



Preface

Calculus for the Life Sciences emphasizes those aspects of calculus most relevant to the life sciences. The application examples and exercises are drawn predominately from biology, medicine, ecology, and other life sciences. A prerequisite of two years of high school algebra is assumed.

Our Approach

Our main goal is to present applied calculus in a concise and meaningful way so that students can understand the full picture of the concepts they are learning and apply it to real-life situations. This is done through a variety of ways.

Focus on Applications Making this course meaningful to students is critical to their success. Applications of the mathematics are integrated throughout the text in the exposition, the examples, the exercise sets, and the supplementary resources. *Calculus for the Life Sciences* presents students with myriad opportunities to relate what they're learning to life science and career situations through the *Apply It* questions, the applied examples, and the *Extended Applications*. To get a sense of the breadth of applications presented, look at the Index of Applications in the back of the book or the extended list of sources of real-world data at the back of this text and on www.pearsonhighered.com/mathstatsresources.

Pedagogy to Support Students Students need careful explanations of the mathematics along with examples presented in a clear and consistent manner. Additionally, students and instructors should have a means to assess the basic prerequisite skills. This can now be done with the *Prerequisite Skills Diagnostic Test* located just before Chapter R. In addition, the students need a mechanism to check their understanding as they go and resources to help them remediate if necessary. *Calculus for the Life Sciences* has this support built into the pedagogy of the text through fully developed and annotated examples, *Your Turn* exercises, *For Review* references, and supplementary material.

Beyond the Textbook Students today take advantage of a variety of resources and delivery methods for instruction. As such, we have developed a robust MyMathLab® course for *Calculus for the Life Sciences*. MyMathLab has a well-established and well-documented track record of helping students succeed in mathematics. The MyMathLab online course for *Calculus for the Life Sciences* contains exercises to challenge students and provides help when they need it. Students who learn best by seeing and hearing can view section- and example-level videos within MyMathLab. These and other resources are available to students as a unified and reliable tool for their success.

New to This Edition

Based on the authors' experience in the classroom along with feedback from many instructors across the country, the focus of this revision is to improve the clarity of the presentation and provide students with more opportunities to learn, practice, and apply what they've learned on their own. This is done both in the presentation of the content and in new features added to the text.

New Textbook Features

- **Exercises and examples have been updated** to reflect the latest data and to incorporate feedback received on the previous version of the text.
- **"Your Turn"** exercises following selected examples provide students with an easy way to stop and check their understanding of the skill or concept being presented. Answers are provided at the end of the section's exercises.

- The answers for each section (at the back of the book) now include a table listing the examples within the section that are most similar to each exercise.
- **Updated Chapter Reviews**
 - A list of important formulas and definitions has been added.
 - Review exercises now begin with Concept Check exercises—a series of true/false exercises designed to assess understanding of key ideas.
 - The answers for review exercises (at the back of the book) now include a table listing which section has examples most similar to each review exercise.
- The **Prerequisite Skills Diagnostic Test**, just prior to Chapter R, gives students and instructors an opportunity to assess students' skills on topics that are critical to success in this course. Answers reference specific review material in the text for **targeted remediation**.
- The updated design makes it **easier to identify graphing calculator and Excel® spreadsheet technology coverage** so instructors can more easily highlight (or skip) the material.

New MyMathLab® Course

- **Extensive exercise coverage**—choose from hundreds of assignable exercises to help you craft just the right assignments.
- **Diagnostic quizzes and personalized homework** provide individualized remediation for any gaps in prerequisite skills.
- **Video program** features example and section coverage.
- **Graphing calculator and Excel® spreadsheet** guidance for students.
- **Application exercises** within MyMathLab are now labeled by type of application.

New and Revised Content

Chapter 1 In Section 1.1, a new example has been added that models the prevalence of cigarette smoking in the United States, and then uses the model to make predictions. Section 1.2 has been revised, giving the formulas for the least squares line explicitly and making them more consistent with the formula for the correlation coefficient. In Section 1.4, an example on vaccination coverage, which illustrates how to derive a quadratic model, both by hand and with technology, has been added. In Section 1.5, material on identifying the degree of a polynomial has been rewritten as an example to better highlight the concept. An example on tuberculosis in the United States, which illustrates how to derive a cubic model, has also been added. Throughout the chapter, real-life exercises have been updated, and new exercises on topics such as cancer, diabetes, gender ratio, energy consumption, meat consumption, the demand for nurses, organic farming, and ideal partner height have been added.

