

REFERENCES

1. Anastas, P.T.; Warner, J.C. *Green Chemistry: Theory and Practice*. Oxford, UK: Oxford University Press., 1998.
2. Armor, J.N. *Appl. Catal. A-Gen.*, **1999**, 189, 153-162.
3. Lenardao, E.J.; Freitag R. A.; Dabdoub M.J.; e Ferreira Batista A. C.; da Cruz Silveira C. *Quim. Nova*, **2003**, 26, 123.
4. Azerad, R. *Curr. Opin. Biotech.*, **2001**, 12, 533.
5. Khosla, C. and Harbury, P.B. *Nature*, **2001**, 409, 247.
6. Walsh, C. *Nature*, **2001**, 409, 226-231.
7. Bull, A.T. ; Bunch A. W.; Robinson G.K. *Curr. Opin. Microbiol.*, **1999**, 2, 246.
8. Schmid, A.; Dordick J. S.; Hauer B.; Kiener A.; Wubbolts M.; Witholt B. *Nature*, **2001**, 409, 258.
9. Steinbuchel, A. *Curr. Opin. Biotechnol.*, **2005**, 16, 607-613
10. Sheldon, R.A. and van Rantwijk, F. *Aust. J. Chem.* **2004**, 57, 281.
11. Shroeder M.; Schweitzer M.; Lenting H. B. M.;Gübitz, G.M. *Biocatal. Biotransform.*, **2004**, 22,. 299.
12. Bajpai, P. *Crit. Rev. Biotechnol.*, **2004**, 24, 1-58.
13. Bode, H.B. and Müller, R. *Angew. Chem. Int. Ed.* **2005**, 44, 6828.
14. Pollard, J. D.; Woodley, J. M. *Trends Biotechnol.* **2006**, 25, 66.
15. Klibanov, A.M., Samokhin, G.P., Martinek, K., Berezin, I.V. *Biotechnology and Bioengineering*, **1977**, 19(9):1351.
16. Tarquis, D, Monsan, P, Durand, G.. *Bulletin De La Societe Chimique De France Partie II-Chimie Moleculaire Organique Et Biologique*, **1980**, (1-2):76.
17. Zaks, A, Klibanov, AM.. *Proc. Natl. Acad. Sci. USA*, **1985**, 82(10):3192-3196.
18. Zaks, A, Klibanov, A M.. *Science*, **1984**, 224:1249-1251.
19. Kvittingen, L.. *Tetrahedron*, **1994**, 50, 8253.
20. (a) Klibanov, A.M. *Chemtech* **1986**, 354. (b) Klibanov, A.M. *Acc. Chem. Res.* **1990**, 114.
21. (a) Kirchner, G.; Scollar, M.P. Klibanov, A.M. *J. Am. Chem. Soc.* **1985**, 107, 7072. (b) Torres, C.; Otero, C. *J. Mol. Catal.,A: Chem.* **1995**, 119. (c) Desai, U.R.; Klibanov, A.M. *J. Am. Chem. Soc.* **1995**, 117, 3940. (d) Louwrier, A.; Drtina, G.J.; Klibanov, A.M. *Biotech. Bioeng.* **1996**, 50, 1.
22. Chen, C.-S.; Sih, C. J. *Angew. Chem. Int. Ed. Engl.* **1989**, 28, 695.
23. (a) Lundhaug, C.; Overbeeke, P.L.A.; Jongejan, J.A.; Anthonsen, T. *Tetrahedron: Asymmetry* **1998**, 2851. (b) Anthonsen, T.; Hoff, B.H. *Chem. Phys. Lipids* **1998**, 93(1-2), 199.
24. Bourg-Garros, S.; Razafindramboa, N.; Pavia, A.A. *Enzyme Microb. Tech.* **1998**, 22, 240.
25. Conceição Almeida, M.; Ruivo, R.; Maia, C.; Freire, L.; Corrêa de Sampaio, T.; Barreiros, S. *Enzyme Microb. Tech.* **1998**, 22, 494.
26. Triantafyllou, A.Ö.; Wehtje, E.; Aldercreutz, P.; Mattiasson, B. *Biotechnol. Bioeng.* **1997**, 54(1), 67.
27. (a) Engbersen, J. F. J.; Broos, J. *Pure & Appl. Chem.* **1996**, 68, 2171. (b) Itoh, T.; Mitsukura, K.; Kanphai, W.; Takagi, Y.; Kihara, H.; Tsukube, H. *J. Org. Chem.* **1997**, 62, 9165.
28. (a) Clausen, I.G. *J. Mol. Catal.,B: Enzym* **1997**, 139. (b) Janes, L.E.; Löwendahl, C.; Kazlauskas, R.J. *Chem. Eur. J.* **1998**, 4, 2324.
29. Combinatorial chemistry in combination with in-vitro evolution: (a) Reetz, M.T.; Zonta, A.; Schimossek, K.; Liebeton, K.; Jaeger, K-E *Angew. Chem. Int. Ed.* **1997**, 36, 2830. (b) Reetz, M.T.; Becker, M.H.; Kühling, K.M.; Holzwarth, A. *Angew. Chem. Int. Ed.* **1998**, 37, 2647.
30. (a) Hirose, Y.; Kariya, K.; Sasaki, J.; Kurono, Y.; Ebike, H.; Achiwa, K. *Tetrahedron Lett.* **1992**, 33, 7157. (b) Wescott, C. R.; Klibanov, A. M. *J. Am. Chem. Soc.* **1993**, 115, 1629. (c) Berglund, P.; Holmquist, M.; Hult, K. *J. Mol. Catal. B: Enzym.* **1998**, 5(1-4), 283.
