Biohazard in the work Environment

Biosafety & Biosecurity

An Overview

UNT HEALTH SCIENCE CENTER

Institutional Biosafety Committee

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:

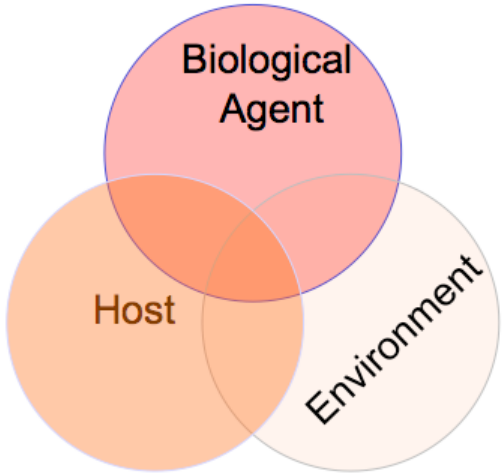
- Workers,
- Products,
- Co-workers,
- Environment,
- Students, and
- Visitors

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

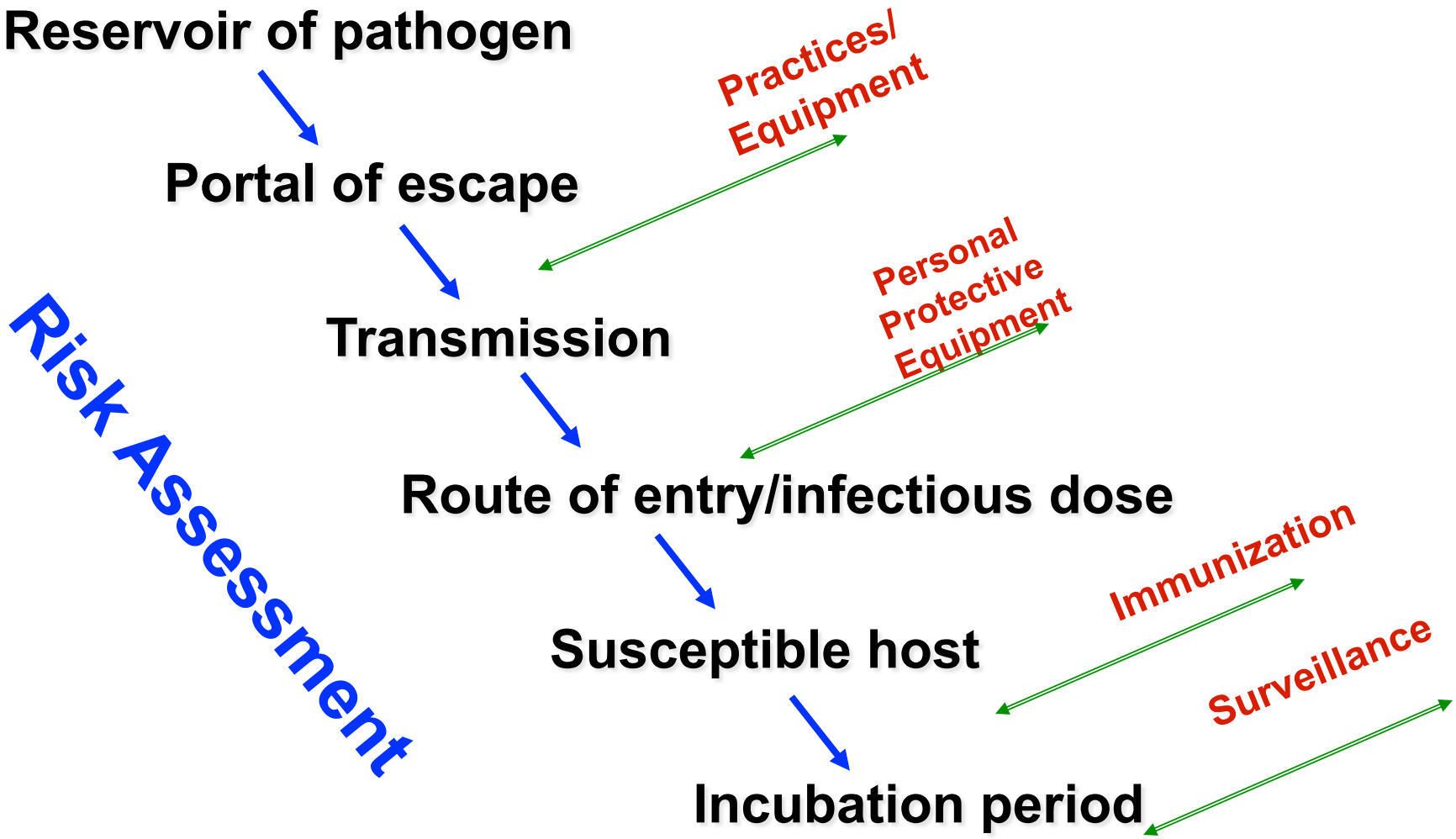
    Geographic considerations (endemic ?)



