BIOLOGICAL SAFETY
AND
CHEMICAL HYGIENE PLAN

School of Biological Sciences

July 2015

Please note that the authors of this plan have taken the liberty of using materials from OSHA and the Chemical Hygiene Plans posted by other Universities and Colleges. We appreciate the use of these materials.

EMERGENCY CONTACTS

Campus Emergency	911

School Director
Dr. Susan M. Keenan 970.351.2510
Main Office 970.351.2921

School Chemical Hygiene Officer (CHO)
Dr. Mark Thomas 970.351.2329

Chemical Stockroom
Mr. Frank Skufca, Lab Manager 970.351.2469

Environmental Health and Safety
Mr. Glenn Adams, Director 970.351.1149

Poison Control Center ..... (800)222.1222

Radiation Safety Officer
Dr. Cynthia Galovich

PREAMBLE

The Culture of Laboratory Safety

As a result of the promulgation of the Occupational Safety and Health Administration (OSHA) Laboratory Standard (29 CFR § 1910.1450), a culture of

Should laboratory instructors, coordinators, research mentors or teaching assistants not adhere to the safety practices outlined in this plan, they will be asked to correct those practices by the CHO and/or School Director. Should that not correct the issue, it is the responsibility of the CHO, School Director and Director of EHS to collectively determine the penalty. That penalty can range from recording the issue in annual reviews (at a minimum) to being banned from the use of laboratory facilities.

INTRODUCTION TO THE BIOLOGICAL SAFETY AND CHEMICAL HYGIENE PLAN

Safety should always be of the utmost concern for anyone working in the laboratory. The safety policies contained in this Plan are written in accordance with the School of Biological Science's commitment to safety.

For teaching laboratories, the laboratory instructor needs to be cognizant of what is considered to be an unsafe action or whether policy is being adhered to, and he or she has the authority to require a student to leave the laboratory. Each student in a lab is required to complete a basic consent form (see appendix B) which must be kept for a minimum of three (3) years.

If appropriate, the laboratory instructor may pursue further disciplinary action. If there is a dispute on the action taken by the laboratory instructor, the student may appeal the decision to the laboratory coordinator (defined here as the faculty member in charge of all sections of that laboratory course).

A student researcher who does not follow the policies in this manual is subject to disciplinary action by the student researcher's primary advisor. Principal investigator(s) (PIs) for each research laboratory should review the policies in this document and append the specific requirements for the appropriate research laboratory. The PI of each research laboratory should prepare Standard Operating Procedures (SOPs) for all laboratory procedures not covered in this general plan. Copies of the SOPs should be available within each research lab.

It is the responsibility of any person in the laboratory to notify the proper authority in the appropriate hierarchical order, first the laboratory instructor, then the laboratory coordinator or the research advisor, and finally the School Director, Dr. Susan Keenan (susan.keenan@unco.edu; 970.351.251) if unsafe laboratory conditions exist or if a possible safety concern is present. This statement will be inserted into all syllabi with the laboratory coordinator's name.

LABORATORY USE

Laboratories at UNC have two primary functions: teaching and research. Undergraduate students are permitted in teaching laboratories only when there is direct or indirect supervision. When teaching laboratories are not in use, the doors to the laboratory must be locked. When a teaching laboratory is in use, all corridor entrance doors to the laboratory must be unlocked to give full access to the room.

Research laboratories should never be left unlocked when unattended for any period of time. Undergraduate researchers can only work in a research lab when approved to work unsupervised by the lab PI. When students are using a research laboratory, they must let another person know when they are going to be in a research laboratory alone.

Personal Hygiene

Everyone working in a chemical laboratory should be aware of the dangers of ingesting or absorbing chemicals. These common sense precautions will minimize the possibility of such exposure:

a. Do not bring or consume food or beverages in any laboratory.
b. Do not smoke, use smokeless tobacco, or chew gum in any laboratory.
c. Do not apply cosmetics when in the laboratory.
d. Wash hands thoroughly before leaving the laboratory.
e. Wash hands thoroughly after removing gloves.
f. Do not leave a laboratory or use instruments with gloves on. Gloves should always be removed and discarded in the trash can before leaving a laboratory or before using instruments that will be handled by people that will not be wearing gloves.
g. Wash lab coats or jackets separately from personal laundry.
h. Never wear or take lab coats or jackets into areas where food is consumed.
i. Never pipet by mouth; always use a pipet aid, suction bulb or thumb roller

General Laboratory Upkeep

Cleanliness leads to a safer and more efficient work environment. For example, laboratory drawers should be closed when not in use for they can pose a potential hazard for others who enter the lab. All laboratory equipment must be used in accordance to the manufacture's specifications. When finished using a piece of equipment, it should be returned in the same condition in which it was found, making sure that no safety concerns are present. Chemicals must be returned to their appropriate storage location immediately after use.

Cleaning Glassware

Dirty glassware should never be allowed to accumulate in large quantities in any laboratory. It should be cleaned daily at the very least. Glassware should be cleaned with warm water and soap or detergent. Cleaned glassware should be dried on a drying rack, or oven if appropriate for the particular laboratory. Once dried, the glassware should be stored in its proper location; the drying rack is not a storage location.

Broken Glassware

If glassware is broken in a teaching laboratory, the laboratory instructor should be notified immediately. If a chemical spill has occurred as well, see the appropriate section in this manual for handling spills. Once chemicals have been dealt with appropriately, the broken pieces should be collected using a broom and dustpan and disposed of in a broken glass disposal box. DO NOT DISPOSE OF BROKEN GLASS IN THE REGULAR TRASH! When the broken glass disposal box is full, it should be securely taped and labeled as trash for the custodial services to pick up.

