

Industrial Enzymes

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Structure, Function and Applications

Edited by

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Cover illustration: Crystal structure of xylanase B from *Bacillus* sp. BP-23.
Courtesy of Julia Sanz-Aparicio.

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PREFACE

INDUSTRIAL ENZYMES IN THE 21st CENTURY

Man's use of enzymes dates back to the earliest times of civilization. Important human activities in primitive communities such as the production of certain types of foods and beverages, and the tanning of hides and skins to produce leather for garments, involved the application of enzyme activities, albeit unknowingly. However, not until the 19th century with the development of biochemistry and the pioneering work of a number of eminent scientists did the nature of enzymes and how they work begin to be clarified. In France Anselme Payen and Jean-François Persoz described the isolation of an amylolytic substance from germinating barley (1833). Shortly afterwards the Swedish chemist Jöns Jacob Berzelius coined the term catalysis (1835) to describe the property of certain substances to accelerate chemical reactions. In Germany the physiologist Theodor Schwann discovered the digestive enzyme pepsin (1836), Wilhelm Kühne proposed the term 'enzyme' (1877), and the brothers Hans and Eduard Buchner demonstrated that the transformation of glucose into ethanol could be carried out by chemical substances (enzymes) present in cell-free extracts of yeast (1897). In the 1870's the Danish chemist Christian Hansen succeeded in obtaining pure rennet from calves' stomachs, the use of which in cheese-making resulted in considerable improvements in both product quantity and quality. Shortly thereafter he industrialised the production of rennet thus setting in motion the first enzyme production industry.

During the 20th century the recognition that enzymes are proteins along with the design of techniques for their purification and analysis, principally the work of James B. Sumner and Kaj Linderstrøm-Lang, paved the way for the development of procedures for their industrial production and use. The nineteen-sixties witnessed two major breakthroughs that had a major impact on the enzyme industry: the commercialisation of glucoamylase which catalyses the production of glucose from starch with much greater efficiency than that of the chemical procedure of acid hydrolysis, and the launch of the first enzyme-containing detergents. The development of genetic engineering in the eighties provided the tools necessary for the production and commercialisation of new enzymes thus seeding a second explosive expansion to the current billion dollar enzyme industry. Recent advances in X-ray crystallography and other analytical methods in the field of protein chemistry along with the ever increasing amounts of biological information available from genomics

programs and molecular techniques such as directed evolution and gene and genome shuffling, are bringing powerful means to bear on the study and manipulation of enzyme structure and function. The search for improvements in existing enzyme-catalysed procedures, the need to develop new technologies and the increasing concern for responsible use and reuse of raw materials can be expected to stimulate not only the rational modification of enzymes to match specific requirements but also the design of new enzymes with totally novel properties.

The aim of this book is to provide in a single volume an updated revision of the most important types of industrial enzymes based on consideration of their physicochemical and catalytic properties, three-dimensional structure, and the range of current and foreseeable applications. The first section of this volume is dedicated to the carbohydrate active enzymes which are extensively used not only in many food industry applications (baking, beverage production, starch processing, *etc.*) but also in the industrial production of textiles, detergents, paper, ethanol, *etc.* The second section, on peptidases, begins with an introductory chapter about the MEROPS database which constitutes the current classification of reference for this important group of enzymes, and subsequent chapters review the most industrially relevant types of peptidases. The section on lipases places special emphasis on the increasing application of these enzymes in synthetic processes. Nucleic acid modifying activities are considered in the fourth section. Whilst the nature of the applications and scale of use of the latter are not yet comparable to those of the enzymes considered in the preceding sections, they are of growing in importance given the indispensability of some in highly specialised fields including basic and applied research, medicine, pharmaceuticals, agronomy and forensics. The final section considers a number of important enzymes that cannot be classified into any of the other sections.

We wish to thank everyone involved in making this book possible and hope that it will become a tool equally useful to researchers, industrialists and students.

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