GEORGIA | PEACH STATE PATHWAYS

Career, Technical, & Agricultural Education

HEALTHCARE SCIENCE

PATHWAY: Biotechnology Research & Development

COURSE: Applications of Biotechnology

UNIT 4: Introduction to Basic Methodologies

INTRODUCTION

Annotation: The outcomes of the best planned experiments are highly dependent on the ability of the laboratory technician to properly prepare solutions used in the lab and how well data is collected, analyzed and presented to the scientific community. Proper analysis of the data is most important if any meaningful data is to be obtained from the experiment. Unit 4 introduces the student to basic calculations, statistics and graphing of data. Students are also introduced to the interpretation of results, bias in experiments and peer review.

Grade(s):

	9th
	10th
X	11th
X	12th

Time: 5 hours

Author: Mandy Latimer

Students with Disabilities:

For students with disabilities, the instructor should refer to the student's IEP to be sure that the accommodations specified are being provided. Instructors should also familiarize themselves with the provisions of Behavior Intervention Plans that may be part of a student's IEP. Frequent consultation with a student's special education instructor will be beneficial in providing appropriate differentiation.

FOCUS STANDARDS

GPS Focus Standards:

HS-ABT-1 **Students will demonstrate the ability to use and apply mathematics and language arts skills.**

a) Perform mathematical calculations related to biotechnology including statistics.
b) Compare the standard deviation and the mean of efficacy testing data of two biotechnology products.
c) Illustrate a set of biotechnology data graphically.

HS-ABT-5 **Students will demonstrate understanding of the important features of the process of scientific inquiry.**

a) Discuss the importance of appropriate controls, standards, and statistical analysis.
b) Assess the quality of data including possible sources of bias in their investigations' hypotheses, observations, data analyses, and interpretations.
c) Explain the strengths and weaknesses of the use of peer review and publication to reinforce the integrity of scientific activity and reporting.
d) Explain how reproducibility is a cornerstone of scientific inquiry.

GPS Academic Standards:

SCSh8 Students will understand important features of the process of scientific inquiry.
MM2P1 Students will solve problems (using appropriate technology).
MM2P3 Students will communicate mathematically their ideas/Use the language of mathematics to express mathematical ideas precisely.
MM2P4 Students will make connections among mathematical ideas and to other disciplines.
MM2P5 Students will represent mathematics in multiple ways.
MM1D2 Students will use expected value to predict outcomes.
MM1D3 Students will relate samples to a population.
ELA9RC2 The student participates in discussions related to curricular learning in all subject areas.
ELA9LSV1 The student participates in student-to-teacher, student-to-student, and group verbal interactions.
ELA9RL5 The student understands and acquires new vocabulary and uses it correctly in reading and writing.
ELA11W3 The student uses research and technology to support writing.
MM1A1 Students will explore and interpret the characteristics of functions, using graphs, tables, and simple algebraic techniques.
MM1P1 Students will solve problems (using appropriate technology).
MM1P4 Students will make connections among mathematical ideas and to other disciplines.
MM1P5 Students will represent mathematics in multiple ways.

UNDERSTANDINGS & GOALS

Enduring Understandings:

Scientists report their significant findings and discoveries at scientific meetings and in scientific journals after their work is reviewed by their peers. Before that, however, they have to employ the scientific method to conduct their experiments. Scientific methods used by scientists vary from lab to lab and situation to situation. Thus, an easy five-step process can be followed to help approach scientific study:

- Observe a phenomenon
- Formulate a testable scientific question
- Develop a hypothesis
- Plan an experiment
- Conduct the experiment
- Formulate a conclusion

Essential Questions:

- Why do scientists repeat experiments?
- How do scientists formulate a conclusion?
- How do scientists share their scientific results?
- What is a buffer?
- What is a hypothesis?
- What is a control and why is it important?
- How is data properly analyzed?
- Why do scientists publish their data?

Knowledge from this Unit:

Students will be able to:

- Describe how to set up and execute an experiment
- Explain why statistics are important
- List the parts of a scientific manuscript
- Describe the proper way make reagents

Skills from this Unit:

Students will be able to:

- Create buffers and pH solutions
- Calculate molarity
- Write, execute, and summarize an experiment protocol and results
- Graph data
- Maintain a laboratory notebook

ASSESSMENTS

Assessment Method Type:

x Pre-test
X Objective assessment - multiple-choice, true- false, etc.
_x_ Quizzes/Tests
__ Unit test
X Group project
_____ Individual project
_____ Self-assessment - May include practice quizzes, games, simulations, checklists, etc.
__ Self-check rubrics
__ Self-check during writing/planning process
__ Journal reflections on concepts, personal experiences and impact on one's life
__ Reflect on evaluations of work from teachers, business partners, and competition judges
__ Academic prompts
_x_ Practice quizzes/tests
_____ Subjective assessment/Informal observations
__ Essay tests

