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Animal Research

Health and Safety Plan

Environmental Health and Safety
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PURPOSE AND SCOPE

This plan is intended to establish the minimum safe operating procedures for direct and indirect work around animals in a research environment. This program is designed to reduce the risk of exposure to diseases transmitted from animals to humans (zoonotic diseases) and educate workers in and around our animal care facilities regarding zoonotic diseases, personal hygiene, and other safety related issues.

This plan applies to all Florida Atlantic University staff, faculty, students, volunteers, contractors, vendors, visitors, and any other person that works with or in close proximity to research animals.

LIMITATIONS

This document addresses Health and Safety with regard to laboratory and field work with research animals and must be used in conjunction with other FAU health and safety plans, such as the FAU Chemical Hygiene Plan (CHP). The CHP provides specific information on hazard assessment, training requirements, exposure monitoring procedures, and accident reporting.

Safety equipment, personal protective equipment, and vaccinations offer a measure of protection, but do not guarantee exposure-prevention against infectious diseases. Layers of protection including safety equipment, engineering controls, personal protective equipment, and work techniques are necessary to build a proper defense against exposure when working with animals in research.

This manual is not intended to be a complete listing of laboratory hazards or safe practices. Because of the diverse nature of work being conducted in FAU laboratories and field activities, additional procedures or requirements may be necessary. For example, laboratories working with biological agents, radioisotopes or labs generating chemical, biological or radioactive wastes all must adhere to strict environmental, health and safety policies and procedures. Individuals having questions are urged to contact their Principal Investigator or Supervisor and alternatively, EH&S for assistance.

ACCOUNTABILITY AND RESPONSIBILITY

Regardless of the source of a hazard, personnel must take several basic measures to reduce the risk of personal exposure. These include understanding the hazards you are likely to encounter during animal care and use, using properly designed and maintained facilities and equipment to minimize exposures, wearing appropriate personal protective equipment (PPE), and demonstrating the technical proficiency necessary to accomplish experimental manipulations or animal care procedures in a safe and humane fashion.

Workers are responsible for their own safety and the safety of their coworkers and visitors to their laboratories. All staff, students and volunteers must demonstrate this responsibility in their actions and attitudes. It will be each worker's responsibility to wear the personal protective equipment (PPE) assigned to them, adhere to prescribed safety rules and regulations, and to know and follow all emergency procedures. Lab staff must pre-plan their work to ensure their safety and the safety of those individuals who work around them. In addition to FAU safety policies, employees conducting research on non-FAU property shall comply with all safety and emergency response policies of the non-FAU facilities host.

The Principal Investigator (PI), Laboratory Supervisor and Laboratory Manager have the responsibility for controlling hazards in their laboratory, including but not limited to:

1. Completing a hazard assessment for all procedures.
2. Conducting hands-on training with laboratory personnel on potential hazards and safe work procedures.
3. Conducting (or delegating) monthly safety self-inspections within the laboratory.
4. Correcting work errors and dangerous conditions immediately and implementing interim measures wherever the hazard cannot be completely abated on-the-spot.
4. Maintaining a safe work environment.
5. Selecting the proper personal protective equipment (PPE) and ensuring that it is worn.
6. Maintaining all relevant compliance records and programs.
7. Investigating the circumstances surrounding a laboratory accident and taking steps to avoid recurrence.
8. Partnering with Environmental Health and Safety to ensure that personnel with indirect or infrequent exposure to research animals are enrolled in the Medical Monitoring Program and receive proper training as referenced in Table 6.

The Division of Research shall support and assist with the implementation and maintenance of this plan. The DOR will be responsible for supporting the PI and research staff with all resources necessary to ensure safety compliance. This will include providing research training to PI and staff members and allowing for time away from work for safety training. The research department will be responsible for, or assigning a responsible party to control, maintain and supervise common use laboratories.

Colleges and Departments within each college are responsible for supporting the PI and research staff with resources necessary to ensure safety compliance. Individual departments will be responsible for maintaining and supervising common use laboratories.

Environmental Health and Safety (EH&S) shall be responsible for providing oversight, EHS expertise and monitoring compliance and implementation of all safety and environmental regulations for all campus laboratories. This will include, but is not limited to, regulation interpretation, implementation of programs, planning reviews, facility surveys, and training and educational services. EH&S shall have enforcement authority when dealing with unsafe or illegal situations.

Florida Atlantic University will provide assistance for the compliance efforts of all staff and researchers. It will foster an attitude that safety is a core value of the institution.

HAZARDS AND CONTROLS

Housekeeping

All animal care areas, including areas in which hazardous materials are used or stored, should be kept neat and clean. Clutter can become contaminated and add to problems of employee exposure, area decontamination, and waste disposal. Work surfaces should be wiped with disinfectant before work begins, immediately after any spill, and at the end of the workday. Floors should be disinfected or decontaminated daily or weekly as appropriate to the potential hazards. Appropriate dust suppression methods should be routinely used. Wet mopping and the use of a HEPA-filtered vacuum cleaner are appropriate for suppressing dust.

Keep hallways clear, as well as 36” clearance around exits, eyewash stations, fire extinguishers, fire alarm pull stations and electrical panels to provide free access to egress pathways and emergency systems when needed. Immediate removal of blockages of exits is imperative.

Ergonomic Hazards

Laboratories provide many opportunities for ergonomic stressors to manifest into injuries or repetitive stress disorders. Major ergonomic issues in the laboratory setting includes static and/or awkward postures and repetitive motions. Use this page to learn a bit more about how to mitigate these stressors.

General

If you stand at your workstation, wear comfortable shoes and consider using an anti-fatigue mat. If you are seated, a highly adjustable chair or stool is recommended. Sit against the back of your chair. If your feet come off the ground, lower the chair, adjust the foot ring, or get a footrest.

- Keep frequently used items within close reach. Most frequently used items should be at approximately a forearm’s reach away, with lesser-used items up to arm’s reach away. Items you are currently working with should be directly in front of the body.
- Adjust the position of your work, your work surface, or your chair or stool so that you can work effectively while maintaining an upright, supported position. Avoid hunching over your work. For precision work, the work surface can be adjusted higher to provide support and reduce bending and hunching. Regular light work generally places the work surface around elbow height or just below. Heavy work places the work surface approximately six inches below elbow height.
- Try to work at a bench cut out or a hood/BSC with adequate knee clearance. If you are seated, you need room for your legs. If you are standing, a foot rail or foot prop is recommended to encourage and aid shifting positions throughout the work day. Propping a foot up relieves pressure on the back.
- Keep shoulders, arms and hands relaxed and elbows close to the sides while working.
- Try to keep the wrists neutral and aligned while working. Sitting close to your work will help with this.

- Make sure all equipment is clean and in good working order to help minimize repetitive or forceful twisting, turning, and pinching. Equipment should be the right size for your hand. Use padding and/or tubing on equipment and work area edges to reduce pressure and force while working.
- Use the lightest pressure possible to use your equipment (e.g. pipettes). Use electronic, automated, or light touch model equipment when possible.
- Remember to take frequent rest breaks. Alternate your grip on items like forceps. Vary your tasks.
- Intensive tasks should be spread through the day or shared between employees when possible.
- Ensure proper lighting for your task.
- Store heavy items on lower shelves.
- Use bottle dispensers and bottom dispensing carboys for dispensing liquids.

Microscopes

- Ensure that you can view the eyepiece while sitting or standing in an upright position. This includes the shoulders, back and neck. Accomplish this by adjusting your chair (if applicable), the work surface, and/or the microscope eyepiece. An angle stand or extendable eye tube may be available to aid in adjustment.
- Bring the microscope as close to you as possible (this usually means it is pulled to the edge of the workbench).
- Arms should be supported and relaxed while using the microscope with the elbows close to the sides. Wrists should be in a neutral position while making adjustments.
- Keep scopes repaired and clean for easier use.

Pipetting

- Where possible, use electronic, light-touch, or latch mode pipettes for intensive pipetting. Multiple finger (as opposed to thumb-only) pipette designs are preferred. Use the lightest touch possible while pipetting and changing tips.
- Work supplies such as trays and beakers should be placed within easy reach and with no obstructions to their access. Keep work in front of the body to minimize twisting and awkward reaching.
- Strive for straight and neutral wrist position while working.
- Try alternating hands or using both hands to pipet.
- Use low profile tubes, containers, and receptacles to avoid bending and twisting of the wrists, neck, and rolled shoulders.
- Avoid working with winged elbows/arms. Keep arms relaxed and elbows close to the body. Ensure that your work surface is at the appropriate height (see general tips, above).
- Keep head and shoulders in an upright, neutral position.

Hoods and Biological Safety Cabinets

- Keep arms relaxed and by the sides. Back, shoulders and neck should be upright and neutral in position.
- Keep the sash clean and free of glare so that you can see without tilting your neck or assuming an awkward position. Use diffused lighting to limit glare.
- Use low profile tubes, containers, and receptacles to avoid bending and twisting of the wrists, neck, and rolled shoulders.

- Keep the work area clean and free of clutter. Keep what you are working on directly in front of you, with frequently accessed items within forearm length and lesser-used items at arm's length. Remove unnecessary supplies.
- Perform all work 6 inches inside the hood.
- Strive to keep wrists straight and neutral while working.
- Avoid contact pressure (forearm and wrists in contact with sharp edges).

