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-

sponse frequently resolve a hanging detail.

Finally, some perseverance may be required to read through the text in its entirety, not because of turgidity in style or any lack of clarity, but because the pages are packed with so many evocative ideas that one's imagination can interrupt concentration. Of course, this is the purpose of the book, and its intentions are superbly fulfilled. The memory of J. A. F. Stevenson is well served by this outstanding volume.

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Practical Scientists

Thinkers and Tinkers. Early American Men of Science. SILVIO A. BEDINI. Scribner, New York, 1975. xx, 522 pp., illus. $17.50.

In the past, historians of science tended to concentrate their attention on the major figures whose intellectual labors were said to have determined the development of modern science. Copernicus, Galileo, Newton, Darwin, and the like were seen as creating science in Europe, and a smaller group as playing a similar role in America—Benjamin Franklin, Joseph Henry, Asa Gray, J. Willard Gibbs, T. H. Morgan. No one of these great men of science, however, could have carried on his work in a cultural milieu devoid of the supporting scientific and technical activity of a host of lesser practitioners. Recent historical research, based on a recognition of this fact, has shifted to the study of the social and intellectual ecology of a community of scientists and technicians who exhibit a wide range of talent and achievement. It is in this modern spirit that Bedini writes about the "little" men who cultivated practical science in America from the time of the first settlements to the early decades of the 19th century. Benjamin Franklin does not dominate the pages of this book; he takes his place in the midst of dozens of now forgotten "thinkers and tinkers."

When a new land is opened to settlement it supplies many opportunities for natural historians to appraise and catalog its geological, botanical, and zoological wonders. A fair amount has been published on this phase of American science, and hence Bedini looks to other examples of the early scientific spirit. A new land must be explored, surveyed, and mapped, its rivers and seacoasts navigated and charted, its cities, towns, and farmlands plotted in a more or less rational fashion. All this calls for specific scientific and mathematical instruments: a variety of compasses, surveying tools, telescopes, navigating equipment, clocks and marine chronometers, and astronomical devices. Initially these instruments were obtained from European suppliers, but their construction and repair were soon to be the responsibility of a colonial band of mathematical practitioners who were able to wed rudiments of abstract science to specific toolmaking skills. The results were American-made instruments and the origins of a class of specialized craftsmen conversant with scientific ideas. The subsequent expansion of the United States, on land and sea, by peaceful and warlike means, accentuated the need for more and varied scientific instruments, texts of instruction, and technical innovations to match peculiar national needs.

"Woodcut by an unknown artist [showing] a figure making astronomical observations with an unidentifiable instrument and surrounded by other scientific instruments. This woodcut, first known from ca 1758, was reprinted several times." It is reproduced in *Thinkers and Tinkers* as part of the title page of *Bickerstaff's Boston Almanack, for the Year of our Redemption 1783. Being the ... Seventh of Independency. ...* The ephemeris for the almanac was calculated by Benjamin West.

This, in rapid summary, is the essence of *Thinkers and Tinkers*, a well-written and detailed book based upon careful research, illustrated with some one hundred photographs of instruments and their makers, and accompanied by a useful glossary of technical terms.

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