UNIVERSITY OF CALIFORNIA

UC CEIN Center for Environmental Implications of Nanotechnology

The Environmental and Biological Implications of Nanoparticles

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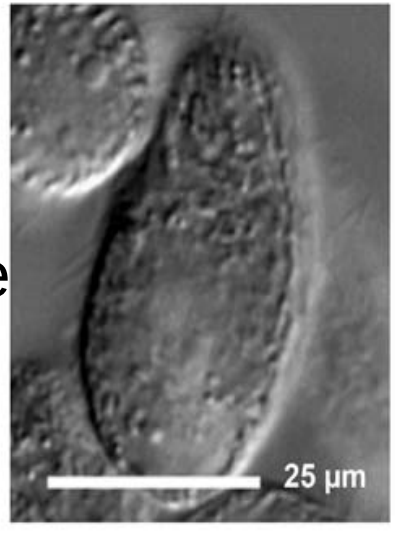
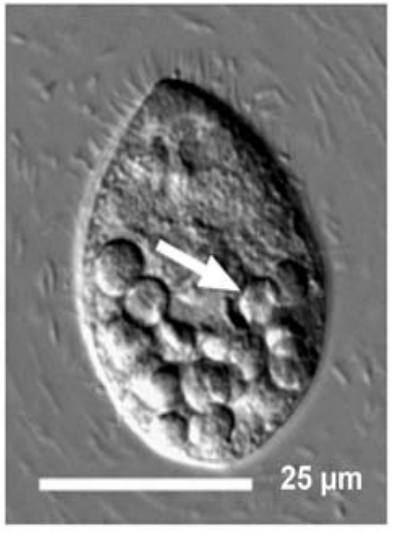
Nanoparticle Lifecycles

- Expand on the knowledge of nanoparticles (NPs)

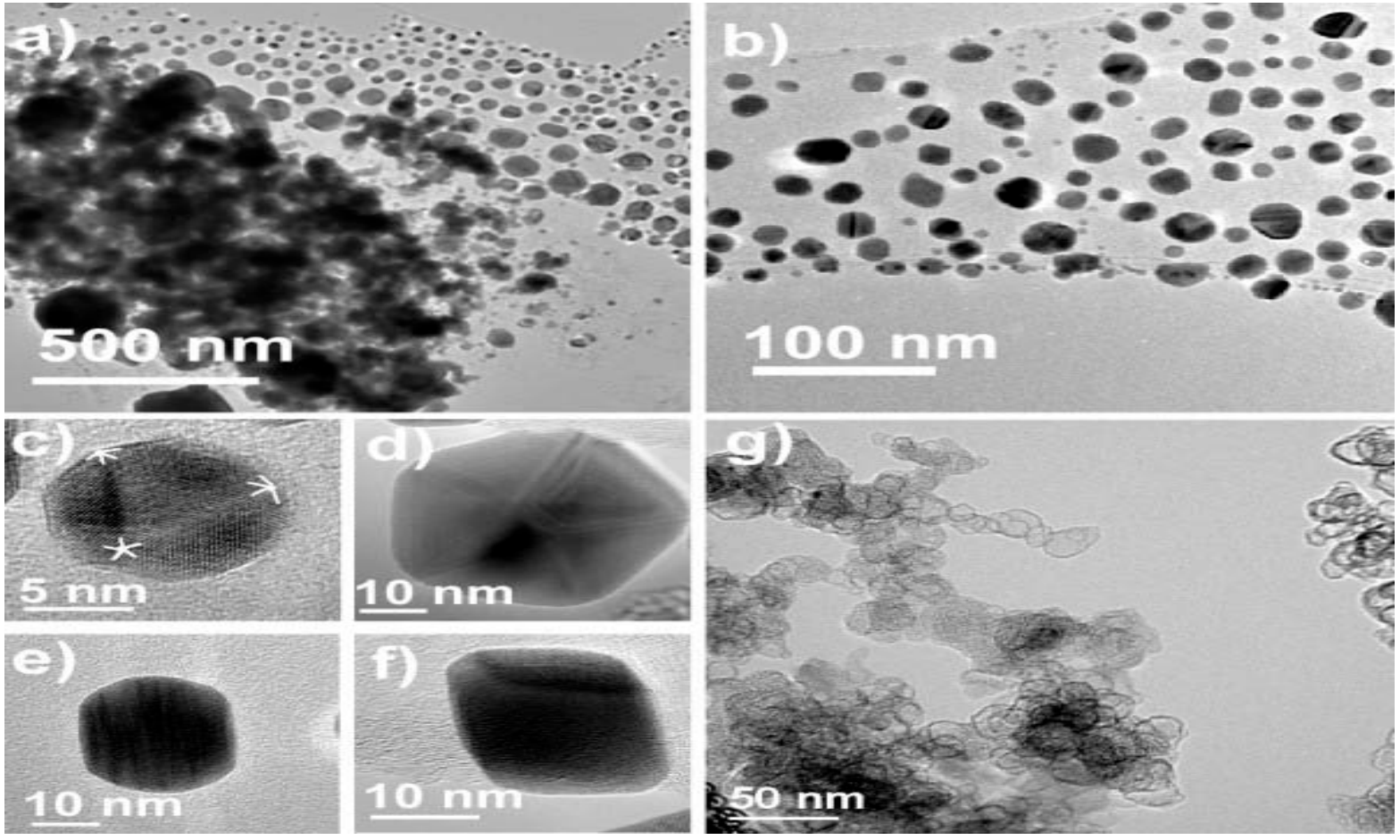
- Increase understanding of NP life cycle
  - During use and after entering environment
  - Interactions with biological systems





http://www.futurity.org/science-technology/designer-dots-could-shield-food-chain/