Microtomes

- Place the microtome at the appropriate height for work (see general tips, above).
- Avoid contact pressure (forearm and wrists in contact with sharp edges). Foam padding or padded arm supports may be used to reduce sharp edges.
- Use as little force as possible when turning the handwheel. When possible, replace manual rotary microtomes with automatic ones, especially for high-intensity work.
- Operate the microtome with the hand in a pistol grip position (wrist aligned with forearm in handshake position).
- Ensure that the microtome can be operated in an upright position with back, shoulders, and neck in neutral positions.
- Keep arms close to the sides.

Material Handling

- Avoid lifting heavy objects from above the head or alone.
- Use material handling equipment when possible and make every effort to reduce the number of times the same item is lifted.
- Store heavy items at or below shoulder height and lighter items above shoulders.
- Safe use of a step stool for removing items stored on high shelves

Once a hazard is recognized, employee education and engineering controls can be applied to reduce the potential for these types of injuries. Training should be updated if new tools are used in an operation and updated periodically to remind employees of proper work techniques. Employee involvement should be part of each solution.

If you have concerns regarding the ergonomics of a task, process or work area in your department, contact EH&S to determine if an ergonomic evaluation would be beneficial.

Animal-Specific Hazards

Animal care and use by their very nature present many situations that require safe practices to protect workers from physical hazards. The hazards of bites, kicks, and scratches are associated inevitably with most animal contact. A survey of animal-related injuries among veterinarians indicated that 35% required sutures for lacerations during their career. Working with heavy animals and equipment, such as metal cages, can stress muscles and joints. The potential for wet floors in animal rooms and cage washing areas increases risks of slipping and falling. Workers can also be exposed to physical hazards that are commonly found in the research environment, such as flammable solvents, ultraviolet radiation, ionizing radiation, pressure vessels, noise, and electric shock. The physical hazards selected for discussion in this section present the highest potential for causing serious harm and are likely to be present in most animal facilities.

The most common hazard associated with animal research is mechanical injury. Animals are capable of causing significant injury to animal handlers. Most research animals can bite or scratch. Livestock, large animals and primates can bite, batter, or crush. Because bites and scratches easily spread disease and infection, persons handling animals must take special care when working with animals.

Researchers who work with animals may develop allergic reactions, including rhinitis, conjunctivitis, asthma and dermatitis. Symptoms of animal allergy may include nasal congestion, sneezing, water eyes, hives and eczema. Rabbits and rodents are the most common research animals that cause severe allergic reactions. Animal dander, fur, bedding, urine, saliva and tissues are the primary sources of allergic antigens. Mold spores and proteins in animal feed may also act as antigens. To reduce exposure to animal allergens, minimize the generation of aerosols and dust and wear respiratory protection (e.g., dust mask) and other protective equipment, especially when feeding or handling animals, changing bedding or cleaning cages. If you believe other types of respiratory protection are needed, contact the Environmental Health and Safety Office to obtain work site evaluation and medical clearance for respirator use as required by OSHA standards.

Bites and scratches and even kicks are ubiquitous hazards associated with animal contact. They are largely preventable through proper training in animal handling techniques.

Following a bite or scratch from a research animal:

- Immediately wash the affected area with large quantities of soap and water.
- For small wounds – allow to bleed freely and if necessary, control bleeding by applying direct pressure.
- Report the incident to the supervisor/principal investigator right away, even if the incident may not seem serious.
- Seek medical treatment from the Occupational Medical Service Provider below, as appropriate. Be certain to report the injury as having originated from a research animal.
- If known infectious pathogens are involved, be certain to report those specifically as well, when receiving care.
- Follow the care instructions from the MSP carefully and attend all recommended follow-up appointments as recommended by the Treating Physician.

Special attention should be given to the training of personnel involved in the handling and restraint of nonhuman primates. Personnel who work with nonhuman primates should wear face shields and other protective garments and equipment appropriate for the circumstances and species involved.

A wide variety of wildlife may be encountered during fieldwork. It is the responsibility of the PI to include potential wildlife hazards in the risk assessment of fieldwork activities. These hazards will be included in the hands-on training provided to laboratory staff by the PI for fieldwork activities.

For more information on the health hazards associated with animal work, refer to the section on Zoonoses

Chemical Hazards

Indirect exposures to chemicals can occur when research animals are intentionally exposed to biological agents, chemicals and radioactive materials which then contaminate animal bedding, equipment, waste products and the atmosphere around cages. The IACUC protocol approval process requires the researcher to identify these agents and provide guidance to protect workers and staff. A description of the hazards and appropriate guidance on how to protect researchers and workers is included in the protocol. Additionally, Principle Investigators must inform animal care personnel of the hazards as well as their responsibilities in the care of treated animals.

Consult the FAU Chemical Hygiene Plan for more information on Chemical Safety.

Below is a list of some of the chemicals we utilize in our laboratories, the types of exposure, and how you can protect yourself against these chemicals. For a list of chemicals used in your laboratory, contact your Supervisor.

Table 1: Common Chemicals in the Laboratory

Hazardous Substance	Common Name	Use	Route of Entry	Hazards	Protective Measures
3,3'-Diaminobenzidine	DAB	Research use; tissue staining	Inhalation, oral, skin and eye.	May cause damage to the following organs: kidneys, lungs, bladder, upper respiratory tract, skin, central nervous system.	Use in fume hood or in well ventilated areas with proper PPE - nitrile gloves, eye protection, lab coat, and approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
Acetone	Acetone	Solvent; used for cleaning purposes in labs.	Inhalation, oral, skin and eye.	Eye, skin, and respiratory system irritant. May impact multiple body organs.	Use in well ventilated areas with appropriate PPE - gloves, eye protection and lab coat.
Alpha-bungarotoxin	α-BTX	Research use only	Inhalation, oral, and skin	Neurotoxin	Use in fume hood or in well ventilated area with PPE - eyeglasses, lab coat, gloves and respirator if necessary.

Hazardous Substance	Common Name	Use	Route of Entry	Hazards	Protective Measures
Buprenorphine	Buprenex, Butrans, Probuphine, and Belbuca, Butrans, Probuphine, and Belbuca	It is used to treat opioid addiction or acute pain.	Inhalation, oral, skin and eye.	Toxic if swallowed. Eye, skin, and respiratory system hazard. Suspected teratogen.	Nitrile gloves and safety glasses.
Cadmium		manufacturing and in research such as in lasers and semiconductors	Inhalation, oral, skin.	May cause cancer and genetic defects, harmful if swallowed, skin and respiratory irritant, teratogen.	Use in fume hood. If local exhaust is unavailable and the exposure limit is exceeded, use appropriate respirator, gloves, eye protection, and long sleeved clothing.
Chlorohexidine diacetate hydrate	Chlorohexidine	cationic broad-spectrum antimicrobial agent	Inhalation, oral, eye, and skin	Irritant - eye, skin, and respiratory system.	Wear protective gloves/protective clothing/eye protection/face protection.
Diethyl Ether	Ether	Solvent	Inhalation, oral, skin and eye.	Extremely flammable; Harmful if swallowed, Eye, skin and respiratory system irritant.	Use in fume hood or in well ventilated areas with proper PPE - gloves, eye protection, lab coat, and approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
Dual Quat 256Quat 256	Dual QuatQuat	Disinfectant	Inhalation, oral, skin and eye.	Harmful if swallowed or inhaled. Eye and skin irritant.	Use in well ventilated areas with appropriate PPE - gloves, eye protection and lab coat.
Ethidium Bromide	EtBr	Research - fluorescent tag, staining	Inhalation	Toxic if inhaled. Suspected of causing genetic defects	Use in fume hood or in well ventilated areas with proper PPE - gloves, eye protection, lab coat, and

Hazardous Substance	Common Name	Use	Route of Entry	Hazards	Protective Measures
					approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
Ethlyneimine	Ethylene imine, Aziridine	Used in DNA research and manufacturing.	Inhalation, oral, skin and eye.	Irritant - eyes, skin, nose, throat; nausea, vomiting; headache, dizziness; pulmonary edema; liver, kidney damage; eye burns; skin sensitization; potential occupational carcinogen	Use in fume hood or in well ventilated areas with proper PPE - nitrile gloves, eye protection, lab coat, and approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
Ethylene oxide	Oxirane	Disinfectant	Inhalation, oral, skin and eye.	At room temperature it is a flammable, carcinogenic, mutagenic, irritating, and anesthetic gas.	Use in fume hood or in well ventilated areas with proper PPE - nitrile gloves, eye protection, lab coat, and approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
Formaldehyde	Formalin	As a preservative and anti-bacterial agent. It is also used in the manufacture of building materials, etc.	Inhalation, eyes, skin, and oral.	Inhalation toxin; may cause burns to skin and eyes, may cause cancer and damage to organs, may cause genetic defects.	Use in fume hood. If local exhaust is unavailable and the exposure limit is exceeded, use appropriate respirator, gloves and protective clothing.
Formamide	Methanamide	Bio reagent and in manufacturing	Inhalation, oral, skin and eye.	May cause cancer, teratogen, eye and skin irritant;	Use in fume hood or in well ventilated areas with proper PPE - gloves, eye

Hazardous Substance	Common Name	Use	Route of Entry	Hazards	Protective Measures
				Chronic exposure may cause damage to multiple organs.	protection, lab coat, and approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
Glacial Acetic Acid	Acetic Acid or ethanoic acid	Research - chemical reagent	Inhalation, oral, skin and eye.	Causes severe eye, skin, digestive and respiratory tract burns. Respiratory effects may be delayed.	Use in well ventilated areas with appropriate PPE - gloves, eye protection and lab coat.
Hydrochloric Acid	Hydrochloric acid	Research - reactions, etc.	Inhalation, oral, skin and eye.	May cause severe burns to skin, eyes, respiratory system, and digestive tract. May be fatal if inhaled.	Use in fume hood or in well ventilated areas with proper PPE - gloves, eye protection, lab coat, and approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
Isoflurane	Forane, Forene, etc., Forene, etc.	General anesthetic	Respiratory system	Eye and skin irritant. May cause drowsiness or dizziness, headache and nausea. May affect the central nervous system (CNS). Some studies suggest that overexposure may result in adverse reproductive effects.	Use appropriate PPE (nitrile gloves, lab coat, safety glasses or goggles if necessary. Use in fume hoods. If a local exhaust ventilation system is not available, use in a well ventilated area and with a scavenging system. Leak checks must be routinely performed on scavenging systems.

