



VCU

Environmental Health and Safety

Safety and Risk Management

VIRAL VECTOR INFORMATION PAGE

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I. BACKGROUND

The [NIH rDNA Guidelines](#) require that all institutions conducting research involving viral vector expression systems operate under the purview of an Institutional Biosafety Committee. The VCU [Institutional Biosafety Committee](#) (IBC) requires all research involving viral vector systems to be registered through completion of BioRAFT Biological Registration (may be accessed at vcu.bioraft.com). The primary purpose of this page is to provide the research community with sufficient information for determining an appropriate level of containment for protocols involving viral vectors expression systems. This information page also details appropriate work methods, personal protective equipment, and engineering controls which are required for suitably limiting exposure hazards in relation to viral vectors. This resource should be reviewed thoroughly and referenced when preparing BioRAFT biological registrations and [Institutional Animal Care and Use Committee](#) (IACUC) protocols for IBC registration and approval which involve use of viral vectors.

II. VIRAL VECTORS: REQUIRING IBC APPROVAL/REGISTRATION

A. [Adenoviral Vectors](#)

1. Transmission: Aerosol, droplet, contact with contaminated fecal material, water-borne transmission, and accidental injection/percutaneous exposure (Health Canada 2011).

2. Epidemiology: Infection with replication competent virus may result in wide range of symptoms from asymptomatic to mild (conjunctivitis, cough, etc.) or serious illness (croup, pneumonia, etc.) (Health Canada 2011). Health risk related to replication-deficient adenoviruses will vary depending upon vector system and genes expressed/suppressed: applications involving expression of oncogenic genes/proteins may present serious health concerns to laboratory and animal workers. (NIH 2002) research involving transducible oncogenes may also pose a serious health threat to researchers.

3. Containment Level: The IBC has established BSL-2+/ABSL-2 as the minimum level of containment for all adenoviral vectors regardless of replication capability. Refer to section IV for required administrative controls, personnel protective equipment, and engineering controls.

4. Suitable Disinfectants: Susceptible to 1% sodium hypochlorite, 2% glutaraldehyde, 0.25% sodium dodecyl sulfate (Health Canada 2011). Routine cleaning of surfaces and sensitive equipment parts which are free of gross contamination may be conducted with freshly prepared 70% EtOH (VCU IBC, 2014). EtOH is not suitable for addressing concentrated spills: contaminated surfaces and equipment must be disinfected with freshly prepared 10% bleach solution or other suitable disinfectant (VCU IBC, 2014).

B. Retroviral Vectors (includes: Moloney Murine Leukemia Virus (MMLV), amphotropic and pantropic murine retroviruses, Lentiviral Vectors).

1. Transmission: Accidental injection/percutaneous exposure, splashes to face (contact with mucous membrane of eyes, nose, and mouth), contact with open skin/open sores, and ingestion (Health Canada 2016, BMBL-5). The potential for transmission via aerosol exposure is unknown (BMBL-5).

2. Epidemiology: Infection with replicable virus may result in wide range of symptoms from asymptomatic to severe disease (HIV, leukemia, other cancers, and autoimmune disorders). Health risks related to replication-deficient retroviruses will vary depending on vector system in use and genes expressed/suppressed (NIH 2006).

a. "Second Generation" Transfer Vectors Involve reduction of genes and splitting of remaining genome onto three separate plasmids. Though still a remote possibility, potential for recovery of replication competence due to wild type virus rescue/recombination is greater than that of third generation vectors (Addgene 2016).

b. "Third Generation" Transfer Vectors: Involve further reduction of functional genes and separation of remaining genes onto four separate plasmids. Potential for recovery of replication competence is greatly reduced from that of second generation vectors (Addgene 2016).

c. Oncogenes: In addition to hazards posed by the virus vector itself, exposure to transducible oncogenic transgenes may also pose a significant risk to researchers when working with retroviral or other viral vectors (NIH 2006).

3. Containment Level: In consideration of the recommendations of the NIH Lentivirus Containment Guidance Document, the IBC has established BSL-2+/ABSL-2 as the minimum level of containment for all retroviral/lentiviral vectors (including use of virus-transfected cells) regardless of generation/replication capability. Refer to section IV for required administrative controls, personnel protective equipment, and engineering controls.

