

## LABORATORY EXERCISE - BACTERIA & HAND WASHING 101

### Purpose/Objectives:

- To determine where bacteria exist in our environment
- To test how time, method, amount of soap, or water temperature affect the efficiency of hand washing
- To test the anti-microbial effect of different hand cleansing products and “natural” antibacterial agents.

### Background information:

Bacteria are a diverse group of microscopic, single-celled organisms. Viruses are microscopic and infect cells using the cells as hosts for reproduction. Both bacteria and viruses can cause disease in humans. However, bacteria and viruses exist in the environment all around us and **most do not harm people.**

A pandemic is an outbreak of a disease around the world. Scientists and health professionals are concerned about the possibility of an H1N1 influenza (flu) pandemic. When a flu pandemic happens, people may have little or no immunity, and a vaccine may not exist for this new flu virus. The disease then spreads easily person-to-person and may cause serious illness across the country and around the world very quickly. A vaccine is currently being tested for the H1N1 influenza.

**According to the Centers for Disease Control and Prevention, the most common method that pathogens are spread is via the hands.** Therefore, proper hand hygiene helps to limit the spread of the flu and other infectious diseases, and is the single most effective way to prevent the spread of disease. Hand washing reduces diseases that are spread through fecal–oral or hand-to-mouth transmission, direct or indirect transmission (i.e., close contact by sharing personal items), and respiratory or airborne transmission (i.e., coughing or sneezing).

There are many hand cleansing products on the market. About 75 percent of liquid soaps currently on shelves in American grocery stores display the word “antibacterial” on their labels, and we are constantly adding new antibacterial products to our cleansing arsenals. The use of antibacterial chemicals is controversial (see “*Do Antibacterial Soaps do More Harm Than Good?*” from Scientific American, February 2008).

In this activity (partially adopted from the National Institute of Environmental Health Sciences), you will

- test where bacteria exist in the environment. (It is important to note that influenza is caused by a virus, not a bacterium.)
- test a hypothesis about the most effective hand-washing method.
- test a hypothesis about the most effective hand-cleansing product.

## **PART I - INVESTIGATING BACTERIA IN THE ENVIRONMENT**

### *Materials:*

- 1 agar plate per group PLUS 1 agar plate per individual
- sterile cotton swabs (6 per plate)
- sterile water
- 1 marker
- 1 ruler
- Parafilm (to seal agar plate)

### *Procedure*

1. Draw lines on the bottom of the group's agar plate (the side with the agar on it) to mark 6 equal sized regions (similar to slicing a pie).
2. As a group, decide what 6 environments you will investigate. It might be some environment in the room or somewhere in the Science building. You can also compare the environment before and after treatment (for example the desk before and after you clean it with Sanisol).
3. Label each region of the plate with the environment you will be testing.
4. Carry a sterile cotton swab and agar plate to the environment, and use the swab to collect the samples. If you are collecting from a dry surface, you should first dip the cotton swab in sterile water and then swab the surface.
5. Open the agar plate and lightly streak the swab back and forth across the agar in the appropriately labeled region. Discard the swab in the receptacle provided.
6. Seal the dish with Parafilm and wait until you have all the groups' plates from all portions of the laboratory. The instructor will incubate the plates at 37°C overnight. The next laboratory period you will observe the results and record data.
7. Repeat this procedure at home with at least one environment on your individual plate on your own time this evening. Bring plate to class next meeting

## **PART II – TESTING “NATURAL” ANTIBACTERIAL AGENTS\**

### *Materials:*

- 1 agar plate per group
- 1 sterile cotton swab
- 1 bacteria culture (shared with class)
- filter paper soaked in lemon juice, tee tree oil, vinegar, grapefruit seed extract oil
- filter paper available to soak in items brought in by students

### *Procedure*

1. Draw lines on the bottom of the group's agar plate (the side with the agar on it) to mark 6 equal sized regions (similar to slicing a pie).
2. Label each of the 6 regions with the “natural” antibacterial agent that will be tested.
3. Dip the sterile cotton swab into the bacteria culture and gently spread bacteria all over the agar plate. Try to completely cover the plate.
4. Place a piece of filter paper soaked in the antibacterial agents on the correctly labeled region of the plate.
5. Seal the dish with Parafilm and wait until you have all the groups' plates from all portions of the laboratory. The instructor will incubate the plates at 37°C overnight. The next laboratory period you will observe the results and record data.

