Laboratory Math for Biotechnology

Week-by-Week Schedule

This class is designed to meet 2 hours/week

Submitted by Madison Area Technical College
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DESCRIPTION: The Biotechnology Laboratory Technician Program at Madison Area Technical College provides instruction in diverse areas of biotechnology, ranging from the use of basic laboratory equipment to molecular biology, fermentation technology, protein purification, microbiology and other topics. Basic laboratory math skills are required for success in any of these areas, and students often struggle with each new application of their math knowledge. Additionally, students often feel uncomfortable with or even antagonistic towards math applications in their courses. In order to decrease the disruption in laboratory instruction that occurs every time a new math application arises, the program requires that all students complete this one-credit introductory course in laboratory-based applications. It is important to recognize that this course is not a math course….it is a course designed to help students construct calculations for various laboratory scenarios and solve them with confidence. The program enrolls students with a wide variety of math backgrounds, and tries to provide different learning opportunities (online, hybrid, face-to-face, self-paced) to meet the needs of these students.

Basic principles of the following topics are introduced:	***Students practice basic math skills including:***
○ Exponents and scientific notation ○ Logarithms ○ Units of measurement ○ Measurements and significant figures ○ Using equations to describe a relationship ○ Ratios and proportions ○ Unit conversions ○ Density ○ Dosages ○ Percents ○ Concentration expressions ○ Preparing single solute	○ Perform basic manipulations involving exponents ○ Convert between standard and scientific notation ○ Use calculators for exponents and scientific notation ○ Determine logs and antilogs for powers of ten only ○ Use calculators to determine logs and antilogs ○ Convert between pH and hydrogen ion concentration ○ Convert between metric units ○ Understand the meaning of significant figures ○ Predict the behavior of one variable in an equation with changes in another variable ○ Understand the difference between “ratios” and “proportions”

solutions
- Dilutions
- Prepare multiple solute solutions
- Graphing linear equations
- Graphing exponential equations

- Use ratios and proportions for unit conversion
- Use unit cancellation for unit conversion
- Solve multiple step problems using ratios and proportions
- Solve problems involving density
- Solve problems involving dosage
- Perform basic calculations using percents
- Set up and solve problems involving percent solutions
- Set up and solve problems involving molarity
- Set up and solve problems using ppm and ppb
- Convert between different units of concentration
- Prepare dilutions of a particular volume
- Determine the concentration of a solution following dilution
- Determine the concentration of a stock solution from a dilution
- Perform calculations involving serial dilutions
- Correctly apply the $C_1V_1 = C_2V_2$ equation
- Prepare solutions containing multiple solutes from stock chemicals
- Prepare solutions containing multiple solutes from stock solutions
- Determine slope and intercept using the equation of a line
- Graph linear equations
- Apply graphing to standard curves
- Understand the difference between linear and exponential relationships
- Plot exponential relationships using semilog graph paper

STUDENTS DEVELOP THE FOLLOWING MORE COMPLEX COMPETENCIES THROUGHOUT THE ENTIRE COURSE:

- Set up and solve calculations required for solution-making in the biotechnology laboratory
- Present and analyze laboratory data using graphical analysis
- Develop an appreciation of the importance of being meticulous in laboratory calculations

Competencies specific to a particular topic are shown in the weekly schedule that follows.

***Additional resources are available on the Additional materials page. These resources are free but log-in is required.**

UNIT 1: EXPONENTS AND SCIENTIFIC NOTATION

WEEKLY AGENDA	**READING ASSIGNMENTS AND RECOMMENDED PRACTICE PROBLEMS** (These are from the textbook, *Basic Laboratory Calculations for Biotechnology*, by Seidman)	**ACTIVITIES AND LECTURES** (These are available on the Additional materials page, as indicated)	**LEARNING OBECTIVES** Students will be able to:
WEEK 1 ▪ Introduce course ▪ Go over syllabus ▪ Complete in-class introductory activity reviewing exponents and illustrating their use/importance ▪ Review PowerPoint companion slides for Chapter 1 ▪ Practice concepts by using practice problems worksheet as a self-test ▪ Assign Chapter 1 problem set as homework	**Chapter 1** **Special points to study:** • Rules for calculations involving exponents in Box 1 (pp. 4 – 6) • Definition of a "number in scientific notation" at the top of page 9 • Mechanism for entering numbers in scientific notation into calculators on p. 16 **Examples to try:** • p. 6 (#1a – f, #2g – l) • p. 10 (#2a – f, #3a – d) • p. 18 (#1a and c)	• Laboratory Math for Biotechnology syllabus • Chapter 1 introductory activity (Classroom activities) • Companion slides for Chapter 1 • Chapter 1 practice problems (Classroom activities) • Chapter 1 homework (Problem sets)	• Perform basic manipulations involving exponents • Convert between standard and scientific notation • Use calculators for exponents and scientific notation

