



INTRODUCTION TO BIOSAFETY

Biosafety Curriculum for High School Students

Day 1: Exposure & Hazard ID

A. Intro Demo of Cross-Contamination

- i. The purpose of this exercise is to engage students in the learning process as soon as they enter the classroom as well as teach them about cross-contamination. The instructor is to position themselves near the door of the classroom and periodically shake hands with a student as they enter. Unknown to the students, the instructor has Glo Germ on their hands. The instructor then uses a blacklight to show the students how microorganisms spread.

1. Exercise outline

- a. Stand near the door to the room before class starts.
- b. Apply Glo Germ to bare hands.
- c. Shake hands as students walk in
- d. Turn out lights, show who has got Glo Germ and where, also show surfaces in the room

B. Wash Hands

- i. After the initial exercise in cross-contamination the instructor can follow with a demonstration in how to properly wash your hands. Using the blacklight as a check to how well the students wash their hands.

1. Exercise outline

- a. Have students wash hands
- b. Check hands for Glo Germ with blacklight again
- c. Demonstrate proper handwashing and repeat exercise

C. Don and Doff Gloves

- i. After the student have washed their hands the instructor can use this as an opportunity to teach them about gloves and their proper usage. The instructor should use Glo Germ along with the gloves to demonstrate proper technique.
- ii. Note: This could be made a game to see who can do it the fastest without contamination. With the losers having to wash their hands again.

1. Exercise outline

- a. Put on disposable lab gloves
- b. Add Glo Germ to gloves

- c. Have students remove gloves, check for Glo Germ with the blacklight
- d. Demonstrate proper handwashing technique and repeat exercise

D. Splash and Splatter

- i. The following exercises are used to demonstrate how laboratory techniques, equipment, and everyday manipulations can lead to unintentional spills or exposure. The purpose of this particular exercise is to show the students how far microorganism can spread using everyday hand movements.
- ii. Note: In order to protect students clothing disposable lab coats should be worn
 - 1. Exercise Outline
 - a. Don disposable gloves
 - b. Apply Glo Germ to gloved hands
 - c. Move hands swiftly over clean surface, rub hands together, clap, slap, etc.
 - d. Use black light to see splatter, noting how far some splatter has traveled

E. Pipetting

- i. The following exercise is used to demonstrate how laboratory techniques, equipment, and everyday manipulations can lead to unintentional spills or exposure. The purpose of this exercise is to demonstrate aerosol generation and spread during pipetting.
- ii. Note: In order to protect students clothing disposable lab coats should be worn
 - 1. Exercise Outline
 - a. Prepare several vials with Glo Germ suspended in liquid
 - b. Have students micropipette Glo Germ solution from one container to another, from a few μL to 1 mL
 - c. Turn lights out and show splatter using black light
 - d. Clean surfaces, demonstrate proper pipetting procedure and repeat exercise
 - 2. Perform exercise with serological pipettes (larger volumes)
 - a. Make a point to note how messy blowing out the pipette tip is
 - b. Distinguish between “to retain” measurements and “to expel” measurements

F. Vortex

- i. The following exercise is used to demonstrate how laboratory techniques,

equipment, and everyday manipulations can lead to unintentional spills or exposure. The purpose of this exercise is to demonstrate aerosol generation and spread during vortexing.

- ii. Note: In order to protect students clothing disposable lab coats should be worn
 1. Exercise Outline
 - a. Close a tube containing Glo Germ and vortex rapidly for several seconds to a few minutes
 - b. Turn lights out and show Glo Germ with the blacklight.
 - c. Clean surfaces, give proper instruction, and repeat exercise

G. Debrief

- i. Discuss how common lab associated infections are; perhaps give some of the more famous LAIs as case studies
- ii. Biohazard symbol ID
- iii. Discuss risk groups and show public health risk group matrix
- iv. Chemical Hazard ID
 1. Global Harmonization System (GHS) symbols and SDSs
 2. Discuss safety procedures with chemicals
 - a. Safe pouring
 - b. Safe measuring
 - c. Chemical reactivity and compatibility

