CONSERVE
Sustainable Water Reuse~Food~Health
Conserve Water for Food

Food Safety and One Health

Foodborne Illness Outbreak Investigation

Contents

Background

The food science discipline encompasses all scientific aspects of the development, production, processing, packaging, and distribution of foods. Food scientists study the biology, chemistry, and engineering design for food systems to enhance product safety, quality, stability, nutritive value, accessibility, affordability, and sustainability. These efforts apply to food for both humans and companion animals.

Food safety is paramount and widely realized in the United States. However, illnesses occur due to unintentional contamination that can occur throughout production, processing, and final consumer handling. The U.S. Centers for Disease Control and Prevention (CDC) estimates 48 million foodborne illnesses occur in the U.S. annually.

Foodborne illness is typically characterized by gastroenteritis, symptoms of which include nausea, vomiting, diarrhea (may be bloody), abdominal pain, and flu-like symptoms, although some foodborne microorganisms and their toxins can affect other bodily systems including the hepatic, renal, reproductive, and neurological systems. Illnesses can be short-lived and self-eliminating; however, some can be severe and result in hospitalization, long-term sequelae, or even death depending on individual vulnerability, exposure, and pathogen characteristics.

Many of the microbial pathogens associated with foodborne illness can be found in the intestinal tract and fecal waste of infected humans and animals. Foodborne pathogens are often zoonotic, meaning they can be transmitted between humans and other animals. Some microorganisms that cause disease in humans may be carried asymptomatically by an animal. Foodborne pathogens are generally transmitted the fecal-oral route, meaning pathogens are shed in the feces of an infected individual and enter the next individual through the oral cavity, generally through consumption of fecally-contaminated food or water. Bacteria, viruses, and parasites can persist in food, water, and the environment for days to months to even years depending on the conditions and microbial characteristics. Bacteria can replicate to increase in number in food and environmental matrices that support their growth. Conversely, viruses and parasites can persist in the environment, but they grow and replicate only in hosts.

Scientists have shared interest and responsibility for food safety to minimize disease transmission cycles involving humans, animals and the environment – a One Health approach to interdependent wellbeing.

Foods that do not receive a proper terminal microbial inactivation treatment such as thermal processing may be particularly vulnerable for transmission of pathogens. For example, raw agricultural commodities contaminated with microbial pathogens have been associated with foodborne illness outbreaks caused by bacteria, parasites, and virus such as *Escherichia coli* O157:H7, *Cyclospora cayetenensis*, and human norovirus, respectively.

Pathogens can be inadvertently introduced to food products through infected food handlers, contaminated food contact surfaces, and contaminated environmental sources such as soil and water. To minimize risks of contamination, guidelines such as Good Agricultural Practices (GAPs) and

regulations such as the Produce Safety Rule (PSR) of the Food Safety Modernization Act (FSMA) have been instituted for the production of produce. One of the regulatory requirements includes evaluation of the microbiological quality of water used to irrigate food crops.

Sources of irrigation water can include ground water and surface water (lakes, ponds, streams), although availability of these traditional water resources have become strained due to droughts and contamination. As a result, research efforts to safely and sustainably recycle water for food production has become a research priority.

In order to evaluate the quality of water to be used for irrigation of food crops, environmental water is collected and transported to a laboratory to be tested for the presence of bacteria typically found in the intestinal tracts of humans and other animals. The bacteria that are quantified are known as fecal coliforms and include *Escherichia coli* (*E. coli*). There are many types of *E. coli*. The bacterial species includes generic *E. coli* which is part of a healthy intestinal microbiome and does not harm the host; whereas other strains, such as *E. coli* O157:H7, can cause severe illness. Fecal coliforms are often quantified in water tests as an indicator of potential fecal contamination of water; however, their presence does not necessarily indicate that pathogens are present in a water sample. Analyzing water for the presence of pathogens requires more extensive and time-consuming laboratory tests.

Educational Resource

The foodborne illness outbreak investigation provides an interactive, problem-based approach to learning about food safety and One Health in the context of a real-life scenario. The investigation features group activities to organize, graph, perform computations, and draw conclusions about data related to epidemiology, laboratory, traceback, recall, environmental risk assessment, and prevention efforts of an investigation. The investigation features gaming elements including text, visual, and manipulative-based data clues that, when successfully interpreted, generate a three-digit numeric code to unlock a preset, programmable combination lock. The group format also exercises communication and other teamwork skills among students as well as communication with the larger class through group presentations. Students are further prompted to consider and discuss thoughts on aspects related to their investigation phase, some of the topics may have no single correct answer based on current scientific knowledge or technologies.

Educational Objectives

As a result of completion of the investigation, students should be able to:

1. Characterize the impact of foodborne illness on public health,
2. Identify factors that contribute to the transmission of pathogens and strategies to minimize risk of disease transmission through food,
3. Identify investigative stages of foodborne illness outbreak investigations and identify the analytical tools and data utilized for resolution of outbreaks,
4. Identify various professional roles and regulations associated with assurance of a safe food supply, and
5. Work as a team member to solve problems and to communicate with small and large groups of individuals.

Education Content Standards Supported

- **Science (Next Generation Science Standards)**
  - High School Life Sciences: Interdependent Relationships in Ecosystems.
    - HS-LS1-1. Mathematical and/or computational representations to support explanations of factors that affect ecosystems
    - HS-LS2-2. Mathematical representations of populations in ecosystems
    - HS-LS2-6. Effects of changing conditions on ecosystems
    - HS-LS2-7. Design, evaluate, and refine a solution for reducing impact of human activity on the environment
    - HS-LS2-8. Evaluate the evidence for the role of group behavior on survival and reproduction
    - Science and Engineering Practices
    - Cross Cutting Concepts
- **Mathematics (Common Core)**
  - High School: Reason abstractly and quantitatively
- **Social Studies**
  - Geography: Ecosystems, human modification and response to natural environment
  - Civics: Structure and purpose of government

Instructor Guidelines

The investigation activity is accompanied by a presentation to provide students background information on microbiological food safety and public health impacts. The same presentation is continued after the students complete the investigation in order to guide the class discussion with visuals of group tasks.

The investigation activity materials are provided in the following pages. There are five groups (designated A through E), and each is provided the same outbreak scenario but a different role in the investigation. Each group is provided a large envelope that contains: 1) the outbreak scenario, 2) a worksheet to record a three-digit code the students generate from successful completion of tasks, 3) additional questions for group discussion and presentation to the class, 4) smaller envelopes containing two to three tasks to complete and the necessary data clues, 5) a small envelope containing a congratulatory note, closed and affixed with a programmable combination lock preset to the correct three-digit code to be generated by each group (paper envelope with a hole punched through the seal to accommodate the lock).

To prepare group activities, instructors print the appropriate group handouts for each group, create the puzzles, fill and label envelopes, and set the locks.

Quick Guide: Group Investigation Resources

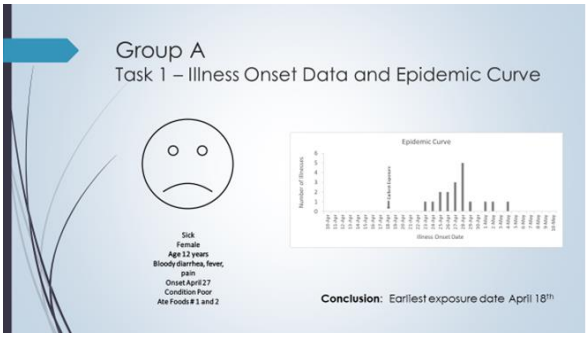
Group	Large Envelope Contents	Small Envelope Contents	Puzzle Solution	Lock Code
A Epidemiology	▪ Outbreak scenario ▪ Code worksheet ▪ Small envelopes with tasks	Task A.1 Patient data Epidemiology curve	18	
		Task A.2 Patient & control data Odds ratio table	3	
	▪ Small envelope – locked			**1-8-3**
B Laboratory	▪ Outbreak scenario ▪ Code worksheet ▪ Small envelopes with tasks	Task B.1 Patient data Pathogens table	4	
		Task B.2 Lab protocol illustration	4	
		Task B.3 PFGE jigsaw puzzle	5	
	▪ Small envelope – locked			**4-4-5**
C Traceback & Recall	▪ Outbreak scenario ▪ Code worksheet ▪ Small envelopes with tasks	Task C.1 Wheel puzzle Magnifier	3	
		Task C.2 Supplier records	4	
		Task C.3 Distribution records	8	
	▪ Small envelope – locked			**3-4-8**
D Environment	▪ Outbreak scenario ▪ Code worksheet ▪ Small envelopes with tasks	Task D.1 Epidemic curve Rainfall data	1	
		Task D.2 Growing field jigsaw puzzle	4	
		Task D.3 Irrigation & produce images	8	
	▪ Small envelope – locked			**1-4-6**
E Prevention	▪ Outbreak scenario ▪ Code worksheet ▪ Small envelopes with tasks	Task E.1 and E.2 Disks with water data Graph to plot data	3-0	
		Task E.3 Microbiological study data Red cellophane	2	
	▪ Small envelope – locked			**3-0-2**

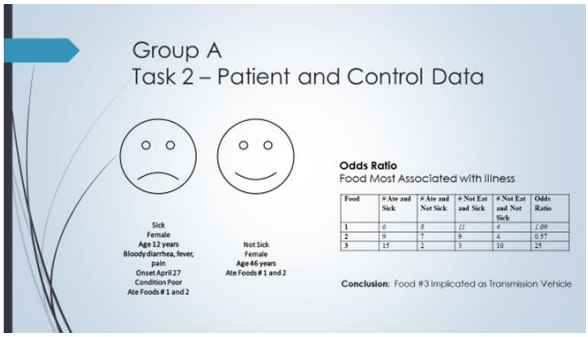
Instructions to Prepare Each Group Activity

Group A – Epidemiology Investigation

Large Envelope Contents

- ☐ Outbreak scenario handout, pages 12 and 13
- ☐ Small Envelope for Task #1
  - Paper circles with ill patient data
    - *Print and cut out the faces with frowns on one side and the patient information on the other side (18 patient cases), pages 15 to 17*
  - Graph to draw epidemic curve, page 20
- ☐ Small Envelope for Task #2
  - Paper circles with ill patient data
    - *Print and cut out the faces with frowns on one side and the patient information on the other side (18 patient cases), pages 15 to 17*
    - *Print and cut out the faces with smiles on one side and the individual information on the other side (12 control cases), pages 18 and 19*
    - *Recommend using different color paper for the patient and control faces*
  - Table to enter odds ratio calculations, page 22
- ☐ Small Envelope with Lock
  - Congratulatory note, cut out on dotted line, page 24
  - Envelope closed with lock with the combination set to the number 1-8-3

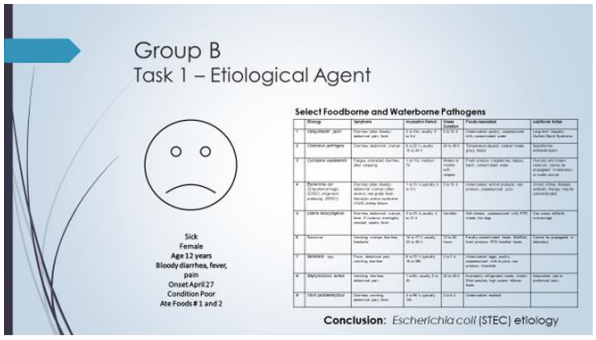


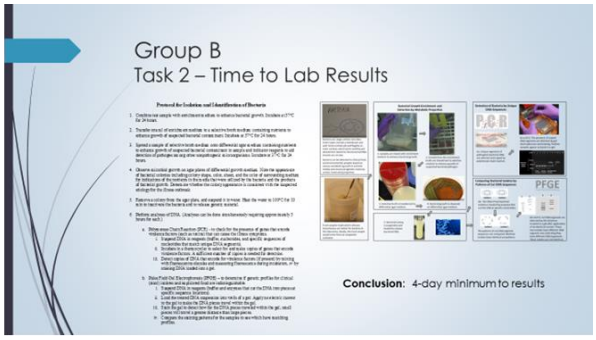


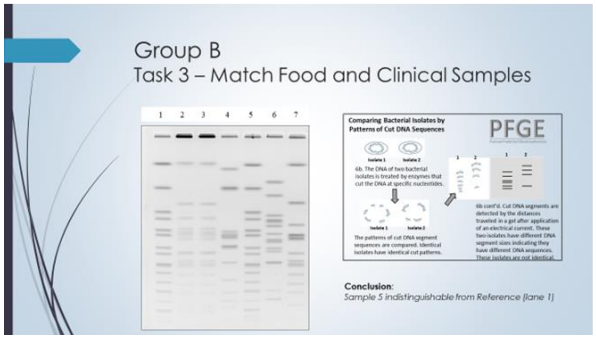
Group B – Laboratory Investigation

Large Envelope Contents

- Outbreak scenario handout, pages 25 and 26
- Small Envelope for Task #1
  - Paper circles with ill patient data
    - *Print and cut out the faces with frowns on one side and the patient information on the other side (18 patient cases), pages 28 to 30*
  - Table – Select Foodborne and Waterborne Pathogens, page 31
- Small Envelope for Task #2
  - Protocol for Isolation and Identification of Bacteria, page 32
  - Illustration of methods to detect and identify bacteria, page 33
- Small Envelope for Task #3
  - PFGE Data for Clinical and Food Samples, page 34
  - Jigsaw puzzle of gel with PFGE data, page 35
    - *Print the image of the aerial view and paste to pre-cut puzzle then score paper along shapes of pre-cut puzzle pieces. Alternatively, print the image and cut the paper into the desired number of irregular shaped pieces to be put back together by students.*
- Small Envelope with Lock
  - Congratulatory note, cut out on the dotted line, page 36
  - Envelope closed with lock with the combination set to the number 4-4-5



