Human Effectiveness & Medicine

Sterilization Station: Building a germ-free contained environment

Grade Levels: $9^{th} – 10^{th}$

Academic Content Areas: Science, Technology, Engineering & Mathematics

Topics: Life Science; Science & Technology; Scientific Inquiry

Recommended area of co-teaching for and AFRL Engineer or Scientist

Main Problem
Design and construct a germ-free container according to specific criteria and constraints.

Summary
Students will research common forms of helpful and harmful bacteria. Students will explore the importance of and need for sterile environments. Students will use their knowledge to design a germ-free prototype container. Students will sterilize their container and test its ability to stay germ-free. Through student led inquiry individuals will rely on the engineering design process and the scientific method as well as their own research skills to design an effective sterile container.

Students will be assessed in the areas of lab participation, research, generated prototype, unit concepts, and application in real world settings as they reflect the Ohio Academic Content Standards. Students will present the majority of their research and findings in a short power point presentation that should be created using the provided rubric.

Big Ideas / Focus
Bacterial and fungal spores are all around us every day. Most of the bacteria that we encounter are not harmful, in fact some are very helpful; however the harmful bacteria can lead to undesirable, even fatal, outcomes. In this activity, students will design and construct a germ-free container and will then test to see if it is truly germ-free.

Bacterial contamination is an ongoing issue for all organisms. For humans, we worry about bacterial infections that can range from deadly to minor nuisances. The human need for sterilized equipment and particulate free facilities ranges from medical, industrial, and consumer manufacturing such as surgical equipment, computer chip manufacturing, as well as food and medicine storage.

Additional societal concerns focus on biological warfare and our ability to safely and effectively contain our supplies or troops should there be an outbreak of a deadly bacteria or virus. This lesson specifically addresses this concern. Through research and engineering students will design, build, and test their own sterile container prototype.

Prerequisite Knowledge

Understanding of the following:

- Lab safety of microorganisms
- Basic knowledge of Google SketchUp (http://sketchup.google.com/)
- Identification of bacterial and fungal colony growth by color and shape (http://www.sciencebuddies.org/science-fair-projects/project_ideas/MicroBio_Interpreting_Plates.shtml)
- Growth, reproduction, metabolism and life cycle of bacteria and fungi

Standards Connections

Content Area: Science

Life Sciences Standard

Students demonstrate an understanding of how living systems function and how they interact with the physical environment. This includes an understanding of the cycling of matter and flow of energy in living systems. An understanding of the characteristics, structure and function of cells, organisms and living systems will be developed. Students will also develop a deeper understanding of the principles of heredity, biological evolution, and the diversity and interdependence of life. Students demonstrate an understanding of different historical perspectives, scientific approaches and emerging scientific issues associated with the life sciences.

Grade 10 – Benchmark J: Summarize the historical development of scientific theories and ideas, and describe emerging issues in the study of life sciences.	27. Describe advances in life sciences that have important long-lasting effects on science and society (e.g. biological evolution, germ theory, biotechnology and discovering germs)

Science and Technology Standard

Students recognize that science and technology are interconnected and that using technology involves assessment of the benefits, risks and costs. Students should build scientific and technological knowledge, as well as the skill required to design and construct devices. In addition, they should develop the processes to solve problems and understand that problems may be solved in several ways.

Grade 9 – Benchmark A: Explain the ways in which the processes of technological design respond to the needs of society.	2. Identify a problem or need, propose designs and choose among alternative solutions for the problem. 3. Explain why a design should be continually assessed and the ideas of the design should be tested, adapted and refined.

