



*“a world of learning”*

# The Science of Food Hygiene

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**Abstract:**

Hygiene and food safety are important for everyone, not just those working in the food industry. This workshop introduces some unusual resources and new ideas to show the relevance and importance of personal hygiene, and correct storage and preparation of food. You will be able to adapt the content for class demonstrations, student experiments, or group projects.

# The Science of Food Hygiene

## 1. Introduction

We are surrounded by untold numbers of micro-organisms. One estimate suggests that at any one time, there are more bacteria in a person's digestive tract than the total number of people that have ever lived on the earth! Fortunately, the vast majority of these microbes are harmless, and many are quite beneficial as they assist our metabolic functions. However, some are dangerous to humans and are known as pathogens.

Pathogens can cause infection by gaining ingress through cuts and abrasions in the skin, or by being inhaled as tiny micro droplets floating in the air, but one of the most common ways is through the mouth when eating. Food poisoning is an illness caused by eating contaminated food or drinking contaminated water.

Anyone can be affected by food poisoning, although children and the sick and elderly are the most susceptible. It is not surprising that food poisoning occurs from time to time. It is surprising that it does not occur more often!

## 2. Foodborne Pathogens

There are many potential pathogens that can cause food poisoning, but here are six of the most well known:

***Campylobacter*** considered in some quarters to be the most common bacterial cause of foodborne illness, *campylobacter* comes primarily from poultry.

***Norwalk virus*** arguably the most common viral cause of foodborne illness, outbreaks caused by Norwalk virus are known to erupt in hotels and cruise ships.

***Salmonella*** this potentially fatal bacterium is acquired mainly from beef, poultry, pork and eggs.

***E. coli*** a common, usually harmless intestinal bacterium, until it morphs into O157:H7 producing a powerful and potentially lethal toxin. Most infections come from contaminated meat, especially beef, in the form of undercooked mince. The bacteria are often spread by poor handwashing or hygiene habits.

***Listeria*** not as well-known as *Salmonella* and *E. coli*, but usually more deadly, with infections leading to blood poisoning or meningitis. *Listeria* is mainly a problem with ready-to-eat foods.

***Shigella*** one of the most frequent causes of gastro-intestinal disease in people, *shigella* typically originates from food or water contaminated with human or animal waste. It passes easily between people – nursing homes and child-care centres are places where frequent outbreaks occur.

## 3. Minimising the Risk

Microbes thrive in warm moist environments. In the right conditions, they can multiply at an astounding rate, and they are very easily transferred from place to place by contact. To ensure food safety, it is essential to minimise the risk of contaminating food during preparation, transport and serving.

- Avoid the "danger zone" of temperatures between 4°C and 65°C. Microbes can multiply in this range, so keep cold food cold, and hot food hot.
- Segregate raw and cooked food.
- Keep all work surfaces, utensils and equipment clean and sanitized.
- Maintain a high standard of personal hygiene, in particular, hand washing.
- Keep food covered.

- Keep sources of contamination such as insects, animals and sick people away from food preparation areas.

## 4. Learning Activities

### 4.1 GlitterBug Potion

Hand washing is now widely recognized as a very important component of personal hygiene, and it is regarded as a key preventative measure in food preparation areas. You can reinforce the importance of hand washing with a series of fun learning activities involving GlitterBug Potion. GlitterBug simulates the presence of germs and helps students learn the correct way to wash their hands. Here are some examples:

- Apply GlitterBug Potion to your hands and see the simulated “germs” under a UV lamp. Wash your hands and check them again with the UV lamp. Carefully look in creases and around nails. Was your hand washing effective?
- Have a student rub GlitterBug Potion onto his or her hands then form a line with the “contaminated” student at one end. Ask this student to shake hands with the second student in line, and ask the second student to shake hands with the third, and so on. Use a UV lamp to see how far the contamination has spread.
- Rub GlitterBug Potion onto a plastic ball and pass it around a group of students. Use a UV lamp to see the simulated “germs” that have been transferred to the students’ hands. Think of the ball as representing a friendly dog.
- Spread GlitterBug Potion onto some coins and hand them around. A UV lamp will show how germs can be spread this way.
- Rub GlitterBug Potion onto some common surfaces such as a phone hand set, a light switch, a plastic spoon handle and a pen. Have students handle these items and use a UV lamp to follow the contamination trail.
- Whilst wearing a pair of latex or rubber gloves, apply GlitterBug Potion to your hands. Remove the gloves and use a UV lamp to check if you have been able to do this without transferring the contamination to your hands. Wash your hands and check again.



