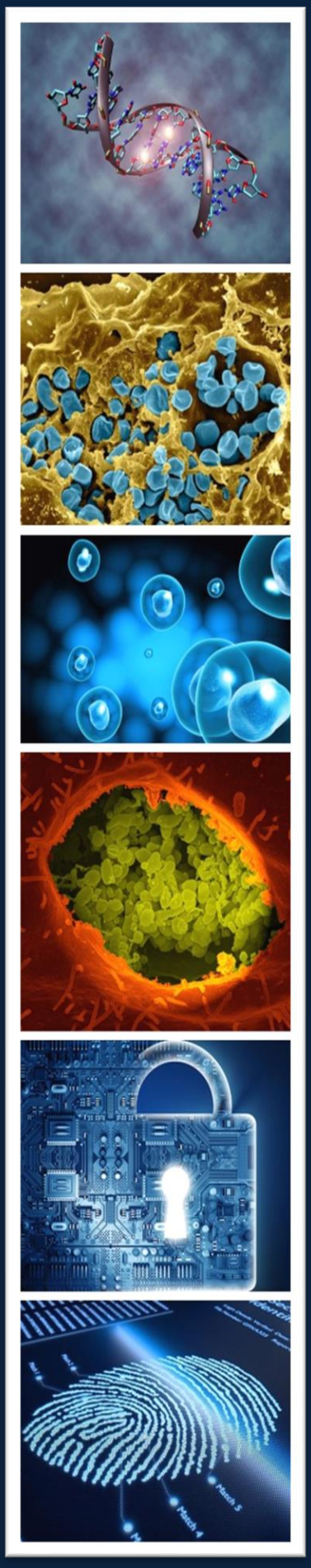

UTSA Laboratory Safety

BIOSAFETY PLAN

Laboratory Safety Division

UTSA

Office of the Vice President for Research, Economic Development, and Knowledge Enterprise

2021

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REVIEW PAGE

This version of the manual has been reviewed for regulatory compliance and best management practices by the listed individuals and committees and is hereby adopted for use and compliance by all employees at the University of Texas at San Antonio owned or operated facilities.

NAME	TITLE	DATE
Amanda Haley	Biosafety Officer	10-19-2021
Jose Lopez-Ribot	Chair, Institutional Biosafety Committee	10-19-2021
Michelle Stevenson	Associate Vice President for Research Integrity	10-19-2021

COMMITTEE

COMMITTEE	REVIEW DATE	APPROVAL DATE
Institutional Biosafety Committee	09-01-2021	10-19-2021

Review: September 1, 2021 (Complete re-write)
Review: September 2020 (no changes)
Review: December 09, 2019
Re-write: September 12, 2018
Replaces: June 7, 2016

This plan constitutes a substantial rewrite therefore individual changes are not tracked and the plan will receive full committee review by the IBC.

EMERGENCY CONTACTS

ROUTINE OFFICE HOURS (8 am – 5 pm)	
Biosafety Officer	210-458-8515
AFTER-HOURS (including weekends)	
Biosafety Officer	210-294-3342
UTSA Police	210-458-4911 (cell or outside phone) x4911 (from a campus phone)
LIFE-THREATENING EMERGENCIES (any time)	
UTSA Police	210-458-4911 (cell or outside phone) x4911 (from a campus phone)

ROUTINE CONTACTS

In case of incidents involving biological exposures, all personnel are required to notify the Biological Safety Officer immediately at 210-458-8515 or 210-294-3342.

After 5:00 pm and on weekends, UTSA Police will assist in contacting Laboratory Safety Personnel.

INTRODUCTION

OVERVIEW

This Biosafety Manual represents the institutional practices and procedures for the safe use and handling of biological materials, recombinant DNA, and synthetic nucleic acids at The University of Texas at San Antonio. The Laboratory Safety Division and Institutional Biosafety Committee have revised this document based on the latest government regulatory requirements, guidelines, and current professional standards.

Safety is a core value at UTSA, and the University is committed to continued advancement of an institutional safety culture. Research excellence and safety are inextricably linked, and the protection of researchers, the environment, and the broader community are an integral part of the responsible conduct of research.

The Laboratory Safety Division is responsible for monitoring individual principal investigators and laboratory facilities for adherence to the practices and procedures described in this manual. However, it is the responsibility of each principal investigator to ensure that all lab workers are familiar with the contents of this manual and that these workers and employees are trained to recognize potential related hazards prior to initiation of the research work. Your cooperation with the Institutional Biosafety Committee and the Laboratory Safety Division Office is essential to comply with the regulatory requirements that our university must follow in order to continue the success of our research endeavors.

PURPOSE

The Laboratory Safety Division and Office of Research Integrity prepared this plan after review of pertinent federal and state regulatory requirements from the following agencies and organizations:

- Occupational Health and Safety Administration (OSHA)
- Texas Department of State Health Services
- Texas Commission on Environmental Quality (TCEQ)
- Centers for Disease Control and Prevention (CDC) https://www.cdc.gov/biosafety/publications/bmbl5/index.htm
- National Institutes of Health – *NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules* https://osp.od.nih.gov/biotechnology/nih-guidelines/.
- U.S. Department of Health and Human Services – Policy of Institutional Oversight of Life Sciences Dual Use Research of Concern http://www.phe.gov/s3/dualuse/Documents/durc-policy.pdf

Research and education in science laboratories involves a variety of hazards. It is the University of Texas at San Antonio's (UTSA) policy to protect and promote the health and safety of students and employees as well as the environment. This plan outlines basic good laboratory safety practices, special procedures for this institution, federal and state guidelines, and references to other information sources for work in laboratories that handle,

use, or store biological agents. This is not intended to be a fully comprehensive reference but rather a guidebook. There may be agents, procedures and other circumstances in each laboratory that present unique or unusual hazards not addressed in this manual. If necessary, such hazards are best addressed by the principal investigator or supervisor of the respective laboratory in consultation with the Laboratory Safety Division.

Faculty, staff, and students who may be exposed to biological hazards in the laboratory must be informed of the nature of these hazards and how to protect themselves and others who may also be exposed. Safety in the laboratory can be achieved only with the exercise of sound judgment and proper use of facilities by informed, responsible individuals.

SCOPE

This plan applies to all UTSA operated (leased or owned) facilities and equipment (including vehicles). It also applies to any UTSA employee, volunteer or student worker(s) who work directly with, or in close proximity to anyone conducting research that falls under federal and state regulations or guidelines for working with biological agents. The NIH guidelines are mandatory for all researchers at institutions receiving NIH funding. Even those researchers who are not receiving NIH funding must follow the NIH guidelines. All federal NIH funding can be removed from an institution for violations of the guidelines by any researcher. Thus, the guidelines apply to all UTSA research.

PERIODIC REVIEW

This plan will be reviewed as needed, and yearly by the Institutional Biosafety Committee. The online version of this plan will be reviewed periodically for updates on the VPREDKE website at: http://www.utsa.edu/safety/#/laboratory/manuals. Questions can be addressed to the Senior Director of Laboratory Safety, who also serves as the Institutional Biosafety Officer, through the Laboratory Safety Division at 210-458-8515.

RESPONSIBILITIES

THE LABORATORY SAFETY DIVISION

1. Establish the general policies and standards for the use of biological hazards at UTSA in conjunction with the Institutional Biosafety Committee (IBC), and as per directives in HOP 9.05 – Occupational Safety & Health and 9.22 – Acquired Immune Deficiency Syndrome, Human Immunodeficiency Virus and Hepatitis B Virus http://www.utsa.edu/hop/chapter9/index.html

2. Provide consulting services for work with biological agents.

3. Review applications and protocols for work with potentially infectious materials or hazardous biological agents and provide recommendations to the Principal Investigator (PI), Institutional Biosafety Committee (IBC), Institutional Review Board (IRB), Institutional Animal Care and Use Committee (IACUC), or University Veterinarian.

4. Develop safety plans and training programs for work with all risk groups of biological agents, blood borne pathogens, and other potentially infectious materials in use at UTSA facilities.

5. Contract for the annual certification, maintenance, and repair of biological safety cabinets to ANSI/NSF-49.

6. Provide support to the biological waste disposal program.

7. Supervise decontamination and clean-up activities following spills or exposures.

8. Ensure periodic review of the Biological Safety Plan and update as necessary.

9. Maintain qualified staff to act as the Responsible or Alternate Responsible Official for Select Agent Program work at UTSA and as the Institutional Biosafety Officer

10. Investigate and provide support following biological exposure incidents.

11. Evaluate laboratories periodically to ensure compliance with institutional, state, and federal guidelines/regulations as they pertain to biosafety.

12. Provide the final clearance for the safe demolition, renovation, or reassignment of UTSA facilities and equipment that used or contained hazardous biological agents or potentially infectious materials.

PRINCIPAL INVESTIGATORS (PI) OR LABORATORY SUPERVISORS

1. Submit protocols for all non-exempt biological work to the IBC (as defined in the IBC policy) and await approval prior to conducting work covered by the protocol.

2. Enforce all UTSA procedures and policies regarding all risk groups of biological agents.

3. Ensure laboratory personnel have been properly trained to work safely within their laboratory to include required safety training provided by UTSA.

4. Develop and train laboratory personnel on safety procedures and protocols that are specific for their lab(s).

5. Advise the Laboratory Safety Division of any significant protocol changes and prior to bringing new biologically hazardous agents onto campus.

6. Report any exposures, spills, thefts, or other incidents involving biological safety to the Laboratory Safety Division immediately or as soon as possible.

7. Maintain a clean and sanitary workplace.

8. Report any plans to remodel or alter UTSA Facilities (HOP 8.3) to Facilities, the Laboratory Safety Division for permission before proceeding.

LABORATORY STAFF AND STUDENTS

1. Observe the established guidelines, protocols, and policies for biological safety.

2. Attend all necessary or required training.

3. Report all spills or incidents to their supervisor and to the Laboratory Safety Division.

4. Report to the supervisor and the Laboratory Safety Division any unsafe practices or conditions in the laboratory.

5. Properly dispose of all laboratory wastes.

INSTITUTIONAL BIOSAFETY COMMITTEE

The IBC is mandated to be a review body for oversight of all research activities involving the use of hazardous biological materials and recombinant or synthetic nucleic acids, as required by the NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules and the CDC/NIH Biosafety in Microbiological and Biomedical Laboratories (BMBL) 6th Edition.

CHEMICAL SAFETY COMMITTEE (CSC)

The CSC is charged with promoting safe research with hazardous chemicals in research and teaching laboratories across campus. The committee reviews risk assessments and protocols for working with high hazard chemicals, reviews and contributes to the Chemical Hygiene Plan, advises in incident investigations. The committee is also empowered to recommend additional general safety rules regarding chemical use and establish standard procedures for handling and working with chemicals.

INSTITUTIONAL ANIMAL CARE AND USE COMMITTEE (IACUC)

The IACUC is a research review committee federally mandated by the Animal Welfare Act and the PHS Policy on the Humane Care and Use of Laboratory Animals. Through the expertise of the committee members, which comprise faculty, compliance professionals, safety professionals and community members the IACUC is charged with ensuring that all animal welfare issues associated with research across UTSA. The IACUC may also, in consultation with the CSC, set standards for the use of certain hazardous chemicals and pharmaceuticals in animal research to protect both animals and animal handlers.

RADIATION AND LASER SAFETY COMMITTEE (RLSC)

The RLSC reviews all work with radioactive materials, X-Ray devices and lasers in research, engineering, and teaching at UTSA. The committee is charged with implementing safety policies, procedures and practices with all systems and provides guidance to the Radiation and Laser Safety Officers in all areas of radiation and laser safety.

INSTITUTIONAL REVIEW BOARD (IRB)

The UTSA Institutional Review Board (IRB) is the university committee that reviews and approves human subject research for the purpose of protecting the rights and welfare of those subjects. The Board is charged with the responsibility to formulate and implement procedures to assure UTSA's compliance with federal, state, and institutional regulations for the safeguarding of the welfare and well-being (physical, mental, social, legal, etc.) of human subjects involved in research projects in which UTSA is engaged or for which UTSA otherwise exercises oversight.

The UTSA IRB operates under a Federal wide Assurance (FWA) with the Office for Human Research Protections (OHRP) under the Department of Health and Human Services. The IRB advises and educates researchers, staff, and students on research with human subjects and promotes best practices for the ethical conduct of research with these individuals.

BIOSAFETY AT A GLANCE

Summary of the minimum requirements to work with recombinant or synthetic nucleic acids, other biohazards, and associated lab requirements.

APPROVALS

Committee	Oversight	Website
IBC	rDNA/RNA, Infectious agents, Biohazards	IBC
IACUC	Use of animals	IACUC
IRB	Human subjects	IRB

TRAINING

How	Content	Where
Biosafety Training	Biosafety	https://utsa.bioraft.com/
Bloodborne Pathogens Training	Bloodborne Pathogens	https://utsa.bioraft.com/
Written document	Bloodborne Pathogens Exposure Control Plan	Bloodborne Pathogen Exposure Control Plan
Written document	Biosafety Plan	Biosafety Plan
Written document	BSL-3 Safety Plan	Keep completed doc. in the lab
Written document	Lab specific safety plans and training	Keep documents and records in the lab

OCCUPATIONAL HEALTH

What	Contact Information	Who
Medical Surveillance	Occupational Health: 210-458-5304	Works with/exposed to hazards
Lab Animal Occupational Health Program	Occupational Health: 210-458-5304	Works with/exposed to animals
BSAT Occupational Health Program	Occupational Health: 210-458-5304	Works with/exposed to BSL-3 agents/select agents

SAFETY

Tools	When	How
Biosafety Cabinets	Annual certification, pre/post/service or repair/moving	Contact the Laboratory Safety Division
Personal Protective Equipment	Per risk assessment	Contact the Laboratory Safety Division

Please contact the Laboratory Safety Division with questions or to request a consultation:
Email: LabSafety@utsa.edu Telephone: 210-458-8515

SAFETY CULTURE

WHAT IS SAFETY CULTURE

Safety culture is a part of organizational culture and is often described by the phrase “the way we do things around here”. According to the American Chemical Society, safety culture at an academic institution is a “reflection of the actions, attitudes, and behaviors” demonstrated by the faculty, staff and students concerning safety”.

Several high-profile accidents in the research world have led to the realization that ensuring excellence in research requires a strong, positive safety culture throughout the University. This means that safety is viewed as an operational priority, because of the benefits thoughtful, safe procedures and attitudes bring to research.

SAFE RESEARCH AT UTSA

Research and education in science laboratories involves a variety of hazards. It is the University of Texas at San Antonio’s (UTSA) policy to protect and promote the health and safety of students and employees as well as the environment. As an educational institution UTSA endeavors to impart a foundation of safety culture that will prepare students to be safe and skilled scientists in academia or industry.

Safety in the laboratory can be achieved only with the exercise of sound judgment and proper use of facilities by informed, responsible individuals.

Safe research starts with recognizing that safety is a fundamental part of the scientific process, adding value by exerting greater control, reducing uncertainty, and increasing the safety and quality of your results or product.

RESEARCH SAFETY EXPECTATIONS

The University expects that all members of our research community integrate safety into their research activities and go beyond minimum compliance. The following elements (Fig 1) help lay the foundation to build and support a safe and productive research environment:

Figure 1. Four Elements of Research Safety

A. Leadership

Lead by example, adhere to the rules, and be willing to speak up if you see unsafe practices. Faculty and other supervisor are urged to include safety on the agenda and incorporate it into their group thinking and practices.

- *Lab members openly discuss safety concerns.*
- *PI/laboratory manager and research group members maintain an environment in which personnel feel free to raise concerns.*
- *Actions confirm safety as a priority that supports and is compatible with good research.*
- *The feedback loop on safety issues (bottom-up and top down) is closed (addressed) at the PI/lab management level.*

B. Design

Take the time to systematically assess risk and plan for the hazards identified. Incorporate safety into laboratory procedures.

- *PI/lab manager understands the risks of the research being conducted, are actively involved in the laboratory safety program, and integrate safety into the laboratory research culture.*

C. Execution

Take action to control your risks. Make sure you have the right protective equipment, engineering controls are working correctly, and researchers are training to safety perform their work. Principal investigators must enforce the established controls in their lab.

- *PI/lab manager ensures that the personnel, equipment, tools, procedures, and other resources needed to ensure safety in the academic research laboratory are available.*
- *Lab members identify and manage their own safety environment and are receptive and responsive to queries and suggestions about laboratory safety from their lab colleagues.*
- *Lab members conduct their research using protocols and procedures consistent with best safety practices in the lab.*

D. Adaptability

Research is not a static endeavor; managing safety requires ongoing reassessment, feedback, and reinforcement. Encourage reporting by members when identifying and reviewing lessons learned after and using these as teaching opportunities. Involve all lab incidents and near-misses.

- *PI/lab manager evaluates the laboratory safety status themselves and knows what and how to manage changes to enhance safety in the laboratory.*
- *The PI/lab manager and lab group supports a continuous learning environment in which opportunities to improve safety are sought, communicated and implemented.*
- *Safety discussions become part of regular lab meetings; near misses within the lab are reported in a timely manner and safety information is requested by lab members to prevent future mishaps through understanding HOW and WHY.*

A. Delegation

Within a lab responsibility for various activities and training may be delegated, by the PI, to a Laboratory Manager, Senior Researcher or Graduate Student. This can provide valuable experience and ensure there are several individuals assisting less experienced researchers. However, there are often two potential issues associated with this model: (1) the delegation involves responsibility but may have little or no authority or power to enforce practices, and (2) communication between the PI and Manager can be affected by numerous demands on PI time. Preparing for these challenges assists in developing and maintaining a strong and healthy research environment. Some key aspects of effective delegation include matching the correct skill level to the task, having firm goals, and providing solid support.

B. Psychological Safety

Cultivating psychological safety within the culture of your research group provides the basis for a sense of openness and trust. These group-level interactions provide a conducive environment for lab members to feel accepted and respected (Fig 2). When psychological safety is rooted in a lab's culture, the ability to address the potential physical safety and health issues inherent in conducting research is enhanced. With greater safety comes greater control and better science.

Psychological Safety has been shown to provide workplace benefits in different ways, including:

- *Acknowledges limits of current knowledge and improves team innovation*
- *Improves likelihood that an attempted process innovation will be successful*
- *Promotes active listening and learning from all members*
- *Increases capacity to learn from mistakes*

Good lab management and leadership provides a closed loop for Psychological Safety. The two most essential actions identified for this functionality are (1) participatory management and (2) Inclusive management. A clear team structure and strong team relationships are characteristics most conducive to Psychological Safety.

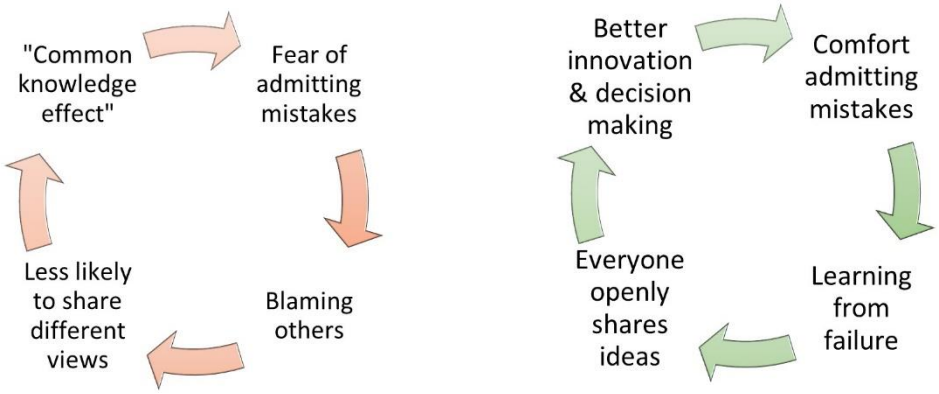


Figure 2. Psychological Danger vs Psychological Safety

RISK ASSESSMENT FOR RESEARCH

Evaluation and assessment of risk is a key part of designing and conducting an experimental protocol. Not only does a thorough risk assessment allow researchers to systematically identify and control hazards, but it also improves the quality of science through more thorough planning, a better understanding of the variables, and by sparking creative and innovative thinking. It allows one to implement tighter controls which reduces uncertainty and increases the safety and quality of your results/product. Failure to consider risk and hazards from the beginning of experimental design can produce delays, roadblocks, and frustration later in the process.

The Risk Assessment process is broken down into four steps: and by sparking creative and innovative thinking.

A. Explore

Determine the scope of your work, beginning with research objective. What question(s) are you trying to answer? Conduct a broad review of the literature. Speak with others who have done similar work. Are the risks different for different approaches?

B. Plan

Outline your procedure/tasks. This may include a deeper dive into specific topics in the literature. Determine hazards associated with each step, and control measures for reducing risk. The Laboratory Safety Division can help with more detailed guidance on how to handle certain hazards.