Grade 10 – Benchmark A: Explain the ways in which the processes of technological design respond to the needs of society.	3. Explain that when evaluating a design for a device or process, thought should be given to how it will be manufactured, operated, maintained, replaced and disposed of in addition to who will sell, operate and take care of it. Explain how the costs associated with these considerations may introduce additional constraints on the design.
Grade 10 – Benchmark B: Explain that science and technology are interdependent; each drives another.	2. Describe examples of scientific advances and emerging technologies and how they may impact society.
Grade 10 – Benchmark J: Summarize the historical development of scientific theories and ideas, and describe emerging issues in the study of life sciences.	28. Analyze and investigate emerging scientific issues (e.g., genetically modified food, stem cell research, genetic research and cloning).

Scientific Inquiry

Students develop scientific habits of mind as they use the processes of scientific inquiry to ask valid questions and to gather and analyze information. They understand how to develop hypotheses and make predictions. They are able to reflect on scientific practices as they develop plans of action to create and evaluate a variety of conclusions. Students are also able to demonstrate the ability to communicate their findings to others.

Grade 9 – Benchmark A: Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations.	3. Construct, interpret and apply physical and conceptual models that represent or explain systems, objects, events or concepts. 5. Develop oral and written presentations using clear language, accurate data, appropriate graphs, tables, maps and available technology. 6. Draw logical conclusions based on scientific knowledge and evidence from investigations.
Grade 10 – Benchmark A: Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations.	2. Present scientific findings using clear language, accurate data, appropriate graphs, tables, maps and available technology. 4. Draw conclusions from inquiries based on scientific knowledge and principles, the use of logic and evidence (data) from investigations.

Preparation for activity

To be done at least one month prior to the activity:

- Order agar plates or items to create your own agar plates (http://www.umsl.edu/~microbes/pdf/homemademedia.pdf)
  Note: You can order nutrient agar plates from biological supply companies in packages of ten. They already have the nutrient agar in them and are ready to go.

- Purchase/ acquire/ create a makeshift incubator.
  - Makeshift incubator: cardboard box with plastic wrap on top kept at a constant 37°C.
- Download free software: Google Sketch Up, to six or seven class computers.
- Order the "Antibiotics" DVD from Bill Nye's The Eyes of Nye series.
- Collect a lot of cardboard boxes and cardboard scraps (each team will need to build a $4ft^3$ prototype germ free container).

Critical Vocabulary

Agar: a gelatinous substance derived from seaweed, used as a solid substrate to contain culture medium for microbiological work.

Bacillus: is a genus of rod-shaped bacteria.

Bacteria: a large group of unicellular, prokaryote, microorganisms.

Bioengineering: is the application of engineering principles to address challenges in the fields of biology and medicine.

Biological warfare: the use of bacteria, viruses, or toxins to destroy humans, animals and/or food.

Cocci: is a genus of spherical shaped bacteria.

Fungi: is a member of a large group of eukaryotic organisms that includes microorganisms such as yeasts and molds, as well as the more familiar mushrooms.

Incubation: maintaining a bacterial culture at a particular temperature for a set length of time, in order to measure bacterial growth.

Microorganism: An organism that is microscopic or submicroscopic, which means it is too small to be seen by the unaided human eye.

Spirilla: is a genus of spiral shaped bacteria.

Sterile environment: one which is free from biological contaminants.

Virus: microscopic, infectious agent that replicates itself only within cells of living hosts.

Timeframe

Day	Time Allotment	Activities
1	20 minutes	Pre test
2	45 minutes	Watch Teacher Tube video (4 minutes): http://www.teachertube.com/viewVideo.php?video_id=56947&title=Wash_Your_Hands Watch The Eyes of Nye "Antibiotics". (26 minutes) Hand out Student Activity Guide: Appendix A and discuss project. Allow enough time for review and questions about constraints of the germ-free container, materials used, etc. Form student engineering teams.
3	45 minutes	Discuss how students might use the engineering design process or scientific method to complete this challenge. (15 minutes) Internet research session
4	45 minutes	Brainstorming design session Create preliminary design for 3-D teacher approved germ-free container using Google Sketch Up or paper and pencil. Determine materials needed Homework: Bring in needed materials that are not provided by teacher.
5	45 minutes	Construct container prototype
6	45 minutes	Swab culture dishes and setup experiment within container prototypes Internet Research & Power point development
7	45 minutes	Internet Research & Power point development
8	45 minutes	Presentations (5 minutes each) Students will submit an electronic version of their presentation.
9	45 minutes	Check for growth of any microorganisms on culture dishes. Discuss class findings and redesign ideas. Discuss a hypothetical "best design" students would test and submit to the CDC.
10	25 minutes	Post test

