8th Grade Module 2: Evolving Germs

This handbook has information for the following people:

8th grade classroom teachers
SciTrek Lead

Welcome to SciTrek

About SciTrek

SciTrek exists to promote the synergies between science inquiry, language arts, and California standards. We work towards providing on-site resources for students, practicing teachers, and teachers in training to cover required grade level standards and experience the processes that form the basis of all evidence based approaches to understanding our world. These resources are our program staff, volunteers and experimental resources.

About Lead Roles within SciTrek

The role of the teacher is essential for the success of the SciTrek program. SciTrek is an experiential learning program that presents students with an experimental scenario (or system) and teaches them to observe any perceivable changes, formulate a question about these observations, design and perform an experiment to test their question, and then present and defend their results to their peers. During this experience, it is the role of the lead (teacher/volunteer) to guide students through critical thinking processes by prompting them with questions. This teaching method empowers students with the hard thinking skills and the confidence to tackle questions about which they have little or no understanding.

For those new to inquiry based, experiential learning, the lead role can be more readily understood by relating SciTrek to with a "choose your own adventure" novel where students are the readers and teachers/volunteers are the authors.

In such a novel, there exists various storylines that contain points of decision for the reader. Similarly, each SciTrek experiment involves a system that changes over time with opportunities for the students to manipulate this system. In the novel, the character relationships and flow of events then dictate how the story unfolds whereas in a SciTrek experiment, different factors (or variables) affect how the system will behave. Readers can choose one option that will determine what storyline ensues and so too do SciTrek student participants choose variables to change that will influence the results of their experiment.

The difference? SciTrek learning is open-ended! This means that **SciTrek volunteers are in charge of understanding the experimental materials, the physical/chemical/ biological/energetic processes occurring in the experiment, the decision points and the inclinations of the students**. **Volunteers should then aid students in capturing their ideas in writing and records.** This can be challenging but also fun and quite rewarding.

Let the adventure begin!

About the Instructions:

This booklet is designed to provide conceptual and logistical information for teachers who will be implementing the SciTrek program.

This document begins with an overview for the entire module to offer an understanding of how things will flow across all of the days. It then provides a "daily breakdown" section which presents the daily activities alongside talking points and responsibilities for the teacher. We also provide a review of fundamental experimental design principles to help volunteers to aid students in designing their experiments as well.

CLASSROOM ROLES

SciTrek Lead: The teacher will run the classroom and is responsible for getting up in front of the class to introduce and summarize the day. The entire SciTrek program is about providing opportunities for your students to engage in real science activities that are primarily student directed. The SciTrek program design creates a first hand experience for students of "how science works;" this is accomplished by initially sparking student curiosity and then supporting students in engaging critical thinking processes, including inquiry, trial and error, data analysis, evaluation and synthesis. Whenever possible, the students should be allowed and encouraged to come up with their own questions and their own proposed experimental procedures to address their questions. "Ownership" of this type is highly motivating and distinguishes the SciTrek program from many others.

Through this tangible experience of excitement, failure, resilience and personal responsibility, students benefit far beyond learning content. This is supported by many testimonials from students expressing an understanding that such experiences helped them grow. The university student volunteers are there largely to enable this process. Finally, we encourage teachers to provide as many opportunities for your students to interact with their peers, argue from evidence, etc., as time allows. This is **truly** one of the hallmarks of doing science, often overlooked but core to "doing."

MODULE INSTRUCTIONS: Germs

8th Grade Module 2: Evolving Germs
[50 minute class periods]

LEARNING OBJECTIVES:
Through experiential learning, students interactively learn three categories of material:

- Cognitive Skills – types of thinking foundational to or examples of of critical thinking, including comparing/contrasting, analyzing, evaluating,
- Content – generally accepted knowledge regarding a system, organism or process
- Lab techniques – motor based skills for performing an experiment

This table lists the specific learning objectives which the Germs module aims to teach:

Cognitive Skills	Experimental Techniques	Content

• Distinguishing inferences and observations
• Writing a testable question (identifying and selecting variables)
• Analyzing data
• Evaluating quality of experimental runs qualitatively and quantitatively
• Making a method
  o Using controls
  o Isolating variables
  o Quantifying results
  o Optimizing conditions
• Analyzing data
• Drawing Conclusions
• Reporting and discussing results
	• Plating:
	  o Sterilization
	  o Streaking
	  o Quantification method: % coverage
		• Distinguishing characteristics of bacteria
		• Specific variables or categories of variables that affect bacteria
		• What antibiotic resistance is and why it is an important problem for us to solve.
		• What natural selection is and how can humans use it to their benefit

Day 1 (Mon): Introductions; 3 Example plates; Variable and constants Plating practice; Plate controls	Day 2 (Tues): Write procedure; Quizlet; Discovery Activity	Day 3 (Wed): Plate exp 1; Analyze control	Day 4 (Thurs): Moth Activity	Day 5 (Fri): Analyze exp 1; Plate exp 2
Day 6 (Mon): Plate exp 3; Analyze exp 2	Day 7 (Tues): Bird Simulation	Day 8 (Wed): Analyze exp 3 Final conclusions; Antibiotic Resistance		

SCHEDULE OF EVENTS:
Note on Schedule: *The following schedule is designed to start on a Monday with volunteers coming on MWF*

Day 1 (with SciTrek Leads) - Monday
- Introduce volunteers
- Present 3 example plates to class (bacteria on normal **(Control)** and on antifungal **(Fluconazole)** and antibacterial **(Ampicillin)** plates)
- Students make observations about the 3 plates and record in their packet
- Students describe the effects of Fluconazole and Ampicillin on the bacteria in their chart
- Students will answer questions regarding why there were differing effects on bacteria
- Students determine possible variables that could affect bacterial growth to test in their own experiment and determine their constants
- Volunteer/teacher demonstrates plating technique
- Students practice plating on Jello plates first
- Students now follow directions on page 4 to plate their controls
- Students generate question to test for Experiment 1
- Students answer the THINK question about Experiment 1
- Students report material needs to UC volunteers

Day 2 (without volunteers) - Tuesday
- Students write procedures for Experiment 1
- Get approval by teacher
- Students will review vocabulary on quizlet
- Students will participate in Discovery Activity where they will write down 3 specific observations and questions about why or how the observation is there

Day 3 (with volunteers) - Wednesday

- Analyze & draw controls results
- Student think out
- Plate Experiment 1

Day 4 (without volunteers) - Thursday

- Moth activity

Day 5 (with volunteers) - Friday

- Record results for Experiment 1
- Plate Experiment 2
- Complete analysis question

Day 6 (with volunteers) - Monday

- Record results for Experiment 2
- Plate exp 3
- Complete analysis question for homework

Day 7 (without volunteers) -Tuesday

- Students should work on poster presentation
- Simulation Game

Day 8 (with volunteers) - Wednesday

- Antibiotic Resistance video and discussion
- Students should finish posters
- Tie into standards
- Complete analysis of exp 3
- Final conclusions and graph

Day 9 (without volunteers) - Thursday

- Students present posters

Next Generation Science Standards Addressed for 8th Grade:

Disciplinary Core Ideas:

1. Natural selection leads to the predominance of certain traits in a population, and the suppression of others.
2. In *artificial* selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed onto offspring.
3. Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes.

Science and Engineering Practices

4. Analyze and interpret data to determine similarities and differences in findings.
5. Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena.
6. Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence.

DAILY BREAKDOWN

Day 1 - With SciTrek Volunteers (Monday)
Activity Overview:
- Introduce SciTrek program and UC volunteers
- Present 3 example plates to class (bacteria on normal and on antifungal and antibacterial plates)
- Students make observations about 3 plates and record in their packet
- Students read description of Ampicillin and Fluconazole
- Students determine possible variables to test in experiment and constants
- Talk about experimental questions and controls
- Volunteer/teacher demonstrates plating technique
- Students practice plating on Jello
- Students plate controls
- Students generate question to test for Experiment 1
- Students report material needs to UC volunteers

In presenting the 3 example plates to the class, the student should be able to notice the different effects the antifungal and the antibacterial have on the bacteria.