Hazardous Substance	Common Name	Use	Route of Entry	Hazards	Protective Measures
Ketamine	Ketala	Anesthetic	Inhalation, oral, skin and eye.	Eye, skin, and respiratory system irritant.	Use in a well ventilated area with eye protection and gloves.
Methanol	Methyl alcohol	Solvent, fuel, antifreeze, etc.	Inhalation, oral, skin and eye.	May cause blindness if swallowed. May cause significant harm if inhaled. Skin and eye irritant.	Use in fume hood or in well ventilated areas with proper PPE - gloves, eye protection, lab coat, and approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
Reserpine	Raudixin, Serpalan, SerpasilRaudixin, Serpalan, Serpasil	Antipsychotic, and antihypertensive drug	Inhalation, oral and skin.	harmful if swallowed, inhaled or in contact with skin. Suspected carcinogen and teratogen.	Use in well ventilated areas with appropriate PPE - gloves, eye protection and lab coat.
Sodium Hypochlorite	Bleach	Disinfectant	Inhalation, oral, eye, and skin	Irritant - eye, skin, and respiratory system.	Use in fume hood or in well ventilated area with PPE - eyeglasses, lab coat, gloves and respirator if necessary.
Tricaine MethanesulfonateMethanesulfonate	Pharmaceutical Grade MS-222	Anesthesia and euthanasia of fish, amphibians, and other aquatic cold-blooded animals.	Respirable, skin, eyes.	Skin irritation, eye irritation, respiratory toxicity, aquatic toxicity.	Use in well ventilated area, weigh and measure under a fume hood. Avoid contact with mucous membranes. PPE includes nitrile gloves, lab coat and safety glasses.
Trichloromethane	Chloroform	Solvent, reagent	Inhalation, oral, skin and eye.	Carcinogen; teratogen; may impact multiple body organs. Eye and skin irritant.	Use in a well ventilated area with eye protection and gloves.

Hazardous Substance	Common Name	Use	Route of Entry	Hazards	Protective Measures
Tris(1-Aziridinyl)Phosphine Sulfide	Tris(1-Aziridinyl)Phosphine Sulfide	Insect sterilant, and cancer medication	Inhalation, oral, and skin	Carcinogen, teratogen, skin and eye irritant. Chronic exposure may lead to bone marrow damage.	Use in a fume hood or with respiratory protection. Use gloves, eye protection, and lab coat.
Tris(2,3-dibromopropyl) phosphate	Tris(2,3-dibromopropyl) phosphate	Research use, and flame retardant	Skin, oral, and inhalation	May cause cancer, harmful if swallowed, skin irritant, toxic to aquatic life.	Wear protective gloves/protective clothing/eye protection/face protection. Proper ventilation or local exhaust should be considered.
Xylazine	Rompun, Anased, Sedazine, Chanazine, Anased, Sedazine, Chanazine	Anesthetic	Inhalation, oral, skin and eye.	Toxic if swallowed. Eye, skin, and respiratory system irritant.	Use process enclosures or in well ventilated areas with appropriate PPE - gloves and eye protection.

Additional Laboratory Hazards

Many more hazards exist in a laboratory setting that must be evaluated and controlled, refer to the links below for more information on these:

- Pressure vessels
- Lighting
- Electricity
- Ultraviolet radiation
- Lasers
- Ionizing radiation
- Machinery
- Noise
- Sharps

For more information on hazards in laboratories, consult the OSHA Laboratory Safety Guidance document.

Hazards with Experimental Protocols

It is important to identify the various hazardous materials (biological, radioactive and chemical) that will be part of an experimental protocol. In some cases, it may be more challenging to control the hazards (e.g. animal biologically shedding the material or agent). Such materials may pose a hazard to laboratory personnel and other personnel (e.g. animal care specialists).

A fundamental principle in the conduct of research is the need to determine the potential hazards associated with an experiment before beginning it. That is extremely important in planning experiments that involve research animals, because investigators might be unfamiliar with the intrinsic hazards presented by the animal species of choice or tissues derived from them, and managers and their employees who care for the research animals should be informed of the hazards presented by the experimental protocol. Consideration of both animal-related hazards and protocol-related hazards would benefit from a collaborative assessment in which the investigator, the institutional veterinarian, the animal care supervisor, and a health and safety professional participate. A collaborative assessment is strongly encouraged if the animal experimentation involves either the testing of chemicals for their toxic properties or research with experimentally or naturally infected animals. Whether or not a collaborative initiative is pursued, investigators have an obligation to identify hazards associated with their research and to select the safeguards that are necessary to protect employees involved in the care and use of their research animals.

Hazards associated with experimental protocols are influenced by two principal factors: the dangerous qualities of the experimental agents and the complexity or type of the experimental operations. For example, toxicity, reactivity, flammability, and explosivity should be considered when an experimental protocol involving chemical agents is being planned, and virulence, pathogenicity, and communicability are possible hazardous qualities of biological agents.

The complexity and type of an experimental operation have a direct impact on the extent of potential exposure that an employee receives while carrying out or participating in an experimental protocol. For example, during incorporation of a test chemical into feed for ingestion studies, a contaminated dust created during milling and mixing and during transfer of the diet could result in respiratory and dermal exposures. Test material applied to the skin of experimental animals might be disseminated by handling of animals, clipping of hair, changing of bedding, and sweeping of the animal room floor. Vapors are potential sources of exposure during the application of test material to the skin. Exposing an animal to an agent by injection will create a risk of accidental self-inoculation. Inhalation challenges are particularly hazardous and should be conducted only by investigators who have appropriate experience and containment equipment.

A comprehensive, rigidly followed plan is necessary for testing chemicals of unknown hazard for their toxic properties. It should be presumed that a chemical is hazardous to humans, and the plan should describe specific procedures for handling the chemical from receipt through disposal of animal waste and processing of tissues for histopathological or biochemical examination. Prudent Practices in the Laboratory: Handling and Disposal of Chemicals provides an excellent general model for planning experiments that involve hazardous

chemicals. It was specifically structured to follow the sequence of stages that should be considered in planning a safe experiment: evaluating hazards and assessing risks in the laboratory, management of chemicals, working with chemicals, working with equipment, disposal of chemicals, laboratory facilities, and government regulation of laboratories. It is important not to underestimate the risk presented by experimental chemicals. But most references on chemical safety provide little guidance that is directly applicable to the care and use of research animals. Therefore, developing plans for a specific research protocol that involves research animals and chemicals of unknown hazard will require ingenuity, a quality best derived from a collaborative planning process.

Field Activity Hazards

Fieldwork can carry with it a multitude of hazards that are often difficult to predict, but the researcher can evaluate and plan for these risks. While it is not possible to include every possible risk, people performing fieldwork must consider the possibilities listed below when conducting the risk assessment for any fieldwork. Remember that this list is not exhaustive and other hazards may exist in the field environment. A plan for how to deal with the risks relevant to any fieldwork must be documented, controlled, and communicated prior to the fieldwork being performed. Contact EHS for assistance with any potential hazards to which prevention or protection is not known.

Table 2: Common Hazards in Field Work

Hazard Category	Examples of Specific Hazards
Physical hazards	• extreme weather • Sun exposure • mountains and cliffs • glaciers, crevasses, ice falls • caves, mines and quarries • forests / woods • freshwater • sea and seashore • marshes and quicksands • roadside • work at height
Biological hazards	• animals • plants • pathogenic microorganisms (e.g. cause of tetanus, leptospirosis)
Chemical hazards	• agrochemicals • dusts • chemicals on site • chemicals associated with the fieldwork activity
Human activity / man made hazards	• farming • forestry

Hazard Category	Examples of Specific Hazards
	• military • recreation • excavations • slurry and silage pits • waste disposal • power lines and pipelines • unsecured buildings
Mechanical	• machinery and vehicles • tools / equipment
Electrical	• generators • equipment
Transport hazards	• driving • boat use • Use of airplanes or helicopters
Personal safety	• lone working / attack on the person • security of accommodation
Hazards to the environment	• waste disposal • pollution • disturbance of eco-systems
General	• health & fitness • behaviour

Contingency planning for reasonably foreseeable emergencies must be made, bearing in mind the likely hazards of the environment and the type of work undertaken. For example, the following items should be considered:

- provision of adequate emergency equipment (e.g. first aid kits, bivouac tents)
- correct treatment of any casualties and equipment e.g. decontamination
- means of summoning aid - emergency service details
- evacuation procedures
- liaison with police and emergency services
- possible need to communicate in a foreign language
- Someone on your team or home university is aware of your field work plans in case of becoming lost or injured

ALLERGENS

Controlling occupational exposure to animal allergens can be a formidable challenge, encompassing a broad range of considerations and often involving an array of solutions. The objective of exposure control is to prevent or minimize occupational exposure to laboratory animal allergens, thus reducing the incidence and prevalence of allergic disease while relieving symptoms among those employees who are sensitive. No clearly established threshold for allergen exposure supports a minimum safe exposure level; however, prospective studies

indicate that reduced exposure will reduce symptoms and decrease the incidence of laboratory animal allergy.

