

A One-step Approach to Tuning the Size of Silver Nanoparticles

By

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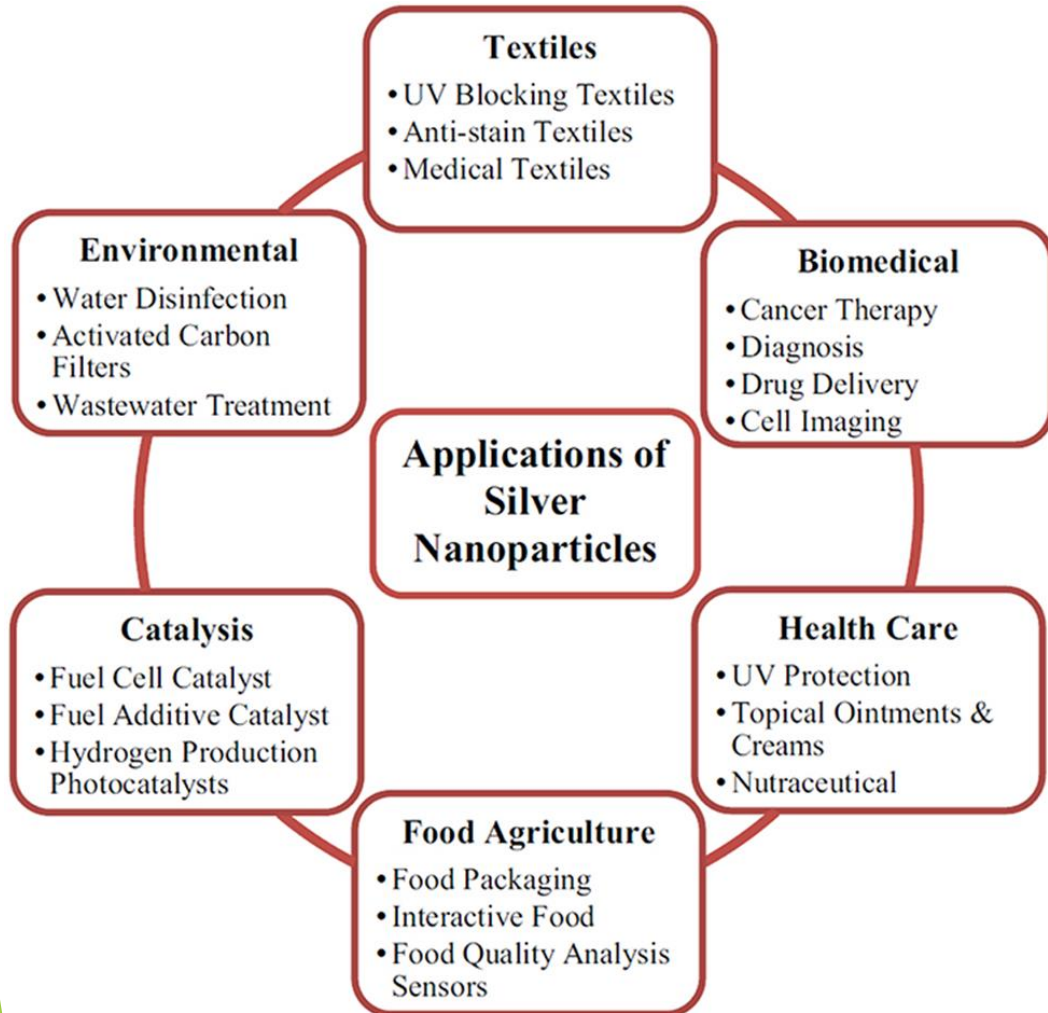


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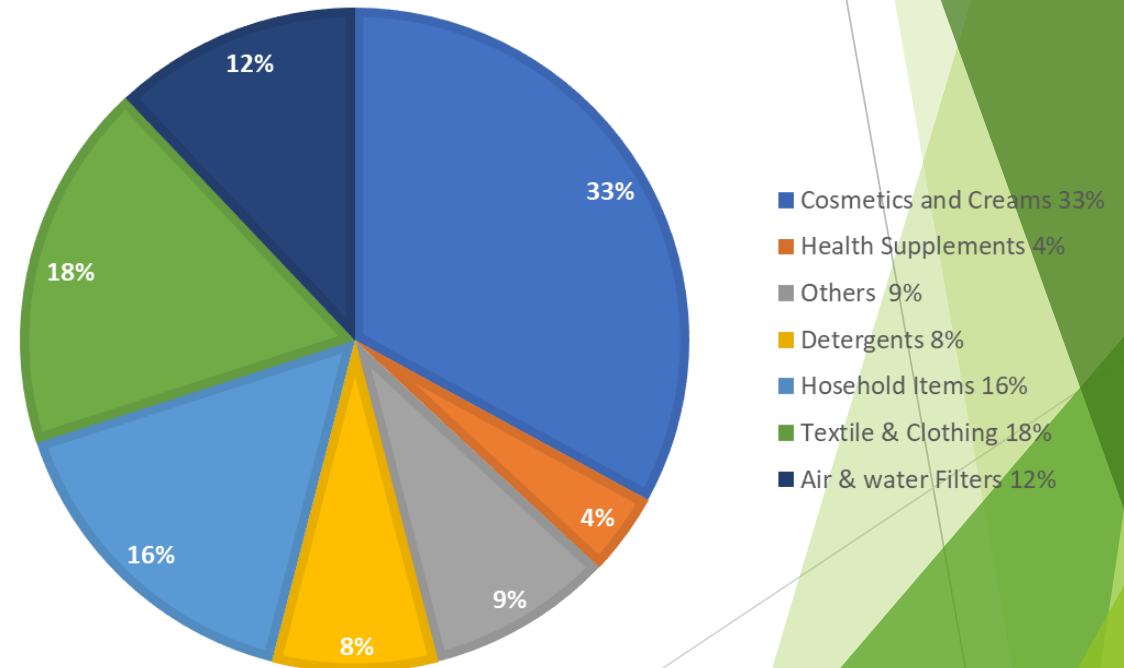


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Applications of silver nanoparticles



