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Biotechnology

Fifth edition

Biotechnology is the major technology of the twenty-first century – yet few people realise how much it impacts on many aspects of human society. The defining aim of this new fifth edition is to re-establish the correct understanding of the term biotechnology. Using the straightforward style that made the previous editions of his textbook so popular, John Smith once again helps students and general readers alike with the deciphering and use of biological knowledge. He explains the historical developments in biotechnology and the range of activities from brewing beer, the treatment of sewage and other wastes, and the creation of biofuels. He also discusses the innovations in molecular biology, genomics and proteomics, systems biology and their impact on new biotechnology. In this edition John Smith also re-examines the ethics and morality of aspects of biotechnology and puts new emphasis on stem cells and regenerative medicine and micro RNA.

JOHN E. SMITH is Emeritus Professor of Applied Microbiology in the Institute of Pharmacy and Biomedical Sciences, University of Strathclyde, Glasgow and Scientific Advisor to GlycaNova, Norway.

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I dedicate this fifth edition to my grown-up children,
Sheri, Jill and Fraser, who have been a constant
source of inspiration.

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Preface

A defining aim of this fifth edition of *Biotechnology* has been to re-establish the correct understanding of the true meaning of biotechnology.

Biotechnology is in essence the deciphering and use of biological knowledge. It is highly multidisciplinary since it has its foundations in many disciplines including biology, microbiology, biochemistry, molecular biology, genetics, chemistry and chemical and process engineering. It may also be viewed as a series of enabling technologies that involve the practical application of organisms (especially microorganisms) or their cellular components to manufacturing and service industries and environmental management. Historically, biotechnology was an artisanal skill rather than a science, exemplified in the manufacture of wines, beers, cheeses, etc. where the techniques of manufacture were well worked out and reproducible, while the biological mechanisms were not understood. As the scientific basis of these biotechnology processes has developed this has led to more efficient manufacturing of the traditional processes that still represent the major financial returns of biotechnology, i.e. bread, beers, wines, cheeses, etc. Modern biotechnological processes have generated a wide range of new and novel products including antibiotics, vaccines and monoclonal antibodies, the production of which has been optimised by improved fermentation practices. Biotechnology has been further revolutionised by a range of new molecular biology innovations, allowing unprecedented molecular changes to be made to living organisms. The increasing understanding of genomics and proteomics has led to the creation of a vast range of transgenic microorganisms, agricultural (genetically modified) crops and animals, and major new recombinant protein drugs, and has revolutionised activities in the traditional food and drinks industries. In the environment, biotechnology innovations are creating major advances in water and land management and also remediating the pollution generated by over-industrialisation.

There have been vast investments in molecular diagnostics, not only in medicine but in plant and animal agriculture and the environment. Will the huge potential of stem cells for remedial medicine soon be realised?

Until recently, much attention has been given to determining the 'nuts and bolts' of biological systems. Now, systems biology is aiming to describe and to understand the operation of complex biological systems and ultimately to develop predictive models of, for example, human disease and complex fermenter systems used in biotechnology.

Some of the new aspects of biotechnology, such as genetic engineering, have aroused certain social sensitivities of an ethical, moral and political character. Regulatory authorities throughout the world are now examining the implications of these new and revolutionary techniques. It is hoped that common sense will prevail.

Undoubtedly, modern biotechnology can only maximise its full potential to benefit mankind through achieving a basis of public understanding, awareness, and knowledge of the technologies. Participating scientists must

learn to communicate openly with the public and attempt to demystify the complex nature of living systems. By doing so they will generate a greater level of confidence and trust between the scientific community and the public at large.

This expanded fifth edition of *Biotechnology* is again aimed to give an integrated overview of its complex, multifaceted and often ill-maligned subjects, and for some young readers to point the way forward to exciting, satisfying and rewarding careers. Biotechnology will undoubtedly be the major technology of the twenty-first century and should be so recognised by the lay public.

I am again deeply indebted to the long-suffering Elizabeth Clements for her skilful processing of the manuscript and her continued dedication.