Summary of recommendations to reduce exposure to animal allergens in the workplace and prevent animal-induced asthma and allergies includes:

- Increase the ventilation rate and humidity in the animal-housing areas.
- Ventilate animal-housing and –h
  andling areas separately from the rest of the facility.
- Direct airflow away from workers and toward the backs of the animal cages.
- Install ventilated animal cage racks or filter-top animal cages.
- Perform animal manipulations within ventilated hoods or safety cabinets when possible.
- Decrease animal density (number of animals per cubic meter of room volume).
- Either scrubs of disposable coats or gowns will be worn while working with captive animals. If scrubs (or non-disposable coats/gowns) are worn, they must be laundered in house or managed through a commercial service equipped to safely launder (or dispose of) contaminated clothing.
- Keep cages and animal areas clean. Take particular care to control exposures during cleaning.
- Use absorbent pads for bedding. If these are unavailable, use corncob bedding instead of sawdust bedding.
- Use an animal species or sex that is known to be less allergenic than others.
- Reduce skin contact with animal products such as dander, serum, and urine by using gloves, laboratory coats, and approved particulate respirators with face shields.
- Provide training to educate workers about animal allergies and steps for risk reduction.
- Provide health monitoring and appropriate counseling and medical follow-up for workers who have become sensitized or have developed allergy symptoms.

Table 3: Common Allergens

Animal	Source	Symptoms	Protective Measures (if allergic)*
Mouse	Hair, dander, urine Serum	Sneezing, congestion, coughing, hives, swelling, watering eyes, itchy eyes and difficulty breathing.	Protective clothing, including protective gloves to avoid nails breaking the skin. Use of a N95 respirator mask. For allergies that produce hives or difficulty breathing, avoid work in Laboratories with these animals. Use dump station for bedding disposal.
Rat	Hair, dander, urine, and saliva Serum	Sneezing, congestion, coughing, hives, swelling, watering eyes, itchy eyes and difficulty breathing.	Protective clothing, including protective gloves to avoid nails breaking the skin. Use of a N95 respirator mask. For allergies that produce hives or difficulty breathing, avoid work in laboratories with these animals. Use dump station for bedding disposal.
Bird	Skin, feathers, cage bedding and droppings	Runny nose, watery eyes, stuffy nose, itchy throat, and sneezing.	Protective clothing, including protective gloves to avoid nails breaking the skin. Use of a N95 respirator mask. For allergies that

Animal	Source	Symptoms	Protective Measures (if allergic)*
			produce hives or difficulty breathing, avoid work in laboratories with these animals. Use care and respiratory protection when cleaning bottom of cage.
Latex or latex containing items	Gloves, vaccine vials, tape, stethoscope, blood pressure cuffs, IV tubing, syringes, and other similar materials.	Nasal, eye, or sinus irritation. Hives or rash. Difficulty breathing. Coughing or wheezing. Nausea, vomiting, or diarrhea.	Notify supervisor of any known allergy to latex before performing work and avoid potential latex sources unless specifically aware those materials do not contain latex.

*Any use of respiratory protection will be conducted under consultation with EHS and the authorized medical service provider.

Job assignment on entry into the laboratory animal work environment should be assessed, PRIOR to commencement of work with animals. People with known risks are best assigned to tasks that minimize exposure. Some tasks—such as simple feeding, weighing, or necropsy—produce low levels of exposure, whereas cage cleaning can lead to high levels of exposure. Selection of job assignment is the first step to minimize exposure of people who have become sensitized or have developed symptoms.

ZOONOSES

Zoonotic diseases are those that can be passed between animals and humans and can be caused by viruses, bacteria, parasites and fungi. The zoonosis by species listed below focuses on zoonotic disease associated with animals used at FAU, including general methods to prevent disease transfer from animals to humans. While most animals at FAU are free of zoonotic disease, it is important to be aware of pathogenic organisms that may be carried by the animals we use in our research. If you observe any symptoms in your study animals, contact your supervisor immediately. If you observe any symptoms in your household pets, contact your personal veterinarian. Optimally, all research animals will be handled as if they are carrying disease.

Table 4: Common Zoonoses

Research Animal **	Pathogen	Specific Zoonosis*	Hazards	Protective Measures
Feline (Sample)	Helminth Infections	Toxoplasmosis	Route of entry: oral. Can cause illness similar to the flu. Young, old and immunosuppressed susceptible to serious illness. Teretogenic. Teretogenic.	Gloves, good hand hygiene. Pregnant women should not handle cat litter.
Bird	Bacterial Diseases	Psittacosis - Chlamydia psittacipsittaci	Route of entry: Inhalation - Breathing in dust that is contaminated with bird droppings. May cause Blood-tinged sputum, dry cough headache, joint aches shortness of breath	Gloves, gowns, respiratory protection, engineering controls, good hand hygiene.

Research Animal **	Pathogen	Specific Zoonosis*	Hazards	Protective Measures
Bird	Fungal Diseases	Histoplasmosis - Histoplasma capsulatumcapsulatum	Route of entry: Inhalation - Breathing in dust that is contaminated with bird droppings. May cause fever and chills, cough, chest pain, mouth sores.	Gloves, gowns, respiratory protection, engineering controls, good hand hygiene.
Dolphin	Fungal Diseases	Lacazia loboi loboi	Route of entry: Broken Skin. May cause skin lesions and tingling sensation	Gloves and good hand hygiene.
Fish	Bacterial Diseases	Mycobacterium species -M. marinum, M. fortuitum and M. cheloneimarinum, M. fortuitum and M. chelonei	Route of entry: Skin -Direct contact with infected fish or contaminated water, may cause skin rash or boils	Gloves, good hand hygiene when handling fish and cleaning aquarium
Fish	Bacterial Diseases	Vibrio species - V. parahaemolyticus and V. parahaemolyticusparahaemolyticus and V. parahaemolyticus	Route of entry: Skin and Ingestion -Direct contact with infected fish or contaminated water. May cause watery diarrhea, vomiting and fever.	Gloves, good hand hygiene when handling fish and or contaminated water
Lion Fish	Toxin	Ciguatera Toxin	Route of entry: Skin puncture and ingestion -may experience nausea, vomiting, and neurologic symptoms (reverse hot and cold)	Cut resistant gloves and good hand hygiene.
Non-human Primate	Viral Diseases	Herpes B Virus	Route of entry: Eyes nose and mouth, can be fatal causing acute ascending myelitis.	Gloves, gown, surgical mask, face shield or safety glasses, gown, booties and bonnet
Non-human Primate	Bacterial Diseases	Mycobacteria tuberculosis	Route of entry: Inhalation - may cause chest pain, coughing, malaise, night sweats	Lab coat, gloves, respiratory protection, TB tine and chest x-ray
Polar Bear	Bacterial Diseases	Coxiella burnetii burnetii	Route of entry: Inhalation- breathing in dust that has been contaminated by infected birth products, feces, and urine. May cause flu-like symptoms or still births	Gloves, respiratory protection and good hand hygiene.
Rodents	Bacterial Diseases	Rat Bite Fever - Streptobacillus moniliformis	Route of entry: Skin- Bite or Scratch from rodent, Ingestion - Contaminated food water bedding may cause chills fever, joint pain, or swelling rash	Gloves, gowns, surgical mask, good hand hygiene. Engineering Controls for bedding
Wild Rodents	Viral Diseases	Hantavirus	Route of entry: Inhalation - Breathing in dust that is contaminated with rodent urine or droppings. May cause fatigue, fever, and body aches. Could be life threatening with hantavirus hemorrhagic fever.	Gloves, gowns, respiratory protection, good hand hygiene.
Sea Lion	Bacterial Diseases	Leptospirosis	Route of entry: Skin and mucous membranes. May cause high fever, muscle aches, jaundice, abdominal pain	Gloves, eye protection and good hand hygiene
Shark	Toxin	Cyanobacterial toxin	Route of entry: Ingestion of shark fin -may experience nausea, vomiting, and neurologic symptoms	Gloves and good hand hygiene.

Research Animal **	Pathogen	Specific Zoonosis*	Hazards	Protective Measures
Sting Ray	Venom	Neurotoxin	Route of entry: Body Puncture - may cause vomiting, fever, tremors, paralysis, death may even occur.	Cut resistant gloves and good hand hygiene.
Turtle, Tortoise, Toad, and Salamander	Bacterial Diseases	Salmonella	Route of entry: Skin and Ingestion -Direct contact with infected turtle. May cause diarrhea (sometimes bloody), abdominal cramps, vomiting, fever, muscle pain. Young, old and immunosuppressed susceptible to serious illness.	Gloves, good hand hygiene when handling turtles. Cover open wounds with a waterproof dressing.
Frog	Bacterial Diseases	Mycobacteriosis, Chlamydiosis, Salmonellosis. Also, other organisms found in tank water.	Route of entry: Skin and Ingestion -Direct contact with infected frog or tank water.	Gloves, good hand hygiene when handling frogs or tank contents. Cover open wounds with a waterproof dressing.
Turtle	Rickettsial Diseases - Ticks Diseases - Ticks	Rocky Mountain spotted fever; ehrlichiosis; Lyme disease, and STARI (southern tick-associated rash illness).ehrlichiosis; Lyme disease, and STARI (southern tick-associated rash illness).	Route of entry: Skin, bite from tick. May cause headache, fever, stupor, skin rash/bullseye, muscle aches	Gloves, good hand hygiene when handling turtles,, white clothing long pants
Whale	Bacterial Diseases	Brucellosis	Route of entry: Skin, Ingestion and Inhalation. May cause fever, sweats, headaches, back pains, and weakness	Gloves, mask or respirator protection and good hand hygiene.

