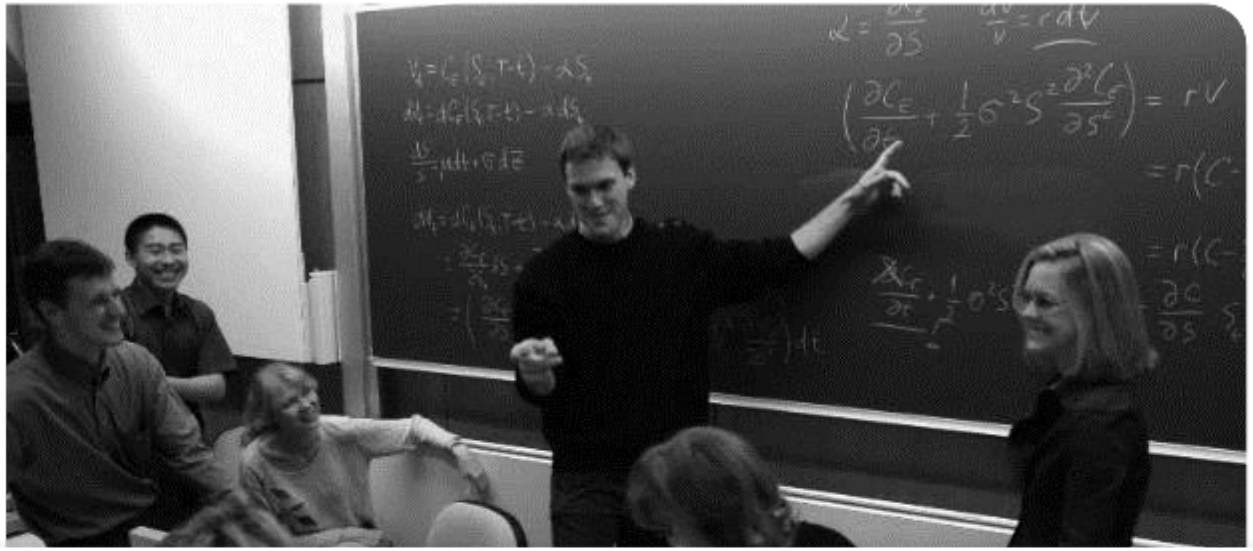
UNIL | Université de Lausanne



Introduction to Lab Safety

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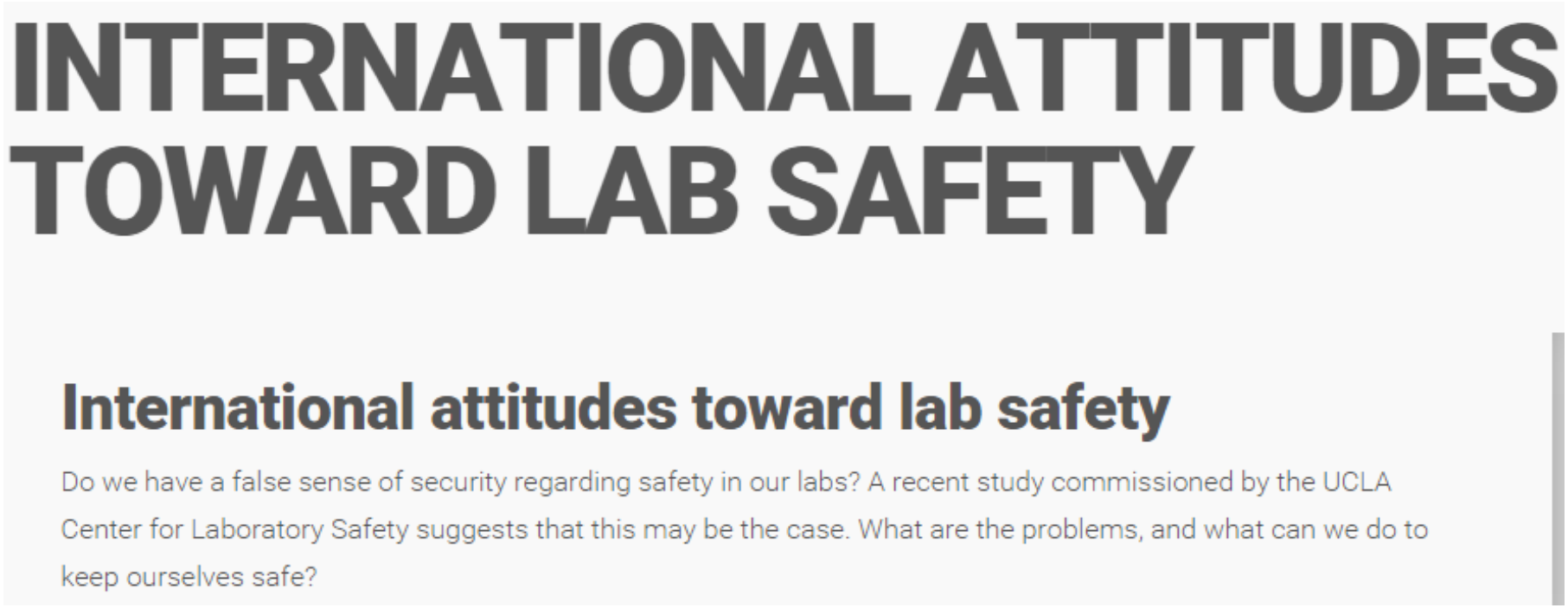
| le savoir vivant |

