celerations (p. 22) be understood? Vector sum is used on pages 23 and 35 and then defined on page 64. Scalar multiplication of matrices is used (pp. 32, 34) before it is formally introduced. The coefficients for quadratic forms—A_{11}, A_{12}, and so on—are used (p. 116) but never explained.

Motivation is sometimes missing. Advanced ideas are assumed and fundamental ones proved. Here are a number of examples: why is distance invariant on page 25; does one example for transformation of coordinates suffice on page 26; why do the decimals appear as they do on page 36; why is the magnitude of the matrix not zero on page 45; why is cT substituted for T on page 52; why is the unit vector dimensionless on page 66; and why do the asymptotes of hyperbolas follow from the discussion on page 119?

Without trying to spot all errors in printing, I noted some on pages 10, 46, 49, 57, 176, and 182.

In the hands of a skillful teacher this book could come to life and be the basis for a fascinating course, but it does not stand on its own feet. It is too condensed to be useful and too vague with respect to the audience it expects and the background it assumes.

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Photosynthesis

Primary Processes in Photosynthesis. Martin D. Kamen. Academic Press, New York, 1963. xii + 183 pp. Illus. $5.50.

The author has defined his task as that of writing a book which will introduce both students and veteran researchers to the newly developing studies of the fundamental physics and physical chemistry of the primary events in photosynthesis. Following the course of events initiated by the arrival of a light quantum at the photosynthetic apparatus, he divides the subsequent processes into "eras"—the era of radiation physics (10^{-15} to 10^{-9} second), the era of photochemistry (10^{-9} to 10^{-4} second), the era of biochemistry (10^{-4} to 10 second), and the era of physiology and ecology (after 10 seconds). His book is restricted to the first two eras.

Those whose backgrounds are in biology and biochemistry will find this an excellent guide to understanding the importance, the language, the methodology, the instrumentation, and the preliminary successes of the more physically oriented approaches to photobiology. Among the topics covered are the light absorption act itself, energy migration, lifetimes and quenching processes of excited states, charge transfer processes, polarization of absorbed and emitted light, resonance phenomena, and difference spectroscopy. Wherever possible, the physical concepts are discussed first with reference to simple monoelectronic, monatomic, or diatomic systems, and the additional features are sketched out for extending studies to the macromolecular systems of the living cell.

Those who approach photosynthesis from the more physical disciplines will find in the book a balanced perspective of the biological setting of the problem. Bacterial and green plant photosyntheses are viewed as similar situations, whose differences should be exploited for the unraveling of some of the complexities of the primary photochemical events.

The problem of photosynthesis, as defined in the first chapter, is to "pump up" electrons from a region of high electron affinity, water, to one of low electron affinity, a primary electron acceptor that mediates between the pigments and the carbon dioxide to be assimilated. Emphasis is placed on the possible role played by important constituents of the chloroplast and the chromatophores, especially by the various forms of chlorophyll, by the other photosynthetic pigments, and by the heme proteins. A thorough review is given of the structural organization of the photosynthetic apparatus. Special attention is given to the experimental and theoretical bases for energy migration and trapping at special reactive sites and for charge separation within pigment aggregates or within a pigment-heme protein complex. The possible role of atom, as opposed to electron, transfer, in primary photochemical events has perhaps been underestimated.

This book should help to bridge the communication gap between the various fields that are contributing to the current activity in photosynthesis. Since a reader who wants more detailed information may be directed to original sources by the excellent bibliography, the author may be forgiven for the occasional use of the same term for two different things, for some contradictory descriptions of certain proposed models, and for the errors introduced in the attempt to simplify spectroscopic concepts.

Kamen wisely did not attempt to synthesize a complete picture of photosynthesis, noting that many important problems are now in a very active stage of research. In fact, very few references are taken from publications after 1960. He has given us an authoritative statement of the current problems, a guide to a critical evaluation of the growing literature, and a renewed enthusiasm for approaching photosynthesis as a whole life process rather than as a collection of isolated steps.

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College Calculus

College Calculus with Analytic Geometry. Murray H. Protter and Charles B. Morrey, Jr. Addison-Wesley, Reading, Mass., 1964. xiv + 897 pp. Illus. $11.50.

In the preface the authors make the following statement: "This text, together with *University Calculus* by Charles B. Morrey, Jr., is designed to solve the problem described above." The problem is that of shifting students between the regular course in calculus and the honors course, after perhaps a semester. Regardless of the direction of the transfer, the student is usually penalized by the incongruence of content in the two courses. After comparing the content of these companion texts, one must agree that this disparity of content will not be a problem if these texts are used. It is also fair to say the texts are written at sufficiently different levels of sophistication to justify their use in courses taught at such different levels as the regular and the honors course. In *College Calculus* the student is frequently referred to *University Calculus* for proofs of theorems stated without proof or for more complete details of proofs.

