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Nature and Distribution of Terpene Quinones

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The terpene quinones observed in Nature are, according to their quinone component, divided into phyloquinone, menaquinones, ubiquinones and plastoquinones. Variations within the particular groups are caused by the length of the side chain, the number of double bonds and, for a few of them, the oxygen function within the side chain.

Plants for phyloquinone and micro-organisms for menaquinones were identified exclusively as places of origin. However, animals, micro-organisms and plants are able to synthesize ubiquinones.

Animals also ingest terpene quinones with their food. Thus the question arises how the administered quinones are distributed, metabolized and excreted. Two methods are particularly suitable for observing the distribution in the various organs and tissues:

(1) administration of labelled compounds and localization of the radioactivity in the tissues after combustion; (2) radioautographic studies in the whole animal.

Results obtained up to now in the rat show that distribution and excretion in certain organs depend mainly on the length of the side chain. The degree of saturation of the side chain, too, seems to exert a certain influence.

Excretion takes place via bile and urine. The radioactive quinones are apparently excreted unchanged in the bile, but metabolites are found in the urine. Independent of the nature of the quinone component and the length and degree of saturation of the side chains, the latter are shortened to seven carbon atoms, and γ -lactones are formed.

Ubiquinones and plastoquinones were also studied with respect to their intracellular distribution. In plants as well as in animal cells, mitochondria are enriched with ubiquinone; however, plastoquinones are found in the chloroplasts.

The Biosynthesis of Terpenoid Quinones†

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Most of the work on this subject before 1966 has been well documented in monographs and reports of the proceedings of several symposia (see, e.g., Morton, 1965; Pridham, 1967; Harris, 1966). This presentation will deal mainly with the synthesis of ubiquinone and reference will be made to other quinones where significant differences appear.

The methyl groups of ubiquinone, both ring methyl and *O*-methyl, have been shown to arise from *S*-adenosylmethionine and the polyprenyl side chain from derivatives of mevalonate. The latter can exist in a variety of chain lengths with one to twelve isoprenoid unit groups in the side chain, depending on the source from which it is derived. The benzoquinone ring, however, has been shown to arise via POB,* and it is presumed that the latter is generated via the shikimate and chorismate pathways. The use of POB has provided a unique probe for tracing the metabolic sequences in ubiquinone biosynthesis, and has played the same role that mevalonate has in steroid and polyisoprenoid synthesis. The use of *p*-hydroxybenzaldehyde and POB as precursors of ubiquinone in *Rhodospirillum rubrum* (Parson & Rudney, 1965a,b)

* Abbreviations: POB, *p*-hydroxybenzoate; IPP, isopentenyl pyrophosphate.

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