Biohazard in the work Environment
Biosafety & Biosecurity
An Overview

By

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Institutional Biosafety Officer
General Biosafety

The consistent application of safety measures to minimize or prevent exposure to the person handling the biohazard agent/organism, coworkers, and the environment.

1. Gives an overview of the
2. Federal guidelines concerning biosafety practices
3. How these practices are applicable to the research laboratory

Who needs this training?

All the Individuals who work with or have access to biohazardous materials.
Biohazard — Biological origin and hazardous to plants, animals and human being

- Biohazard n (1967): a biological agent or condition (as an infectious organism or insecure laboratory conditions) that constitutes a hazard to man or his environment; also a hazard posed by such an agent or condition.

  - Webster's 9th New Collegiate Dictionary, Miriam-Webster Inc. Publishers, Springfield, MA USA, 1985

90% of exposure/accident in the lab are related to a breakdown in good microbiological work practices – need for biosafety practices
Biosafety Applications are required for

• Research, including:
  rDNA research, Human Gene Transfer, plants, animals, large scale
  human & animal pathogens, select agents
  toxins of biological origin
  shipping, transport, import, export, permits
  field work, inspection and training
  Emergency response, environmental issues

• Clinical/Hospital Settings
  – Pathology labs, microbiological lab
  – infection control, standard precautions, airborne precautions
  – social workers
NIH Guidelines

• Federal guidelines that must be followed when performing research using biohazardous agents

• The *Guidelines’* purpose
  – To specify practices for constructing and handling rDNA molecules and organisms containing these molecules.

• UNTHSC also use these guidelines to….
  – Include the handling of other biohazardous agents (not associated with rDNA) as a part of a total biosafety program.
Biohazard Risk Assessment: Involves You and ........

- Principal Investigator - initiates risk review
- Biosafety Officer - assists PI
- Institutional Biosafety Committee - assists PI, reviews/approve PI’s protocol submission
- Facilities staff
- Assistance through
  - published listings, guidelines (U.S. and abroad)
  - other experts at host institution, local public health
  - other institutions working with same agents
  - Government entities (CDC, NIH, USDA, FDA, etc.)
Institutional Biosafety Committee

• Duties include
  – Review research for compliance with *NIH Guidelines*;
  – Notify Primary Investigator of the results of an IBC review;
  – Set containment levels for experiments;
  – Review research periodically to ensure adherence to *NIH Guidelines*;
  – Report significant problems with or violations of the *NIH Guidelines*.

(*NIH Guidelines*, Section IV-B-2b)
Biosafety Officer

• Duties
  – Periodic inspections to ensure that laboratory standards are rigorously followed;
  – Report to the IBC any significant problems, violations of the *NIH Guidelines*, and significant research-related accidents or illnesses;
  – Develop an emergency plan for handling accidental spills and personnel contamination;
  – Provide advice on laboratory security; and
  – Provide technical advice to PIs and the IBC on research safety procedures.

(*NIH Guidelines*, Section IV-B-3)
Principal Investigator’s Responsibility

• Make available to all laboratory staff
  – Protocols that describe the potential biohazards and the precautions
• Instruct and train laboratory staff
  – In the practices and techniques required to ensure safety and the procedures dealing with accidents
• Inform the lab staff
  – Of the reasons and provisions for any precautionary medical practices advised or requested
• Supervise
  – The safety performance of the laboratory staff;
• Investigate and report
  – Any significant problems pertaining to the operation and implementation of containment practices to the IBC
• Correct work errors and conditions
  – That may result in a release of a biohazardous agent
• Ensure the integrity
  – Of the physical and biological containment.

*(NIH Guidelines, Section IV-B-7-c,d,e)*
Why biosafety practices?

To protect:

• Workers,
• Products,
• Co-workers,
• Environment,
• Students, and
• Visitors
Risk Assessment Process

• To determine the level of containment to handle a biohazardous agent
  – Subjective process
• Based on the following
  – Virulence
  – Pathogenicity
  – Infectious dose
  – Environmental stability
  – Route of spread
  – Communicability
  – Operations
  – Quantity
  – Availability of vaccine or treatment
  – Gene product effects
    • Toxicity, physiological activity, and allergenicity
    Host range
    Geographic considerations (endemic?)
• All IBC applications include a section describing this risk assessment process
• The IBC gives final approval to the biosafety level of containment
  (NIH Guidelines, Section II)
Chain of Infection and Means of Protection

