

Pathogen Tracker



Play the Game

About this Site

Players' Resources

Educators' Resources



Cornell University



Memo: FBI Investigator
Re: Possible Outbreak

URGENT:

A high incidence of foodborne illness has been documented over the last few months. Immediate action is required.

About this Site

Overview

The Pathogen Tracker Game has been created as a fun challenge for anyone interested in learning more about the spread of foodborne illnesses and how online databases can help track down the source of the organisms that cause them.

The game centers around *Listeria monocytogenes*, a potentially deadly cause of "food poisoning," especially in pregnant women. *Listeria* was the featured organism for the initial prototype of the Pathogen Tracker bioinformatics system developed at the Laboratory of Food Microbiology & Pathogenesis of Foodborne Diseases directed by Dr. Martin Wiedmann.

Credits

The original game was initially part of SciCentr, an outreach component for Cornell's supercomputing center. It was conceived and created by Jennifer Peth, Cornell '06, and produced by Margaret Corbit, SciCentr director, with technical support from Richard Bernstein, and artistic support from David Peth, Cornell '04.

Educational materials were produced in 2010 by master science teacher Mimi Cooper, with support of a team funded by the FDA and including: Dr. Alicia Orta-Ramirez (Cornell Food Science), Tracy DuVernoy, D.V.M. (FDA), Louise Dickerson (FDA), Isabelle Howes (The Graduate School), and Margaret Corbit (MD Corbit, LLC).

About the FDA

The United States Department of Agriculture (USDA) and United States Food and Drug Administration (FDA) and Centers for Disease Control and Prevention (CDC) work cooperatively to enhance food safety. The FDA is responsible for protecting the public health by assuring the safety, efficacy, and security of human and veterinary drugs, biological products, medical devices, our nation's food supply, cosmetics, and products that emit radiation. The FDA is the agency of the U.S. government authorized by Congress to inspect, test, and set safety standards for all food, except meat, poultry, and processed eggs.



Pathogen Tracker Game Teacher's Guide

SUBJECT AREAS: biology, culinary arts, environmental science, epidemiology, food science, life science and statistics

OVERVIEW:

In this lesson, through the use of an interactive, web-based game, Pathogen Tracker, students learn how foodborne illness outbreaks are investigated. The game is divided into three stages. In "Stage One: Declare an Outbreak," the students determine which bacterium is responsible for the outbreak; use a simulated form of the Pathogen Tracker 2.0 database to identify the specific strain; and determine if they have the appropriate data to declare an outbreak. In "Stage Two: Find the Contaminated Food," students conduct a matched-pairs analysis to determine the particular food responsible for the outbreak. In "Stage Three: Find the Source of the Contaminated Food," students: conduct simulated interviews with the patients to determine where they ate the contaminated food; conduct simulated interviews with the restaurants to determine which manufacturer produced the contaminated food; analyze lab results from the plant that was the source of the contaminated food; and, finally determine an action plan for that source.

The Pathogen Tracker Game is distinctive because it integrates areas of science and mathematics so students understand the overall picture of how science is applied to everyday life.

OBJECTIVES:

To introduce students to Pathogen Tracker 2.0, a powerful web-based tool used by scientists around the world to exchange information on bacterial subtypes and strains, and for studies of bacterial biodiversity and strain diversity

To familiarize students with the steps followed to conduct an investigation into a foodborne illness outbreak

To learn that it takes years of scientific research and technology to keep improving our lives

To demonstrate how knowledge learned in the classroom can be used outside the classroom to investigate foodborne illness outbreaks

To introduce students to the varied food safety careers

SUGGESTED TIME:

Three to four 50-minute class periods

PREREQUISITE KNOWLEDGE:

Understanding of the causes of foodborne illnesses, including a basic knowledge of microbiology

Understanding of the factors that promote the spread of a foodborne illness

Understanding of genetic fingerprinting

Understanding of the classification of bacteria

Understanding how to construct appropriate tables and graphs

MATERIALS NEEDED:

Computers with access to the Internet

Handouts of the Student Worksheets for each student

Copies of Pathogen Tracker Vocabulary and Encyclopedia for each student or group

MULTIMEDIA RESOURCES:

Pathogen Tracker Game - <http://game.pathogentracker.net>

PROCEDURE:

Students assume the role of Foodborne Illness Investigators (FBII) as they play all three stages of the Pathogen Tracker Game. As FBII agents, the students plot out the steps to be taken to get to the source of the outbreak. As they play the game, they complete the worksheet for each stage and participate in class discussions. Students can work individually or in small groups. The game and worksheets can be completed at home, but it is recommended that they be done in class. It is intended that students complete all three stages.

