



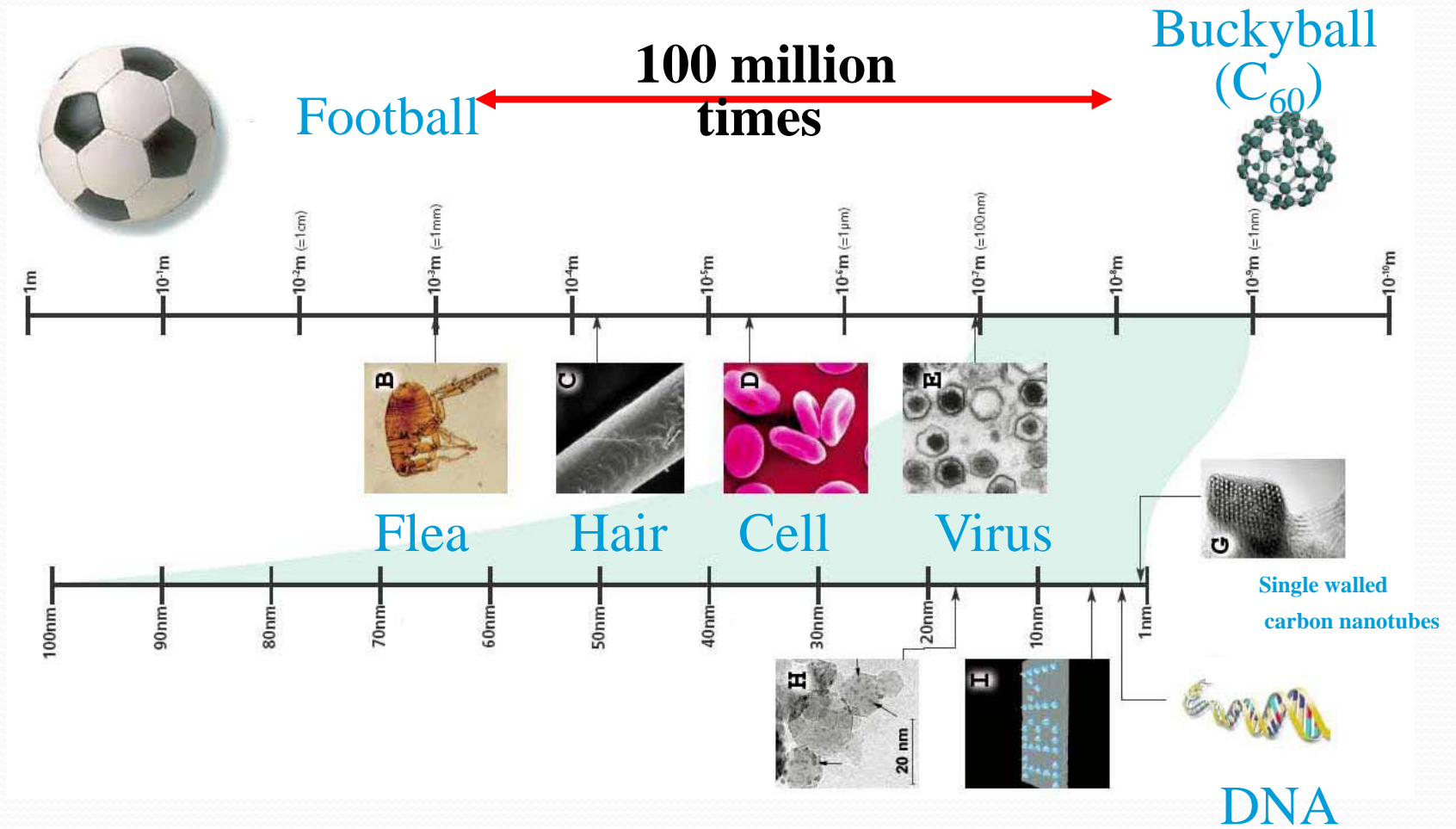
UNIVERSITY OF  
BIRMINGHAM



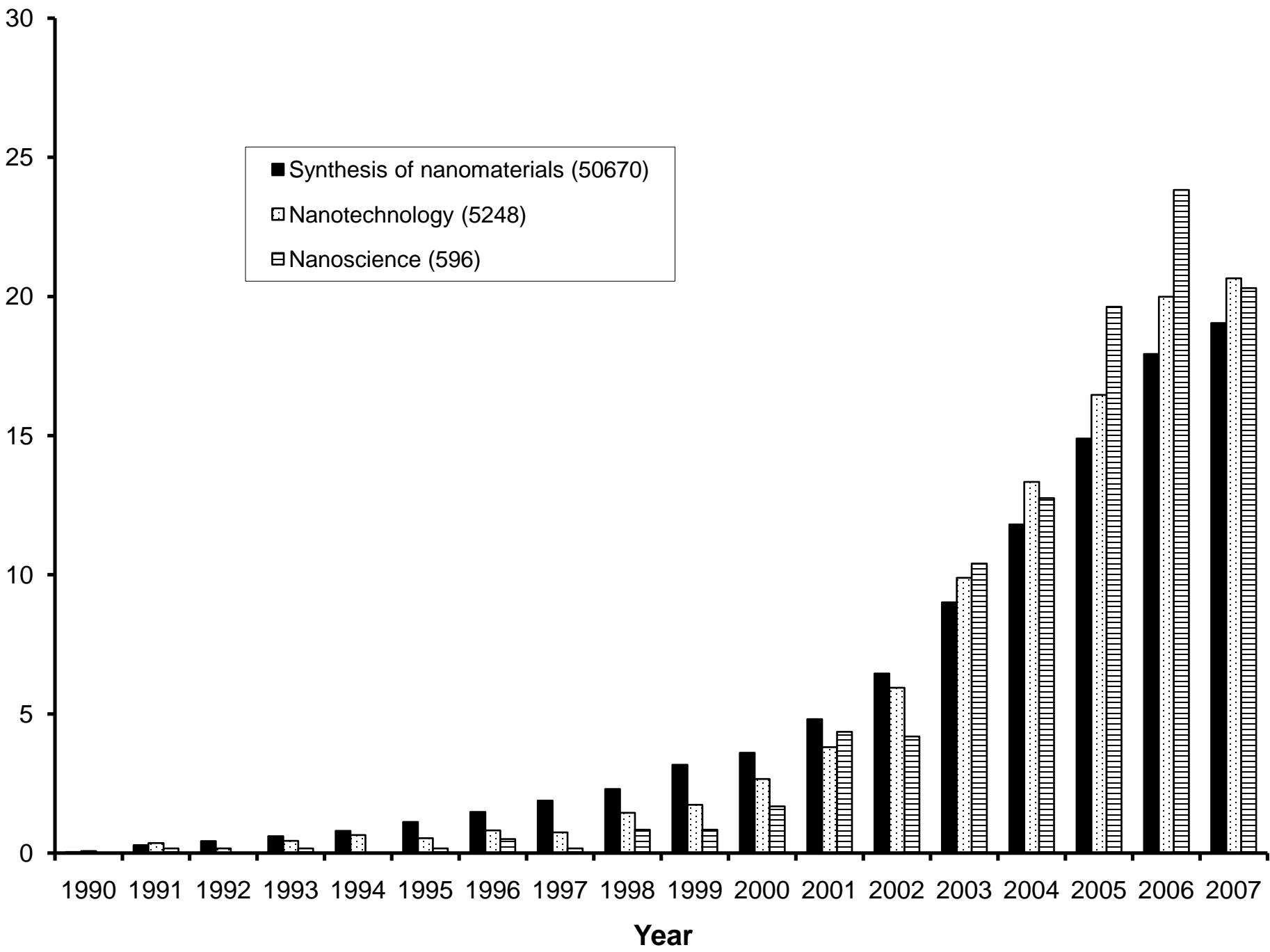
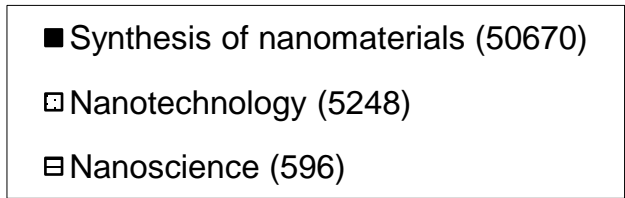
# Ag Nanoparticles in the Environment

