Contribution ID : **37** Type : **Oral**

Adventures in Iron Biochemistry: X-ray Spectroscopy as a Tool for Studying Biological Iron Coordination Chemistry

Tuesday, 3 December 2019 10:45 (15)

Transition metals like iron (and copper) are catalytic biological cofactors of fundamental importance. The over abundance of potential ligands in biological fluids limits the fraction of solvated metal ions to vanishingly lower levels means coordination chemistry determines the reactivity and availability of biometals across cellular environments. Coordination chemistry is dynamic, responding to the pH, redox potential and concentration of ligands and metals. Traditionally, characterisation of specific metal-ligand species requires isolation of the complex, necessitating disruption of biological systems despite the attendant risk of mismetallation and loss of biochemical context. Despite the confounding potential of typical preparation methodologies, the tools available to study biological coordination chemistry in situ have remained limited. The synergy of synchrotron-based X-ray fluorescence microscopy (XFM) and X-ray absorption near edge structure (XANES) spectroscopy represents a powerful analytical approach for studying iron (and copper) biochemistry of individual cells within intact organisms. This permits quantitative mapping of metal distribution and profiling of the native coordination environment without the need for exogenous molecular probes.

We demonstrate the development of non-destructive XANES imaging, to study copper and iron speciation within cultured cells and the simple multi-cellular model organism Caenorhabditis elegans respectively. Further we utilise this technique to explore the changes in iron metabolism that accompany ageing and models of human disease in C. elegans showing how and where iron homeostasis is lost. This work has demanded particularly careful monitoring of the imaging dose associated with the measurement to avoid photoreduction in conjunction with monitoring of the sample environment to ensure data are representative of the native metalloarchitecture. While work is ongoing, we will highlight the potential applications of XANES imaging in biology and propose some heuristics that can safeguard against the introduction of measurement artefacts.

Speakers Gender

Male

Travel Funding

No

Level of Expertise

Experienced Researcher

Do yo wish to take part in the poster slam

No

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Session Classification : Session 16

Track Classification : Spectroscopy