not matter if all archeologists and historians had anthropological or biological backgrounds—a fault that will be healed by the closer association of science and the humanities in the world's universities. For this coalescence, Brothwell's book is a nicely engineered bridge, concise in structure, economical, and sparse in language.

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Man-Machine Relationships

Biotechnology: Concepts and Applications. Lawrence J. Fogel. Prentice-Hall, Englewood Cliffs, N.J., 1963. xviii + 826 pp. Illus. $22.

The rate at which knowledge is acquired and the rate of technological advance is so rapid that most of those who are engaged in research and development find it difficult to keep abreast of progress, even in narrowly circumscribed or highly specialized fields. This problem is greatly magnified by the rapid growth of interdisciplinary fields. Thus, in recent times, the application of quantitative methods to biology and medicine have led to the emergence of biophysics, bioengineering, and biomathematics, interdisciplinary areas that cannot be precisely or uniquely defined. In this remarkable book, *Biotechnology: Concepts and Aplications*, the author's stated purpose is to clarify man-machine relationships by the use of quantitative description. A precise definition of biotechnology is not immediately apparent and may remain obscure until the reader turns to chapter 20 in which the author provides both a graphic and an operational definition of the field. In summary, biotechnology is shown as an approach to human engineering for the man-machine system, an approach that utilizes applications of mathematics (that is, systems analysis), biology (including appropriately selected information from physiology, anatomy, biochemistry, pharmacology, and biophysics), and psychology in the study of the reactions of human beings to their environment. Many readers will profit by turning directly to chapter 20 for preliminary orientation.

The volume is a remarkable synthesis of pertinent and interesting material, gathered from diverse sources and woven into a text with continuity and purpose. The total body of information from which the book was synthesized is so huge that one reviewer should not be expected to judge the authority and accuracy of all aspects of the book. The presentations in the first section contain a most interesting and challenging consideration of mathematical models as they are related to the scientific method. Section B contains concise descriptions of the mechanisms by which human organs receive information (vision, audition, position sense, cutaneous sensations, taste, smell, and some interrelations between them). The functions of these sensory mechanisms are clearly described and supplemented by much information of particular interest to engineers (that is, intensity ranges and intensity discrimination, frequency discrimination, and the like). The material was well selected, and it is authoritative.

A section on decision making with respect to control-systems analysis should be particularly interesting to engineers, but it is an area in which my own competence is insignificant. Chapter 11, on human decision making, can be appreciated without a strong quantitative background. In controlling man-machine systems, incoming information leads to decisions which are converted into a response in terms of adjustments of movable controls or of verbal responses. These are considered in terms of the characteristics of the intended human-output information. In addition, information about the performance of the human being can be extracted by recording the electrical resistance of the skin or the electrical potentials that emanate from the heart, brain, or skeletal muscles. The fact that these techniques are traditional, pedestrian, and unimaginative emphasizes the immature state of the art from the point of view of biology. I found this to be the weakest section of the book.

Section E is devoted to an extensive discussion of machine and system design. A very large number of human engineering problems are presented, with emphasis on matching the properties of man to machine. This chapter should be of great interest to engineers who deal with problems of developing personal equipment, artificial environments, controls, and displays. The final section presents a brief overview of biotechnology.

In summary, this book contains a remarkable quantity of factual and conceptual material of interest to biologists, psychologists, and engineers who are concerned with problems related to the performance characteristics of human beings as an essential component of a man-machine system. It provides concepts and material for interesting reading and reflection by men with broad interests in any of these fields.

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Tamiya Volume

Studies on Microalgae and Photosynthetic Bacteria. A collection of papers. Edited by the Japanese Society of Plant Physiologists. University of Tokyo Press, Tokyo, Japan, 1963. xxiv + 636 pp. Illus.

Hiroshi Tamiya, the distinguished Japanese plant physiologist, was 60 years of age on 5 January 1963. His accomplishments include the founding of the Japanese Society of Plant Physiology and the initiation of its journal, *Plant and Cell Physiology*. It is particularly fitting, therefore, that the Society, with help from private industry and government sources, has edited and published, as a special issue of its journal, this commemorative birthday volume. The editing and the manufacturing of the book are well done.