Otherwise *College Calculus* is largely traditional in content and approach. One noteworthy exception is the treatment of the differential, which is in-

troduced as a function of two variables. Definitions and theorems are precisely stated, but no special knowledge of sets or logic is needed. Vectors are not treated as extensively, nor are they subsequently used as extensively, as in many other current texts. The standard physical applications are included, and there is an adequate supply of exercises with answers to the odd numbered exercises. Figures, for the most part, are good, except in the chapter on multiple integration. Here a good figure is admittedly difficult to produce but is desirable.

The text appears quite suitable for the majority of students. The entire book evidences careful attention to detail by authors and publisher, and there are very few of the printing errors usually found in a first printing.

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History of Medicine

Andreas Vesalius of Brussels, 1514–1564. C. D. O'Malley. University of California Press, Berkeley, 1964. xvi + 480 pp. Illus. $10.

In the introduction to *Illustrations from the Works of Andreas Vesalius*, edited by J. E. de C. Saunders and C. D. O'Malley, O'Malley set the task for the biographer of the important Renaissance anatomist—"The great achievement of Vesalius has led to strenuous efforts by historians to uncover and understand the forces responsible for the sudden emergence of the modern observational method of science in the midst of the Renaissance cult of antiquity. For this reason every aspect of his life and personality has been examined with the utmost care." In this biographical volume, *Andreas Vesalius of Brussels*, O'Malley has collected the harvest of several generations of detailed historical investigations, and he presents a remarkably lucid, yet convincingly documented study of the work and life of one of the figures who brought modern science into being.

It has been more than 70 years since a biographer attempted a study of Vesalius, and during the intervening period scholars have made available much new evidence concerning the early and late years of his life as well as contemporary accounts of his practice of anatomical dissections; the printing history of each of Vesalius' works has been detailed, and controversy has raged over the credit for the impressive anatomical plates in the *De humani corporis fabrica*. These and many other "Vesalian problems" have been scrutinized by the biographer and laid before the reader in this new biography, which is published to coincide with the 400th anniversary of the death of Andreas Vesalius.

The question which we really want answered, and to which O'Malley devotes the first half of his analysis, concerns the novelty in Vesalius' work and how this innovation came about. Vesalius' own words are used to describe the old approach—"' . . . that detestable procedure by which usually some conduct the dissection of the human body and others present the account of its parts, the latter like jackdaws aloft in their high chair, with egregious arrogance croaking things they have never investigated but merely committed to memory from the books of others, or read what has already been described ' " (p. 50). This image of the professor sitting at his lecturn, at a considerable distance from the cadaver, while an unlettered barber surgeon wielded the scalpel is in marked contrast to the picture that leaps at the reader from the title page of the *Fabrica* of Vesalius (and which is reproduced in part on the cover of O'Malley's biography)—in that illustration Vesalius stands at the dissecting table, his own hands on a body with the abdomen laid open. The key to the Vesalian achievement is found, not so much in the numerous corrections made in the anatomical descriptions of Galen and the other ancients, but in what Vesalius considered the *re*construction of the anatomical practices of the golden age of Alexandria—"' . . . I, with Galen, have encouraged the candidates of medicine in every way to undertake dissection with their own hands' " (p. 323).

O'Malley, in charting the steps taken by Vesalius, begins with the medical student who relied, as did all his contemporaries, on the anatomical knowledge of Galen, but who slowly came to realize, through his own dissections, that Galen, "the prince of physicians," had never dissected a human body and had constructed his human anatomy on the basis of analogy to animal structures. In the course of correcting this fundamental error, Vesalius made clear the necessity of relying upon human sources for human anatomy and incidentally set off a wave of body snatching and grave robbing among the medical students (p. 113). As a means of illustration, Vesalius took the first step in establishing comparative anatomy by reconstructing "two skeletons, an ape and a human, the latter 'articulated from the bones of the French priest.' " (p. 100).

Although Vesalius substituted accurate anatomical descriptions for Galen's erroneous ones and instituted a new pedagogy that involved direct observation in the place of slavish adherence to the Galenic texts, O'Malley correctly notes that the Galenic physiology remained virtually untouched (p. 167). It is this factor that causes my one criticism of an otherwise outstanding volume; the early chapters are structured so that the reader comes to expect the total overthrow of the Galenic approach to the study of the human organism, but, as the author clearly demonstrates, Vesalius provided only one lever, which alone was not sufficient to topple the Galenic system as a whole. Vesalius, in the tradition of both Aristotle and Galen, preserved a teleological approach to the living organism, albeit structure became the dominant feature (see pp. 150 and 151).

The final half of the narrative is taken up with a detailed reconstruction of Vesalius' life after the publication of the *Fabrica* (1543), the year in which he gave up his teaching post at Padua. No one will claim that these years of imperial medical service were characterized by anything like the creativity exhibited by the youthful Vesalius in the few years prior to the publication of his great anatomical volume.

O'Malley provides one other great service to those interested in the development of the sciences during the Renaissance. Not only is his text filled with quotation of relevant passages, he has included more than 100 pages of translated texts, letters, and documents bearing on the scientific method as well as on the life of Vesalius. Of particular interest is the series of instructions or "dissection procedures" which make it quite clear that Vesalius intended his readers to follow his example as well as his word.

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