jeudi 7 juillet 2016

Program

- Lab safety: general considerations
- Hazard classes:
  - Mechanical – *Physical* – *Chemical* - *Biological*
- Exposure
- Control measures: STOP!
- Safety equipment & first aids
- Storage and Waste
- The Ten [lab] Commandments

INTERNATIONAL ATTITUDES TOWARD LAB SAFETY



International attitudes toward lab safety

Do we have a false sense of security regarding safety in our labs? A recent study commissioned by the UCLA Center for Laboratory Safety suggests that this may be the case. What are the problems, and what can we do to keep ourselves safe?

"Safety survey reveals lab risks", *Nature*.

Berkeley Science Review.

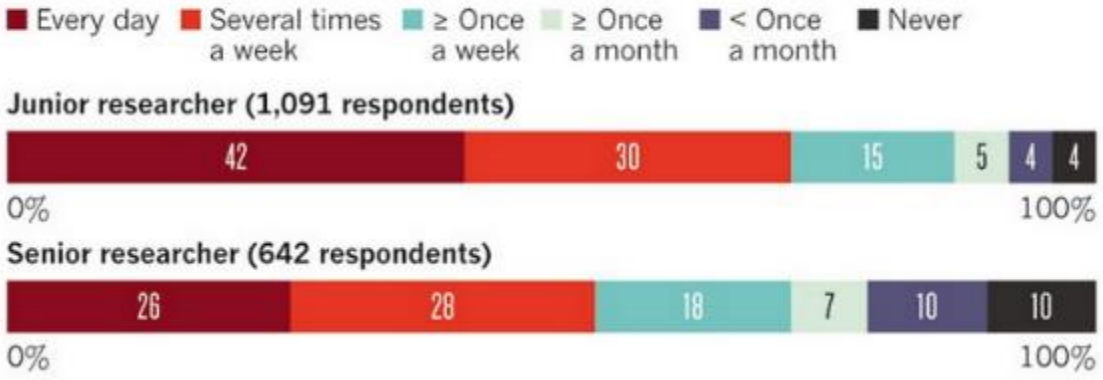
Do you *feel* safe?

A QUESTION OF SAFETY

A survey of almost 2,400 scientists shows that although most believe their laboratories to be safe, about half have experienced injuries in the workplace. It also shows that junior and senior researchers have very different views of potentially hazardous practices.