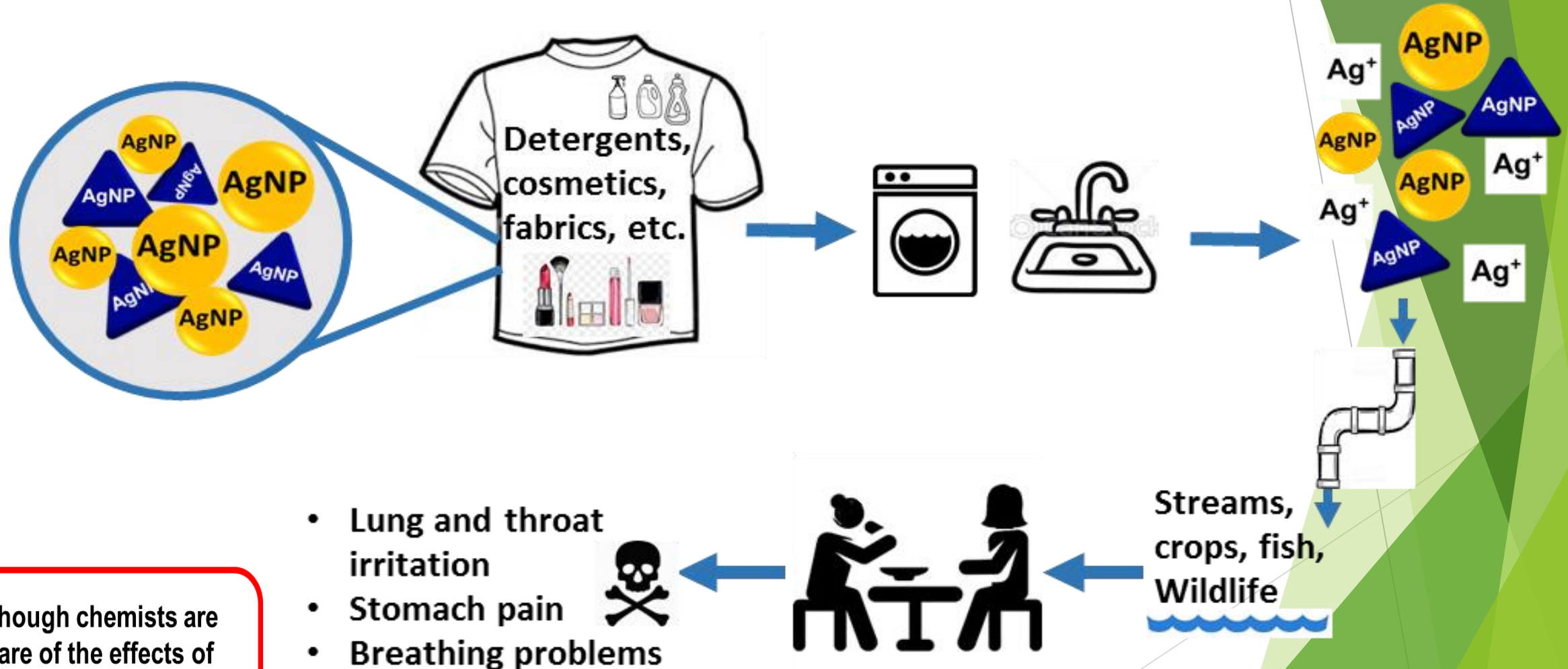
SILVER NANOPARTICLES IN THE MARKET





What are the environmental
and human health impacts?

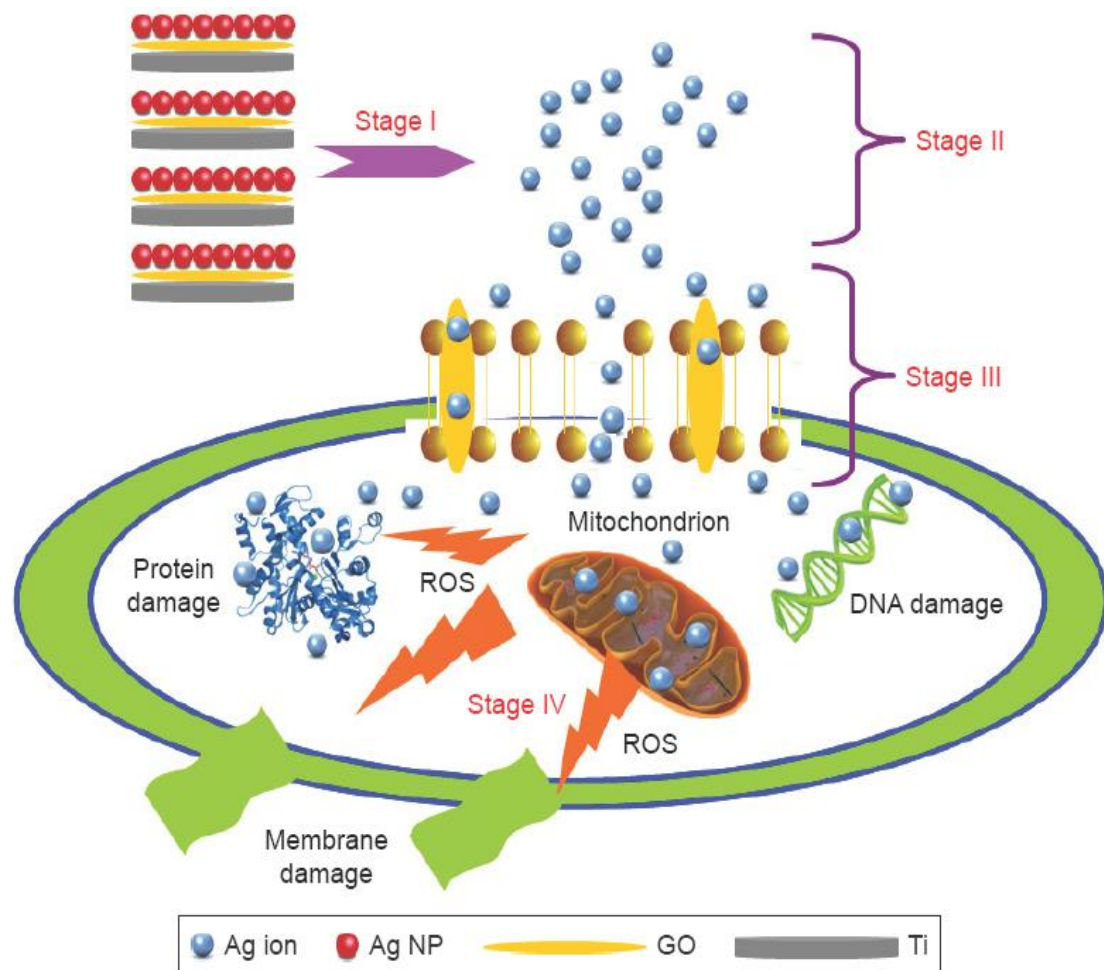
Impact of Silver Nanoparticles and Their Ultimate Fate



- Lung and throat irritation
- Stomach pain
- Breathing problems

Although chemists are aware of the effects of Silver NPs the majority of the public is not.

Dangers of Silver Nanoparticles



There is no regulation!!!

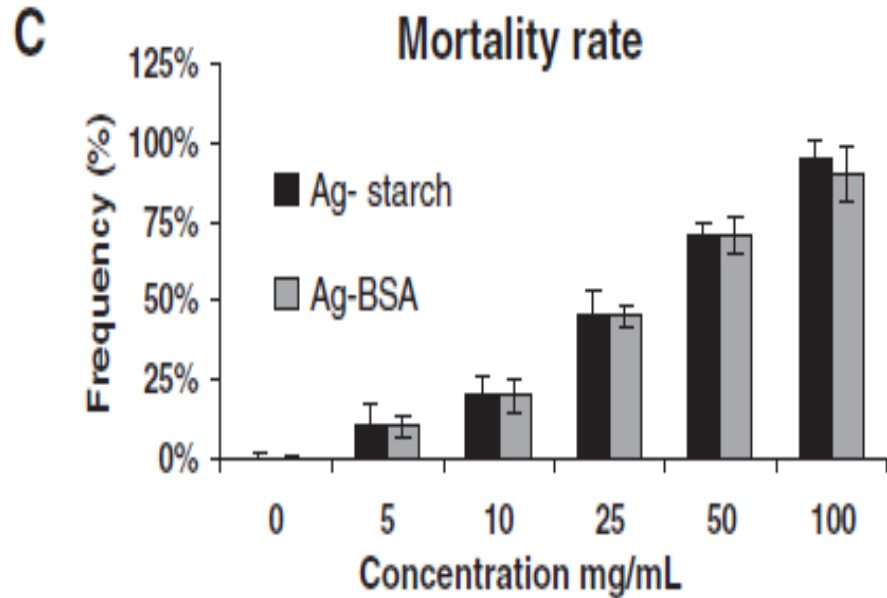
What do we know about AgNP toxicity?