Materials & Equipment

Cardboard

Duct tape and/or packing tape

Plastic wrap

Sterile gloves / Kitchen cleaning gloves (1 pair per group)

Building tools such as: students hot glue gun, hair dryer, power screw driver, small screws

Petri dishes with agar

Sterile cotton swabs

Incubator (real one or homemade)

Computers with internet access

Projector & screen for PowerPoint presentations

Eyes of Nye DVD on "Antibiotics" (order at http://www.ioffer.com/i/99913819)

Teacher tube video:
http://www.teachertube.com/viewVideo.php?video_id=56947&title=Wash_Your_Hands

Various liquid antiseptics such as: vinegar, foam soap, hand sanitizer, rubbing alcohol, etc.

Safety & Disposal

Address proper use of equipment, proper lab behavior, and safe disposal of consumables with students.

Pre-Activity Discussion

Researchers in Aerospace medicine from the 711th Human Performance wing can speak with the class on the need for sterile environments/tools for battle field medicine.

Teacher Instructions

Day 1

- Administer Pre-Test.

Day 2

Set up videos for student viewing.

- Have students watch Teacher Tube video: Wash Your Hands (4 minute video clip about growing cultures from germs collected in various common locations).
- Have students watch The Eyes of Nye "Antibiotics" (26 minutes)
- Hand out student activity guide and copies of grading rubrics.
- Form student engineering teams.

Day 3

- As a class, discuss how students might use the engineering design process or scientific method to complete this challenge. (15 minutes)

- Allow students to use the remaining class time to start their Internet research.

Day 4

- Have students spend 10-15 minutes brainstorming on a container design.
- Have students create a preliminary design for 3-D teacher approved germ-free container using Google Sketch Up (an alternative is to have students draw out the design).
- Have student engineering teams determine needed materials
- Homework: Bring in needed materials that are not provided by teacher.

Day 5

- Have students construct their germ-free container

Day 6

- Swab culture dishes and setup experiment within container prototypes.
- Use remaining class time to conduct Internet research.
- Homework: Teams should break up the PowerPoint presentation rubric research sections and complete research as homework. Remind students the importance of documenting their references

Day 7

- PowerPoint presentation development.
- Remind students that they will have 10 minutes for a brief presentation. Unaddressed slides will be graded later by the teacher.

Day 8

- PowerPoint presentations (10 minutes per team)

Day 9

- Remaining presentations.
- Check for growth of any microorganisms on culture dishes.
- Discuss class findings and redesign ideas. Discuss that it is important to continually assess ideas and designs in order to refine and improve designs and address design flaws.
- Discuss a hypothetical “best design” students would test and submit to the CDC.
- Evaluate the “best design” generated by the class and discuss how it could be manufactured, operated, maintained, replaced and disposed of in addition to who will sell, operate and take care of it. Discuss potential costs associated with these considerations may introduce additional constraints on the design.
- Review any misconceptions or areas of confusion that have arisen throughout the unit, in preparation for the post-test.

Day 10

- Post-test

Background Information

Some examples of helpful bacteria: Probiotics such as Lactobacillus Acidophilus and Lactobacillus Rhamnosus.

Some examples of harmful bacteria: anthrax, tuberculosis, pneumonia, strep throat, meningitis, whooping cough, staph infections, streptococcus, and E. coli.

Some examples of airborne viruses: viral pink eye, influenza, Ebola, and swine flu.

