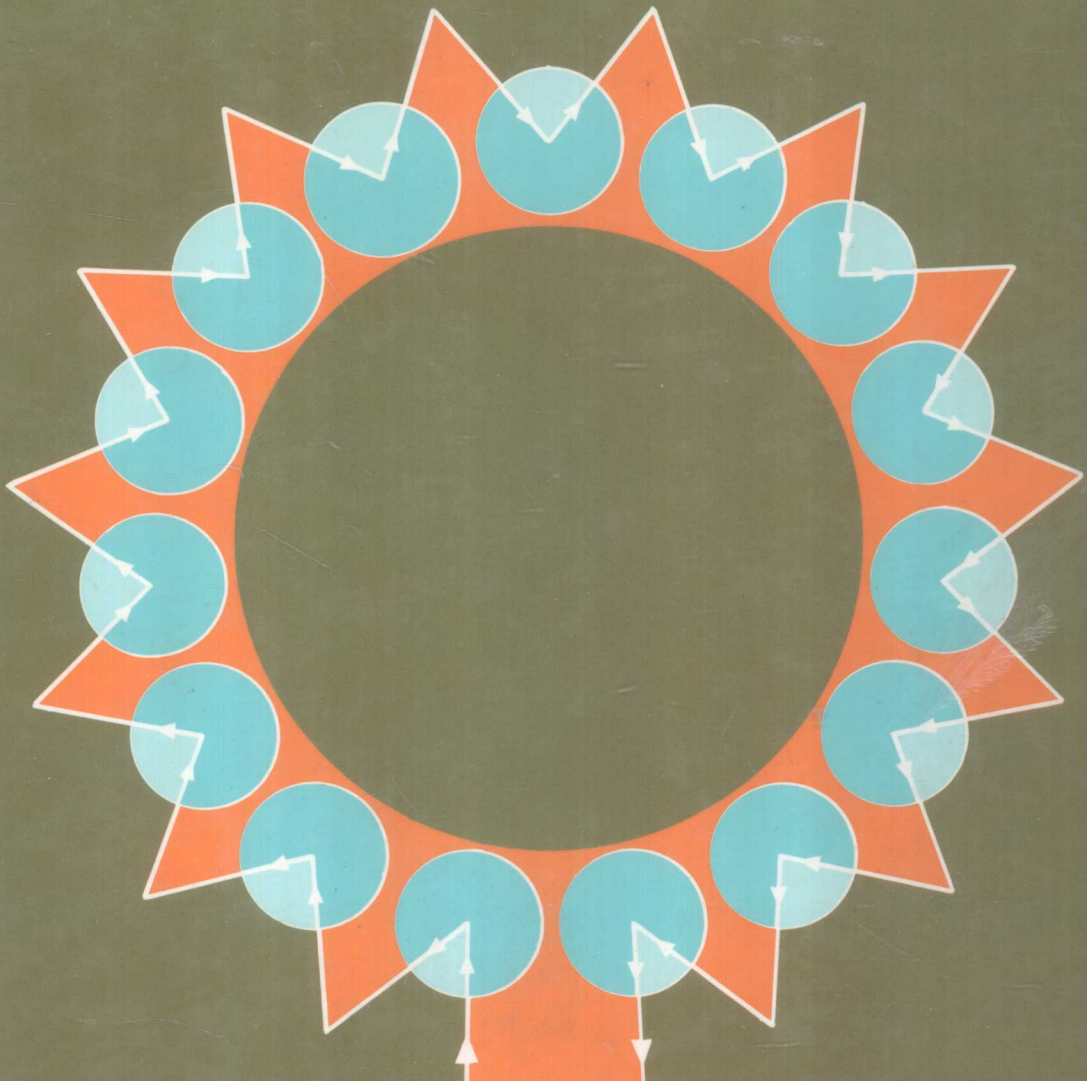
handbook of ENZYME BIOTECHNOLOGY

second edition

editor ALAN WISEMAN



HANDBOOK OF ENZYME BIOTECHNOLOGY

Second Edition

Editor: ALAN WISEMAN, Department of Biochemistry, University of Surrey, Guildford, UK

Since the first edition of *Handbook of Enzyme Biotechnology* (Ellis Horwood, 1975) was published almost a decade ago, many important advances have been made in this growing scientific discipline. This new book, almost completely rewritten and therefore virtually a new publication, takes due account of these changes, recording up-to-date developments in research. *Handbook of Enzyme Biotechnology, Second Edition* will have wide application, as did its predecessor and will take its place as one of the most important books in the field.