Chapter 2 In Section 2.1, a new example on the surplus of food, which illustrates how to derive an exponential model, both by hand and with technology, has been added. In Section 2.4, an example using a trigonometric function to model the pressure on the eardrum has been included. A new Extended Application on power functions has been added. Throughout the chapter, real-life exercises have been updated and new exercises on topics such as the bald eagle population, minority population growth, carbon monoxide emissions, wind energy, metabolic rate, physician demand, and music have been added.

Chapter 3 In Section 3.1, the introduction of limits was completely revised. The opening discussion and example were transformed into a series of examples that progress through different limit scenarios: a function defined at the limit, a function undefined at that limit (a “hole” in the graph), a function defined at the limit but with a different value than the limit (a piecewise function), and then, finally, attempting to find a limit when one does not exist. New figures were added to illustrate the different scenarios. In Section 3.2, the definition and examples of continuity have been revised using a simple process to test for continuity. A medical device cost analysis has been added as an example. In Section 3.3, an example calculating the rate of change of the number of households with landlines has

been added. The opening discussion of Section 3.5, showing how to sketch the graph of the derivative given the graph of the original function, was rewritten as an example. An Extended Application on the modeling of drugs administered intravenously has been added. Throughout the chapter, real-life exercises have been updated, and new exercises on topics such as Alzheimer's disease, body mass index, and immigration have been added.

Chapter 4 The introduction to the chain rule was rewritten as an example in Section 4.3. In Section 4.4, a new example illustrates the use of a logistic function to develop a model for the weight of cactus wrens. An Extended Application on managing renewable resources has been added. Throughout the chapter, real-life exercises have been updated, and new exercises on topics such as tree growth, genetics, insect competition, whooping cranes, cholesterol, involuntal psychosis, radioactive iron, radioactive albumin, heat index, Jukes-Cantor distance, eardrum pressure, online learning, and minority populations have been added.

Chapter 5 Twenty-six new exercises were added throughout Chapter 5, nine of them applications based on scientific sources, such as three on foraging and two on cohesiveness, which involves the spacing between fish in a school or birds in a flock. There are now more trigonometric exercises in the chapter, along with an additional example involving trigonometry.

Chapter 6 Throughout Chapter 6, thirteen new exercises and three examples were added. Five of the new applications are based on scientific sources, such as the one on cancer cells and the one on honeycombs in Section 6.2 on Applications of the Derivative. In addition, there are now more trigonometric exercises in the chapter.

Chapter 7 The antiderivatives of the trigonometric functions have been moved to the first section so they can now be applied throughout the chapter. In addition, six exercises were added, some involving trigonometry and others involving integration using real data (such as those related to energy usage). The examples were improved by adding two new examples involving trigonometry and updating six involving real data.

Chapter 8 An example using tables to find trigonometric integrals has been included in Section 8.2. New graphics help illustrate the calculation of the volume of a solid of revolution in Section 8.3. Throughout the chapter, real-life exercises have been updated.

Chapter 9 In Chapter 9, seven of the new applications are based on scientific sources and fifteen new exercises were added, such as those on zooplankton growth, hypoxia (when the lungs receive inadequate oxygen), and Body Shape Index. In addition, many more trigonometric exercises are found throughout the chapter. The Extended Application has been revised to include an additional question involving technology as well as a group project option. Finally, material was added to justify the second derivative test for functions of two variables.

Chapter 10 In Section 10.1, a brief summary of solutions of two equations in two variables has been added. An alternate method for fraction-free Gauss-Jordan has been added to the first example. Section 10.5 has been revised, with the beginning discussion rewritten as examples on insect population growth, determinant calculations, and eigenvalue and corresponding eigenvector calculations. New exercises on finding the determinant of a matrix have also been included in this section. Throughout the chapter, real-life exercises have been updated, and new exercises on topics such as cancer, motorcycle helmets, calorie expenditure, basketball, and baseball have been added.

Chapter 11 The chapter opener was changed to relate to an exercise involving diseases in mouse populations. Material on equilibrium points and stability was added to Section 11.1. In addition, thirteen new exercises were added, six of them applications based on scientific sources. One of the new exercises compares the three population growth models discussed in the chapter: exponential, limited growth, and logistic. There are now more trigonometric exercises throughout the chapter. Finally, exercises were updated and an example, a Your Turn exercise, a For Review box, and a Technology Note were added.