_____
__ Observe students working with partners
__ Observe students role playing

x Peer-assessment
__ Peer editing & commentary of products/projects/presentations using rubrics
__ Peer editing and/or critiquing

_____ Dialogue and Discussion
__ Student/teacher conferences
__ Partner and small group discussions
__ Whole group discussions
__ Interaction with/feedback from community members/speakers and business partners

_____ Constructed Responses
__ Chart good reading/writing/listening/speaking habits
__ Application of skills to real-life situations/scenarios

_____ Post-test

Assessment Attachments and / or Directions:

LESSON PLANS

• LESSON 1: SCIENTIFIC INQUIRY

1. Identify the standards. Standards should be posted in the classroom.

HS-ABT-1 **Students will demonstrate the ability to use and apply mathematics and language arts skills.**
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2. Review Essential Questions. Post Essential Questions in the classroom.

- Why do scientists repeat experiments?
- How do scientists formulate a conclusion?
- How do scientists share their scientific results?
- What is a buffer?
- What is a hypothesis?
- What is a control and why is it important?
- How is data properly analyzed?
- Why do scientists publish their data?

3. Identify and review the unit vocabulary. Terms may be posted on word wall.

ANOVA	Null Hypothesis	P Value
Buffer	Percent Solution	Reagent
Calibration	pH	Standard Deviation
Control	Population	Statistical Analysis
Hypothesis	Positive Control	Time Point
Molarity	Protocol	Treatments
Negative Control	PubMed	Variable

4. Interest approach – Mental set
    - Create sticky notes with different animal, plant, or flower names.
        - Place one on each student's back without the student seeing what his word is.
        - Instruct students they are to find out what their word is by asking their classmates only "yes" or "no" questions
            - **Example:**
                - "Do I swim?"
                - "Do I have fur?"
                - "Do I have pink petals?"
        - The student will see how hard it is to find something out by only asking these types of questions.
            - Have students record their thoughts in their laboratory notebooks.
    - Obtain several small jars. Place an object in each jar and fill the jar with small candies.
        - Split the class into small groups.
        - Give one jar, a balance, some loose candy, and an empty jar and lid of the same size to each group.
        - Instruct each group they are to determine how many candies are in their jar without opening it. Have them write their procedure in their laboratory notebooks.
        - When the students are done, record their findings on the board.
        - Allow students to open their jars and see how close they came to the correct answer.
        - When the students pour out the candy, they will find the hidden object.

- The students will see that we are limited by what we know and that experiments can sometimes surprise them.
- Have students record their observations on this in their notebooks.

• LESSON 2: COMMON LABORATORY CALCULATIONS

1. Review Essential Questions. Post Essential Questions in the classroom.

    - What is a buffer?

2. Lead a brief discussion about different types of solutions.
    - Ask students, "What is a buffer?"
    - What is pH?
    - What are the differences between acids and bases?
    - What is a solution?
    - What are some common foods or chemicals we use that are solutions?

3. Solutions Experiment
    - **Note:** Before teaching this lesson, find a suitable experiment for students to perform in order to learn how to make solutions and calculate molarity, percent concentration and stock concentration.
        - The experiment procedure should involve making salt water and a serial dilution of colored water.
    - Instruct students to record everything in their laboratory notebooks following the procedure in Unit 1.
    - Write the following questions on the board and have students answer them in their notebooks:
        - Does your lab have the chemicals you need?
        - Are there any hazardous chemicals in the experiment?
        - How do you dispose of the chemicals you will be using?
    - Have students note which type of water will be used in the experiment (tap, deionized, distilled, or ultra pure)
    - Ask students to read the labels of some common chemicals in the lab.
        - Ask students, "What is the molecular weight of this chemical?"
    - Give each student a copy of the **Common Calculations** handout to use during their experiment.
        - See attached supplementary files

4. Summary
    - Review **Common Calculations**. Question students to ensure they know how to complete the calculations.

• LESSON 3: EXPERIMENT DESIGN

1. Review Essential Questions. Post Essential Questions in the classroom.
    - Why do scientists repeat experiments?
    - How do scientists formulate a conclusion?
    - What is a hypothesis?
    - What is a control and why is it important?

2. Lead a discussion about experiment design.
    - Ask students, "What are some components of an experiment?"
    - What is the purpose of doing experiments more than once?

- Why do scientists do experiments?
- What other professions, other than researchers, perform experiments?

