Biology applied to chemistry

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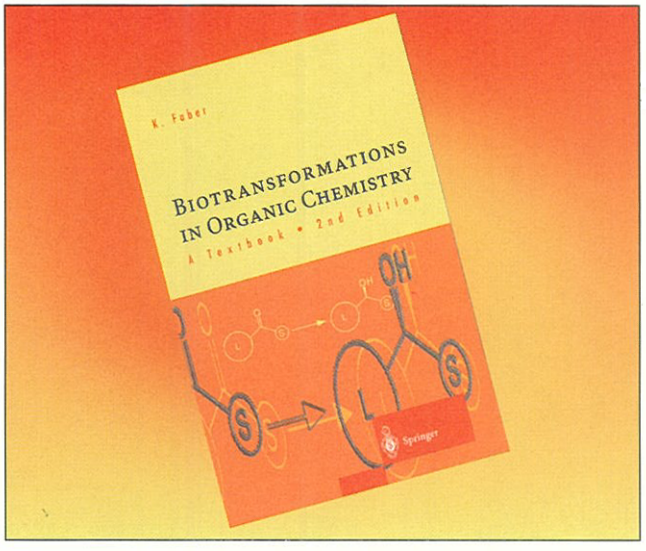
Biotransformations in Organic Chemistry (2nd ed.) by Kurt Faber. Springer-Verlag, 1995, 356 pages. $39.50 paper (ISBN 3-540-58503-6).



This book is about the use of free enzymes and cells in organic synthesis. It was written for organic chemists interested in synthesis and covers the literature to the end of 1993 in four chapters with over 1400 references.

Chapter 1 provides an introduction and background of the field, including a discussion of the advantages and disadvantages of biocatalysis, the use of isolated enzymes versus whole cells, simple kinetic and mechanistic aspects of general enzymatic reactions, enzyme nomenclature, classification and sources, and types of coenzymes. The subjects are generally treated well, although some concepts are not clearly assessed. For example, "enzymes display their highest catalytic activity in water" is treated as a disadvantage because the author believes that water is rarely the solvent of choice for organic reactions. This is true if enzymatic reactions have to compete with traditional organic syntheses in organic solvents. Enzymatic catalysis in water, however, has clear advantages for certain types of transformations, such as the synthesis of compounds related to sugars and nucleic acids and the formation or cleavage of complex peptides or proteins. There are no good non-enzymatic methods currently available for these types of transformations. Some enzymatic reactions, for instance lipase and protease reactions, can be conveniently carried out in organic solvents in laboratories, though it is unclear whether these can replace chemical processes. It may not really be a disadvantage that enzymatic reactions are often cofactor-dependent; many such reactions are novel, and most cofactors can now be regenerated. It is disappointing that sugar nucleotides were excluded from the sections dealing with common cofactors. The value of an enzymatic transformation should not be judged solely by how often it is used in laboratories; the criteria for inclusion in a book such as this ought to be the type of reaction and its efficiency. Many important transformations used in industry are based on biocatalysts which are not necessarily commercially available.

Chapter 2 covers the application of biocatalysis to organic synthesis and contains sections on hydrolytic reactions, oxidoreductions, formation of C–C bonds, additions and eliminations, glycosyl-transfer reactions and halogenation/dehalogenation reactions. The section on hydrolytic reactions is the most comprehensive, describing many useful approaches based on hydrolases (ligases, proteases, epoxide hydrolases and nitrile hydrolases) in enantio- and regioselective reactions. It also describes the techniques required to predict and improve enantioselectivity in reactions with chiral, prochiral, and *meso* compounds, and illustrates active-site models of several hydrolytic reactions and their use to explain known and to predict new reactions. The section on oxidoreductions covers reactions using both isolated enzymes and whole cells, including nicotinamide-dependent and metal-dependent oxidoreductases. Some of the oxygenase reactions described are quite interesting. Unfortunately, the author omits discussion of several new and useful dehydrogenases because the enzymes are not commercially available (yet covers in great detail reactions with enzymes or cells that are not readily available). The C–C bond forming reactions (especially aldolase reactions), glycosyl-transfer reactions (for instance glycosidase and glycosyltransferase reactions) and ATP-dependent phosphorylation are only briefly discussed, and little information is provided for addition/elimination and halogenation/dehalogenation reactions.

Chapter 3 covers some special techniques used in enzymatic processes, such as reactions in organic solvents in esterase- and protease-catalyzed reactions, medium engineering, enzyme immobilization, modified and artificial enzymes, and catalytic antibodies. The discussion and coverage of the organic solvents is good, in particular, the discussion of the problems of the reversible nature of reactions (for example transesterification) in organic solvents, and solutions to the problems with the use of irreversible transfer reactions are described. In addition, the effects of media on enantioselectivity are discussed. Chapter 4 gives an overview of the state of the art and the outlook of the field. In general, the book contains useful information and is a good reference for those who are interested in the use of enzymes in organic synthesis.

Chi-Huey Wong, Department of Chemistry, The Scripps Research Institute, 10666 North Torrey Pines Road, La Jolla, CA 92037, USA.

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