MLS Teaching Lab Fire Evacuation Plan
(HSEB Level 4)

Instructors' Preparation Area
MLS Teaching Lab
Building exit on level #1
Stairwell
Additional Stairs in the center lobby area and north end of the building.

Primary Fire Exit Route
Secondary Fire Exit Routes
Fire Alarm Pull Boxes
Fire Extinguisher
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Laboratory Safety Manual

Introduction

The modern clinical laboratory is a workplace where many hazardous chemicals, complex instrumentation, and potential pathogens are encountered on a daily basis. However, the laboratory can be a safe place to work and learn if possible hazards are identified and safety and infection control protocols are followed. Very specific work practice controls, engineering controls, and personal protective equipment are available to help provide safeguards against hazardous materials and pathogens.

This safety manual has been prepared as an educational resource for students, staff, and faculty. This manual is intended to:

1. Outline general principles of infection control.

2. Describe potential laboratory safety hazards and protective mechanisms associated with each of the following categories:
   a. biological (including blood-borne pathogens)
   b. chemical
   c. fire and explosion
   d. electrical
   e. equipment or mechanical

3. Define safety rules for the clinical laboratory, including good personal habits, housekeeping practices, and laboratory techniques.

4. Describe accidental biohazards or other physical and chemical hazards that might exist in the Teaching Laboratory, and proper protocols for exposure prevention and follow-up.

5. Discuss factors associated with disaster preparedness as it pertains to the Teaching Laboratory.

NOTE: Students are prohibited from being alone in the Health Science Education Building (HSEB) Teaching Laboratory.
General Laboratory Safety

Introduction

We all have the responsibility to maintain a constant concern for safety in the laboratory. Good personal habits, housekeeping practices, and laboratory technique can all help ensure that the laboratory is a safe place to learn and work.

Laboratory Dress Code and Personal Protective Equipment (PPE) Policy

- Medical Laboratory Science students, staff, and faculty are required to dress according to the standards established when in the HSEB Teaching Laboratory. This dress code policy addresses issues related to safety.

- Legs must be covered to avoid skin contamination or injury from pathogens, chemicals, or reagents. Shorts and Capri pants are not allowed. Skirts and dresses are allowed if they cover the legs. Leggings and hosiery (nylons) are not recommended because chemicals or specimens, if spilled, can ‘wick” and be held against the skin for prolonged periods of time, causing extensive exposure and/or injury.

- Shoes should be comfortable, water-repellent, and must enclose the entire foot. To avoid injury to the feet from items dropped or spilled, open-toed, open-heeled, perforated, mesh, or canvas shoes are not allowed. Nonskid, flat-soled shoes should be worn to prevent possible serious injuries from falls.

- Hats with a brim that obscures the eyes are not allowed. Other headgear, including beanies, scarves, headbands, etc., may be worn as long as they do not pose a danger of being caught in equipment, contaminating or being contaminated with specimens/reagents, and are not distracting.

- Jewelry may be worn as long as it does not pose a danger of being caught in equipment, contaminating or being contaminated with specimens/reagents, and is not distracting.

- Long hair and beards must be tied back in such a way as to avoid contamination and interference with laboratory equipment and specimens.

- Sunglasses and other darkly tinted eyewear are not allowed.

- Students may keep laboratory-appropriate clothing or shoes in their assigned laboratory lockers to change into as necessary. Students are encouraged to have spare, clean laboratory-appropriate clothing in their lockers in the event of a spill or an emergency.

- Food, water bottles, gum, and drinks of any kind are prohibited in the laboratory.

- Touching one’s face, applying cosmetics, adjusting contact lenses, biting nails, and chewing on pens or pencils in the laboratory is prohibited.

- All personal items must be stowed while in the laboratory. The use of cell phones is prohibited.

- Mouth pipetting is prohibited.
• **Personal protective equipment (PPE)** is specialized clothing or equipment worn or used for protection against hazards. Personal protective equipment is used as an additional safeguard from contamination of clothing, skin, mucous membranes, or puncture wounds.

• Types of personal protective equipment available for use in the Teaching Laboratory include laboratory coats, hand protection (gloves), eye protection (safety goggles or safety glasses), and splash protection (face shields and gowns, aprons, and smocks).

**Laboratory coats**

  - Laboratory coats must be knee-length. They must be clean and in good repair. They must be worn fully buttoned/snapped, and at all times in the Teaching Laboratory, regardless of the activity. This includes, but is not limited to, lecturing in the laboratory area, practicing manual differentials or reviewing gram stains outside of a regularly scheduled laboratory session, studying in the laboratory outside of scheduled laboratory sessions, etc. Laboratory coats must not be worn outside of the laboratory.

  - Ideally, laboratory coats should consist of non-permeable material and have tight-fitting cuffs on the sleeves. (The coats available from the University Bookstore Health Sciences Branch usually do not have these features, but they are adequate for procedures performed in the Teaching Laboratory.) Disposable coats may be reused but must be replaced on any sign of contamination, damage or degradation.

  - Laboratory coats must be stored within the laboratory and must be assigned to individual students, not shared.

  - Scrubs are acceptable, but a laboratory coat must still be worn when in the laboratory.

  - If a laboratory coat, gown, or apron becomes contaminated, it is important to remove the garment in such a way as to avoid contacting the outer surface. If the contamination penetrates the inner surface of the coat, gown, or apron, use extreme caution when removing. Any contaminated clothing must be removed as well. Students should have an extra set of clothes in their laboratory lockers in the event of contamination to their personal clothing.

  - Laboratory coats contaminated with blood, body fluids, and infectious materials, or with toxic chemicals, dusts, fumes, or liquids, must be decontaminated before removal from the laboratory. Decontaminate blood, body fluids, and other infectious materials with 10% (v/v) bleach for at least five minutes. Household bleach is 5.25% w/v sodium hypochlorite. Request help from the faculty or staff to decontaminate toxic chemicals, dusts, fumes, or liquids.

• Students are responsible for changing laboratory coats whenever they appear soiled or at the end of each semester. Students are NOT allowed to take their own coats home to launder them. The laboratory coats need to be laundered on site or by a commercial company as stated in the University Biosafety Manual and Chemical Hygiene Plan. The Occupational Safety and Health Administration (OSHA) bloodborne pathogen standard prohibits laundering laboratory coats at home for work.

• Soiled laboratory coats may be turned in to the laboratory preparatory room immediately prior to fall break, winter break, spring break, summer break and the end
of the school year, during which time they will be taken to the University Hospital laundry for cleaning at no cost to the student.

- If coats become soiled at other times, they can be exchanged for a clean coat from the MLS prep room.

**Hand Protection (Gloves)**

- Gloves provided in the Teaching Laboratory are disposable. Inspect the gloves before each use and replace them frequently to avoid contaminating other objects or yourself. Do not wash and re-use gloves. Gloves provide an effective barrier, but disinfecting or washing them may enhance penetration of liquids.

- Gloves must be selected based on the hazard present in the laboratory. Nitrile gloves offer a broad spectrum of protection and are appropriate for most purposes. Vinyl gloves must not be used.

- Glove integrity will decrease over time. Prior to putting on, visibly check for holes and defects. Changes gloves periodically as sweat and movement may increase permeation.

- ALWAYS discard gloves into biohazardous waste when visibly contaminated, torn, or when use is completed.

**Eye Protection (Safety Goggles or Safety Glasses)**

- In the United States, the federal government establishes safety guidelines for workplaces, to decrease the risk of on-the-job injuries. The Occupational Safety and Health Administration (OSHA) within the U.S. Department of Labor oversees safety practices in the workplace and in educational settings. OSHA has adopted safety eyewear standards established by the American National Standards Institute (ANSI), a private, non-profit organization that creates quality and safety standards for a wide variety of products. The University of Utah also follows these standards.

- Current ANSI safety eyewear standards include the following key features:
  
  - Safety lenses now have two classifications of performance: basic impact and high impact. For most biology laboratory environments, lenses meeting the basic impact standard are sufficient. Non-prescription lenses used for high impact testing are considered to be structurally weaker than prescription lenses made of the same material; the prescription lenses are generally thicker. Non-prescription safety eyewear with non-removable lenses must be permanently marked with the manufacturer's trademark and "Z87" (basic impact) or "Z87+" (high impact) on either the front of the frame or on one temple.

  - Prescription safety lenses are allowed if they meet the high impact testing requirements. Prescription safety frames must be permanently marked with the manufacturer's trademark and "Z87-2" on the front of the frame and on both temples.

  - Indirectly vented, chemical-splash goggles, Z87+, should be the standard eye protection when using chemicals (solids and liquids), glassware, heating sources, preserved specimens, or dust/solid particles. An indirectly vented, chemical-splash goggle should fit snugly on the face surrounding the eyes, and the soft, pliable flange seals should
extend around the eye. Since goggles need ventilation to reduce fogging, indirectly vented chemical-splash goggles are required to have hoods or caps over the vent openings to prevent chemical splashes from entering the inside of the goggle and causing injury to the eye.

- Face shields alone do not protect the face from impact hazards. Face shields may be used in addition to safety goggles or safety glasses if additional splash protection is required: see “Can any eye and face protection be used? Under OSHA eTools, Eye and Face Protection Home >> Frequently Asked Questions (https://www.osha.gov/SLTC/etools/eyeandface/faqs.html#can_any).

- Eye protection (safety goggles or safety glasses (with side shields)) is provided for students and must be worn at all times in the lab, except during microscopy.

- Personal prescription safety glasses must have side shields and be decontaminated with a freshly made 1:10 dilution household bleach solution before leaving the laboratory. Household bleach is 5.25% w/v sodium hypochlorite.

- Prescription glasses are not usually a substitute for safety glasses, but can be worn under many goggles and safety glasses available in the Teaching Laboratory

- Masks and eye protection must be worn together.

- Masks should never be reused.

**Surgical Masks**

Standard surgical masks are also available. (Surgical masks provide minimal protection from aerosols and air-borne contaminants. Respirator masks can be obtained for students with severe respiratory conditions and on recommendation of a physician, but must be specially fitted and tested.)

**Face Shields**

- Face shields provide an alternative to a mask for splash protection, but do not substitute for safety goggles or safety glasses with side shields.

- Face shields must be cleaned appropriately with 10% (v/v) bleach if contaminated then discarded.

**Gowns / Aprons / Smocks**

- These items may provide additional protection if spraying or splashing is anticipated.

- Disposable gowns, aprons, or smocks will be distributed by MLS faculty or staff if needed. The need is rare.

**Good Personal Habits: Reminders**

- Wear proper attire and protective clothing as described above in the section on Laboratory Dress Code Policy.

- Wash hands after entering and before leaving the laboratory. Develop the habit of frequent hand washing, especially after removing gloves and other protective wear, before leaving
the laboratory, before eating or drinking, after using the lavatory, and when hands are visibly contaminated with blood, body fluids, or tissues.

- **Never** eat, smoke, drink, chew gum, apply cosmetics, or adjust contact lenses while in the laboratory.

- Tie back long hair and trim beards to avoid possible entanglement in equipment or instruments. In addition to personal injury, contamination of specimens, work areas, or reagents may occur from shedding of long hair and beards.

- **Never** pipette by mouth, rather, use pipetting bulbs.

- Develop the habit of keeping hands away from the face and hair, but especially the mouth, nose, eyes to prevent self-inoculation with infectious agents.

- **Do not** put objects in mouth (like pens, pencils, or pipettes).

- Always wear appropriate gloves when working with biological specimens or hazardous chemicals. Change gloves when contaminated.

- Wear goggles and masks or face shields when splashing or spattering of chemicals or specimens may occur. Carefully dispose of contaminated glassware and other objects to avoid “back-splash”.

- **Never** store food or beverages in refrigerators or freezers containing chemicals, microorganisms, or clinical specimens.

**Good Housekeeping Practices**

- Keep work areas free of chemicals, dirty glassware, and contaminated articles such as paper towels or lint-free tissues.

- Decontaminate equipment and counters upon entering the laboratory and before leaving the work area with a freshly made 1:10 dilution of household bleach.

- Clean up spills immediately per policy (see Decontamination Procedures below).

- Store chemicals according to their labels and Safety Data Sheets (SDSs).

- Do not submit worksheets that have become contaminated; transfer results and data to new worksheets before submission. NOTE: This is not an acceptable practice in the clinical laboratory. *All recorded results must be indelible.*

**Good Laboratory Techniques**

- Use the provided PPE.

- Read all labels and instructions carefully.

- Be familiar with the properties and hazards of chemicals and biological agents for their safe handling and disposal.

- Label reagent and solution containers with the substances contained and appropriate warnings.
• Be careful when transferring chemicals from one container to another container.

• **Never** add water to an acid; **always** add acid to the water, **slowly**.

• **Do not** operate unfamiliar equipment until proper training and authorization have been given.

• In preparing specimens, prevent aerosols and the resultant possible spread of infectious agents by:
  
  o **Never** opening the lids of centrifuges until the centrifuge has come to a complete stop.
  
  o **Only** opening specimen tubes by gently twisting the stoppers and lifting them out (sometimes holding a lint-free tissue over the stopper may prevent aerosolization).
  
  o Capping all tubes to be centrifuged prior to centrifugation (except blood bank tubes).

• The laboratory instructor must approve all persons entering the laboratory.

• Handle glassware carefully to avoid breakage that could cause injury or infection. Do not expose hot glassware to cold water. (Allow hot glassware to cool before washing or placing in a sink.) Minimize use of sharps.
  
  o Needles and scalpels are to be used according to institutional guidelines.
  
  o Store sharp objects carefully to avoid skin punctures or cuts.

• Dispose of contaminated glass and sharp objects (microcapillary pipettes, Pasteur pipettes, and needles) in puncture-resistant sharps containers.
  
  o Most sharps should be discarded in sharps containers that are closable, puncture-resistant, and leak-proof on sides and bottoms. However, non-contaminated plastic pipettes that are sharp enough to burst a balloon, Pasteur pipettes, and pipette tips should be disposed of in broken glass receptacles.
  
  o Contaminated sharps, including coverslips, slides, glass, plastic pipettes that are sharp enough to burst a balloon, Pasteur pipettes, and pipette tips are discarded immediately or as soon as possible in biohazard sharps containers that are closable, puncture-resistant, leak-proof on sides and bottoms, and labeled or color-coded appropriately.