4. Suitable Disinfectants: Susceptible to 1% sodium hypochlorite, 2% glutaraldehyde, 0.25% sodium dodecyl sulfate (Health Canada 1996). Routine cleaning of surfaces and sensitive equipment parts which are free of gross contamination may be conducted with freshly prepared 70% EtOH. Contaminated surfaces should be disinfected with freshly prepared 10% bleach solution or other suitable disinfectant.

D. Herpes Simplex Viral Vectors

1. Transmission: Through contact with skin, via saliva (type 1), or sexual contact (type 2) (Health Canada 2001).

2. Epidemiology: Infection with replicable virus may result in a wide range of symptoms from asymptomatic to minor (cold sores, fever blisters, etc.) to serious disease (encephalitis, meningitis, etc.) (Health Canada 2001).

3. Containment Level: The IBC has established BSL-2+/ABSL-2 as the minimum level of containment for all research involving herpes simplex viral vectors. Refer to section IV for required administrative controls, personnel protective equipment, and engineering controls.

4. Suitable Disinfectants: Susceptibility to 1% sodium hypochlorite, iodine solutions containing ethanol, glutaraldehyde, formaldehyde, and 70% ethanol. Routine cleaning of surfaces and sensitive equipment parts which are free of gross contamination may be conducted with freshly prepared 70% EtOH. Contaminated surfaces must be disinfected with freshly prepared 10% bleach solution or other suitable disinfectant (VCU IBC, 2014).

E. Sinbis Virus Vectors

1. Transmission: Through bite of several mosquito species – human to human transmission is not known (Health Canada 2001).

2. Epidemiology: Infection with replicable virus may result in wide range of symptoms from asymptomatic to serious disease (myocardial damage, arthritis, arthralgia, jaundice, etc.) (Health Canada 2001).

3. Containment Level: The IBC has established BSL-2+/ABSL-2 as the minimum level of containment for all research involving Sindbis virus vectors. Refer to section IV for required administrative controls, personnel protective equipment, and engineering controls.

4. Suitable Disinfectants: Susceptible to 1% sodium hypochlorite, 2% glutaraldehyde, 0.25% sodium dodecyl sulfate (Health Canada 1996). Routine cleaning of surfaces and sensitive equipment parts which are free of gross contamination may be conducted with freshly prepared 70% EtOH. Contaminated surfaces should be disinfected with freshly prepared 10% bleach solution or other suitable disinfectant.

F. Vaccinia /Pox Virus) Vectors: Readily transmitted via aerosols, droplets, and percutaneous. Infection poses greater health risks to immunocompromised/pregnant individuals. (NCSU 2008) No research involving vaccinia is currently being undertaken at the university. If you plan on conducting research involving this virus or related viral expression kits, Contact the

Biosafety Office (mtelliott@vcu.edu) in advance if you plan to use this virus or related viral expression kits.

G. Epstein-Barr (EBV) Vectors: Readily transmitted via aerosols, droplets, sexual contact, and percutaneous (Health Canada 2010). No *in vivo* research involving EBV is currently being conducted at the university. Research involving established commercial cell lines which were transduced by EBV is occasionally undertaken. These procedures are typically performed at BSL-2/ABSL-1 depending on nature of gene expression. If you plan on conducting research involving this virus or related viral expression kits, contact the Biosafety Office (mtelliott@vcu.edu) in advance if you plan to use this virus or related viral expression kits.

H. Adeno-associated Virus (AAV) Vectors: Risk of infection in the presence of helper viruses is considered to be significant. Risk of harmful exposure in the absence of helper viruses is considered to be limited; however, since these materials are produced in living cells, there is minimal potential for recombination and restoration of a wild type virus (UNC 2004, Duke 2017).

1. Transmission: Anticipated to be similar to adenovirus: aerosol, droplet, and contact with contaminated fecal material, water-borne transmission, and percutaneous exposure (UNC 2004, Duke 2017).