31. Tawaki, S.; Klibanov, A. M. *J. Am. Chem. Soc.* **1992**, 114, 1882.

32. (a) Sakurai, T.; Margolin, A. L.; Russell, A. J.; Klibanov, A. M. *J. Am. Chem. Soc.* **1988**, *110*, 7236. (b) Kitagushi, H.; Fitzpatrick, P. A.; Huber, J. E.; Klibanov, A. M. *J. Am. Chem. Soc.* **1989**, *111*, 3094. (c) Secundo, F.; Riva, S.; Carrea, G. *Tetrahedron: Asymmetry* **1992**, *3*, 267. (d) Nakamura, K.; Kinoshita, M.; Ohno, A. *Tetrahedron* **1994**, *50*, 4681. (e) Nakamura, K.; Kinoshita, M.; Ohno, A. *Tetrahedron* **1995**, *51*, 8799.
33. (a) Kvittingen, L.; Sjursnes, B.; Anthonsen, T.; Halling, P. *Tetrahedron* **1992**, *48*(13), 2793. (b) Halling, P.J. *Biochem. Soc. Trans.* **1997**, *25*(1), 170. (c) Wehtje, E.; Costes, D.; Aldercreutz, P. *J. Mol. Catal. B: Enzym.* **1997**, *3*, 221.
34. Ducret, A.; Trani, M.; Lortie, R. *Enzyme Microb. Tech.* **1998**, *22*, 212.
35. Cabral, J. M. S.; Best, D.; Boross, L.; Tramper, J. (eds) *Applied Biocatalysis*, Harwood, Chur, **1994**.
36. Drauz, K.; Waldmann, H. (eds) *Enzyme Catalysis in Organic Synthesis*, 2 vols., Verlag Chemie, Weinheim, **1995**.
37. Crosby, C. In *Chirality in Industry* (A. N. Collins, G. N. Sheldrake and J. Crosby, eds.), pp. 1-66. Wiley, Chichester, **1992**.
38. Faber, K. *Biotransformations in Organic Chemistry - A Textbook*, 3rd edn., Springer, Heidelberg, 1997.
39. Hough, D.W.; Danson, M.J. *Curr. Opinion Chem. Biol.* **1999**, *3*, 39.
40. Prieur, D. *Trends Biotechnol.* **1997**, *15*, 242.
41. Laane, C.; Boeren, S.; Vos, K.; Veeger, C. *Biotechnol. Bioeng.* **1987**, *30*, 81.
42. Carrea, G.; Ottolina, G.; Riva, S. *Trends Biotechnol.* **1995**, *13*, 63.
43. Bell, G.; Halling, P.J.; Moore, B.D.; Partridge, J.; Rees, D.G. *Trends Biotechnol.* **1995**, *13*, 468.
44. Koskinen, A.M.P.; Klibanov, A.M. *Enzymatic Reactions in Organic Media* (eds), Blackie Academic & Professional, London, 1996.
45. Sweers, H.M.; Wong, C.H. *J. Am. Chem. Soc.* **1986**, *108*, 6421.
46. Bashir, N.B.; Phythian, S.J.; Reason, A.J.; Roberts, S.M. *J. Chem. Soc., Perkin Trans.* **1995**, *1*, 2203.
47. Sih, C.J.; Wu, S.H. *Topics Stereochem.* **1989**, *19*, 63.
48. Schuster, M; Aaviksaar, A.; Jakubke, H.D. *Tetrahedron* **1990**, *46*, 8093.
49. Roberts, S.M.; Wiggins, K.; Casy, G.; (eds.) *Preparative Biotransformations: Whole Cells and Isolated Enzymes*, Wiley, Chichester, 1993.
50. Roberts, S.M.; Turner, N.J.; Willetts, A.J.; Turner, M.K. *Introduction to Biocatalysis Using Enzymes and Micro-organisms*, Cambridge University Press, Cambridge, 1995.
51. Jones, J.B.; Sih, C.J.; Perlman, D. (eds) *Applications of Biochemical Systems in Organic Chemistry*, 2 parts, Wiley, New York, 1976.
52. Davies, H.G.; Green, R.H.; Kelly, D.R.; Roberts, S.M. *Biotransformations in Preparative Organic Chemistry*, Academic Press, London, 1989.
53. Dordick, J.S. (ed) *Biocatalysts for Industry*, Plenum Press, New York, 1991.
54. Halgas, J. *Biocatalysts in Organic Synthesis*, Studies in Organic Chemistry, vol. 46, Elsevier, Amsterdam, 1992.
55. Collins, A.N.; Sheldrake, G.N. and J. Crosby. (eds) *Chirality in Industry*, Wiley, Chichester, 1992.
56. Poppe, L; Novak, L. *Selective Biocatalysis*, Verlag Chemie, Weinheim, 1992.
57. Kieslich, K. *Microbial Transformations of Non-Steroid Cyclic Compounds*, Thieme, Stuttgart, 1976.
58. Drauz, K.; Waldmann, H. (eds) *Enzyme Catalysis in Organic Synthesis*, 2 vols., Verlag Chemie, Weinheim, 1995.
59. Crosby, C. In *Chirality in Industry* (A. N. Collins, G. N. Sheldrake and J. Crosby, eds.), pp. 1-66. Wiley, Chichester, 1992.
60. Carrea, G.; Riva, S. *Angew. Chem. Int. Ed. Engl.* **2000**, *39*, 2226.

61. (a) Bisht, K. S.; Parmar, V.S.; Crout, D.H.G. *Tetrahedron Asymm.* **1993**, *4*, 957-958; (b) Kondaveti, L; Al-Azemi T.F.; Bisht, K.S. *Tetrahedron Asymm.* **2002**, *13*, 129-135; (c) Carr, J.A.; Al-Azemi, T.; Long, T.E.; Shim, J.Y.; Coates, C.M.; Turos, E.; Bisht, K.S. *Tetrahedron*, **2003**, *59*, 9147;
62. Sundby, E.; Perk, L.; Anthonsen, T; Aasen, A.J.; Hansen, T.V. *Tetrahedron* **2004**, *60*, 521.
63. Benjamin S, Pandey A. *Candida rugosa* lipases: molecular biology and versatility in biotechnology. *Yeast* 1998;14:1069-87.