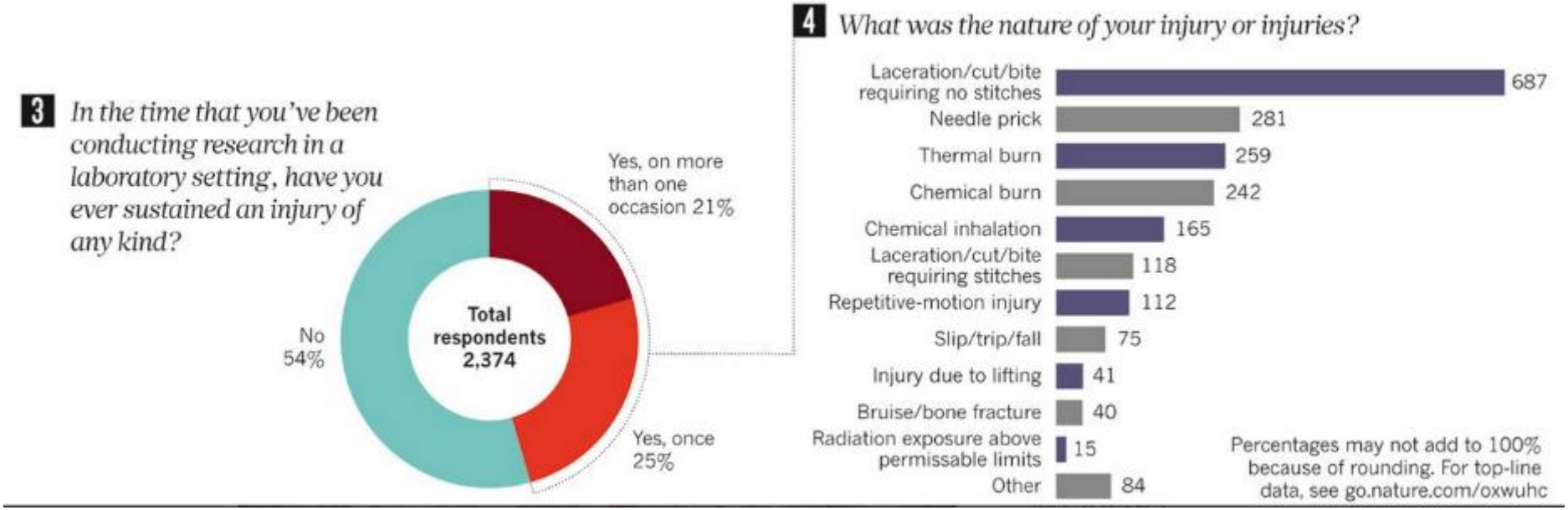
1 *To what extent do you agree or disagree with the following statement? "I feel that my lab is a safe place to work."*

2 *In your lab, how frequently do people conduct experiments while working alone?*