* Note that most laboratory animals are obtained through controlled procurement chains to be free of the common zoonoses listed herein, unless specifically designated to host a pathogen or pathogens. While laboratory animals certified "pathogen free" are indeed considered to be safe, they may still host bacterium or other unknown constituents.

**Hazards and precautions extend not only to the adults and young of the species, but also the eggs, fur, feathers, feces and body fluids.

OCCUPATIONAL SAFETY AND EXPOSURE CONTROL

Safe Work Practices

Workers should be made aware of the risks and be instructed in proper measures to control and avoid exposure as much as possible. Work practices are the most important element in controlling exposures. Employees should understand the hazards associated with the procedures that they are performing, recognize the route through which they can be exposed to those hazards, select work practices that minimize exposures, and through training and experience acquire the discipline and skill necessary to sustain proficiency in the conduct of safe practices.

Below are recommended practices to reduce employee exposure to biological and chemical contaminants by category. These practices must be taken into consideration when performing any work at FAU Animal Facilities and/or Laboratories:

(Several categories of work practices should be considered:)

- Practices to reduce the number of employees at risk of exposure.
  - Restrict access to the work area.
  - Provide warnings of hazards and advice about special requirements.
- Practices to reduce exposures by direct and indirect contact.
  - Keep hands away from mouth, nose, eyes, and skin.
  - Wash hands when contaminated and when work activity is completed.
  - Decontaminate work surfaces before and after work and after spills of a hazardous agent.
  - Use appropriate methods to decontaminate equipment, surfaces, and wastes.
  - Substitute less-hazardous materials for hazardous materials whenever possible.
  - Wear personal protection equipment (gloves, gowns, and eye protection).
- Practices to reduce percutaneous exposures.
  - Eliminate the use of sharp objects whenever possible.
  - Use needles with self-storing sheaths or those designed to protect the user.
  - Keep sharp objects in view and limit use to one open needle at a time.
  - Use appropriate gloves to prevent cuts and skin exposure.
  - Select products with puncture-resistant features whenever possible.
  - Use puncture-resistant containers for the disposal of sharps.
  - Handle animals with care and proper restraint to prevent scratches and bites.
- Practices to reduce exposure by ingestion.
  - Use automatic pipetting aids; never pipette by mouth.
  - Do not smoke, eat, drink, or apply cosmetics in work areas (including field activities) used for the care and use of research animals.
  - Keep hands and contaminated items away from mouth.
  - Protect mouth from splash and splatter hazards.
- Practices to reduce exposure by inhalation.
  - Use chemical fume hoods, biological safety cabinets, and other containment equipment to control inhalation hazards.
  - Handle fluids carefully to avoid spills and splashes and the generation of aerosols.
  - Use in-line HEPA filters to protect the vacuum system.

Housing, Handling and Transport of Animals

Solid-bottom cages with bedding should be used for mice and rats. Selection of bedding materials can be beneficial in reducing worker exposure. Use of noncontact absorbent pads,

rather than such wood-based contact litter as chips and sawdust, substantially reduced airborne concentrations of rat urinary allergen.

Safety precautions are needed during animal handling and animal transportation to prevent transmission of zoonotic agents to employees. Employees should wear personal protective equipment specifically chosen for the exposures that might be related to the animals being handled or transported. Safety concerns are relevant to all who have access to the animals being transported and those who receive and use them.

Care will be taken to avoid incidental exposure to others in the transport route; i.e. hallways, elevators, stairwells, etc. Wherever possible, animals will not be transported in the same elevator as workers that do not work with animals.

Restraint of Animals

Species specific safe techniques should be used to restrain animals. Physical restraint might require more than one animal handler. The use of mechanical restraint devices or chemical restraints can reduce the potential for escape or injury when animals are being examined or handled. Employees should be aware that physical restraint can increase the inherent risks associated with the animal by intensifying excretions, secretions, and aggressive behavior of the animal.

Cleaning Cages

Caution should be used in removing animals from their cages before cage cleaning to avoid escape. Contaminated shavings, feces, urine, and other potentially biohazardous, contaminated, or allergenic materials should be removed with methods that protect the workers. Biological safety cabinets, laminar flow hoods and the like are designed to pull gases and particulate away from the worker and are suitable as bedding dump stations to protect workers from hazardous aerosols that might be generated during cage cleaning. Protective clothing is required to protect workers from contact and percutaneous exposure. The eyes, face, and body should be protected during use of hazardous chemicals.

Automatic cage washers pose several problems that should be addressed, including excess noise that might require hearing protection and ergonomic deficiencies that might contribute to back injuries and repetitive-motion injuries. Sharp edges on cages and ancillary equipment should be identified and eliminated. Heat in cage washing areas might require changes in ventilation and work practices to avoid excessive heat exposure. Employees should wear appropriate footwear and remain vigilant to the ever-present hazard of wet, slippery surfaces.

Always follow the approved procedure used in the specific lab where the work is being performed as there can be subtle differences between labs.

Waste Disposal

Segregate wastes appropriately including biological/medical waste, hazardous/chemical waste, solid/non-hazardous wastes, etc. Wastes need to be removed at scheduled intervals based on the amount of waste generated and the risk posed by the hazardous agents in the waste

material. Planning is required to ensure that sufficient space is available for on-site collection, storage, treatment, and disposal of waste. The disposal of hazardous wastes is subject to federal, state, and local regulations. The environmental health and safety staff should stay informed of regulations, which change often. They should keep all on-site generators of hazardous waste informed of disposal procedures to ensure that they are in compliance with current requirements.

Personal Hygiene

Scrupulous attention to personal hygiene is essential for all personnel who care for and use research animals. They should wash their hands before and after handling animals and whenever protective gloves are removed. Hair should be neatly groomed and pulled back and if needed, tucked into the lab coat. There should be no eating, drinking, smoking, application of cosmetics, or other activities that can increase the risk of exposure to hazardous materials, biological materials, or allergens in animal care and animal use areas. Closed-toed shoes are required in a laboratory environment and shoes made of non-absorbent materials are required wherever there is a potential for splashes of hazardous or biological materials.

Facility Design and Operations

Attention to facility design is necessary in reducing the incidence of laboratory animal allergy. The airborne-allergen load in an animal room depends on the rate of production, which is a function of the numbers of animals present, and the rate of removal, which is a function of ventilation. Achieving a substantial reduction of airborne allergen in a heavily populated area requires extremely high ventilation rates in excess of 100 air changes per hour. These standards can be met with the use of high-efficiency-particulate-air-filtered (HEPA-filtered) laminar-flow units, or otherwise conducting work under biological safety cabinets or fume hoods, as appropriate.

Airborne concentrations of rat allergens also depend on the relative humidity of the environment. An increase in relative humidity from 54% to 77% was shown to reduce airborne rat-allergen concentrations substantially. This simple maneuver could be of benefit in reducing exposure in some facilities; however, raising humidity to 77% might exceed the optimal range for animals, produce employee discomfort, and induce mold growth.

Cage-emptying where loose bedding is used results in particularly high levels of allergen exposure. Use of ventilated hoods or work stations for cage emptying and cage-cleaning with filtered, recirculated air can reduce exposure.

The type of caging will undoubtedly influence exposure to airborne allergens. Filter-top cages have been shown to reduce concentrations of airborne allergens, compared with conventional open-top cages. Ventilated cage and rack systems that can reduce exposure are commercially available. Cage and rack systems that exhaust air through a HEPA filter system before returning it into the room substantially reduce the concentration of airborne rat allergen, *Rat n 1,* compared with non-HEPA-filtered cage racks. However, data to support the routine use of these devices to prevent sensitization or reduce symptoms in workers have not appeared.

Laboratory Signage Requirements

The goal of Laboratory signage is to protect human health and safety, protect research, identify what types of PPE and information are needed before entering the laboratory and to alert unsuspecting visitors to the potential hazards within the space.

At a minimum, Laboratory entrance doors will include the following signage:

- Name and contact information for Laboratory Director, Manager, and/or Supervisors.
- Emergency contact for spills or accidental releases.
- Minimum level of PPE required for entry into the space, i.e. lab coat, safety glasses, gloves, etc.
- Indicate “Restricted Area, Authorized Personnel Only”
- Individual signs for the following agents if they are present within the laboratory;
    - Lasers (include highest classification used)
    - Biologicals (include highest BSL classification used)
    - Radiation
    - Chemicals (include type of hazards, i.e. flammable, corrosive, toxic)

Labs or storage areas which can only be accessed via another lab, the door to which is already posted, need not be individually posted but the hazards they contain must also be represented on the sign posted on the exterior access door.

