

EDUCATIONAL RESOURCES FOR K-12 EDUCATORS

'degrees that work, Nanotechnology'

Lesson Planning Guide:

Science Teacher Series

Grade 10

(7-9 with modifications)



Pennsylvania College of Technology
College Information & Community Relations
Roger and Peggy Madigan Library, Rm. 321-339
One College Avenue
Williamsport, PA 17701
(570) 320-2400, ext. 7253

‘degrees that work, Nanotechnology’

Lesson Planning Guide – Science Teacher Version

Unit: Bacteria

Competency: Describe bacterial reproduction and silver nanoparticles effect on bacterial growth.

PA Science & Technology Standards Included: 3.1.10A, 3.3.10A, 3.7.10A, 3.8.10C

Grade Level: 10th (7th thru 9th with some modification)

Approximate Time: Five to Six 45-minute periods.

Prerequisite Skills

Reading, Writing, Speaking and Listening*

1.2.8 Reading Critically in All Content Areas

C. Produce work in at least one literary genre that follows the conventions of the genre.

1.4.8 Types of Writing

B. Write multi-paragraph informational pieces (e.g., letters, descriptions, reports, instructions, essays, articles, interviews).

C. Write persuasive pieces.

1.6.8 Speaking and Listening

F. Use media for learning purposes.

1.8.8 Research

B. Locate information using appropriate sources and strategies.

C. Organize, summarize and present the main ideas from research.

Mathematics*

None

Science and Technology*

3.1.10 Unifying Themes

A. Discriminate among the concepts of systems, subsystems, feedback and control in solving technological problems.

3.3.10 Biological Sciences

A. Explain the structural and functional similarities and differences found among living things.

* Academic Standards, Pennsylvania Department of Education

Competency: Describe bacterial reproduction and silver nanoparticles effect on bacterial growth.

3.7.10 Technological Devices

A. Identify and safely use a variety of tools, basic machines, materials and techniques to solve problems and answer questions.

3.8.10 Science, Technology and Human Endeavors

C. Evaluate possibilities consequences and impacts of scientific and technological solutions.

Career Education and Work*

13.1.8 Career Awareness and Preparation

A. Relate careers to individual interests, abilities and aptitudes.

Performance Standards

Performance Standard	Suggested Evaluation Method
1. Describe the process/steps by which bacteria reproduce with 90% accuracy based on the classroom discussion.	Written examination
2. Grow bacteria using competent lab techniques with 90% accuracy based on the lab notebook.	Performance evaluation
3. Explain how silver nanoparticles effect bacterial growth with 90% accuracy according to knowledge gained from the lab and discussion.	Oral examination
4. In groups, create your own nanotech product with 90% on the rubric.	Performance evaluation: rubric
5. Describe the field of nanotechnology, the types of jobs and industries utilizing it and the training necessary for a career in it according to the video and discussion with 90% accuracy.	Oral examination

Suggested Projects

None

Multiple Intelligence Types

Verbal/Linguistic

Visual/Spatial

Bodily/Kinesthetic

Interpersonal

* Academic Standards, Pennsylvania Department of Education

Competency: Describe bacterial reproduction and silver nanoparticles effect on bacterial growth.

Resources

1. Teacher Lab Guide: Nanotechnology in the Classroom Biology Activity Set
See attached
2. Website: CELLS alive!
www.cellsalive.com
3. Video: degrees that work. Nanotechnology
View or download at. www.pct.edu/degreesthatwork/

Equipment/Materials/Software

1. Computer with internet access and video projector
Any supplier
2. Lab materials, see list in attached Resource #1, page 13
Any science materials supplier