Nature *493*: 9-10. 3 Jan 2013

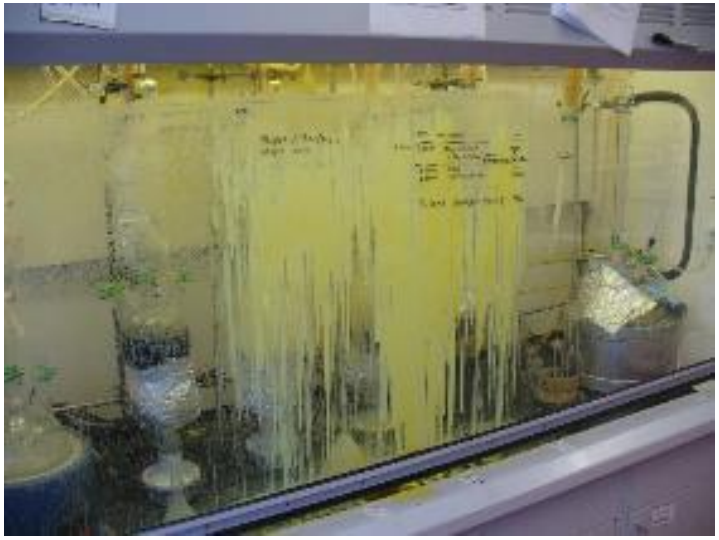
Lab Injuries



Nature *493*: 9-10. 3 Jan 2013

Potential lab hazards at UNIL

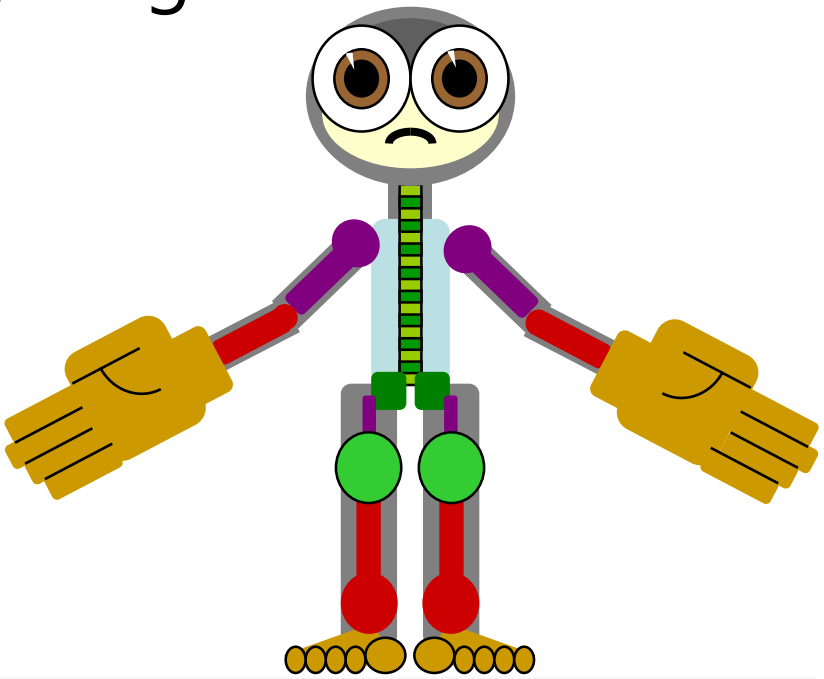
- Cuts
- Mini-explosions
  - Incompatible waste
- Potential biological exposures
  - Cuts & pricks by contaminated equipment
  - Biological liquids
- Fires, etc.



Why is lab safety important?

Lab safety rules and symbols are needed to help collaborators avoid injuring themselves or other people.

Size of each body part is proportional to injury frequency



Be responsible and safe in the lab

- Perform scientific procedures safely
- Watch out for your own safety and others
  - Anticipate problems and prevent them
  - Be aware of your surroundings
  - Be proactive
  - Ask questions!
- Inform yourself about the rules specific to your own lab/department

Emergency Numbers

- Any kind of emergency on campus: **115** (intern)
- From your mobile phone: **0041 21 692 20 00**
- Ambulance: **144**
- Fire: **118**
- Police: **117**
- In case of doubt : **112** or 115 (intern)

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Mechanical Hazards

- Moving machinery
- Cutting activities
- Crushing activities

- Do not work alone!
- Use technical and personal protective equipment (gloves, goggles/shield, ear muff)
- Turn off equipment before leaving

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Physical Hazards

- Explosives and gases under pressure
  - Includes projection hazard
  - Air compressors

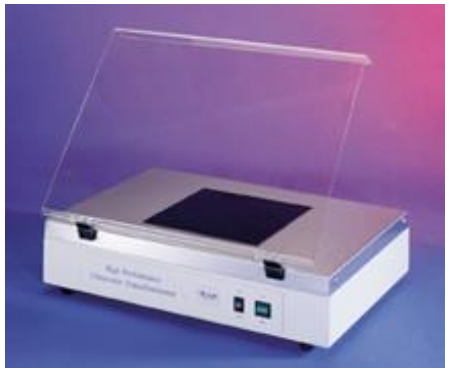
- Lasers, UV, radiation sources
- Extreme temperatures
  - Freezers, liquid nitrogen; heating plates, open fire sources, autoclaves

