# Health, Safety, and Risks in the Chemistry Laboratory

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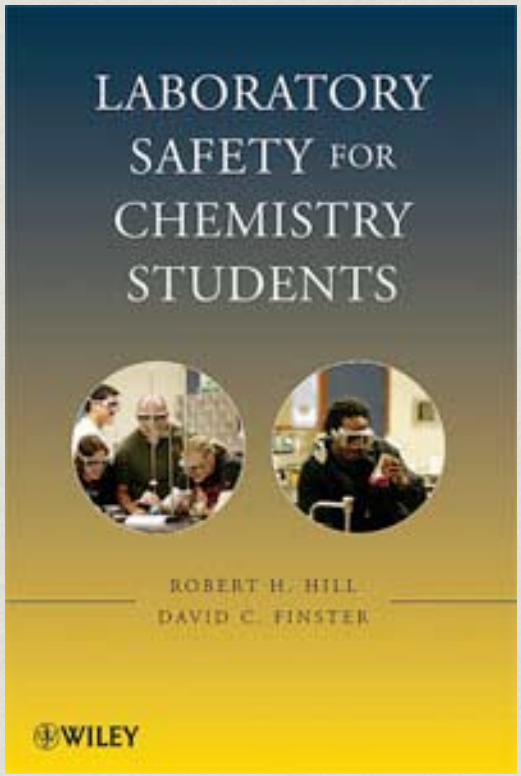
# Objectives

- Discuss the sources of risk in the lab, common safety practices, and the types of health concerns professionals might see.
- Review the types of students engage in chemical laboratory work everyday.
  - Many students are either novices, unaware of their surrounds or experienced graduate students who can be a bit too cavalier.
  - These are the students who inevitably end up seeking professional medical help.

# A little about myself...

- Instruct 300+ students in General Chemistry laboratories
  - >85% freshman
  - Supervise 15 Teaching Assistants
- Direct undergraduate research program
- Lab experience at Ithaca College, Penn State, Cornell, and ESF
- Certification in Secondary Chemistry Education

# A topic of Relevance

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# Tragic Incidents in the News

## Deadly UCLA lab fire leaves haunting questions

March 01, 2009 | Kim Christensen

Los Angeles Times

UCLA's Molecular Sciences Building was mostly closed for the holidays on Dec. 29 as research assistant Sheri Sangji worked on an organic chemistry experiment.

Only three months into her job in the lab, the 23-year-old Pomona College graduate was using a plastic syringe to extract from a sealed container a small quantity of t-butyl lithium -- a chemical compound that ignites instantly when exposed to air.

C&EN
CHEMICAL & ENGINEERING NEWS

## Negligence Caused UCLA Death

**State safety and health agency faults university for training lapses, unsafe practices**

## Rare Form of Mercury Kills Dartmouth Chemistry Teacher

**The News York Times** **1996**

**HANOVER, N.H., June 10** - A Dartmouth College chemistry professor has died from exposure to a rare form of mercury, first synthesized more than 130 years ago.