Suggested Learning Sequence

Strategy	Outline	Resources/Equipment
Performance Standard 1		
Introduction	In the Teacher Lab Guide read Section I, <u>Set at a Glance</u> . Begin the lab by explaining to the students some general concepts about bacteria, bacterial growth and the prevention of bacterial growth. This can be done using your own textbook and resource materials or using the website cellsalive.com	Resource #1, pages 1-2 Resource #2 Equipment #1
Activity	Read and follow the instructions in the Teacher Lab Guide, Section II A, <u>Focus-Background on Bacteria</u> . Have the students make observations of the Petri dishes. Help them to understand what they are seeing in the dishes. Use the <u>Focus: Background on Bacteria</u> worksheet in Section III.	Resource #1, pages 2-3, 5-6 Equipment #2
Discussion	Bring the students back together after observing the Petri dishes and socks. Discuss what they observed in each dish and what may be the cause of the differences in each dish. Related SCANS/Soft Skills: Thinking F	Resource #1, pages 2-3
Activity/ Discussion	Have the students do their own research to learn more about bacteria and bacteria prevention. Read and follow the instructions in the Teacher Lab Guide in Section II A, <u>Focus: Background on Bacteria</u> . Use the <u>Focus: Research Bacteria Activity Sheet</u> to complete this exercise. When they are done, bring students together for a classroom discussion about the key concepts they should have discovered. Finish the activity with the <u>Focus: Bacterial Prevention</u> worksheet. Related Academic Skills: 1.4.8B	Resource #1, pages 2-3, 7-8 Equipment #2

Competency: Describe bacterial reproduction and silver nanoparticles effect on bacterial growth.

Performance Standard 2		
Introduction	Read and follow the instructions in the Teacher Lab Guide in II B, Explore – <u>The Effect of Silver Nanoparticle on Bacterial Growth</u> . Also read the <u>Teachers Notes</u> in the back of the Lab Guide. Introduce the students to the Explore portion of this lesson. You will want to review proper lab procedures, lab reports and hypothesis. Use the handout <u>Explore: The Effect of Silver Nanoparticle on Bacterial Growth</u> .	Resource #1, pages 3, 9, 12 Equipment #2
Activity	Have the students complete the lab following the directions from the lab worksheet. Related Academic Skills: 1.4.8B; 1.8.8C; 3.7.10A Related SCANS/Soft Skills: Information A; Technology B	Resource #1, page 9 Equipment #2
Performance Standard 3		
Introduction	Read and follow instructions in the Teacher Lab Guide, Section II C, <u>Reflect – How Does It Happen</u> . Explain to the students that this is the reflect portion of the lesson. The students are to think about what they have learned about bacteria and nanoparticles. They will do this to help process the information they have gathered. They will use this information to complete Performance Standard #4. Related Academic Skills: 3.3.10A; 3.8.10C	Resource #1, pages 3-4
Discussion	Have the students discuss as a group what they learned. Lead the discussion making sure to cover the questions found in the Reflect portion of the Teacher Lab Guide.	Resource #1, page 4
Performance Standard 4		
Introduction	Read and follow instructions in the Teacher Lab Guide, Section II D, <u>Apply – Make It Work For You</u> . Explain to students that this is the Apply portion of the lesson. Point out that they will use what they learned about bacteria and nanotechnology to produce a nanotech product of their own. Introduce the assignment with a discussion of some possible ideas and a review of the information they could use to complete the assignment.	Resource #1, page 4 Equipment #2
Assignment	Distribute the rubric for the project, <u>Apply: Silver Nanoparticle Product Project Rubric</u> to each student. As a class, review it to make sure they understand each criteria and the point value for each. Have each group complete the project using the instructions on the <u>Apply: Silver Nanoparticle Product Project Rubric</u> handout. Related Academic Skills: 1.4.8C; 1.8.8B; 3.1.10A Related SCANS/Soft Skills: Interpersonal A; Thinking A,B,C	Resource #1, pages 4, 10, 11

Competency: Describe bacterial reproduction and silver nanoparticles effect on bacterial growth.

