ABSA INTERNATIONAL
The Association for Biosafety and Biosecurity
1200 Allanson Road • Mundelein, IL 60060-3808 • 866-425-1385 • Fax: 847-566-4580 • E-mail: info@absa.org • Web Site: www.absa.org

INTRODUCTION TO BIOSAFETY

Biosafety Curriculum for Undergraduate and Graduate Students
One Credit—One Semester Learning Objectives

Week 1: Introduction and History

A. History of Biosafety
    1. Students will be able to identify the following as major historical events that contributed to the development of the profession of Biosafety:
        a. The U.S. Bioweapons Program (in the context of the Cold War)
        b. Operation Whitecoats
        c. The first Asilomar Conference

B. Laboratory Acquired Infections
    1. Students will understand that LAI's were considered an occupational hazard in the past, but have not been considered acceptable since passage of the Occupational Safety and Health Act and the bloodborne Pathogens rule

C. Intro to Biosafety Levels
    1. Students will be able to describe the basic features of a BSL-1, -2, -3, and -4

D. LAI Case Studies
    1. the exercise will walk students through three famous LAI cases:
        a. Janet Parker - 40 year old medical photographer with office adjoining smallpox lab (via HVAC): fatal smallpox infection
        b. Richard Din - 25 year old unvaccinated laboratory technician working with *Neisseria meningitidis*: fatal meningococcal disease
        c. Malcolm Casadaban - 60 year old PhD research professor studying attenuated *Yersinia pestis* but had the condition hemochromatosis which complemented the mutation: fatal case of plague

E. Movie Night: *Outbreak*
    1. Students will watch the movie *Outbreak* and will write down at least three items, practices, or summarized conversations they saw in the movie that were intended to improve safety in the laboratory. The instructor will facilitate a discussion about these same topics in class using the students' notes as a starting point.

Week 2 - Risk Assessment

A. Student will be able to define the components of a biological risk assessment
B. Student will be able to differentiate between formal, Informal, and dynamic risk assessment and know when to apply them.

C. Student will be able to explain how the laboratory procedures influence a risk assessment
D. Students will demonstrate how to correctly perform a risk assessment based on case studies and projects
    1. The projects for the class should all build off of one another and include progressively more difficult situations.
        a. Classifying the pathogenesis of an unknown organism
            a. ***in vitro* work (i.e. tissue culture challenge):** initial pathogen characterization
            b. **in vivo work (working with animals):** studying disease progression using animal models
            c. ***in vivo* recombinant work:** modifying the wild-type organism to better characterize pathogenesis
            d. **Vaccine development**: creating a chimeric organism for the purpose of vaccine protection studies.

Week 3-4 - Biosafety Levels

A. Biosafety Level 1
    1. Students will be able to describe facility features and special practices of a BSL-1 laboratory including Standard Microbiological Practices and aseptic technique
    2. Students will be able to identify or list PPE that is appropriate for BSL-1 laboratory
    3. Students will use risk assessment to describe research that would be conducted at BSL-1
B. Biosafety Level 2
    1. Students will be able to describe facility features and special practices of a BSL-2 laboratory and how BSL-1 features contribute to it.
    2. Students will be able to identify or list PPE that is appropriate for BSL-2 laboratory
    3. Students will use risk assessment to describe research that would be conducted at BSL-2
        a. particularly focusing on the properties of the organism, the procedures or types of experiments being performed, and if any genetic modification
    4. Students will be able to understand what goes into biosafety 2 laboratory with 3 practices
C. Biosafety Level 3 (Briefly)
    1. Students will be able to describe facility features and special practices of a BSL-3 laboratory and how BSL-2 features contribute to it.
    2. Students will be able to identify or list PPE that is appropriate for BSL-3 laboratory
    3. Students will use risk assessment to describe research that would be conducted at BSL-3
D. Biosafety Level 4 (Briefly)
    1. Students will be able to describe facility features and special practices of a BSL-4 laboratory and how BSL-3 features contribute to it.
    2. Students will be able to identify or list PPE that is appropriate for BSL-4 laboratory

3. Students will use risk assessment to describe research that would be conducted at BSL-4

E. Students will learn that some research projects involving infectious agents are performed in nonstandard models and require specialized features to be work with safely in containment (Briefly)
    1. Students will understand the facility features of agricultural facilities
    2. Students will be able to understand the features in a containment greenhouse
    3. Students will be able to understand the feature in an arthropod containment laboratory
    4. Students will be able to understand the features of an aquatics containment facility.

Week 5 - Mid-term and catch-up

Week 6 - Personal Protective Equipment

A. Students will understand how PPE protect the different routes of exposure from infection
B. Types of PPE
    1. Students will describe when it is appropriate to use the following types of PPE:
        a. Gloves
            a. Bite scratch resistant glove
            b. Chemical resistant gloves
            c. Nitrile verse Latex
                i. double gloving
                ii. taping gloves
                iii. working with 2 colors
        b. Lab coats and gowns
            a. Reusable lab cloth coat
                i. cotton vs. polyester vs. blend
            b. Closed front gowns disposable gowns
            c. Water impermeable closed front gowns
            d. Tyvek
        c. Eye protection
            a. Face shields
            b. Safety glasses
            c. Safety Goggle
        d. Respiratory protection
            a. Surgical mask is not respiratory protection
            b. N95
            c. PAPR
            d. Positive pressure suit
    2. Students will understand how and when to use respirators in the laboratory and will be

made aware of the requirement for medical evaluation and fit testing

3. Students will demonstrate risk assessment based PPE selections by recommending appropriate PPE for several case studies
4. A laboratory that uses botulinum neurotoxin in tissue cultures assays to study cytotoxicity
5. A laboratory that uses *mycobacterium tuberculosis* in aerosol challenges of guinea pigs
6. A laboratory that studies innate immune response to West Nile Virus using a primary cell line
7. A laboratory doing a necropsy on a mouse infected with hantavirus