**Karen Wetterhahn**

Methyl mercury, $[Hg(CH_3)_2]$

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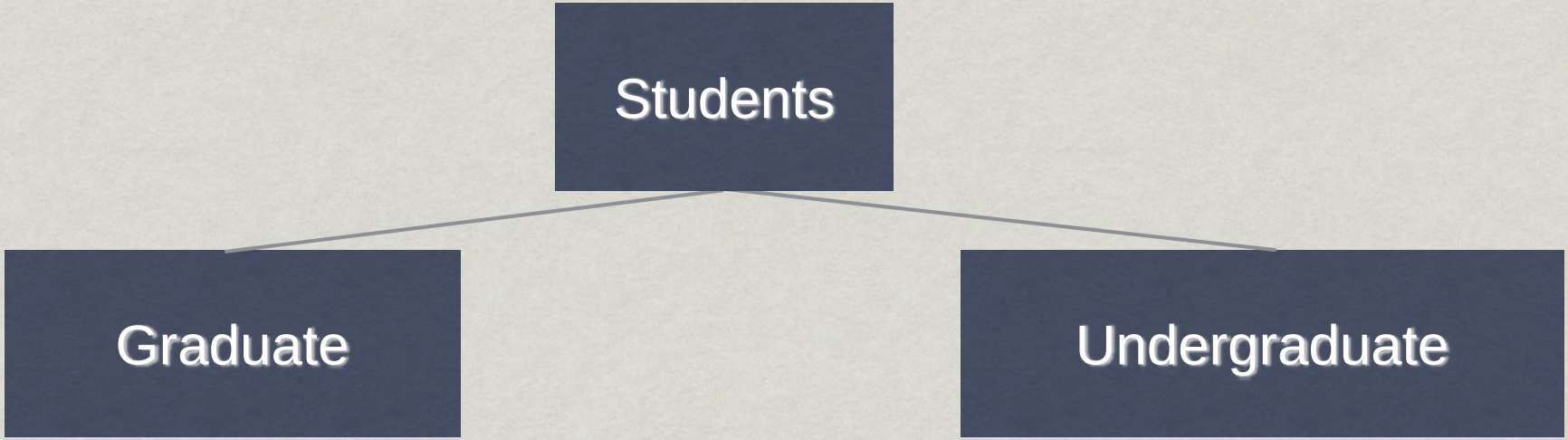
...but these are very rare

ESF State University of New York
College of Environmental Science and Forestry

# Students Types: Health, Safety, and Risks




## TRAINED IN RISKS, BUT CAVALIER

- HAVE AN UNDERGRADUATE DEGREE
- MAY OR MAY NOT BE IN CHEMISTRY
- WORK IN LABS FOR 5+ YEARS
- SOMEWHAT LESS INVINCIBLE

## UNTRAINED, BUT EXPOSED TO FEWER RISKS

- TYPICALLY FIRST-TIMERS
- OFTEN NON-MAJORS
- INEXPERIENCED
- INVINCIBLE

# The Graduate Student Experience (this is my life)

- 4-5+ years working in one or more research groups
- Trained initially by EHS, then by department, then by lab mates
- Comfortable in the lab, good workers
- Day-to-day autonomous research
- Late-night and weekend work

# The Undergraduate Experience (this is something additional)

- Generally novices in the lab
- Minimal knowledge about chemical interactions
- Somewhat clumsy
- Trained within classes, then in research labs
- May perform research under a graduate student
  - Secondary direction by advisor
- Only working when others are present

# Risk:  The human factor

- Students are:
  - Sleepy
  - Sick (colds, flu, allergies)
  - Low on nutrition (blood sugar)
  - Depressed/agitated/anxious

# Safety Measures and PPE

- Goggles
- Gloves
- Lab coats (sometimes)
- Eye wash
- Safety shower
- Fire extinguisher
- Fire blanket

# Risks in the Lab

If you can think of it, we have it...