Silver Nanoparticle Size

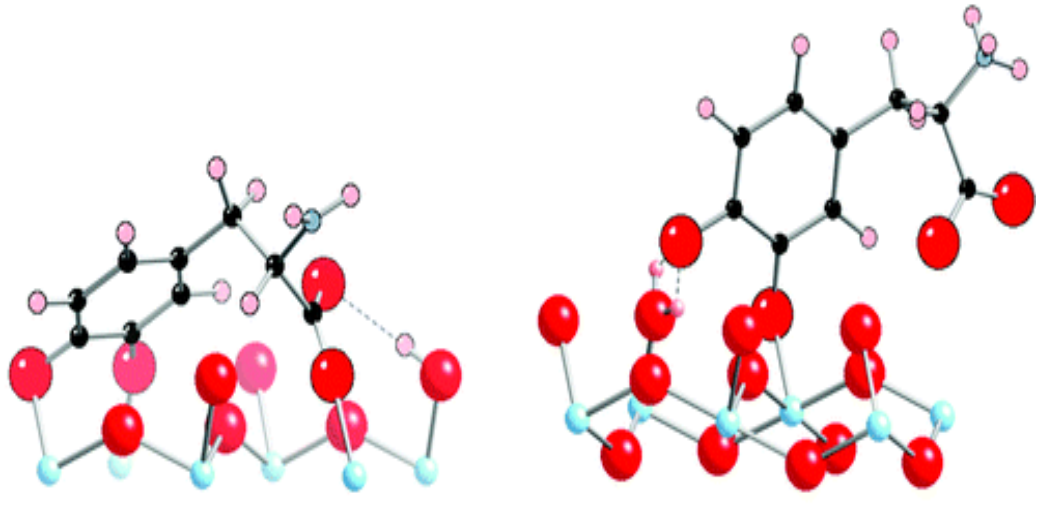


http://www.jnanobiotechnology.com/content/figures/1477-3155-3-6-1.jpg

Amino Acid Adsorption and NP Behavior

- TiO_2 and Ag-citrate NPs
  - Widely used in consumer products
- Effects of ionic strength, pH
- Stability of suspension:
  - -Amino acid adsorption
  - -Surface charges
  - -Aggregation

Surface species of DOPA on rutile (α-TiO_2)



