Detection of Nanoparticles in Sediment-dwelling Worms

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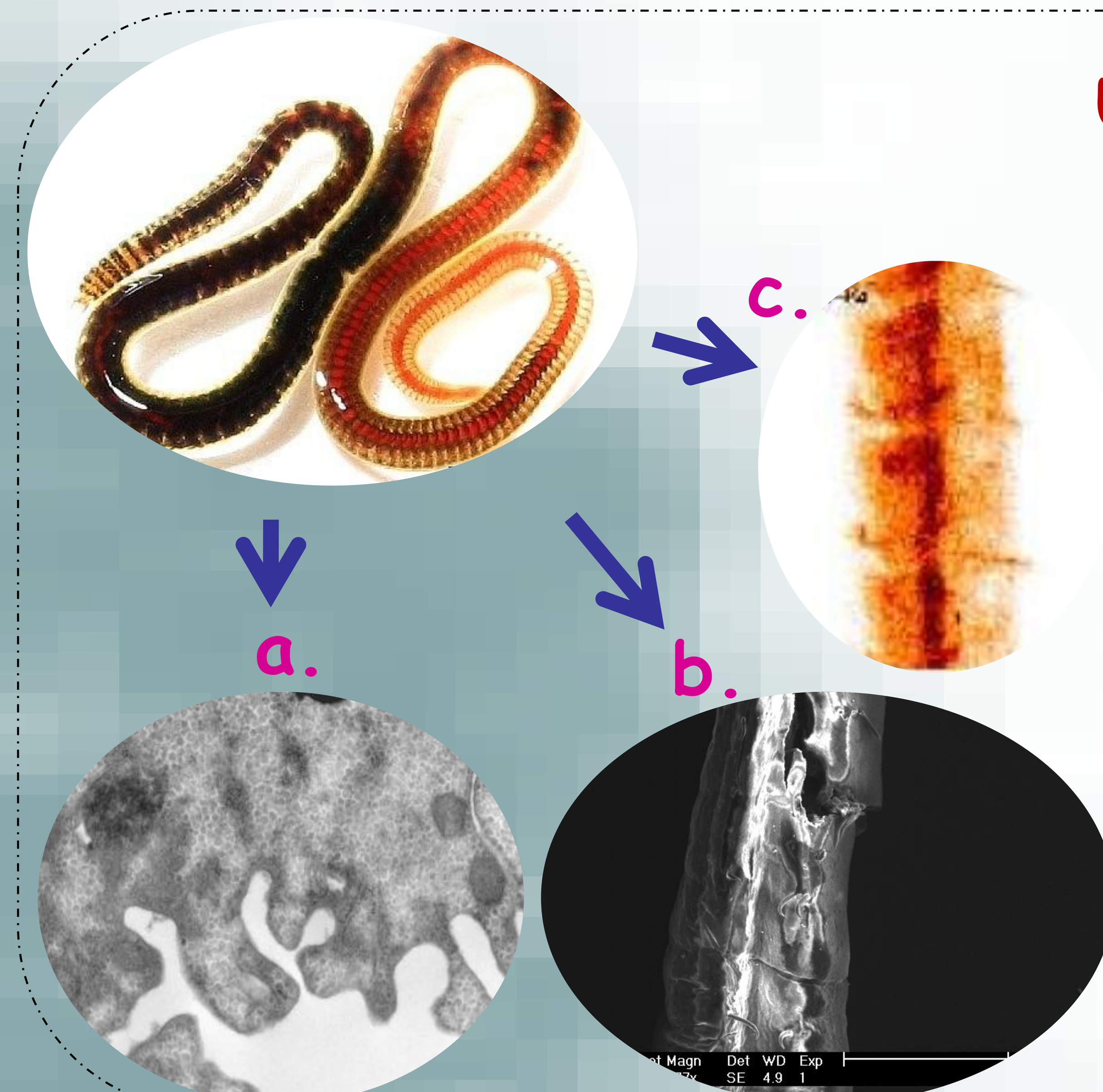
INTRODUCTION

Nanotechnology is a new and fast emerging field and it is inevitable that increasing amounts of engineered nanoparticles (ENPs) will be released to the environment. Due to their small size and unique properties, ENPs could pose a risk to humans and the environment. The aim of this study was to quantify and visualise the uptake of different Au ENPs in *Lumbriculus variegates (L. variegates.)* and to establish the effect of particle size and surface coating on ENPs uptake.

EXPERIMENTAL DESIGN

Characterisation of ENPs

10 nm and 30 nm Au ENPs with either citrate or mercaptoundecanoic acid (M11) capping were prepared by the University of Alberta, Canada. Prior to the experiment, particles size, mass and number concentration of each ENP were determined by transmission electron microscopy (TEM), scanning electron microscopy (SEM) and inductively coupled plasma mass spectrometry (ICP-MS) and nanosight (NTA, hydrodynamic diameter).



Uptake Studies

L. variegatus were exposed to Au ENPs - spiked sediment at different concentrations for seven days. Organisms were then prepared according to the specific requirements of the analytical techniques used. Samples were analysed using;

a.) TEM

b.) SEM

c.) SR-XRS (Synchrotron X-ray spectroscopy)

d.) ICP-MS

RESULTS

Characterisation details of each ENP are shown in Tab 1. and Fig 2. and uptake results are shown in Fig 1. TEM and SEM analysis showed no uptake of the ionic Au or ENPs into *L. variegatus*. However, SR-XRS images obtained from scanning whole organisms showed that both ionic gold (Fig 1b.) and 10 nm Au ENPs with M11 capping (Fig 1d.) were taken up into the organism. Analysis of total uptake concentrations by ICP-MS is still on-going.

