VTC Chemical Safety Training for Instructors and Students

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Today's Training Agenda

- Why is safety important?
- Physical, chemical & health hazards
  - Categories
  - Routes of exposure
- How you can minimize your risks
  - MSDS, labeling & storage
  - PPE & engineering controls
  - Spills, wastes & disposal
  - Emergency response
- Resources and where to find them

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People can get hurt:

- Dartmouth Chemistry Professor dies of dimethyl-mercury exposure - *wrong gloves* (1997).
- UT Austin lab destroyed by fire when a post-doc placed a sodium/alcohol mixture in a wet sink (1996).
- Thirteen high school students injured, one critically, by demonstration with methane gas (2000).
- UC Irvine labs destroyed by fire, graduate student injured while distilling benzene (2001).
- MIT graduate students injured while mixing acids in a container they thought was clean and safe (2000).

www.chem.purdue.edu/safety/stories.htm
pubs.acs.org/cen/safety/index.html

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Environmental Impact

- The biggest environmental impact of our lab work ***should be*** the energy used to heat and cool the lab.
- Fume hoods dilute vapors but don't make detoxify them.
- Anything you pour down drain goes into local ground water and streams.

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EPA Fines:

• Yale (1994)	**$300,000**
• BU (1995)	**$2.2 million**
• UConn (1996)	**$300,000**
• UNH (1999)	**$300,000**
• Brown (2000)	**$500,000**
• MIT (2001)	**$550,000**
• Harvard & UMaine	**$0**
• Stanford, UNebraska, UHawaii	**~$1million**

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Lab Safety at VTC

VTC has a 'Chemical Hygiene Plan'

- Please let me know if you'd like a copy!

- SOPs for common lab procedures
- forms for ordering & inspections
- logs for safety equipment and checks
- safety training for all freshman taking Chem
- guidelines

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Chemical Safety Training

Training of instructors, employees, and paid students….

- …is the responsibility of the CHO.
- …is required before exposure to hazards…
- …and when new hazards are introduced.

Training of students is the responsibility of their instructor.

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How do you avoid dangerous situations in your lab?

- Use SDS & labeling.
- Know hazard categories.
- Know routes of exposure.
- Focus on minimizing risks.

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Know what you're dealing with.

Safety Data Sheets (SDS)

Each lab must have SDS on-hand for all chemicals in its inventory.

SDS provide information:

- health hazards, precautions, first-aid measures
- chemical reactivity
- storage & segregation information

SDS can be found at several websites, and should be included in each chemical shipment.

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Hazard Categories

Chemical:

1. Physical
2. Flammable
3. Corrosive (bases & acids)
4. Reactive

Health:

Toxicities

Routes of Exposure:

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Physical Hazards

- Gas cylinders can have pressure of **>3000 psi**.
- CO_2 and other 'inert' gases can displace oxygen if they off-gas into an unventilated space, causing <u>oxygen deficiency</u>.
- Liquified gases <u>freeze tissue</u> on contact.

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Flammables

- flash point <140°F (60°C)
- alcohols, solvents, fuels
- Acetone -18°C
- Diethyl ether -45°C
- Methyl alcohol 11°C

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Corrosive Bases

- Inorganic:
  - hydroxides
  - cleaning chemicals
  - ammonia

- Organic:
  - amines

Corrosive: the chemical eats away at matter, or degrades it, upon contact

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Corrosive Acids

1. Inorganic (mineral):
   - hydrochloric acid
   - muriatic acid
   - sulfuric acid
   - phosphoric acid
   - ferric chloride

2. Organic:
   - acetic acid
   - formic acid
   - phenol or carbolic acid
   - trichloroacetic acid

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Corrosive Acids

3. Oxidizing:
   - nitric acid
   - chromic acid
   - perchloric acid
   - chromium trioxide

Note: oxidizing acids and organic acids should **NEVER** be stored together.

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Classes of Chemical Reactivity

- Oxidizers
- Reactive with water
- Reactive with air (pyrophoric)
- Peroxide formers

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Oxidizers

- May ignite or explode in contact with organics.
- Supply oxygen & source of ignition to a fire.
- Include:
  - Nitrates
    - ammonium nitrate fertilizer
    - silver nitrate
  - Peroxides
  - Perchlorates
  - Hydrogen peroxide (>30%)

