

## **The Nightmare Buffet: Materials for Instructors**

### **Purpose:**

Despite the impact of public health and epidemiology on the everyday lives of students in any career path, introductory biology programs rarely cover the science of these practices in lecture or laboratory settings. “The Nightmare Buffet” is a multi-step, inexpensive laboratory activity designed for high school and college students that introduces them to epidemiological concepts in an easy, interactive way and underscores the importance of proper food handling techniques to limit the spread of foodborne diseases.

In this hypothesis-driven lab, students select foods from a mock buffet, and a portion of them “get sick” with what is believed to be norovirus. The goal is for the students to ask questions and ultimately determine which food(s) were at fault, as well as when and where the food became contaminated. Along the way, the instructor(s) and students will calculate some odds ratios, a commonly used tool in epidemiology.

### **Feedback from previous students:**

This lab has been given a handful of times to high school and college students, across multiple semesters and course levels. Responses to an anonymous student survey indicated that students found the Nightmare Buffet a valuable activity, while increasing their knowledge of disease transmission and public health practices. Many students also said that this lab increased their interest in the field of public health and even changed their day-to-day approach to food safety.

### **Background information:**

Norovirus is the most common cause of foodborne illness in the United States, and is the most common cause of acute diarrheal disease in the world. The virus only infects humans, and is shed in the stool and vomit of infected individuals. The typical symptoms of norovirus infection are a couple of days of vomiting, diarrhea, and abdominal pain, sometimes with a fever, headaches, and body aches, which begin around 12-48 hours after someone takes the virus particles in through the mouth. Around 20 million Americans will experience the virus each year.

The virus is spread through direct person-to-person contact, through contact with contaminated surfaces, or through consuming food or water containing the virus. In each of these cases, the original source of the virus was human stool or vomit. The virus is invisible on foods and surfaces, is resistant to most sanitizers and disinfectants, can resist freezing, and in some cases can persist on foods longer than their normal shelf

life. Unlike bacteria and molds, the presence of these viruses does not alter the look or taste of food.

The most commonly implicated simple foods in norovirus outbreaks are leafy greens, fruits such as berries, and molluscan shellfish such as oysters (these animals can concentrate the virus in their bodies if they feed in waters contaminated with human sewage). Norovirus contamination is also associated with foods that are served raw or minimally cooked, or are prepared by hand without a final cooking step. Hence we also tend to see norovirus outbreaks associated with items such as salads, deli sandwiches, and on occasion with baked goods assembled or decorated by hand.

There is approximately one foodborne norovirus outbreak every day in the US, and when a source can be found, about 70% the time it is traced back to a person infected with the virus handling and preparing food, often with bare hands. Yet foods can become contaminated with the virus at any point from the farm to a person's plate, such as through contaminated irrigation or washing water being used on produce, or breakdowns in sanitation during the food's processing and preparation.

When it appears the food was contaminated somewhere farther back in its production, investigators can implement a traceback investigation. This involves following the foods and sometimes their individual ingredients backwards along the farm-to-fork chain, investigating production facilities, distributors, and farms, sometimes with the addition of laboratory tests, to discover where and when the food(s) were contaminated or mishandled. Depending on the size of the event and if it crosses state or national borders, local, state, federal, or even international food safety professionals may become involved to identify and contain the source of the disease. Once identified, implementing a recall of the implicated food may also occur to protect the public.

This laboratory exercise was created by NoroCORE, the USDA-NIFA Food Virology Collaborative, and is made freely available to instructors.