- High intensity/frequency sounds
  - Sonicators, blenders
  - Machining equipment

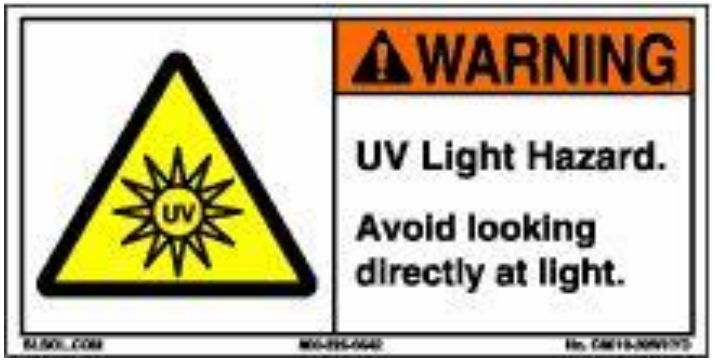
Physical Hazards: UV radiation

DNA linker

UV transilluminator



Biological safety hood

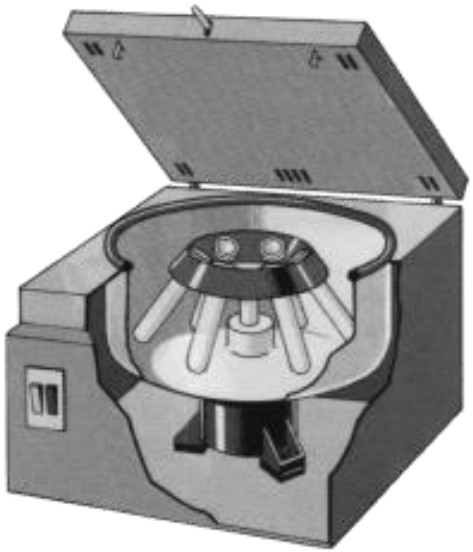


Physical hazards: Sonicator

- Wear ear muffs while sonicating
- Enclose the sonicator in a "sound-proof" cabinet while sonicating
- *Do not* sonicate in a room containing people who are *not* wearing ear protection
- Shut doors of the room where sonication is taking place
- Protect yourself and others from aerosols

Physical hazards: Centrifugal forces

- Use appropriate tubes or recipients
- Ensure all tubes are properly closed to prevent aerosolization of materials
- If liquids are spilled, eliminate debris, clean thoroughly, disinfect



Program

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Chemical classification and labeling