The new work takes a broad overview of enzyme biotechnology today, systematically establishing the theory and practice of large-scale enzyme manufacture and utilization in many fields of industry in the widest sense of the word. As before, Dr. Wiseman has divided the text into two logical, inter-related sections, dealing with principles and practice respectively of enzyme utilization both in free and immobilized form.

The book is extensively documented, as befits an advanced work: and serves to up-date the popular *Topics in Enzyme and Fermentation Biotechnology* series (edited by Alan Wiseman, published in Volumes 1 to 10 by Ellis Horwood). It is a most timely integration into a single volume of the theoretical principles as related to the industrial methodology, essential to the continuing development of the concepts which constitute enzyme biotechnology.

"of great industrial importance – for industrial scientists interested, but with no prior knowledge, it provides an absorbable overview" – T. Bryan Jones, University of Toronto, reviewing the *First Edition* for *Journal of the American Chemical Society*.

Readership: Biochemists, chemists, microbiologists, chemical engineers, and all those working in or researching in food science, medical science, organic chemistry, textile chemistry and the textiles industry, the leather industry, paper manufacture, analytical chemistry, pathology, pharmaceutics, clinical chemistry, physical chemistry. Those teaching or studying any of these subjects in universities, colleges and polytechnics.

Dr. Alan Wiseman, editor of this book, graduated in 1956 from Imperial College of Science and Technology, University of London. In 1959 he was awarded a Ph.D. (in the field of biochemistry) by the University of London for research on protein structure carried out at the University of Bradford. After industrial research experience in the fermentation industry he returned to Imperial College's Metabolic Reactions Research Unit, sponsored within the Department of Biochemistry by the Medical Research Council.

He was appointed Lecturer in Biochemistry at the University of Surrey, Guildford, in 1965, and promoted to Senior Lecturer in Biochemistry and Head of the Biochemistry Division from 1978.

Dr. Wiseman's research on enzymes and proteins has to date yielded more than 100 published papers and 15 books including the first edition of *Handbook of Enzyme Biotechnology,* and Volumes 1–10 of *Topics in Enzyme and Fermentation Biotechnology,* published by Ellis Horwood Limited.

He holds the office of Honorary Recorder of the Biotechnology Group of the Society of Chemical Industry, and is a member of the Kent, Surrey and Sussex Branch Committee of the Institute of Biology, a member of the Biological Council and Honorary Secretary of the Industrial Biochemistry and Biotechnology Group of the Biochemical Society, and member of the Professional and Education Sub-committee of the Biochemical Society. Dr. Wiseman is a member of the Editorial Board of the *Journal of Chemical Technology and Biotechnology* (Biotechnology Board).

