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New insights into uranyl interaction with proteins

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Given uranium toxicity, comprehension of uranyl interaction with biological material of human relevance is of utmost importance, from the whole body scale to the molecular level. At the molecular level, uranium interaction with proteins has attracted a lot of attention, in particular the blood serum proteins Human Serum Albumin (HSA) and Transferrin, which are likely to transport uranyl in the body and therefore to play a key role in its toxicity (1-5).
It is well known that uranyl undergoes complex speciation at physiological pH, and can form complexes with serum small molecules such as carbonates, making the study of such systems rather intricate.

The interaction of uranyl with a protein was studied, while taking into account all known uranyl species that could exist at physiological pH. Bovine Serum Albumin (BSA) is well known to bind several metals, and shares similarities with Human Serum Albumin, which makes it a good candidate for a uranyl-binding protein model. The interaction was followed by means of UV-Visible spectroscopy, circular dichroism and fluorescence measurements (static and time-resolved). Strong fluorescence quenching of the protein was observed upon uranyl addition. Addition of BSA to a uranyl solution also resulted in uranyl fluorescence quenching. The data obtained were treated using speciation software CHEAQS and a fitting program developed in the laboratory.

On this experimental basis, the model proposed, involving two successive complexations of several uranyl moieties is in very good agreement with the experimental data. Our results allowed determination of the number of uranyl moieties complexed by the protein, as well as the corresponding equilibrium constants. Further experiments are in progress to determine the functional groups of the proteins involved in the complexation.

The experimental protocol and data analysis could be applied to virtually any protein containing enough fluorescent residues to measure the quenching induced by uranyl addition. Further studies with HSA are in progress, and first results will be also presented and compared to the literature (2,6).

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