

# Outbreak Investigators

by Nancy Balter and Arturo Martinez

**I**n teaching middle school students about diseases and microbes, it is surprising to discover how little they know about transmission. Misconceptions range from the idea that “giving a disease to someone” actually means “giving it away so you didn’t have it anymore yourself” to a lack of understanding that tiny living things, and not dirt, are generally the cause of illness. For instance, Kit-fong Au and Romo (1996) have shown that many students do not understand that germs multiply over time, and therefore they do not comprehend why people often become ill a day or two after infection.

As a result, we decided to create a unit that would teach students about the microbes in their world with an emphasis on those that cause sickness. Anything that might be considered “disgusting” (and that includes gastrointestinal illness) generally appeals to middle school students. Additionally, this activity was designed to introduce students to careers in epidemiology by allowing them to investigate an outbreak themselves.

In this simulated outbreak, one class represents the victims and the other acts as Centers for Disease Control and Prevention (CDC) researchers. The CDC students interview the student victims to try and determine the cause of the outbreak. As two science teachers with the same schedule, we were able to coordinate this activity so students went back and forth interviewing each other within one class period. However, this activity could also be conducted by a single teacher by splitting the class in half. One half would be the victims, the other the researchers. In this case, the victims would have to each play two people who attended the picnic, as we have designed this for the CDC researchers to interview 30 people. Another idea would be to partner up with an elective class that meets at the same time, with

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the science class acting as the researchers and the elective class acting as the victims.

**Background**

Before doing this activity, it is wise to introduce some concepts about food poisoning (although you may prefer to do the investigation first to pique their interest in the lesson afterwards). We presented the concepts but encouraged students to do further Internet research, using keywords or vocabulary from this activity.

Students should understand that there is always a low level of bacteria in all their food, but it is generally kept below disease-causing levels. Refrigeration and freezing slow, but do not prevent, the growth of bacteria. Cooking will kill bacteria, but will not necessarily stop food poisoning because some bacteria produce toxins that linger and cause illness. Cooking will kill the bacteria but will not deactivate the toxins they have produced. A good example of this would be the disease botulism, often caused by improperly canned foods. Bacteria may grow in an improperly canned (or damaged) product. Even if it is cooked before it is eaten, the toxins will not be affected by the cooking and therefore may make a human severely ill (or even cause death).

In the United States, the most common bacterial cause of food-borne illness is *Staphylococcus aureus*, which is most likely what

would have caused the illness in this simulation. Other common bacterial agents are *Clostridium perfringens* and salmonella. Salmonella is most often found in poultry and eggs because it lives in birds. For cooked meals eaten while hot (as opposed to cooked foods that sit too long at room temperature, when other bacteria may grow to infectious levels), *E. coli* is often the cause because some strains produce a toxin that is heat resistant.

**The scenario**

Using an actual case from the CDC, we made the source of the outbreak a community potluck supper. In the scenario, members of the class had attended this potluck supper. We compiled up a master list of the people who attended this

**FIGURE 1** Victim card

ID number <u>74</u> Name _____					
This weekend there were some youth activities at a potluck supper. You were one of the participants at the events.					
Food and drinks you had at the potluck:	Time you ate at the potluck	Got sick?	Date you got sick	Time you got sick	Symptoms
Baked ham	UNKNOWN	YES	1/19	2:15 A.M.	Vomiting, diarrhea, and stomach ache
Mashed potatoes					
Coffee					
Water					
Brown bread					
Jello					
Rolls					
Cake					
Vanilla ice cream					
Chocolate ice cream					

**FIGURE 2** Master list

Line listing from investigation of an outbreak of gastroenteritis, all cases.