64. Jaeger KE, Eggert T. Lipases for biotechnology. *Curr Opin Biotechnol* 2002;13(4):390-7.
65. Reviews: (a) Bosley, J. *Biochem. Soc. Trans* **1997** *25*(1), 174. (b) Schmid, R.D.; Verger, R. *Angew. Chem. Int. Ed.* **1998**, *37*, 1608. (c) Weete, J.D. *Food Sci. Tecnol. (N.Y.)* **1998**, *88* (Food Lipids: Chemistry, Nutrition and Biotechnology), 641. (d) Willis, W.M.; Maragoni, A.G. *Food Sci. Technol. (N.Y.)* **1998**, *88* (Food Lipids: Chemistry, Nutrition and Biotechnology), 665. (e) Jaeger, K-E; Reetz, M.T. *Trends Biotechnol.* **1998**, *16*(9), 396. (f) Mori, K. *Chem. Commun.* **1997**, 1153.
66. Jaeger, K.E.; Ransac,S.; Dijkistra, B.W.; Colson, C.; van Heuvel, M.; Misset, O. *FEMS Microbiol. Rev.* **1994**, *15*, 29-63
67. Gilbert, E.J. *Enzyme Microb. Technol.* **1993**, *15*, 634-645.
68. Wohlfahrt, S.; Jaeger, K.E. *BioEngineering* **1993**, *9*, 39-46.
69. Carriere, F.; Gargouri, Y.; Moreau, H.; Ransac, S.; Rogalska, E.; Verger, R. in Wooley, P.; Petersen, S.B. *Lipases: Their structure, Biochemistry and Application*, Cambridge University Press, Cambridge, 1994.
70. Carriere, F.; Bezzine, S.; Verger, R. *J. Mol. Catal. B* **1997**, *3* (special issue devoted to "Microbial Lipases in the Biocatalysis")
71. Mukherjee, K.D.; Hills, M.J. in Wooley, P.; Petersen, S.B. *Lipases: Their structure, Biochemistry and Application*, Cambridge University Press, Cambridge, 1994.
72. Pandey, A, Benjamin, S, Soccol, CR, Nigam, P, N, K, Soccol, VT. *Biotech. Appl. Biochem.* **1999**, *29*:119.
- 73 Houde, A, Kademi, A, Leblanc, D. *Appl. Biochem. Biotech.*, **2004**, *118*:155.
- 74 Gotor-Fernández, V, Brieva, R, Gotor, V.. Lipases. *Journal of Molecular Catalysis B: Enzymatic* **2006**, *40*:111-120.
75. Ollis, D. L.; Cheah, E.; Cygler, M.; Dijkstra, B., Frolov, F.; Franken, S. M.; Harel, M.; Remington, S. J.; Silman, I., Schrag, J. D.; Sussman, J. L.; Verschueren, K. H. G.; & Goldman, A. 1992, *Protein Eng.*, *5*, 197.
76. Uppenberg, J, Hansen, MT, Patkar, S, Jones, TA. *Structure*, **1994**, *2*(4):293.
- 77 Brady, L, Brzozowski, A, Derewenda, ZS, Dodson, E, Dodson, G, Tolley, S, Turkenburg, JP, Christiansen, L, Huge-Jensen, B, Norskov, L *Nature* 1990, *343*:767.
78. Cygler, M, Grochulski, P, Kazlauskas, RJ, Schrag, JD, Bouthillier, F, Rubin, B, Serreqi, AN, Gupta, AK. *J. Am. Chem. Soc.*, **1994**, *116*, 3180.
79. Pleiss, J, Fischer, M, Schmid, RD. *Chem. Phys. Lipids*, **1998**, *93*:67.
- 80 Drauz, K.; Waldmann, H. in *Enzyme Catalysis in Organic Synthesis, A Comprehensive Handbook*, Vol. 1; VCH: Weinheim, 1995, 1st edition.
- 81 *Porcine pancreatic lipase and Candida cylindracea:* (a) Zaks, A.; Klibanov, A.M. *Science*, **1984**, *224*, 1249. *Candida antarctica:* (b) Drouin, J.; Costante, J.; Guibé-Jampel, E. *J. Chem. Edu.* **1997**, *74*, 992.
- 82 Arroyo, M.; Sánchez-Montero, J.M.; Sinisterra, J.V. *Enzyme Microb. Technol.* **1999**, *24*, 3.
- 83 Goto, S, Sugiyama, J, Iizuka, H. *Micologia*, 1969, *61*(4):748-774.
- 84 Ivanov, A.E.; Schneider, M.P. *J. Mol. Catal. B: Enzym.* **1997**, *3*, 303.
85. de Maria, PD, Carboni-Oerlemans, C, Tuin, B, Bargeman, G, van der Meer, A, van Gemert, R. *Journal of Molecular Catalysis B: Enzymatic* **2005**, *37*(1-6):36-46.
- 86 Nielsen, TB, Kirk, O. Lipase A and B from the yeast *Candida antarctica*. In: Margesin R, Schinner F, editors. *Biotechnological applications of cold-adapted organisms*. New York: Springer, 1999.
- 87 Anderson, E, Larsson, K, Kirk, O.. *Biocatalysis and Biotransformation*, **1998**, *16*(3):181.

- 88 Trodler, P, Pleiss, J. *BMC Structural Biology*, **2008**, 8(1):9.
89. Uppenberg, J, Oehrner, N, Norin, M, Hult, K, Kleywelt, GJ, Patkar, S, Waagen, V, Anthonsen, T, Alwyn Jones, T. *Biochemistry*, **1995**, 34(51):16838-16851
- 90 Homann, MJ, Vail, R, Morgan, B, Sabesan, V, Levy, C, Dodds, DR, Zaks, A.. *Advanced Synthesis & Catalysis*, **2001**, 343(6-7):744-749.