• Test tube racks or other secondary containers such as carts must be used to move specimens in the laboratory in order to minimize the risk of dropping specimens.

• Stocks and other cultures must be stored in leak-proof containers when work is complete. A sealed, leak-proof container, labeled with a biohazard symbol, must be used to transport stocks and cultures from one room to another.

• Cultures should be disinfected/inactivated prior to disposal, either by chemical disinfection or autoclaving.

• Contaminated materials that are to be decontaminated at a site away from the laboratory shall be placed in a durable leak-proof container labeled with a biohazard symbol, which is closed before being removed from the laboratory. Hazardous waste can be picked up by OEHS,
arranged through the OEHS Lab Management System (http://oehs.utah.edu/topics/lab-management-system).

- Broken glass must be handled using a dustpan and broom or forceps/tongs; not picked up by hand. Broken glass must be disposed of in a broken glass box, unless it is contaminated, in which case, it should be disposed of in a biohazard sharps container. If contaminated, the broom will need to be disposed of or sterilized.

- Know where the Safety Data Sheets (SDSs) are located.

- Learn emergency procedures and become familiar with the location of fire exits, fire extinguishers, eyewash stations, fire alarms, and showers.
General Principles of Infection Control

Disease Transmission

General
Infectious organisms travel by very specific routes of transmission. The four major pathways are contact, airborne, vehicle, and vector. However, the contact and airborne routes are the main methods of transmission in the health care environment, as vehicle and vector routes are rarely encountered.

Contact
- This type of organism transmission is the most significant and frequent of the four routes. It may involve:
  - Direct contact in which a physical transfer of an infectious agent occurs between an infected individual and a susceptible host.
  - Invasive contact in which moist body substances containing infectious organisms (like blood) touch non-intact skin or mucous membranes. For example, inoculation of contaminated materials, as in fecal-oral transmission via poor hand hygiene or touching the face or mouth with contaminated hands in the laboratory; or percutaneous injection via mishandled needles or sharp objects.
  - Indirect contact in which a susceptible individual contacts a contaminated object, such as contaminated instruments or equipment.

Airborne and Droplet Transmission
- **Airborne transmission** occurs when the moisture in respiratory droplets evaporates and leaves pathogens suspended in the air. Infectious organisms can travel on air currents and through ventilation systems before being inhaled by a susceptible individual. Tuberculosis, chickenpox, and measles are transmitted via this route.
- **Droplet transmission** is usually thought of as a splashing or splattering that can cause aerosol formation producing large particles that pass three feet or less. It can be of particular concern in the laboratory when handling potentially infectious liquids.

Blood-borne Pathogens

Definition
**Blood-borne pathogens** are disease-causing infectious agents that may be present in human blood and can cause disease in humans. The pathogens of significance for clinical laboratories are the Hepatitis B Virus (HBV), Human Immunodeficiency Virus (HIV), Hepatitis C Virus (HCV), Hepatitis D Virus (Delta Agent, HDV), and syphilis.
Transmission

Infectious blood-borne pathogens are transmitted when blood or "other potentially infectious materials" (OPIM) contact mucous membranes, non-intact skin, or when contaminated surfaces or items are touched.

- OPIM are substances such as body fluids, objects visibly contaminated with blood, any unfixed human tissue or organ (other than intact skin), HBV- or HIV-containing cell or tissue cultures, and organs or tissues from experimental animals infected with HBV or HIV.

- Non-intact skin may include, but is not limited to: abrasions, burns, cuts, hangnails, paper cuts, and rashes. Puncture wounds or cuts from contaminated sharps may also transmit blood-borne pathogens.

- Cerebrospinal fluid (CSF) may harbor prions in addition to other blood-borne pathogens.

Table 1 summarizes possible routes of exposure.

<table>
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<th>Route</th>
<th>Situation</th>
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<tr>
<td><strong>Ingestion</strong></td>
<td>Mouth pipetting, Splashed infectious material, Contaminated clothing, devices, fingers, or gloves, Contaminated pens or pencils inserted into the mouth, Consumed food/drink</td>
</tr>
<tr>
<td><strong>Inoculation</strong></td>
<td>Needle stick accident, Cuts from sharp objects</td>
</tr>
<tr>
<td><strong>Skin and mucous membrane contamination</strong></td>
<td>Splashes into eyes, mouth, nose, Spills or splashes on intact or non-intact skin</td>
</tr>
<tr>
<td><strong>Inhaled infectious aerosol</strong></td>
<td>Streaking media, Flaming or cooling inoculating loop, Mixing microbial suspensions by pipette, Expelling air from a syringe, Withdrawing needle from rubber stopper, Separating needle from syringe, Centrifuging specimens, Mixing instruments such as blenders or shakers, Pouring or decanting fluids, Opening culture containers or blood tubes, Spilling infectious material</td>
</tr>
</tbody>
</table>

*Adapted from Sewell, D.L. (1996)*
**Blood-borne Pathogens Standard and Universal Precautions**

- **The Blood-borne Pathogens Standard** was enacted to protect any individual who might reasonably contact blood or other possible infectious material in the normal course of performing their job or laboratory procedure.

- **Universal Precautions** refers to a standard method of infection control in which **ALL** human blood and certain human body fluid specimens are treated as if known to be infectious.

  - Universal Precautions apply to the following potentially infectious fluids:
    - Amniotic
    - Blood
    - Cerebrospinal
    - Pericardial
    - Peritoneal
    - Pleural
    - Saliva
    - Semen
    - Vaginal Secretions

  - Universal Precautions also apply to these other body fluids. The precautions for blood-borne pathogens do not apply to the following body fluids unless they are visibly contaminated with blood:
    - Feces
    - Nasal Secretions
    - Sputum
    - Sweat
    - Tears
    - Urine
    - Vomitus

**Standard Precautions**

*This is the guideline to which the Teaching Laboratory adheres.*

In 1996, the CDC published new guidelines which synthesized the major features of Universal Precautions and Body Substance Isolation to prevent transmission of a variety of organisms. Standard Precautions represent minimum infection prevention measures that apply to all patient care. Standard Precautions include guidelines on hand hygiene, use of personal protective
equipment, respiratory hygiene and cough etiquette, safe injection practices, and safe handling of potentially contaminated equipment or surfaces. Standard Precautions imply that “all blood and body fluids are potentially infectious and should be treated accordingly.”

**Containment, Risk Assessment, and Biosafety Levels**

**Containment**

The fundamentals of *containment* include the microbiological practices, safety equipment, and facility safeguards that protect laboratory workers, the environment, and the public from exposure to infectious microorganisms that are handled and stored in the laboratory.

**Risk Assessment**

- *Risk assessment* is the process that enables the appropriate selection of microbiological practices, safety equipment, and facility safeguards that can prevent laboratory-associated infections (LAI).

- The primary factors to consider in risk assessment and selection of precautions fall into two broad categories
  - Agent hazards
  - Laboratory procedure hazards
  - Risk assessment identifies
    - The principal hazardous characteristics of a known infectious or potentially infectious agent or material:
      - Its capability to infect and cause disease in a susceptible human or animal host
      - Its virulence as measured by the severity of disease
      - The availability of preventive measures and effective treatments for the disease
    - The activities that can result in a person’s exposure to an agent
    - The likelihood that such exposure will cause a LAI
    - The probable consequences of such an infection

- The information identified by risk assessment will provide a guide for the selection of appropriate biosafety levels and microbiological practices, safety equipment, and facility safeguards to minimize the risk of LAIs.

- The World Health Organization (WHO) has recommended an agent risk group classification for laboratory use that describes four general risk groups based on these principal characteristics and the route of transmission of the natural disease. The four groups address the risk to both the laboratory worker and the community. The National Institutes of Health (NIH) Guidelines established a comparable classification and assigned human etiological agents into four risk groups on the basis of hazard.
**Table 2: Classification of Infectious Microorganisms by Risk Group**

<table>
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<tr>
<th>Risk Group Classification</th>
<th>NIH Guidelines for Research involving Recombinant DNA Molecules 2002²</th>
<th>WHO Laboratory Biosafety Manual 3rd Edition 2004¹</th>
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<tr>
<td>Risk Group 1</td>
<td>Agents not associated with disease in healthy adult humans.</td>
<td>(No or low individual and community risk) A microorganism unlikely to cause human or animal disease.</td>
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<td>Risk Group 2</td>
<td>Agents associated with human disease that is rarely serious and for which preventive or therapeutic interventions are <em>often</em> available.</td>
<td>(Moderate individual risk; low community risk) A pathogen that can cause human or animal disease but is unlikely to be a serious hazard to laboratory workers, the community, livestock or the environment. Laboratory exposures may cause serious infection, but effective treatment and preventive measures are available and the risk of spread of infection is limited.</td>
</tr>
<tr>
<td>Risk Group 3</td>
<td>Agents associated with serious or lethal human disease for which preventive or therapeutic interventions may be available (high individual risk but low community risk).</td>
<td>(High individual risk; low community risk) A pathogen that usually causes serious human or animal disease but does not ordinarily spread from one infected individual to another. Effective treatment and preventive measures are available.</td>
</tr>
<tr>
<td>Risk Group 4</td>
<td>Agents likely to cause serious or lethal human disease for which preventive or therapeutic interventions are not usually available (high individual risk and high community risk).</td>
<td>(High individual and community risk) A pathogen that usually causes serious human or animal disease and can be readily transmitted from one individual to another, directly or indirectly. Effective treatment and preventive measures are not usually available.³</td>
</tr>
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*Table 1, *Biosafety in Microbiological and Biomedical Laboratories, 5th Edition. (2009)*

**Risk Criteria for Establishing Ascending Levels of Containment (Biosafety Levels)**

- Risk assessment determines the *biosafety level (BSL)* of the workspace. A thorough risk assessment takes into account:
  - The microorganism being used
  - The manipulations performed with the organism
  - The risks inherent in performing the laboratory activity
Another important risk factor for agents that cause moderate to severe disease is the origin of the agent, whether indigenous or exotic. Each level of containment describes the microbiological practices, safety equipment, and facility safeguards for the corresponding level of risk associated with handling a particular agent. The basic practices and equipment are appropriate for protocols common to most research and clinical laboratories. The facility safeguards help protect non-laboratory occupants of the building, public health, and the environment. Laboratory members should consult the website of the CDC (http://www.cdc.gov/biosafety/publications/BiologicalRiskAssessmentWorksheet.pdf) or Public Health Agency Canada (http://www.phac-aspc.gc.ca/lab-bio/res/psds-ftss/index-eng.php) to clarify safety requirement information about a particular organism.

- **Biosafety level 1 (BSL-1)** is the basic level of protection and is proper for agents that are unlikely to cause disease in normal, healthy humans and are a low level of risk to the community.

- **Biosafety level 2 (BSL-2)** is proper for handling microbes that pose a moderate risk to the individual and a low community risk for infection. They cause human disease of varying severity by ingestion or through percutaneous or mucous membrane exposure.

- **Biosafety level 3 (BSL-3)** is proper for agents with a known potential for aerosol transmission, for agents that may cause serious and potentially lethal infections and that are indigenous or exotic in origin. There is one BSL-3 laboratory at the University of Utah.

- **Biosafety level 4 (BSL-4)** laboratories are high containment laboratories and are proper for exotic agents that pose a high individual risk of life-threatening disease by infectious aerosols and for which no treatment is available. There are no BSL-4 laboratories in Utah.

Table 2 gives more details:
<table>
<thead>
<tr>
<th>BSL</th>
<th>Agents</th>
<th>Practices</th>
<th>Primary Barriers and Safety Equipment</th>
<th>Facilities (Secondary Barriers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Not known to consistently cause diseases in healthy adults</td>
<td>Standard microbiological practices</td>
<td>• No primary barriers required.</td>
<td>Laboratory bench and sink required</td>
</tr>
<tr>
<td>2</td>
<td>• Agents associated with human disease</td>
<td>BSL-1 practice plus:</td>
<td>Primary barriers:</td>
<td>BSL-1 plus:</td>
</tr>
<tr>
<td></td>
<td>• Routes of transmission include percutaneous injury, ingestion, mucous membrane exposure</td>
<td>• Limited access</td>
<td>• BSCs or other physical containment devices used for all manipulations of agents that cause splashes or aerosols of infectious materials</td>
<td>• Autoclave available</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Biohazard warning signs</td>
<td>• PPE: Laboratory coats, gloves, face and eye protection, as needed</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• “Sharps” precautions</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Biosafety manual defining any needed waste decontamination or medical surveillance policies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Indigenous or exotic agents that may cause serious or potentially lethal disease through the inhalation route of exposure</td>
<td>BSL-2 practice plus:</td>
<td>Primary barriers:</td>
<td>BSL-2 plus:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Controlled access</td>
<td>• BSCs or other physical containment devices used for all open manipulations of agents</td>
<td>• Physical separation from access corridors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Decontamination of all waste</td>
<td>• PPE: Protective laboratory clothing, gloves, face, eye and respiratory protection, as needed</td>
<td>• Self-closing, double-door access</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Decontamination of laboratory clothing before laundering</td>
<td></td>
<td>• Exhausted air not recirculated</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Negative airflow into laboratory</td>
</tr>
<tr>
<td>4</td>
<td>• Dangerous/exotic agents which post high individual risk of aerosol-transmitted laboratory infections that are frequently fatal, for which there are no vaccines or treatments • Agents with a close or identical antigenic relationship to an agent requiring BSL-4 until data are available to redesignate the level • Related agents with unknown risk of transmission</td>
<td>BSL-3 practices plus:</td>
<td>Primary barriers:</td>
<td>BSL-3 plus:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Clothing change before entering</td>
<td>• All procedures conducted in Class III BSCs or Class I or II BSCs in combination with full-body, air-supplied, positive pressure suit</td>
<td>• Separate building or isolated zone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Shower on exit</td>
<td></td>
<td>• Dedicated supply and exhaust, vacuum, and decontamination systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• All material decontaminated on exit from facility</td>
<td></td>
<td>• Other requirements outlined in the text</td>
</tr>
</tbody>
</table>

* Table 2, *Biosafety in Microbiological and Biomedical Laboratories, 5th Edition.* (2009)
Limiting Exposure to Infectious Agents

Engineering Controls

- Per the National Institute of Occupational Health and Safety (NIOSH), “Engineering controls protect workers by removing hazardous conditions or by placing a barrier between the worker and the hazard. Examples include local exhaust ventilation to capture and remove airborne emissions or machine guards to shield the worker.” ([http://www.cdc.gov/niosh/engcontrols/](http://www.cdc.gov/niosh/engcontrols/))

- Examples encountered in the Teaching Laboratory include:
  - Hand washing facilities
  - Eyewash stations
  - Sharps containers
  - Orange biohazard signs, labels, and bags

Work Practice Controls or Administrative Controls

- Work practice controls are the behaviors required to use engineering controls effectively. Work practice controls in the BSL-2 Teaching Laboratory include procedures listed under “General Laboratory Safety”, starting on page 6:
  - Timely hand washing (before beginning laboratory procedures, after removing gloves, when visibly contaminated, before leaving the laboratory, and after using restroom facilities).
  - The proper use and removal of personal protective equipment before leaving the laboratory.
  - Keeping use of sharps to a minimum. Proper needle and sharps disposal.
  - No eating, drinking, chewing gum, smoking, applying cosmetics or lip balm, or handling contact lenses in the laboratory.
  - No mouth pipetting, splashing, or aerosolization occurs in the laboratory.
  - Proper storage of food or drink in areas away from blood or OPIM.
  - The laboratory door must remain closed at all times when the lab is in session.
  - Personal electronic devices are prohibited.
    - Cell phones: Faculty, staff, and students are allowed to have cell phones in the laboratory for emergency purposes only. The cell phone must be kept in a clean pocket, but not in the pocket of the laboratory coat and not on the benchtop. To answer or respond to a communication on a cell phone, persons must remove their lab coats, wash their hands, and exit the laboratory area.
      - Use of a cell phone in the laboratory area for instructional purposes requires instructor permission. The device must be sanitized with a decontaminant appropriate for the contaminant before it is removed from the laboratory.
Recording devices: Students must have instructor permission to use recording devices in the Teaching Laboratory. The device must be protected with an impermeable plastic wrapper. If it becomes contaminated, it must be sanitized with decontaminant appropriate for the contamination before it is removed from the laboratory.

