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

1951, 1965, 1976 - Sulkin and Pike
Surveys for lab-associated infections
+ More than 5,000 labs
+ Cumulative total of 3,921 cases cited
+ Most commonly reported:
  6 Hepatitis
  6 Brucellosis
  6 Tuberculosis
  6 Tularemia
  6 Typhoid
  6 Venezuelan Equine Encephalitis

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

Biosafety Levels 1-3
Guidelines to describe combinations of:
+ Laboratory Practices and Techniques
  6 Standard Practices
  6 Special Practices
+ Safety Equipment (Primary Barriers)
+ Laboratory Facilities (Secondary Barriers)

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

Introduction

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

Safety Equipment

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]

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.

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

Biosafety Level 1

Laboratory Facilities (Secondary Barriers)

- Sink for handwashing
- Work surfaces easily cleaned
- Bench tops
- Sturdy furniture
- Windows fitted with flyscreens
Facility Design
(Secondary Barriers) - Introduction

Easily cleaned and decontaminated

Facility Design
(Secondary Barriers) - Introduction

+ Laboratory location
+ Laboratory structure
+ Laboratory ventilation

Biosafety Level 1
Standard Microbiological Practices

Use mechanical pipetting devices

Biosafety Level 1
Standard Microbiological Practices

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

Biosafety Level 1
Standard Microbiological Practices (cont.)

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

Biosafety Level 1
Safety Equipment (Primary Barriers)

Protective clothing
+ Lab coat
+ Gloves

Biosafety in Microbiological and Biomedical Laboratories
Biosafety Level 1

Safety Equipment (Primary Barriers)

Additionally, PPE may be needed

- Face protection
- Eye protection

Biosafety Level 1

Special Practices

NONE

Biosafety Level 1

Standard Microbiological Practices

Wash hands

Biosafety Level 1

Supervision

- Scientist with general training in microbiology or related science

Lab Personnel

- Specific training in lab procedures

Biosafety Level 2

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

Biosafety Level 2

Immunization or antibiotic treatment is available

Examples:

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

Biosafety in Microbiological and Biomedical Laboratories
**Biosafety Level 2**

Extreme precaution with contaminated
needles or sharp instruments

Examples:
+ Bloodborne pathogens
+ Human body fluids/particularly when
  visibly contaminated with blood

**Biosafety Level 2**

Laboratory Facilities (Secondary Barriers)

**Biosafety Level 2**

Standard Microbiological Practices

As in BSL-1

With emphasis on :
+ Gloves
+ Mechanical pipetting
+ Attention to sharps

**Biosafety Level 2**

Special Practices

**Needles & Sharps Precautions**

DON’T
Break, bend, resheath or reuse syringes
or needles

DO
Use sharps containers

**Biosafety Level 2**

Special Practices (cont.)

**Needles & Sharps Precautions**

DON’T
Touch broken glass with hands
**Biosafety Level 2**

**Special Practices (cont.)**

**Needles & Sharps Precautions**

**DO**

Use plasticware

**Biosafety Level 2**

**Special Practices (cont.)**

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

**Biosafety Level 2**

**Special Practices (cont.)**

**+ Use leak-proof transport containers**

**Biosafety Level 2**

**Special Practices (cont.)**

**+ Immunizations**
**+ Baseline serum samples**

**Biosafety Level 2**

**Special Practices (cont.)**

**+ Decontaminate work surfaces**
**+ Report spills and accidents**
**+ No animals in laboratories**

**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

Biosafety in Microbiological and Biomedical Laboratories
Biosafety in Microbiological and Biomedical Laboratories

Biosafety Level 2
Safety Equipment (Primary Barriers)

Class II Biosafety Cabinets
+ Airflow

Biosafety Level 2
Safety Equipment (Primary Barriers)

Class II Biosafety Cabinets
+ Layout of equipment

Biosafety Level 2
Safety Equipment (Primary Barriers)

Class II Biosafety Cabinets
+ Technique

Biosafety Level 2
Laboratory Facilities (Secondary Barriers)

BSL-1 Facilities PLUS:
+ Autoclave available
+ Eyewash station available

Biosafety Level 2
Special Practices

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

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

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.
Biosafety Level 3

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

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

Facility Design
(Tertiary Barriers)

Location of CDC’s MCL

Facility Design
(Tertiary Barriers)

Lab structure
Lab ventilation

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

Biosafety in Microbiological and Biomedical Laboratories
Biosafety Level 3

BSL-2 Special Practices PLUS:
+ Work in certified BSC
+ Use bioaerosol-containing equipment
+ Decontaminate spills promptly

Biosafety Level 3

BSL-1 and 2 Facilities PLUS:
+ Vacuum lines protected

Biosafety Level 3

BSL-3 Special Practices

BSL-1 and 2 Facilities PLUS:
+ BSC class II or III to manipulate infectious material

Biosafety Level 3

Standard Microbiological Practices
As in BSL-1 and -2

Biosafety Level 3

Safety Equipment (Primary Barriers)

BSL-1 and 2 Safety Equipment PLUS:
+ Respiratory protection may be indicated

Biosafety Level 3

Safety Equipment (Primary Barriers)

BSL-1 and 2 Safety Equipment PLUS:
+ Supervisor is a competent scientist experienced working with agents
  + Establishes criteria for entry
  + Restricts access
  + Develops policies/procedures
  + Trains lab personnel

Biosafety in Microbiological and Biomedical Laboratories
Biosafety Level 3
Special Practices

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

Principles of Biosafety
Summary

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