Old pictograms

Explosive

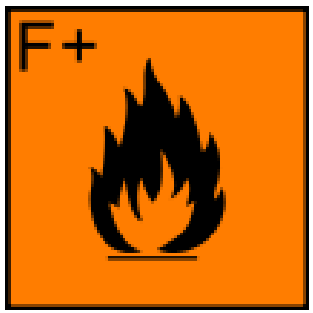
Highly flammable

Harmful

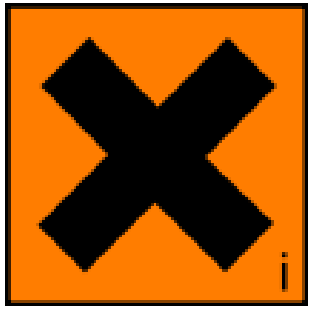
Toxic

Corrosive

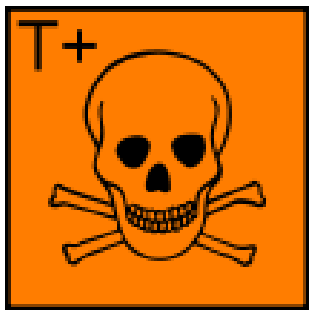
Oxidising



Extremely flammable



Irritant



Very toxic

Dangerous to the environment

Chemical classification and labeling

Globally Harmonized System (GHS) pictograms

SGH01
Explosive

SGH02
Flammable

SGH05
Corrosive

SGH06
Toxic

SGH03
Oxidizing

physical

SGH04
Compressed, liquefied gas

SGH07
Irritant, sensitizer

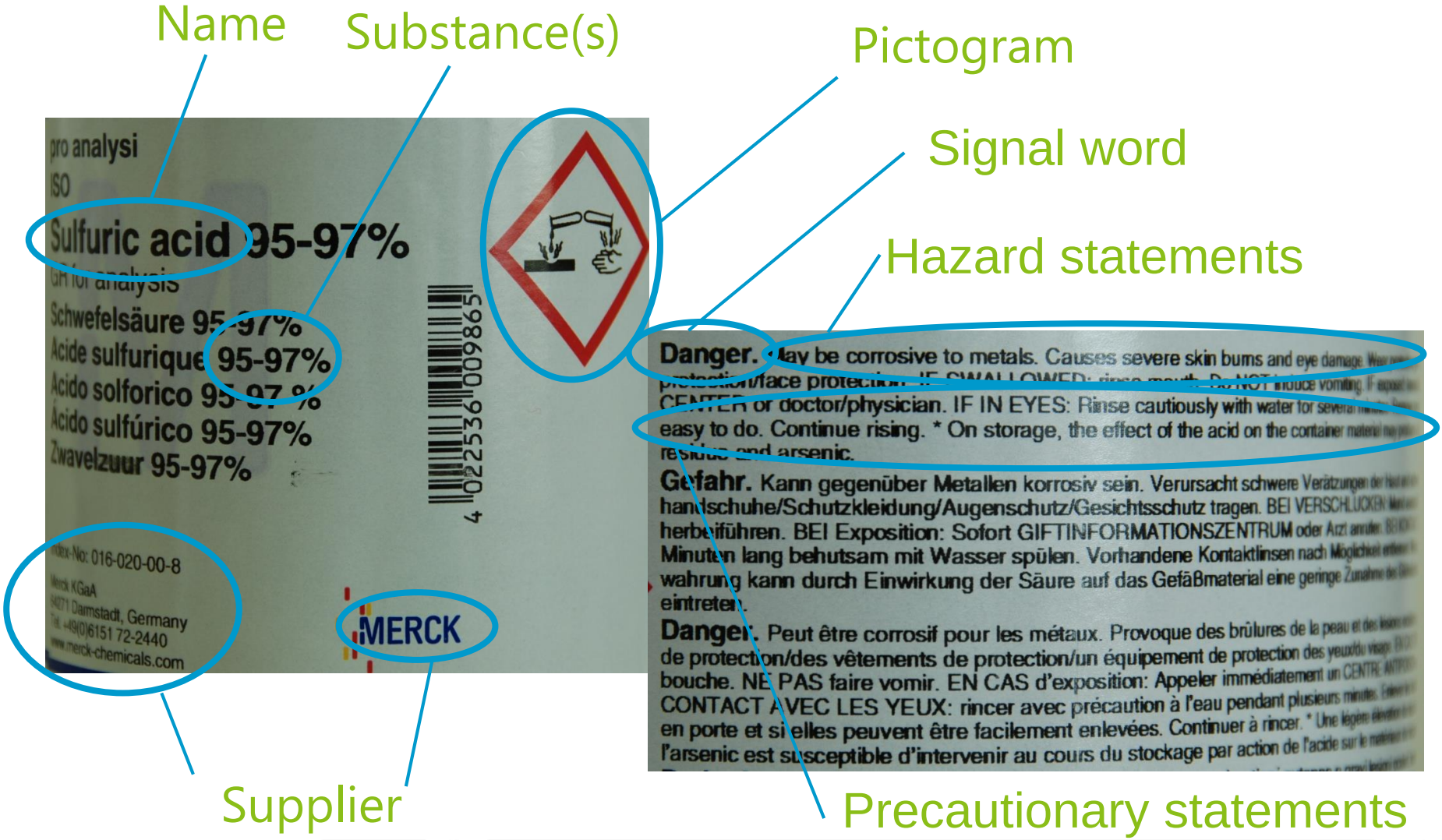
SGH08
Health Hazard

health

SGH09
Aquatic/Environ-mental Toxicity

environment

Label example with GHS



Safety Data Sheets SDSs

2. HAZARDS IDENTIFICATION

Classification of the substance or mixture

According to Regulation (EC) No1272/2008
Flammable liquids (Category 2)
Acute toxicity, Inhalation (Category 4)
Acute toxicity, Dermal (Category 4)
Acute toxicity, Oral (Category 4)
Serious eye damage/eye irritation (Category 2)

According to European Directive 67/548/EEC as amended.