C. Challenge

What assumptions did you use? Question the importance of each step. Seek advice from others. Ask yourself "what could go wrong?". Have I missed anything? Consider all possible outcomes, how high is the risk?

D. Assess

Implement a model, prototype, or trial run. Can you perform a dry run to familiarize yourself with equipment and procedures? Can you test your experimental design at a smaller scale or with a less hazardous material? Determine if any design changes are needed. Run your experiment and monitor how your controls perform. Assess as you go and make changes as needed.

HIERACHY OF CONTROLS

Controlling exposure to hazards is a fundamental reference for protecting individuals against hazards. The hierarchy of controls is commonly represented as:

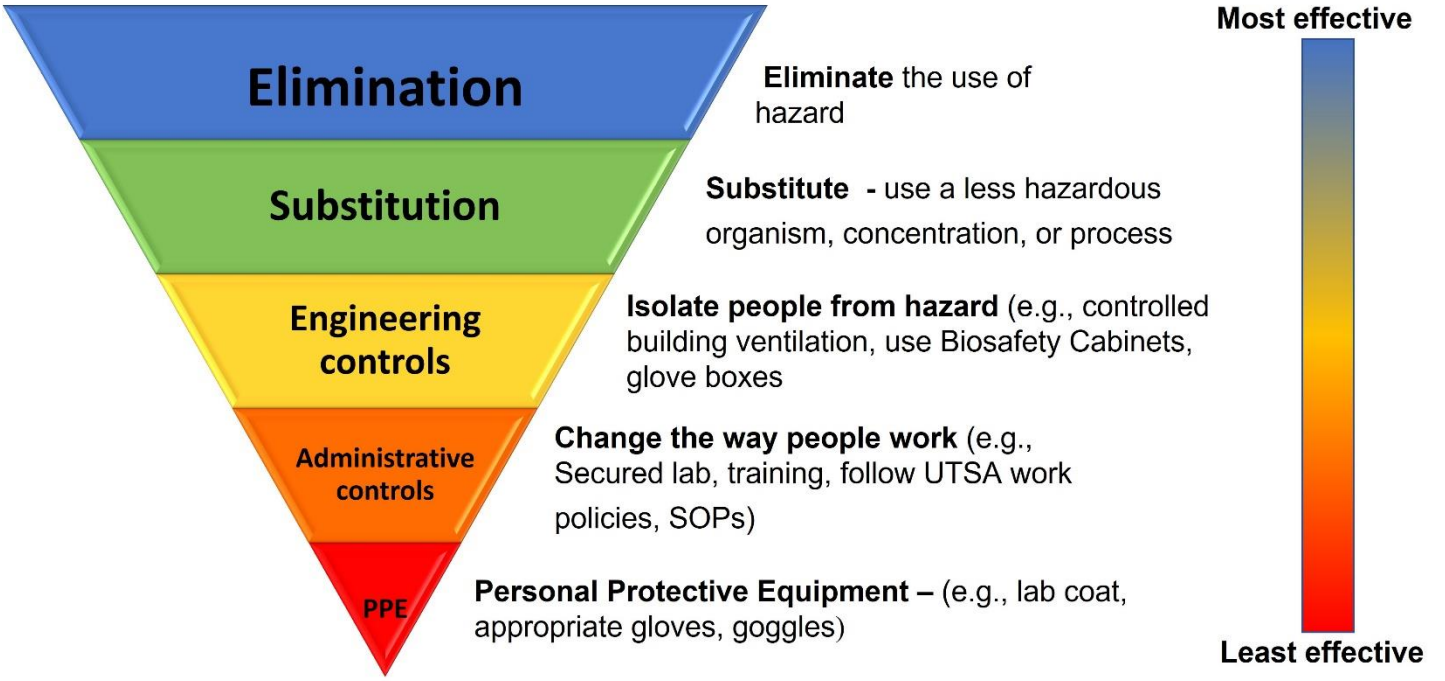


Figure 3. Hierarchy of controls for minimizing hazards.

A. Elimination

While elimination of a hazard is always the safest option it is often not practical in the research environment. Elimination of hazards can be effective when designing new projects but difficult or impossible for existing studies. An example of eliminating a hazard would be autoclaving biological materials therefore removing the biohazard potential.

B. Substitution

Substitution is often an easier option in procedures. Substitution can be common in many biological studies involving infectious agents where a virulent pathogen is replaced with a less virulent, or attenuated strain.

C. Engineering Controls

Engineering controls are a key laboratory feature and are designed to remove the hazard at the source before it can encounter the worker. Engineering controls are highly effective as a safety measure if they are used correctly. Examples of the most used engineering controls in biological facilities are Biosafety Cabinets. These are highly effective at protecting the worker and the samples. However, to be effective the worker must understand how to safely use the equipment and maintain it.

D. Administrative Controls

Administrative controls are used extensively to support safety in facilities. Examples of administrative controls include Standard Operating Procedures (SOPs), Safety Committee protocols, training, and safety plans. The effectiveness of administrative controls is often overlooked as it can be time consuming however, they are an essential component of any strong safety program.

E. Personal Protective Equipment

Personal Protective Equipment (PPE) is generally considered one of the least effective safety controls. PPE does not control the hazard at the source rather protects the worker if all other control methods have failed. As with engineering controls, PPE is only effective if used and maintained correctly.

SAFETY CULTURE AND BIOSAFETY

What is special or unique about Safety Culture for researchers working with biological agents or rDNA? All the above attributes form the basis for safe research but just like any science specialty, there are unique issues that must be considered when working with these materials, including:

- *They can be alive and as such, can grow, replicate and sometimes, move.*
- *Their effect on the researcher can be influenced by the health of the researcher.*
- *They can spread through numerous mechanisms (droplet, aerosol, mucosal, oral, fecal, blood borne).*
- *They can insert themselves into a genome and have long term effects.*

Many factors that must be considered when planning to work with biologicals and/or rDNA; many of these issues will be discussed in this manual. This is not intended to be a fully comprehensive reference but rather a guidebook. There may be agents, procedures and other circumstances in each laboratory that present unique or unusual hazards not addressed in this manual. If necessary, such hazards are best addressed by the principal investigator or supervisor of the respective laboratory in consultation with the Laboratory Safety Division.

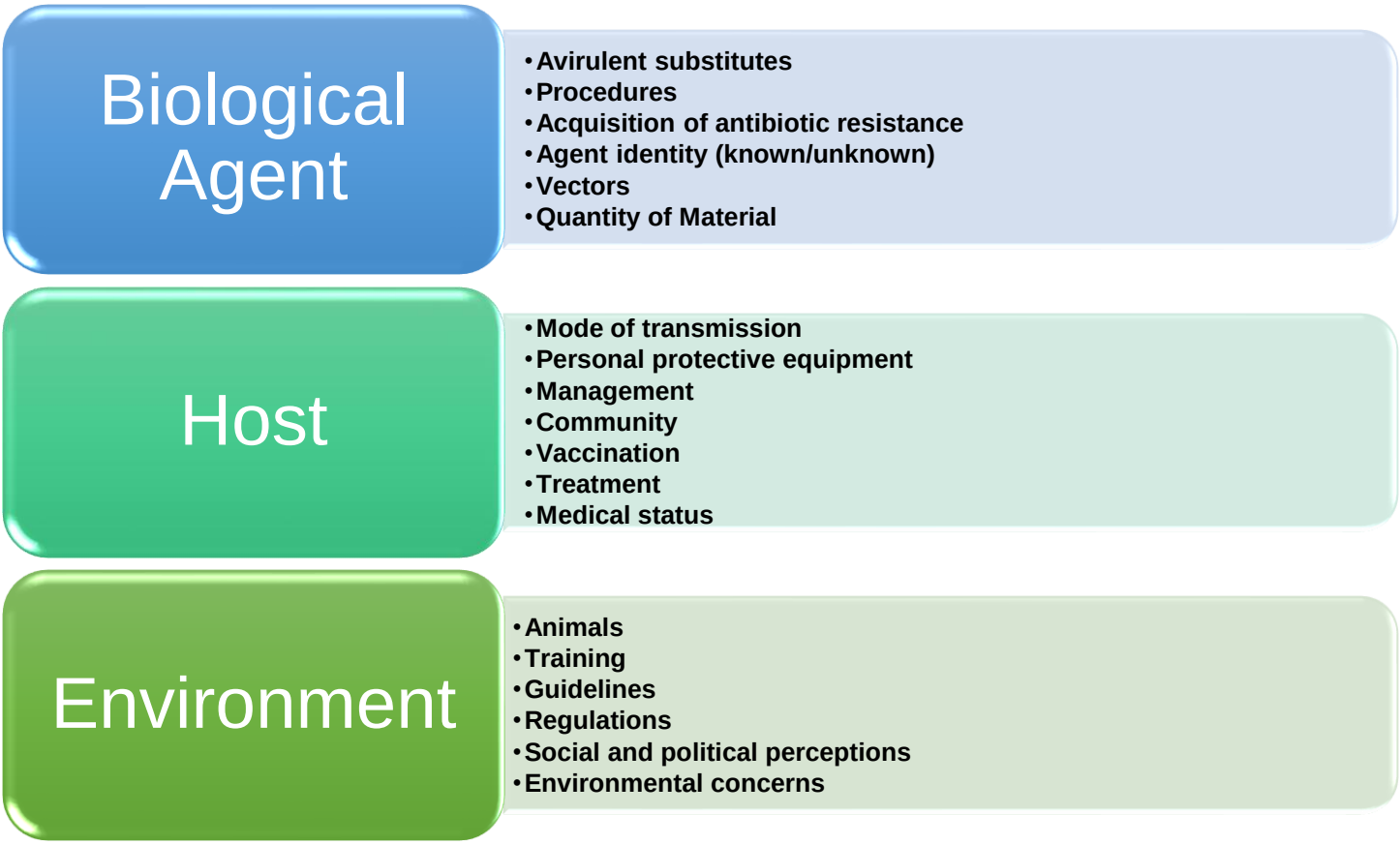


Figure 4. Factors to consider when working with biologicals and/or recombinant nucleic acids.

INFECTIOUS AGENTS

Laboratories working with any infectious agent, or potentially infected material, pose a significant risk to individuals working in them and in proximity to them. There are many examples of researchers contracting infections from agents they are working with. Infections can occur in any lab but is most highly correlated with lack of training or inexperience.

BLOODBORNE PATHOGENS – TISSUE CULTURE, HUMAN AND NON-HUMAN PRIMATE TISSUE

Human cells and bodily fluids present a hazard to researchers associated with bloodborne pathogens such as:

- Hepatitis B virus (HBV)
- Hepatitis C virus (HCV)
- Human immunodeficiency virus (HIV)

In addition, there are many other infectious agents in human and non-human primate tissues and body fluids that present a risk including:

- Herpes B virus
- *Mycobacterium tuberculosis*
- *Toxoplasma*

Commonly used cell lines used in laboratories can also contain viral agents (for example HeLa cell lines contain Human papillomavirus 16 and 18), viral genomic material and tumorigenic genes. All of these can pose a hazard to researchers.

Cultured cells that contain a known bacteria or viral agent are classified at the same Biosafety Level (BSL) as the wild-type agent. Otherwise, human, and non-human primate cells are handled using BSL-2 practices and containment. Examples of material that must be handled according to BSL-2 practices and procedures include (but are not limited to):

1. Blood cells, lymphoid cells, and neural tissue.
2. All primary cell lines.
3. Secondary (immortalized) cell lines.
4. Cell lines exposed to, or transformed by, a human or non-human primate oncogenic virus.
5. Cells deliberately exposed to a pathogenic agent.
6. Fresh or frozen tissue explants.
7. Saliva, semen, breast milk, cerebrospinal fluid.

LABORATORY ACQUIRED INFECTIONS – CASE STUDY

On October 30, 2010, a national network established to monitor foodborne diseases detected a multistate cluster of *Salmonella typhimurium* infections with a specific genetic characteristic. Between August 20, 2010, and June 29, 2011, 109 individuals, across 38 states, were infected with the same strain of *Salmonella*. Infected individuals ranged in age from <1 year to 91 years old. Twelve percent of the patients were hospitalized, and one patient died.

Preliminary analysis of the cluster indicated that clinical and teaching microbiology teaching laboratories were the likely source of the infection. Illnesses were identified in among students who had participated in microbiology teaching classes and employees in clinical microbiology laboratories. Multiple individuals had worked with *Salmonella* in a microbiology teaching laboratory in the week before falling ill. The strain isolated from the patients was indistinguishable from a commercially available strain used in laboratory settings. The same commercially available strain was used in several teaching and clinical laboratories associated with ill students or employees. Several children who lived in households with a person who had worked or studied in a microbiology laboratory became ill with the outbreak strain.

Factors thought to contribute to the outbreak included:

Lack of safety training, awareness, and materials.

Use of handheld devices (e.g., cell phones, laboratory notebooks) in the lab.

LESSONS LEARNED

Bacteria used in laboratories can infect you and your close contacts.

Bacteria can be spread on contaminated lab coats, pens, notebooks, and other items you bring into the lab.

Personnel must be aware of the hazards and trained in biosafety practices and techniques.

Frequent handwashing is essential, particularly before leaving the lab.

Items not needed for research should remain outside the lab (e.g., cell phones, food and drinks, and other personal items.

Lab coats should always be worn in the laboratory and removed before leaving the lab space.

(CDC, Human *Salmonella typhimurium* infections associated with exposure to clinical and teaching microbiology laboratories. January 17, 2012)

UNIVERSAL PRECAUTIONS

UNIVERSAL PRECAUTIONS

Universal precautions is the concept of treating all human and non-human primate material, including cell lines, as if they contain a pathogen.

All human and non-human primate blood, blood products, body fluids, and unfixed human tissue must be handled with Universal Precautions and BSL-2 practices and containment. The precautions include:

- Frequent hand washing
- No food or drink in the laboratories
- No mouth pipetting
- Engineering controls:
  - Biosafety cabinets
  - Closed top centrifuge rotors
  - Ventilation systems
- Personal Protective Equipment (PPE) such as:
  - Gloves
  - Laboratory Coats
  - Eye Protection

LABORATORY COATS

Did you know that laboratory coats are available, free, to all researchers from vending machines at four locations on campus: AET, BSE, SEB and MBT?

Contact the Laboratory Safety Division for your vending machine card.

BIOSAFETY LEVELS

Infectious agents are categorized into Biosafety Levels as described in the Biosafety in Microbiological and Biomedical Laboratories (BMBL), 6th Edition. Biosafety levels (BSL) are used to identify the protective measures, practices, procedures, and facilities needed in a laboratory setting to protect workers, the environment, and the public. There are four defined biosafety levels defined in the BMBL that also parallel the levels described in the

NIH Guidelines. In addition to the biosafety levels described for microbial agents there are biosafety levels for working with both animals and plants.

Work Practices	BSL-1	BSL-2	BSL-2+	BSL-3
Public Access	Not recommended	Access limited while work is in progress	Restricted	Restricted
Bench-top work	Permitted	Permitted only for low-risk procedures	Not permitted for biohazardous materials	Not permitted for biohazardous materials
Decontamination	Daily and following spills	Daily and following spills	Daily, immediately following work with biohazardous materials, and following a spill	Daily, immediately following work with biohazardous materials, and following a spill
Eating, drinking, applying cosmetics, etc.	Not permitted	Not permitted	Not permitted	Not permitted
Lab coats	Recommended	Barrier coat required	Barrier coat required	Tyvek coverall required
Personal Protective Equipment	Based on risk assessment	Required	Required	Required: must include a powered air purifying respirator (PAPR)
Biological Safety Cabinet	Not required	Required for any work likely to generate an aerosol	Required for all work with biohazardous material	Required for all work with biohazardous material
Storage Equipment	Not required	Biohazard signs required	Biohazard signs required	Biohazard signs required
Physical Containment	Decontaminate equipment after use	Use physical containment devices during procedures that have a high potential to generate aerosols. Decontaminate immediately after use.	Use physical containment devices for all activities involving biohazardous materials; open containers in a BSC. Decontaminate immediately after use.	Use physical containment devices for all activities involving biohazardous materials; open containers in a BSC. Decontaminate immediately after use.
Handwashing Facilities	Required	Required	Required	Required (foot, elbow or electronic activation required).
Pipetting	Only mechanical devices	Only mechanical devices	Only mechanical devices	Only mechanical devices
HEPA-filtered Vacuum Lines	Recommended	Required	Required	Required

Table 1. Summary of Biosafety Level Practices.

A. Biosafety Level 1 (BSL-1)

BSL-1 is suitable for work with well characterized agents that are not known to consistently cause disease in immunocompetent adult humans and present minimal potential hazard to laboratory personnel and the environment. BSL-1 labs follow basic safety procedures, called Standard Microbiological Practices and require no special equipment or design features. Standard engineering controls in BSL-1 laboratories include easily cleaned surfaces that can withstand the basic chemicals used in the laboratory.

B. Biosafety Level 2 (BSL-2)

BSL-2 is suitable for work with agents associated with human disease and pose moderate hazards to personnel and the environment. BSL-2 differs from BSL-1 in requiring that:

1. Laboratory personnel must receive specific training in handling pathogenic agents and are supervised by individuals experienced with working with the agents.
2. Access to the facility is restricted when work is being conducted.
3. All procedures with infected material are carried out in a Biosafety Cabinet (or other physical containment) if there is a potential for generating aerosols.

Design requirements for BSL-2 laboratories include hand washing sinks, eye washing stations in case of accidents, and doors that close automatically and lock. BSL-2 labs must also have access to equipment that can decontaminate laboratory waste, including an incinerator, an autoclave, and/or another method, depending on the biological risk assessment.

C. Biosafety Level 3 (BSL-3)

BSL-3 is suitable for work with indigenous, or exotic agents, that may cause serious or potentially lethal disease through the inhalation route.

Laboratory personnel receive specific training in handling pathogenic and potentially lethal agents, and they are supervised by individuals experienced at working with BSL-3 agents. A BSL-3 laboratory has special engineering and design features. Researchers perform all experiments in biosafety cabinets that use carefully controlled air flow or sealed enclosures to prevent infection. BSL-3 laboratories are designed to be easily decontaminated. These laboratories must use controlled, or "directional," air flow to ensure that air flows from non-laboratory areas (such as the hallway) into laboratory areas as an additional safety measure.

Other engineered safety features include the use of two self-closing, or interlocked, doors, sealed windows and wall surfaces, and filtered ventilation systems. BSL-3 labs must also have access to equipment that can decontaminate laboratory waste, including an incinerator, an autoclave, and/or another method, depending on the biological risk assessment. UTSA has two BSL-3 facilities. Access is highly restricted, please contact the Biosafety Officer if you wish to work with any BSL-3 agent.

D. Biosafety Level 4 (BSL-4)

BSL-4 is required for work with dangerous and exotic agents that pose a high individual risk of aerosol transmitted laboratory infections and life-threatening diseases that are frequently lethal, agents for which there are no vaccines or treatments, or work with a related agent with unknown risk of transmission.

UTSA has no BSL-4 facility and work with these agents is prohibited at the institution.

For details on all biosafety level practices and procedures in detail please refer to the BMBL.

RISK GROUPS

Risk Groups are classifications that describe the relative hazard posed by infectious agents or toxins in the laboratory. The risk group to which an infectious agent or toxin is assigned is the primary, but not only, consideration used in a biological risk assessment to determine the appropriate biosafety level in which a worker can handle the infectious agent or toxin. Other considerations used in a biological risk assessment include the ability of an infectious agent or toxin to cause disease, the way in which the infectious agent or toxin causes disease, the activities performed in the laboratory, the safety equipment and design elements present in the laboratory, and the health and training of the laboratory worker. **Risk group levels do not always correspond to biosafety levels.**

Risk groups are designated from 1 (the lowest risk) to 4 (the highest risk).

The NIH Guidelines defines the risk group as:

A. Risk Group 1 (RG1)

Agents that are not associated with disease in healthy adult humans. This group includes a list of animal viral etiologic agents in common use. These agents represent no or little risk to an individual and no or little risk to the community.

B. Risk Group 2 (RG2)

Agents that are associated with human disease which is rarely serious and for which preventive or therapeutic interventions are often available. These agents represent a moderate risk to an individual but a low risk to the community.

C. Risk Group 3 (RG3)

Agents that are associated with serious or lethal human disease for which preventive or therapeutic interventions may be available. These agents represent a high risk to an individual but a low risk to the community.

D. Risk Group 4 (RG4)

Agents that are likely to cause serious or lethal human disease for which preventive or therapeutic interventions are not usually available. These agents represent a high risk to the individual and a high risk to the community.

