Coenzyme Q10

Since some forms of vitamin E have potent anticancer activity, we now consider another lipid-soluble antioxidant, coenzyme Q10. There is evidence that coenzyme Q10 levels are lower in cancer patients, perhaps reflecting increased oxidative stress.[1068,1069]

Coenzyme Q10 is a member of a class of related molecules, called ubiquinones, because of their chemical structure and the fact that they are found in so many cell types. Coenzyme Q10 is manufactured in the body, although synthesis depends on many other nutrients, including eight vitamins.[1070] Its production therefore depends on good nutrition. Some drugs, such as the statins that are used to lower cholesterol, can prevent synthesis of coenzyme Q10.[e] Ensuring an adequate supply of coenzyme Q10, especially during aging, may be difficult without nutritional supplementation.

The health benefits of coenzyme Q10 are widely reported and it has become a popular nutritional supplement. For years, it has been used to treat heart failure and other cardiovascular disorders.[1071,1072] Coenzyme Q10 has also been used to reduce the tissue damage caused by conventional cancer chemotherapy.[1073]

Karl Folkers, a leading chemist, was a major proponent of coenzyme Q10 and its use in the prevention and treatment of disease.[1074] Working at **Merck,** he led a research team that was first to isolate vitamin **B_{12}, in 1948**. In 1951, he gained the Scientific Award of the Board of Directors at Merck.

[e] Anyone taking statin drugs needs to supplement with coenzyme Q10 to reduce the risks of severe side effects. However, this advice is generally not provided by the prescribing physician.

This award was given,
"To honor his vision and research acumen, and to honor his many scientific contributions to mankind, especially his research on antibiotics and vitamins, culminating in the isolation and crystallization of vitamin B-12."

Nowadays, it seems surprising that a pharmaceutical company could value basic research into nutrients in this way. In 1956, Folkers was promoted to the position of Executive Director of Fundamental Research at Merck. **In 1958, he determined the structure of coenzyme Q10**. However, he resigned from Merck in 1963, as he wished to continue his work on coenzyme Q10 and its implications in disease. By this time, the drug company did not agree with the direction of his research. In later years, Folkers published many papers on the benefits of coenzyme Q10 in health and disease.

In one of these, an uncontrolled study, 32 **breast cancer patients** with poor prognosis were given an antioxidant cocktail, **in addition to coenzyme Q10 at 90mg per day. This included vitamin C (2,850 mg), vitamin E (2,500 iu), beta-carotene (32.5 iu), selenium (387 µg), essential fatty acids and other supportive vitamins and minerals**. No patient died, although the expected number of deaths was reported as four, and nonehad additional metastases.[1075] The patients' quality of life was improved, reflected by reduced weight loss and need of painkillers. In addition, **six patients appeared to have a partial remission**. However, the number of nutrients given makes interpretation of this study difficult.

In a later report, Folkers described how he gave an increased dose of coenzyme **Q10 (390 mg per day) to one of these patients**, who was showing signs of remission. After one month, the tumour could no longer be felt through the skin. Two months later, it could not be seen using X-ray examination.

Encouraged, Folkers treated another case with **300mg** per day of coenzyme Q10. This patient had a verified, residual breast tumour, following non-radical surgery. Three months later, the patient was in excellent condition, with no residual tumour tissue. Three additional remissions from advanced breast cancer were reported.[1076]

These patients had undergone conventional therapy, with the addition of coenzyme Q10 at 390mg per day. Over a period of 3-5 years, numerous metastases in the liver of a 44-year-old patient "disappeared", and no new metastases were found in the body. In another case, a 49-year-old patient had a tumour in her pleural cavity. After six months, all signs of this disappeared and her condition was described as excellent. The final patient in this group was a 75-year-old,

who had a lumpectomy for cancer of one breast and, after treatment including coenzyme Q10, showed no residual cancer, in either the tumour bed or metastases. Folkers also reported eight patients who survived for a period of five to fifteen years.[1077]

Folkers' evidence is relatively weak. For example, the experiments were poorly controlled and the patients had other treatments that could have been effective. However, even if we assume that these patients were "best case" studies, the findings indicate a need for follow-up research. In 1999, researchers from Britain and Denmark suggested that coenzyme Q10 might have a role in cancer therapy. As a result of the animal studies and the above clinical observations, they demanded proper clinical trials.[1078] Some cancer patients, especially women, may already be

self-supplementing with coenzyme Q10 as an alternative cancer therapy.[1079] John Ely has suggested that if coenzyme Q10, glycaemic reduction and vitamin C supplementation were employed regularly, cancer would cease to be a leading cause of death.[814]

The chemical structure of coenzyme Q10 is similar to that of vitamin K.[f] Like vitamin K, coenzyme Q10 has an oxidation-reduction cycle. There are other similarities. Coenzyme Q10 inhibits cell division and apoptosis.[1080,1081] Moreover, coenzyme Q10 is directly involved in metabolism and affects the oxidation state of mitochondria.[1082,1083] Oxidation of coenzyme Q10 can produce hydrogen peroxide.[1084,1085] Mitochondrial oxidation of coenzyme Q10 has been cited as a primary source of both superoxide and hydrogen peroxide in cells.[1086] This oxidant generation is controlled by the redox state, and is related to the energy available in the mitochondria.[1085] Conditions such as increased oxidative stress, which disturb the binding of coenzyme Q10 to protein, may encourage peroxide production.[1087] Coenzyme Q10 may selectively produce oxidation in cancer cells.

Finally, we have mentioned that dietary restriction can help to slow or kill cancers. It has been proposed that these effects work, at least in part, by increasing levels of coenzyme Q10.[1088] We can conclude that the evidence for coenzyme Q10 is suggestive of a redox-mediated anticancer effect. Indeed, coenzyme Q10 has properties consistent with our requirements for a non-toxic anticancer substance.

[f] Both vitamin K and coenzyme Q10 are quinones.