Genetic Transfer and Antibiotic Resistance

Resource Type: Curriculum: Classroom

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Authors

Kristine Snow
Fox Valley Technical College
Appleton, Wisconsin

Abstract

Students view several internet sites and video clips on genetic transfer and antibiotic resistance. Students work with one or two other students to create a 3-D model that visually demonstrates the step-by-step process of genetic transfer. Models are made with common household objects such as paper cups, string, pipe cleaners, yarn, and styrofoam. Students present their model and process to the instructor and/or the class and relate genetic transfer to antibiotic resistance and emerging bacterial pathogens.

Activity

Invitation for User Feedback. If you have used the activity and would like to provide feedback, please send an e-mail to MicrobeLibrary@asmusa.org. Feedback can include ideas which complement the activity and new approaches for implementing the activity. Your comments will be added to the activity under a separate section labeled "Feedback." Comments may be edited.

INTRODUCTION

Learning Time.

- 1 hour class time for students to work together at the beginning of their project
- 1 to 2 hours, depending on class size, to present their projects to the class
- Presentation can be done just to the instructor to save class time

To access links, place curser on hyperlink, right click, and left click on "open link."

Learning Objectives.
At the completion of this activity, students will be able to:

- demonstrate one type of genetic transfer and describe how this process impacts the recipient bacterium,
- describe how genetic transfer in bacteria impacts health care and antibiotic resistance, and
- discuss ways that health care professionals can help curb antibiotic resistance.

Background
Antibiotic resistance presents a major problem for the health care system. During the traditional lecture description of genetics and genetic transfer, students have difficulty relating these processes to what is happening in the bacterial cell and how this impacts antibiotic resistance. This activity was designed to help students apply genetic transfer to the problems occurring in health care. For more information on antibiotic resistance, see the following websites:

- http://www.fda.gov/oc/opacom/hottopics/anti_resist.html
- http://www.wisconsinmedicalsociety.org/warn/proresources.cfm
- http://www.who.int/csr/drugresist/en/

PROCEDURES

Materials.
Student handout that describes the project and lists the internet resources for the project.
Genetic Transfer Activity (Word document)

Instructor Version.

- Students require a brief introduction to protein synthesis and genetic transfer.
- The “Unseen Life on Earth: genetic transfer” video is an excellent introduction to this unit.
- If desired, show examples of class projects:
    - Transduction–Hanging Model
    - Transduction–Using a Milk Jug

    - Transformation–Using a Feltboard
    - Transformation–Using Styrofoam
    - Conjugation–Using Soda Bottles
    - Conjugation–Circular Format
    - Transposition
- Allow class time for students to get together so that they have an opportunity to ask questions before beginning their project.
- It works well to allow one lecture class for students to work together and a portion of one lab period for students to present their work.

Safety Issues. None.

ASSESSMENT and OUTCOMES

Suggestions for Assessment.

- Oral and written reports
- Presentation to class
- Display of activity in lab for all students to view
- Options for grade:

    1. Participation as determined by the group members.
    2. Score from instructor:
       Grading Rubric-Genetic Transfer

- To ensure that students put their models and size relationships into context, a series of questions can be attached to the assignment regarding these relationships. Below are some suggestions.
    1. For transduction:
        - What is the relative size difference between a bacterium (a typical *Escherichia coli*) and a typical bacteriophage? (T-even bacteriophage capsids are 85 nm by 100 nm and the tail is 25 nm by 110 nm; *E. coli* is about 1 micrometer by 3 micrometers.)
        - What is the typical number of kilobases in a bacteriophage DNA versus the typical number in bacterial DNA? (T-4 has DNA with about 168 kilobase pairs; bacterial DNA typically has between 1,000 and 5,000 kilobase pairs.)
        - How long does the lytic cycle take and how many virions are typically released in one cycle? (The T-4 phage cycle is 30 minutes, and 100 or more virions are released.)
    2. For conjugation:
        - What is the typical size of the sex pilus and how does this relate to the overall size of the bacterium? (The sex pilus is about 9 to 10 nm; *E. coli* is about 1 micrometer wide by 2 micrometers long.)
    3. For transformation:
        - How many base pairs are typically involved in transformation? (DNA fragments of about 15 to 20 kilobase pairs are typically taken up by a competent cell during transformation.)
        - How many fold magnification is your bacterial cell compared to a real bacterial cell? How does this relate to a typical eukaryotic cell? (An *E. coli* is about 1 micrometer by 3 micrometers; a typical eukaryotic cell may be 7 to 10 micrometers in diameter.)
    4. Plasmids:
        - Plasmids vary in size from 1 to over 1,000 kilobase pairs; a typical plasmid is about 1/20th the size of the bacterial chromosome.