91. Rotticci, D.; Häffner, F.; Orrenius, C.; Norin, T.; Hult, K. *Journal of Molecular Catalysis B: Enzymatic* **1998**, 5, 267.
92. Kazlauskas, R. *Curr. Opin. Chem. Biol.* **2000**, 4, 81.
93. Brady, L.; Brzozowski, A.M.; Derewenda, Z.S.; Dodson, E.; Dodson, G.; Tolley, S.; Turkenburg, J.P.; Christiansen, L.; Huge-Jensen, B.; Norskov, L.; Thim, L.; Menge, U. *Nature*, **1990**, 343, 767.
94. Kazlauskas, R.J.; Weissflock, A.N.E.; Rappaport, A.T.; Cuccia, L.A. *J. Org. Chem.*, **1991**, 56, 2656.
95. Uppenberg, J.; Hansen, M.T.; Patkar, S. Jones, T.A. *Structure*, **1994**, 2, 293–308.
96. Magnusson, A.O. Rotticci-Mulder, J.C. Santagostino, A. Hult, K. *Chembiochem*, **2005**, 6, 1051–1056.
97. Uppenberg, J.; Ohrner, N.; Norin, M.; Hult, K.; Kleywelt, G.J.; Patkar, S.; Waagen, V.; Anthonsen, T.; Jones, T.A.; *Biochemistry*, **1995**, 34, 16838–16851.
98. Rotticci, D.; Orrenius, C.; Hult, K.; Norin, T. *Tetrahedron Asymmetry*, **1997**, 8, 359-362.
99. Hamada, H.; Shiromoto, M.; Funahashi, M.; Itoh, T.; Nakamura, K. *J. Org. Chem.*, **1996**, 61, 2332.
100. Rotticci, D.; Orrenius, C.; Hult, K.; Norin, T. *Journal of Molecular Catalysis B: Enzymatic*, **1998**, 5, 267-272.
101. (a) Ruzicka, L. *Helv. Chim. Acta*, **1926**, 9, 230. (b) Ruzicka, L. *Helv. Chim. Acta*, **1926**, 9, 715. (c) Ruzicka, L. *Helv. Chim. Acta*, **1926**, 9, 1008.
102. Baeyer, A. *Ber. Dtsch. Chem. Ges.*, **1885**, 18, 2269.
103. Kerschbaum, M. *Ber. Dtsch. Chem. Ges.*, **1927**, 60B, 902.
104. Back, T.G. *Tetrahedron*, **1977**, 33, 3041.
105. Williams, A.S. *Synthesis*, **1999**, 1707.
106. Brockmann, H.; Henkel, W. *Naturwissenschaften*, **1950**, 37, 138.
107. Muxfeldt, H.; Shrader, S.; Hansen, P.; Brockmann, H. *J. Am. Chem. Soc.*, **1968**, 90, 4748.
108. Kirst, H.A. In *Kirk-Othmer Encyclopedia of Chemical Technology*, Vol 3, Kroschwitz, J.I.; Howe-Grant, M. Eds., John Wiley & Sons, New York, 4th Ed., 1992, 169-213.
109. Paterson, I.; Mansuri, M.M. *Tetrahedron*, **1985**, 41, 3569.
110. Gharbi-Benarous, J.; Evrard-Todeschi, N.; Ladam, P.; Bertho, G.; Delaforge, M.; Girault, J.-P. *J. Chem. Soc., Perkin Trans. 2*, **1999**, 529.
111. (a) George, K.M.; Chatterjee, D.; Gunawardana, G.; Hayman, J.; Lee, L.; Welty, D.; Small, P.L.C. *Science*, **1999**, 283, 854. (b) Gunawardana, G.; Chatterjee, D.; George, K.M.; Brennan, P.; Whittern, D.; Small, P.L.C. *J. Am. Chem. Soc.*, **1999**, 121, 6092.
112. Rohr, J. *Angew. Chem. Int. Ed.*, **2000**, 39, 2847.
113. Michel, K.H.; Demarco, P.V.; Nagarajan, R. *J. Antibiot.*, **1977**, 30, 571. *Chem. Abstr.*, **1977**, 87, 132250.
114. Sekiguchi, J.; Kuroda, H.; Yamada, Y.; Okada, H. *Tetrahedron Lett.*, **1985**, 26, 2341.
115. Rodphaya, D.; Sekiguchi, J.; Yamada, Y. *J. Antibiot.*, **1986**, 39, 629.
116. Wong, J.W.; Verigin, V.; Oehlschlager, A.C.; Borden, J.H.; Pierce, Jr., H.D.; Pierce, A.M.; Chong, L. *J. Chem. Ecol.*, **1983**, 9, 451.
117. Oehlschlager, A.C.; King, G.G.S.; Pierce, Jr., H.D.; Pierce, A.M.; Slessor, K.N.; Millar, J.G.; Borden, J.H. *J. Chem. Ecol.*, **1987**, 13, 1543.
118. Pierce, A.M.; Pierce, Jr., H.D.; Borden, J.H.; Oehlschlager, A.C. *Environ. Entomol.*, **1989**, 18, 747.
119. Pierce, A.M.; Pierce, H.D. U.S. Patent 4 560 551 Dec. **1985**.

120. Kuwahara, S.; Tsuruta, T.; Leal, W. S.; Kodama, O. *Biosci., Biotechnol., Biochem.* **1998**, *62*, 1261.
121. Flam, F. *Science*, **1994**, *266*, 1324.
122. Spinella, A.; Zubia, E.; Martinez, E.; Ortea, J.; Cimino, G. *J. Org. Chem.*, **1997**, *62*, 5471.
123. Rao, B.V.; Kumar, V.S. *Tetrahedron Letters*, **1995**, *36*, 147.
124. Gustafson, K.; Roman, M.; Fenical, W. *Am. Chem. Soc.*, **1989**, *111*, 7519.
125. Kobayashi, J.; Tsuda, M. *Nat. Prod. Rep.*, **2004**, *21*, 77.
126. For a review see: Wood, T. E Chemistry of Synthetic Musks. In Fragrance Chemistry; Theimer, E. T., Ed.; Academic Press: Orlando, 1982, pp. 495-534.