- 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



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 <u>often</u> 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

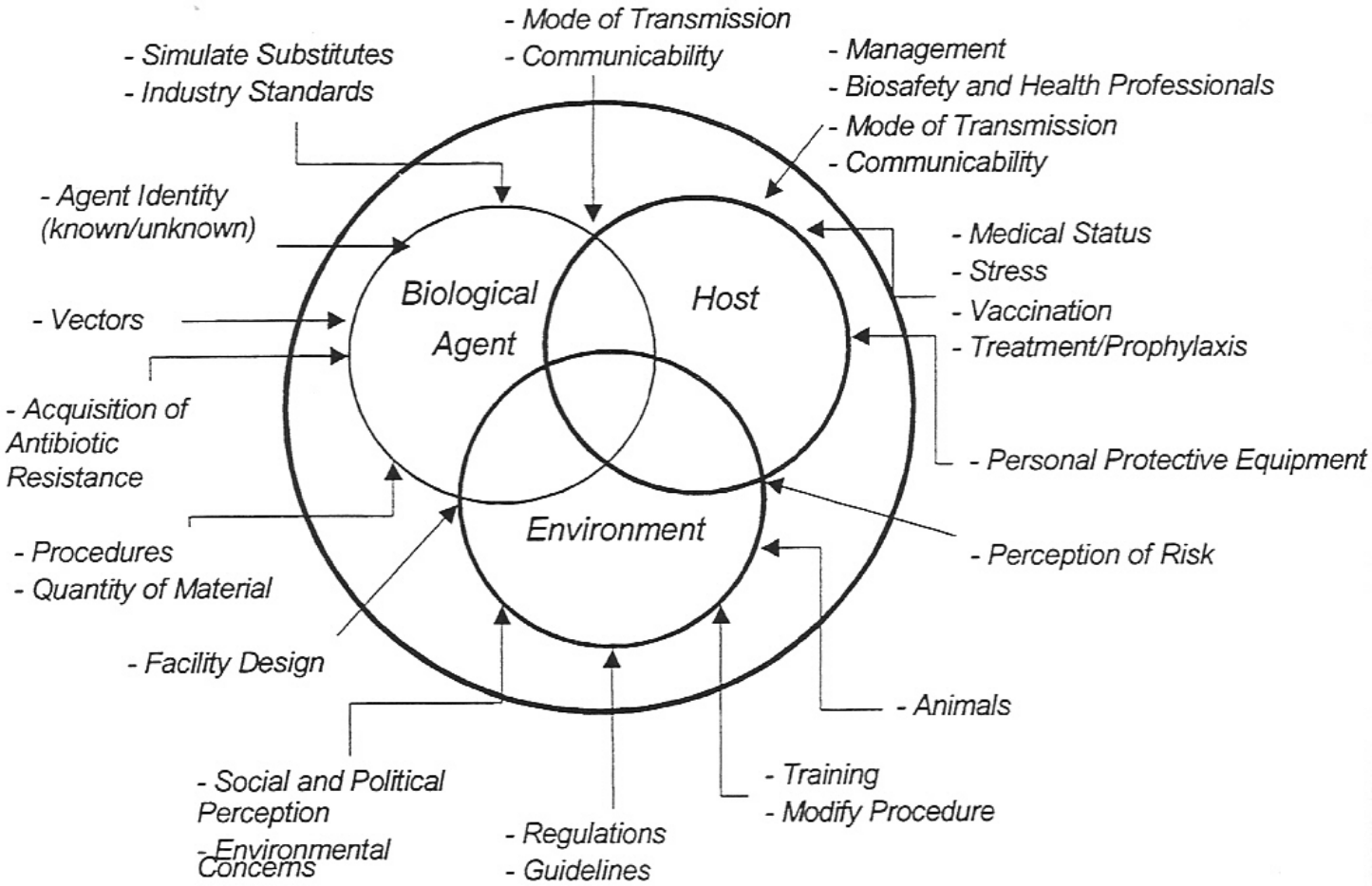
Reference: Wedum, A.G., Barkley, W.E., and Hellman, A. 1972. *J Am Vet. Med Assoc.* 161:11, 1557-1567.