Background Information for the Teacher

A suspected outbreak of a foodborne illness has occurred in several states resulting in many people going to the emergency departments at their local hospitals. Several victims went to the hospital complaining of headaches, vomiting, body aches, diarrhea, loss of balance, confusion, and miscarriage. Suspected outbreaks such as this are usually caused by the consumption of contaminated food. People with compromised immune systems are particularly at risk of serious illness. These include people who are very young or old, those with transplanted organs, and those with diseases such as leukemia, HIV, and diabetes. *Listeria* is especially dangerous for pregnant women, as it can cause miscarriage. Pathogenic bacteria can often

cause food contamination. Sometimes outbreaks result from the consumption of toxins from the bacteria living in the food.

A foodborne illness outbreak team has visited the hospitals to interview the attending physicians and the patients. Some stool samples were obtained from the patients for microbiological identification of the pathogen. The team knows that these types of outbreaks usually occur within two to three days and last for one to four days after people ingest the contaminated food. The team will gather data to determine the exact pathogen found in the patients, the relationship of that pathogen to known strains of the organism, the food that the patients ingested that contains the pathogen, and the source of that contaminated food. Once the source of the food has been found, public officials, following USDA or FDA guidelines, will determine a course of action for that source.

BEFORE STARTING THE GAME

Explain to the students that they are going to become Foodborne Illness Investigators (FBI) and, as such, they will have to determine the cause of a suspected foodborne illness outbreak.

Discuss with the students what they know about foodborne illnesses and foodborne illness outbreaks. Ask if any of them have ever had a foodborne illness or been part of a foodborne illness outbreak and ask them to tell about their experiences. At the end of this discussion, ask the students to list the steps they think scientists follow in solving a foodborne illness outbreak. It is important in these discussions to accept all responses from the students, because they will be reviewing their ideas as they complete each of the three stages of the Pathogen Tracker Game.

WARM-UP ACTIVITY

To introduce the concept of foodborne illnesses, consider having students look at a Salmonella outbreak (<http://www.cdc.gov/salmonella/wandsworth.htm> or more recent example) on the Centers for Disease Control's OutbreakNet site: <http://www.cdc.gov/outbreaknet/outbreaks.html>.

TEACHER NOTE: There are two different levels of worksheets. Level I is the more challenging of the two levels. The basic difference in the two is the amount of input that is required from the student. To request the password to download the answer sheets, please use the form at [????????????????????](#)

Level I

Stage One - Worksheet (download: [Word](#) | [PDF](#))

Stage One - Answer Sheet (download: [Word](#) | [PDF](#)) 🔒

Stage Two - Worksheet (download: [Word](#) | [PDF](#))

Stage Two - Answer Sheet (download: [Word](#) | [PDF](#)) 🔒

Stage Three - Worksheet (download: [Word](#) | [PDF](#))

Stage Three - Answer Sheet (download: [Word](#) | [PDF](#)) 🔒

Level II

Stage One - Worksheet (download: [Word](#) | [PDF](#))

Stage One - Answer Sheet (download: [Word](#) | [PDF](#)) 🔒

Stage Two - Worksheet (download: [Word](#) | [PDF](#))

Stage Two - Answer Sheet (download: [Word](#) | [PDF](#)) 🔒

Stage Three - Worksheet (download: [Word](#) | [PDF](#))

Stage Three - Answer Sheet (download: [Word](#) | [PDF](#)) 🔒

At the top of each worksheet is a list of the vocabulary words that are introduced in that particular Stage. The words either appear in the actual game or in the encyclopedia entries encountered during that stage. Each of these words is defined in the Vocabulary (download: [Word](#) | [PDF](#)) Less experienced students may have difficulty with the process in which a riboprint is made and the differences among the taxonomic groups of bacteria. You may want to review these topics with your students before they begin the game or you could address them at the appropriate times while playing the game.