Instruments and Equipment

member, or the Lab Manager. Failure to seek proper authorization may result in dismissal from the laboratory and loss of the privilege to use instrumentation and equipment.

Training from Chad Wangeline or Ken Cochran is required **prior to t**

Although not a cryogen, solid carbon dioxide or dry ice which converts directly to carbon dioxide gas at Shipments packed with dry ice, samples preserved with liquid nitrogen, and in some cases, techniques that use cryogenic liquids, such as cryogenic grinding of samples, present potential hazards in the laboratory. Cold contact burns, asphyxiation and pressure or chemical explosion are all potential issues

Whenever handling or transferring cryogenic fluids might result in exposure to the cold liquid, boil-off gas, or surface, protective clothing must be worn, which includes face shield or safety goggles, cryogenic gloves and long-sleeved shirts, lab coats, aprons. Eye protection is required at all times when working with cryogenic fluids. When pouring a cryogen, working with a wide-mouth Dewar flask or around the exhaust of cold boil-off gas, use of a full face shield is recommended. Hand protection is required to guard against the hazard of touching cold surfaces. It is recommended that cryogen safety gloves be used by the worker.

Due to the high expansion ratios for liquid cryogens and ability for solid CO_2 to sublimate, these materials should only be stored in areas with adequate ventilation. Large mobile Dewars or LN2 48] TJ nrg 0.1 2 refrigerators (or the trolleys carrying these) used for transporting cryogens within a building or between buildings should be equipped with a braking mechanism. Large mobile Dewars at risk for tipping should be transported on appropriate carts. Wheeled trolleys may not be used if the vessel must pass over elevator thresholds or other slots/crevasses wider than 25% of the wheel width. Use two people to move tall mobile Dewars over door thresholds, if there is the possibility of tipping the container. Smaller vessels of liquid nitrogen or other cryogens transported by hand

Autoclaves/sterilizers

Autoclaves and sterilizers are such a familiar feature within laboratories it is often easy to overlook the hazards which they present. In order to render a material sterile, the autoclave utilizes hot pressurized steam (270°F & 30 lbs/in^2), which presents serious burn hazards. Because the conditions within autoclaves are so extreme, the chance for malfunction is high if not properly operated and maintained.

Each autoclave has unique characteristics, so it is important for users to review and understand the operator's manual or receive training prior to use. Since any unsafe practice could result in injury to laboratory staff, the following safety precautions should be enforced when using autoclaves:

- NEVER attempt to autoclave items which contain hazardous chemicals or other hazardous materials (other than potentially infectious materials).
- Firmly lock autoclave doors prior to operation. Most autoclaves are equipped with an interlock system, which does not allow operation without the door being completely closed. Determine if your autoclave is equipped with an interlock system. If it does not, be sure all users are aware of this feature and advise them to utilize extra caution when operating the autoclave.
- Do not store combustible materials near autoclaves.
- Always utilize the appropriate Personal Protective Equipment (PPE) when handling items being placed into or removed from an autoclave. This includes heat resistant gloves, safety goggles, and if handling large amounts of liquid, rubber boots and rubber apron to protect against splash/spill hazards.
- Be sure autoclave is not operating and pressure is low before opening doors. Open autoclave doors slowly, keeping the head, face, and hands away from the opening to prevent direct contact with steam. Wait at least 30 seconds after opening the door before reaching into the autoclave to remove sterilized items. Wearing appropriate gloves and protective equipment, remove items slowly.
- Before loading the autoclave, check the inside for items left by previous users.
- Load autoclaves as per the manufacturer's recommendations. Not following these recommendations may result in incomplete sterilization of items.
- To prevent bottles from shattering during pressurization, the caps of containers with liquids must be loosened before loading.
- Use a tray with a solid bottom and walls to contain the contents and catch spills, should

In addition to the above safety precautions, all manufacturer safety recommendation should be in place and effectively enforced. If injury occurs from exposure to autoclave steam or autoclaved materials, follow procedures for treatment of a burn and seek immediate medical attention

Centrifuges

Centrifuges, due to the high speed at which they operate, have great potential for injuring users if not operated properly. Unbalanced/damaged/worn centrifuge rotors can result in injury, even death. The majority of all centrifuge accidents are the result of user error. Follow the manufacturer's recommendations for use.

Pregnancy Policy

A chemical may pose a hazard to both an adult and an unborn fetus. Students who are pregnant or think that they might become pregnant during the course should discuss their enrollment in this course with their physician(s). Student researchers should also discuss potential hazards with their physician. Safety data sheets (SDSs) are available within each laboratory, and the chemical materials ( )-14(d)4(i)8 ph5(u)4(d)4(e)-2(n)4(n)4(j)-1(u)4(r)8(y)-7(,)-10( )] TJ ET Q

Lab coats must be closed (buttoned) when worn
Lab coats are not to be worn in or removed to areas outside of the designated lab area, except in cases where a lab related function is being performed elsewhere, the handling

heels, or open-toe shoes may be worn in the laboratory. Long hair and loose clothing should be tied back, out of the way of chemicals or fire.

Jewelry should be worn judiciously in the laboratory with the knowledge that chemicals can seep under a ring or bracelet, jewelry can get caught on equipment and/or come into contact with an electrical hazard.