Day 2: Protection

1 Identifying Route of Exposure and Protective Measures

- a. Students will be asked to identify the proper laboratory equipment that will give them the best protection from the scenarios given by the instructor. An explanation of the equipment can be given after they make their selections.
- b. Exercise Outline
 - i. Break the students into groups and identify one spokesperson
 - ii. Have different combinations of PPE on a table that corresponds to different routes of exposure
 1. i.e., goggle for eye protection, earbuds for hearing protection, face mask for eye and mouth/nose protection, gloves for hand protection, lab coat for body protection, puncture resistant gloves, heat resistant gloves
- c. Pose different scenarios and allow the students identify the proper PPE, e.g.:
 - i. Chemical spill on shoes
 - ii. Sharps fallen on foot or floor

- iii. Molten agar on clothes or in face
- iv. Mouse or rat bite
- v. Poke with a pipette tip
- vi. etc.

1. Note: The instructor should get creative and when creating scenarios for the students

1. Donning and Doffing PPE

- a. Now that the students have chosen the PPE it is now time to teach them how to where the appropriate PPE.
 - i. Note: This is a time to allow the students to take pictures and pose with friends. This may be their first time putting on full PPE and may want pictures to show family and friends.
- b. Exercise Outline
 - i. Allow the students to fully don PPE (lab coat, gloves, face shield, etc.)
 - ii. Cover them in Glo Germ and have them remove the PPE
 - iii. Check for Glo Germ contamination
 - iv. Demonstrate proper procedures on doffing, repeat exercise

2. Standard Microbiological Practices

- a. Review the “Standard Microbiological Practices” handout with students, ask them if they have any questions.

3. Aseptic Technique

- a. One of the fundamental techniques that any microbiologist must learn is aseptic technique. Proficiency in aseptic technique can also provide protection to the student when working with microorganism. This exercise is meant to teach the students aseptic technique.
- b. Exercise Outline
 - i. With Flame
 1. Using the flaming loop method transfer *B. subtilis* from a stock tube and streak a lawn on nonselective media
 2. Be aware of nearby flammables and proper use of heated metal loop (i.e. how to prevent and extinguish an ethanol fire)
 3. Be aware of surface contamination and cross- contamination
 - ii. Without Flame (potentially do this after BSC demo)
 1. Using disposable loops in a BSC, transfer *B. subtilis* from a stock tube and streak a lawn on nonselective media
 2. Be aware of surface contamination and cross- contamination

4. Biosafety cabinet

- a. The students will then move their aseptic technique into the biosafety cabinet. Here they will learn how to work in a biosafety cabinet and some common points of failure.
- b. Exercise Outline
 - i. Demonstrate proper setup of a BSC: clean side \leftrightarrow dirty side
 - ii. Demonstrate overcrowding and impact on spill potential, etc.
 - iii. Gas/smoke demonstration
 1. Air disruption from improper exit and entry of hands
 2. Air disruption from walk-by or open doors
 3. Air disruption from rapid movements inside cabinet
 4. Air disruption from blocking grilles
 5. Proper use of a BSC

5. Biosafety Levels

- a. Diagram and explain the 4 levels
- b. Explain that they will not be going into a BSL-3 or BSL-4 lab

Day 3: Plan an experiment

1. Project Planning/Risk Identification

- a. Part of being able to work safely in a laboratory is properly planning your experiments. Poor planning can lead to accidents in the laboratory. Here the students will work through planning an experiment in the laboratory. They will research the agent and techniques they will use and move into completing a small procedure.
 - i. Notes: Please refer to the High School Course Supplemental Material for more information
 - ii. Notes: No matter what the organism the students pick they should be given RG1 material to use in the exercise
 - iii. Exercise Outline
 1. Have students choose an agent
 2. Have students select a basic lab procedure
 - a. Charge the students with coming up with a complete list of equipment and reagents for the experiment
 - b. Make them find the SDSs for the chemicals needed (will need a “library” of resources in the classroom for the students)
 3. Have the students identify the hazards inherent in their experiment and bullet point how to mitigate them
 - iv. Have the instructor or class review the hazard and mitigation “plan” and point

out any gaps

- v. Allow the student to carry out experiment
- vi. Debrief as a group for any unexpected hazards

2. “What’s wrong with this picture?”

