



Keeping our Food Safe – Rapid Detection of Contamination Using Bioassays

Lesson Overview:

Every day we consume food; some is prepared, some fresh, some cooked and some is even raw, like sushi. No matter the type of food we eat, we wish to be assured of a safe and dependable supply. Some of the most serious threats to food safety come from something we cannot see with the naked eye – bacteria. To detect such dangerous microbes, special technology is needed in order to test them quickly, effectively and accurately. This lesson will explain the technology of bioassays and their use in monitoring food safety.

Unit question: How can we reliably screen a growing variety of foods for contaminants?

Learning objectives:

- Develop a basic knowledge of the scientific dimensions of contamination and food safety
- Compare and contrast options for rapid detection of food pathogens
- Investigate 3M innovations for pathogen detection
- Synthesize and present to class best options for food pathogen detection
- Demonstrate learning by presenting a pathogen detection mechanism for a specific food and pathogen and explain why detecting that pathogen is important

Academic Standards:

Science in Personal and Social Perspectives

Personal and Community Health

- The severity of disease symptoms is dependent on many factors, such as human resistance and the virulence of the disease-producing organisms.
- Selection of foods and eating patterns determine nutritional balance.

Science and Technology

- Identify a problem.
- Evaluate the solution and its consequences.
- Communicate the problem, process, and solution.

Background for the teacher:

This lesson explores various dimensions of food safety and food-borne pathogens. It provides students with practical use of their knowledge of bacterial organisms, while giving them a chance to review the concepts of bacterial infection. The lesson then focuses on four specific pathogens and the use of modern technologies that allow for their timely detection. Students organize into groups to become pathogen detectives, learning how pathogens infect food and those who consume it, how to prevent infections, and modern ways to detect pathogens before they cause more serious illnesses. Graphic organizers and appendices are provided

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Materials for teacher:

- Microscope slides of the pathogens used during student investigations
- Light microscopes with three increasing powers of objectives
- LCD projection system
- Student access to computer lab and media center for research
- Art supplies for poster preparation

Materials for students:

- Handouts containing photocopies of student material found in lesson and appendices
- Provision of art supplies for poster construction

Classroom Activities:

Engage

1. Before we begin, discuss what it means for something to be ‘contaminated.’ Use Frayer Word Organizer (see below) for students to work in groups of two to four on the word “contaminate.” Have them define this term in their own words, then ask them to put down examples of contamination (does not have to be related to food). Finally, provide a standard definition of the word.
2. The second word to study is pathogen. Let students brainstorm on its meaning. Then, ask students if they know any specific pathogens.
3. Introduce one food-borne pathogen through this short report on Salmonella and how it spreads:
<http://healthguide.howstuffworks.com/salmonella-enterocolitis-dictionary.htm>
 Follow this reading with a discussion of how Salmonella has tricked the human immune system and what happens when Salmonella becomes an infectious disease.

Explore

1. Cause of Contamination
 Most food-borne illnesses are results of different ways our food becomes contaminated. For example, things such as undercooking or storing foods at the wrong temperature, or poor personal hygiene of food handlers, can increase the chances of contamination. Students will now determine facts and characteristics of contaminants, using the categories below:
 - Personal hygiene of workers: for example, even when hands look clean, they still carry bacteria
 - Melted fat and juices: found at bottom of pan (such as, meat and poultry drippings) can carry bacteria if not properly stored and used
 - Coughs and sneezes: can spread bacteria if uncovered
 - Mishandling of foods: can occur in food preparation, cooking, or storage, which allows for spread of pathogens

Appendix 1 provides an organizer to capture information for student discussion and exchange. Four copies are given to each student, or one each to a group of four. Each one of the categories above fits onto one sheet of the appendix.

2. Know Your Bacteria.

The following site provides an overview of several pathogens affecting our food supplies. Students should explore four pathogens and become experts: Campylobacter, Listeria, Salmonella, and Pseudomonas. An organizer is provided in Appendix 2 to gather their facts. Link to:

<http://www.fda.gov/food/foodsafety/foodborneillness/foodborneillnessfoodbornepathogensnaturaltoxins/badbugbook/default.htm>. (Source: FDA, Bad Bug Book: Introduction Foodborne Pathogenic Microorganisms and Natural Toxins Handbook).

3. Understanding Bioassays

Students will now read and watch from Florida International University's Department of Biomedical Engineering for extended information on the operation of biosensors:

<http://www.nanobio.fiu.edu/>. Once at this page, its contents can be read and other sites of interest explored; however, all students should watch the video on the first page of the site.

4. A. Become a Pathogen Detective – exploring rapid detection of pathogens.

Have students break into groups of four. Each student is assigned to one of the tasks below for one of the four pathogens: Campylobacter, Listeria, Salmonella, or Pseudomonas.