Fume Hood

The fume hood is often the primary control device for protecting laboratory workers when working with flammable and/or toxic chemicals. OSHA's Laboratory standard (29 CFR 1910.1450) requires that fume hoods be maintained and function properly when used.

Materials to be decontaminated outside of the immediate laboratory are packaged in accordance with applicable local, state, and federal regulations before removal from the facility.

i. A biohazard sign can be posted at the entrance to the laboratory whenever infectious agents are present. The sign may include the name of the agent(s) in use and the name and phone number of the investigator.
j. An insect and rodent control program is in effect.

2. Special Practices – None

3. Safety Equipment (Primary Barriers)
    a. Special containment devices or equipment such as a biological safety cabinet are generally not required for manipulations of agents assigned to Biosafety Level 1.
    b. It is recommended that laboratory coats, gowns, or uniforms be worn to prevent contamination or soiling of street clothes.
    c. Gloves should be worn if the skin on the hands is broken or if a rash is present. Alternatives to powdered latex gloves should be available.
    d. Protective eyewear should be worn for conduct of procedures in which splashes of microorganisms or other hazardous materials is anticipated.

4. Laboratory Facilities (Secondary Barriers)
    a. Laboratories should have doors for access control.
    b. Each laboratory contains a sink for hand washing.
    c. The laboratory is designed so that it can be easily cleaned. Carpets and rugs in laborator

The following standard and special practices, safety equipment, and facilities apply to agents assigned to Biosafety Level 2:

1. Standard Microbiological Practices
    a. Access to the laboratory is limited or restricted at the discretion of the laboratory director when experiments are in progress.
    b. Persons wash their hands after they handle viable materials, after removing gloves, and before leaving the laboratory.
    c. Eating, drinking, smoking, handling contact lenses, and applying cosmetics are not permitted in the work areas. Food is stored outside the work area in cabinets or refrigerators designated for this purpose only.
    d. Mouth pipetting is prohibited; mechanical pipetting devices are used.
    e. Policies for the safe handling of sharps are instituted.
    f. All procedures are performed carefully to minimize the creation of splashes or aerosols.
    g. Work surfaces are decontaminated on completion of work or at the end of the day and after any spill or splash of viable material with disinfectants that are effective against the agents of concern.
    h. All cultures, stocks, and other regulated wastes are decontaminated before disposal by an approved decontamination method such as autoclaving. Materials to be decontaminated outside of the immediate laboratory are placed in a durable, leakproof container and closed for transport from the laboratory. Materials to be decontaminated off-site from the facility are packaged in accordance with applicable local, state, and federal regulations, before removal from the facility
    i. An insect and rodent control program is in effect.

2. Special Practices
    a. Access to the laboratory is limited or restricted by the laboratory director when work with infectious agents is in progress. In general, persons who are at increased risk of acquiring infection, or for whom infection may have se.9981 0 0 1 144 283.68 T

that must be worn in the laboratory, and any procedures required for exiting the laboratory

d. Laboratory personnel receive appropriate immunizations or tests for the agents handled or potentially present in the laboratory (e.g., hepatitis B vaccine or TB skin testing).
e. When appropriate, considering the agent(s) handled, baseline serum samples for laboratory and other at-

i. Cultures, tissues, specimens of body fluids, or potentially infectious wastes are placed in a container with a cover that prevents leakage during collection, handling, processing, storage, transport, or shipping.
j. Laboratory equipment and work surfaces should be decontaminated with an effective disinfectant on a routine basis, after work with infectious materials is finished, and especially after overt spills, splashes, or other contamination by infectious materials. Contaminated equipment must be decontaminated according to any local, state, or federal regulations before it is sent for repair or maintenance or packaged for transport in accordance with applicable local, state, or federal regulations, before removal from the facility.
k. Spills and accidents that result in overt exposures to infectious materials are immediately reported to the laboratory director. Medical evaluation, surveillance, and treatment are provided as appropriate and written records are maintained.
l. Animals not involved in the work being performed are not permitted in the lab.

3. Safety Equipment (Primary Barriers)
    a. Properly maintained biological safety cabinets, preferably Class II, or other appropriate personal protective equipment or physical containment devices are used whenever:
    b. Procedures with a potential for creating infectious aerosols or splashes are conducted. These may include centrifuging, grinding, blending, vigorous shaking or mixing, sonic disruption, opening containers of infectious materials whose internal pressures may be different from ambient pressures, inoculating animals intranasally, and harvesting infected tissues from animals or embryonate eggs.
    c. High concentrations or large volumes of infectious agents are used. Such materials may be centrifuged in the open laboratory if sealed rotor heads or centrifuge safety cups are used, and if these rotors or safety cups are opened only in a biological safety cabinet.
    d. Face protection (goggles, mask, face shield or other splatter guard) is used for anticipated splashes or sprays of infectious or other hazardous materials to the face when the microorganisms must be manipulated outside the BSC
    e. Protective laboratory coats, gowns, smocks, or uniforms designated for lab use are worn while in the laboratory. This protective clothing is removed and left in the laboratory before leaving for non-laboratory areas (e.g., cafeteria, library, administrative offices). All protective clothing is either disposed of in the laboratory or laundered by the institution; it should never be taken home by personnel.
    f. Gloves are worn when hands may contact potentially infectious materials, contaminated surfaces or equipment. Wearing two pairs of gloves may be appropriate. Gloves are disposed of when overtly contaminated, and removed when work with infectious materials is completed or when the integrity of the glove is compromised. Disposable gloves are not washed, reused, or used for touching "clean" surfaces (keyboards, telephones, etc.), and they should not be

worn outside the lab. Alternatives to powdered latex gloves should be available. Hands are washed following removal of gloves

