Chapter III: Health and Physical Hazards of Chemicals:

Chemical exposures can result from inhalation (most common), ingestion, absorption, and injection. While the Chemical Hygiene Plan’s main purpose is to prevent exposure, it also is to inform personnel of the effects of a possible exposure and what to do in case you or a colleague is exposed. Below are some of the health and physical hazards of chemicals. It should be noted that many chemicals can exhibit many types of health and physical hazards.

**Health Hazards** - chemicals that are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins (liver), nephrotoxins (kidneys), neurotoxins (nervous system), agents that act on the hematopoietic systems (blood), and agents which damage the lungs, skin, eyes, or mucous membranes. Chemicals can have effects after a single exposure or after repeat long term exposures, therefore it is important to minimize any exposure to hazardous chemicals.

**Corrosives** - cause irreversible damage to living tissue (i.e. skin, eyes, lungs, and mucous membranes). Typically these will be for substances or solutions with a pH <2 or >11.5, however pH is not the only factor in determining corrosivity. Corrosive chemicals also present a physical hazard as they can corrode metal and other surfaces. Common examples include hydrochloric acid, sodium hydroxide, phenol, and glutaraldehyde. Personnel handling corrosives should implement the appropriate controls to minimize the likelihood of an exposure to a corrosive chemical.

**Irritants** - cause reversible effect to living tissue (skin, eyes, lungs, and mucous membranes). While irritants are not as hazardous as corrosives, similar care should be taken to avoid their contact.

**Sensitizers** - cause hypersensitivity and an allergic response following an exposure. Common laboratory sensitizers include nickel, formaldehyde, and latex. Caution to avoid initial exposure to sensitizers should be taken, however if a chemical hypersensitivity develops please contact Office of Research Safety, University of Chicago Occupational Medicine, and your supervisor to discuss ways to further avoid exposure.

**Particularly Hazardous Substances** - chemicals with certain health hazards that the Occupational Safety and Health Administration (OSHA) has determined additional provisions are required to protect worker safety. Refer to Chapter IV: General Laboratory Hygiene for additional information on how to handle these chemicals. The health hazards that qualify as particularly hazardous substances include carcinogens, reproductive toxins, and substances with a high degree of acute toxicity.

**Carcinogens** - may cause cancer. There are many different types of carcinogens in terms of regulatory definitions. Select carcinogens are substances that are regulated by OSHA as a carcinogen; listed by the National Toxicology Program (NTP) as either “known to be carcinogens” or “reasonably anticipated to be carcinogens”; or listed by International Agency for Research on Cancer Monographs (IARC) as Group 1, 2A, or 2B. Common examples of select carcinogens include chloroform, cobalt and nickel compounds, formaldehyde, and dichloromethane.

A subset of select carcinogens include regulated carcinogens which are chemicals regulated by OSHA with certain standards such as formaldehyde, benzene, dichloromethane (methylene chloride), and ethylene oxide. OSHA also has “Listed Carcinogens” that are regulated under the 13 Carcinogens standard (29CFR 1910. 1003). These 13 carcinogens have some of the highest restrictions regarding their use, storage, and disposal.
**Reproductive Toxicants**- can damage to the reproductive system or to a fetus. OSHA defines chemicals that are mutagenic or teratogenic as reproductive toxicants. Some reproductive toxicants found in the laboratory include ethidium bromide, toluene, and lead.

**Substances with a High Degree of Acute Toxicity**- can cause immediate harm and possible death in the event of an exposure. Median lethal dose (LD\textsubscript{50}) experiments in animal models are typically reported and used to determine if a chemical has a high degree of acute toxicity. These tests are administered orally, dermally, and via inhalation. Chemicals considered highly toxic have an oral LD\textsubscript{50} less than or equal to 50mg/ kg for rats, dermal LD\textsubscript{50} of 200mg/kg when administered by continuous contact for 24 hours to rabbits, or median lethal concentration (LC\textsubscript{50}) of 200ppm or 2mg/L when administered by continuous inhalation for 1 hour to rats. Common examples include sodium cyanide, hydrofluoric acid, and carbon monoxide.

**Physical Hazards**- chemicals can have many hazards beyond the ones that directly affect one's health. Classes of physical hazards include flammable, pyrophoric, water reactive, explosive, potentially explosive, compressed gases, oxidizers and corrosives.

**Flammables**- can ignite readily. For a liquid to be considered flammable its flash point is to be less than 100 degrees Fahrenheit. There are also flammable solids and gases. Flammables should be handled away from ignition sources and with proper ventilation to avoid the concentration of flammable vapors or dust.

**Pyrophorics**- chemicals that react with the air and ignite. As such special technique or additional engineering controls are required to handle pyrophoric chemicals. While most pyrophorics are liquids or handled in solution there are a number of pyrophoric solids and gases. Common examples of pyrophoric chemicals include tert-butyl lithium, silane, triethylaluminum, and lithium aluminum hydride. These chemicals require very specialized handling techniques which can vary from lab to lab. Please conduct and review laboratory-specific training for handling this class of chemicals.

**Water reactive chemicals**- chemicals that release either a toxic or flammable gas when in contact with water. Some chemicals react so violently with water that even the humidity in the air can cause a reaction. Laboratory chemicals that are water reactive include lithium, trichlorosilane, and sodium hydride. Laboratory-specific handling and training may be required for the handling of water reactive chemicals.

**Compressed Gases**- pressurized chemicals typically in metallic cylinders that are ubiquitous in research laboratories. These possess a physical hazard if they were to violently release the contents and pressure. Compressed gasses can also cause asphyxiation or frost bite. Environmental Health and Safety offers a training involving compressed gas cylinders, however a laboratory-specific training may also be needed.

**Explosives (Potentially explosive chemicals)**- many labs will not be handling explosive chemicals such as trinitrotoluene or black powder, however many labs will handle and store chemicals that may become explosive upon decomposition, polymerization, oxidation, drying out, or some other destabilizing event. A common potentially explosive chemical is picric acid which is extremely sensitive to detonation when it is dried. This is why it is typically sold moistened with water. Also very common in research labs are peroxide forming chemicals. These chemicals can form explosive crystals after being exposed to air. These chemicals must be dated when they are received when they are open. For disposal requirements please see the hazard class SOP for peroxide forming chemicals.
Oxidizers- can initiate or promote combustion in other materials through a chemical reaction. This chemical reaction can cause a fire or explosion. Oxidizers such as nitric acid, osmium tetroxide, pure oxygen gas or liquid, potassium permanganate, and hydrogen peroxide (concentrations ≥30%) should be carefully stored and handled to avoid unintentional mixing with flammables or other incompatible chemicals.