- Calculators will be provided by the MLS program for use in laboratory sessions and should not be removed from the laboratory.

- For decontamination procedures, see the section of that name below on this page.

**Personal Protective Equipment (PPE)**

- Possible exposure to infectious agents may exist even when engineering and work practice controls are implemented. *Personal protective equipment (PPE)* is specialized clothing or equipment worn or used for protection against hazards. Personal protective equipment is used as an additional safeguard from contamination of clothing, skin, mucous membranes, or puncture wounds.

- **NOTE:** Faculty or staff can require specific PPE at any time.

**Decontamination Procedures**

**Cleaning a spill of blood, body fluids, or cultured organisms**

- Always wear gloves (puncture-resistant utility gloves are best) and a laboratory coat, gown or apron. Two pairs of gloves are better for clean-up.

- Contain the spill by covering an area that extends beyond all visible material and liquid with disposable, absorbent material (gauze pads or paper towels).

- Saturate the absorbent material with a freshly made 1:10 (v/v) dilution of household bleach. If the spill is large (> 10 mL), use undiluted to 1:4 (v/v) diluted bleach solution of bleach. Start pouring or squirting at the outer edge of the absorbent material and work toward the center, generously saturating all of the material. A 15–20 minute contact time is recommended, but if the spill is turbid, request help from the faculty or staff to determine the time to decontaminate.

- Commonly used disinfectants for microbiology laboratories include a 1:10 dilution of bleach (approximately 0.5% (v/v) sodium hypochlorite), 70% (v/v) and 95% (v/v) ethanol, and 70% (v/v) and 91% (v/v) isopropanol. Many others are available; efficacy and cost are considerations. This is not an endorsement of any one commercial product. Squirt bottles stamped with the ethanol or sodium hypochlorite and the NFPA symbol are available. Instructors and student assistants should be familiar with the proper concentrations utilized for each disinfectant and follow the manufacturer’s instructions for proper application techniques and required contact times. Dilutions of alcohol are not suitable for cleaning up spills of blood or disinfecting blood-borne pathogens: an EPA-registered disinfectant must be used.

- Sodium hypochlorite is readily available and inexpensive. Commercial bleach products are typically 5-6% aqueous solutions of sodium hypochlorite. Sodium hypochlorite is used to decontaminate surfaces; clean up spills, and to decontaminate waste containers.
used for pipettes, tips and swabs. Bleach is corrosive to metals and should be used sparingly on stainless steel. Metal surfaces that have been treated with bleach should be “rinsed” with 70% ethanol, or water after a 20 minute contact time.

- For other disinfectants, carefully follow the manufacturer’s instructions. Keep the material moist. Add more disinfectant if necessary.

- Discard everything into the appropriate container by using the biohazard-designated dustpan and brush. If there is no broken glass or other “sharps” in the spill, it can be discarded into a biohazard bag. If the spill contains broken glass, everything, including all of the absorbent material, should be discarded into a large sharps container. Do not remove broken glass from the debris.

**Decontaminating and cleaning pipettes and glassware**

- Because of their potential to puncture, all serological pipettes, either glass or disposable plastic, and all pipette tips, whether or not used to manipulate blood, blood products or other potentially infectious materials (OPIMs) **CANNOT** be disposed in any plastic bags. All disposable pipettes used for handling potentially infectious materials are considered to be contaminated sharps and must EITHER be decontaminated prior to disposal in a broken glass container OR must be disposed in a rigid, closable, appropriately labeled sharps container constructed to contain all contents and prevent leakage. Also, any item that has a pointed end or can poke through a biohazard bag should be disposed of in a sharps container; this includes wooden applicator sticks, glass pipettes, glass microscope slides and cover glasses, and broken glass tubes. Intact glass tubes should be gently placed in biohazard bags to prevent breakage.

- Pipettes and glassware that have not been exposed to biological specimens, but have transferred or stored reagents and chemicals, must be placed in appropriate containers for cleaning.

**Decontaminating and cleaning instruments or equipment**

- Instruments or equipment that have been in contact with infectious materials must be handled carefully.

- Refer to the instrument-specific manual to determine the appropriate cleaning procedure. If no procedure is specified, wearing gloves, safety glasses, and a laboratory coat, clean with freshly made 1:10 (v/v) dilution of household bleach then soap until no blood or contaminants are visible.

- Autoclave any parts of an instrument or equipment that can be placed safely in the autoclave.

- Dispose of cleaning towels in appropriate biohazard containers.

**Routine Decontamination**

All equipment and working surfaces, including bench tops, are to be cleaned and decontaminated with an appropriate disinfectant, such as a freshly made 1:10 (v/v) dilution of household bleach solution, routinely before and after completing laboratory sessions. In
addition, surfaces must be disinfected immediately after becoming contaminated. The surfaces should be left damp with the disinfectant and allowed to air dry.

**Disposal of Contaminated Materials**

- Dispose all materials and specimens used in the Teaching Laboratory in biohazard bags or sharps containers that will be autoclaved. Such materials and samples include, but are not limited to: Petri dishes with organisms, agar and broth tubes with organisms, EDTA and citrated blood tubes, blood culture bottles, and tubes containing serum. **Dispose of paper towels used to decontaminate work surfaces in a biohazard container.** Dispose of paper towels used for drying hands in a regular trash receptacle.

- Figure 1 illustrates an Occupational Safety and Health Administration (OSHA) approved biohazard label that identifies acceptable biohazard disposal receptacles. This symbol should be found on all sharps containers and biohazard bags in the Teaching Laboratory.

**Figure 1: Approved Biohazard Label**

(Note: OSHA BBP states “These labels shall be fluorescent orange or orange-red or predominantly so, with lettering and symbols in a contrasting color.” However, “Red bags or red containers may be substituted for labels.”)
Chemical Safety

Introduction

Certain chemical substances used in the Teaching Laboratory are potentially hazardous. These hazards depend on the physical and chemical properties of the materials. Knowing how to properly move and store chemicals, as well as what to do in case of an accident, will minimize danger from exposure.

Hazardous Chemicals

- Hazardous chemicals are those substances that pose a risk of damage to the lungs, skin, eyes, or mucous membranes following short or long-term exposure. Per OSHA (OSHA Hazard Communication: Hazard Classification Guidance for Manufacturers, Importers, and Employers. OSHA 3844-02 2016), these include any chemical which is classified as a physical hazard or a health hazard, a simple asphyxiant, combustible dust, pyrophoric gas, or hazard not otherwise classified.

- Hazardous chemicals may be categorized as follows:
  - **Organic Solvents**
    In general, solvents are liquids capable of dissolving or dispersing other substances. In the laboratory, organic solvents are generally light hydrocarbons used for solubilizing lipids or extracting desired substances from a non-miscible aqueous solution. They are usually volatile and can often penetrate the skin. Work in a well-ventilated area when using solvents.
  - **Corrosives (Caustics)**
    - The major classes of corrosive chemicals are strong acids (pH < 2.1), highly alkaline bases (pH > 12.5), dehydrating agents, and oxidizing agents. Mixing should always be performed by adding the chemical to water to avoid a possibly violent reaction and subsequent spattering.
    - Corrosives, if inhaled or ingested, cause severe damage to the gastrointestinal and respiratory tracts. Some substances, like sulfuric acid, penetrate deep into tissues and cause serious burns. Other corrosives may be extremely damaging to the eyes. Immediately irrigating the exposed tissue with water is critical. Continued flushing with water for a minimum of 15 minutes is essential in minimizing tissue damage. If the eyes have been affected, they must be rinsed thoroughly while the eyelids are held open.
  - **Irritants**
    - These substances cause reversible inflammatory effects on living tissue by chemical action at the site of contact.
    - Formaldehyde is both an irritant and a potential carcinogen. OSHA has issued a specific formaldehyde standard that recognizes the hazards associated with the use of formaldehyde in the laboratory. An aqueous solution of formaldehyde is called “formalin.” It is used to preserve fecal parasites for laboratory examination as well as to fix tissue specimens for anatomic pathology.
o Carcinogens

- Carcinogens are actual or potential cancer-causing agents. Per OSHA (OSHA Hazard Communication: Hazard Classification Guidance for Manufacturers, Importers, and Employers. OSHA 3844-02 2016), carcinogens are substances or mixtures of substances which induce cancer or increase its incidence. Substances and mixtures which have induced benign and malignant tumors in well-performed experimental studies on animals are considered also to be presumed or suspected human carcinogens unless there is strong evidence that the mechanism of tumor formation is not relevant for humans.

- Widely recognized carcinogens are benzene and toluene. Small amounts of the weak carcinogen alpha-naphthol (1-naphthol) are used to develop the Voges-Proskauer reaction in microbiology. Ethidium bromide, a powerful mutagen, is used to visualize DNA in molecular diagnostics. Students must carefully follow instructions for the use and disposal of these reagents.

o Toxins (Poisons)

Many chemicals are toxic or poisonous, and cause illness or death, when relatively small amounts are inhaled, swallowed, or absorbed through the skin. Toxic effects may be either local or systemic. Metallic mercury and its compounds are toxic. OSHA standards specify permissible exposure limits (PELs) to OSHA-regulated toxic chemicals. A PEL identifies the level and duration of allowable exposure to a particular toxic chemical. Check warning labels and other available information to determine if a chemical is toxic.

o Ignitables

Per OSHA, ignitables are solids, liquids, or compressed gasses which are capable of being set afire. These chemicals include both combustible and flammable liquids, as defined by their flash points. The flash point is the lowest temperature at which a liquid emits vapors in such quantities that, when combined with air near the surface of the liquid, forms an ignitable mixture. Flammable liquids have a flash point below 100 °F. OSHA defines combustible liquids as those substances with a flash point at or above 100 °F but below 200 °F. Acetone and ethanol are flammable liquids while acetic acid is a combustible liquid. Avoid open flames and sparks and ensure proper ventilation when handling or storing flammables.

o Explosives (Reactives)

Explosive chemicals are reactive and unstable substances that explode easily and sustain a violent chemical change, often at normal temperatures and pressures. Store and handle explosives according to the SDS.
<table>
<thead>
<tr>
<th><strong>Table 3: Definitions of exposure limits and related terms</strong>*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dose</strong></td>
</tr>
<tr>
<td><strong>Absorbed Dose</strong></td>
</tr>
<tr>
<td><strong>Acute Dose</strong></td>
</tr>
<tr>
<td><strong>Explosive chemical</strong></td>
</tr>
<tr>
<td>- <strong>Pyrotechnic chemical.</strong></td>
</tr>
<tr>
<td>- <strong>Explosive item.</strong></td>
</tr>
<tr>
<td>- <strong>Pyrotechnic item.</strong></td>
</tr>
<tr>
<td>- <strong>Unstable explosive.</strong></td>
</tr>
<tr>
<td>- <strong>Intentional explosive.</strong></td>
</tr>
<tr>
<td><strong>Explosive Limits</strong></td>
</tr>
<tr>
<td><strong>Flammable</strong></td>
</tr>
<tr>
<td><strong>Ignitable</strong></td>
</tr>
<tr>
<td><strong>Flashpoint</strong></td>
</tr>
<tr>
<td><strong>Autoignition Temperature</strong></td>
</tr>
<tr>
<td><strong>LEL or LFL - Lower Explosive Limit or Lower Flammable Limit</strong></td>
</tr>
<tr>
<td><strong>UEL or UFL [Upper Explosive Limit or Upper Flammable Limit]</strong></td>
</tr>
</tbody>
</table>
| **LC<sub>50</sub> - Lethal Concentration 50, 50% Lethal Concentration** | The concentration of a chemical in air or of a chemical in water which causes the death of 50% (one half) of a group of test animals. The LC<sub>50</sub> can be expressed in several ways:  
- as parts of material per million parts of air by volume (ppm) for gases and vapors,  
- as micrograms of material per liter of air (µg/L), or  
- as milligrams of material per cubic meter of air (mg/m³) for dusts and mists, as well as for gases and vapors. |
| **LD<sub>50</sub> - Lethal Dose 50** | The amount of a chemical, given all at once, which causes the death of 50% (one half) of a group of test animals. The LD<sub>50</sub> dose is usually expressed as milligrams or grams of material per kilogram of animal body weight (mg/kg or g/kg). |
| **PEL - Permissible Exposure Limit** | A legally enforceable occupational exposure limit established by OSHA, usually measured as an eight-hour time-weighted average, but also may be expressed as a ceiling concentration exposure limit. |
| **STEL [Short-Term Exposure Limit]** | Short-Term Exposure Limit (ACGIH [The American Conference of Governmental Industrial Hygienists] terminology); see TLV. |
| **TLV - Threshold Limit Value** | The occupational exposure limit published by the American Conference of Governmental Industrial Hygienists (ACGIH). ACGIH expresses Threshold Limit Values in four ways:  
- **TLV-TWA**: The allowable Time-Weighted Average - A concentration for a normal 8-hour workday or 40-hour workweek.  
- **TLV-STEL**: Short-Term Exposure Limit - A maximum concentration for a continuous 15-minute exposure period (maximum of four such periods per day, with at least 60 minutes between exposure periods, and provided the daily TLV-TWA is not exceeded).  
- **TLV-C - Ceiling limit** - A concentration that should not be exceeded even instantaneously.  
- **TLV-Skin** - The skin designation refers to the potential contribution to the overall exposure by the cutaneous route, including mucous membranes and the eye. Exposure can be either by airborne or direct contact with the substance. This designation indicates that appropriate measures should be taken to prevent skin absorption. |
| **TWA [Time-Weighted Average]** | The concentration of a material to which a person is exposed, averaged over the total exposure time – generally the total workday (8 to 12 hours); also see TLV. |
| **Specific target organ toxicity - single exposure (STOT-SE)** | Specific, non-lethal target organ toxicity arising from a single exposure to a chemical. All significant health effects that can impair function, both reversible and irreversible, immediate and/or delayed and not specifically addressed in Appendices A.1 to A.7 and A.10 of 29 CFR 1910.1200 are included. |
| **Specific target organ toxicity - repeated exposure (STOT-RE)** | Specific target organ toxicity arising from repeated exposure to a substance or mixture. All significant health effects that can impair function, both reversible and irreversible, immediate and/or delayed and not specifically addressed in Appendices A.1 to A.7 and A.10 of 29 CFR 1910.1200 are included. |