Figure 11 Schematic mechanisms for antimicrobial ability of GO-Ag-Ti.

Notes: Blue ball, red ball, yellow sheet, and circular platform represent Ag ion, Ag nanoparticle, GO sheet, and Ti substrate, respectively. The roman numerals I, II, III and IV are the different periods of antimicrobial process. The 20, 50, 80 and 100 µg/mL are designated as G20, G50, G80, and G100, respectively.

Abbreviations: Ag, silver; GO, graphene oxide; NP, nanoparticles; ROS, reactive oxygen species; Ti, titanium.

Previous Toxicity Studies of Silver Nanoparticles

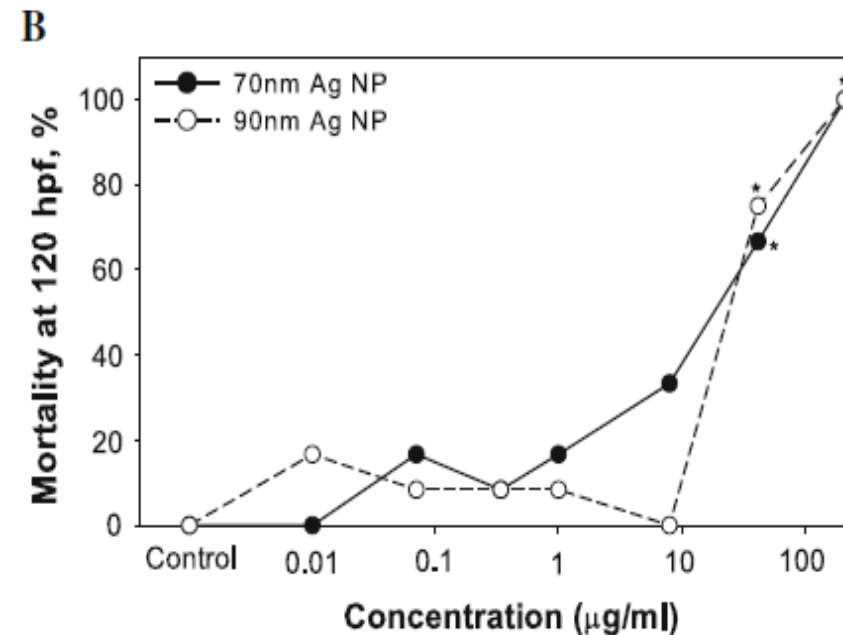


Asharani et al. (2008). Toxicity of silver nanoparticles in zebrafish models. *Nanotechnology*, 19, 255102

Challenge

- AgNP release Ag^+ ions
- There is no way to study how the shape, size, surface area, and surface chemistry influence nanoparticle-biological interactions and toxicity

- Synthesized and commercially available AgNPs were tested for toxicity using zebrafish models
- With increasing concentration of AgNPs introduced, there is also an increase in mortality



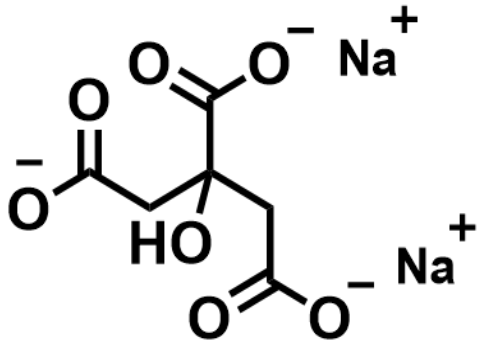
Boventre et al. (2014) The impact of animated surface ligands and silica shells on the stability, uptake, and toxicity of engineered silver nanoparticles. *J Nanopart Res*, 16, 2761



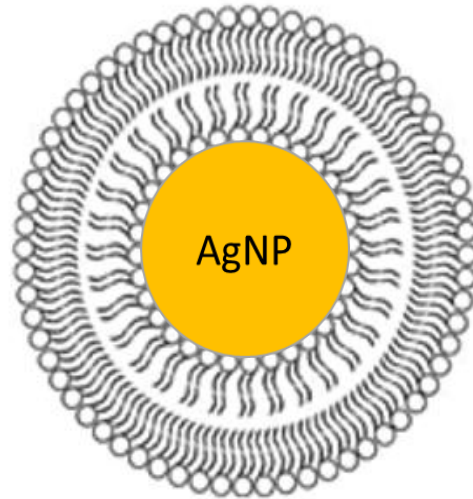
How can we control for the presence of Ag ions in samples used for evaluating toxicity?

Designing a Series of Different Stable AgNPs

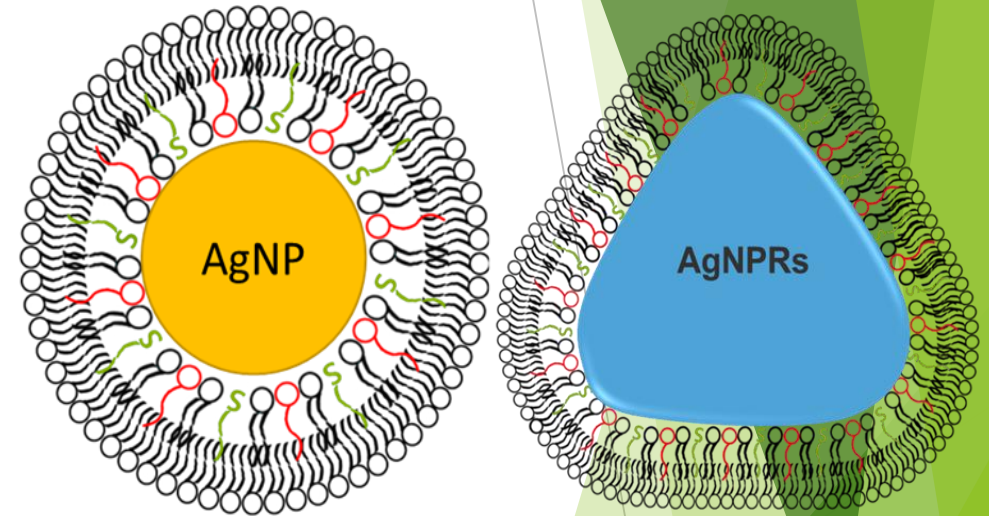
Citrate



SOA-PC



Hybrid Lipids



Key:

- SOA - Sodium Oleate
- PC - Phosphatidylcholine
- PT - Propanethiol
- HT - Hexanethiol