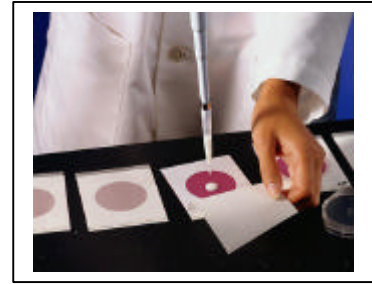
### 4.2 GlitterBug Powder

GlitterBug Powder has the same fluorescent ingredient as GlitterBug Potion, but it is dispersed in powder form rather than as a hand lotion. The powder form is particularly useful for showing how contamination can spread in food preparation areas. Here are some examples:

- Sprinkle GlitterBug Powder onto several sheets of paper, and ask students to pick up the sheets and pass them around. Use a UV lamp to view the results.
- Sprinkle GlitterBug Powder lightly around a bench and sink. After cleaning, examine the area with a UV lamp to see how effective you have been. Can you identify any areas for improvement?
- Mix some GlitterBug Powder into a small amount of minced meat or fruit on a cutting board. Knead the mixture well and cut it several ways with a knife, then spoon it onto a plate or into a bowl. Use a UV lamp to check everything for contamination. Now wash your hands and the utensils, and clean up the work area, then examine them again with the UV lamp. How effective was your cleaning?

### 4.3 Petrifilm

Since microbes are far too small to see under normal circumstances, there are a number of methods and techniques that are employed to detect the presence of bacteria. In the past, samples were “cultured” (grown) on agar gels in Petri dishes then examined under a microscope and treated with special stains to identify them. Today, the food industry makes use of safer and more cost effective growth media such as Petrifilm (3M Corporation) in their routine quality checks and safety audits.



#### **What is Petrifilm?**

A Petrifilm plate is a thin film, sample ready, dehydrated version of the conventional Petri dish agar plate. Petrifilm is widely used in the food industry throughout the world to monitor quality and to audit cleaning and sterilisation processes. Foods, beverages and surfaces can be tested for the presence of harmful bacteria (pathogens), indicator bacteria (that indicate the possible presence of pathogens), and spoilage organisms that can affect the shelf-life.

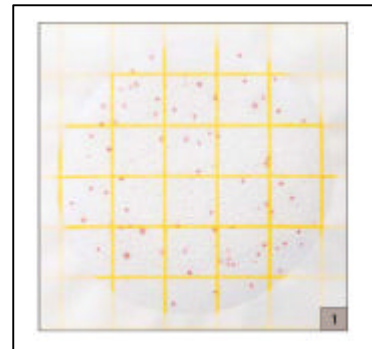
The advantages of Petrifilm include:

- Ready to use – no preparation required
- Long shelf life when shielded from moisture and humidity
- Simple to use and interpret
- Built-in biochemical confirmation
- Smaller (thinner) and less likely to be damaged than agar plates.



#### **Types of Petrifilm**

There are many types of Petrifilm, each formulated and designed for a specific purpose. Of the total number available, four are suggested for use in education. Other types that are used in industry to isolate known pathogens are regarded as unsuitable for use by students. For the purpose of this workshop, we will be dealing with the Aerobic Count (AC) plate.



#### **Aerobic Count (AC) Plate (product code M6400)**

Designed to enumerate common aerobic bacteria. The AC plate contains Standard Methods nutrients, a cold water gelling agent, and triphenyl tetrazolium chloride (TCC), an indicator that colours bacterial colonies red.

#### **Using Petrifilm**

Petrifilm is supplied in sealed packs that should be kept cool and dry. Storage in the dry atmosphere of a freezer is recommended, but ensure you allow the pack to warm up to room temperature before opening to avoid condensation forming.

Take out just the plates you will need for a piece of work, then reseal the pack and put it back in the freezer.