Materials:
- 3 demo plates
- SciTrek packets
- **Trays include**: 1x B0 plate,, Bacteria culture tubes, inoculation loops, cup with ethanol

Introduction: Introduce the SciTrek concept to the students. Today they will do an activity that introduces them to the general topic of microorganisms, bacteria and fungi. Also, SciTrek is about the processes involved in doing science, or "how science works," and they will be doing experiments to investigate questions they design. Emphasize that there is no right answer for most of what they do next week.

(Lead) Demo plates:
There are 6 plates total. Bacteria will not be able to grow on plates that have ampicillin, an antibiotic. This is to get the kids started thinking about what is in the plate affects how the yeast and bacteria grow.

Bacteria
B. + ampicillin
D. + fluconazole
F. Control (just LB agar)

(Lead)

It is important to state WHY we want controls. Discussion on what is a control and why it is necessary. The best way to convey this concept is through compelling examples. We've all heard about controls, the scientific method, etc; SciTrek is about learning these through direct experience. The UC lead will then guide the class how to do the control plating.

Learning Objectives/Core Concepts:

- The difference between yeast and bacteria and what antifungal and antibacterial do to them ***(NGSS #1)***
- The purpose of a control in an experiment and why it is necessary for a successful experiment
- Proper plating techniques

(Teacher and UC volunteers) ***Control Plating:***

Students will plate controls for the bacteria and the yeast. One set of controls per group of students.

How to Create a Control: The students will be making their own controls for their experiments. ***(NGSS #6)***

- Take one agar plate for the bacteria and label (see "How to Label Your Plates")
- Take a plastic swab and dip it in ethanol and shake it to dry.
- Take the sterile swab and dip it into the bacterial culture and gently streak the bacteria labeled agar plates. Streaking in a zig zag manner (4 streaks)
- Rotate plate 90° and streak another 4 streaks in a zig zag.
- Place controls in plastic box provided and put in incubator overnight
- MAKE SURE EVERYTHING IS LABELED PROPERLY ON THE BOTTOM!
- IF A STUDENT WANTS TO ADD LIQUID FOR EXPERIMENTS:
    - The way to add solutions to a plate is to make various dilutions and add a constant (1-10 drops using pipette) to a plate, air dry for 5-10 minutes in incubator.

How to Label Your Plates:

- Write on the bottom edge of the plate:
    - B for the bacteria plate
    - 0, 1, 2, or 3 depending on if it is the control, experiment 1, exp 2, or exp 3
    - Period
    - Teacher's name
    - Group Number
- For example, if I was plating my bacteria control and I was in group 2 of Ms. Smith's 4th period, my plate would be labeled: B0. 4. Smith. 2

Learning Objectives/Core Concepts:
- The difference between yeast and bacteria and what antifungal and antibacterial do to them ***(NGSS #1)***
- The purpose of a control in an experiment and why it is necessary for a successful experiment
- Proper plating techniques

Day 2: Without Volunteers (Tuesday)

Overview of Activities:
- Write up of procedure
- Vocab Review
- Discovery Activity

Learning Objectives/Core Ideas
- Observations and asking questions about those observations

Day 3 – Volunteers (Wednesday)

Overview of Activities:
- Analyze controls
- Plate Experiment 1

Materials:

Trays include: Controls from Day1 for each group, 1x B1 plate, Bacteria culture tubes, inoculation loops, cup with ethanol, materials needed for experiment

Discussion on how to record results:

1. Have the students individually compare results to those on handout given.
2. Match the student's plates up with those to the closest percentage on the handout.
3. If their colonies are in between two different images given have them go somewhere in the middle.
4. Have the students' compare their results to the rest of their groups and have them debate as to who they think is correct. This gives them an opportunity to back up their results and argue their point.

Developing an Experimental Question:
- Students come up with a plan for Experiment 1 (which they will plate out so they can analyze the following day)

-What are they looking to get out of their question?