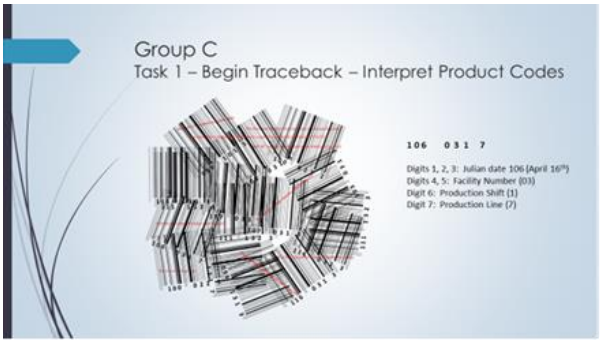


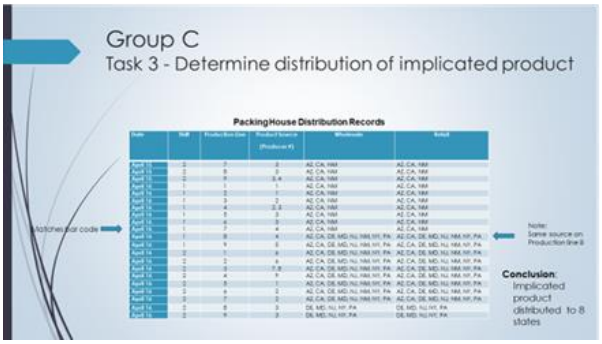


Group C – Traceback and Recall Investigation

Large Envelope Contents

- Outbreak scenario handout, pages 37 and 38
- Small Envelope for Task #1
  - Bar code wheel puzzle
    - *Print three copies of the bar code illustration. Cut one of the copies along the outside edge of the bar codes. Cut the second copy into a circle of approximately one centimeter smaller in diameter than the first copy. Cut the third copy into a circle of approximately one centimeter smaller in diameter than the second copy. Stack the circles, aligned in the center. Fasten the circles through a hole in the center of the stack with a round-head fastener. Page 39*
    - *Provide a sheet of magnifying plastic for students to view the fine print of instructions embedded in the bar code image. Magnifiers are available at discount stores.*
  - Wheel Puzzle Solution, page 40
- Small Envelope for Task #2
  - Packing Facility Records for Sources of Products, page 42
  - Packing House Distribution Records, pages 43
- Small Envelope with Lock
  - Congratulatory note, cut out on the dotted line, page 44
  - Envelope closed with lock with the combination set to the number 3-4-8

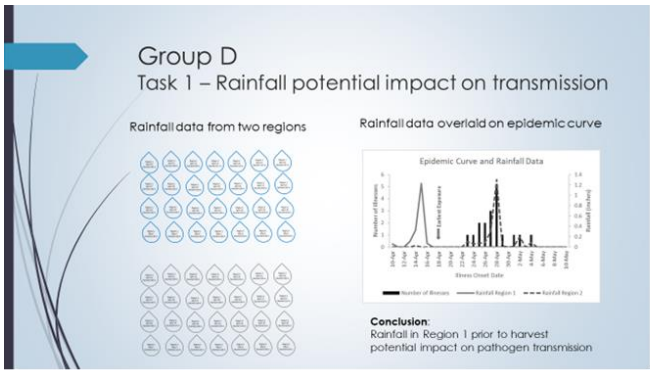


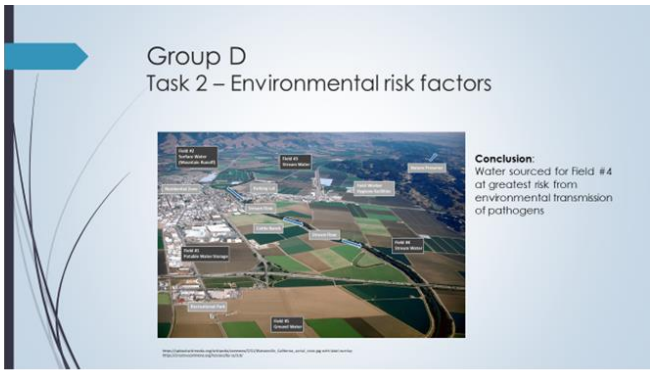


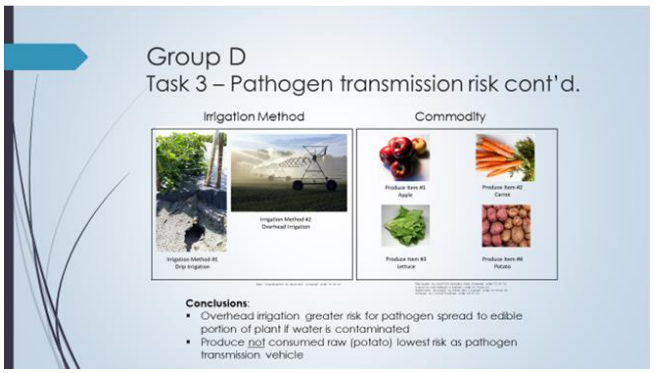
Group D – Environmental Investigation and Risk Assessment

Large Envelope Contents

- Outbreak scenario handout, pages 45 and 46
- Small Envelope for Task #1
  - Graph of Epidemic Curve, page 48
  - Rainfall data in droplets for regions 1 and 2, pages 49 and 50
- Small Envelope for Task #2
  - Aerial view of fields, page 52
    - *Print the image of the aerial view and paste to pre-cut puzzle then score paper along shapes of pre-cut puzzle pieces. Alternatively, print the image and cut the paper into the desired number of irregular shaped pieces to be put back together by students.*
- Small Envelope for Task #3
  - Images of growing fields and produce types, page 53
- Small Envelope with Lock
  - Congratulatory note, cut on the dotted line, page 54
  - Envelope closed with lock with the combination set to the number 1-4-6



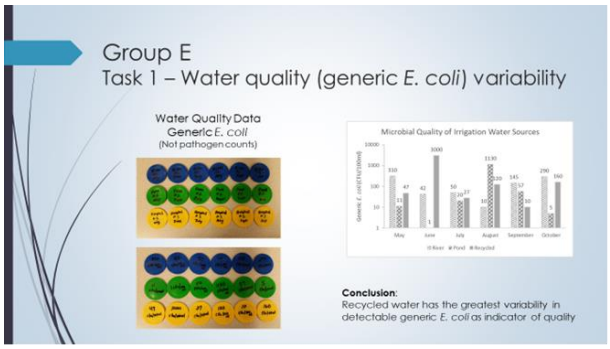


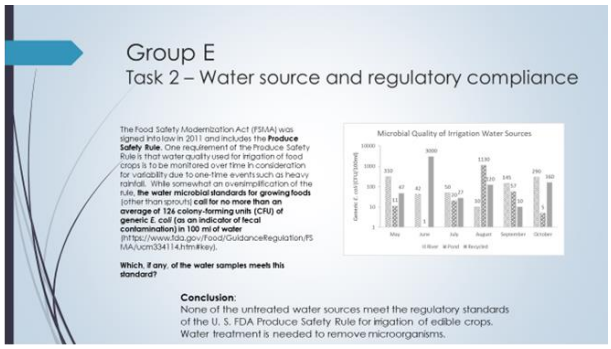


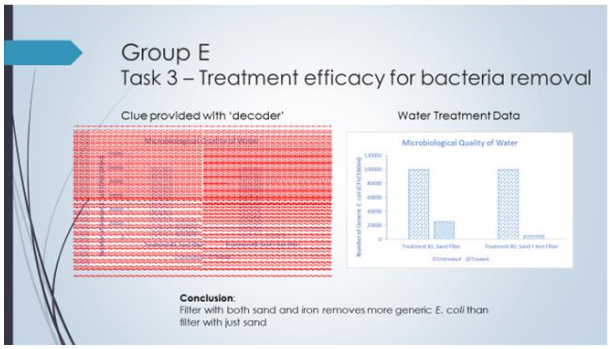
Group E – Research for Prevention of Recurrence

Large Envelope Contents

- Outbreak scenario handout, pages 55 to 57
- Small Envelope for Task #1 and #2
  - Disks with generic *E. coli* data from three water sources, data in table on page 58
    - *Obtain three different colored disks (available from education supply stores). On one side of the disk, write the name of the water source (river, pond, recycled) and the month. On the other side of the disk, write the corresponding data on* E. coli *counts as found in the data table on page 58. Alternatively, paper can be used instead of plastic disks.*
  - Graph for Microbial Quality of Irrigation Water, page 60
- Small Envelope for Task #3
  - Microbiological Quality of Water graph under red lines
    - *Print in color the graph of the microbiological quality of water hidden by the squiggly red lines. Provide a piece of red cellophane paper in the envelope for students to reveal the hidden data, page 61*
- Small Envelope with Lock
  - Congratulatory note, page 62
  - Envelope closed with lock with the combination set to the number 3-0-2







Group Activities – Worksheets and Puzzles

CONSERVE EXERCISE – Interactive Outbreak Investigation

Group A – Epidemiological Investigation

Physicians in seven states in the United States have diagnosed severe gastroenteritis among 187 individuals. Certain findings make this an event reportable to public health authorities. This number of concurrent, similar illnesses is greater than the numbers typically reported for these regions and time period. This suggests the illnesses may be related and part of an outbreak.

You are part of a team of professionals who must work together to determine the cause and source of illness and to take measures to protect the public from continued exposure. The professionals involved in solving this outbreak include state and federal public health officials who conduct the epidemiological investigation, regulatory authorities who help identify the source of implicated product and potential cause of contamination, and producers and distributers of any implicated products who recall product from commerce and take corrective action. These experts also work with the media to inform the public of risk and protective measures. They may also work with research scientists to resolve the problem and prevent recurrence.

Your role in the investigation is as a state public health professional who interviews patients to help determine the illness onset and contaminated transmission vehicle. Your job is not an easy one. Concerned producers, manufacturers, distributors, regulators, and consumers are relying on you to help improve the safety of the food supply.

Tasks

1. Determine illness onset date.
    a. Organize the individual patient data from your state according to illness onset date.
    b. Create an epidemic curve by plotting the illness onset dates on the x-axis and the number of patients who became ill on each date on the y-axis.
    c. If the incubation period (the time between exposure and onset of illness symptoms) for this illness ranges from 2 to 5 days, what was the *earliest date* of exposure to the disease agent?

2. Determine the common exposure.
    a. Organize the individual patient data from your state according to foods consumed.
    b. Organize data from control individuals (the people who were exposed to the same foods but who did not become ill).
    c. Complete the table and calculate the odds ratio for each food consumed. Which number food has the highest odds ratio that is also greater than one (and therefore has the greatest likelihood of being the source of contamination exposure)?

    $$\text{Odds Ratio} = \frac{[(\#\text{ Ate and became sick}) \div (\#\text{ Did not eat and became sick})]}{[(\#\text{ Ate but did not get sick}) \div (\#\text{ Did not eat and did not get sick})]}$$

3. The numerical answers from Tasks 1c (use only the number for the day, do not include the number of the month in your answer) and 2c form your 3-digit code.

Group A

Numeric Code

Test your code to open the lock, and prepare to share the following information with the class.

Group presentations will be given in alphabetical order by group letter. Each group presentation will be 5 minutes or less.

Present to the class:

1. The group's tasks and solutions.

2. Define the term *incubation period.*

3. Describe the purpose of calculating the *odds ratio* and the information needed to do so.

4. Your group's observations regarding the severity of symptoms as related to patient characteristics.

5. Your thoughts on why the date of exposure is important. (How do you think this information is critical to the rest of the investigation)?

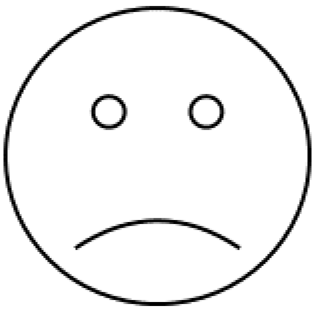
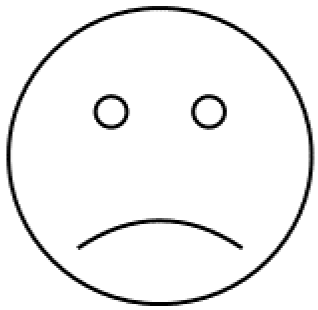
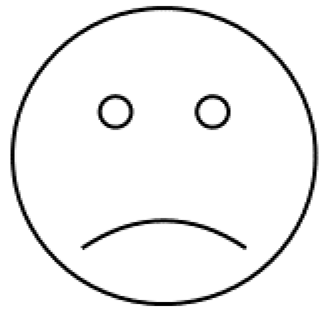
Task 1 DATA (in text format for instructor reference)

Individual	Sick or Not Sick	Gender	Age (yrs)	Symptoms	Illness Onset	Foods Consumed	Prior Health Concerns	Current Health Status
1	Sick	Female	12	Bloody diarrhea, fever, pain	April 27	1, 2	N/K	Poor
2	Sick	Female	45	Diarrhea, fever, pain, nausea	April 28	2	N/K	Recovering
3	Sick	Male	43	Diarrhea, fever, pain, nausea	April 29	1, 3	N/K	Recovering
4	Sick	Male	15	Bloody diarrhea, fever, pain	April 28	3	N/K	Recovering
5	Sick	Female	23	Diarrhea, fever, pain, nausea	April 28	2, 3	Pregnant	Poor
6	Sick	Female	8	Bloody diarrhea, fever, pain, nausea, HUS	April 28	3	N/K	Critical
7	Sick	Female	29	Diarrhea, fever, pain, nausea	April 26	3	N/K	Recovering
8	Sick	Male	55	Diarrhea, fever, pain, nausea	April 27	1, 2, 3	N/K	Recovering
9	Sick	Male	72	Bloody diarrhea, fever, pain	April 28	1, 3	N/K	Recovering
10	Sick	Male	61	Diarrhea, fever, pain, nausea	May 4	1, 2, 3	N/K	Recovering
11	Sick	Male	25	Diarrhea, fever, pain, nausea	May 2	2, 3	N/K	Recovering
12	Sick	Female	31	Diarrhea, fever, pain, nausea	April 26	1, 3	N/K	Recovering
13	Sick	Male	7	Bloody diarrhea, fever, pain, HUS	April 23	3	N/K	Critical
14	Sick	Male	40	Diarrhea, fever, pain, nausea	April 24	2, 3	N/K	Recovering
15	Sick	Female	37	Diarrhea, fever, pain, nausea	April 27	2, 3	N/K	Recovering
16	Sick	Female	81	Bloody diarrhea, fever, pain, nausea, HUS, kidney failure	April 25	3	Immune-compromised	Deceased
17	Sick	Female	51	Diarrhea, fever, pain, nausea	April 25	3	N/K	Recovering
18	Sick	Female	54	Diarrhea, fever, pain, nausea	May 1	2	N/K	Recovering
19	Not Sick	Female	46	N/A	N/A	1, 2	N/K	Good
20	Not Sick	Male	31	N/A	N/A	1, 3	N/K	Good
21	Not Sick	Male	48	N/A	N/A	2	N/K	Good
22	Not Sick	Female	49	N/A	N/A	1	N/K	Good
23	Not Sick	Female	28	N/A	N/A	2, 3	N/K	Good
24	Not Sick	Female	33	N/A	N/A	1, 2	N/K	Good
25	Not Sick	Male	45	N/A	N/A	1, 2	N/K	Good
26	Not Sick	Male	36	N/A	N/A	2	N/K	Good
27	Not Sick	Female	37	N/A	N/A	2	N/K	Good
28	Not Sick	Male	49	N/A	N/A	1	N/K	Good
29	Not Sick	Male	25	N/A	N/A	1	N/K	Good
30	Not Sick	Male	28	N/A	N/A	1	N/K	Good

HUS, hemolytic uremic syndrome (destruction of red blood cells, compromised kidney function)
N/A, Not Applicable; N/K, None Known

Group A – Tasks 1 and 2 – Interactive Format (symptoms printed on back of faces)



