Dr. Malgorzata Korbas

○アブストラクトデータ

Probing Hg Localization & Transformation in Tissues using X-ray Fluorescence Imaging and X-ray Absorption Spectroscopy

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Mercury exposure and toxicity is a health concern for many communities across the world.
Understanding the chemical changes in mercury and in related elements (e.g. selenium or calcium) within tissues is of vital importance in understanding mechanism and hence the health risks associated with exposure. Our research is focused on the development and the use of *in situ* probes of chemical form and localization using X-rays generated by synchrotron light. In this presentation we will review and discuss information on transport, localization and chemistry of mercury in tissues in both animal models and human tissues obtained using X-ray fluorescence imaging and X-ray absorption spectroscopy. Two recent studies on mercury and selenium speciation in human brain samples and whale skeletal muscles will be highlighted to illustrate the potential of these techniques to investigate molecular toxicology of mercury. We will also discuss the role of mercury speciation in the uptake and accumulation of mercury in different organs/tissues/cells of developing vertebrates. A special emphasis will be placed on specific accumulation of methylmercury in the sensory cells of the retina and the olfactory epithelium. Our results suggest that methylmercury may not only impact vision, hearing and olfaction on a neurological level, but also by a more direct effect on the respective sensory tissue.

○発表データ

Probing Hg Localization & Transformation Using Synchrotron Techniques

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John L. O'Donoghue
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Patrick H. Krone
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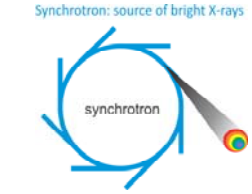
Stanford Synchrotron Radiation Lightsource, CA, USA

Advanced Photon Source, ANL, IL, USA

Synchrotron as a sensitive elemental probe



Various samples / model systems

Zebrafish

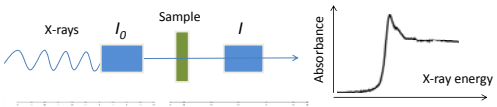
Pigmy whale

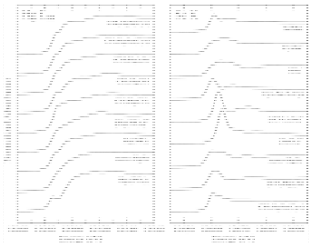
Human brain

X-ray Absorption Spectroscopy → **Chemical speciation**
Intact biological/environmental samples

X-ray Fluorescence Imaging → **Spatial distribution**
Thin slices/sections
Cell cultures
Intact plants

X-ray Absorption Spectroscopy





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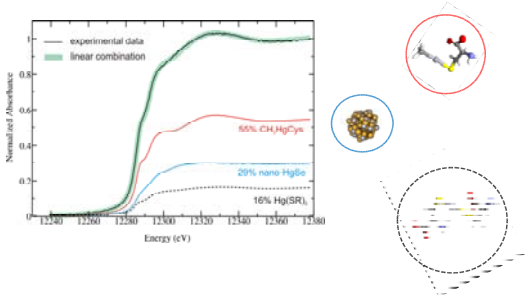
Near edge as chemical fingerprint



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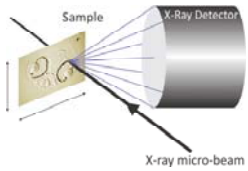
X-ray Fluorescence Imaging



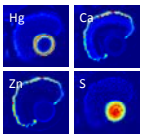
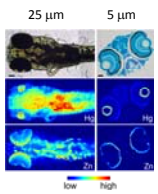


Image resolution determined by size of X-ray beam



Korbas et al. *Proc. Natl. Acad. Sci. USA* **2008**, 105, 12108-12112
Korbas et al. *ACS Chem. Biol.* **2012,** 7, 411-420

Mercury and Selenium

Methylmercury can cross the blood-brain barrier and accumulate in the brain

Mercury has very high affinity for selenium

It may specifically sequester the brain's selenium

This in turn may negatively affect the formation/activity of selenoproteins

SELENIUM DEPLETION HYPOTHESIS

Research objectives

To investigate the molecular nature of **mercury** and **selenium** in human brain samples

Case	1	2	3
Gender	F	F	M
Age (yrs)	29	48	60
Exposure	acute poisoning at age 8 yrs	acute poisoning 10 months prior to death	fish consumption
Toxicant	CH_3Hg-X	$(CH_3)_2Hg$	CH_3HgS(thiol)
Hg(ppb)	1179	2670	324
Pathology	severe atrophy	severe atrophy	normal

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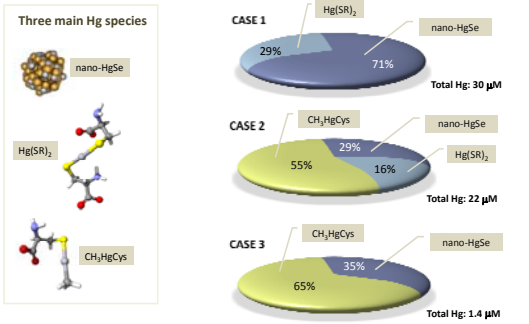
Hg speciation in human brain



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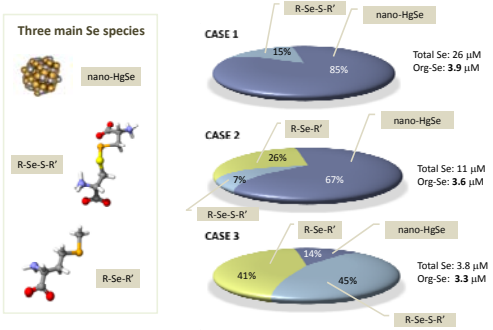
Se speciation in human brain



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Conclusions

Two chemically distinct Hg species following high and low exposures:

- mobile and **toxic** CH_3-Hg-S-(thiol)
- inert **nontoxic** HgSe

Total brain Hg cannot be used as a measure of Hg toxic potential

Se **not** involved in forming HgSe (organic Se) is remarkably invariant in all samples