Field Testing.
This project was field tested in an allied health microbiology class of 36 students. A pretest and posttest were given, and the students completed an evaluation at the end of the project. The attached documents include the tests given, the results, and comments from the students.

Pretest
Posttest
Pre- and Posttest Results
Comments on Genetic Transfer Activity

GENETIC TRANSFER AND ANTIBIOTIC RESISTANCE

Bacterial genetic transfer is a primary cause of bacterial antibiotic resistance and can contribute to the emergence of new pathogens. This unit will introduce you to the 3 ways that bacteria transfer DNA and the effect these processes have on bacterial antibiotic resistance.

Internet resources to review DNA and protein synthesis:
DNA structure:
http://www.microbelibrary.org/FactSheet.asp?SubmissionID=432
Prokaryotic transcription:
http://www.microbelibrary.org/images/smerkel/Images/transcriptionsm.mov
Prokaryotic translation:
http://www.microbelibrary.org/images/smerkel/Images/translationsm.mov

Internet resources for genetic transfer:
Horizontal Gene Transfer: cartoon
http://www.microbelibrary.org/images/Mondomedia/4hirez.mov

Bacterial Conjugation
http://www.microbelibrary.org/images/MondoMedia/Conjugation/hirez.mov

Bacterial transformation:
http://www.microbelibrary.org/images/MondoMedia/Transformation/lorez.mov

Bacteriophage infection:
http://www.microbelibrary.org/images/MondoMedia/Bacteriophage/hirez.mov
(See your text for a description of transduction)

Internet resources for Antibiotic Resistance:
http://www.microbeworld.org/htm/cissues/resist/resist_0.htm
http://www.cdc.gov/ncidod/eid/vol7no2/weinstein.htm#Figure%203

Note: When viewing internet sources from this document, place your curser on the web site, right click to access the menu and click on 'open hyperlink'. If this process takes you to the MicrobeLibrary authorization to use page, scroll to the bottom of the page and click 'accept'. You will be connected directly to the appropriate web page.

PROCEDURE:
View all of the web sites related to DNA and prokaryotic transcription and translation. Then view the web sites demonstrating genetic transfer. Also, refer to your class notes and textbook for a more detailed description of genetic transfer.

Genetic Transfer project, complete in groups of 2 or 3

1. Make a 3-D model of 1 type of genetic transfer. This model can be made of common household items (paper cups, string, pipe cleaners, yarn, etc.). Create a model that demonstrates visually how this process of genetic transfer works. You must present your project to the class and/ or instructor.
2. Write a short description of this type of genetic transfer and attach to your project.
3. Describe how genetic transfer results in antibiotic resistance. Attach a description of this process to your project.
4. Discuss several ways of slowing the development of bacterial antibiotic resistance in health care settings.