2. Epidemiology: Anticipated to be similar to adenovirus infection (see section II.A.).

3. Containment Level:

a. Protocols utilizing AAV involving use of a helper virus and or expression of genes with known/suspected oncogenic, toxin producing, or other potentially harmful effects will be conducted under a minimum of BSL-2+/ABSL-2 containment conditions. Refer to section IV for required administrative controls, personnel protective equipment, and engineering controls.

b. Protocols not involving use of helper virus or expression of oncogenic, toxin-producing, or other potentially harmful genes may be conducted under BSL-1/ABSL-1 conditions (dependent on IBC review).

4. Suitable Disinfectants: Susceptible to 1% sodium hypochlorite (10 % bleach solution) (Duke 2017). Routine cleaning of surfaces and sensitive equipment parts which are free of gross contamination may be conducted with freshly prepared 70% EtOH (VCU IBC 2014). Contaminated surfaces must be disinfected with freshly prepared 10% bleach solution or other suitable disinfectant (IBC VCU 2014).

I. Rabies Virus Vectors :

1. Transmission: Parenteral injection, droplet or aerosol exposure of mucous membranes or broken skin with infectious fluids or tissues (Health Canada 2010).

2. Epidemiology: Gene deletion and secondary alteration of tropism results in significant risk reduction because the viral vector has no known potential to infect or trans-

synaptically transport to any mammalian cells, including human and mice (Stanford 2017). Nonetheless the viral vector should be handled with great care under BSL-2+

3. Containment Level: Applications involving any Rabies Virus vector at VCU will require a minimum of BSL-2+/ABSL-2 precautions.

4. Suitable Disinfectants: Rabies Virus is susceptible to 70% ethanol, phenol, formalin, ether, trypsin, β -propiolactone, and some other detergents (Health Canada MSDS, 2010), and 10% bleach solution (New York Dept of Health, 2011).

J. Baculoviral Vectors:

1. Transmission: No evidence of transmission/infection to humans (University of Iowa, 2002).

2. Epidemiology: Incidence of human or animal infection is not known (University of Iowa, 2002).

3. Containment Level: Unless involving other hazards, protocols involving baculoviruses typically may be conducted at BSL-1/ABSL-1.

4. Suitable Disinfectants: Unknown, IBC advises use of 1% sodium hypochlorite solution (1 part household bleach to 9 parts water, prepared daily is considered an acceptable disinfectant).

C. Ecotropic Murine Retroviral Vectors: Ecotropic retroviruses are limited in host range to murine cell lines. Use of registered murine cell lines which are certified to be free of helper viruses may further reduce risk to researchers (NIH 2002).

1. Transmission: Unknown

2. Epidemiology: Host range is limited to murine cell lines (NIH 2002).

3. Containment Level: The IBC reviews protocols involving ecotropic viruses on a case-by case basis, BSL-1/ABSL-1 has been established as the minimum level of containment, but protocols with potential for presence of helper virus/expansion of host range or which may express oncogenes may require full IBC approval and require a higher containment level.

4. Suitable Disinfectants: Susceptible to 1% sodium hypochlorite (1 part household bleach to 9 parts water, prepared daily is considered an acceptable disinfectant), 2% glutaraldehyde, 0.25% sodium dodecyl sulfate (Health Canada 1996), and 70% EtOH (University of Iowa, 2002).

B. Other viral vector systems which can demonstrated by the principal investigator to fall under NIH Section III-F “exempt” studies.

III. SAFE WORK METHODS: The potential for laboratory-acquired infection necessitates that principal investigators conduct thorough risk assessments and prepare protocols which include measures for minimizing staff exposure potential. The IBC instruction for principal investigators is to: eliminate or reduce exposure potential as much as feasible through implementation of the safe work methods listed below.

A. Administrative Controls

1. Risk Assessment: The potential for laboratory-acquired infection necessitates that principal investigators conduct thorough risk assessment when considering the addition of any viral vector or other biohazardous agent to the laboratory regimen. Upon completion of the risk assessment, PIs must prepare protocols designed to minimize potential for staff exposure potential and for protection of the environment.