Privacy shielding is recommended on any windows to laboratory space containing animals for the comfort and wellbeing of the animals housed inside.

Equipment Performance

Engineering controls are a combination of safety equipment and physical features of the facility that help to minimize hazardous exposures of personnel and the surrounding environment. Safety equipment provides a barrier between employees and hazards, and physical features can prevent or reduce the potential for release of hazardous agents from the immediate work area. Some engineering controls commonly used in animal care and research are barriers and airlocks, chemical fume hoods, biological safety cabinets, and isolation cages.

Barriers help to confine potential contamination to areas where it is generated and to control access to these areas. In animal biosafety level 3 facilities, barriers isolate animal areas from other, adjacent areas. The principal barriers are exhaust air ventilation systems that provide directional airflow, architectural barriers that control access to the animal facility, and airlocks that help to maintain air pressure differentials to ensure the proper direction of airflow. Access control barriers also have value for any animal facility because they can be used to prevent unauthorized people from entering the animal facility; this kind of control is difficult to accomplish without constructing an access foyer or special entrance area through which authorized people must pass before entering the facility.

Chemical fume hoods are local exhaust devices that help to prevent toxic, offensive, and flammable vapors or dusts from entering a work area. They provide employee protection from such hazards as chemical spills, splashes or sprays, other accidentally released materials, fires, and minor explosions. Hoods should be properly located in the laboratory away from doors, supply air ducts, and high traffic areas. Hoods should be evaluated before use to ensure adequate face velocities (typically 80-100 ft/min) and the absence of excessive turbulence. The hood installation should include a continuous airflow monitoring device to allow the user to check operating conditions before conducting hazardous procedures. If inadequate hood performance is suspected, correct operation should be verified before the hood is used. The hood sash opening should be kept as narrow as reasonably practicable to improve the overall performance of the hood. The containment capability of hoods is also influenced by the amount and placement of equipment in the hood, persons walking by the hood, and the opening and closing of doors. Careful technique by the user is essential in achieving optimal performance.

Biological safety cabinets are among the most effective, as well as the most commonly used, primary containment devices for work with infectious agents. Several types of cabinets are available, and authoritative references should be reviewed before a cabinet is selected for a particular experimental use. As with any piece of laboratory equipment, personnel should be trained in the proper use of biological safety cabinets. Air balance and inward airflow are critical in the safe operation of these cabinets. Biological safety cabinets should be certified in accordance with the National Sanitation Foundation Standard 49. Containment can be compromised by interruption in airflow caused by insertion and removal of a worker’s arms through the work opening, opening and closing of room access doors, and movement of staff near the cabinet. Fans, heating and air conditioning diffusers, and other air-handling devices near the cabinet can also disrupt airflow patterns. Biological safety cabinets have been configured to provide containment space for cleaning cages. They can protect both the animals and personnel from exposures to aerosols that are generated by cleaning procedures.

Cage filter tops are used in animal research to prevent cross contamination with infectious agents. They prevent transmission of agents between and among animals and people by preventing particles from entering the cage. Isolation cages with filter tops that fit tightly to the cage rim can constitute an effective barrier to transmission of agents by the aerosol route, but they should be used in conjunction with a biological safety cabinet to ensure containment during procedures that involve removing the cage top.

Ventilated caging systems also control hazards. Exhaust fans create a negative pressure gradient between the cage and the surrounding environment, and exhaust air is filtered with a high-efficiency-particulate-air (HEPA) filter before discharge into the animal room or the building exhaust; this combination can prevent the escape of bioaerosols from the animal environment.

Downdraft necropsy tables capture chemical vapors generated during necropsy. The tables are constructed with exhaust fans that produce a downdraft by drawing air through the work surface. Air velocities above the work surface, however, are not sufficient to capture aerosols that are generated by the procedure. The protective capacity of these tables can be

compromised by air turbulence in the room, the size of the animal on the table, and general work practices. Their use should be carefully assessed by knowledgeable health and safety professionals.

Room ventilation is an important engineering control used to maintain comfortable temperature and humidity in the work area. Changing air continuously can reduce the concentration of airborne contaminants but does not replace the use of such containment devices as chemical fume hoods, biological safety cabinets, and filter top cages. A ventilation system that provides directional airflow can prevent the migration of airborne contaminants to unprotected space in the facility.

Cage cleaning and cage washing can result in high concentrations of particulate contaminants and very high heat loads from the cage washing equipment. Consequently, high ventilation rates are important for providing acceptable environmental conditions for personnel.

Local exhaust can be effective in controlling contaminants at the point of generation. Properly engineered and used canopy hoods and flexible exhaust ducts can substantially reduce occupational exposures to such hazards as animal dander and excreta liberated during cage cleaning, aerosols and vapors generated during anesthesia or necropsy, and heat emanating from cage cleaning or waste decontamination. Slot hoods can also be used in controlling these exposures, but their effectiveness depends on the correct static pressure, flow rate, and hood geometry. Local exhaust devices are particularly useful for controlling emissions from equipment or procedures that cannot reasonably be contained in a hood. Local exhaust devices are not as effective as chemical fume hoods, so engineering and industrial hygiene professionals should be consulted to assist with selection or design for each specific application.

The value of engineering controls in protecting the health and safety of employees depends on the performance and operational integrity of the protective equipment. The environmental health and safety office should include programs for certifying and monitoring equipment to ensure that it is capable of providing the necessary protection and maintaining adequate performance.

The American National Standards Institute (ANSI) has published consensus guidelines for laboratory ventilation systems, which include recommendations regarding chemical fume hood performance. The ANSI standards are excellent reference documents and provide relevant guidance for engineering control of hazards in the care and use of research animals. The following ANSI recommendations refer specifically to chemical fume hoods:

- A routine performance test should be conducted on every fume hood at least once a year or whenever a substantial change has been made in the operational characteristics of the system.
- Each hood should maintain an average face velocity of 80-120 ft/min with no face-velocity measurement more than 20% greater or less than the average. ft/min with no face-velocity measurement more than 20% greater or less than the average.
- New and remodeled hoods should be equipped with a flow-measuring device.

Biological safety cabinets testing/certification after installation and whenever a stationary cabinet is moved and will be recertified at least once a year. Performance certification criteria have been established by the National Science Foundation International.

Ultraviolet (UV) radiation of 254-nanometer (254-nm) wavelength may be used to control airborne and surface microorganisms in various locations in an animal care and research facility. The biocidal capacity of UV bulbs decreases with time and is adversely affected by contamination with dust or chemical films. They should be cleaned once a week and replaced on a regular schedule or monitored at least once a year to verify adequate performance.

HEPA filtration units require periodic monitoring to ensure filtration efficiency (NSF 1992). Performance tests should be conducted at least once a year. Appropriate controls or decontamination should be used during replacement and certification because filters can become contaminated with potentially infectious agents, toxic chemicals, or radioisotopes during use.

Charcoal filtration can be used to control the environmental release of toxic materials or radionuclides. Performance is difficult to certify, and performance testing should be specific to the hazard that is being controlled. Performance should be monitored either by using continuous monitoring instruments, which are calibrated to the chemicals of concern and placed downstream of the exhaust-filter bed, or by periodically sampling the discharge air. An acceptable alternative to monitoring charcoal filtering systems is to replace the filters at established intervals that are based on their calculated effective life. Ductless fume hoods that use mainly activated charcoal filters should not be used for protection from volatile toxic compounds.

Ventilation system performance should be checked periodically to document adequacy of room air exchanges and air pressure gradients in accordance with authoritative guidelines (NRC 1996). Air pressure gradients indicate airflow relationships; the frequency of monitoring them should be based on the degree of risk associated with the hazardous materials being used. Continuous readout monitoring instruments might be appropriate to provide instantaneous performance information in high containment facilities.

Effluent monitoring might be required by local ordinances designed to protect the sewage treatment works of the municipality. Specific, periodic monitoring might be required for ensuring compliance with discharge limits for chemical, biological, or radiological agents. Additional monitoring could also be necessary to demonstrate adequate control after accidental spills or releases of materials that might have entered the sewage system.

Validation and verification are important aspects of autoclave performance testing. The use of biological indicators that contain bacterial spores is an effective method of validating sterilization cycles for various load types. Monitoring of autoclave operational measures (temperature, pressure, and time) can verify performance routinely.

Fire protection systems and equipment (such as fire extinguishers) should be inspected and tested periodically to ensure operational integrity. Insurance companies and local fire authorities generally specify the frequency with which these inspections and tests should be performed.

Emergencies

All departments (units) have an emergency response plan and all personnel under that department need to train on the requirements of that plan annually. Emergency situations will occur, and they require a rapid, coordinated response to minimize harm to personnel and facilities. It is the responsibility of the PI and lab manger to keep the emergency contact numbers of lab members up to date.

An emergency response plan provides a structure for effective response by defining employee responsibilities, interactions between responding personnel, the sequence of response procedures, and availability of emergency equipment. All on-site employees should know their roles in responding to emergency situations and should know the limitations of their training and equipment and not perform activities for which they have not been trained.

Typically, the hierarchy for response will be to protect personnel, then animals, and finally the animal care facility and surrounding buildings. The plan should include provisions for caring for the animals in place and moving or relocating animals to temporary housing facilities.

Student Health Services and the Occupational Clinics used by FAU will have a copy of this policy to reference the unique hazards related to emergency response procedures in the animal facility. They will need to be prepared to support the potential exposures and injuries related to emergency responses.