Chapter 12 In Section 12.1, an example on endangered species has been added to illustrate set operations. In Section 12.2, an exam on student health has been included to show how Venn diagrams can be used to determine probabilities. In Section 12.3, the beginning discussion has been rewritten as an example of conditional probability. Examples on environmental inspections and on playing cards, both illustrating the product rule, have been added. The solution to the example on sensitivity and specificity has been rewritten for clarity. Challenging problems from actuarial exams have been included as exercises throughout this chapter as well.

Chapter 13 New material was added on the Poisson random variable and its connection to the exponential random variable. In addition, new material was inserted on a random sample, its mean, and the Central Limit Theorem. To support the new material as well as to better align with the existing content, four new examples were included, and thirty new exercises were added, of which four are applications based on scientific sources, such as the ones on plant growth and on the Hodgkin-Huxley model for excitable nerve cells.

Chapter 14 Chapter 14 in the last edition was available online for those who chose to cover discrete dynamical systems. With increased attention on this topic, the chapter has been heavily revised and supplemented to make for a robust topic in this course. Along with a new chapter opener, twelve new exercises were added to Section 14.1, six to Section 14.2, and thirteen to Section 14.3. A Chapter Review was added, with thirty exercises, two of them applications based on scientific sources. Finally, a new Extended Application was included, based on modeling the growth and decline of polio, as well as other life science situations that can be modeled by discrete dynamical systems.

Prerequisite Skills Diagnostic Test

The Prerequisite Skills Diagnostic Test gives students and instructors a means to assess the basic prerequisite skills needed to be successful in this course. In addition, the answers to the test include references to specific content in Chapter R as applicable so students can zero in on where they need improvement. Full solutions to the questions in this test are in Appendix A.

Your Turn Exercises

The **Your Turn** exercises, following selected examples, provide students with an easy way to quickly stop and check their understanding of the skill or concept being presented. Answers are provided at the end of the section's exercises.

More Applications and Exercises

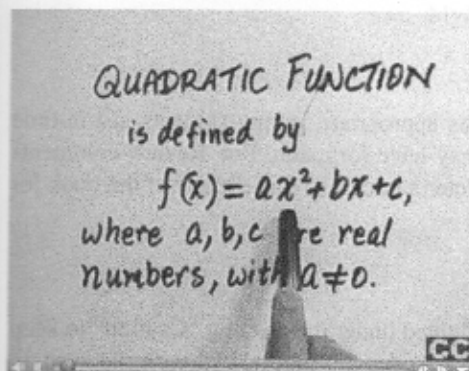
This text is used in large part because of the enormous amounts of real data contained in examples and exercises throughout. This second edition will not disappoint in this area. Every section of this text has new and updated examples, exercises and applications. The data has been updated in the applications whenever possible and new examples have been added altogether to provide additional guidance to students or new applications of the mathematics.

Coverage of Technology

Graphing calculator or Microsoft Excel® material is now set off to make it easier for instructors to use. Figures depicting graphing calculator screens have been redrawn to create a more accurate depiction of the math. In addition, this edition provides students with a transition to the new MathPrint™ operating system of the TI-84+C through the Technology Notes, a new appendix, and the *Graphing Calculator Manual*. An *Excel® Spreadsheet Manual* is also available.

MyMathLab®

Available now with *Calculus for the Life Sciences* are the following resources within MyMathLab that will benefit students in this course.



- “Getting Ready for Applied Calculus” chapter covers basic prerequisite skills.
- Personalized Homework allows you to create homework assignments based on the results of student assessments.
- Premade “Getting Ready for Chapter X” quizzes are available for instructors to assign as a way to assess student preparedness for upcoming topics.
- Videos with example and section coverage.
- Hundreds of assignable exercises.
- Application labels within exercise sets (e.g., “Life Sciences”) make it easy to find types of applications appropriate for students with different interests.
- Additional graphing calculator and Excel spreadsheet help.

A detailed description of the overall capabilities of MyMathLab is provided on pages xiii and xiv.

Source Lines

Sources for the exercises are now written in an abbreviated format within the actual exercise so that students immediately see that the problem comes from, or pulls data from, actual research or industry. The complete references are available at www.pearsonhighered.com/mathstatsresources as well as on page S-1.