### Part III: Investigating hand washing methods

**This section involves designing your own experiment. Read the information and remember to use scientific method to think about how to answer a specific question.**

*Materials:*

Glo gel (shared with the class)  
Hand washing soap & paper towels  
Stopwatches (shared with your group)  
UV lights (shared with the class)  
optional – fingernail brush, scrub soap

*General Information & Guidelines for Glo Gel experiment:*

1. You will conduct an experiment to determine the best method to wash hands.
2. *Glo Gel* will be used to simulate “germs”. Note that the *Glo Gel* is not actually germs, it just SIMULATES germs. This way you can observe before and after without having to grow the bacteria overnight. To use the *Glo Gel*, apply a small amount as if the gel were hand lotion, making sure to spread the gel completely on hands (i.e., front and back, between fingers).
3. A UV light will illuminate the “germs” to test the effectiveness of the hand washing method. It is important to NOT LOOK AT THE UV LIGHT DIRECTLY as it can cause damage to the eyes. The UV light is used only to observe the effectiveness of hand washing.
4. Divide into groups of at least five students per group. Possible group member roles: at least one recorder and timer, and three to four hand washers. Note that the control will be to use the hand gel but not wash, since washing is what is being tested.
5. Some possible independent variables are length of time spent washing, temperature of the water, method for scrubbing, or number of pumps of soap. Type of soap would not be used as a variable for this segment of the investigation as the *Glo Gel* does not distinguish between various soaps or cleaners/disinfectants (i.e., hand sanitizer versus antibacterial soap or dish soap). Your group should ONLY choose ONE variable that changes. Make your life “easy”.
6. Here are some sample questions to investigate:
  - How does length of time effect hand washing effectiveness (0, 10, 20, or 30 seconds)?
  - How does temperature of water effect hand-washing effectiveness (cold, lukewarm, or hot)?
  - How does method for scrubbing affect hand-washing effectiveness (use of fingernail brush, rubbing hard, etc.)?
  - How does the number of pumps of soap effect hand-washing effectiveness (0, 1, 2, 3)?
7. In your experiment, you will change the independent variable (time, temperature, method, or pumps) while other factors will not change. For example if I were designing an experiment to test how the number of pumps of soap effects hand-washing, then I would test 1 pump, 2 pumps, and 3 pumps as the independent variables. For each of those trials, I will keep the time, temperature, and method constant. The dependent variable is hand cleanliness. You are testing how the dependent variable changes at different levels of the independent variable.
8. BEFORE beginning the experiment, develop a hypothesis and complete that portion of the Assignment. Define your dependent and independent variables.
9. Design your experiment. Seek out the instructor for assistance and approval before starting to execute the experiment.

10. To help with the data collection, complete the Handprint Figures as your data recording to estimate the percentage of the hands that were cleaned as the independent variable changed. The recorder can color or shade in boxes showing where the hands are still DIRTY (these areas will illuminate under the UV light). Remember to look at both sides of the hands and then estimate the percentage of the hands that were CLEANED by counting the number of “clean” boxes.

To estimate the percentage of the hands that was cleaned:

1. Count the total number of “clean” boxes, to the nearest quarter of a box, for each side (top and bottom) of each hand
2. Then divide that number by 308, the total number of boxes. **Do not count boxes that are less than half the size of a regular box.**

The whole group will turn in one data set of hand figures. Be sure to include everyone’s names on the data sheets. Provide all the information requested and give DETAILED explanations for each section of the assignment. This is particularly important for the protocol and results/conclusion sections.