127. Ciamician, G.; Silber, P. *Ber.*, **1896**, *29*, 1811.
- 128 Bauer, A. *Ber. Dtsch. Chem. Ges.* **1891**, *24*, 2832.
129. Ippen, H. *Int. Arch. Occup. Environ. Health* 1994, *66*, 283.
130. Lovell, W. W.; Saunders, D. J. *Int. J. Cosm. Sci.* 1988, *10*, 271.
131. Rimkus, G.; Wolf, M. *Chemosphere* 1995, *30*, 641.
132. Bernard, T.; Perineau, E; Bravo, R.; Delmas, M. *Parr. Costa. Parf. Cosm. Aromes* **1988**, *83*, 65.
133. Weber, S. H.; Spoelstra, D. B.; Polak, E. H. *Recl. Trav. Chim. Pays-Bas* **1955**, *74*, 1179.
134. Beets, M. G. J.; Van Essen, H.; Meerburg, W. *Recl. Trav. Chim. Pays-Bas* **1958**, *77*, 854.
135. US 4 352 748 (priority NL, Febr. 25, 1977, to Quest).
136. DE 1 015 798 (priority US, Jan. 28, 1955, to Givaudan Roure).
137. US 3 360 530 (priority US, 1967, to IFF).
138. Eschke, H. D.; Traud, J.; Dibowski, H.-J. *Z Umweltchem. Okotox.* **1994**, *6*, 183.
139. Eschke, H. D.; Dibowski, H.-J.; Traud, J. *Z Umweltchem. Okotox.* **1995**, *7*, 131.
140. Miller, S.; Schmid, P.; Schlatter, C. *Chemosphere* **1996**, *33*, 17.
141. Meng, Q.; Hesse, M. *Top. Curr. Chem.*, 1991, **161**, 107.
142. Illuminati, G.; Mandolini, L. *Acc. Chem. Res.* **1981**, *14*, 95.
143. Galli, C.; Mandolini, L. *J. Chem. Soc., Chem. Commun.* **1982**, 251.
144. Rossa, L.; Vogtle, F. *Top. Curr. Chem.* **1983**, *113*, 1.
145. Galli, C.; Mandolini, L. *Eur. J. Org. Chem.*, **2000**, 3117.
146. (a) Nicolaou, K.C. *Tetrahedron*, 1977, **33**, 683. (b) A. Parenty, X. Moreau, and J.-M. Campagne *Chem. Rev.*, **2006**, *106* (3), 911-939.
147. Corey, E. J.; Nicolaou, K. C. *J. Am. Chem. Soc.* **1974**, *96*, 5614.
148. Mukaiyama, T. *Angew. Chem., Int. Ed. Engl.* **1979**, *18*, 707.
149. Wollenberg, R. H.; Nimitz, J. S.; Gokcek, D. Y. *Tetrahedron Lett.* **1980**, *21*, 2791.
150. Corey, E. J.; Brunelle, D. J.; Stork, P. J. *Tetrahedron Lett.* **1976**, *17*, 3405.
151. Examples of synthetic applications : (a)Kitahara, T.; Mori, K. *Tetrahedron* **1984**, *40*, 2935. (b) Taber, D. F.; Silverberg, L. J.; Robinson, E. D. *J. Am. Chem. Soc.* **1991**, *113*, 6639. (c)Corey, E. J.; Carpino, P. *Tetrahedron Lett.* **1990**, *31*, 7555.(d) Tatsuta, K.; Amemiya, Y.; Kanemura, Y.; Kinoshita, M. *Tetrahedron Lett.* **1981**, *22*, 3997. (e)Grieco, P. A.; Inanaga, J.; Lin, N. H.; Yanami, T. *J. Am. Chem. Soc.* **1982**, *104*, 5781. (f) Lu, S.-F.; O'Yang, Q.; Guo, Z.-W.; Yu, B.; Hui, Y.-Z. *J. Org. Chem.* **1997**, *62*, 8400. (g)Bundy, G. L.; Peterson, D. C.; Cornette, J. C.; Miller, W. L.; Spilman, C. H.; Wilks, J. W. *J. Med. Chem.* **1983**, *26*, 1089. (h) Corey, E. J.; Nicolaou, K. C.; Melvin, L. S. *J. Am. Chem. Soc.* **1975**, *97*, 653. (i) Woodward, R. B.; Au-Yeung, B. W.; Balaram, P.; Browne, L. J.; Ward, D. E.; Card, P. J.; Chen, C. H. *J. Am. Chem. Soc.* **1981**, *103*, 3213. (l) Nakata, M.; Arai, M.; Tomooka, K.; Ohsawa, N.; Kinoshita, M. *Bull. Chem. Soc. Jpn.* **1989**, *62*, 2618. (m)Shishido, K.; Tanaka, K.; Fukumoto, K.; Kametani, T. *Tetrahedron Lett.* **1983**, *24*, 2783. (n)Maruyama, K.; Sohmiya, H.; Tsukube, H.

- Tetrahedron* **1992**, *48*, 805. (p)Barbour, R. H.; Robins, D. J. *J. Chem. Soc., Perkin Trans. I* **1988**, 1923. (q) Janssen, H. M.; Peeters, E.; van Zundert, M. F.; van Genderen, M. H. P.; Meijer, E. W. *Angew. Chem., Int. Ed.* **1997**, *36*, 122. (r) Hansen, T. V.; Stenstrom, Y. *Tetrahedron: Asymmetry* **2001**, *12*, 1407.