[https://www.osha.gov/Publications/OSHA3844.pdf](https://www.osha.gov/Publications/OSHA3844.pdf)*
Chemicals in the Clinical Laboratory

- Common hazardous chemicals found in clinical laboratories include:

<table>
<thead>
<tr>
<th>Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>acetone</td>
</tr>
<tr>
<td>acetic acid</td>
</tr>
<tr>
<td>any common concentrated acid (hydrochloric, nitric, sulfuric)</td>
</tr>
<tr>
<td>any common concentrated base (sodium hydroxide, ammonium hydroxide)</td>
</tr>
<tr>
<td>ethanol</td>
</tr>
<tr>
<td>formaldehyde</td>
</tr>
<tr>
<td>glutaraldehyde</td>
</tr>
<tr>
<td>isopropanol</td>
</tr>
<tr>
<td>methanol</td>
</tr>
<tr>
<td>toluene</td>
</tr>
<tr>
<td>xylene</td>
</tr>
</tbody>
</table>

- Table 4 lists OSHA permissible exposure limits (PEL) for some of these common chemicals as well as additional substances. Students shall not exceed the PEL for any substance while in their laboratory sessions. Because the list is not comprehensive, the student must take the time to read procedures carefully before performing any laboratory test.
Table 4: OSHA Permissible Exposure Limits (PEL) as of 21 June 2016

<table>
<thead>
<tr>
<th>Chemical</th>
<th>PEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic Acid</td>
<td>10 ppm TLV-TWA</td>
</tr>
<tr>
<td></td>
<td>15 ppm STEL</td>
</tr>
<tr>
<td>Acetone</td>
<td>500 ppm TLV-TWA</td>
</tr>
<tr>
<td></td>
<td>750 ppm STEL</td>
</tr>
<tr>
<td>Ammonium hydroxide (10%-35% solution)</td>
<td>25 ppm TLV-TWA</td>
</tr>
<tr>
<td></td>
<td>40 ppm STEL</td>
</tr>
<tr>
<td>Chloroform</td>
<td>10 ppm TLV-TWA</td>
</tr>
<tr>
<td></td>
<td>No STEL</td>
</tr>
<tr>
<td>Ethanol</td>
<td>1000 ppm TLV-TWA</td>
</tr>
<tr>
<td></td>
<td>No STEL</td>
</tr>
<tr>
<td>Hydrochloric acid (Hydrogen chloride)</td>
<td>2 ppm (7 mg/m³) TLV-C</td>
</tr>
<tr>
<td></td>
<td>No STEL</td>
</tr>
<tr>
<td>Iodine</td>
<td>0.1 ppm (1 mg/m³) TLV-C</td>
</tr>
<tr>
<td></td>
<td>No STEL</td>
</tr>
<tr>
<td>Isopropanol</td>
<td>200 ppm TLV-TWA</td>
</tr>
<tr>
<td></td>
<td>400 ppm STEL</td>
</tr>
<tr>
<td>Methanol</td>
<td>200 ppm TLV-TWA</td>
</tr>
<tr>
<td></td>
<td>250 ppm STEL (skin)</td>
</tr>
<tr>
<td>Nitric acid</td>
<td>2 ppm TLV-TWA</td>
</tr>
<tr>
<td></td>
<td>4 ppm STEL</td>
</tr>
<tr>
<td>Phenol</td>
<td>5 ppm (19 mg/m³) TLV-TWA (skin)</td>
</tr>
<tr>
<td></td>
<td>No STEL</td>
</tr>
<tr>
<td>Potassium hydroxide</td>
<td>2 mg/m³ TLV-C</td>
</tr>
<tr>
<td></td>
<td>No STEL</td>
</tr>
<tr>
<td>Sodium hydroxide (Caustic soda, Soda lye)</td>
<td>2 mg/m³ TLV-C</td>
</tr>
<tr>
<td></td>
<td>No STEL</td>
</tr>
<tr>
<td>Toluene</td>
<td>50 ppm TLV-TWA</td>
</tr>
<tr>
<td></td>
<td>150 ppm STEL</td>
</tr>
<tr>
<td>Xylenes (o-, m-, and p-isomers)</td>
<td>100 ppm TLV-TWA</td>
</tr>
<tr>
<td></td>
<td>150 ppm as STEL</td>
</tr>
</tbody>
</table>

STEL: Short-term exposure limit (highest permissible exposure for any 15 minute period).
TWA: Time-Weighted Average.
TLV-C: Ceiling limit: A concentration that should not be exceeded even instantaneously.
TLV-TWA: The allowable Time-Weighted Average (average exposure over an 8 hour period).
Product Warning Labels Used in Laboratories

NFPA System

- Labels warning of a hazard should be affixed to a chemical or product. The National Fire Protection Association (NFPA) developed the Hazard Identification System (HIS). The basic HIS symbol consists of four small square diamonds in a larger diamond, each color-coded to indicate a specific hazard. The numerical rating of 0 – 4 shows the severity of the hazard.

Figure 2: National Fire Protection Rating System (NFPR)

<table>
<thead>
<tr>
<th>Health Hazards (blue):</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 = No hazard.</td>
</tr>
<tr>
<td>1 = Can cause irritation if left untreated.</td>
</tr>
<tr>
<td>3 = Can cause serious injury despite medical treatment.</td>
</tr>
<tr>
<td>4 = Can cause death or major injury despite medical treatment.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flammability (red):</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 = Will not burn.</td>
</tr>
<tr>
<td>1 = Ignites after considerable preheating.</td>
</tr>
<tr>
<td>2 = Ignites if moderately heated.</td>
</tr>
<tr>
<td>3 = Can be ignited at all normal temperatures.</td>
</tr>
<tr>
<td>4 = Very flammable gases or very volatile flammable liquid.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reactivity (yellow):</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 = Normally stable. Not reactive with water.</td>
</tr>
<tr>
<td>1 = Normally stable. Unstable at high temperature and pressure. Reacts with water.</td>
</tr>
<tr>
<td>2 = Normally unstable but will not detonate.</td>
</tr>
<tr>
<td>3 = Can detonate or explode, but requires strong initiating force or heating.</td>
</tr>
<tr>
<td>4 = Readily detonates or explodes.</td>
</tr>
</tbody>
</table>

In the diamond designated other (achite) one might use the following descriptions:

- OX = Oxidizer.
- ACID = Acid.
- ALK = Alkali.
- COR = Corrosive.
- W = Use no water.
The NFPA hazard sign is most often displayed on commercial product labels. However, when a chemical is transferred from its original container, the new container must be labeled to indicate the identity of the contents and appropriate hazard warnings. The hazard labeling is not required if the contents of the secondary container are completely used during the same shift or laboratory session by the same individual who originally transferred the chemical. The label must include the following information:

- Name of reagent
- Reagent concentration
- Initials of person who prepared the reagent
- Date of preparation
- Expiration date
- Special storage requirements

**HMIS System**

The National Paint and Coatings Association developed the Hazardous Materials Information System (HMIS) that also uses a numerical rating system color-coded by category to indicate the potential degree of hazard associated with a chemical material. The HMIS method specifies the PPE that should be used when handling a chemical with a letter-coding system and representative pictographs.

**Figure 3: HAZARDOUS MATERIALS INFORMATION SYSTEM (HMIS)**
Safety Data Sheets (SDS)

- Per OSHA, “The Hazard Communication Standard (HCS) (29 CFR 1910.1200(g)), revised in 2012, requires that the chemical manufacturer, distributor, or importer provide Safety Data Sheets (SDSS) (formerly MSDSs or Material Safety Data Sheets) for each hazardous chemical to downstream users to communicate information on these hazards. The information contained in the SDS is largely the same as the MSDS, except now the SDSs are required to be presented in a consistent user-friendly, 16-section format.” (Hazard Communication Standard: Safety Data Sheets. OSHA 3514)

- The SDS should include the following information:

  Section 1: Identification
  Section 2: Hazard(s) Identification
  Section 3: Composition/Information on Ingredients
  Section 4: First-Aid Measures
  Section 5: Fire-Fighting Measures
  Section 6: Accidental Release Measures
  Section 7: Handling and Storage
  Section 8: Exposure Controls/Personal Protection
  Section 9: Physical and Chemical Properties
  Section 10: Stability and Reactivity
  Section 11: Toxicological Information
Household chemicals that can be purchased by the consumer for personal use in the same concentration as what is used in the clinical laboratory (substances like bleach or sink cleaners) do not have to be listed in the chemical inventory, nor do they require an SDS. Table 4 provides an example of an SDS.

Table 5: Sample Safety Data Sheet (SDS)

<table>
<thead>
<tr>
<th>SAFETY DATA SHEET</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACME Chemical Company</td>
</tr>
<tr>
<td>1000 Main Street</td>
</tr>
<tr>
<td>Omaha, Nebraska 91876</td>
</tr>
<tr>
<td>(199) 123-4567</td>
</tr>
<tr>
<td><a href="http://www.acmechecmical.com">www.acmechecmical.com</a></td>
</tr>
</tbody>
</table>

Version: 1.1 Date issued 6-22-2016 Replaces: MSDS 5-16-2010

1. PRODUCT AND COMPANY IDENTIFICATION

1.1. Product identifiers

Product name: 10% neutral buffered formalin (Formaldehyde solution, 10%, buffered
Product Number: F-NB-104

1.2. Relevant identified uses of the substance or mixture and uses advised against

Identified uses: Chemical synthesis, Preservation of biological specimens

1.3. Details of the supplier of the safety data sheet

ACME Chemical Company (see above)
Emergency telephone number: (555) 555-9876

2. HAZARDS IDENTIFICATION

2.1. Classification of the substance or mixture
This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Classification in accordance with 29 CFR 1910 (OSHA HCS)

Flammable liquids Category 4
Acute toxicity, Oral Category 4
Skin irritation Category 2
Serious eye damage Category 1
Skin sensitization Category 1
Germ cell mutagenicity Category 2
Carcinogenicity Category 1A
Specific target organ toxicity - single exposure Category 1
  Target Organs - Respiratory system, Central nervous system (CNS)
Specific target organ toxicity - (repeated exposure) Category 2
  Target Organs - Kidney, Liver, Blood

2.2. Label elements, Including precautionary statements

Signal Word  Danger

Hazard statements
• Combustible liquid
• Harmful if swallowed
• Causes skin irritation
• May cause an allergic skin reaction
• Causes serious eye irritation and damage
• May cause respiratory irritation
• May cause drowsiness or dizziness
• Suspected of causing genetic defects
• May cause cancer
• Causes damage to organs

Precautionary statements

Prevention
• Obtain special instructions before use
• Do not handle until all safety precautions have been read and understood
• Keep away from heat/sparks/open flames/hot surfaces
• Do not breathe dust/ fume/ gas/ mist/ vapors/ spray
• Wash face, hands and any exposed skin thoroughly after handling
• Do not eat, drink or smoke when using this product
• Contaminated work clothing should not be allowed out of the workplace
• Wear personal protective equipment (protective gloves/ protective clothing/ eye protection/ face protection)

Response
• IF SWALLOWED: Call a POISON CENTER/doctor if you feel unwell. Rinse mouth
• IF ON SKIN: Wash with plenty of soap and water
• IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER/doctor
• IF EXPOSED: Call a POISON CENTER or doctor/ physician
• If skin irritation or rash occurs: Get medical advice/ attention. P362 Take off contaminated clothing and wash before reuse
• IN CASE OF FIRE: Use CO₂, dry sand, dry chemical or alcohol-resistant foam to extinguish

Storage
• Store in a well-ventilated place. Keep cool
• Store locked up

Disposal
• Dispose of contents/ container to an approved waste disposal plant.