Presentation/ Discussion	Use the rubric to grade the projects. After grading have groups present their results to the class. Follow each presentation with a class discussion on the pros and cons of the groups' project.	Resource #1, page 10
Performance Standard 5		
Activity	<p>Introduce the Penn College video on nanotechnology and review with the students what you expect them to learn from it. Include:</p> <ul style="list-style-type: none"> • what is nanotechnology • what interests and abilities does one need to work in nanotechnology • in what industries is nanotechnology being used • what jobs are available in nanotechnology • what training do you need for a career in nanotechnology <p>Show the class the video. After the video discuss the growing field of nanotech with them, the interests and abilities one would need to be successful in nanotechnology and the possible job and training opportunities.</p> <p>Related Academic Skills: 1.6.8F; 13.1.8A</p>	Resource #3 Equipment #1

Related SCANS/Soft Skills

Resources

None

Interpersonal

A. Participates as Member of a Team - contributes to group effort

Information

A. Acquires and Evaluates Information

Systems

None

Technology

B. Applies Technology to Task – Understands overall intent and proper procedures for setup and operation of equipment

Thinking Skills

A. Creative Thinking – generates new ideas

B. Decision Making – specifies goals and constraints, generates alternatives, considers risks and evaluates and chooses best alternative

C. Problem Solving – recognizes problems and devises and implements plan of action

F. Reasoning – discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem

Personal Qualities

None

Related Worksite/Work Based Activities

None

Additional Resources

None

This planning guide was written by Eric Broughton, Science Teacher, Liberty High School, Liberty, PA.

Nanotechnology in the Secondary Classroom
Biology Activity Set
Silver Nanoparticles Effect on Bacteria

Traditional science: The study of bacterial characteristics including growth/multiplication, conditions required for growth, and impacts on human health.

Nanotechnology: The use of silver nanoparticles to combat the growth of bacteria.

I. The Set at a Glance

A. Level

This activity set is designed for the Biology classroom. It is to be used in a 10th grade Biology class but could be adjusted to also work with a 7th grade Life Science class.

B. Nanotechnology Core Concepts Addressed

1. CC3: Properties as a Function of Scale and/or Structure
 - a. How do properties change as we move from more familiar scales to the nanoscale?
 - b. What new properties arise at the nanoscale that can be exploited?
 - c. How can nanotechnology help us to understand differences in structure that produce objects made of the same materials that have different properties?

2. CC6: Health and Safety Issues: Risk Analysis and Unintended Consequences
 - a. What advantages are gained by producing materials at the nanoscale that could not be seen at different scales?
 - b. What problems could arise from materials produced at the nanoscale that might not be seen in materials at different scales?
 - c. How can we determine whether it is in our best interest to pursue a certain application at the nanoscale?

C. PA State Science Standards Addressed:

3.1.10.A	Analyze and describe the effectiveness of systems to solve specific problems.
3.3.10.A	Explain the relationship between structure and function at the molecular and cellular levels.
3.7.10.A	Select and safely apply appropriate tools, materials, and processes to solve problems.

3.8.10.C	Relate scientific and technological advancements in terms of cause and effect. Compare and contrast potential solutions to technological, social, economic, and environmental problems.
----------	---

D. Number of Class Periods Required:

1. Focus Activity: Background on Bacteria – 1-2 periods
2. Explore Activity: The Effect of Silver Particles on Bacterial Growth – 1 period to complete and part of a period to analyze results
3. Reflect Activity: How does it Happen? – 1-2 periods
4. Apply Activity: Make it Work for You – 1-2 periods

II. Activity Set Structure

A. Focus – Background on Bacteria

Why do some people's feet stink worse than others? Why do scratches and cuts get infected? These questions are relevant to everyone. At some time in your life you have smelled stinky feet. You probably also had a scratch or cut that became infected. The answers to these questions lie in the Biology classroom. Millions of tiny organisms that are found all around you at this very moment are the cause of the aforementioned problems. There must be a way to prevent these problems and it is your job to find out how it can be done?

In the opening activity of this lesson hand the students two Petri dishes that contain cultures of bacteria taken from somebody's feet (most likely yours). One Petri dish should contain a swab of a "dirty foot" and the other Petri dish should contain another swab but this dish should be treated with the silver nanoparticles solution or a silver band aide. This second Petri dish should have very little or no bacterial growth in it. Along with the Petri dishes you will hand out a regular pair of socks and a pair of socks with silver nanoparticles woven in the fabric. Ask the students to make observations of the Petri dishes and the socks and record them on their observation sheet. Then have them discuss amongst themselves in small groups what they think the correlation is between the socks and the Petri dishes.