NIH Guidelines – Section II

- **Safety Considerations**
  - **Risk assessments: (Appendix B)**

RG 1	RG 2	RG 3	RG 4
Agents that are not associated with disease in healthy adult humans	Agents that are associated with human disease which is rarely serious and for which preventive or therapeutic interventions are *often* available	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)	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)

Risk Assessment Factors



Anthology of Biosafety IV, Issues in Public Health, Chapter 10. J.Y. Richmond, Ed. ABSA, 2001 page 152

ENVIRONMENTAL SYSTEMS APPROACH TO HEALTH

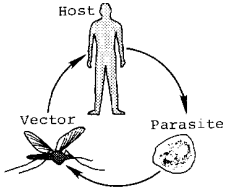
Analyte Matrix	Myco-toxins	Pesticides	Allergens	Anti-biotics	Drugs of Abuse	Hormones	Drug Residues
Milk							
Meat							
Beverages	Food and feed						
Fruits and Vegetables							
Feed							
Soil							
Water		Environment					
Air/Dust							
Saliva							
Urine					Medical diagnostics		
Blood							

FOOD SYSTEM

AIR

SEWAGE SYSTEM

WATER SYSTEM



SOLID WASTE DISPOSAL SYSTEM

VECTOR/ ANIMAL INFLUENCE

HEALTH OUTCOMES

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.

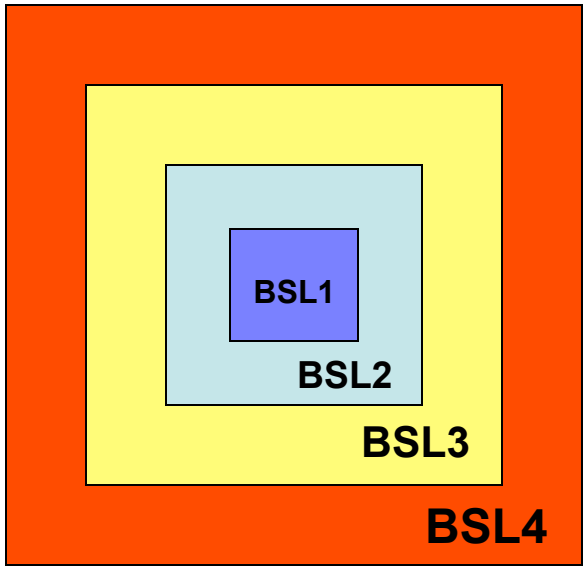
11. Do not wear work clothes home or outside the work environment.

