Lincoln sequence operates in photosynthetic bacteria.

ζ -Carotene from tomato fruit or carrot root has absorption maxima in light petroleum at 378, 400 and 425nm., but the corresponding values for the *R. rubrum* heptaene are 376, 396 and 418nm., suggesting that the two heptaenes are different.

Chromatographic studies have eliminated the possibility of one of the heptaenes either having a different number of carbon atoms in the molecule or containing two β -ionone rings, and isomerization studies show that both have the all-*trans* configuration. The possibility that the *R. rubrum* heptaene has its chromophore located unsymmetrically in the molecule is strengthened by the close agreement between its absorption spectrum and that reported for a synthetic unsymmetrical isomer of ζ -carotene (Davis *et al.* 1966).

Mass spectrometry confirms that both the natural heptaenes are $C_{40}H_{60}$ and that the ζ -carotene from carrot root is symmetrical (7,8,7',8'-tetrahydrolycopene), showing fission at the C-3-C-4 and C-7-C-8 bonds. The heptaene from *R. rubrum*, however, shows additional fission at the C-11-C-12 bond, confirming that it is the unsymmetrical isomer (7,8,11,12-tetrahydrolycopene).

Thus, in these bacteria, there is a novel dehydrogenation sequence, involving two consecutive dehydrogenations at one side of the central chromophore followed by two at the other, so that phytofluene, 7,8,11,12-tetrahydrolycopene and neurosporene are the intermediates in the formation of lycopene from phytoene.

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Trisporic Acid Biosynthesis and Carotenogenesis in *Blakesleea trispora*

By D. G. AUSTIN, J. D. BU'LOCK and D. J. WINSTANLEY. (*Microbial Chemistry Laboratory, Department of Chemistry, University of Manchester*)

Trisporic acids form only in mixed cultures of (+) and (-) strains of *B. trispora* and related Phyco-

mycetes, where they mediate increased carotenoid synthesis by an inducer-like action on the (-) strain. They are oxidized unsaturated derivatives of 1,1,3-trimethyl-2-(3-methyloctyl)cyclohexane, and biogenetically they could be classed as elaborated sesquiterpenes, or as degraded diterpenes, or as degraded carotenoids. However, synthesis of the trimethylcyclohexyl system has so far only been demonstrated to occur at the C_{40} level, i.e. in cyclic carotenoids.

With pre-mated cultures on malt-extract media, to optimize trisporic acid yields, added $[2-^{14}C]$ -mevalonate was incorporated into both β -carotene and trisporic acids. Degradation of the latter by reductive ozonolysis revealed four equally labelled C_5 units in the C_{18} molecule, which must therefore be derived either from a diterpenoid or from carotenoid precursor. Plausible mechanisms can be proposed for the formation of trisporic acids from a dicyclic diterpene or from β -carotene but currently we prefer the latter suggestion for the following reasons.

Labelled β -carotene is a better precursor of trisporic acids than is $[2-^{14}C]$ -mevalonate. Moreover, when the conversion of phytoene into β -carotene is blocked with diphenylamine the trisporic acids are not formed. This suggests that the trisporic acids are formed from the carotenoids whose synthesis they promote. Similar biogenetic origins seem equally probable for related trimethylcyclohexane derivatives in other organisms, such as β -ionone, the abscisins, and various insect products.

New Pathways of Methoxy Carotenoid Formation in *Rhodospirillum rubrum*

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

In *Rhodospirillum rubrum*, spirilloxanthin is normally formed from lycopene by a series of consecutive reactions that involves the hydration of an isopropylidene end group to form a tertiary alcohol, the introduction of a double bond in conjugation with the polyene chain at the hydroxylated end, and the methylation of the tertiary hydroxyl group. These reactions convert lycopene first into anhydorrhodovibrin and then, by occurring at the unchanged end of the molecule, convert anhydorrhodovibrin into spirilloxanthin (Jensen, 1961; Jensen, Cohen-Bazire & Stanier, 1961).

In the present work on the pigments of diphenylamine-inhibited cultures of *R. rubrum*, two carotenoids that were described by Goodwin & Osman (1954) and designated P450 and P412 by Jensen,