After the students have had time to discuss, bring them together and ask them what they have come up with. Most students may not make a correlation between socks and Petri dishes so hand out some hand lenses and have them look at the Petri dishes and socks again. They should make more observations and record them on their observation sheet. Have the students discuss their observations and bring them back together to see what they have discovered. Most of the students should see that one pair of socks is different from the other when viewed through the hand lens. Discuss with the students what they have

found. Make sure they have made the correlation between the differences in the socks causing the differences in the Petri dishes.

It is important that the students understand this correlation to be able to continue on to the Explore step. If they do not make the correlation you need to lead the students in the right direction. They must understand that the difference in Petri dishes is a direct result of the difference in socks. As part of the discussion, make sure the students realize the socks have shiny fibers in them and that those fibers are made of silver. You also need to make the students understand that the Petri dishes contain bacterial growth.

The next part of this activity will have the students learning about bacteria. This can be accomplished in a number of ways. You can lead the students in the direction you would like to go using a lecture and discussion setup. A research based approach may also be used. An activity sheet needs to be given to the students that they would fill out using resources such as textbooks, internet, and the library. At the end of the research session you bring the students back together to discuss the findings of their results making sure they understand the key point of bacteria that you would like them to understand such as size and structure, growth and reproduction, conditions required for growth, and impacts on human health.

The final part of this activity involves studying the prevention of bacterial growth. Have the students brainstorm to figure out ways to kill bacteria and to prevent its growth. Have them fill out a brainstorming sheet while doing this. When they are done bring them back together and discuss what they have come up with. If none of the students come up with silver nanoparticles as a solution you need to introduce them to the idea. This will help lead them into the Explore Activity.

B. Explore - The Effect of Silver Nanoparticles on Bacterial Growth

So the students have learned what bacteria are, how they reproduce, and how they impact human's health. Now it is time to do some hands on activities to further that knowledge. In this activity the students will create bacterial cultures from their own feet and experiment with silver nanoparticles to see the effect of them on the bacteria. This will allow students to study how bacteria grow and look at the effects of nanotechnology on traditional science. As the students perform the lab they need to document their observations in a lab report. As part of the lab report they should create a hypothesis for what they believe is happening. They also need to think of other uses for nanotechnology in the field of Biology, particularly dealing with bacteria.

C. Reflect – How Does it Happen?

Now that the students are done with the Focus and the Explore activities the teacher must bring them together to gather their thoughts. A link between the

traditional science and the nanoscience must be made. Based on your results from your experiment, it appears that silver has the ability to kill bacteria. The question is “How does this work?” How does silver actually kill bacteria? Many people wear silver rings, earrings, and other jewelry but yet skin cells are not damaged or killed. How is it that silver nanoparticles can kill bacteria but a silver ring won’t kill skin cells? What does it mean to be a nanoparticle? Do you think this makes a difference in the effect of the silver on living cells? How might this work? Can you come up with any hypothesis of how nanoparticles might work differently than larger particles?

D. Apply – Make It Work for You

Now that students have seen the antibacterial effects of silver nanoparticles, introduce the fact that people are busy inventing products that take advantage of these properties of silver. Some examples of current products include silver coated band aids, plastic gloves and odor free and antimicrobial socks and shoes. It is now your turn to be an inventor. Your job is to invent a new product using silver nanoparticles. You must write a paragraph explaining your products design features and how it works along with possible uses of your product. Explain how this new product will be beneficial to mankind. You must also draw a prototype of your new product and label it. Be careful to use the proper scale.

In order to accomplish this task you will be placed in groups of three. One group member will be the Economist/Marketer that will design an ad campaign to sell your product. The second group member will be the Engineer/Designer that designs and tests your product. The third group member will be the Manufacturing Specialist that will be in charge of how to build your product efficiently. To make it realistic you must research silver nanoparticles and find out all that you can about them. You will also need to look into where bacteria control is needed.