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4. Laboratory Facilities (Secondary Barriers)
    a. Provide lockable doors for facilities that house restricted agents (as defined in 42CFR 72.6).
    b. Consider locating new laboratories away from public areas.
    c. Each laboratory contains a sink for hand washing.
    d. The laboratory is designed so that it can be easily cleaned. Carpets and rugs in laboratories are inappropriate.
    e. Bench tops are impervious to water and are resistant to moderate heat and the organic solvents, acids, alkalis, and chemicals used to decontaminate the work surfaces and equipment.
    f. Laboratory furniture is capable of supporting anticipated loading and uses. Spaces between benches, cabinets, and equipment are accessible for cleaning. Chairs and other furniture used in laboratory work should be covered with a non-fabric material that can be easily decontaminated.
    g. Install biological safety cabinets in such a manner that fluctuations of the room supply and exhaust air do not cause the biological safety cabinets to operate outside their parameters for containment. Locate biological safety cabinets away from doors, from windows that can be opened, from heavily traveled laboratory areas, and from other potentially disruptive equipment so as to maintain the biological safety cabinets' air flow parameters for containment.
    h. An eyewash station is readily available.
    i. Illumination is adequate for all activities, avoiding reflections and glare that could impede vision.
    j. There are no specific ventilation requirements. However, planning of new facilities should consider mechanical ventilation systems that provide an inward flow of air without recirculation to spaces outside of the laboratory. If the laboratory has windows that open to the exterior, they are fitted with fly screens.

Proper use of Biosafety Cabinets (BSCs)

Properly maintained Biosafety Cabinets (BSCs), when used in conjunction with good microbiological techniques, provide an effective containment system for safe manipulation of moderate- and high-risk infectious agents [Biosafety Level 2 (BSL-2) and 3 (BSL-3) agents]. BSCs protect laboratory workers and the immediate lab environment from infectious aerosols generated within the cabinet. BSCs must be certified when installed, whenever they are moved and at least annually [29 CFR 1910.1030(e)(2) (iii)(B)]. Employers should ensure that a risk assessment has been completed and approved for the work to be conducted and to identify the class and type of BSC needed for the q BT /F1 12 Tf i(t)-5( )5(l)8(a)-21(b)4(o)6(r)8(a)-6(h)4(e)e ee

Before using the BSC

Prepare a written checklist of materials necessary for a particular activity and place only necessary materials in the BSC before beginning work.

Turn off any overhead room germicidal ultraviolet light (UV) and any BSC UV lights. A general rule of thumb is to run the UV lights for 10-20 minutes prior to BSC use.

Confirm that the BSC is currently certified for use.

Confirm that the BSC is operating properly prior to beginning work by checking airflow gauges.

Adjust the stool height so that armpits are level with the bottom of the view screen or sash.

Working inside the BSC

Store extra supplies outside the BSC. Only materials and equipment needed for the immediate work should be placed in the BSC.

Do not use equipment or store supplies inside the BSC that may disrupt the protective BSC airflow pattern.

If large equipment must be placed inside the BSC, place it as far back in the BSC as practical.

Do not work with open containers of infectious or hazardous materials in front of the large equipment.

Move arms in and out of the cabinet slowly, perpendicular to the face opening, to limit disruption of the air curtain.

Wear appropriate personal protective equipment. Lab coats must be buttoned and back closing laboratory gowns tied, if utilized, for greater protection. Gloves should be pulled over the wrists of lab coats, not worn inside the sleeve.

Manipulation of materials inside the cabinet should be delayed for 1 minute after placing hands/arms inside the cabinet to allow the air to stabilize and to “air sweep” arms.

Do not rest arms on front grille (unless the BSC is specifically equipped with features that permit this action) because doing so allows room air to flow directly into the work area rather than being drawn through the front grille. Instead, work with both arms raised slightly.

Do not block the front grille with papers or other materials.

Perform all operations on the work surface and at least 4 inches from the front grille.

Allow cabinet blowers to operate for at least 3 to 5 minutes before beginning work to allow the BSC to “purge” particulates.

Make sure that active work flows from the clean to contaminated area across the work surface.

To minimize frequent in/out arm movement and maintain the air barrier, do not tape autoclavable biohazard collection bags to the outside of the BSC; upright pipette collection containers should not be used in the BSC and/or placed on the floor outside the BSC. (Instead, horizontal discard trays containing an appropriate chemical disinfectant should be used).

Use the aseptic techniques below to reduce splatter and aerosol generation:

- Opened bottles or tubes should not be held in a vertical position.
- Hold the lid above open sterile surfaces to minimize direct impact of downward air.
- Open flames should not be used because they create turbulence that disrupts the pattern of air supplied to the work surface.

    If absolutely necessary to do so, touch plate microburners that provide a flame on demand or electric furnaces are available and should be placed in the back third of the BSC. All flames must be turned off before disinfectants are used.

Aspirator bottles or suction flasks should be connected to an overflow collection plastic flask containing an appropriate disinfectant, and to an in-line HEPA filter and located in the back corner of the BSC.

If spilled liquid enters through the front or rear grilles, close the drain valves and pour decontaminating solution into the drain pans. Use the appropriate decontamination solution and contact time for the pathogens used in the BSC.

