Biosafety in Microbiological and Biomedical Laboratories

3rd Edition
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5th National Symposium on Biosafety:
A Rational Basis for Biocontainment

BMBL
Introduction

1941 - Meyer and Eddie
- 74 lab associated brucellosis infections in US

1949 - Sulkin and Pike
- 222 viral infections (21 fatal)
- Only 27% related to known accidents

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BMBL
Introduction

1951,1965, 1976 - Sulkin and Pike

Surveys for lab-associated infections
- More than 5,000 labs
- Cumulative total of 3,921cases cited
- Most commonly reported:
  - Hepatitis
  - Brucellosis
  - Tuberculosis
  - Tularemia
  - Typhoid
  - Venzuelan Equine Encephalitis

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BMBL
Introduction

1951,1965, 1976 - Sulkin and Pike (cont.)

Surveys for lab-associated infections
- Fewer than 20% associated with known accidents
- Exposure to infectious aerosols plausible (but unconfirmed) for >80% of reported cases

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Principles of Biosafety
Introduction

Biosafety Levels 1-3

Guidelines to describe combinations of:
- Laboratory Practices and Techniques
  - Standard Practices
  - Special Practices
- Safety Equipment (Primary Barriers)
- Laboratory Facilities (Secondary Barriers)

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Principles of Biosafety
Introduction

Biosafety Levels 1-3 Provide
- Increasing levels of personnel and environmental protection
- Guidelines for working safely in microbiological and biomedical laboratories

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Lab Practices and Techniques
Introduction

- Knowledgeable supervisor
- Personnel
  - Aware of potential hazards
  - Proficient in practices/techniques
- Biosafety manual specific to lab

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Safety Equipment
(Primary Barriers) - Introduction

- Biosafety cabinets (BSCs) [BSL-2/3]
- Personal protective clothing
  - Gloves
  - Gowns
- Pipetting Devices
- Safety centrifuge cups and rotors
- Eye and face protection
- Respiratory protection [BSL-3]

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Biosafety Level 1
Introduction

Suitable for work involving well-characterized agents not known to cause disease in healthy adult humans and of minimal potential hazard to laboratory personnel and the environment.

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Biosafety Level 1
Introduction

Examples:

- *Bacillus subtilis*
- *Naegleria gruberi*
- Infectious canine hepatitis virus
- *E. coli*

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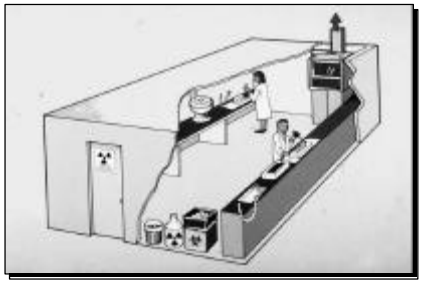
Biosafety Level 1
Laboratory Facilities (Secondary Barriers)



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Biosafety Level 1
Laboratory Facilities (Secondary Barriers)

- Sink for handwashing
- Work surfaces easily cleaned
- Bench tops
- Sturdy furniture
- Windows fitted with flyscreens

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Facility Design
(Secondary Barriers) - Introduction

Easily cleaned and decontaminated

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Facility Design
(Secondary Barriers) - Introduction

- Laboratory location
- Laboratory structure
- Laboratory ventilation

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Biosafety Level 1
Standard Microbiological Practices

Use mechanical pipetting devices

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Biosafety Level 1
Standard Microbiological Practices

- Use mechanical pipetting devices
- Wash hands
- Restrict or limit access when working
- Prohibit eating, drinking and smoking

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Biosafety Level 1
Standard Microbiological Practices (cont.)

- Minimize splashes and aerosols
- Decontaminate work surfaces daily
- Decontaminate wastes
- Maintain insect & rodent control program

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Biosafety Level 1
Safety Equipment (Primary Barriers)

Protective clothing
- Lab coat
- Gloves

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Biosafety Level 1
Safety Equipment (Primary Barriers)

Additionally, PPE may be needed

- Face protection
- Eye protection

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Biosafety Level 1
Special Practices

NONE

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Biosafety Level 1
Standard Microbiological Practices

Wash hands

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Biosafety Level 1

Supervision
- Scientist with general training in microbiology or related science

Lab Personnel
- Specific training in lab procedures

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Biosafety Level 2

Suitable for work involving agents of moderate potential hazard to personnel and the environment.

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Biosafety Level 2

Immunization or antibiotic treatment is available

Examples:
- Measles virus
- Salmonellae
- Toxoplasma spp.
- Hepatitis B virus

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Biosafety Level 2

Extreme precaution with contaminated needles or sharp instruments

Examples:

- Bloodborne pathogens
- Human body fluids/particularly when visibly contaminated with blood

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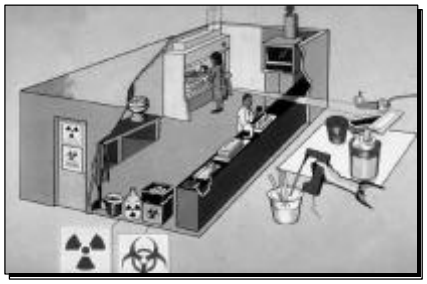
Biosafety Level 2

Laboratory Facilities (Secondary Barriers)



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Biosafety Level 2

Standard Microbiological Practices

As in BSL-1

With emphasis on :

- Gloves
- Mechanical pipetting
- Attention to sharps

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Biosafety Level 2

Special Practices

Needles & Sharps Precautions

DON'T

Break, bend, resheath or reuse syringes or needles

DO

Use sharps containers

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Biosafety Level 2

Special Practices (cont.)

Needles & Sharps Precautions

So someone won't be injured later

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Biosafety Level 2

Special Practices (cont.)

Needles & Sharps Precautions

DON'T

Touch broken glass with hands

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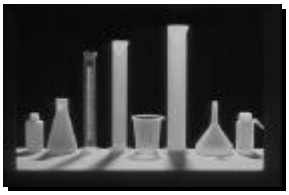
Biosafety Level 2
Special Practices (cont.)

Needles & Sharps Precautions

DO
Use plasticware



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Biosafety Level 2
Special Practices (cont.)

- Policies and procedures for entry
- Biohazard warning signs
- Biosafety manual specific to lab
- Training with annual updates

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Biosafety Level 2
Special Practices (cont.)

- Use leak-proof transport containers

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Biosafety Level 2
Special Practices (cont.)

- Immunizations
- Baseline serum samples

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Biosafety Level 2
Special Practices (cont.)

- Decontaminate work surfaces
- Report spills and accidents
- No animals in laboratories

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Biosafety Level 2
Safety Equipment (Primary Barriers)

BSL-1 PLUS:

Use biosafety cabinets (class II) for work with infectious agents involving:

- Aerosols and splashes
- Large volumes
- High concentrations

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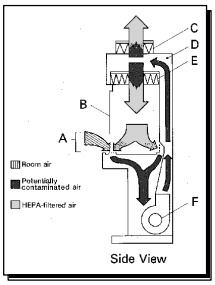
Biosafety Level 2
Safety Equipment (Primary Barriers)

Class II Biosafety Cabinets
- Airflow



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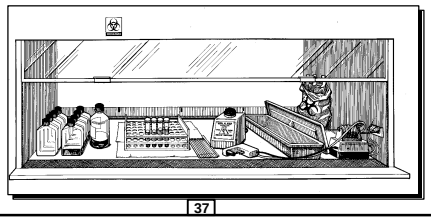
Biosafety Level 2
Safety Equipment (Primary Barriers)

Class II Biosafety Cabinets
- Layout of equipment



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Biosafety Level 2
Safety Equipment (Primary Barriers)

Class II Biosafety Cabinets
- Technique

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Biosafety Level 2
Laboratory Facilities (Secondary Barriers)

BSL-1 Facilities PLUS:

- Autoclave available
- Eyewash station available

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Biosafety Level 2
Special Practices

Supervision
- Supervisor is a competent scientist with increased responsibilities
  - ♦ Limits access if immunocompromised
  - ♦ Restricts access to immunized

Lab Personnel
- Aware of potential hazards
- Proficient in practices/techniques

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Biosafety Level 3

Suitable for work with infectious agents which may cause serious or potentially lethal disease as a result of exposure by the inhalation route.

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Biosafety Level 3

- Exposure potential to pathogens spread by aerosol
- Infection serious, possibly lethal
- Examples:
  - *M. tuberculosis*
  - St. Louis encephalitis virus
  - *Coxiella burnetii*

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Biosafety Level 3
Laboratory Facilities (Secondary Barriers)

BSL-1 and 2 Facilities PLUS:

- Separate building or isolated zone
- Double door entry
- Directional inward airflow
- Single-pass air

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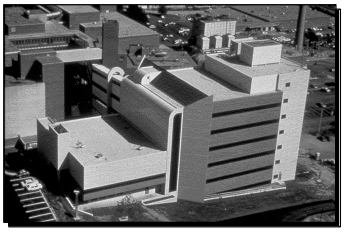
Facility Design
(Tertiary Barriers)



Location of CDC's MCL

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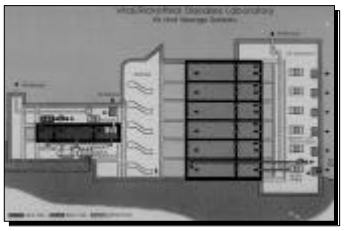
Facility Design
(Tertiary Barriers)



Lab structure
Lab ventilation

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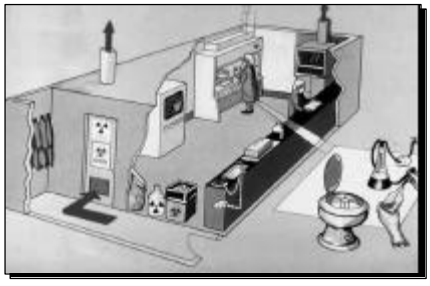
Biosafety Level 3
Laboratory Facilities (Secondary Barriers)



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Biosafety Level 3
Laboratory Facilities (Secondary Barriers)

BSL-1 and 2 Facilities PLUS (cont.):

- Enclosures for aerosol generating equipment
- Room penetrations sealed
- Walls, floors and ceilings are water resistant for easy cleaning

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Biosafety Level 3
Special Practices

BSL-2 Special Practices PLUS:

- Work in certified BSC
- Use bioaerosol-containing equipment
- Decontaminate spills promptly

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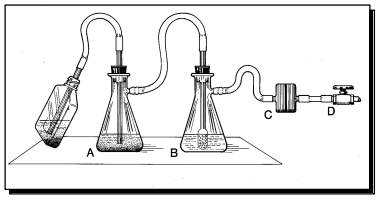
Biosafety Level 3
Laboratory Facilities (Secondary Barriers)

BSL-1 and 2 Facilities PLUS:

- Vacuum lines protected



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Biosafety Level 3

Standard Microbiological Practices

As in BSL-1 and -2

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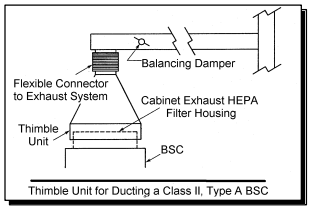
Biosafety Level 3
Safety Equipment (Primary Barriers)

BSL-1 and 2 Safety Equipment PLUS:

- BSC class II or III to manipulate infectious material



Thimble Unit for Ducting a Class II, Type A BSC

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Biosafety Level 3
Safety Equipment (Primary Barriers)

BSL-1 and 2 Safety Equipment PLUS:

- Respiratory protection may be indicated

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Biosafety Level 3
Special Practices

Supervision

- Supervisor is a competent scientist experienced working with agents
  - Establishes criteria for entry
  - Restricts access
  - Develops policies/procedures
  - Trains lab personnel

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Biosafety Level 3
Special Practices

Lab Personnel
- Strictly follow guidelines
- Demonstrate proficiency
- Receive appropriate training
- Report incidents
- Participate in medical surveillance

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Principles of Biosafety
Summary

BSL 1-3
- Standard Practices
- Special Practices
- Safety Equipment (Primary Barriers)
- Laboratory Facilities (Secondary Barriers)
- Building (Tertiary Barriers)

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