III. Student Versions of the Activity Set Hand-outs

Focus: Background on Bacteria

Name: _____ Date: _____

Instructions: Use this activity sheet to record your observations of the focus activity.

1. I handed you two Petri dishes. Look at each of the dishes and record your observations below.

Petri Dish #1 Observations:

Petri Dish #2 Observations:

2. I also handed you two socks. Look at each sock and record your observations below.

Sock #1 Observations:

Sock #2 Observations:

Resource #1

3. When you are done with the first set of observations write a brief statement of what you think the correlation between the socks and the Petri dish is.

Correlation:

4. Use the provided magnifying glass to look at the Petri dishes and the socks again and record your results below.

Petri Dish # 1:

Petri Dish #2

Sock # 1:

Sock # 2:

5. Now revise your thought above to create a new correlation between the socks and the Petri dishes based on your new observations.

Revised Correlation:

III. Student Versions of the Activity Set Handouts

Focus: Research Bacteria Activity Sheet

Name: _____ Date: _____

Instructions: Use this sheet to guide your research on bacteria. Be sure to fill out all parts of the worksheet.

Research Sources to be used include the internet (reputable sources), textbook, and/or the library.

1. The first characteristics of bacteria you are to research is the size and structure of a bacterial cell. List sources used.

2. The second characteristics of bacteria you are to research is the growth and reproduction processes of a bacterial cell. List sources used.

3. The third characteristic of bacteria you are to research is the conditions (environment) required for bacterial growth. List sources used.

4. The fourth characteristic of bacteria you are to research is bacteria's impact on human health. List sources used.

III. Student Versions of the Activity set Hand-outs

Focus: Bacteria Prevention

Name: _____ Date: _____

Instructions: Use this activity sheet to brainstorm how to prevent bacteria growth and reproduction. You will be divided into groups later on to do a group project and use what you brainstorm so do a good job at it. Try to be original with your thoughts. I don't want to see things like antibiotics, antibacterial cleaners, or hand soap. Try to think outside the box.

Possible ways to prevent bacterial growth:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

After you are done brainstorming you must research 3 of your most probable ideas to see if any information exists about that idea. You will be using one of those ideas in a project so find as much information as possible. List your sources of information.

III. Student Versions of the Activity Set Hand-outs

Explore: The Effect of Silver Nanoparticles on Bacterial Growth

Name: _____ Date: _____

Purpose: To test the efficacy of silver nanoparticles in fighting infection/bacterial growth.

Materials:

Quantity	Description
2	Petri dishes with agar
1	Permanent marker
2	Sterile swabs
1	Incubator set at 37° C

Procedure:

1. Select two Petri dishes with agar and write your initials on the lid with a permanent marker and mark on lid “control”.
2. Get two sterile swabs.
3. Open one sterile swab and roll the clean cotton swab between you big toe and the toe next to it. (Be careful not to touch anything else with the swab)
4. Quickly lift the lid of the Petri dish and gently rub the swab over the Petri dish in a zigzag shape without breaking the surface of the agar.
5. Repeat steps three and four using the other foot and the other Petri dish.
6. Place the “control” dish in the incubator at 37° C for 24 hours.
7. Lift the lid of the other Petri dish and add 10 drops silver solution with a micropipette.
8. Place the Petri dish with the silver into the incubator at 37° C for 24 hours.
9. After 24 hours observe both of your Petri dishes and count the number of colonies of bacteria on each.

Data:

	Number of Colonies (24 hrs)	Number of Colonies (48 hrs)	Visual Observation of Bacteria
Control			
Ag nanoparticles added			

Conclusion:

Write a paragraph and try to explain your results and provide a good hypothesis to support your results. Include modifications you could do to the lab to help prove your hypothesis

III. Student Versions of the Activity set Hand-outs

Apply: Silver Nanoparticle Product Project Rubric

Name: _____ Date: _____

Purpose: The objective of this exercise is for you to use what you have learned about silver nanoparticles effects on bacterial growth. You will design a product using silver nanoparticles that could be marketed to consumers. You must write a paragraph explaining your products design features and how it works along with possible uses of your product. Explain how this new product will be beneficial to mankind. You must also draw a prototype of your new product and label it. Be careful to use the proper scale. Once I have reviewed your paragraph you will create a presentation.

