day data, R. G. Hipkin concludes that the best value for this is about 4 percent per 100 million years, a figure that is in poor agreement with many of the paleontologic data and that is also probably too high to be explained merely by tidal friction. A lower value is also indicated by P. M. Muller and F. R. Stephenson in the longest article of the book, in which they review all the astronomical observations from 1375 B.C. onward; they conclude that for 3000 years the acceleration rate in day length due to all causes (both tidal and nontidal components) has been a constant 2.5 milliseconds per century.

Several authors examine ways in which the speed of the earth's rotation can be altered. The variety of methods indicates how much ferment there is in the field. P. S. Wesson investigates the consequences of a changing G (Newtonian constant of gravity) vis-à-vis global expansion on the order of several hundred kilometers, and favors the latter. K. M. Creer believes the consequences are geophysically reasonable and significant for changes in the depth of the transitional zone of the mantle, as well as for differences between the oblateness of the geoid and the hydrostatic figure, with fluctuations on a 100-million-year time scale. In yet another approach, J. A. Jacobs and K. D. Aldridge examine coupling of the core to the mantle in conjunction with Urey's idea of 1952 that changes in day length may be linked to changes in the moment of inertia related to the rate of core growth (and Runcorn's corollary of 1962 that this involves changes in the number of convection cells). O. H. Weinstein and J. Keeney discuss Hubble's law and "a cosmological drag force," and J. Gribbin focuses on the 11-year sunspot cycle and solar tides. D. H. Tarling's solution to the problem of "excess deceleration" is to deny the existence of deep oceans in the past, and thereby to increase lunar tidal torque.

It seems that, in general, even low-frequency geophysics may be no better off than this high-frequency paleontology, and that adequate paleontological data would greatly help in distinguishing among at least some of the possible mechanisms of the earth's deceleration (*5*). Indeed, as Hipkin concludes,

> Now that palaeontology has confirmed that past changes in the lengths of day and month are of the same order of magnitude as the original geophysical predictions, the role of the geophysicist can only be the reactionary one of interpreting the data given him. Its reliability is a problem for the biologists.

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Molecular Rearrangements

Isotopes in Organic Chemistry. Vol. 1, Isotopes in Molecular Rearrangements. E. BUNCEL and C. C. LEE, Eds. Elsevier, New York, 1975. xvi, 302 pp., illus. $41.75.

The current revival in tracer studies, after a period of commonplace use and then a decline, is due principally to the sophistication of nuclear magnetic resonance techniques. The editors announce that this volume is the first of a series that will also include volumes on the use of isotopes in hydrogen-transfer processes, aromatic systems, and elucidation of structure and on the use of carbon-13 and isotopic sulfur in organic chemistry. The intent of the series is to bring together information from areas of organic chemistry that have in common the use of isotopes.

Only a 26-page chapter is devoted to deuterium labeling in carbonium-ion rearrangements. Its author, Deno, writes, "No great effort has been made to secure complete coverage since many deuterium studies were auxillary [sic] to other work and are of import for their bearing on mechanistic problems rather than for illustrating techniques in deuterium labeling." He describes as "ingenious" a double-labeling experiment that is now commonplace. That method is at least as old as the work of Bloch and Rittenberg, whose double-labeling experiment, reported in 1945, showed that a metabolic acetylation reaction does not involve loss of carbon-bound deuterium. Deno's treatment of protonated cyclopropanes (pages 3 and 4) leaves the reader confused by the statement that kinetic isotope effects are of the secondary type and can be neglected, since his chart (page 4) shows the making and breaking of deuterium bonds, for which a primary isotope effect is expected. The "mechanisms" he presents on page 4 are shown, surprisingly, as nonreversible carbonium-ion rearrangements.

