

LESSON:

Handwashing 101

Summary: Students develop a hypothesis about the most effective handwashing method, develop an experiment protocol to test their hypothesis, and carry out their handwashing experiment.

Lesson Type: Experiment and Extension Lesson—Students collect, manipulate, and/or summarize data from an experiment or activity they conduct by extending a topic in an *EHP Student Edition* article.

EHP Article: “An Outbreak of New Sources of Avian Flu Drug”
EHP Student Edition, November 2006, p. A464
<http://www.ehponline.org/docs/2006/114-8/forum.html#anou>

Objectives: By the end of this lesson, students should be able to

1. write an experiment protocol;
2. carry out a handwashing experiment;
3. summarize results from their handwashing experiment; and
4. draw conclusions based on their results.

Class Time: Part 1, 60–90 minutes; Part 2, 45 minutes (homework may be added to each part)

Grade Level: 10–12

Subjects Addressed: Biology, General Science, Health

► Prepping the Lesson (30 minutes)

INSTRUCTIONS:

1. Download the entire November 2006 *EHP Student Edition* at <http://www.ehponline.org/science-ed/>, or download just the article “An Outbreak of New Sources of Avian Flu Drug” at <http://www.ehponline.org/docs/2006/114-8/forum.html#anou>.
2. Review the Instructions, Student Instructions, and Background Information.
3. Make copies of the Student Instructions, Experiment Report Form, and Handprint Figures.
4. Obtain the Glo Gel and other materials for the experiment.

MATERIALS

per student:

- 1 copy of *EHP Student Edition*, November 2006, or 1 copy of “An Outbreak of New Sources of Avian Flu Drug”
- 1 copy of the Student Instructions
- 1 copy of the Experiment Report Form

per group:

- 4 copies of the Handprint Figures (number may vary per group protocol)
- 1 additional copy of the Student Instructions (for sharing experiment with another group)
- Glo Gel*
- UV light or lamp*
- Liquid handsoap
- Stopwatch
- Access to sink and water
- Graph paper (optional)
- Colored markers/pencils

*Glo Gel and UV lights/lamps are available for purchase through the manufacturer, Glo Germ, and several science education suppliers, such as Carolina Biological. The Glo Gel is more user-friendly than the Glo Germ Oil or Liquid.



VOCABULARY:

- avian flu
- dependent variable
- independent variable
- pandemic
- virus

BACKGROUND INFORMATION:

A pandemic is an outbreak of a disease around the world. Scientists and health professionals are concerned about the possibility of an 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.

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. Handwashing 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).

RESOURCES:

Environmental Health Perspectives, Environews by Topic page, <http://ehp.niehs.nih.gov>. Choose Infectious Disease
American Society of Microbiology, Wash Up, <http://www.washup.org/index.html>
Centers for Disease Control and Prevention, Clean Hands Campaign, <http://www.cdc.gov/cleanhands/>
Glo Germ, <http://www.glogerm.com/>
Microbeworld.org, Gross...You Didn't Wash Your Hands? <http://www.microbeworld.org/know/wash.aspx>
U.S. Department of Health and Human Services, Pandemic Flu, <http://www.pandemicflu.gov/>

► Implementing the Lesson**INSTRUCTIONS:**

1. Hand out the article to students and have students read the article (reading could be assigned as homework). Discuss the article. Have students share their thoughts about the possibility of a flu pandemic.
2. Introduce the idea of hand hygiene as an effective method to prevent the spread of disease, not just for a flu pandemic, but for many common illnesses and 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).
3. Discuss experimental design, including independent and dependent variables, hypotheses, use of control, need for clear procedures, etc.
4. Divide students into small groups and hand out the Student Instructions, Experiment Report Form, and Handprint Figures. If you will complete Part 2, be sure you have an even number of groups.
5. Explain to students that they are going to develop an experiment to determine the best method to wash hands. They will use Glo Gel to simulate “germs” on their hands, and the UV light will illuminate the “germs” to test the effectiveness of their handwashing method.
6. Discuss the safe use of the UV light. Students should not look at the UV light directly as it can cause damage to the eyes. The UV light should only be used to observe the effectiveness of handwashing.
7. Have students complete Part 1 of the Student Instructions and the Experiment Report Form. The Experiment Report Form is open-ended to allow students to develop their procedures for completing the experiment. If you want to provide students with more guidance, see the sample Completed Experiment Report Form in the Assessing the Lesson Section.
 - Possible group member roles: recorder, handwasher (1–3 students), control, timer/door opener (Note: the control will use the hand gel but not wash, since washing is what is being tested).
 - Possible Independent Variables: length of time spent washing, temperature of water, method for scrubbing, or number of pumps of soap. Type of soap should not be used as a variable as the Glo Gel does not distinguish between various soaps or cleaners/disinfectants (i.e., hand sanitizer versus antibacterial soap or dish soap). You could ask students how they would conduct an experiment that distinguishes between soaps



(e.g. bar, antibacterial, dish, and hand sanitizers). They could swipe samples from their hands after washing and then plate for bacteria.