2. Required Protocols

a. BioRAFT Biological Registration. All protocols involving viral vector expression systems require registration with the IBC via completion of a BioRAFT registration (accessed through vcu.bioraft.com). The IBC convenes monthly on the third Thursday of each month, biological registrations must be submitted via BioRAFT no later than the first Thursday of the month and must complete the prereview process by the second Thursday of the month in order to be included on the monthly IBC review docket.

b. IACUC Protocols (Group Drugs/Compounds section): In addition to registration through completion BioRAFT registration, [Institutional Animal Care and Use Committee](#) (IACUC) protocols involving *in vivo* application of viral vectors or cells transformed by viral vectors will require completion of the “Group Drugs/Compounds” section provided in the IACUC protocol..

c. Laboratory-Specific Standard Operating Procedures (SOPs). SOPs which identify task-related hazards and specify proper work procedures must be developed for all laboratory applications including those involving viral vectors. PIs and laboratory managers are required to ensure that all procedures carried out under their supervision are consistent with applicable SOPs. Boiler plates for SOP construction have provided on the [University Model Biosafety Manual](#).

3. Biosafety Manual: Laboratories participating in research involving viral vectors must maintain laboratory-specific biosafety manuals. The IBC has created a [University Model Biosafety Manual](#) to aid researchers in fulfilling this requirement. Please note that researchers are required to provide the requested laboratory-specific information and to document staff participation/understanding prior to considering the manual complete.

4. Required Training Elements. Records of training completion are subject to inspection during annual laboratory safety inspections; therefore, certificates of completion for the following laboratory safety training modules must be maintained in the laboratory’s central files. For additional information concerning annual laboratory safety inspection or training requirements contact the [VCU Safety and Risk Management](#) (SRM).

a. BioRAFT supported training:

i. “Fundamentals of Laboratory Safety” training course: All staff working within research facilities are required to complete this training program

ii. “Principal Investigator Responsibilities: All VCU Principal investigators involved in laboratory research are required to complete this program.

b. Task-Specific Training: Laboratory personnel must be provided with task-specific training which includes review of laboratory SOPs addressing hazards posed by the agent(s) and identifies required work methods and engineering controls for suitably reducing exposure potential prior to participating in research activities involving viral vectors.

5. Medical Evaluation and Follow-up: Accidental exposures involving viral vectors and/or other rDNA/biological hazards should be reported to Employee Health as soon as possible. Staff working with viral vectors and other biohazardous agents are to be provided with medical evaluation, treatment, and consultation following exposure incident free of charge. Additionally, the NIH rDNA Guidelines require that the Biosafety Office be notified of any accident involving rDNA materials.

B. Personal Protective Equipment (PPE). Viral vectors may be harmful via all exposure routes: aerosols, droplets, splashes/skin contact (especially mucous membrane), percutaneous, and ingestion. Staff involved in any tasks where potential for exposure exists must don appropriate PPE:

1. Laboratory Procedures: Minimum Acceptable PPE:

a. Examination Gloves: Use powder-free latex, nitrile, or rubber examination gloves which cover hands and wrists completely through overlapping sleeve of lab coat when working with viral vectors. Wearing of an additional glove layer (“double gloving”) is advised whenever practical. Laboratory personnel should thoroughly wash hands with soap and water before and immediately upon removal of examination gloves.

b. Eye and Face Protection: Safety glasses or safety goggles (ANSI Z-87 approved) are considered the minimum appropriate level of eye protection. Work involving liquids with potential for splashing/generation of significant concentration of aerosols will require use of safety goggles in conjunction with a face shield.

c. Lab Coat: Lab coats or disposable coveralls that provide complete coverage of all skin surfaces not protected by PPE are required. Laboratory personnel whose clothing has been potentially contaminated by viral vectors or biological hazards should change into clean clothing promptly. Contaminated clothing should be disposed of as regulated medical waste (RMW).

d. Appropriate Laboratory Attire: Laboratory personnel handling viral vectors must don attire which when worn in combination with lab coat and other PPE provides entire coverage of the body. Short pants/dresses and open-toed shoes are not appropriate laboratory attire.

e. Respiratory Protection: Though utilization of a biological safety cabinet (BSC) and implementation of proper work methods alone should provide sufficient for most procedures involving viral vectors; some protocols (use of competent viruses as vectors, potential for generation of significant quantities of aerosols, etc.) may necessitate the use of N-95 or other respirators. Prior to issuing N-95 or other respirators, researchers are required to participate in a Respiratory Protection Program which involves respirator training, fit-testing, and medical evaluation of all staff.