If this chapter seems short, the chapter by Hunter on carbanion rearrangements seems unduly long, because investigators have found little use for isotopes in the study of carbanions. Consequently, some sections of the chapter contain only the barest reference to a labeled compound. The chapter does, however, provide a good and profusely illustrated up-to-date, critical review of carbanion chemistry, and it includes an excellent appendix that lists, according to type, the specific compounds referenced in the chapter.

A once-popular book on molecular rearrangements contained a chapter by Rhoads on "no mechanism" pathways. Dolbier describes some of these inscrutable reactions in a chapter that relates secondary deuterium isotope effects to pericyclic reactions and includes cycloadditions, sigmatropic rearrangements, ene reactions, and retroene reactions. His discussion of the [2 + 2] cycloaddition reaction describes only the transition state proposed by Baldwin and Kapecki and offers no comment on the later (1969 to 1971) evidence by Huisgen, Dreiding, Brook, Ghosez, and their co-workers that the reaction proceeds through a crosswise transition state.

The remainder of the book is devoted to a review, by Holmes, of the use of isotopic labeling in the determination of mass spectral fragmentation mechanisms and another, by Swenton, of the use of deuterium in organic photochemical rearrangements. Swenton emphasizes that deuterium substitution is useful not only for establishing gross molecular change but also for synthesizing specifically deuterated molecules in reactions whose course is often profoundly altered by deuterium substitution in either reactant or solvent.

The references in this volume contain several errors. Running heads would have aided the reader. In spite of being a little ragged in a few places, the book is a good beginning in what should be a worthwhile series.

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Applications of Spectroscopy

Nuclear Magnetic Resonance in Biochemistry. Principles and Applications. THOMAS L. JAMES. Academic Press, New York, 1975. xiv, 414 pp., illus. $26.50.

Nuclear magnetic resonance (NMR) spectroscopy has developed over the past 30 years into a very powerful and versatile technique in the study of molecular structures, kinetics, interactions, and mechanisms. In the last half decade or so, remarkable advances in instrument design, particularly the advent of fast Fourier transform and pulse methods, have tremendously improved the sensitivity of

NMR spectrometers and made them capable of performing convenient time-resolved studies, such as relaxation measurements on individual resonances of a complex spectrum. These advances have opened up a new era of applications of NMR to the diverse problems of the chemical basis of life. Most books on the subject have been written largely for physicists, who are more interested in the phenomenon of resonance itself than in its applications, or for organic chemists, who use NMR spectra primarily as fingerprints to identify chemical structures. Several books have also been written for physical chemists, but these are of limited use in understanding the NMR behavior of complex biomolecules. The book under review describes the NMR phenomenon and its applications so as to be useful to life scientists with varying backgrounds. It is intended primarily for biochemists, biophysicists, and molecular biologists, but will be useful to anyone interested in aspects of NMR that are relevant to biochemical research.

There are eight chapters in the book, all of which are written carefully and lucidly. The first provides the reader with an introduction to the concepts of resonance, relaxation, chemical shifts, and spin-spin splittings and is free of complex mathematics. It should be useful for those with little prior knowledge of the field. The author goes on to discuss, in chapters 2 and 3, the theoretical basis of magnetic resonance applications. Mathematical equations are presented and their meaning is conveyed without indulgence in detailed derivations, which are covered in the references. Examples of the use of NMR parameters in the investigation of the structure and interactions of small molecules in the early chapters prepare the reader for the more complex biological applications in the later chapters. A useful description of the experimental apparatus and procedures employed in NMR studies of biological systems along with a short discussion of the dynamic range problem caused by the strong water signal is provided in chapter 5. A few misconceptions are present, however. For example, the capabilities of long pulse methods exceed those attributed to them by the author.

Actual biochemical applications of NMR are discussed in chapters on biomolecular interactions, NMR spectra of biopolymers, NMR investigations of the state of motion of lipids in membranes and model membranes, the state of water in macromolecular and cellular systems, and the state of sodium ions in biological tissues. Emphasis is placed on NMR relaxation studies, as is appropriate in view of the prominent place relaxation phenomena have in biochemical applications.