Instructional tips

Student engineering groups should be formed by the teacher to ensure an equal distribution of student strengths and weaknesses.

Assignment of Student Roles and Responsibilities:

Every student in each small group is responsible for performing experimental tests, manipulating equipment safely & properly, recording data, writing results and conclusions. In addition, each student will be assigned one of the following roles:

Role Name	***Brief Description***
Project Manager	Responsible for organizing the team and keeping them on task to meet goals and deadlines. Responsible for presenting the PowerPoint presentation. Responsible for obtaining the necessary supplies for container prototype. Responsible for participating in all activities. Responsible for assisting in prototype construction.
Design Engineer	Responsible for using Google Sketch Up or drawing a blue print of container. Responsible for obtaining necessary supplies for container prototype. Responsible for participating in all activities. Responsible for assisting in prototype construction.
Materials Engineer	Responsible for researching material that will be used to create the container. Research best antiseptic that will be used inside container. Responsible for obtaining necessary supplies for container prototype. Responsible for participating in all activities. Responsible for assisting in prototype construction. Responsible for disinfecting the prototype.
Technical Writer	Responsible for documenting the scientific method (or EDP) related to their problem/project. Responsible for obtaining necessary supplies for container prototype. Responsible for participating in all activities. Responsible for assisting in prototype construction. Responsible for organizing the PowerPoint presentation.

Student Instructions

Follow teacher instructions and use rubric and student activity guide to further guide proper classroom participation.

Formative Assessments

Student Activity Guide (100 points)

Research and Presentation Rubric is provided in Appendix B (50 points).

Unit concepts will additionally be assessed in the post-test, a rubric is provided in the pre-test/ post-test rubric section. (45 points)

Post-Activity Discussion

Materials scientists from AFRL materials directorate or researchers the 711th Human Performance Wing can speak with students about real life applications and real world field experience in regards to covered subject matter.

After presentations the teacher can start discussions relating this to real world situations. The teacher can use either the book (see above) that was read or the current event articles as a basis for the discussion.

Some open ended questions:

- What do we mean by good bacteria? *Good bacteria eats bad bacteria or other microorganisms, aids in digestion, helps the decay of organic matter, etc.*
- What is a probiotic? *A type of good bacteria that we eat to aid in digestion. (Many yogurts now contain probiotics. Some people and animals take probiotic supplements particularly when they are taking antibiotics.*
- If reading a book or current event article or if the students watch a medical show such as House or Scrubs, they could discuss how bacteria are passed from person to person.
- Discuss what a staph infection is (http://www.medicinenet.com/staph_infection/article.htm).
- What is an antibiotic?
- How can antibiotics be hurtful (prohibit the development of a healthy immune system; slow down the breakdown of organic matter when they get in a sewage system such as a septic tank, have been linked to the increase in food allergies, etc)?
- What is good about antibiotics? *Save many lives and prevent or cure serious infections*
- Why is it very important that people closely follow their doctor's instructions when they take an antibiotic? *Bacteria can become resistant to antibiotics.*

Pre-Test / Post-Test

Grade Level: 9th- 10th

Provided in Appendix C, answers provided in the Pre-Test/Post-Test Rubric section.