12. Use gloves to prevent skin abrasion.

http://www.cdc.gov/niosh/docs/2002-149/2002-149.html

NIH Guidelines – Section II

- **Safety Considerations**



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

Biosafety Levels of Containment

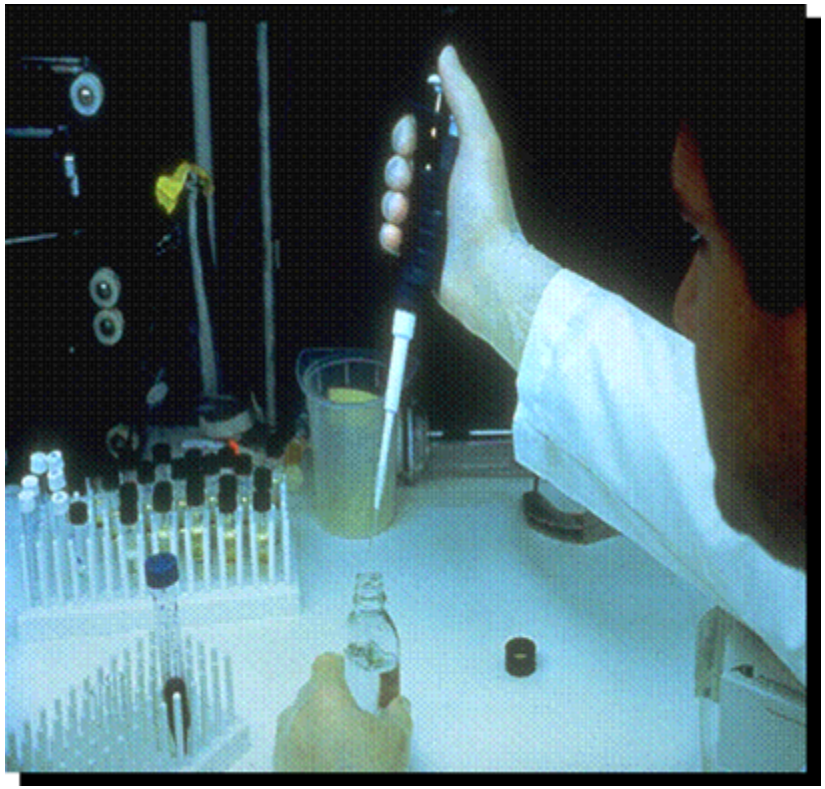
- Containment involves a combination of laboratory issues to include:
  - Standard microbiological practices
    - Personal protective equipment
  - Safety equipment
    - Primary barrier
  - Laboratory facilities
    - Secondary barrier

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

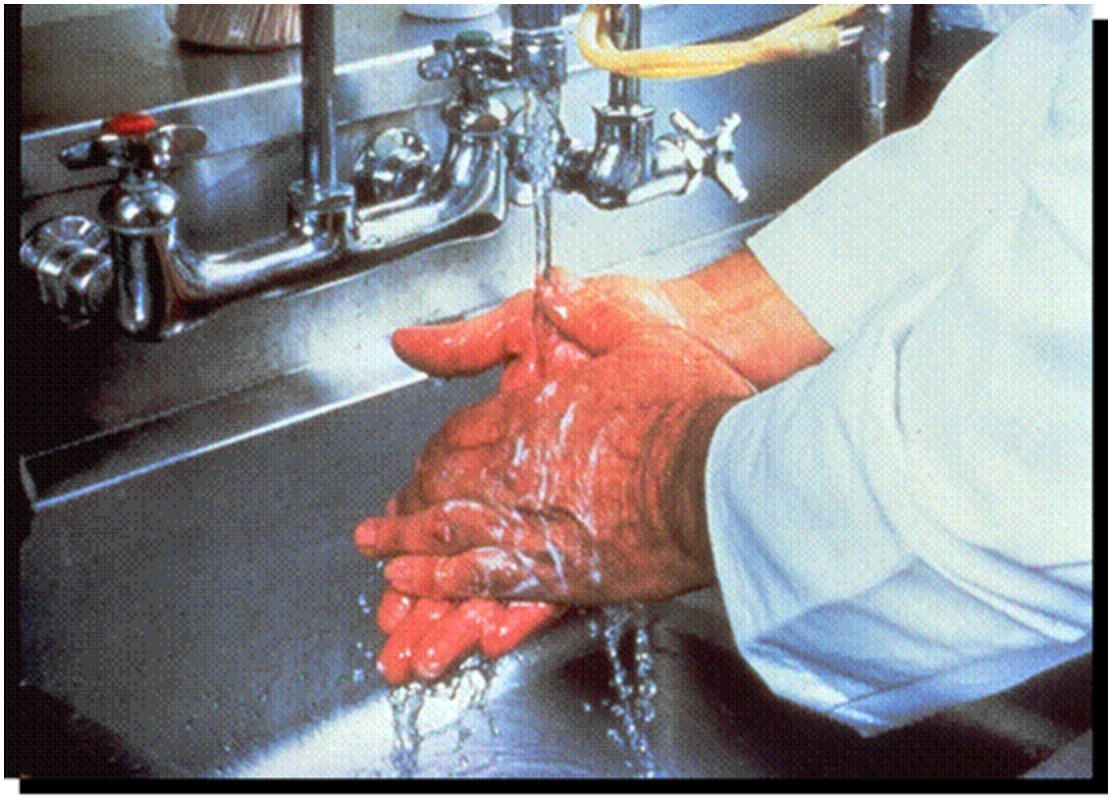
DON'T place needles or sharps in office waste containers