ID #	Time of meal	Ill (Yes or No)	Date of onset of symptoms	Time of onset	Baked ham	Spinach	Mashed potatoes	Cabbage salad	Jello	Rolls	Brown bread	Milk
1	UNKNOWN	N			N	N	N	N	N	N	N	N
4	6:30 P.M.	Y	1/19	12:30 A.M.	Y	Y	N	N	N	N	N	N
6	7:30 P.M.	Y	1/18	10:30 P.M.	Y	Y	N	Y	Y	N	N	N
7	7:30 P.M.	Y	1/18	10:30 P.M.	Y	Y	Y	N	Y	Y	Y	N
8	7:30 P.M.	Y	1/19	2:00 A.M.	N	N	N	N	N	N	N	N
12	UNKNOWN	N			Y	Y	Y	N	N	Y	N	N
15	UNKNOWN	N			Y	Y	Y	Y	Y	Y	Y	Y
16	UNKNOWN	Y	1/19	10:30 A.M.	Y	Y	N	N	N	Y	N	N
*19	UNKNOWN	N	1/17	10:00 A.M.	Y	Y	Y	Y	N	Y	N	N
20	UNKNOWN	Y	1/18	10:00 P.M.	Y	Y	Y	Y	Y	Y	N	N
21	10:00 P.M.	Y	1/19	1:00 A.M.	N	N	N	N	N	N	N	N
25	UNKNOWN	N			Y	Y	Y	Y	Y	N	Y	N
26	UNKNOWN	Y	1/18	9:45 P.M.	N	Y	Y	Y	N	Y	Y	N
28	UNKNOWN	N			Y	Y	N	Y	N	Y	Y	N
29	UNKOWN	Y	1/18	11:00 P.M.	Y	Y	Y	N	Y	Y	Y	N
30	10:00 P.M.	N			N	N	N	N	N	N	N	N
31	UNKNOWN	Y	1/18	9:00 P.M.	Y	Y	Y	N	Y	Y	Y	N
33	10:00 P.M.	Y	1/19	1:00 A.M.	N	N	N	N	N	N	N	N
35	UNKNOWN	N			Y	Y	Y	N	N	Y	Y	N
38	UNKNOWN	Y	1/18	11:30 P.M.	Y	Y	N	Y	Y	Y	Y	N
40	UNKNOWN	Y	1/18	9:30 P.M.	Y	N	Y	Y	N	N	Y	N
44	UNKNOWN	Y	1/18	9:30 P.M.	Y	Y	Y	N	N	N	Y	Y
*45	UNKNOWN	N	1/17	10:00 A.M.	N	N	N	N	N	N	N	N
48	7:00 P.M.	Y	1/19	1:00 A.M.	Y	N	N	N	N	Y	N	N
52	4:00 P.M.	Y	1/18	8:00 P.M.	N	N	N	N	N	N	N	N
54	UNKNOWN	Y	1/18	12:00 P.M.	Y	Y	Y	Y	Y	Y	Y	Y
57	UNKNOWN	Y	1/18	10:30 P.M.	Y	Y	Y	Y	Y	Y	Y	N
66	UNKNOWN	Y	1/19	12:30 A.M.	Y	N	Y	Y	Y	N	N	N
68	7:30 P.M.	N			Y	Y	Y	Y	N	Y	N	N
74	UNKNOWN	Y	1/19	2:15 A.M.	Y	N	Y	N	Y	Y	Y	N

simulated supper, which included all the information regarding what they ate and when and if they became ill (see Figure 2). We chose 30 victims (a class size) from the CDC's original list of 75. The 30 victims were chosen so that, when the students analyzed the data (particularly by percentage), it would be fairly simple for them to come up with the solution. We then assigned intentionally random ID numbers to each line on the chart, which represented a guest at the potluck. From this master list, we created individual cards for each of the victims that identified what they had eaten at the potluck, if and when they got sick, their symptoms (if any), as well as which food item they brought to the potluck (see Figure 1 on page 15). We typed all the cards beforehand, which took a couple of hours. To reduce this work, we suggest having student helpers assist with writing the cards up outside of class. Another option would be to cut a copy of Figure 2 into strips, write the

column headings on the board, hand out blank cards, distribute the strips, and let students fill in their own information. (The only problem with this latter option is that it gives students a chance to see how they might organize a table, a task your more advanced classes could otherwise be encouraged to do on their own.)

The day before the activity, take 15 minutes to hand out cards, go over rules, and conduct mock interviews. In class, each student victim is given a card and told to use it to answer any questions they are asked about the potluck or their illness. If asked about any other meals or other days, they are to feel free to devise an answer so long as it is consistent for each interviewer. Students are urged not to change any of the information on their card because that would not be helpful to the investigators. We strongly recommend that you do some "mock" interviews with students in front of the class to give them an

Y= person ate that food  
 N= person did not eat that food  
 \*= person had cold symptoms

	Coffee	Water	Cake	Vanilla ice cream	Chocolate ice cream	Fruit salad
	N	N	N	N	Y	N
	Y	N	Y	Y	Y	N
	N	Y	N	Y	N	N
	Y	Y	N	Y	N	N
	N	N	N	Y	Y	N
	Y	N	N	Y	Y	Y
	Y	Y	Y	N	N	N
	Y	N	Y	Y	Y	N
	N	Y	N	N	Y	N
	Y	Y	Y	Y	Y	N
	N	N	Y	Y	N	N
	Y	N	Y	Y	Y	N
	N	Y	Y	Y	N	N
	Y	Y	Y	N	Y	N
	Y	N	Y	Y	N	N
	N	N	Y	Y	N	N
	Y	N	Y	Y	Y	N
	N	N	Y	Y	N	N
	Y	Y	N	N	Y	N
	Y	N	Y	Y	Y	N
	Y	N	N	Y	N	Y
	N	N	Y	N	Y	N
	N	N	N	Y	N	N
	N	N	N	Y	Y	N
	Y	N	Y	Y	Y	N
	Y	N	Y	Y	N	N
	N	N	Y	Y	Y	N
	Y	N	Y	Y	N	N
	Y	Y	Y	Y	Y	N

## Their **MISSION** is to identify where the **OUTBREAK BEGAN** and to figure out the food that actually **CAUSED THE ILLNESS.**

idea as to how you want them to answer interview questions based on what is on the cards. It is also a good idea to go over a “Professional Code of Conduct” with the students at this time; encourage them to behave like professionals and to be serious about the endeavor. We also let the students know that they will receive performance points for this activity—we walk around with a clipboard and give them points based on the professional manner in which they play interviewer and interviewee. We have found that students behave better merely by seeing the clipboard in the teacher’s hands.