## Chemical

Flammable

Toxic

Corrosive

Reactive

## Mechanical

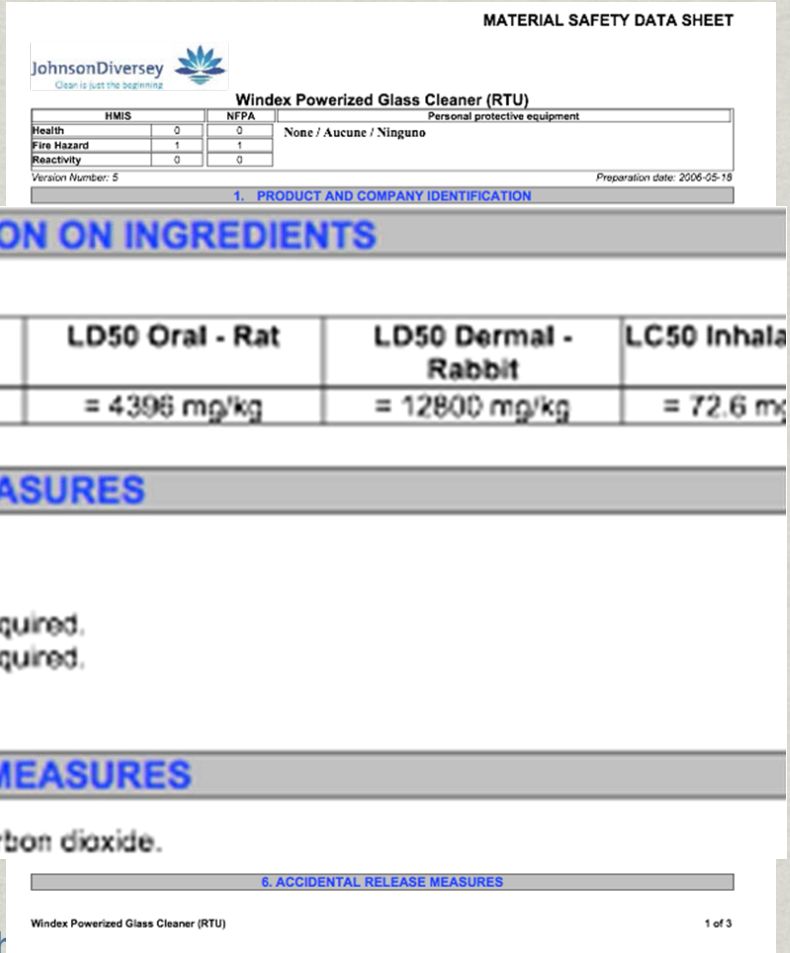
Thermal

Sharps

Explosive

# How do we know the risks?

- No one can know everything about each of the many chemicals



MATERIAL SAFETY DATA SHEET

JohnsonDiversey
Clean is just the beginning

Windex Powerized Glass Cleaner (RTU)

| HMIS | | NFPA | Personal protective equipment |
|---|---|---|---|
| Health | 0 | 0 | None / Aucune / Ninguno |
| Fire Hazard | 1 | 1 | |
| Reactivity | 0 | 0 | |

Version Number: 5 Preparation date: 2006-05-18

1. PRODUCT AND COMPANY IDENTIFICATION

3. COMPOSITION/INFORMATION ON INGREDIENTS

HAZARDOUS COMPONENTS

| Ingredient(s) | CAS # | Weight % | LD50 Oral - Rat | LD50 Dermal - Rabbit | LC50 Inhala |
|---|---|---|---|---|---|
| Isopropyl alcohol | 67-63-0 | 1 - 5% | = 4396 mg/kg | = 12800 mg/kg | = 72.6 m |

4. FIRST AID MEASURES

Eye contact: Rinse with plenty of water.
Skin contact: Rinse with plenty of water.
Inhalation: No specific first aid measures are required.
Ingestion: No specific first aid measures are required.
Aggravated Medical Conditions: None known.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media: Dry chemical, water spray, foam, carbon dioxide.

6. ACCIDENTAL RELEASE MEASURES

Windex Powerized Glass Cleaner (RTU) 1 of 3

- **Required list of information about a chemical including physical and chemical characteristics, fire and explosion hazards, lethal dose, etc**
- **Must be available for every chemical in the laboratory**
- **Provided by suppliers, also online**

# Chemical Hazards

- Carcinogens (benzene)
- Mutagens (radiation)
- Teratogens (tobacco, PCBs)
- Sensitizers (formaldehyde)
- Lachrymators (think onions...)
- Sternutators (capsaicin)
- Explosives/flammables

# Assumptions We Make

- The practical work is carried out or supervised by a qualified science teacher with adequate knowledge of chemistry and the equipment used
- Practical work is conducted in a properly equipped and maintained laboratory
- Rules for student behavior are strictly enforced
- Care is taken with normal laboratory operations such as heating substances and handling heavy objects
- Good laboratory practice is observed when chemicals are handled
- Eye protection is worn whenever wet-work is being done
- Reactions resulting in fumes/smoke will be kept in a fume hood
- Hand-washing facilities are readily available in the laboratory
- Students are taught safe techniques for such activities as heating chemicals, smelling them, or pouring from bottles

# The Principles of Chemical Safety

Jay A. Young

*From keynote address, 48th NEACT Summer Conference, August 18-22, 1986*

- **The essence of chemical safety is comprised in four principles, each with a corollary and examples.**

1. Every chemical without exception is hazardous.

   *The corollary:* "Hazardous" means possessing a potential to cause harm. The manner of use of a chemical determines the probability that harm is caused.