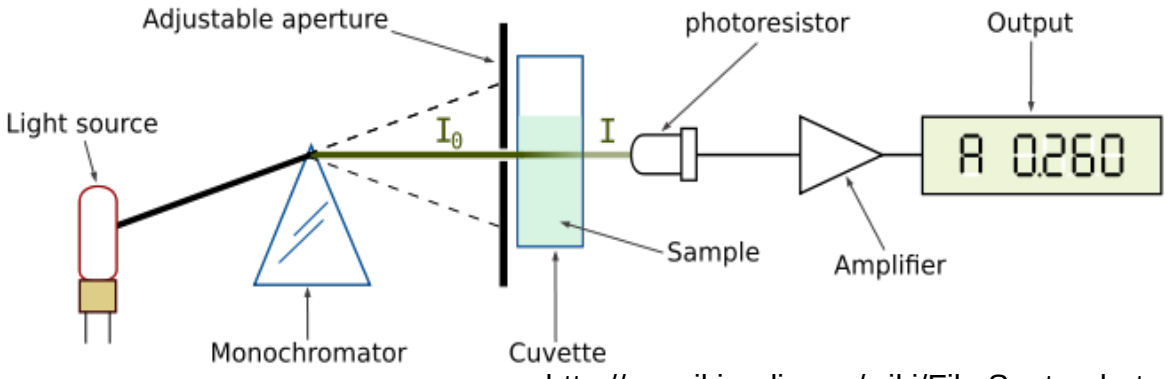
pH = 3: DOPA lying down

pH = 6: DOPA standing up

http://pubs.acs.org/doi/full/10.1021/es1042832

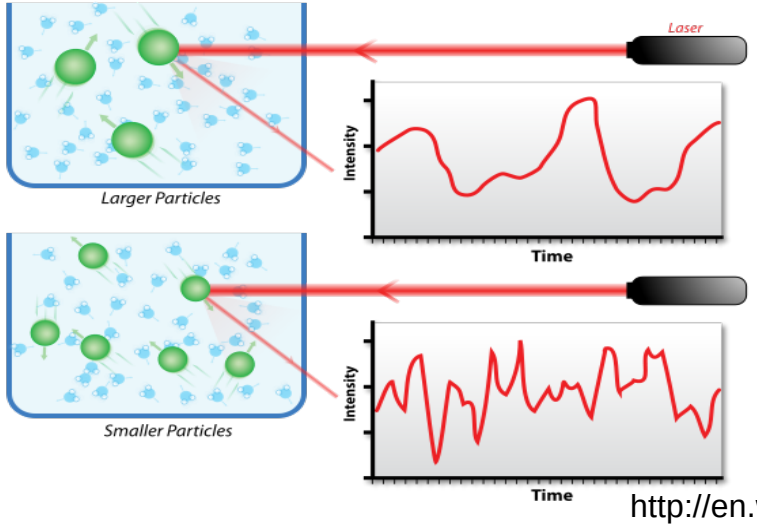
Determining Suspension Characteristics

Spectrophotometry



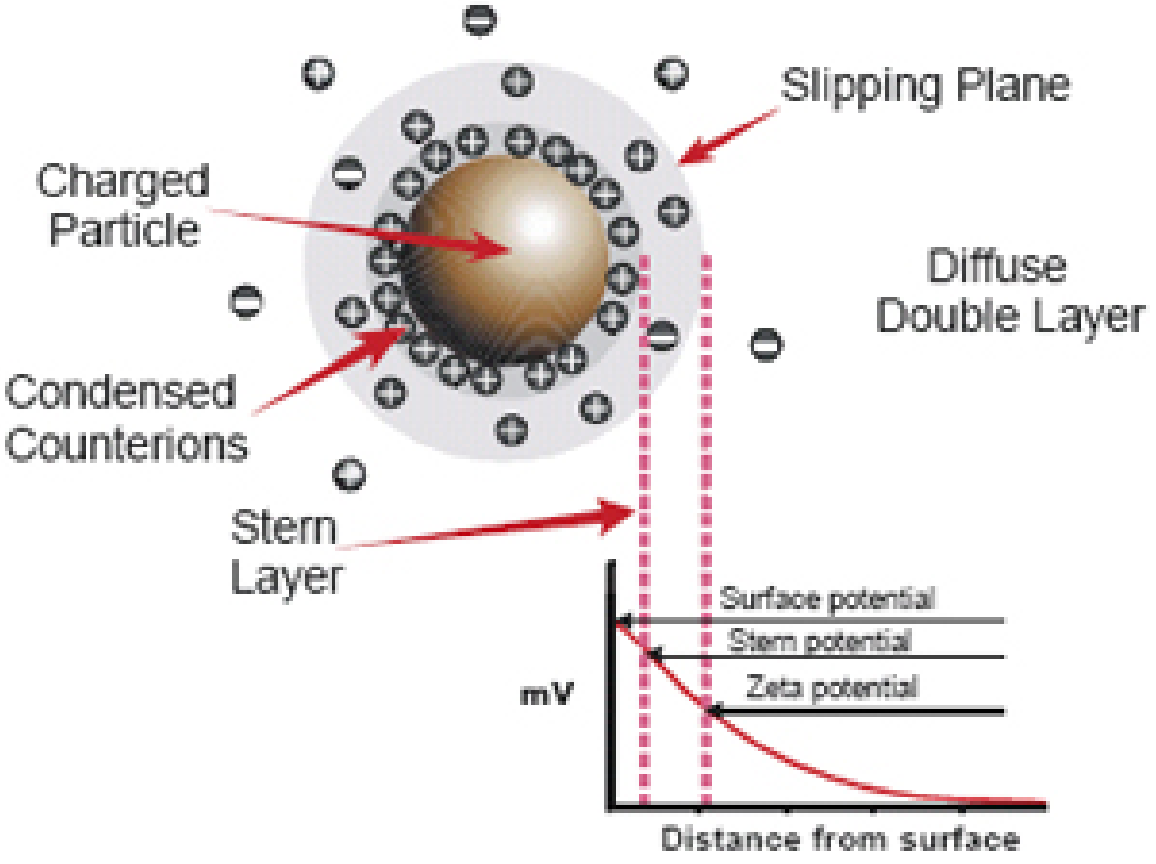
http://en.wikipedia.org/wiki/File:Spetrophotometer-en.svg

Dynamic Light Scattering



http://en.wikipedia.org/wiki/File:DLS.svg

Zeta Potential and Suspension Stability



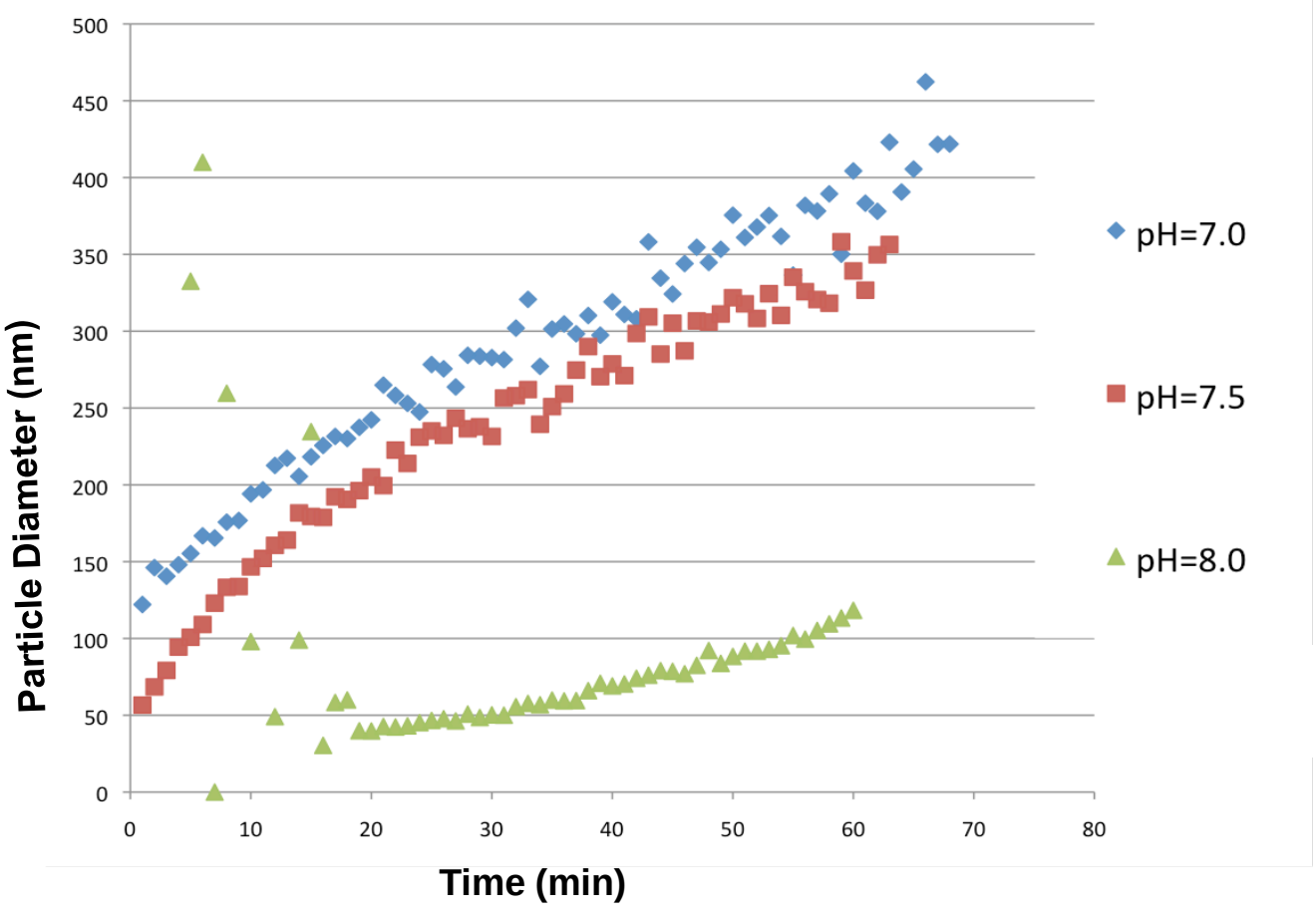
http://www.bioresearchonline.com/article.mvc/Automated-Protein-Characterization-With-The-M-0002