POLIOVIRUS ERADICATION AND CONTAINMENT

Due to the success of worldwide efforts to contain and eliminate polio, the CDC and WHO are moving towards the eventual eradication of all polioviruses. Currently, all poliovirus type 2 (PV2) materials, including WPV2, vaccine-derived poliovirus type 2 (VDPV2), and Sabin type 2-related poliovirus, are subject to containment. This includes both laboratory strains and isolates and other potentially infectious materials, such as stool or respiratory specimens that originate from areas with a high prevalence of poliovirus. The CDC and WHO plans to move towards the containment of all poliovirus types. Users of these materials will eventually be asked to register with the CDC as a designated poliovirus essential facility. The criteria for these facilities are like Biosafety Level 3 laboratories with additional biosecurity elements. Please refer to the CDC webpage and the

WHO GAPIII document for more information on the upcoming requirements and conditions for poliovirus research. Laboratories using poliovirus or other materials potentially containing poliovirus are encouraged to re-evaluate their use of these materials and destroy any unneeded samples. If you are currently working with poliovirus or materials that may contain poliovirus, contact the Biosafety group.

SELECT AGENTS AND TOXINS

Select Agents and Toxins are a collection of 67 designated infectious agents and toxins, that the US Government have determined have the potential to pose a severe threat to public health and safety. Use of Select Agents and Toxins is controlled by several legislative acts:

1. Antiterrorism and Effective Death Penalty Act
2. USA PATRIOT Act
3. Public Health Security and Bioterrorism Preparedness and Response Act

These acts restrict the transfer, possession and used of biological agents, and toxins, that have the potential to be a severe threat to public or environmental health. Possession of select agents without registration carries civil and criminal penalties.

UTSA has an approved registration to work with Select Agents over the exempted quantities however no work with any select agent or toxin should proceed without the prior approval of the UTSA Select Agent Responsible Official. To discuss initiating work with select agents please contact amanda.haley@utsa.edu or dianna.olukotun@utsa.edu.

A complete list of select agents and toxins can be found on the Federal Select Agents Registry website.

UTSA SELECT TOXINS PROGRAM

Possession of small quantities of select toxins may be exempt from registration with the federal select agent program. Use of these toxins requires approval from the Biosafety Officer and the Institutional Biosafety Committee. Select toxins may be used in laboratories in the following exempt quantities (if your lab has over the exempt quantity on hand at any one time you must contact the Responsible Official immediately):

TOXIN	PERMISSABLE AMOUNT (TOTAL IN LAB)
Abrin	1000 mg
Botulinum neurotoxins	1 mg
Short, paralytic alpha conotoxins	100 mg
Diacetoxyscirpenol (DAS)	10, 000 mg
Ricin	1000 mg
Saxitoxin	500 mg
Satphylococcal Enterotoxins (Subtypes A, B, C, D, E)	100 mg
T-2 Toxin	10,000 mg
Tetrodotoxin	500 mg

Table 2. Exempt quantities of Select Toxins.

DUAL USE RESEARCH OF CONCERN

A subset of research that has the greatest potential for generating information that could be readily misused to threaten public health and national security has been termed “dual use research of concern” or DURC. Regulation of DURC is administered by the NIH and managed by the UTSA Institutional Review Entity (IRE).

The DURC policies are currently restricted to a subset of 15 biological agents and toxins and 7 categories of experiment.

A. Regulated agents

1. Avian influenza (highly pathogenic)
2. *Bacillus anthracis*
3. Botulinum neurotoxin
4. *Burkholderia mallei*
5. *Burkholderia pseudomallei*
6. Ebola virus
7. Foot-and-mouth disease virus
8. *Francisella tularensis*
9. Marburg virus
10. Reconstructed 1918 influenza virus
11. Rinderpest virus
12. Toxin-producing strains of *Clostridium botulinum*
13. Variola major virus
14. Variola minor virus
15. *Yersinia pestis*

B. Experiment categories

1. Enhances the harmful consequences of the agent or toxin
2. Disrupts immunity or the effectiveness of an immunization against the agent or toxin without clinical or agricultural justification

3. Confers to the agent or toxin resistance to clinically or agriculturally useful prophylactic or therapeutic interventions against that agent or toxin or facilitates their ability to evade detection methodologies

4. Increases stability, transmissibility, or the ability to disseminate the agent or toxin

5. Alters the host range or tropism of the agent or toxin

6. Enhances the susceptibility of a host population to the agent or toxin

7. Generates or reconstitutes an eradicated or extinct agent or toxin

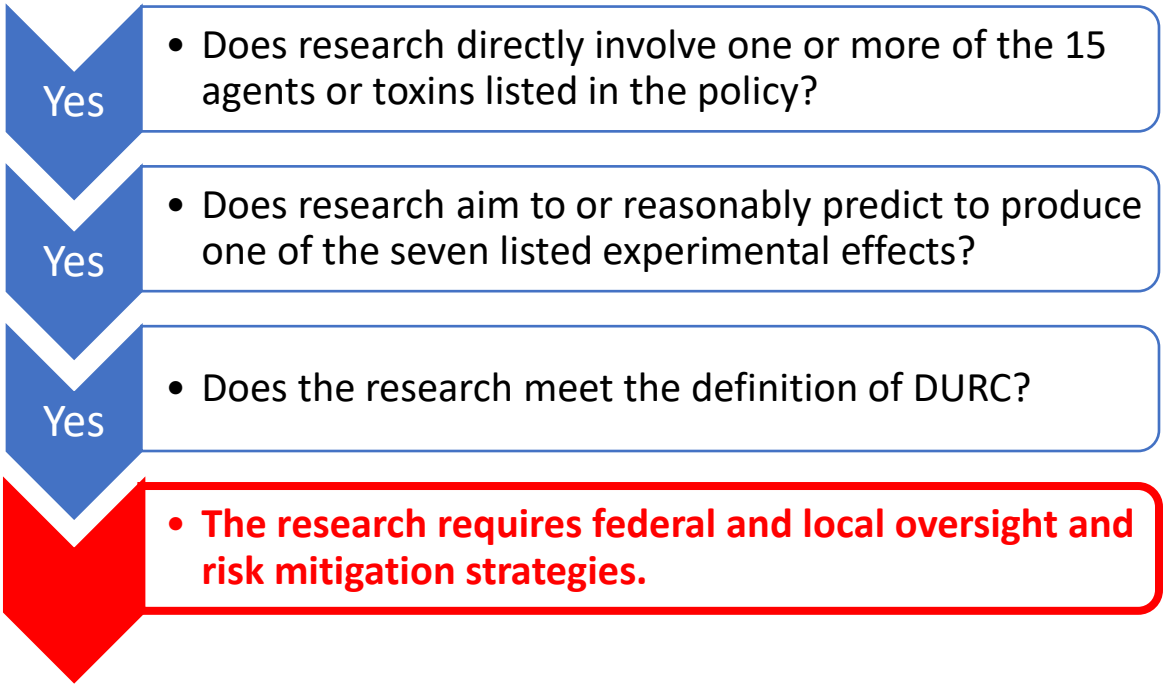


Figure 5. Determining whether research meets DURC criteria.

PRIONS AND PRION-LIKE PROTEINS

PRIONS AND PRION-LIKE PROTEINS

Research related activities involving prions directly, tissue that contains prions, or tissue that could be contaminated with prions should be handled with caution and all projects involving this material reviewed by the IBC.

Prions and prion-like proteins are defined as proteins that fall into one of the categories listed below:

1. Proteins that are associated with pathology including, but not limited to:

    a. Major prion protein/PrP/CD230 Creutzfeldt-Jakob Disease (CJD), variant CJD (vCJD), Kuru, fatal familial insomnia, bovine spongiform encephalopathy (BSE), Gerstmann Strausler-Scheinker syndrome.

    b. Alpha-synuclein (Parkinson's Disease)

    c. Tau, beta-amyloid (Alzheimer's Disease)

    d. Tau, RNA-binding protein Fused in Sarcoma (FUS) (Frontotemporal lobar dementias)

    e. Polyglutamine-containing proteins (polyQ) (Huntington's Disease)

    f. Superoxide dismutase 1 (SOD1); transactivation response element (TAR) DNA binding protein-43 (TDP-43; RNA-binding protein Fused in Sarcoma (FUS); Ubiquilin (ALS/Lou Gehrig's Disease)

2. Proteins that confer a disease state that is transmissible from cell to cell.

3. Proteins that have a fibrillar, or aggregated form, that has been shown to cause a pathology associated with a disease.

Human prions are commonly handled and BSL-2 or 3. The biosafety level is dependent on the activities conducted and on the risk assessment performed prior to work commencing. The risk assessment should account for the nature and host range of the agent, as well as procedures, concentration and quantity of the agent. Due to the high probability that BSE prions have been transmitted to humans BSL-3 facilities may be more appropriate for certain procedures.

DISEASE	NATURAL HOST	PRION	PATHOGENIC PrP ISOFORM	BIOSAFETY LEVEL
Scrapie	Sheep and goats	Scrapie prion	$OvPrP^{Sc}$	**2**
Transmissible Mink Encephalopathy (TME)	Mink	TME prion	$MkPrP^{Sc}$	**2**
Chronic Wasting Disease	Mule deer, elk, and white tail deer	CWD prion	$MdePrP^{Sc}$	**2**

Bovine Spongiform Encephalopathy	Cattle	BSE prion	$BoPrP^{Sc}$	**2/3**
Feline Spongiform Encephalopathy (FSE)	Cats	FSE prion	$FePrP^{Sc}$	**2**
Exotic Ungulate Encephalopathy (EUE)	Nyala, greater kudu, oryx	EUE prion	$UngPrP^{Sc}$	**2**
Kuru	Humans	Kuru prion	$HuPrP^{Sc}$	**2/3**
Creutzfeldt-Jakob Disease (CJD)	Humans	CJD prion	$HuPrP^{Sc}$	**2/3**
Gerstmann Strausler-Scheinker Syndrome	Humans	GSS prion	$HuPrP^{Sc}$	**2/3**
Fatal Familial Insomnia (FFI)	Humans	FFI prion	$HuPrP^{Sc}$	**2/3**

Table 3. Summary of common prion diseases and suggested biosafety levels (BMBL, 6th ed.)

COMPLIANCE

All protocols for working with prions or prion-risk materials must be approved by the IBC before work begins. A United States Department of Agriculture (USDA) permit is required to receive and work with animal prions.

HIGH RISK MATERIALS

The highest concentration of prions is found in the central nervous system (CNS), and extreme caution should be used with CNS samples. Prions can also be found in cerebrospinal fluid (CSF), lung, liver, kidney, spleen/lymph nodes, and placenta.

Unfixed samples of tissues known to, or suspected to, contain human prions should be handled at BSL-3. It is also recommended that animal tissue samples known to, or suspected to, contain BSE prions should also be handled at BSL-3. For other samples, the biosafety level will be dependent on the risk assessment and the amount of material.

Formaldehyde or formalin-fixed, glutaraldehyde-fixed and paraffin-embedded tissues, particularly of the brain can remain infectious for extended periods of time. They should be handled with the same level of caution as fresh materials from fixation through embedding, sectioning, staining and mounting on slides, unless treated with 95% formic acid.

LABORATORY TRANSMISSION

There are no documented examples of a laboratory-acquired prion infection however the primary hazard is accidental parenteral inoculation or ingestion. Cuts and punctures should be avoided, and the use of sharps minimized. Cut resistant gloves should be worn if the use of sharps cannot be avoided.

Wherever possible laboratory equipment used for work with prions should be dedicated to this work alone. All employees must be informed and aware of the potential for prion contamination if work with known or suspected prion infected material is in use. The use of PPE is mandatory and should be kept separate from PPE used for other tasks.

DECONTAMINATION OF WASTE FROM PRION CONTAMINATED MATERIAL

The following provisions for decontamination of waste, reusable instruments and contaminated surfaces must be followed to assure effective inactivation of prions:

A. Liquid Waste

Liquid waste can be treated in the following ways:

1. Mix with NaOH for a final concentration of 1.0 N NaOH and hold at room temperature for 1 hour: or
2. Mix with bleach for a final concentration of 20,000 ppm available chlorine and hold at room temperature for 1 hour.

Decontamination should be conducted in a fume hood for the duration of the treatment. After treatment the waste can be neutralized and discharged to the sewer via the lab sink or submitted as liquid chemical waste.

B. Contaminated Surfaces

Contaminated surfaces can be treated in the following ways:

1. Bleach solution (20,000 ppm available chlorine) for 1 hour; or
2. 1N NaOH for 1 hour

After treatment the surfaces should be thoroughly rinsed with water.

C. Contaminated Reusable Instruments

Contaminated reusable instruments can be treated in the following ways:

1. Immerse in 1N NaOH or sodium hypochlorite (20,000 ppm available chlorine) for 1 hour, transfer to water, autoclave (gravity displacement) at 121^{o}C for 1 hour.
2. Immerse in 1N NaOH or sodium hypochlorite (20,000 ppm available chlorine) for 1 hour, transfer to water, autoclave (gravity displacement) at 121^{o}C for 1 hour or at 134^{o}C for 1 hour (porous load).
3. Immerse in 1N NaOH or sodium hypochlorite (20,000 ppm available chlorine) for 1 hour.

D. Contaminate Dry Waste

All contaminated dry waste should be sent for incineration and clearly marked. Contact the Laboratory Safety Division for assistance with treatment and disposal.

E. Spills

All laboratories with prion-risk materials must have an established procedure for spill management. All spills must be reported immediately to the UTSA Biosafety Officer .

F. Exposures

Intact skin exposure to prion-risk materials should be washed thoroughly for at least 15 minutes. For needlesticks or lacerations, gently encourage bleeding of the site, wash with soap and water, rinse, and cover with a waterproof dressing.

All exposures must be immediately reported to Occupational Health or Student Health Services for further guidance and treatment.

All exposures must be reported to the UTSA Biosafety Officer .

REFERENCES

For further information regarding prions and prion work please refer to:

Biosafety Microbiological and Biomedical Laboratories (Section VIII-H Prion Diseases)

Centers for Disease Control and Prevention (CDC) (Prion Diseases)

RECOMBINANT AND SYNTHETIC NUCLEIC ACIDS

Recombinant and synthetic nucleic acids are defined as:

1. Recombinant Nucleic Acid molecules:
    a. Are constructed by joining nucleic acid molecules
    b. Can replicate in a living cell
2. Synthetic Nucleic Acid molecules:
    a. Chemically, or by other means, synthesized or amplified, including those that are chemically or otherwise modified but can base pair with naturally occurring nucleic acid molecules
3. Molecules that result from the replication of those described in 1 and 2.

NIH GUIDELINES

The use of recombinant DNA (rDNA) and synthetic nucleic acids (sNA) are regulated by the National Institutes of Health (NIH); the guidelines can be found in the publication NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules (NIH Guidelines) (Guidelines) (http://osp.od.nih.gov/office-biotechnology-activities/biosafety/nih-guidelines). These guidelines are the official guide to all rDNA and sNA work done at UTSA. It is important to realize that following these guidelines is the responsibility of all investigators at UTSA and not solely that of investigators that are funded by NIH.

EXEMPT rDNA/sNA

The guidelines specify several different categories of rDNA/sNA molecules. One of the most important categories is the Exempt category (experiments are exempt from the NIH Guidelines). Experiments that qualify for this category are still reviewed by the UTSA IBC to ensure all applicable safety protocols are in place and to determine whether the experiments truly meet the requirements of exempt experiments, see Chapter 5). To determine if your experiments are **exempt**, you can check Section III, Category F in the NIH Guidelines (online); a short reference guide is presented in Table 1.

STUDY DESCRIPTION	YES / NO	EXEMPT CATEGORY
Is your synthetic nucleic acid designed to: (1) neither replicate nor generate nucleic acids that can replicate in any living cell, and (2) not integrate into DNA, and (3) not produce a toxin that is lethal for vertebrates at an LD50 of less than 100 nanograms per kilogram body weight?	YES	**III-F-1**
Is your recombinant or synthetic nucleic acid molecule not in an organism, cell or virus and not been modified or manipulated to render it capable of penetrating cellular membranes?	Yes	**III-F-2**
Is your recombinant or synthetic nucleic acid molecule solely from a single source that exists contemporaneously in nature?	Yes	**III-F-3**

Is your recombinant or synthetic nucleic acid molecule solely from a prokaryotic host and propagated in the same host or transferred to another host by naturally occurring means?	Yes	**III-F-4**
Is your recombinant or synthetic nucleic acid molecule from a eukaryotic host and propagated in the same host?	Yes	**III-F-5**
Is your recombinant or synthetic nucleic acid molecule from species that naturally exchange DNA?	Yes	**III-F-6**
Does your genomic DNA contains a transposable element that does not contain any recombinant and/or synthetic nucleic acids?	Yes	**III-F-7**
Recombinant or synthetic nucleic acid molecule which does not present a significant risk to health or the environment, as determined by the NIH*	Yes	**III-F-8**

The NIH has determined that rDNA/sNA from infectious agents of BSL-2 (see Appendix A) or above is* **not exempt *and must receive Biosafety approval. Additionally, certain* **cloning vectors***, i.e. Adeno- or Sindbis-based vectors, or amphotropic MMLV based vectors, are some examples of rDNA that are non-exempt.*

Table 4. Recombinant and synthetic nucleic acids (NIH Guidelines) – Exempt experiments.

NON-EXEMPT rDNA/sNA

All non-exempt experiments **must** obtain approval from the IBC regardless of your department or funding source, these are briefly described in Table 2.

NIH GUIDELINE SECTION	APPROVAL REQUIRED FOR EXPERIMENTS INVOLVING	FURTHER INFORMATION
III-A-1-a	**Deliberate transfer of a drug resistance trait to microorganisms that are not known to acquire the trait naturally if such acquisition could compromise the ability to control disease agents in humans, veterinary medicine or agriculture.**	• Transferring a drug resistance trait that is used, had previously been used, may be used (including outside the U.S.), or that is related to other drugs that are used to treat or control disease agents. Examples include transfer of: erythromycin resistance into Borrelia burgdorferi; pyrimethamine resistance into Toxoplasma gondii; chloramphenicol resistance into Rickettsia conorii; tetracycline resistance into Porphyromonas gingivalis
III-B-1	**Cloning of DNA, RNA or synthetic nucleic acid molecules encoding toxins lethal to vertebrates at an LD50 of <100 ng/kg body weight.**	• Cloning toxins (or using plasmids that express toxins with low LD50s). Examples include: botulinum, tetrodotoxin, ricin, T-2, saxitoxin, abrin, tetanus, Shigella dysenteriae neurotoxin, pertussis, Staph aureus Beta, shigatoxin, and conotoxins.
III-C-1	**Transfer of recombinant or synthetic nucleic acid molecules, or DNA or RNA derived from recombinant or synthetic nucleic acid molecules into human research participants.**	• Use of recombinant or synthetic nucleic acid molecules, or DNA or RNA derived from recombinant or synthetic nucleic acid molecules, that meet ANY of the following four criteria: • Contain >100nt, or Possess biological properties that enable genome integration, or • Have the potential to replicate in a cell, or • Can be translated or transcribed. Examples include: use of a defective adenoviral vector to deliver the CFTR gene intranasally to patients with Cystic Fibrosis; introduction of an HSVTK transduced cell line into

		patients with epithelial ovarian carcinoma; introduction of a shRNA delivered in a plasmid, bacterial or viral vector.
III-D-1	**Risk Group 2, Risk Group 3, Risk Group 4 or Restricted Agents used as Host-Vector Systems.**	• The introduction of recombinant or synthetic nucleic acid molecules into Risk Group 2, 3, 4, or Restricted Agents that meet ANY of the following criteria: • Have the potential to replicate in a cell, or • Possess biological properties that enable genome integration, or • Produce a toxin lethal to vertebrates at an LD50 of <100ug/kg body weight. Examples include: Adenovirus, Herpes virus, Lentivirus, Amphotropic or VSV-g pseudotyped Murine Retrovirus, Human Retrovirus, Vaccinia virus Vesicular Stomatitis virus, and Adeno-Associated virus with helper virus.
III-D-2	**DNA from Risk Group 2, Risk Group 3, Risk Group 4 or Restricted Agents cloned into nonpathogenic prokaryotic or lower eukaryotic host-vector systems.**	• Transfer of DNA from Risk Group 2, 3, 4, or Restricted Agents into nonpathogenic prokaryotes or lower eukaryotes. • Use of pathogens or defective pathogens as vectors. Examples include: Adenovirus, Herpes virus, Lentivirus, Amphotropic or VSV-g pseudotyped Murine Retrovirus, Human Retrovirus, Vaccinia virus Vesicular Stomatitis virus, and Adeno-Associated virus with helper virus.
III-D-3	**Infectious DNA or RNA viruses or defective DNA or RNA viruses in the presence of helper virus in tissue culture systems.**	• rDNA experiments involving Risk Group 2, 3, or 4 pathogens. • rDNA experiments involving ≤ 2/3 of the genome from eukaryotic viruses in the presence of a helper virus. Examples include: HIV, HTLV-I & II, West Nile Virus, and Lymphocytic Choriomeningitis Virus.
III-D-4	**Whole animals, including transgenic animals.**	• Experiments utilizing any of the following that may lead to transmissible infection either directly or indirectly as a result of complementation or recombination in the animal: • 2/3 of eukaryotic viral genome, or Animals containing sequences from viral vectors, or Stable integration of recombinant or synthetic nucleic acid molecules, or nucleic acids derived therefrom, into the germline. • Use of viable recombinant or synthetic nucleic acid molecule-modified Risk Group 2, 3, 4 or Restricted Agent microorganisms tested on whole animals.
III-D-5	**Whole plants**	• Experiments involving exotic infectious agents when recombinant or synthetic nucleic acid molecule techniques are associated with whole plants. • Experiments with plants involving cloned genomes of readily transmissible exotic infectious agents. • Experiments with plants involving readily transmissible exotic infectious agents (i.e. soybean rust fungus Phakopsora pachyrhizi, maize streak or other viruses) in the presence of their specific arthropod vectors. • Experiments involving plants or their associated organisms and the introduction of sequences encoding potent vertebrate toxins. Experiments involving microbial pathogens of insects, arthropods or small animals associated with plants if the

		recombinant or synthetic nucleic acid molecule-modified organism can detrimentally impact the ecosystem.
III-D-6	**Large-Scale DNA work**	• ≥ 10 liters of culture combined. Examples include: Use of ≥10 L fermentor; growing up to five 2 L flasks of rDNA culture (i.e. E. coli K-12).