2.3. Hazards not otherwise classified (HNOC)

WARNING! This product contains a chemical known in the State of California to cause birth defects or other reproductive harm

---

3. COMPOSITION / INFORMATION ON INGREDIENTS

3.2. Mixtures

<table>
<thead>
<tr>
<th>Hazardous components</th>
<th>Component Classification</th>
<th>Concentration (Weight %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formaldehyde</td>
<td>Flammable Liquid</td>
<td>4</td>
</tr>
<tr>
<td>CAS-No. 50-00-0</td>
<td></td>
<td>3.8 – 4.2</td>
</tr>
<tr>
<td>EC-No. 200-001-8</td>
<td>Acute Toxicity</td>
<td>3</td>
</tr>
<tr>
<td>Index-No. 605-001-00-5</td>
<td>Skin Corrosion</td>
<td>1B</td>
</tr>
<tr>
<td>Registration number 012119488953-20-0169</td>
<td>Serious Eye Damage</td>
<td>1</td>
</tr>
<tr>
<td>Methanol</td>
<td>Flammable Liquid</td>
<td>2</td>
</tr>
<tr>
<td>CAS-No. 67-56-1</td>
<td></td>
<td>1.9 – 2.1</td>
</tr>
<tr>
<td>EC-No. 200-659-6</td>
<td>Acute Toxicity</td>
<td>3</td>
</tr>
</tbody>
</table>
4. FIRST AID MEASURES

4.1. Description of first aid measures

<table>
<thead>
<tr>
<th>General Advice</th>
<th>Immediate medical attention is required. Move out of dangerous area. Show this safety data sheet to the doctor in attendance.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin Contact</td>
<td>Wash off immediately with soap and plenty of water for at least 15 minutes. Take victim immediately to hospital. If skin irritation persists, consult a physician.</td>
</tr>
<tr>
<td>Ingestion</td>
<td>DO NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician or Poison Control Center immediately.</td>
</tr>
<tr>
<td>Eye Contact</td>
<td>Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Continue rinsing eyes during transport to hospital. If eye irritation persists, consult a specialist.</td>
</tr>
<tr>
<td>Inhalation</td>
<td>Immediate medical attention is required. Move to fresh air. If breathing is difficult, give oxygen. DO NOT use mouth-to-mouth resuscitation if victim ingested or inhaled the substance; induce artificial respiration with a respiratory medical device.</td>
</tr>
</tbody>
</table>

4.2. Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the section 2.2 (Label elements, Including precautionary statements) and/or in section 11 (TOXICOLOGICAL INFORMATION).

4.3. Indication of any immediate medical attention and special treatment needed

No data; treat by symptoms.

5. FIRE-FIGHTING MEASURES

5.1. Extinguishing media
Suitable extinguishing media: Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2. Special hazards arising from the substance or mixture

Combustible material. Risk of ignition. Containers may explode when heated. Keep product and empty container away from heat and sources of ignition.

5.3. Advice for firefighters

As for any fire, wear self-contained breathing apparatus (SCBA) pressure-demand, MSHA / NIOSH-approved or equivalent, and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

5.4. Further information

Use water spray to cool unopened containers

**NFPA:**

<table>
<thead>
<tr>
<th>Health</th>
<th>Flammability</th>
<th>Reactivity</th>
<th>Physical hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2</td>
<td>0</td>
<td>N/A</td>
</tr>
</tbody>
</table>

6. ACCIDENTAL RELEASE MEASURES

6.1. Personal precautions, protective equipment and emergency procedures

Use personal protective equipment. Evacuate personnel to safe areas upwind of spill or leak. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Remove all sources of ignition and take precautionary measures against static discharges. Beware of vapors accumulating to form explosive concentrations, especially in low areas. For personal protection see section 8.

6.2. Environmental precautions

Prevent further leakage or spillage if safe to do so. DO NOT let product enter drains. DO NOT flush into surface water or sanitary sewer system. DO NOT release into the environment. See Section 12 for additional ecological information.

6.3. Methods and materials for containment and cleaning up

Contain spillage by soaking up with inert absorbent material, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13). Keep in suitable, closed containers for disposal. Remove all sources of ignition and take precautionary measures against static discharges.

6.4. Reference to other sections
For disposal see section 13.

7. HANDLING AND STORAGE

7.1. Precautions for safe handling

Use only under a chemical fume hood. Wear personal protective equipment. Avoid contact with skin and eyes. Avoid breathing vapors or spray mist. Wear personal protective equipment. Do not ingest. Keep away from sources of ignition. Take measures to prevent the build-up of electrostatic charge. For precautions see section 2.2.

7.2. Conditions for safe storage, including any incompatibilities

Keep container tightly closed in a dry, cool, well-ventilated place. Keep away from heat and sources of ignition. Carefully re-seal opened containers and keep them upright to prevent leakage.

7.3. Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1. Control parameters

<table>
<thead>
<tr>
<th>Component</th>
<th>ACGIH TLV</th>
<th>OSHA PEL</th>
<th>NIOSH IDLH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formaldehyde</td>
<td>TLV-C: 0.3 ppm</td>
<td>(Vacated) TWA: 3 ppm (Vacated) STEL: 10 ppm (Vacated) Ceiling: 5 ppm TLV-TWA: 0.75 ppm STEL: 2 ppm</td>
<td>IDLH: 20 ppm TWA: 0.016 ppm TLV-C: 0.1 ppm</td>
</tr>
<tr>
<td>Methyl alcohol</td>
<td>TWA: 200 ppm STEL: 250 ppm Skin</td>
<td>(Vacated) TWA: 200 ppm (260 mg/m³) (Vacated) STEL: 250 ppm (325 mg/m³) Skin TLV-TWA: 200 ppm (260 mg/m³)</td>
<td>IDLH: 6000 ppm TWA: 200 ppm (260 mg/m³) STEL: 250 ppm (325 mg/m³)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ACGIH American Conference of Governmental Industrial Hygienists
OSHA Occupational Safety and Health Administration
NIOSH IDLH The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health

8.2. Exposure controls

Appropriate Engineering Controls
Use only under a chemical fume hood. Ensure that eyewash stations and safety showers are close to the workstation location. Ensure adequate ventilation, especially in confined areas. Wash hands before breaks and at the end of workday.

**Personal protective equipment**

**Eye / Face Protection**

Tightly fitting safety goggles or face shield (8-inch minimum). Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US).

**Skin Protection**

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove’s outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

**Body Protection**

Complete suit protecting against chemicals. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

**Respiratory Protection**

Where risk assessment shows air-purifying respirators are appropriate use a full-face powered air-purifying respirator (PAPR) with multipurpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU). Follow the OSHA respirator regulations found in 29 CFR 1910.134. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

**Hygiene Measures**

Handle in accordance with good industrial hygiene and safety practice.

**Control of Environmental Exposure**

Prevent further leakage or spillage if safe to do so. Do not let product enter drains

---

9. **PHYSICAL AND CHEMICAL PROPERTIES**
9.1. Information on basic physical and chemical properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Liquid, Clear</td>
</tr>
<tr>
<td>Odor</td>
<td>Pungent</td>
</tr>
<tr>
<td>Odor Threshold</td>
<td>No data available</td>
</tr>
<tr>
<td>pH</td>
<td>7</td>
</tr>
<tr>
<td>Melting point/freezing point</td>
<td>No data available</td>
</tr>
<tr>
<td>Initial boiling point and boiling range</td>
<td>100 °C (212 °F) at 1,013 hPa (760 mmHg)</td>
</tr>
<tr>
<td>Flash point</td>
<td>90 °C / 194 °F</td>
</tr>
<tr>
<td>Autoignition</td>
<td>430 °C / 806 °F</td>
</tr>
<tr>
<td>Evaporation rate</td>
<td>&gt; 1.0</td>
</tr>
<tr>
<td>Flammability (solid, gas)</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Upper/lower flammability or explosive limits</td>
<td>Upper explosion limit: 70 % (V)</td>
</tr>
<tr>
<td></td>
<td>Lower explosion limit: 7 % (V)</td>
</tr>
<tr>
<td>Vapor pressure</td>
<td>53 hPa (40 mmHg) at 39 °C (102 °F)</td>
</tr>
<tr>
<td>Vapor density</td>
<td>1.0</td>
</tr>
<tr>
<td>Relative density</td>
<td>1.080 g/cm³</td>
</tr>
<tr>
<td>Water solubility</td>
<td>completely miscible</td>
</tr>
<tr>
<td>Partition coefficient: n-octanol/water</td>
<td>No data available</td>
</tr>
<tr>
<td>Auto-ignition temperature</td>
<td>No data available</td>
</tr>
<tr>
<td>Decomposition temperature</td>
<td>No data available</td>
</tr>
<tr>
<td>Viscosity</td>
<td>No data available</td>
</tr>
<tr>
<td>Explosive properties</td>
<td>No data available</td>
</tr>
<tr>
<td>Oxidizing properties</td>
<td>No data available</td>
</tr>
</tbody>
</table>

9.2. Other safety information

No data available

10. STABILITY AND REACTIVITY

10.1. Reactivity

No data available

10.2. Chemical stability

Stable under recommended storage conditions. May self-polymerize to form paraformaldehyde, which precipitates, and trioxane.

10.3. Possibility of hazardous reactions

No data available

10.4. Conditions to avoid
Incompatible products; Sources of ignition and static discharges

10.5. Incompatible materials

Strong bases, Acids, Oxidizing agents, Alkali metals, Amines, Acid chlorides, Acid anhydrides, Reducing agents, Peroxides, Isocyanates, Phenol, Aniline

10.6. Hazardous decomposition products

Hazardous decomposition products formed under fire conditions: Carbon oxides
Other decomposition products: No data available
In the event of fire: See section 5

11. TOXICOLOGICAL INFORMATION

11.1. Information on toxicological effects

<table>
<thead>
<tr>
<th>Acute Toxicity</th>
<th>No data available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral LD&lt;sub&gt;50&lt;/sub&gt;</td>
<td>ATE &gt; 2000 mg / kg</td>
</tr>
<tr>
<td>Inhalation (Vapor LC&lt;sub&gt;50&lt;/sub&gt;)</td>
<td>ATE &gt; 20 mg / L</td>
</tr>
<tr>
<td>Dermal LD&lt;sub&gt;50&lt;/sub&gt;</td>
<td>ATE &gt; 2000 mg / kg</td>
</tr>
<tr>
<td>Skin Corrosion / Irritation</td>
<td>Irritating</td>
</tr>
<tr>
<td>Serious Eye Damage / Eye Irritation</td>
<td>Damaging / Irritating</td>
</tr>
<tr>
<td>Respiratory or skin sensitization</td>
<td>No data available</td>
</tr>
<tr>
<td>Germ cell mutagenicity</td>
<td>No data available</td>
</tr>
<tr>
<td>Carcinogenicity</td>
<td>IARC: 1 - Group 1: Carcinogenic to humans (Formaldehyde)</td>
</tr>
<tr>
<td></td>
<td>NTP: Known to be human carcinogen (Formaldehyde)</td>
</tr>
<tr>
<td></td>
<td>OSHA: OSHA specifically regulated carcinogen (Formaldehyde)</td>
</tr>
<tr>
<td>Reproductive toxicity</td>
<td>Experiments have shown reproductive toxicity effects on laboratory animals</td>
</tr>
<tr>
<td>Developmental Effects / Teratogenicity</td>
<td>Developmental / teratogenic effects have occurred in experimental animals</td>
</tr>
<tr>
<td>Specific target organ toxicity - single exposure</td>
<td>Respiratory system, Central nervous system (CNS)</td>
</tr>
<tr>
<td>Specific target organ toxicity - repeated exposure</td>
<td>Kidney, Liver, Blood</td>
</tr>
<tr>
<td>Aspiration hazard</td>
<td>No data available</td>
</tr>
<tr>
<td>Additional Information</td>
<td>RTECS: Not available</td>
</tr>
<tr>
<td></td>
<td>Methyl alcohol may be fatal or cause blindness if swallowed. Cannot be made non-poisonous. Effects due to ingestion may include: Nausea, Dizziness, Gastrointestinal disturbance, Weakness, Confusion, Drowsiness,</td>
</tr>
</tbody>
</table>
12. ECOLOGICAL INFORMATION

12.1. Toxicity

Toxic to aquatic organisms. May cause long-term harmful effects in aquatic environments.

12.2. Persistence and degradability

No data available, but miscible with water

12.3. Bioaccumulative potential

No data available

12.4. Mobility in soil

No data available, but miscible with water

12.5. Results of PBT and vPvB assessment

PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6. Other adverse effects

No data available

13. DISPOSAL CONSIDERATIONS

13.1. Waste treatment methods

Product

May be classified as hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.
Combustible material; may be burned in a chemical incinerator equipped with an afterburner and scrubber. Contact a licensed professional waste disposal service to dispose of this material.

**Contaminated packaging**

Dispose of as unused product.

---

### 14. TRANSPORT INFORMATION

**USDOT**
- Not regulated
- NA-Number: 1993
- Class: NONE
- Packing group: III
- UN-No: UN3334
- Proper Shipping Name: Combustible liquid, n.o.s. (Methanol, Formaldehyde)
- Proper technical name: (10% FORMALIN)
- Hazard Class: 9
- Reportable Quantity (RQ): 2500 lbs.

**TDG**
- Not regulated

**IMDG/IMO**
- Not regulated
- UN-No: FS0002
- Proper Shipping Name: NOT REGULATED BY IMDG/IMO
- Hazard Class: NONE

---

### 15. REGULATORY INFORMATION

**SARA Title III, Section 302 Components**

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formaldehyde</td>
<td>50-00-0</td>
<td>2007-07-01</td>
</tr>
</tbody>
</table>

**SARA Title III, Section 313 Components**

<table>
<thead>
<tr>
<th>Component</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol</td>
<td>67-56-1</td>
<td>2007-07-01</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>50-00-0</td>
<td>2007-07-01</td>
</tr>
</tbody>
</table>

**SARA Title III, Section 311/312 Hazards**

- Fire Hazard
- Acute Health Hazard
- Chronic Health Hazard

**Massachusetts Right To Know Components**
<table>
<thead>
<tr>
<th>Chemical</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol</td>
<td>67-56-1</td>
<td>2007-07-01</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>50-00-0</td>
<td>2007-07-01</td>
</tr>
</tbody>
</table>

**Pennsylvania Right To Know Components**

<table>
<thead>
<tr>
<th>Chemical</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>7732-18-5</td>
<td></td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>50-00-0</td>
<td>2007-07-01</td>
</tr>
<tr>
<td>Methanol</td>
<td>67-56-1</td>
<td>2007-07-01</td>
</tr>
<tr>
<td>Disodium hydrogenorthophosphate</td>
<td>7558-79-4</td>
<td>2007-03-01</td>
</tr>
</tbody>
</table>

**New Jersey Right To Know Components**

<table>
<thead>
<tr>
<th>Chemical</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>7732-18-5</td>
<td></td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>50-00-0</td>
<td>2007-07-01</td>
</tr>
<tr>
<td>Methanol</td>
<td>67-56-1</td>
<td>2007-07-01</td>
</tr>
</tbody>
</table>

**California Prop. 65 Components**

Warning! This product contains a chemical known to the State of California to cause cancer.

