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