Pre-Test / Post-Test Rubric

	5 points	3 points	1 point
1. Define: Bacteria	Student defines bacteria as a large group of unicellular, prokaryote, microorganisms	Student defines bacteria as a unicellular organism, prokaryote, or microorganism.	Student provides an example of bacteria such as mold, yeast, bacillus, cocci, or spirilla.
2. Define: Bioengineering	Student defines bioengineering as the application of engineering principles to address challenges in the fields of biology and or medicine.	Student defines bioengineering as a field of engineering OR biology.	Students define it as a field of science.
3. Define: Sterile environment	Students define sterile environment as one which is free from biological contaminants (or lists out biological contaminants as bacteria and viruses).	Students define sterile environment as being free of germs OR bacteria OR viruses.	Students define as clean.
4. Define: Virus	Student defines virus as a microscopic, infectious agent that replicates itself only within cells of living hosts.	Student defines virus as a microscopic, infectious agent.	Student provides an example of a virus such as the flu, HIV, hepatitis, herpes, pink eye, etc.
5. Provide two reasons humans need to be able to make something germ free.	Student provides two acceptable reasons such as; sterile equipment for surgery, sterile equipment for manufacturing, food processing, food storage, food preservation, etc.	Student provides one acceptable reason such as; sterile equipment for surgery, sterile equipment for manufacturing, food processing, food storage, food preservation, etc.	
6. Provide two examples of a medical technology and the positive effects it has on our society.	Student provides two acceptable reasons such as: Inoculations: keep people safe from disease. Sterile bandages: help keep wounds disease and bacteria free for faster healing. Sterile surgical equipment: less risk of surgical infection. Air purifiers/ filters: clean air borne containments from air for cleaner breathing. *Answers will vary.*	Student provides one acceptable reason such as; Inoculations: keep people safe from disease. Sterile bandages: help keep wounds disease and bacteria free for faster healing. Sterile surgical equipment: less risk of surgical infection. Air purifiers/ filters: clean air borne containments from air for cleaner breathing. *Answers will vary.*	Student provides one or two examples but does not explain the positive effect it has on society.

7. What is biological warfare and how can we possibly protect ourselves from it?	Students define biological warfare as the use of bacteria, viruses or toxins to destroy humans, animals, and or food. Students provide an acceptable solution for protection such as gas masks, filtration systems, detection systems, containment systems, etc.	Students provide incomplete definition of biological warfare and acceptable solution.	Student provides definition of biological warfare OR an example of how to protect ourselves from it.
8. Provide an example of a technology and a risk associated with it.	Student provides a technology and an appropriate associated risk. Such as: iPod: ear damage due to loud music. Car/ Plane: Deadly accident due to being a passenger. Tanning Bed: Skin cancer due to exposure to UV rays Cigarettes: Lung cancer due to exposure to carcinogenic toxins. *Answers will vary.*	Student provides either a technology OR risk OR the risk in inappropriate. (An example of an inappropriate risk is: iPod: dropping it and it breaks)	Student provides an example of something an associated risk but it is not a form of technology. (An example may be: Uncooked chicken: salmonella or music: ear damage)
9. Why is it important to continually assess engineering and scientific designs?	Student answers that it is important to continually assess ideas and designs in order to refine/ improve designs, and address design flaws.	Student answers that it is important to continually assess ideas and designs in order to refine OR improve designs OR address design flaws.	Student answers that it is to make the design better.

Technology Connection

The **ADISC** Model of technology created by ITEL:

Integration Model	**Application Description**
Technology that supports students and teachers in **dealing effectively with data**, including data management, manipulation, and display	Google Sketch Up Microsoft PowerPoint
Technology that supports students and teachers in conducting **inquiry**, including the effective use of Internet research methods	Eyes of Nye: Antibiotics DVD Video: Teacher Tube Computers Internet

Technology that supports students and teachers in **simulating** real world phenomena including the modeling of physical, social, economic, and mathematical relationships	Agar Google Sketch Up
Technology that supports students and teachers in **communicating and collaborating** including the effective use of multimedia tools and online collaboration	Computers Internet Google Sketch Up Microsoft PowerPoint Projector & screen for PowerPoint presentations Optional: Skype

Interdisciplinary Connection

Math: Mathematical concepts can be applied to this unit including measurement standards such as area, surface area, and volume.

English: Language Arts concepts such as writing processes and research standards can be measured for growth or expanded upon. Students could address literary text standards by reading books that deal with the impact of disease in history (The Betrothed, The Last Man, The Decameron (Oxford World's Classics), Fictions of Disease in Early Modern England). Students could research current events for articles that discuss current health events (pandemic, epidemic, water borne illnesses in developing countries or after a disaster) or write a research paper on careers and focus on systems engineering.