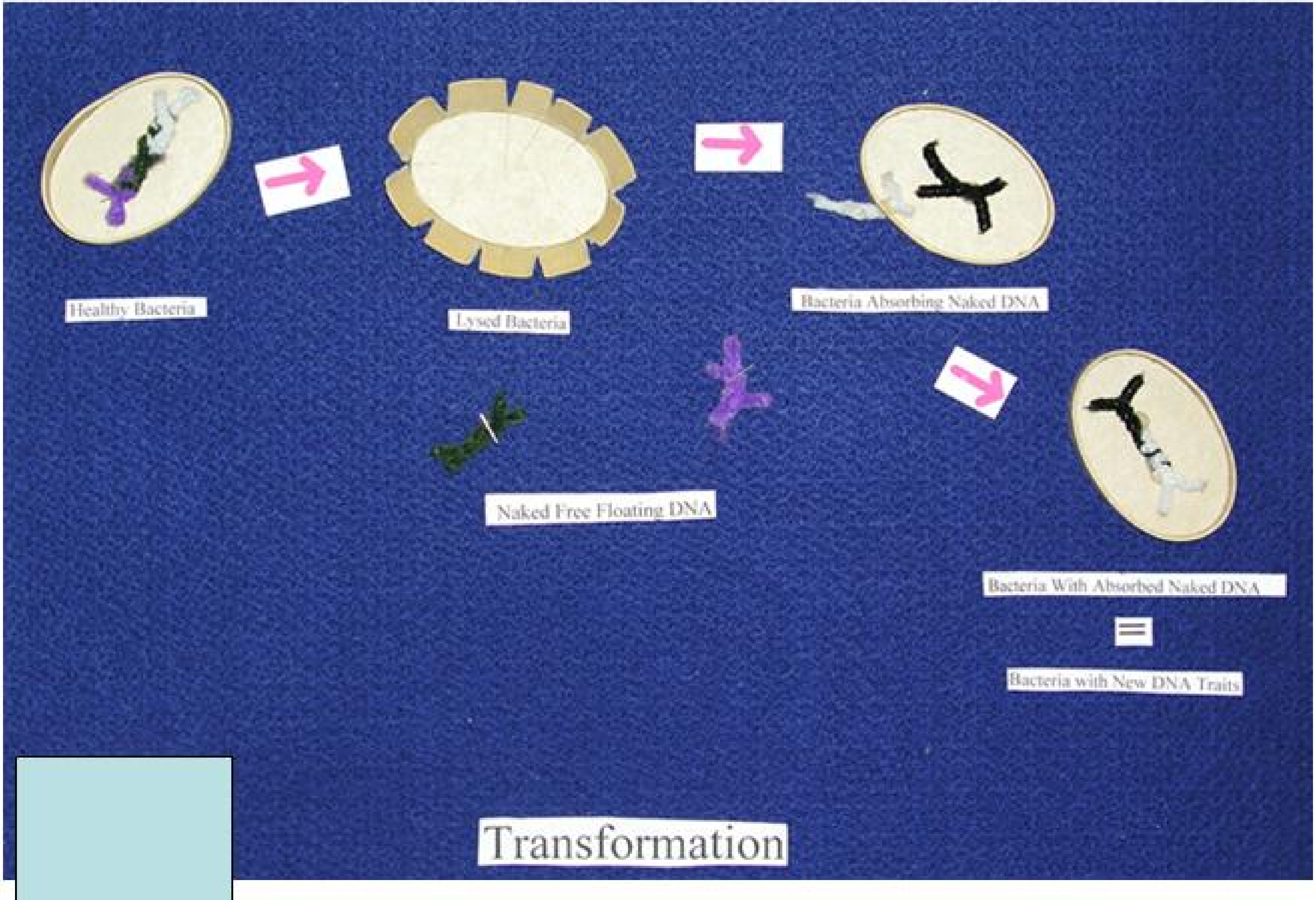
Transduction

Transduction

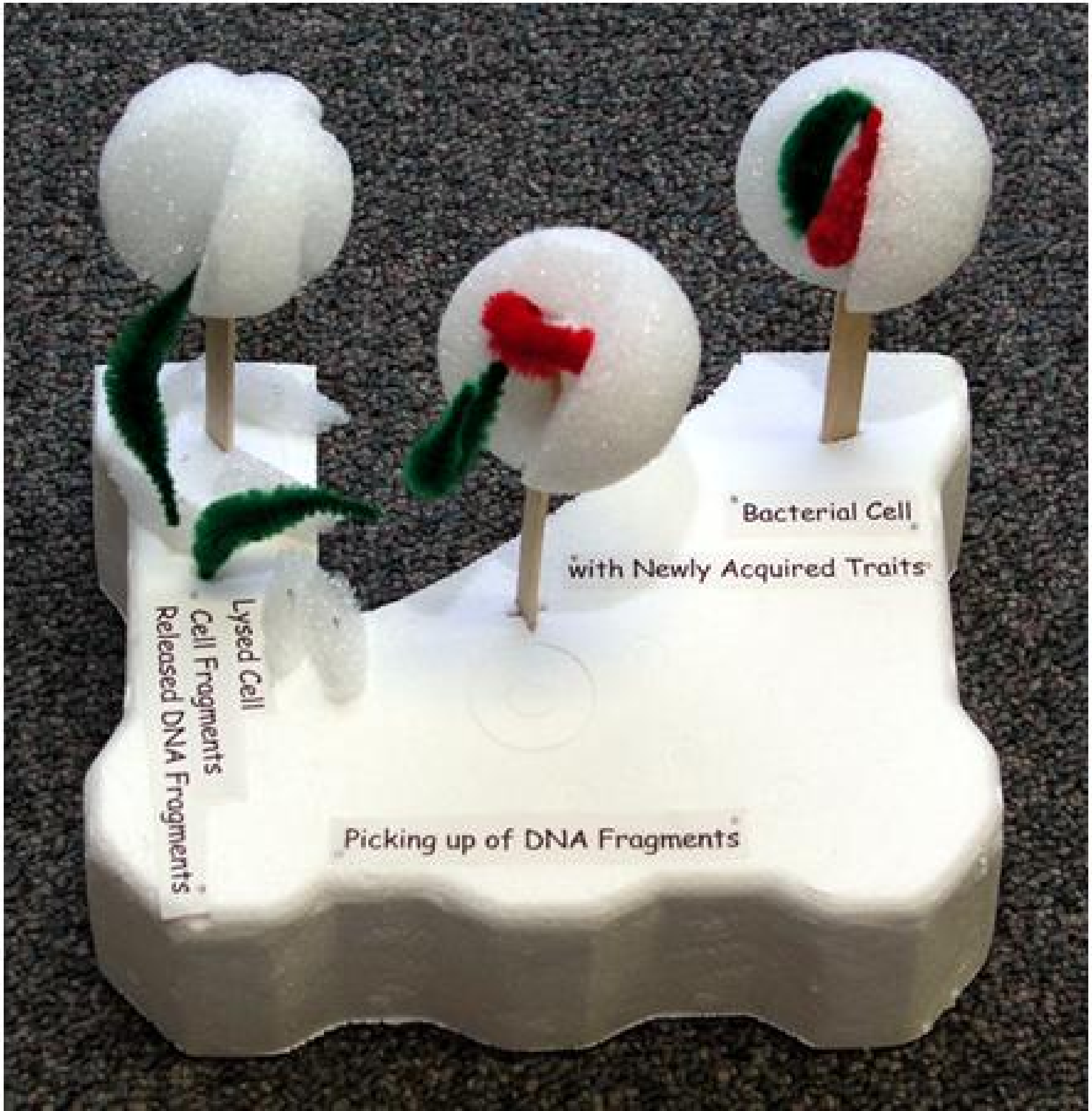
Transduction

Transduction

Transformation



Transformation



Conjugation

Conjugation

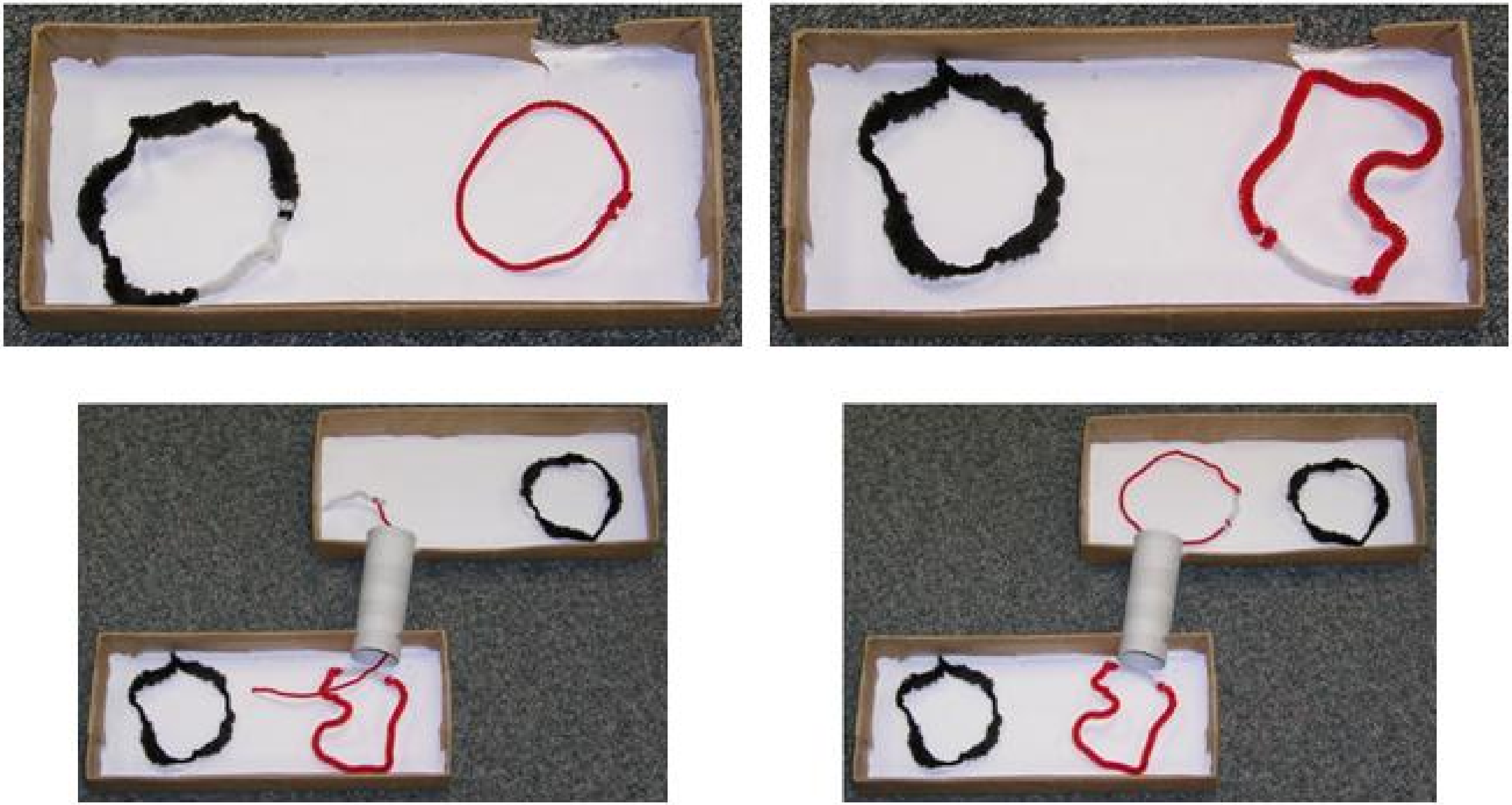
1

2

3

4

Transpostion and conjugation



GRADING RUBRIC FOR GENETIC TRANSFER PROJECT

	Does not meet class requirements	Meets minimum class requirements	Most requirements met and well done	Exceeds class requirements
Completeness	0 – 5 Several elements missing for multiple items; little or incomplete details; concept understanding not possible.	