To this transformation no one man has made more significant contributions than the author of the book under review. With creative mastery in particular domains he combines an unusually extensive and penetrating acquaintance with the whole background of mathematical analysis, and almost unique experience in presenting the essentials of complicated theories with the greatest possible compactness.

The result is a treatise which will be of the greatest value both to the general student and to those seeking more specialized information. A large amount of previously existing material is brought together and made readily accessible, much of it for the first time, new results are presented in their proper place, and the way is prepared for further research in various directions.

Needless to say, so extensive a domain with so many contacts can not be accurately delimited by a title in two words. Some arbitrariness in the selection of material has been inevitable. Applications, except those of a purely mathematical nature, *e.g.*, to problems of interpolation and mechanical quadrature, have been left aside. The dominant and most significant purpose of the book from the point of view of the specialist, an exposition of the theory of asymptotic representation and equiconvergence due to the author and to S. Bernstein, has been kept constantly in view.

No less valuable to a wider group of readers, however, including those who for their own purposes are primarily interested in the applications, is the development of the fundamentals of the theory from first principles, with sustained emphasis on the "classical" orthogonal polynomials of Jacobi, Laguerre and Hermite, as well as orthogonal polynomials in a real variable with an arbitrary weight function and the author's own orthogonal polynomials on a circle or more general curve in the complex plane. Numerous facts which can not be developed in detail are presented in summary, with references to the literature.

At the end the reader's interest is directed further afield with a list of sixty "Problems and Exercises" and a sixteen-page bibliography

DUNHAM JACKSON

THE UNIVERSITY OF MINNESOTA

MATHEMATICAL METHODS IN ENGINEERING

Mathematical Methods in Engineering. An Introduction to the Mathematical Treatment of Engineering Problems. 505 pp. By THEODORE V. KARMAN and MAURICE BIOT. New York and London: McGraw-Hill Book Company, Inc., $4.00.

A TEXT-BOOK devoted to mathematical methods in engineering or in physics may be organized in two different ways. The first way is to concentrate upon a certain group of practical problems and to gather the various mathematical aids which can be used in this field. The other would be to start with a definite group of mathematical methods and to accumulate the diversified problems in which these methods might be applied. The book we are analyzing, a very remarkable contribution to the existing engineering texts, is a combination of both approaches. The first two chapters, *e.g.*, serve as an introduction to the elementary theory of ordinary differential equations and of so-called Bessel functions. The following chapters on the other hand deal with dynamics, both generally and with a special view to the problem of small oscillations. A wide range of questions concerning modern engineering design is here discussed clearly and in detail. Mention may be made of such topics as the flight path and stability of an airplane or the vibrations and buckling of beams. Within these discussions the authors take the opportunity to introduce numerous mathematical aids which go beyond the field familiar even to engineers of advanced training. The notions of elliptic integrals and of elliptic functions are developed in connection with the motion of a pendulum; the use of matrices and certain methods for numerical solution of algebraic equations are explained in the chapter concerned with the theory of oscillations. A reader who follows the authors in studying these carefully selected special topics acquires a great deal of systematic knowledge of applied mathematics. The same is true for the later sections of the book which deal with diversified problems of structural analysis, etc. Finally, the so-called operational calculus and the method of finite differences are presented in their application to electrical and other problems. No problem requiring the solution of partial differential equations is mentioned. Although the authors do not promise it, it may be expected that they intend to treat advanced theories in a second volume of their book.

The main purpose of the authors was obviously to acquaint the reader with the art of setting up a mechanical or engineering problem. A great deal of experience in creative research work enabled them to conceive such a task. One can hardly imagine a writer more competent for this than Professor v. Karman. On the other hand it may be doubtful whether this aim can be fully attained by a single book, no matter how good it may be. The ideal reader, such as the authors may have had in mind, would have to apply a mathematical idea which he finds exposed in the book in connection with a definite practical problem, to a quite different one. This may happen in very rare cases. The average reader will extract from the book only the factual information about the problems which are explicitly dealt with. But even if used in this way the Karman-Biot book will be a great and useful help in promoting the science of theoretical engineering in this country.

I would like to stress that the text, the formulas and the diagrams are very carefully executed so that the reviewer in examining them found practically no errors or inaccuracies. A great number of expertly selected problems proposed for solution augments the value of the book for students and other interested readers.

