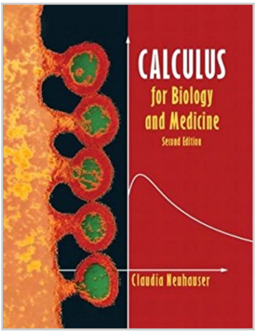

Calculus for Biology and Medicine (2nd Edition)

By Claudia Neuhauser

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This volume teaches calculus in the *biology* context *without* compromising the level of regular calculus. The material is organized in the standard way and explains how the different concepts are logically related. Each new concept is typically introduced with a biological example; the concept is then developed *without* the biological context and then the concept is tied into additional biological examples. This allows readers to first see *why* a certain concept is important, then lets them focus on how to use the concepts *without* getting distracted by applications, and then, once readers feel more comfortable with the concepts, it revisits the biological applications to make sure that they can *apply* the concepts. The book features exceptionally detailed, step-by-step, worked-out examples and a variety of problems, including an unusually large number of word problems. The volume begins with a preview and review and moves into discrete time models, sequences, and difference equations, limits and continuity, differentiation, applications of differentiation, integration techniques and computational methods, differential equations, linear algebra and analytic geometry, multivariable calculus, systems of differential equations and probability and statistics. For faculty and postdocs in biology departments.

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Editorial Review

From the Back Cover
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When the first edition of this book appeared three years ago, I immediately started thinking about the second edition. Topics absent from the first edition were needed in a calculus book for life science majors: difference equations, extrema for functions of two variables, optimization under constraints, and expanded probability theory. I also wanted to add more biological examples, in particular in the first half of the book, and add more problems (the number of problems in many sections doubled or tripled compared with the first edition).

Despite these changes, the goals of the first edition remain: To model and analyze phenomena in the life sciences using calculus. do a traditional calculus course, biology students rarely see why the material is relevant to their training. This text is written exclusively for students in the biological and medical sciences. It makes an effort to show them from the beginning how calculus can help to understand phenomena in nature.

This text differs from traditional calculus texts. **First,** it is written in a life science context; concepts are motivated with biological examples to emphasize that calculus is an important tool in the life sciences. The second edition has many more biological examples than the first edition, particularly in the first half of the book. **Second,** difference equations are now extensively treated in the book. They are introduced in Chapter 2, where they are accessible to calculus students without a knowledge of calculus and provide an easier entrance to population models than differential equations. They are picked up again in Chapters 5 and 10, where they receive a more formal treatment using calculus. **Third,** differential equations, one of the most important modeling tools in the life sciences, are introduced early, immediately after the formal definition of derivatives in Chapter 4. Two chapters deal exclusively with differential equations and systems of differential equations; both chapters contain numerous up-to-date applications. **Fourth,** biological applications of differentiation and integration are integrated throughout the text. **Fifth,** multivariable calculus is taught in the first year, recognizing that most students in the life sciences will not take the second year of calculus and that multivariable calculus is needed to analyze systems of difference and differential equations, which students encounter later in their science courses. The chapter on multivariable calculus now has a treatment of extrema and Lagrange multipliers.

This text does not teach modeling; the objective is to teach calculus. Modeling is an art that should' be taught in a separate course. However, throughout the text, students encounter mathematical models for biological phenomena. This will facilitate the transition to actual modeling and allows them to see how calculus provides useful tools for the life sciences.

Examples. Each topic is motivated with biological examples. This is followed by a thorough discussion outside of the life science context to enable students to become familiar with both the meaning and the mechanics of the topic. Finally, biological examples are given to teach students how to use the material in a life science context.

Examples in the text are completely worked out; steps in calculation are frequently explained in words.

Problems. Calculus cannot be learned by watching someone do it. This is recognized by providing the students with both drill and word problems. Word problems are an integral part of teaching calculus in a life science context. The word problems are up to date; they are adapted from either standard biology texts or original research. Many new problems have been added to the second edition. Since this text is written for c911ege freshmen, the examples were chosen so that no formal training in biology is needed.

Technology. The book takes advantage of graphing calculators. This allows students to develop a much better visual understanding of the concepts in calculus. Beyond this, no special software is required.