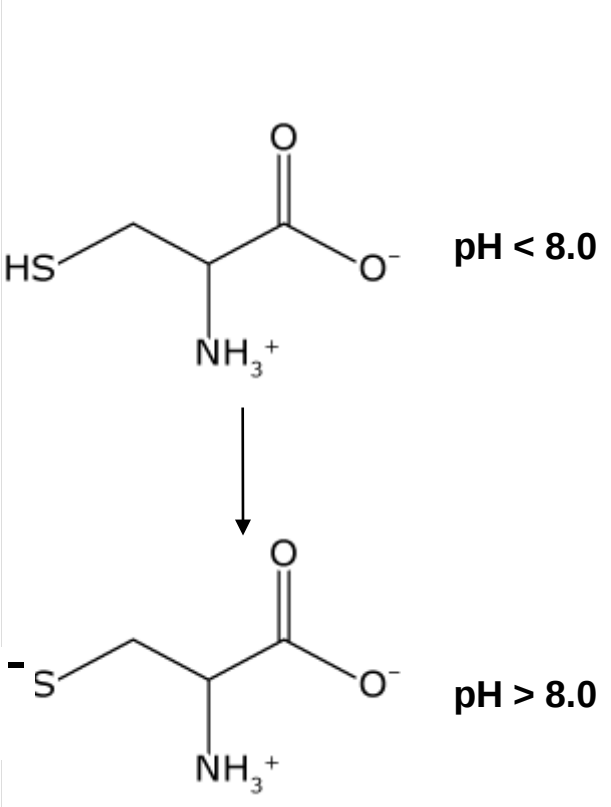
Environmental Thiol Concentrations

	CONCENTRATION µM
Dimethylsulfoniopropanoate (DMSP)	100 - 200
Carbon disulfide	0.17 - 0.2 nM
Dimethyl sulfide	0.05 - 0.1 nM
Mercaptomethane	0.75 - 1.1 nM
3-Mercaptoglycerol	1.6 - 20
3-Mercaptopropanoic acid (3MPA)	0.02 - 20
2-Mercaptopropanoic acid (2MPA)	0.04 - 5.4
3-Mercaptopyruvic acid (MPV)	0.04 - 20
Mercaptoacetic acid (MAC)	0.04 - 0.6
Glutathione (GSH)	0.04 - 2400
Cysteine (CSH)	0.04 - 12.4
N-Acetylcysteine	0.03 - 0.3