R. v. Mises

Harvard Engineering School

SPECIAL ARTICLES

THE CENTRIOLE IN RADIATED TUMOR TISSUE

Although previous studies on the cytology of Walker rat carcinoma 256 had not emphasized the presence of centrioles[1, 2, 3] we have found paired bodies in the interkinetic stage of the cells of this tumor embedded in a surrounding mass of granular centrosomal substance. They are specific granules consistently revealed with hematoxylin stains following appropriate fixatives. We assume them to be centrioles. They apparently migrate to opposite poles in the early stages of mitotic activity. The metaphase spindle reveals a single compact body at each focal point although this body is not apparent if the spindle is wide at the poles. Our own Zenker-fixed unradiated material with the stains used in our previous studies do not show these bodies. We found that the Zenker-fixed material after radiation (single dose, 2400 r) did show them with a variety of stains. On further investigation other fixatives, such as Bouin, show these bodies whether the tissue has been radiated or not, particularly if stained with Heidenhain's iron hematoxylin. Thus we may follow the effect of radiation on them and this gives further evidence for their probable identification as centrioles.

The method of killing the animals, the nature of the tumor and the preparation of the tissue were the same as described in previous papers.[4, 5, 6] The type and dosage of radiation were as follows: 200,000 volt X-ray —50 cm distance—Filter 0.5 Cu, 1 mm Al—one dose 2400 r. The rate of radiation in r per minute was 40.6.

Control as well as radiated tumor tissue was fixed either in Bouin or Zenker. The stains used were Heidenhain's iron hematoxylin and eosin, eosin Y and methylene blue and phosphotungstic acid hematoxylin. 18, 48, 72, 96 and 120 hours after radiation animals were killed for study.

A quantitative study was made of cells showing centrioles. We assumed that all cells in the interkinetic stage properly fixed and stained would show centrioles in the centrosomal region. Only those cells were counted which were lying in such a plane that the centrioles could be clearly identified. Since necrotic cells were not counted this study does not include all the cells in a given region. If radiation produces centriolar change, it should be apparent in one thousand selected cells.

In control tissue there are some cells which show higher numbers of centrioles as 3, 4 or very rarely 5. The term "multiple centrioles" as used here will refer to any number over the normal unit 2. After radiation centrioles, not previously seen in Zenker-fixed control tumor cells, can be demonstrated and tumor tissue fixed at varying intervals after radiation shows a variation in the frequency of multiple centrioles.

The interval immediately following radiation when mitosis has been largely inhibited shows only a slight increase in the number of centrioles. With a dose of 2400 r this tumor renews mitotic activity by 24 hours or later.[7] This suggests that the increase in number of centrioles (Table 1) is associated with the cellular division processes. By 48 hours there is a sharp increase in the number of multiple centrioles per cell which continues until 72 hours and then decreases. By 120 hours the tissue has returned to normal for this feature. Cells with 6 or more centrioles are at their peak at 72 to 96 hours. There is a predominance of even numbered centrioles. This suggests that there has been one or more incomplete cell divisions where certain cell components have divided but where the separation of the cytoplasm has been suppressed. This hypothesis and the possibility that radiation may have fragmented the centrioles bears further investigation.

TABLE 1

Effect of 2400 r on Centrioles in Walker Rat Carcinoma 256

Hours after radiation	Number of cells with visible centrioles counted	Number of centrioles per cell									Per cent. of multiple centrioles
		2	3	4	5	6	7	8	9	10	
18	1000	900	81	17	1	0	1	0	0	0	10
48	1000	605	97	274	5	15	2	2	0	0	40
72	1000	401	62	355	14	113	7	41	1	6	60
96	1000	538	77	236	11	94	7	30	0	7	46
120	1000	966	26	6	2	0	0	0	0	0	3
Control	1000	958	39	2	1						4

After radiation a greater variation in the shape, size and number of nuclei per cell occurs. Typically the control nuclei are single and roughly somewhat kidney

[1] W. R. Earle, *Amer. Jour. Cancer*, 24: 566–612, 1935.

[2] E. Waldschmidt-Leitz and E. McDonald, *Ztschr. f. physiol. Chem.*, 219: 115–127, 1933.

[3] M. R. Lewis, *Abst. Anat. Rec.*, 45: 268–269, 1930.

[4] L. C. Fogg and S. Warren, *Amer. Jour. Cancer*, 31: 567–577, 1937.

[5] *Ibid.*, 31: 578–585, 1937.

[6] *Ibid.*, *Proc. Soc. Exp. Biol. and Med.*, 39: 91–93, 1938.

[7] S. Warren, *Am. Jour. Roent.*, 38: 899–902, 1937.