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Research into chemical separation techniques for production of Bi-213 via irradiation of Ra-226

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Bismuth 213 is an alpha radioimmunotherapeutic agent used in cancer treatment. Neutron bombardment of radium 226 is being investigated as an alternative method of producing Bi-213. For this project, a literature search of existing chemical separation steps for the production of Bi-213 for radioimmunotherapy was performed in order to optimize the combination of irradiation schemes with chemical separation steps. For the first step, the separation of actinium and radium from thorium 229 and recovery of radium for further irradiation, several successful methods were described in the literature. Organic cation exchange columns such as AG50W-X8 have traditionally been used to perform this step, but these suffer high radiolysis, which newer methods have tried to address. Some of these are an extraction chromatography method using a UTEVA column followed by a RE-resin column on a silica gel support, an inorganic titanium phosphate ion exchanger, and sublimation of the anhydrous chlorides of Th-229 and its daughter isotopes performed in a quartz tube, featuring complete separation of the elements while radium is retained at the bottom of the tube and available for further irradiation in one step. For the second part of the process, the elution of Bi-213 from an Ac-225 generator, quite a few successful techniques are described in the literature. Some of the better ones found are a multicolumn selectivity inversion generator, a renewable column, tandem column extraction chromatography, a PNNL automated generator, a MSKCC generator, an inorganic hydrated zirconium cation exchanger, and silica based resins, as well as the more traditional organic cation and anion exchange columns. A method using alpha recoil of Bi-213 from Ac-225 incorporated into a sealed isotope generator has the benefit of resulting in no radioactive, chemical, or mixed wastes, in contrast to chemical separation methods. In conclusion, several promising separation techniques were found in the literature.