BSL-1
Standard Microbiological Practices



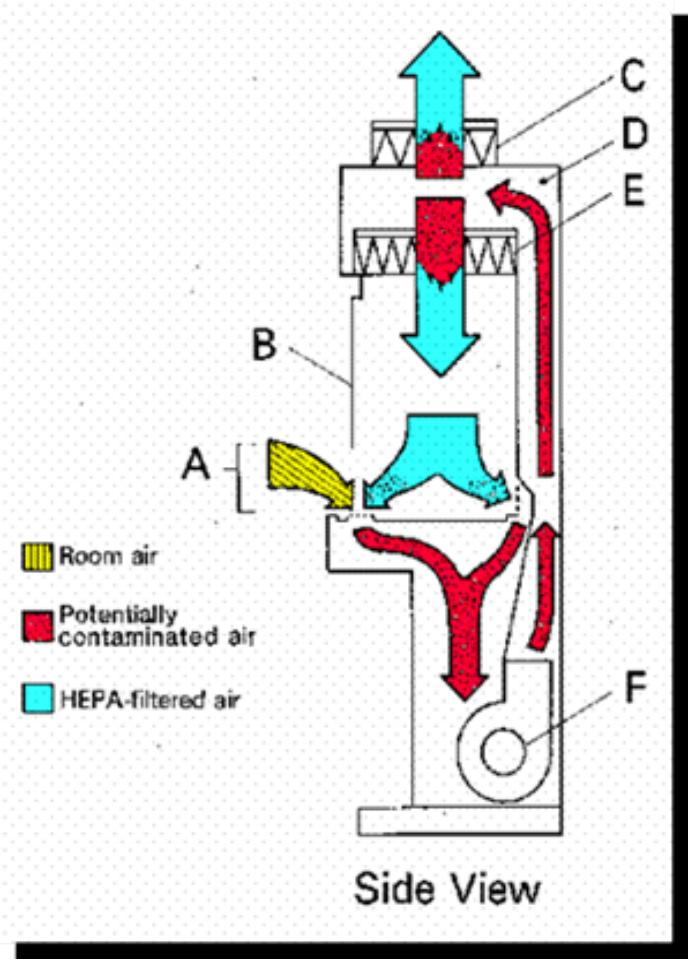
Use mechanical pipetting devices

BSL-1
Standard Microbiological Practices



Wash hands

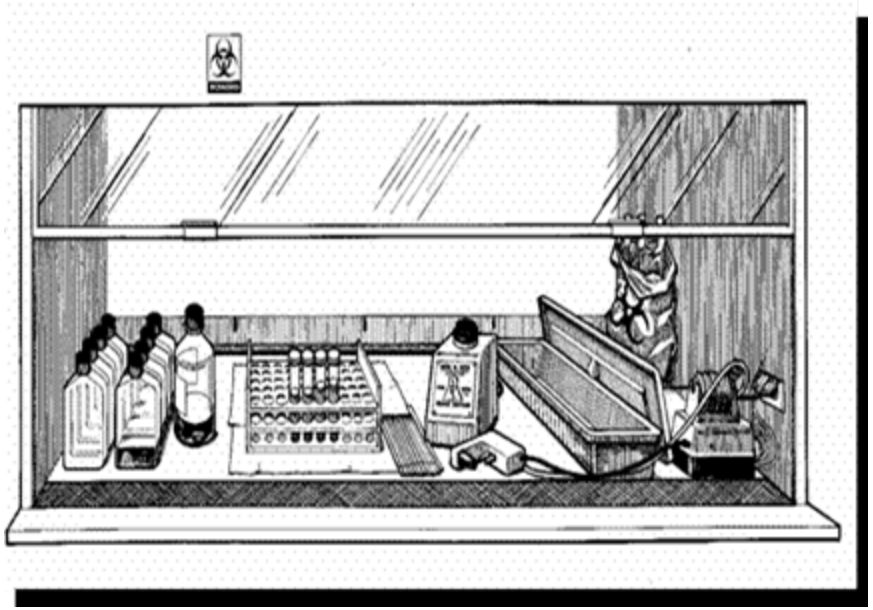
BSL-2 Safety Equipment (Primary Barrier)



