

# Hot Off the Grill

## Grades 6-12

Science, Family and Consumer Sciences, Agriscience, Health

---



### Objectives

Students will observe the amounts of bacteria in Petri dishes inoculated with hamburger meat that has been cooked to different temperatures. They will also learn that cooking hamburgers to the recommended temperature of 160° F (71° C) will kill pathogenic bacteria.

### Vocabulary

**bacteria**—a widely distributed group of typically one celled microorganisms, many of which produce diseases. Many are active in processes of fermentation, the conversion of dead organic matter into soluble food for plants and the fixing of atmospheric nitrogen.

**contaminate**—to make impure by contact or mixture with harmful bacteria, fungi, or dangerous chemicals.

**cross-contamination**— transmitting bacteria from one thing to another.

**ground beef**—beef that has been ground

**hamburger**—a sandwich made with a patty of ground meat usually in a roll or bun.

**transmit**—to send from one person, thing, and or plant to another

### Background

About 6 million people get sick every year from eating food that is contaminated. Most food contamination can be prevented by proper food handling. One common way food is contaminated is by **cross-contamination**. If you pet the dog, then open the refrigerator and pull out a slice of bologna for a sandwich, you may **transmit** germs from the dog to the food you are about to put in your mouth. If you prepare the sandwich on a bare counter that has not been washed, you are exposing your sandwich to germs from anything that has been on the counter since the last time it was washed thoroughly. If the plate you use to hold your cooked **hamburger** is the same one you used to carry the raw patty to the grill, you may **contaminate** your burger with the same kind of bacteria you just killed by cooking it.

It's easy to avoid cross-contamination simply by washing your hands thoroughly before preparing or eating food, by washing counters often with hot, soapy water and clean wiping cloths, by keeping dishes and cooking implements clean and by storing meats and other foods that require cooking separate from fruits, vegetables and other foods that you can eat raw.

Meat, poultry and fish are not safe to eat until they have been cooked. That's because they are particularly attractive to the kind of **bacteria** that can make us sick. Bacteria growth slows down at temperatures below 40 degrees, so meats can be stored for short periods of time at that temperature, in the refrigerator, until we are ready to use them.

Cooking meat at high temperatures kills bacteria, but the meat must be cooked to the proper temperature. Steaks, chops and roasts must be cooked to at least 145°F while ground meats, like ground beef, must be reach at least 160°F or higher. Poultry and stuffing should be cooked to 165°F or higher. Ground meats require a higher minimum temperature than “whole” cuts of beef, pork or lamb because grinding distributes any bacteria that might be present throughout the meat rather than just on the surface of the meat.

## Hot Off the Grill (continued)

---

The only way to make sure meat is done all the way through is to use a meat thermometer. Color is not a good indicator of whether a hamburger is safe to eat. Research done by the U.S. Department of Agriculture shows that one out of every four hamburgers turns brown in the middle before it is safely cooked. Some **ground beef** patties look done at internal temperatures as low as 135° F (57° C). Most people are suspicious of meat that is pink, but some turkey, pork, ground beef or veal remains pink even after it has been cooked thoroughly. Meat and poultry grilled or smoked outdoors can also look pink, even when well done.

Hamburgers got their name from a village in Hamburg, Germany. They were named for a style of preparing meat which originally involved slicing the meat very, very thin and eating it raw. That practice may have been safe when the meat was prepared and eaten almost immediately after slaughtering the beef animal, but most of us eat meat that has been transported over many miles and stored in several places before it makes it to our tables, so there are many more opportunities for bacterial growth.

The ground beef we buy in the store is usually made from the less tender and less popular cuts of beef. Trimmings from more tender cuts may also be used. Grinding tenderizes the meat, and the fat reduces its dryness and improves flavor. Grinding also exposes more of the meat surface to the bacteria normally occurring in the air, on the meat, on the butcher's hands and on the cutting equipment. For that reason ground beef is more likely to be contaminated than larger cuts of meat.