On the worksheet for "Stage One: Declare an Outbreak," have students complete the first four questions, either in their small groups or individually. If the students are working in groups, they could also write the steps on chart paper and as they go through the game, change their steps as needed. At this time there is no right or wrong answer to question 3. **Special Note** - The Stage One Level II Student Worksheet contains an organizational table for the students to use in recording the "Predicted Steps" and "Actual Steps" for this question. Initially, the students list their predicted steps and then as they play the three stages of the game, they record the actual steps the scientists followed.

STARTING THE GAME – STAGE ONE: DECLARE AN OUTBREAK

Using the Pathogen Tracker Game pages, introduce students to the game. Be sure students understand the purposes of Casefile, Email, Encyclopedia (Encyc.), and Lab.

Casefile – contains all the particulars of the case

Email – used by the chief to give instructions

Encyc. – encyclopedia – offers background information on pathogens and the science of pathogen tracking

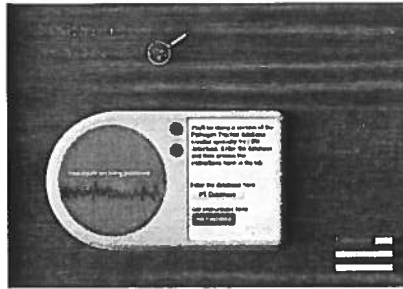
Lab – can help with the fundamental science behind Pathogen Tracker

In addition to these resources, remind the students that they have access to the Vocabulary (download: [Word](#) | [PDF](#)) and Encyclopedia (download: [Word](#) | [PDF](#)).

Allow students to play the game and encourage them as they complete the worksheet for Stage One. If someone wants to go backward in the sequence of the game, the best way is to use the BACK button at the top of the browser (below).



When students reach the screen shown below, it is important that they read the **Instructions first** and then use the back button to return to this screen and click on the **PT Database** button.



The professional PathogenTracker database, currently running in version 2.0, is used by researchers at Cornell University, as well as others throughout the world, to deposit and store DNA fingerprint data for different bacteria, such as *Salmonella*, *Listeria monocytogenes*, and certain *E. coli* types, that cause foodborne diseases. These fingerprint data represent bacterial isolates and include information about their various different sources (e.g., foods, humans with illness, animals with and without illnesses, natural environments). The fingerprint database is often queried to better understand transmission of these disease-causing bacteria and to help resolve disease outbreaks in much the same way as experienced in the Pathogen Tracker Game's simplified version.

In addition, when students get to this part of the game, some of them may need extra help to understand the process of ribotyping and the different levels in the classification of bacteria. The following site could be used by you and the students to review the process of DNA fingerprinting: "Create a DNA Fingerprint" - <http://www.pbs.org/wgbh/nova/sheppard/analyze.html>.

Younger students may not need an explanation of ribotyping as in-depth as older students. It may be sufficient for them to understand that a riboprint is an example of a genetic fingerprint.

At the end of Stage One, review with students their answers to the questions. Discuss with them the steps that have been completed so far in solving the foodborne illness outbreak. If using the Level I Worksheet, ask them to go back to the questions they answered before beginning Stage One and make any revisions necessary to the plan that was suggested. Emphasize to the students that they also need to include their reasons for making those changes. At this point in the game, you are only looking for correct responses as they relate to Stage One of the game. If you are using the Level II Worksheet, the students are asked to discuss how well they did in predicting the steps that the scientists would follow.

Students completing Stage One will be given the password needed to begin Stage Two. The following password should be recorded on their worksheets: Listeria.

Note: If students do not complete a particular stage by the end of the class period, they can write down the URL of the page where they are currently working and continue from there the next day rather than going back to the beginning of the game.