1. Conduct in-depth research about their pathogen.
2. Find out how their pathogen makes an impact on food safety along the Farm-to-Table Continuum.
3. Discover what can be done to control the growth of their pathogen.
4. Explore the one of the 3M innovations for pathogen detection and how it can be used for rapid detection of bacterial food pathogens

4. B. Rapid Pathogen Detection

Students will investigate a group of products used to detect food pathogens. To get started, please have computers ready. They will explore the following site showing 3M innovations for pathogen detection:

http://solutions.3m.com/wps/portal/3M/en_US/Microbiology/FoodSafety/product-applications/two/

Students read up on the various links for each of the pathogen detection assays, and summarize their knowledge in Appendix 4.

4. C. Students study the 3M technical paper for using the above bioassay. Have them use Listeria to understand how the assay is applied to suspect food sources. This can be found in Appendix 4.

4. D. Students are now ready to complete the Pathogen Detective activity. Each one of the students compiles information on the specific topics listed in Activity 4.A. Next, they prepare a public campaign poster on their particular bacteria, which should include all of the information they have gathered. From this, they prepare an oral presentation to give to the class. The students will tell the class the dangers these microbes pose to our food supply and how to apply the 3M testing assays for pathogen contamination.

Explain

1. Each member of the four groups presents on his/her role with the Disease Detective activity, along with their poster presentation. Students should begin by describing his/her pathogen selected, why it is important to detect it in our food supply and which technology can be used for rapid detection. Move around the room until all groups have presented.
2. Teacher will then lead a discussion on one or two cases of food contamination that made national news. The students will then propose solutions, using detection or sanitary measures, which could keep the problem from occurring.
3. Students, working in groups, develop a PowerPoint presentation on one of the pathogens selected, what might cause a wide spread contamination, how it would be diagnosed and conclude with a "Prevention Campaign," to fight against further outbreaks.

Extend

1. Students will explore the 3M technology used to detect pathogens. Students will study the 3M™ Tecra™ Visual Immunoassay, by reading "Reliable and Trusted Pathogen Test", pages 4-5, in the 3M Microbiology Food Safety Products and Services.
Link:http://solutions.3m.com.au/3MContentRetrievalAPI/BlobServlet?locale=en_WW&md=1231540417000&assetId=1180608668985&assetType=MMM_Image&blobAttribute=ImageFile

Evaluate

1. Develop a basic knowledge of the scientific dimensions of contamination and food safety
2. Submit a Venn diagram to compare and contrast options for rapid detection of food pathogens
3. Essay describing 3M innovations for pathogen detection
4. Synthesize and give an oral presentation to the class after forming study groups that consider the best options for food pathogen detection
5. Develop a poster presentation presenting a pathogen detection mechanism for a specific food and pathogen and explain why detecting that pathogen is important

Appendix 1. Understanding the Sources of Contamination

The diagram consists of a central oval shape. Four rectangular boxes are arranged around the oval, each connected to it by a vertical line. The top-left box is labeled **DEFINITION**, the top-right box is labeled **CHARACTERISTICS**, the bottom-left box is labeled **EXAMPLES**, and the bottom-right box is labeled **NON-EXAMPLES**. All text is in bold, uppercase letters.

Appendix 2. Organizer for Pathogen Characteristics, Detection, and Symptoms

Pathogen name	Foods infected by pathogen	Human symptoms when pathogen is consumed	Existing methods for food analysis and detection of pathogen

Appendix 3. 3M™ Tecra™ Environmental Listeria Test

DESCRIPTION

The 3M™ Tecra™ Listeria VIA is a rapid and specific screening test for detection of *Listeria* spp. in food and environmental samples. The limit of sensitivity is the lowest concentration point where reliable analytical results can be obtained. This may vary with different serotypes. Positive results need to be confirmed using a second method or as specified by local regulations.

USER RESPONSIBILITY

When selecting a test method, it is important to recognize that external factors such as sampling methods, testing protocols, sample preparation, handling, and laboratory technique may influence results. It is the user's responsibility to determine that any test methods and results meet its customers' and suppliers' requirements.

INSTRUCTIONS FOR USE

These instructions must be carefully followed. Failure to do so may lead to inaccurate results.

Sample Enrichment.

1. It is important to ensure that all media (including primary and secondary media) are pre-warmed to the incubation temperature specified.
2. Aseptically combine the enrichment medium and sample, thoroughly mix and incubate as outlined in Table 1 of the more detailed directions.

Preparation of Tecra Listeria VIA reagents for detection of Listeria.

Avoid cross-contamination of reagents. Ensure caps for the reagent bottles are not exchanged. To reconstitute reagents, mix gently by inverting and allow to completely dissolve at 20-25°C. Do not vigorously shake the contents.

Appendix 4. Rapid pathogen detection using 3M™ Tecra™ Pathogen & Toxin Testing

(Refer to link below for supplemental information.

http://multimedia.3m.com/mws/mediawebserver?mwsId=66666UuZjcFSLXTtNxfXIXM_EVuQEcuZgVs6EVs6E666666--&fn=70-2009-9362-7.pdf)

Pathogen	Method of detection – details from 3M website	How is sample prepared and tested using the 3M assay