6 - 7 A few required elements missing or incomplete; detail lacking and difficult to understand the concepts.	8 - 9 All required elements are included with each portion of the assignment; some detail is lacking making concept understanding more difficult.	10 All required elements are included with each portion of the assignment; detail is present that allows learner to understand concepts.
Accuracy	0 – 5 Information includes substantial unscientific information. Documentation and clarity is lacking. Visual representation is inaccurate.	6 - 7 Information is not scientific and/ or not clearly documented and presented. There is confusion in scientific terminology. Visual representation is unclear or inaccurate	8 - 9 Information is scientific, but less clearly presented and documented. There is confusion in the use of scientific terms. Visual representation is slightly unclear.	10 Information is scientific, clearly presented, and well documented. All scientific words are used appropriately and accurately Visual representation is very precise.
Value as a learning tool (format and writing elements)	0 -2 Little organization evident. Visual representation is inaccurate. Lacks clarity with multiple spelling and grammar errors	3 Not well organized, visual representation unclear or inaccurate. Spelling and grammar errors are evident throughout.	4 Organization and visual representation are difficult to follow. Clarity is lacking. Good spelling and grammar throughout document.	5 Clear, excellent visual representation, and neatly presented with excellent spelling and grammar

You will lose 10% per day for late assignments.

Pre-test
Genetic transfer:

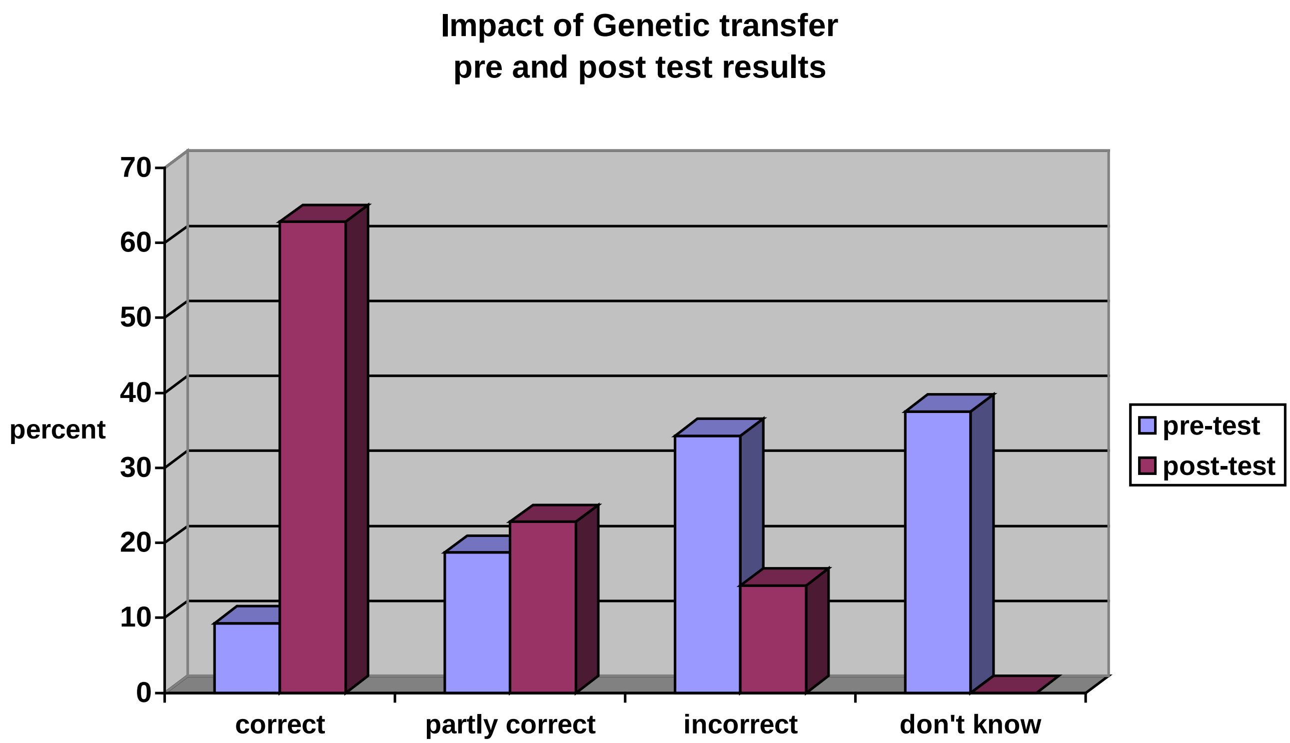
1. Describe how genetic transfer in bacteria impacts health care and antibiotic resistance.