Table 5. Recombinant and synthetic nucleic acids (NIH Guidelines) experiments requiring IBC review

VIRAL VECTORS AND TRANSGENES

All vectors are not the same. More importantly, the class of gene insert can change the Biosafety level of the construct. It is also important to realize that obtaining a cloning/expression vector from a commercial source does not mean it is automatically exempt or a BSL - 1. Table 3 lists many of the more common viral vectors in combination with different classes of inserts and their associated BSL level. The UTSA IBC Policy on AAV and rAAV should also be consulted when determining appropriate biosafety levels for viral vector work.

Viral Vectors Inserts and Envelopes

Some inserts such as oncogenes or toxins will raise the biosafety containment level of the viral vector, the same is true for certain envelopes.

GENE TRANSFER VECTOR[a]	HOST RANGE[b]	INSERT OR GENE FUNCTION[c]	LABORATORY CONTAINMENT LEVEL[d]
MMLV based – *gag, pol,* and *env* deleted	Ecotropic Amphotropic, VSV-G pseudotyped	S, E, M, G, CC, T, MP, DR, R, TX O_v,O_c S, E, M, MP, DR, T, G, Ov, Oc, R, CC TX	BSL-1* BSL-2 BSL-2+ BSL-3
Herpesvirus based – nonlytic	Broad host range	S, E, M, MP, DR, T, G O_v, O_c, R, CC TX	BSL-2 BSL2+ BSL-3
Lentivirus based – HIV, SIV, EIAV, FIV, etc.; *gag, pol, env, nef,* and *vpr* deleted	Ecotropic, amphotropic, VSV-G pseudotyped	S, E, M, MP, DR, T, G Ov, Oc, R, CC TX	BSL-2 BSL-2+ BSL-3
Adenovirus based – serotypes 2, 5 and 7; E1 and E3 or E4 deleted	Broad host range	S, E, M, MP, DR, T, G, R, CC Ov, Oc, TX	BSL-2 BSL-2+ BSL-3
Alphavirus based – SFV, SIN	Broad host range	S, E, M, MP, DR, T, G, R, CC Ov, Oc, TX	BSL-2 BSL-2+ BSL-3
Baculovirus based	Broad mammalian host cell range	S, E, M, MP, DR, T, G, R, CC Ov, Oc, TX	BSL-1* BSL-2 BSL-2+/BSL-3
AAV based – *rep, cap* defective	Broad host range; infective for many cell types, including neurons	S, E, M, MP, DR, T, G Ov, Oc, R, CC TX	BSL-1* BSL-2 BSL-2+/BSL-3
Poxvirus based – canarypox, Vaccinia	Broad host range	S, E, M, MP, DR, T, G, R, CC Ov, Oc, TX	BSL-2 BSL-2+ BSL-3

[a]Refers to the parental or wild-type virus and some of the common deletions used in viral vectors. MMLV, Moloney murine leukemia virus; SIV, simian immunodeficiency virus.

[b]Refers to ability of vector to infect cells from a range of species. Ecotropic generally means able to infect only cells of the species originally isolated from or identified in. Please note that the ecotropic host for HIV and HSV would be human cells, but the ecotropic host for MMLV would be murine cells. Amphotropic and VSV-G-pseudotyped virus host range includes human cells.

[c]Shown are general categories of cellular genes and functions. Please note that there are differences in the containment level for the same class depending on whether the viral vector integrates into the recipient genome at a high rate. The general categories are as follows: S, structural proteins (actin, myosin, etc.); E, enzymatic proteins (serum proteases, transferases, oxidases, phosphatases, etc.); M, metabolic enzymes (amino acid metabolism, nucleotide synthesis, etc.); G, cell growth, housekeeping; CC, cell cycle, cell division; DR, DNA replication, chromosome segregation, mitosis and meiosis; MP, membrane proteins, ion channels, G-coupled protein receptors, transporters, etc.; T, tracking genes such as those for green fluorescent proteins and luciferases and photoreactive genes; TX, active subunit genes for toxins such as ricin, botulinum toxin and Shiga and Shiga-like toxins; R, regulatory genes for transcription and cell activators such as cytokines, lymphokines and tumor suppressors; Ov and Oc, oncogenes identified via transforming potential of viral and cellular analogs, or mutations in tumor suppressor genes resulting in a protein that inhibits/moderates the normal cellular wild-type proteins. This does not include SV40 T antigen. SV40 T-antigen-containing cells should not be considered more hazardous than the intact virus. SV40 is considered a risk level 1 agent (the lowest level) according to the NIH Guidelines. The prevalence of SV40 infection in the U.S. population due to contaminated polio vaccine does not seem to have caused a statistically significant increase in the rate of cancers. However, the data from the various studies on SV40 association with cancer are equivocal (Strickler et al. 1998; Butel and Lednicky, 1999; Dang-Tan et al., 2004).

[d]This is a general assessment of containment levels for laboratory construction and use of these vectors for nonproduction quantities only based on the 4th edition of BMBL. This table cannot cover every potential use within a research or laboratory settings; as information is gained, risk assessments and containment levels may be changed. Local IBCs should use all available information and their best judgment to determine appropriate containment levels. BSL - 1 refers to the containment level based on parent virus risk group. However, most procedures involving the handling and manipulation of the viral vectors are done at BSL - 2 to protect cell cultures and viral stocks from contamination.*

[e]Certain specific strains of poxviruses, such as MVA, NYVAC, ALVAC and TROVAC, are considered low-risk agents and can be handled at BSL - 1 in certain cases.

From Biological Safety Principles and Practices, 4th ed., pg. 524, D.O. Fleming and D.L. Hunt, Ed, ASM Press, 2006.

Table 6. Viral vectors and transgene containment

HUMAN GENE TRANSFER

Protocols involving the use of rDNA/sNA for gene transfer into humans, whether done directly in the subject or *in vitro* and subsequently put into the subject, must be submitted to both the IBC and the UTSA Institutional Review Board (IRB). Federal regulations require the local IBC, upon receiving submission of a Human Gene Transfer protocol, to review the following aspects to determine if NIH Recombinant Advisory Committee (RAC) review is required:

- *The protocol uses a new vector, genetic material, or delivery methodology that represents a first-in-human experience, thus presenting an unknown risk.*
- *The protocol relies on preclinical safety data that were obtained using a new preclinical model system of unknown and unconfirmed value.*
- *The proposed vector, gene construct, or method of delivery is associated with possible toxicities that are not widely known and that may render it difficult for oversight bodies to evaluate the protocol rigorously.*

Dependent upon the above findings the protocol will be either be submitted for RAC review or the APB will state that RAC review is not required.

Human Gene Transfer

Conducting Gene Transfer experiments into human subjects requires both IBC and IRB protocols.

GENOME EDITING AND GENE DRIVES

Multiple technologies exist to create permanent genomic modifications in *in vitro* cell culture and *in vivo* animal research models (Figure 4). Methodologies include, but are not limited to, Transcription Activator-Like Effector Nucleases (TALENS), Zinc Finger Nuclease mediated DNA repair (ZNF), Meganucleases, and CRISPR/Cas9 (clustered regularly interspaced short palindromic repeats) (Figure 5). These technologies can be used to create gene drives, a modification of an organism's genome resulting in a more efficient spread of a trait through the population as compared to Mendelian inheritance. Per NIH regulation conducting genome-editing experiments on human embryos is prohibited.

Figure 4. Wild-type and gene edited, fluorescent, fish.
Example of Gene Editing

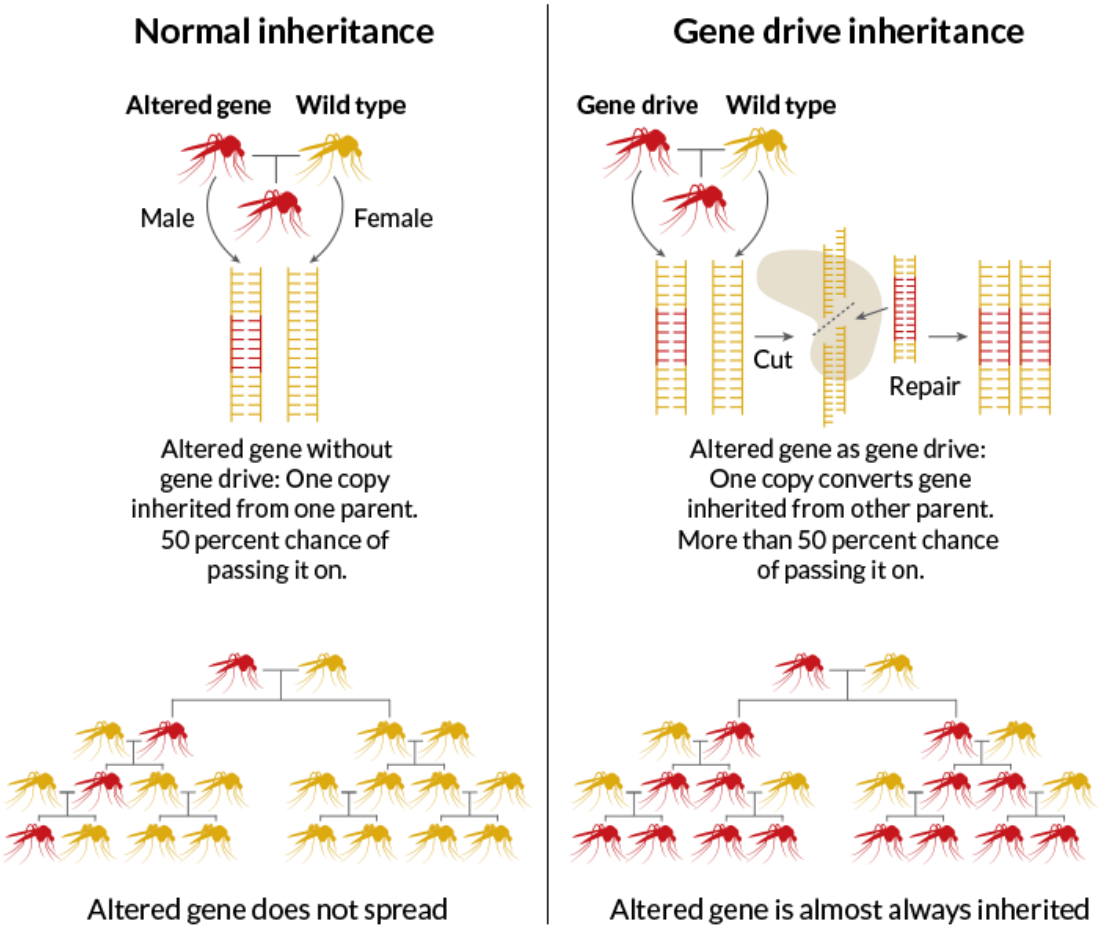


Figure 5. Genome Editing and Gene Drives
Image credit: E. OTWELL AND M. TELFER

A. Experiments that Require IBC Approval

1. Human Clinical Studies

- Experiments or protocols that include either direct gene modification or the administration of genetically modified donor cells must be reviewed and approved by both the IBC and the IRB.

2. Basic Research Studies

- **Delivery via viral vectors:** Non-exempt viral vectors and Risk Group 1 viral vectors (e.g., AAV) with human target sequences. Genome target scans of the guide RNA (gRNA) sequence is highly recommended to identify the possibility of off-target effects on the human genome. www. rgenome.net/cas-offinder.
- **Usage of a gene drive (via viral or non-viral delivery methods) with invertebrate and vertebrate animals or on plants:** In addition to the description of the planned experiments and safety of the delivery mechanism, the APB protocol must also address the following containment guidelines.
- **Molecular Containment:** Will the guide RNA and the nuclease be located at separate loci? Will a synthetic target sequence be used that is absent from the wild type target?
- **Ecological Containment:** Will the experiments be performed outside of the habitable range of the target organism.

- **Reproductive Containment:** Will a laboratory isolate/organism be utilized that cannot reproduce with wild type organisms?
- **Barrier Containment:** What physical and chemical barriers will be used to contain the organism and prevent their release into the environment.
- **Genome editing tools (delivered via viral or non-viral delivery methods that:**
    - Modify an infectious agent to increase host range transmissibility, or pathogenicity of that agent.
    - Modify the host to increase its susceptibility to an infectious agent.
    - Express a toxin with a low LD50 ($\leq$100ng/kg) in the genome of both *in vitro* and *in vivo* research models.

The UTSA IBC, as with most IBC's, also review protocols beyond recombinant and synthetic nucleic acids. The IBC's charge covers the review of any protocols involving biohazardous or potentially biohazardous material. This enables the committee to ensure that biosafety standards are in place in all labs where workers may be exposed to biological hazards.

TRANSGENIC PLANTS

Experiments involving genetic manipulation of plants requires review by the IBC. The NIH Guidelines have specific containment guidance to prevent transgenic plants from impacting the environment.

RISK ASSESSMENTS

RISK ASSESSMENT

Risk implies the probability that harm, injury, or disease will occur. In the biomedical laboratory, the assessment of risk focuses on the prevention of lab-acquired illnesses (LAI). In other laboratories, risk focuses on the release of genetically modified organisms into the environment, or the release of an exotic pest/ plant into the ecosystem. Risk assessment is a process used to identify the hazardous characteristics of a known infectious or potentially infectious agent or material, the activities that can result in a person's exposure to an agent, the likelihood that such exposure will cause a LAI, and the probable consequences of such an infection.

The information identified by risk assessment will provide a guide for the selection of appropriate BSL, microbiological practices, safety equipment, facility safeguards, medical monitoring and post exposure prophylaxis that can prevent release into the environment and LAIs.

A. Performing a Risk Assessment:

3. Identify agent hazards and perform an initial assessment of risk

Consider the principal hazardous characteristics of the agent, including its capability to infect and cause disease in a susceptible host, severity of disease, and the availability of preventative measures and effective treatments. For recombinant and synthetic nucleic acids, assess the nature of the expressed protein and the nucleic acid of interest.

4. Identify laboratory procedure hazards

The principal laboratory procedure hazards are agent concentration, suspension volume, equipment and procedures that generate small particle aerosols and larger airborne particles (droplets), and the use of sharps. Procedures involving animals can present several hazards such as bites, scratches, exposure to zoonotic agents, and the handling of experimentally generated infectious aerosols.

5. Determine the appropriate biosafety level and select additional precautions indicated by the risk assessment

The final selection of the appropriate biosafety level and the selection of any additional laboratory precautions require a comprehensive understanding of the practices, safety equipment, and facility safeguards. There will be situations where the intended use of an agent requires greater precautions than those found in an authoritative reference. These situations will require the careful selection of additional precautions. An obvious example would be a procedure for exposing animals to experimentally generated infectious aerosols or the planting of a transgenic plant.

6. Evaluate the proficiencies of staff regarding safe practices and the integrity of safety equipment

The protection of laboratory workers, other persons associated with the laboratory, and the public will depend ultimately on the laboratory workers themselves. In addition, the PI should ensure that the necessary safety equipment is available and operating properly. For example, a BSC that is not certified represents a potentially serious hazard to the laboratory worker using it, and to others in the laboratory.

7. Submit a preliminary risk assessment to Laboratory Safety and the Institutional Biosafety Committee for review

A review of the risk assessment and selected safeguards by knowledgeable individuals is always beneficial and sometimes required by regulatory or funding agencies, as is the case with the NIH Guidelines. Review of potentially hazardous protocols by the IBC is standard at UTSA.

B. Using Biosafety Levels and Risk Groups information in risk assessments

Risk assessments for biohazardous agents are not straightforward and will depend on several factors including the agent risk group and the recommended BSL. In addition, all the other factors listed below need to be evaluated before a final determination for the safe use of the agent is made:

1. Pathogenicity

The ability of a pathogenic agent to cause disease in humans, animals, and plants, including disease incidence and severity must be evaluated.

2. Route of transmission

The predominant routes of transmission in the laboratory are:

- Direct skin, eye, or mucosal membrane exposure to an agent
- Parenteral inoculation by a needle or other contaminated sharp, or by bites from infected animals
- Ingestion of an infectious agent, or by contaminated hand to mouth exposure
- Inhalation of infected aerosols

An agent capable of infecting through inhalation of an aerosol is a serious hazard to a worker. When working with plants the ability of a transgenic plant to interbreed with local plants should be considered.

3. Agent stability

The agent's ability to survive in the environment over time defines agent stability. Factors such as sunlight (UV rays), chemical disinfectants, drying, pH and the ability of an agent to form spores can all affect its stability and transmissibility.

4. Infectious dose

The infectious dose (ID) is defined as the number of individual units required to cause an infection or illness. The ID should be considered for each route of infection by the specific microorganism.

AGENT	INFECTIOUS DOSE
***Salmonella* species**	10^4 bacteria
Campylobacter jejuni	<1000 bacteria
Francisella tularensis	1-10 bacteria
Listeria monocytogenes	>100 bacteria/g
***Escherichia coli* O157**	4-20 CFUs
Yersinia enterocolitica	$>10^4$ CFUs
Giardia lamblia	10-100 cysts
Adenovirus	>150 viral particles

Coxiella burnetti	10 bacteria

Table 7. Examples of different microbial agents and their average infectious dose.

5. Origin

May refer to geographic location, host, or nature of the source.

6. Genetic modification

Genetic modifications may alter many characteristics of an agent significantly changing any of the factors used in determining hazard and risk.

7. Concentration

The number of infectious units in the samples used in the work and the milieu containing the organism (e.g., solid tissue, viscous blood, or liquid medium) and the lab activity (e.g., sonication, vortexing, pipetting etc.

8. Host factors

For a microbial agent to be a pathogen it must have a susceptible host. There are microbial agents that are pathogenic for animals and plants but not humans. There are some agents that are species specific. A laboratory workers immune status may also increase susceptibility to an agent.

9. Availability of an effective prophylaxis or therapeutic intervention

In some instances, immunization may affect the BSL required. Immunization only serves as an additional layer of protection beyond engineering controls, proper practices and procedures, and the use of personal protective equipment. Work with a pathogenic agent may need to be carried out at a higher level because there are no effective treatments available for the pathogenic agent or the agent may be resistant to normal treatment regiments (e.g., multi-drug resistant *Mycobacterium tuberculosis*). For persons working with animals and human blood lines or blood products, the Hepatitis B vaccination is available prior to beginning work or contact with these materials. The Hepatitis B vaccine is important in preventing laboratory/ clinically acquired Hepatitis B infection.

10. Skill level of employees

The PI should determine the educational and skill level of the employee/student and their ability to implement safe work practices with the pathogenic agent. If there are additional trainings needed the PI must ensure the employee/student receives those trainings before performing laboratory work. Those working in animal facilities or in a BSL3 or ABSL3 are required to undergo specific trainings for those facilities in addition to those listed earlier in the BSG. An individual must demonstrate proficiency at the lower biosafety level(s) during the training process prior to “graduating” and being permitted to work at the next higher level (e.g., demonstrate ABSL2 proficiency before working at ABSL3). Unless personnel have met all training requirements in a proficient manner, they should not be performing experiments at that BSL.