2. Vivaria and Support Facilities: Animal care workers will don PPE as specified in the IBC approval form which is required for all IACUC protocols involving rDNA and biological hazards. Researchers are advised to follow these instructions for determining minimum levels of PPE required for entry into vivaria. The IBC has established the following as minimum levels of PPE for entry into vivaria housing animals exposed to viral vectors:

a. Respiratory Protection:

i. DAR staff: Entry into vivaria classified at ABSL-2 or greater will require wearing of respirators rated at N-95 or greater. Records of annual completion of fit-testing/respirator training and medical clearances will be maintained within the DAR central office file.

ii. Researchers: The IBC strongly advises that all staff don respirators rated at N-95 or greater prior to entering vivaria classified at ABSL-2 or greater. PIs should arrange for fit-testing through [VCU Safety and Risk Management](#) (SRM) and complete medical evaluations as required by VCU Employee Health for affected staff prior to initiating animal studies.

b. Protective Clothing:

i. Disposable Coveralls: Worn in combination with lab coat and other PPE must provide entire coverage of the body. The coveralls must be removed and disposed of (via red or orange bag waste streams) immediately prior to exiting the animal or other potentially contaminated spaces. Tasks which may involve high potential for splashing of contaminated materials will require use of full-length disposable apron in addition to disposable coveralls.

ii. Head Covers/Bonnets: A disposable head cover must be donned prior to entry into rooms with potential viral vector exposure hazards. The head cover should be removed and placed in red or orange-bag lined infectious waste receptacle immediately prior to exiting contaminated spaces.

iii. Shoe Covers: Disposable shoe covers must be donned prior to entry into rooms with potential viral vector exposure hazards. Shoe covers should be removed and placed in red or orange-bag lined infectious waste receptacles immediately prior to exiting contaminated spaces.

c. Eye and Face Protection: Safety glasses or safety goggles (ANSI Z-87 approved) are considered the minimum appropriate level of eye protection; however, safety glasses alone

will not protect from splash. Donning of an additional full-face shield is required for all procedures posing potential for splashing and/or generation of aerosols/droplets.

d. Examination Gloves: Use powder-free latex, nitrile, or rubber examination gloves which cover hands and wrists completely through overlapping sleeve of lab coat when working with viral vectors. Gloves should be removed and placed in a red bag-lined infectious waste receptacle prior to exiting contaminated spaces. Laboratory personnel should thoroughly wash hands with soap and water immediately after removing examination gloves.

C. Engineering Controls

1. Biological Safety Cabinet: All manipulation of viral vectors classified at BSL-2 or greater will be conducted within a Class II Biological Safety Cabinet (BSC) which has a valid annual certification per National Sanitation Foundation Standard 49 (NSF-49).

2. Directional Air Flow: Vivaria housing animals under ABSL-2 or greater containment level and all related procedural rooms where potentially infected animals or waste materials are manipulated (cage wash, surgery suites, etc.) must demonstrate directional/single-pass air flow: air from clean areas outside of vivaria must flow toward contaminated areas, and may not be recirculated within the building (must be directly exhausted to building exterior).

3. Cage Dump Station: All potentially contaminated bedding materials (classified at ABSL-1 or greater) must be dumped within a HEPA-filter equipped unit which provides user and environmental protection (a Class I or II BSC). Dumps station will be receive annual certification per NSF-49 and should be maintained so as to provide intended protection.

4. Transfer Procedures: If transfer of infected animals or contaminated cages is necessary, microisolator cages will be utilized. The outer surfaces of the cages will be disinfected utilizing a suitable disinfectant. Immediately following disinfection, animal cages will be enveloped within red biohazard bags or other preapproved conveyance (per IBC approval letter). The animals may then be transferred.