Most ground beef is ground and packaged in local stores. All meat transported and sold in interstate commerce must be federally inspected. The larger cuts are usually shipped to local stores, where some of it is ground.

All meat will shrink in size and weight during cooking. The amount of shrinkage will depend on its fat and moisture content, the temperature at which the meat is cooked and how long it is cooked. The higher the cooking temperature, the greater the shrinkage.

### Additional Reading

Davidson, Marjorie, Dickerson, Louise, et. al., *Science and Our Food Supply: Investigating Food Safety from Farm to Table*, Food and Drug Administration Center for Food Safety and Applied Nutrition, 2014

University of Tennessee Institute of Agriculture, *Hands On: Real World Lessons for Middle School Classrooms - Food Safety and Instructor's Guide*, University of Tennessee, 2015

National Restaurant Association, *ServSafe Food Handler Guide*, Pearson, 2016

### Websites

<https://www.fda.gov/food/students-teachers/science-and-our-food-supply>

<https://www.fda.gov/food/science-and-our-food-supply/food-safety-z-reference-guide>

<https://www.fightbac.org/kids/>

# Hot Off the Grill

## Activity 1

## Grades 6-12 Teacher Resources and Standards

---

### Activity 1: Safe Food Handling, (Science, Family and Consumer Sciences, Agriscience, Health) 1 50 minute class period

Students will conduct experiments to determine the amount of bacteria remaining in ground beef patties cooked to different end-point temperatures.

#### Oklahoma Academic Standards

#### Activity 1: Title (Science, Family and Consumer Sciences, Agriscience, Health)

- |                |   |
|----------------|---|
| 6.LS1.1        | Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.  |
| 7.LS2.1        | Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.  |
| 8.LS4.4        | Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.                     |
| FACS 8.2.1     | Identify characteristics of major food borne pathogens, their role in causing illness, foods involved in outbreaks, and methods of prevention.  |
| FACS 8.2.7     | Demonstrate safe food handling and preparation techniques that prevent cross contamination from potentially hazardous foods, between raw and ready-to-eat foods, and between animal and fish sources and other food products. |
| FACS 8.5.4     | Apply the fundamentals of time, temperature, and cooking methods to cooking, cooling, reheating, and holding of variety of foods.   |
| FPP.02.03.01.a | Explain techniques and procedures for safe handling of food products.   |
| HEALTH 7.8.3   | Demonstrate behaviors that avoid or reduce health risks to self and others.   |

#### Materials:

- Activity 1 Information Sheet 1 “**Inoculating a Petri Dish**”
- Activity 1 Reading Page 1 “**Minimum Internal Food Temperatures**”
- Activity 1 Reading Page 2 “**Safe Food Handling**”
- Activity 1 Worksheet 1 “**Food Safety**”
- Dishwashing detergent
- Disinfecting bleach solution (1 tsp. household bleach in 1 cup of tap water)
- Alcohol wipes or cotton balls and isopropyl alcohol
- Paper towels
- 5 sterile Petri dishes with nutrient agar and covers
- Parafilm to seal dishes
- Sterile cotton swabs
- Permanent marker

# Hot Off the Grill

## Materials, continued:

- ½ pound (8 ounces) of inexpensive, ground beef, (enough to make 4 patties, approximately 2 ounces each. DO NOT USE PRE-MOLDED HAMBURGER PATTIES.)
- Ruler
- Food scale for weighing the hamburgers
- Hot plate and a regular skillet (or electric skillet)
- Non-stick spray to keep the hamburgers from sticking to the pan during cooking
- 1 digital, instant-read food thermometer (rapid-read, thin-probe type is best)
- Sharp knife
- Spatula for removing hamburgers from skillet
- Clean paper plates for cooked hamburgers