INSTITUTIONAL BIOSAFETY COMMITTEE

The NIH mandates that an Institutional Biosafety Committee (IBC) be in place for all organizations that come under the NIH regulations.

IBC REVIEW

The IBC reviews all projects involving the following:

Infectious Agents

- All biological agents classified at BSL-2 or above.

Recombinant and Synthetic Nucleic Acids

- Recombinant DNA (rDNA)
- Recombinant RNA (rRNA)
- Synthetic nucleic acids (sNA)
- Exempt and non-exempt nucleic acid research

Prions and Prion-Like Proteins

- Prions
- Prion-risk material

Human and Non-Human Primate Materials

- Human and non-human primate tissues
- Human and non-human primate body fluids

Animal tissue

- Animal tissue that may be contaminated with zoonotic agents

Biological toxins

- Toxins with a biological origin e.g., ricin, botulinum toxin etc.

IBC PROCESS

Research involving the materials listed above (excluding exempt rDNA) must be reviewed and approved by the IBC prior to work being initiated. The IBC uses a web-based system for new protocols, amendments, and renewals. To submit an IBC protocol, amendment or renewal go to https://utsa.bioraft.com

The IBC process is indicated in Figure 6.

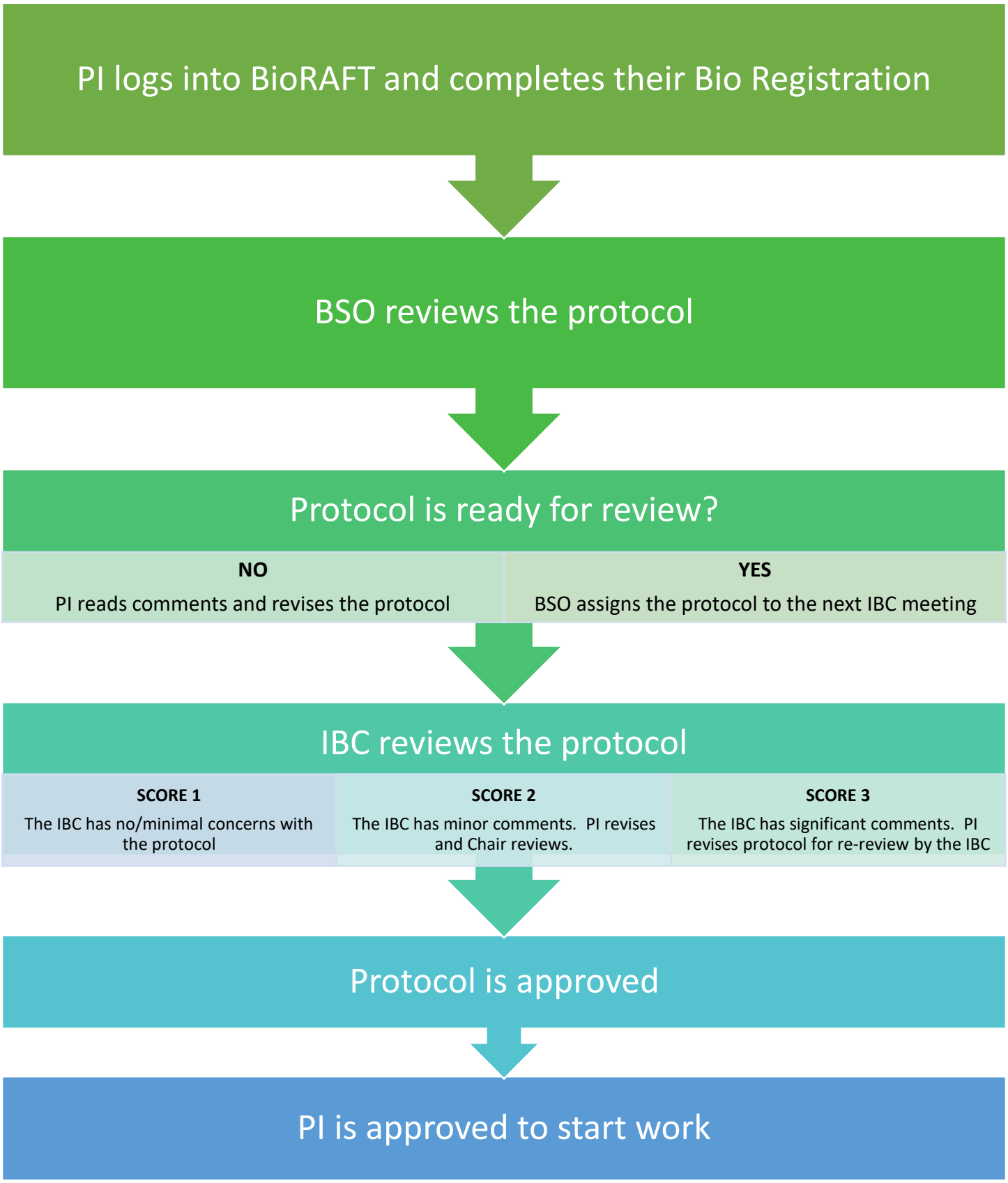


Figure 6. IBC protocol submission, review, revision and approval process.

IBC MEETINGS

The IBC meets on the first Wednesday of every month. Protocols must be submitted at least one week before the meeting date to be reviewed at that month's meeting. Meetings are conducted via Microsoft Teams and are open to the public on request. To attend an IBC meeting please refer to the IBC website for the meeting schedule and contact amanda.haley@utsa.edu for an access link to the meeting.

A. Approvals

Approvals are granted for three years, with a requirement to renew the protocol at the end of its approval cycle. Approvals are conditional on the PI maintaining the safety standards and research detailed in the protocol

B. Protocol Terminations

1. End of approval cycle

At the end of the three years cycle the protocol must be either renewed, or terminated, by the PI. Failure to renew the protocol will lead to termination of the protocol and all approved work must cease until a renewal has been submitted and approved.

2. Early protocol termination

Protocols can be terminated at any time, by the PI, if the project is no longer active. The PI must notify the BSO that the project is complete so the protocol can be administratively terminated.

3. Violations, suspensions or terminations

A PI, with an approved protocol, that willfully or negligently violates UTSA, federal or state rules and regulations governing the use of biohazardous agents may have their protocol suspended or terminated by the Biosafety Officer pending review by the IBC. The Biosafety Officer will prepare a report describing the violations in detail and submit the report to the IBC Chair and the Associate Vice President for Research Integrity (AVPRI). The IBC Chair will then determine the final course of action.

C. Amendments

If, at any point in the life cycle of the protocol, there are modifications to any of the approved work the modifications must be submitted to the IBC for review and approval.

SAFETY TRAINING

ONLINE SAFETY TRAINING

Numerous safety training courses are available to faculty, staff and students at UTSA. The following training listed in Table 8 are required:

COURSE	MUST BE TAKEN BY	TRAINING RENEWAL
Hazardous Waste Generator	Anyone generating hazardous waste (biological or chemical)	Must be taken every 3 years
Hazard Communication and General Safety	Anyone working with hazardous or potentially hazardous materials	Must be taken every 3 years
Biosafety	Anyone working with biological materials	Must be taken every 3 years
Bloodborne Pathogens	Anyone working with human/non-human primate material or other potentially infectious materials	Must be taken annually
Autoclave Safety	Anyone operating an autoclave	Must be taken every 3 years
Radiation Safety	Anyone working with radiation	Must be taken every 3 years
X-Ray Safety	Anyone working with x-ray	Must be taken every 3 years
Laser Safety	Anyone working with lasers	Must be taken every 3 years
Controlled Substances	Anyone working with controlled substances	Must be taken annually
Field Safety	Anyone participating in field work	Must be taken every 3 years

Table 8 Safety training courses available, requirements and renewal frequency.

IN PERSON TRAINING

Any of the training courses provided online can be provided in person on request to suit the needs of a specific lab or individual. To schedule and in person training please contact amanda.haley@utsa.edu

Additional safety training can be provided in any (but not restricted to) of the following areas:

- Working in a Biosafety Cabinet
- Selecting, donning and doffing PPE
- Sharps and broken glass training
- Incident reporting
- Spill management
- Compressed gas cylinder use

- Viral vectors and biosafety

1. Customized training

The Laboratory Safety Division can also create customized training for your laboratory specifically to meet the needs of your personnel, please contact amanda.haley@utsa.edu to discuss custom training needs.

2. Safety consultations

The Laboratory Safety Division personnel are available to attend lab group meetings to discuss safety topics or answer questions from researchers. Please contact your LSD contact to schedule a meeting.

MEDICAL SURVEILLANCE

Working with biohazards, animals or material falling under Universal Precautions may present concerns that trigger a recommendation for medical surveillance or participation in the Occupational Health Program.

PARTICIPATION IN THE OCCUPATIONAL HEALTH PROGRAM

Participation in the occupational health program is mandatory for individuals working with biological agents at BSL-3. Annual screening and is required for BSL-3 workers.

Animal handlers are required to register with the Occupational Health Program (faculty and staff) or SMSI (students, visiting scholars, volunteers).

Faculty, staff and students will be directed to the appropriate registration during IACUC approval process or BSL-3/Select Agent Program approval.

HEPATITIS B VACCINATION

Hepatitis B Vaccination

University employees with potential for any exposure to human or non-human primate blood, body fluids or any other substances covered by the Bloodborne Pathogens program as part of their work at UTSA will be offered the Hepatitis B vaccine at no cost to the employee.

Hepatitis B is a serious infection that affects the liver and is caused by the hepatitis B virus. Hepatitis B can cause mild illness lasting a few weeks or cause serious lifelong disease. Infections can be acute or chronic.

- **Acute**
    - Short-term illness that occurs within the first 6 months after exposure to the hepatitis B virus. This can lead to fever, fatigue, loss of appetite, nausea and/or vomiting, jaundice, or pain in muscles, joints and stomach.
- **Chronic**
    - Long-term illness that occurs when the virus remains in the body. Chronic infections can lead to liver damage, liver cancer, or death. Chronically infected individuals can spread hepatitis B virus even while they are asymptomatic.

Occupational exposure to hepatitis B can occur through a puncture or cut with a contaminated sharp, contact with infectious material through broken skin, or splashes of infected material onto the mucous membranes. Hepatitis B vaccination can prevent infection and subsequent long-term effects. While vaccination is encouraged for at risk workers it is not a condition of employment.

Refer to the Bloodborne Pathogens Exposure Control Plan for further information on vaccination.

SPECIAL WORK CIRCUMSTANCES

Special work circumstances may require registration with the Occupational Health Program. If you have any questions or concerns regarding the nature of your work and associated health concerns, please contact the Occupational Health Program.

1. Personal Protective Equipment (PPE)

A risk assessment of work may indicate the need for enhanced PPE such as the use of respiratory protection. N95, half or full-face respirator use requires personnel to complete annual medical clearance and fit testing prior to use. Respiratory protection is required for work with BSL-3 agents, work with BSL-2 aerosol-transmissible agents that cannot be done within a Biosafety Cabinet, field work generating dust or debris which may contain zoonotic agents, or an allergy to animals used in the course of research.

INCIDENT OR EXPOSURES

Basic response to incidents/exposure

Wash the infected area for at least 15 minutes with soap and water, or flush eyes with water at an eye wash station
Contact the Occupational Health Program (employees) or Student Health Services (students)
Notify your supervisor

Following an exposure, or suspected exposure to biohazardous material personnel should contact either the Occupational Health Program (OHP) or Student Health Services for advice and medical consultation. For more serious injuries contact UTSA Police Department for immediate assistance. Personnel that are injured outside of normal working hours should seek treatment at an appropriate emergency facility. Occupational Health or Student Health Services should be notified of outside working hours injuries as soon as possible. The Biosafety Officer and PI should also be notified immediately.

PLANT BIOSAFETY

Plants are an important research tool used to learn more about basic life processes and to help answer questions in agriculture, health and the environment. Plant research generally does not pose a risk to human health but can pose a hazard to other plants and the environment. Research involving plant diseases, plant pests, or genetically modified plants requires containment from the natural environment and from agricultural crops and markets.

Plant containment is intended to prevent any potential release of a genetically modified plant or associated organism. The movement, use, possession or release of exotic or potentially harmful plant-associated arthropods, biological control agents, plant pests, plant pathogens, noxious weeds and invasive plants are regulated by local, state, and federal agencies.

TRANSGENIC PLANTS

Transgenic plants are plants that have been genetically engineered or modified using recombinant DNA to create plants with new characteristics. The NIH Guidelines for Research Involving Recombinant DNA Molecules cover all research with genetically engineered plants and their associated microbes and macroorganisms (arthropods and nematodes). Biological Use Authorization is required for all experiments using genetically modified plant materials or associated organisms. Sections III-D-5 and III-E-2 of the NIH Guidelines describes experiments involving whole plants.

Field work with transgenic plants requires permits from APHIS prior to the start of work. If you have any plans to do field work with genetically engineered plants or associated organisms, inquire about permits first.

Permits from the Animal and Plant Health Inspection Service of the U.S. Department of Agriculture (USDA-APHIS or APHIS) may also be required. APHIS issues permits for genetically engineered organisms that pose a plant pest risk, including plants, insects or microorganisms. Inquire with APHIS to determine if a permit is required.

PLANT BIOSAFETY LEVELS

Biosafety levels for plants are defined in Appendix P of the NIH Guidelines. The requirements for practices and facilities are divided into Greenhouse Access levels (BL1-4-P) and standard laboratory plant biosafety levels (BL1-4-P)

A. Greenhouse Access Levels

1. Greenhouse Access Level 1 (BL1-P)

Greenhouse Access Level 1 (BL1-P) is a standard greenhouse with open windows and gravel walks permitted.

2. Greenhouse Access Level 2 (BL2-P)

Greenhouse Access Level 2 (BL2-P) is GAL-1 (BL1-P) plus screens over the openings and an autoclave available.

3. Greenhouse Access Level 3 (BL3-P)

- GAL-2 (BL2-P) plus an anteroom or head house
- Impervious bench tops and work surfaces. An autoclave inside the facility
- An independent air supply with negative pressure
- The exhaust must have a HEPA filter.
- A security fence or an equivalent form of security is present

4. Greenhouse Access Level 4 (BL4-P)

- GAL-3 (BL3-P) plus the area is accessed through an airlock.
- There is a shower facility at all entrances.
- A dunk tank or fumigation chamber.

B. Plant Biosafety Levels

1. Plant Biosafety Level 1 (BL1-P)

- Has limited access.
- An entry log is maintained.
- A standard procedures manual must be used.
- Experimental organisms must be inactivated.
- Pest, rodent and weed control program must be in place.

2. Plant Biosafety Level 2 (BL2-P)

Standard Laboratory Plant Biosafety Level 2 (BL2-P) is BL1-P plus biohazard signs in place where applicable:

- Cages for small animals.
- Procedures to minimize the escape of motile organisms.

3. Plant Biosafety Level 3 (BL3-P)

Standard Laboratory Plant Biosafety Level 3 (BL3-P) is:

- BL2-P plus access restricted to trained workers
- Equipment and supplies must be decontaminated,
- Biohazards signs in place,
- Efforts to minimize the formation of aerosols must be made,
- The surfaces of secondary containers used to take live organisms out of the laboratory must be decontaminated.
- A written record of accidents must be maintained.
- Special clothing must be worn in the laboratory and the clothing must be decontaminated prior to laundering.

4. Plant Biosafety Level 4 (BL4-P)

Standard Laboratory Plant Biosafety Level 4 (BL4-P) is:

- BL3-P plus an entry/exit log.
- Must be strictly maintained.

- Personnel must shower and change into special clothing upon entry and exit.
- All experimental materials and clothing must be decontaminated prior to removal.
- All accidents must be reported immediately.

PLANT CONTAINMENT AND HANDLING

Plant containment can be physical or biological. Physical containment can include a plant growth chamber or a greenhouse, whereas biological containment refers to removal or inactivation of plant reproductive structures (pollen and seed). Methods to contain or handle plants may include:

- Facilities such as research labs, growth rooms, or greenhouses
- Procedures, practices, and personal protective equipment (PPE)
- Transportation and storage

For transgenic plant research, standard operating procedures (SOPs) that describe methods to contain plants, associated organisms and waste are required.

BIOHAZARDOUS PLANT WASTE

Plant waste, including all transgenic plants, seeds, spores, plant debris and soil materials, and any plants exposed to plant pathogens are considered biohazardous waste and must be inactivated prior to disposal. Contact Hazardous Materials Management for more information on methods of decontamination and disposal.

REGULATORY OVERSIGHT FOR PLANT RESEARCH

Regulations and guidance for the importation, interstate movement, and release into the environment of genetically engineered organisms are implemented by the Biotechnology Regulatory Services within USDA-APHIS. USDA-APHIS also regulates and guides the movement of certain non-genetically engineered plants, pathogens, and related insects and microbes. Products of biotechnology are also regulated by the Environmental Protection Agency (EPA) and the Food and Drug Administration (FDA) under the Coordinated Framework for the Regulation of Biotechnology.

Depending on the type of research and whether it involves plants, plant pathogens, plant-associated organisms, noxious weeds or invasive plants, and other biological agents, regulations from the federal to local level may apply.

ARTHROPOD BIOSAFETY

Laboratories in which living arthropods are reared and maintained for research purposes have been in existence for decades with few reports of harm to their workers or to the communities in which they are located. Many of these organisms are associated with potential risks should they escape since many are vectors of infectious human diseases. When they are experimentally infected with a human pathogen, the arthropods represent an immediate risk to those who come into contact with them. Even when they are uninfected, they can represent a risk to the community if, by escaping, they become the crucial link completing the transmission cycle for a disease they vector.

DETRIMENTAL INTRODUCTION OF EXOTIC ARTHROPOD SPECIES – CASE STUDY

In the early 1900s, anopheline mosquitoes were drastically reduced in northeastern South America because of eradication campaigns. The concomitant drop in incidence of malaria and other human infectious diseases was reversed after *Anopheles gambiae* was discovered in the port city of Natal, Brazil in 1930.

The African malaria vector was accidentally introduced into the area, probably by rapid marine mail service. Although the release was not from a laboratory, the introduction of a highly efficient vector is widely thought to be responsible for the resurgence of malaria in Brazil. Fortunately, an aggressive effort to eradicate *An. gambiae* by conventional means was successful.

ARTHROPOD VECTOR RESEARCH GUIDANCE

Arthropod risk assessment is primarily a qualitative. Several factors must be considered in combination: the agents transmitted, whether the arthropod is or may be infected, the mobility and longevity of the arthropod, its reproductive potential, biological containment, and epidemiological factors influencing transmission in the proposed location or region at risk. Arthropod vectors of infectious agents can be assigned to the following discrete categories. Each category has a range of risks that need to be assessed.

A. Arthropods known to be free of specific pathogens

Public health risk is likely to be low unless conditions exist that could facilitate the transmission of an endemic disease in the area, or release of the vector could lead to a significant risk of future transmission. The following factors should be considered when working with uninfected arthropods:

1. Is the species already established in the area?
2. If there was a release could the species become temporarily or permanently established?
3. Is the species a known vector for any agents in the local area?
4. Would the release of the arthropod significantly increase the risk to humans and animals above that already in existence?
5. Could the arthropod be controlled or eradicated by traditional methods in the event of a release?

6. Are strains of the arthropod available that would have limited viability in the event of a release (e.g., cold sensitive mutants)

B. Arthropods known to contain specific pathogens

The pathogenicity of the infectious or suspected infectious agent, including disease incidence and severity (i.e., mild morbidity versus high mortality, acute versus chronic disease) is the most important consideration in assessing the risk due to accidental exposure to an infected arthropod vector.

C. Arthropods containing known infectious agents or whose status is uncertain

Arthropods in this category should be thoroughly risk assessed before work begins. The following should be considered:

1. Why is an infectious agent suspected?
2. What route of transmission is indicated?
3. Are agents that the arthropod transmits transferred horizontally?
4. Are there reasons to believe that a novel or unknown agent is present?
5. What epidemiologic data are available?
6. What is the morbidity or mortality rate associated with the agent?

D. Transgenic arthropods or arthropods containing transgenic agents

Any work with transgenic arthropods, or arthropods containing transgenic agents, must be reviewed and approved by the IBC before work commences. The PI must consider the following, at minimum, when determining the appropriate safety measures for transgenic work:

1. Does the inserted gene encode a product known or likely to alter the vector capacity or competence for pathogens it is known to transmit?
2. Does the inserted gene cause phenotypic changes that could significantly affect the ability to control the arthropod if there were an accidental escape, e.g., an insecticide resistance marker?
3. Does the modification have the potential to alter the range or seasonal abundance of the arthropod?
4. If so, would the new range increase the likelihood that the vector could transmit new pathogens?
5. Is the modified strain disabled in a way that viability after escape would be limited (e.g. eye-color mutants, cold-sensitive)?
6. Does the modification have the potential to increase the reproductive capacity of the arthropod that carries it?

