SAFE SCIENCE: BE PROTECTED

TARGETING BIOSAFETY for HIGH SCHOOL LEVEL BIOTECHNOLOGY

By Dr. Ken Roy*

I. New blip on the radar screen!

Over the past twenty years, the major concern in laboratory safety was how to deal with chemical hazards. With the advent of OSHA's Hazard Communications Standard or HazCom in 1986, appropriate protocols for hazardous chemicals were put into place to address information access, protection and employee training. Enter stage left - molecular biology/biotechnology along with biological hazards. Today, in addition to undergraduate laboratories, many high schools are beginning to embrace biotechnology in their programs of study. Although this movement is essential in the evolution of the biological sciences, appropriate safeguards or biosafety must be put into place for the operation of these laboratories.

II. What is the profile of the bogey?

Biohazards are infectious agents or biologically derived infectious materials, which present or may present a risk to other living things, including humans. Biohazards invade the body through similar portals of entry as chemical hazards; e.g., eyes, mouth, lungs, etc. However, unlike hazardous chemicals, biological hazards can reproduce and spread the infection in a relatively short amount of time.

Categories of biohazards or potentially infectious materials include the following::

Human, animal and plant pathogens: bacteria, fungi, viruses, parasites, rickettsiae, chlamydiae, and toxins;

All human and animal blood, blood products, tissues and body fluids.

Cultured cells and potentially infectious agents. These cells may contain allergens

Recombinant DNA products

Clinical, necropsy and surgical specimens (tissues, fluids, etc.)

III. Counteroffensive to contain the bogey!

The Center for Disease Control (CDC) has developed biosafety protocols to safely handle biohazards. The safety methods have been characterized as "containment." The focus of containment is to reduce or eliminate exposure of laboratory workers and the outside environment/community to potentially hazardous agents. Containment is achieved in three ways: 1.) laboratory practice and techniques, 2.) safety equipment and 3.) facility design.

"No high school level laboratory course should be dealing with infectious agents or potentially infectious materials!"

IV. Drills for skills!

The first line of defense relative to containment is adherence to micro biological practices and techniques. Employees working with infectious agents or potentially infectious materials must be aware of possible hazards. In addition, they must be trained and skilled to safely handle biohazard materials.

In the case of high school science labs, the emphasis should be on "possible hazards." No high school level laboratory course should be dealing with infectious agents or potentially infectious materials! High school science departments need to develop operations manuals that identify possible biohazards and adopt practices and procedures for biosafety.

V. Establishing the primary defense perimeters!

Depending on the type of biohazard, personal protective equipment (PPE) such as gloves, laboratory coats, safety goggles, etc. should be required. Additional safety equipment might include biosafety cabinets, enclosed containers and other engineering controls (eyewash/shower, master utility shutoffs, etc.). Cabinets are used to contain infectious splashes or aerosols generated by many micro biological procedures. Again, at the high school level, only the noted PPE and "other" engineering controls are necessary and appropriate.

VI. Establishing the secondary defense perimeters!

The facility contributes to laboratory protection, provides a barrier to protect people outside the laboratory and protects people/animals in the community. Depending on the biosafety level of a facility, design features need to include specialized ventilation systems, air treatment systems, controlled access, airlocks, etc. Ventilation requirements are referenced in the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) standards. In the case of high schools, primary focus is on non-recycling ventilation systems in science laboratories. The forced air supply side provides fresh out-of-doors air and this air is then directly returned to its source, without traveling through other parts of the facility.

VII Determining the level of defense!

The CDC has established four biosafety levels (BSLs) consisting of combinations of laboratory practices and techniques, safety equipment and laboratory facili-

ties. The BSLs are specific to operations performed, transmission of infectious agents and laboratory functions. The CDC biosafety levels include the following descriptors:

BSL 1: No known or minimal potential hazard of exposure to infectious agents.

BSL 2: Moderate potential hazard/low risk of exposure to infectious agents.

BSL 3: Moderate risk of exposure to agents that can cause serious or potentially lethal disease.

BSL 4: High individual risk of exposure to dangerous or exotic agents which cause life-threatening disease.

BSL 1 is the only appropriate level for high school laboratories offering courses in microbiology and/or biotechnology. This designation is based on safety equipment, practices, facility design and construction. BSL 1 is for laboratories where work is done with defined, characterized strains and viable microorganisms not known to cause disease in healthy humans; e.g. *Bacillus subtilus, Naegleria gruberi;* and exempt organisms under NIH Recombinant DNA guidelines.

It must be noted that, many agents not ordinarily associated with disease processes in humans can be opportunist pathogens. They can cause infection in the young, the aged and the immunodeficient or immunosurpressed individuals.

BSL 1 is a basic level of containment based on standard micro biological practices with no special primary or secondary barriers recommended, other than a sink for hand washing. The level 1 laboratory is not necessarily separated from general traffic patterns in the facility. Work is generally conducted on open bench tops utilizing standard micro biological protocol. Special containment equipment or facility design is not required. Lab personnel have special training in laboratory protocol, supervised by a qualified science supervisor.

BSL 2-4 range from moderate-risk to work with dangerous/exotic agents – life threatening disease. These levels are inappropriate for secondary schools!