## Procedures

1. Prepare 5 sterile Petri dishes containing nutrient agar and familiarize yourself with the proper use of a food thermometer.
2. Prepare 1 hamburger patty (approximately 2 ounces) to cook as students enter the classroom.
3. As students walk into the room ask them how they like their hamburgers cooked—well done, medium, or rare?”
4. Ask for a volunteer to take a tally of the class. Ask students to explain and discuss their choices. If no one has mentioned cooking thoroughly so that “it’s safe to eat” or “so you won’t get sick,” ask, “How can you be sure that this hamburger will be safe to eat?”
5. Read and discuss background and vocabulary about food safety. Explain that most ground beef from the supermarket is safe; however, there is a remote possibility that bad bacteria, such as E. coli O157:H7, can find its way into some foods, like ground beef. Because of that possibility it is important to cook all ground meat to a safe internal temperature.
6. Explain that you will be exploring the amount of bacteria present in raw ground beef and in ground beef patties cooked to different temperatures.
7. Review Activity 1 Information Sheet 1 **“Inoculating a Petri Dish”**. Ask volunteers to assist you in labeling 5 Petri dishes:
  - control
  - raw
  - 120° F
  - 140° F
  - 160° F
8. Demonstrate how to set up a control dish.
9. Show students how to swab the raw hamburger, inoculate the “raw” dish, and seal the dish with Parafilm.
10. Discuss:
  - “What factors should be considered?” (Weight, size, thickness of hamburgers, temperature, consistency, etc.)
  - “How can we assure that all the hamburgers are the same size?” (They should be weighed.)
  - “Why?” (If the hamburgers vary in size, another variable is introduced.)
  - “Does thickness of the hamburgers matter?” (Burgers should be about ½ inch [1.3 cm] thick. It’s easier to accurately insert the thermometer in a burger of this thickness.)

# Hot Off the Grill

## Procedures, Continued

11. Demonstrate how to prepare three hamburgers—weigh and measure them to assure that they are all the same weight and thickness. Cook one hamburger to 120° F (49° C).  
Discuss:  
— “Why is it important to take the hamburger out of the pan to measure the temperature?” (The heat from the pan will interfere with getting an accurate temperature reading of the inside of the hamburger.)  
—“How should you take the temperature?” (Take the temperature through the side and into the center, making sure the temperature probe reaches the center of the burger, not just the outer edge. Follow the instructions on the thermometer package.)
12. Clean the thermometer with alcohol after every temperature reading.  
Discuss:  
—“Why is this necessary? (If there are bacteria in the meat, they might get onto the thermometer and be transferred to the next hamburger you’re cooking.) This is called ‘cross-contamination’.”
13. When the hamburger has reached 120° F (49° C), break it in half and demonstrate how to swab the inside.  
—Ask, “Why do you break it rather than cut it in this scientific test?” (The knife might have bacteria on it and you might transfer that bacteria into the hamburger.)
14. Have a volunteer swab inside the broken edge of the hamburger and inoculate the “120° F” dish. Seal the dish with Parafilm.
15. Cook the two remaining hamburgers: one to 140° F (60° C) and the other to 160° F (71° C).
16. Volunteers will inoculate the dishes after each hamburger has reached the desired temperature. Seal the dishes with Parafilm.
17. Place the inoculated Petri dishes in the incubator at 95° F (35° C) for 1 to 2 days, or let them sit at room temperature for the appropriate amount of time.
18. Distribute Activity 1 Reading Page 1 “**Minimum Internal Food Temperatures**”.
19. —Discuss how the information of the reading page relates to the experiment.
20. —Encourage students to predict what will happen in the Petri dishes.
21. After the Petri dishes have set for a day or two, students will observe, record, and report bacterial numbers in the four samples.
22. Discuss:  
—“Which temperature produced the most effective results in reducing bacterial numbers?” (The temperature of 160° F [71° C] should show the best results. This is the recommended temperature for safely cooking ground meat.)  
—“How did the amount of bacteria in the raw hamburger compare to the cooked burgers?” (The raw hamburger will have much more bacteria than any of the cooked hamburgers.)  
—“What did your control show?”
23. Hand out Activity 1 Reading Page “**Safe Food Handling**”. Have student read and discuss the information in small groups.
24. Use Activity 1 Worksheet 1 “**Food Safety**” to evaluate student learning.

