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Interaction mechanisms between actinides and a protein: the CALMODULIN

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Considering the environmental impact of the Fukushima nuclear accident, it is fundamental to study the mechanisms governing the effects of the released radionuclides on the biosphere and thus identify the molecular processes generating the transport and deposition of actinides, such as neptunium and uranium. However, the information about the microscopic aspect of the interaction between actinides and biological molecules (peptides, proteins···) is scarce. The data being mostly reported from a physiological point of view, the structure of the coordination sites remains largely unknown. These microscopic data are indeed essential for the understanding of the interdependency between structural aspect, function and affinity.

The Calmodulin (CaM) (abbreviation for CALcium-MODULated proteIN), also known for its affinity towards actinides act as a metabolic regulator of calcium. This protein is a Ca carrier, which is present ubiquitously in the human body, may also bind other metals such as actinides. Thus, in case of a contamination, actinides that bind to CaM could avoid the protein to perform properly and lead to repercussions on a large range of vital functions.

The complexation of Np and U was studied by EXAFS spectroscopy which showed that actinides were incorporated in a calcium coordination site. Once the thermodynamical and structural aspects studied, the impact of the coordination site distortion on the biological efficiency was analyzed. In order to evaluate these consequences, a calorimetric method based on enzyme kinetics was developed. This experiment, which was conducted with both uranium (50 –500 nM) and neptunium (30 –100 nM) showed a decrease of the heat produced by the enzymatic reaction with an increasing concentration of actinides in the medium. Our findings showed that the Calmodulin actinide complex works as an enzymatic inhibitor. Furthermore, at higher neptunium (100 nM) and uranium (500 nM) concentration the metals seem to have a poison-like behavior and "kill"completely the enzymatic activity.

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