152. Gerlach, H.; Thalmann, A. *Helv. Chim. Acta* **1974**, *57*, 2661.
153. Masamune, S.; Kim, C.U.; Wilson, K.E.; Spessard, G.O.; Georghiou, P.E.; Bates, G.S. *J. Am. Chem. Soc.*, 1975, **97**, 3512.
154. Mukaiyama, T.; Usui, M.; Saigo, K. *Chem. Lett.*, **1976**, 49.
155. Schreiber, S. L.; Kelly, S. E.; Porco, J. A., Jr.; Sammakia, T.; Suh, E. M. *J. Am. Chem. Soc.* **1988**, *110*, 6210.
156. (a) Matsushita, M.; Yoshida, M.; Zhang, Y.; Miyashita, M.; Irie, H.; Ueno, T.; Tsurushima, T. *Chem. Pharm. Bull.* **1992**, *40*, 524. (b) Naoshima, Y.; Nakamura, A.; Munakata, Y. *Bull. Chem. Soc. Jpn.* **1990**, *63*, 1263. (c) Boden, C. D. J.; Chambers, J.; Stevens, I. D. R. *Synthesis* **1993**, 411. (d) Millar, J. G.; Oehlschlager, A. C. *J. Org. Chem.* **1984**, *49*, 2332.
157. McNaughton-Smith, G. A.; Taylor, R. J. K. *Tetrahedron* **1996**, *52*, 2113.
158. Smith, A. B.; Malamas, M. S. *J. Org. Chem.* **1982**, *47*, 3442.
159. Boden, E. P.; Keck, G. E. *J. Org. Chem.* **1985**, *50*, 2394.
160. Neises, B.; Steglich, W. *Angew. Chem., Int. Ed. Engl.* **1978**, *72*, 522.
161. Morales-Serna, J. A.; Gaviño, R.; Negrón, G.; Cárdenas, J. *ARKIVOC* **2005**, *VI*, 428.
162. Inanaga, J.; Hirata, K.; Saeki, H.; Katsuki, T.; Yamaguchi, M. *Bull. Chem. Soc. Jpn.*, 1979, **52**, 1989.
163. Kalita, D.; Khan, A. T.; Barua, N. C.; Bez, G. *Tetrahedron*, **1999**, *55*, 5177.
164. Thijs, L.; Egenberger, D.M.; Zwanenburg, B. *Tetrahedron Lett.*, 1989, **30**, 2153.
165. Jeong, E. J.; Kang, E. J.; Sung, L. T.; Hong, S. K.; Lee, E. *J. Am. Chem. Soc.* **2002**, *124*, 14655.
166. Mori, K.; Sakai, T. *Liebigs Ann. Chem.* **1988**, 13.
167. Kaisalo, L.; Koskimies, J.; Hase, T. *Synthesis* **1996**, 1122.
168. Enev, V. S.; Kaehlig, H.; Mulzer, J. *J. Am. Chem. Soc.* **2001**, *123*, 10764.
169. Kurihara, T.; Nakajima, Y.; Mitsunobu, O. *Tetrahedron Lett.* **1976**, 2455.
170. Mitsunobu, O. *Synthesis* **1981**, 1.
171. Ohta, K.; Mitsunobu, O. *Tetrahedron Lett.* **1991**, *32*, 517.
172. Tsutsui, H.; Mitsunobu, O. *Tetrahedron Lett.* **1984**, *25*, 2163.
173. Justus, K.; Steglich, W. *Tetrahedron Lett.* **1991**, *32*, 5781.
174. (a) Noda, Y.; Kashin, H. *Heterocycles* **1998**, *48*, 5. (b) Ghera, E.; Ramesh, N. G.; Laxer, A.; Hassner, A. *Tetrahedron Lett.* **1995**, *36*, 1333. (c) Kuwahara, S.; Tsuruta, T.; Leal, W. S.; Kodama, O. *Biosci., Biotechnol., Biochem.* **1998**, *62*, 1261. (d) Haviv, F.; Ratajczyk, J. D.; DeNet, R. W.; Martin, Y. C.; Dyer, R. D.; Carter, G. W. *J. Med. Chem.* **1987**, *30*, 254.
175. Meng, Q.; Hesse, M. *Top. Curr. Chem.*, **1991**, *161*, 107.
176. Roxburgh, C.J. *Tetrahedron*, **1995**, *51*, 9767.
177. Trost, B.M.; Verhoeven, T.R. *Tetrahedron Lett.*, **1978**, 2275.
178. Trost, B.M.; Verhoeven, T.R. *J. Am. Chem. Soc.*, **1980**, *102*, 4743.
179. (a) Stork, G.; Nakamura, E. *J. Org. Chem.*, **1979**, *44*, 4010. (b) Bestmann, H.J.; Schobert, R. *Angew. Chem. Int. Ed. Engl.* **1983**, *22*, 780. (c) Bestmann, H.J.; Schobert, R. *Synthesis*, **1989**, 419. (d) Yvergnaux, F.; Le Floc'h, Y.; Grée, R.; Toupet, L. *Tetrahedron Lett.*, **1989**, *30*, 7393. (e) Le Floc'h, Y.; Yvergnaux, F.; Toupet, L.; Grée, R. *Bull. Soc. Chim. Fr.*, **1991**, *128*, 742.
180. (a) Grubbs, R. H.; Miller, S. J.; Fu, G. C. *Acc. Chem. Res.* **1995**, *28*, 446. (b) Fürstner, A.; Langemann, K. *Synthesis*, **1997**, 792. (c) Grubbs, R.H.; Chang, S. *Tetrahedron*, **1998**, *54*, 4413. (d) Lee, C.W; Grubbs, R.H. *J. Org. Chem.*, **2001**, *66*, 7155.