Activity adapted from *The Science and Our Food Supply Curriculum*, US Food and Drug Administration Center for Food Safety and Applied Nutrition and the National Science Teachers Association.

These general guidelines should be followed anytime you culture a substance in a Petri Dish:

1. Label each Petri dish  
—Divide the Petri dish into sections (if applicable), and label the bottom (agar side) of the dish using a permanent marker.  
—Label along the outer edges of the dish or the sections, so the labels don't interfere with viewing the colonies.



2. Inoculate  
—Use a sterile cotton swab\* to wipe the surface or liquid being tested. Hold the cotton swab at one end — do not touch the end that will be used to inoculate the agar.  
\* If you use a control dish, new, untouched cotton swabs are good to use. Inoculate the control dish with a new swab to check for any microbial contamination.

### For a Dry Surface

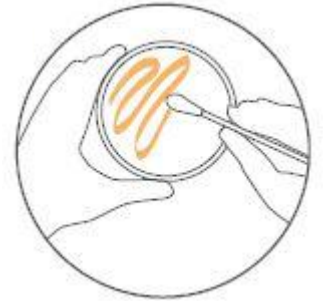
—Wet the swab by dipping it in boiled or sterile water. Then, wring out the swab by wiping it against the inside of the container. (If the swab is too wet, the liquid will flow into other sections and the microbial colonies will run into each other.)

—Swab the dry surface.

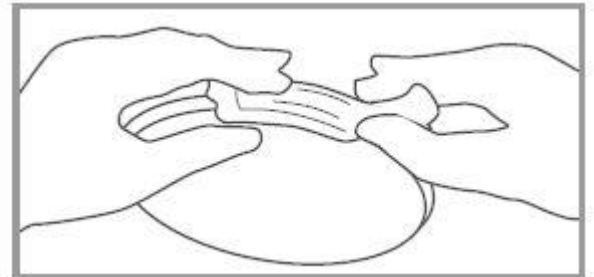
### For a Liquid

—Dip the sterile cotton swab in the liquid. Then, wring out the swab by wiping it against the inside of the container.

—Inoculate the nutrient agar using a back-and-forth motion, covering the entire area of the dish or section.



3. Parafilm  
Place the cover on the Petri dish and seal it closed using Parafilm.  
—Cut a narrow strip and stretch it around the outside edge (along the full circle perimeter) of the covered dish.



4. Incubate  
—Place dishes upside down (label side up) in an incubator set at 95° F (35° C) or let the dishes sit at room temperature (away from the sun) for the appropriate amount of time.

### For Viewing Inoculated Petri Dishes

Use a light box if available

—Line up all the Petri dishes and compare the results.

Use an overhead projector

—Line up the Petri dishes on the projector and project onto a screen, so the entire class can view the results.

If neither a light box nor overhead projector is available, simply view the dishes on a light-colored surface or a piece of white poster board.

