

**Mathematics for the Life Sciences.** Erin N. Bodine, Suzanne Lenhart and Louis J. Gross. Princeton University Press, 41 William St, Princeton, New Jersey 08450, USA. Hardcover. 2014. 640 pp. Price: US\$ 85.00/£59.00. ISBN: 978069-1150727.

Mathematics has been well integrated in the teaching of physics and chemistry at the tertiary level (B Sc and M Sc) in Indian higher education system and has lagged behind in biology (zoology, botany, microbiology). In general there is very little discussion on the formal teaching of mathematics to biologists at the undergraduate or the postgraduate level in Indian universities and educational institutions. This is also reflected in the article by Venkataraman, Sholarpurkar and Sarma in the book *Mathematics Education in India – Status and Outlook* (edited by R. Ramanujam and K. Subramaniam, HBCSE, TIFR, Mumbai) – National Institute of Mathematics education launched under the auspices of the Indian National Science Academy. Although issues related to mathematics education in general have been discussed, there is no emphasis or focus on educating the biologists in mathematics.

The book under review has been designed primarily for the US undergraduate education system, where the NSF/AAAS 2011, in its Vision and Change in Undergraduate Biology Education report emphasizes the linking of quantitative and computational components in biology education. I tried to search for similar kind of reports from Government bodies in India. There is a brief report by the Academy panel of the Indian Academy of Sciences ([http://www.ias.ac.in/initiat/sci\\_ed/report\\_general.html](http://www.ias.ac.in/initiat/sci_ed/report_general.html)) that emanated from its concern of the quality of science education at the undergraduate and post-graduate level in

the country. It was emphasized that the students of biology should receive formal training in mathematics besides physics and chemistry.

The book is the first edition designed to be used by students of the life sciences. There are a lot of innovations in the design of this book to make it attractive and usable to the serious students of the life sciences. Conventionally, biology is regarded as a non-mathematical subject. The curricula at the B Sc level in the university affiliated colleges that form the base where biology students get trained, generally emphasizes descriptive biology at the level of the organism and the cell. The mathematically rich areas of biology, viz. genetics, physiology and ecology are taught much later in the curriculum and usually by a biologist rather than a mathematician. A balanced approach is required in the teaching of mathematics to a student of the life sciences, a balance between the rigour of the mathematics and the descriptive nature of biology. This book helps a student of life sciences to understand how mathematical results can be used to solve and understand problems in the life sciences.

It was interesting to learn from the preface of the book about the ‘Rule of Four’ in the Undergraduate mathematics education reform movement in the US that emphasizes the four complementary teaching approaches, i.e. symbolic, numerical, graphical and verbal, considering the diverse approaches towards learning used by the students. Unfortunately, in my view the Indian education system starts with the assumption that the learning styles by the students is homogeneous, and in this system only the ones who have the ‘gift of the abstract’, do make the mark, leaving the others unconfident however bright they may be otherwise. The book has added one more rule to the ‘Rule of Four’, the ‘Rule of Five’, by including biological data and worked out examples to enhance conceptualization and develop intuition. I am not formally ‘mathematically trained’ and I find learning through actual data and examples very comforting.

The book begins well with Unit 1 on ‘Descriptive Statistics’ with four chapters that initiate the student to explore experimental data mathematically to abstract the main properties and interpret them. Unit 2 on ‘Discrete time modeling’ analyse how biological variables change at discrete time intervals – change in

blood concentration of a drug for instance. The different chapters are on Sequence and difference equations, Vectors and matrices, Matrix algebra, Leslie–matrix models and Eigen values. Unit 3 is on Probability that deals with unpredictability in the life sciences, the most common question relates to understanding if the outcomes of two different experiments differ or are the same. The unit has chapters related to probability of events, compound events, conditional probability, sequential events including Partition theorem and Bayes theorem and population genetics models. Many physiological processes in organisms change continuously like body temperature or enzyme concentrations and not as ‘jumps’. Unit 4 is on ‘Limits and Continuity’. Change is central to biology – some changes are instantaneous. Unit 5 is on ‘Derivatives’ with chapters on derivatives of functions – exponential, trigonometric, logarithmic and using derivatives to find maxima and minima. Biological processes undergo change, and it is important to understand the total change across time when the rate of change is known. The mathematics needed to understand this is ‘integration’ which is discussed in unit 6. The chapters under this relate to estimation of the area under a curve, antiderivatives and the fundamental theorem of calculus, methods of integration, applying integrals to area and volume, and probability in a continuous context. Understanding differential equations is one of the basic essentials in biology. A common cited model is the differential equation where the rate of growth of bacteria in a dish is proportional to the population of the bacteria in a dish, whose general solution can be used to estimate the number of bacteria at different time points – and follow the exponential growth of bacteria. Unit 7 is an ‘Introduction to differential equations’ and has chapters on separation of variables, equilibria and homeostasis. Biological processes are complex and rarely occur in isolation. The interactions between processes are also rarely linear. A separate chapter on Implicit differentiation has been added to help the reader understand the relationship between rates of change using implicit differentiation. For additional reading, there is a separate bibliography section and weblinks.