Sick
Male
Age 7 years
Bloody diarrhea, fever,
pain, HUS
Onset April 23
Critical Condition
Ate Food # 3

Sick
Male
Age 40 years
Diarrhea, fever, pain,
nausea
Onset April 24
Recovering
Ate Foods # 2 and 3

Sick
Female
Age 37 years
Diarrhea, fever, pain,
nausea
Onset April 27
Recovering
Ate Foods # 2 and 3

Sick
Female
Age 81 years
Bloody diarrhea, fever,
pain, nausea, HUS,
kidney failure
Onset April 25
Immunocompromised
Deceased
Ate Food # 3

Sick
Female
Age 51 years
Diarrhea, fever, pain,
nausea
Onset April 25
Recovering
Ate Food # 3

Sick
Female
Age 54 years
Diarrhea, fever, pain,
nausea
Onset May 1
Recovering
Ate Food # 2






Sick
Female
Age 12 years
Bloody diarrhea, fever,
pain
Onset April 27
Condition Poor
Ate Foods # 1 and 2

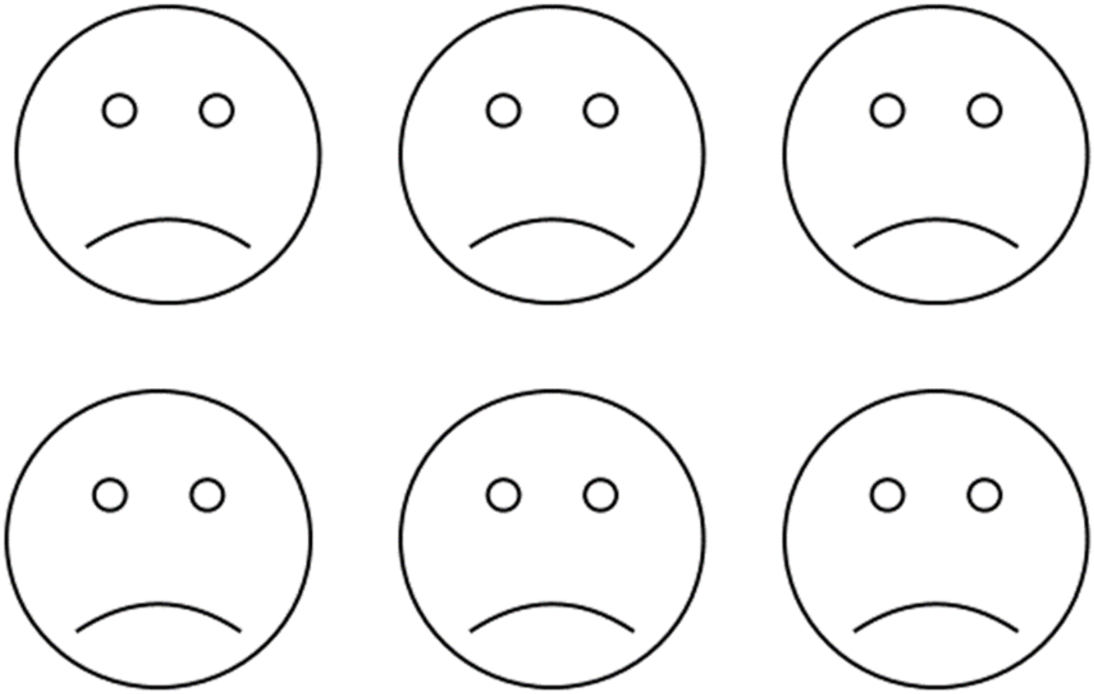
Sick
Female
Age 45 years
Diarrhea, fever, pain,
nausea
Onset April 28
Recovering
Ate Food # 2

Sick
Male
Age 43 years
Diarrhea, fever, pain,
nausea
Onset April 29
Recoverying
Ate Foods # 1 and 3

Sick
Male
Age 15 years
Bloody diarrhea, fever,
pain
Onset April 28
Recovering
Ate Food # 3

Sick
Female
Age 23 years
Diarrhea, fever, pain,
nausea, HUS
Onset April 28
Pregnant, Poor
Condition
Ate Foods # 2 and 3

Sick
Female
Age 8 years
Bloody diarrhea, fever,
pain, nausea, HUS
Onset April 28
Critical Condition
Ate Food # 3



Sick
Female
Age 29 years
Diarrhea, fever, pain,
nausea
Onset April 26
Recovering
Ate Food # 3

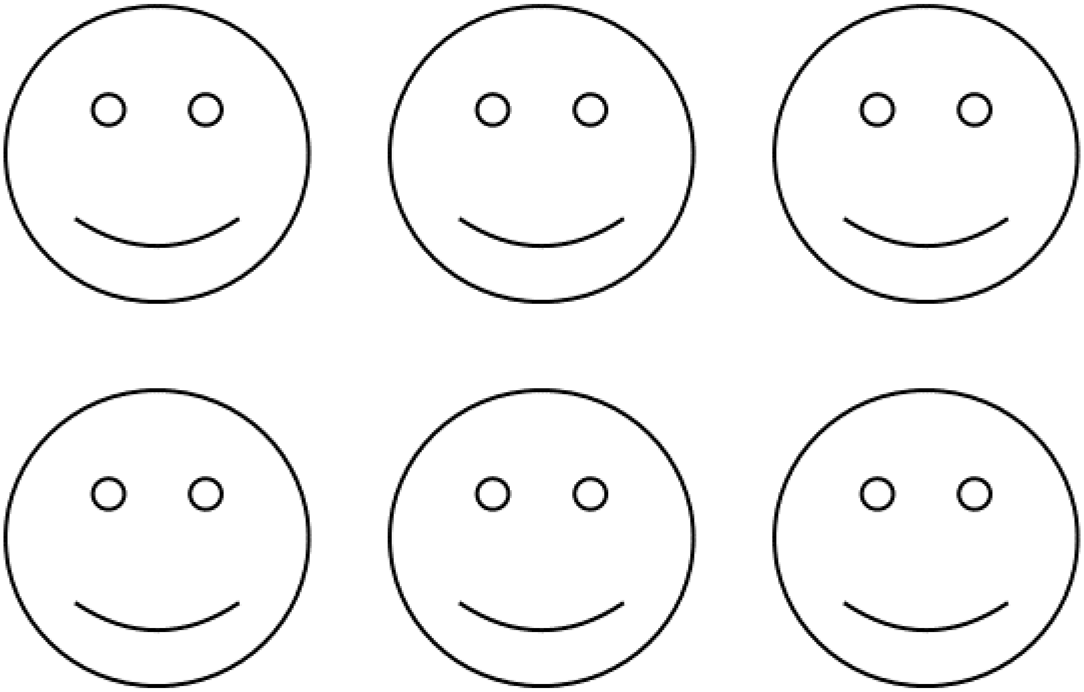
Sick
Male
Age 55 years
Diarrhea, fever, pain,
nausea
Onset April 27
Recovering
Ate Foods # 1, 2 and 3

Sick
Male
Age 72 years
Bloody diarrhea, fever,
pain
Onset April 28
Recovering
Ate Foods # 1 and 3

Sick
Male
Age 61 years
Diarrhea, fever, pain,
nausea
Onset May 4
Recovering
Ate Foods # 1, 2, and 3

Sick
Male
Age 25 years
Diarrhea, fever, pain,
nausea
Onset May 2
Ate Foods # 2 and 3

Sick
Female
Age 31 years
Diarrhea, fever, pain,
nausea
Onset April 26
Recovering
Ate Foods # 1 and 3



Not Sick
Female
Age 46 years
Ate Foods # 1 and 2

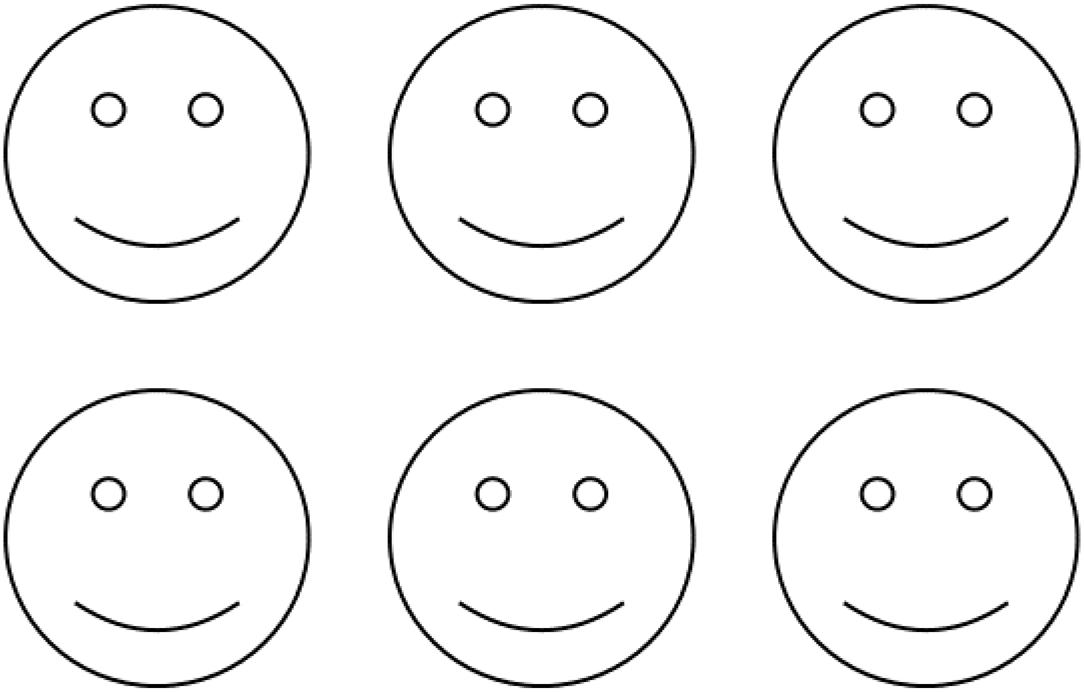
Not Sick
Male
Age 31 years
Ate Foods # 1 and 3

Not Sick
Male
Age 48 years
Ate Food # 2

Not Sick
Female
Age 49 years
Ate Food # 1

Not Sick
Female
Age 28 years
Ate Foods 2 and 3

Not Sick
Female
Age 33 years
Ate Foods # 1 and 2



Not Sick
Male
Age 45 years
Ate Foods # 1 and 2

Not Sick
Male
Age 36 years
Ate Food # 2

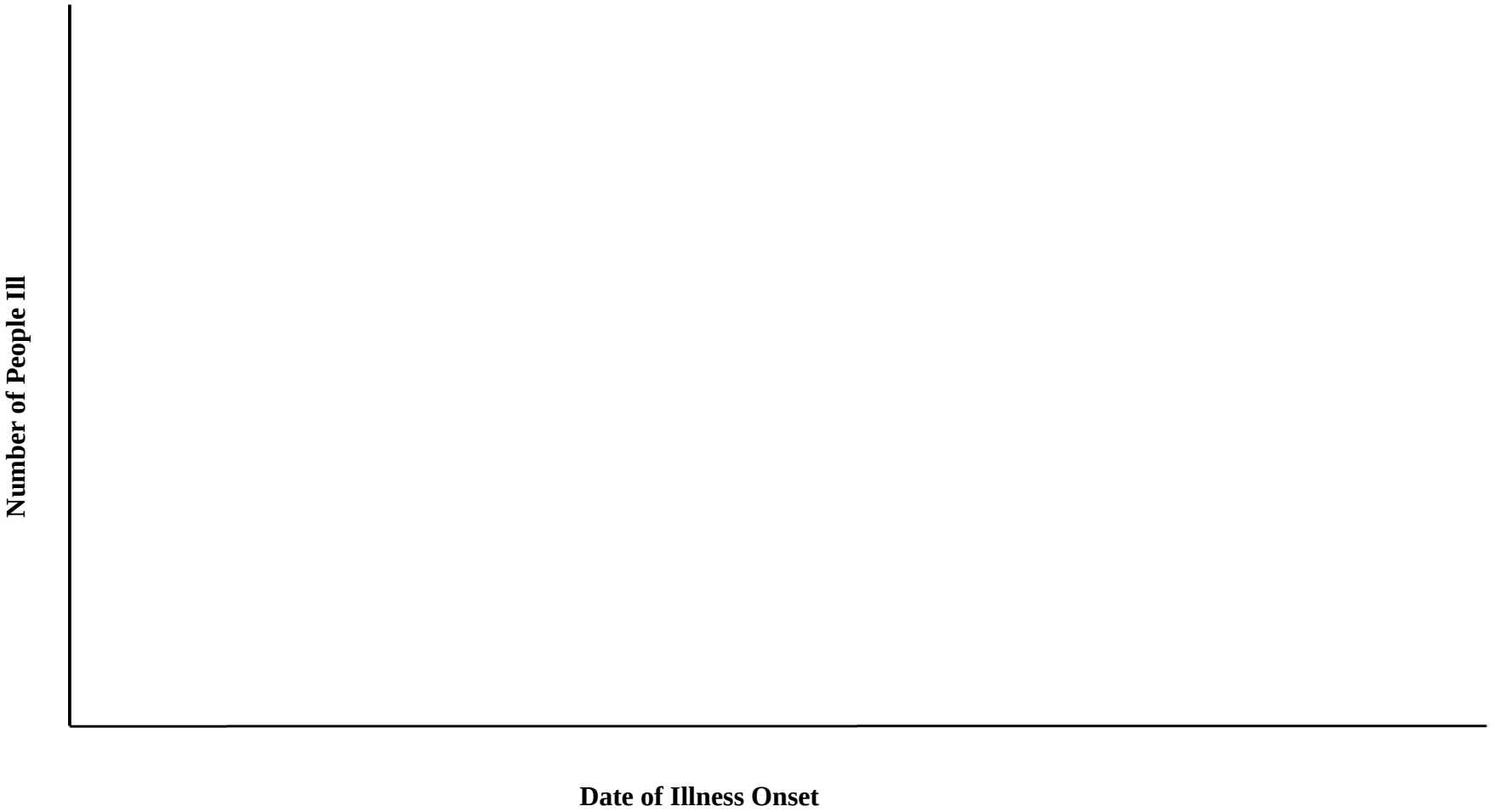
Not Sick
Female
Age 37 years
Ate Food # 2