5. Drain Traps: Drain traps in rooms where potentially infected animals are housed will be charged on a weekly basis (minimum allowable frequency) with suitable disinfectant (dilute bleach and an array of phenolic products are suitable for this purpose).

6. Flow Cytometry: Cell sorting of viral vector and other rDNA/biohazardous materials will require use of flow cytometry equipment which has been enclosed within an approved secondary containment system. Researchers will follow the conditions indicated by the SOP developed by the VCU Flow Cytometry Core Facility entitled: "Cell Sorting of Biohazardous Materials" whenever conducting cell sorting of material with potential viral vector/biohazardous contamination. Researchers will provide prior notice to the Flow Cytometry Core prior to submitting any materials for sorting with potential for viral vector/other biohazard contamination.

D. Work Practices:

1. Access to rooms where active research involving viral vectors is in progress must be restricted to properly trained and protected personnel. The door leading to the work area must be secured and marked with appropriate [Biohazard Warning Signage](#) .

2. Sharps Minimization: Use of sharps in association with viral vectors (especially those classified at BSL-2 or greater) should be limited as much as feasible. If use of needles/syringes or other sharps is absolutely necessary, the PI must replace/or demonstrate a diligent effort towards replacement of conventional sharps with safety-engineered sharps (e.g., self-sheathing needles). Increased cost is not adequate justification for not using engineered sharps.

3. Use of sharps devices in association with viral vectors classified at BSL-2/ABSL-2 or greater will require incorporation of SOP into BioRAFT submission indicating work methods and training requirements for mitigating exposure potential to all staff involved in these procedures.

4. Needles should never be bent, sheared, or recapped. If recapping is absolutely necessary, a "[Needle Recapping Waiver](#)" must be submitted for IBC review/approval prior to proceeding.

5. All manipulation of viral vectors classified at BSL-2 or greater and handling of potentially contaminated materials must be conducted within a certified BSC.

6. Researchers and animal care workers will don PPE as detailed in section III.B.

7. The total volume of cultures containing viral vectors listed in Section II.A - H within any research space may not exceed 1 (one) liter.

8. Surfaces and equipment will be thoroughly decontaminated immediately following task completion with a suitable disinfectant (refer to virus-specific MSDS).

9. The IBC recommends that 3 – 5 washes be conducted post transfection to allow safer manipulation of cells during cell-sorting and other procedures with potential for generation of significant concentrations of aerosol.

10. Centrifuging Procedures: The IBC requires that all protocols involving the centrifuging of materials contaminated with viral vectors include SOPs which convey safe work methods and incident response measures to lab staff. The SOPs should provide the following details:

a. The location (building/room number) where centrifuging will be performed (note: use of "shared" equipment for centrifuging of viral vectors is discouraged).

b. Personal protective equipment to be donned by staff while conducting centrifuging, should include at a minimum: latex or nitrile examination gloves, lab coat worn in conjunction with proper attire, and eye protection (safety glasses or goggles).

c. Hazard Communication: Verification of posting of appropriate hazard signage and other measures taken to notify staff not involved in the study of presence of potential exposure hazard.

d. Securing of Hazard: The area where centrifuging is to occur must be secured by locked door or other effective means during the procedure.

e. Incident Response: The PI must provide details of response actions to be taken in the event of occurrence of mishap (breaking of centrifuge tube, spilling of contents, etc.).

f. Decontamination of equipment: The PI must indicate routine procedures to be taken to decontaminate centrifuge equipment following use, and also identify disinfectants to be utilized (note: the use of bleach solution may damage centrifuge equipment and is thus not recommended for routine cleaning).

g. Indication of approximate revolutions per minute (rpm) for centrifuge operation.

E. Waste Disposal:

1. Vivaria-Generated Waste

a. Animal Carcasses: All animal carcasses will be managed as RMW through DAR. All carcasses will be red-bagged and treated via incineration by the university's RMW disposal contractor.

b. Bedding, and Other Wastes:

i. ABSL-2 or greater: All materials with potential for contamination with viral vectors classified at ABSL-2 or greater will be managed as RMW through DAR. Ultimate disposal will be via incineration by the university's RMW disposal contractor.

ii. ABSL-1: Disposal requirements for materials with potential for contamination with viral vectors classified at ABSL-1 will provided by the IBC - Biosafety Office on the IBC IACUC hazard approval form. Note the IBC will require treatment of all BSL-1/ABSL-1 waste materials via either red-bagging, autoclaving, or acceptable chemical means – BSL-1/ABSL-1 waste materials should never be disposed of in the municipal waste stream prior to undergoing proper treatment.