In the meantime (or immediately afterward, if this is being done in the same class and/or by a single teacher), the CDC researchers are told there has been an epidemic in a local community (the community in the neighboring classroom) and they are asked to investigate it. Their mission is to identify the location the outbreak began and to figure out the food that actually caused the illness.

The CDC epidemiologists are then put into teams of at least four students (teams can compete to see who finds the source first). The team approach allows students to interview the victims more quickly because teams can split up (one CDC researcher interviews one victim) so that if a team has four members, four victims are being interviewed at a time. Each victim is therefore interviewed only once by each team. Groups who are struggling can be given a pre-made blank table to fill out as they interview (see Figure 3). Another suggestion might be to have the more effective groups do a demonstration interview for the CDC researchers to show how they’re successfully gathering data. Send one or two teams to the victim class for 15–20 minutes, then have them return and send a couple more. Once the inter-

**FIGURE 3** Investigator worksheet

	ID#_____	ID#_____	ID#_____
Name			
Ill? (yes/no)			
Date/Time of illness			
Symptoms			
Places you ate in the last 72 hours			
What you ate			



Explore infectious disease  
at [www.scilinks.org](http://www.scilinks.org).

Enter code SS110302.

views are complete, teams pool the data from all of their researchers and begin organizing and analyzing it. Students not engaged in an interview should be given quiet seatwork to complete. If you have classroom Internet access, they could be actively doing background research on germs and disease transmission (or they could be quietly looking through books or magazines on this same topic). If they have previously done the research outside of class, this would be a good time to have waiting teams/victims discuss and summarize their library research. Those that return should begin organizing their data into a comprehensible table (part of the written assignment they turn in at the end). We focus students towards developing a chart somewhat similar to the master list in Figure 2.

### Ending the investigation

Once all students have completed their role, use the collected data to solve the problem of which food caused the illness. Student teams should complete this assignment by proposing which food they think most likely caused the illness and how they came to that conclusion. Students might also hypothesize about how that food became contaminated and perhaps make recommendations for safer food handling in the future. To discover which food most likely caused the illness, student teams should use the data chart they made to do a data analysis. If necessary, we prompt them to calculate, for each food in the list, the percentage of people that got sick who ate that food. Once the percentages are calculated, the answer is fairly obvious. Further, students should explain, to the best of their ability, any inconsistencies with their data. For instance, in this example two people (#19 and #45) became sick, but did not eat the vanilla ice cream that was to blame for the illness. Students should be able to suggest some ideas as to why that occurred, for example, those victims had different symptoms (i.e., runny nose) and got sick much earlier than the other victims. For more advanced students you could make the symptoms and onset of illness for those two victims more similar to the other victims. Students should be able to understand that random events alone may explain why some people got sick at the same time for other reasons. Note that #19 and #45 did eat the chocolate ice cream. In the actual sample from which this has been borrowed at the CDC, it turned out that the same scoop had been used for both the chocolate and vanilla ice cream, and thus the chocolate ice cream may have become contaminated from the common scoop. Another irregularity is that three people who ate the vanilla ice

cream did not become sick (#12, #25, and #68). Again, a discussion should follow about some people being resistant to various illnesses or having milder symptoms.

There are several ways to assess the students in this project. Student teams can be assessed through an oral report on their findings. Alternatively, you may choose to have an entire class discussion on the activity and then have students turn in a written report that is graded not only on their findings, but also on the clarity of the chart, ways in which they attempted to discover the “culprit food,” and student predictions on how the food became contaminated. We also make the performance points part of the student’s grade on the project.

### Further suggestions

You might want to contact your local public health department to see if an epidemiologist would be willing to speak to your class. Another suggestion would be to get pre-stained slides of the bacteria that commonly cause food-borne illness. Students could look at them under the microscope. Alternatively, you could have an extra slide of one bacteria, unlabeled, and tell the students it’s a blood sample from one of the outbreak victims. See if they can match strain the “sample” with the labeled pre-stained slides and determine the actual bacteria that caused the illness.

Our students really enjoyed this activity and experienced what a career in epidemiology might be like (which was amazing, as few had previously heard of this field). This activity capitalized on students’ interest in food poisoning to teach them about germs and their role in human illness. This activity also addresses science standards for scientific process (asking meaningful questions and conducting careful investigations); composition of life (all living organisms are composed of cells, from just one to many trillions, whose details are visible only through a microscope); and the function of organ systems (because of the contribution of individual organs, tissues, and cells). As a result of this activity, students gained a much greater understanding of the power of microbes and the effect they have on our lives. ■

### References

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