Not Sick
Male
Age 49 years
Ate Food # 1

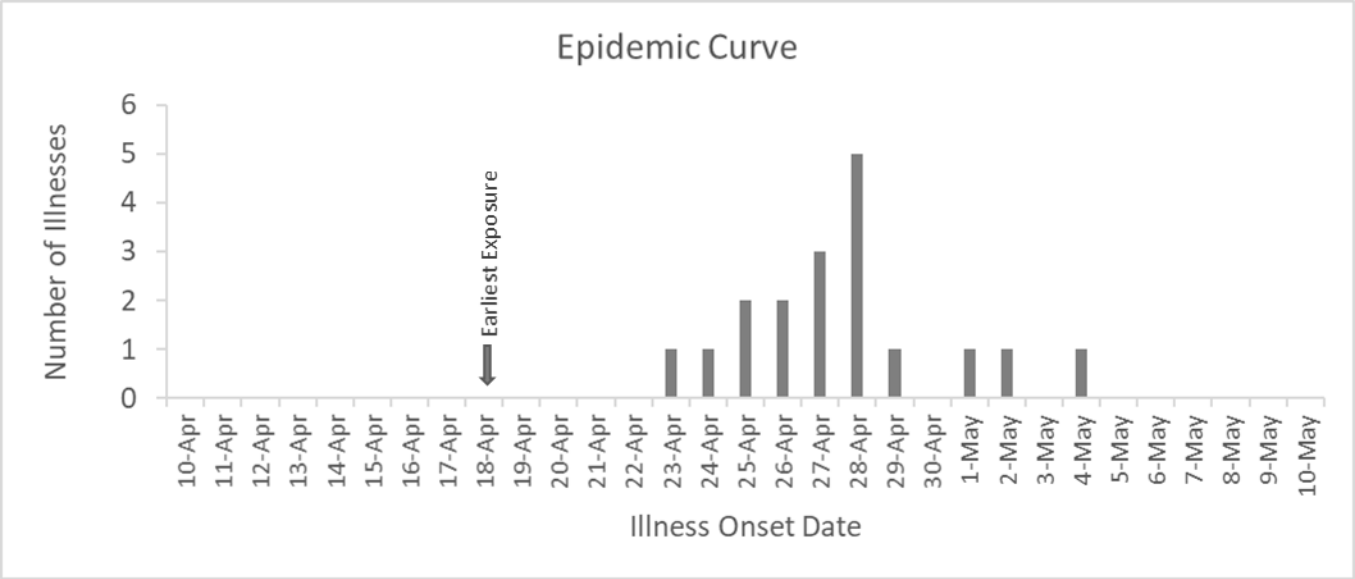
Not Sick
Male
Age 25 years
Ate Food # 1

Not Sick
Male
Age 28 years
Ate Food # 1

Group A - Task 1



Group A – Task 1 Answer



Group A - Task 2

Food	# Ate and Sick	# Ate and Not Sick	# Not Eat and Sick	# Not Eat and Not Sick	Odds Ratio
1	*6*	*8*	*12*	*4*	*0.25*
2					
3					

Odds Ratio = $\frac{[(\#\text{Ate and Sick}) \div (\#\text{Not Eat and Sick})]}{[(\#\text{Ate Not Sick}) \div (\#\text{Not Eat and Not Sick})]}$

Group A – Task 2 Answer

Food	# Ate and Sick	# Ate and Not Sick	# Not Eat and Sick	# Not Eat and Not Sick	Odds Ratio
1	*6*	*8*	*11*	*4*	*1.09*
2	9	7	9	4	0.57
3	15	2	3	10	25

Group A

Code Solution: 183

CONSERVE EXERCISE – Interactive Outbreak Investigation

Group B – Laboratory Investigation

Physicians in seven states in the United States have diagnosed severe gastroenteritis among 187 individuals. Certain findings make this an event reportable to public health authorities. This number of concurrent, similar illnesses is greater than the numbers typically reported in the same regions and time period. This suggests the illnesses may be related and part of an outbreak.

You are part of a team of professionals who must work together to determine the cause and source of illness and to take measures to protect the public from continued exposure. The professionals involved in solving this outbreak include state and federal public health officials who conduct the epidemiological investigation, regulatory authorities who help identify the source of implicated product and potential cause of contamination, and producers and distributers of any implicated products who recall product from commerce and take corrective action. These experts also work with the media to inform the public of risk and protective measures. They may also work with research scientists to resolve the problem and prevent recurrence.

Your role in the investigation is as a laboratory professional who determines what tests should be run and interprets the data. Your job is not an easy one. Concerned producers, manufacturers, distributors, regulators, and consumers are relying on you to help improve the safety of the food supply.

Tasks (Note: Task 2 information will be helpful for interpreting results for Task 3)

1. Determine lab tests to be conducted on patient stool samples.
    a. Review patient symptoms and compare to food and waterborne pathogen characteristics.
    b. Determine which pathogen number is most likely responsible for disease symptoms.

2. Determine time frame for results.
    a. Review the protocol for the suspected disease agent.
    b. Determine the minimum number of experimental days that will be needed to obtain results on the identity of the contaminant in clinical samples.

3. Determine which, if any, of the food sample data matches patient clinical samples.
    a. Complete the puzzle to rebuild the broken gel for lab data.
    b. Review data for clinical and food samples.
    c. Determine which food sample has an isolate indistinguishable from the reference clinical sample (lane 1).

4. The numerical answers from Tasks 1b, 2b and 3c form your 3-digit code.

Group B

Numeric Code

Test your code to open the lock, and prepare to share the following information with the class.

Group presentations will be given in alphabetical order by group letter. Each group presentation will be 5 minutes or less.

Present to the class:

1. The group's tasks and solutions

2. *E. coli* STEC symptoms and transmission vehicles

3. Your thoughts on if a food sample does not test positive for the same disease agent identified in stool samples, does it *guarantee* the food product was *not* associated with the outbreak?

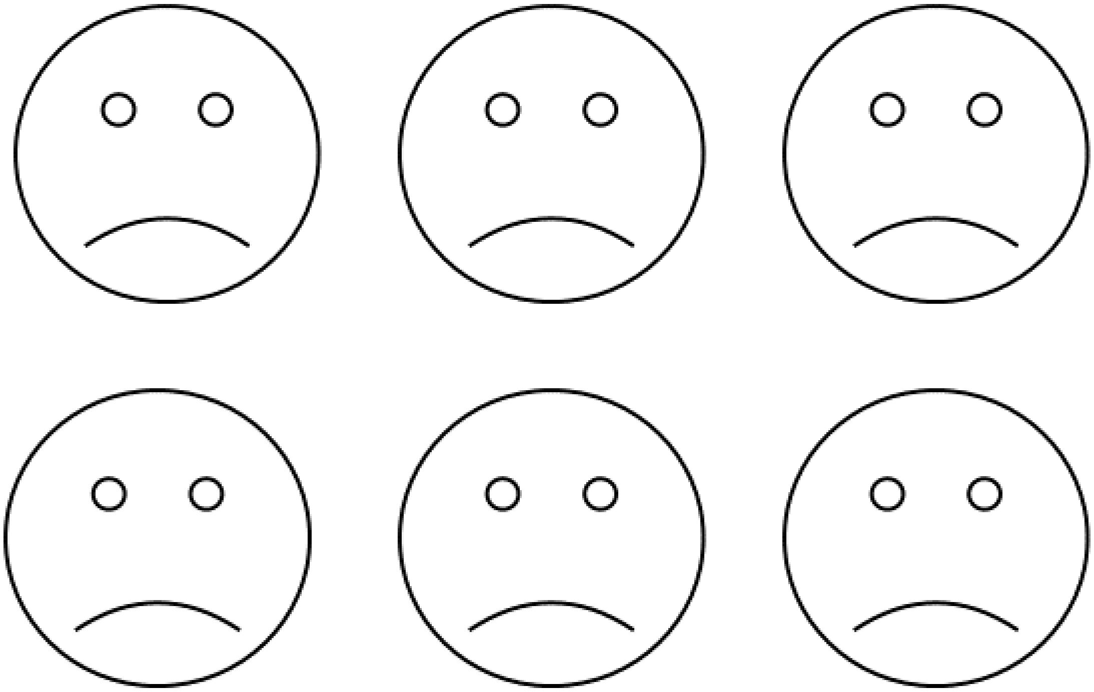
Group B – Task 1

Patient Symptoms

Patient Stool Sample Bar Code	Sick or Not Sick	Gender	Age (yrs)	Symptoms	Illness Onset	Foods Consumed	Prior Health Concerns	Current Health Status
111111	Sick	Female	12	Bloody diarrhea, fever, pain	April 27	1, 2	N/K	Poor
111112	Sick	Female	45	Diarrhea, fever, pain, nausea	April 28	2	N/K	Recovering
111113	Sick	Male	43	Diarrhea, fever, pain, nausea	April 29	1, 3	N/K	Recovering
111114	Sick	Male	15	Bloody diarrhea, fever, pain	April 28	3	N/K	Recovering
111115	Sick	Female	23	Diarrhea, fever, pain, nausea	April 28	2, 3	Pregnant	Poor
111116	Sick	Female	8	Bloody diarrhea, fever, pain, nausea, HUS	April 28	3	N/K	Critical
111117	Sick	Female	29	Diarrhea, fever, pain, nausea	April 26	3	N/K	Recovering
111118	Sick	Male	55	Diarrhea, fever, pain, nausea	April 27	1, 2, 3	N/K	Recovering
111119	Sick	Male	72	Bloody diarrhea, fever, pain	April 28	1, 3	N/K	Recovering
111120	Sick	Male	61	Diarrhea, fever, pain, nausea	May 4	1, 2, 3	N/K	Recovering
111121	Sick	Male	25	Diarrhea, fever, pain, nausea	May 2	2, 3	N/K	Recovering
111122	Sick	Female	31	Diarrhea, fever, pain, nausea	April 26	1, 3	N/K	Recovering
111123	Sick	Male	7	Bloody diarrhea, fever, pain, HUS	April 23	3	N/K	Critical
111124	Sick	Male	40	Diarrhea, fever, pain, nausea	April 24	2, 3	N/K	Recovering
111125	Sick	Female	37	Diarrhea, fever, pain, nausea	April 27	2, 3	N/K	Recovering
111126	Sick	Female	81	Bloody diarrhea, fever, pain, nausea, HUS, kidney failure	April 25	3	Immune-compromised	Deceased
111127	Sick	Female	51	Diarrhea, fever, pain, nausea	April 25	3	N/K	Recovering
111128	Sick	Female	54	Diarrhea, fever, pain, nausea	May 1	2	N/K	Recovering

HUS, hemolytic uremic syndrome (destruction of red blood cells, compromised kidney function)
N/K, None Known

Group B – Task 1 – Clue (symptoms printed on back of faces)



Sick
Female
Age 12 years
Bloody diarrhea, fever,
pain
Onset April 27
Condition Poor
Ate Foods # 1 and 2

Sick
Female
Age 45 years
Diarrhea, fever, pain,
nausea
Onset April 28
Recovering
Ate Food # 2

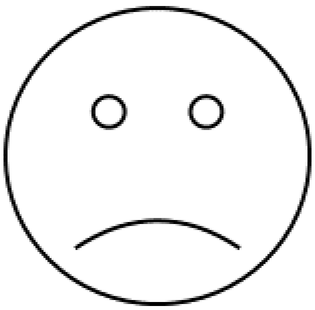
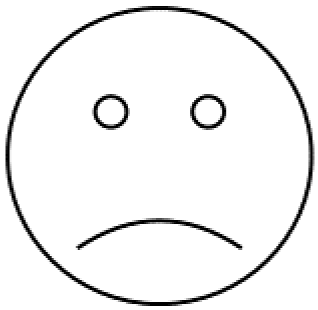
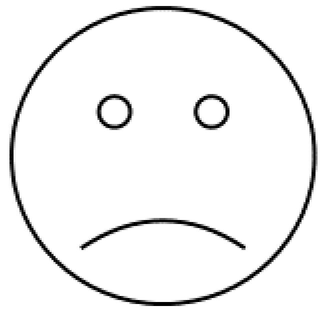
Sick
Male
Age 43 years
Diarrhea, fever, pain,
nausea
Onset April 29
Recoverying
Ate Foods # 1 and 3

Sick
Male
Age 15 years
Bloody diarrhea, fever,
pain
Onset April 28
Recovering
Ate Food # 3

Sick
Female
Age 23 years
Diarrhea, fever, pain,
nausea, HUS
Onset April 28
Pregnant, Poor
Condition
Ate Foods # 2 and 3

Sick
Female
Age 8 years
Bloody diarrhea, fever,
pain, nausea, HUS
Onset April 28
Critical Condition
Ate Food # 3



Sick
Female
Age 29 years
Diarrhea, fever, pain,
nausea
Onset April 26
Recovering
Ate Food # 3

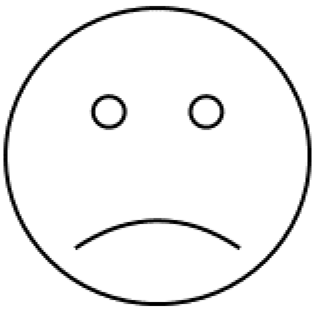
Sick
Male
Age 55 years
Diarrhea, fever, pain,
nausea
Onset April 27
Recovering
Ate Foods # 1, 2 and 3

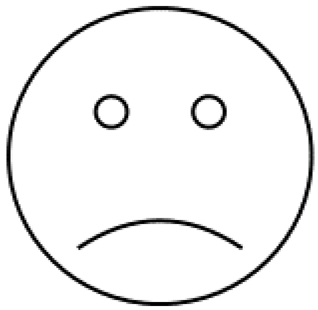
Sick
Male
Age 72 years
Bloody diarrhea, fever,
pain
Onset April 28
Recovering
Ate Foods # 1 and 3

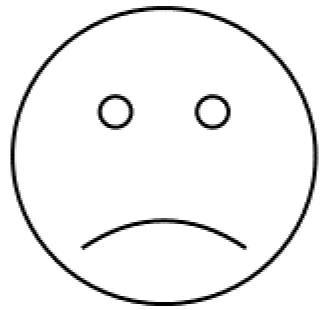
Sick
Male
Age 61 years
Diarrhea, fever, pain,
nausea
Onset May 4
Recovering
Ate Foods # 1, 2, and 3

Sick
Male
Age 25 years
Diarrhea, fever, pain,
nausea
Onset May 2
Ate Foods # 2 and 3

Sick
Female
Age 31 years
Diarrhea, fever, pain,
nausea
Onset April 26
Recovering
Ate Foods # 1 and 3







Sick
Male
Age 7 years
Bloody diarrhea, fever, pain, HUS
Onset April 23
Critical Condition
Ate Food # 3

Sick
Male
Age 40 years
Diarrhea, fever, pain, nausea
Onset April 24
Recovering
Ate Foods # 2 and 3

Sick
Female
Age 37 years
Diarrhea, fever, pain, nausea
Onset April 27
Recovering
Ate Foods # 2 and 3

Sick
Female
Age 81 years
Bloody diarrhea, fever, pain, nausea, HUS, kidney failure
Onset April 25
Immunocompromised
Deceased
Ate Food # 3

Sick
Female
Age 51 years
Diarrhea, fever, pain, nausea
Onset April 25
Recovering
Ate Food # 3

Sick
Female
Age 54 years
Diarrhea, fever, pain, nausea
Onset May 1
Recovering
Ate Food # 2