- Reservoir of pathogen
- Portal of escape
- Transmission
- Route of entry/infectious dose
- Susceptible host
- Incubation period

Risk Assessment

Practices/Equipment
Personal Protective Equipment
Immunization
Surveillance
Biosafety Lab Manual Components

Note: All laboratories conducting biohazardous agent research are required to have a biosafety manual available

- Contact information
- Information of IBC, IRB, and/or IACUC protocols
- Standard Operating Procedures
  - For unique procedures
- Laboratory inspection checklist
- Emergency plan for handling spills and personnel contamination
- List of biohazard materials using in the lab
Classification of Infectious Agents

• Classified into risk groups on the basis of...
  – Risk to the individual and
  – Risk to the community

• Four risk group levels have been designated
  – Minimal risk (RG-1)
  – Moderate risk (RG-2)
  – High risk (RG-3)
  – Extreme risk (RG-4)

• NIH Guidelines, Appendix B
Risk Group Classifications (1-4)
Center for Disease Control and Prevention (CDC)

- **Risk Group 1 (RG1); Managed at Biosafety Level 1 (BSL1)**
  - Agents are not associated with disease in healthy adult humans.
    - e.g. *E. coli* K12 strains, *B. subtilis*, *S. cerevisiae*

- **Risk Group 2 (RG2); Managed at Biosafety Level 2 (BSL2)**
  - Agents are associated with human disease of varying severity (rarely serious) and for which preventative or therapeutic interventions are often available.
    - e.g. *Salmonella*, *Shigella*, Vibrio, Plasmodium, Hepatitis B Virus, Cryptococcus neoformans, *E. coli* 0157:H7
  - Both BSL1/BSL2 in basic lab
    - containment equipment to contain aerosols
Risk Group Classifications (1-4)
Center for Disease Control and Prevention (CDC)

• Risk Group 3 (RG3);
  – Managed at Biosafety Level 3 (BSL3)
  – Agents are associated with serious or lethal human disease for which preventative or therapeutic interventions *may* be available (high individual risk, low community risk).
    • e.g. *Brucella abortus*, *Mycobacterium tuberculosis*, *HIV*
  – Specialized facility; double-door entry, dedicated HVAC (HEPA filtration optional), on-site decontamination, all activities performed in BSC
Risk Group Classifications (1-4)
Center for Disease Control and Prevention (CDC)

• Risk Group 4 (RG4);
  – Managed at Biosafety Level 4 (BSL4)
  – Agents are likely to cause serious or lethal human disease for which preventative or therapeutic interventions are not usually available (high individual risk and high community risk).
    • e.g. Ebola, Cercopithecine herpesvirus 1 (Herpes B or Monkey B virus)
  – Highly specialized facilities; air locks, HEPA filtration, kill tanks, moon suits, glove boxes, etc.
Biological Agent:

- The number of microorganisms required to initiate infection
  - Q fever: 10 organisms by inhalation
  - *E. coli*: $10^8$ organisms by ingestion
  - Malaria: 10 organisms by IV injection
  - Poliovirus 1: 2 pfu by ingestion

Environmental stability
- Resistance to drying
- Relative resistance to certain disinfectants
- Growth cycle: spores – vegetative stage

### NIH Guidelines – Section II

#### Safety Considerations

- Risk assessments: (Appendix B)

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<th>RG 1</th>
<th>RG 2</th>
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<th>RG 4</th>
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<td>Agents that are associated with human disease which is rarely serious and for which preventive or therapeutic interventions are often available</td>
<td>Agents that are associated with serious or lethal human disease for which preventive or therapeutic interventions may be available (high individual risk but low community risk)</td>
<td>Agents that are likely to cause serious or lethal human disease for which preventive or therapeutic interventions are not usually available (high individual risk and high community risk)</td>
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# Environmental Systems Approach to Health

## Analyte Matrix

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## Environmental Systems

- **Food System**
- **Air**
- **Sewage System**
- **Water System**
- **Solid Waste Disposal System**
- **Vector/Animal Influence**

[http://www.cdc.gov](http://www.cdc.gov)
Blood borne Pathogens Training
• Need to refresh yearly

Blood borne pathogens are present in human blood and may cause chronic disease or death in people who are exposed.

These pathogens are most often spread through contact with infected blood, semen and vaginal secretions, torn or loose skin, or body fluids.

