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Uranyl Phthalocyanines Show Promise in the Treatment of Brain Tumors

The problem:

To devise a process for synthesizing sulfonated and nonsulfonated uranyl phthalocyanines. These are stable, nontoxic uranyl compounds which have shown promise as fissionable materials for the neutron therapy of brain tumors.

The solution:

Two new processes have been developed for synthesizing uranyl phthalocyanine and sulfonated uranyl phthalocyanine. Tests conducted on laboratory animals to determine the effectiveness of these compounds in treating brain tumors indicate that the compounds offer a number of advantages over the boron and lithium compounds that have been used previously for this treatment.

How it's done:

The water-insoluble uranyl phthalocyanines are made by mixing an inorganic uranyl salt, such as uranyl nitrate hexahydrate or uranyl chloride, with a Lewis-base-type nitrogen or sulfur-containing organic compound, such as dimethyl formamide (DMF) or methyl sulfoxide. This mixture causes the following reaction:

$$UO_2(NO_3)_2 \cdot 6H_2O + 2DMF \rightarrow UO_2(NO_3)_2 \cdot 2DMF + 6H_2O$$

In this reaction a water-free complex is formed between the uranyl salt and the organic compound. The uranyl compound is then separated from the liquid and mixed with a stoichiometric quantity of lithium phthalocyanine at room temperature under anhydrous conditions, forming a uranyl salt according to the following equation:

$$Li_2Pc + UO_2(NO_3)_2 \cdot 2DMF \rightarrow UO_2Pc + 2LiNO_3 + 2DMF$$

The uranyl phthalocyanine is isolated from the reaction mixture as a crystalline precipitate. Metal phthalocyanines of sodium, potassium, magnesium, or beryllium can also be used in this synthesis in place of the lithium phthalocyanine.

Sulfonated uranyl phthalocyanine can be synthesized by mixing sulfonated phthalocyanine in a water solution with a water-soluble salt such as uranyl sulfate and then boiling the solution for about three hours. This causes the uranyl radical to replace the hydrogen ions bound in the sulfonated phthalocyanine. The precipitate formed in this reaction is filtered off and suspended in water, through which hydrogen sulfide is bubbled, and the mixture is then refluxed. The uranyl precipitate is evaporated from this solution after filtering off the black precipitate with which it was mixed. The sulfonated uranyl phthalocyanine compounds prepared by this method are water soluble and can be purified with anion exchange resins.

These sulfonated or nonsulfonated monouranyl phthalocyanines contain fissionable uranium isotopes but are chemically nontoxic. The uranyl radical is bonded in the molecule so strongly that its dissociation cannot be detected analytically.

Both of these uranyl compounds have been found to be very effective in the treatment of locatable tumors in laboratory animals. A colloidal suspension of the insoluble uranyl phthalocyanine can be injected directly into the tumor of the animal. Bombardment with slow neutrons will then produce radiation to destroy the tumor. With the uranyl compounds of fissionable isotopes, not only gamma rays but also fission fragments of high energy levels are obtained.

The sulfonated water-soluble compounds can also be injected directly into a brain tumor in a laboratory

(continued overleaf)

animal, and bombarded with neutrons to produce radiation. It was found that the healthy brain tissue of laboratory animals rejects these compounds while the tumor tissue retains them. Within minutes the ratio of compound in the tumor to that in the healthy tissue is 50:1. The neutron bombardment is relatively harmless to any tissue other than the tumor tissue because of the small concentration of the phthalocyanine in the healthy tissue. When the tumor is bombarded with neutrons the ranges of the particles formed are 40-100 microns, thus damage to healthy tissue surrounding the tumor should be less than that caused by surgery.

The preferential concentration of the uranyl phthalocyanines in the tumor tissue affords a considerable advantage over the use of lithium and boron compounds previously employed, as these do not concentrate well in the brain tumor tissues.

Notes:

1. Additional details are contained in:
   a. Patent #3,027,391, available from U.S. Patent Office; $0.50 each.
   b. "Recent Developments in the Theory of Neutron Capture Theory," ANL-6910. This report is available from the Clearinghouse for Scientific and Technical Information, Springfield, Virginia 22151; price $1.00.
2. Inquiries concerning this innovation may be directed to:

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Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

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