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UNIT 2: LOGARITHMS

WEEKLY AGENDA	**READING ASSIGNMENTS AND RECOMMENDED PRACTICE PROBLEMS** (These are from the textbook, *Basic Laboratory Calculations for Biotechnology*, by Seidman)	**ACTIVITIES AND LECTURES** (These are available on the Additional materials page, as indicated)	**LEARNING OBECTIVES** Students will be able to:
WEEK 2 ▪ Complete in-class introductory activity reviewing logs, antilogs, and the use of calculators for these functions ▪ Review PowerPoint slides discussing pH ▪ Practice concepts by using practice problems worksheet as a self-test ▪ Assign Chapter 2 problem set as homework ▪ *Evaluation: Quiz 1 on Unit 1*	**Chapter 2** **Special points to study:** • Define a **"common log"** and **"antilogarithm"** • Use a scientific calculator to determine both common logarithms and antilogarithms • ESTIMATE the values of common logarithms and antilogarithms • Define and calculate **pH** **Examples to try:** • p. 25 #4, #6 (a –c), #7 (a & b), #9 (a & b)	• Chapter 2 introductory activity (Classroom activities) • "The relationship between pH and hydrogen ion concentration" (PowerPoints for "difficult" concepts) • Chapter 2 practice problems (Classroom activities) • Chapter 2 homework (Problem sets) • *Quiz 1 (Sample quizzes)*	▪ Determine logs and antilogs for powers of ten only ▪ Use calculators to determine logs and antilogs ▪ Convert between pH and hydrogen ion concentration

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UNIT 3: UNITS OF MEASUREMENT AND SIGNIFICANT FIGURES

WEEKLY AGENDA	READING ASSIGNMENTS AND RECOMMENDED PRACTICE PROBLEMS (These are from the textbook, *Basic Laboratory Calculations for Biotechnology*, by Seidman)	ACTIVITIES AND LECTURES (These are available on the Additional materials page, as indicated)	LEARNING OBECTIVES Students will be able to:
WEEK 3 ▪ Complete in-class introductory activity on units of measurement and conversions ▪ Review PowerPoint companion slides for units of measurement ▪ Review PowerPoint slides discussing scale: length, mass and volume ▪ Practice concepts by using practice problems worksheet as a self-test ▪ Assign Chapter 3 problem set as homework	**Chapter 3** **Special points to study:** ▪ Memorize the underlined prefixes in the metric system in Table 1, p. 32 ▪ Examine Table 3, p. 34 ▪ Study the example problems on p. 37 covering conversion between metric units **Examples to try:** • p. 38 #3 and #4 **Chapter 4** **Special points to study:** ▪ Understand Section 4.1, which explains how significant figures are used to express	• Chapter 3 introductory activity (Classroom activities) • Companion slides for Chapter 3 • "Getting some perspective: mass, length and volume" (PowerPoints for "difficult" concepts) • Chapter 3 practice problems (Classroom activities) • Chapter 3 homework (Problem sets)	▪ Convert between metric units ▪ Understand the meaning of significant figures

	uncertainty in measurements. Focus on Example 1 on p. 51 as a nice illustration of the concept of "uncertainty" in measurements. ▪ Examine Box 1 on pp. 53 – 54 ▪ Read through Box 2 on pp. 55 – 56 and then read the three examples on p. 56 **Examples to try:** • p. 57 #1, #5, #7		