Bell, 1997

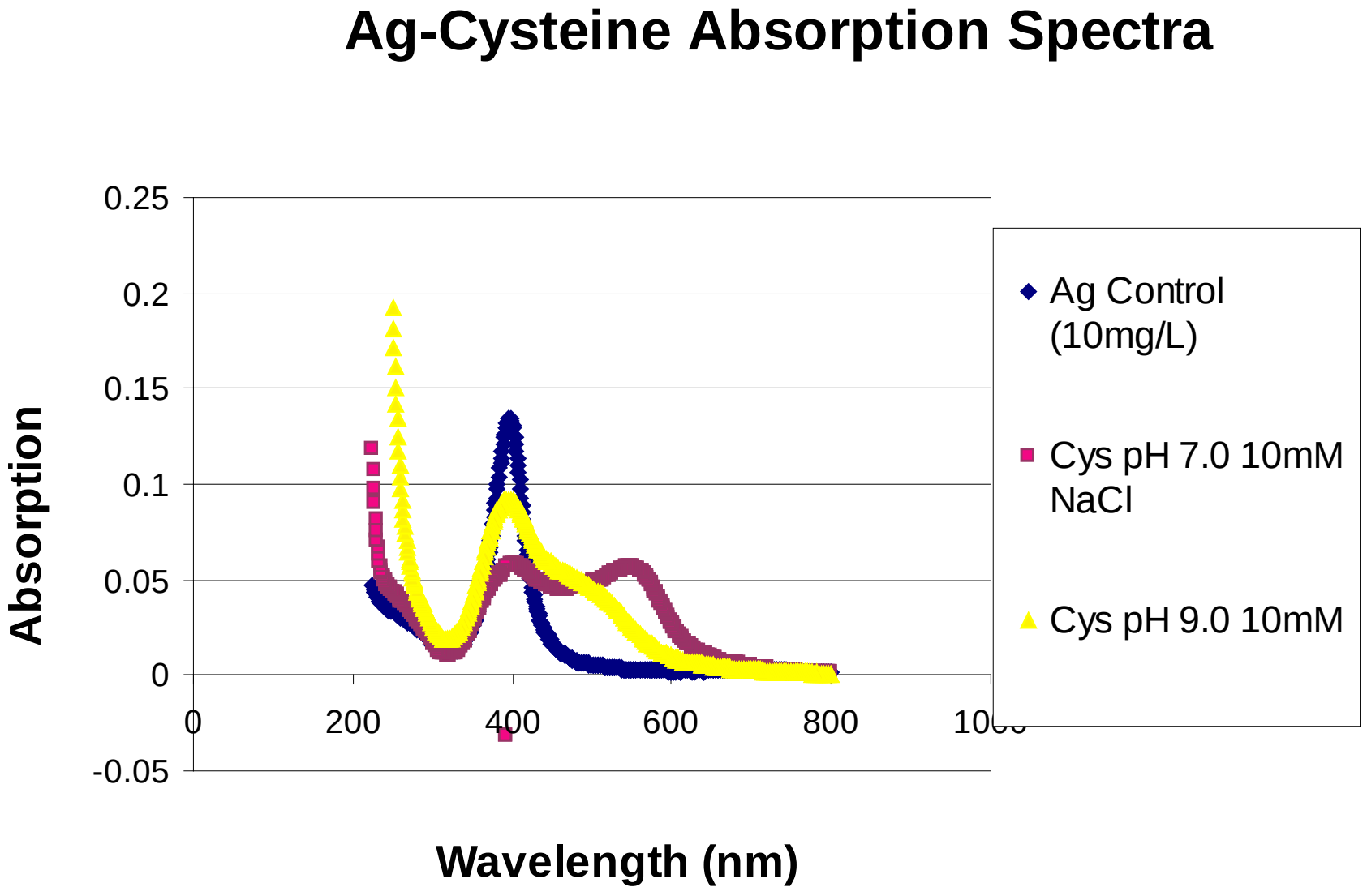
Ag, L-Cysteine Complex Aggregation



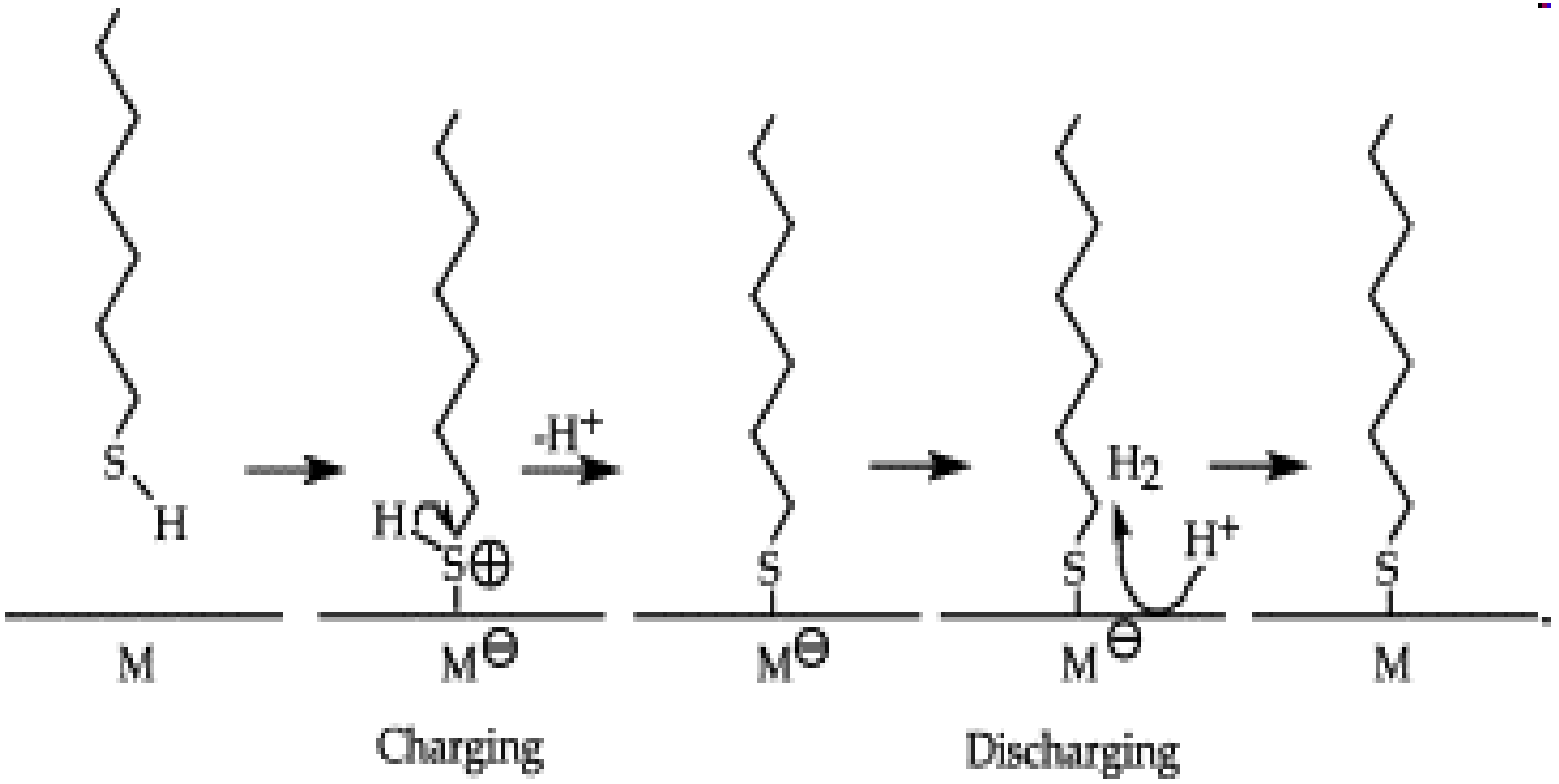


Samples: Ag NPs (1 mg/L), L-cysteine (10 mM), NaCl (10 mg/L)