AgNP stability, in order, from lowest to highest

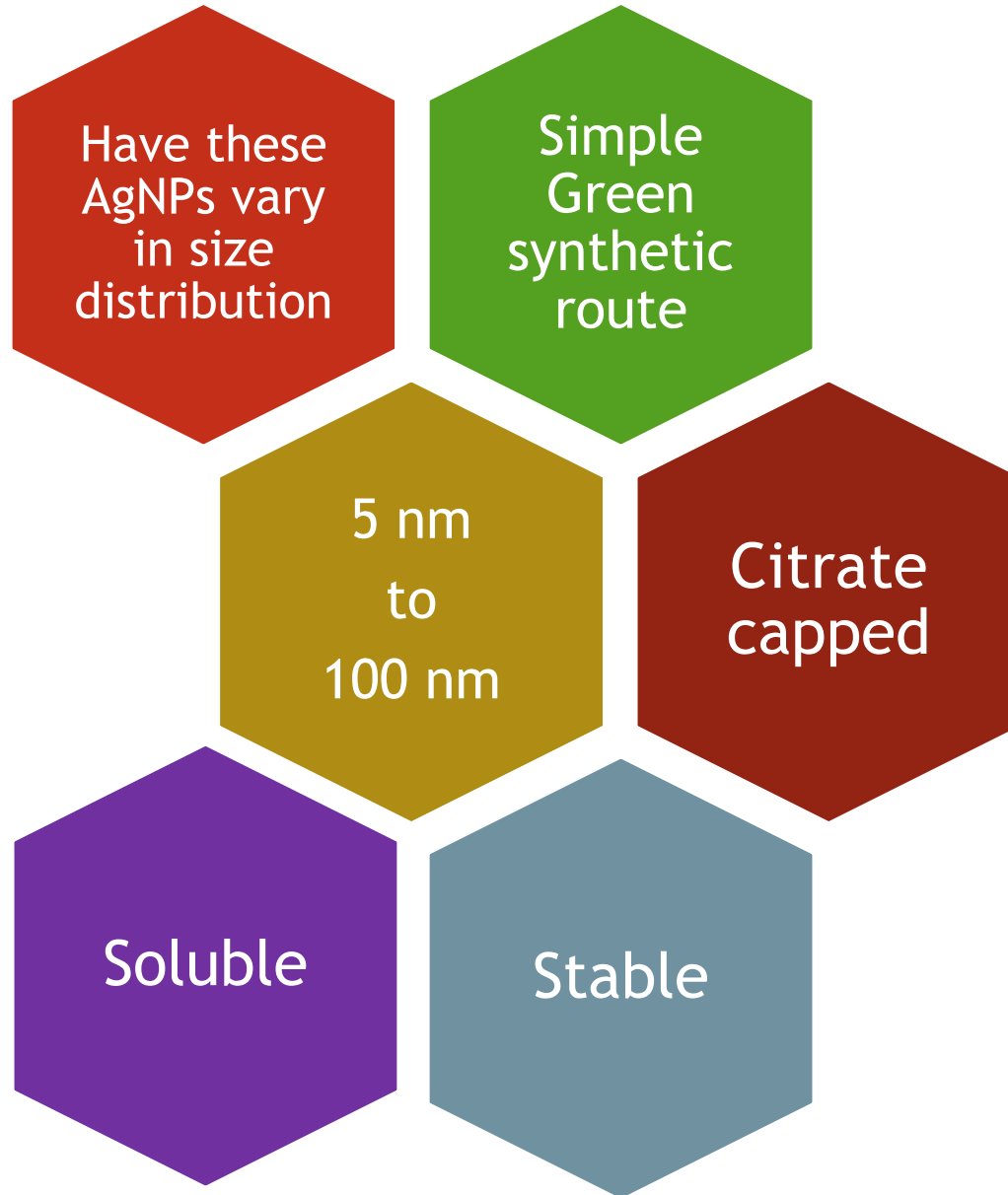
- Ag-Cit (lowest), Ag-SOA-PC, Ag-SOA-PC-PT, Ag-SOA-PC-HT, and Ag-SOA-PC-HT-Purified (highest)

How does shape
play a role in
toxicity?

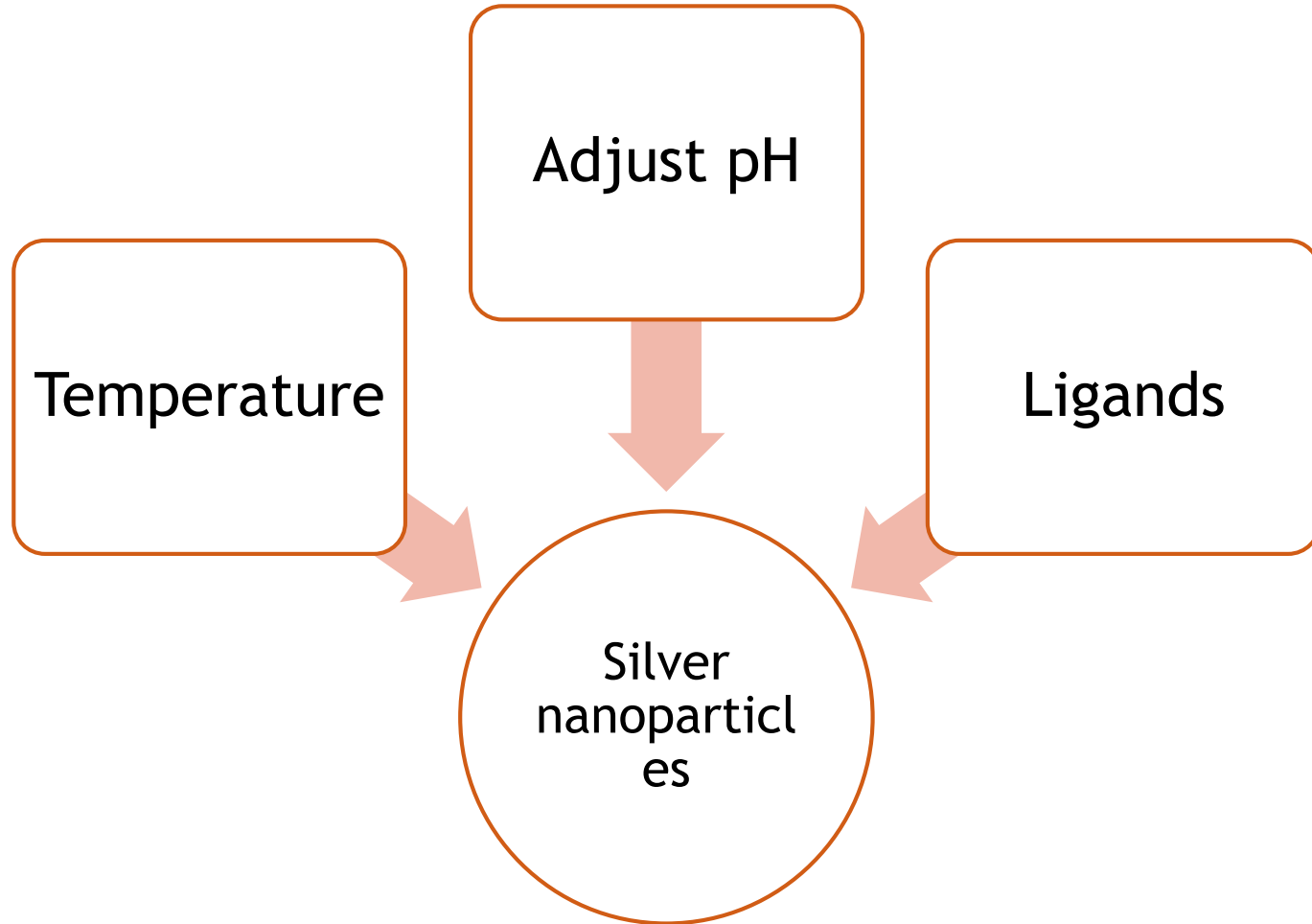
How does size
play a role in
toxicity?