2. Laboratory-Generated Waste:

a. Disposal of all materials with potential for contamination with viral vectors classified at BSL-2 or greater, will be via red-bagging/incineration or via orange-bagging protocol. If the PI hazard assessment or IBC review deems necessary, additional/preliminary disinfecting actions may be required (bleaching of contaminated equipment/cultures, autoclaving of waste prior to red-bagging, etc.). Disposal requirements for BSL-1 classified vector work will be determined on a case-by-case basis and detailed in the BioRAFT registration.

b. Serological pipettes and pipette tips coming into contact with viral vectors will be soaked in plastic vessels containing 10% bleach solution (or other effective disinfectant) for at least 30 minutes prior to disposal as RMW. If bleach solution is the selected disinfectant, fresh stocks shall be made on a daily basis. All pipette tips and pipettes are considered sharps for disposal purposes and must be placed into rigid puncture-resistant containers prior to disposal.

c. Aspirator flasks shall be provided with reservoir of bleach or other approved disinfectant. Final concentration of liquid waste must be adjusted to at least 10% bleach. Following 30 minutes contact time, the waste fluid may be poured down drain. Plastic tubing used in association with aspiration pumps must also be disinfected (concentrated bleach is advised) prior to reuse or disposal (as RMW). When dilute bleach solution is the selected disinfectant, fresh stocks shall be made on a daily basis. If the house vacuum service (i.e., central or local) is provided, each service connection must be fitted with liquid disinfectant traps and an in-line HEPA filter, placed as near as practicable to each use point or service cock. Filters are installed to permit in-place decontamination and replacement.

d. Sharps Disposal: Discarded sharps materials, whether engineered or traditional, must be disposed of in a suitable sharps container. Upon filling the sharps container should be closed securely and then placed within double red biohazard bags. The sealed red bags should then be placed into a biohazard incineration box for pick-up/disposal by the university RMW contractor.

F. Spills: Laboratory personnel must don appropriate PPE (refer to section III.B) prior to attempting to manage any spill involving viral vectors. University policy for addressing spills is provided below (refer to the [University Model Biosafety Manual](#) for complete spill-response SOPs):

1. Spills occurring within the BSC: (Maintain BSC in operation throughout procedure) Cover affected area with paper towels and then mist area heavily with 10% bleach solution, starting with the outer periphery working toward the center. Cover the misted area of the spill with paper towels. Allow 15 minute contact time, then wearing appropriate PPE, remove paper towels and place in red bag. Treat the area of the spill again with disinfectant and allow area to air dry. Dispose of all paper towels and gloves utilized in spill cleanup with a red bag.

2. Spills Occurring Outside of the BSC.

a. Small Spills: Minor spills may be handled by laboratory staff as indicated above (Section III.E.1); however, staff should leave the spill area for approximately 30 minutes to allow any aerosols generated during spill to settle prior to attempting cleanup.

b. Significant Spills: Staff should leave the affected space immediately and contact the SRM emergency line (828-9834) for assistance.

3. Spills involving sharps materials: Minor spill areas should be misted with 10% bleach solution or other appropriate disinfectant then covered with paper towels; staff should then contact the SRM emergency line (828-9834) for assistance prior to attempting completion of spill clean-up.