The treatment is selective rather than comprehensive, and important references are occasionally omitted. Newer theoretical and experimental developments render certain sections of the book incomplete and somewhat obsolete. It is inevitable that readers will compare the present book with a book of the same title by R. A. Dwek. Dwek's book deals effectively with a more limited range of topics, but James's book provides a more balanced overview of the field. James has quite successfully drawn together the threads of a diverse subject.

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Regulatory Neurophysiology

Neural Integration of Physiological Mechanisms and Behaviour. J. A. F. Stevenson Memorial Volume. GORDON J. MOGENSON, FRANCO R. CALARESU, and BLANCHE BOX, Eds. University of Toronto Press, Toronto, 1975. xvi, 442 pp., illus. $C35.

The late professor of physiology at Western Ontario, J. A. F. Stevenson, to whom this book is dedicated, was a vibrant individualist, a dedicated scientist, and a critical thinker who would have savored the diverse contributions of his compatriots, who today include some of the world's great regulatory physiologists. It is clear that the editors encouraged the contributors to write personal essays that emphasize concepts and theories rather than impersonal, data-packed articles. The editors are to be commended because most of the papers are both readable and scientifically distinguished.

The breadth of the volume seems to reflect one's image of Stevenson, who, in contrast to the very specialized scientists of today, belonged to a vanishing breed of regulatory physiologist. He was anti-isolationist about every functional event, he sought to relate the mechanism underlying one process to its kindred function, and he treated a homeostatic response holistically and integrated its respective components one with another.

Because of his fascination with the phenomena of energy balance, Stevenson's research interests evolved naturally to the study of how food intake, body temperature, water level, and autonomic and endocrine activity are regulated, and more important, how they are linked to one another. As is documented throughout the book, these functions are tied together in close anatomical proximity, at least within elements of the hypothalamus. The study of this diencephalic structure is basic to any integrative analysis of a vital, life-sustaining process.

The first three papers contain a charming montage of the type of experience that influenced Stevenson's way of thinking. Adolph's paper reveals how some notable physiologists of years past came to grips with the matter of a regulatory concept. There follow two neuroanatomical essays: Morgane's masterly portrayal of a massive body of evidence that suggests that the key to understanding diverse systems in the brain now lies in the investigation of neuronal circuits, differentiated according to chemical constituents, rather than of a clump of cells within one nucleus or region, and Hall's intriguing schematization of the pathways that interconnect the components of the limbic system.

The next seven papers deal coherently with many of the current issues concerning energy balance, feeding, and the multitude of factors responsible for the regulated ingestion of food. Heavy emphasis is rightly given to the metabolism of sugar, characteristics of central and peripheral glucose receptors, gastric processes, and other important facets of the feedback control of eating behavior. In this group of papers one sees the scientific beliefs of colleagues unfold in quiet but diametrically opposed pronouncements. For example, one reads that "short term control of food intake by the glucostatic mechanism is no longer doubtful" (Le Magnen), and only 45 pages later that "the glucostatic theory is in serious doubt in all major respects, and it is important that we recognize it to be no more than hypothetical in order to unburden future research of its preconceptions" (Epstein, Nicolaïdis, and Miselis).

Four consecutive papers consider the central and peripheral mechanisms underlying the control of salt balance and the drinking of water. The treatments of these complex systems are sophisticated and include recent experimental findings. Succeeding essays sample broadly the intriguing issues involved in the respiratory apparatus, thermoregulation, neuroendocrine factors, and sexual behavior. The concluding series of papers forms a cogent discourse on the intricate control systems in the brain, the approach to their comprehension, and the notable discoveries related to the behavior of an animal.

The only disappointment worthy of mention centers on a word in the book's title, "integration." It would have been useful to publish selected discussions among contributors, perhaps at four intervals in the book. The reason is that the attempts to integrate specific points to more general physiological concepts are sometimes uneven. On-line questioning and re-