Continued Pedagogical Support

This second edition has undergone a significant revision to address the needs of today’s students. However, the signature writing style and features that make this text accessible to the average student have been maintained. Some of those signature features are the following:

Exposition and Examples

Nothing in a text is more important to a student than the examples and surrounding explanations. This text is known for its careful explanation of the mathematics and the fully developed examples. The examples often include explanatory comments in color, to the side of the worked-out examples, to help guide students through the steps. In addition, the authors frequently summarize key rules and formulas throughout the text to help students recognize the advantages of, or differences between, multiple techniques for solving a problem.

Multiple Methods of Solution

An emphasis remains on multiple representations of a topic, whenever possible, by examining each topic symbolically, numerically, graphically, and verbally, and by providing multiple methods of solution to various examples. Some of these alternative methods involve technology, while others represent a different way of performing a computation. These multiple representations give instructors the flexibility to emphasize the method they prefer and will ultimately help students better understand a topic.

Apply It

An **Apply It** question (previously named “Think About It”), typically at the start of a section, asks students to consider how to solve a real-life situation related to the math they are about to learn. The **Apply It** question is solved in an application within the section or the exercise set so students see it in context with the mathematics.

Extended Applications

In-depth applied exercises called “Extended Applications” are included at the end of every chapter to stimulate student interest and for use as group projects. These applications are also ideal for use in honors sections of the course.

For Review

For Review boxes are provided in the margin as appropriate, giving students just-in-time help with skills they should already know but may have forgotten. **For Review** comments sometimes include an explanation, while others refer students to earlier parts of the book for a more thorough review.

Caution and Notes

Common student difficulties and errors are highlighted under the heading “Caution” to keep students on track. In addition, important hints and asides are highlighted with the heading “Notes.”

Full-Color Graphics and Photography

To make this book lively and fun to read, full-color graphics have been included. As needed, color is used to enhance the exposition. More often, color is used to clarify the different parts of a figure or to highlight important aspects of an illustration.

Supplements

STUDENT RESOURCES

Student's Solutions Manual

- Provides students with detailed solutions to odd-numbered section-level exercises, and all review exercises.
- Authored by Beverly Fusfield.
- ISBN 0321963830 / 9780321963833

Graphing Calculator Manual (download only)

- By Victoria Baker, Nicholls State University
- Contains detailed instruction for using the TI-83/TI-83+/TI-84+ C.
- Instructions are organized by topic.
- Available in MyMathLab.

Excel® Spreadsheet Manual (download only)

- By Stela Pudar-Hozo, Indiana University—Northwest
- Contains detailed instructions for using Excel 2013.
- Instructions are organized by topic.
- Available in MyMathLab.

Video Lectures with Optional Captioning (download only)

- Videos with extensive example and section coverage, for student use at home or on campus.
- Ideal for distance learning or supplemental instruction.
- Available in MyMathLab.

INSTRUCTOR RESOURCES

Instructor's Edition

- Includes all the answers, for quick reference in back of text.
- ISBN 0321963822 / 9780321963826

Instructor's Solutions Manual (download only)

- Provides instructors with detailed solutions to all section-level exercises, review exercises, and Extended Applications.
- Authored by Beverly Fusfield.
- Available to qualified instructors within MyMathLab or through the Pearson Instructor Resource Center, www.pearsonhighered.com/irc

PowerPoint® Lecture Presentation

- Includes lecture content and key graphics from the book.
- Available to qualified instructors within MyMathLab or through the Pearson Instructor Resource Center, www.pearsonhighered.com/irc

Media Resources

MyMathLab® Online Course (access code required)

MyMathLab delivers **proven results** in helping individual students succeed.

- MyMathLab has a consistently positive impact on the quality of learning in higher education math instruction. MyMathLab can be successfully implemented in any environment—lab-based, hybrid, fully online, traditional—and demonstrates the quantifiable difference that integrated usage has on student retention, subsequent success, and overall achievement.
- MyMathLab's comprehensive online gradebook automatically tracks your students' results on tests, quizzes, homework, and in the study plan. You can use the gradebook to quickly intervene if your students have trouble, or to provide positive feedback on a job well done. The data within MyMathLab is easily exported to a variety of spreadsheet programs, such as Microsoft Excel. You can determine which points of data you want to export, and then analyze the results to determine success.

MyMathLab provides **engaging experiences** that personalize, stimulate, and measure learning for each student.

