incubated wheat bran, the induction was not inhibited by actinomycin D, chloramphenicol, puromycin or cycloheximide. Further, when homogenates of the bran from ungerminated grain were incubated alone for several hours at 30°, their phytase activities steadily increased. This situation is similar to that described for β -amylase by Rowsell & Goad (1964).

We are indebted to the Science Research Council for the award of Research Studentships to D.E. and R.J.A.T.

Eastwood, D. & Laidman, D. L. (1968). *Biochem. J.* **109**, 10P.

Eastwood, D., Tavener, R. J. A. & Laidman, D. L. (1969). *Nature, Lond.*, **221**, 1267.

Rowsell, E. V. & Goad, L. J. (1964). *Biochem. J.* **90**, 12P.

Tavener, R. J. A. & Laidman, D. L. (1968). *Biochem. J.* **109**, 9P.

The Effects of Plant Hormones on the Efflux of Inorganic Ions from Wheat Aleurone Tissue

By D. EASTWOOD and D. L. LAIDMAN. (*Department of Biochemistry and Soil Science, University College of North Wales, Bangor*)

During germination the macro-nutrient elements potassium, phosphorus, magnesium and calcium stored in the aleurone tissue of the quiescent grain are translocated to the developing seedling. Undoubtedly, the permeability of the membranes of the aleurone cells plays an important role in controlling this process. Some permeability characteristics of these membranes in the aleurone cells of ungerminated grain were reported by Eastwood & Laidman (1968).

Bran isolated from ungerminated, quiescent grains rapidly released its entire reserves of macro-nutrient elements into aqueous incubation media. In contrast, bran from grains germinated for 48 hr. released inorganic ions at rates less than half of the values with ungerminated grain. Further, about 50% of the aleurone content of potassium, phosphorus, magnesium and calcium was now unavailable for efflux from the tissues. After further periods of germination, efflux rates from the isolated, incubated brans increased again to a maximum on the fifth day of germination.

De-embryoed grains (endosperm halves) were allowed to imbibe water for 48 hr. under germination conditions. The bran of these endosperm halves was found to have undergone a decrease in ion-efflux capacity identical to that occurring in the intact germinating grain. However, when the bran from ungerminated grain was incubated alone under conditions of minimal mineral loss, no reduction in its ion-efflux capacity occurred. Applications of

starchy endosperm extracts with known cytokinin activity (Tavener & Laidman, 1968) to the bran induced a decrease in efflux rates almost as great as that induced by the changes *in vivo*. Authentic cytokinins at 0.05 μ M were also active in inducing the reduction in efflux rate. The other plant hormones were completely inactive. The cytokinin action was strongly suppressed by inhibitors of DNA transcription and protein synthesis. These observations suggest that a cytokinin from the endosperm of wheat induces changes in the permeability of membranes in the aleurone cells early during germination. Protein synthesis appears to be involved in the induction process.

When cytokinin-treated bran was subsequently incubated for up to 3 days with 10 μ M-gibberellic acid, an increase in ion-efflux rates resulted. Cycloheximide and 1.0 μ M-abscissic acid completely inhibited the gibberellic acid action, although a number of other inhibitors of DNA transcription and protein synthesis were without effect.

We are indebted to the Science Research Council for the award of a Research Studentship to D.E.

Eastwood, D. & Laidman, D. L. (1968). *Biochem. J.* **109**, 10P.

Tavener, R. J. A. & Laidman, D. L. (1968). *Biochem. J.* **109**, 9P.

The Dehydrogenation Sequence leading to Coloured Carotenoids in Photosynthetic Bacteria

By B. H. DAVIES and E. ANN HOLMES. (*Department of Biochemistry and Agricultural Biochemistry, University College of Wales, Aberystwyth*)

The sequence of reactions in which phytoene undergoes a stepwise dehydrogenation through phytofluene, ζ -carotene and neurosporene to lycopene was first suggested by Porter & Lincoln (1950) and is now established as the basic pathway of carotenoid formation in a wide variety of organisms. The structures of the intermediates were established by unambiguous synthesis (Davis, Jackman, Siddons & Weedon, 1961, 1966); the symmetrical structure of ζ -carotene (7,8,7',8'-tetrahydrolycopene) implies that the dehydrogenation steps occur alternately to the left and to the right of the central chromophore.

A conjugated heptaene, assumed to be ζ -carotene, was isolated from diphenylamine-inhibited cultures of *Rhodospirillum rubrum* by Goodwin & Osman (1954). Jensen, Cohen-Bazire, Nakayama & Stanier (1958) showed that this compound, together with other precursors, disappeared when the inhibition was removed and they deduced that the Porter &