Highly flammable. Harmful by inhalation, in contact with skin and if swallowed. Irritating to eyes.

Label elements

Pictogram

Signal word — Danger

Hazard statement(s)

H225	Highly flammable liquid and vapour.
H302	Harmful if swallowed.
H312	Harmful in contact with skin.
H319	Causes serious eye irritation.
H332	Harmful if inhaled.

Precautionary statement(s)

P210	Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P280	Wear protective gloves/protective clothing/eye protection/face protection.
P303 + P361 + P353	IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.

Hazard symbol(s)

F	Highly flammable
Xn	Harmful

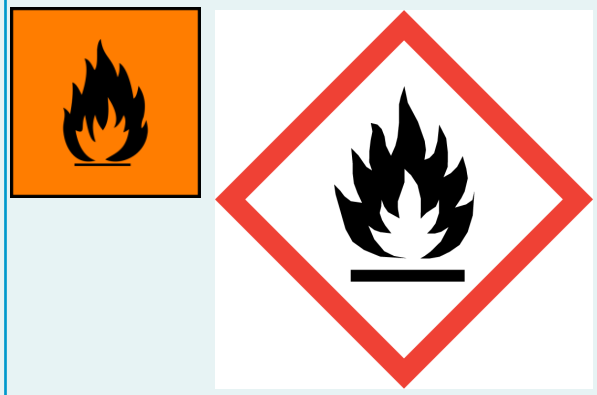
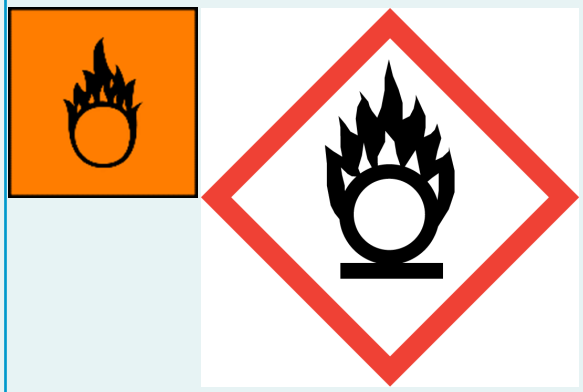
R-phrase(s)

R11	Highly flammable.
R20/21/22	Harmful by inhalation, in contact with skin and if swallowed.
R36	Irritating to eyes.

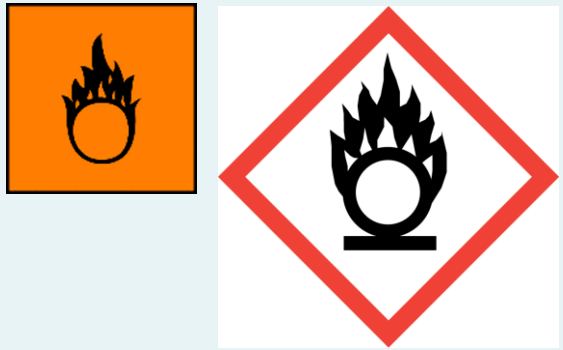
S-phrase(s)

S16	Keep away from sources of ignition - No smoking.
S36/37	Wear suitable protective clothing and gloves.