Jamie Lead

# How big is small?



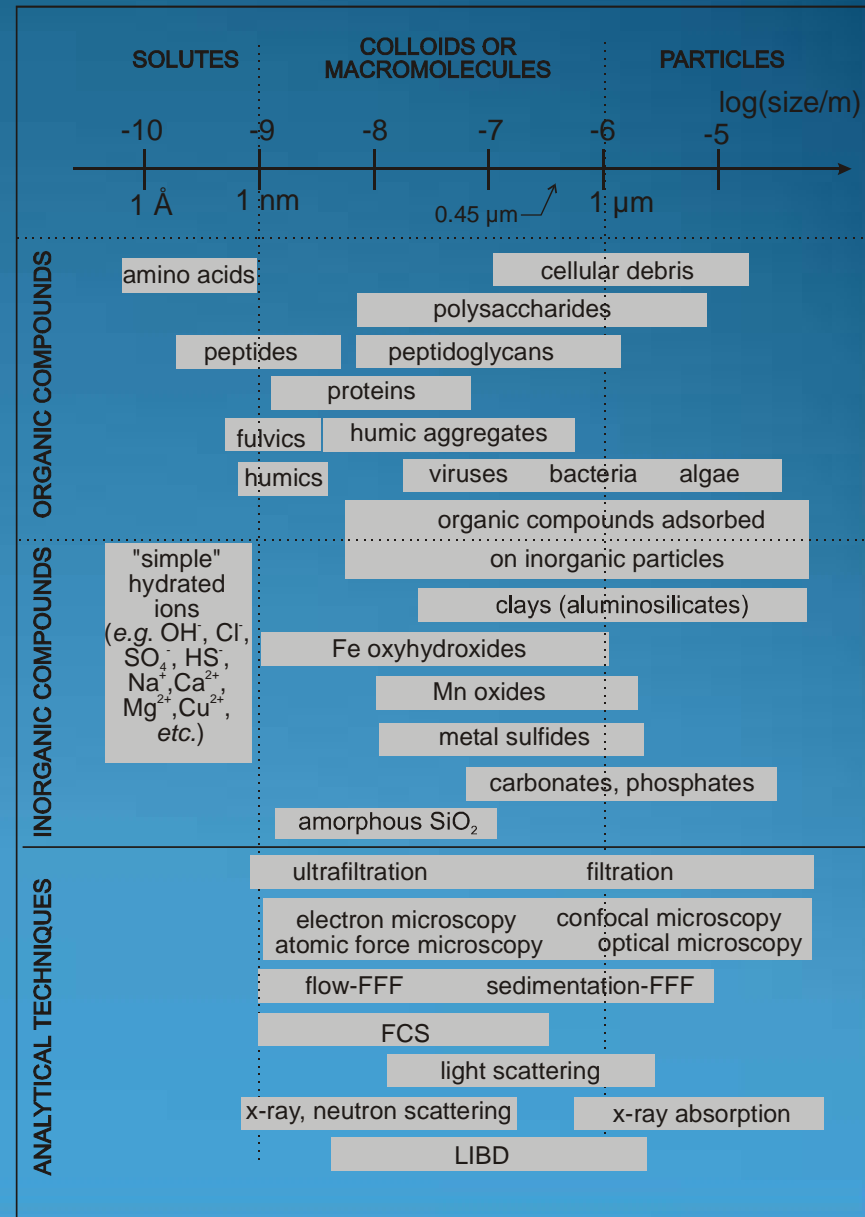
Percentage of all references



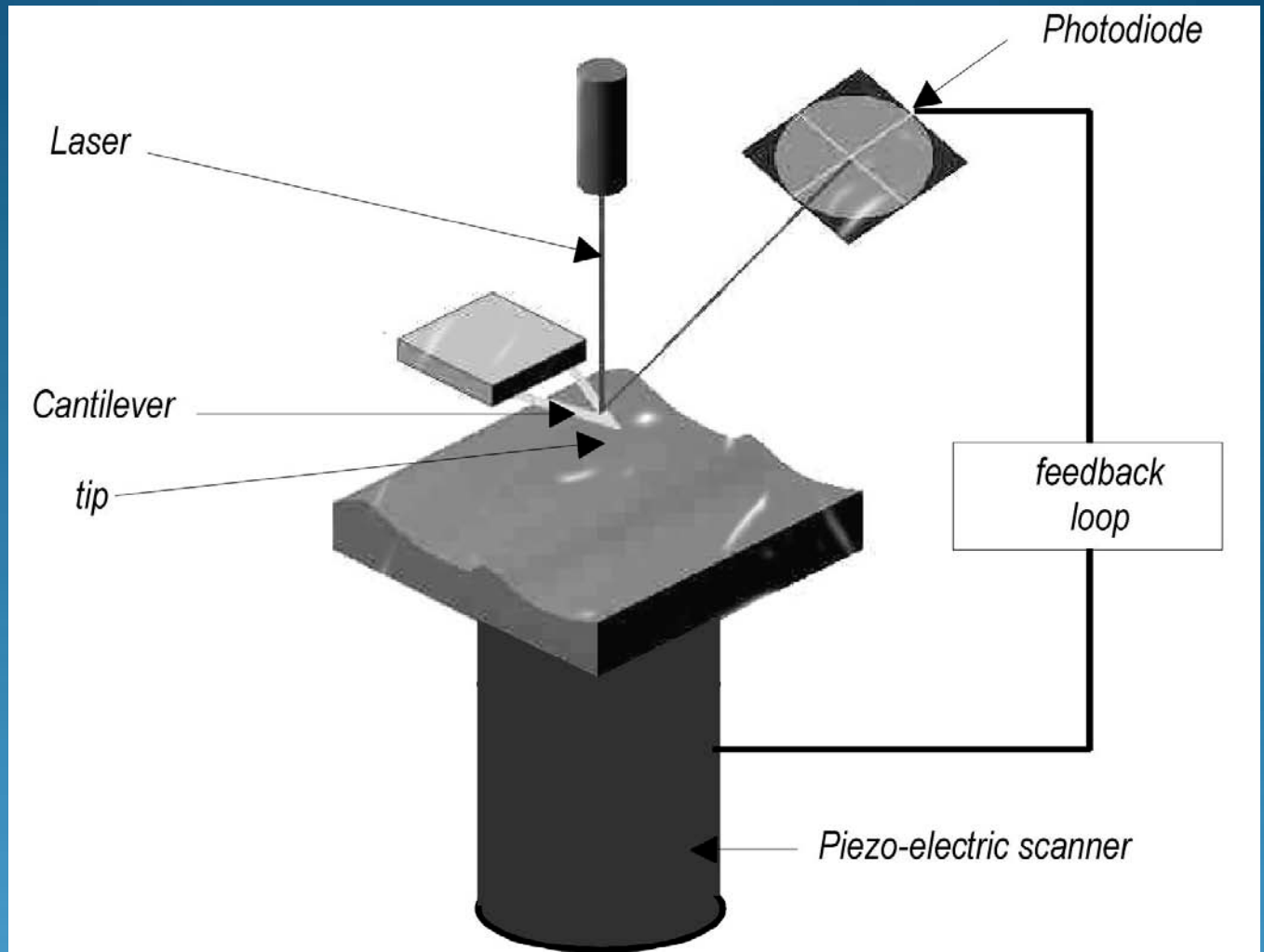
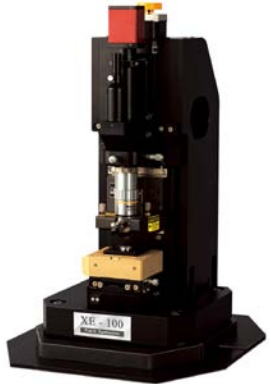


# NOM (HS) interactions with NPs

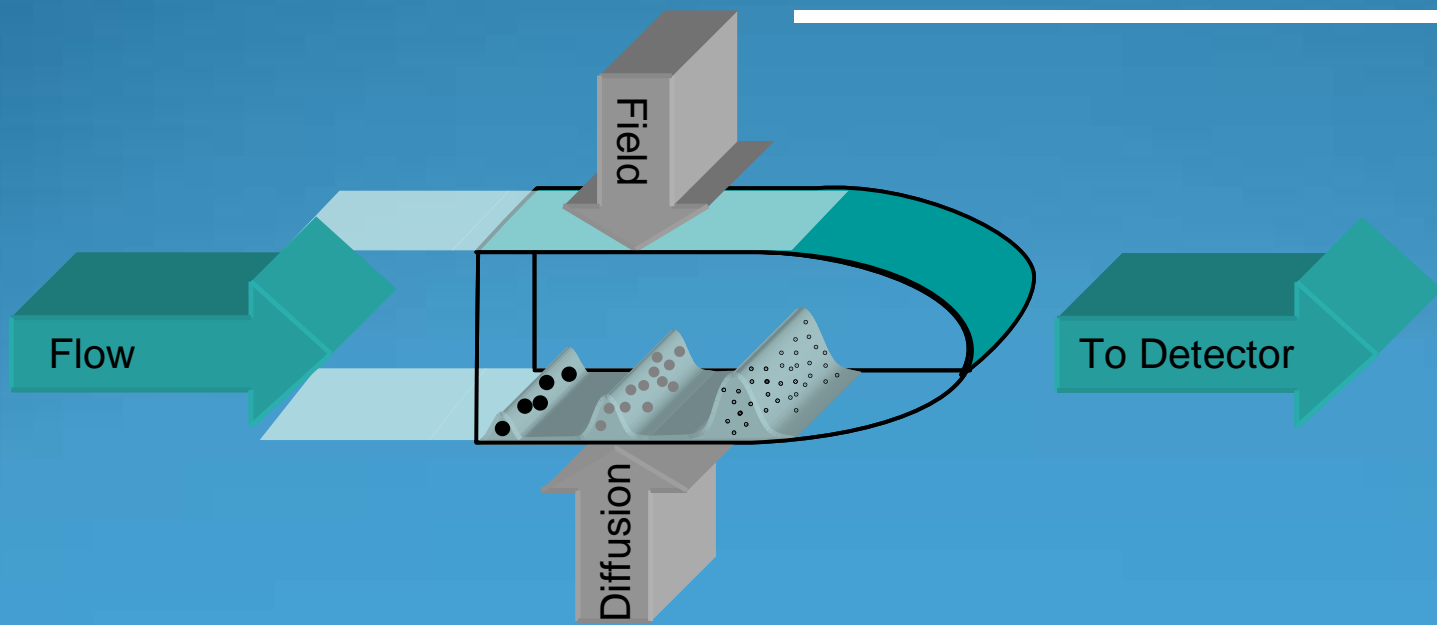
- 1 nm – 1  $\mu\text{m}$  (NPs, 1-100 nm).
- Naturally produced, weathering, hydrolysis, microbial action etc.
- Complex, spatially and temporally variable.
- Present at 0.1-100  $\text{mg L}^{-1}$  levels (cf MNPs at 0.1-100  $\mu\text{g L}^{-1}$ ).



