Microbial Polysaccharides and Polysaccharases

Edited by

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1979

Published for the
Society for General Microbiology
by
ACADEMIC PRESS
London New York San Francisco
A subsidiary of Harcourt Brace Jovanovich, Publishers

ACADEMIC PRESS INC. (LONDON) LTD.
24/28 Oval Road,
London NW1

United States Edition published by
ACADEMIC PRESS INC.
111 Fifth Avenue
New York, New York 10003

Library of Congress Catalogue Card Number: 79-50534
ISBN: 0-12-091450-6

Typed by Joan Wilkins Associates Ltd., London, and
printed in Great Britain by Whitstable Litho Ltd, Whitstable, Kent

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PREFACE

Polysaccharides are ubiquitous - they are by far the most abundant biopolymers on earth. They show a wide variety of chemical composition, and we can now begin to understand how these give rise to the wide variety of physical and biochemical properties shown by polysaccharides.

Polysaccharides are renewable resources, and present a wide range of potential products of use to man. Some, such as cellulose, have been prepared and used by man for centuries; others, such as the bacterial xanthans, are recent products of microbial technology. It is amongst the microbial polysaccharides that we can look for the greatest potential production of useful polysaccharides. The techniques and equipment for the selection and industrial mass culture of microbes are at our disposal.

Hand in hand with the production of polysaccharides must go an understanding of their degradation. Microbes are of paramount importance in the enzymic breakdown of polysaccharides. For man this is doubled-edged, with properties such as cellulolysis and amylolysis leading to great commercial benefit or great commercial loss according to circumstances.

This book is an outcome of the 83rd Ordinary Meeting of the Society for General Microbiology, at the University of Aberdeen, September 1978. It combines the Society Symposium, 'The Microbial Degradation of Polysaccharides' and the Microbial Cell Surfaces and Membranes Group Symposium 'Microbial Extracellular Polysaccharides'. Our intention has been to provide a timely compilation of the current academic and industrial achievements in these topics, and to point to future developments.

ACKNOWLEDGEMENTS

We wish to thank Georges Ware, Cyd van Hemel and Helen Parker for their considerable assistance in compiling the index by computer, Renate Majumdar for the excellence of her typing and Judy Sibley and Sue Corbett of Academic Press for their unfailing helpfulness.

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Chapter 1

MICROBIAL EXOPOLYSACCHARIDES: CONTROL OF SYNTHESIS AND ACYLATION

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Introduction

Microbial extracellular polysaccharides (exopolysaccharides) range in the complexity of their chemical structures from homopolysaccharides with one or more type of linkage to heteropolysaccharides containing several different monosaccharides, some of which may be present in more than one molar equivalent. In addition, various acyl groups may be present, the most common being acetate as O-acetyl groups and pyruvate in the form of ketals attached to the 3 and 4 or 4 and 6 positions of one of the neutral sugar residues, or more rarely, to a uronic acid (Figure 1). Although the gross structure of a number of exopolysaccharides has now been determined, only two of these can currently be considered to be of industrial importance - alginates [see Jarman, Chapter 2] and the exopolysaccharide of the plant pathogen *Xanthomonas campestris* [Jansson *et al.*, 1975; Melton *et al.*, 1976; Evans *et al.*, Chapter 3; Gabriel, Chapter 8]. Detailed structures of several other polysaccharides produced industrially have not yet been reported. Alginates can be considered essentially as homopolymers of D-mannuronic acid subsequently modified by an extracellular epimerase converting some of the D-mannuronic acid residues to L-guluronic acid [Deavin *et al.*, 1977]. Most heteropolysaccharides are however, composed of repeating units varying in size from disaccharides to hexasaccharides or even larger oligosaccharides. In this respect, *Xanthomonas campestris* polysaccharide (Figure 2) resembles a number of other exopolysaccharides, the structures of which have been elucidated and examples of which are shown in Table 1. Where it differs from these other polymers is that the backbone is a cellulose molecule substituted on alternating glucose units by an acylated trisaccharide (or possibly occasionally smaller oligosaccharide) which may also be pyruvylated.