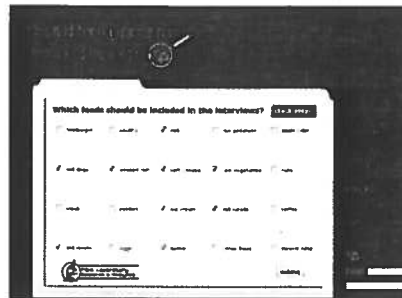
Level I (download: [Word](#) | [PDF](#) ) and **Level II** (download: [Word](#) | [PDF](#) ) **answer sheets for Stage One**

CONTINUING THE GAME – STAGE TWO: FIND THE CONTAMINATED FOOD

Before beginning Stage Two, review with your students the procedures to be followed in a matched-pairs analysis.

The students begin Stage Two by entering the recorded password provided at the end of Stage One. If using the Level II Worksheet, remind the students that they will continue to use the Table from page 2 of the Stage One Worksheet. They play through the game and, again, are encouraged to record data and complete the worksheet questions as they go.

When the students reach the screen shown below, where they must select the **exact** foods to include in the interview, some of them may become frustrated with their incorrect responses. The game, other than referring the student to the encyclopedia, does not give them any hints as to why their selections are incorrect. However, if they have recorded their data on the worksheet, they have the right answers. You could encourage these students with additional hints such as, “You’ve chosen eggs – look back in the Encyclopedia – with which pathogens are eggs usually linked?”



After the students have completed an analysis of which foods were eaten by the infected group and the control group, the older students are asked to stop the game and create graphs of their data. They are not instructed what kind of graph to make – they should be encouraged to look carefully at the data and determine the best way to graph them. Once they have made their own graphs, they continue the game and compare the graphs they made with those presented in the game. At the completion of Stage Two, they should record the password, HOTDOG, for the next stage.

At the end of Stage Two, review with students their answers to the questions. Discuss with them the steps that have been completed so far in solving the foodborne illness outbreak. Discuss with them their choices for graphing methods. If using the Level I Worksheet, ask them to go back to the questions they answered before beginning Stage One and reviewed at the end of that stage. Ask them to make any further revisions to ensure a correct plan. Emphasize to the students that they also need to include their reasons for making those changes. Again, at this point in the game, you are looking for correct responses only so far as Stage One and Two are concerned. If using the Level II Worksheet, the students again compare the predicted steps to the actual steps the scientists followed.

Level I (download: [Word](#) | [PDF](#) 📄) and **Level II** (download: [Word](#) | [PDF](#) 📄) answer sheets for Stage Two

CONTINUING THE GAME – STAGE THREE: FIND THE SOURCE OF THE CONTAMINATED FOOD

Students begin Stage Three by entering the recorded password provided at the end of Stage Two. If using the Level II Worksheet, remind the students that they will continue to use the Table from page 2 of the Stage One Worksheet. They continue playing the game by virtually interviewing the patients to find out where they have eaten hotdogs. On the worksheet, they are asked to discuss whether or not they have enough information to determine the source of the outbreak. Students continue the game.

When investigating the meat processing companies, the students are cautioned that testing is expensive and they should make their choices accordingly. They should choose Frank N. Furter and the month to be tested – August. If these are not chosen, there should be a discussion focusing on why the incorrect choices were made.

Once the correct company and month are identified, the areas of the plant where contamination could have taken place need to be tested. Be sure students understand these steps. You may also need to review with them the process by which a riboprint is made.

At the end of Stage Three, review with students their answers to the questions. If using the Level I Worksheet, have one final discussion with them regarding the steps involved in solving a foodborne illness outbreak. Ask them to go back to the questions they answered before beginning Stage One and reviewed at the end of Stages One and Two. Ask them to make any further revisions so as to have a correct plan. Emphasize to the students that they also need to include their reasons for making changes. If using the Level II Worksheet, the students again compare the predicted steps to the actual steps the scientists followed.

Level I (download: [Word](#) | [PDF](#) 📄) and **Level II** (download: [Word](#) | [PDF](#) 📄) answer sheets for Stage Three

COMPLETING THE GAME – CONTEXT, CAREER AND RECOGNITION

There is an optional, downloadable certificate provided (download: [PDF](#) 📄) that can be distributed to students who have completed the module.