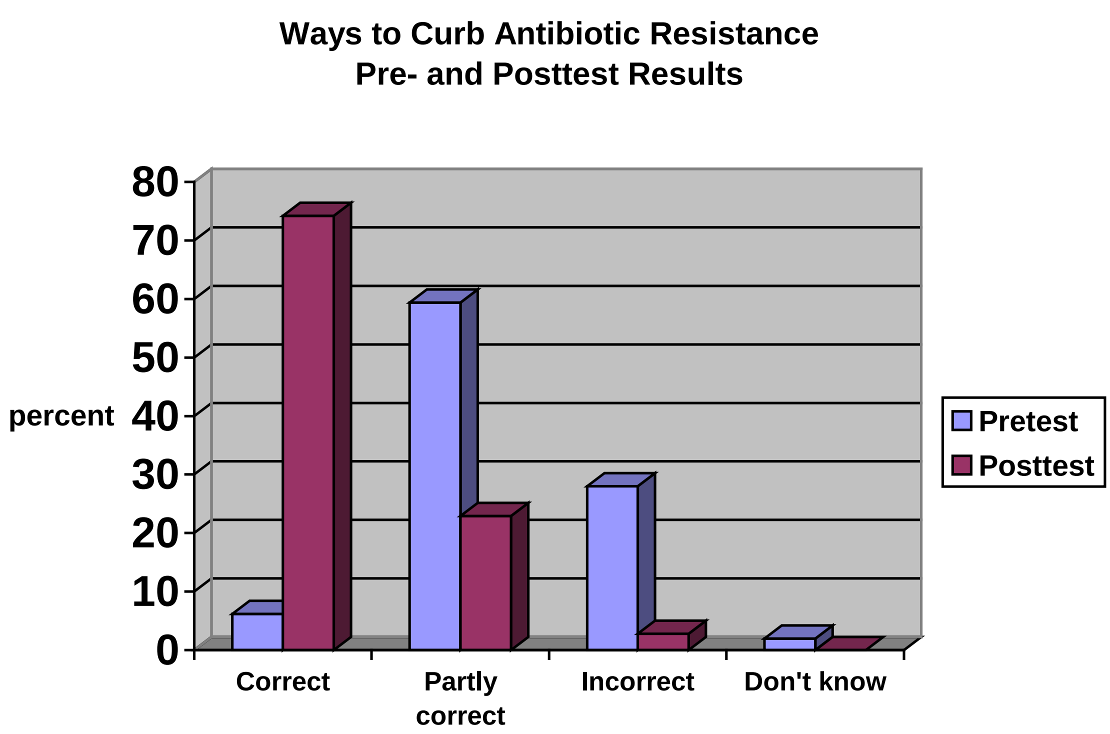
2. Discuss ways in which health professionals can help curb antibiotic resistance.

Post-test
Genetic transfer:

1. Describe how genetic transfer in bacteria impacts health care and antibiotic resistance.

2. Discuss ways in which health professionals can help curb antibiotic resistance.


Impact of Genetic transfer
pre and post test results
percent
70
60
50
40
30
20
10
0
correct
partly correct
incorrect
don't know
pre-test
post-test


Ways to Curb Antibiotic Resistance
Pre- and Posttest Results
percent
80
70
60
50
40
30
20
10
0
Correct
Partly correct
Incorrect
Don't know
Pretest
Posttest

Comments on genetic transfer activity:
How worked:

- It was much easier than listening to it.
- I am more of an auditory learner but visualizing helps retain information
- It made me understand and forced me to find the answers.
- I learn visually
- Yes, visual learning helps me.
- Visual is good for me to understand. I like to work in a group, it helps me talk through and understand better.
- Instilled info for longer retention
- Practical application
- Yes, because I can see what's going on
- I had to understand it
- Able to see what is going on
- Yes – doing a hands-on project does help me retain the info.
- This worked for me because the questions on antibiotic resistance forced me to read up on it. It's not anything I couldn't have learned in a lecture, but either way, I did learn the material.
- It helps to better understand the material.
- I learn by doing as well as lecture.
- I am not very creative and it is hard to show the material in a 3_D form – it didn't work for me.
- It helped me understand it and retain the information.
- I prefer a lecture format rather than demonstrations.
- Allowed me to apply my understanding of what I read and learned in class.
- I personally don't enjoy drawing and making things because I don't think I'm good at it.
- Yes, having to make the model made us think more critically of all the steps required for the genetic transfer.
- Learned the steps of conjugation
- Yes, I learn better with hands on material rather than lecture
- No, because all I knew well was my own method of transfer, not anyone elses.
- Yes, hands-on
- Yes, I'm a visual learner, I need to see something to make sense of it.
- It was a change from the normal and I really understood it well.
- Yes, I needed to really take time out and just learn this – the repetition
- I do like lecture, but also enjoy the projects.
- Works for me as I am a visual learner.
- I feel that I will remember this material longer.
- I enjoy using different techniques for learning, not so routine and change is good.
- Hands on made me concentrate on what I was learning.
- Yes, because it is hands-on and makes one think through the subject more thoroughly

Liked the most:

- Working with a partner.
- Gives chance to be creative
- That it takes place of a test
- Making the model
- Working with a partner
- Team work
- Thinking it through
- Explaining the process with a model
- Working in a group
- I liked this better than the other project because it was easier to divide up the work between my partner and me.
- A break from lecture – a different way of learning
- It helped me learn.
- Project
- Working as a team because you learn more.
- Working on the project itself.
- Learning the material was very interesting.
- Seeing a physical picture helped me to understand it.
- The student interaction.
- Working with a partner.
- Building the model
- Visual and hands-on aspect.
- I liked playing with the pipe cleaners.
- Helps to not always sit in lecture. Makes things interesting.
- Learning about antibiotics.
- Coming up with the idea.
- The perfection of my own

- Explaining it to you because I proved to myself that I actually knew the material.
- I like creating something 3D and being creative.
- It was fun to try and be creative.
- It was enjoyable and fun to work with my partner.
- Building the model.
- Visually seeing - projects.
- Doing the model
- The actual project

Liked the least:

- Trying to be creative
- Thinking of what to do
- I wasn't sure how detailed it needed to be – I didn't get all the other types of DNA transfer.
- Trying to know what all to put on the paper for preventing antibiotic resistance.
- Using hands-on technique to teaching.
- Inability to get together with partner.
- I cut myself with a razor when I was cutting milk cartons. Otherwise I enjoyed it.
- Material we use for model – "floral foam"
- Nothing.
- Nothing
- Nothing
- The fact that my partner and I couldn't get together and work because of distance. I felt that she did too much work and didn't let me help enough.
- Having to "build" the project
- I'm taking microbiology and pharmacology. So it was difficult to make time, but that's just how school goes for now.
- Just the fact that there was one more thing to do outside of class.
- I'm not creative at all, so my model was pretty lame. I'm missing the "creative gene"!
- Not enough class time
- Time consuming in an already packed course.
- That we only did one type of genetic transfer, we didn't get to really learn about every one.
- Coming up with the best idea to show our method of transfer.
- You didn't give us as much time with partners.
- I prefer lecture and am not really a visual learner.
- Trying to be creative, I'm not
- The actual making of the 3-D model
- The time it took to complete it.
- Nothing.
- I started to over analyze the process and second guess my understanding.
- Writing out the different ways of slowing antibiotic resistance. I did a lot of research.
- The feeling at first of – we're going to have to do what??
- No much of an artist
- The models, harder to get materials
- Finding time to work together