a large number of quinones are capable of restoring oxidation, they do not restore this activity by the same respiratory sequence as does the natural quinone. By the use of respiratory inhibitors or by following the reduction of the respiratory carriers spectrophotometrically, it has been possible to show that many of the quinones that restore only oxidation fail to utilize the major respiratory chain but instead by-pass completely or bridge a section of the respiratory chain. Since quinones may accept electrons from one segment of the respiratory chain, by-pass other respiratory carriers and re-enter the terminal position of the major chain, it is possible to determine sites of phosphorylation within the segments that have not been by-passed. In this manner it has been possible to demonstrate phosphorylative sites in the span between NAD^+ and quinone, between quinone and cytochrome *b* and between cytochrome *c* and oxygen.

Studies with the quinone-depleted system have indicated that the quinones may be directly involved in the phosphorylative events. Incubation of the quinone-depleted system with vitamin K_1 , inorganic phosphate containing ^{32}P , and an electron donor resulted in the formation of a lipid-extractable quinone that was distinct from vitamin K_1 and dihydrovitamin K after chromatography. Of interest was the finding that the enzymically formed compound co-migrated with the synthetic chromanyl phosphate derivative of vitamin K_1 . The enzymically formed compound appeared to be derived from vitamin K_1 , since it was found to contain ^{14}C in experiments in which the starting quinone was ^{14}C -labelled vitamin K_1 . The u.v. and i.r. spectra and chromatographic properties of the enzymically formed compound were found to be compatible with a phosphorylated derivative of reduced vitamin K . Although the enzymically formed compound is unstable, a stable addition complex can be formed with mercaptoethanol. This stable complex may permit chemical characterization of the quinol derivative.

It has been possible to obtain some information about the role of quinones in oxidative metabolism. However, it has been shown that bacteria contain a large number of different types of quinones. For example, *M. phlei* contains $\text{MK}_9(\text{II-H})$ and $\text{MK}_8(\text{II-H})$. Other micro-organisms may contain both benzo- and naphtha-quinones, a series of one type of quinone differing in side chain length ($\text{C}_4\text{--C}_{10}$), or differing in the number of saturated isoprenoid units in the side chain. Any analysis of the role of quinones in oxidative metabolism must take into account the possible function of the numerous quinones found in one system. These compounds may represent residual products of quinone biosynthesis or degradation or may play a more subtle metabolic role.

Terpenoids in Insects

By PETER KARLSON. (*Institut für Physiologische Chemie der Philipps-Universität, Marburg/Lahn, Germany*)

This review deals with the occurrence and function in insects of various compounds that are presumably derived from mevalonic acid. The biochemical pathways of their biogenesis are largely unknown.

Sterols and steroid hormones. It is well known that insects are unable to synthesize cholesterol or other sterols from mevalonate. Sterols are essential nutritional factors. However, insects are able to convert cholesterol into ecdysone and 20-hydroxyecdysone. The biochemistry of these 'moulting hormones' will be reviewed briefly. Recent work in my laboratory has led to the preliminary characterization of an enzyme system that converts ecdysone into two metabolites that are biologically inactive.

Juvenile hormones. Two naturally occurring juvenile hormones have been identified. They differ from methyl 10,11-epoxyfarnesoate in having one or two ethyl groups instead of the usual methyl groups. Several C_{15} terpenoids from plants, e.g. juvabione, have considerable juvenile-hormone activity. The same is true for derivatives of farnesol and for synthetic substances structurally related to juvabione.

Pheromones and defence substances. Pheromones are secretions that serve as 'chemical messengers' among individuals of the same species. Among these, we find some terpenoid alcohols and aldehydes (e.g. geraniol, citronellal). The biology of these compounds will be reviewed. Even larger is the spectrum of the defence substances. Remarkably, cortexone and other corticosteroids serve as defence substances for some aquatic beetles. Ants produce a wide variety of defence substances, which are mostly related to terpenoids, e.g. dendrolasin and iridomyrmecin, a lactone possessing antibiotic and insecticidal properties.

Biosynthesis of Terpenoid Alkaloids

By A. R. BATTERSBY. (*Department of Organic Chemistry, University of Liverpool*)

Both the fungi and the higher plants form natural products in which nitrogen has been built into a skeleton which, by its structure, is apparently terpenoid in origin or at least partly so. Examples are the alkaloids of ergot, the diterpene bases present in many *Aconitum* species, the simple pyridine and piperidine alkaloids from *Skytanthus* and so on. Undoubtedly the largest group of nitrogenous terpenes, however, is that containing