Below is a general list of animal-related emergency events and recommended actions; for all other events, refer to the emergency response plan for the unit or department.

Table 5: Injuries and Exposures

Event	Immediate Action	Contact	Send to	Notify
Injury or exposure (student)	Assess injury and determine if it requires emergency medical attention or follow up with a physician. If the injury/exposure is animal related, prepare a copy of this plan to send with the person	911 (if an emergency) Student Health (if medical care beyond first aid is necessary during working hours) **Boca: 561-297-3512** **Broward: 954-236-1556** **Jupiter: 561-799-8678** **HBOI – 772-871-5900**	Student Health (if not sent by ambulance) Nearest Hospital (if medical care is needed after hours)	EHS (send e-mail to Henry Hutchison regarding the incident)
Injury or exposure	Assess injury and determine if it requires emergency	911 (if an emergency)	US Healthworks /Concentra	EHS (send e-mail to Henry Hutchison

Event	Immediate Action	Contact	Send to	Notify
(employee or volunteer)	medical attention or follow up with a physician. If the injury/exposure is animal related, prepare a copy of this plan to send with the person	Occupational Clinic (during working hours) or nearest hospital **(Boca) US Healthworks/ Concentra: 561-368-6920** **(Jupiter) Jupiter Medical Center Urgent Care: 561-263-7010** **(HBOI) Lawnwood Regional Medical Center 772-461-4000** **(Davie/Dania) Concentra: 954-941-6301**	(during working hours) Nearest Hospital Emergency Room (after hours)	regarding the incident)
Injury or exposure (not otherwise listed)	Assess injury and determine if it requires emergency medical attention or follow up with a physician. If the injury/exposure is animal related, prepare a copy of this plan to send with the person	911 (if an emergency) **(Boca) US Healthworks/ Concentra: 561-368-6920** **(Jupiter) Jupiter Medical Center Urgent Care: 561-263-7010** **(HBOI) Lawnwood Regional Medical Center 772-461-4000** **(Davie/Dania) Concentra: 954-941-6301**	Nearest Hospital Emergency Room or the individual's personal physician	EHS (send e-mail to Henry Hutchison regarding the incident)

Must be posted in each laboratory space.

Personal Protective Equipment (PPE)

The following matrix outlines the attire and PPE requirements based on the locations indicated. These are preliminary PPE requirements and may be upgraded or downgraded based on the most current risk assessment for the area. The list below represents lab types that are typically associated with working with research animals. Occupants must observe the specific PPE requirements for the labs in which they work.

For the purposes of this program, the following lab environments associated with animal use are defined as follows:

Chemical Labs – Labs where hazardous chemicals are used and stored, but are used in association with animal research.
Outdoor Animal Labs – Labs which are used for animal research and are located outside or aquatic labs such as those at Gumbo Limbo, HBOI, research on boats, the shore and inland waterways.
Indoor Animal Labs – Labs indoors where research animals are transported and removed from their enclosures.
Vivarium – An indoor lab housing animals under environmentally controlled conditions.

Table 7: General Attire and PPE Requirements for Work with Animals

Required to Wear	Chemical Labs	Outdoor Animal Labs	Indoor Animal Labs	Vivarium
General Attire				
Shirt or Scrubs Top	XX	XX	XX	XX
Long Pants or Scrubs Bottoms	XX	--	XX	XX
Socks	XX	--	XX	XX
Closed Toed Shoes*	XX	XX	XX	XX
Long hair pulled back or tucked in shirt	XX	XX	XX	XX
Necklaces tucked in shirt or lab coat/gown	XX	XX	XX	XX
Personal Protective Equipment				
Laboratory Coats or Gowns	XX	--	XX	XX
Safety Glasses	Where physical eye hazards exist	Where physical eye hazards exist	Where physical eye hazards exist	Where physical eye hazards exist
Safety Goggles	Where chemical (mild to moderate) splash hazards exist	Where chemical (mild to moderate) splash hazards exist	Where chemical (mild to moderate) splash hazards exist	Where chemical (mild to moderate) splash hazards exist
Full face shield with Goggles	Where splash hazards exist while working with toxins, communicable diseases, and strong corrosives	Where splash hazards exist while working with toxins, communicable diseases, and strong corrosives	Where splash hazards exist while working with toxins, communicable diseases, and strong corrosives	Where splash hazards exist while working with toxins, communicable diseases, and strong corrosives
Nitrile Gloves	XX	XX	XX	XX
Chemical Resistant Gloves	Work with toxins and moderate to strong corrosives	Work with toxins and moderate to strong corrosives	Work with toxins and moderate to strong corrosives	Work with toxins and moderate to strong corrosives
Heavy Duty Work Gloves (cotton, etc.)	Materials handling	Materials handling	Materials handling	Materials handling

Required to Wear	Chemical Labs	Outdoor Animal Labs	Indoor Animal Labs	Vivarium
Respirators	Based on Risk Assessment	Based on Risk Assessment	Based on Risk Assessment	Based on Risk Assessment

* Shoes must be constructed of impermeable, non-porous material that is cleanable by wiping with a damp cloth.
** Match glove type suitable to the work being performed; the standard of care is usually to wear nitrile, but material handling may warrant the use of work gloves or use of chemicals may warrant the use of chemical resistant gloves.
XX = required to wear at all times
-- = Not required
“Text” = conditions under which it is required.

If all other methods to eliminate or reduce a hazard to acceptable levels are not successful or possible, the use of personal protective equipment is the final measure for controlling exposures to potentially hazardous agents. Personal protective equipment provides a physical barrier to hazardous materials that might otherwise come into contact with employees’ skin, eyes, mucous membranes, and clothing. The equipment should protect the part of the body that is reasonably expected to come into contact with hazardous agents. Selection should be based on specific knowledge of the potential hazards, experience, and sound professional judgment.

Gloves are the most commonly used personal protective clothing. Nitrile or other appropriate protective gloves should be worn for handling potentially contaminated animals or hazardous materials. Care should be taken to ensure that the glove material provides an adequate barrier against the expected hazard. For example, nitrile or rubber gloves might be required to protect against some solvents, whereas thick leather would provide better protection against animal bites or scratches. Gloves should be long enough to cover the area to be protected and gloves will include gauntlets wherever hazardous liquids may drip up the sleeve of the lab coat.

Disposable gloves should not be reused. Heavy duty rubber gloves will hold up well in cleaning and disinfecting; these are of the type commonly used for washing cages. Uniforms, gowns, or laboratory coats are provided to prevent contamination of animal care personnel by animal urine and feces. Such clothing should not be worn outside the work area (unless it is covered). Protective clothing should be selected so that it provides an adequate barrier against the type and extent of exposure expected, i.e. lab coats should be resistant to absorption. For example, cage washing personnel might wear heavy rubber aprons to protect themselves when using strong detergents and cleaning agents. Safety shoes might be advisable for employees engaged in moving cage carts and other heavy equipment. Similar protective clothing might be required for those who clean and disinfect animal rooms. The need to decontaminate and dispose of protective equipment is an important consideration in its selection.

Face protection is advised if the eyes, nose, or mouth might be exposed through splashes or splatters of potentially hazardous agents. Safety glasses should be considered minimal eye protection and worn to prevent injury from projectiles, minor splashes, or contact of contaminated hands with eyes. Goggles or face shields might be needed for tasks involving infectious or hazardous liquids if there is a potential for splashing and splattering. Goggles or face shields are especially important when disinfectants and cleaning agents are used under pressure. Surgical masks also provide some protection of the mouth from splashes.

Respiratory protection might be necessary to control occupational exposures

to aerosols. Surgical masks are not and do not provide respiratory protection. Employees who require respiratory protection must be enrolled in a respiratory program for FAU. The selection and use of proper respiratory protection equipment should be coordinated through the environmental health and safety staff. Annual training and fit testing is required when enrolled in the Respiratory Protection Program.

OCCUPATIONAL HEALTH PROGRAM

A robust occupational health and safety program is necessary to provide the maximum protection to workers in the animal laboratory environment. Occupational health-care services are required for FAU to meet its expectation to provide a safe and healthful laboratory environment.

The Occupational Health Program consists of several layers of protection.

1. Risk ratings for those working in animal laboratories
2. Risk-specific education
3. Risk-based advice for participation in the medical screening and monitoring program
4. Ongoing access to an Occupational Physician
5. Follow-up care should an exposure occur
6. Updates to the program if new species/risks are introduced to the work environment.

The scope of this program applies to:

- University employees
- University students
- University Volunteers

If there is a question regarding the applicability of this program to a person with exposure or potential exposure to animals in FAU research, please contact EHS for clarification.

* Collaborators, vendors, and other 3rd parties under Risk Category 3 or higher are required to comply with their own medical monitoring programs.

Risk-Based Participation

The requirements for level of training and the participation in the Medical Monitoring Program depend upon an individual's level of potential risk. The risk categories to be utilized with this program are as follows:

Table 6: Risk Categories

Risk Category	Worker Types	Requirements	Optional	Exceptions
1	• Veterinary Service Center Personnel • Animal Care Staff • Direct contact with Laboratory Animals • Work in an animal laboratory.	Participation in the medical monitoring program is required. Training for Animal Laboratory Workers	Recommended to participate in the medical screening for work in animal laboratories. Vaccines Allergy Screening	None
2	• Direct contact with animals in the field	Participation in the medical monitoring program is required. Training for Animal Field Workers	Recommended to participate in the medical screening for work in animal laboratories. Vaccines Allergy Screening	If the field work involves contact with only domesticated animals.
3	• Indirect contact with laboratory animals o Maintenance workers o Vendors o Workers in nearby areas o Others may apply	Participation in the medical monitoring program is required. Training in Laboratory Animal Awareness	Recommended to participate in the medical screening for work in animal laboratories. Vaccines Allergy Screening	If accessing animal laboratories 2 or less times per year may qualify for Category 4.
4	• Field work involving non-contact with animals • Infrequent and limited access to animal laboratory facilities for inspections, etc.		Optional participation in the medical monitoring program. Optional participation in the medical screening program for	

Risk Category	Worker Types	Requirements	Optional	Exceptions
			work in animal laboratories.	