   *Examples:* Oxygen inhaled at a concentration a bit or more greater than about 20% is poisonous. We take care to refrain from breathing oxygen at high concentrations for long periods of time. (Or, if you like, mother nature in this case has taken care of this for us.)

   No one deliberately pours water at, say, 95°C on themselves.

# Laboratory Safety Information

Jay A. Young

*From keynote address, 48th NEACT Summer Conference, August 18-22, 1986*

2. Every accident announces that it will happen before it happens.

   *The corollary:* All accidents are predictable and therefore in principle preventable.

   *Examples:* In the middle of the lab periods, a student says, "Ouch!" because they inadvertently but briefly touched a piece of hot glass tubing. That "Ouch" was the accident, a serious burn from hot glass, announcing its forthcoming arrival.

   You see a student briefly remove their safety glasses in order to more conveniently read the meniscus level of a liquid in a graduated cylinder. And eye injury accident has just announced it is coming.

   Spilled water, or other liquid, on the lab bench is not cleaned up within a reasonable times. Now you have been told that some one is going to slip and fall because of an un-mopped-up liquid spill on the floor.

# Laboratory Safety Information

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3. If it might happen, it will happen -- eventually.

   *The corollary:* There is no such thing as personal immunity from harm. Each of us has said (me included) at one time or another, "I'll take a chance, it won't happen to me this one time." And, since we survived, it didn't happen; we beat the odds. Remember that when we say to ourselves, "I'll take a chance and do it because the probability of harm is very low," we are really saying that the probability of harm is not zero. Whenever the probability of an event is greater than zero, no matter how small, then it is *certain* that the event will occur. (It is foolish to hope that it will not occur to us.)

   *Example:* When when was the last time you did not "buckle up" when driving your car?

# Laboratory Safety Information

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4. Each person is individually and personally responsible for the safe use of chemicals.

   *The corollary:* Use a chemical only after you have
   a. Reviewed the kinds of hazards presented by that chemical.
   b. Established the precautions that will minimize the probability of harm.
   c. And, have prepared in advance for emergency measures in the event something goes wrong.

   *Example:* Unless washed off by vigorous scrubbing under copiously flowing water initiated within 90 seconds after exposure, a spill of phenol on approximately 100 square inches of skin (e.g. a circle whose radius is a bit less than 6 inches) can be fatal.

# When Will a Student Seek Help?

- As a last resort.  They don't want to deal with or think about:
  - Paperwork, paperwork, paperwork
  - Immortality
  - Shame

What would you do if your options were to stand virtually naked under a 55 °F shower in front of your classmates or...just go home?

# Things you might see

- Lacerations from glassware
- Burns
  - Thermal
  - Chemical
- Rash/irritation
- Indirect physical injury
- Injury to the eye?

# Lacerations/cuts

- The most important factor is what you don't see
  - What was on the glassware/needle beforehand...


http://www.hexarmor.com/products/needlestick-resistant/

# Burns

- Thermal:  Hot or cold
  - Sources:  Hot plates, oil, water, liquid nitrogen
    - Some oil baths heated to > 300 °C (572 °F)
    - Boiling point of liquid nitrogen: -196 °C or -321 °F
- Chemical
  - Acids, bases, others
    - e,g. silver nitrate, $AgNO_3$

# Rashes/Irritation

- Similar to burns, though not usually instantaneous or debilitating
  - Dilute acids, bases

# Indirect injuries

- Physical injury due to:
  - Tripping, falling, slipping, lifting, etc.

# Eye Injuries

## Should NEVER happen

- “Contact lenses worn with goggles are acceptable, but safety glasses and prescription safety glasses without goggles do not provide adequate protection. Increase the degree of protection (use face shields, laboratory hoods, etc.) when the hazards increase.”
- “In some workplaces where hazardous chemicals are used or handled, wearing con- tact lenses is prohibited or discouraged. These prohibitions are based on rumors and perceived risks. Studies of the literature have refuted these risks.”
- “The consensus is that contact lenses can be worn in most chemical laboratories, as long as safety goggles are also worn” *ACS Comm. on Safety*

# To Lab Coat or not to Lab Coat

- An on-going debate

Peter Cutts Photography

**COATS OPTIONAL** George Washington University teaching assistant Anice Mathew instructs chemistry students in the use of an extraction funnel before they attempt to extract chlorophyll from spinach.