3. Create-an-Experiment Activity
    - **Note:** For this activity, students can either create their own biotechnology-related question to answer, or you can provide them with one to design an experiment for.
    - Divide the class into small groups.
    - Instruct the groups to develop a biotechnology-related question they can answer using a simple experiment, or provide the groups with one you have researched for them.
    - Tell students everything must be documented appropriately in their notebooks.
    - Give students a copy of the **Experimental Design** guided worksheet.
        - See attached supplementary files
    - Have students critique each others' procedures using the evaluation questions on the worksheet.
    - Once the students have their experiment reviewed, have students perform their procedures and collect the necessary data.
    - After completing the experiments, have students discuss any complications and mistakes they made.
        - List common mistakes on the board, and lead the class in a brief discussion about avoiding these errors.
    - Instruct students to repeat the experiment, correcting any errors they made.

4. Summary
    - Instruct students to write a short lab report comparing the results from their first experiment and the second try.
    - In the paper, make sure students include the following:
        - Basic procedure followed in the first experiment
        - Mistakes and errors made
        - Methods to correct errors and mistakes
        - Procedure followed in the repeat experiment
        - Results and how they compared or contrasted to one another
        - Why repeating experiments is a necessary evaluation technique

• LESSON 4: DATA ANALYSIS

1. Review Essential Questions. Post Essential Questions in the classroom.

    - How is data properly analyzed?

2. Examining the Results
    - Instruct students to individually create a graph of their data for both experiments on a spreadsheet program, or using the website **http://nces.ed.gov/nceskids/createagraph/default.aspx**.
    - Have students add standard deviations to their graphs.
        - Write the following calculations on the board and have students use them to find standard deviation using Microsoft Excel.
            - For the unbiased method, type =STDEV(A1:Z99)
            - For the biased method, type =STEDVP(A1:z99)
            - Substitute the call name of your first valued in your data set for A1, and the cell name of the last value for Z99.
    - Instruct students to analyze the differences between time points and treatments they can see on their graphs, and whether statistical analysis agrees with their perceptions.

3. Lead a discussion about the outcome of students' experiments.
    - Ask students, "Was the outcome what you expected in your hypothesis?"
    - What differences did you see in the graphs between experiments?
    - What happens if the experiment didn't work?
    - Should you try an experiment again if you didn't get the expected results?
    - What type of data can indicate whether an experiment went wrong?

• LESSON 5: PUBLISH OR PERISH

1. Review Essential Questions. Post Essential Questions in the classroom.

    - Why do scientists publish their data?

2. Journal Research
    - Explain to students that when everything goes well with a series of experiments, scientists typically write the experiment and results for publication.
    - Instruct students to locate five different journals which publish scientific research.
        - Make sure students write the name of these journals in their lab notebooks.

3. Lead a brief discussion about the use of journals.
    - Ask students, "What are the main sections of a published paper?"
        - **Answer:** Abstract, Introduction, Methods, Materials, Results and Discussion
    - Why do you think scientists like to be published?
    - Are there any other sources besides online and print journals where scientists can display their work?
    - Which journal that you looked up would be most likely to publish your experimental research?

4. Ethical Considerations
    - Ask students, "Why do you think scientists make up data?"
    - Do you think data should be private or should it be publicized?
    - What happens when the media misinterprets scientific data?
    - Have there been any recent problems with the news reporting incorrect information about biotechnology research?
    - How do scientists regulate each other?

5. Summary
    - Have students look up one published paper in their pathway, either online or in a print journal depending on what your school has access to.
    - Instruct students to briefly summarize the paper in a one-page report:
        - Title of the journal, experiment, and names of researchers
        - Purpose of the experiment
        - Methods used
        - Results obtained
        - How the experiment relates to your pathway

• ATTACHMENTS FOR LESSON PLANS

Common Calculations
Experimental Design
Vocabulary Glossary

- **NOTES & REFLECTION:**

CULMINATING PERFORMANCE TASK

Culminating Unit Performance Task Title:

Publish or Perish Experiment

Culminating Unit Performance Task Description/Directions/Differentiated Instruction:

Students will write a full lab report about the experiment they created in Lesson 3. The lab report should be based on ones researched in class, following all format regulations suggested by the journal of their choice. They will choose a journal they wish to be published in and explain, on a separate page, why they chose this journal and how it will publicize the experiment.

Note: It is suggested students complete this task individually.

Attachments for Culminating Performance Task:

Experimental Design

UNIT RESOURCES

Web Resources:

http://nces.ed.gov/nceskids/createagraph/default.aspx
http://www.ncbi.nlm.nih.gov/pubmed/

Materials & Equipment:

Suggested Texts:

At the Bench: A Laboratory Navigator by Kathy Barker
Biotechnology: Science for the New Millenium by Ellyn Daugherty
Introduction to Biotechnology by William J. Thieman and Michael A. Palladino

21st Century Technology Used:

	Slide Show Software	X	Graphing Software		Audio File(s)
	Interactive Whiteboard	X	Calculator		Graphic Organizer
	Student Response System		Desktop Publishing		Image File(s)
	Web Design Software		Blog		Video
	Animation Software		Wiki		Electronic Game or Puzzle Maker
	Email	X	Website		