Group B – Task 1 - Select Foodborne and Waterborne Pathogens (incomplete list)

	Etiology	Symptoms	Incubation Period	Illness Duration	Foods Associated	Additional Notes
1	*Campylobacter jejuni*	Diarrhea (often bloody), abdominal pain, fever	2 to 10d, usually 2 to 5 d	2 to 10 d	Undercooked poultry, unpasteurized milk, contaminated water	Long-term sequela: Guillain-Barré Syndrome
2	*Clostridium perfringens*	Diarrhea, abdominal cramps	8 to 22 h, usually 10 to 24 h	24 to 48 h	Temperature-abused cooked meats, gravy, beans	Sporeformer, endoenterotoxin
3	*Cyclospora cayetanensis*	Fatigue, protracted diarrhea, often relapsing	1 to 11d, medium: 7d	Weeks to months with relapse	Fresh produce (raspberries, lettuce, basil), contaminated water	Humans only known reservoir, cannot be propagated in laboratory or model animal.
4	*Escherichia coli* (Enterohemorrhagic, (EHEC), shiga-toxin producing (STEC))	Diarrhea (often bloody), abdominal cramps (often severe), low-grade fever, hemolytic uremic syndrome (HUS), kidney failure	1 to 10 d, typically 2 to 5 d	5 to 10 d	Undercooked animal products, raw produce, unpasteurized juice	chronic kidney disease; antibiotic therapy may be contraindicated
5	*Listeria monocytogenes*	Diarrhea, abdominal cramps, fever. If invasive, meningitis, neonatal sepsis, fever	3 to 70 d, usually 4 to 21 d	Variable	Soft cheese, unpasteurized milk, RTE meats, hot dogs	Can cause stillbirth, miscarriage
6	Norovirus	Vomiting, cramps, diarrhea, headache	15 to 77 h, usually 24 to 48 h	12 to 60 hours	Fecally-contaminated foods. Shellfish, fresh produce, RTE handled foods.	Cannot be propagated in laboratory
7	*Salmonella* spp.	Fever, abdominal pain, vomiting, diarrhea	6 to 72 h, typically 18 to 36h	4 to 7 d	Undercooked eggs, poultry, unpasteurized milk or juice, raw produce, chocolate	
8	*Staphylococcus aureus*	Vomiting, diarrhea, abdominal pain	1 to 8h, usually 2 to 4h	24 to 48 h	Improperly refrigerated meats, cream-filled pastries, high protein leftover foods	Intoxication due to preformed toxin
9	*Vibrio parahaemolyticus*	Diarrhea, vomiting, abdominal pain, fever	4 to 96 h, typically 12h	2 to 5 d	Undercooked seafood	

Sources:
Morbidity and Mortality Weekly Report, October 25, 1996, vol. 45, No. SS-5, pp. 58-67
Procedures to Investigate Foodborne Illness, 5th Ed. 1999. IAFP, Des Moines, IA.
Diagnosis and Management of Foodborne Illness, A Primer for Physicians and Other Health Care Professionals, AMA, ANA, CFSAN/FDA, FSIS/USDA,2004.

Group B – Task 2

Protocol for Isolation and Identification of Bacteria

1. Combine test sample with enrichment medium to enhance bacterial growth. Incubate at 37°C for 24 hours.

2. Transfer one ml of enrichment medium to a selective broth medium containing nutrients to enhance growth of suspected bacterial contaminant. Incubate at 37°C for 24 hours.

3. Spread a sample of selective broth medium onto differential agar medium containing nutrients to enhance growth of suspected bacterial contaminant in sample and indicator reagents to aid detection of pathogen among other nonpathogenic microorganisms. Incubate at 37°C for 24 hours.

4. Observe microbial growth on agar plates of differential growth medium. Note the appearance of bacterial colonies including colony shape, color, sheen, and the color of surrounding medium for indications of the nutrients in the media that were utilized by the bacteria and the products of bacterial growth. Determine whether the colony appearance is consistent with the suspected etiology for the illness outbreak.

5. Remove a colony from the agar plate, and suspend it in water. Heat the water to 100°C for 10 min to inactivate the bacteria and to release genetic material.

6. Perform analyses of DNA. (Analyses can be done simultaneously requiring approximately 3 hours for each.)

    a. Polymerase Chain Reaction (PCR) - to check for the presence of genes that encode virulence factors (such as toxins) that can cause the illness symptoms.
        i. Suspend DNA in reagents (buffer, nucleotides, and specific sequences of nucleotides that match unique DNA segments).
        ii. Incubate in a thermocycler to select for and make copies of genes that encode virulence factors. A sufficient number of copies is needed for detection.
        iii. Detect copies of DNA that encode for virulence factors (if present) by mixing with fluorescent molecules and measuring fluorescence during incubation, *or* by staining DNA loaded into a gel.

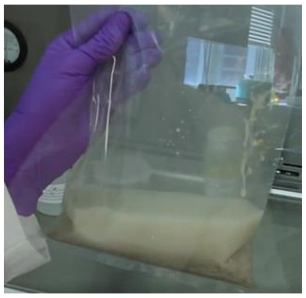
    b. Pulse Field Gel Electrophoresis (PFGE) – to determine if genetic profiles for clinical (stool) isolates and implicated food are indistinguishable.
        i. Suspend DNA in reagents (buffer and enzymes that cut the DNA into pieces at specific sequence locations).
        ii. Load the treated DNA suspension into wells of a gel. Apply an electric current to the gel to make the DNA pieces travel within the gel.
        iii. Stain the gel to detect how far the DNA pieces traveled within the gel; small pieces will travel a greater distance than large pieces.
        iv. Compare the staining patterns for the samples to see which have matching profiles.

Bacteria are single cellular microbes. Outer layers include a membrane and wall. Some contain pili and flagella on outer surfaces which aid in motility and attachment. Bacterial chromosomal DNA strands are circular.

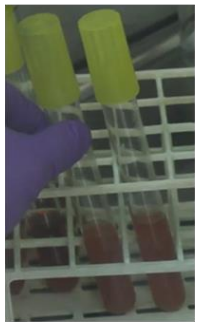
Bacteria can be detected in clinical, food, and environmental samples based on various metabolic (growth in nutrient media) and structural (genetic material, surface molecules) properties.

Food samples implicated in disease transmission are tested for bacteria in the laboratory. Ideally, the food sample would come from an unopened container.

Bacterial Growth Enrichment and Detection by Metabolic Properties

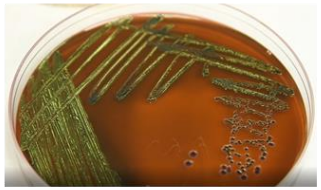


1. Samples are mixed with enrichment medium to enhance bacterial growth.



2. Growth from the enrichment broth are transferred to selective medium to enhance growth of suspected bacterial pathogen.

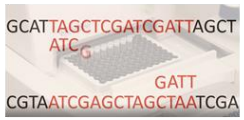
3. Selective broth is transferred to differential agar medium.



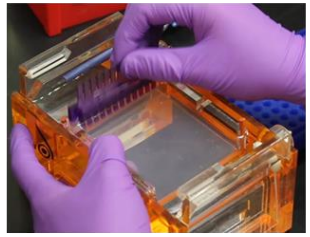
4. Bacterial growth is observed on differential agar medium.

5. Bacterial colony is suspended and heated to release bacterial DNA.

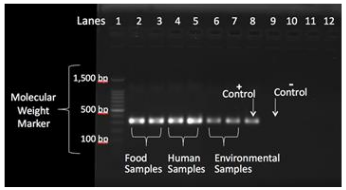
Detection of Bacteria by Unique DNA Sequences



6a. Unique segments of pathogenic bacterial DNA are selected and copied by polymerase chain reaction.

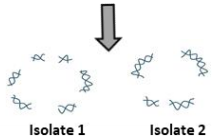


6a cont'd. The presence of copied DNA segments are detected by gel electrophoresis and staining. Positive samples appear as bands in a gel.

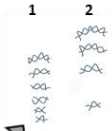


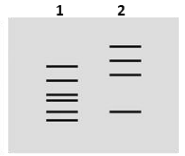
Comparing Bacterial Isolates by Patterns of Cut DNA Sequences

6b. The DNA of two bacterial isolates is treated by enzymes that cut the DNA at specific nucleotides.



The patterns of cut DNA segment sequences are compared. Identical isolates have identical cut patterns.





6b cont'd. Cut DNA segments are detected by the distances traveled in a gel after application of an electrical current. These two isolates have different DNA segment sizes indicating they have different DNA sequences. These isolates are not identical.

Group B – Task 3

PFGE Data for Clinical and Food Samples

Determine which, if any, of the food sample data matches patient clinical samples.

- Complete the puzzle to rebuild the broken gel for lab data.
- The gel visualizes DNA of bacteria isolated from various samples.
- Bacterial DNA is cut experimentally with enzymes into smaller pieces. The pieces are separated and visualized as bands by gel electrophoresis whereby all of the DNA of each isolate is loaded into a well at the top of a horizontal gel. This gel has seven wells for seven sample isolates. The gel is subjected to an electric current and pieces of DNA move through the gel. Smaller pieces of DNA move through the gel faster and appear farthest from the well (just below the lane numbers).
- Sample isolates that are the same will have the same DNA banding pattern.
- Review data for clinical (lane 1) and food samples (lanes 2 through 7).
- Determine which food sample has a bacterial isolate indistinguishable from the reference clinical stool sample (lane 1).

Group B – Task 3 – (jigsaw puzzle)

Group B

Code Solution: 445

CONSERVE EXERCISE – Interactive Outbreak Investigation

Group C – Traceback and Recall Investigation

Physicians in seven states in the United States have diagnosed severe gastroenteritis among 187 individuals. Certain findings make this an event reportable to public health authorities. This number of concurrent, similar illnesses is greater than the numbers typically reported in the same regions and time period. This suggests the illnesses may be related and part of an outbreak.

You are part of a team of professionals who must work together to determine the cause and source of illness and to take measures to protect the public from continued exposure. The professionals involved in solving this outbreak include state and federal public health officials who conduct the epidemiological investigation, regulatory authorities who help identify the source of implicated product and potential cause of contamination, and producers and distributers of any implicated products who recall product from commerce and take corrective action. These experts also work with the media to inform the public of risk and protective measures. They may also work with research scientists to resolve the problem and prevent recurrence.

Your role in the investigation is to trace the implicated food product back to its source and determine the full distribution of the implicated product.

Your job is not an easy one. Concerned producers, manufacturers, distributors, regulators, and consumers are relying on you to help improve the safety of the food supply.

Tasks

1. Begin traceback to product source by interpretation of product label codes.
    a. Align the wheel puzzle to reveal clues to interpret the bar codes.
    b. Determine the single-digit facility number associated with the implicated product.

2. Trace product back to source through distribution records.
    a. Review the packing facility records for the production date of the product implicated in the illness outbreak.
    b. Determine the product source (producer #) associated with the implicated product.

3. Determine breadth of distribution of implicated product to support recall efforts.
    a. Review the distribution records for the packing house.
    b. Using the production date of the implicated product (determined in Task 1) and the product source (determined in Task 2), identify the states to which implicated product was distributed.
    c. Determine how many states to which implicated product was distributed.

4. Your numerical answers from tasks 1b, 2b, and 3c form your 3-digit code.

Group C

Numeric Code

Test your code to open the lock, and prepare to share the following information with the class.

Group presentations will be given in alphabetical order by group letter. Each group presentation will be 5 minutes or less.

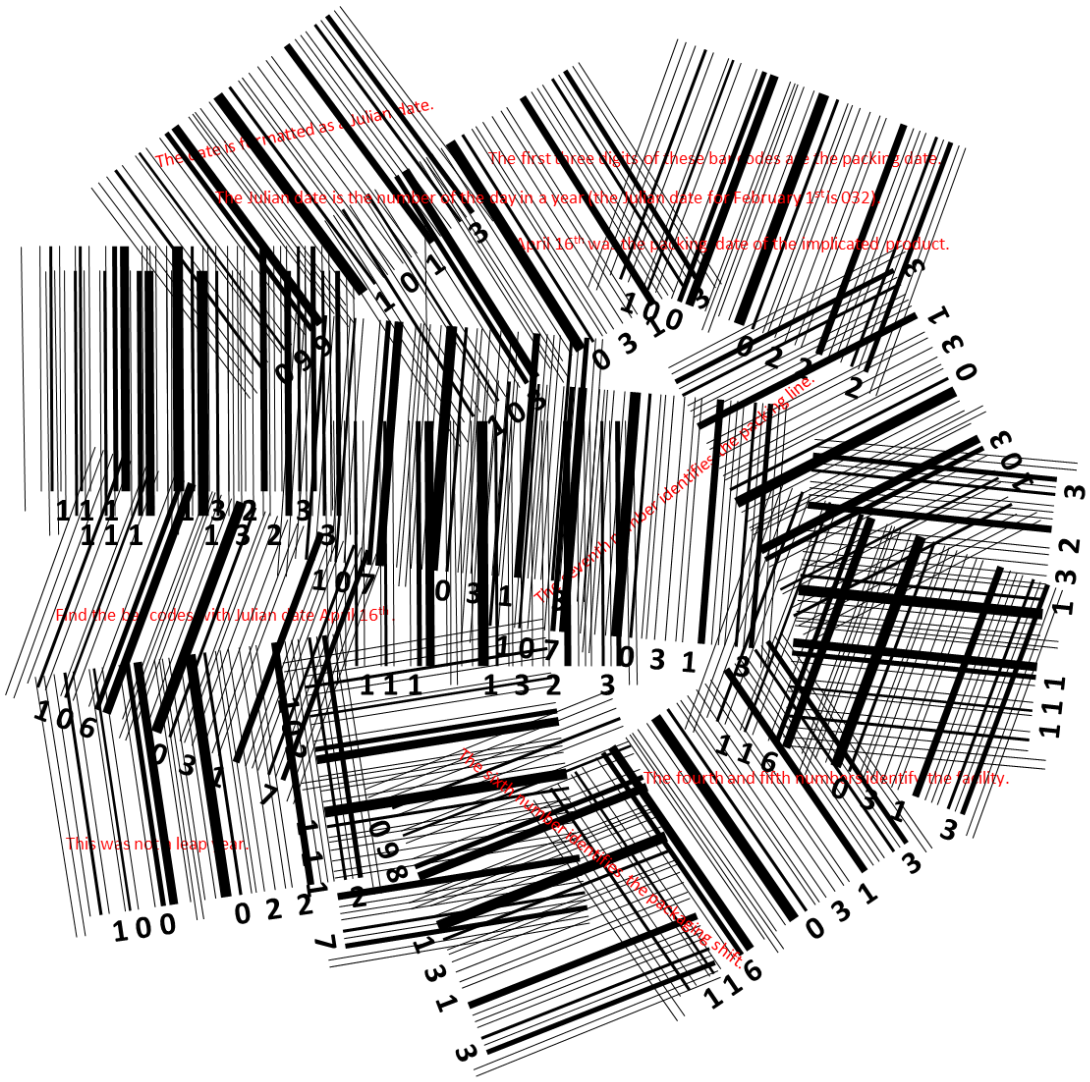
Present to the class:

1. The group's tasks and solutions

2. Your thoughts on how traceability software could impact investigations and product recalls.

3. Your thoughts on what measures would be needed to notify and protect the public from a contaminated product in commerce with a long shelf life or as a common ingredient in multiple products.

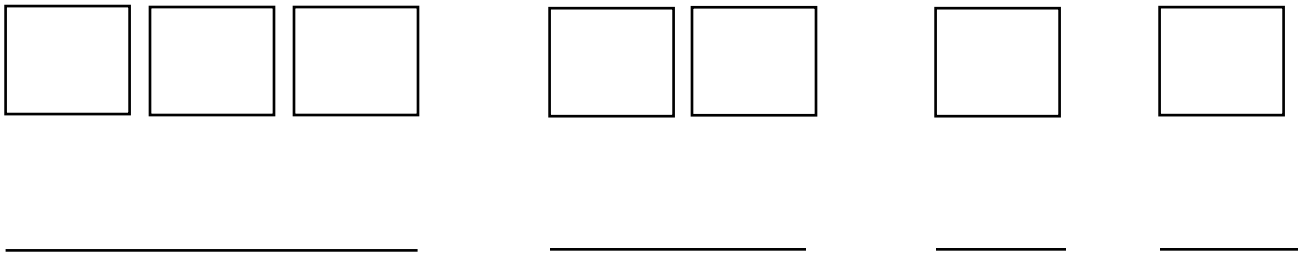
Group C – Task 1



Group C – Task 1

Wheel Puzzle Solution (Bar Code of Implicated Product and Bar Code Identifiers)

- Align the wheel puzzle to reveal clues in red font behind the bar codes.
- Use the magnifier to read the clues in red font.
- Use the clues to identify the bar code of the implicated product found on the puzzle.
- Use the boxes to fill in the numbers of the implicated product.
- Use the lines below the boxes to indicate what the numbers of the bar code identify.
- Use the bar code of the implicated product to solve Task 1.
- Use the rest of the bar code to help solve Tasks 2 and 3.



Group C - Task 1 Solution

1 0 6 0 3 1 7

Digits 1, 2, 3: Julian date 106 (April 16th)
Digits 4, 5: Facility Number (03)
Digit 6: Production Shift (1)
Digit 7: Production Line (7)

Group C – Task 2

Packing Facility Records for Sources of Products

Date	Shift	Production Line	Product Source (Producer #)
April 15	2	7	3
April 15	2	8	3
April 15	2	9	3, 4
April 16	1	1	1
April 16	1	2	1
April 16	1	3	2
April 16	1	4	2, 3
April 16	1	5	3
April 16	1	6	3
April 16	1	7	4
April 16	1	8	4
April 16	1	9	5
April 16	2	1	6
April 16	2	2	6
April 16	2	3	7, 8
April 16	2	4	9
April 16	2	5	1
April 16	2	6	2
April 16	2	7	2
April 16	2	8	3
April 16	2	9	3
April 17	1	1	1
April 17	1	2	3
April 17	1	3	3

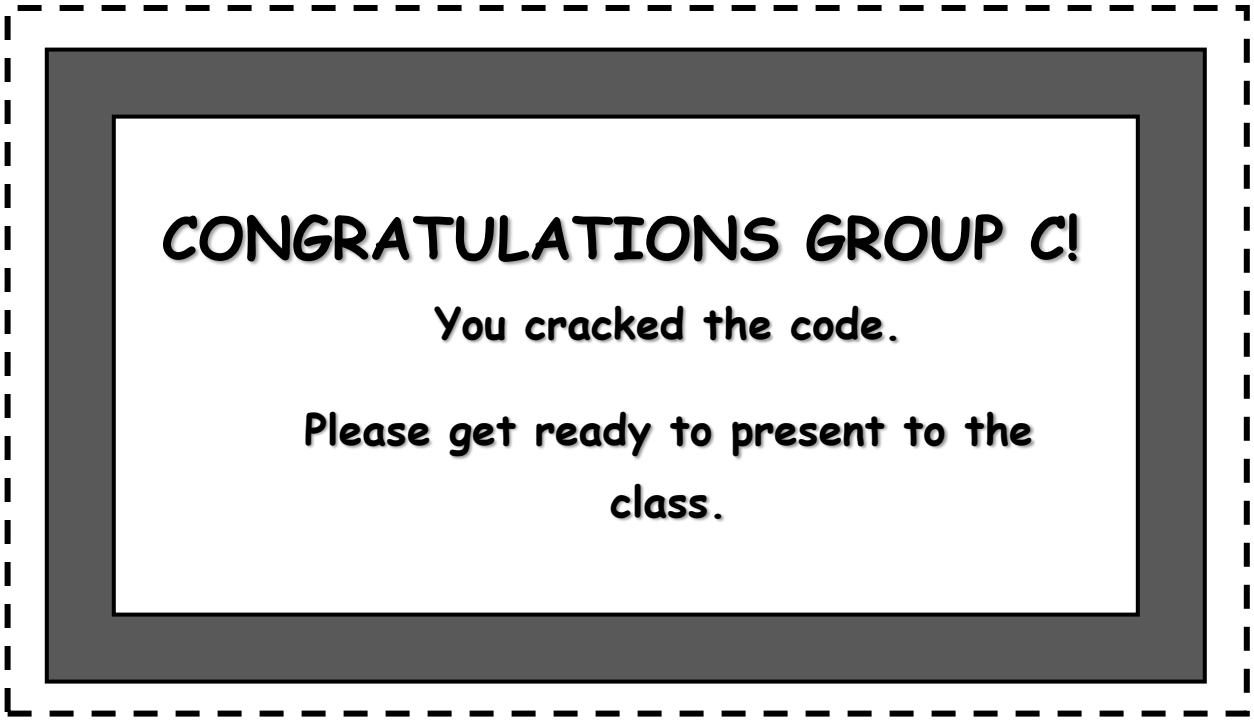
Group C – Task 3

Packing House Distribution Records

Date	Shift	Production Line	Product Source (Producer #)	Wholesale	Retail
April 15	2	7	3	AZ, CA, NM	AZ, CA, NM
April 15	2	8	3	AZ, CA, NM	AZ, CA, NM
April 15	2	9	3, 4	AZ, CA, NM	AZ, CA, NM
April 16	1	1	1	AZ, CA, NM	AZ, CA, NM
April 16	1	2	1	AZ, CA, NM	AZ, CA, NM
April 16	1	3	2	AZ, CA, NM	AZ, CA, NM
April 16	1	4	2, 3	AZ, CA, NM	AZ, CA, NM
April 16	1	5	3	AZ, CA, NM	AZ, CA, NM
April 16	1	6	3	AZ, CA, NM	AZ, CA, NM
April 16	1	7	4	AZ, CA, NM	AZ, CA, NM
April 16	1	8	4	AZ, CA, DE, MD, NJ, NM, NY, PA	AZ, CA, DE, MD, NJ, NM, NY, PA
April 16	1	9	5	AZ, CA, DE, MD, NJ, NM, NY, PA	AZ, CA, DE, MD, NJ, NM, NY, PA
April 16	2	1	6	AZ, CA, DE, MD, NJ, NM, NY, PA	AZ, CA, DE, MD, NJ, NM, NY, PA
April 16	2	2	6	AZ, CA, DE, MD, NJ, NM, NY, PA	AZ, CA, DE, MD, NJ, NM, NY, PA
April 16	2	3	7, 8	AZ, CA, DE, MD, NJ, NM, NY, PA	AZ, CA, DE, MD, NJ, NM, NY, PA
April 16	2	4	9	AZ, CA, DE, MD, NJ, NM, NY, PA	AZ, CA, DE, MD, NJ, NM, NY, PA
April 16	2	5	1	AZ, CA, DE, MD, NJ, NM, NY, PA	AZ, CA, DE, MD, NJ, NM, NY, PA
April 16	2	6	2	AZ, CA, DE, MD, NJ, NM, NY, PA	AZ, CA, DE, MD, NJ, NM, NY, PA
April 16	2	7	2	AZ, CA, DE, MD, NJ, NM, NY, PA	AZ, CA, DE, MD, NJ, NM, NY, PA
April 16	2	8	3	DE, MD, NJ, NY, PA	DE, MD, NJ, NY, PA
April 16	2	9	3	DE, MD, NJ, NY, PA	DE, MD, NJ, NY, PA

Group C

Code Solution: 348



CONSERVE EXERCISE – Interactive Outbreak Investigation

Group D – Environmental Investigation and Risk Assessment

Physicians in seven states in the United States have diagnosed severe gastroenteritis among 187 individuals. Certain findings make this an event reportable to public health authorities. This number of concurrent, similar illnesses is greater than the numbers typically reported in the same regions and time period. This suggests the illnesses may be related and part of an outbreak.

You are part of a team of professionals who must work together to determine the cause and source of illness and to take measures to protect the public from continued exposure. The professionals involved in solving this outbreak include state and federal public health officials who conduct the epidemiological investigation, regulatory authorities who help identify the source of implicated product and potential cause of contamination, and producers and distributers of any implicated products who recall product from commerce and take corrective action. These experts also work with the media to inform the public of risk and protective measures. They may also work with research scientists to resolve the problem and prevent recurrence.

Your role as an outbreak investigator is to evaluate the practices and conditions that may have contributed to contamination of the implicated product. Your job is not an easy one. Concerned producers, manufacturers, distributors, regulators, and consumers are relying on you to help improve the safety of the food supply.

Tasks

1. To evaluate the production environmental conditions that may have contributed to contamination of the implicated food product. Heavy rainfall can cause runoff of surface microbial contaminants from areas surrounding growing fields.
    a. Organize rainfall data for two potential growing regions of the product implicated in the illness outbreak.
    b. Plot the rainfall data on the provided graph of illness onset and exposure dates.
    c. If product distribution occurred within 48 hours after harvest, for which growing operation was rainfall a *potential* factor in pathogen transmission from surrounding surfaces.
2. To evaluate the production environment and practices that may have contributed to contamination of the implicated food product.
    a. Complete the puzzle.
    b. Review the image for potential risks for microbial contamination.
    c. Identify the food production field with the water source at greatest risk for pathogen contamination.
3. Determine the risk for foodborne disease transmission by irrigation method and commodity.
    a. Review the images.
    b. Select the irrigation method that poses the greater risk for spread of microbial pathogens to the edible portion of produce in the event of contamination of the irrigation water.
    c. Select the produce item with the least risk for foodborne disease transmission in the event of irrigation with contaminated water.
    d. Add the selected numbers from answers 3b and 3c.
4. The numerical answers from Tasks 1c, 2c, and 3d form your 3-digit code.

Group D

Numeric Code

Test your code to open the lock, and prepare to share the following information with the class.

Group presentations will be given in alphabetical order by group letter. Each group presentation will be 5 minutes or less.

Present to the class:

1. The group's tasks and solutions

2. The role of environmental waters for potential transmission of microorganisms to food crops

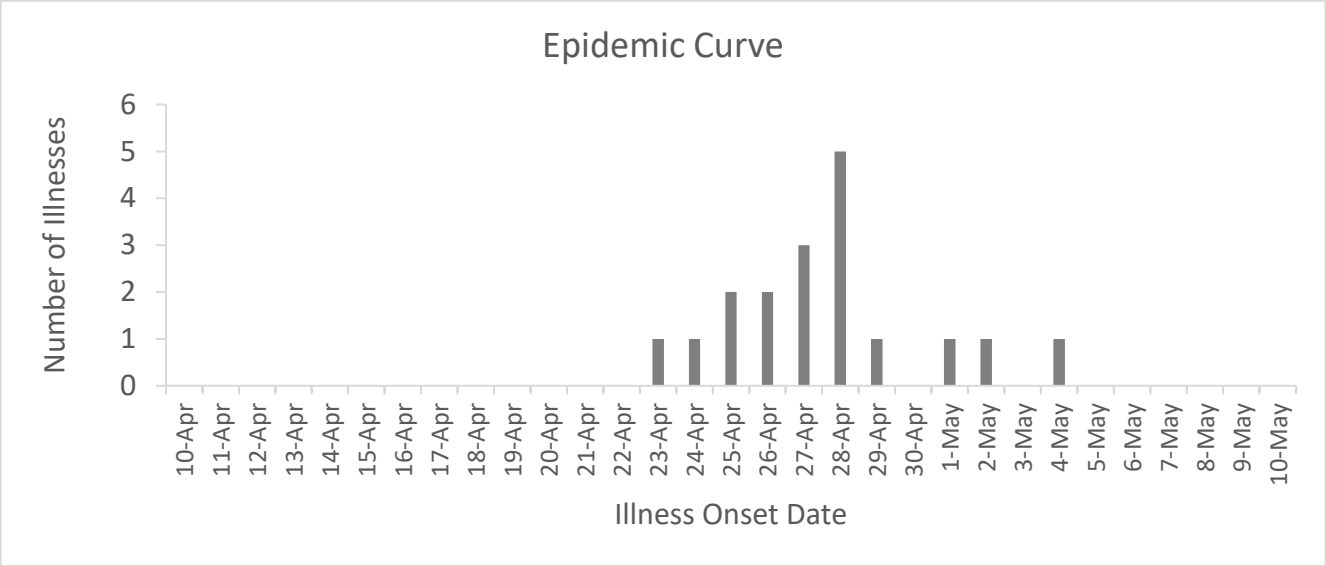
3. Your thoughts on what actions a grower could take to minimize risk of contamination to harvested crops if there were a heavy rain event shortly before harvest