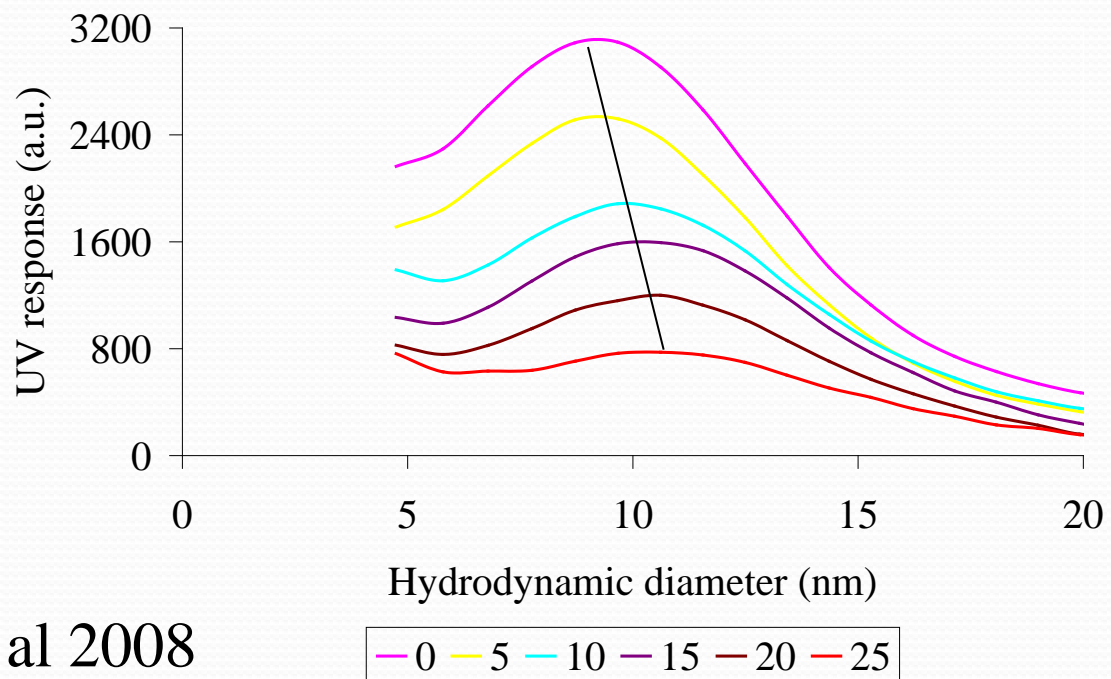
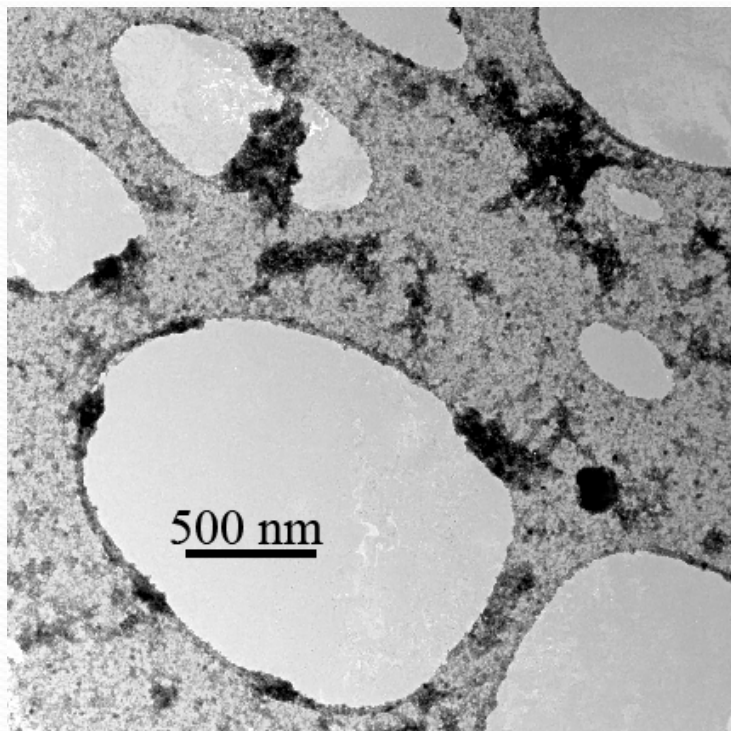
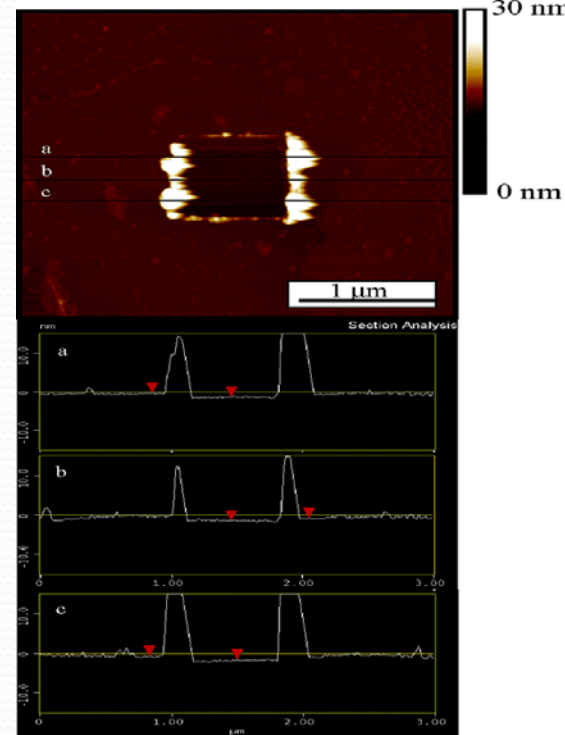
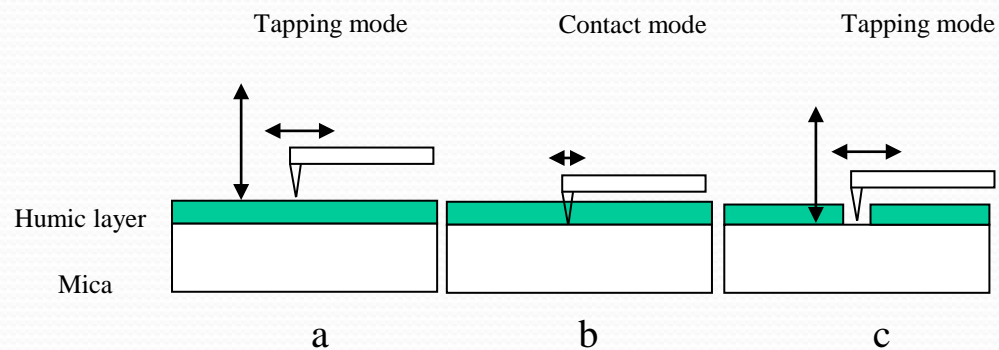
# Atomic force microscope (AFM)