Discuss with the students who is responsible for food safety and what is required to prepare for such careers. Which jobs interest them most, have the best potential for contributing to society, for financial gain, for independence, etc. A document is provided that can be used to guide or prepare for the discussion of potential food safety careers (download: [Word](#) | [PDF](#)).









NATIONAL SCIENCE EDUCATION STANDARDS AND BENCHMARKS FOR SCIENCE LITERACY CORRELATION

Listed below are Standards and Benchmarks addressed by the Pathogen Tracker Game

STANDARDS

- Cells carry on the many functions needed to sustain life. They grow and divide, thereby producing more cells. This requires that they take in nutrients, which they use to provide energy for the work that cells do and to make the materials that a cell or an organism needs. C3; 5 - 8
- Disease is a breakdown in structures or functions of an organism. Some diseases are the result of intrinsic failures of the system. Others are the result of damage by infection by other organisms. C 6; 5 - 8
- Hereditary information is contained in genes, located in the chromosomes of each cell. Each gene carries a single unit of information. An inherited trait of an individual can be determined by one or by many genes, and a single gene can influence more than one trait. A human cell contains many thousands of different genes. C 10; 5 - 8
- Cells store and use information to guide their functions. The genetic information stored in DNA is used to direct the synthesis of the thousands of proteins that each cell requires. C 3; 9 - 12
- In all organisms, the instructions for specifying the characteristics of the organism are carried in DNA, a large polymer formed from subunits of four kinds (A, G, C, and T). The chemical and structural properties of DNA explain how the genetic information that underlies heredity is both encoded in genes (as a string of molecular "letters") and replicated (by a templating mechanism). Each DNA molecule in a cell forms a single chromosome. C 7; 9 - 12
- Food provides energy and nutrients for growth and development. Nutrition requirements vary with body weight, age, sex, activity, and body functioning. F 5; 5 - 8
- The severity of disease symptoms is dependent on many factors, such as human resistance and the virulence of the disease-producing organism. Many diseases can be prevented, controlled, or cured. Some diseases, such as cancer, result from specific body dysfunctions and cannot be transmitted. F 2; 9 - 12

Available at: http://www.nap.edu/openbook.php?record_id=4962

American Association of Family and Consumer Sciences Standards also available at:
http://www.doe.in.gov/octe/facs/NASAFACS/sc_1.html

BENCHMARKS

- The information passed from parents to offspring is coded in DNA molecules, long chains linking just four kinds of smaller molecules, whose precise sequence encodes genetic information. 5B/H3
- All living things are composed of cells, from just one to many millions, whose details usually are visible only through a microscope. 5C/M1a
- Before a cell divides, the instructions are duplicated so that each of the two new cells gets all the necessary information for carrying on. 5C/H4c
- Food provides molecules that serve as fuel and building material for all organisms. 5E/M1a
- Viruses, bacteria, fungi, and parasites may infect the human body and interfere with normal body functions. A person can catch a cold many times because there are many varieties of cold viruses that cause similar symptoms. 6E/M3
- Specific kinds of germs cause specific diseases. 6E/M6
- New medical techniques, efficient health care delivery systems, improved diet and sanitation, and a fuller understanding of the nature of health and disease give today's human beings a better chance of staying healthy than their ancestors had. 6E/H3a
- Sanitation measures such as the use of sewers, landfills, isolation, and safe food handling are important in controlling the spread of organisms that cause disease. Improving sanitation to prevent disease has contributed more to saving human life than any advance in medical treatment. 8F/M1
- Many diseases are caused by bacteria or viruses. 8F/M5
- Owing to the large amount of information that computers can process, they are playing an increasingly larger role in medicine. They are used to analyze data and to keep track of and communicate diagnostic information about individuals and statistical information on the distribution and spread of various maladies in populations. 8F/H1
- Biotechnology has contributed to health improvement in many ways, but its cost and application have led to a variety of controversial social and ethical issues. 8F/H7

Available at: <http://www.project2061.org/publications/bsl/online/index.php>