For detailed descriptions of sample preparation, inoculation methods, incubation conditions and interpretation of results, visit [www.southernbiological.com](http://www.southernbiological.com) then follow the links:

Catalogue

- Kits & Equipment

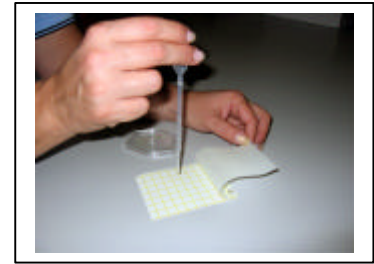
- Petrifilm

- Petrifilm Plates and Accessories.

From here, you can click through each product code for access to detailed information.

### **Testing Liquids**

Liquids such as orange juice, milk or water can be tested directly by inoculating the Petrifilm plate with 1mL and incubating. If the count is too high, you should dilute the sample then correct for the dilution factor when expressing the result. For information on serial dilution, download the "Tips on Sample Preparation – Serial Dilution" sheet from our website.



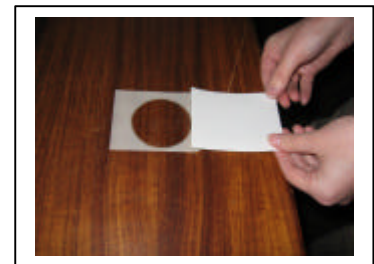
### **Testing Solids**

Solids need to be macerated in sterile liquid to extract microorganisms before they can be tested, but once this has been done, the plate can be inoculated with 1mL of the extract. For detailed instructions, download the "Coliform Information Insert" sheet from our website (follow links from product code M6410).

### **Testing Surfaces**

Two approaches are possible when using Petrifilm to test for the presence of microorganisms on surfaces. One method is to swab an area, and then to extract the swab with sterile liquid that can be tested. This is useful when testing irregular surfaces such as a tap, door handle, light switch or hand. The 3M Quick Swab (M6432) is a self-contained ready-to-use surface swab system, otherwise you can use a sterile cotton wool or rayon swab held with sterile forceps.

The second method is direct contact with a Petrifilm plate. This is suitable for smooth regular surfaces such as bench tops and floors, and even the surface of the skin. In order to activate the plates, they need to be hydrated with 1mL of sterile liquid before contact. Hydrated plates should be allowed to gel for at least one hour, but can be stored under refrigeration for up to a week before being used to test a surface. For more information, visit our website.



### **Testing the Atmosphere**

By taking a hydrated plate and peeling back the protective film, you can expose the activated surface of the plate to the air to check for the presence of airborne microorganisms. For example, compare different air conditioner outlets. For a description of the experimental method, download the "Yeast & Mould Information Insert" sheet from our website (follow links from product code M6407).



### **Student Experiments**

Petrifilm plates are suitable for many student experiments because of their ease of use and versatility. As well as meeting outcomes in the field of food technology and microbiology, the use of Petrifilm touches on areas such as maths (dilution and correction factors, calculations, scaling and statistics), scientific experimental design, and use of laboratory equipment. Download a copy of the "Petrifilm Experiment Manual" from our website (follow the link from any of the product codes).

### **Accuracy and Precision**

Microbiology is a branch of science that is concerned with accuracy but not so much with precision. Even though Petrifilm plates are designed for counting and enumeration of microorganisms, it is usual to speak in terms of "tens" or "hundreds" rather than giving precise numbers such as "47" or "163". All Petrifilm plates are calibrated to receive "1mL", so it is acceptable to use plastic Pasteur pipettes, and there is no need to discard plates that might have a slightly irregular gel shape.

## ***Sterile Technique***

All microbiological procedures require sterile methods to avoid contamination that would interfere with the determinations being made. Basic measures include:

- Wash hands thoroughly before and after each procedure.
- Tie back hair.
- Swab the work surface with 70% ethanol before starting work. Leave wet and allow to evaporate dry.
- Use a Bunsen flame to form a heat curtain to shield the work area from airborne microorganisms.
- Use "economical" movements and minimize the time that surfaces and samples are exposed.

When mixing or diluting samples, it is acceptable to use well boiled water that has been allowed to cool. For macerating food samples, you can get good results in a fresh polythene lunch bag. Provided they haven't been opened, these bags can generally be considered as sterile for the purpose of school experiments.