181. Nicolaou, K.C.; Bulger, P. G.; Sarlah, D. *Angew. Chem. Int. Ed.*, **2005**, 44, 4490.
182. Fürstner, A.; Langemann, K. *Synthesis* **1997**, 792.
183. Gradillas, A.; Perez-Castells, J. *Angew. Chem., Int. Ed. Engl.* **2006**, 45, 6086.
184. Lee, C. W.; Grubbs, R.H. *J. Org. Chem.* **2001**, 61, 7155.
185. Fürstner, A.; Langemann, K. *J. Org. Chem.* **1996**, 61, 3942.
186. Taskinen, J.; Nykien, L. *Acta Chem. Scand.* **1975**, B29, 757.
187. Mookherjee, B.D., Trenkle R.W. and Patel R.R.. **1972**, *J.Org. Chem.*, 37,3846.
188. Schreiber, S.L.1980. *J.Am.Chem.Soc.* **102**: 6163-6165.
189. (a) Beeker, J.; Ohloff, G. *Helv. Chim. Acta* 1971, 54, 2889-2895; (b) DE 2 026 056 (priority CH, Dec. 3, 1970, to Firmenich).
190. EP 424 787 (priority CH, Oct. 27, 1989, to Firmenich).
191. (a) DE 2 136 496 (priority DE, July 21, 1971, to Haarmann&Reimer); (b) DE 2 731 543 (priority DE, July 13, 1977, to Haarmann&Reimer); (c) EP 512 348 (priority DE, Mai 5, 1991, to Haarmann&Reimer).
192. Schreiber, S. L.; Hulin, B.; Liew, W. F. *Tetrahedron* **1986**, 42, 2945.
193. Rozat, J.-P.; N~, E General Ideas About the Flavour and Fragrance Industry with Regard to the Use of Essential Oils and Aroma Chemicals. In *Proceedings of the 13th International Congress of Flavours, Fragrances and Essential Oils, Istanbul, 1995*; Baser, K. H. C., Ed; AREP Publ.: Istanbul, 1995, Vol. 2, pp. 6-26.
194. Story, P.R.; Denison, D.D.; Bishop, C.E.; Clark Jr., B.C.; Farine, J-C. *J. Am. Chem. Soc.*, **1968**, 90, 817.
195. Bursh, P.; Story, P.R.; Denison, D.D.; Wright, C.E. *U.S. Patent 2034737* **1969**, Research Corp.; *Chem. Abstr.* **1971**, 74, 14104.
196. Story, P.R.; Bursh, P.; Denison, D.D.; Wright, C.E. *U.S. Patent 3925421* **1973**, Research Corp.; *Chem. Abstr.* **1976**, 84, 73673.
197. Story, P.R. *U.S. Patent 3776926* **1968**, Research Corp.; *Chem. Abstr.* **1972**, 77, 61273.
198. Spanagel, E. W.; Carothers, W. H. *J. Am. Chem. Soc.* 1936, 58, 654-656.
199. Carothers, W.H.; Spanagel, E.W. *J. Am. Chem. Soc.* **1936**, 58, 654.
200. Carothers, W.H.; Hill, J.H. *US Patent 2020298* **1935**, DuPont de Nemours & Co.; *Chem. Abstr.* **1939**, 33, 7816.
201. Yokozaki, K.; Yamanaka, S.; Takinami, K.; Hirose, Y.; Tanaka, A.; Sonomoto, K.; Fukui, S. *Eur. J. Appl. Microbiol. Biotechnol.* **1982**, 14, 1
202. Chen, C.S.; Wu, S.H.; Girdaukas, G.; Sih, C.J. *J. Am. Chem. Soc.* **1987**, 109, 2812
203. Hayes, D.G. *J. Am. Oil. Chem. Soc.* **1996**, 73, 5 and references reported therein.
204. Gatfield, I.L. *Ann. N.Y. Acad. Sci.*, **1984**, 439, 569
205. (a) Makita, A.; Nihira, T.; Yamada, Y. *Tetrahedron Lett.*, **1987**, 28, 805. (b) Kageyama, Y., Nihira, T., Yamada, Y., *Ann. N.Y. Acad. Sci.* **1990**, 613, 681.
206. Zhi-wei, G. Ngooi, T.K.; Scilimati, A.; Fülling, G.; Sih, C.J. *Tetrahedron Lett.*, **1988**, 29, 5583.
207. Zaidi, N.A.; O'Hagan, D.; Pitchford, N. A.; Howard, J. A. K. *J. Chem. Res. (s)* **1995**, 427.
208. Guo, Zhi-Wei, G.; Sih, C.J. *J. Am. Chem. Soc.* **1988**, 110, 1990.
209. Robinson, G.K., Alston, M.J., Knowles, C.J., Cheetham, P.S.J., Motion, K.R., *Enzyme Microb. Technol.* **1994**, 16, 855..
210. Antczak, U.; Gora, J.; Antczak, T.; Galas, E. *Enzyme Microb. Technol.* **1991**, 13, 589.
211. Lobell, M.; Schneider, M. P. *Tetrahedron: Asymmetry* **1993**, 4, 1027.
212. Yamada, H.; Ohsawa, S.; Sugai, T.; Ohta, H.; Yoshikawa, S. *Chem. Lett.*, **1989**, 1775.