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UNIT 4: USING EQUATIONS TO DESCRIBE RELATIONSHIPS

WEEKLY AGENDA	**READING ASSIGNMENTS AND RECOMMENDED PRACTICE PROBLEMS** (These are from the textbook, *Basic Laboratory Calculations for Biotechnology*, by Seidman)	**ACTIVITIES AND LECTURES** (These are available on the Additional materials page, as indicated)	**LEARNING OBECTIVES** Students will be able to:
WEEK 4 ▪ Review PowerPoint companion slides for using equations to describe a relationship ▪ Review classroom activity on order of operations: rules and calculator use ▪ Assign Chapter 5 problem set as homework ▪ *Evaluation: Quiz 2 on Units 2 and 3*	***Chapter 5*** **Special points to study:** ▪ Understand the concepts of "constants" and "variables" in equations (Section 5.1), and how the solution of an equation varies by changing these parameters ▪ Study Section 5.2, as the importance of being able to express solutions with the PROPER UNITS cannot be overemphasized!!! **Examples to try:** ▪ p. 65 #8 and #9 ▪ p. 72 #5	• Companion slides for Chapter 5 • Order of operations and calculator use exercise for Chapter 5 (Classroom activities) • Chapter 5 homework (Problem sets) • *Quiz 2 (Sample quizzes)*	• Predict the behavior of one variable in an equation with changes in another variable

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UNIT 5: RATIOS AND PROPORTIONS

WEEKLY AGENDA	**READING ASSIGNMENTS AND RECOMMENDED PRACTICE PROBLEMS** (These are from the textbook, *Basic Laboratory Calculations for Biotechnology*, by Seidman)	**ACTIVITIES AND LECTURES** (These are available on the Additional materials page, as indicated)	**LEARNING OBECTIVES** Students will be able to:
WEEK 5 ▪ Complete in-class introductory activity on ratios and proportions ▪ Review PowerPoint companion slides for ratios and proportions ▪ Review PowerPoint slides introducing ratios and proportions ▪ Assign Chapter 6 problem set as homework	***Chapter 6*** **Special points to study:** ▪ Master the process of cross-multiplication illustrated in 'The Chocolate Cake Problem' on p. 80 ▪ Understand the importance of keeping units with your proportions as explained in point 2 on p. 81 **Examples to try:** • p. 82 – 83 (1, 5, 7, 9, 11, 13, 17)	• Chapter 6 introductory activity (Classroom activities) • Companion slides for Chapter 6 • "Ratios and proportions: an introduction" (PowerPoints for "difficult" concepts) • Chapter 6 homework (Problem sets)	• Understand the difference between "ratios" and "proportions"

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UNIT 6: UNIT CONVERSION, DENSITY AND DOSAGES

WEEKLY AGENDA	**READING ASSIGNMENTS AND RECOMMENDED PRACTICE PROBLEMS** (These are from the textbook, *Basic Laboratory Calculations for Biotechnology*, by Seidman)	**ACTIVITIES AND LECTURES** (These are available on the Additional materials page, as indicated)	**LEARNING OBECTIVES** Students will be able to:
WEEK 6 ▪ Review PowerPoint companion slides for unit conversion, density and dosages ▪ Review PowerPoint slides on working with impure chemicals and density ▪ Practice concepts by using ratios and proportions applications practice problems ▪ Practice concepts by using multistep practice problems ▪ Assign Chapters 7, 8, and 9 problem set as homework ▪ *Evaluation: Quiz 3 on Units 4*	***Chapter 7*** **Special points to study:** ▪ Study Box 1 on p. 95, which compares the two methods of unit conversion ▪ Closely examine the multistep example problems in Section 7.5 **Examples to try:** ▪ #16, 21 and 26 on pp. 97 – 98 ▪ #2 and #5 on pp. 106 – 107 ***Chapter 8***	• Companion slides for Chapters 7, 8, and 9 • "Working with impure chemicals" and "Density: an introduction to the concept" (PowerPoints for "difficult" concepts) • Chapters 7, 8, and 9 ratios and proportions applications practice problems (Classroom activities) • Chapters 7, 8, and 9 multistep practice	▪ Use ratios and proportions for unit conversion ▪ Use unit cancellation for unit conversion ▪ Solve multiple step problems using ratios and proportions ▪ Solve problems involving density ▪ Solve problems involving dosage

and 5	**Special points to study:** • Study the concept of "density" discussed in Section 8.1 **Examples to try:** • #2 and 3 on p. 112 **Chapter 9** **Special points to study:** • Study the two example problems on pp. 114 – 116 **Examples to try:** • #1 and 2 on p. 116	problems (Classroom activities) • Chapters 7, 8, and 9 homework (Problem sets) • *Quiz 3 (Sample quizzes)*	