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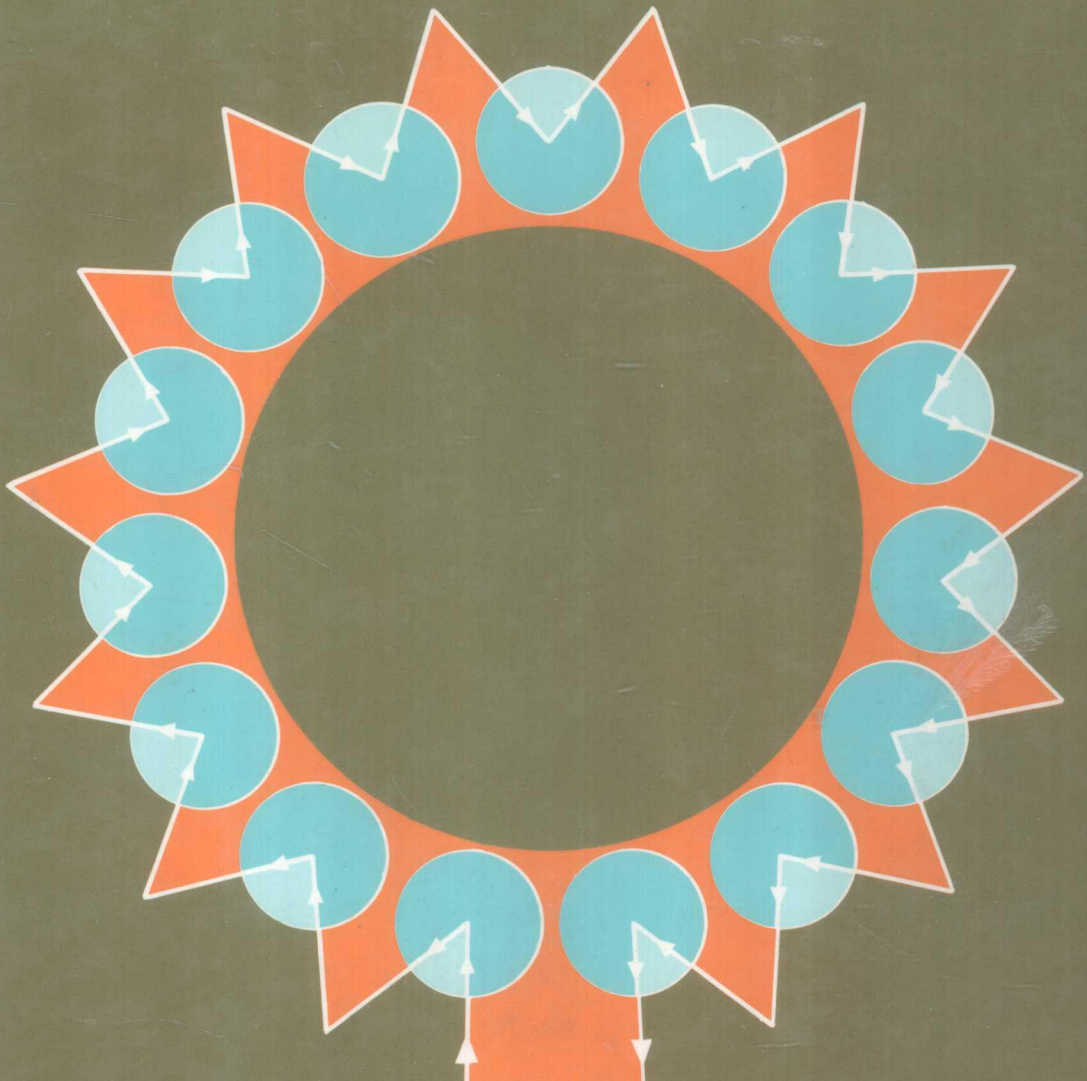

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Series Editor: ALAN WISEMAN, Biochemistry Division, Department of Biochemistry, University of Surrey

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Table of Contents

PART A

PRINCIPLES OF INDUSTRIAL ENZYME ISOLATION AND UTILIZATION

CHAPTER 1

Introduction to principles

Dr. ALAN WISEMAN, Biochemistry Division, Department of Biochemistry, University of Surrey, Guildford, England

1.1 GENERAL INTRODUCTION

The first edition of *Handbook of Enzyme Biotechnology,* edited by Alan Wiseman, was published in 1975 by Ellis Horwood, and this most successful book was later translated into Japanese (1977) and Czech (1981). Part I of that book covered the principles of enzyme production and utilization, while Part 2 was a collection of data for use in industrial and other applications, of enzymes. Many specialist topics were mentioned in this source book, although only a few were subjected to detailed analysis. This led therefore to a series of books, *Topics in Enzyme and Fermentation Biotechnology,* published from 1977 by Ellis Horwood.