Balnois et al, in Wilkinson and Lead 2007



# Gibson et al, 2007



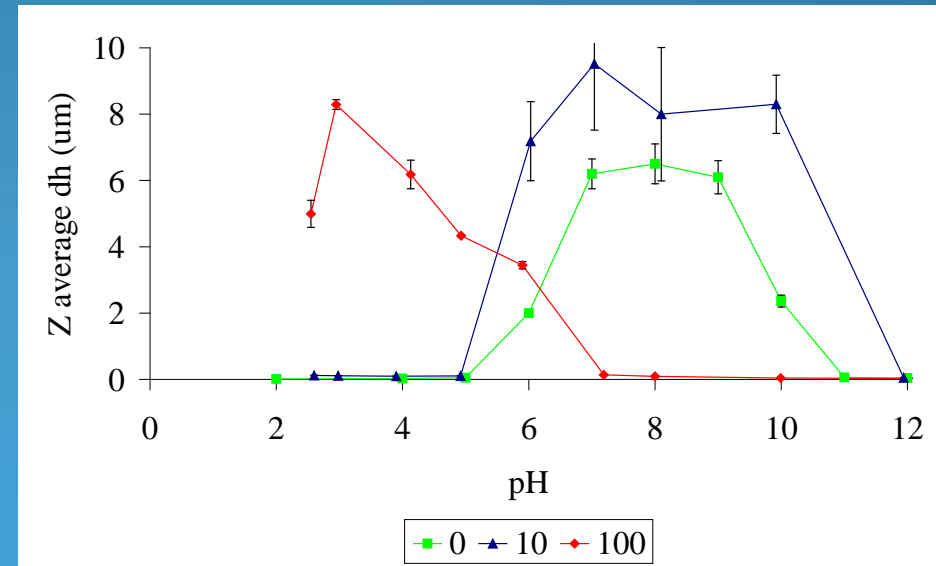
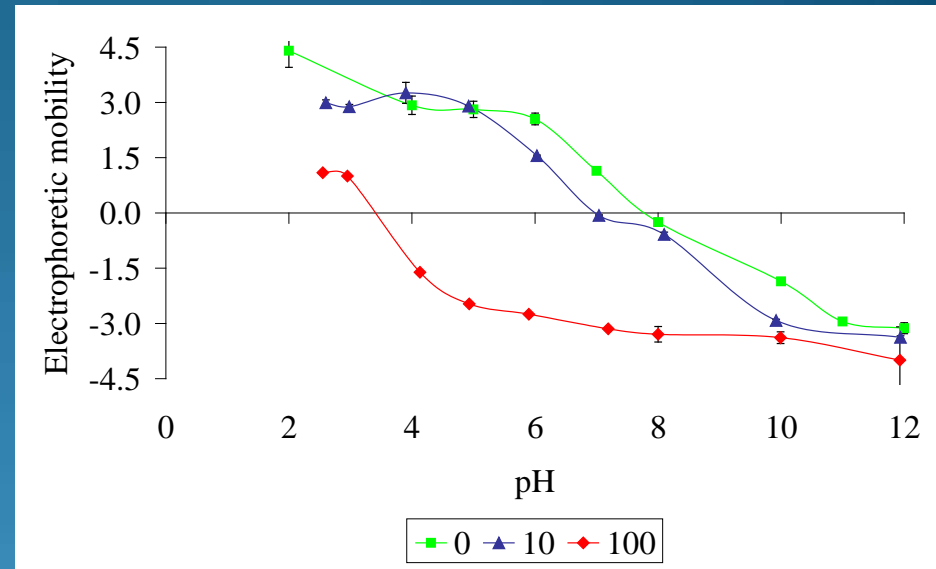
# Baalousha et al 2008

# Aggregation/disaggregation

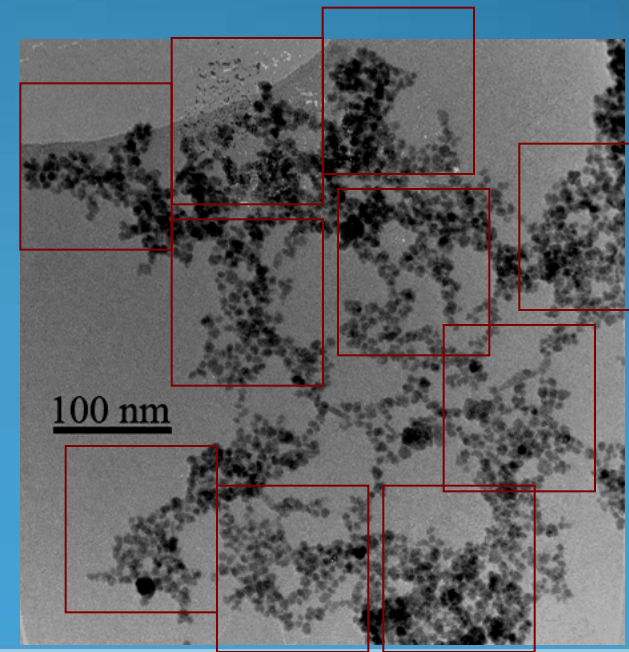
