LABORATORY INVESTIGATION

27 TESTING WATER QUALITY

Problem: *How can the quality of a nearby water source be tested?*

INTRODUCTION

Background Only 3 percent of Earth's water is fresh water, and most of it is stored in polar ice caps. Considering that humans consume great amounts of fresh water, scientists must be concerned with both the quantity of fresh water available to the regions of Earth and the quality of this precious resource. Criteria for water quality differ according to the water's use. For example, the standard of water quality for human consumption differs from that used in industry or that needed to sustain aquatic life. Contaminants in any of these types of water can be harmful.

Goals In this investigation, you will **perform** two tests to determine the quality of a sample of water from a nearby source. You will **determine** the amount of oxygen dissolved in the water and **test** for the presence of coliform bacteria. You will then use your data to **deduce** the quality of the water from the source you have chosen, and **infer** the possible effects of the water's quality on the ecosystem.

LAB WARMUP

Concepts Several methods are used to determine the quality of water. There are tests to detect the presence of nitrates, phosphates, minerals such as calcium and magnesium, and heavy metals such as lead. Other tests determine the pH of the water, the amount of dissolved oxygen, and the presence of coliform bacteria.

The *dissolved oxygen content (DO)* refers to the amount of oxygen gas dissolved in a sample of water. In general, a higher DO indicates relatively better water quality. The amount of oxygen that can dissolve in water depends on the temperature of the water. The lower the temperature, the more oxygen can dissolve. Dissolved oxygen content is measured in parts per million, or ppm. At room temperature (20°C) the maximum amount of oxygen that can dissolve in water is 9 parts of oxygen per 1 million parts of water (9 ppm).

The amount of bacteria present in a water source is another indicator of water quality. Coliform bacteria live in the intestines of mammals and are excreted with feces. Their presence in a water source usually suggests the water has been contaminated with fecal material that has come from pasture runoff or from untreated human sewage. The presence of coliform bacteria also suggests the water may be contaminated with other types of bacteria that may be more harmful, since many types of bacteria can thrive in the same environment. If coliform bacteria are found in a sample, further investigations can reveal the extent to which bacterial colonies are present in a given volume of water, and water safety can then be evaluated according to government standards.

Review Section 20.2, Water Resources, and 20.3, Water Treatment, should be completed before beginning this investigation. You should also understand the following terms before you perform this investigation.

dissolved oxygen content **coliform bacteria**

Make a **prediction** about the outcome of this experiment and write it in the Lab Notebook.

MATERIALS (PER GROUP)

- 4 pairs of gloves
- 4 goggles
- 4 aprons
- 1-gallon plastic bucket
- clear plastic cup
- HACH Water Quality Test Kits
- Dissolved Oxygen Test Kit
- Presence/Absence Kit for Total Coliform
- thermometer
- water bath

PROCEDURE

CAUTION: The chemicals used in the following test kits may be harmful. Do not touch any chemicals unless instructed to do so. Read all accompanying warnings carefully, and use appropriate safety equipment. Wear gloves, goggles, and an apron.

PART A DISSOLVED OXYGEN TEST

1. Pour some of the water sample into a clear plastic cup. Briefly examine the water and record your observations in the Lab Notebook. Determine the temperature of your water sample with the thermometer and record it in the Lab Notebook.
2. Fill the supplied bottle with your sample. Pour the water from the bucket into the bottle, allowing it to overflow for several seconds. Tip the bottle slightly and thrust the stopper into the bottle quickly to avoid trapping air bubbles in the bottle. It is very important not to trap any air bubbles during this procedure. If this occurs, pour out the water and repeat the procedure with more water from the bucket.
3. Remove one Dissolved Oxygen 1 Reagent Powder Pillow and one Dissolved Oxygen 2 Reagent Powder Pillow from the kit. Remove the stopper from the bottle. Open the pillows with the clippers and add the contents of each to the bottle. Carefully stopper the bottle so that no air bubbles are trapped in the bottle. Holding both the bottle and the stopper, shake vigorously to mix the contents. A brownish-orange precipitate will form if oxygen is present in the sample. Allow the sample to stand for a few minutes.

4. When the precipitate has settled so that the upper half of the solution is clear, shake the bottle again. Allow it to stand until the upper half of the solution is clear again.
5. Remove one Dissolved Oxygen 3 Reagent Powder Pillow from the kit, and open it with the clippers. Remove the stopper from the bottle, add the contents of the pillow, and carefully replace the stopper. Shake the contents to mix. If oxygen is present, the precipitate will dissolve and the solution will turn yellow.
6. Remove the plastic measuring tube and the square mixing bottle from the kit. Fill the tube with the yellow solution from step 5 and pour it into the mixing bottle.
7. Remembering to count each drop as it is added, add Sodium Thiosulfate Standard Solution drop by drop to the solution in the mixing bottle. After each drop, gently swirl the bottle to mix the contents. Continue until the solution turns colorless. Record the number of drops necessary to achieve the color change in the Lab Notebook.
8. The total number of drops added indicates the value of dissolved oxygen in parts per million. Thus, if 5 drops were used to change the solution from yellow to colorless, then the DO content is 5 ppm. Record this value in the Lab Notebook.

PART B TEST FOR THE PRESENCE OF COLIFORM BACTERIA

1. Heat a water bath to 35°C.
2. The bottle supplied for this test is presterilized. Do not contaminate the bottle by touching the inside of the cap or the neck of the bottle. Fill the bottle with 100 mL of water to be tested.
3. Using care to avoid contamination, open the vial containing the P/A broth and pour the broth into the water sample. Replace the bottle cap.
4. Place the bottle in the water bath and allow it to remain in the water bath for 24 hours. If coliform bacteria are present, the solution will change color from reddish purple to yellow. If no color change occurs after 24 hours, incubate for another 24 hours, and check again for color change. If the color of the solution still has not changed, coliform bacteria are not present in your sample.
5. Record your observations in the Lab Notebook.

Name: _____ Class: _____ Date: _____

LAB NOTEBOOK: INVESTIGATION 27

PREDICTION

_____

_____

_____

OBSERVATIONS

WATER SAMPLE

Date collected: _____

Source location: _____

DISSOLVED OXYGEN TEST

General observations about water sample: _____

_____

water temperature °C _____

Number of drops needed for color change _____

Dissolved oxygen (D) ppm _____

COLIFORM BACTERIA PRESENCE/ABSENCE TEST

Color of solution before step 3 _____

Color of solution after 24 hours _____

Color of solution after 48 hours _____

Test for coliform bacteria was (positive/negative) _____

DATA ANALYSIS

1. Most fish cannot survive at DO levels less than 4 ppm. Is there an ample amount of dissolved oxygen in your sample to sustain a fish population?

2. If the water was heated, how would the amount of dissolved oxygen change?

3. Why was it important not to contaminate the presterilized bottle during the test for the presence of coliform bacteria?

4. What does a positive coliform test indicate? Does this necessarily prove the water is of low quality?

CONCLUSION

1. **Recall** How is dissolved oxygen produced in water? Why is there a minimum level of dissolved oxygen needed for most organisms to survive?

2. **Infer** How does your water sample rate according to the three tests you performed? What additional tests could be performed to better estimate the quality of your sample?

3. **Integrate** If the quality of the water from the source you tested is poor, how could you improve the situation?

EXTENSION

Hypothesize How would a plant affect the quality of your water sample? Pour some of the water in a large glass jar and add a water plant such as *Elodea* or *Anacharis*. Keep the jar near a window for one day, and then repeat the tests for pH, dissolved oxygen, and coliform bacteria. Which tests showed different results? Explain your findings.