Introduction and background

Bacteria are prokaryotic (having no nucleus), one-celled organisms. Individual bacterial cells are visible only with the aid of a high-powered microscope. Under proper nutritional and environmental conditions, bacteria can be grown in a laboratory. They are usually cultivated in sterile petri dishes containing a gelatin-like nutrient called agar.

Bacteria reproduce rapidly. Each single cell divides about every twenty minutes. When a population of bacteria has multiplied to a thousand or more cells, a pattern of growth called a colony can be seen with the naked eye. The specific shape and color of a bacterial colony can be used to identify the species of bacteria that form it.

Bacteria are important in many ways. Some bacteria break down organic materials from dead organisms and wastes, returning nutrients to the environment. Nitrogen-fixing bacteria convert nitrogen gas from the air into forms of nitrogen that can be used by plants and animals. Some bacteria are used in making food, such as vinegar, yogurt, butter, cheese, pickles, and sauerkraut. A few bacteria cause disease and are known as pathogens. Some examples of diseases caused by bacteria include tuberculosis, pneumonia, strep throat, and ear infections.

Because bacteria multiply so rapidly, it is often necessary to control their growth in the human body, in food, and in the kitchen. Several varieties of products are used to control bacterial growth, including antibiotics, disinfectants, and antiseptics. All these products are antimicrobial agents. Different kinds of bacteria are sensitive to some chemicals and insensitive to others. Thus, different types of antimicrobial agents vary in the way they affect bacterial growth.

In this Virtual Lab you will determine the effectiveness of different antimicrobial agents by inoculating agar in a petri dish with different pathogenic bacteria, adding various antimicrobial agents, and measuring the bacterial growth around each antimicrobial agent.

Pre-Lab Questions:
1. Describe bacteria. How can bacteria be grown in a lab?
2. Describe how bacteria reproduce. What is a colony, and how can colonies be used to identify bacteria?
3. Describe bacteria’s role as a decomposer. Why are nitrogen-fixing bacteria important?
4. What are the similarities and differences between antibiotics, disinfectants, and antiseptics?

Objectives:
Describe how bacterial cultures are grown and investigated • in a laboratory
• Determine the effectiveness of antibiotics and antiseptics in inhibiting the growth of bacterial cultures.

Procedure:
1. Inoculate the agar in the petri dish by clicking one of the test tubes containing pathogenic bacterial stock culture-Staphylococcus aureus, Hemophilus influenzae, or Streptococcus pneumoniae.
2. Vials 1 through 7 contain filter paper disks that have been soaked in antimicrobial agents such as antibacterial soap, household bleach, household disinfectant, penicillin, amoxicillin, and erythromycin, or in sterile water (as a control). Drag a disk from each vial and place it in the petri dish.

   Note: To avoid contamination, disks should not be moved after they have been dropped into the petri dish.
3. At any time in the Virtual Lab, click the Microbiology book to find out about specific pathogenic bacteria and antimicrobial agents. Click the fingers pointing left and right to page through the information.
4. Click the incubator to place the petri dish in it.
5. Click the red button on the incubator to turn it on. When the timer shows that 24 hours have passed, click the incubator to remove the petri dish.
6. Examine the patterns of bacterial growth. The colored area that covers most of the surface of the petri dish is the lawn culture of the bacteria-a visible layer of thousands of bacterial cells.
7. Drag the ruler to measure the diameters of the zones of inhibition around the disks (the tan areas).

   Some disks may be surrounded by large zones of inhibition, where no bacteria grew due to the strong inhibitory effect of the antibiotic, antiseptic, or disinfectant on the disks. Other disks may have caused little or no inhibition-meaning that the bacteria are partially or completely resistant to the antimicrobial agent on them. To find out which antimicrobial agent corresponds to a specific number, move the cursor over the number. In the Table, enter the measurement for each antimicrobial agent.
8. Click the Reset button and repeat the Virtual Lab until you have tested all the antimicrobial agents on all three types of pathogenic bacteria.
9. Use the data in the Table to compare the effectiveness of different antimicrobial agents on different bacteria. Complete the Conclusion questions.
Data Table

<table>
<thead>
<tr>
<th>Bacteria Species</th>
<th>Sterile Filter Paper (Control)</th>
<th>Anti-Bacterial Soap</th>
<th>Household Bleach</th>
<th>Household Disinfectant</th>
<th>Penicillin</th>
<th>Amoxicillin</th>
<th>Erythromycin</th>
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</thead>
<tbody>
<tr>
<td>Hemophilus influenzae</td>
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<td>Staphylococcus aureus</td>
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<td>Streptococcus pneumoniae</td>
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</tbody>
</table>

Conclusion Questions

1. Describe the effects of the various antibiotic drugs you used. Were they all equally effective at controlling bacterial growth? How do you know?

2. Describe the effects of various chemical disinfectants you used. Were they all equally effective at controlling bacterial growth? Would you use them to halt the growth of bacteria in your home or on your body?

3. Compare the effectiveness of the different antibiotic drugs and chemical disinfectants. Which seem to be better at controlling bacterial growth? Why do you think this is so?

4. If you were a doctor treating a patient infected with Staphylococcus aureus, a bacterium that causes mild to moderate skin infections, which antibiotic would you prescribe? Why?

5. Can you think of any limitations of this technique of testing the effectiveness of antimicrobial agents? If a real person were involved, what other tests might give you more confidence in your results?