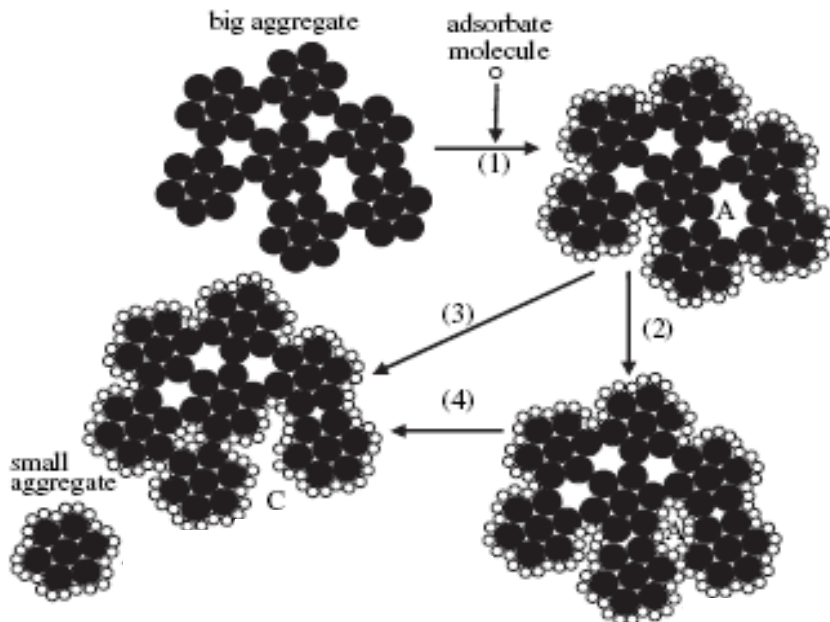
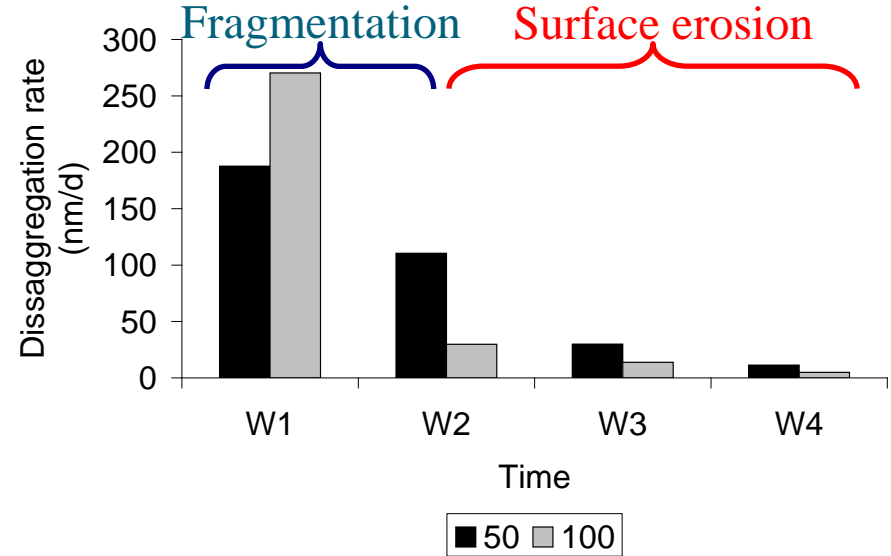
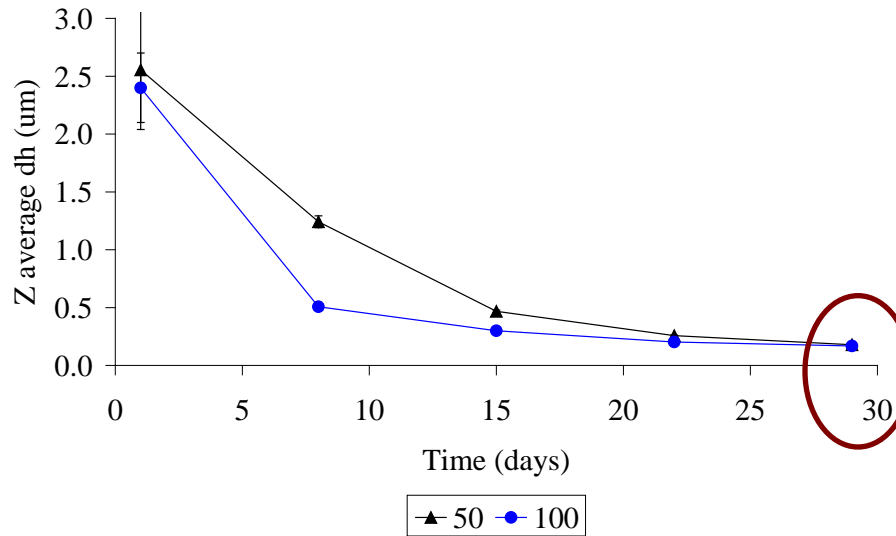
➤ FeO (10 mg l<sup>-1</sup> Fe) + HA (10 and 100 mg l<sup>-1</sup>) at pH 2