How does
surface
chemistry
play a role in
toxicity?

My goals



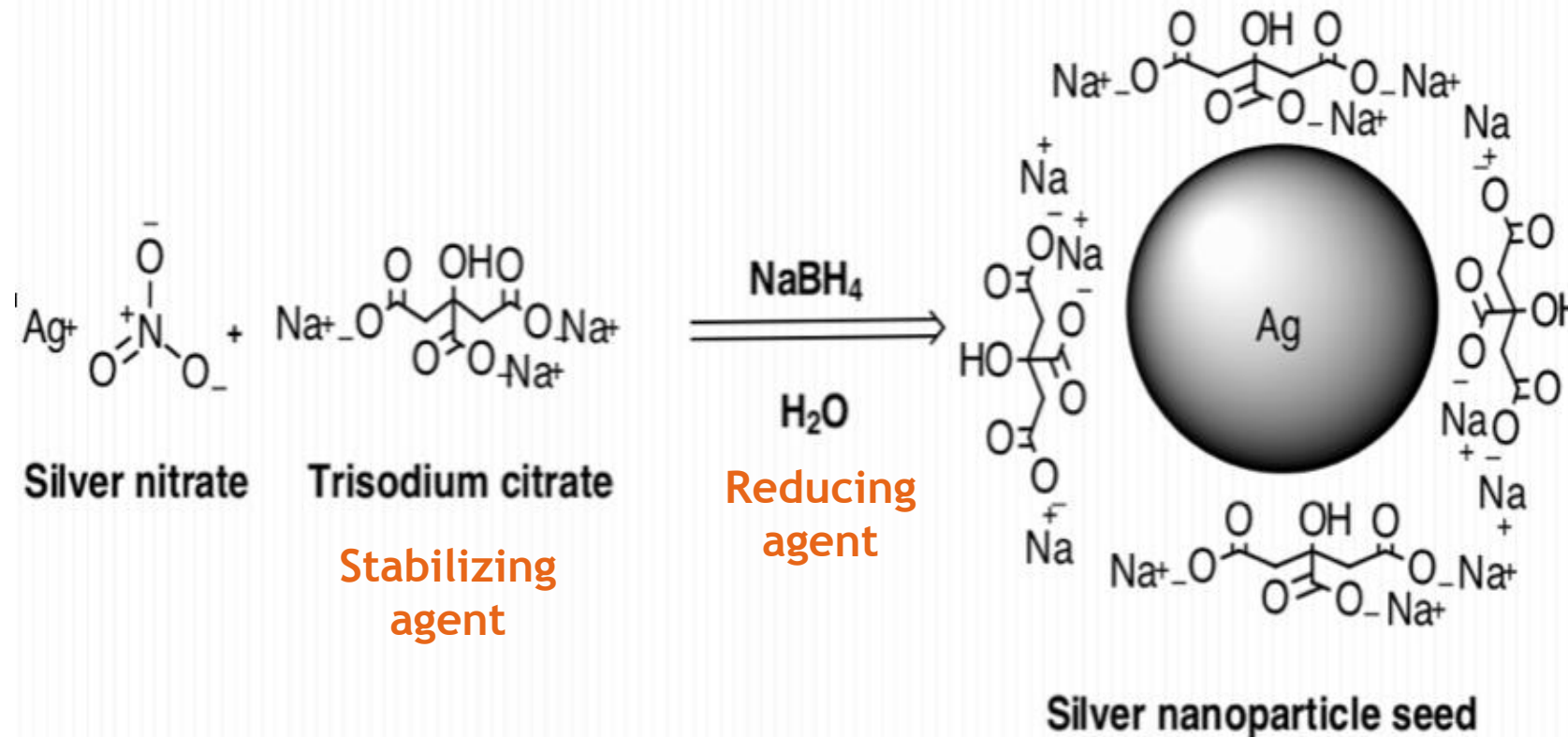
Previous work



We want:

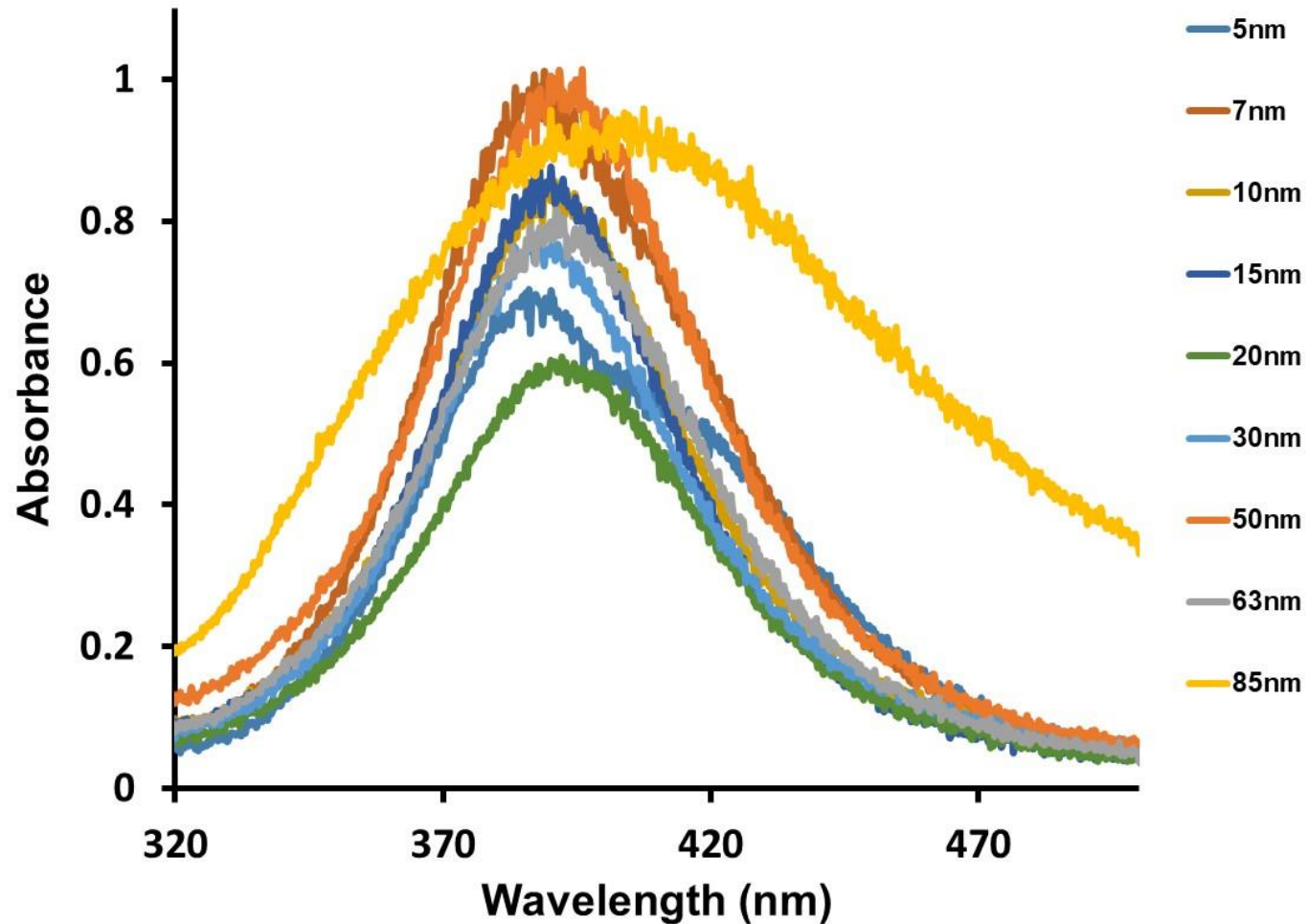
- Simpler green synthetic route
- Citrate capped because citrate ligands are easily displaceable

How Were These Silver Nanoparticles Made?