The 54 reports on original research have, as their leitmotiv, the organisms —unicellular photosynthetic algae and bacteria—that have entered so prominently into Tamiya's own research. Scholars in laboratories throughout the world were invited to submit the papers, which were received by the editors during the early fall of 1962. Eight of the papers are in German, one in French, and the rest in English. A number of papers that arrived too late for inclusion in the volume will be published in future issues of *Plant and Cell Physiology*.

The volume is divided into six parts: taxonomy and cytology (8 papers); the physiology of growth and ecology (11); photometry and photochemical processes (14); photosynthetic pigments and apparatus (6); enzymic reactions and carbon metabolism (8); and phosphorus and sulfur metabolism (7). As one

would expect, almost half of the reports are concerned with photosynthesis, and they cover such aspects as the process itself, the pigments, the photosynthetic apparatus, and methodology. Another major group involves research based on synchronous cultures, while a third series considers various aspects of metabolism other than photosynthesis. In addition, of course, there are some individual papers that stand isolated from these major subject areas.

This volume is a testimonial not only to Hiroshi Tamiya but also to the role that microalgae and photosynthetic bacteria now play as experimental organisms in the investigation of a variety of biochemical and physiological problems. Among Tamiya's contributions to making them important was his demonstration, in 1953, that the growth of *Chlorella* could be synchronized. Since then, the principle of synchronous culturing has become a powerful tool in elucidating the life cycle of unicellular organisms at the physiological and biochemical level. The book is a fitting tribute to Tamiya, and it is essential reading for investigators in many different areas of research.

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Tissue Culture

The Cultivation of Animal and Plant Cells. Philip R. White. Ronald, New York, ed. 2, 1963. viii + 228 pp. Illus. $9.

Methods of tissue culture are used to study an ever-widening range of biological problems. Yet few courses in the principles and methods of tissue culture are given at the university level, and the novice must learn either by apprenticeship or from a text. White's book is one of a half dozen available textbooks, and a new edition, published 9 years after the first, is most welcome. Although the second edition contains no more pages than the first, changes in the format have allowed the author to use at least 50 percent more words.

This book is the result of an individual's effort, not the product of team work. It reflects White's special authority in the areas where botanical and zoological aspects of tissue culture overlap. The opening chapter gives historical perspective and carries over from the first edition a photographic gallery of outstanding investigators, several of whom are still very active. The next several chapters consider fundamentals: sources of plant and animal tissues suitable for cultivation; designing and equipping a laboratory; nutrients; and basic techniques. These chapters are brought up-to-date and include, for example, recently developed methods for the culture of insect tissues. White maintains a nice balance between "how to do it" information and conceptual issues, such as the definition of nutritional requirements in terms of a particular objective (survival, growth, specialized function). A new chapter deals with methods of establishing clones of mammalian and plant cells. Unfortunately, efforts to establish a large population of identical cells are usually thwarted by somatic mutations and perhaps other changes. Another chapter deals with the vexing problems of measurement. Better nondestructive analytical methods are needed to avoid the statistical averaging of data on groups of nonidentical cultures. The final chapter briefly surveys some of the results obtained with tissue culture.

There are two appendixes in which the author describes basic expriments that are designed for use in the classroom and the long term preservation and storage of cell cultures by freezing methods. A useful bibliography follows. The index contains only one reference to DNA, a refreshing if anomalous state of affairs in 1963 for a 200-page work on cell biology.

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New Books

Mathematics, Physical Sciences, and Engineering

Advances in Electronics and Electron Physics. suppl. 1, *Electroluminescence and Related Effects.* Henry F. Ivey. Academic Press, New York, 1963. 288 pp. Illus. $11.

Advances in Physical Organic Chemistry. vol. 1. V. Gold, Ed. Academic Press, New York, 1963. 458 pp. Illus. $13.