<table>
<thead>
<tr>
<th>Chemical</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formaldehyde</td>
<td>50-00-0</td>
<td>2007-09-28</td>
</tr>
</tbody>
</table>

Warning: This product contains a chemical known to the State of California to cause birth defects or other reproductive harm.

<table>
<thead>
<tr>
<th>Chemical</th>
<th>CAS-No.</th>
<th>Revision Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol</td>
<td>67-56-1</td>
<td>2012-03-16</td>
</tr>
</tbody>
</table>

16. **OTHER INFORMATION**

Disclaimer The information provided on this Safety Data Sheet:

1) Is correct to the best of our knowledge, information and belief at the time of publication but does not allege to be all-inclusive.

2) Shall be used only as a guide for safe handling, use, processing, storage, transportation, disposal and release.

3) Is neither a warranty nor a certificate of quality.

4) Relates only to the specific material designated and may be invalid for the specific material used in combination with any other material or in any process, unless specified above.
Handling of Chemicals

- Know how to identify hazardous chemicals and know what special warning labels mean.
- Use the SDS to learn specific hazards of a chemical as well as any special handling requirements and emergency and first aid requirements.
- Ensure ventilation is adequate for the chemical being handled.
  - Wear approved respirators when the air may be contaminated with harmful fumes, mists, gases, or vapors.
  - Use a fume hood for any procedure which might result in the release of toxic chemical vapors.
    - Generally, a hood or local ventilation device should be used when working with any perceived volatile substance. Leave the hood on when not in active use if toxic substances are also stored within the hood. Work toward the center of the hood and avoid using the first six inches behind the opening. Also, while working in the hood, notify the instructor immediately if fumes are smelled.
    - The student should be able to explain the difference between a fume hood and a biosafety cabinet. Because of the delicate nature of the filters in a biosafety cabinet, caustic and volatile chemicals should never be used there. Conversely, the strong exhaust pressure and lack of filters make a fume hood an inappropriate area to handle cultures, body fluids and other biohazardous materials.
- Personal protective equipment and clothing/Tips for handling chemicals
  - Also see under Laboratory Dress Code and Personal Protective Equipment (PPE) Policy, page Error! Bookmark not defined.
  - Flush the outside of acid bottles with water before opening them.
  - *Pour acid into water; do not pour water into acid.*
  - Keep acids and other bottles containing corrosive chemicals tightly stoppered. Flush with water and dry them before storing or replacing on a shelf.
  - Do not lay stoppers down on any surface where persons may contact them and/or leave residual reagent on the bench.
Carry beakers, reagents, and flasks with fingers around the body of the container. Do not grasp or carry containers by holding the edge of the lip.

Do not stopper bottles of alkaline solutions, or solutions containing significant quantities of soluble salts, with glass stoppers. There is a high probability that the stopper will stick in the neck of the bottle. This tightness results because of etching of the glass at the stopper, by evaporation of the solution, or because of the formation of adducts binding the glass. Clean, washed artificial rubber stoppers or teflon-lined screw caps should be used.

When heating liquids on a hot plate, use beaker covers, if available, to prevent spattering.

Always wipe bench tops clean. Drops of acid or other corrosive chemicals may cause severe burns.

Always use a suction filler or bulb when pipetting chemicals.

Storage of Chemicals

The storage of hazardous chemicals is partly controlled by standards set by governmental agencies as well as other factors, such as the environmental controls of the building. Efforts have been made to maintain the storage of hazardous chemicals used in the Teaching Laboratory in the most acceptable manner. The following are general guidelines for the storage of chemical hazards regardless of the setting.

- Chemicals should have a specific storage place and should be returned to the location after use.
- Only use approved storage containers.
- Obtain breakage protection for large glass bottles. Use rubber bottle carriers for containers of concentrated reagents containing more than 500 mL if available.
- Store large containers near the floor to minimize the danger of falling.
- If possible, store chemicals on shelves with lips or raised edges to reduce the possibility of a container falling off and to contain leaks or spills should they occur. Try to avoid storage on bench tops and in hoods.
- Store the smallest amounts of chemicals as practical.
- Discard chemicals that are no longer used, that show signs of deterioration, or whose container is old, leaking, or corroded.
- Do not store water-reactive chemicals where contact with water might occur; likewise, avoid exposure to heat or direct sunlight.
- Separate chemicals that are potentially incompatible and that might react with one another to produce an explosive, toxic, or flammable product. For example, store acids in an acid cabinet and store flammable chemicals in a flame cabinet.
- Isolate toxic chemicals from other substances and store them in an identified area that is cool, well-ventilated, and away from moisture, light, heat, acids, and oxidizing agents.
• Secure cylinders of compressed gases to a wall or counter and store them in well-ventilated, dry areas, and away from corrosive chemicals, vapors, or sources of ignition.

• The storage of flammable liquids requires special procedures:
  o Store containers of one gallon or less in a solvent storage cabinet.
  o Bottles used at the bench should not exceed one pint (almost 500 mL).
  o Ethyl ether should be stored either in a storage room or in an explosion-proof refrigerator.
  o Flammable organic extracts should be placed in an explosion-proof refrigerator or freezer.
  o All aisles and exits near flammable storage cabinets should be open and not blocked.
  o Ensure that exposure to strong oxidizing agents is not possible.
  o Store flammables away from any possible source of ignition.
Spills and Exposures

All spills should be cleaned up using appropriate biosafety procedures described below. If there is any question what to do, call the **Biosafety Officer: 1-6590 or the University’s internal emergency number: 5-2677**.

Cleaning

- **First**, report the incident to the laboratory instructor.
- For spills greater than 100 mL:
  - Warn others of the hazard.
  - Avoid breathing vapors.
  - Remove all sources of ignition.
  - Evacuate the area immediately.
  - Consult the appropriate SDS or product label for information regarding spills and leaks, cleanup techniques, and personal protective equipment to be worn during a cleanup.
  - Notify emergency personnel, if necessary.
  - Arrange for the safe cleanup of the chemical using a commercially available spill kit or by notifying the institutional spill control team by calling University Police Dispatch at 801-585-2677 (801-585-COPS).
  - *If it is a biohazard spill*, contain spill with absorbent material then saturate the material with a freshly made 1:10 dilution of household bleach solution from the edges inward. Let stand 20 minutes as described above under “Decontamination Procedures”, starting on page 21. Wipe up the absorbent material then dispose in biohazard bag. Wipe spill area with more 1:10 bleach. Wash hands.
- For spills less than 100 mL:
  - Wear nitrile gloves and other appropriate protective clothing.
  - Absorb the spill with paper towels.
  - *If it is a biohazard spill*, follow the directions in Cleaning a spill of blood, body fluids, or cultured organisms™, page 21.
  - **Call the Environmental Health and Safety Office for the proper disposal of wastes generated from spills (1-6590).**
Figure 4: Chemical Spill Protocol

**CHEMICAL SPILL**

- Notify instructor
- Alert other students
- Assist any contaminated students
- Flammable spill?
- Turn off heat source
- Identify chemical and volume

- **>100 mL**
  - Avoid breathing vapors
  - Evacuate area
  - Notify emergency personnel, if necessary

- **< 100 mL**
  - Perform safe clean-up
  - Properly dispose of contaminated materials

Arrange for safe clean-up
Contact Exposure

- Notify the laboratory instructor immediately.
- Flush copiously with water and wash with soap and water.
- Remove any contaminated clothing.
- **If the eyes or mucous membranes are involved, flush with water for at least 10 – 15 minutes by using a sink eyewash.** Go either immediately to the University Hospital Emergency Room, escorted by MLS faculty or staff, or directly to the Student Health Center, Madsen Clinic, 555 South Foothill Boulevard, escorted by MLS faculty or staff, for medical evaluation and follow-up. For life threatening injury or illness call emergency medical services by dialing 911. The Madsen Clinic address and map are at the end of this section.
- Complete and submit the Incident/Accident Report form to Risk Management within 24 hours of the incident. The form can be downloaded from the Risk Management website, [https://riskmanagement.utah.edu/intranet/insurance/incident-accident-info.php](https://riskmanagement.utah.edu/intranet/insurance/incident-accident-info.php). **NOTE:** Eyewash stations are located at sinks in the Teaching Laboratory. Their location and the location of the showers should be noted by each student.
- If severe burns are involved, apply cold wet cloths, gauze, or paper towels, and immediately seek medical attention as above.
- If there is a liquid nitrogen contact, treat it as frostbite; apply cold water and seek medical attention as above.

Post-Exposure/Injury Procedures

If there is an exposure of potential blood-borne pathogens to non-intact skin or mucous membranes (such as a needle stick or splashing in the eyes), or a chemical exposure or other serious injury, exposed students should proceed as follows, depending on their location.

- **MLS Students in the BSL-2 Teaching Laboratory (HSEB 4730):**
  - **Immediately** notify the laboratory instructor.
  - Perform appropriate first-aid procedures to include washing the skin or wound with soap and water or flood the affected mucous membranes with water.
  - If possible, go immediately to a University provider, such as the Work Wellness Center (AC 147 University Hospital, 801-581-2227), or the University of Utah Emergency Department or to the Student Health Center, Madsen Clinic, 555 Foothill Dr. Level 1, escorted by MLS faculty or staff.
  - OR
  - The student can go to the health care provider/facility of the student’s choice but must let the facility know that it is a worker’s compensation injury.

- **MLS Faculty and Staff in the BSL-2 Teaching Laboratory (HSEB 4730):** Working with the student, complete the following forms:
  - MLS Program Incident/Accident Report Form (Appendix II)
- University of Utah Incident Accident Report Form – Risk Management (Students and Visitors) (https://riskmanagement.utah.edu/).

- Forms (https://go.utah.edu/cas/login?service=https%3a%2f%2friskmanagement.utah.edu%2fintranet%2fforms%2ffindex.php)
  - MLS faculty or staff will submit the MLS Program Incident/Accident Report Form to the Program Director and will send the University of Utah Incident/Accident Report Form to the University Risk Manager.
  - Form 122: The MLS Program (acting as the employer) will submit E-1 — HR Worker’s Compensation (First Report of Injury Form 122) (https://oehs.utah.edu/resource-center/forms/e-1-hr-workers-compensation-first-report-of-injury-form-122, fillable PDF) to Human Resources, University of Utah, Customer Resource Specialist, in the Human Resource Management Team, 801-581-7448, in the Department of Pathology. This must be done within 7 days of the injury.

  NOTE: During laboratory sessions in the HSEB Teaching Laboratory as part of enrollment in a designated MD LB course, the student is covered by personal insurance and not the University.

- Non-MLS Students in the BSL-2 Teaching Laboratory (HSEB 4730) or in the BSL-1 Teaching Laboratory (HSEB 4300):
  - Immediately notify the laboratory instructor.
  - Perform appropriate first-aid procedures to include washing the skin or wound with soap and water or flood the affected mucous membranes with water.
  - If possible, go immediately to a University provider, such as the Work Wellness Center (AC 147 University Hospital, 801-581-2227), or the University of Utah Emergency Department or to the Student Health Center, Madsen Clinic, 555 Foothill Dr. Level 1, escorted by MLS faculty or staff.

  OR

  - The student can go to the health care provider/facility of the student’s choice but must let the facility know that it is a worker's compensation injury.
    - The procedures on page 59 of the [Health Sciences] Student Handbook: https://medicine.utah.edu/students/current-students/files/2018-19-student-handbook-final-8.pdf are useful but are written with non-MLS students in hospital or clinical rotations in mind.

- Both the MLS faculty or staff member and the non-MLS student must notify the senior resident, attending physician, or program director.
  - For programs under Pathology education for the School of Medicine, notify Janet E. Lindsley, PhD, 801-581-2797, janet@biochem.utah.edu.
    - Professor of Biochemistry / Assistant Dean of Curriculum / Adjunct Professor of Nutrition and Integrative Physiology, School of Medicine
Office: Eccles Institute of Human Genetics 5150

- **For Medical Host and Defense**, notify one of the course directors:
  - Paloma Cariello, 801-585-2382, paloma.cariello@hsc.utah.edu
  - Karen Eilbeck, 801-585-9934, keilbeck@genetics.utah.edu

- **MLS Faculty and Staff working with non-MLS Students**: Working with the student, complete the following forms:
  - MLS Program Incident/Accident Report Form (Appendix II)
  - University of Utah Incident Accident Report Form – Risk Management (Students and Visitors) (https://riskmanagement.utah.edu/).
  - Forms (https://go.utah.edu/cas/login?service=https%3a%2f%2friskmanagement.utah.edu%2fintranet%2fforms%2findex.php)
  - MLS faculty or staff will submit the MLS Program Incident/Accident Report Form to the Program Director and will send the University of Utah Incident/Accident Report Form to the University Risk Manager.
  - Form 122: The MLS Program (acting as the employer) will submit E-1 — HR Worker’s Compensation (First Report of Injury Form 122) (https://oehs.utah.edu/resource-center/forms/e-1-hr-workers-compensation-first-report-of-injury-form-122, fillable PDF) to Human Resources, University of Utah, Customer Resource Specialist, in the Human Resource Management Team, 801-581-7448, in the Department of Pathology. *This must be done within 7 days of the injury.*

- **In cases involving non-MLS students where no other protocol is available, the preceding guidelines will be followed.**

- **MLS Students in a clinical rotation:**

  **NOTE:** During the clinical rotation, the student is considered a “student intern” and is covered by Workers Compensation for medical expenses.

  - **Immediately** notify the education coordinator or supervising technologist.
  - Perform appropriate first-aid procedures to include washing the skin or wound with soap and water or flooding the affected mucous membranes with water.
  - Go to the RedMed Employee Medicine Clinic, located at the Student Union; if after hours, go to the Redwood Urgent Care Clinic.

    OR

  - The student can go to the health care provider/facility of the student’s choice but must let the facility know that it is a worker's compensation injury.
  - Work with MLS faculty or staff, complete Form 122: See above.
NOTE: If the student is in a clinical rotation at ARUP, they should NOT go to the ARUP employee clinic, regardless if they are an employee. The student should follow the directions immediately above. However, if the student is not in clinical rotations but is working as an employee, it is appropriate to go to the ARUP employee clinic.