- Sodium citrate- prevents the nanoparticles from collapsing in yield bulks
- Sodium Borohydride- donates electrons creating silver nanoparticles

Citrate-capped Silver Nanoparticles



- There was variation in size when measuring lambda max.
- Stable and soluble
- Could be some improvement on the monodispersity of the AgNPs

NaOH was Introduced to the Silver Nanoparticles

pH: 7

7

7

7

6

6

5

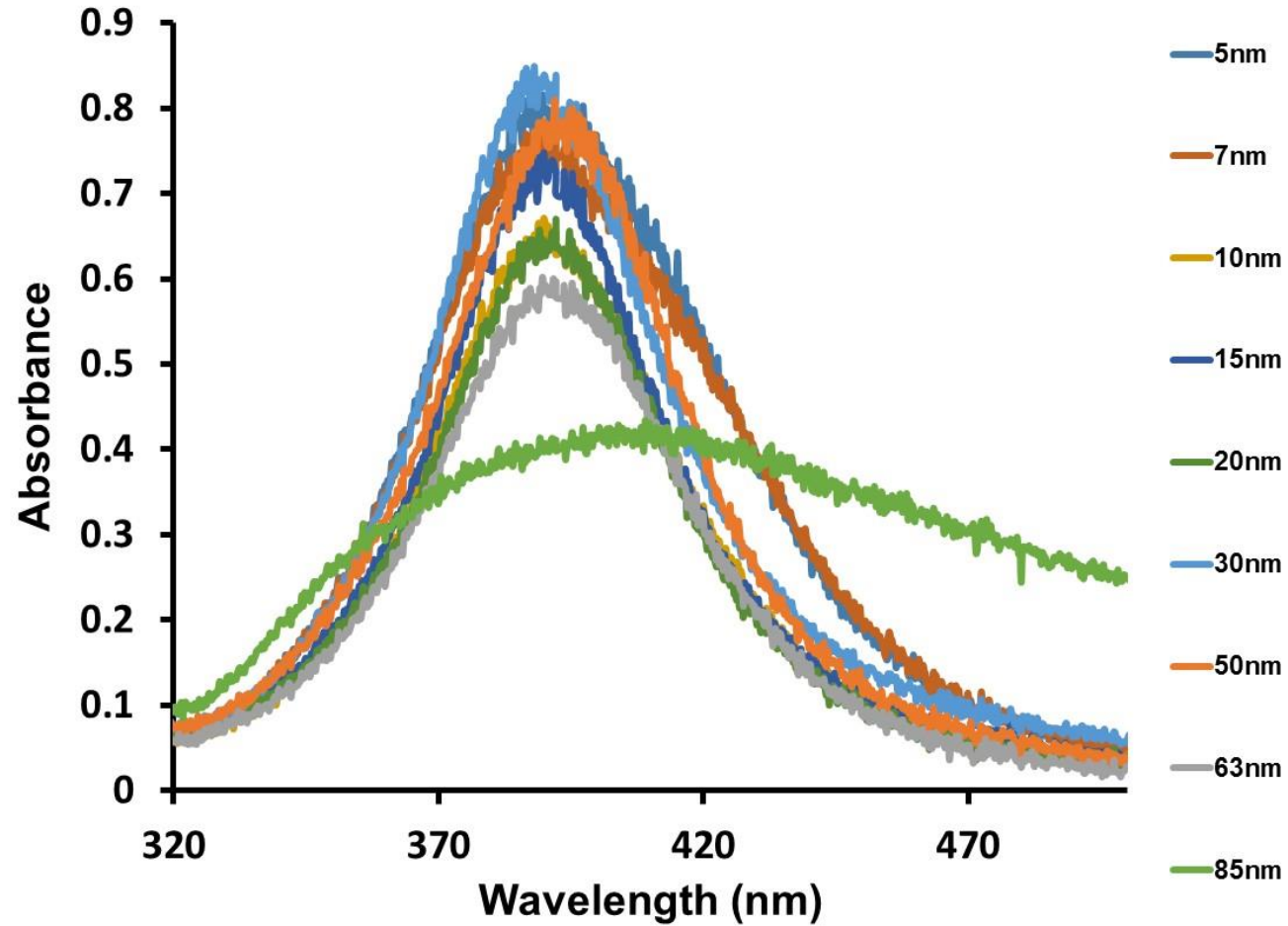
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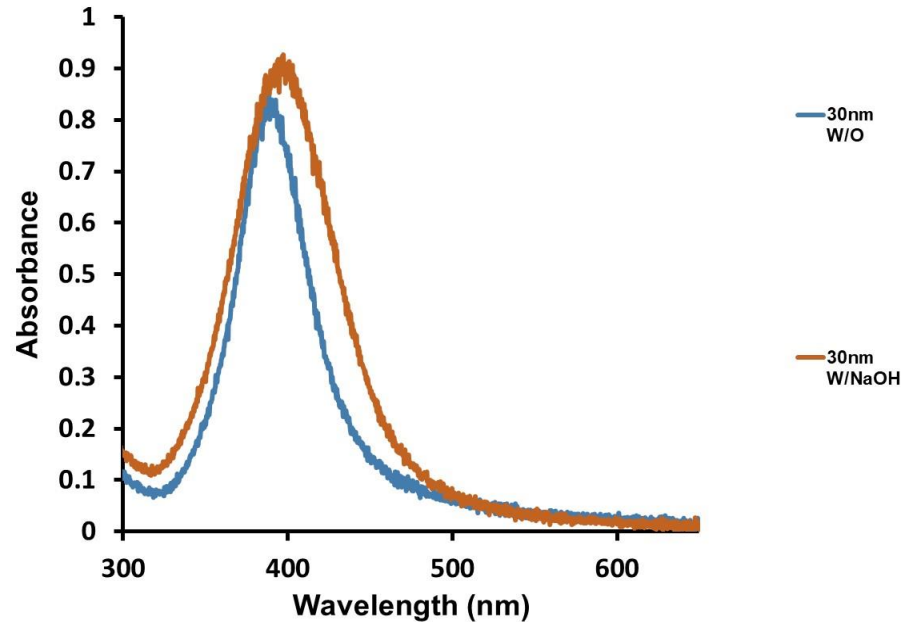
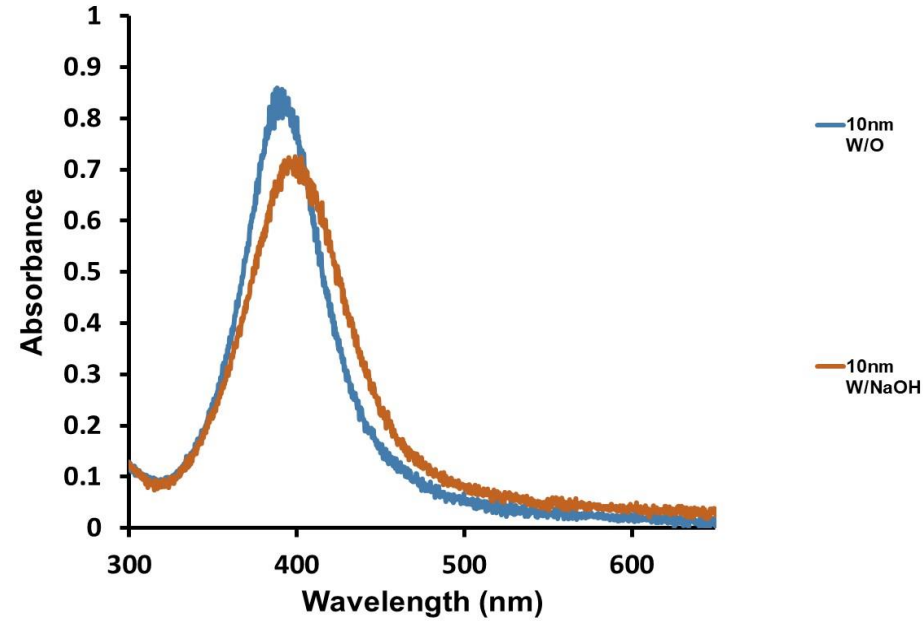
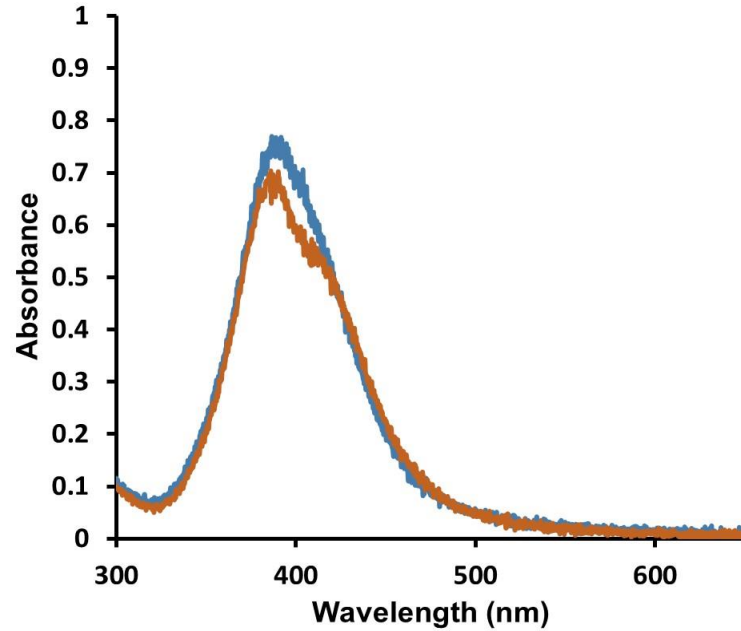
- NaOH - OH ions increase the electrostatic repulsion force between silver nanoparticles
- Elevate reducing ability of citrate
- Improves uniformity and increases size

