

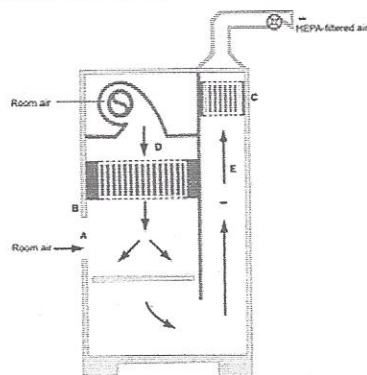


FIGURE 3. Class II, Type B2 biological safety cabinet
 Legend: (A) front opening, (B) sash, (C) exhaust HEPA filter, (D) supply HEPA filter, (E) negative pressure exhaust plenum. *Note:* The carbon filter in the exhaust system is not shown. The cabinet exhaust needs to be hard-connected to the building exhaust system. (Source: CDC 2009)

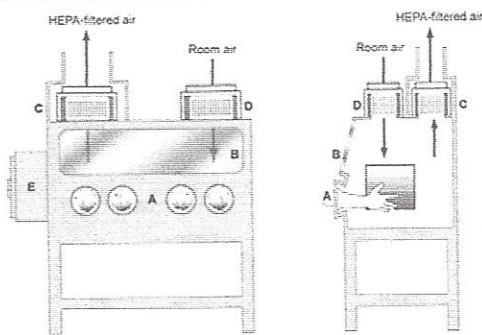


FIGURE 4. Class III biological safety cabinet
 Legend: (A) glove ports with O-ring for attaching arm-length gloves to cabinet, (B) sash, (C) exhaust HEPA filter, (D) supply HEPA filter, (E) double-ended autoclave or pass-through box. *Note:* A chemical dunk tank may be installed, which would be located beneath the work surface of the BSC with access from above. The cabinet exhaust needs to be hard-connected to an exhaust system where the fan is generally separate from the exhaust fans of the facility's ventilation system. The exhaust air must be double HEPA-filtered or HEPA-filtered and incinerated. (Source: CDC 2009)

The Class III biological safety cabinet offers the maximum amount of protection for the product, worker, and outside environment. The inside of a Class III BSC may be thought of as totally isolated from the outside environment. Many safety professionals would be familiar with a similar protective device termed a *glove box*. Incoming air is HEPA-filtered, and the con-

tained product has no direct connection outside of the BSC. Figure 4 depicts the Class III BSC. The Class III cabinet is normally found only in the highest level of biological agent containment (e.g., BSL-4). The exhausted air is HEPA-filtered when leaving the unit. Generally, the air is also HEPA-filtered a second time prior to entering the external exhaust fan.

The prudent safety professional also encourages routine testing of primary safety devices such as BSCs. The primary standard for testing BSCs is the National Sanitation Foundations Standard 49 (NSF 2002). This standard is commonly used to evaluate and test the operation of *biohazard cabinetry*. It also specifies training necessary for individuals to conduct assessment or certifications of BSCs.

Training

Employee training encompasses a primary focus of the safety professional for biological hazards. Specific biological safety training is *risk-based* in accordance with the BMBL (CDC 2009). A general rule of thumb is that higher levels of containment dictate additional biological safety training. The frequency of refresher training is also based on the selected level of containment. Training for laboratory staff is based on assumed knowledge and competency of safe microbiological practices.

The following are abridged topics for biological safety training courses (NRC 1989):

1. **Aseptic techniques:** Fundamental microbiological techniques require laboratory techniques to prevent cross-contamination. The use of aseptic (or contamination-free) techniques is crucial when propagating infectious substances.
2. **Laboratory and personnel hygiene:** A review of historical accidents and exposures shows that failed adherence to good laboratory practices and poor hygiene habits played an important role in laboratory-acquired diseases. Training must encourage safe behavior that is congruent with OSHA regulations, especially in occupations where employees are exposed to bloodborne pathogens (OSHA 2001).
3. **Laboratory safety practices:** Laboratory safety practices generally involve the application of

primary containment devices, engineered safety equipment (e.g., sealed centrifuges or eyewashes), and risk assessment. These practices generally become more restrictive with the higher levels of containment.

4. **Personal protective equipment (PPE):** The availability of PPE varies as a function of the hazard posed by the pathogen. For example, respiratory protection will be required for any pathogen that could become airborne and infect a healthy adult worker. Additional protective equipment is generally associated with higher levels of biological containment.
5. **Containment levels:** The primary levels of biological containment are reviewed in the BMBL (CDC 2009). Higher containment of human pathogens also corresponds with higher hazard pathogens. Infectious diseases with no cures generally require rigorous containment facilities and procedures.
6. **Decontamination, disinfection, and sterilization:** The differences among decontamination, disinfection, and sterilization are reviewed in this chapter. Common procedures to monitor the efficacy of *chemical, heat, and steam sterilization* are also included.
7. **Signage, notices, entrance criteria, and postings:** For hazard awareness and protective equipment-donning purposes, areas that use biological agents must include appropriate notices and postings. Employees must refer to entrance criteria prior to entering a containment facility. These criteria may include protective equipment or immunization requirements.
8. **Prudent management of biological/infectious wastes:** Procedures for safe disposal of medical waste and sharps waste apply to many employers in the United States. Improper disposal of contaminated waste materials and laundry have been associated with secondary infections in the recent past.
9. **Operation and use of biological safety cabinetry:** The primary containment devices, such as BSCs, represent a fundamental part

of biological containment. These devices provide protection to employees, their research specimen, and the surrounding public. An overview with figures from the BMBL (CDC 2009) is included in this chapter.

10. **Emergency action, spill response, needlesticks and self-inoculation:** The CDC gives health-care providers guidance on emergency response and needlestick treatment protocols in an effort to reduce the probability of transmitting a human pathogen. OSHA requires needlestick procedures under its bloodborne pathogen regulations (OSHA 2001).

Institutional Biosafety Committees (IBCs)

The NIH recommends that all individuals, corporations, or institutions not strictly covered by the *NIH Guidelines* establish a properly constituted IBC. Even if an entity is not using recombinant DNA, a properly constituted safety committee should review the presence of biological hazards in the workplace. The IBC is responsible for the following on behalf of the institution:

1. Reviewing procedures, tasks, and protocols involving biohazardous agents, toxins originating from biohazardous materials, and blood and tissues from humans and nonhuman primates
2. Reviewing recombinant DNA research and approving those proposed projects that conform to the *NIH Guidelines*. Specific IBC review items are detailed within those guidelines (2011).
3. Notifying a principal investigator of the results of the committee protocol review.
4. Lowering containment levels for certain agents.
5. Setting acceptable containment levels for experiments involving whole plants or animals.
6. Periodically reviewing recombinant DNA or other applicable research at the institution.
7. Adopting emergency response plans.
8. Reporting significant problems or violations of the *NIH Guidelines* (2011) to the NIH.