Ag-Cysteine Complex as Function of Ionic Strength, pH



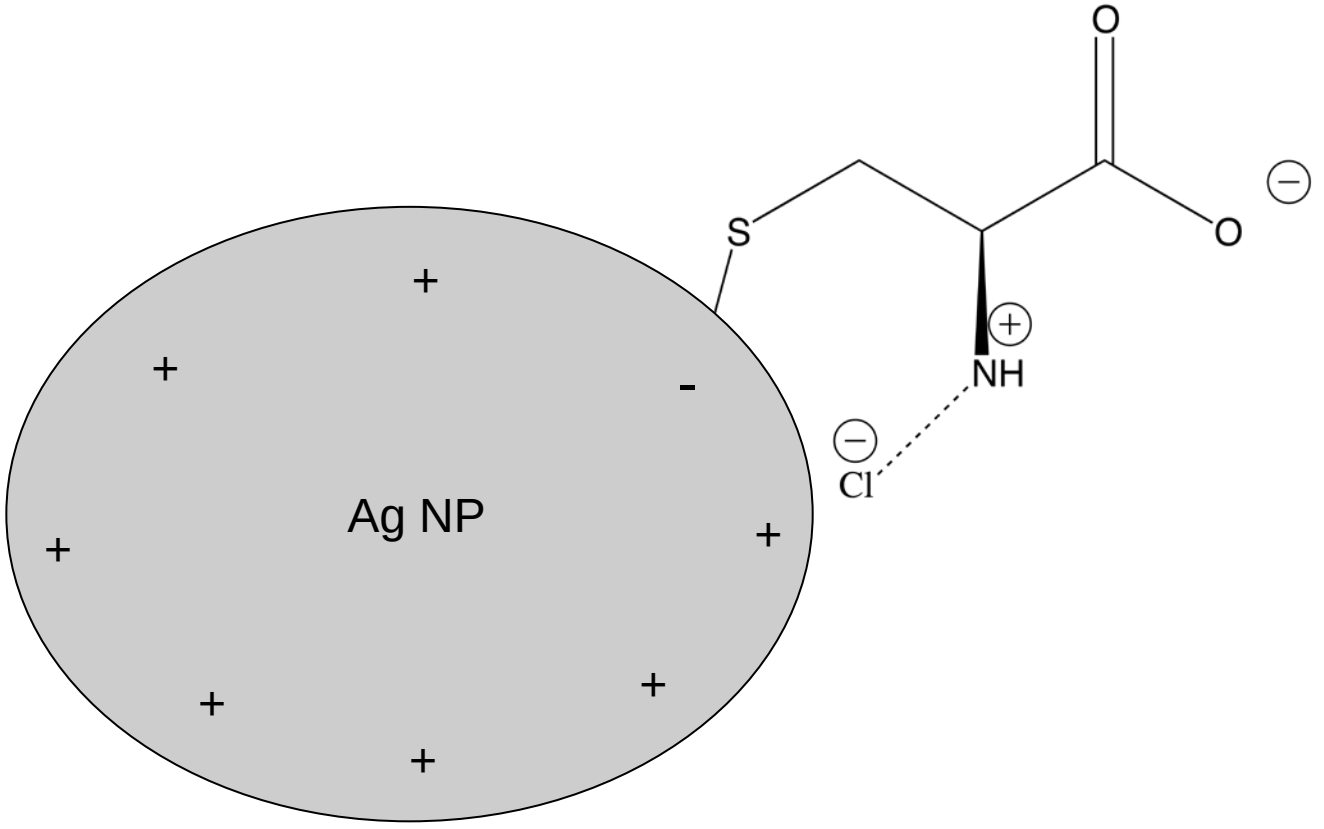
Formation Mechanism



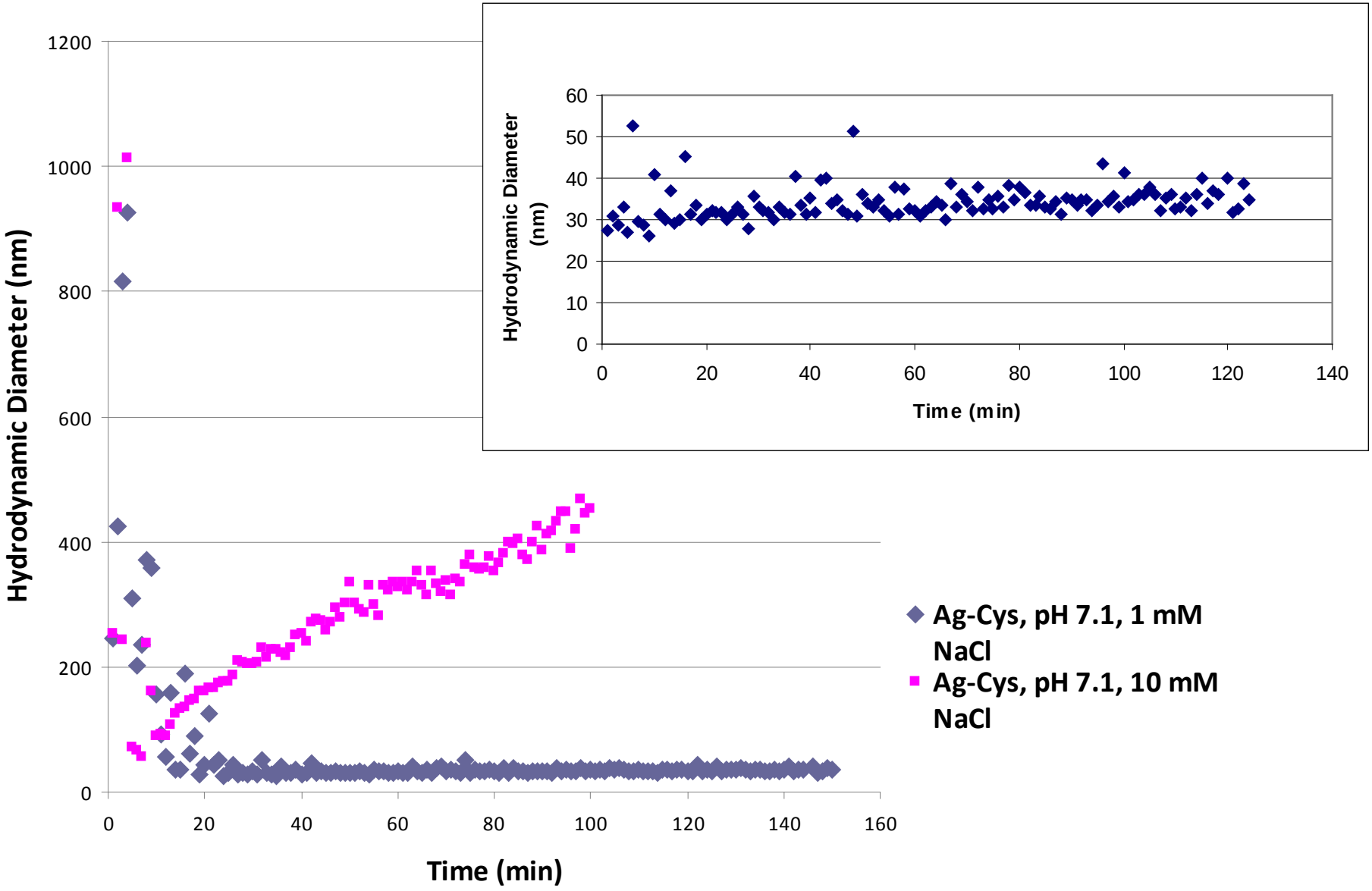
