Biosafety “Primer”

An introduction to the world of biosafety
Assessment in the Rapidly Evolving Biosafety World

**Biosafety:**
Keeping the pathogens away from people

**Biosecurity:**
Keeping people away from pathogens

**Biocontainment:**
Keeping the pathogens where they are supposed to be
Controlling the Chain of Infection

Virulence

Mode of Transmission

Agent

Infectious Dose

Susceptible Host

Portal of Entry

PPE Facilities Work practices
Modes of Transmission

• Contact
  – Direct (person to person, animal to person): touching, kissing
  – Indirect: Fomite-inanimate object capable of retaining or transporting pathogens
Modes of Transmission

• Droplet/Airborne
Aerosol/Droplet-Generating Activities

- Blending, homogenization
- Centrifugation
- Vortexing
- Sonication
- Flame sterilizing tools
- Syringe loading and injection
- Popping tube caps
- Animal handling, cage changing
- Pipetting, pouring
Modes of Transmission

• Vectors

• Vehicles
Risk Groups

• Classification of Biohazardous Agents
• Organism specific
  – Pathogenicity, infectious dose
  – Mode of transmission, hosts
  – Effective preventive measures, treatments
• Used for initial risk assessment
• No regard for how the organism will be used
• Risk groups ≈ Biosafety levels

• http://www.absa.org/resriskgroup.html
• http://www4.od.nih.gov/oba/rac/guidelines_02/APPENDIX_B.htm
Principles of Biological Safety

• Biosafety levels
  – Increasing levels of personal and environmental protection (BSL1-4)
  – Protect worker, coworker from potential exposure, prevent environmental contamination
Containment, Biosafety Levels

- Lab practices, techniques
- Facility design, operations
- Safety equipment
Laboratory Practices & Techniques

• Standard laboratory practices
  – DO NOT eat, drink, apply cosmetics or handle contact lenses in work areas
  – Avoid contact with mucous membranes
  – Use mechanical devices when pipetting
  – HANDWASHING
Laboratory Practices & Techniques

• Handwashing
  ♦ Every time you handle infectious material, remove gloves, before eating, etc.
  ♦ Ordinary soap OK
  ♦ Wash for 15-20 seconds
  ♦ CDC- “one of the simplest and most important means of preventing the spread of infection”
Disinfection

- Factors impacting selection of appropriate disinfectant
  - Degree of microbial killing required
  - Nature of item/ surface to be treated
  - Method of application
  - Safety, ease of use, cost

- Efficacy dependent on
  - Type and concentration of organism
  - Amount of organic material
  - Time, environmental conditions
# Commonly Used Disinfectants

<table>
<thead>
<tr>
<th>Disinfectant</th>
<th>Plus</th>
<th>Minus</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chlorine</strong> (bleach, Clidox)</td>
<td>Broad activity, kills hardy organisms, inexpensive, quick kill</td>
<td>Inactivated with organic matter, corrodes metals</td>
<td>1:10 dilution most common. Make fresh before use. Irritant, corrosive</td>
</tr>
<tr>
<td><strong>70% ethanol</strong></td>
<td>Wide activity, inexpensive, noncorrosive</td>
<td>Evaporates quickly, poor contact time, not sporicidal</td>
<td>Flammable</td>
</tr>
<tr>
<td><strong>Iodophors</strong> (Wescodyne, Betadyne)</td>
<td>Broad activity, low toxicity</td>
<td>Staining, limited activity in organic matter</td>
<td>Corrosive, irritant</td>
</tr>
<tr>
<td><strong>Phenolics</strong> (Lysol, Metar)</td>
<td>Broad activity, maintain activity in organics</td>
<td>Not sporicidal</td>
<td>Corrosive, irritant</td>
</tr>
<tr>
<td><strong>Quaternary Ammonium</strong> (Roccal Plus, Novalsan)</td>
<td>Contains detergent, low toxicity</td>
<td>Not sporicidal, limited activity in hard water, organic matter</td>
<td>”User friendly”</td>
</tr>
</tbody>
</table>
Protecting Lab Workers: Primary Containment

- Good microbiological practices
- Use of safety equipment
  - Personal Protective Equipment
  - Biosafety Cabinets
  - Enclosed containers
  - Other engineering controls designed to minimize exposures
Equipment in the biosafety lab is designed to provide both primary containment (to protect laboratory workers) and secondary containment (to protect the environment).