7. Is the phenotype conferred by the modification, including its marker and other expressed genes, if any, consistently expressed after numerous generations of propagation?

8. Is the modification undergoing rearrangement or other mutation at a measurable rate?

9. Can the DNA transgene vector be mobilized in natural populations?

10. Is the host range of the symbiont known?

11. Would the modified symbiont pose increased risk to immunocompromised persons relative to the native symbiont?

12. Is the entire sequence of the DNA insertion known, and are the coding sequences defined?

13. Is horizontal transfer of the transgene to other microbes with which the modified microbe is likely to come into contact possible?

14. Is the original insertion site known so that stability can be assessed later?

ARTHROPOD CONTAINMENT LEVELS

A. Arthropod Containment Level 1 (ACL-1)

ACL-1 containment addresses activities with uninfected arthropod vectors or those infected with a non-pathogen including: arthropods that are already present in the local geographic region regardless of whether there is active vector borne disease transmission in the locale and exotic arthropods that upon escape would be inviable or become only temporarily established in areas not having active vector-borne disease transmission. The ACL-1 facilities have restricted access and are separated from the flow of general traffic. The doors are covered by plastic sheets with inward directional airflow. The area is maintained to allow detection of escaped arthropods. Work areas and primary containers are cleaned and disinfected. A pest exclusion program and mechanism of monitoring arthropod escape is in place.

B. Arthropod Containment Level 2 (ACL-2)

ACL-2 containment addresses activities using exotic and indigenous arthropods infected with BSL-2 agents associated with animal and/or human disease, or that are suspected of being infected with such agents. Uninfected genetically modified arthropod vectors also fall under this level provided the modification has no, or only negative effects on viability, survivorship, host range, or vector capacity. ACL-2 facilities have restricted access and are physically separated from general traffic areas by at least two self-closing doors that prevent direct escape of flying and crawling arthropods. A pest exclusion program should be in place. Mechanisms for preventing harborage and escape through drains, penetrations and other portals are considered. Illumination strategies of the facility are considered to reduce escape. Special practices are implemented for blood feeding.

C. Arthropod Containment Level 3 (ACL-3)

ACL-3 containment addresses practices suitable for work with potential or known vectors that are, or may be infected with, BSL-3 agents associated with human disease. Arthropods that are infected or potentially infected with BSL-3 agents may pose an additional hazard if the arthropod containment level 3 room is located in an area where the species is indigenous, or if alternative suitable vectors are present, as an escaped arthropod may introduce the pathogen into the local population. ACL-3 builds upon the practices, procedures, containment equipment, and facility requirements of ACL-2. It differs in that access is more restricted, and the microbiological containment takes a more prominent role in determining the practices and facilities. The use of sharps must be restricted. Floor drains are not recommended. HEPA filtration on both supply and exhaust air is recommended. An accurate inventory and labeling system for tracking arthropods is recommended. All work with arthropods is performed in specialized arthropod handling containers. Biosafety cabinets or appropriate primary barrier are used when infecting arthropods.

ARTHROPOD RESEARCH AND CONTAINMENT GUIDELINES

The "Arthropod Containment Guidelines" (ACG) were drafted by members of the American Committee Medical Entomology (ACME), a subcommittee of the American Society of Tropical Medicine and Hygiene (ASTMH), and other interested persons. The ACG provides detailed guidance on risk assessment and determining containment levels for arthropods not covered in the BMBL or NIH Guidelines. UTSA uses the ACG when determining containment for arthropod research. PI's interested in starting work with arthropods should consult this document prior to submitting an IBC protocol and establishing facility specific SOP's.

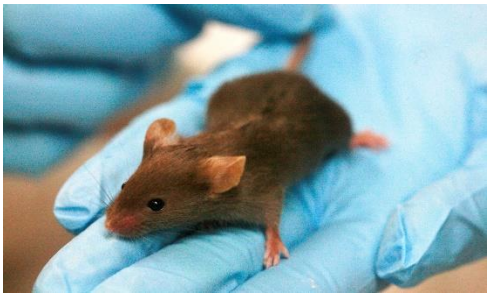
ANIMAL BIOSAFETY

Animal Biosafety Levels

Animal Biosafety Levels are determined through a combination of biosafety and animal biosecurity.

Animals increase the potential for exposure to biohazards via aerosol generation, bites and scratches, shedding of infectious agents, and accidental release.

There are four animal biosafety levels which must be applied when working with experimentally infected animals in research facilities, animals exposed to recombinant or synthetic nucleic acids, maintenance of laboratory animals that may contain zoonotic infectious agents, and wild animals collected in the field and returned to UTSA. Broadly the biosafety level for working with animals is the same as working with the infectious agent strain. However, the Biosafety Officer, University Veterinarian (UV) and IBC may recommend a higher ABSL dependent on the research scope and activities. In addition to IBC review for experimentally infected animals, animals exposed to recombinant or synthetic nucleic acids, maintenance of laboratory animals that may contain zoonotic infectious agents, and wild animals collected in the field all animal work must be reviewed by the Institutional Animal Care and Use Committee (IACUC) prior to initiation.



The BSO and UV will also take into consideration the biosecurity of animals housed at UTSA facilities. Measures are in place to ensure that infectious agent spread is not only minimized between animals and humans but also between animals within the facilities. In some cases, additional requirements may also be in place to protect the animals from human pathogens. These measures include work practices, PPE, risk assessments, SOPs, IACUC policies, housing requirements and vaccination.

ANIMAL BIOSAFETY LEVELS

Animal Biosafety Levels 1-3 are summarized in Figure 7. All animals inoculated with infectious agents or administered with recombinant or synthetic nucleic acids must be housed at the appropriate biosafety level within the vivarium. Biosafety level assignment must take into consideration the protection of animal care staff as well as researchers.

ABSL WORK PRACTICES

ABSL work practices build on BSL work practices but incorporate specific animal related items. All BSL-1, 2 and 3 work practices, including decontamination, BSC use, physical containment, must be followed for the equivalent ABSL.

The Laboratory Animal Resource Center (LARC) determines appropriate PPE, facility practices and procedures within the vivarium. PPE is provided and all posted directions must be followed. Work with animals at ABSL-1,

2 and 3 may require PPE over and above that required at the comparable BSL, for example respiratory protection, protective sleeves, and disposable gowns.

Cages containing animals inoculated with infectious agents or administered viral vectors or recombinant nucleic acids must be clearly labelled according to LARC requirements.

For further guidance on animal practices and procedures please contact the LARC.

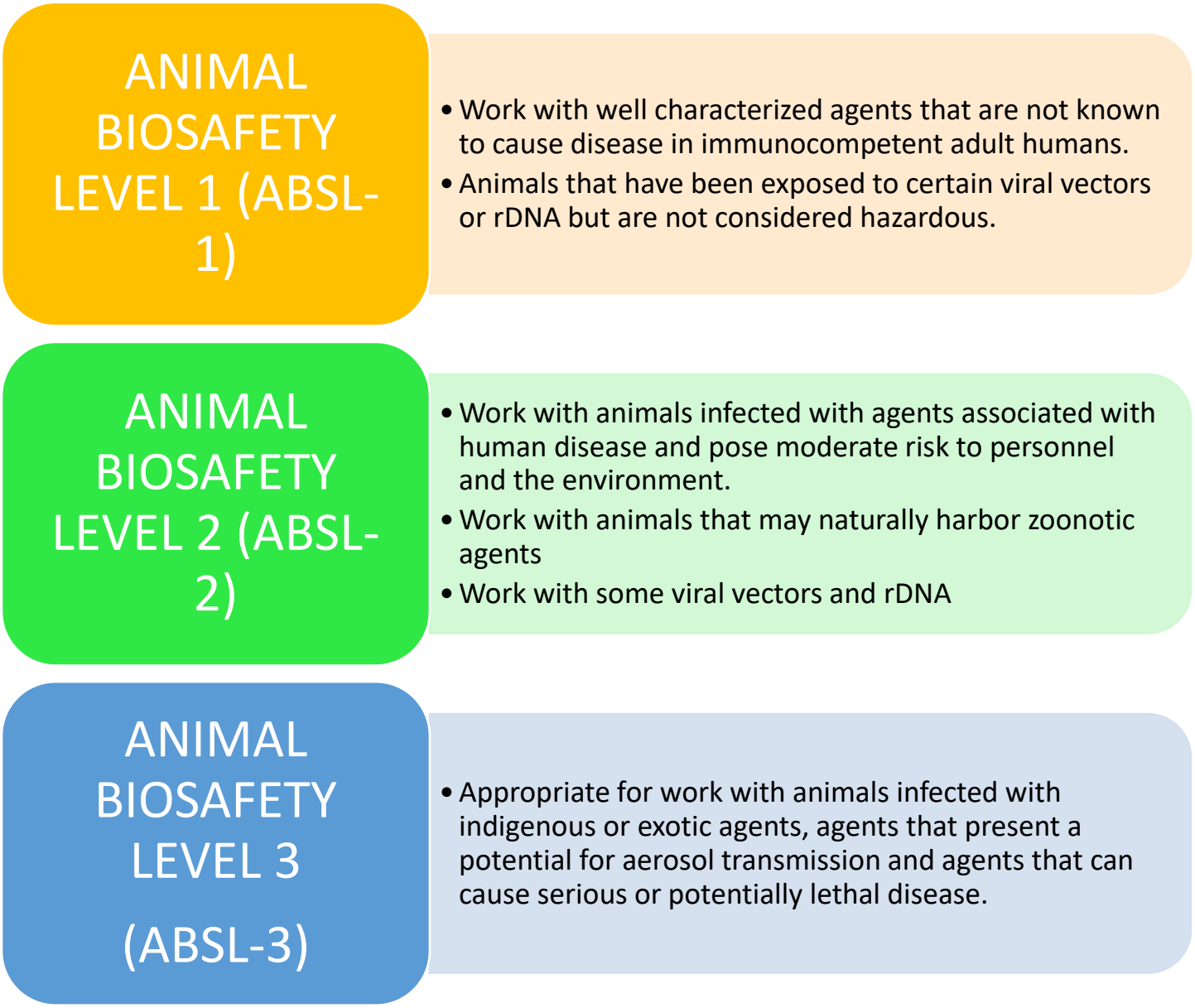


Figure 7. Summary of Animal Biosafety Levels (ABSL) 1, 2 and 3. UTSA does not have ABSL-4 facilities.

ANIMAL BIOSAFETY LEVELS FOR ANIMALS EXPOSED TO VIRAL VECTORS

Table 9 gives a brief overview of the appropriate biosafety levels for commonly used viral vectors. However, the gene inserted into the vector will potentially significantly impact the ABSL. This table should be used for guidance only.

VIRAL VECTOR (Replication defective)	BIOSAFETY LEVEL *In vitro*	ANIMAL BIOSAFETY LVEL *In vivo* w/o human cells	ANIMAL BIOSAFETY LVEL *In vivo* with human cells
AAV (without helper)	BSL-1+	ABSL-1+	ABSL-1+
AAV (with helper)	BSL-2	ABSL-1+	ABSL-2
Adenovirus	BSL-2	ABSL-2	ABSL-2
Canine Adenovirus	BSL-2	ABSL-2	ABSL-2
Murine Retrovirus	BSL-2	ABSL-2	ABSL-2
Lentivirus – 3rd generation or higher	BSL-2+	ABSL-2	ABSL-2
Retrovirus (SIAV, EIAV)	BSL-2	ABSL-2	ABSL-2
Herpes simplex virus	BSL-2	ABSL-2	ABSL-2
Pseudorabies virus (if amplicon only)	BSL-2	ABSL-2	ABSL-2
Vaccinia	BSL-2	ABSL-2	ABSL-2
Rabies	BSL-2	ABSL-2	ABSL-2
Sendai virus	BSL-2	ABSL-2	ABSL-2

Table 9. Commonly used viral vectors with their applicable BSL and ABSL.

ZOONOSES

Zoonotic agents are infectious agents that can be transmitted between species (humans and animals). Human exposure to zoonoses can occur through routes including bites, scratches, aerosol droplets, mucosal secretions, feces or urine. Many laboratory animals are bred to be free of zoonoses but there are zoonotic agents that can be associated with laboratory animals which pose a risk to humans or other animals within the facility.

Humanized animals (animals implanted with human tissues or cells) capable of supporting replication of human agents, animals with altered genotypes resulting in new or increased susceptibility to infectious agents, and animals with altered immune systems require additional risk assessment.

Wild animals can pose a significant zoonotic risk as their exposure history is unknown. Field work with, or around, animals should be risk assessed to determine appropriate PPE, practices and procedures. Use and housing of any animals transported from the field to UTSA must adhere to the LARC standards for quarantine be reviewed for zoonotic agents, and may require

permits. No animals should be brought from the field to campus without IACUC approval and approval from the UV.

PERSONAL PROTECTIVE EQUIPMENT

Biosafety is a combination of good work practices, facility design, equipment training, and protective clothing employed to provide a safe environment for all personnel and the environment. All these factors rely on researchers to know, understand, and implement the appropriate measures consistently and constantly. Not only to protect themselves from the agents they work with, but also to protect other personnel in the space including support staff, housekeepers, facilities personnel etc.

UNIVERSAL PRECAUTIONS

Universal Precautions requires workers to treat all human/primate blood and other body fluids, tissues, and cells as if they were known to contain infectious bloodborne pathogens (BBP). Universal Precautions includes employing frequent handwashing, mechanical pipetting devices, prohibiting food and drink in the laboratory, proper disposal of waste, and use of PPE and engineering controls.

PERSONAL PROTECTIVE EQUIPMENT

Personal Protective Equipment (PPE) is an essential part of laboratory safety in addition to good work practices and engineering controls. PPE is designed to be the final barrier between a worker and the biohazard. Required PPE for biological research include:

- Lab coat
- Gloves
- Eye protection

PPE is only effective if worn correctly and over appropriate clothing. UTSA requires that researchers in laboratories wear appropriate street clothes which includes:

- Close toed shoes which cover the whole foot – no sandals
- Long pants or other full leg coverage – shorts are prohibited in laboratories

Supervisors have the primary responsibility for implementing consistent PPE practices in their work area. This includes evaluating the hazards to determine the appropriate PPE, ensuring that the PPE is available, and that all personnel are trained and consistently use the PPE.

The Laboratory Safety Division is available to assist PI's in determining appropriate PPE for their work area and training personnel in the correct use of PPE items.

LAB COAT PROGRAM

In 2020 the Vice President for Research, Economic Development and Knowledge Enterprise (VPREDKE) initiated the lab coat program at UTSA. The program makes lab coats available to all researchers free, via vending machines. Dirty coats are returned to the vending unit and laundered off site. This ensures that all researchers have access to clean, safe and properly fitting lab coats. Vending machines are accessed via a card issued by the Laboratory Safety Division.

There are four vending units across campus in the following locations:

- Margaret Batts Tobin Building (MBT) (main entry)
- Biosciences and Engineering Building (BSE) (ground floor)
- Applied Engineering and Technology Building (AET) (ground floor)
- Science and Engineering Building (SEB) (3rd floor)

The vending machines dispense four different coat types and their functions are summarized in Table 10.

LAB COAT MACHINE CODE	COAT TYPE	USE
S	Standard lab coat	BSL-1, general lab activities
B	Barrier lab coat	BSL-2 laboratories
FR	Flame resistant	Areas where flammables and flames are frequently used
FCR	Flame and Chemical resistant	Areas where hazardous chemicals, flammables, pyrophores etc. are used.

Table 10. Lab coat vending machine guide

Barrier coats should be used in all BSL-2 laboratories at UTSA.

Lab coats are accessed by swiping the vending card, selecting the coat type and size. The machine will then dispense a clean, wrapped lab coat. When users are ready for a clean lab coat the vending card should be swiped on the return unit and the coat placed in the unit. The user will then be able to take a new coat from the vending machine. Lab coats must not be removed from campus.

If a lab coat becomes heavily soiled, or damaged due to a spill or other incident, the coat should be discarded into a biohazard container and Laboratory Safety notified.

BIOLOGICAL SAFETY CABINETS

Biological Safety Cabinets (BSC) are one of the primary engineering controls in biological research facilities. They are specifically designed to provide three types of protection:

- Protect personnel from the material inside the cabinet.
- Protect the material inside the cabinet from personnel and the environment.
- Protection for the environment from the material inside the cabinet.

There are three types of BSCs: Class I, II, and III.

Biosafety cabinets are not interchangeable with either fume hoods or laminar flow hoods.

BIOSAFETY CABINETS VS. FUME HOODS AND LAMINAR FLOW HOODS

Both chemical fume hoods and biosafety cabinets are specialized types of laboratory equipment. While chemical fume hoods and biosafety cabinets look similar and both protect laboratory workers from laboratory hazards - their purpose, function, and operation differ significantly.

A chemical fume hood is designed to remove chemical fumes and aerosols from the work area while a biosafety cabinet is designed to provide both a clean work environment and protection for employees who create aerosols when working with infectious agents or toxins.

CHEMICAL FUME HOOD

BIOLOGICAL SAFETY CABINET

Figure 8. Chemical fume hood and biological safety cabinet

A chemical fume hood protects the user while a biosafety cabinet protects the user, the environment, and the material. Biosafety cabinets have high-efficiency particulate air (HEPA) filters while chemical fume hoods do not. The HEPA filter in the exhaust system of a biosafety cabinet will effectively trap all known infectious agents and ensure that only microbe-free exhaust air is discharged from the cabinet (i.e., 99.97% of particles 0.3 µm in diameter and 99.99% of particles of greater or smaller size). Laminar flow hoods are designed to protect the

product only, they are not suitable for use with infectious material or hazardous chemicals. The difference between the three is summarized below in Figure 9.

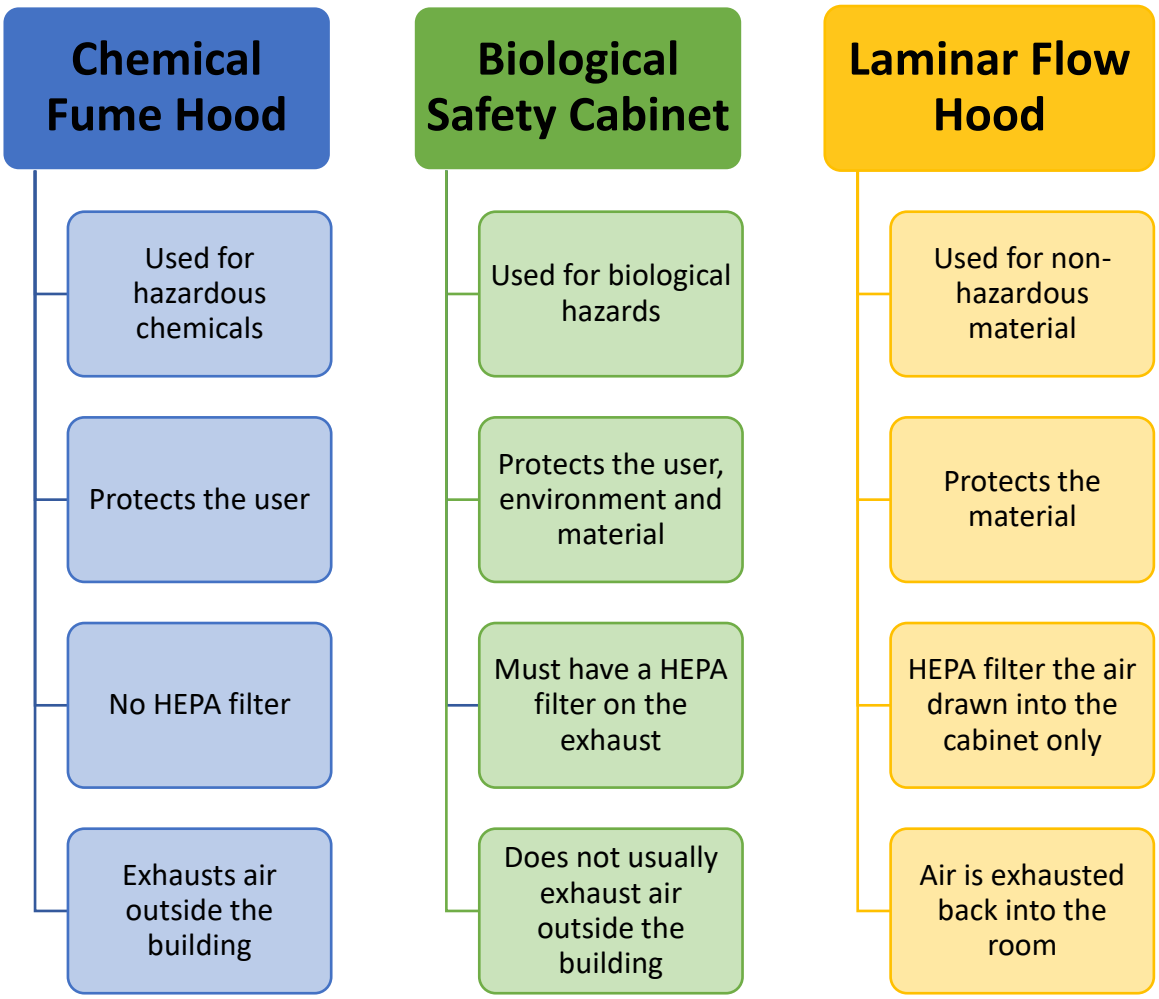


Figure 9. Summary of the principal differences between a chemical fume hood, laminar flow hood and a biosafety cabinet.