**Student Health Center, Madsen Clinic**
555 Foothill Dr. Level 1
Salt Lake City, UT 84112
Phone: 801-581-6431
Fax: 801-585-5294
Operating Hours: Monday–Friday, 7:30 am to 5 pm
Appointment Hours: Monday–Friday, 8 am to 4 pm
Walk-in (vaccines, laboratory tests) Hours: Monday–Friday, 9 am to 4 pm
Note: Clinic is closed on Wednesdays, 12–2pm.

**RedMed Employee Health Center**
200 Central Campus Drive
Salt Lake City, UT 84112
Phone: 801-213-3303
Hours: Monday–Friday, 8 am to 4 pm Th5Fri: 9:00 AM-3.30 PM

**Redwood Urgent Care Clinic**
1525 West 2100 South
Salt Lake City, UT 84119
Phone: 801-213-8841
Hours: 7 Days/Week 9:00 am to 9:00 pm

**WORK WELLNESS CENTER**
SOM Rm AC147
Non-emergency illness, free same day visits
Phone: 801-581-2227
Make Appointment Online: [https://pulse.utah.edu/site/hhr/work-wellness-center](https://pulse.utah.edu/site/hhr/work-wellness-center)
Hours: M–F 7:00 am–3:30pm

**University Hospital Emergency Room**
(Main floor northeast side of the hospital)
50 N. Medical Drive
Salt Lake City, UT 84132
Phone: 801-581-2292
Hours: 7 Days/Week 24 hours
Medical Assistance
Student Health Center at the Madsen Clinic

Location

Disposal
The exact procedures in which chemical wastes are discarded varies from substance to substance. The following are general guidelines to be used:

- **NO chemicals are to be poured down the sewer with the exception of crystal violet, stabilized iodine and safranin.**

- Spent solvent wastes:
  
  This type of waste must be deposited in a separate container labeled as “solvent waste” and discarded according to University policy.

- Concentrated acids or bases:

- Formalin, methanol, and ethanol:
  
  NO chemicals may be discarded into the sewer system.

- Malodorous, lachrymatory (chemical that causes tears, pain and blindness), highly toxic substances, and flammable chemicals:
  
  Consult the instructor and the SDS for proper disposal methods.

**NOTE:** The University of Utah has a detailed system for hazardous waste management which can be found on the website for the University’s Department of Environmental Health and Safety at [http://www.ehs.utah.edu/](http://www.ehs.utah.edu/).

- All chemicals used in the Teaching Laboratory are listed with the Department of Environmental Health and Safety's Laboratory Management System. That list is available upon request.
Fire Safety

Introduction

- Many potential fire hazards exist in the Teaching Laboratory. However, knowing basic concepts associated with flammable substances, guidelines for fire prevention, and specific procedures for fire protection can ensure that the Teaching Laboratory is a safe place to work and learn.

- Three factors must exist simultaneously for a fire to occur: fuel, oxygen, and an ignition source. The most practical methods for fire control involve restricting contact between flammable substances and an ignition source.

Sources of Fire

Flammable Substances

- Flammable materials readily catch fire and liquids may emit vapors that can burn or explode.

- Liquids

  - Common flammable liquids in the clinical laboratory are solvents which release vapors that burn.

  - The **flash point** of a liquid is the lowest temperature at which it emits vapors in such quantities that, when combined with air near the surface of the liquid, forms an ignitable mixture.

  - Liquids with low flash points, high vapor pressures, and a wide flammability range have the greatest potential for catching on fire.

  - Common flammable liquids used in the clinical laboratory and their flash points are listed below:

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Flash Point (°C / °F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic acid</td>
<td>39 / 102.2</td>
</tr>
<tr>
<td>Acetic anhydride</td>
<td>49 / 120.2</td>
</tr>
<tr>
<td>Acetone</td>
<td>−18 / −0.4</td>
</tr>
<tr>
<td>Benzene</td>
<td>−11 / 12.2</td>
</tr>
<tr>
<td>1-Butanol</td>
<td>29 / 84.2</td>
</tr>
<tr>
<td>Ethanol (anhydrous)</td>
<td>13 / 55.4</td>
</tr>
<tr>
<td>2-Propanol (Isopropyl alcohol)</td>
<td>11.7 / 53.06</td>
</tr>
<tr>
<td>Methanol</td>
<td>12 / 53.6</td>
</tr>
<tr>
<td>Toluene</td>
<td>4 / 39.2</td>
</tr>
<tr>
<td>m-Xylene</td>
<td>27 / 80.6</td>
</tr>
</tbody>
</table>
\[\text{o-Xylene}^4 \quad 32 / 89.6\]
\[\text{p-Xylene}^5 \quad 27 / 80.6\]

1. \text{\textit{n}-butanol, Butyl alcohol, \textit{n}-butyl alcohol, Propyl carbinol}
2. Ethyl methyl ketone, 2-Butanone, MEK, Methyl acetone
3. meta-Xylene, 1,3-Dimethylbenzene
4. ortho-Xylene, 1,2-Dimethylbenzene
5. para-Xylene, 1,4-Dimethylbenzene

- Consider the following when storing flammable liquids:
  - Quantities greater than one liter should be stored in metal containers, preferably safety cans.
  - Small quantities in use at the bench should be stored in well-ventilated areas, away from exposure to direct sunlight.

- **Gases**
  - Compressed and liquefied gases are dangerous.
  - Be aware that during a fire, heat will raise enough pressure to rupture the cylinder.

- **Solids**
  - Most combustible solids are fire safe unless ground into powder form.
  - Magnesium and zinc dust may explode on contact with air. Use exhaust hoods with these chemicals.
  - Metal solids like sodium react on contact with air and their moisture causes rapid oxidation that can result in ignition; handle with extreme caution.
  - Peroxide-forming compounds (including ethyl ether, isopropyl ether, dioxene, tetrahydrofuran) are very sensitive to heat, friction, impact, light, oxidizing agents and reducing compounds. Peroxides should be handled as follows:
    - Use minimal quantities.
    - Use ceramic or wooden spatulas (instead of metal) to avoid metal contamination and possible explosive decomposition.
    - Clean up spills with vermiculite.
    - When disposing, dilute with water and then with a liquid-reducing agent such as ferrous sulfate or sodium bisulfate.
**Sources of Ignition**

- Common ignition sources are open flames, electrical equipment, hot surfaces, spontaneous heating, sparks, static charges, friction, and overheating of flammable liquids.

- Flammable substances and ignition sources should not come into contact.

- Refrigerators are sources of ignition sources that demand special awareness. Vapors released by low flash point flammable liquids have been ignited when non-explosion-proof refrigerators have been used for their storage (the light bulb or switch provided the ignition source).

- Static Electricity
  - It is recommended that 100% cotton be used in laboratory coats.
  - Laboratory coats made of synthetic fabrics may accumulate static electricity that will discharge with a spark near metallic objects.

- Electrical Equipment
  - Motor-driven electrical equipment should have a non-sparking induction motor instead of a series-wound motor with carbon brushes.
  - Non-sparking motors in vacuum pumps, mechanical shakers, stirring motors, magnetic stirrers and rotary evaporators ensure that flammable liquids will not ignite.

**Fire Prevention**

Any fire may be prevented by implementing safe laboratory practices as follows:

- Do not use refrigerators for storage of flammables unless properly modified and labeled.
- Avoid storing flammables in direct sunlight.
- Ventilate areas where flammables are to be used.
- Avoid filling low boiling point liquids to the top of a closed container.
- Store flammable acids and bases separately.
- Use proper disposal methods for flammables.
- Do not use gasoline, alcohol, or other highly flammable volatile liquids for cleaning.
- Empty containers should be rinsed three times with distilled water and disposed of with caps or stoppers removed.
- Do not use a hot plate, gas, or flame to heat flammable solvents.
- Any spilled liquid should be cleaned up immediately; sand or commercial absorbent will prevent spread and reduce the fire hazard.
- Safety shielding should be worn during procedures with explosion risk.
• Keep work areas obstruction-free.
• Transfer flammable solvents by pouring through a stainless steel funnel to which ground leads have been attached.

**Fire Safety Equipment**

- **Fire extinguishers: Types**
  - Several types of fire extinguishers are available depending on the nature of the fire. The multipurpose (or ABC) extinguisher is often used in healthcare institutions because it reduces the confusion associated with choosing the type of extinguisher.
  - **Each student has the responsibility to know the location of all fire extinguishers in the laboratory.**

<table>
<thead>
<tr>
<th>Class of Fire</th>
<th>Type of Fire</th>
<th>Type of Extinguisher</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Wood, paper, cloth, trash, plastics</td>
<td>Water, CO₂, dry chemical</td>
</tr>
<tr>
<td>B</td>
<td>Flammable liquid, gases, grease</td>
<td>Dry chemical, CO₂, foam</td>
</tr>
<tr>
<td>C</td>
<td>Electrical</td>
<td>CO₂ or vaporizing liquid nonconductor</td>
</tr>
<tr>
<td>D</td>
<td>Combustible metals (magnesium, sodium, potassium)</td>
<td>Dry chemical</td>
</tr>
</tbody>
</table>

- **Operation (the “PASS” procedure)**
  - **P**ull pin.
  - **A**im nozzle on horn at the base of the fire.
  - **S**queeze the lever or handle.
  - **S**weep the base of the fire.

**Fire Protocol**

- **ESAFE:**
  - **E**valuate the Fire
    - Is it manageable, not spreading and not too smoky?
    - Is it small enough to manage with appropriate means or a fire extinguisher (trash can size or smaller)?

  *NOTE: Only consider fighting a small, manageable fire like a wastebasket fire, non-spreading liquid fire, or an electrical fire where the plug can be safely pulled.*
o **Sound the Alarm**
  - Pull the nearest alarm box. **Each student is responsible for knowing the location of fire alarms available to the laboratory.**
  - If access to the alarm is blocked, call 911 and report the fire, but the alarm box should always be activated first if possible.
  - Remove anyone from immediate danger.
  - Close all doors and windows in the area.

o **Alert Others ***Calmly***
  - **DO NOT** shout, "Fire", or incite panic.

o **Fight the fire if it is manageable with a fire extinguisher**

o **Evacuate**
  - Immediately evacuate the laboratory and the building. The evacuation routes are posted in the Teaching Laboratory. The evacuation routes can also be found inside the front cover of this manual.
  - Walk — **DO NOT RUN** — to the nearest exit.
  - **DO NOT** use the elevators.
  - Assemble together outside and wait for directions from the instructor; assist in identifying missing persons, if necessary.

**Summary of Fire Safety**

- **Precautions**
  o Know where the fire evacuation plan is located.
  o Know where fire extinguishers and fire alarms are located.
  o Maintain marked, unobstructed exits.
  o Store flammables in explosion-proof cabinets and in safety cans.
  o Keep sources of ignition away from flammables.
  o Only use equipment approved by Underwriter's Laboratories (UL).
  o Avoid using extension cords.
  o Prohibit smoking in the laboratory.
  o Dispose of flammables properly.
• Dos and Don’ts
  o Pull the alarm nearest to the area of the fire.
  o Report the fire.
  o If the fire is small, attempt extinguishing it by using the proper extinguisher.
  o If evacuation becomes necessary, use only stairwells for exiting.
  o Close all windows and doors before leaving an area.
  o STOP, DROP and ROLL: If clothing catches fire, drop to the floor and roll.
  o If trapped in a fire, crawl to the exit; smoke rises, so breathing is easier at floor level; also, breathing through a wet towel helps.
  o Do not block exits and do not re-enter a building.
  o Do not panic.
  o Do not run.

• The acronym “RACE” is another useful method for remembering the proper response to a fire:
  o Rescue — Rescue anyone in immediate danger; alert others to assist.
  o Alarm — If the fire alarms have not sounded, pull the nearest fire pulls.
  o Contain — Make sure all doors are closed. Turn off all fans, hoods or other air-moving systems. Place water-saturated blankets or towels under doors to contain smoke. Turn off all oxygen sources.
  o Extinguish (or Evacuate) — Extinguish the fire if your safety can be assured by smothering it with a fire blanket or with a fire extinguisher. Evacuate to the nearest “safe zone.”
Electrical Safety

Introduction

Electrical equipment may be a source of fire, burns, or electrical shocks. Care must be taken to minimize electrical hazards in the laboratory, especially since so much electrical equipment is used.

Causes of Electrical Hazards

- Spilled liquids in contact with instrument circuit boards.
- Broken or damaged instrument components.
- Faulty cords or wires (especially ground wires).
- Improper repairs to electrical equipment.

Precautions

- All electrical equipment should be inspected periodically for current leakage, faulty cords, or damaged components.
- Restrict the use of extension cords to only temporary or emergency use. Note that longer cords leak more current. Heavier gauge cords leak less.
- All electrical equipment should be grounded and have three-pronged Underwriter Laboratory (UL) or Canadian Standards Association (CSA) approved plugs.
- Immediately alert MLS Faculty or Staff of any faulty, worn, or broken cords or connectors.
- Do not overload electrical outlets or circuits.
- Unplug electrical equipment before servicing; even if the service is as minor as replacing the light bulb in a microscope.
- Use electrical equipment according to the manufacturer’s directions.
- Use a surge protector on sensitive electronic equipment (and computers) to allow for unexpected spikes in electrical power.
- Signs and labels should be used to warn of the presence of high voltage equipment or other electrical hazards.
- Report all shocks to the instructor, including minor tingles.
  - Small tingles may indicate a potentially greater problem.
  - Shut off the current or unplug the instrument.
Do not use an instrument that is causing shocks.

**Electrical Emergency**

- Immediately call 9-911 if someone is experiencing electrical shock.
- Call plant operations dispatch at 801-581-7221 (or call 585-COPS) to report an electrical emergency and get the power turned off.
- Use a Class C fire extinguisher to control an electrical fire.
- Do not attempt to turn off or unplug malfunctioning instruments or equipment because of the considerable danger of further injury.
- Do not touch an individual who is receiving live current as the current can pass through the individual.
- If the person is still in contact with the electrical source, only attempt to rescue the shocked individual by using a non-conductive material such as a wooden chair to move the individual away from the electrical source. Even this should be done extremely carefully, making sure the rescuer is not wet or standing in water, and is not wearing any conductive material such as necklaces, etc.
- **If the electrical source is a high voltage source, no one should approach closer than 20 feet.** In all reality, the safest course is to get the experts on the scene as quickly as possible and let them handle it.
Mechanical Safety

Introduction

Research and clinical laboratories utilize a variety of equipment and instruments. Mechanical hazards may result from improper use, storage, or disposal of glassware, sharps, or equipment. Some general guidelines follow below.