Cohen-Atiya *et al*, Journ. Elec. Chem., 2002

Cysteine Adsorption Conformation

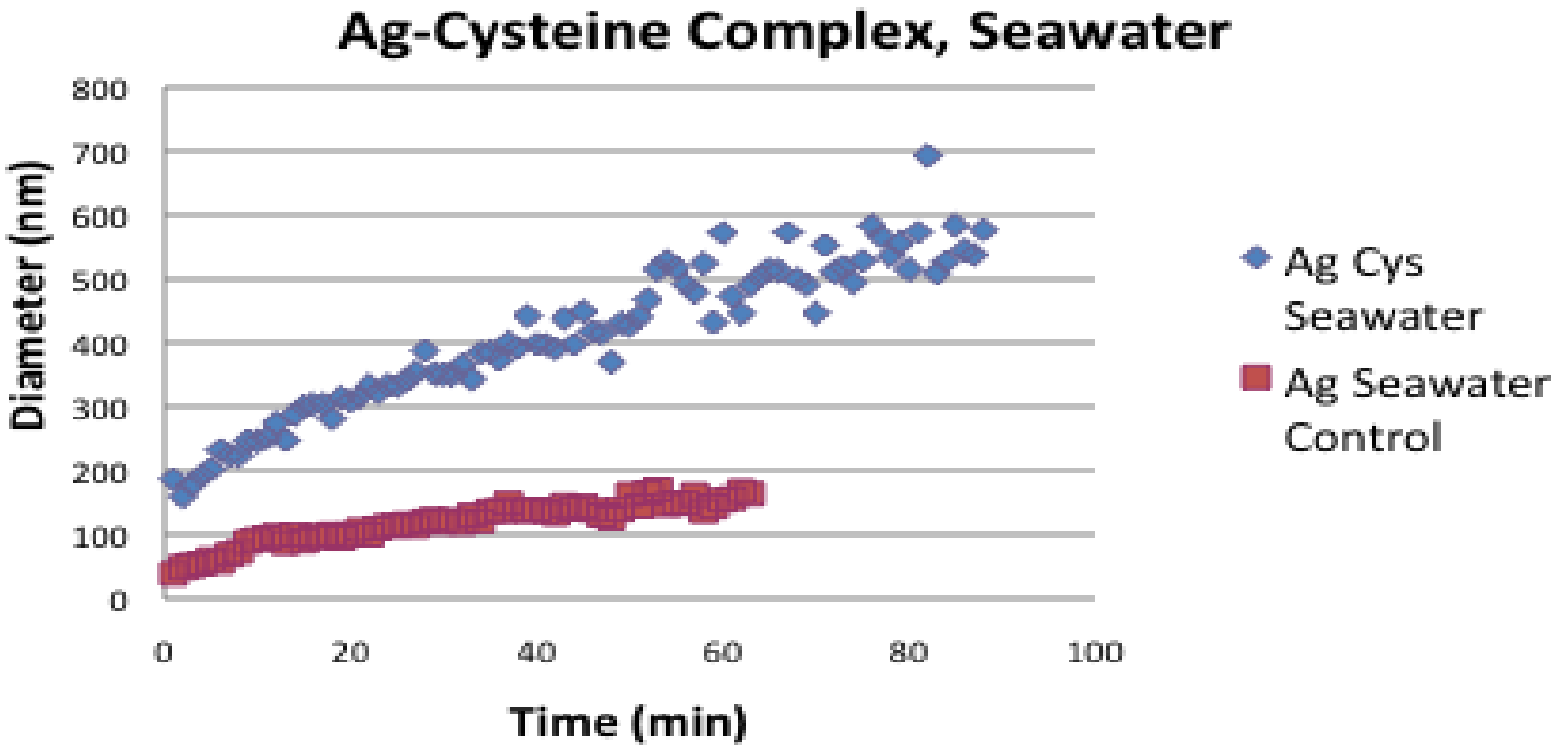
- **Coadsorption of chloride ion with cysteine**