- 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



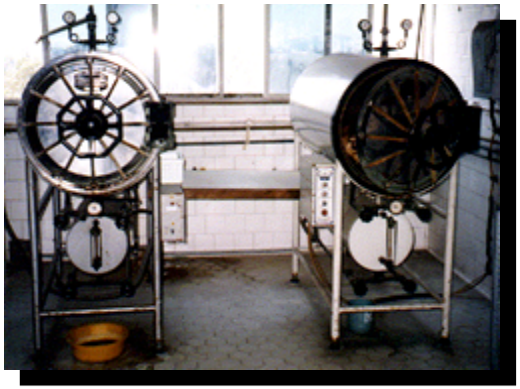
BSL-2 Facility Design (Secondary Barrier)

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

CDC/BMBL

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 <u>if canopy connected</u>
- Ensure annual certification
- Place all work materials into cabinet before starting

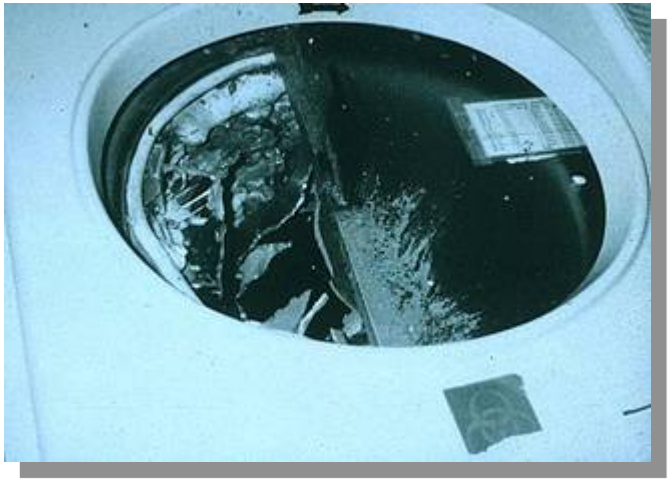
Biological Safety Cabinet Operation

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:

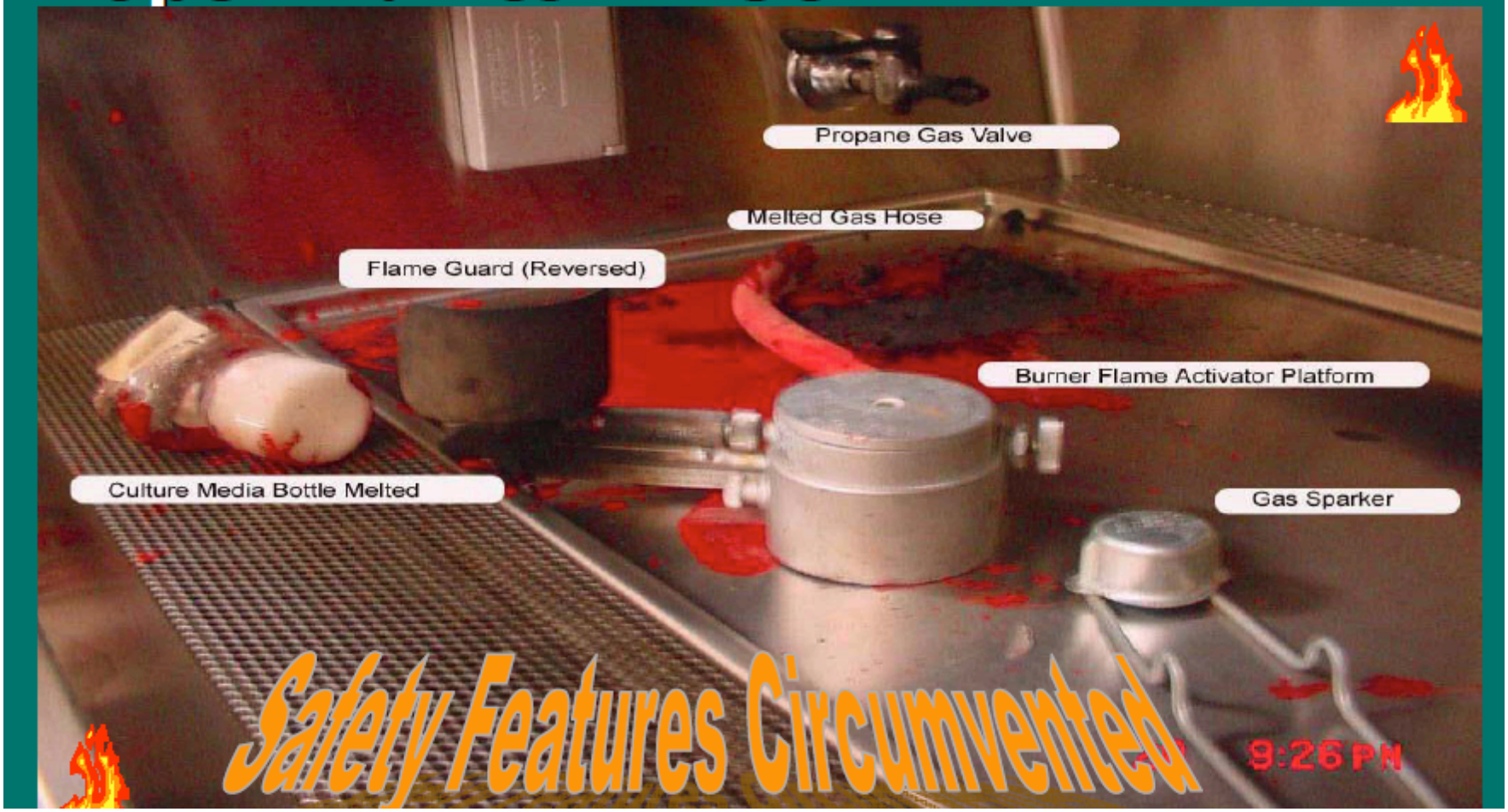
- Cleaned weekly to remove dirt and dust
  (they block germicidal effectiveness of UV light)
- Checked periodically to ensure the appropriate intensity of UV light is being emitted
- Turned off when the room is occupied to protect eyes and skin from UV exposure

**can burn the cornea and cause skin cancer

NO Open Flame in BSC

- **Open Flames in BSC**

Open Flames in BSC



Biohazard work area

Mark the work area with the warning sign and contact information

Laboratory Hygiene

<u>DO NOT</u>:

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

Hand Washing

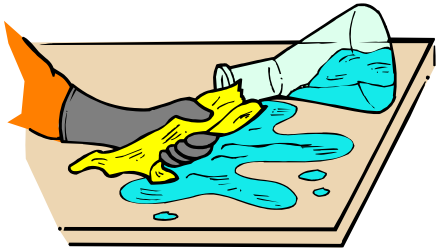
- Wash hands immediately after removing PPE
- Use a soft soap
- A hand sanitizer can be used but wash with soap and water as soon as possible.

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

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)