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UNIT 7: PERCENTS AND INTRODUCTION TO CONCENTRATION PROBLEMS

WEEKLY AGENDA	**READING ASSIGNMENTS AND RECOMMENDED PRACTICE PROBLEMS** (These are from the textbook, *Basic Laboratory Calculations for Biotechnology*, by Seidman)	**ACTIVITIES AND LECTURES** (These are available on the Additional materials page, as indicated)	**LEARNING OBECTIVES** Students will be able to:
WEEK 7 ▪ Review PowerPoint companion slides for percents ▪ Review PowerPoint slides discussing percents as ratios ▪ Practice concepts by using percents practice problems worksheet as a self-test ▪ Practice concepts by using introduction to concentration practice problems worksheet as a self-test ▪ Assign Chapters 10 and 11 problem set as homework	***Chapter 10*** **Special points to study:** ▪ Study Box I on pp. 120 – 122 ▪ Study the example problems on p. 126 that illustrate the concept of percent error. **Examples to try:** • #2, 4 and 6 on p. 122 ***Chapter 11*** **Special points to study:** ▪ Study Figure 1 on p. 131 ▪ Review the example problem on p. 133 ▪ Review the example problem on pp. 136 – 137 ▪ Examine the example	• Companion slides for Chapter 10 • "Percents as ratios: how treating percents as ratios can simplify your work " (PowerPoints for "difficult" concepts) • Percents practice problems (Classroom activities) • Introduction to concentration practice problems (Classroom activities) • Chapters 10 and 11 homework (Problem	▪ Perform basic calculations using percents ▪ Convert between different units of concentration

	problem on p. 139 **Examples to try:** ▪ #1 and #2 on p. 132 ▪ #3 on p. 134 ▪ #1 on p. 137 ▪ #1 and #3 on p. 140	sets)	

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UNIT 8: PREPARING LABORATORY SOLUTIONS THAT CONTAIN ONE SOLUTE

WEEKLY AGENDA	**READING ASSIGNMENTS AND RECOMMENDED PRACTICE PROBLEMS** (These are from the textbook, *Basic Laboratory Calculations for Biotechnology*, by Seidman)	**ACTIVITIES AND LECTURES** (These are available on the Additional materials page, as indicated)	**LEARNING OBECTIVES** Students will be able to:
WEEK 8 ▪ Review PowerPoint slides discussing solution-making ▪ Review PowerPoint slides discussing the mole ▪ Practice concepts by using concentration practice problems worksheets 1 and 2 ▪ Have students use molarity, percent solutions, and parts per million study guides as self-tests for directed study ▪ Assign Chapter 12 problem set as homework ▪ *Evaluation: Quiz 4 on Units 6 and 7*	***Chapter 12*** **Special points to study:** • Briefly read Sections 12.1 and 12.2 • Study carefully Boxes 1, 2 and 3 in Section 12.3 • Examine the discussion of **parts** on p. 157 ▪ Review the example problems on p. 163 ▪ Study Box 4 on p. 165, and the associated example problem on p. 166 ▪ Study the definitions of mM and mM solutions on p. 171 **Examples to try:** • #2, 3, 10 and 12 on pp.	• "The basics of solution-making" (PowerPoints for "difficult" concepts) • "What's a mole?" (PowerPoints for "difficult" concepts) • Concentration practice problems 1 and 2 (Classroom activities) • Molarity, percent solution, and parts per million study guides (Classroom activities) • Chapter 12 homework (Problem sets) • *Quiz 4 (Sample quizzes)*	▪ Set up and solve problems involving percent solutions ▪ Set up and solve problems involving molarity ▪ Set up and solve problems using ppm and ppb

	155 – 156 • #2, 3 and 4 on pp. 159 – 160 ▪ #1, 3, 5, and 6 on p. 167 ▪ #8, 9, and 10 on p. 175		