Group D – Task 1

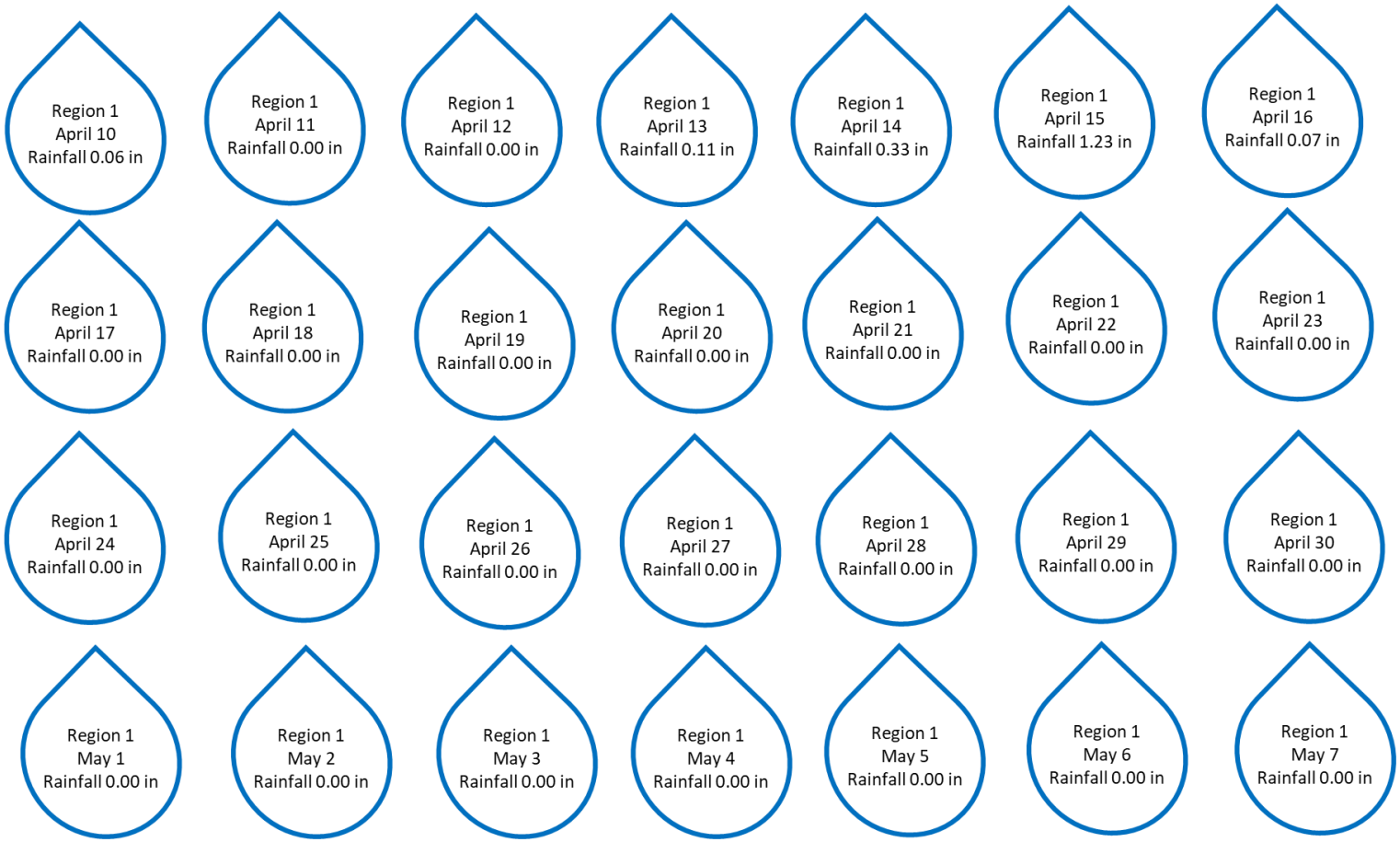
Illness Onset	Number Ill	Rainfall Region 1	Rainfall Region 2
10-Apr	0	0.06	0
11-Apr	0	0	0
12-Apr	0	0	0
13-Apr	0	0.11	0
14-Apr	0	0.33	0.03
15-Apr	0	1.23	0
16-Apr	0	0.07	0
17-Apr	0	0	0
18-Apr	0	0	0
19-Apr	0	0	0
20-Apr	0	0	0
21-Apr	0	0	0
22-Apr	0	0	0
23-Apr	1	0	0.1
24-Apr	1	0	0.06
25-Apr	2	0	0.07
26-Apr	2	0	0.09
27-Apr	3	0	0.3
28-Apr	5	0	1.3
29-Apr	1	0	0.02
30-Apr	0	0	0
1-May	1	0	0.01
2-May	1	0	0.2
3-May	0	0	0
4-May	1	0	0.08
5-May	0	0	0
6-May	0	0	0
7-May	0	0	0
8-May	0	0	0
9-May	0	0	0
10-May	0	0	0

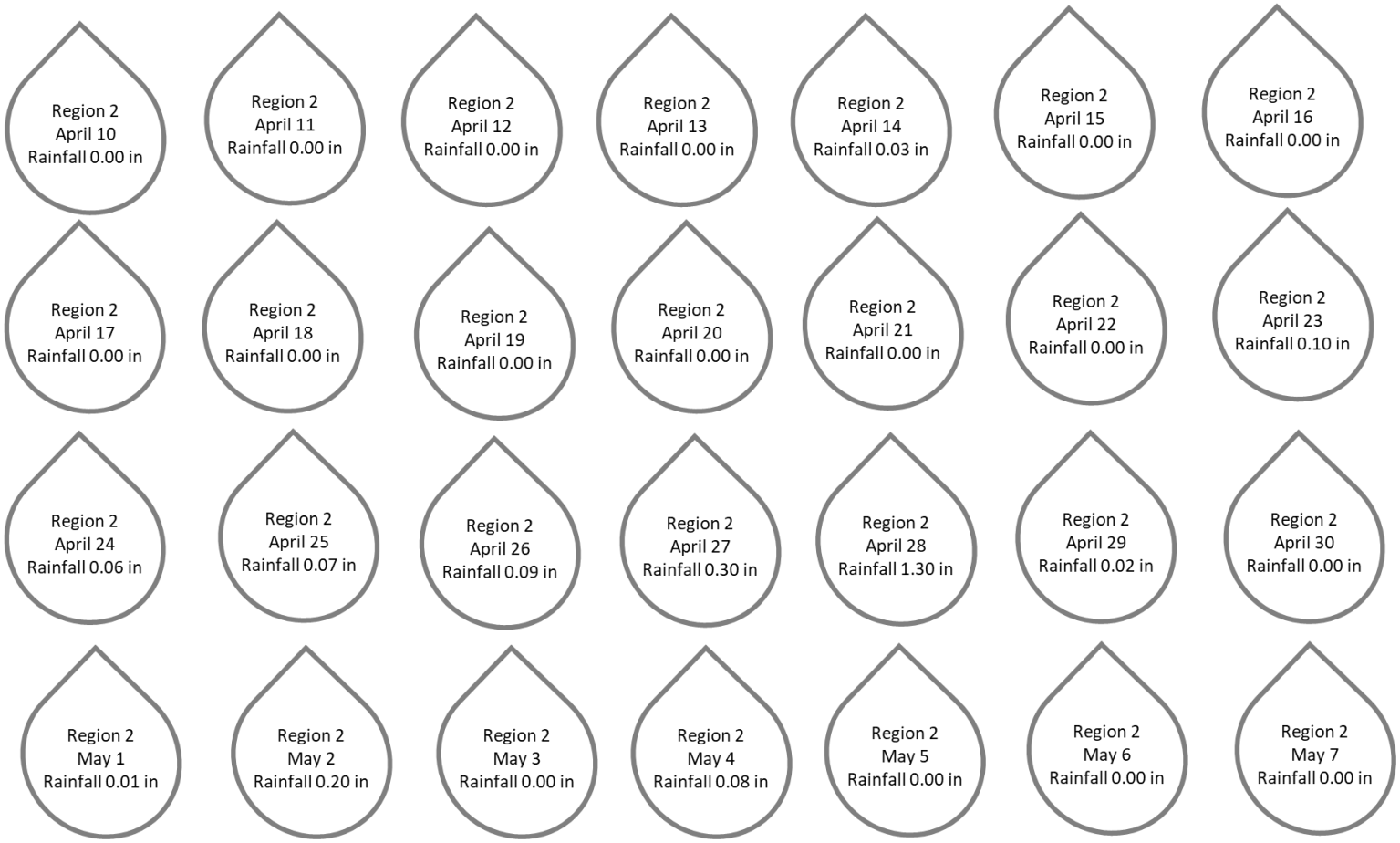
https://www.wunderground.com/history/monthly/us/ca/salinas/KSNS/date/2018-5

Group D – Task 1

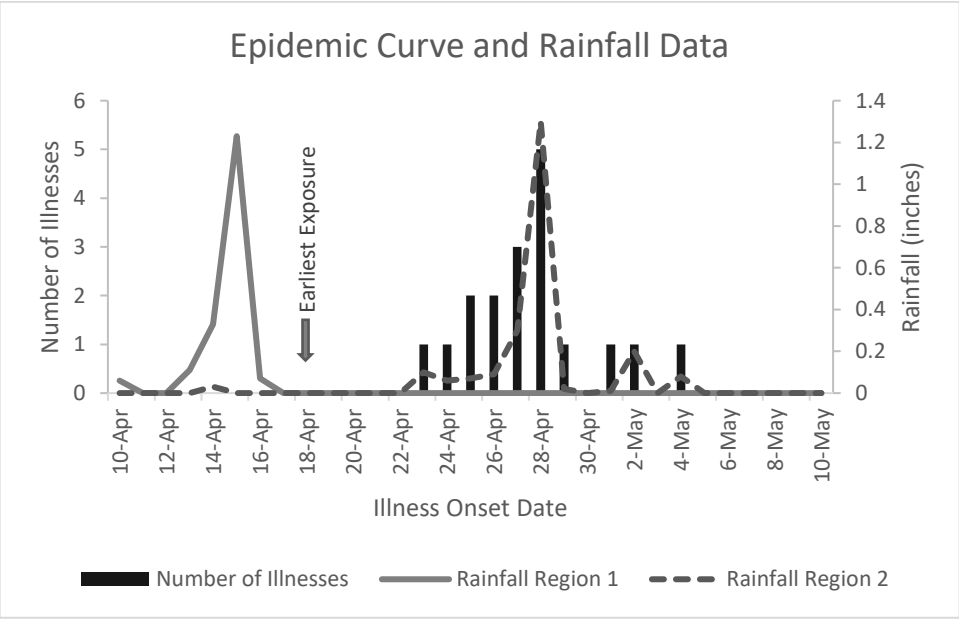


Group D – Task 1




Region 2
April 10
Rainfall 0.00 in
Region 2
April 11
Rainfall 0.00 in
Region 2
April 12
Rainfall 0.00 in
Region 2
April 13
Rainfall 0.00 in
Region 2
April 14
Rainfall 0.03 in
Region 2
April 15
Rainfall 0.00 in
Region 2
April 16
Rainfall 0.00 in
Region 2
April 17
Rainfall 0.00 in
Region 2
April 18
Rainfall 0.00 in
Region 2
April 19
Rainfall 0.00 in
Region 2
April 20
Rainfall 0.00 in
Region 2
April 21
Rainfall 0.00 in
Region 2
April 22
Rainfall 0.00 in
Region 2
April 23
Rainfall 0.10 in
Region 2
April 24
Rainfall 0.06 in
Region 2
April 25
Rainfall 0.07 in
Region 2
April 26
Rainfall 0.09 in
Region 2
April 27
Rainfall 0.30 in
Region 2
April 28
Rainfall 1.30 in
Region 2
April 29
Rainfall 0.02 in
Region 2
April 30
Rainfall 0.00 in
Region 2
May 1
Rainfall 0.01 in
Region 2
May 2
Rainfall 0.20 in
Region 2
May 3
Rainfall 0.00 in
Region 2
May 4
Rainfall 0.08 in
Region 2
May 5
Rainfall 0.00 in
Region 2
May 6
Rainfall 0.00 in
Region 2
May 7
Rainfall 0.00 in

Group D – Task 1 (answer)



Group D – Task 2

https://upload.wikimedia.org/wikipedia/commons/5/51/Watsonville_California_aerial_view.jpg with label overlay
https://creativecommons.org/licenses/by-sa/3.0/

Group D – Task 3

Irrigation Method #1
Drip Irrigation

Irrigation Method #2
Overhead Irrigation

Produce Item #1
Apple

Produce Item #2
Carrot

Produce Item #3
Lettuce

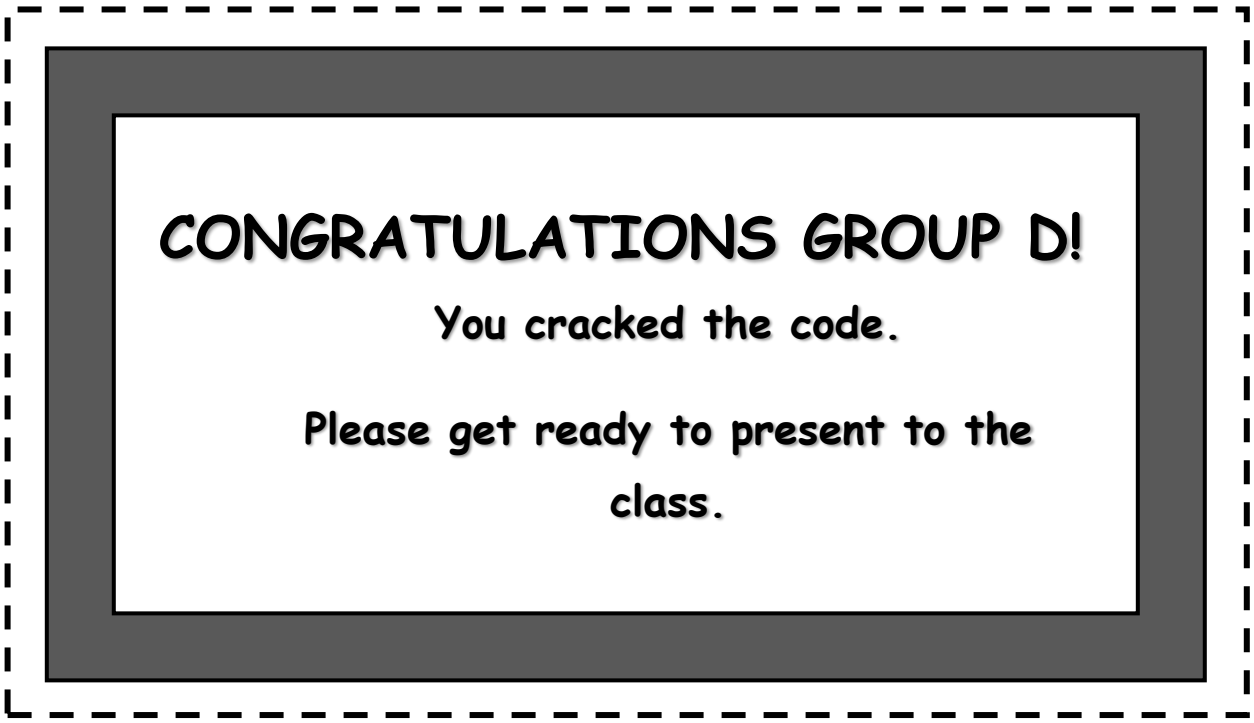
Produce Item #4
Potato

Right: "Crop Irrigation" by aqua.mech is licensed under CC BY 2.0

"Red Apples" by mari27454 (Marialba Italia) is licensed under CC BY 2.0
"Carrots" by Matt Biddulph is licensed under CC BY-SA 2.0
"File:Romaine lettuce.jpg" by Rainer Zenz is licensed under CC BY-SA 3.0
"Potatoes" by 16:9clue is licensed under CC BY 2.0

Group D

Code Solution: 146



CONSERVE EXERCISE – Interactive Outbreak Investigation

Group E – Research for Prevention of Recurrence

Physicians in seven states in the United States have diagnosed severe gastroenteritis among 187 individuals. Certain findings make this an event reportable to public health authorities. This number of concurrent, similar illnesses is greater than the numbers typically reported in the same regions and time period. This suggests the illnesses may be related and part of an outbreak.