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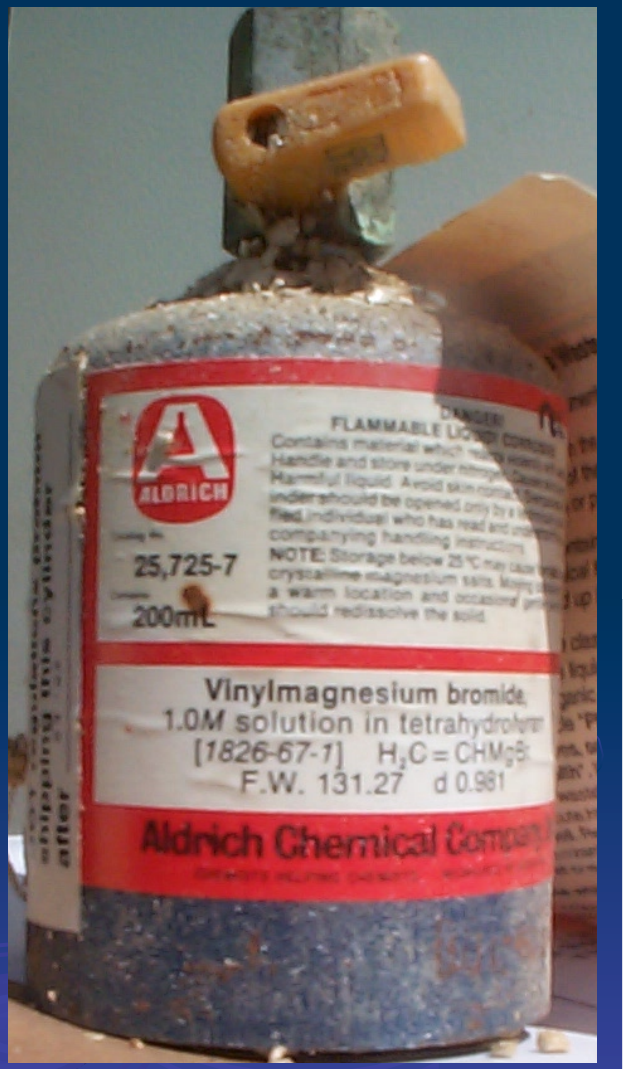
React with Water or Air

- May *ignite* on contact with water or air (pyrophoric).
  - Phosphorous
  - Sodium
  - Other alkaline metals
  - Grignard reagents
    - Methyl magnesium bromide



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Peroxide formers

- Degrade over time.
- Form explosive crystals
  - Ethers
  - THF
  - 1,4-dioxane

- Should never be kept for more than 3 months.
- Order minimal amounts and discard frequently.

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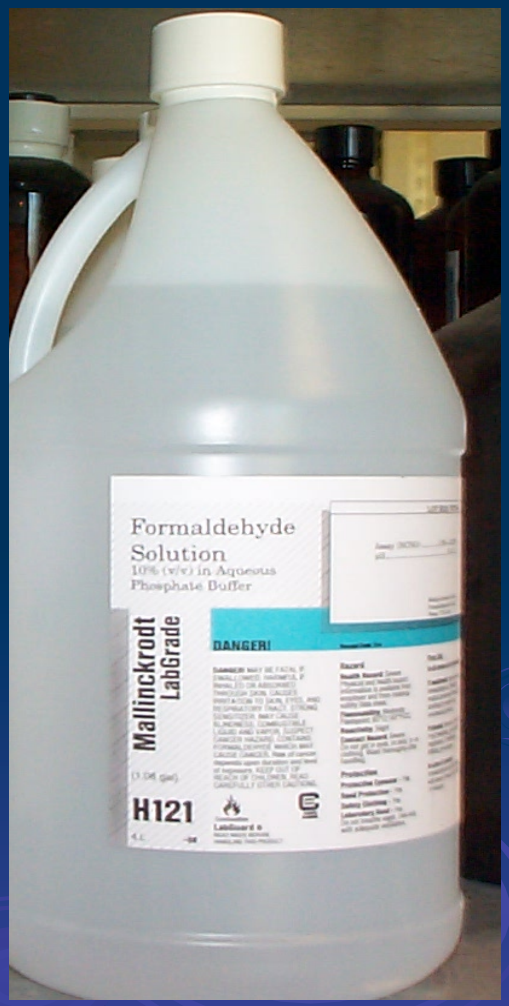
Health Hazards

Toxicity:

- Not always known
- Not completely understood

- Effects can be acute and/or chronic.
  - signs & symptoms?
  - target organs & systems?