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UNIT 9: DILUTIONS

WEEKLY AGENDA	READING ASSIGNMENTS AND RECOMMENDED PRACTICE PROBLEMS (These are from the textbook, *Basic Laboratory Calculations for Biotechnology*, by Seidman)	ACTIVITIES AND LECTURES (These are available on the Additional materials page, as indicated)	LEARNING OBECTIVES Students will be able to:
WEEK 9 ▪ Complete in-class introductory activity on dilutions ▪ Review PowerPoint slides discussing the concept of dilutions ▪ Assign Chapter 13 problem set A as homework	***Chapter 13*** **Special points to study:** • Master the material in Box 1 on p.181, which contrasts the different ways to express dilutions • Study Figure 2, which shows how dilutions are made in the lab, and expressed as fractions **Examples to try:** • #2 and #3 on p. 182 • #6 – 10 on p. 184 • #2 on p. 185	• Dilutions introductory activity (Classroom activities) • "What dilution did I make?" (PowerPoints for "difficult" concepts) • Chapter 13A homework (Problem sets)	• Prepare dilutions of a particular volume

WEEK 10 ▪ Complete in-class introductory activity on dilutions and concentration of solution ▪ Review PowerPoint slides discussing an introduction to dilutions and concentration of solutions ▪ Practice concepts using the dilutions and concentration of solutions study guide and practice problems ▪ Assign Chapter 13 problem set B as homework ▪ *Evaluation: Quiz on Unit 8 and the beginning of Unit 9*	***Chapter 13*** **Special points to study:** • Carefully review Section 13.4 • Study Figure 3 on p. 191 • Review the examples on p. 193 **Examples to try:** ▪ #5, 7, an 8 on p. 188 ▪ #1, 4, and 5 on p. 192 ▪ #1, 6 and 9 on p. 194	• Dilutions and concentration of solutions activity (Classroom activities) • "Dilutions: an introduction" (PowerPoints for "difficult" concepts) • Dilutions and concentration of solutions study guide and practice problems (Classroom activities) • Chapter 13B homework (Problem sets) • *Quiz 5 (Sample quizzes)*	▪ Determine the concentration of a solution following dilution ▪ Determine the concentration of a stock solution from a dilution
WEEK 11 ▪ Review PowerPoint slides discussing serial dilutions ▪ Practice concepts using the dilution series problem set ▪ Practice concepts using the $C_1V_1 = C_2V_2$ practice problems ▪ Assign Chapter 13 problem set C as homework	***Chapter 13*** **Special points to study:** ▪ Carefully review Figure 4 on p. 196 and the accompanying sample calculations provided on p. 197 ▪ Examine Box 2 on p. 207 **Examples to try:** ▪ #1 and 3 on pp. 201 – 202 ▪ #2, 4, 5, and 6 on pp. 203 – 204 ▪ #7, 9, and 10 on p. 210	▪ "Serial dilutions" (PowerPoints for "difficult" concepts) • Dilution series problem set (Classroom activities) • $C_1V_1 = C_2V_2$ practice problems (Classroom activities) • Chapter 13C homework (Problem sets)	▪ Perform calculations involving serial dilutions ▪ Correctly apply the $C_1V_1 = C_2V_2$ equation

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UNIT 10: PREPARING LABORATORY SOLUTIONS THAT CONTAIN MORE THAN ONE SOLUTE

WEEKLY AGENDA	**READING ASSIGNMENTS AND RECOMMENDED PRACTICE PROBLEMS** (These are from the textbook, *Basic Laboratory Calculations for Biotechnology*, by Seidman)	**ACTIVITIES AND LECTURES** (These are available on the Additional materials page, as indicated)	**LEARNING OBECTIVES** Students will be able to:
WEEK 12 ▪ Review PowerPoint slides discussing making multiple component solutions: Parts I and II ▪ Review study guide for preparing multiple component solutions ▪ Assign Chapter 14 problem set as homework ▪ *Evaluation: Quiz on Unit 9*	***Chapter 14*** **Special points to study:** ▪ Study Section 14.2 which shows two ways of preparing the same multicomponent solution- from pure solutes, and from stock solutions ▪ Review the steps in Box 1 for the proper method to adjust the pH of a solution **Examples to try:** • #3 and #4 on pp. 219 - 220	• "Making solutions with multiple components: Parts I and II" (PowerPoints for "difficult" concepts) • Preparing solutions that contain more than a single solute study guide (Classroom activities) • Chapter 14 homework (Problem sets) • *Quiz 6 (Sample quizzes)*	▪ Prepare solutions containing multiple solutes from stock chemicals ▪ Prepare solutions containing multiple solutes from stock solutions