- **Personalized Learning:** MyMathLab offers features that support adaptive learning: personalized homework and the adaptive study plan. These features allow your students to work on what they need to learn when it makes the most sense, maximizing their potential for understanding and success.
- **Exercises:** The homework and practice exercises in MyMathLab correlate to the exercises in the textbook, and they regenerate algorithmically to give students unlimited opportunity for practice and mastery. The software offers immediate, helpful feedback when students enter incorrect answers.
- **Chapter-Level, Just-in-Time Remediation:** The MyMathLab course for this text includes a short diagnostic, called "Getting Ready," prior to each chapter to assess students' prerequisite knowledge. This diagnostic can then be tied to Personalized Homework so that each individual student receives a homework assignment specific to his or her prerequisite skill needs.
- **Multimedia Learning Aids:** Exercises include guided solutions, sample problems, animations, videos, and eText access for extra help at point-of-use.

And, MyMathLab comes from an **experienced partner** with educational expertise and an eye on the future.

- Knowing that you are using a Pearson product means knowing that you are using quality content. This means that our eTexts are accurate and our assessment tools work. It also means we are committed to making MyMathLab as accessible as possible. MyMathLab is compatible with the JAWS 12/13 screen reader, and enables multiple-choice and free-response problem types to be read and interacted with via keyboard controls and math notation input. More information on this functionality is available at <http://mymathlab.com/accessibility>.
- Whether you are just getting started with MyMathLab, or have a question along the way, we're here to help you learn about our technologies and how to incorporate them into your course.
- To learn more about how MyMathLab combines proven learning applications with powerful assessment and continuously adaptive capabilities, visit www.mymathlab.com or contact your Pearson representative.

MyMathLab® Ready to Go Course (access code required)

These new "Ready to Go" courses provide students with all the same great MyMathLab features, but make it easier for instructors to get started. Each course includes preassigned

homework and quizzes to make creating a course even simpler. In addition, these prebuilt courses include a course-level “Getting Ready” diagnostic that helps pinpoint students’ weaknesses in prerequisite skills. Ask your Pearson representative about the details for this particular course or to see a copy of it.

MyLabsPlus®

MyLabsPlus combines proven results and engaging experiences from MyMathLab® and MyStatLab™ with convenient management tools and a dedicated services team. Designed to support growing math and statistics programs, it includes additional features such as:

- **Batch Enrollment:** Your school can create the login name and password for every student and instructor, so everyone can be ready to start class on the first day. Automation of this process is also possible through integration with your school’s Student Information System.
- **Login from your campus portal:** You and your students can link directly from your campus portal into your MyLabsPlus courses. A Pearson service team works with your institution to create a single sign-on experience for instructors and students.
- **Advanced Reporting:** MyLabsPlus’s advanced reporting allows instructors to review and analyze students’ strengths and weaknesses by tracking their performance on tests, assignments, and tutorials. Administrators can review grades and assignments across all courses on your MyLabsPlus campus for a broad overview of program performance.
- **24/7 Support:** Students and instructors receive 24/7 support, 365 days a year, by email or online chat.

MyLabsPlus is available to qualified adopters. For more information, visit our website at www.mylabsplus.com or contact your Pearson representative.

MathXL® Online Course (access code required)

MathXL® is the homework and assessment engine that runs MyMathLab. (MyMathLab is MathXL plus a learning management system.)

With MathXL, instructors can:

- Create, edit, and assign online homework and tests using algorithmically generated exercises correlated at the objective level to the textbook.
- Create and assign their own online exercises and import TestGen tests for added flexibility.
- Maintain records of all student work tracked in MathXL’s online gradebook.

With MathXL, students can:

- Take chapter tests in MathXL and receive personalized study plans and/or Personalized Homework assignments based on their test results.
- Use the study plan and/or the homework to link directly to tutorial exercises for the objectives they need to study.
- Access supplemental animations and video clips directly from selected exercises.

MathXL is available to qualified adopters. For more information, visit our website at www.mathxl.com or contact your Pearson representative.

TestGen®

www.pearsoned.com/testgen

TestGen® enables instructors to build, edit, print, and administer tests using a computerized bank of questions developed to cover all the objectives of the text. TestGen is algorithmically based, allowing instructors to create multiple but equivalent versions of the same question or test with the click of a button. Instructors can also modify test bank questions or add new questions. The software and testbank are available for download from Pearson Education’s online catalog at www.pearsonhighered.com.

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