Silver Nanoparticles in the Presence of NaOH



- The bands were more broad
- There was a slight red shift in surface plasma resonance
- 85 nm silver nanoparticle showed broadening of the band, indicating aggregation

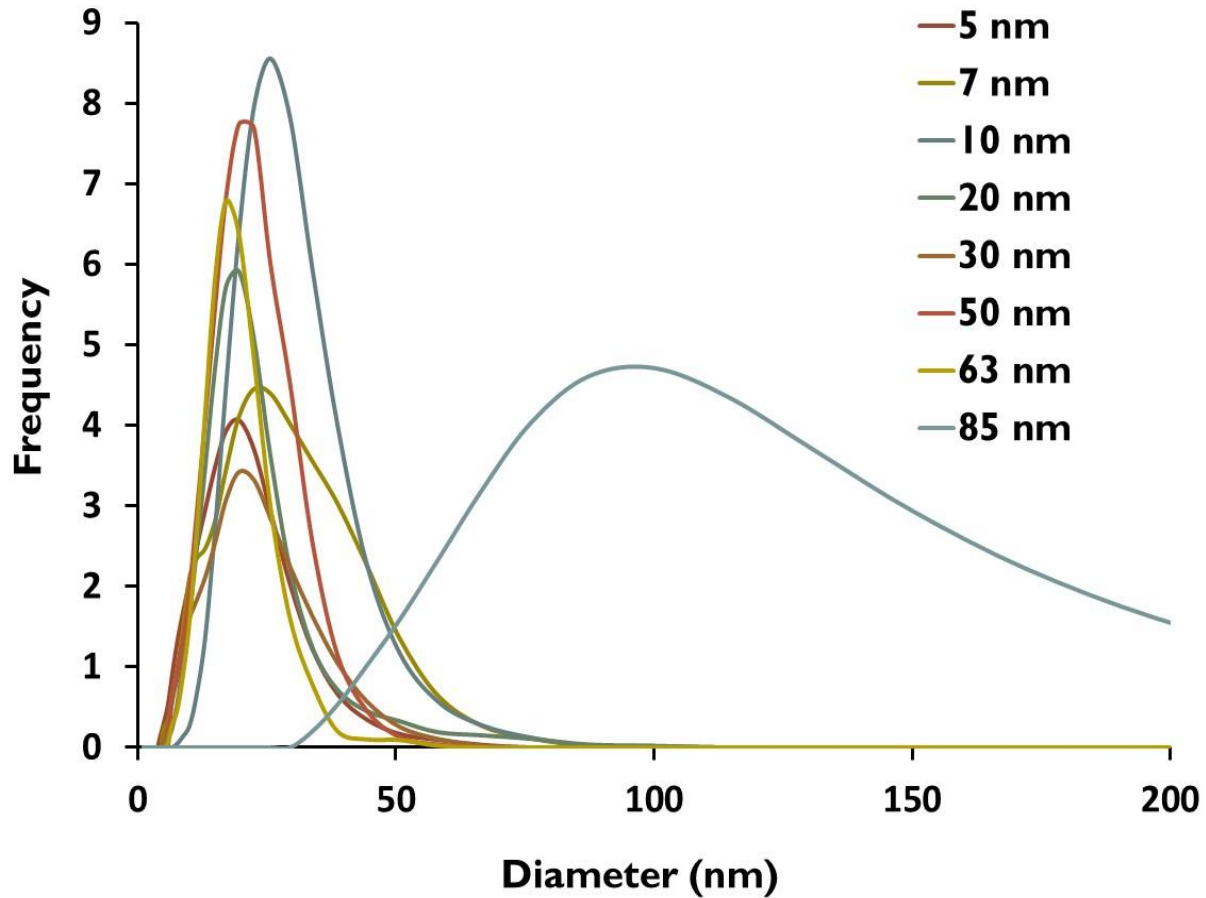
Comparison with and without NaOH



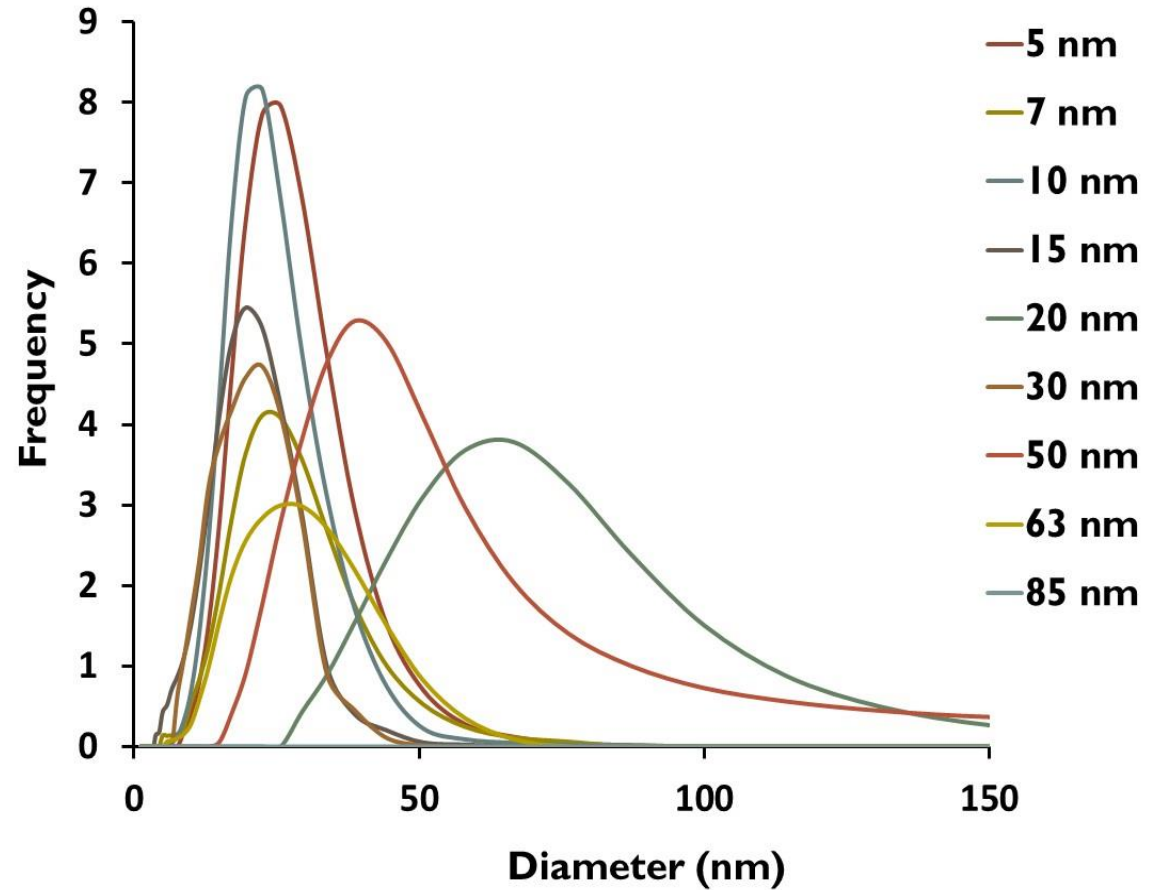