Proper use of this equipment protects both lab workers and their science.
Containment in the Biolab

http://www.youtube.com/watch?v=nD2ohBCNbH8
Using the Biosafety Cabinet

http://www.youtube.com/watch?v=miJn1nhYA8U
Laminar Flow Hoods

- HEPA filtration
- Protects work surface only
- NO personal or environmental protection
- Not for use with infectious agents or other hazardous materials
Chemical Fume Hoods

No HEPA filtration

- No protection of work or environment
- Work surface is “dirty”
Using Sharps Safely

Sharps are one of the most common sources of injuries in biolabs.

Scalpels and syringes both require practice and ongoing care to use safely.

Proper disposal of sharps is important to protect others from potential exposures.
Working with Sharps in the Biolab

http://www.youtube.com/watch?v=IR8GZh6Pa9A
Engineered sharps

- Injury protection
- Isolate hazard
Personal Protective Equipment

http://www.youtube.com/watch?v=4SEG7q-pkDY
Personal Protective Equipment

• Laboratory coats/gowns
  – Solid front, cuffed sleeves
  – Minimize contamination, reduce shedding
  – Laundered at work
• Safety glasses, goggles, face shield

The ever-popular "lab coat-caught-in-the-door knob" arabesque
Personal Protective Equipment

Resist wearing open-toed shoes or sandals

What’s wrong with these pictures??
Managing Biowastes in the Lab

**Sharps Containers**
- Rigid, puncture resistant
- Leak proof
- Biohazard label or symbol

**Red Bag Containers**
- Red biohazard bags
- Non-sharps waste
- Covered when not in use
Regulated Medical Waste

- "Soft" waste: gloves, paper, intact plastics
- Sharps waste: syringes, needles, broken glass
- Liquid waste: cell culture fluids, supernatant
What Not To Do
Spill Cleanup

OOPS!!

Cover spill with absorbent and saturate with disinfectant

Carefully discard and reapply disinfectant

Remove sharps
What’s in a Spill Kit?

- PPE (gloves, eyewear, mask, gown, booties)
- Disinfectant
- Absorbent
- Tongs, dust pan
- Biohazard bags
- Sharps disposal
- Hand sanitizer
Post-Exposure Procedures

• When possible, contain hazard, recruit assistance
• Leave area, remove PPE
• Wash and decontaminate
• Perform first aid, if necessary
• Obtain medical evaluation at Cornell Health, CMC
• Report incident to supervisor, EH&S
• Complete accident report form (https://rmpps-prod.hosting.cornell.edu/accinj/)
Protecting the Environment:
Secondary Containment

- Facility design
- Operational procedures
- Waste management practices
Secondary Level Containment

- Work surfaces easily cleaned
- Single pass, 100% outside air without recirculation
- Separation of laboratory from public access
Secondary Level Containment

Eyewash and emergency shower readily available
# An Overview of Biosafety Levels

<table>
<thead>
<tr>
<th>BSL</th>
<th>Agents</th>
<th>Practices</th>
<th>Primary Barriers</th>
<th>PPE</th>
<th>Secondary Barriers</th>
</tr>
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</table>
| 1   | Not known to *consistently* cause diseases in *healthy* adults         | Standard microbiological practices            | No primary barriers required | • Laboratory coats and gloves  
                 |                                                                         |                  |                               | • Eye and face protection, as needed           | Laboratory bench and sink required           |
| 2   | Human disease  
• Percutaneous injury  
• Ingestion  
• Mucous membrane | • Limited access  
• Biohazard warning signs  
• “Sharps” precautions  
• Biosafety manual with waste and medical surveillance policies | BSCs or other physical containment devices used for all manipulations of agents that cause *splashes or aerosols of infectious materials* | • Laboratory coats, gloves,  
                 |                                                                         |                  |                               | • Eye and face protection, as needed           | BSL-1 plus: Autoclave available              |
| 3   | Indigenous or exotic agents that may cause serious or potentially lethal disease  
• *Inhalation* | BSL-2 practice plus:  
• Controlled access  
• Decontamination of all waste  
• Decontamination of laboratory clothing before laundering | BSCs or other physical containment devices used for all *open manipulations of agents* | • Protective laboratory clothing, gloves,  
                 |                                                                         |                  |                               | • Eye, face and respiratory protection, as needed | BSL-2 plus: Self-closing, double-door access  
                 |                                                                         |                  |                               |                                                                                 | Entry through airlock or anteroom          
                 |                                                                         |                  |                               |                                                                                 | Hand washing sink near laboratory exit       |
A Basic Biolab

- Lab coat & gloves
- Sink for Hand washing
A Biosafety Level 2 Laboratory

- Autoclave
- Door Signage
- Enclosed Waste Container
- Biosafety Cabinet
- Closed container for sample management
A Biosafety Level 3 Laboratory

- 2 doors
- Airflow
- Security
- Shower
- Window
- Floors
- PPE
- Autoclave
- Hands free
- Sink