Learning Objectives/Core Concepts:
- Students should understand how to record the results of a plate ***(NGSS #4)***

- Students should understand what they are testing ***(NGSS #2)***
- They should have some sense of where their experiment is going to go (ie they should have a rough outline of what they are doing for experiments 2 and 3

Day 4 – Without Volunteers (Thursday)

Overview of Activities:

- Moth Activity
    - 30 white circle & 30 newspaper circles are placed on a white background
    - With forceps, one person will pick up as many circles as they can within 30 seconds
        - PICK UP EACH CIRCLE ONE AT A TIME
        - in the next generation (round), double the amount of circles left over
    - This is repeated again on a newspaper background

<u>Learning Objectives/Core Concepts:</u>

Day 5 - Volunteers (Friday)

Overview of Activities:

- Fill Exp 1 chart and questions in notebook
- Fill out analysis question from experiment 1
- Plate Exp 2
- Write out analysis in notebook

Materials:

- Trays include: 1x B2 plate, Bacteria culture tubes, inoculation loops, cup with ethanol, materials needed for new experiment

When filling out the charts for the different experiments, the control should remain the same throughout.

When writing a question for experiment 2, the question should still be related to original hypothesis. The second question should expand on the original question. Since the students know how the first variable affected the growth of bacteria on the agar plates, the second question should try to get a new view on the first question.

This is also where you would note any changes in procedures. Like was stated above, noting the changes in procedure is an extremely important part of the scientific process. Part of the SciTrek program is teaching young students the scientific process and how to think about science. Writing everything down in an extremely important part of the scientific process and your job as a volunteer is to make sure that the students are doing this.

The hypothesis for experiment 2 may change, or may stay the same as experiment 1. It just depends on how the question has changed for experiment 2.

Learning Objectives/Core Concepts:

- Students should be able to analyze how the variable they used in experiment 2 affected their colony growth ***(NGSS #4)***
- Students should then use the knowledge they gained from experiment 1 and 2 to inform their decision on what to plate for experiment 3 ***(NGSS #5)***

Day 6 - Volunteers (Monday)

Overview of Activities:

- Record results for Experiment 2
- Plate Experiment 3
- Complete analysis question

Materials:

- Trays include: 1x B2 plate, Bacteria culture tubes, inoculation loops, cup with ethanol, materials needed for new experiment

Experiment 2 analysis and questions are very similar to those of experiment 1.

The control for experiment 2 is the same as experiment 1.

By the third experiment the students should have a solid understanding of what they are trying to test for. They have had the first two experiments to play around and explore different options, but this experiment should be a way for them to fully validate their point. By this point they should be confident in what they are testing and should be able to explain to you why they are doing this. They should also be able to have a prediction for what their final conclusion should be. You should be discussing this with them and questioning them on their thought process. We really want to stretch their understanding of what they are doing and why.

Learning Objectives/Core Concepts:

- Students should be able to analyze how the variable they used in experiment 1 affected their colony growth ***(NGSS #4)***
- Students should then use the knowledge they gained from experiment 1 to inform their decision on what to plate for experiment 2 ***(NGSS #5)***

Day 7 –Simulation Game - Without Volunteers (Tuesday)

Overview of Activities:

- Natural selection simulation with birds
- http://sepuplhs.org/high/sgi/teachers/evolution_act11_sim.html

Materials:
- Computer and **website**

Day 8 - Conclusions - With volunteers (Wednesday)

Overview of Activities:
- Record results for Experiment 3
- Complete conclusion questions
- Complete final data table and graph
- Antibiotic Resistance video and discussion

Materials:
- Experiment 3 plates
- Antibiotic Resistance video

Learning Objectives/Core Concepts:
- Students should be able to analyze how the variable they used in experiment 3 affected their colony growth ***(NGSS #4)***
- Students should be able to make conclusions based on their three experiments on what affects the growth of bacteria and yeast ***(NGSS #5)***
- Students should know what antibiotic resistance is and why it is a problem ***(NGSS #3)***
- Students should be able to see how the work they have done for the past two weeks ties into the bigger concepts they are learning ***(NGSS #1, #2, & #3)***