Analytical Chemistry. Proceedings of the international symposium (Birmingham University, England), April 1962. Philip W. West, A. M. G. Macdonald, and T. S. West, Eds. Elsevier, New York, 1963. 423 pp. Illus. $16.

Basic Mathematics for General Education. Harold C. Trimble, E. W. Hamilton, and Ina Mae Silvey. Prentice-Hall, Englewood Cliffs, N.J., ed. 3, 1963. 343 pp. Illus. $8.

Combinatorial Mathematics. Herbert John Ryser. Published for the Mathematical Assoc. of America. Wiley, New York, 1963. 168 pp. Illus. $4.

Digital Computer Engineering. Harry J. Gray. Prentice-Hall, Englewood Cliffs, N.J., 1963. 399 pp. Illus. $16.

Digital Processing. A system orientation. Louise Schultz. Prentice-Hall, Englewood Cliffs, N.J., 1963. 415 pp. Illus. $11.90.

Elementary Chemical Thermodynamics. Bruce H. Mahan. Benjamin, New York, 1963. 167 pp. Illus. Paper, $1.95; cloth, $3.95.

Erosion and Sedimentation. Henri Termier and Geneviève Termier. Translated and edited by D. W. Humphries and Evelyn E. Humphries. Van Nostrand, Princeton, N.J., 1963. 445 pp. Illus.

How Chemical Reactions Occur. An introduction to chemical kinetics and reaction mechanisms. Edward L. King. Benjamin, New York, 1963. 159 pp. Illus. Paper, $1.95; cloth, $3.95.

On the Interaction Between Atomic Nuclei and Electrons. H. B. G. Casimir. Freeman, San Francisco, 1963 (© 1939, Haarlem, Netherlands). 108 pp. Illus. Paper, $2.

An Introduction to Polymer Chemistry. W. R. Moore. Aldine, Chicago, 1963. 270 pp. Illus. $7.50.

Introductory College Mathematics. Adele Leonhardy. Wiley, New York, ed. 2, 1963. 494 pp. Illus. $7.50.

Microelectronics. Theory, design, and fabrication. Edward Keonjian, Ed. McGraw-Hill, New York, 1963. 402 pp. Illus. $12.50.

Modern Physics. The quantum physics of atoms, solids, and nuclei. Robert L. Sproull. Wiley, New York, ed. 2, 1963. 644 pp. Illus. $9.75.

The Modern Structural Theory of Organic Chemistry. Lloyd N. Ferguson. Prentice-Hall, Englewood Cliffs, N.J., 1963. 608 pp. Illus. $17.55.

Nouveau Traité de Chimie Minérale. vol. 20, pt. 2, *Alliages Métalliques.* Paul Pascal, Ed. Masson, Paris, 1963. 1104 pp. Illus. Paper, F. 200; cloth, F. 212.

Organic Syntheses. Collective vol. 4 (a revised edition of annual volumes 30–39). Norman Rabjohn, Ed. Wiley, New York, 1963. 1050 pp. Illus. $16.50.

The Physics of Experimental Method. H. J. J. Braddick. Reinhold, New York, ed. 2, 1963. 503 pp. Illus. $12.

Principles of Chemistry. R. T. Sanderson. Wiley, New York, 1963. 636 pp. Illus. $7.95.

The Quantum Theory of Molecular Electronic Structure. Robert G. Parr *et al.* Benjamin, New York, 1963. 525 pp. Illus. Paper, $6.95; cloth, $10.

Rocket Propulsion Elements. An introduction to the engineering of rockets. George P. Sutton. Wiley, New York, ed. 3, 1963. 471 pp. Illus. $10.50.

Rutherford at Manchester. J. B. Birks, Ed. Benjamin, New York, 1963. 374 pp. Illus. $12.50.

The Shape of Carbon Compounds. An introduction to organic chemistry. Werner Herz. Benjamin, New York, 1963. 165 pp. Illus. Paper, $1.95; cloth, $3.95.