#### **Part IV: Comparison of hand cleansing products**

##### *Materials (per group)*

- 2-3 agar plates (1/2 of a plate per person)
- sterile cotton swabs (2 for each person)
- sterile water
- 1 marker
- Parafilm (to seal all agar plates)
- Hand cleansing products (dish soap, Purell, antibacterial soap (with Triclosan))

##### *Procedure*

1. Draw lines on the bottom of the group’s agar plates (the side with the agar on it) to mark 4 equal sized regions (similar to slicing a pie).
2. Each group member will choose one type of soap to test (try to have a variety of soaps amongst your group). Two of the 4 regions will correspond to one type of soap. One section representing “before” and the other section representing “after”.
3. To make everyone’s hands “dirty” each person should handle (hold, touch, jingle, count) 10 pennies or something dirty for 1 minute
4. For the section labeled “before” take a sterile cotton swab and dip it into sterile water. Rub the wet cotton swab over the whole index finger and palm of the left hand. Then Open the agar plate and lightly streak the swab back and forth across the agar on the “before” side. Discard the swab in the receptacle provided.
5. For the section labeled “after”, wash or cleanse hands using the chosen product. (If it is soap, take one pump and wash in warm water for 20 seconds and dry with paper towels. If it is antibacterial gel, take one dime-sized squirt and rub until dry). After cleansing, take a sterile cotton swab and dip it into sterile water. Rub the wet cotton swab over the whole index finger and palm of the left hand. Then open the agar plate and lightly streak the swab back and forth across the agar on the “after” side. Discard the swab in the receptacle provided.
6. After each plate is finished, seal the dish with Parafilm, place all your group’s plates in a stack, and bring them to the area indicated by the instructor. The instructor will incubate the plates at 37°C overnight. You will observe and describe the results in the next laboratory period.

# LABORATORY ASSIGNMENT - BACTERIA & HAND WASHING 101

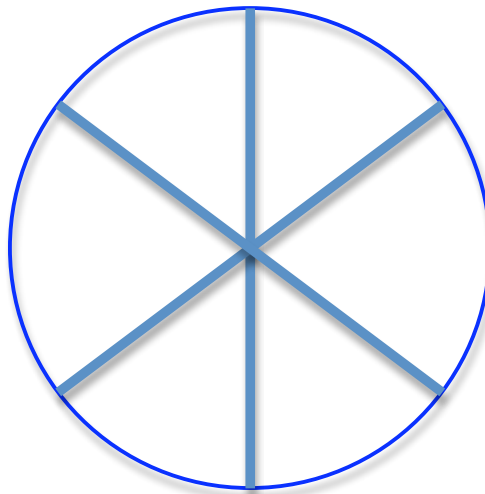
Group Members: \_\_\_\_\_

## Part I – Investigating Bacteria in the environment

1. What environments did you investigate? Indicate any treatments you applied.

- 1
- 2
- 3
- 4
- 5
- 6

2. Draw and describe what your plate looked like following incubation:



3. Examine plates from another group that investigated different environments. Record your observations from three of those environments below:

Environment \_\_\_\_\_

Observations:

Environment \_\_\_\_\_

Observations:

Environment \_\_\_\_\_

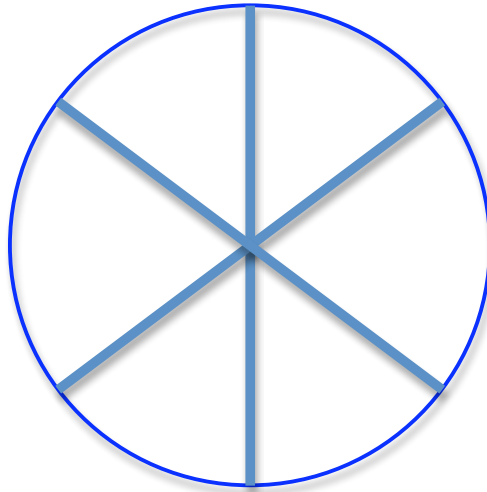
Observations:

## Part II – Testing “natural” antibacterial agents

1. What chemicals did you investigate?

- 1
- 2
- 3
- 4
- 5
- 6

2. Draw and describe what your plate looked like following incubation:



3. Did any of these natural products prevent bacterial growth? Which one(s) worked the best and why?

4. Why would organisms, such as plants, have antibacterial properties?

### Part III: Investigating hand washing methods

**Experiment Title:** *Include a descriptive title of your experiment.*

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**Independent Variable:**

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Control: \_\_\_\_\_

Level 1: \_\_\_\_\_

Level 2: \_\_\_\_\_

Level 3: \_\_\_\_\_

**Dependent Variable(s):**

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**Question:**

*What are you trying to figure out?*

**Hypothesis:**

*Write your prediction regarding how the independent variable will affect the dependent variable.*

