

Kurt Faber  
Biotransformations in Organic Chemistry

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# **Biotransformations in Organic Chemistry**

**A Textbook**

**Fourth Completely Revised and Extended Edition**

With 33 Figures, 183 Schemes, and 28 Tables



**Springer**

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# Preface

The use of natural catalysts - enzymes - for the transformation of non-natural man-made organic compounds is not at all new: they have been used for more than one hundred years, employed either as whole cells, cell organelles or isolated enzymes [1, 2]. Certainly, the object of most of the early research was totally different from that of the present day. Thus the elucidation of biochemical pathways and enzyme mechanisms was the main reason for research some decades ago. It was mainly during the 1980s that the enormous potential of applying natural catalysts to transform non-natural organic compounds was recognized. What started as a trend in the late 1970s could almost be called a fashion in synthetic organic chemistry in the 1990s. Although the early euphoria during the 'gold rush' in this field seems to have eased somewhat, there is still no limit to be seen for the future development of such methods. As a result of this extensive, recent research, there have been an estimated 13 000 papers published on the subject. To collate these data as a kind of 'super-review' would clearly be an impossible task and, furthermore, such a hypothetical book would be unpalatable for the non-expert [3-7].

The point of this textbook is to provide a condensed introduction to this field. It is written from an organic chemist's viewpoint in order to encourage more 'pure' organic chemists of any level to take a deep breath and leap over the gap between the 'biochemical' sciences and 'classic organic chemistry' and to make them consider biochemical methods as an additional tool when they are planning the synthesis of an important target molecule. At several academic institutions this book has served as a guide for updating a dusty organic-chemistry curriculum into which biochemical methods had to be incorporated. The wide arsenal of classic synthetic methods has not changed radically but it has been significantly widened and enriched due to the appearance of biochemical methods. This is illustrated by the fact that the proportion of papers on the asymmetric synthesis of enantiopure compounds employing biocatalytic methods has constantly risen from zero in 1970 to about 8% in 1989 [8] and it can be estimated that this value is approaching

about 15% by now. Certainly, biochemical methods are not superior in a general sense - they are no panacea - but they definitely represent a powerful synthetic tool to complement other methodology in modern synthetic organic chemistry.

In this book, the main stream of novel developments in biotransformations, which in many cases have already had significant impact on organic chemistry, are put to the fore. Other cases, possessing great potential but still having to show their reliability, are mentioned more briefly. The literature covered by the fourth edition of this volume extends to the end of 1999. Special credit, however, is given to some 'very old' papers as well to acknowledge the appearance of novel concepts. References are selected according to the philosophy that 'more is not always better'. Generally, I have attempted to sort out the most useful references from the pack, in order to avoid writing a book with the charm of a telephone directory! Thus special emphasis is placed on reviews and books, which are often mentioned during the early paragraphs of each chapter to facilitate rapid access to a specific field if desired.

The first edition of this book appeared in September 1992 and was predominantly composed as a monograph. It was not only well received by researchers in the field but also served as a basis for courses in biotransformations at several universities. In the second, completely revised edition was given to the educational aspects in order to provide the first textbook on this topic in 1995. Its great success has led to the demand for an updated version within two years. This fourth edition not only incorporates a revision of the cited literature, but also places emphasis on new trends and developments. In this context, novel techniques which lead to the formation of a single stereoisomeric product in 100% theoretical yield from a racemate - dynamic resolution, stereo-inversion and enantio-convergent processes - were incorporated into the text. Furthermore, an additional chapter on enzymatic peroxidation-reactions and some basic rules for the handling of biocatalysts were added.

My growing experience of teaching the basics of biotransformations at several universities and research institutions has enabled me to modify the text so as to facilitate a deeper understanding of the principles. I am grateful to numerous unnamed students for raising questions.

I wish to express my deep gratitude to Stanley M. Roberts (UK) for undergoing the laborious task of correcting the manuscripts of the preceding editions of this book, for raising numerous questions and for helpful comments. Special thanks also go to W.-D. Fessner, M. Pietzsch (Germany), J.

G. T. Kierkels (The Netherlands), and D. V. Johnson (Graz) for their helpful hints and discussions. G. Koberwein assisted me considerably in the retrieval of literature.

I shall certainly be pleased to receive comments, suggestions and criticism from readers for incorporation in future editions.

Graz, December 1999

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