With the presence of NaOH:

- Increase in size
- The bands were more broader indicating they were less homogenous

DLS Size Comparison of AgNPs in the Presence of NaOH

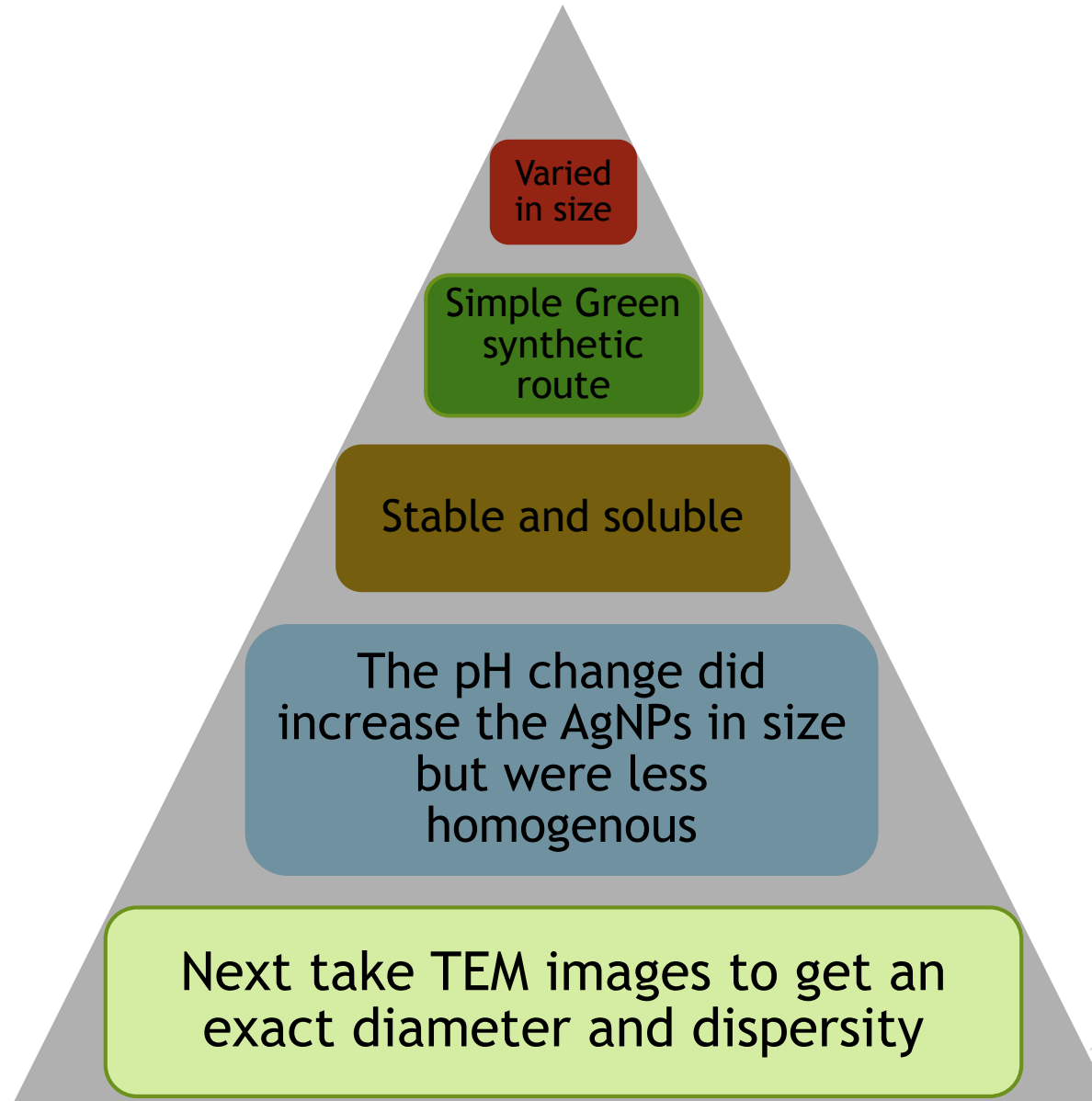


No NaOH



With NaOH

Summary and Future Goals



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