Figure 1. SR-XRS images showing the elemental distribution of Au inside *L. variegatus* after exposure to a.) deionised water b.) ionic and Au NPs with the size and coating of c.) 30 nm & M11 d.) 10 nm & M11 e.) 30 nm & citrate f.) 10 nm & citrate, respectively.

Table 1. Characterization of different Au ENPs a.) 30 nm & M11 b.) 10 nm & M11 c.) 30 nm & citrate d.) 10 nm & citrate

	Mass Con ug ml^{-1}		No. Con 10^{11}	Size in nm	
	ICP-MS	NTA	NTA	NTA	TEM
a	42.7	144.6	1.33	47.6	27.5
b	45.7	-	-	-	11.7
c	30.9	136.4	1.13	49.3	32.6
d	42.8	-	-	-	12.3

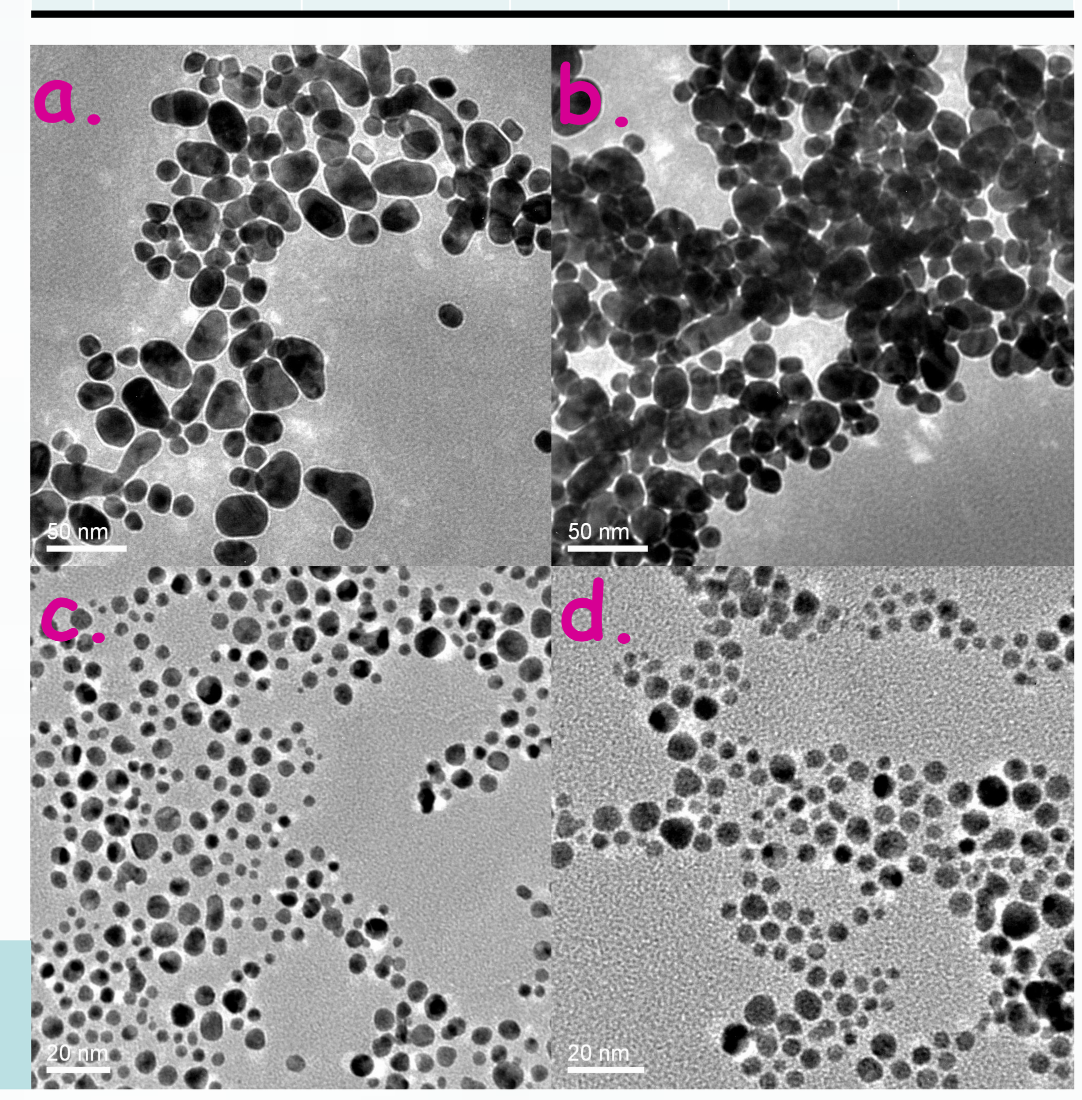


Figure 2. TEM images of Au ENPs with the size and coating of a.) 30 nm & M11 b.) 10 nm & M11 c.) 30 nm & citrate d.) 10 nm & citrate

CONCLUSIONS

•A combination of multiple analytical techniques such as nanosight, TEM and ICP-MS provided a comprehensive characterisation of ENPs in terms of particle size, number and mass concentration.

•SR-XRS is a powerful tool to visualize uptake of NPs into organisms without high impact sample preparation.

•Preliminary results from SR-XRS images confirm a selective uptake of 10 nm Au NPs with M11 as capping material into *L. variegatus*, whilst SEM and TEM were not suitable for ENP detection within the organism.

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