To check for the presence of a background level of microorganisms in the water and/or bag, run a control that substitutes sterile liquid for the test substance.

## ***Safety and Disposal***

Following inoculation, plates should be taped shut or placed in a press-seal bag to keep them isolated. Follow good laboratory practice and have students thoroughly wash their hands after handling microbiological samples and equipment. Adequate antibacterial hand wash and hand rub sanitizer solutions should be provided.

Treat plates with viable colonies as you would deal with cultures on conventional Petri dishes. Autoclave or treat in a pressure cooker using a sterile confirmation strip to verify that the microbes have been destroyed. Alternatively, you can use a contract collection service such as that provided by Stericorp.

## ***Trouble Shooting***

The most common problems we have seen tend to occur with novice users of Petrifilm, but they are easily avoided:

### **Dispensing more than 1mL of liquid**

If you accidentally draw more than 1mL of liquid into the pipette and dispense it onto the Petrifilm plate, it will overflow off the plate when the spreader is applied. Be careful to apply only 1mL.

### **Having the liquid roll off the plate as it is being applied**

This can occur if you hold the pipette at a low angle. Place the Petrifilm plate on a flat surface and hold the pipette perpendicular to the surface, in the central region. Dispense the liquid onto the plate with care.

### **Waiting too long**

Have the plate, spreader and sample to be tested ready, and apply the spreader without delay after dispensing the sample onto the plate. Proper spreading may not occur if you wait too long between dispensing the liquid and applying the spreader.

### **Trapping bubbles on the plate**

First of all, ensure the sample does not have entrained air bubbles. Allow it to stand if necessary to allow bubbles to clear. As a further measure, use the recommended method to lower the protective film back onto the plate after dispensing the sample. For the AC and YM plates, allow the film to drop back into place. For the CC and EC plates, roll the film gently back into place.

### Using the wrong spreader

Ensure you use the correct spreader. For YM plates, use only the special (larger size) Yeast and Mould Plate Spreader. For AC plates, use the General Purpose Spreader with the ridge side down (smooth side up). For CC and EC plates, use the General Purpose Spreader with the smooth side down (ridge side up).

### Getting contamination

Avoid contamination by planning your work and using good aseptic technique and sterile equipment. This applies to all microbiological work, not just Petrifilm.

### Further Information

The key to good results with microbiology experiments is familiarity with the equipment, confidence in the techniques, and respect for the safety aspects. For more information, contact us or attend a hands-on practical workshop session at a forthcoming conference or seminar. See the "Events" section of our web site for times and locations.

## 4.4 Temperature Measurements

Temperature is a key aspect of food safety. Microbes can multiply in the "danger zone" of 4°C to 65°C, so it is important to ensure food is stored outside this range. In other words, cold food should be kept cold (below 4°C), and hot food should be kept hot (above 65°C).

Temperature measurement is a key part of proper food storage. You can use a simple thermometer to monitor the conditions in your refrigerator, but there are many more possibilities opened up when you use a data logging system.

Dataloggers are widely used in industry for monitoring refrigerated storage areas and shipping containers. Being robust, economical and easy to use, they are ideal for student projects. Here are some ideas:



### How long does thawing take?

Fill 3 identical tumblers with the same volume of water (e.g. 200mL). Insert a datalogger temperature probe to each and freeze. Take each tumbler out of the freezer, connect the temperature sensors to a datalogger, then allow the tumblers to thaw in different conditions. Try different volumes thawing in the same conditions. Discuss the results in terms of safe food handling.

### Is your refrigerator working properly?

Run a temperature probe into a refrigerator and monitor the temperature for several days. How long does it take for the temperature to recover if the door is frequently opened? How does it perform when left closed for long periods, e.g. overnight?

## 5. Conclusion

There are many ways in which students can be introduced to the methods and resources that are currently being used around the world in the food and hospitality industries. The goal is to use and adapt ideas that can turn abstract concepts such as "microbes and bacteria" into engaging learning experiences that lead to understanding and new behaviours.

If you have any questions about this workshop, please contact Peter Ball of Southern Biological

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