➤ pH increased by a step of 1 to pH 12

➤ Electrophoretic mobility and Z average hydrodynamic diameter

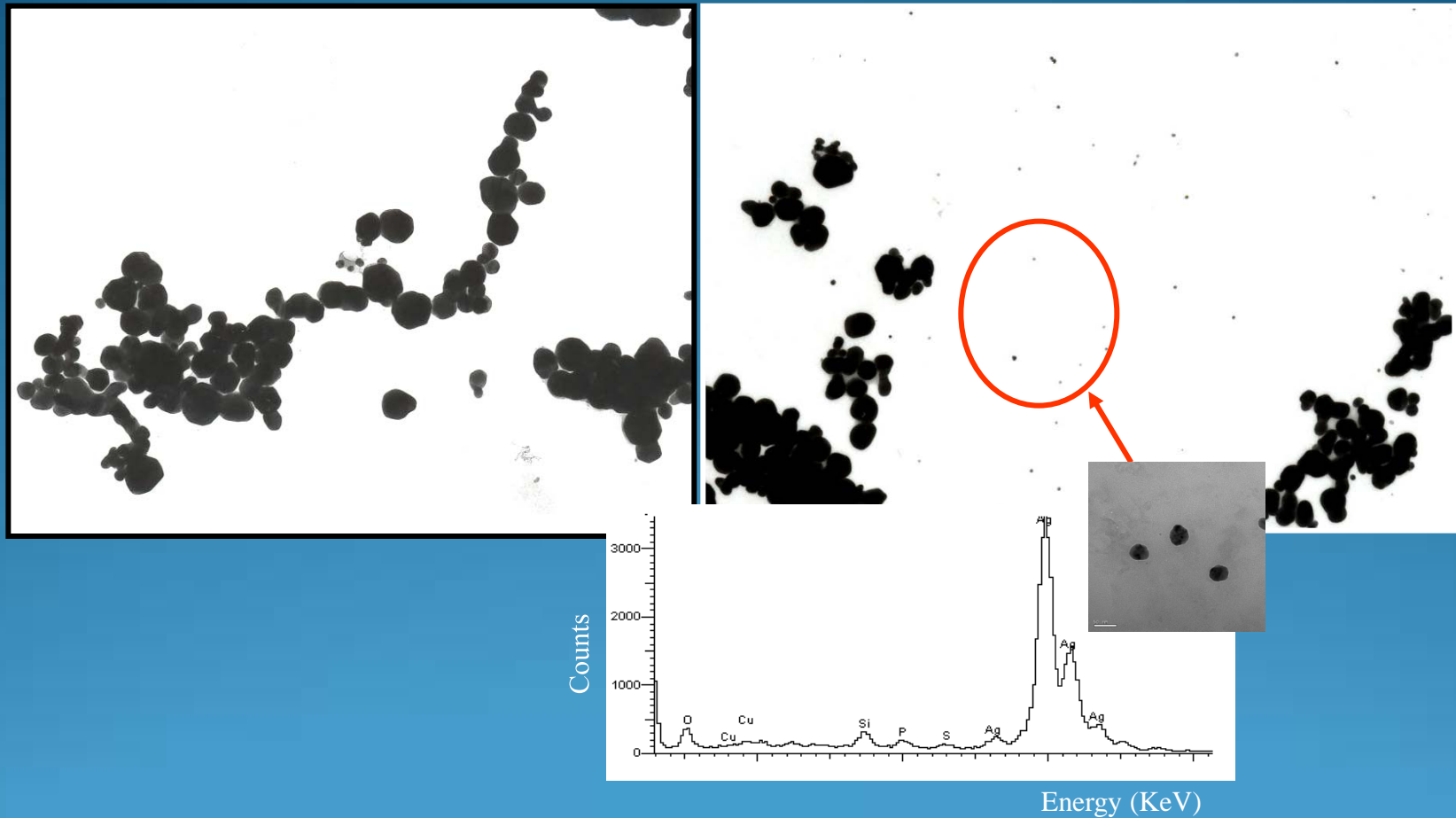


# Disaggregation

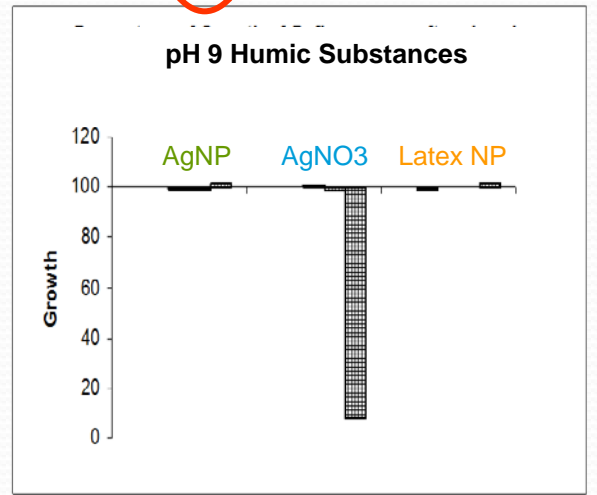
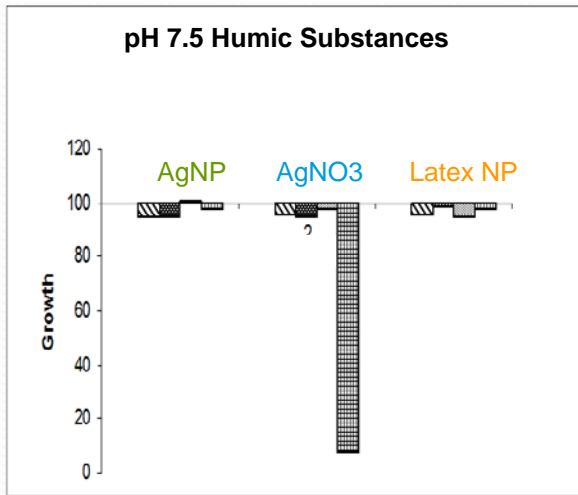
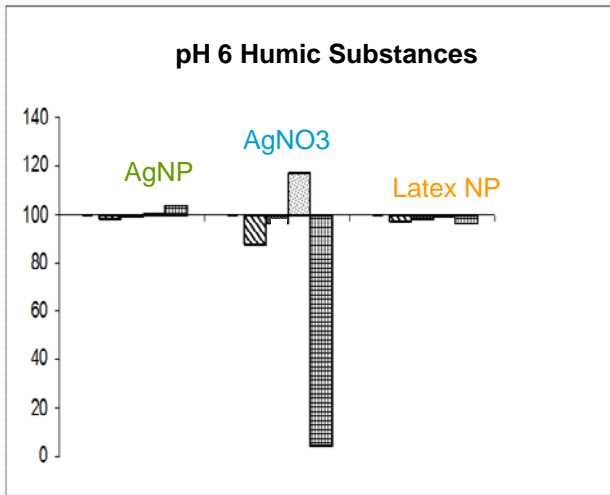
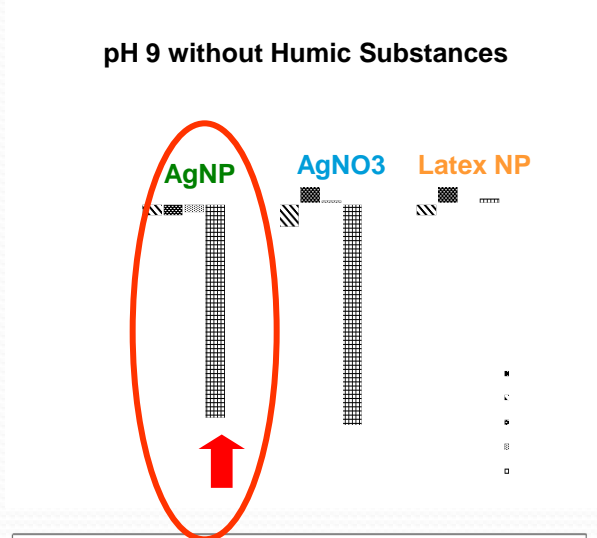
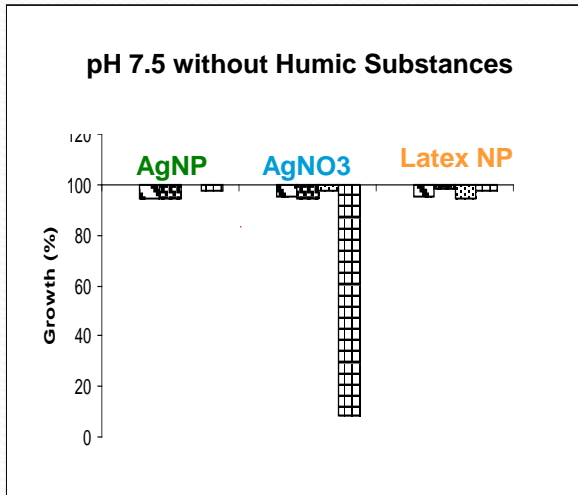
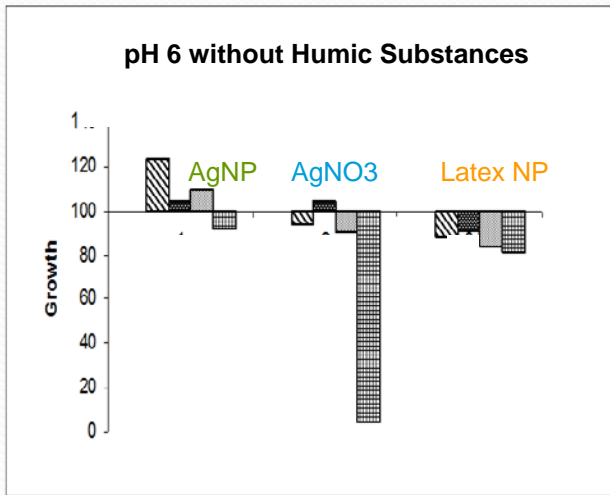