- Students need to decide how many repetitions per person will be performed. This will determine how many handprint figures they need.
- Dependent Variable: Percentage of Hands Cleaned. To estimate the percentage of hands cleaned, have students use the Handprint Figures, or trace their hands (back and front) on graph paper. The student recorder can color or shade in boxes showing where the hands are still dirty (these areas will illuminate under the UV light). Remind them 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. This will allow students to estimate the percentage of the hands that were cleaned. Use the UV light in a darkened area for best results.

8. Have students complete Part 2 of the Student Instructions. Have two groups switch Experiment Report Forms and complete the other's experiment. Groups should discuss their results.

NOTES & HELPFUL HINTS:

1. To use the Glo Gel, students 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). Place hands under the UV light to see the Glo Gel "germs" shine white. Wash hands and then place hands under the UV light to see whether any "germs" remain after handwashing. See the Glo Gel bottle for more complete instructions.
2. Depending on the number of students in the groups, you may want to have students assign roles to their group members. At least one student per group should act as the recorder.
3. Be sure to have all students use the Glo Gel so that can see the effectiveness of their handwashing technique.
4. Another option for this activity is to have students put the Glo Gel on their hands and go about their normal activities for a period of time, then use a portable battery-powered UV light to observe how "bacteria" can be spread and which surfaces (e.g., door handles) appear to collect the most bacteria.
5. The September 2005 *EHP Student Edition* has another lesson on the avian flu titled *On Hens and Needles* where students construct a PMI (Plus/Minus/Implications) table to help them analyze the decisions health officials must make as they combat the spread of the H5N1 Avian Flu virus. The lesson is located at <http://www.ehponline.org/science-ed/lessons2005.html>.

► Aligning with Standards

SKILLS USED OR DEVELOPED:

- Communication
- Comprehension
- Computation
- Critical thinking and response
- Experimentation
- Manipulation
- Observation

SPECIFIC CONTENT ADDRESSED:

- Experimental design
- Handwashing

NATIONAL SCIENCE EDUCATION STANDARDS MET:

Science Content Standards

Science as Inquiry Standard

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Life Science Standard

- Interdependence of organisms
- Matter, energy, and organization in living systems
- Behavior of organisms

Science in Personal and Social Perspectives Standard

- Personal and community health

History and Nature of Science Standard

- Science as a human endeavor



▶ Assessing the Lesson

SAMPLE COMPLETED EXPERIMENT REPORT FORM

Experiment Title: Handwashing and Length of Time

Include a descriptive title of your experiment

Group Members: _____

Independent Variable: Length of time spent washing

Level 1: 10 seconds

Level 2: 20 seconds

Level 3: 30 seconds

Choose one independent variable to test in your experiment, such as time spent washing or water temperature. (The independent variable is the factor that is manipulated to determine whether it affects the dependent variable.) Then identify three levels of this variable to test (such as 10 seconds, 20 seconds, and 30 seconds) for time as the independent variable.

Dependent Variable: Percentage of hands cleaned

As the point of your experiment is to examine the most effective method for handwashing, the dependent variable is effectiveness of handwashing, or the percentage of hands cleaned. (The dependent variable is the factor that might be influenced or modified by some treatment or exposure, or the independent variable.)

Hypothesis: The more time spent washing, the cleaner the hands

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

Materials Needed:

List the materials you will need to conduct your experiment. The list has been started for you.

- Glo Gel
- UV light
- Liquid handsoap
- Stopwatch
- Access to sink/water
- Paper towels
- 8 Handprint Figures (2 reps for each level 1, 2, 3 and control)
- Colored markers/pencils

Protocol:

Assign each Handwasher to a length of time (10 seconds, 20 seconds and 30 seconds.) Each person, including the control, will perform two trials. Write the time and names of the Control and Handwashers on the Handprint Figures.