The most common bloodborne pathogens are: Hepatitis B Virus (HBV) Hepatitis C Virus (HCV) Human Immunodeficiency Virus (HIV)
Basic hygiene precautions are important for workers handling biosolids. The following list, originally developed by EPA, provides a good set of hygiene recommendations.

1. Wash hands thoroughly with soap and water after contact with biosolids.
2. Avoid touching face, mouth, eyes, nose, genitalia, or open sores and cuts while working with biosolids.
3. Wash your hands before you eat, drink, or smoke and before and after using the bathroom.
4. Eat in designated areas away from biosolids-handling activities.
5. Do not smoke or chew tobacco or gum while working with biosolids.
6. Use barriers between skin and surfaces exposed to biosolids.
7. Remove excess biosolids from footgear prior to entering a vehicle or a building.
8. Keep wounds covered with clean, dry bandages.
9. Thoroughly but gently flush eyes with water if biosolids contact eyes.
10. Change into clean work clothing on a daily basis and reserve footgear for use at worksite or during biosolids transport.
11. Do not wear work clothes home or outside the work environment.
12. Use gloves to prevent skin abrasion.
NIH Guidelines – Section II

- Safety Considerations

- Containment
  - Physical (Appendix G)
    - Practices
    - Equipment/facilities
  - Biological (Appendix I)
    - Survival
    - Transmission
**Biosafety Levels of Containment**

- Containment involves a combination of laboratory issues to include:
  
  - Standard microbiological practices
    - Personal protective equipment
  - Safety equipment
    - Primary barrier
  - Laboratory facilities
    - Secondary barrier
BSL-1
Standard Microbiological Practices

• Needles & sharps precautions
  – Use sharps containers
  – DON’T break, bend, re-sheath or reuse syringes or needles
  – Use alternatives to needles when available

DON’T place needles or sharps in office waste containers
BSL-1
Standard Microbiological Practices

Use mechanical pipetting devices
BSL-1
Standard Microbiological Practices

Wash hands
**BSL-2 Safety Equipment**
*(Primary Barrier)*

- **Class II Biological Safety Cabinet**
  - To protect product, personnel, and the environment.
BSL-2 Safety Equipment
(Primary Barrier)

• Class II Biological Safety Cabinet
  – Equipment is laid out to not restrict airflow in the cabinet
BSL-2 Facility Design
(Secondary Barrier)

Requirements:

- Laboratory has lockable doors
- Sink available for hand washing
- Work surfaces easily cleaned
- Bench tops are impervious to water
- Sturdy furniture Adequate illumination
- Air flows into lab without re-circulation to non-lab areas
- Windows fitted with fly screens
BSL-2 Facility Design (Secondary Barrier)

- BSL-1 Facilities PLUS:
  - Decontamination method
    - Autoclave may be available
    - Off-site program
  - Eyewash station present
BSL-3 and BSL-4 Containment

- BSL3 and BSL-4 containment is not available on the UNTHSC campus.
Reporting of Research Related Adverse Events

• Research related adverse events include
  – Biological spills
  – Exposure to biohazardous agents
  – Non-adherence to NIH Guidelines

• All such events must be reported to the IBC

• Biosafety Officer can be contacted for additional information (extn 5431)
Biological Safety Cabinets
Overview

• Protection of
  – Product
  – Personal
  – Environment
Biological Safety Cabinet Operation

- Class II A1
  - not designed for chemical use
  - May be used for non-volatile toxic chemicals or low-level radioactive materials
- Class II A2
  - may be used for “minute” amounts of volatile chemicals if canopy connected
- Ensure annual certification
- Place all work materials into cabinet before starting
Biological Safety Cabinet
Operation

CAUTIONS

• Chemicals may damage HEPA filter
• Volatile chemicals NOT retained by HEPA filter
  – Exposes personnel if not exhausted
• Fans NOT spark proof
  – Chemical use may result in fire and/or explosion
  – Never use flammable
  – Open fire can damage HEPA filter
Centrifuge - Hazards

- Mechanical failure
- Lab equipment failure
  - tubes etc.
- Aerosol generation
- Operator error
Ultraviolet Lamps in BSCs

UV lamps are not required or recommended in BSCs. If operated properly, BSCs do not need UV lights.

