BIOCHEMISTRY OF MICROBIAL DEGRADATION

Biochemistry of microbial degradation

Edited by

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Preface

Life on the planet depends on microbial activity. The recycling of carbon, nitrogen, sulphur, oxygen, phosphate and all the other elements that constitute living matter are continuously in flux: microorganisms participate in key steps in these processes and without them life would cease within a few short years. The comparatively recent advent of man-made chemicals has now challenged the environment: where degradation does not occur, accumulation must perforce take place. Surprisingly though, even the most recalcitrant of molecules are gradually broken down and very few materials are truly impervious to microbial attack.

Microorganisms, by their rapid growth rates, have the most rapid turn-over of their DNA of all living cells. Consequently they can evolve altered genes and therefore produce novel enzymes for handling "foreign" compounds – the xenobiotics – in a manner not seen with such effect in other organisms. Evolution, with the production of micro-organisms able to degrade molecules hitherto intractable to breakdown, is therefore a continuing event. Now, through the agency of genetic manipulation, it is possible to accelerate this process of natural evolution in a very directed manner. The time-scale before a new microorganism emerges that can utilize a recalcitrant molecule has now been considerably shortened by the application of well-understood genetic principles into microbiology. However, before these principles can be successfully used, it is essential that we understand the mechanism by which molecules are degraded, otherwise we shall not know where best to direct these efforts.

The biochemical understanding of degradation is therefore of paramount importance if we are to use microorganisms successfully. This then implies that microorganisms can be successfully used in a controlled manner to achieve degradation of unwanted materials and, of course, this is now increasingly proving to be the case. Indeed, new words such as "bio-remediation" and "land-farming" are now appearing to describe what are intrinsically old processes.

Not all compounds in the environment are, of course, undesirable but are nevertheless still broken down as part of the natural recycling processes. The

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understanding of how these processes occur also has considerable economic importance. The advantages in being able to accelerate or decelerate these activities is fundamental to our control of the environment and also in the direct use of microorganisms in many biotechnological processes.

The biotechnological application of microorganisms is one of the major developments of the twentieth century. The controlled large-scale cultivation of microorganisms begins with the growth of selected microorganism on a chosen substrate. Routes of degradation of the major carbohydrates have, of course, been well-established for many years but numerous biotechnological processes use complex substrates whose routes of breakdown are not as well established. From such processes not only are many products produced, but also the enzymes that carried out the initial breakdown of the substrate. These enzymes are often extracellular and so can be recovered and then used elsewhere. Lipases, carbohydrases, proteases all fit this category.

An entire spectrum of microbial degradations can therefore be seen: from the breakdown of natural materials through the destruction of recalcitrant xenobiotics to the use of enzymes for accelerating key steps in other biotechnological-linked processes. Biodegradations involving inorganic nitrogen compounds, attack on metals to accelerate corrosion are also of increasing economic importance. Also increasing in awareness is the ability of anaerobic microorganisms to carry out degradation of molecules not previously considered as susceptible to anaerobic attack. Anaerobic degradations may prove to be much more wide-spread than we currently suspect.

All these aspects of biodegradation are covered in this volume. It has, however, been the overall aim of this book to move away from the more descriptive aspects of the suject and to focus on the fundamental underlying science: the biochemistry of the processes themselves. In these chapters the reader will not find an amassed mountain of information on bioremediation – what to do with oil spills, how to deal with soil and water contaminations, etc. – but rather the nature of the processes that occur within the microorganisms themselves will be covered in some detail. How microorganisms attack water-insoluble substrates when they live in aqueous surroundings; how do microorganisms derive both carbon and energy from molecules on which they can grow. How do new enzymes evolve: how are recalcitrant molecules broken down and how are new compounds not seen before in the environment then handled by the most ubiquitous of all organisms: the microbe.

It is this information which is central to the understanding of how microorganisms function. It is only from a basis of such knowledge can then advancement be made to improve the capabilities of microorganisms in a manner that brings advantage to us all.

It will be clear to any interested reader that it would be impossible to cover the microbial degradations of all compounds, natural as well as man-made, in even a substantial volume such as this. As editor I have therefore had to select the major topics of current and hopefully future interest to give a breadth of coverage rather than to concentrate on one single area of degradation. I am

very conscious that there are omissions from this book but to have included everything would have doubled the size of the book without necessarily increasing our fundamental understanding of the biochemistry of microorganisms. Readers finding fault with the coverage can therefore rightly castigate the editor: for those, hopefully, greater number of readers finding within these covers the answers to their questions, they can commend the authors for their perspicacity and wisdom in catering for the readers' needs.

It is a pleasure for me to thank all the contributors for producing not only first-class manuscripts that have been focused exactly where they should be, but also for the promptness by which they have produced such worthy chapters. It has been a pleasure to have worked with them.

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