Carefully handle the paper towels used for

making workplace conditions safer for all employees exposed to chemical hazards. The U.S. officially adopted the GHS on March 26, 2012. OSHA adopted a revision of the Hazard Communication Standard to align with the GHS. OSHA calls this revision, HazCom 2012. GHS is not a global law or regulation– a common misconception – it is a system. Think of it as a set of recommendations or collection of best practices.

The two major elements of GHS are:
Classification of the hazards of chemicals according to the GHS rules: GHS provides guidance on classifying pure chemicals and mixtures according to its criteria or rules.
Communication of the hazards and precautionary information using Safety Data Sheets and labels

Hazardous Materials Identification System (HMIS) and the National Fire Protection Association (NFPA) NFPA 704 system.
At first glance, the HMIS and NFPA labeling systems appear quite similar; both have four sections colored blue, red, yellow and white. Despite their similarities, the two systems are not identical and each system serves a specific purposes;

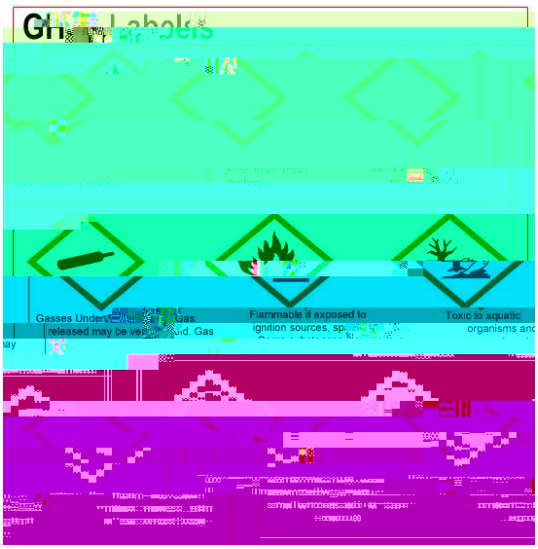
HMIS is a complete system designed to aid employers and their employees in day-to-day compliance with OSHA's Hazard Communication Standard. It includes hazard evaluations; a rating system for acute and chronic health, flammability and physical hazards; labels providing at-a-glance information on the hazards and PPE; employee training; and;

Use of Hazard System in Biological Science Laboratories at the University of Northern Colorado.

In all teaching and research laboratories the Hazardous Materials Identification Guide

a. Globally Harmonized System (GHS) classification including pictograms. It is important to realize that this is not the system that we use to label laboratory risk or secondary chemical containers—we use NFPA and HMIS systems respectively. In terms of threat, the numbering system for GHS is the opposite to NPFA/HMIS

b. Pictograms are used in the GHS system to identify threat and these can be used to augment our HMIS secondary labeling. For example:



c. A signal word is used to indicate the relative level of severity of hazard and alert the reader to a potential hazard on the label. The GHS uses 'Danger' and 'Warning' as signal words. The appropriate signal word to use is set out by the classification system. For example, the signal word for Self-heating substances and mixtures, Category 1 is *Danger* while *Warning* is used for the less serious Category 2. There are categories where no signal word is used. *We are augmenting our HMIS secondary labeling with this information*

3. Composition/Information on Ingredients
4. First Aid Measures
5. Fire Fighting Measures
6. Accidental Release Measures
7. Handling and Storageanr7e3-T 0 1 108 2m [(t)-5(h)4(e)-2( )5Tm [(C)-8(0 rg 0.9981 0 —)0 0 rg 0.9981 0

13. Disposal Considerations. Recommended disposal methods
14. Transport Information. Shipping name, hazard class (GHS) and secondary risk, labeling requirements
15. Regulatory Information. Federal, state, and international regulations, risk phrases and safety phrases.
16. Other Information including the department issuing the data sheet, product use and training information. *Keep in mind of a chemical has specific training suggested this should become part of the PI training for his/her research laboratory and the lab manual/training for teaching laboratories.*

Identifying Hazardous Materials

Hazardous materials are those substances with the Hazardous Material Identification System's or the National Fire Protection Association's diamond placard hazard code of four for health, reactivity, and/or flammability depicted on a container or structure (see page 24). Additionally the GHS system identifies hazards in section 2 of the SDS (above). Hazards can also include carcinogens, cancer suspect agents, reproductive toxins, any chemical rated as highly toxic (acute or chronic), any explosive chemical and any chemical deemed particularly hazardous by the professor.

A chemical may also be considered a hazardous waste if exhibits one of the following characteristics defined in 40 CFR Part 261 Subpart C: ignitability, corrosively, reactivity and toxicity. Brief descriptions of these characteristics are included below:

> Ignitable wastes can create fires under certain conditions, are spontaneously combustible, or have a flash point less than 60 °C (140 °F). Examples include waste oils and used solvents. Test methods that may be used to determine ignitability include the Pensky-Martens Closed-Cup Method for Determining Ignitability.
> Corrosive wastes are acids or bases (pF225.84 clu4(i)-11 be0 1 222-1(r)8(t)-64(r)8(4(g)-9( )5)5(C)-8(l)48

If the composition of the chemical substance produced exclusively for the laboratory's use is known, the professor in charge of the laboratory shall determine if it is a hazardous chemical as defined by the OSHA Hazard Communication Standard 29 CFR 1910.1200. If the chemical is determined to be hazardous, the professor shall provide appropriate handling procedures. Proper labeling is the responsibility of the professor in whose lab the substance is stored, used, or generated. All laboratories will have a sign posted indicating the person responsible for the area.