Home Connection

Students can discuss what types of food storage containers have the best material for limiting the growth of microorganisms and developing best practices for cleaning these storage containers.

Students could then test the food storage containers for vapor seals (store a peeled onion in it) to test their top choices as an additional class challenge.

Differentiated Instruction

Process: Have students design a germ-free container prototype before researching and learning about germs & viruses then have students follow through the provided lesson, after which have students compare and contrast their first and second container prototype.

Content: Students can conduct an experiment as to which antiseptic works best.

Extension

Students can connect their research and prototype to developing a conceptual design for a clean room or sterile environment. Students can create a sketch in Google Sketch up and be responsible for researching other necessary aspects of a clean room including accessories such air purification system and protective clothing.

Career Connection

Scientists and Engineers from AFRL directorates such as 711th Human Performance wing, materials directorate, and Human Effectiveness directorate are concerned with devloping and maintaining, specialized environments for a variety of military and industrial uses. For example some environments need to be germ free, hermetically sealed, particulate free and/or sterile environments for human safety or production purposes.

Throughout history military research contracts have been awarded to independent research and manufacturing industries to design and supply MRE's, meals ready to eat. These nitrogen sealed meals are stored in specialized packaging to ensure the longevity of its consumable contents for years.

The materials used to design germ free containers could also serve to store bacteria, viruses, and contaiminments, in a clean environment. Industry as well as military is constantly concerned with creating safer storage containers to minimize risk of cross contamination or exposure to contained materials in order to ensure safe, repeatable science practices. Materials, Biotechnical, Biomedical engineers as well as Biologists, and chemists are all involved in this form of research.

Additional Resources

Resource:	**Purpose and Application:**
"Antibiotics" DVD from Bill Nye's The Eyes of Nye series http://www.ioffer.com/i/99913819	Inquiry Lesson 2
Teacher tube video: http://www.teachertube.com/viewVideo.php?video_id=56947&title=Wash_Your_Hands	Inquiry Lesson 2
http://sketchup.google.com/	Lesson 4
http://www.umsl.edu/~microbes/pdf/homemademedia.pdf	Agar plates
http://www.sciencebuddies.org/science-fair-projects/project_ideas/MicroBio_Interpreting_Plates.shtml	Identification of bacterial and fungal colony growth by color and shape
http://www.medicinenet.com/staph_infection/article.htm	Staph infection information

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Teacher Reflections

- Were students focused and on task throughout the lesson? *Insert answer here.*
- If not, what improvements could be made the next time this lesson is used? *Insert answer here.*
- Were the students led too much in the lesson or did they need more guidance? *Insert answer here.*
- Did the students learn what they were supposed to learn? *Insert answer here.*
- How do you know? *Insert answer here.*
- How did students demonstrate that they were actively learning? *Insert answer here.*
- Did you find it necessary to make any adjustments during the lesson? *Insert answer here.*
- What were they? *Insert answer here.*
- Did the materials that the students were using affect classroom behavior or management? *Insert answer here.*
- What were some of the problems students encountered when using the …? *Insert answer here.*
- Are there better items that can be used next time? *Insert answer here.*
- Which ones worked particularly well? *Insert answer here.*

Additional Comments

Appendix A: Student Activity Guide

Sterilization Station:

Challenge: Your bioengineering team has been hired by the CDCP (Center of Disease Control and Prevention) and Air Force to design and construct a germ free container. This container is to serve as a prototype for food storage and/ or surgical supply storage.