Further information on chemical fume hoods can be found here.

CLASS I BIOSAFETY CABINETS

Class I biosafety cabinets are designed to protect personnel and the environment only. The material contained within the cabinet is not protected from environmental contamination. Class I cabinets operate with a similar airflow pattern as a chemical fume hood however exhaust air passes through a HEPA filter (Figure 10).

Class I cabinets are not used at UTSA.

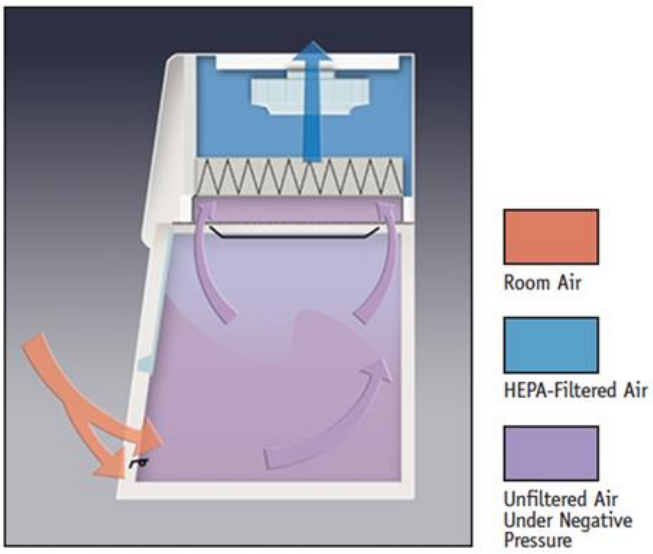


Figure 10. Airflow inside a Class I BSC (Labconco.com)

CLASS II BIOSAFETY CABINETS

Class II BSCs protect personnel, the environment and the product within the cabinet. Personnel are protected by an open front with inward airflow, the product is protected by downward HEPA-filtered laminar airflow, and the environment is protected by HEPA-filtered exhaust air. There are four types of Class II cabinet (A, B1, B2, and B3) they differ in their construction and amount of air recirculated.

At UTSA Class II A and Class II B2 are used.

A. Class II A1

Class II A BSCs do not need to be connected to the building HVAC (although they can be if needed). Class A1 BSCs must maintain an average inward flow of 75fpm through the sash opening, 70% of the air is recirculated and 30% is HEPA-filtered to the room. These hoods are suitable for use of low to moderate risk agents but not volatile toxic chemicals or volatile radionuclides. Airflow in an A1 cabinet is demonstrated in Figure 11.

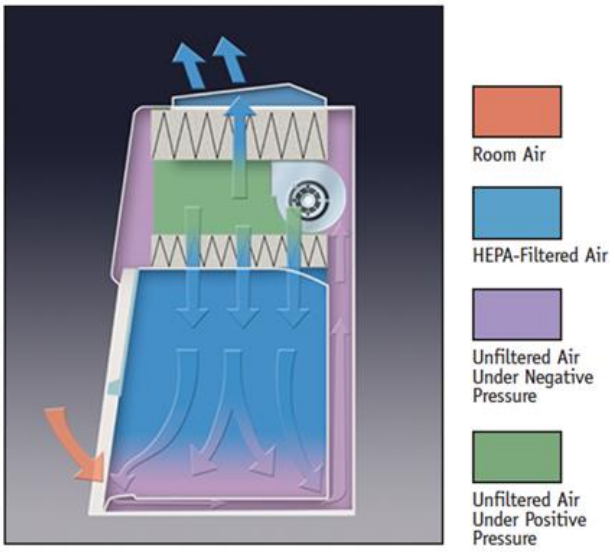


Figure 11. Airflow inside a Class II A1 BSC (Labconco.com)

B. Class II A2

Class II A2 cabinets are the most common type of cabinet found on campus. The cabinet must maintain an inward air velocity of 100fpm through the open sash, 70% of the air is recirculated and 30% is HEPA-filtered to the room. They generally exhaust HEPA-filtered air back into the room although may be connected to the HVAC system via a canopy. These hoods, when not connected to the HVAC, are suitable for use of low to moderate risk agents but not volatile toxic chemicals or volatile radionuclides. If connected to the HVAC then they are safe for use involving biological agents treated with minute quantities of hazardous chemicals. They may also be used with tracer quantities of radionuclides that won't interfere with the work if recirculated in the downflow air. Airflow in an A2 cabinet is demonstrated in Figure 12.

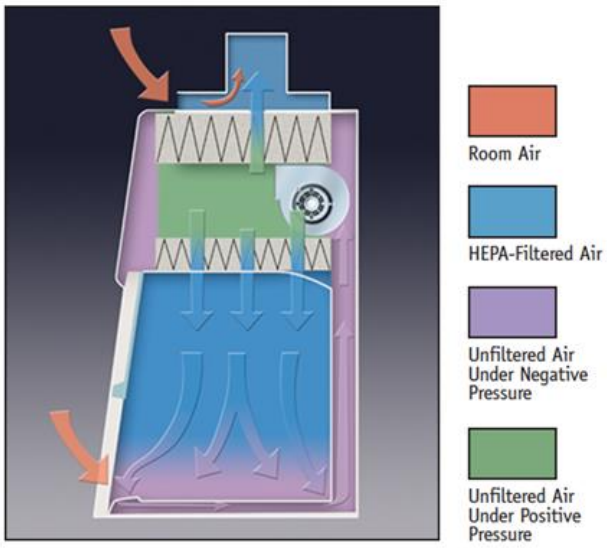


Figure 12. Airflow inside a Class II A2 BSC (Labconco.com)

C. Class II B2

Class II B2 cabinets must maintain an inward airflow velocity of 100fpm and have 100% of their exhaust air exhausted through a duct connected to the HVAC system. These are the second most common type of cabinet at UTSA. Because these cabinets do not exhaust air back into the room, they are suitable for work with biological agents treated with small amounts of hazardous chemicals and radionuclides required as an adjunct to microbiology applications. Airflow in an B2 cabinet is demonstrated in Figure 13.

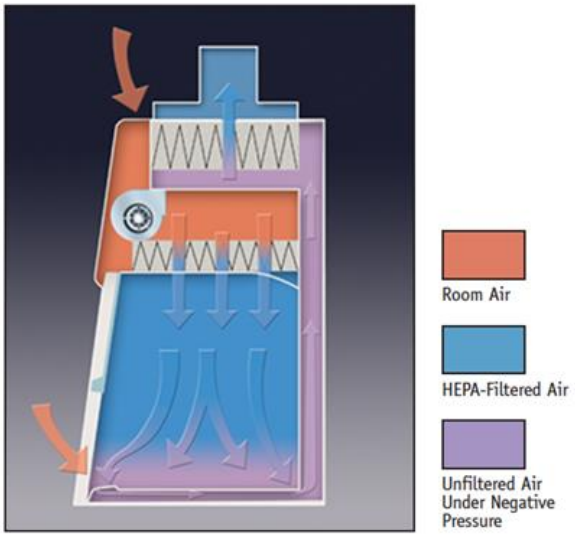


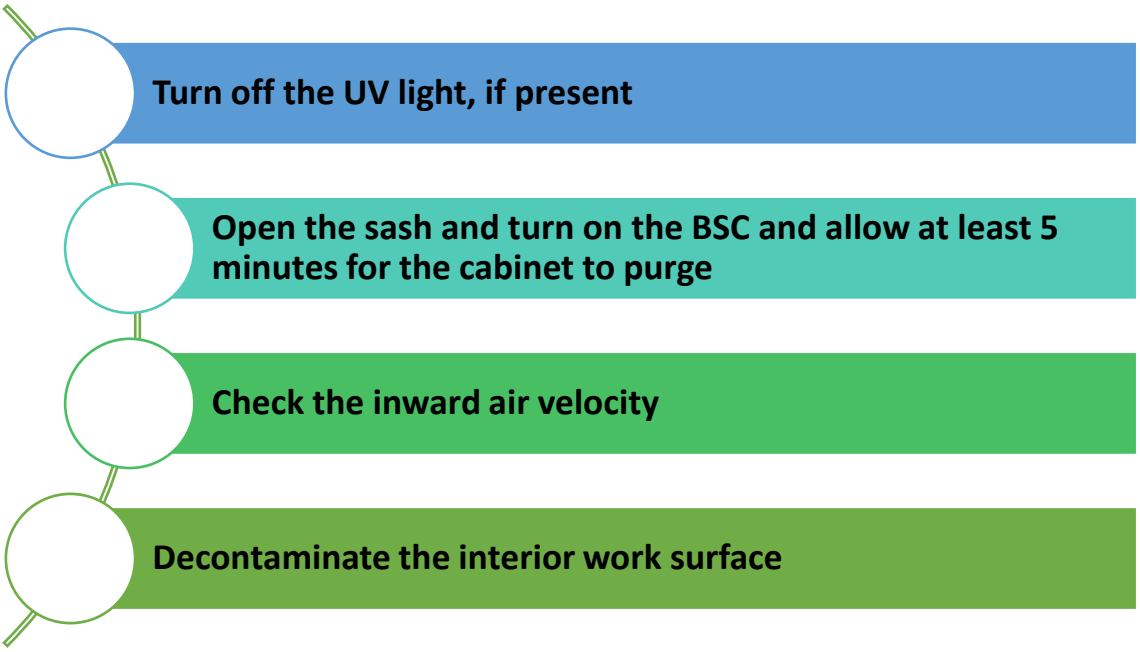
Figure 13. Airflow inside a Class II B2 BSC (Labconco.com)

CLASS III BIOSAFETY CABINETS

Class III cabinets are gas-tight gloveboxes with double HEPA exhausts and are designed for use with high-risk pathogens (BSL-3 or 4) and work that produces high-hazard aerosols.

SETTING UP A BIOSAFETY CABINET

Working in a BSC still requires that all PPE is worn, it does not act as a substitute for PPE. Before beginning work there are a number of steps that must be followed:



Biosafety cabinets should contain minimal clutter and only essential items should be placed in the cabinet. If the work involves the use of a vacuum trap/ aspiration setup it should be checked prior to starting work.

A. Vacuum traps

A vacuum flask system (Fig. 14) is required to protect the central building system or vacuum pump from contamination and must be set up, and maintained, correctly.

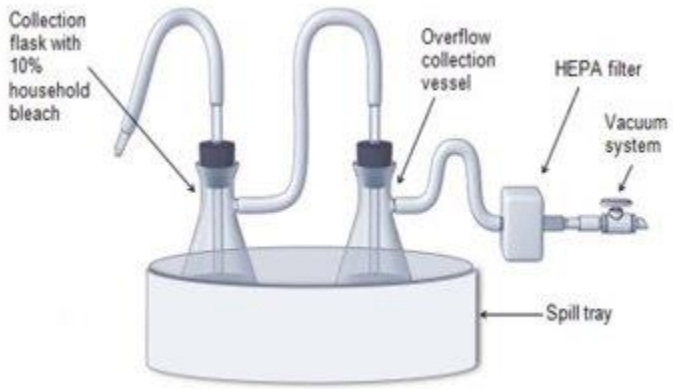
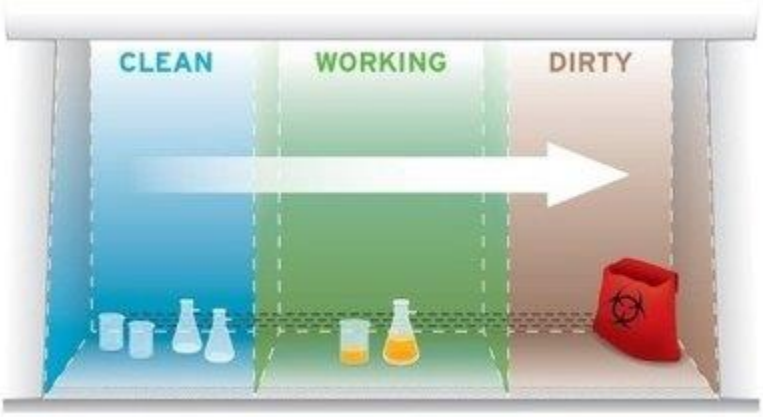


Figure 14. Correct set up of a vacuum trap system.

The system must comprise two flasks, containing 10% bleach or other appropriate disinfectant. The flasks must be emptied regularly or immediately after use. The second, overflow flask, connects to an inline HEPA filter, which protects the vacuum system, before being connected to the vacuum system. The entire setup must be placed in a secondary container.

B. Workflow

To maintain a clean environment that minimizes contamination of the interior of the BSC and the product, the work materials should be set up correctly so that the workflow is “clean” to “dirty” (Fig 15.). The perforated grills at the front and rear of the biosafety cabinet should be left clear to avoid disrupting the airflow. Blocking the grill may cause contaminated air to enter the cabinet.

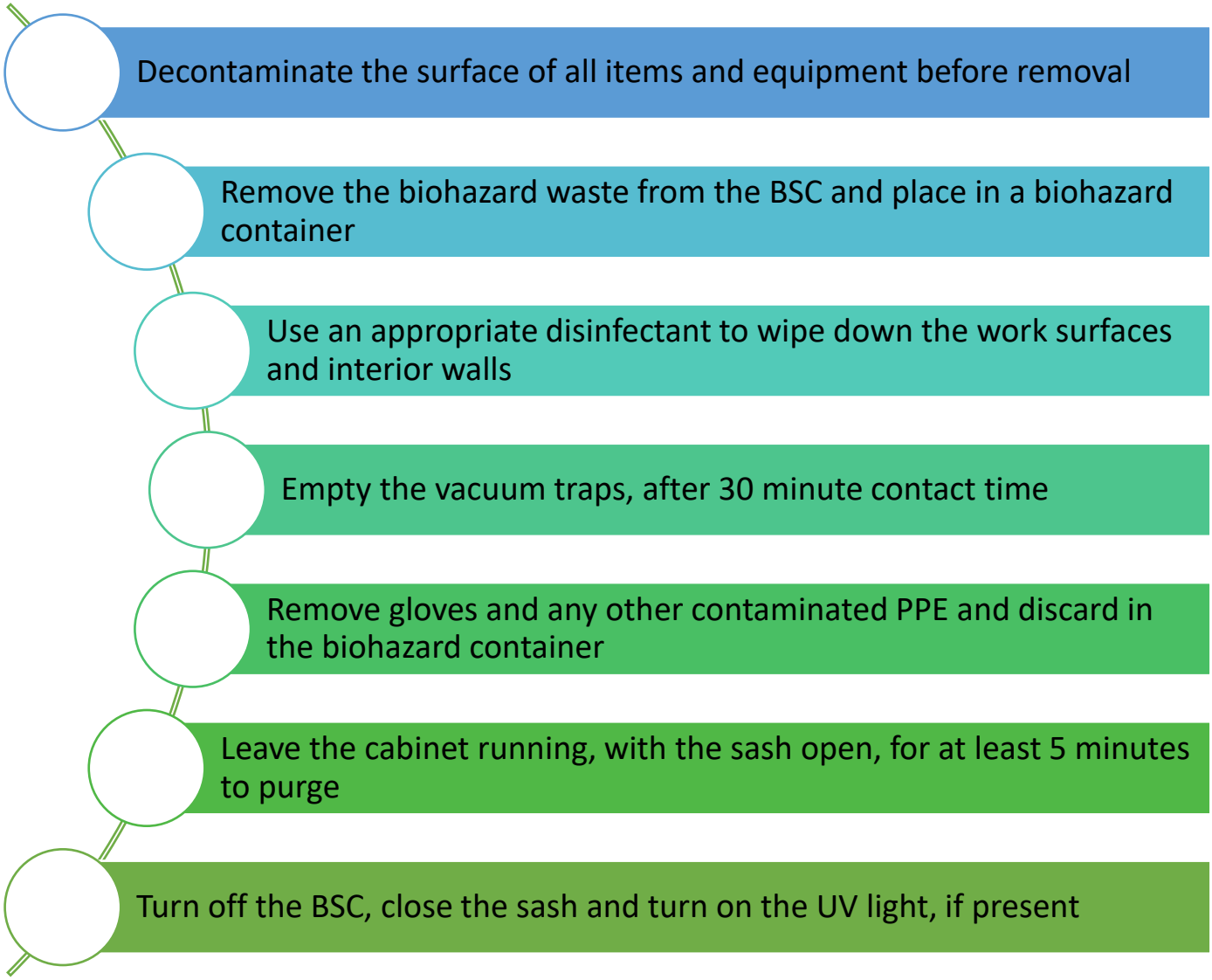


When working, use slow movements and avoid sweeping motions that could disrupt the air curtain at the sash opening. Ensure that the sash remains at the correct height, the cabinet will alarm if the sash is set too high. Only one user should work in a BSC at a time.

Figure 15. Clean to dirty work set up.

CONCLUDING WORK IN THE BIOSAFETY CABINET

BSCs are commonly shared equipment designed for use with infectious, or potentially infectious, material therefore it is essential that they are cleaned correctly at the end of the work assignment.



A. UV Lights

UV lights should not be relied on to decontaminate equipment and surfaces in place of chemical disinfection. Chemical disinfection must always be used as the primary method of cleaning the BSC and equipment. UV lamps are discouraged as:

- UV is not effective on porous materials that are opaque to the light (wood or foam)
- UV is not effective if a microbe is protected by dust, dirt, or other organic matter
- UV light is affected by the accumulation of dust and dirt on the bulb surface

- UV does not work in shadowed areas; penetrate into cracks or through the grill of a BSC

BIOSAFETY CABINET MAINTENANCE

Biosafety cabinets require constant maintenance to ensure safety and product protection.

Weekly	• Clean the UV lamp and remove any dust
Weekly	• Clean the catch basin underneath the BSC work surface plate
6 months	• Replace the in-line HEPA filter in the aspiration setup
12 months	• Change the UV light (optional)
Annually	• Recertify the Biosafety Cabinet (contact Laboratory Safety)

Biosafety cabinets are recertified annually, or after a move or a repair, by a qualified external vendor. Recertification is coordinated by the Laboratory Safety Division. Any new cabinet purchased must be certified before work begins, if you purchase a cabinet, please contact the Laboratory Safety Division to ensure it is scheduled for certification.

OPEN FLAMES IN BIOSAFETY CABINETS

Use of an open flame in a biosafety cabinet is prohibited for several reasons:

1. Disrupts the air flow, compromising protection of the worker and work.
2. Causes excessive heat buildup, may damage HEPA filters and/or melt the adhesive holding the filter together compromising the cabinets integrity.
3. Presents a potential fire or explosion hazard. Electrical components such as the fan motor etc., are not designed to operate where a flash fire could be ignited by a spark (Figure 16).
4. Voids manufacturers warranties. The cabinet manufacturer will assume no liability for cabinet damage or personnel injuries as a result of a fire or explosion caused by the use of an open flame.

Figure 16. The results of a fire/explosion in a Biosafety Cabinet.

There are many alternatives that can be used to remove the need for Bunsen burners or other open flames.

- Follow good BSC work practices.
- Replace open flames with alternative technology such as electric burners.
- Use disposable loops and other equipment.
- Autoclave metal instruments such as tweezers and scissors, before use.
- Reduce the quantity of flammable chemicals in the BSC.
- Use alcohol to sterilize glassware that is being used.

EXPOSURES AND SPILLS

Work Hours (Monday-Friday 8am-5pm)

If an exposure, or injury, occurs during normal working hours contact Occupational Health/Student Health Services for medical attention.

Notify the Laboratory Safety Division.

In the event of a serious injury contact UTSA Police Department (x4911)

After work hours

After hours, and on weekends, if an exposure or injury occurs contact UTSA Police Department (x4911) for immediate assistance.

EXPOSURES

For any exposure, or incident, the following steps should be followed:

1. **Care for personnel**

- If there has been a needlestick/puncture wound, wash the affected area with antiseptic soap and warm water for 15 minutes. If the wound is bleeding, encourage bleeding while washing. Dry and cover the wound with a bandage.

- For mucous membranes, flush the affected area for 15 minutes at the eyewash station.

