Appendix 1: Safety Information

General Safety Considerations

Safety and personal protection are of utmost importance in a laboratory environment. In the United States, the Occupational Safety and Health Administration (OSHA) establishes guidelines and enforcement of the Material Safety Data Sheet (MSDS) which contains critical safety information for every chemical used in a lab. Combined with university policies and safety practices, individuals can avoid hazards while conducting chemical experiments. The following outlines general precautions and chemical-specific precautions employed in relation to this project.

Personal Protective Equipment (PPE) was used at all times in the lab. This equipment included safety glasses, gloves, long pants, close-toed shoes, and a lab coat when appropriate. A chemical fume hood was used when handling volatile solvents and for conducting reactions. Broken glassware was handled with a broom, dustpan, gloves, and eye protection and disposed of in a specified glass waste container. No food was consumed in the lab and all chemicals were properly disposed of in accordance with the Environmental and Occupational Health and Safety department standards.

Chemical-Specific Considerations

The following chemical-specific safety guidelines outline the potential hazards of each chemical with the appropriate PPE or techniques used to mitigate danger. The referenced material safety data sheet is provided for each chemical which contains more detailed information.

Acetone (2-propanone)

1. Skin Hazard

b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard

a. Mitigation: Safety glasses.

b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Vapor Hazard

a. Mitigation: Chemical fume hood.

b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard

a. Mitigation: Keep from sources of ignition.

b. Response: Evacuate and notify emergency services.

5. Disposal: Non-halogenated waste container.


**Base Bath (ethanol, potassium hydroxide)**

1. Skin Hazard

   a. Mitigation: Heavy-duty acid/base protective gloves (cover wrist). Rinsed with water before and after use.

   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard

   a. Mitigation: Safety glasses.

   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Vapor Hazard
a. Mitigation: Cover with lid when not in use.

b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard

a. Mitigation: Keep from sources of ignition.

b. Response: Evacuate and notify emergency services.

5. Disposal: Contact Environmental and Occupational Health and Safety department.


**Dichloromethane (methylene chloride)**

1. Skin Hazard


   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard

   a. Mitigation: Safety glasses.

   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Vapor Hazard

   a. Mitigation: Chemical fume hood.

   b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard
a. Mitigation: Keep from sources of ignition.

b. Response: Evacuate and notify emergency services.

5. Disposal: Halogenated waste container.


Acetonitrile (ethyl nitrile)

1. Skin Hazard

   
   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard

   a. Mitigation: Safety glasses.
   
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Vapor Hazard

   a. Mitigation: Chemical fume hood.
   
   b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard

   a. Mitigation: Keep from sources of ignition.
   
   b. Response: Evacuate and notify emergency services.

5. Disposal: Non-halogenated waste container.

N,N-diisopropylethylamine (DIPEA)

1. Skin Hazard
   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard
   a. Mitigation: Safety glasses.
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Vapor Hazard
   a. Mitigation: Chemical fume hood.
   b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard
   a. Mitigation: Keep from sources of ignition.
   b. Response: Evacuate and notify emergency services.

5. Disposal: Non-halogenated waste container.


N,N-dimethylformamide (DMF)

1. Skin Hazard
   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.
2. Eye Hazard
   a. Mitigation: Safety glasses.
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Vapor Hazard
   a. Mitigation: Chemical fume hood.
   b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard
   a. Mitigation: Keep from sources of ignition.
   b. Response: Evacuate and notify emergency services.

5. Disposal: Non-halogenated waste container.


**Methanol**

1. Skin Hazard
   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard
   a. Mitigation: Safety glasses.
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Vapor Hazard
   a. Mitigation: Chemical fume hood.
b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard
   a. Mitigation: Keep from sources of ignition.
   b. Response: Evacuate and notify emergency services.

5. Disposal: Non-halogenated waste container.


Silica Gel

1. Skin Hazard
   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard
   a. Mitigation: Safety glasses.
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Inhalation Hazard
   a. Mitigation: 3M dust mask.
   b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard
   a. None

Acetic Acid

1. Skin Hazard
   a. Mitigation: Heavy duty gloves. Changed upon contamination and rinsed before/after use. Lab coat worn.
   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard
   a. Mitigation: Safety glasses.
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Vapor Hazard
   a. Mitigation: Chemical fume hood.
   b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard
   a. Mitigation: Keep from sources of ignition.
   b. Response: Evacuate and notify emergency services.

5. Disposal: Neutralized with sodium bicarbonate then poured down drain with copious water. Knight Chemical Lab is equipped with acid-neutralization sewage and glass pipes.


Hydrobromic Acid

1. Skin Hazard
   a. Mitigation: Heavy duty gloves. Changed upon contamination and rinsed before/after use. Lab coat worn.
   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard
   a. Mitigation: Safety glasses.
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Vapor Hazard
   a. Mitigation: Chemical fume hood.
   b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard
   a. Mitigation: Keep from sources of ignition.
   b. Response: Evacuate and notify emergency services.

5. Disposal: Neutralized with sodium bicarbonate then poured down drain with copious water. Knight Chemical Lab is equipped with acid-neutralization sewage and glass pipes.


Heptane

1. Skin Hazard
b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard
   a. Mitigation: Safety glasses.
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Vapor Hazard
   a. Mitigation: Chemical fume hood.
   b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard
   a. Mitigation: Keep from sources of ignition.
   b. Response: Evacuate and notify emergency services.

5. Disposal: Non-halogenated waste container.


**Toluene (methylbenzene)**

1. Skin Hazard
   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard
   a. Mitigation: Safety glasses.
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Vapor Hazard
a. Mitigation: Chemical fume hood.

b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard

a. Mitigation: Keep from sources of ignition.

b. Response: Evacuate and notify emergency services.