You are part of a team of professionals who must work together to determine the cause and source of illness and to take measures to protect the public from continued exposure. The professionals involved in solving this outbreak include state and federal public health officials who conduct the epidemiological investigation, regulatory authorities who help identify the source of implicated product and potential cause of contamination, and producers and distributers of any implicated products who recall product from commerce and take corrective action. These experts also work with the media to inform the public of risk and protective measures. They may also work with research scientists to resolve the problem and prevent recurrence.

Your role in the investigation is as a food safety expert who evaluates both risks and potential food safety benefits associated with changes in food production practices. This includes evaluating new resources and emerging technologies. Your job is not an easy one. Concerned producers, manufacturers, distributors, regulators, and consumers are relying on you to help improve the safety of the food supply.

Tasks

1. Evaluate the potential microbial risk of various water sources for irrigation of edible crops.
    a. Organize the data for the various water samples based on water type and time.
    b. Plot the data on the provided graph.
    c. Which water sample number has the greatest variability of generic *E. coli* levels?

2. Determine whether water sources meet regulatory standards.

    The Food Safety Modernization Act (FSMA) was signed into law in 2011 and includes the Produce Safety Rule. One requirement of the Produce Safety Rule is that water quality used for irrigation of food crops is to be monitored over time in consideration for variability due to one-time events such as heavy rainfall. While somewhat an oversimplification of the rule, the water microbial standards for growing foods (other than sprouts) call for no more than an average of 126 colony-forming units (CFU) of generic *E. coli* (as an indicator of fecal contamination) in 100 ml of water (https://www.fda.gov/Food/GuidanceRegulation/FSMA/ucm334114.htm#key).

    Which, if any, of the water samples meets this standard?

3. Evaluate potential treatment methods to improve the microbiological quality of irrigation water.

    Environmental water used to prepare drinking water is treated to meet microbiological safety standards. Treatment typically includes filtration to physically remove

microorganisms and disinfection to inactivate any microorganisms that remain in the water after filtration. Research continues on methods to improve the microbiological quality of irrigation water. One of those methods is to incorporate iron particles in sand filters in an effort to enhance retention of microorganisms in the filter and reduce the number remaining in the treated water.

a. Use the decoder to reveal the laboratory data for these filtration methods
b. Which treatment method was most effective in removal of tested microorganisms?

4. The numerical answers from Tasks 1c, 2, and 3b form your 3-digit code.

Group E

Numeric Code

Test your code to open the lock, and prepare to share the following information with the class.

Group presentations will be given in alphabetical order by group letter. Each group presentation will be 5 minutes or less.

Present to the class:

1. The group's tasks and solutions

2. Examples of water sources investigated for irrigation of edible crops as alternatives to groundwater and emerging water remediation methods to address water scarcity issues.

3. Your thoughts on what contaminants other than microorganisms that might be present in environmental waters as result of human activity.

Group E – Task 1

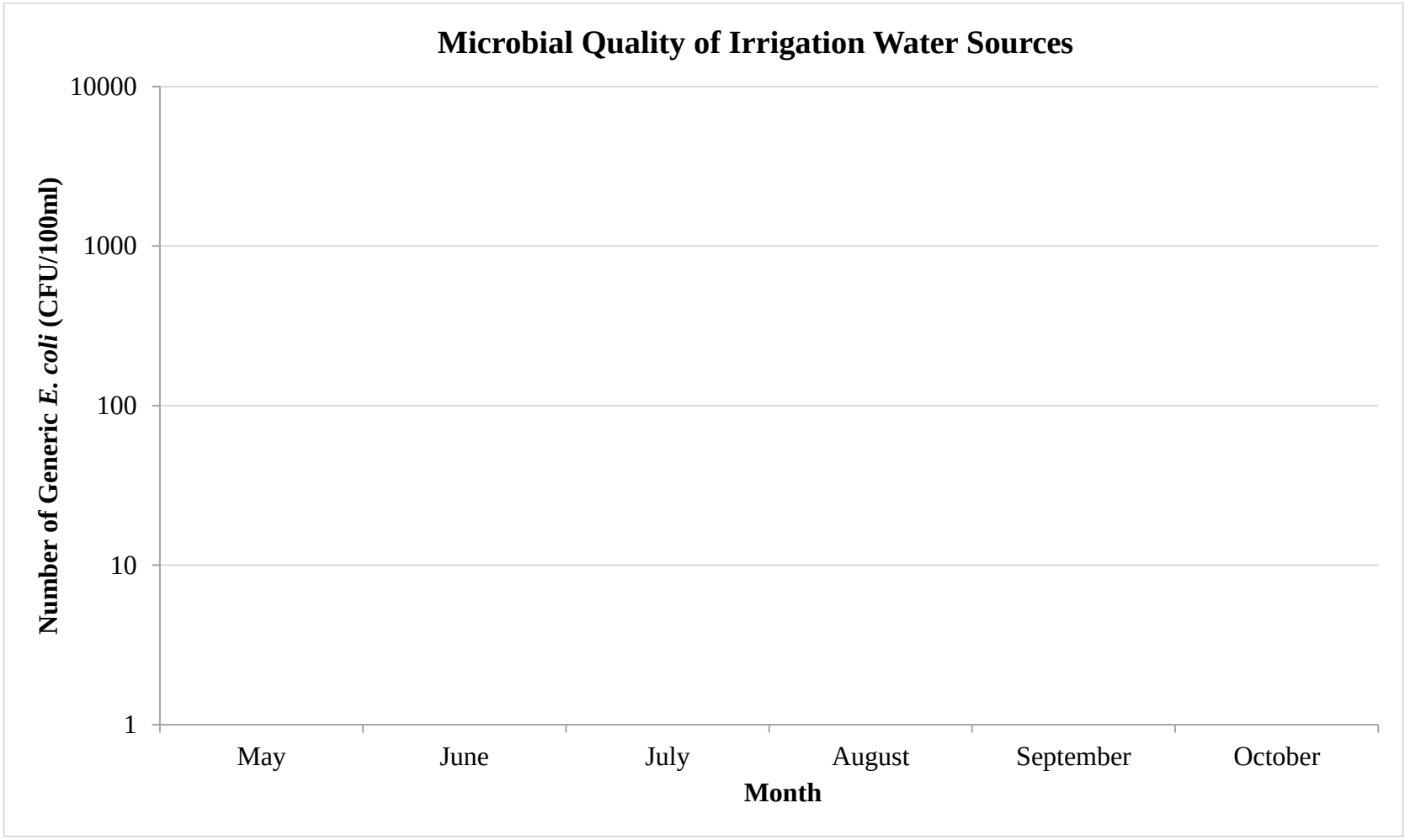
		Generic *E. coli* (CFU/100ml) (nonpathogenic bacterium used as indicator of potential fecal contamination)					
Sample Reference Number	**Water Source**	**May**	**June**	**July**	**August**	**September**	**October**
1	River	310	42	50	10	145	290
2	Pond	11	1	20	1130	57	5
3	Recycled	47	3000	27	120	10	160

CFU, colony forming units (bacterial growth on agar growth medium; each colony represents outgrowth from one bacterium)

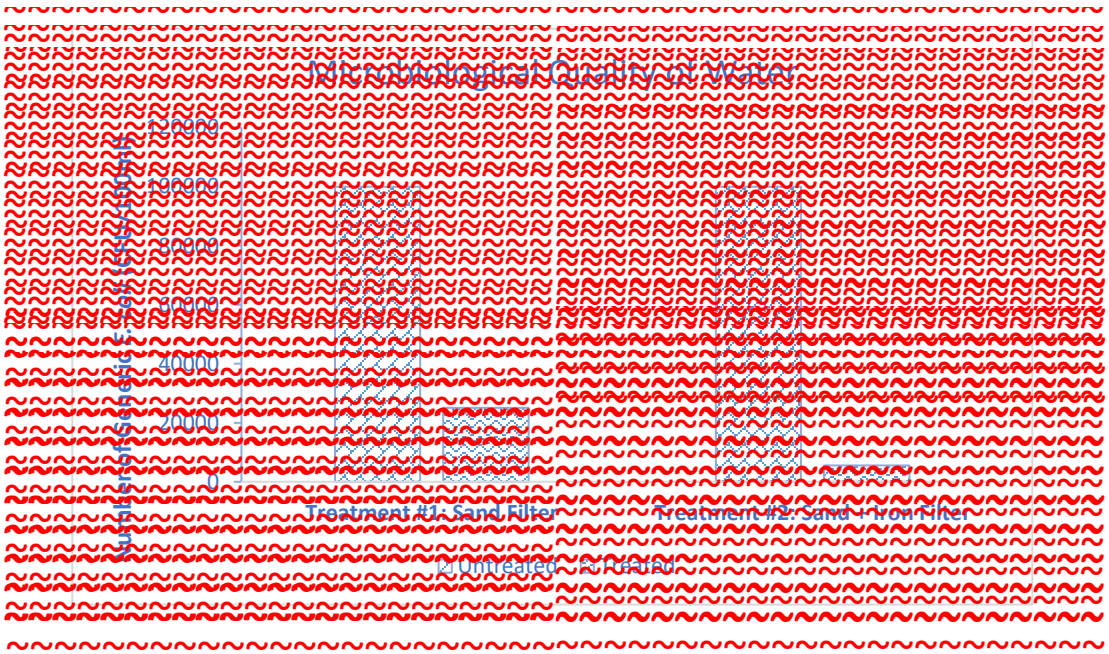
Group E – Task 3 (data for graph)

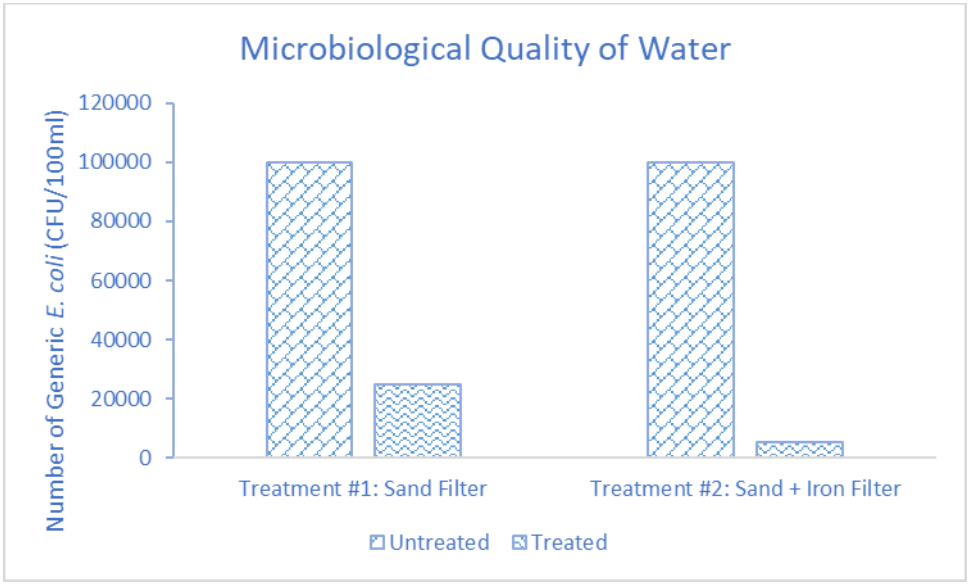
	Generic *E. coli* (CFU/100ml)	
Inoculated Water Sample	**Treatment #1 Sand Filter**	**Treatment #2 Sand + Iron Filter**
Untreated	100,000	25,000
Treated	100,000	5,500

Group E – Task 1



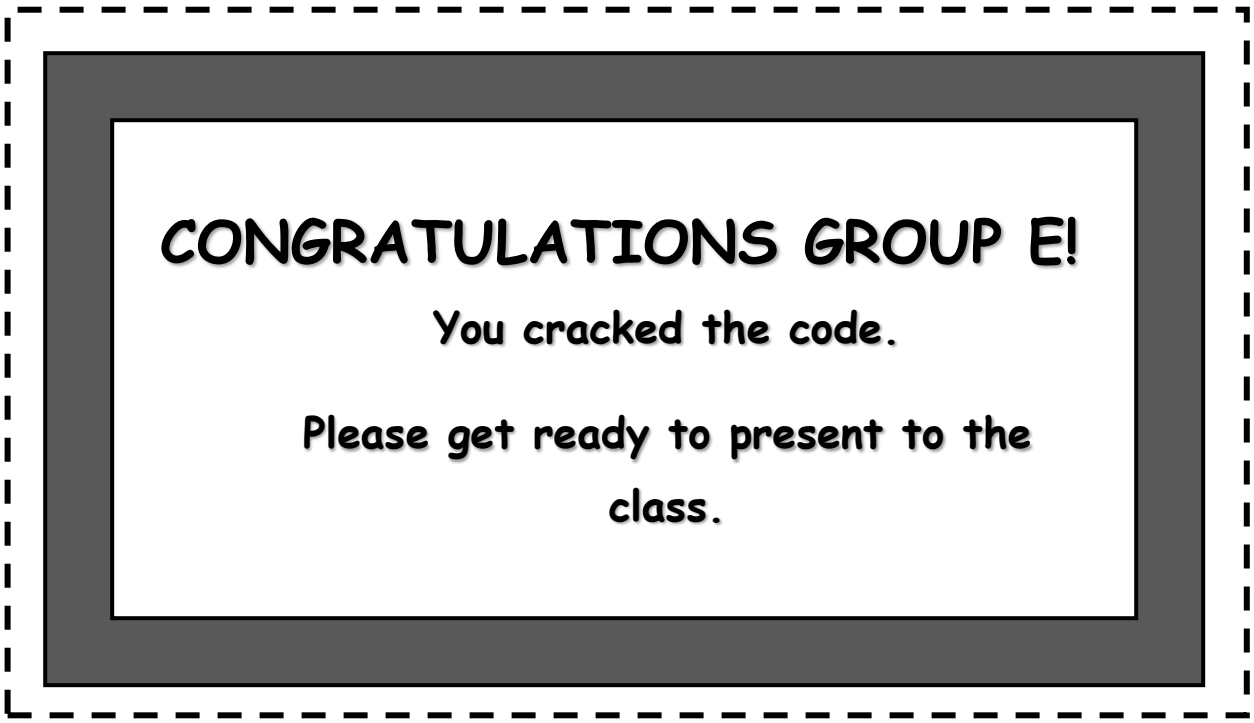
Group E – Task 3





Group E

Code Solution: 302



Acknowledgement

This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 2016-68007-25064. Any opinions, findings, conclusions, or recommendations expressed in the publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.