Laboratory Door Signage

NFPA Hazard Identification Placards. The National Fire Protection Association has developed a system for indicating the toxicity (-5(y)-7(7( )5((-5. 480-25(i)( )5((-r)8(iTf 0 0 0 rg 0.9981 0 0 1 156.96 591.36 Tm [(S)-7(i)5(g)36 7 [(o)6(

Labeling of Chemicals within the laboratory

Primary Container: From the manufacturer, the bottle that the chemical was shipped in. Has all relevant labeling

Secondary Container: Is defined as any container being used beyond the original manufacturer's bottle that the chemical was shipped in. This may include, but is not limited to:

Portable or working containers, such as flasks, beakers or small storage bottles in "immediate" use.

Storage bottles that are created for distribution of smaller amounts of the chemical to students or colleagues.

Storage bottles that are created for **solutions of the original chemical**.

Sample vials or sealable tubes.

Mixtures

Mixtures are considered primary and should be labeled accordingly. If a substance or mixture has more than one hazard the following should be used on the label HMIG: For Physical Hazards (flammability and reactivity) the highest level of hazard should be indicated. For health, all hazardous should be listed. For PPE, the most protective PPE should be indicated.

Labeling Secondary Containers

Labeling requirements are regulated by the Occupational Safety and Health Administration (OSHA).

Portable or working containers are exempt from the labeling regulations as long as the portable/working container remains in the direct control and supervision of the employee, and *only over the duration of a standard working day.*

Storage bottles that are created for distribution of smaller amounts of the chemical are regulated and require at minimum:

Chemical name

Concentration

HMIS label will be filled out

Date prepHMIS

Storage bottles that are created for solutions of the original chemical. These bottles require the same minimum requirements as the storage bottles created for distribution, but

MUST also include concentration of the solution and in what solvent system.

7. SDSs for all chemicals used in the Biology laboratories are available on MSDS online https://msdsmanagement.msdsonline.com/63823649-8784-473c-b01a-785b4e981fa1/ebinder/?nas=True

8. Toxicity Values to be used for determining relative hazards are as follows: (per 29 CFR 1910.1200)
    a. Highly toxic: LD_{50} (oral) <= 50 mg/kg
    b. LC_{50} (inhalation) <= 200 ppm gas or vapor<=[2 mg/1 dust or mist]
    c. LD_{50} (dermal) <= 50 mg/kg
    d. Toxic: $_{LD50}$ (oral) > 50 <500 mg/kg
    e. LD_{50} (dermal) >50 <500 mg/kg
    f. LC_{50} (inhalation) > 200 < 2000 ppm gas [>2 <20 mg/l dust or mist]
    g. Corrosive: A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact.
    h. Irritant: A chemical, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact.
    i. Sensitizer: A chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.
    j. LD_{50} Lethal dose at which 50% of test animals died when either given chemical orally or applied dermally.
    k. LC_{50} Lethal air concentration at which point 50% of test animals died when breathing chemical gas or vapor (in ppm), or mist, dust or fumes (in mg/l)

Using Chemicals

The SDS should be consulted before using any chemical, and all necessary precautions and safety equipment must be utilized when handling chemicals. A spill must be cleaned up immediately to avoid possible exposure to others, see the section on chemical spills. After a chemical is used, the bottle should be returned to its storage location. When the bottle is fully depleted, the bottle should be cleaned and removed from the appropriate electronic Chemical Inventory. If the empty bottles from the Stockroom, it should be delivered to the stockroom, so that the chemical can be removed from the Stockroom inventory.

Storage of Hazardous Materials

There are numerous physical hazards which may be present in the laboratory. While not as exotic as chemical and biological hazards, physical hazards are responsible for the majority of

Oxidizers:

1. Oxidizers are materials which readily yield oxygen or another oxidizing gas, or that readily react to promote or initiate combustion of flammable/combustible materials.
2. Uncontrolled/unknown oxidation reactions are a frequent cause of chemical accidents.
3. Know the reactivity of the materials involved in the experiment or process.
4. Make sure that there are no extraneous materials in the area which could become involved in a reaction.
5. If the reaction can be violent or explosive, use shields or other methods for isolating the materials or the process.
6. Use the minimum amounts necessary for the procedure. Do not keep excessive amounts of the material in the vicinity of the process.
7. Oxidizers should be stored away from organic materials, flammable materials and other reducing agents.
8. Perchloric acid should be used only in specially-designed perchloric acid fume hoods equipped with wash-down systems to prevent deposition of shock-sensitive perchlorates in the ductwork and machinery. Before purchasing perchloric acid, the laboratory supervisor should arrange for use of an approved perchloric acid hood.

Pyrophoric/water-reactive materials:

1. Materials which react with water to produce a flammable or toxic gas, or other hazardous condition are said to be water-reactive. Pyrophoric materials ignite spontaneously upon contact with air. The flame may or may not be visible. Store and use all pyrophoric in an inert atmospheres
2. Examples of water-reactives include alkali and alkaline earth metals (e.g. Li, Na, K, Ca, Mg), metal hydrides, some metal and nonmetal chlorides (e.g. $SiCl_4$, PCl_3, $AlCl_3$), calcium carbide, acid halides and acidanhydrides. Examples include butyllithium, silane, and yellow phosphorous.
3. Fire and explosion are serious concerns when working with these materials.
4. Special precautions for safe handling of water-reactive materials will depend on the specific material, and the conditions of use and storage. Review SDS for information on the safe use and storage of a specific material.
5. The policy and guidelines for safe handling of these materials, as well as a list of some pyrophoric/water-reactive materials can be found on the EHS website.