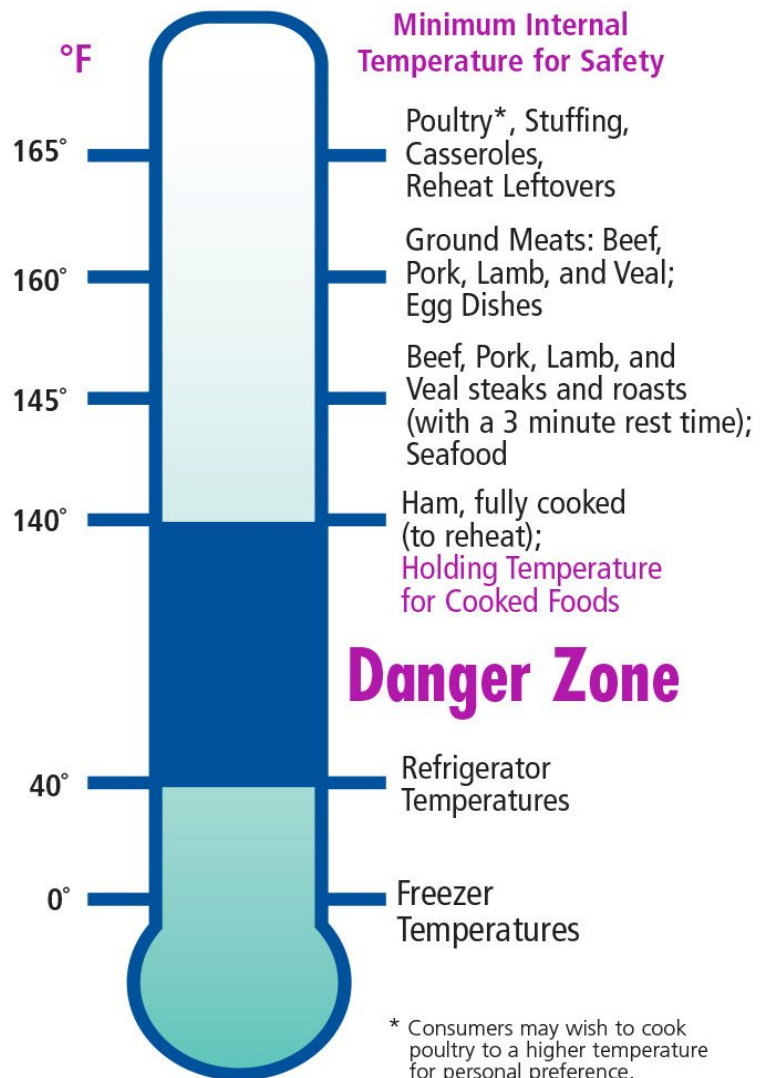
The chart to the right shows minimum internal temperatures for a variety of foods. Notice that ground meats must be cooked to a higher temperature than “whole” cuts like steaks, chops and roasts.

It's important to cook ground meats such as hamburger thoroughly, because there's a greater chance for bacterial contamination. The bacteria start out on the outside of the meat. When the meat is ground, any bacteria that were originally on the outside can be distributed throughout the hamburger. In addition, when making patties, harmful bacteria from hands, utensils, and surfaces can be transferred to the inside of the hamburger patty.

It's important to make sure that the internal temperature of the hamburger has reached a safe internal temperature (160° F [71° C]) to kill any foodborne pathogens that might be present.



## Apply the Heat Chart



An “instant-read” food thermometer with a probe in the tip is best for checking the proper temperature of hamburgers. The probe should be inserted in the side of the burger, so the entire sensing area (usually 2 to 3 inches [5 to 8 cm]) is positioned into the center of the burger.

It may not always be possible to check the hamburger with a thermometer – for example, when you're eating in a restaurant. In this case, the safest thing is to ask for the hamburger to be cooked to a temperature of 160° F or well done. Send it back if it's pink in the middle, although keep in mind that the color of the meat is not an accurate indicator of whether it reached a safe temperature

The United States has one of the safest food supplies in the world. From the farm to the grocery store, there are many “quality control points” that insure that the food on our table is as safe and wholesome as possible.

Once we pick up a food package in the store, it becomes our responsibility to keep it safe for our families.

### At the Store:

- Check “use by” or “sell by” dates on all perishable foods
- Put raw meat and poultry packages in the plastic bags provided at most meat counters to be sure juice does not drip on other foods in your cart.
- Shop for cold and frozen foods last.
- Use a cooler or ice chest for the ride home - especially if you are running other errands or the weather is warm.
- Be sure to get cold foods home and in the refrigerator or freezer in two hours or less.



