the smallest acceptor to give an incorporation product. The linkage of the incorporated radioactive glucose to the maltosaccharide was shown to be (1→6) by partial acid hydrolysis and methylation studies on a branched heptasaccharide formed from maltohexaose and radioactive glucose. The incorporation products were resistant to pullulanase, indicating that the radioactive glucose residue is present as a single stub. The action of β -amylase on the branched oligosaccharides gave further information on their structures.

The variation of the extent of incorporation with pH was studied with different acceptor substrates. With glycogen or Schardinger dextrans as acceptor substrates optimum incorporation occurred at pH 7.0 and 5.6, whereas with glycogen β -limit dextrin as acceptor a single optimum value at pH 7.0 was produced. With maltosaccharides of degree of polymerization 7 and 13 maximal incorporation occurred at pH 5.6. These results indicate that two related types of incorporation reaction that differ in pH optima are taking place.

We thank Professor D. J. Manners for his advice and encouragement during the course of this work.

Hers, H. G. (1964). *Adv. metab. Disorders*, 1, 2.

Manners, D. J. & Stark, J. R. (1967). *Abstr. FEBS 4th Meet., Oslo*, p. 14.

Nelson, T. E. & Larner, J. (1970). *Biochim. biophys. Acta*, 198, 538.

Properties of an α -Mannosidase from *Streptomyces* WL 6

By J. K. BAIRD and W. L. CUNNINGHAM. (*Department of Brewing and Biochemistry, Heriot-Watt University, Edinburgh EH1 1HX, U.K.*)

The purification and properties of α -mannosidases from several sources have been described recently. The enzyme from jack-bean meal (Li, 1967; Snaith & Levvy, 1968) hydrolyses α -mannosides containing aromatic aglycones, whereas the enzyme from an *Arthobacter* species shows little activity against such compounds but will degrade yeast mannan extensively (Jones & Ballou, 1969), a property that is not always associated with the other α -mannosidases.

Tanaka & Phaff (1965) observed that glucose and mannose were liberated from yeast cell walls by *Streptomyces* WL 6, an organism isolated by them from soil. They concluded that the streptomycete produced both glucanase and mannanase. During a study on the production of protoplasts from yeast cells by using the culture filtrate of this organism, we observed that an active α -mannosidase was also present. This α -mannosidase could be induced, in

quantity, by substituting yeast mannan as the carbon source, as found with *Streptomyces griseus* (Hockenhull, 1960).

Streptomyces WL 6 was grown for 6 days at 25°C in medium of pH 6.5, containing yeast mannan (0.5%), yeast extract (0.05%), tryptone (0.05%) KH_2PO_4 (1.36%) and salts. Ammonium sulphate was added to the culture fluid after removal of the cells. The fraction precipitated by 10–70% saturation was dialysed against 10 mM-phosphate buffer, pH 6.5, containing 0.1 mM- Ca^{2+} . Non-diffusible material was further purified by chromatography on DEAE-Sephadex.

A fraction was obtained that showed a 36-fold increase in purification of α -mannosidase activity measured with *p*-nitrophenyl α -mannoside as substrate. This preparation also hydrolysed manno-biose, mannotriose and mannotetraose derived from yeast mannan, methyl α -mannoside to a limited extent, and *p*-nitrophenyl α -glucoside, methyl α -glucoside, isomaltose, maltose and laminaribiose not at all. K_m values obtained were: for *p*-nitrophenyl α -mannoside, 3.3×10^{-3} M; for manno-biose, 2.0×10^{-3} M; for mannotriose, 7.5×10^{-3} M. Yeast mannan was slowly hydrolysed to mannose to a limited extent, indicating that the enzyme has exomannanase activity. The activity of the enzyme against *p*-nitrophenyl α -mannoside was stimulated by Ca^{2+} but inhibited by Cu^{2+} , Mg^{2+} and Zn^{2+} . There are therefore some differences between this enzyme and the α -phenylmannosidase present in *Streptomyces griseus* (Hockenhull, Ashton, Fantes & Whitehead, 1954).

We are indebted to Dr H. J. Phaff for a culture of *Streptomyces* WL 6. We thank the Science Research Council for a research studentship to J. K. B.

Hockenhull, D. J. D. (1960). *Prog. ind. Microbiol.* 2, 133.
Hockenhull, D. J. D., Ashton, G. C., Fantes, K. H. & Whitehead, B. K. (1954). *Biochem. J.* 47, 93.

Jones, G. H. & Ballou, C. E. (1969). *J. biol. Chem.* 244, 1043.

Li, Y.-T. (1967). *J. biol. Chem.* 242, 5474.

Snaith, S. M. & Levvy, G. A. (1968). *Biochem. J.* 110, 663.

Tanaka, H. & Phaff, H. J. (1965). *J. Bact.* 89, 1570.

An Effect of Amino Acid Analogues on Extension Growth in Pea Root Segments under Aseptic Conditions

By D. VAUGHAN and EVELYN CUSENS. (*Department of Biochemistry, The Macaulay Institute for Soil Research, Aberdeen AB9 2QJ, U.K.*)

Segments cut 2–4 mm from the root tip of 2-day-old seedlings of *Pisum sativum* (var. Meteor) elongate by 30% when cultured aseptically in water for 18 h. Elongation is enhanced by the