## **Objectives:**

- Understand some of the process and people involved in a disease outbreak investigation
- Calculate and interpret odds ratios
- Review some of the food types commonly associated with norovirus outbreaks
- Understand how a single contamination event can lead to numerous cases of human disease

## **Materials and Set-up:**

1. Sticky notes in five colors – *enough so that each student may have one of each color*
2. Plates and/or bowls - *to display the sticky notes on the buffet*
3. Plates for students - *to carry through the buffet and hold their sticky notes*

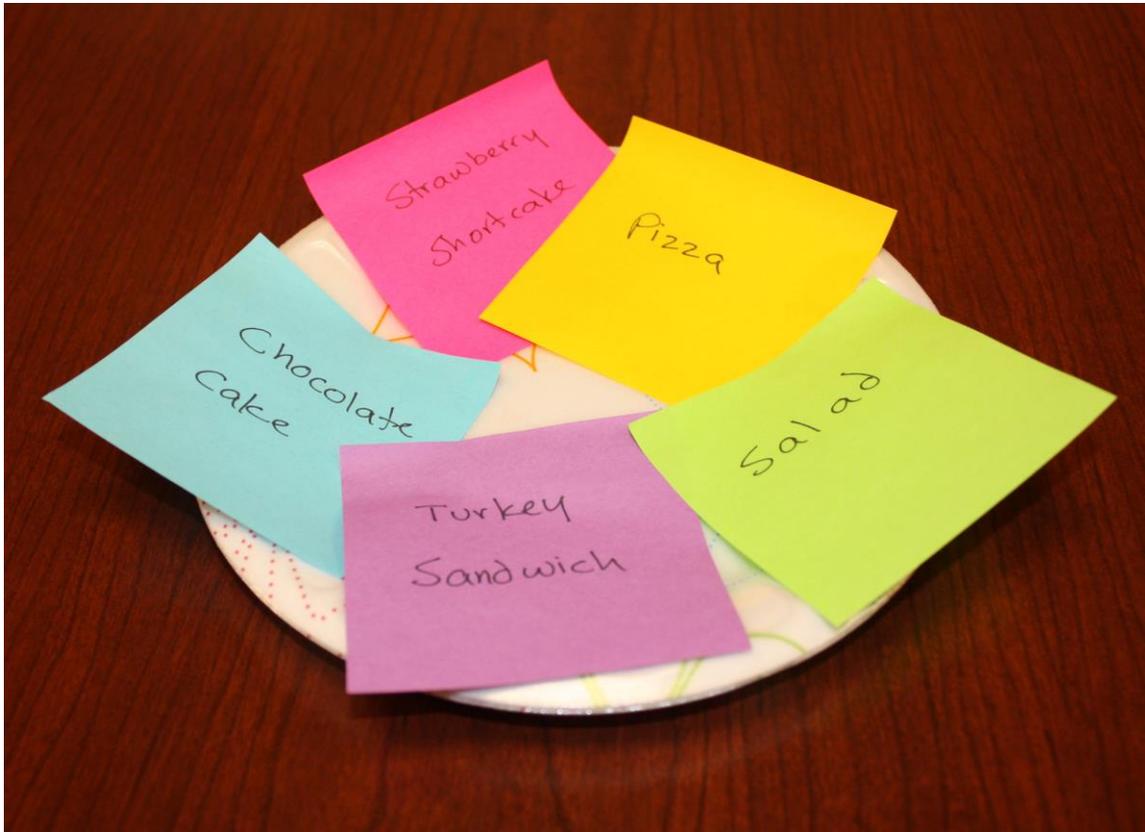
### **Part 1: The buffet**

The instructor sets up dishes with labeled sticky notes representing the different foods, with enough notes to provide one of each food per student (Figure 1).



**Figure 1.** The mock buffet setup. The “foods” here are salad, pizza, turkey sandwich, chocolate cake, and strawberry shortcake.

Before the start of the lab, the instructor selects one food to be contaminated with norovirus. Please see the included spreadsheet, and one food has been preselected for this exercise, but the culprit food can be changed each time. **\*\*Strawberries were chosen as a route in the spreadsheet, but the scenario could be altered each time the exercise is given.\*\*** While the pizza and chocolate cake would be less likely to be the source of the virus since they were not handled much after baking, each of the food items could be the culprit if you make a convincing story.