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UNIT 11: GRAPHING LINEAR EQUATIONS

WEEKLY AGENDA	**READING ASSIGNMENTS AND RECOMMENDED PRACTICE PROBLEMS** (These are from the textbook, *Basic Laboratory Calculations for Biotechnology*, by Seidman)	**ACTIVITIES AND LECTURES** (These are available on the Additional materials page, as indicated)	**LEARNING OBECTIVES** Students will be able to:
WEEK 13 ▪ Practice concepts by using the linear equations practice problems ▪ Practice concepts by completing Chapter 15 problem set A in class ▪ Assign Chapter 15 problem set B as homework	***Chapter 15*** **Special points to study:** ▪ Review Figure 5 on p. 231 which shows how to graphically determine the slope of a line ▪ Review Box 1 on p. 233 which shows how to graphically determine the equation of a line ▪ Study closely all of section 15.3 ▪ Examine Figure 11 **Examples to try:** ▪ #1, 2, 7, 8, 11 and 16 on pp. 237 – 242 ▪ a and b on p. 250 ▪ #1 and #2 on pp. 254 – 255	• Graphing linear equations study guide and practice problems (Classroom activities) • Chapter 15A problem set (Problem sets) • Chapter 15B problem set (Problem sets)	▪ Determine slope and intercept using the equation of a line ▪ Graph linear equations ▪ Apply graphing to standard curves

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UNIT 12: GRAPHING EXPONENTIAL EQUATIONS

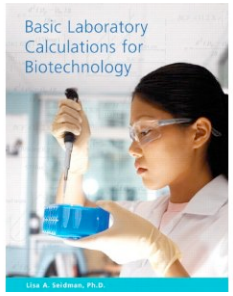
WEEKLY AGENDA	**READING ASSIGNMENTS AND RECOMMENDED PRACTICE PROBLEMS** (These are from the textbook, *Basic Laboratory Calculations for Biotechnology*, by Seidman)	**ACTIVITIES AND LECTURES** (These are available on the Additional materials page, as indicated)	**LEARNING OBECTIVES** Students will be able to:
WEEK 14 ▪ Review PowerPoint slides discussing the difference between linear and exponential equations ▪ Practice concepts by using the exponential relationships practice problems ▪ Assign Chapter 17 problem set as homework ▪ *Evaluation: Quiz on Units 10 and 11* ▪ *Final exam administered either as a take-home exam or during final exams period.*	***Chapter 17*** **Special points to study:** ▪ Examine Figure 1 on p. 289, which shows the shape of an exponential curve ▪ Study Figures 4 and 5 on p. 293 and 294, which show how to label the axes of semi-log graphing paper ▪ Examine Figure 8 on p. 297, which graphically shows the process of radioactive decay ▪ Review the "General Equation for Radioactive Decay" on p. 297 **Examples to try:** ▪ #1, 2 and 5 on p. 301	• "Linear vs. exponential graphing: understanding the difference" (PowerPoints for "difficult" concepts) • Introduction to exponential relationships practice problems (Classroom activities) • Chapter 17 problem set (Problem sets) • *Quiz 7 (Sample quizzes)* • *Final exam (Sample Final Exam)*	▪ Understand the difference between linear and exponential relationships ▪ Plot exponential relationships using semilog graph paper

ADDITIONAL NOTES

1. **ORDER OF UNITS IN THE COURSE.** The order of units as provided in the course schedule can be modified. Additionally, some units can be presented as online units, or review units, depending upon the unique backgrounds of students. This course is offered in several formats in our program: online, hybrid, face-to-face and self-paced.

2. **ADDITIONAL TOPICS.** More advanced topics, such as those related to spectrophotometry, cell culturing and molecular biology are covered in individual courses in our program.

3. **TEXTBOOKS.**



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