213. Rees, G.D.; Robinson, B.H.; Stephenson, G.R. *Biochimica et Biophysica Acta*, **1995**, 1257, 239.
214. Pawar, A.S.; Chattopadhyay S.; Chattopadhyay A.; Mamdapur, V.R.; *J.Org. Chem.* **1993**, 58, 7537.
215. Mori, K.; Tomioka, H. *Liebigs Ann. Chem.*, **1992**, 1011.
216. Pawar, A.S.; Sankaranarayanan, S.; Chattopadhyay S. *Tetrahedron: Asymmetry* **1995**, 6, 2219.
217. Nanda, S. *Tetrahedron Lett.*, **2005**, 46, 3661.
218. Gargouri, M.; Drouet, P. ; Legoy, M.D.; *Journal of Biotechnology* **2002** 92 259.
219. Pozo, M.; Pulido, R.; Gotor, R. *Tetrahedron*, **1992**, 48, 6477.
220. Yamada, H.; Sugai, T.; Ohta, H.; Yoshikawa, S. *Agric. Biol. Chem.*, **1990**, 1579-1580.
221. Bisht, K.S.; Bhatt S.; Muppalla, K. *Tetrahedron Lett.*, **2006**, 47, 8645.
222. Sugai, T.; Katoh, O.; Ohta, H. *Tetrahedron*, **1995**, 51, 11987.
223. Zacharis, E.; Omar, I.C.; Partridge, J.; Robb, D.A.; Halling, P.J. *Biotechnology and Bioengineering*, **1997**, 55, 367.
224. Inoue, A.; Horikoshi, K. *J. of Fermentation and Bioengineering*, **71**, **1991**, 194
225. Yang, Z.; Russel, A. J. "Fundamentals of non-aqueous enzymology". in: Koskinen, A. M. D. and Klibanov, A. M. (EDS), *Enzymatic Reactions in Organic Media*, 1a ed., London, Blackie Academic & Professional, **1996**.
226. Bell, G.; Halling, P. J.; May, L.; Moore, B. D.;Robb, D. A.; Ulijn, R., Valivety, R. H. Methods for measurement and control of water in nonaqueous biocatalysis; in *Methods in Biotechnology* , Vol. 15 "*Enzymes in Nonaqueous Solvents: Methods and Protocols*" Vulfson, E. N.; Halling, P. J.; Holland, H. L. (EDS). Humana Press Inc. Totowa, NJ, 2001.
227. Zaks, A.; Klibanov, A. M. *J. of Biol. Chem.*, **1988**, 263, 8017.
228. Yamada, Y.; Nippon Mining Co., Ltd., Japan, *Patent JP 63039594*, **1988**.
229. Kerschbaum, M. *Ber. Dtsch. Chem. Ges.*, **1927**, 60, 902.
230. a) Dhekne,V. V.; Ghatge, B. B.; Nayak, U. G.; Chakravarti, K. K.; Bhattacharyya, S.C., *Indian J. Chem.*, **1966**, 4, 524–526. b) Sato, T.; Kawara, T.; Kokubu, Y.; Fujisawa, T., *Bull. Chem. Soc. Jap.*, **1981**, 54, 945–946. c) Dhekne,V. V.; Ghatge, B. B.; Nayak, U. G.; Chakravarti, K. K.; Bhattacharyya, S.C., *J. Chem. Soc.*, **1962**, 2348–2352. d) Subbaraman, A. S. *Synthesis of some natural products of plant and insect origin*, Ph. D. Thesis, University of Mumbai, **1996**. e) Subramanian, G. B. V.; Mehrotra, A.; Mehrotra, K., *Chem. Ind.*, **1985**, 47, 379–380.
231. Rotticci, D.; Ottosson, J.; Norin, T.; Hult, K., Candida Antarctica Lipase B: A Tool for the Preparation Of Optically Active Alcohols; in *Methods in Biotechnology* , Vol. 15 "*Enzymes in Nonaqueous Solvents: Methods and Protocols*" Vulfson, E. N.; Halling, P. J.; Holland, H. L. (EDS). Humana Press Inc. Totowa, NJ, 2001.
232. Kuwahara, S.; Tsuruta, T.; Leal, W.S.; Kodama, O. *Biosci. Biotechnol. Biochem.* **1998**, 62, 1261.
233. Leal, W.S.; Kuwahara, S.; Shi, X.; Higushi, H.; Marino, C.E.B.; Ono, M.; Meinwald, J. *Journal of Chemical Ecology*, **1998**, 24, 1817.
234. White, J.D.; Blakemore, P.R.; Browder, C.C.; Hong, J.; Lincoln, C.M.; Nagornyy, P.A.; Robarge, L.A.; Wardrop, D.J. *J. Am. Chem. Soc.* **2001**, 123, 8593.
235. (a)Ramaswamy, S.; Morgan, B.; Oehlschlager, A.C. *Tetrahedron Letters*, **1990**, 31, 3405. (b) Parmar, V.S.; Sinha, R.; Gupta, S.; Prasad, A.K.; Taneja, P. *Tetrahedron*, **1993**, 49, 4107. (c) Theil, F.; Weidner, J.; Ballschuh, S.; Kunath, A.; Schick, H. *J. Org. Chem.*, **1994**, 59, 388.
236. Sharpless, K. B.; Amberg, W.; Bennani, Y. L.; Crispino, G. A.; Hartung, J.; Joeng, K., S.; Kwong, H. L.; Morikawa, K.; Wang, Z. M.; Xu, D; Zhang, X. L. *J. Org. Chem.* **1992**, 57, 2768.
237. Wang, Z.H.I.; Shen, M. *Tetrahedron: Asymmetry* **1997**, 8, 3393.
238. Brown, C. A.; Yamashita, A. *J. Am. Chem. Soc.*, **1975**, 97, 891; Macaulay, S.R.; *J. Org. Chem.* **1980**, 45, 734.
239. Bruno, G.; Caruso, T.; Peluso A.; Spinella A.; *Phytochem. Rev.* **2004**, 3, 417.

- 240 Caruso, T.; Donnamaria, C.; Artillo, A.; Peluso A.; Spinella A.; Monaco, G. *J. Phys. Org. Chem.*, **2009**, 22, 978.
- 241 Ohtani, I.; Kusumi, T.; Kashman, Y.; Kakisawa, H. *J. Am. Chem. Soc.* **1990**, 113, 4092