots

6 \_\_\_\_\_ Cheese

**Who Has a Greater Risk?** Write an X next to each group that has a higher risk of getting a foodborne illness because of their immune systems.

1 \_\_\_\_\_ School teachers

2 \_\_\_\_\_ College students

3 \_\_\_\_\_ Preschool students

4 \_\_\_\_\_ Health-care providers

5 \_\_\_\_\_ Transplant recipients

6 \_\_\_\_\_ Nursing home residents