# Ag NPs exposure to *Pseudomonas* sp.

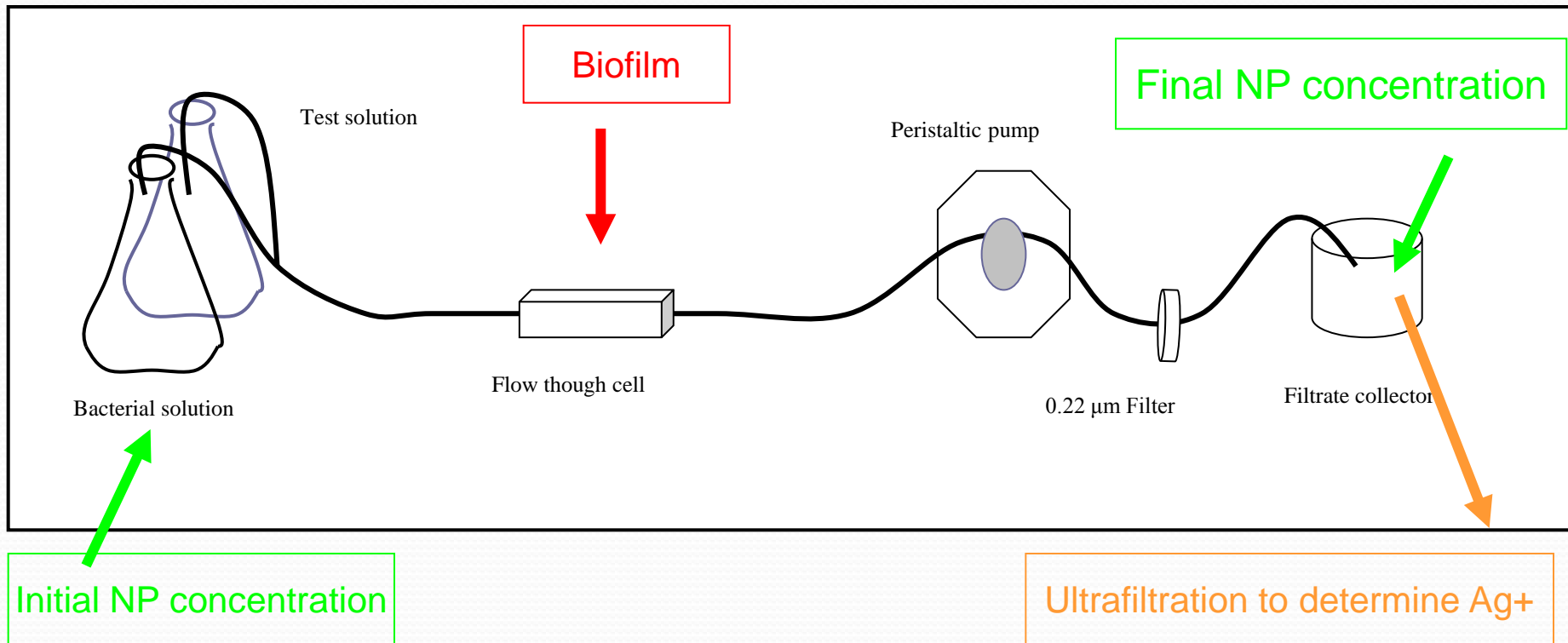
NPs in growth media alone (left) and media with Suwannee River FA



Citrate stabilise commercial NPs Dissolution low; nanoaggregates formed;  $60 \pm 30$  nm;



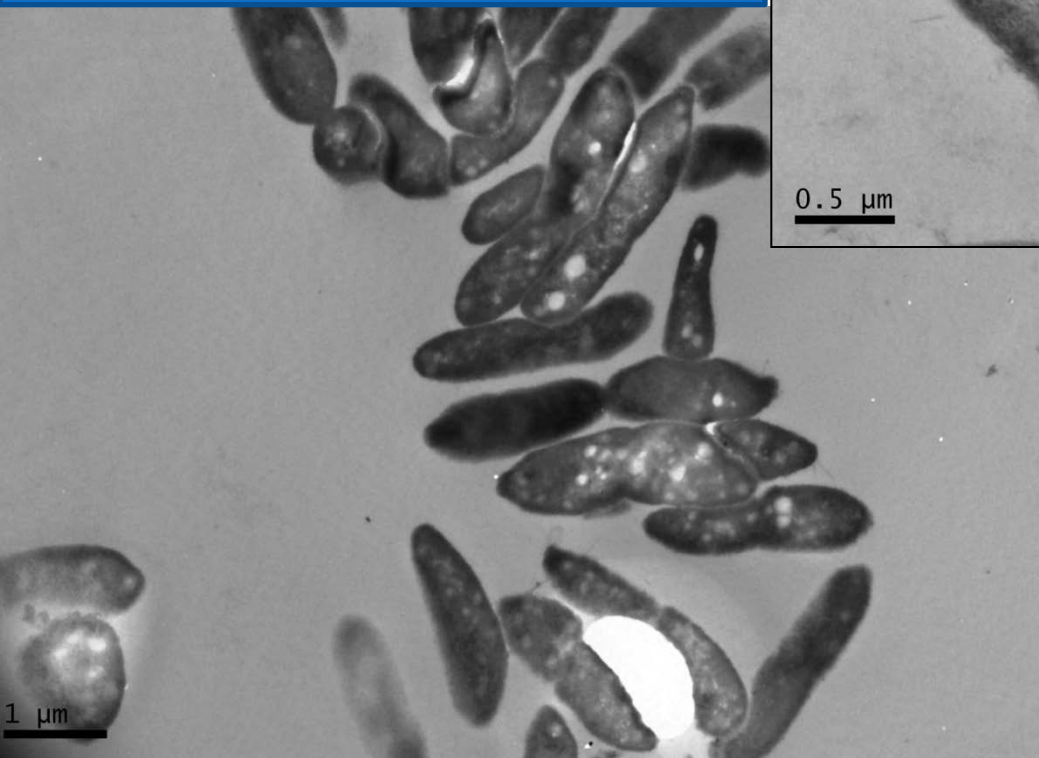
# Toxicity of AgNPs to biofilm *P. putida*



Fabrega et al (2009b)

Ag NPs

4-d old biofilm pH 7.5 SRFA-  
Control



0.5 μm

4-d old biofilm-pH 7.5 SRFA- Ag NPs



Changes in cell morphology

Fabrega et al, 2009

# Conclusions

- Ag NPs fate and behaviour controlled by pH, ionic strength, Ca, NOM
- NPs may have toxicity separate from dissolved Ag
- Toxicity of nanoaggregates in many cases low
- Toxicity of dispersed NPs likely to be higher.

# Acknowledgements

Mohammed Baalousha

Chris Gibson

Yon Ju-Nam

Ruth Merrifield

David Muirhead

Svetlin Mitov

Adam Hitchman

Bjorn Stolpe

Zhiwei Wang

Isabella Romer

Julia Fabrega

Isabella Romer

Sue Cumberland

Mila Tejamaya

NERC, EU and other funding agencies