B. Students will be able to demonstrate how to properly select, don, and doff different types of PPE (exercise)

C. Students will be able to demonstrate proper doffing procedure with a functional assessment using GloGerm or equivalent. The exercise will focus on cross- contamination, proper doffing, disposal of PPE exercise

D. Poor combinations of PPE (more =/= better)

1. Students will consider at least one scenario in which a researcher or technician is encumbered or impeded by too much PPE, especially redundant PPE and participate in a discussion about acceptable risk and choosing the appropriate solution for a given hazard. Examples below:
    a. Wearing 3 pairs of gloves
    b. Wearing a PAPR over a surgical mask
    c. Face shield and goggles

Week 7 - Laboratory Facilities and Safety Equipment

A. Principles of engineering control, e.g.: mechanical pipetters, sharps safety

1. Students will learn that an engineering control is the removal of a hazard at its source by design of equipment or facility.
2. Students will learn that great examples of engineering controls are:
    a. A mechanical pipetter that replaces mouth pipetting,
    b. Safer sharps that minimize the chance of a needlestick,
    c. A facility design that avoids moving contaminated material through the same space that uncontaminated material moves through

B. Biosafety cabinets

1. Students will learn that a biosafety cabinet provides, user, product, and environmental protection
2. Students will learn by observing a smoke demonstration (in-person or on video) how fragile the directional airflow in a BSC is and how it is partitioned as it moves from the top of the cabinet to the grilles.
    a. Students will learn how to enter and exit the BSC with minimal airflow disruption
    b. Students will learn how blocking the grilles compromises BSC function

c. Students will learn to avoid walking near a functioning BSC or leaving nearby doors open
d. Students will learn how even small movements and clutter in the cabinet can cause turbulence and compromise the effectiveness of the BSC

3. Students will learn how to verify function and certification of a BSC
4. Students will learn to set up their cabinet from clean to dirty and establish a workflow in the same direction

C. Directional airflow
1. Students will learn that directional airflow provides protection from contaminated aerosols
2. Students will learn that the support space housing the mechanical components providing directional airflow is large, expensive, and managed by engineers

D. Building Automation Systems
1. Students will learn that HVAC, doors, fire, and other alarms and statuses are frequently monitored by building engineers via a Building Automation System

E. Fire Detection and Control Systems
1. Students will learn that laboratories are rated by the estimated volume of flammable materials present and designed accordingly with sprinkler systems, fire extinguishers, and emergency exits

F. Effluent Decontamination Systems
1. Students will learn that liquid waste (effluent) from some labs is treated by effluent decontamination systems
2. Students will learn that EDSs can use heat inactivation or chemical inactivation, but either must be validated
3. Students will understand that EDS systems can be of various size and capacity

G. Design a Facility Assignment
1. Students will receive an assignment to design a high containment laboratory which will be assessed from both a safety and a function perspective

Week 8 - Disinfection and Decontamination

A. Spill Cleanup
1. Students will learn to surround a spill with absorbent material, flood it with fresh disinfectant, allow contact time, and dispose of properly
2. Students will learn to avoid cross contamination by implementing the following best practices:
a. Flood and wipe, don't spray
b. Communicate
c. Go slow, allow contact time

d. Think through what is contaminated very carefully - your gloves and clothes are likely dirtier than you think

B. Waste Disposal
    1. Students will learn that waste disposal is a complicated topic, specific to a given location, and if done improperly, can result in large fines or other negative consequences
    2. Students will learn to contact the appropriate Safety professional for help in disposing of waste

C. Selection of Disinfectants
    1. Students will learn that there is no perfect disinfectant; it is always a trade-off
    2. Students will learn that different organisms (and sometimes, growth phase of organism) have different susceptibilities to different disinfectants.
    3. Students will learn that they need to select an appropriate disinfectant based on the organism, it's growth phase or other modifications, the matrix containing the organism, the environment that needs to be decontaminated, and what equipment will need to be exposed to the disinfectant
    4. Students will understand that different disinfectants have different chemical properties and therefore different interactions with different surfaces or matrix components (e.g. high organic load)
    5. Students will learn that they need to verify the activity of their disinfectant on their target organism in their planned application

D. Mechanisms of action and categories of disinfectants
    1. Students will learn that there are: quaternary ammonium compounds, oxidizers (bleach, chlorine dioxide, hydrogen peroxide), phenolics, reducers (sodium hydroxide), alcohols, and formaldehyde
    2. Students will learn that quaternary ammonium compounds have several mechanisms of action including membrane and protein disruption; oxidizers chemically modify lipids, proteins, and nucleic acids to render them non-functional; phenolics are membrane and protein disruptors; alcohols are protein and membrane disruptors, and formaldehyde is a protein and membrane disruptor

E. Mixed waste
    1. Students will learn that mixed waste is a combination of radioactive and biohazardous or chemically hazardous materials.
    2. Students will learn that mixed waste is either disposed of at great expense directly or treated to remove one or more of the hazards before being disposed of as only one kind of waste