Topics 1 (1977) reviewed enzyme synthesis in continuous culture, foam separation of biological materials, aeration of culture fluids, enzymic modifications of antibiotics, patents, glucose isomerase, and cytochromes P-450. *Topics 2* (1978) reviewed enzymes immobilized on inorganic supports, enzyme electrodes and enzyme-based sensors, antibiotic-inactivating enzymes, biological treatment of aqueous wastes, and stabilization of enzymes. *Topics 3* (1979) reviewed the uses of oxyanions in enzyme equilibrium displacement, developments in microbial extra-cellular enzymes, rennets and cheese, scale-up of fermentation processes, and new and modified invertases and their applications. *Topics 4* (1980) reviewed enzymes in therapy, medical uses of proteolytic enzymes, solid substrate fermentation, measurement of process variables, and immobilized microbial cells. *Topics 5* (1981) reviewed immobilized coenzymes, large-scale enzyme extraction and recovery, aspects of Gramicidin S, papain, and a¹cohol dehydrogenases. *Topics 6* (1982) reviewed 4-hydroxycoumarin antibiotics, microbiological aspects of secondary metabolites, enzyme stabilization, beer fermentation, and microbial oxygenases. *Topics 7* (1983) reviewed immobilized plant and animal cells, disordering macromolecular structure for enzyme attack, microbial enymes in the biodegradation of sulphated surfactants, thermophilic, anaerobic, and cellulolytic bacteria, monoclonal antibodies, immobilized enzymes in water and

air purification, and the limitations of fermentation processes for utilization of food wastes. *Topics 8* (1984) reviewed xylanses: function properties and applications, biological control of nitrogenous pollution in waste water, and computers and microprocessors in industrial fermentation. *Topics 9* (1984) reviewed the physiology of hydrocarbon-utilizing microorganisms, applications of reactive dyes in biotechnology and biochemistry, application of immobilized enzymes to fundamental studies on enzyme structure and function, and progress with design of enzymes and mimics. *Topics 10* (1985) is in press.

Many theoretical possibilities have come to fruition in the ten years since the first edition of the *Handbook of Enzyme Biotechnology* was published. Nevertheless, a vast number of such possibilities have not emerged at industrial level, so far as one can ascertain, perhaps because of a lack of the real scientific information required for success. Another factor is always the economics of a suggested process at any particular time.

Once again, the *Handbook* sets out to summarize in concise form the principles and practice associated with industrial enzymes in their widest sense. We have therefore extended the coverage to the range of enzymes used in clinical laboratories, where repeated use of these procedures gives rise to a part of the general 'industrial' requirement for enzymes.

1.2 INTRODUCTION TO PART A OF *HANDBOOK OF ENZYME BIOTECHNOLOGY II*, PRINCIPLES OF INDUSTRIAL ENZYME ISOLATION AND UTILIZATION

The most important principles involved in enzyme utilization are becoming clearer with the move towards the use of immobilized enzymes in various forms. Much of classical enzyme kinetics has needed to be remoulded towards the particular general requirement of product formation – and indeed in every process the key features of enzymology have to be re-established. Stability and stabilization of enzymes is often of great importance in this context. (See Part A: sections 3.27 and 4.4 and review by Mozhaev & Martinek, (1984)).

Enzymes are bought and sold, by activity rather than by weight. There is no need to use a more highly purified, or modified, enzyme than is necessary for the particular process, as work done on the enzyme will be expensive. Nevertheless, the presence of inhibitors could make the prediction of the effect of the enzyme difficult, especially in enzyme kinetic terms. Deciding if the process will really work on a large scale may defy prediction.

Many of the important principles are associated with the use of a variety of immobilized enzyme reactors. This area of enzyme engineering is of great importance in assessing the practicalities of the particular application of the immobilized enzyme or immobilized cell (see Part A: Chapter 3). But first the enzyme must be successfully isolated (see Part A: Chapter 2) and immobilized (see Part A; Chapter 4). Some of the most sophisticated applications of

enzymes, however, are to be found in clinical biochemistry, and here the use of antibodies has allowed the development of a variety of remarkable techniques such as enzyme immunoassay (see Part A: Chapter 5). The reader is referred to Part B of the book for data, practical details, and applications.

REFERENCES

Mozhaev, V. V. & Martinek, K. (1984) *Enzyme & Microbial Technology*, **6**, 50–59.

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