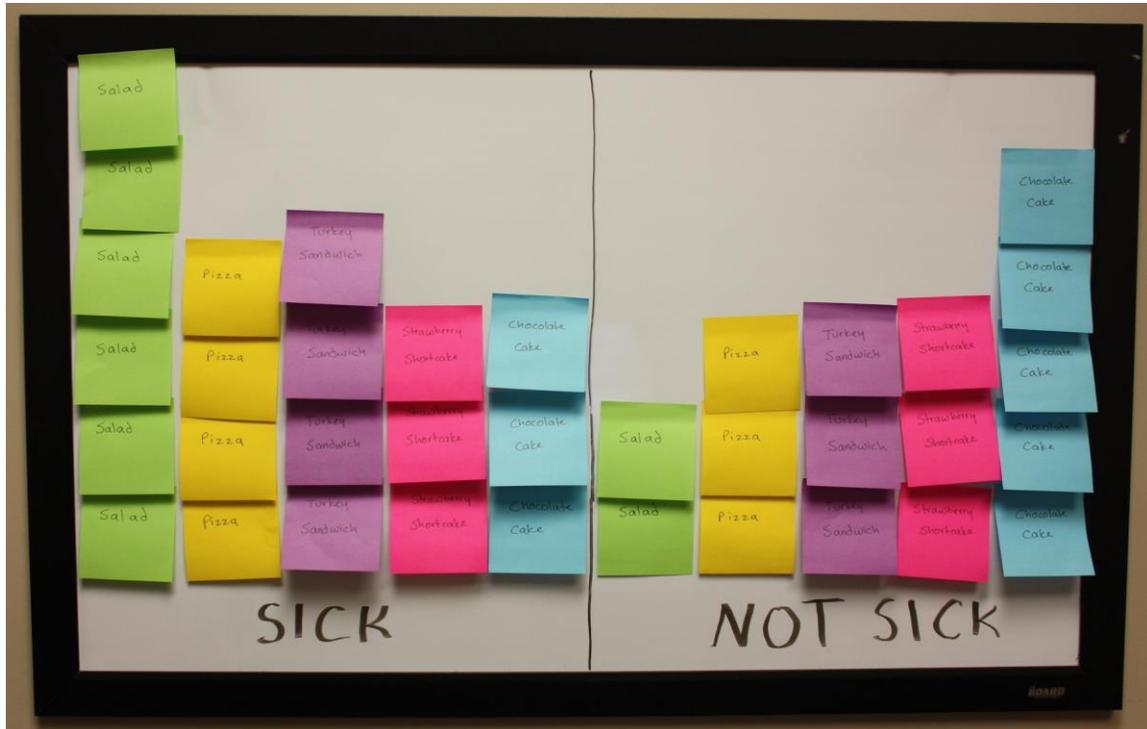
**Figure 2.** A student's plate where they selected all of the available foods.

The students are invited to the buffet, and are allowed to select foods they wish to eat (Figure 2). The instructor then goes around the room, looks at each student's selections, and tells the student whether or not they became sick with norovirus the next day.

**\*\*IMPORTANT\*\*** For ease in the upcoming odds ratio calculations, select at least one student who ate the contaminated food but is not sick, and likewise someone who did not eat the food but is sick. This prevents dividing by zero in the formula, gives a slight red herring, and more closely mimics real life, where there could be people who became sick by other means, people who are immune to the virus, did not receive enough virus to become infected, etc., and could be made its own teaching point.

## Part 2: Hypothesis testing

Based on who became sick and who did not, the students hypothesize which food was contaminated with norovirus. Separating the students by “sick” and “not sick” and having them arrange their sticky notes in separate graphs may help them identify likely foods (Figure 3). For example, in the figure below, sick people tended to eat salad (green).



**Figure 3.** Simple histograms of food eaten by sick and well students.

To be more certain of the hypothesis, some statistics are in order. A common and quick measure used in disease outbreak investigations is the odds ratio. Basically, it is the odds of illness among the exposed, compared to the odds of illness among the unexposed. In this case, the exposure is whether or not the students ate a certain food item.