Newer methods of teaching mathematics including technology using calculators

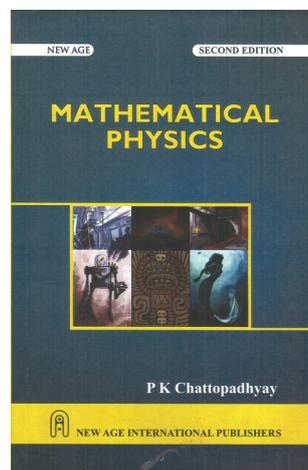
and computers apart from the conventional use of notebooks and chalk boards are important in mathematics education. Innovations and design of mathematics teaching material is equally important to make the understanding of mathematical tools enjoyable and meaningful to the student of life sciences. The book does not fail in this. The book has two appendices. Appendix A is about 'Getting started with Matlab', which has a very basic introduction to Matlab to help the novice in getting familiar with the matlab codes. Further, this has references to weblinks for documentation and tutorials. An R supplement is available online as well. Familiarization with this section would help the student to not only solve problems given at the end of each chapter in the book under Matlab skills but in various fields of life sciences. Appendix B is on mathematical notations. Matlab is a programming environment instead of packaged software. Many students of life sciences use spread sheets and packaged software with graphical interface. However, programming is very limited in these and the formula-related details are usually hidden. In Matlab, the entire program can be seen and used by modifying an existing script and has the advantage of advanced graphics of professional quality. Mathematics education in India at the school level has a strong Math Homework component with Math problems that students learn to solve and work through. The book has lot of problems at the end of each chapter that allows one to practice and learn.

The commitment in making the book easy to understand by biologists has in great measure to do with the authors of the book. Erin Bodine is an Assistant Professor at the Rhodes College, Memphis, with research interest in mathematical ecology and teaches a course on math for the life sciences including calculus. Suzanne Lehhart is a Professor of Mathematics at the University of Tennessee, Knoxville, with research interest in population and disease models, Louis J. Gross is the Director of the National Institute for Mathematical and Biological Synthesis and Professor of Ecology and Evolutionary Biology and Mathematics at the University of Tennessee, Knoxville with research interests in computational and mathematical ecology and has been actively involved in quantitative training in the life sciences.

Considering the challenges in the teaching of mathematics and its application to the life sciences, the *Mathematics for Life Sciences* can form a core text book for teaching the students of life sciences. Education in the life sciences in India at the undergraduate level is undergoing metamorphosis, a rather slow one, with universities like the Delhi university now having a B Sc. Life Sciences program with mathematics and statistics as integral part of the curriculum. In select universities and institutes, mathematics is taught at the Masters level as a core subject to biology students. Problem with the study of mathematics is the fear associated with its learning. This book would help serious students of biology to conquer that fear and help them to appreciate its potential application in the life sciences and in their own research. I would recommend serious students of modern biology to have a personal copy of this book. Mathematics cannot simply be ignored anymore by the biologists.

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**Mathematical Physics.** P. K. Chattopadhyay. New Age International (P) Ltd, 7/30A, Daryaganj, New Delhi 110 002. 2003. xii + 352 pp. 2nd edn. Price: Rs 250.

The book under review, *Mathematical Physics*, is designed as a text book for students pursuing M Sc degree in physics in most Indian universities. Divided into

8 chapters the book covers, in about 350 pages, all topics which form an integral part of the basic training of a physics student at the Master's level. These include: complex variables, partial differential equations, second order differential equations, special functions, boundary value problems, Green's functions, linear vector spaces and group theory. Each chapter contains a large number of problems, solved and unsolved, to illustrate the concepts and the methods developed therein. To sustain the interest of the intended readership, the exercises and worked out examples are largely drawn from various areas of physics such as quantum mechanics, electrodynamics, elementary particle physics, etc.

Going through this book, particularly if one has had occasions to teach mathematical physics, one cannot help appreciate the fact that this book is a product of years of teaching experience and a strong commitment to quality teaching. Written with care, in a reader-friendly style, it provides sufficient prior motivation for each new concept that is discussed and also cautions the reader against pitfalls that arise when one tries to apply a given mathematical result beyond its domain of validity.

Having said that I would also like to take note of the fact that the book has not been properly proof-read prior to its publication. For instance, the chapter on linear vector spaces and matrices consisting of 47 pages has at least 35 typographical errors in the form of missing symbols, inconsistent use of fonts, misspelt names, etc.

As to the overall organization of the book, I have some specific suggestions for improvement, should there be a plan to bring out the third edition of this rather useful book:

- The locations of the chapter on linear vector spaces and matrices and that on complex variables should be swapped. Within the scope of this book, the chapter on complex variables stands on its own and can appear as chapter seven without affecting the flow of the book. On the other hand, the notions and constructs developed in the chapter on linear vector spaces thread through chapters 2 to 6 and it should therefore rightfully be placed ahead of them.
- In the chapter on complex variables, while discussing functions with branch