UNIT III: BASIC LABORATORY SKILLS

Lesson 1: The Scientific Method

Competency/Objective: Describe the steps in the scientific method.

Study Questions

1. **What are the steps of the scientific method?**

2. **Why is it important to follow the scientific method?**

3. **What information should a laboratory notebook include?**

References

1. *Biotechnology: Applications in Agriculture (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1998, Unit III.

2. Activity Sheet

   a) AS 1.1: Using the Scientific Method

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TEACHING PROCEDURES

A. Introduction

This unit will introduce some basic laboratory skills that are important in almost every type of biotechnology research. This lesson focuses on the scientific method and its application in biotechnology. The scientific method is an important and widely used research strategy. Scientific research is essentially a rational and logical search for answers to scientific questions. This search must be done in a calculated way to increase the chances of finding the desired answer.

B. Motivation

Trip the breaker for the classroom. Have students use the scientific method to analyze the problem. Guide them through the process using the steps below.

Step 1: Identify the problem. (Why are the lights in the classroom off?)

Step 2: Research the available information. (Is the switch on, are there light bulbs in the sockets, have the lights been on before, etc.?)

Step 3: Formulate a hypothesis. (The lights went off because the breaker was tripped.)

Step 4: Design the investigation/experiment. (The breaker will be turned back on.)

Step 5: Conduct the experiment and collect data. (The breaker is turned on and the lights are observed.)

Step 6: Draw conclusions. (The breaker being tripped caused the lights to go out.)

C. Assignment

D. Supervised Study

E. Discussion

1. Ask students to list the steps of the scientific method.

What are the steps of the scientific method?

a) Identify the problem in a statement that expresses the general purpose of the research.
b) Investigate earlier research to identify alternative explanations or solutions to the problem.
c) Formulate a hypothesis about the anticipated outcome of the research.
d) Design the experiment.
e) Conduct the experiment and collect data.
f) Analyze the data and draw conclusions about the success of the experiment in terms of the hypothesis.

2. Ask students why following the scientific method is important.

Why is it important to follow the scientific method?

a) The scientific method provides a logical approach to solving a problem.
b) The scientific method helps researchers look objectively at their research.
c) The scientific method allows experiments to be repeated by other researchers (replication), which is necessary to establish the validity of the experiment.

3. Ask students why it is important for businesses to keep a financial record book (to be able to analyze the business, to show weak areas, and to provide a credible record for the IRS). Laboratory notebooks are like financial record books; they are kept to analyze experiments, show weak areas, and provide a credible record for other professionals. Relate recording research to the activities of farmers or businesspeople who must keep an accurate record of his or her operation.

What information should a laboratory notebook include?

a) Cover that identifies the subject of the research
b) Table of contents
c) Laboratory sheets
    1) Title of the experiment, date, and name(s) of the investigator(s) of the experiment
    2) Brief description of the purpose of the experiment
    3) List of materials needed
    4) Procedures for the experiment
    5) A record of the results of the experiment, including data and observations
    6) Conclusions drawn from the research

F. Other Activities

G. Conclusion

The scientific method has been used to guide the research process for centuries. It provides a clear, logical method for investigating phenomena. The way a researcher approaches a problem is critical to the success of the investigation. The approach must be documented in a laboratory notebook. This documentation is important for many reasons, including the fact that it often is needed to prove ownership of research.

H. Answers to Activity Sheet

AS 1.1

1. (Answers will vary.) The use of an ultraviolet light is a better method of preventing culture media contamination than the use of either 70 percent alcohol or a 10 percent bleach solution.

2. (Answers will vary.) Exposure to the air, the procedure, the temperature, etc.

3. The sterile cotton swab or ball placed in the petri dish without being swabbed

I. Answers to the Evaluation

1. d
2. b
3. Problem statement
4. Hypothesis
5. a) 5 d) 1
    b) 6 e) 4
    c) 3 f) 2

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Lesson 1: The Scientific Method Date _____

EVALUATION

Circle the letter that corresponds to the best answer.

1. The scientific method is important to biotechnology researchers because it:

   a. Guarantees that the research will be successful.
   b. Has always been used in scientific research.
   c. Provides a biased view of a research effort.
   d. Gives a logical structure to a research effort.

2. Which of the following is <u>not</u> necessarily a part of a laboratory sheet?

   a. Date of research and names of researchers
   b. Table of contents
   c. Description of experimental procedures
   d. Observations

Fill in the blanks with the most appropriate term(s).

3. A statement that describes the general purpose of the research is called the _____.

4. A focused and detailed statement that indicates the anticipated outcome of the research is called the _____.

Number the six steps of the scientific method in the order in which they occur.

5.
   a. _____ Conduct the experiment and collect data.

   b. _____ Draw conclusions.

   c. _____ Formulate a hypothesis.

   d. _____ Identify the problem.

   e. _____ Design the experiment.

   f. _____ Investigate earlier research.

Lesson 1: The Scientific Method Name _____

Using the Scientific Method

Objective: Perform a simple experiment following the principles of the scientific method and document the experiment in a laboratory notebook.

Materials and Equipment:

4 petri dishes or test tubes purchased with sterile culture media
4 sterile cotton swabs or balls
4 pairs of sterile latex gloves or regular latex gloves dipped in alcohol and allowed to dry
4 strips of Parafilm™ or clear tape
2 strips of sterile first aid gauze
1 bottle of a 10 percent bleach solution
1 ultraviolet light
Clean table or countertop divided into three sections by cardboard dividers taped to the surface

To successfully complete genetic manipulation techniques, a microbe-free or aseptic environment is necessary. This aseptic environment can be obtained in several ways, including wiping the surfaces with 70 percent alcohol, wiping the surfaces with a 10 percent bleach solution, or exposing the surfaces to an ultraviolet light. This experiment will determine which of these methods is most effective.

Procedure:

1. Your teacher will divide the class into groups. Before beginning the experiment, record the title of this experiment, the date, and the names of the members of your group on a lab sheet.

2. Write down a brief statement of the purpose of the experiment.

3. List the materials that will be used on your lab sheet.

4. Carry out the experiment. As you do, write down the steps of the procedure in the form of a descriptive paragraph.

5. Label each section of the table to match one of the treatment methods being used.

6. Using a piece of sterile gauze, wipe down one section of the table with 70 percent alcohol.

7. Using a new piece of sterile gauze, wipe down another section of the table with 10 percent bleach solution.

8. After these sections of the table have completely dried, put on sterile latex gloves and swab one section with a sterile cotton swab or ball.

9. Place the swab immediately into a petri dish or test tube containing sterile culture media. Seal the container with Parafilm™ or tape.

10. Label the petri dish or test tube with the name of the section of the table.

11. Repeat this process for the second section of the table using a new pair of sterile gloves.

12. Expose the third section of the table to an ultraviolet light overnight.

13. Immediately after the light is turned off, swab the table area using the same procedure as in steps 8 and 9.

14. Using a new pair of sterile gloves, open the fourth petri dish or test tube and place a sterile cotton swab or ball in it. Seal the lid in the same way as the others.

15. Keep the petri dishes or test tubes in a warm place for one to three weeks. Observe the results and record them daily on the laboratory sheet.

16. At the end of the period, write down the conclusions drawn from the experiment.

Key Questions:

1. What is a possible hypothesis for this experiment?

2. What factors were kept equal for all samples?

3. What is the control in this experiment?

Title:

Date:

Name(s):

Purpose:

Materials Needed:

Procedure:

Results:

Conclusions: