# Comparative Analysis of the Fourth and Fifth Editions of *Biosafety in Microbiological and Biomedical Laboratories*, Vertebrate Animal Biosafety Level Criteria (ABSL1-4)

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## Abstract

*We have developed a matrix of changes between the Vertebrate Animal Biosafety Level Criteria sections of the current and former editions of* Biosafety in Microbiological and Biomedical Laboratories *(BMBL). Citations containing multiple statements were subdivided into individually-addressable statements and statements with similar/identical scope were aligned, thereby allowing a precise comparative analysis. In addition, statements were categorized for further analysis based on the subject of the change. Results are presented in a change matrix tool that uses a basic Microsoft Excel filter function to allow the user to sort the data based on the animal biosafety level and subject. The tool also contains a side-by-side comparison of animal biosafety levels one through three (ABSL1-3) in the fifth edition of BMBL. In this report, we present a brief summary of major changes.*

## Introduction

First introduced in 1984, *Biosafety in Microbiological and Biomedical Laboratories* (BMBL) is an advisory document recommending best practices for the safe conduct of work in biomedical and clinical laboratories. Since its inception, it has become one of the most frequently used codes of practice in biosafety and an authoritative reference for the development of laboratory policies and procedures, the construction of new laboratories, and the renovation of existing laboratories (U.S. Dept. of Health and Human Services, CDC, & NIH, 1999). Over the past two decades, periodic updates have been made to BMBL to "refine guidance based on new knowledge and experiences and to address contemporary issues that present new risks that confront laboratory workers and the public health" (U.S. Dept. of Health and Human Services, CDC, & NIH, 2007). In February 2007, a consortium of individuals from the Centers for Disease Control and Prevention (CDC) and National Institutes of Health (NIH) released the fifth edition of BMBL which contained a number of revisions and additions from the former, including:

- Added guidance on laboratory biosecurity and risk assessment.
- Added guidance on agricultural Biosafety Level 3 (BSL3-Ag) laboratories.
- Revisions and additions to agent summary statements.
- Expanded guidance on a number of topics including decontamination, sterilization, occupational medicine, and immunization.

In 2008, we developed a matrix of changes between the Laboratory Biosafety Level Criteria sections of the current and former editions of BMBL and published our findings in *Applied Biosafety*, Volume 13, Number 1, 2008 (Crews & Gaunt, 2008). We report here the development of a change matrix between the Vertebrate Animal Biosafety Level Criteria sections of the fourth and fifth editions of BMBL (BMBL4 and BMBL5, respectively). Our analysis is organized by subject matter with a particular focus on identifying key similarities and differences between animal biosafety levels. To facilitate a side-by-side comparison, we have also aligned BMBL5 animal biosafety levels one through three (ABSL1-3). Due to the extent of procedural and facility differences between ABSL4 and the other containment levels, ABSL4 is considered separately in our analysis.

## Methods

The Vertebrate Animal Biosafety Level Criteria sections from both BMBL4 and BMBL5 were analyzed and a matrix of changes was developed for ABSL1-ABSL4. (Note: The PDF version of BMBL5 used for this analysis was revised on March 31, 2008 and available at: www.cdc.gov/od/ohs/biosfty/bmbl5/BMBL_5th_Edition.pdf.) Both editions were transferred electronically to a Microsoft Excel spreadsheet and separated by citation. Citations containing multiple statements were further subdivided into individually-addressable statements to facilitate a detailed comparative analysis independent of simple structural/format differences not affecting meaning. BMBL4 statements were then reorganized and horizontally aligned with BMBL5 statements having similar or identical scope (Figure 1). The ABSL1-ABSL3 sections from BMBL5 were also horizontally aligned to facilitate biosafety level comparisons (Figure 2). Each statement, or statement pair, was also categorized based on subject. Based upon observed trends in BMBL topics and laboratory commonalities, the following 16 biosafety-related subjects were assigned to each statement or statement pair:

- Animal Containment

## Figure 1

A sample of the change matrix comparing the Vertebrate Animal Biosafety Level Criteria sections from the fourth and fifth editions of *Biosafety in Microbiological and Biomedical Laboratories*. The complete tool may be obtained on the ABSA web site at www.absa.org/restool.html.

| Heading | Subject | BMBL4 Section | BMBL4 Citation | BMBL4 | BMBL5 Section | BMBL5 Citation | BMBL5 (March 31, 2008) |
|---|---|---|---|---|---|---|---|
| | | | | **Animal Biosafety Level 3 (ABSL-3)** | | | **Animal Biosafety Level 3** |
| | | | | ***D. Facilities (Secondary Barriers)*** | | | **D. *Laboratory Facilities (Secondary Barriers)*** |
| ABSL3 | Facility Construction and Design | D | 13 | Illumination is adequate for all activities, avoiding reflections and glare that could impede vision. | D | 10 | Illumination is adequate for all activities, avoiding reflections and glare that could impede vision. |
| ABSL3 | Biological Safety Cabinets | | | | D | 11 | BSCs (Class II, Class III) must be installed so that fluctuations of the room air supply and exhaust do not interfere with its proper operations. |
| ABSL3 | Biological Safety Cabinets | | | | D | 11 | Class II BSCs should be located away from doors, heavily traveled laboratory areas, and other possible airflow disruptions. |
| ABSL3 | Biological Safety Cabinets | D | 9 | HEPA-filtered exhaust air from a Class II biological safety cabinet can be recirculated into the animal room if the cabinet is tested and certified at least annually. | D | 11 | HEPA filtered exhaust air from a Class II BSC can be safely re-circulated back into the laboratory environment if the cabinet is tested and certified at least annually and operated according to manufacturer's recommendations. |
| ABSL3 | Biological Safety Cabinets | D | 9 | When exhaust air from Class II safety cabinets is to be discharged to the outside through the building exhaust air system, the cabinets must be connected in a manner that avoids any interference with the air balance of the cabinets or the building exhaust system (e.g., an air gap between the cabinet exhaust and the exhaust duct). | | | |
| ABSL3 | Biological Safety Cabinets | D | 9 | When Class III biological safety cabinets are used, they should be directly connected to the exhaust system. | | | |
| ABSL3 | Biological Safety Cabinets | | | | D | 11 | BSCs can also be connected to the laboratory exhaust system by either a thimble (canopy) connection or a direct (hard) connection. |
| ABSL3 | Biological Safety Cabinets | | | | D | 11 | Provisions to assure proper safety cabinet performance and air system operation must be verified. BSCs should be certified at least annually to assure correct performance. |
| ABSL3 | Biological Safety Cabinets | D | 9 | If the Class III cabinets are connected to the supply system, it is done in a manner that prevents positive pressurization of the cabinets (see Appendix A). | D | 11 | Class III BSCs must supply air in such a manner that prevents positive pressurization of the cabinet or the laboratory room. |
| ABSL3 | Biological Safety Cabinets | | | | D | 11 | All BSCs should be used according to manufacturers' recommendations. |
| ABSL3 | Special Containment | | | | D | 11 | When applicable, equipment that may produce infectious aerosols must be contained in devices that exhaust air through HEPA filtration or other equivalent technology before being discharged into the animal facility. |

## Figure 2

A sample of the Change Matrix comparing Animal Biosafety Levels 1-3 in the fifth edition of *Biosafety in Microbiological and Biomedical Laboratories*. The complete tool may be obtained on the ABSA web site at www.absa.org/restool.html.

| BMBL5 Section | Subject | ABSL1 Citation | Animal Biosafety Level 1 | ABSL2 Citation | Animal Biosafety Level 2 | ABSL3 Citation | Animal Biosafety Level 3 |
|---|---|---|---|---|---|---|---|
| C | Heading | Heading | C. *Safety Equipment* (Primary Barriers and Personal Protective Equipment) | Heading | C. *Safety Equipment* (Primary Barriers and Personal Protective Equipment) | Heading | C. *Safety Equipment* (Primary Barriers and Personal Protective Equipment) |
| C | Personal Protective Equipment | 3 | Protective eyewear is worn when conducting procedures that have the potential to create splashes of microorganisms or other hazardous materials. | 3 | Eye and face protection (mask, goggles, face shield or other splatter guard) are used for anticipated splashes/sprays from infectious or other hazardous materials and when the animal or microorganisms must be handled outside the BSC or containment device. | 3 | Appropriate eye, face and respiratory protection are worn by all personnel entering areas where infectious materials and/or animals are housed or are manipulated. |
| C | Personal Protective Equipment | | | | | 3 | To prevent cross contamination boots, shoe covers, or other protective footwear, are used where indicated. |
| C | Personal Protective Equipment | | | 3 | Eye and face protection must be disposed of with other contaminated laboratory waste or decontaminated before reuse. | 3 | Eye and face protection must be disposed of with other contaminated laboratory waste or decontaminated before reuse. |
| C | Personal Protective Equipment | 3 | Persons who wear contact lenses should also wear eye protection when entering areas with potentially high concentrations or airborne particulates. | 3 | Persons who wear contact lenses should also wear eye protection when entering areas with potentially high concentrations or airborne particulates. | 3 | Persons who wear contact lenses should also wear eye protection when entering areas with potentially high concentrations or airborne particulates. |
| C | Personal Protective Equipment | 3 | Persons having contact with the NHP should assess risk of mucous membrane exposure and wear appropriate protective equipment (e.g., masks, goggles, face shields, etc.) as needed. | 3 | Persons having contact with the NHP should assess risk of mucous membrane exposure and wear appropriate protective equipment (e.g., masks, goggles, face shields, etc.) as needed. | | |
| C | Personal Protective Equipment | | | 3 | Respiratory protection is worn based upon risk assessment. | | |
| C | Personal Protective Equipment | 4 | Gloves are worn to protect hands from exposure to hazardous materials. | 4 | Gloves are worn to protect hands from exposure to hazardous materials. | 4 | Gloves are worn to protect hands from exposure to hazardous materials. |
| C | Personal Protective Equipment | 4 | A risk assessment should be performed to identify the appropriate glove for the task and alternatives to latex gloves should be available. | 4 | A risk assessment should be performed to identify the appropriate glove for the task and alternatives to latex gloves should be available. | 4 | A risk assessment should be performed to identify the appropriate glove for the task and alternatives to latex gloves should be available. |
| C | Personal Protective Equipment | | | | | 4 | Procedures may require the use of wearing two pairs of gloves (double-glove). |

- Biological Safety Cabinets
- Decontamination and Waste
- Entry/Exit Procedures
- Facility Construction and Design
- Facility Ventilation and Filtration
- Medical Surveillance and Restrictions
- Miscellaneous Practices
- Personal Protective Equipment
- Policies and Procedures
- Protocol Review
- Sharps Handling
- Signage
- Special Containment Procedures
- Spills and Incidents
- Training

Unlike BMBL5, in some cases, BMBL4 instructs the reader to refer to the facility requirements described in the Laboratory Biosafety Level Criteria section of BMBL4 in conjunction with the recommendations described in the Vertebrate Animal Biosafety Level Criteria section. For our comparison, we therefore incorporated Laboratory Biosafety Level Criteria sections of BMBL4 (specifically, Section III-BSL4-D of BMBL4) into our ABSL analysis and denoted these citations with italics.

In most cases in both BMBL4 and BMBL5, the statements of the previous ABSL are either reiterated for each successive ABSL, or additional guidance is explicitly provided. There are, however, notable exceptions. For example, BMBL5 requires that "cabinets and bench tops must be impervious to water and resistant to heat, organic solvents, acids, alkalis, and other chemicals" for ABSL1-3 containment levels; however, this requirement is not reiterated for ABSL4. Since BMBL5 clearly states in the introductory paragraphs for each Animal Biosafety Level that each successive ABSL "builds upon the standard practices, procedures, containment equipment, and facility requirements" of the previous ABSL, our analysis is built upon the assumption that a statement at a given ABSL applies to all progressively higher ABSLs unless otherwise noted.

The change matrix tool uses a basic Microsoft Excel filter function to allow the user to sort the data based on subject matter and biosafety level. The matrix may be downloaded free of charge from the American Biological Safety Association (ABSA) web site via the following address: www.absa.org/restool.html. A brief summary of major changes is presented herein. The reader is advised to consult the change matrix for a full comparison.

## Results and Discussion

### Animal Containment

Our discussion of animal containment focuses on the use of restraint devices and the design and usage considerations for animal housing. Cage washing is discussed in the "Decontamination and Waste" section.

### Restraint Devices

BMBL5 recommends the use of restraint devices (e.g., physical restraint devices, chemical restraint medications, mesh, or Kevlar gloves) for research at ABSL2-4. The use of these devices is not addressed at any containment level in BMBL4. For ABSL2-3, BMBL5 recommends that "consideration should be given to the use of restraint devices and practices that reduce the risk of exposure during animal manipulations." For ABSL4, BMBL5 states that these devices and practices "should be used where practicable" in the cabinet laboratory.

### Animal Housing

The recommendations for primary animal biosafety containment at ABSL2 have been elaborated upon in BMBL5 to address both rodents and "larger animals." Solid wall and bottom cages covered with filter bonnets are recommended for rodents in BMBL5 whereas "large cages placed in inward flow ventilated enclosures or other equivalent primary containment systems" are recommended for larger animals. BMBL5 specifies that the need for primary containment at ABSL2 should be determined by risk assessment (as opposed to "as needed").

Additional recommendations for the design and use of actively ventilated caging systems at ABSL3 are provided in BMBL5. These systems must be designed to prevent the escape of microorganisms though the sealing of exhaust plenums, the HEPA filtration of exhaust, the incorporation of safety mechanisms to prevent positive air flow, and the installation of an alarm system to indicate operational malfunctions.

The recommendations for animal housing in the ABSL4 suit lab at BMBL5 are similar to BMBL4; however, unlike the previous edition, BMBL5 explicitly states that "infected animals should be handled within a primary barrier system, such as a Class II biological safety cabinet (BSC) or other equivalent containment system."

## Biological Safety Cabinets

We have organized our discussion of biological safety cabinets (BSCs) by class (Class II and III). The special requirements for ABSL4 BSCs are discussed separately.

### Class II BSCs

New criteria for Biological Safety Cabinet (BSC) design and use at ABSL2 have been added to BMBL5. For ABSL2, BMBL5 states that "if BSCs are present, they must be installed so that fluctuations of the room air supply and exhaust do not interfere with proper operations, and "should be located away from doors, heavily traveled laboratory areas, and other possible airflow disruptions." These criteria are also echoed in the Class II BSC guidance for ABSL3 and ABSL4 (when Class II cabinets are present). Although no requirements for the class of BSCs required at ABSL2 are provided, guidance

on the use of Class II BSCs is provided that mimics Class II BSC guidance at ABSL3 and ABSL4. Like BMBL4, BMBL5 permits HEPA filtered exhaust air from Class II BSCs to be re-circulated into the laboratory if the cabinet is tested and certified at least annually and operated according to the manufacturer's recommendations. They can also be connected to the laboratory exhaust system by either a thimble (canopy) or direct (hard) connection.

### Class III BSCs

Major changes in the design and use recommendations for Class III BSCs exist between BMBL4 and BMBL5. In BMBL5, Class III BSCs in the ABSL3 facility "must supply air in such a manner that prevents positive pressurization of the cabinet or the laboratory room." In BMBL4, the recommendation is rather that "if Class III cabinets are connected to the supply system, it is done in a manner that prevents positive pressurization." A host of other Class III BSC design requirements for ABSL4 cabinet laboratories are introduced in BMBL5. These include specific requirements for decontamination (e.g., pass-through dunk tank or fumigation chamber), HEPA filtration requirements, supply and exhaust, maintenance, and general design characteristics. The reader should consult the change matrix for a comprehensive list of additions.

### ABSL4 BSC Requirements

BMBL5 requires that procedures involving the manipulation of infectious materials at ABSL4 be conducted within a biological safety cabinet or other physical containment device. This requirement is absent from BMBL4. BMBL5 guidance for ABSL4 cabinet laboratories states that "all manipulations of infectious animals and materials within the laboratory must be conducted in the Class III BSC," and "when procedures can not be performed in a BSC, alternate containment equipment should be used." This is more stringent than previous BMBL4 guidance for ABSL4 cabinet laboratories which states that "laboratory animals infected with Biosafety Level 4 agents must be housed within a Class III BSC in a BSL4 cabinet laboratory."

## Decontamination and Waste

The subject of decontamination practices and waste handling is one of the most heavily expanded topics in BMBL5. While it is impossible to detail every change with potentially important implications here, the most pertinent changes are addressed.

### Autoclaves

The requirements for autoclave availability in the ABSL2 laboratory have been lowered in BMBL5. Whereas BMBL4 requires that an autoclave be available in the ABSL2 animal facility, BMBL5 states that "an autoclave should be considered in the animal facility." At ABSL3, the requirements for autoclave availability have not changed. As in BMBL4, BMBL5 states that "an autoclave is available which is convenient to the animal rooms where the biohazard is contained." Unlike BMBL4, however, BMBL5 states that "a method for decontaminating all infectious materials (e.g., autoclave, chemical disinfection, or other approved decontamination method) must be available within the facility, preferably within the areas where infectious materials and/or animals are housed or manipulated." There are numerous new recommendations in BMBL5 for autoclaves in the ABSL4 laboratory. For instance, BMBL5 requires that gas and liquid discharge from the autoclave chamber be decontaminated. BMBL5 also states that "when feasible, autoclave decontamination processes should be designed so that over-pressurization cannot release unfiltered air or steam exposed to infectious material to the environment." Both of these statements are echoed for both the ABSL4 cabinet and suit laboratories. The reader should consult the change matrix for more details on ABSL4 autoclave recommendations.

### Cage Washing and Bedding Decontamination

BMBL4 is silent about the need to autoclave cages prior to washing at ABSL2; however, it is stated explicitly in BMBL5. In addition, the authors of BMBL5 have listed additional factors to consider when designing a cage wash area in an ABSL2 (or higher containment) facility. These include: the ability to accommodate high pressure systems, humidity, strong chemical disinfectants, and 180°F water temperatures.

At ABSL3 containment, BMBL4 states explicitly that "cages are autoclaved or thoroughly decontaminated before bedding is removed and before they are cleaned and washed." On the other hand, BMBL5 states that "it is recommended that animal bedding and waste be decontaminated prior to manipulation and before removal from the areas where infectious materials and/or animals are housed or are manipulated, preferably within the caging system."

### Special Decontamination Practices

Several specific decontamination practices are recommended or required in BMBL5 that were not previously addressed in BMBL4. For instance, BMBL5 recommends that "consideration should be given to [a] means for decontaminating routine husbandry equipment, sensitive electronic and medical equipment" at ABSL2-4. At ABSL2 containment, BMBL5 also states that "materials to be decontaminated outside of the immediate areas where infectious materials and/or animals are housed or are manipulated must be placed in a durable, leak proof, covered container and secured for transport." For ABSL3 and ABSL4 cabinet and suit labs, BMBL5 recommends that "decontamination of an entire animal room

should be considered when there has been a gross contamination of the space, significant changes in usage, for major renovations, or maintenance shut downs."

Also at ABSL4, BMBL5 requires that "equipment or material that might be damaged by high temperatures or steam must be decontaminated using an effective and validated procedure such as gaseous or vapor method in an airlock or chamber designed for this purpose." In the ABSL4 suit laboratory, there is a new requirement for a method for decontaminating positive pressure suits in the event of an emergency exit or failure of the chemical shower. Finally, BMBL5 requires that the decontamination of all liquid wastes be documented at ABSL4.

## Entry/Exit Procedures

The entry and exit procedures for ABSL4 laboratories have been expanded in BMBL5 to include guidance on the removal of biological materials that are to remain in a viable or intact state. These materials must:

- Be transferred to a non-breakable, sealed primary contained and then enclosed in an non-breakable, sealed secondary container,
- Be transferred through a disinfectant dunk tank, fumigation chamber, or decontamination shower, and
- Not be opened outside of ABSL4 containment unless inactivated by a validated method.

In addition, BMBL5 also includes new guidance on personnel entry and exit procedures for ABSL4 laboratories. For instance, BMBL5 requires that "a logbook, or other means of documenting the date and time of all persons entering and leaving the ABSL4 laboratory must be maintained." Also, BMBL5 includes a provision that necessary staff may enter and exit the ABSL4 laboratory without following the clothing change and shower requirements if the laboratory has been completely decontaminated by a validated method.

## Facility Construction and Design

In this section, we discuss the new guidance on sinks, flooring, and other facility appurtenances introduced in BMBL5. Ventilation and filtration are discussed in the next section.

### Sinks/Eyewashes

Sink traps are not discussed in BMBL4, but are made a requirement in BMBL5 for ABSL1-4. For ABSL1-3, sink traps must be "filled with water and/or appropriate liquid to prevent the migration of vermin and gases." At ABSL4, sinks must contain traps and be connected to the wastewater decontamination system.

BMBL5 states for ABSL2-3 that in addition to the requirement for a hand washing sink located at the exit of the of the areas where infectious materials and/or animals are housed or are manipulated, "additional sinks should also be located in other appropriate locations within the facility." The guidance goes on to state that "if the animal facility has segregated areas where infectious materials and/or animals are housed or manipulated, a sink must also be available for hand washing at the exit from each segregated area." Furthermore, guidance for ABSL3 suggests that these sinks "should be hands-free or automatically operated." In BMBL5, emergency eyewashes and showers must be readily available in ABSL1-4 laboratories. The location of these fixtures should be determined by risk assessment.

### Penetrations/Flooring

BMBL4 does not address the sealing of penetrations in floors, walls, or ceilings except for ABSL3 containment levels and above. However, BMBL5 **recommends** that penetrations in floors, walls, and ceiling surfaces (including openings around air ducts, doors, and door frames) be sealed at ABSL1, and **requires** that these penetrations be sealed at ABSL2 and above. Likewise BMBL5 requires that flooring in the ABSL3 laboratory be "seamless, sealed resilient or poured floors, with integral coved bases," therefore aligning the ABSL3 flooring requirements with those found at ABSL4.

### Other General Design Considerations

Prior guidance on ABSL3 facility design, found in BMBL4, indicates that "entry into the animal room is via a double-door entry which **may** include a change room and shower(s)." A similar statement is found in BMBL5 that puts more emphasis on the requirement for a change room. Specifically, BMBL5 states that "entry into the containment area is via a double-door entry which constitutes an anteroom/airlock and a change room. Showers may be considered based on risk assessment."

A new recommendation is found in BMBL5 for ABSL4 laboratories which states that one should "consider placing ABSL4 areas away from exterior walls of buildings to minimize the impact from the outside environmental [sic] and temperatures." The requirement for an automatically activated emergency power source is not discussed in BMBL4 for the ABSL4 cabinet laboratory, though it is stated explicitly for the suit lab. In BMBL5, an automatically activated emergency power source is required for ABSL4 cabinet and suit laboratories, and there is an added recommendation that "monitoring and control systems for air supply, exhaust, life support, alarms, entry and exit, and security systems should be on a UPS" (uninterruptible power supply).

## Facility Ventilation

This section focuses on new design characteristics for ventilation systems in the ABSL4 laboratory, and new recommendations for local and central vacuum systems.

### Ventilation Systems

A new recommendation for ventilation systems is introduced in BMBL5 which states that "ventilation system design should consider the heat and high moisture load produced during the cleaning of animal rooms and the cage wash process." It is recommended that this be a consideration for ventilation system design at all four ABSL containment levels. Also new to BMBL5 is the requirement that atmospheric venting systems in ABSL4 cabinet and suit laboratories "be provided with two HEPA filters in series and be sealed up to the second filter."

Like BMBL4, BMBL5 states that a dedicated nonrecirculating ventilation system must be provided for ABSL4 cabinet and suit laboratories. However, BMBL5 adds that "only laboratories with the same HVAC requirements (i.e., other BSL-4 labs, ABSL-4, BSL-3 Ag labs) may share ventilation systems if each individual laboratory system is isolated by gas tight dampers and HEPA filters." BMBL4 previously stated that in an ABSL4 suit lab supply/exhaust system, "redundant supply fans are recommended [and] redundant exhaust fans are required." This is echoed in BMBL5, but extended to ABSL4 cabinet laboratories as well.

### Vacuum Systems

Considerations for central or local vacuum services were previously unaddressed in BMBL4 for ABSL2. BMBL5 states that "if vacuum service is provided, each service connection should be fitted with liquid disinfectant traps and an in-line HEPA filter, placed as near as practicable to each use point." Neither BMBL4 nor BMBL5 recommend central vacuum systems in ABSL4 containment suites; however, BMBL4 states that if there is a central vacuum system, in-line HEPA filters are placed as near as practicable to each use point or service cock. In BMBL5, this practice is continued; however, BMBL5 specifically recommends that **two** in-line HEPA filters be placed at each use point.

## Medical Surveillance and Restrictions

Key differences between BMBL4 and BMBL5 exist regarding the restriction of access to the laboratory based on a person's susceptibility to infection and the need for specific medical surveillance practices, including serum banking.

### Restricting Laboratory Access

BMBL4 states that "in general, persons who may be at an increased risk of acquiring infection, or for whom infection might be unusually hazardous, are not allowed in the animal facility unless special procedures can eliminate the extra risk." This statement applies in BMBL4 to ABSL2-4. In BMBL5, the concept of restriction from laboratory access based on a person's susceptibility to infection has been eliminated. Rather, BMBL5 states that "all laboratory personnel…should be provided with information regarding immune competence and conditions that may predispose them to infection. Individuals having these conditions should be encouraged to self-identify to the institution's healthcare provider for appropriate counseling and guidance."

### Medical Surveillance

In general, the importance of an "appropriate medical surveillance program" at all ABSL containment levels has not changed between BMBL4 and BMBL5. However, BMBL5 places more emphasis on the necessity of a proper risk assessment to determine what constitutes an "appropriate" program. At ABSL4 containment, BMBL4 states that "a medical surveillance program must be instituted for all personnel entering the ABSL4 facility [that includes] appropriate immunizations, serum collection, and availability of post-exposure counseling and potential prophylaxis." However, BMBL5 does not make the same blanket statement concerning the need for serum collection. Rather, BMBL5 states that "each institution must establish policies and procedures describing the collection and storage of serum samples from at-risk personnel."

BMBL5 offers expanded guidance on the factors to be considered as part of a medical surveillance program. Factors not mentioned in BMBL4 include the need to consider an animal allergy prevention program, and the need to enroll personnel using respirators in an "appropriately constituted respiratory protection program." The reader should consult the change matrix for other medical surveillance considerations.

## Personal Protective Equipment

Most of changes and additions to personal protective equipment (PPE) guidance in BMBL5 focus on the use (and disposal) of gloves and eye/face protection. As with other sections, the importance of conducting a risk assessment is emphasized in BMBL5. The reader should consult the change matrix for details on other types of PPE.

### Gloves

The use of gloves at ABSL1 is not specifically addressed in BMBL4; however, BMBL5 explicitly states that "gloves are worn to prevent skin contact with contaminated, infectious and hazardous materials, and when handling animals." At ABSL1 and above, BMBL5 states that "a risk assessment should be performed to identify the appropriate glove for the task and alternatives to latex should be available." The need for latex alternatives is not addressed in BMBL4. At ABSL3, BMBL5 states that "double glove practices should be used when dictated by risk assessment"—a practice not mentioned in BMBL4. In the ABSL4 cabinet lab, BMBL5 states that "gloves must be worn to protect against breaks or tears in the cabinet gloves." Likewise, in the

ABSL4 suit lab, "inner gloves must be worn to protect against breaks or tears in the outer suit gloves."

BMBL4 does not address the disposal requirements for used gloves until ABSL3, in which it states that gloves should be "removed aseptically and autoclaved with other animal room wastes before disposal." In BMBL5, a blanket statement is provided for glove disposal at ABSL1-4 which directs the user to "dispose of used gloves with other contaminated waste." In the ABSL4 suit lab, BMBL5 requires that "inner gloves must be removed and discarded in the inner change room prior to the personal shower." Likewise, BMBL5 states that the "decontamination of outer suit gloves is performed during operations to remove gross contamination and minimize further contamination of the laboratory."

### Eye, Face, and Respiratory Protection

The use of eye and face protection at ABSL1 in BMBL4 is recommended for persons having contact with non-human primates. This is echoed in BMBL5; however, BMBL5 also states that eye, face, and respiratory protection "should be used in rooms containing infected animals, as dictated by the risk assessment." Likewise, "when conducting procedures that have the potential to create splashes or microorganisms or other hazardous materials," protective eyewear must be used. BMBL5 also states for all animal biosafety levels that persons who wear contact lenses should also wear eye protection "when entering areas with potentially high concentrations of airborne particulates."

The recommendations for eye and face protection at ABSL1 in BMBL4 become requirements at ABSL2 for "all personnel entering animal rooms that house non-human primates. BMBL5 builds upon this ABSL2 requirement, stating that eye and face protection must be used "for anticipated splashes/sprays from infectious or other hazardous materials and when the animal or microorganism must be handled outside the BSC or containment device." BMBL5 states that at ABSL2, "respiratory protection is worn based on risk assessment." Also, for ABSL2 and above, "eye and face protection must be disposed of with other contaminated laboratory waste or decontaminated before reuse." Finally, in the ABSL4 cabinet lab, BMBL5 adds that "prescription eye glasses must be decontaminated before removal through the personal body shower."

## Sharps Handling

The authors of BMBL5 have elaborated upon BMBL4 guidance by providing more details on the precautions that must be taken when handling sharp items in the laboratory. These precautions are universal to all animal biosafety levels. Some specific BMBL5 precautions not mentioned in BMBL4 are listed below; however, the reader should consult the change matrix for a complete list.

- Disposable needles must not be bent, sheared, broken, recapped, removed from disposable syringes, or otherwise manipulated by hand before disposal.
- Used disposable needles must be carefully placed in puncture-resistant containers used for sharps disposal and placed as close to the work site as possible.
- Non-disposable sharps must be placed in a hard-walled container for transport to a processing area for decontamination, preferably by autoclaving.
- Broken glassware must not be handled directly. Instead, it must be removed using a brush and dustpan, tongs, or forceps.
- Equipment containing sharp edges and corners should be avoided.

BMBL5 also contains new guidance on other topics, such as the development of policies and procedures, the requirements for laboratory signage, reporting spills and incidents, and the conduct of specialized training; the change matrix can be sorted based on all of these criteria.

## Summary

Although BMBL is not intended as a regulatory document, in some circumstances, compliance with BMBL has been mandated by legislature. For individuals tasked with ensuring that their animal facilities are in compliance with BMBL, keeping abreast of changing guidance poses a unique challenge since the revision summaries of rapidly and dramatically changing guidance documents are often scant or non-existent. The change matrix we have developed is intended to be a resource for biological safety officers, veterinarians, investigators, and others with a vested interest in biosafety to assist in the identification of the issues most pertinent to their facility or institution. The information contained herein does not necessarily represent the position of the federal government. Questions regarding the interpretation of BMBL5 should be addressed to its authors.

## References

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