**Materials Used:**

*List the materials used to conduct the experiment. Be specific and include everything (Hint: there should be about 8 items). This list will help you write a detailed experimental protocol as required in the next section.*

**Protocol:**

*Identify the steps you took to complete the experiment. Be sure to be clear, concise, and include details so that another group would be able to correctly follow the procedure as you intended. For example, how many pumps of soap were used? Was the water running and then hands placed under the running water at the same time the stopwatch is started? What was the temperature of the water? How were hands dried?*

## Handprint Figure Data (1 per independent variable)

Independent Variable: \_\_\_\_\_ (i.e. 30 seconds, or 1 pump)

The image shows a template for recording handprint figure data. It consists of four hand outlines arranged in a 2x2 grid, each overlaid with a 10x10 grid. The top row is labeled "RIGHT HAND" and the bottom row is labeled "LEFT HAND". The left hand in the bottom row is labeled "Top" and the right hand in the bottom row is labeled "Bottom (Palm Up)".

RIGHT HAND

LEFT HAND

Top

Bottom  
(Palm Up)

**Results, Conclusions & Discussion:**

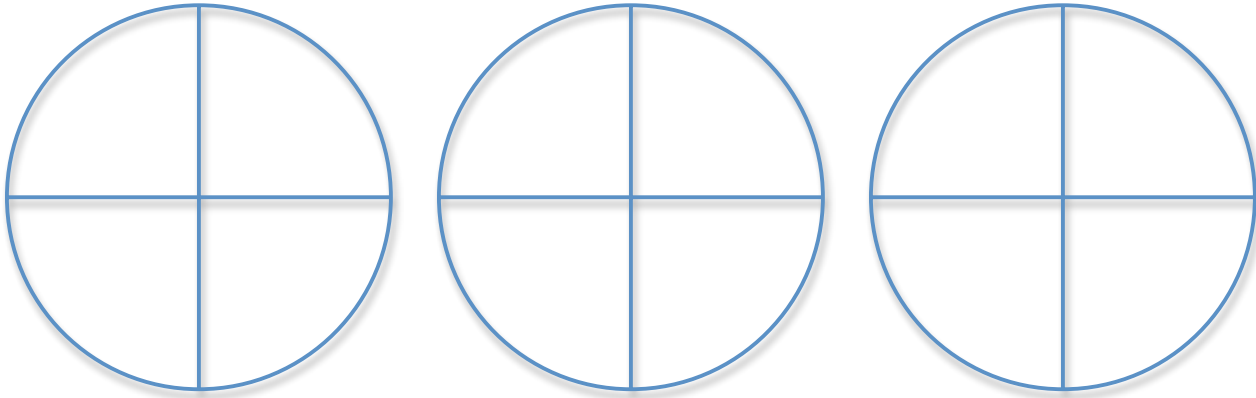
*Explain the results of your experiment and draw any conclusions.*

- *Be sure to discuss both quantitative (i.e. percentage of hands cleaned) and qualitative (e.g. the glow gel remained in the nail cuticles) results.*
- *Make sure the connections between the dependent and independent variables are explained clearly.*
- *Discuss possible errors and how each of those errors may have affected your results. For example, differences in hand washing technique, and other things that may have varied beyond your control.*
- *Give suggestions for further study or refinement of the present experimental protocol.*

## Part IV - Comparison of hand cleansing products

1. Record which cleansing products your group used:

2. Draw and describe what the plates for each produce looked like following incubation:



3. Compare your results to other individuals or groups' and record any observations below (were they the same, did they get different results, etc.)

Cleansing product \_\_\_\_\_

Observations:

Cleansing product \_\_\_\_\_

Observations:

Cleansing product \_\_\_\_\_

Observations:

4. BASED ON THE DATA AND OBSERVATIONS, which of the three hand cleansing products is most effective and why?

5. What are some things one should consider before purchasing or using any type of cleanser (hand, body, kitchen, bathroom, etc.)?