Exposure	Disease	
	Yes	No
Yes	A	B
No	C	D

$$\text{Odds ratio} = (A/C) \div (B/D), \text{ which can also be written as } (AD) \div (BC)$$

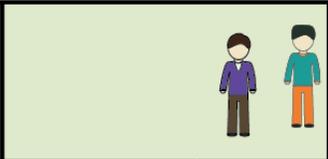
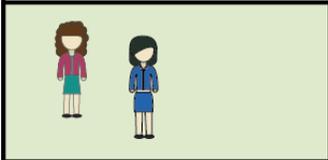
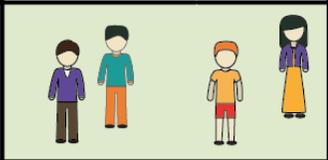
In this lab, the table can also be written this way:

Ate ___X___?	Got sick?	
	Yes	No
Yes	A	B
No	C	D

The result of an odds ratio calculation is a number, and in this case it is saying that *“People who got sick were \_\_\_\_\_ times as likely to have eaten \_\_\_X\_\_\_ than people who did not get sick.”*

An odds ratio may be more than, less than, or equal to 1. A value of 1 means there is no relationship between the exposure and the outcome. In other words, eating a food had no impact on whether or not someone became sick. A value greater than one means there is an increased risk of disease among the exposed, and a value less than one means there is a decreased risk among the exposed. In an outbreak investigation, odds ratios may be calculated for single ingredients, or even an entire restaurant menu, to determine what food may have been the source of the disease.

Divide the classroom in half and first have students take sides depending on whether they or not they became sick. Then have the students divide themselves again on their halves of the room into whether they ate a particular food or not. They have now formed a living odds ratio table (Figure 4), and the instructor can record these values for the students to calculate. Each food can be tested, with students moving based on what they ate, but they will never cross the midline since their health status never changes. Barring the unexpected, a single food should be the obvious source of the virus.

		Disease (Did the person get sick?)	
		Yes	No
Exposure (Ate food of interest?)	Yes		
	No		

**Odds ratio** =  $(A/C) \div (B/D)$ , which can also be written as  $(AD) \div (BC)$

- OR = 1      No relationship between exposure and disease
- OR < 1     Increased odds of disease among exposed
- OR > 1     Decreased odds of disease among exposed

**Interpretation:** “People who got sick were \_\_\_\_\_ times as likely to have eaten \_\_\_\_\_ than people who did not get sick.”

**Figure 4.** Creating a living odds ratio table using the corners of the classroom. In this example, the odds ratio is  $(4/2)/(2/4) = 4$ .

**\*\*FUN FACT\*\*** This living odds ratio table was performed during an actual disease outbreak. In 2012, Germany had its largest foodborne outbreak ever recorded. Almost 11,000 people, mostly schoolchildren, became sick with norovirus in a matter of days. The investigators visited affected schools and had the students take assigned corners of the school auditoriums based on if they were sick and what they ate. The contaminated food turned out to be frozen strawberries imported from China that had been prepared different ways at different schools, and disease was more common when the berries were not given a thorough cooking step before serving. Due to the immensity of the outbreak, it has been thought the berries were exposed to contaminated irrigation water, but a source was not identified.