In order to accomplish this task you will be placed in groups of three. One group member will be the Economist/Marketer that will design an ad campaign to sell your product. The second group member will be the Engineer/Designer that designs and tests your product. The third group member will be the Manufacturing Specialist that will be in charge of how to build your product efficiently. To make it realistic you must research silver nanoparticles and find out all that you can about them. You will also need to look into where bacteria control is needed.

Your outcome of this project will be a presentation to the class. The presentation can be a video, a PowerPoint, or any way that you can inform the class about your product. You must convince your audience that your product is feasible and something that they would want to buy. The following rubric will be used to grade your presentation.

Paragraph Grading

- | | |
|-----------------------------------|--------|
| 1. Innovative choice of a Product | 10 pts |
| 2. Usefulness of the Product | 10 pts |
| 3. Prototype Drawing of Product | 10 pts |

Group Work/Presentation Grading

- | | |
|--|---------------|
| 4. Effective use of Time during Research | 20 pts |
| 5. Economist/Marketer Ad Campaign portion | 30 pts |
| 6. Engineer/Designer Design and Testing portion | 30 pts |
| 7. Manufacturing Specialist portion | 30 pts |
| 8. Effective use of technology in presentation | 10 pts |
| 9. Effectiveness of presentation at convincing audience to buy | 20 pts |
| 10. Feasibility of product (could it be produced and used) | 20 pts |
| 11. References cited | <u>10 pts</u> |

Total 200 pts

III. Student Versions of the Activity Hand-out

SMELLY FOOT FACTS YOU SHOULD KNOW

1. Your feet sweat about 1 cup of water per day. (about 1/3 of a soda can per foot)
2. Your feet contain lots of sweat glands to keep them cool
3. Corynebacteria and micrococci bacteria like to hang out on your feet because they are heavy drinkers.
4. Oils and fatty acids are secreted from your feet and are considered great eating by the bacteria
5. The waste product of the bacteria is what cause your feet to stink! Peeeeuuuuu! YUCK!

THE SMELLY FEET LIMERICK

**There once was a man on the telly.
Whose feet they were so very smelly.
When he took off his shoes.
His friends said, "PEEEEEEEEEEE U."
You can smell them clear out to New Delhi.**

**The man had to find a solution
To the source of his strong air pollution
So he cut off his feet
And he buried them deep.
The dirt made for good stench dilution.**

**The lesson of this one is quick.
If the smell of your feet makes you sick,
Wash and powder each day,
And the stench goes away,
And your feet will always smell slick.**



Teachers Notes

Here are a few notes to help plan and deliver this activity.

1. Explore: If silver nanoparticle solution is not available a piece of a silver band aide can be substituted on the Petri dish. These band aides can be found at any drug store or supermarket.
2. Explore: Agar can be mixed and poured ahead of time into the Petri dishes and kept overnight in the refrigerator. Students can also mix their own agar if this is a technique you would like your students to learn. Be sure to boil the agar.
3. Explore: Incubator should be preheated the day before to 37 ° C to insure it is at the proper temperature when you perform the lab.
4. Explore: If a disposable micropipette is not available you can add 3 drops with a regular disposable pipette or eye dropper. Make sure they are sterile to avoid contamination of your project.

Materials List

Quantity	Description
2	1000 ml Beakers
2	250 ml Beaker
1	10 ml Beakers
20	60 X 15 Petri Dishes
1	Hot Plate (Preferably with magnetic stirrer)
1	Scale (preferable an electronic balance)
2	Stirring Rods
20	Disposable Micro Pipettes
1	Beaker Tongs
1	Forceps
1	Small spray bottle
30	Sterile Cotton Swabs
25 g	Agar
1250 ml	Sterile or De-ionized water
2 pair	Socks with silver nanoparticles
1	Box of silver band aides or vial of silver nanoparticle solution