Acetaminophen Binding with Gold Nanoparticles

Sekinat Mumuney

Faculty Advisor: Philip T. McCreaor, Ph.D.

Mercer University - School of Engineering, Macon, GA

Abstract

Nanoparticles are currently being studied for their applications as drug delivery systems. They offer an advantage over other drug delivery systems because of their ability to target specific cells and release a drug in a controlled manner. This characteristic of nanoparticles also allows them to reduce the undesirable side effects of drugs. In order to use nanoparticles as drug delivery systems, the drugs must first be bound to the nanoparticles.

The purpose of this project was to synthesize gold nanoparticles and test the nanoparticles’ drug binding ability. Gold nanoparticles were created and bound to the drug Acetaminophen. The binding of the nanoparticles and the acetaminophen were modeled after the binding of gold nanoparticles and proteins. A flocculation test was performed to measure the stability of the nanoparticles and the Acetaminophen.

Experimental Details

Process of Creating Gold Nanoparticles

- Gold nanoparticles were created using the Griff Prep Method. Add 50 mL of 10 mM HAuCl₄ to 450 mL of ultrapure water to make a 500mL 1 mM solution.
- Heat to a rolling boil with stirring rod in a round bottom flask, let reflux for 10 minutes.
- In a separate beaker, prepare 38.8 mM Na₂Citrate by adding 1.141 g Na₂Citrate to 100 mL of ultrapure water.
- Quickly add the Na₂Citrate while stirring.
- The color should change from a light yellow to a deep red.
- Let boil for an additional 10 minutes.
- Remove solution from heat and let sit for 15 minutes.
- Allow solution to cool to room temperature.
- Filter through a 8 micron filter.
- Examine to see if any particles precipitated out of solution.
-_Store solution in a clean dark glass container.

Preparation of Acetaminophen Solution

An Acetaminophen solution of concentration 0.75 mg/mL was prepared in which the gold nanoparticles would be added to. The concentration of the solution was also modeled after the binding of nanoparticles.

- Add 0.0375 g of C₃H₆NO₂ to a 50 mL volumetric flask.
- Fill the flask to the mark with deionized water.
- Place the stopper in the flask, invert flask to stir solution.

Flocculation Test

A flocculation test is a way to measure the stability of the nanoparticles once the Acetaminophen has been added. Stable and uniform nanoparticles increase the likelihood that binding will take place. First, 1 mL of gold nanoparticles were added to ten cuvettes. Increasing amounts of C₃H₆NO₂ were added to the cuvettes in 10 μL increments. The nanoparticles were allowed fifteen minutes to bind to the drug. Then 150 μL of 1.0 M NaCl was added to each cuvette, and the volume of each sample was corrected to 1.5 mL with ultrapure water. The color of the samples would indicate the stability of the nanoparticles.

Results

During the 15 minutes, there were no noticeable changes in any of the samples. Upon the addition of NaCl, the color of all the samples rapidly changed from a wine red to a deep purple.

Conclusion and Future Work

The gold nanoparticle solution tuned deep purple because the nanoparticles flocculated, causing precipitation to occur. There was not enough surface coverage from the Acetaminophen to prevent the nanoparticles from aggregating. The flocculation of the nanoparticles indicated that the Acetaminophen and gold nanoparticles were not stable in solution.

The test was not decisive in determining whether binding occurred between the nanoparticles and Acetaminophen. A greater concentration of Acetaminophen may be necessary to prevent the nanoparticles from flocculating.

Further research needs to be done in order to determine whether binding occurs. A binding study will be performed in order to determine the optimal amount of Acetaminophen necessary for binding, and whether binding occurs.

References


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