2. **Seek medical attention**

Contact Occupational Health (faculty/staff) or Student Health Services (students) for medical advice on non-life-threatening incidents. Notify the medical staff of any exposure risks. For more serious injuries seek immediate emergency medical attention at the closest emergency department, or contact UTSA Police Department for assistance. Always notify first responders and medical staff of any infectious agents you may have been exposed to.

3. **Notifications**

Notify your PI, manager, or supervisor to initiate an accident or exposure incident report. The report must be done at the earliest possible time, and within 24 hours of the incident. If the incident involved a contaminated sharp (including an animal bite) include this Form.

4. **Reporting**

Notify the Laboratory Safety Division at the earliest opportunity with initial details of the incident. If the exposure included recombinant or synthetic nucleic acids, cells or organisms provide all details of the agent. Any incident, exposure, or spill involving recombinant or synthetic nucleic acid material must be reported to the NIH, by the Biosafety Officer, in accordance with the NIH Guidelines. Use the Recombinant Nucleic Acid Incident Report Form.

Do not hesitate to report incidents so you can receive quick and effective treatment.

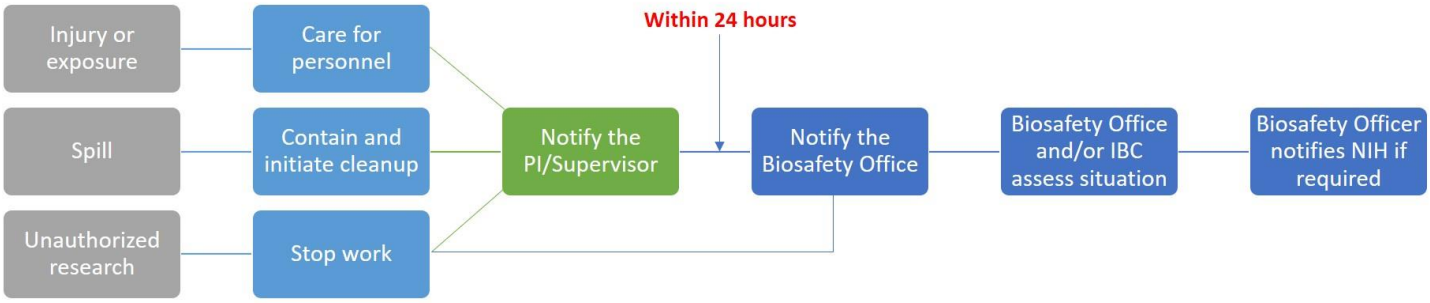


Figure 17. Summary of reporting requirements for incidents with biohazardous or recombinant nucleic acid material.

SPILLS

The procedures listed below are intended as a general guide to cleaning up spills of biohazardous material. Each lab should develop their own specific spill response plans reflecting the hazards in their facility.

If the spill is too large or unmanageable contact the Laboratory Safety Division (210-294-3342), immediately, for assistance. Bleach is recommended as a standard disinfectant; however other agent appropriate disinfectants may be used.

A. Spills inside a Biosafety Cabinet

1. Wait for 10 minutes to allow the BSC to contain any aerosols.
2. Don PPE (lab coat, goggles, and double gloves).
3. With the BSC running, place paper towels over the spill and apply disinfectant to the paper towels.
4. Change the outer pair of gloves.
5. Leave in place for the minimum contact time (at least 30 minutes).
6. Wipe up the spill and materials using disinfectant-soaked paper towels. Do not lean into the cabinet to clean the spill. Do not raise the sash above the approved height.
7. Clean the sides, work surface, and any equipment in the BSC with disinfectant-soaked paper towels.
8. Discard the spill materials in an appropriate biohazard container.

9. Place autoclavable, reusable items into an appropriate autoclave bag or lidded pan and autoclave.
10. Expose non-autoclavable materials to disinfectant for the appropriate contact time before removal from the BSC.
11. If material spilled through the grill, lift the work surface plate and clean underneath.
12. Remove PPE and discard in the biohazard container. If the lab coat is contaminated discard this also, if not return it to the vending machine.
13. Run the BSC for at least 10 minutes before resuming work or turning the BSC off.
14. Wash hands with soap and water.

If the spill is large and floods the entire work surface and/or underneath the work surface plate please call the Laboratory Safety Division for assistance. The cabinet may need more specialized decontamination.

B. Spills outside of the Biosafety Cabinet

1. Notify everyone in the laboratory and evacuate. Place a notice on the door informing personnel that there is a spill and not to enter. Allow the spill to settle for at least 30 minutes.
2. Gather spill cleanup materials (paper towels, disinfectant, biohazard bags and forceps/tongs).
3. Don PPE (lab coat, goggles, and double gloves).
4. Cleanup the spill as follows:
    a. Place paper towels over the spill.
    b. Carefully pour disinfectant onto the paper towels, start at the edges and work in.
    c. Allow the disinfectant to remain in contact with the spill for at least 30 minutes.
    d. Apply more paper towels to wipe up the spill.
    e. Clean the spill area, and surrounding surfaces and furniture, with disinfectant soaked paper towels.
    f. Dispose of all paper towels in a biohazard container. If any sharp objects are present collect them with forceps or tongs and place in a sharps container.
    g. Remove PPE and segregate for disposal. If your lab coat is contaminated also discard with biohazard waste.
    h. Wash hands with soap and water.

SPILLS INSIDE A CENTRIFUGE

1. Notify everyone in the laboratory and evacuate. Place a notice on the door informing personnel that there is a spill and not to enter.
2. Wait 30 minutes for aerosols to settle.
3. If the spill is discovered after the centrifuge lid is opened, and the rotor does not have a lid, close the lid and evacuate. Place a notice on the door informing personnel that there is a spill and not to enter. Allow aerosols to settle for 30 minutes.
4. Don PPE (lab coat, goggles, and double gloves).
5. Remove rotors/buckets to the nearest BSC for decontamination.
6. If using a small microfuge transfer the entire centrifuge to the BSC for decontamination.
7. Thoroughly disinfect the inside of the centrifuge with an appropriate disinfectant.
8. Clean all rotors and buckets with an appropriate disinfectant.
9. Wash hands with soap and water.

SPILLS OUTSIDE OF THE LABORATORY

To prevent spills always transport labeled biohazardous material in an unbreakable, well-sealed primary container placed inside of a second unbreakable, lidded container (cooler, plastic pail, plastic container) labeled with a biohazard symbol, biosafety level, and contact details. Use freight elevators only if transferring materials between floors. If items are heavy use a cart for transport.

1. If a spill occurs in a public area, do not attempt to clean it up without appropriate PPE. Do not leave the area unattended.
2. Secure the area, keeping people well clear of the spill.
3. Notify the Laboratory Safety Division for assistance.
4. Stand by during spill response and clean up to provide information on the agent.

Spills

Always report all spills to the Laboratory Safety Division.

WASTE AND DECONTAMINATION

WASTE

Biohazard waste includes all laboratory waste that may contain biohazardous material or were in contact with biohazardous material. All biohazardous waste must be disposed of in red biohazard bags marked with the biohazard symbol, and be secondarily contained in a biohazard container.

Figure 18. Biohazard containers.

Waste containers should be filled no more than two thirds full and not exceed a total weight of 20lbs. Once full the containers should be closed and clearly labeled with the PI name and contact number. Waste pickup requests must be submitted in BioRAFT and the pickup request attached to the outside of the box.

SHARPS

Sharps waste includes any rigid item capable of cutting or piercing. Examples include:

- Hypodermic needles
- Microscope slides and cover slips
- Broken glass
- Bone fragments

SHARPS

Do not recap, bend, shear, clip needles or separate needles from syringes.
Do not disinfect needles before disposal.
KEEP MANIPULATION OF SHARPS TO A MINIMUM

All sharps waste must be placed in an approved sharps container constructed of hard plastic labeled with a biohazard symbol. Sharps containers can be requested from Hazardous Materials Management.

Containers should be no more than two thirds full. Before disposal the lid must be closed and sealed with a piece of tape.

MIXED WASTE

Waste can often comprise a mixture of biohazardous and non-biohazardous. Mixed waste is categorized as biohazardous unless:

- A mixture of biohazardous waste and chemical waste – categorized as hazardous **chemical waste**.
- A mixture of biohazardous waste and radioactive waste - categorized as **radioactive waste.**
- A mixture of biohazardous waste, chemical waste and radioactive waste – categorized as **radioactive waste.**

For all mixed biohazard and chemical waste please contact Hazardous Materials Management for guidance on appropriate disposal.

All mixed radioactive waste should be segregated from disposal and packaged in a yellow container with a universal radiation symbol. Radioactive waste is collected by the Radiation and Laser Safety Coordinator for storage prior to disposal.

ANIMAL CARCASSES

After euthanasia of research animal carcasses are placed in biohazard bags (if exposed to biological agents) or black plastic bags and stored in designated freezers in the LARC vivaria. All LARC policies for animal disposal must be followed. Contact LARC for further information on disposal.

ITEMS REQUIRING DISPOSAL			PROPER DISPOSAL METHOD	
SHARPS		**ALL** Blades Glass pipettes Syringes with needles attached Microscope slides	Sharps container 	**BIOHAZARD WASTE**
CULTURES AND DISPOSABLES		**CONTAMINATED** Petri dishes Disposable tissue culture flasks Materials (paper towels etc.)	Biohazard container 	**BIOHAZARD WASTE**
		CONTAMINATED Liquid waste in container (not blood)	Decontaminate the liquid	**Dispose of the decontaminated liquid in the sink with running water**
			Empty Container Biohazard container 	**BIOHAZARD WASTE**
GLASS		**CONTAMINATED** Broken and unbroken	Sharps container 	**BIOHAZARD WASTE**
		NON-CONTAMINATED Broken and unbroken	Broken glass box 	**SEALED BOX – REGULAR TRASH**
BLOOD & BODY FLUIDS		**ALL** Human blood Animal blood Body fluids	Dilute with bleach 1:10 (final conc. 0.5% sodium hypochlorite)	**Dispose of the decontaminated liquid in the sink with running water**
ANIMAL CARCASS		**ALL** Contaminated animal carcasses and body parts Uncontaminated animal carcasses and body parts	Red biohazard bag or black plastic bag placed in LARC carcass freezer	**BIOHAZARD WASTE**

CHEMICAL AND RADIATION		**ALL** Biohazardous material with radioactive contamination	Call Radiation and Laser Safety Coordinator x5807
		**ALL** Biohazardous material with chemical contamination	**CHEMICAL WASTE**

Figure 18. Summary of biohazardous waste disposal routes.

DECONTAMINATION, DISINFECTION AND STERILIZATION

1. Decontamination

Decontamination reduces the microbial contamination of materials or surfaces rendering it safe for handling. Decontamination is usually achieved by the use of chemical agents. Sterilization and disinfection are forms of decontamination.

2. Sterilization

Sterilization renders an object or surface completely free of living microbial agents. Sterilization kills all microbial agents. Sterilization methods include, heat, ethylene oxide gas, hydrogen peroxide gas, plasma, ozone and radiation. Sterilization will kill spores. The most common form of sterilization is autoclaving

3. Disinfection

Disinfection eliminates most microbial agents but not all. It is a reduction in the level of microbial agents. Common disinfectants include 10% bleach, Cavicide, and 70% ethanol. There are three levels of disinfection:

- **High Level Disinfection**
    - Comprises high concentrations of chemical germicides (ex: concentrated sodium hypochlorite).
    - Kills vegetative microorganisms and inactivates viruses
    - Does not kill high numbers of bacterial spores
    - High level disinfectants are typically used for short time periods (10-30 min) for disinfection purposes, but may achieve sterilization if left in contact with the surface for long time periods (6-10 hours).
    - Not for use on environmental surfaces like floors or lab benches
- **Intermediate Level Disinfection**
    - Kills vegetative microorganisms, including Mycobacterium tuberculosis, all fungi, and inactivates most viruses
    - EPA Approved Hospital Disinfectants which are also tuberculocidal fall into this category

- May be used for housekeeping and disinfection of laboratory benches

- **Low Level Disinfection**
  - Kills most vegetative bacteria, some fungi, and inactivates some viruses.
  - Does not kill M. tuberculosis
  - Also known as “hospital disinfectants” or “sanitizers”

A. Disinfection Selection

Selection of an appropriate disinfectant is based on several factors:

- The target organism.
- The physical characteristics of the surface being disinfected (porosity, reactivity).
- The length of the contact time required to achieve an acceptable level of disinfection.

1. Bleach

Bleach is a commonly used laboratory disinfectant. However, it is important to remember that dilute bleach is not stable for long periods of time. Working dilutions of bleach should be made weekly. Working solutions of 10% bleach is effective in most cases for laboratory disinfection. Undiluted bleach is an irritant and a corrosive. Bleach will corrode stainless steel over time and if used on metal surfaces should be followed with a water rinse. Bleach must never be autoclaved.

To be an effective disinfectant bleach solutions must contain >0.5% but <2% sodium hypochlorite, Hypochlorite concentration in household bleach can vary by manufacturer therefore bleach working solutions should be prepared according the to brand of bleach in use.

2. Ethanol

Ethanol diluted to 70% in water is an effective disinfectant however, it is also not stable over time. Ethanol is a good disinfectant for equipment and surfaces that are susceptible for corrosion. Ethanol is effective against most vegetative bacteria, fungi and lipid containing viruses. They are not effective against *Mycobacterium tuberculosis,* bacterial spores and viruses such as HBV. Fresh alcohol dilutions should be made daily if possible.

3. Quaternary ammonium compounds

Commonly used for surface cleaning such as floors and bench tops. They are effective at inactivating most vegetative bacteria, fungi and lipid containing viruses. They are not effective against *Mycobacterium tuberculosis,* bacterial spores and many viruses.

4. Phenolics

Phenolics are commonly used to decontaminate surfaces such as bench tops. They are effective at inactivating vegetative bacteria, fungi, TB, lipid containing viruses and have some effect on bacterial spores.

5. Iodophores

Iodine containing compounds are commonly used on metal surfaces or equipment. They are effective at inactivating vegetative bacteria, fungi, TB and lipid containing viruses. They are not effective on bacterial spores.

AUTOCLAVES

An autoclave is a device used to sterilize items with the use of steam, high heat and pressure. Sterilization is based on, cycle length (exposure time), temperature, contact, pressure and steam. Autoclaves generate superheated steam that is capable of killing microorganisms and spores. Autoclaves at UTSA are used for decontaminating certain types of waste (waste from BSL-3 facilities), sterilizing media, instruments and labware.

Need to Autoclave?

Unless otherwise stated at UTSA autoclaving materials prior to disposal of biohazardous waste is **not** necessary. Exceptions to this are BSL-3 agents and associated waste.

A. How to autoclave effectively

- Use autoclavable biohazard bags to contain items.
- Do not overload the bags. Steam and heat will not penetrate to the center of an over packed load.
- Do not overload the autoclave. To be effectively sterilized there must be space around the items in the load.
- Do not mix "dry" items with liquid loads. Liquids usually require a shorter time in the autoclave.
- Validate the autoclave effectiveness regularly with a spore test.
- Only autoclave items that can withstand high temperature and pressure.
- Do not seal autoclave bags tightly, there should be a 3-4 inch opening at the neck of the bag to allow steam to enter.

B. Safety considerations

Autoclaves can be extremely dangerous if not used correctly and with the appropriate safety equipment.

Anyone using an autoclave must be trained, autoclave training is available online through BioRAFT and in person from trained staff. The following safety precautions must always be observed:

- Wear PPE – lab coat, goggles or face shield (face shields are preferred when an individual is autoclaving liquids), heat resistant gloves. Always wear closed toed shoes when working with an autoclave.
- Use the correct cycle for the load type.
- Wait for the chamber pressure to drop to zero before trying to open the door.
- Use caution when opening the autoclave door after the cycle is complete. Stand behind the door and open it slowly, to allow steam to escape without contact.
- Wait for the load to cool before trying to remove items.
- Always loosen the caps of containers.
- Ensure that containers have not pressurized during the cycle. If the lids of containers were tightened too much before autoclaving superheated liquid may explode from the container.
- Lift bags with caution, agar will liquify and can cause severe burns if the bag is not in appropriate secondary containment or is punctured during the run.
- Glassware can crack or shatter if it comes into contact with cold liquids or surfaces immediately after autoclaving.
- Never place items directly on the bottom of the autoclave. Always place containers in secondary containment such as trays.
- Never operate an autoclave if you are unsure how to do so safely.

NEVER AUTOCLAVE THE FOLLOWING SUBSTANCES

Flammable, reactive, corrosive, toxic, or radioactive materials
Household bleach
Alcohol
Any liquid in a tightly sealed container

C. Material compatibility

COMPATIBLE MATERIALS	INCOMPATIBLE MATERIALS
Tissue culture flasks	Acids, bases, and organic solvents
Surgical instruments	Chlorides, sulphates
Glassware	Seawater
Pipette tips	Chlorine, bleach
Media solutions	Non-stainless steel
Animal food and bedding	Polystyrene
Polypropylene	Polyethylene
Stainless steel	Low density and High-density polyethylene
Cloth	Polyurethane

Table 11. Summary of autoclave compatible and incompatible materials.

AUTOCLAVE EXPLOSION – CASE STUDY

A laboratory technician was using an autoclave to sterilize some tools and materials. The autoclave completed its cycle and the technician opened the door to remove the load. As the technician opened the door, a bottle inside the autoclave exploded and sprayed the individual with 4 liters of superheated liquid and steam; causing serious burns on multiple parts of the technician's body.

Lab workers immediately aided the technician to the safety shower to cool the affected burn area and called the emergency department. The technician was transported to the emergency room.

What happened?

One of the bottles in the load had a tightly sealed cap causing pressure to build up in the vessel and burst. The bottles were placed directly on the autoclave rack, and not on secondary containment which could have contained the spill. The technician was not wearing PPE which could have protected them from the hot liquid.

APPENDIX A – GLOSSARY

Aerosol Transmissible Disease (ATD)
A disease or pathogen for which droplet or airborne precautions are required.

Biosafety
The application of knowledge, techniques and equipment to prevent personal, laboratory and environmental exposure to potentially infectious agents or biohazards. Biosafety defines the containment conditions under which infectious agents can be safely manipulated.

Biosafety Cabinet (BSC)
An enclosed ventilated laboratory workspace for safely working with materials contaminated with (or potentially contaminated with) pathogens requiring a defined biosafety level.

Biosafety Level
A set of biocontainment precautions required to isolate biological agents in an enclosed laboratory facility. The levels of containment range from BSL-1 to BSL-4.

Biohazardous Agents
A biological agent that can cause disease in healthy individuals, animals, or plants.

Bloodborne Pathogens (BBP)
Pathogenic microorganisms that are present in human/primate blood and other potentially infectious material (OPIM) and can cause disease.

Engineering Controls
Safety equipment (primary barriers) includes biosafety cabinets, enclosed containers and other designed controls that remove or minimize exposures to hazardous biological agents.

Gene Transfer
Delivery of exogenous genetic material (DNA or RNA) to somatic cells for the purpose of modifying those cells.

NIH Guidelines
The NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules (NIH Guidelines) detail safety practices and containment procedures for basic and clinical research involving recombinant or synthetic nucleic acid molecules, including the creation and use of organisms and viruses containing recombinant or synthetic nucleic acid molecules.

Pathogen
A bacterium, virus, or other microorganism that can cause disease.

Personal Protective Equipment
Refers to protective clothing (lab coats, gowns, gloves, etc.) eye protection (safety glasses, goggles, face shields, etc.) or equipment (Biosafety Cabinets) designed to protect the wearer's body from injury or infection.

Recombinant Nucleic Acid

Refers to DNA which has been altered by joining genetic material from two different sources. It usually involves putting a gene from one organism into the genome of a different organism, generally of a different species.

Synthetic Nucleic Acid
Nucleic acid molecules that are chemically or by other means synthesized or amplified, including those that are chemically or otherwise modified but can base pair with naturally occurring nucleic acid molecules (i.e., synthetic nucleic acids).

Transgene
A gene that is taken from the genome of one organism and introduced into the genome of another organism by artificial techniques.

Transgenic
An organism that contains genetic material into which DNA from an unrelated organism has been artificially introduced.

Universal Precautions
An approach to infection control to treat all human blood and certain human body fluids as if they were known to be infectious for HIV, HBV and other bloodborne pathogens. Universal Precautions includes frequent handwashing, no mouth pipetting, no food or drink in the lab and proper disposal of biohazardous/medical waste, as well as the use of engineering controls and Personal Protective Equipment (PPE). Engineering controls include items such as biosafety cabinets, ventilation systems, closed top centrifuge rotors, etc.; are the primary methods to control exposure. PPE such as gloves, lab coats, eye protection, face shields or others must be selected and used as appropriate.

Viral Vector
Viruses that are used to deliver genetic material into cells.