Complex Formation as a Function of IS



Ag-Cysteine Complex in Environment



Complex Characterization

- Formation is highly dependent on pH, IS, and concentration of L-cysteine
- Chloride ions are coadsorbed on Ag surface with cysteine
- Complex results in aggregation or disaggregation of NPs based on IS
- Prevents stabilization by natural organic matter (NOM)

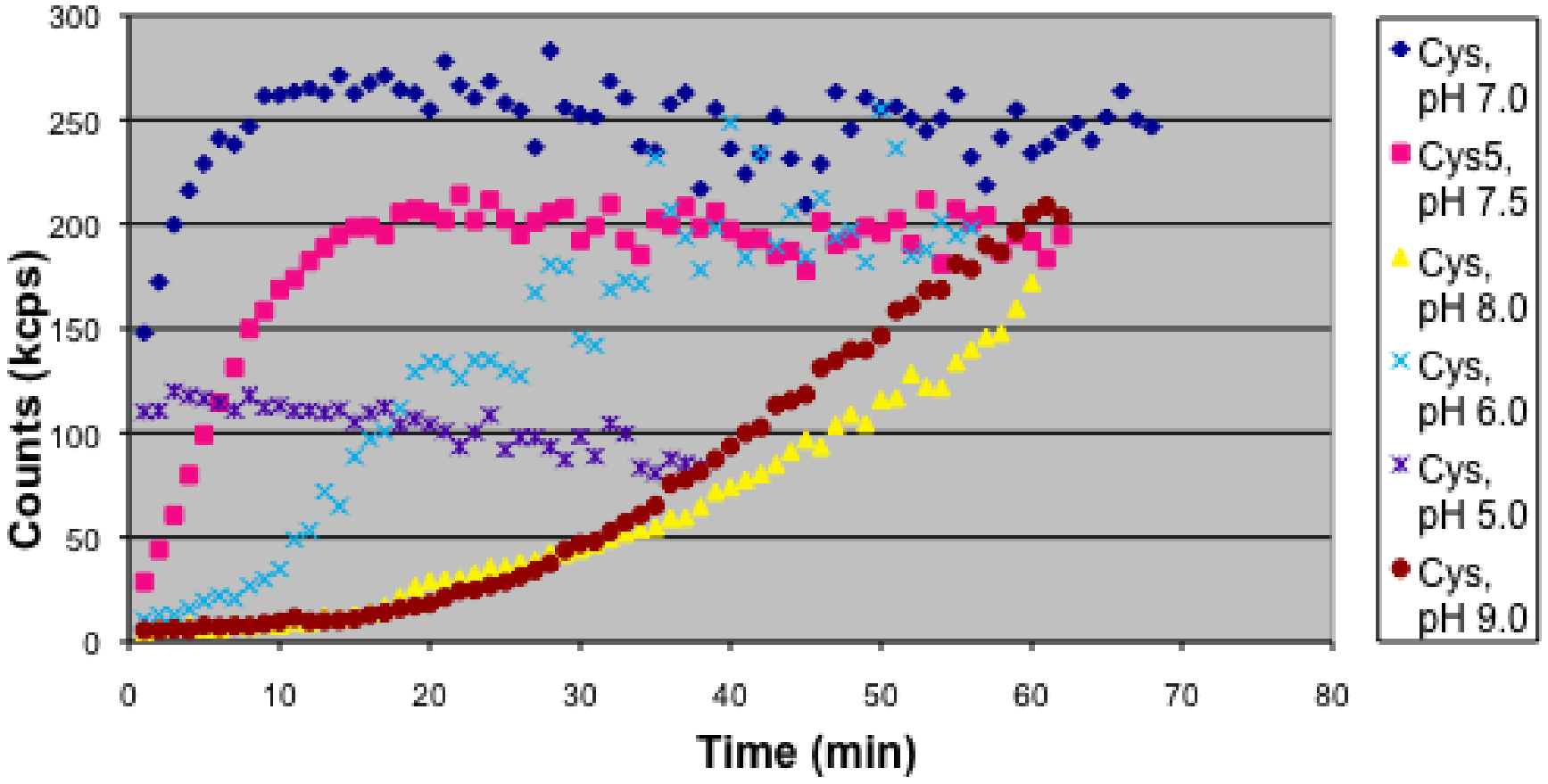
Future Research

- Environmental Scenarios - involving freshwater with natural organic matter

- Adsorption isotherms – characterizing the Ag-cysteine complex formation as a function of cysteine concentration

- Fate of Ag-cysteine complex

Ag-Cysteine Count Rates, [NaCl]=10 mM



Complex Formation and Aggregation