CHAPTER SUMMARY

Chapter 1. Basic tools from algebra and trigonometry are summarized in Section 1.1. Section 1.2 contains the basic functions used in this text, including exponential and logarithmic functions. Their graphical properties and their biological relevance are emphasized. Section 1.3 covers log-log and semilog plots; these are graphical tools that are frequently used in the life sciences. In addition, a section on translating verbal descriptions of biological phenomena into graphs will provide students with much needed skills when they read biological literature.

Chapter 2. This chapter was added to the second edition. It covers difference equations (or discrete time models) and sequences. This provides a more natural way to explain the need for limits. Classical models of population growth round up this chapter; this gives students a first glimpse at the excitement of using models to understand biological phenomena.

Chapter 3. Limits and continuity are key concepts for understanding the conceptual parts of calculus. Visual intuition is emphasized before the theory is discussed. The formal definition of limits is now at the end of the chapter and can be omitted.

Chapter 4. The geometric definition of a derivative as the slope of a tangent line is given before the formal treatment. After the formal definition of the derivative, differential equations are introduced as models for biological phenomena. Differentiation rules are discussed. These sections give students time to acquaint themselves with the basic rules of differentiation before applications are discussed. Related rates and error propagation, in addition to differential equations, are the main applications.

Chapter 5. This chapter presents biological and more traditional applications of differentiation. Many of the applications are consequences of the mean value theorem. Many of the word problems are adapted from either biology textbooks or original research articles; this puts the traditional applications (such as extrema, monotonicity, and concavity) in a biological context. A section on analyzing difference equations is added.

Chapter 6. Integration is motivated geometrically. The fundamental theorem of calculus and its consequences are discussed in depth. Both biological and traditional applications of integration are provided before integration techniques are covered.

Chapter 7. This chapter contains integration techniques. However, only the most important techniques are covered. Tables of integrals are used to integrate more complicated integrals. The use of computer software is not integrated in the book, though their usefulness in evaluating integrals is acknowledged. This chapter also contains a section on Taylor polynomials.

Chapter 8. This chapter provides an introduction to differential equations. The treatment is not complete, but it will equip students with both analytical and graphical skills to analyze differential equations. Eigenvalues are introduced early to facilitate the analytical treatment of systems of differential equations in Chapter 11. Many of the differential equations discussed in the text are important models in biology. Although this text is not a modeling text, students will see how differential equations are used to model biological phenomena and will be able to interpret differential equations. Chapter 8 contains a large number of up-to-date applications of differential equations in biology.

Chapter 9. Matrix algebra is an indispensable tool for every life scientist. The material in this chapter covers the most basic concepts; it is tailored to Chapters 10 and 11, where matrix algebra is frequently used. Special emphasis is given to the treatment of eigenvalues and eigenvectors because of their importance in analyzing systems of differential equations.

Chapter 10. This is an introduction to multidimensional calculus. The treatment is brief and tailored to Chapter 11, where systems of differential equations are discussed. The main topics are partial derivatives and linearization of vector-valued functions. The discussion of gradient and diffusion is not needed for Chapter 11. A section on extrema and Lagrange multipliers is added, which is also not required for Chapter 11. If difference equations were covered early in a course, the final section in this chapter will provide an introduction to systems of difference equations with many biological examples.

Chapter 11. This material is most relevant for students in the life sciences. Both graphical and analytical tools are developed to enable students to analyze systems of differential equations. The material is divided into linear and nonlinear systems. Understanding the stability of linear systems in terms of vector fields, eigenvectors, and eigenvalues helps students to master the more difficult analysis of nonlinear systems. Theory is explained before applications are given—this allows students to become familiar with the mechanics before delving into applications. An extensive problem set allows students to experience the power of this modeling tool in a biological context.

Chapter 12. This chapter contains some basic probabilistic and statistical tools. It is greatly expanded compared with the first edition; in particular, Chapter 8 of the first edition is now incorporated into Chapter 12. It cannot replace a full-semester course in probability and statistics but allows students to see early some of the concepts needed in population genetics and experimental design.

Users Review

From reader reviews:

Robin Martz:

Have you spare time for the day? What do you do when you have much more or little spare time? That's why, you can choose the suitable activity to get spend your time. Any person spent their very own spare time to take a go walking, shopping, or went to typically the Mall. How about open or maybe read a book eligible

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Armando Rodgers:

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