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Corrosives with systemic effects:

corrosive:	systemic effect:
formaldehyde	metabolic acidosis
hydrofluoric acid	bone degradation
phenol	seizures, liver/kidney
phosphorus	liver, kidney injury
permanganate	methemoglobinemia
silver nitrate	methemoglobinemia

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Routes of Chemical Exposure:

- oral/ingestion

  Dangers: food & drink in the lab
  chemicals in food refrigerators
  chemicals in offices

- inhalation
- skin contact
- eyes & mucus membranes
- injection/wounds

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Oral LD50 values:

substance:	LD50 (mg/kg):
ethyl alcohol	10,000
sodium chloride	4,000
phenol	317
DDT	100
nicotine	1
dioxin	0.001
botulinus toxin	0.00001

LD50 = the dose of a chemical that will kill ½ of test subjects to whom that dose is administered (lethal dose 50%)

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Routes of Chemical Exposure:

- oral/ingestion
- inhalation

  Dangers: powder residues
  uncapped bottles

- skin contact
- eyes & mucus membranes
- injection/wounds

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Routes of Chemical Exposure:

- oral/ingestion
- inhalation
- skin contact
- eyes & mucus membranes

Dangers: inappropriate storage
contaminated surfaces

- injection/wounds

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Routes of Chemical Exposure:

- oral/ingestion
- inhalation
- skin contact
- eyes & mucus membranes
- injection/wounds

Dangers: loose needles, scalpels, razor blades

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How can you minimize the risks?

- Know what you're working with.
  - inventory
  - labeling & SDS
- Protect yourself.
  - personal protective equipment
  - engineering controls
- Know how to respond to an emergency.
  - accidents & spills
- Know how to deal with waste & hazards.
  - waste pickup vs. dilute wastes

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Labeling chemical & solutions:

Chemicals should be dated and initialed as:

a) received
b) opened

Use standard labels with safety information.

6 M Hydrochloric acid

VTC *23 Oct 02*

- Chemical formulae are not allowed.
- Include concentration.
- Target organs?
- Solutions must be labeled with all components.
- Bottles must be sealed with **screw-tops**.

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Personal Protective Equipment:

Eyewear has to be worn at the bench at all times.

- contact lenses
- eyewash (hands-free model)

Gloves ***only delay contact***.

And they've got to be the appropriate glove.

Glove selection link

- Contaminated gloves should be:
  - rinsed under water
  - changed
- Hands should be washed upon contact, and always upon leaving the lab.

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Engineering controls:

...are there to separate people from hazards.

- chemical flow hoods
- biological flow hoods

} *Flow tested regularly.*

Emergency equipment:

- emergency showers
- eyewashes

} *Monthly testing & logs.*

- fire extinguishers & blankets
- spill kits
- posted emergency procedures

All lab workers and students must be aware of location and use of this equipment.

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Emergency Response

- Evacuation
- Emergency Equipment

- 728-1292 for VTC Security (fire, injury, spill)
- Randolph Fire at (9)-911 (large spill)

- Medical attention
  - Emergency room
  - First Report of Injury to security & health

If you have any doubts, call the CHO & read the SOP.

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HHMI Emergency Response video is a good resource.

Chemical spills:

- minor: <2L, and low hazard
- major: >2L or flammable or toxic

Your first priority is always to protect people.

Minor spills can be dealt with the instructor.

Major spills:

1. Turn off ignition sources.
2. Evacuate.
3. Call security or the local fire department.
4. Wait for the responders.

If you have any doubts, read the SOP and call the CHO.

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Safety Training Resources:

UVM Environmental Safety Facility Powerpoints

www.uvm.esf/

- Polymerase Chain Reaction (PCR)
- Cell and Tissue Culture
- Peroxide Forming Chemicals
- Gel Electrophoresis
- Centrifuges and Ultracentrifuges
- Ethylene Oxide
- Glutaraldehyde
- Autoclave Safety
- Flammable & Combustible Liquid Safety
- Laboratory Ergonomics
- Latex
- Reducing Lab Waste

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Safety Training Resources:

Howard Hughes Medical Institute Training Videos
www.hhmi.org

- Practicing Safe Science
- Controlling Your Risks: HIV in the Research Laboratory
- Radionuclide Hazards
- Chemical Hazards
- Centrifugation Hazards
- Chemical Storage Hazards
- Glassware Washing Hazards
- Mammalian Cell Culture Hazards
- X-Ray Diffraction Hazards
- Assessing Risks of Toxic Chemicals
- Emergency Response

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Links:

MSDS:	www.siri.uvm.edu, or manufacturers' sites
Hazardous chemicals:	www.anr.state.vt.us/dec/wmd.htm www.epa.gov/swercepp/ehs/ehsalpha.html
Storage issues:	www.flinnsci.com/homepage/safe/chemlabel.htm
Glove guide:	www.inform.umd.edu/DES/ls/print.html
EPA:	www.epa.gov
OSHA:	www.osha.gov
General Safety:	www.hhmi.org/science/labsafe/lcss/lcss.html www.practicingsafescience.org www.vtc.edu/linc/safety esf.uvm.edu www.hazard.com www.flinnsci.com

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