

Name: _____ Date: _____ Class: _____

Student Worksheet

Using Gold Nanoparticles for Bacterial Detection

Safety

Always wear appropriate safety gear when using chemicals, including safety goggles, plastic gloves, and if needed, aprons. Never dump chemicals down the sink unless told to do so by an instructor. Dispose of chemicals appropriately.

Introduction

How do scientists and doctors test for diseases? How do they use nanotechnology to assist in early detection of diseases... especially contagious diseases like bacterial meningitis (*Neisseria meningitides*)? Over the next few days you will learn about applications of gold in nanotechnology, create gold nanoparticles (GNP's) to be used to detect a disease (GNP assay test), and simulate an assay test for meningitis. A real meningitis test would involve a spinal tap to test samples of one's cerebral spinal fluid (CSF), a painful procedure! Instead, the second part of this lab will be done as a simulation, due to the fact that modifying GNP's in the classroom to be able to test for a specific antigen is beyond the scope of this class...and using real meningitis would lead to a lawsuit!



During part I of this lab you will be creating gold nanoparticles (GNP's) approximately 15 nm in size (that's small!). The particles will be covered in a citrate layer that will prevent the gold particles from 'bumping' into each other, sticking and therefore making larger and larger particles. The nanoparticle surfaces can be modified to attach to just about any molecule or antigen. These GNP's will be used to detect simulated meningitis bacteria which will "infect" some of your classmates.

Part II of this lab will consist of all students "kissing" two other students (bacterial meningitis is only contagious through bodily fluids)! Ok, settle down, you won't actually kiss...we will simulate swapping spit by using test tubes and eye droppers. We will then use our engineered GNP's to detect those of you who have contracted the disease.

Optional: For those interested in the work of an epidemiologist, try looking at the results and determine who was the original carrier/vector of the disease.

Part III of this lab will enable groups to research ways in which GNP's are being used in the medical field and share the info to the class via PowerPoint.

Prelab - Read the following and answer the questions below.

1. Introduction to Metallic Nanoparticles-

<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2996072/>

2. BioAssay Works- *<http://www.bioassayworks.com/>*

3. Meningococcal Disease- *<http://www.cdc.gov/meningococcal/about/symptoms.html>*

1. What are metallic nanoparticles and list 2 ways in which the medical field uses them.

2. Why are gold nanoparticles used in the nano field? What properties make them a great candidate for nanotechnology?

3. What is Bacterial Meningitis?

4. What are 4 symptoms of bacterial meningitis and how is it passed from person to person?

Question: How can gold nanoparticles be used to detect the presence of bacterial meningitis?

Make a Prediction:

Part I Procedure - Making Gold Nanoparticles

Materials

Part I- Making Gold nano particles

- HAuCl₄- Chloroauric acid
- Na₃C₆H₅O₇-Sodium citrate
- 50 ml Erlenmeyer Flasks
- Test tubes or screw top vials
- Eye droppers/pipets (graduated if possible)
- Hot plate/stirrers
- Stir bars
- 10mL graduated cylinder
- Marker/grease pencil

Part II Meningitis outbreak!

- Test tubes with simulated CSF fluid
- Eye Droppers
- GNP's from Part 1

1. Obtain a vial of 1.0 mM HAuCl₄ solution from your teacher. This vial contains ~ 20 ml of solution.
2. Pour the contents of this vial into a 50 ml Erlenmeyer flask.
3. Place the Erlenmeyer flask on a hot place and heat to boiling. Stir while the solution is heating.
4. Obtain a vial of 38.8 mM Na₃C₆H₅O₇ solution from your teacher and use a 10 ml graduated cylinder to measure out 2 ml of the 38.8 mM Na₃C₆H₅O₇ solution.
5. After the HAuCl₄ solution begins to boil, add the 2 ml of Na₃C₆H₅O₇ solution.
6. Continue to boil and stir the solution until a deep red color appears. This takes about 10 minutes.
7. Turn off the hot plate and allow the solution to cool to room temperature.
8. Label your vial with your names and pour the nanoparticles into your labeled vial.
9. Bring your vial of gold nanoparticles to the teacher to store for use in Part II.

Part II - Meningitis outbreak!

Today you will be working in a group of about a dozen people to be determined by your teacher. Each member of the group will receive a test tube filled with a clear liquid that is your simulated bodily fluid. One sample is a carrier of simulated meningitis. Your job is to determine who has the disease after all the “kissing” is done by analyzing the simulated cerebral spinal fluid (CSF) samples.

Optional: For an added challenge play the part of epidemiologists as a group and see if you can decide who originally had the disease. To do this, each one of you will need to record who you have exchanged fluids with, and in what order. You can then create a flow chart of the group members to illustrate who was infected and who was the original carrier. At the end of the simulation, those who test positive for the simulated meningitis can compare notes and trace the disease back to its source.

Procedure:

1. Your teacher will break the class into groups of 10-15 people. Don't worry if you are not with your part I groups.
2. Get an eye dropper and a test tube filled with bodily fluids from your teacher. (Don't worry-- it's not really bodily fluids, just water. Still, do not drink it!).
3. When your teacher tells you to begin, you will "kiss" another person in your group.
NOTE- No need to really kiss! Instead, squirt 2ml of bodily fluid from your test tube into a partners test tube being careful not to touch the other test tube or fluid (don't contaminate your eye dropper). At the same time you partner will squirt 2ml of bodily fluid into yours. Mix your test tube afterwards with your eye dropper.
4. Complete step 3 one more time with a second person in your group.
5. You will now use your GNP's from part I to detect if you have contracted bacterial meningitis.
6. Because everybody has possibly been "exposed", you must all unfortunately receive a spinal tap...ouch! Your test tubes now represent cerebral spinal fluid (CSF).
7. Add 1.5ml of GNP specific to bacterial meningitis antigen to your CSF. Stir sample.
8. A color change will signal a positive result for meningitis (positive results should change to blue). No color change or a slight brightening of the pink red signals a negative result for meningitis.

Record Your Observations:

Patient Name(group member)	Test result	Patient Name(group member)	Test result

Part III- how are GNP's used in the medical field?

1. In your assigned group, research and create a 2-3 min presentation to share with the class discussing one specific example of how GNP's are used in the medical field. Be sure to give specific examples of GNP creation, surface modification, uses, side effects, and outlook.

Draw Conclusions

1. Why was it important to treat the gold particles with citrate? How would your results have been different if we hadn't used citrate?

2. Why did we have to run a simulation with a meningitis assay test using GNP's ?

3. How many people were in your group? How many people tested positive? Explain why a negative test doesn't necessarily clear an individual from having the disease. What limitations do assay tests have?

4. In your part I group research a method of modifying the surface of GNP's to be specific to an antigen, virus, RNA or DNA etc. Give a short PowerPoint presentation to share your findings with the class.