2.11 Investigation: Observing the Effects of Antiseptics

BACKGROUND INFORMATION

About 76% of the liquid soap market is classified as "antibacterial." Antibacterial products—soaps, lotions, and mouthwashes—commonly contain an active ingredient called triclosan. This chemical disrupts bacterial functioning, killing or inhibiting the growth of bacteria that cause skin infections, intestinal illnesses, or other commonly transmitted diseases. Triclosan requires several minutes of contact to work and most people wash their hands for just 3 to 5 s. This short washing time is likely why a recent study found the same number of bacteria on hands after a year of using either an ordinary liquid soap or an antibacterial product. A year is the study period chosen in this investigation, as its purpose was to determine the long-term effect of antibacterial products on bacterial colonization. Washing longer and more vigorously with ordinary soap will effectively remove most bacteria. For people with babies or those with a compromised immune system, the U.S. Centers for Disease Control and Prevention recommends using an alcohol-based gel, which kills germs by drying them out. Alcohols, peroxides, and bleaches act immediately and then dissipate, allowing the return of normal, healthy bacteria. Antibacterials leave residues on the skin. Consumers are encouraged to read labels to determine the active ingredient in a product.

Misconceptions

Is too much of a good thing harmful? The American Medical Association is concerned about bacterial resistance developing in the 0.4% of the bacteria that antibacterial soap does not kill. The weakest 99.6% of the bacteria may be killed the first time hands are washed with an antibacterial soap, but the remaining few spread out to take up the available space. A similar process occurs each time antibacterial agents are used, and the end result is a population of bacteria that can't be killed by the chemical in the product. Most people don't need the extra 2% protection that antibacterial soaps can give them, but sick people in hospitals and their caregivers certainly do. When the resistant bacteria get into a hospital, the drugs cannot kill them. To a certain extent, a similar problem exists with regular soaps, but other antibacterial chemicals can kill those few remaining bacteria. A second problem with antibacterial agents is their negative effect on helpful bacteria and the immune system. Also, antibacterial chemicals work against bacteria and have no effect on viruses, which are the cause of most hard-to-treat diseases.

Related Background Resources

- Canadian Bacterial Diseases Network: Flesh-Eating Disease: http://www.cbdn.ca/english/discover/grpA.html
- Antibacterial Soaps: http://www.healthatoz.com/healthatoz/Atoz/hl/sp/home/alert09192000.html
- Antibacterias and Disinfectants: http://www.biol.vt.edu/faculty/Claus/GWC%2004_usable%20news/Disinfection/01_%20CR_clean.html
- Could Antibacterial Soaps Create New Bacterial Strains?: http://www.nurseweek.com/features/98-10/soap.html
- Germ Warfare: http://www.greenbaypressgazette.com/news/archive/life_360545.shtml
- Doctor's Group Questions Antibacterial Soaps: http://www.anapsid.org/drkoop.html

ASSESSMENT PLANNING

Overall Skills Expectations
SIS.01
SIS.02
SIS.03
SIS.05
SIS.06
SIS.07
SIS.08
SIS.10
Overall Expectations
M.02
Specific Expectations
M2.03 design and conduct an experiment to determine the effect of antibacterial agents on different bacterial cultures

Achievement Chart Categories	Assessment/Evaluation Opportunities (Evidence)	Assessment Tools
Knowledge/Understanding	Investigation, q. (a)–(i) M2.03	Rubric 1: Knowledge/Understanding
Inquiry	Investigation, q. (a)–(i) M2.03	Rubric 2: Inquiry Tracking Sheet: Inquiry Skills Self-Assessment Checklist 1: Inquiry Skills
Communication	Investigation, q. (a)–(i) M2.03	Rubric 3: Communication
Making Connections	Career Connection SIS.10	Rubric 4: Making Connections

Assessment Opportunities

Knowledge/Understanding Collect student answers to the Investigation questions (c), (d), (h), and (i). To determine their level of achievement, use *Assessment Rubric 1: Knowledge/Understanding* assessment criteria:
- Understanding of concepts, principles, laws, and theories (identifying assumptions, communicating misconceptions, providing explanations)
- Knowledge of facts and terms
- Transfer of concepts to new contexts
- Understanding of relationships among concepts

Inquiry Observe students during the Investigation to assess their inquiry skills. To determine their level of achievement, use *Assessment Rubric 2: Inquiry* assessment criteria:
- Initiating
- Planning
- Performing and recording
- Analyzing and interpreting

Students may also assess their own skills using *Self-Assessment Checklist 1: Inquiry Skills*. Use the *Tracking Sheet: Inquiry Skills* to track the ongoing development of skills.