If installed UV lamps must be:

• Cleaned weekly to remove dirt and dust (they block germicidal effectiveness of UV light)

• Checked periodically to ensure the appropriate intensity of UV light is being emitted

• Turned off when the room is occupied to protect eyes and skin from UV exposure

**can burn the cornea and cause skin cancer**
NO Open Flame in BSC

- Open Flames in BSC

Biosafety training material from Marcia Finucane and Brandy Nelson at the University of Kentucky
Open Flames in BSC

Safety Features Circumvented

Biosafety training material from Marcia Finucane and Brandy Nelson at the University of Kentucky.
Biohazard work area

Mark the work area with the warning sign and contact information
Laboratory Hygiene

DO NOT:

• Eat
• Drink
• Smoke
• Apply cosmetics (including lip balm)
• Handle contact lenses
• Store food or drink in lab refrigerators
• Wear open-toed shoes
Hand Washing

- Wash hands immediately after removing PPE
- Use a soft soap
- A hand sanitizer can be used but wash with soap and water as soon as possible.
Personal Protective Equipment

• PPE can become an important line of defence (last line of defence).
• USE proper PPE
Spills

- Spill response will vary depending on:
  - What was spilled?
  - How much was spilled?
  - Where was the spill?
  - What is the potential for release to the environment?
- Spills should be cleaned up immediately to ensure proper decontamination.
- **All spills** are to be reported **ASAP** to the lab supervisor and Safety office.
Spills

• When cleaning up surfaces use 10% bleach solution or approved disinfectant (Mix bleach solution fresh each time.)
• Put wipes or paper twel on top of the spill
• Spray and allow it to stand for at least ten minutes before wiping up up.
• Dispose of all wipes in biohazard containers.
• Decontaminate any materials used to clean up blood or OPIM (mops, sponges, buckets, etc.)
• PPE should be removed and disposed of in biohazard containers.
Decontamination

• Generally for disinfection rather than sterilization

• Choice depends on;
  • Type of material to be disinfected
  • Organic load
  • Chemical characteristics

• Most common are chlorine compounds and alcohols (broad range)
Disinfection: What to use for my organism?

**Bacteria**

**Vegetative bacteria** (E.coli,)
- 2% domestic bleach
- 75% Ethanol
- Quaternary ammonia
- 6% formulated Hydrogen peroxide*

**Mycobacteria and fungi**
- 10% domestic bleach
- 75% Ethanol
- Phenolic compounds
- 6% formulated Hydrogen peroxide*

**Spore forming bacteria** (Bacillus)
- 10% domestic bleach
- Gluteraldehyde
- Formaldehyde
- 6% formulated Hydrogen peroxide*

**Viruses**

**Enveloped** (HIV, Herpes)
- 2% domestic bleach
- 75% Ethanol
- Quaternary ammonia
- 6% formulated Hydrogen peroxide*

**Non enveloped** (Hepatitis, Adenovirus)
- 10% domestic bleach
- 6% formulated Hydrogen peroxide*
- Gluteraldehyde
- Formaldehyde
Biohazardous Waste

- Biohazardous waste containers shall be clearly marked with the universal biohazard symbol.

Biohazard waste disposal at UNTHSC

- Biological waste Other than Human origin
- Biological waste Human origin
- Sharps

Call custodial service for pick up
Transportation

Transportation of Dangerous Goods

- packaging requirements (primary and secondary containers, dry ice etc)
- means and route of transportation (use of cart with guard rails, low traffic area etc.)
- regulatory requirements (classification, labelling, signing, documenting)

Comply, or assure compliance, with applicable U.S. Department of Transportation, EPA, and USDA criteria in the transportation (on campus) or shipping (off campus) of regulated potentially biohazardous materials or wastes.
Housekeeping

A well-organized work area can help prevent accidents.

Biosafety training material from Marcia Finucane and Brandy Nelson at the University of Kentucky.
No Soap at Handwashing Sink

Biosafety training material from Marcia Finucane and Brandy Nelson at the University of Kentucky.
No sandals when working in the laboratory!!!

Biosafety training material from Marcia Finucane and Brandy Nelson at the University of Kentucky.
Best Glove Use

- Gloves Not Worn Outside Laboratory
- Use an Appropriate Secondary Container
  - Leakproof Container
  - Open and Close in BSC
  - Disinfect Outside Prior to Transport
Watch Out!

This person passes you in the hallway, going to the break area!

Keep the Bugs in the Lab!

Leave PPE in Lab

Biosafety training material from Marcia Finucane and Brandy Nelson at the University of Kentucky.
With proper knowledge, planning and care, a biological exposure is avoidable.

Let Us be Safe !!!!!!!!!!
Questions?

Please contact Bio Safety Office UNTHSC (CBH -160 E)

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