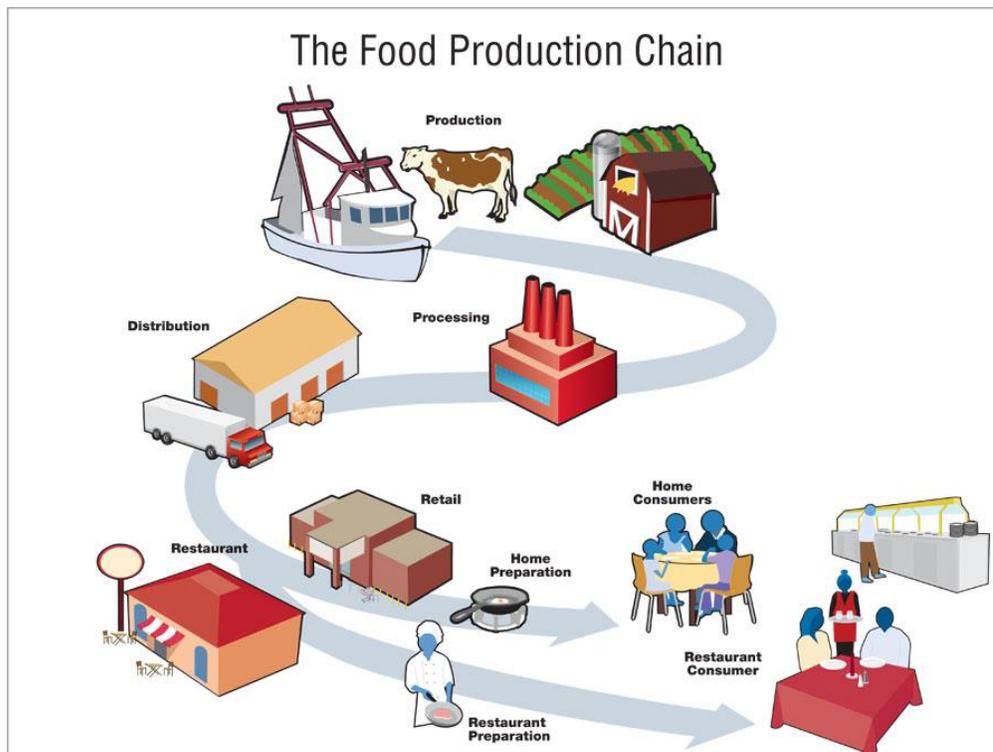
Source: Bernard, H. et al. 2014. Large multistate outbreak of norovirus gastroenteritis associated with frozen strawberries, Germany, 2012. *Eurosurveillance*, 19(8): pii=20719. Available here: <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=20719>

### Part 3: The traceback investigation

Now that the contaminated food has been identified, the students will continue their role as epidemiologists to discover where the food, and even what ingredient in the food, became contaminated with norovirus. Singly or in groups, the students ask the instructor specific questions about the food's history, and the instructor uses the Traceback Spreadsheet as a reference. Students should gain an appreciation for the largely invisible chain of events that plays out for the foods they eat (Figure 5).

For example, if the salad was the contaminated food, students may ask what ingredients are in the salad, who prepared it, where it was prepared, and if ingredients in the salad tested positive for norovirus. Over time, the students will hone in on the specifics of where the single ingredient was contaminated, such as lettuce that was picked by a farm worker in another state, who came to work the day after recovering from norovirus infection and handled the produce with their bare hands.

The Traceback Spreadsheet has one story presented, but with slight modifications, other stories could be told. For example, the strawberries in the shortcake may have been washed with water contaminated with human sewage after a septic tank leak, or the chocolate cake was exposed to the virus after someone in the bakery vomited and the virus particles distributed in the air, landing on the finished cake.



**Figure 5.** The farm-to-fork continuum. Image by the Centers for Disease Control and Prevention.

### **Helpful resources:**

1. CDC Vital Signs: Norovirus, available at <http://www.cdc.gov/vitalsigns/norovirus/>
2. Hall, A. et al. 2014. Vital Signs: Foodborne Norovirus Outbreaks – United States, 2009-2012. MMWR 63(22): 491-5. Available at [http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6322a3.htm?s\\_cid=mm6322a3\\_w](http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6322a3.htm?s_cid=mm6322a3_w)
3. Hall, A. et al. 2012. Epidemiology of Foodborne Norovirus Outbreaks, United States, 2001-2008. EID 18(10): 1566-1573. Available at [http://wwwnc.cdc.gov/eid/article/18/10/12-0833\\_article](http://wwwnc.cdc.gov/eid/article/18/10/12-0833_article)
4. Current FDA recalls, market withdrawals, and safety alerts: <http://www.fda.gov/Safety/Recalls/>
5. Animation of norovirus transmission: <https://www.youtube.com/watch?v=jWmF0NOGia4>