Privacy and Confidentiality

It is important to remember that Information gathered during the course of enrollment and participation in the medical monitoring program and beyond, will be protected and held in confidence between the participant and the Medical Service Provider.

Requirements for Health-Care Services

Individuals (employees, students, and volunteers) working with vertebrate animals on behalf of FAU will be afforded appropriate medical monitoring throughout the course of their animal work.

The medical screenings, vaccines, and immediate care following an exposure incident are provided to participants at no cost.

Responsibility of the Principle Investigator or Supervisor

When an individual becomes associated with a Principal Investigator or supervisor and will have direct physical contact with vertebrate research animal(s), the Principal Investigator or supervisor must ensure that the Medical Monitoring Authorization Packet is completed. The packet includes the following forms (also click here):

Medical Referral Form – Required to be signed by the Supervisor or EHS prior to seeking consultation at the Occupational Clinic.
Hazard Assessment Form – Required to be completed by the participant and their supervisor to determine the type of work and potential exposure.

Initial Health Questionnaire – Completed by the participant for review by the Medical Service Provider to determine potential risks for exposure, including allergies.

Medical Screening Consent/Declination Form – Completed by the Participant to accept or decline appropriate vaccines, allergy testing, or other treatment prior to work with animals. Declining these services does not affect the participant's other benefits of enrollment.

Animal Work Clearance Form – Completed by the Medical Service Provider to clear the participant for work with animals with or without conditions; in rare cases, the participant may be denied access to work with animals based on extenuating circumstances such as serious risk of life-threatening allergic reactions.

Please note, whenever a participant uses a different species, a new Hazard Assessment must be completed and sent to EH&S.

Require participants to update their medical monitoring each year by completing and submitting the Annual Health Questionnaire and Clearance Form to the MSP.

Responsibility of the Participant (Animal Worker)

The "Medical Monitoring Authorization Packet" authorizes the MSP to perform appropriate medical screening procedures. The participant will submit their completed packet to the MSP either by fax, e-mail or mail or make an in-person appointment with the MSP.

The MMAP can be found on the EH&S web site here.

Responsibilities of the Medical Service Provider (MSP)

MSP's offer professional medical support services for the medical monitoring program. EH&S has agreements with MSP's who will partner with EHS to determine the risks associated with animal contact for each individual. The MSP's will provide physical examinations, administer appropriate immunizations, provide treatment for animal related illnesses or injuries, when appropriate, and follow-up services when authorized by the University. The MSP's will also provide a completed Clearance Form to EHS and participants.

The MSP will review the packet and may request the employee come in for further evaluation if necessary. If the employee is cleared to work with animals, the MSP will generate a Clearance Form. Once this Clearance Form is received by the EHS, the individual is "enrolled" in the medical monitoring program. The participant, the PI, EHS, and the Division of Research will be notified that the participant is cleared to work in the Laboratory and under what (if any) restrictions.

The MSP will provide annual clearance renewal, follow up guidance and care to participants as needed.

Annual Program Renewal

Annual renewal of suitability for work with animals will be conducted through an updated MMAP which will be provided to the participants by the MSP. The periodic reevaluation will include completion of an annual health questionnaire and a renewal for the medical clearance form. Clearance for work with animals will again be returned to EHS and the participant and a copy provided to Research for access records. Obtain annual form here.

Episodic Health Evaluations

Persistent symptoms, symptoms that indicate the onset of a work-related illness, or the occurrence of a work-related injury should prompt appropriate medical evaluation and care. Participants experiencing new symptoms are encouraged to present to the MSP for evaluation for potential sensitivity to animals based on prolonged and recurring exposure. These

evaluations are at no cost to the participant and do not require a new clearance to work with animals if there are no changes.

Recognition, Evaluation, Recording, and Follow-up of Adverse Health Outcomes

The incidence and prevalence of medical symptoms, injuries, or illnesses will be assessed periodically by EHS in collaboration with the MSP, Comparative Medicine and the IACUC. Several mechanisms will be used to recognize adverse health risks and adverse health outcomes. Incident reports completed when medical symptoms occur as the result of a workplace event or exposure and reports obtained during laboratory inspections will be used to evaluate the efficacy of the control measures.

Consenting to Participation in Medical Monitoring and Screening

Personnel working around or in close proximity to research animals at FAU are required to enroll in the Medical Monitoring Program as a condition of working with animals. Personnel required to enroll in the program must consent or decline to participate in the Medical Screening portion of the program; where such individuals are offered vaccinations, testing, and medical consultation regarding potential exposures associated with performing the work.

Personnel are required to complete all forms within the enrollment package and may decline medical treatment at any time.

Annual Medical Monitoring Update Form

Annual Questionnaire and Clearance Form – This form will be completed annually by all MMP participants to update their medical history allowing the Medical Service Provider to ensure all medical history is up to date and the clearance for work with animals renewed, renewed with conditions or in rare cases, denied based on special circumstances that could post a serious health risk to the participant.

TRAINING AND EDUCATION

Occupational health and safety objectives of an institution can be achieved only if employees know the hazards associated with their work activities; understand how the hazards are controlled through institutional policies, engineering controls, work practices, and personal protective equipment; and have sufficient skills to execute safe work practices proficiently. All that requires a multifaceted education and training effort that addresses the full range of health and safety issues related to the care and use of research animals. Approaches for providing an education and training effort depend on the size, resources, animal species, research activities, staff experience, and technical expertise of the institution. However, successful programs have three common attributes:

- The occupational health and safety goals of the institution and how they will be achieved, including precise guidance on regulatory-compliance strategies, are clearly communicated to all employees. This function is commonly carried out by the

environmental health and safety staff through formal orientation, distribution of written guidelines, and periodic refresher training.

- Employees are fully apprised of all relevant hazards and control strategies pertaining to their general work assignments. Information provided to employees is developed through the interaction of several key people, including a veterinarian or other professional familiar with zoonotic risks presented by the research animals, a health and safety professional who has knowledge of occupational hazards common to animal care and use and relevant hazard control strategies, and scientists who can assess the health risks associated with planned experimentation or research protocols. This interaction will define the knowledge needed by employees to protect themselves from hazards associated with their work and point to needs for further training.
- Supervisors in the animal care and research groups are actively involved in ensuring that their employees have acquired the necessary skills and attitudes to work safely. If deficiencies are present, on-the-job training supervised by an experienced employee is provided until appropriate standards of proficiency are demonstrated.

Training will consist of:

- Review of plans and procedures
- Completion of relevant computer-based-training materials,
- Attending relevant in-person training
- On-the-job training with a supervisor
- Work with other laboratory or research professionals.

It is important to remember that training and experience is the culmination of all training methods and that any one piece of the training program alone is not adequate.

RECORDKEEPING

EH&S will maintain records of all reported animal-related injuries and exposures. EH&S will partner with Research and the Medical Service Provider to ensure the safety program addresses any potential gaps, additional training needs, or other modifications that may be beneficial in reducing animal-related injuries in the future.

PROGRAM EVALUATION

The quality and effectiveness of an institution’s occupational health and safety program can be sustained only through periodic evaluations of the program and a commitment to respond to changing circumstances.

Evaluation of program efficacy can be gained through a multitude of data points including incident reports, near miss investigations, IACUC and Biosafety compliance reports, and interviews with workers in the programs.

Audits and Self Inspections

In order to ensure compliance and maintain the level of care consistent with higher education facilities throughout Florida, the following Audit Schedule is required at FAU.

Type of Audit	Conducted By	Frequency
Self-inspection:	Laboratory Manager or Designee	Monthly
Compliance Inspection:	EH&S or Designee	Annually
Animal Care Inspection:	IACUC	Semi-annually

Forms to guide the process of the self-inspections and compliance inspections are provided as appendices to this document. Completed Self-inspection forms will be maintained at the laboratory location for a period of no more than one year for inspection during other audits. Electronic storage of these records is acceptable. Compliance inspection forms will be sent to the Laboratory Manager for review and action following the completion of the inspection. Laboratories are responsible for ensuring correction of any deficiencies cited.

PLAN REVISIONS AND APPROVALS

This plan will be reviewed annually by EHS and Research to maintain safety information that is relevant and effective. Necessary updates regarding new protocols, animals, and hazards will be integrated into this document and published as needed.

Animal Research Safety Links

National Academies Press, Occupational Health and Safety in the Care and Use of Research Animals

Centers for Disease Control and Prevention

BMBL 4th Edition

Proceedings of the 4th National Symposium on Biosafety

Training Materials - OFFICE OF LABORATORY ANIMAL WELFARE

ILAR Journal Online, Volume 42(1) 2001 Laboratory Animal Allergy

NIOSH/Asthma in Animal Handlers Alert

Prudent Practices in the Laboratory: Handling and Disposal of Chemicals (NRC 1995)