Peroxide forming materials:

1. Peroxidizables are substances or mixtures which react with oxygen, light, or heat to form unstable peroxides.
2. Some peroxides can explode with impact, heat, or friction such as that caused by removing a lid.
3.

6. The schedule and guidelines for safe handling of these materials, as well as a list of some potential peroxide forming materials can be found on the EHS website.

Light-sensitive materials:

1. Light-sensitive materials are unstable with respect to light energy.
2. They tend to degrade in the presence of light, forming new compounds which can be hazardous, or resulting in conditions such as pressure buildup inside a container which may be hazardous.
3. Store light-sensitive materials in a cool, dark place in amber colored bottles or other containers which reduce or eliminate penetration of light.
4. Review SDS for information on the safe use and storage of a specific material.

Shock-sensitive or explosive materials:

1. Shock-sensitive/explosive materials are substances or mixtures which can spontaneously release large amounts of energy under normal conditions, or when struck, vibrated, or otherwise agitated.
2. Some materials become increasingly shock-sensitive with age and/or loss of moisture.
3. The inadvertent formation of shock-sensitive/explosive materials such as peroxides, perchlorates, picrates and azides is of great concern in the laboratory.
4. Review SDS for information on the safe use and storage of a specific material.

All chemicals must be stored according to their chemical reactivity; oxidizers are stored with oxidizers, reducers are stored with reducers, etc. All attempts will be made to ensure that classifications of compounds dictate storage procedures (for example, the Fisher Chemical Storage method). In no case should incompatible compounds be stored within the same location. A list of incompatibilities in Figure 3 is below:

Incompatibilities by Hazard Class

WASTES

General Chemical Waste Handling Procedures

1. All acidic/basic solutions containing NO heavy metal ions or organic compounds should be neutralized and then disposed of down the drain.
2. NO organic compounds will be sink-disposed unless approved by laboratory instructor (with concurrence of EHS).
3. Experiments utilizing heavy metals (chromium, nickel, copper, lead, barium, silver, arsenic), sulfides, cyanides, oxidizers, and peroxides will be minimized.
4. Whenever possible, any leftover chemical (that is not contaminated) should be recycled into the laboratory experiments, possibly as an unknown.
5. All other wastes will be collected with a minimum amount of handling. If consolidation of waste must be done, the chemicals must be compatible. If a volume greater than 4 liters of waste is anticipated (such as non-halogenated solvents), a larger container (20 liter can/carboy) should be used for collection.

Biological Wastes Handling and Disposal Procedures

There are four designated containers for refuse disposal in Biology laboratories.

1. Uncontaminated soft materials are disposed of in trash cans.
2. Uncontaminated sharps (scalpel blades, broken glass, etc.) are disposed of in sharps/broken glass containers. Place only uncontaminated sharps in the sharps box (The sharps box is not a trash can.) The uncontaminated sharps box will be a pasteboard box with a plastic liner.
3. Contaminated (body fluids, blood, etc.) sharps are disposed of in biowaste sharps containers. Place only contaminated sharps in the sharps box (The sharps box is not a trash can). The contaminated sharps box will be a hard plastic box usually red in color.
4. Contaminated items (non-sharps) are disposed of in the biohazard waste container with a lid and must be autoclaved at 121°C for at least 60 minutes.

Disposing of Hazardous Chemicals

If a chemical is classified as hazardous material, i.e., material that cannot be disposed of in the sewer system or landfill, the compounds are to be placed in a labeled container with a lid. The label must include the following:

The term “Hazardous Chemical Waste”
Name of the waste
Component chemicals that make up the waste (along with the % of each)
The date that chemicals were added to the waste container

Similar products that pose no safety hazard if mixed, and do not cost more for disposal when mixed may be placed in a single container (refer to the SDS to verify compatibility and consult with the Safety Committee if appropriate).

Hazardous Material Disposal tags
When a hazardous waste container is full, a Hazardous Material/Waste tag must be completed before pick up. Contact the Lab Coordinator, Frank Skufca for tags and to arrange for waste pickup. The tag must be affixed to a container as soon as it is full or no additional material is to be added to the container.

Use and Disposal of Radioactive Materials
Radioactive materials are no longer used within labs associated with the School of Biological Sciences. Existing sources should be made known to the University's Radiation Safety Officer (see contact information) who will coordinate storage or removal.

DECONTAMINATION PROCEDURES

Eyewashes and Showers
Eyewashes and showers must be activated at least once every one (1) and three (3) months respectively with the date of operation indicated on an inspection tag. When required, both eyewash and shower should be used for a minimum of 10 minutes.

Eye Contact
If chemical is splashed into the eyes, flush with water for a minimum of 15 minutes and transport to the nearest emergency room.

Ingestion of Chemical
Refer to specific SDS for appropriate action.

Skin Contact
Flush affected area with water for 15 minutes while removing contaminated clothing. If symptoms persist after flushing, seek medical attention. If spilled chemical was hydrofluoric acid or another fluoride compound, prompt medical attention is required.