Communication Collect student work for the Investigation Report. To determine their level of achievement, use *Assessment Rubric 3: Communication* assessment criteria:
- Communication of information and ideas
- Use of scientific terminology, symbols, conventions, and standard (SI) units
- Use of various forms of communication (e.g., reports, essays)
- Use of information technology for scientific purposes (e.g., specialized databases)

Making Connections Collect student work for the Career Connection. To determine their level of achievement, use *Assessment Rubric 4: Making Connections* assessment criterion:
- Proposing courses of practical action in relation to science- and technology-based problems

INSTRUCTIONAL PLANNING

Suggested Time
Planning—30 min
Investigation—setup 15 min; readings and completion 15 min
Report—30 min

Materials and Equipment

Material/Equipment	Quantity per station	Quantity for 16 stations
laboratory apron	1 per student	32
petri dish with nutrient agar and bacterial culture	1	16
3 different antiseptics (e.g., bathroom cleaner, hand sanitizer, mouthwash)	6 options per class	6 options per class
50-mL beaker	3	48
hole punch	1 per class	1 per class
forceps	3	48
incubator	1 per class	1 per class
wax marker	1	16
soft pencil	1	16
masking tape	1 roll per class	1 per class
ruler	1	16
disinfectant	1 bottle per class	1 per class
bleach	1 bottle per class	1 per class

- Order prepared bacterial growth plates or pour agar plates 1–3 days before using. This procedure may take 1–3 h per class. Store poured plates upside down after they begin to set to prevent damage by condensation.

- Teachers may choose *Lactobacillus* in yogurt as a bacterial culture or one of the successful sources used in the bacteria-culturing activity (Section 2.5). Alternatively, the culture medium can be inoculated with mouth bacteria by following the directions in Getting Started.
- A single pair of forceps can be given to each group, but it must be washed well between uses.

Safety and Disposal
- Students should clean lab tops and equipment with a bleach solution.
- Students should wash their hands thoroughly with antibacterial soap.
- After use, plates should be soaked in bleach, drained, and placed in a double plastic bag for disposal. Follow school board procedures for disposing of toxic materials.

TEACHING SUGGESTIONS

Pre-lab Discussion
- Review the definition of antiseptics and disinfectants in Section 2.9. Canvass the class on their use of these products and make a list. Encourage students to bring in samples of products to test in the lab.
- Display a variety of antibacterial agents or use Figure 1 on page 125 of the Student Text. Remind students that antiseptics are products used on humans (skin, mouth). Allow time for students to examine the labels of the antiseptics in order to make an informed prediction.

During the Lab
- Circulate during the setup and readings. Ensure that students observe safety procedures.
- Growth inhibition zones may not be perfect circles. Help students determine how to estimate diameter from irregular shapes.
- Encourage students to provide good descriptors of bacterial growth or the lack thereof. Remind them to consider the characteristics used to describe colonies (students can review the diagrams found in *Appendix A8*).
- A lab report structure is presented in **Workbook 2.11 Investigation: Observing the Effects of Antiseptics**.

Post-lab Discussion
- Compile a list of students' experimentation results for the class. Have students rank the effectiveness of all antiseptics used. Ask students whether they can account for the differences based on the product information on the labels.
- Now that students have compared the antibacterial action of some common products, ask what potential problems placing small doses of antiseptics in skin-care products might create. Students' answers could include the development of resistant bacteria, the destruction of helpful bacteria along with harmful ones, and complacency about hand washing (remember, antibacterial agents have no effect against viruses, protists, or fungi).
- Ask students to write a reflective paragraph on their hygiene practices. Do they wash their hands before and after each meal and before and after using the toilet? Pass on this fact: there are more bacteria in every gram of feces than there are humans in the world. Why is rigorous hand washing important?
- **Workbook 2.11 Case Study: Treating Body-Piercing Infections** is a comprehension exercise. It presents facts on and practical advice about preventing infections from body piercings. Provide this background information to students: Body piercings heal through a process medically known as "secondary intention," in which the skin from the outside of the

piercing slowly grows through the tract. Initially, the area around the entry and exit sites will be red and there will be drainage—clear, yellow, or bloody. Infections are indicated by increased redness and pain. Granulation tissue (heaped up flesh) may appear at the puncture site, with drainage, bleeding, and a foul smell. Colonies of *Pseudomonas* bacteria and *Candida* fungi may develop below nipple line piercings, causing a foul odour without pain. Keeping wounds clean and ensuring drainage is the best way to prevent infection.

Extensions and Modifications

- Have students repeat their experiment using a variety of disinfectants. Compare disinfectant results with antiseptic results and account for the differences.
- One new antibacterial product advertises the following:

  "Kill the bacteria, not your hands: destroy bacteria instantly without alcohol. Fresh Cleanse is a scientific breakthrough in the fight against bacteria, germs, and the threat that they pose to good health. Fresh Cleanse is a moisture-enriched product designed to safely and effectively remove bacteria, fungi, yeast, and viruses from the skin. The Fresh Cleanse family of products all contain an antimicrobial/antibacterial formulation combined with skin-softening emollients and botanicals proven to moisturize and condition without the harsh, drying effects of alcohol, iodine, and other irritating actives found in leading antimicrobial/antibacterial products."
- Ask students to analyze this pitch. What claims are being made? How plausible are they? Identify inaccurate statements. What additional information would support these claims?
- A new mouthwash announces that, in place of alcohol, the following active ingredients provide antibacterial properties: folic acid, zinc, myrrh oil, cloves, and distilled water. As an enrichment exercise, ask students to investigate these claims. (The original article is posted at http://www.vitamyr.com/naturalteethwhitening.htm.)