Symposium on Medical Radioisotope Scanning.

The measurement of influx, efflux, appearance, disappearance, and circulation rates by isotope kinetics is not new. Indeed such concepts antedate the application of isotopes and find their ancestors in such time-honored clinical curves as glucose tolerance tests and glomerular filtration rates. The added dimension that justifies the symposium, and makes the book so important, is the development of new instrumentation and more sophisticated mathematical analysis which make the short-term coordinates significant. Measurements, formerly documented on the basis of minutes, hours, or days, to study disappearance curves, biological turnover rates, and the like, can now be recorded in terms of seconds to yield critical information about events that occur rapidly in the living organism, events that are difficult or impossible to analyze in any other way.

Metabolic studies of body components and physiologic events—for example, blood flow, organ flow, gas flow, cardiac output, liver function, kidney function, albumin synthesis and degradation, and turnover rates for such metallo-ions as calcium, magnesium, and copper—can now be quantified readily. Many of these techniques are brought together in this volume.

What, then, can one find to criticize in such a fine contribution? First, there is the criticism that is intrinsic in any type of symposium in the isotope field. When national symposiums on isotope applications were first held, about 1940, it was immediately evident that the isotopes were the tools, but that the physiological and biological variables did not provide a common ground for discussion. Should the symposium be on "isotopes" or on "the liver"? Does the common use of a laboratory device justify the cohabitation of studies relating to so many different organ systems and synthetic pathways? Possibly the next symposium at Oak Ridge will concentrate on one or two organ systems or biological parameters, rather than on the tools themselves, despite the fact that Oak Ridge must necessarily be identified with the isotopic tracer techniques rather than with the biological processes being studied. One cannot escape the conclusion that the biological problem is more important, more challenging, and more difficult than is the radioisotope application itself.

The most disturbing thing to the reader, however, is the wide variety of mathematical terms used. The mathematical models employed are not very numerous. There are only a limited number of kinetic situations that demand analysis. It would be a great service to workers in this field if the differential equations derived for these applications could be expressed using common terms and standard nomenclature. One could then derive a standard set of equations that would cover most of the situations encountered.

As a minor criticism, one would hope that at another symposium more consideration would be given to water kinetics as revealed by deuterium or tritium curves—one of the earliest applications in this field and still one of the most important.

Looking back over the volume, I consider it unlikely that any single reviewer, surely not this one, could speak with authority on all the biological problems and organ systems involved. One can only pluck from the volume those derivations, computer applications, and isotope measurements that are important and applicable in his own field. And for such a use, this volume truly has no competitor.

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Operational Procedures

Generalized Functions and Direct Operational Methods. vol. 1, *Non-Analytic Generalized Functions in One Dimension.* T. P. G. Liverman. Prentice-Hall, Englewood Cliffs, N.J., 1964. xiv + 338 pp. Illus. $14.

One suspects that generalized functions were invented to make an honest woman of the Dirac delta function, which mathematicians have tended to look upon as one of the physicists' little sins. The present volume provides them with an opportunity to sin no more. As might be expected the incumberances attendant upon the legitimatizing process make the Dirac delta function lose some of its racy appeal. The generalized function theory impinges upon several conventional mathematical disciplines, such as differential equations, the Laplace transform, and Fourier series. As with all operational procedures there is a moot economic question, important to the student, "does what it accomplishes justify the time spent in learning it, when compared with the conventional methods?"

If the student elects to proceed he will find this book extremely well written by a man with a flair for English composition unusual among mathematicians. On page 209 one finds the following comment, "A certain brevity of treatment is achieved here at the reader's expense: by unloading most of the proofs required into the exercise hopper." Pleasant tidbits like this are to be found throughout the book.

The generalized function is defined in terms of a linear functional which may, in turn, be expressed in terms of an inner product. As a specific illustration, suppose that instead of a function $f(t)$ we treat the "smoothed" function $\int_a^b f(t)\phi(t)dt$, where $\phi(t)$ is infinitely differentiable. Then many of the operations that would have been performed on $f(t)$ can be transferred, by integration by parts, to $\phi(t)$ which may be much more able to take them. By this device the generalized function theory can, for instance, make sensible definitions of the Dirac delta function and its derivatives.

There is, happily, chapter 0, "Introductory, heuristic background."

Chapters 1 and 2 are devoted to developing the calculus of the generalized functions. Chapters 3 and 4 are devoted to its application to differential equations with constant coefficients and systems of differential equations, plus a few applications to such topics as integro-differential equations and linear difference equations. Chapters 5 and 6 penetrate more deeply into generalized function theory. The Laplace transform, with applications, is studied in chapter 7 and Fourier series in chapter 8.

The book is written as a textbook, but would serve very well as a reference source. Its mathematics is within the range of upper division undergraduates and graduate students, although some of the former may lack the experience to grasp the motivation in places.

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