SPILL RESPONSE

Spill kits are available as outlined below:

Spill Kit Locations	For use in:
1650	1691, 1681, 1671, 1660, 1640
1621	1611, 1631, 1641
1360	1330, 1331, 1380, Herbarium, Museum
2360	2320, 2385, 2335, 2380
2551	2615, 2621, 2640, 2545, 2551
Head house	Greenhouse, 0402

8. Place contaminated materials in disposal bags.
9. Wash area with basic soluti14(l)8506(i)8(t)-5(h)-16( )5(b)4(a)-1(s)-9(i)8(c)2(S-806(i)R)1as inicwitl40 0 rg(l

one be needed, the information contained below is important to know. There are several types of extinguishers that can be used to fight small fires.

UNC Students

All accidents and/or injuries must be reported to the NHS Dean's office by way of the Injury Report (available on the NHS website). The course instructor (or comparable) must complete the report and sign. After the student, any witnesses and the School Director signs, the original should be taken to Gunter 1000. The student and the School should keep a copy.

EMPLOYEE HEALTH MONITORING

Any employee or students who is subject to an exposure that is above the listed OSHA limit shall undergo a medical evaluation as prescribed via standards indicated by the Code of Federal Regulations (20 CFR Part 1910)

The Policy for the School of Biological Sciences at UNC is to promptly investigate incidents in which even a remote possibility of over exposure to a toxic substance. The following list includes events or circumstances that might reasonably constitute an over exposure:

Health incident/Personal Injury
Emergency: Call the University Police at 911 or use an emergency phone
Non-Emergency*:* University Police: 970.351.2245; Environmental Health and Safety: 970.351.1149; Facilities Management: 970.351.2446

Keep calm and give the following information:

Where you are
Nature of the problem
Who you are and the phone number from which you are calling
What type of assistance is needed (ambulance, fire department, police, plumbers, electricians)
If the situation of location changes, re contact the appropriate number

What to do until help arrives:

Do not move the victim unless he/she is in further risk of injury
If you or someone is trained in first aid, remember the ABCs
- Airway open and maintained
- Bleeding, control with direct pressure
- Circulation, cardiac pulmonary resuscitation

Keep the victim calm and reassure them that help is on the way
If possible have someone meet the emergency responders outside the building to guide them to the exact location
DO NOT put yourself or others in jeopardy to assist or rescue a victim of injury if a hazard still exists

Evacuation, Fire and Other.
Emergency procedures are in effect whenever the fire alarm system is activated. *Never assume that it is a false alarm.* A safe evacuation is the first priority. All personnel are responsible for evacuating the building when the fire alarm sounds. Faculty and TAs are responsible to communicate to students to evacuate the buildinth she auildingsis BT /F6 12 T 0 rg 0.9BT /F1 12 Tf 0 0(c)2(u

Power Outages
All power outages (longer than a few minutes) should be reported to UNC Police 970.351.2445 and instructions that they provide should be followed.

RESOURCES

American National Standards Institute (ANSI), Standards Z87.1-2003 (Occupational and Educational Personal Eye and Face Protection Devices) and Z358.1-2004 (Emergency Eyewash and Shower Equipment).

Flinn Chemical and Biological Catalog, Flinn Scientific Inc. www.flinnsci.com

National Research Council, *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals,* National Academy Press, Washington, D.C., 2011.

National Fire Protection Association (NFPA), Standard 45 (Fire Protection for Laboratories Using Chemicals, 2004)

Occupational Safety and Health Administration (OSHA), Occupational Exposure to Hazardous Chemicals in Laboratories, the "Lab Standard," CFR 1910.1450

OSHA Hazard Communication Standard, CFR 1910.1200

Safety Audit/Inspection Manual. American Chemical Society, 2000.

Safety in Academic Laboratories. American Chemical Society, 7th ed. vols 1 (student) and 2 (faculty), 2003. (One copy of each vol FREE—call 800-227-5558.)

Young, Kingsley, Wahl. *Developing a Chemical Hygiene Plan.* American Chemical Society, 1990.

APPENDIX A

Laboratory Incident/Spill Report

DATE:

LABORATORY:

TIME:

INSTRUCTOR:

CHEMICAL AMOUNT SPILLED:

SPILL CLEANUP METHODS:

Chemical Hygiene Officer Notified? YES ___ NO ___

WAS AN INJURY SUSTAINED IN THE INCIDENT? YES ___ NO ___

IF YES, WAS AN ACCIDENT REPORT FILED? YES ___ NO ___

INCIDENT DESCRIPTION/COMMENTS:

Send Copies of this report to EHS and NHS Dean's office

APPENDIX B

School of Biological Sciences
Laboratory Safety Policies Bio XXX

Please read the following safety rules carefully. Enrollment in this course requires that you observe these policies throughout the course. Sign both copies. Leave one copy in your lab manual and turn the other copy in to your instructor.

Note: The School has a Chemical Hygiene Plan. A copy of this plan is available to you and is located XXX

1. ***ABSOLUTELY NO FOOD OR DRINK WILL BE STORED OR CONSUMED IN LAB***.
2. At all times, wear close-toe shoes and wear personal protective equipment (PPE—such as gloves and lab coats) when appropriate. For example, wear gloves whenever handling potentially hazardous materials, such as strong acids, strong bases, biological hazards, and toxicants.
3. Chemical glasses will be worn in the lab whenever working with hazardous substances.
4. Mouth pipetting is ***absolutely prohibited***.
5. Use extreme caution when using sharp instruments, such as razor blades.
6. Read labels before handling any chemicals.
7. Check with your instructors for proper discard procedures for any solutions or materials.
8. Wash your hands before you leave the lab at ***any*** time.
9.