Germ Free Container Specifications: (each worth 10 points)
1. Must have a volume of at least 2.4 ft^3
2. Must be able to insert contents into the container after the container has been constructed
3. Must be portable
4. Must be able to view inside of container clearly from the top and from one side
5. Container cannot weigh more than 8 lbs
6. Must hold the following contents:
   a. Two sterile unopened cotton swabs
   b. A Petri dish with nutrient agar held horizontally from the bottom of the container
   c. Your choice of liquid antiseptic, maximum of 10 ml will be allowed and will be in the container at the bottom
   d. One unknown item, loose in the container.
7. Must be able to manipulate the contents inside the container without opening the container

Materials:
The main material used for the container is up to the design team. These items will be provided to you:
- Cardboard / boxes
- Clear plastic wrap
- Duct tape
- Packaging Tape
- Glue gun
- Kitchen cleaning gloves / Medical examination gloves

Participation:
Student provides assistance, constructive feedback, and plays an integral role in the lab activities. Student uses all class time to address the engineering challenge and presentation requirements. (30 points)

___________/ 100 Points
(70 group points, 30 individual points)

Appendix B: Research & Presentation Rubric

	5 points	3 points	1 point
Slide 1: **Germ Free Container Name and Engineering Design Team**			
Slide 2: **Design**	Detailed design from Google Sketch Up provided. Design includes labels.	Detailed design from Google Sketch Up provided.	Design provided, but it was incomplete or inaccurate.
Slide 3: **Container use explanation**	List of used materials provided along with an explanation of why specific materials were chosen. Cites source.	List of used materials provided along with an explanation of why specific materials were chosen.	List of used materials provided
Slide 4: **Antiseptic**	Explanation of antiseptic used, and why it was chosen. Cites source.	Explanation of antiseptic used, why it was chosen	Antiseptic used is provided.
Slide 5: **Current Events**	Need for a germ free container is linked to a current event (within the past year). Explanation is provided as to the impact this germ free container would have to societal situation. Source is cited.	Need for a germ free container is linked to a current event (within the past year). Explanation is provided as to the impact this germ free container would have to societal situation. No source is provided.	Need for a germ free container is linked to a societal issue but benefits are not expounded upon.
Slide 6: **Ideas for redesign**	At least two ideas for a redesign are provided along with explanation as to what issues these ideas address.	One idea for a redesign is provided along with explanation as to what issue this idea addresses.	One or more ideas are provided however, explanation as to the issue it/they address is not provided.
Slide 7: **How it could be manufactured, operated, or maintained.**	Provides brief explanation to each of these 3 issues.	Provides brief explanation to two of these issues	Provides brief explanation to one of these issues.

Slide 8: **Which agency should be responsible for distributing and maintaining this device and why?**	Provides specific agency and two reasons this agency should be responsible for this device. Cites Source.	Provides specific agency and a reason this agency should be responsible for this device. Cites Source.	Provides specific agency and reason(s). But does not provide source.
Slide 9: **Biological Warfare**	Provides definition of biological warfare and two examples of how the germ free container design may help protect our military troops.	Provides definition of biological warfare and an example of how the germ free container may help protect our military troops.	Provides either definition or an example of how the germ free container may help protect our military troops.
Background Information Slide: **Bacteria**	Student provides definition of bacteria, two examples of helpful bacteria and two examples of harmful bacteria.	Student provides definition of bacteria, one example of helpful bacteria and one example of harmful bacteria.	Student provides partial information.
Background Information Slide: **Common types of airborne viruses.**	Student defines virus and provides two examples of airborne viruses.	Student defines virus and provides one example of an airborne virus.	Student provides definition or example.

Total: /50 points

Appendix C: Test

Name________________________________

/45 points

Define the following words.

1. Bacteria-

2. Bioengineering-

3. Sterile environment-

4. Virus-

Answer the following questions/ statements.

5. Provide two reasons humans need to be able to make something germ free.

6. Provide two examples of medical technology and the positive effects it has on our society.

7. What is biological warfare and how can we possibly protect ourselves from it?

8. Provide an example of a technology and a risk associated with it.

9. Why is it important to continually assess engineering and scientific designs?