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APPENDIX A. VIRAL VECTOR RESEARCH REQUIREMENTS TABLE

Viral Vector	Biosafety Level		Special Requirements	IBC Requirements
	<i>in vitro</i>	<i>in vivo</i>		
Adenovirus	BSL-2+	ABSL-2	All laboratory procedures involving vector must be conducted within certified BSC. Use of sharps eliminated wherever possible. Access to lab restricted during work involving vector.	BioRAFT: IBC approval and registration <i>in vivo</i> : IBC approval of IACUC protocol “Group Drugs/Compounds section” (following BioRAFT approval)
Murine Retrovirus-Ecotropic	*BSL-1	*ABSL-1	Requirements for laboratory/ vivaria detailed on BioRAFT and IBC IACUC hazard approval form.	BioRAFT: IBC approval and registration <i>in vivo</i> : IBC approval of IACUC protocol “Group Drugs/Compounds section” (following BioRAFT approval)
Murine Retrovirus-Amphotropic/Pantropic	BSL-2+	ABSL-2	All laboratory procedures involving vector must be conducted within certified BSC. Use of sharps eliminated wherever possible. Access to lab restricted during work involving vector.	BioRAFT: IBC approval and registration <i>in vivo</i> : IBC approval of IACUC protocol “Group Drugs/Compounds section” (following BioRAFT approval)
Lentivirus-2nd and 3rd generation (3 or 4 vector systems)	BSL-2+	ABSL-2	All laboratory procedures involving vector must be conducted within certified BSC. Use of sharps eliminated wherever possible. Access to lab restricted during work involving vector.	BioRAFT: IBC approval and registration <i>in vivo</i> : IBC approval of IACUC protocol “Group Drugs/Compounds section” (following BioRAFT approval)

AAV: involving use of helper virus and/or oncogenes or toxin-producing genes	BSL-2+	ABSL-2	All laboratory procedures involving vector must be conducted within certified BSC. Use of sharps eliminated wherever possible. Access to lab restricted during work involving vector.	BioRAFT: IBC approval and registration <i>in vivo: IBC approval of IACUC protocol "Group Drugs/Compounds section" (following BioRAFT approval)</i>
AAV: helper virus free vector systems not expressing onco/toxin-producing genes	BSL-1	ABSL-1	Use of prudent practices and utilization of BSC recommended whenever feasible.	BioRAFT: IBC approval and registration <i>in vivo: IBC approval of IACUC protocol "Group Drugs/Compounds section" (following BioRAFT approval)</i>
EBV, Pox, Vaccinia viruses	BSL-2+	ABSL-2	All laboratory procedures involving vector must be conducted within certified BSC. Use of sharps eliminated wherever possible. Access to lab restricted during work involving vector. Some applications involving Pox/Vaccinia viruses may require additional precautions.	BioRAFT: IBC approval and registration <i>in vivo: IBC approval of IACUC protocol "Group Drugs/Compounds section" (following BioRAFT approval)</i>
Herpes Simplex Viruses	BSL-2+	ABSL-2	All laboratory procedures involving vector must be conducted within certified BSC. Use of sharps eliminated wherever possible. Access to lab restricted during work involving vector.	BioRAFT: IBC approval and registration <i>in vivo: IBC approval of IACUC protocol "Group Drugs/Compounds section" (following BioRAFT approval)</i>
Rabies Virus	BSL-2+	ABSL-2	All laboratory procedures involving vector must be conducted within certified BSC. Use of sharps eliminated wherever possible. Access to lab restricted during work involving vector.	BioRAFT: IBC approval and registration <i>in vivo: IBC approval of IACUC protocol "Group Drugs/Compounds section" (following BioRAFT approval)</i>
Sindbis Virus	BSL-2+	ABSL-2	All laboratory procedures involving vector must be conducted within certified BSC. Use of sharps eliminated wherever possible. Access to lab restricted during work involving vector.	BioRAFT: IBC approval and registration <i>in vivo: IBC approval of IACUC protocol "Group Drugs/Compounds section" (following BioRAFT approval)</i>

Baculovirus	*BSL-1	*ABSL-1	Requirements for laboratory/ vivaria detailed on BioRAFT and IBC IACUC hazard approval form. Biosafety level may increase if oncogene or foreign protein expression is involved	BioRAFT: IBC approval and registration <i>in vivo: IBC approval of IACUC protocol "Group Drugs/Compounds section" (following BioRAFT approval)</i>
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* Applications involving oncogenic and/or foreign protein expression may require an increase in biosafety safety and will require IBC preapproval.