Equipment/Instruments

- Tie back long hair, including beards, to avoid them being caught in moving parts of equipment or instruments.
- Never stop a centrifuge with the hands, but wait until it stops on its own.
- Do not operate unfamiliar equipment or instruments without proper training and authorization.
- Follow preventive maintenance schedules established by the manufacturer or instructor for equipment and instruments.

Glassware and Sharps

See under Good Laboratory Techniques, page 11
Exposure to Blood or Body Fluids via Puncture or Mucous Membrane Exposure

What to expect if you are exposed to potentially infectious materials such as blood or body fluids via puncture (needle stick) or exposure to mucous membranes:

- The student will be counseled by health care professionals about HIV risk and the possibility of prophylactic treatment.

- A baseline blood sample will be drawn as soon as possible for HIV and Hepatitis C as well as to confirm Hepatitis B immune status and to determine the need for additional Hepatitis B vaccination.

- A blood sample will be drawn for HIV testing at one week, 6 weeks, 3 months and 6 months post-exposure.

- A blood sample will be drawn for Hepatitis C testing at 6 months post-exposure.
Disaster Preparedness

An integral component of safety in the laboratory is disaster preparedness. The University of Utah is committed to providing guidance to all employees and students in this regard and has produced an outstanding disaster preparedness website that all employees and students are required to review (http://www.emergencymanagement.utah.edu/node/25). Be sure to click on “Videos: A Tale of Disaster and Preparedness” for further information about being prepared for any emergency.

Preparation

- As part of our preparation, the MLS Program will institute a “buddy system” so that each person will be accounted for in case of any disaster.

- The three central themes for individual disaster preparedness are as follows:
  - Have an emergency kit. It is recommended that all faculty, staff, and students have an emergency kit. At minimum, kits should contain:
    - Drinking water (one gallon per day per person)
    - Food
    - Flashlight with fresh batteries
    - Important documents including phone numbers and descriptions of medical conditions
    - Medicine
    - Complete change of clothing, including shoes
    - Whistle or tapping device (so that potential rescuers can hear you)
    - Blanket
    - Personal hygiene goods
    - Plastic bags
    - NOAA all-hazards radio with fresh batteries
  - Make a plan.
    - Know your facility's evacuation plan (evacuation plan for the Teaching Laboratory can be found in the inside cover of this manual) and potential exit sites.
    - Primary assembly point (EAP) for HSEB is parking lot #70 (EAP 5) immediately south of the HSEB. The alternate EAP is 4A, located on the sidewalk west of the Health Sciences Campus Parking Terrace (east of JMRB).
  - Stay informed.
• If you have not done so, go to CIS and sign up for Campus Alerts.

• Also sign up for text alerts. Text messages have proven to be the best mode of electronic communication during a disaster.

• Be aware of the potential threats in your environment and make sure you are prepared for them. Review the University’s disaster preparedness website to learn about disaster potential in Utah.

Earthquakes

In Utah, earthquakes are not a matter of “if,” but “when,” and preparedness is critical. In the event of an earthquake:

If Indoors

• DROP to the ground and take COVER by getting under a sturdy table or other piece of furniture; and HOLD ON until the shaking stops. If there is not a table or desk near you, cover your face and head with your arms and crouch in an inside corner of the building.

• Stay away from glass, windows, outside doors and walls, and anything that could fall, such as lighting fixtures or furniture.

• Stay in bed if you are there when the earthquake strikes. Hold on and protect your head with a pillow, unless you are under a heavy light fixture that could fall. In that case, move to the nearest safe place.

• DO NOT use a doorway UNLESS you know it is a strongly supported, load-bearing doorway and it is close to you. Many inside doorways are lightly constructed and do not offer protection.

• Stay inside until the shaking stops and it is safe to go outside. Do not exit a building during the shaking. Research has shown that most injuries occur when people inside buildings attempt to move to a different location inside the building or try to leave.

• DO NOT use the elevators.

• Be aware that the electricity may go out or the sprinkler systems or fire alarms may turn on.

If Outdoors

• Stay there.

• Move away from buildings, streetlights, and utility wires.

• Once in the open, stay there until the shaking stops.

• The greatest danger exists directly outside buildings, at exits and alongside exterior walls. Many of the 120 fatalities from the 1933 Long Beach earthquake occurred when people ran outside of buildings only to be killed by falling debris from collapsing walls. Ground movement during an earthquake is seldom the direct cause of death or injury. Most earthquake-related casualties result from collapsing walls, flying glass, and falling objects.
If in a Moving Vehicle
- Stop as quickly as safety permits and stay in the vehicle.
- Avoid stopping near or under buildings, trees, overpasses, and utility wires.
- Proceed cautiously once the earthquake has stopped.
- Avoid roads, bridges, or ramps that might have been damaged by the earthquake.

If Trapped Under Debris
- Do not light a match.
- Do not move about or kick up dust.
- Cover your mouth with a handkerchief or clothing.
- Tap on a pipe or wall so rescuers can locate you. Use a whistle if one is available. Shout only as a last resort. Shouting can cause you to inhale dangerous amounts of dust.

References

1. ARUP Laboratory Safety Manual.


Respirator Information. Healthcare-Related FAQs [N95 respirators].


   a. ACETIC ACID. http://www.cdc.gov/niosh/pel88/64-19.html. Accessed 21 June 2016. “However, OSHA’s review of the evidence for acetic acid has demonstrated that there is no basis at this time for a STEL, and the final rule thus retains the 8-hour TWA PEL.”


   a. ACETIC ACID.
   b. ACETIC ANHYDRIDE.
   c. ACETONE
   d. AMMONIUM HYDROXIDE (10%-35% solution).
   e. BENZENE.
   f. 1-BUTANOL [n-butanol, Butyl alcohol, n-butyl alcohol, Propyl carbinol].
   g. CARBON DISULFIDE.
   h. CYCLOHEXANE.
   i. 1,4-DIOXANE.
   j. ETHANOL (ANHYDROUS).
   k. HYDROGEN CHLORIDE.
   l. IODINE.
   m. ISOPROPYL ALCOHOL [2-Propanol].
   n. METHANOL.
   o. METHYL ETHYL KETONE [Ethyl methyl ketone, 2-Butanone, MEK, Methyl acetone].
   p. NITRIC ACID.
   q. PHENOL.
   r. POTASSIUM HYDROXIDE.
s. SODIUM HYDROXIDE.

t. TOLUENE.

u. m-XYLENE [meta-Xylene, 1,3-Dimethylbenzene].

v. o-XYLENE [ortho-Xylene, 1,2-Dimethylbenzene].

w. p-XYLENE [para-Xylene, 1,4-Dimethylbenzene].


6. U. S. Department of Labor, Occupational Safety & Health Administration, OSHA Alliance Program [OSHA and American Biological Safety Association (ABSA) Alliance].


   a. image1 = Flame Over Circle
   b. image2 = Flame
   c. image3 = Exploding Bomb
   d. image4 = Skull and Crossbones
   e. image5 = Corrosion
   f. image6 = Gas Cylinder
   g. image7 = Health Hazard
   h. image8 = Environment
   i. image9 = Exclamation Mark


APPENDIX I: Pathogen Data Sheets

Below is a list of biological agents with which students work in the Medical Laboratory Science Program. The Pathogen Data Sheets from the Canadian Public Health Agency for each biological agent can be accessed by going to the link: http://www.phac-aspc.gc.ca/lab-bio/res/psds-ftss/index-eng.php

**Bacteria and Viruses:**

<table>
<thead>
<tr>
<th>Bacteria/Agent</th>
<th>Bacteria/Agent</th>
<th>Bacteria/Agent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aeromonas hydrophila</td>
<td>Acinetobacter baumanii</td>
<td>Bacillus cereus</td>
</tr>
<tr>
<td>Bacteroides fragilis</td>
<td>Bordetella pertussis</td>
<td>Burkholderia cepacia</td>
</tr>
<tr>
<td><em>Citrobacter spp.</em></td>
<td><em>Clostridioides</em> (Clostridium)</td>
<td><em>Clostridium perfringens</em></td>
</tr>
<tr>
<td>Diphtheroids (Corynebacterium spp.)</td>
<td>Edwardsiella tarda</td>
<td>Enterobacter spp.</td>
</tr>
<tr>
<td>Enterococcus spp.</td>
<td>Escherichia coli</td>
<td>Fusobacterium nucleatum</td>
</tr>
<tr>
<td>Haemophilus influenzae (type b)</td>
<td>Haemophilus parainfluenzae</td>
<td>Klebsiella spp.</td>
</tr>
<tr>
<td>Legionella pneumophila</td>
<td>Listeria monocytogenes</td>
<td>Micrococcus spp.</td>
</tr>
<tr>
<td>Moraxella catarrhalis</td>
<td>Morganella morganii</td>
<td>Neisseria gonorrhoeae</td>
</tr>
<tr>
<td>Neisseria lactamica</td>
<td>Neisseria sicca</td>
<td>Pasteurella multocida</td>
</tr>
<tr>
<td>Peptostreptococcus anaerobius</td>
<td>Plesiomonas shigelloides</td>
<td>Prevotella melaninogenica</td>
</tr>
<tr>
<td>Cutibacterium (Propionibacterium) acnes</td>
<td>Proteus spp.</td>
<td>Providencia stuartii</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>Salmonella Group B — typhimurium</td>
<td>Serratia spp.</td>
</tr>
<tr>
<td>Shewanella putrefaciens</td>
<td>Shigella sonnei</td>
<td>Staphylococcus aureus</td>
</tr>
<tr>
<td>Staphylococcus saprophyticus</td>
<td>Coagulase negative</td>
<td>Stenotrophomonas maltophilia</td>
</tr>
<tr>
<td></td>
<td>Staphylococcus spp.</td>
<td></td>
</tr>
<tr>
<td>Streptobacillus moniliformis</td>
<td>Streptococcus agalactiae</td>
<td>Streptococcus pneumoniae</td>
</tr>
<tr>
<td>Streptococcus pyogenes</td>
<td>Streptococcus, beta hemolytic groups C, F, G</td>
<td>Streptococcus spp., Group D</td>
</tr>
<tr>
<td>Streptococcus, viridans group</td>
<td>Vibrio alginolyticus</td>
<td>Vibrio parahaemolyticus</td>
</tr>
</tbody>
</table>
**Parasitology:**

We use purchased, formalin-preserved material), with the exception of *Trichomonas vaginalis* (live culture). Preserved parasites include:

<table>
<thead>
<tr>
<th>Ancylostoma duodenale</th>
<th>Ascaris lumbricoides</th>
<th>Balantidium coli</th>
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<tbody>
<tr>
<td>Clonorchis sinensis</td>
<td>Cryptosporidium parvum</td>
<td>Endolimax nana</td>
</tr>
<tr>
<td>Entamoeba histolytica</td>
<td>Entamoeba coli</td>
<td>Enterobius vermicularis</td>
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<tr>
<td>Fasciola hepatica</td>
<td>Giardia lamblia</td>
<td>Hymenolopis spp.</td>
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<tr>
<td>Iodamoeba butschlii</td>
<td>Necator americanus</td>
<td>Schistosoma spp.</td>
</tr>
<tr>
<td>Taenia spp.</td>
<td>Trichomonas vaginalis</td>
<td>Trichuris trichiura</td>
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</table>

**Mycology:**

<table>
<thead>
<tr>
<th>Candida albicans</th>
<th>Candida glabrata</th>
<th>Geotrichum spp.</th>
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<tbody>
<tr>
<td>Cryptococcus neoformans</td>
<td>Rhodotorula spp.</td>
<td>Candida parapsilosis</td>
</tr>
<tr>
<td>Candida lipolytica</td>
<td>Scopulariopsis spp.</td>
<td>Aspergillus spp.</td>
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<tr>
<td>Syncephalastrum spp.</td>
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</table>
APPENDIX II: MLS Incident Report Form

MLS PROGRAM
INCIDENT/ACCIDENT REPORT FORM

Student Name: _______________________________________________

Instructor Name: _____________________________________________

Description of the incident/accident (include all names of persons involved):

If the injury involves sharps complete details in the following table.

<table>
<thead>
<tr>
<th>Type of Device (e.g. syringe, suture needle, razor, scissors)</th>
<th>Brand Name of Device</th>
<th>Work Area where injury occurred (e.g. benchtop, biosafety cabinet, etc)</th>
<th>Brief description of how incident occurred (i.e., procedure being done, action being performed (disposal, injection, etc.), body part injured)</th>
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</tbody>
</table>

Follow-up course of action (attach copies of any hospital/university forms, if appropriate):

Signature of Student ______________________________ Signature of Faculty/Staff ______________________________

Date ______________________________ Date ______________________________
Student Health Center, Madsen Clinic  
555 Foothill Dr. Level 1  
Salt Lake City, UT 84112  
Phone: 801-581-6431  
Fax: 801-585-5294  
Operating Hours: Monday-Friday, 7:30 am to 5 pm  
Appointment Hours: Monday-Friday, 8 am to 4 pm  
Walk-in (vaccines, lab tests) Hours: Monday-Friday, 9 am to 4 pm  
Note: Clinic is closed on Wednesdays, 12-2pm.

Redwood Health Center  
Occupational Medicine Clinic  
1525 West 2100 South  
Salt Lake City, UT 84119  
Phone: 801-213-9777  
Hours: M – F 8:00 AM- 4:00 PM

Redwood Urgent Care Clinic  
1525 West 2100 South  
Salt Lake City, UT 84119  
Phone: 801-213-8841  
Hours: 7 Days/Week 9:00 AM – 9:00 PM

University Hospital Emergency Room  
(Main floor northeast side of the hospital)  
50 N. Medical Drive  
Salt Lake City, UT 84132  
Phone: 801-581-2292  
Hours: 7 Days/Week 24 hours