5. Disposal: Non-halogenated waste container.


**Hexanes**

1. Skin Hazard


b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard

a. Mitigation: Safety glasses.

b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Vapor Hazard

a. Mitigation: Chemical fume hood.

b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard

a. Mitigation: Keep from sources of ignition.

b. Response: Evacuate and notify emergency services.

5. Disposal: Non-halogenated waste container.
DMSO-δ₆ (Dimethyl sulfoxide, deuterated)

1. Skin Hazard
   a. Mitigation: Nitrile gloves. Changed upon contamination and rinsed before/after use.
   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard
   a. Mitigation: Safety glasses.
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Vapor Hazard
   a. Mitigation: Used in open area and bottle closed and returned to sealed container immediately.
   b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard
   a. Mitigation: Keep from sources of ignition.
   b. Response: Evacuate and notify emergency services.

5. Disposal: Non-halogenated waste container.

Valeraldehyde (pentanal)

1. Skin Hazard
   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard
   a. Mitigation: Safety glasses.
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Vapor Hazard
   a. Mitigation: Chemical fume hood.
   b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard
   a. Mitigation: Keep from sources of ignition.
   b. Response: Evacuate and notify emergency services.

5. Disposal: Non-halogenated waste container.


Butanal (butyraldehyde)

1. Skin Hazard
b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard
   a. Mitigation: Safety glasses.
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Vapor Hazard
   a. Mitigation: Chemical fume hood.
   b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard
   a. Mitigation: Keep from sources of ignition.
   b. Response: Evacuate and notify emergency services.

5. Disposal: Non-halogenated waste container.


4-hydroxybenzaldehyde

1. Skin Hazard
   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard
   a. Mitigation: Safety glasses.
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Inhalation Hazard
a. None.

4. Flammability Hazard
   a. None.

5. Disposal: Solid waste container.


Hexanal

1. Skin Hazard
   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard
   a. Mitigation: Safety glasses.
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Vapor Hazard
   a. Mitigation: Chemical fume hood.
   b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard
   a. Mitigation: Keep from sources of ignition.
   b. Response: Evacuate and notify emergency services.

5. Disposal: Non-halogenated waste container.

2-(bromomethyl)naphthalene

1. Skin Hazard
   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard
   a. Mitigation: Safety glasses.
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Inhalation Hazard
   a. Mitigation: Chemical fume hood.
   b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard
   a. None.

5. Disposal: Solid waste container.


Imidazole (1,3-diaza-2,4-cyclopentadiene)

1. Skin Hazard
1. Skin Hazard
   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard
   a. Mitigation: Safety glasses.
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Inhalation Hazard
   a. Mitigation: Chemical fume hood.
   b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard
   a. None.

5. Disposal: Solid waste container.


**Potassium bromide (KBr)**

1. Skin Hazard
   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard
   a. Mitigation: Safety glasses.
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Inhalation Hazard
   a. Mitigation: Chemical fume hood.
b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard
   a. None.

5. Disposal: Solid waste container.


**Sodium bromide (NaBr)**

1. Skin Hazard
   
   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard
   a. Mitigation: Safety glasses.
   
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Inhalation Hazard
   a. None.

4. Flammability Hazard
   a. None.

5. Disposal: Solid waste container.


**Chloroform (trichloromethane)**

1. Skin Hazard
   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard
   a. Mitigation: Safety glasses.
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Vapor Hazard
   a. Mitigation: Chemical fume hood.
   b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard
   a. Mitigation: Keep from sources of ignition.
   b. Response: Evacuate and notify emergency services.

5. Disposal: Halogenated waste container.


**Diethyl ether**

1. Skin Hazard
b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard
   a. Mitigation: Safety glasses.
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Vapor Hazard
   a. Mitigation: Chemical fume hood.
   b. Response: Evacuation to a well-ventilated area if inhaled.

4. Flammability Hazard
   a. Mitigation: Keep from sources of ignition.
   b. Response: Evacuate and notify emergency services.

5. Disposal: Non-halogenated waste container.


Sodium bicarbonate

1. Skin Hazard
   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard
   a. Mitigation: Safety glasses.
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Vapor Hazard
   a. Mitigation: Chemical fume hood.
   b. Response: Evacuation to a well-ventilated area if inhaled.
4. Flammability Hazard
   a. Mitigation: Keep from sources of ignition.
   b. Response: Evacuate and notify emergency services.

5. Disposal: Solid waste container.


Cisplatin and Novel Imidazolium Salts

1. Skin Hazard
   b. Response: Skin washed vigorously with soap and water. Safety shower if spilled.

2. Eye Hazard
   a. Mitigation: Safety glasses.
   b. Response: Eyewash station with continual flushing for at least 15 minutes.

3. Respiratory Hazard
   a. Mitigation: Chemical fume hood.
   b. Response: Evacuation to a well-ventilated area if inhaled.
   c. Danger: Dust formation should be avoided due to possible inhalation.

4. General Health Effects
   a. Cisplatin is a chemotherapeutic drug that should not be ingested without a prescription. Acute toxicity is possible leading to symptoms such as neurological deficit, diarrhea, and allergic reactions. Long term exposure may lead to carcinogenic effects.
b. The novel imidazolium salts synthesized in this experiment demonstrated antitumor efficacy (3 and 5) comparable to cisplatin indicating additional precaution should be taken to ensure they are not ingested. The purpose of these compounds as chemotherapeutics has strong implications for negative health effects if improperly handled. While currently approved chemotherapeutics have medicinal benefit, they are often highly toxic if used improperly.

5. Flammability Hazard
   
   a. None