- a. The purpose of this exercise is to show the student commonly issues that occur in the laboratory and have them identify the hazards associated. Students can be broken into teams (like Family Feud). Shown a picture and have to buzz in to answer.
- b. Exercise Outline
 - i. Create or obtain several pictures that have a potentially hazardous situation, e.g.:
 1. Fire near a gas line or open container of flammables
 2. Lab furniture with absorbent material for upholstery
 3. Overcrowded bench
 4. Unsecured lids
 5. Uncovered sharps
 6. Full sharps bins
 7. Top of BSC with stuff piled on it
 8. Electrical cords across the floor
 - ii. Allow students to pick out the hazard and discuss why it is a hazard

Day 4: Cleanup

1. Spill Cleanup and Spill Response

- a. The purpose of this exercise is to teach student how to respond to a spill. Instead of giving the students a spill response protocol, you will have them instruct the instructor how to clean the spill. This reversal of roles will be fun for them and allow them the chance to evaluate the process in real time.
- b. Exercise Outline
 - i. Make a spill using Glo Germ, colored water, or chocolate syrup
 - ii. Have the students walk you through the proper spill cleanup
 - iii. Use the Socratic Method to get them to identify the gaps in their procedure
 1. Prompt them to pick the right disinfectant
 - a. Briefly cover different types of disinfectant and what they’re good for and not good for, instructor should use disinfectants in use at his or her institution
 - i. Bleach
 - ii. Ethanol/isopropanol
 - iii. Vesphene

- iv. Discussion: Once the students have successfully instructed you on how to clean up the spill give them the institution's spill cleanup procedure. How close were they to what is recommended? Where there any improvements to the institutions policies that can be suggested?
- c. Now that the students have walked you through the spill response and you have discussed the institutions policy it is time to test their ability to clean up spills. Have the students clean up a small spill of Glo Germ and then show them how well they did.

2. Autoclaving Waste and Waste Streams

- a. The purpose of this section is for the students to be able to identify the correct waste stream for hazardous waste commonly generated in the laboratory.
- b. Discussion: Prepare spill waste for autoclave or chemical disposal
 - i. Talk briefly about how autoclaves work and how they're tested/validated
 - 1. Include things to never put into an autoclave
 - 2. Demonstrate how to load an autoclave
- c. Exercise Outline: Waste Stream Game
 - i. Use flashcards, PowerPoint, or other appropriate media to display different types of waste commonly found in a laboratory (e.g. pipette tips, syringes, used glassware, broken glass, etc.). Have to students put into different groups and answer questions about the waste.
 - ii. Topics to Cover
 - 1. Sharps
 - 2. Biologicals (medical waste)
 - 3. When do you autoclave or chemically inactivate before disposal
 - 4. Chemical hazards and chemical disposal
 - 5. First drop policy - label waste containers with contents as soon as the first drop enters the container
 - 6. Compatibility
 - 7. Timeliness- how soon after generation must waste be disposed of
 - 8. Radiological
 - 9. Normal waste and recycling
- d. Optional (per institution): give students info on how to report an exposure - from a spill or otherwise. Instructor will determine best method for this, we recommend having them actually call and talk to someone in medical services to get over the stigma of calling.

Day 5: Demonstrated Proficiency with Resources Available

- a. Students are will work through different stations that have them work through activities

covered earlier in the week. This is to test the students' retention of information but instructors should coach students as needed.

- b. Stations with one or more skills per station, depending on how many instructors available
 - a. Don & Doff PPE
 - b. Handwashing
 - c. Reagent prep (chemical safety and aseptic technique)
 - d. Workspace setup and proficiency in BSC or with flame
 - e. Waste handling, labeling, and disposal
 - f. Spill communication and cleanup
- c. Fill out the "People You Should Know" worksheet
- d. Make them ask questions/identify gaps/provide feedback: make students bring in a question that they care about and go over it in class