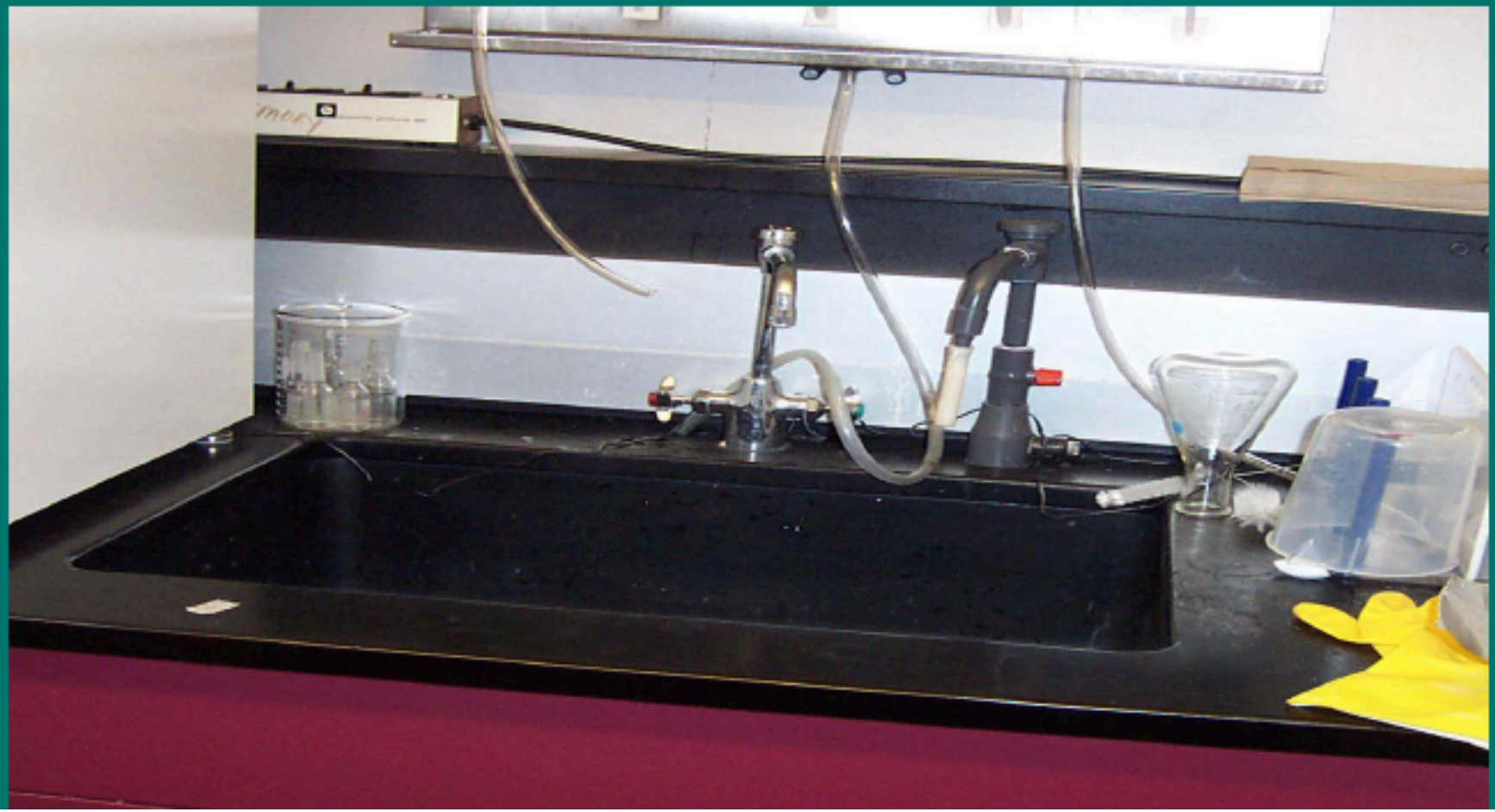
Comply, or assure compliance, with applicable U.S. Department of Transportation, EPA, and USDA criteria in the transportation (on campus) or shipping (off campus) of regulated potentially biohazardous materials or wastes.

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.

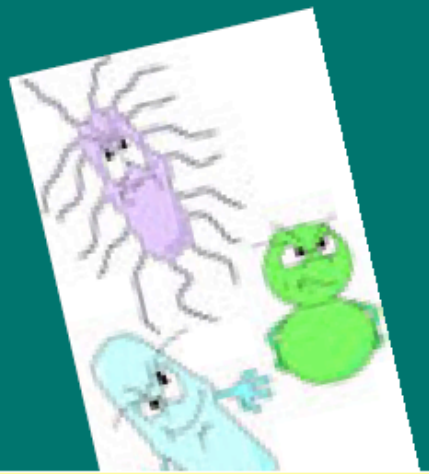
Best Glove Use

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

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

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?

UNT HEALTH SCIENCE CENTER

Institutional Biosafety Committee

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