### At Home

- Always wash your hands in hot, soapy water before preparing and after handling raw meat, poultry, seafood or eggs.
- Cook all meat and poultry—or casseroles that contain meat or poultry—at a minimum oven temperature of 325°F.
- Cook meats to the recommended minimum temperature.
- Keep your refrigerator at no warmer than 40°F. and your freezer at 0°F.
- Store fresh fruits and vegetables on higher shelves and raw meats on lower shelves in refrigerator to avoid cross contamination.
- Store or thaw meats in a pan or tray with sides to contain any juice that might leak.
- Don't store raw fish in your refrigerator for more than 24 hours. Raw poultry or ground beef will keep for one to two days and larger cuts like raw steaks, roasts and chops for three to five days.
- Thaw frozen food in the fridge or in a microwave, not at room temperature.
- Never put cooked food on the plate used when it was raw.
- To keep bacteria from growing, put your sponge or scouring pad in the dishwasher every time you run it.



# Hot Off the Grill

## Activity 1 Worksheet 1: Food Safety



Name: \_\_\_\_\_ Date: \_\_\_\_\_

---

Using the information from Activity 1, Reading Page 1 “**Minimum Internal Food Temperatures**” and Activity 1 Reading Page 2 “**Safe Food Handling**”, answer the questions below:

1. Name one way you can be sure you select safe and wholesome food at the store?

\_\_\_\_\_

2. How can you prevent cross-contamination in the grocery cart?

\_\_\_\_\_

3. What can you do to keep cold foods safe until you get home from the store?

\_\_\_\_\_

4. What should you do before handling food at home?

\_\_\_\_\_

\_\_\_\_\_

5. Where should meats be stored in relation to fruits and vegetables in the refrigerator? \_\_\_\_\_

6. What method can you use to limit the spread of juice that leaks from a meat package in the refrigerator? \_\_\_\_\_

\_\_\_\_\_

7. If you grilled hamburgers and then put the cooked burgers back on the plate that held the raw patties, you could contaminate the cooked food by:

\_\_\_\_\_

8. Why should ground meat be cooked to a higher internal temperature than steaks, chops or roasts? \_\_\_\_\_

\_\_\_\_\_

9. The best way to be sure meat is cooked to a safe temperature is to use a

\_\_\_\_\_

# Hot Off the Grill

## Activity 1 Worksheet 1: Food Safety

### ANSWER KEY



Name: \_\_\_\_\_ Date: \_\_\_\_\_

---

Using the information from Activity 1, Reading Page 1 “**Minimum Internal Food Temperatures**” and Activity 1 Reading Page 2 “**Safe Food Handling**”, answer the questions below:

1. Name one way you can be sure you select safe and wholesome food at the store?  
Check the “use by” or “sell by” dates on fresh food before buying
2. How can you prevent cross-contamination in the grocery cart?  
Place meat, poultry and fish packages in plastic bags before putting them in cart
3. What can you do to keep cold foods safe until you get home from the store?  
Pick up cold foods last in the store and put them in a cooler for the trip home
4. What should you do before handling food at home?  
Wash hands with hot, soapy water before preparing and after handling raw meat, poultry, seafood or eggs
5. Where should meats be stored in relation to fruits and vegetables in the refrigerator?  
Meats should be stored on a lower shelf than fruits and vegetables
6. What method can you use to limit the spread of juice that leaks from a meat package in the refrigerator?  
The package can be put in a shallow pan or tray to catch any juice that might leak and contaminate other surfaces
7. If you grilled hamburgers and then put the cooked burgers back on the plate that held the raw patties, you could contaminate the cooked food by:  
Cross-contamination
8. Why should ground meat be cooked to a higher internal temperature than steaks, chops or roasts?  
On steaks, chops and roasts, any bacteria is on the surface and quickly killed by heating. Any bacteria in ground meat is distributed through the meat
9. The best way to be sure meat is cooked to a safe temperature is to use a  
Use a probe-type instant read thermometer inserted in the center or thickest part