"And, instructors and safety experts say, a "one size fits all" approach to personal protective equipment (PPE) doesn't teach students what they need to know."

"Having people wear latex gloves all the time is one of the habits that cost us Dr. Wetterhahn," says Ralph Stuart, environmental safety manager at the University of Vermont, referring to a fatal mercury-poisoning incident at Dartmouth College, in New Hampshire."

C & EN, June 2010

# Current Safeguards

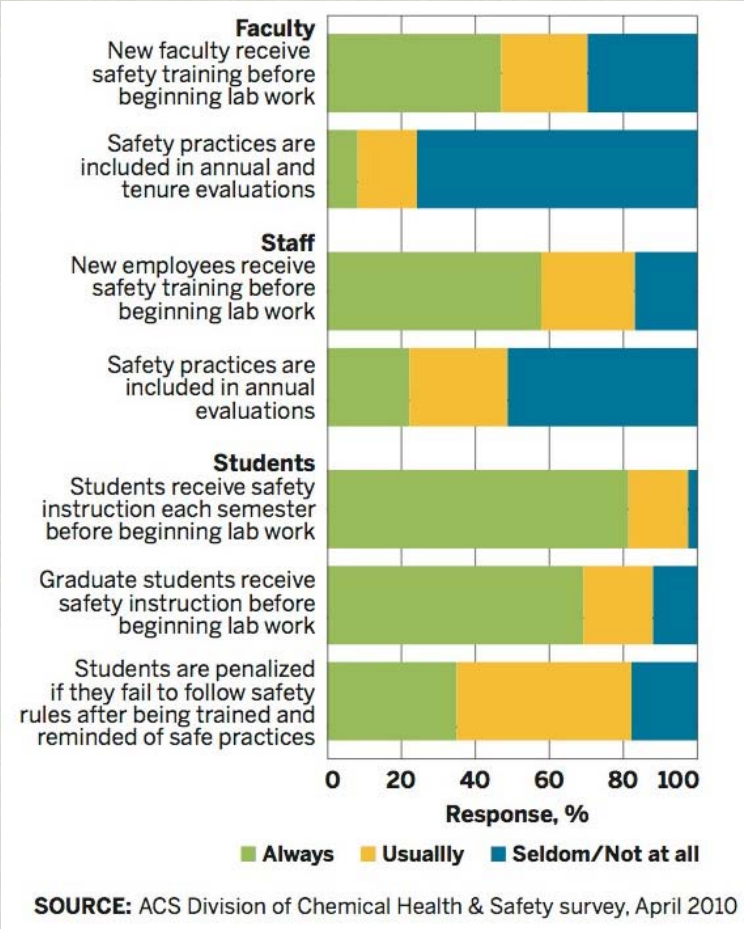
- Trained faculty, TAs
- Presence of PPE, safety equipment
- Low-hazard experiments
  - Planning for “worst case scenario”, i.e. incompatible chemicals
- Safety quizzes, prelab notes
- Common sense?

# Sources of Training

- The American Chemical Society's Committee on Professional Training
- OSHA/EPA
- Faculty input
- Grad students/Postdocs
- Here say

# A Safety Culture?

- What are the risks of not teaching safety?
- How important is safety



# Topics that are Covered (or should be) in laboratory classes

- What to do in an Emergency
- Personal protective equipment (PPE)
- Types of chemicals and their associated hazard
- Materials safety data sheets (MSDSs)
- Lab housekeeping

# How Can we Augment Safety Training?

- Remove the stigma of “a bunch of rules”
- Get schools and student to incorporate safety as a part of everyday study
- Include safety as a part of faculty evaluations

# Time for some personal anecdotes

- There was this one time...

# Methods of Training

- In-class presentation
- Syllabus
- Videos

QuickTime™ and a
decompressor
are needed to see this picture.