1. Assign roles to each member of the group: recorder, handwasher (1–3 people), control, and timer.
2. Assign each handwasher to a length of time (10 seconds, 20 seconds, or 30 seconds). Write the time and names of the control and handwashers on the Handprint Figures.
3. Have the control and handwashers apply about 1–2 pumps of the Glo Gel to their hands and rub the gel completely around their hands like hand lotion.
4. Use the UV light to illuminate the “germs” on the control’s and handwashers’ hands. (Control and handwashers should not touch anything.)
5. Go to a sink.



6. Using 2 full pumps of liquid handsoap, the handwashers should thoroughly wash their hands, including the backs of hands, wrists, and between fingers. The timer should time each handwasher as they thoroughly wash and rinse their hands for the assigned time (10 seconds, 20 seconds, or 30 seconds).
7. Have the handwashers dry their hands. Handwashers should not touch anything other than the paper towels.
8. Use the UV light to illuminate the “germs” remaining on the handwashers’ hands after washing.
9. Complete the Handprint Figures to estimate the percentage of the hands that were cleaned at the three lengths of time.
10. Draw conclusions based on the most effective method.

Conclusion:

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.*
- *Explain how you would change your protocol next time and why.*

Answers will vary. Make sure the students address all of the bullet points and write in a clear and logical fashion. If the students conducted 2 or more repetitions of the experiment, make sure they correctly averaged the data. Students should revise their conclusions multiple times until they have a clear, concise, and detailed product. This will significantly improve writing skills and student understanding of the experiment and the scientific method.

► Authors and Reviewers

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Give us your feedback! Send comments about this lesson to ehpscienceed@niehs.nih.gov.



PART 1

Step 1: Read the article "An Outbreak of New Sources of Avian Flu Drug."

Step 2: As a group, use the Experiment Report Form to develop an experiment to determine the best method to effectively wash hands. Your experiment should include:

- Independent variable. You will test three levels of this variable.
- Dependent variable: percentage of hands cleaned. To estimate the percentage of hands cleaned, use the Handprint Figures.
- Control: Because we are testing hand washing, this experiment should have a positive control where someone puts Glo Gel on his/her hands but does not wash their hands.
- Hypothesis
- Materials needed
- Protocol, or procedures, to carry out the experiment. This includes deciding how many times the experiment will be repeated.
- Conclusions

Step 3: Conduct your experiment based on your Experiment Report Form, and draw any conclusions based on the results.

PART 2

Step 4: Copy your experiment onto another Experiment Report Form without your conclusions. Exchange this Experiment Report Form with another group and conduct their experiment while they conduct your experiment.

Step 5: Compare the results and answer the following questions.

- Whose protocol did you follow?
- What did you observe?
- What would you change about the protocol? Were there any differences between the conclusions for your experiment and the one developed by the other group? Describe any differences or similarities and provide possible explanations.

EXPERIMENT REPORT FORM

Experiment Title: _____

Include a descriptive title of your experiment.

Group Members: _____

Independent Variable: _____

Level 1: _____

Level 2: _____

Level 3: _____

Choose one independent variable to test in your experiment, such as time spent washing or water temperature. (The independent variable is the factor that is manipulated to determine whether it affects the dependent variable.) Then identify three levels of this variable to test (such as 10 seconds, 20 seconds, and 30 seconds) for time as the independent variable. Since you are investigating handwashing, the control should use Glo Gel and not was his or her hands.

Dependent Variable: Percentage of hands cleaned

As the point of your experiment is to examine the most effective method for handwashing, the dependent variable is effectiveness of handwashing, or the percentage of hands cleaned. (The dependent variable is the factor that might be influenced or modified by some treatment or exposure, or the independent variable.)

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

Materials Needed: *List the materials you will need to conduct your experiment. The list has been started for you.*

- Glo Gel
- UV light
- Liquid handsoap
- _____ (number) Handprint Figures handouts
- _____
- _____
- _____
- _____

Protocol: *Identify the steps you will take to complete your experiment. Be sure to be clear and concise so that another group is able to correctly follow the procedure as you intended. For example, how many pumps of soap are used? Will the water be running and then hands placed under the running water at the same time the stopwatch is started? Will you air-dry your hands or use a paper towel? If so, how? There is additional space on the next page if needed.*



Conclusion: *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.*
- *Explain how you would change your protocol next time and why.*



HANDPRINT FIGURES

Color or shade in the boxes that are still dirty on the top and bottom of the hands (these areas will shine white under the UV light). Then estimate the percentage of the hands that were cleaned by 1) counting the total number of "clean" boxes, to the nearest quarter of a box, for each side (top and bottom) of each hand; and 2) dividing that number by 308, the total number of boxes. (Do not count boxes that are less than half the size of a regular box.)

NAME _____

Level of Independent Variable _____