VIII. What are the standard operating procedures?

The following standard and special practices, safety equipment and facilities apply to agents assigned to Biosafety Level 1:

A. Standard Micro biological/Biotechnology Practices

1. Access to the laboratory is limited or restricted at the discretion of the laboratory teacher or science supervisor when experiments or work with cultures and specimens are in progress.

2. Laboratory occupants wash their hands with soap after they handle viable materials and animals, after removing gloves, and before leaving the laboratory.

3. Eating, drinking, smoking, handling contact lenses, and applying cosmetics are not permitted in the work areas where there is reasonable likelihood of exposure to potentially infectious materials. Persons who wear contact lenses in laboratories should also wear goggles. Food is stored outside the work area in cabinets or refrigerators designated and used for this purpose only.

4. Mouth pipetting is prohibited; mechanical pipetting devices are used.

5. All procedures are performed carefully to minimize the creation of splashes or aerosols.

6. Work surfaces are decontaminated at least once a day and after any spill of viable material.

7. All cultures, stocks, and other regulated wastes are decontaminated before disposal by an approved decontamination method, such as autoclaving. Materials to be decontaminated outside of the immediate laboratory are to be placed in a durable, leak proof container and closed for transport from the laboratory.

Materials to be decontaminated at offsite from the laboratory are packaged in accordance with applicable local, state, and federal regulations, before removal from the facility.

8. An insect and rodent control program is in effect.

9. Only closed toed shoes or sneakers are allowed.

10. Hair must be tied back from the face.

B. Special Practices: None

C. Safety Equipment (Primary Barriers)

1. Special containment devices or equipment such as a biological safety cabinet are generally not required for manipulations of agents assigned to Biosafety Level 1.

2. It is recommended that laboratory coats be worn to prevent contamination or soiling of street clothes.

3. Gloves must be worn, especially if the skin on the hands is broken or if a rash exists.

4. Protective eye wear must be worn for anticipated splashes of microorganisms or other hazardous materials to the face.

D. Laboratory Facilities (Secondary Barriers)

1. Each laboratory contains a sink for hand washing.

2. The laboratory is designed so that it can be easily cleaned. Rugs in laboratories are not appropriate, and should not be used because proper decontamination following a spill is extremely difficult to achieve.

3. Bench tops are impervious to water and resistant to acids, alkalis, organic solvents, and moderate heat.

4. Laboratory furniture is sturdy. Spaces between benches, cabinets, and equip-

Bio-Safety Continued on page 8

Bio-Safety Continued from page 7

ment are accessible for cleaning.

5. If the laboratory has windows that open, they are fitted with fly screens.

IX. Remember the code!

The OSHA Code (29 CFR 1910.1030) Bloodborne Pathogens, requires employers to have an "Exposure Control Plan" if exposure is likely. Bloodborne pathogens include viruses, bacteria, and parasites present in blood or other body fluids. Although use of these pathogens would be prohibited in a microbiology or biotechnology course, chance of exposure via laboratory work is increased. In addition, this standard does cover special practices, access, warning signs, PPE, biosafety and training requirements. For the high school science laboratory, an Exposure Control Plan needs to be in place.

X. Lock on to the target!

Biology at the high school level has become revolutionary and very exciting with the advent of biotechnology and advances in microbiology. Along with the revolution is the need to maintain a safe and productve working environment. Both can be achieved by locking on to the target - establishment and implementation of an effective biosafety program.

RESOURCES:

American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.: HYPERLINK "http://www.ashrae.com"

Centers for Disease Control: HYPERLINK "http://www.cdc.gov"

International Centre for Genetic Engineering and Biotechnology: HYPERLINK "http://www.icgeb.trieste.it"

Michigan State University: HYPERLINK

the revolution is the need to maintain a safe and productve working environment. Both can be achieved by locking on to the target - establishment and implementation of an effective biosafety program.

RESOURCES:

American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.: HYPERLINK "http://www.ashrae.com"

Centers for Disease Control: HYPERLINK "http://www.cdc.gov"

International Centre for Genetic Engineering and Biotechnology: HYPERLINK "http://www.icgeb.trieste.it"

Michigan State University: HYPERLINK "http://www.orcbs.msu.edu/biological"

National Centre for Biotechnology Education, Safety Guidelines: HYPERLINK "http://134.225.167.114/ncbe/"

National Committee for Clinical Laboratory Standards:HYPERLINK "http://www.nccls.org"

North Michigan University, Department of Clinical Lab Science: http://www.nmu.edu/cls/links.html

Occupational Safety and Health Administration: HYPERLINK "http://www.osha.gov"

United Nations Environmental Programme, Register on Biosafety: HYPERLINK "http://chem.unep.ch/biodiv/"

University of Virginia, Biosafety Program: HYPERLINK: http://keats.admin.virginia.edu/bio/home.html

LIVE LONG AND PROSPER SAFELY!

*Dr. Ken Roy
K-12 Director of Science & Safety
c/o Glastonbury Public Schools
Glastonbury, CT 06033-3099;
Authorized OSHA Instructor
Fax 860-652-7275
Email: Royk@glastonburyus.org

✧✧✧