pentoses, did not appear unless both hexosediphosphate and glycolaldehyde were present as substrates, and then only after the formation of xylulose, it is most unlikely that it was the product of the oxidative decarboxylation of hexose compounds. The evidence suggests that the synthesis was the result of the coupling of dihydroxyacetone phosphate and glycolaldehyde to give xylulose-1-phosphate, and the successive conversion of this compound to a ribulose phosphate and thence to ribose phosphate.

Since liver tissue has been shown to contain a pentose-phosphate isomerase[6], the synthesis of ribose in a system already giving rise to ribulose phosphate might be expected; the conversion is established as an essential step in the formation of ribose by the oxidative decarboxylation of hexose derivatives[7]. The mechanism of the formation of ribulose phosphate from xylulose phosphate, involving an inversion at carbon-3, is less readily explained, though it could be regarded as bearing some analogy to the conversion of glucose to galactose for which a specific waldenase enzyme system exists[8], or to the interconversion of ribulose and arabinose, for which an enediol intermediate has been suggested[2]. It seems clear, however, from these experiments that, contrary to earlier views, ribose—like deoxyribose—can be synthesized in animal tissues by a condensation of 2-carbon and 3-carbon compounds.

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Prosthetic Group of Cytochrome a_2

Cytochrome a_2, which is found in certain bacteria, for example, *Aerobacter aerogenes* and *Azotobacter*, has particular interest as it may play the part of a cytochrome oxidase in these organisms. The main absorption band of this cytochrome in the visible part of the spectrum is in the red region: reduced, 630 mμ; oxidized, 645 mμ; carbon monoxide complex, 635 mμ. Spectroscopic similarities to some ferrophæophorbides[1] as well as to certain bile pigment iron complexes[2] have been observed.

We have now obtained hæmin a_2 free from protohæmin. *A. aerogenes* was cultivated under conditions of vigorous aeration by which the cytochrome a_2 content is increased[3]. The hæmins were extracted with acid-acetone and, after removal of phospholipids, the green hæmin a_2 was separated from protohæmin by precipitation of the latter by benzene.

The acid hæmatin (in glacial acetic acid) has a principal maximum of absorption at 603–5 mμ and a smaller maximum, of one-fifth the height, at 750 mμ. The alkaline hæmatin shows a maximum at 662–64 mμ, the hæm at 618 mμ, and the pyridine hæmochromogen at 613–15 mμ. Cyanide forms a compound with hæmatin a_2 in alkaline solution, causing the disappearance of the band at 662 mμ; on reduction with dithionite, a band appears at 618 mμ. Carbon monoxide also reacts with hæm a_2; the band has the same position as that of the hæm, but is of greater intensity.

By removal of the iron from the hæmin by means of the ferrous acetate–hydrochloric acid or the ferrous formate method a chlorin-like pigment is obtained. Re-introduction of the iron restores the spectrum of hæmatin a_2. In neutral solvents this chlorin has two principal maxima of absorption. In dioxane they are 654 mμ and 503 mμ. Three much weaker bands are found at 597, 572 and 533 mμ. The Soret band has a maximum at 405 mμ. In 10 per cent hydrochloric acid a maximum is shown at 630 mμ. The position of these maxima differs from those of the chlorins, phæophorbides or rhodins, for which data are recorded in the literature.

The 'HCl number' of the free chlorin is close to that of protoporphyrin; but the R_F value of the methyl ester of the chlorin when run on paper chromatograms using the kerosene–chloroform or kerosene–propanol solvents of Chu *et al.*[4] is markedly less than that of protoporphyrin ester.

Lipoid material remains even in the purest preparations. It is possible that, like porphyrin *a*[5], the prosthetic group of cytochrome a_2 possesses a lipophilic side-chain.

When the chlorin and the hæmatin were treated with hydroxylamine by the methods of Lemberg and Falk[6], there was no shift in the position of the band at 652 mμ of the chlorin in pyridine or the band at 615 mμ of the pyridine hæmochromogen. Thus it is unlikely that the side-chains of the prosthetic group possess a formyl or carbonyl group.

The evidence for assuming that this hæmin and chlorin were derived from cytochrome a_2 is as follows. The intensity of the acid hæmatin band at 603 mμ, or of the chlorin band at 652 mμ in acetone, was proportional to that of the cytochrome a_2 band. *Azotobacter vinelandii*, *Escherichia coli* and *Proteus vulgaris*, all known to contain cytochrome a_2, yielded this hæmin and chlorin. When the bacteria were grown anaerobically, neither cytochrome a_2, hæmin a_2, nor chlorin was obtained. Some organisms such as *Bacillus mycoides*, *Bacillus subtilis* and *Pseudomonas aeruginosa* developed relatively small amounts of cytochrome a_2 when grown in liquid medium with vigorous aeration, and correspondingly gave small amounts of this hæmin and chlorin.

We therefore conclude that the isolated hæm and chlorin are the prosthetic group and iron-free prosthetic group, respectively, of cytochrome a_2.

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