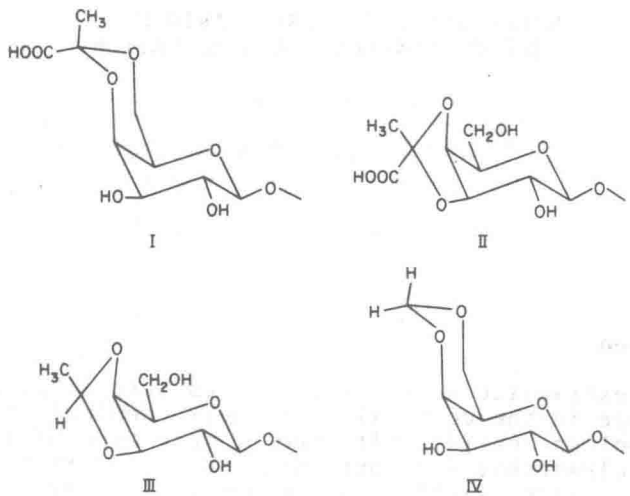


Fig. 1 Ketals attached to the terminal reducing galactose residues of colanic acids from different strains of *Escherichia coli* and *Salmonella typhimurium*. From Garegg *et al.* [1971a, b].

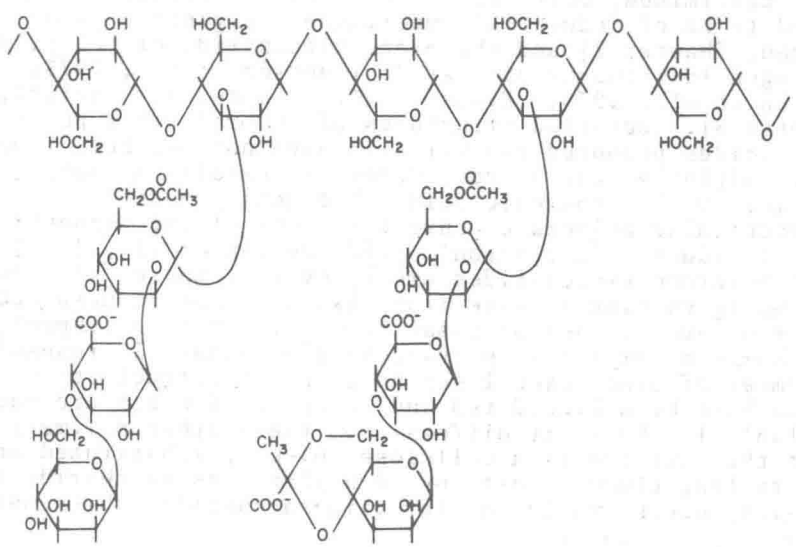
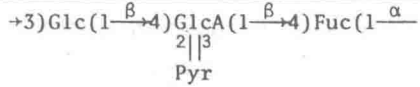
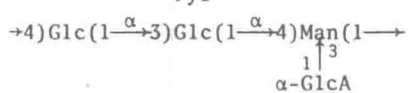
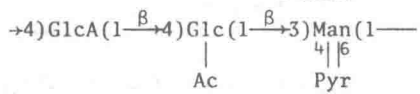
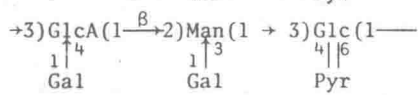
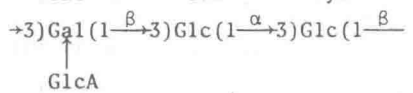
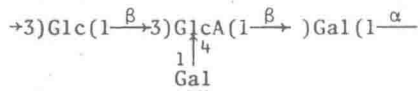
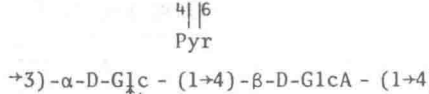


Fig. 2 Structure of extracellular polysaccharide of *Xanthomonas campestris*, according to Jansson *et al.* [1975].

TABLE 1

Repeating unit structures of Klebsiella exopolysaccharides

Type	Components	Structure	Reference
1	Fucose, glucose, glucuronic acid, pyruvate		Erbing *et al.* [1976]
2	Mannose, glucose, glucuronic acid (various acyl groups)		Gahan *et al.* [1967] Sutherland [1972]
5	Mannose, glucose, glucuronic acid, pyruvate, acetate		Dutton and Yang [1973]
7	Mannose, glucose, galactose, glucuronic acid, pyruvate		Dutton *et al.* [1974]
8	Glucose, galactose, glucuronic acid (acetate, pyruvate)		Sutherland [1970]
11	Galactose, glucose, glucuronic acid, pyruvate		Thurow *et al.* [1975]
16	Fucose, glucose, glucuronic acid, galactose		Chakraborty *et al.* [1977]