Chemical hazard pictograms and definitions

Explosives	Flammables	Oxidizers
		
Any substance that may explode if exposed to heat, flame or shocks, shaking or friction	Any substance that will burn if exposed to an open flame	Any substance that spontaneously evolve oxygen at room temperature or with slight heating, or that promote combustion

Chemical hazard pictograms and definitions

Explosives	Flammables	Oxidizers
		

- Avoid sparks
- Keep away from flames and heat sources (sunlight)
- Avoid formation of vapors or aerosols
- Reduce quantities stored in the lab to a minimum
- Always reseal carefully after use
- Keep the rest in separate fire-proof and ventilated chemical cabinets. Store separately!

Chemical hazard pictograms and definitions

Pressurized gases: Gas under pressure

- Compressed, liquefied, refrigerated liquefied, and dissolved gases
- Usually contains other properties: irritant, flammable, cryogenic, etc.
- Has to be fixed!

Chemical hazard pictograms and definitions

Corrosive – Any substance that can destroy or burn living tissue and can eat away at other materials. Ex. concentrated NaOH, acids, bleach

- Do not breath vapors/aerosols, work under fume hood
- Avoid any direct contact with skin, eyes, mucosa
- Use protective clothing, gloves and goggles
- Do not store acids and flammable substances together

Acid Burns

Chemical hazard pictograms and definitions

Fatal/Toxic –

Any substance that can lead to death if inhaled, ingested, or absorbed by the skin.

- Avoid any type of direct contact by using gloves, a lab coat, goggles and if required a mask

Chemical hazard pictograms and definitions

Harmful	Irritant	Skin sensitizer
Any substance that can be harmful if inhaled, ingested, or absorbed by the skin	Any substance that causes irritation upon contact with skin, eyes, airways or mucous membranes	Any substance that causes that can causes an allergic skin reaction
		

Chemical hazard pictograms and definitions

Harmful	Irritant	Skin sensitizer
	 	
Harmful if: • **swallowed**: avoid cross-contamination • in contact with **skin**: wear lab coat and gloves • **inhaled**: wear protective mask	• **Skin** irritation: wear lab coat and gloves • **Eyes** irritation: wear googles • **Skin and eyes** irritation: wear lab coat, googles and gloves	• Avoid **skin** contact by wearing lab coat and gloves

Chemical hazard pictograms and definitions

- Carcinogen
- Mutagen
- Reproductive Toxicity
- Target Organ Toxicity
- Respiratory Sensitizer

CMR

One pictogram used for many different hazards!

Chemical hazard pictograms and definitions

CMR	Target Organ Toxicity	Resp. sensitizer
		
• Avoid any type of direct contact by using gloves, a lab coat, goggles and when required a mask with appropriate filter	• Avoid any type of direct contact by using gloves, a lab coat, goggles and when required a mask with appropriate filter	• Wear a mask with appropriate filter if formation of dust, vapour or aerosols is expected

Chemical hazard pictograms and definitions

In case you feel any type of physical discomfort (headache, nausea, drowsiness), contact a colleague and consult a doctor.

Report to supervisor to help prevent exposure.

Maternity Cases

Alert your supervisor or the occupational health nurse ASAP.

- The most sensitive time of pregnancy is during the first trimester

Risk assessment completed to ensure safe working conditions

Chemical hazard pictograms and definitions

Environmental:
Substances that are harmful to the environment. They must be disposed of properly, not washed down the drain.

Exposure Limits

The dose makes the poison. – Paracelsus

Time Weighted Average (TWA) (VME in French)
Average exposure allowed over an 8-hour workday

Short-term Exposure Limit (STEL) (VLE in French)
Average exposure allowed in a 15-minute period

Some chemicals used in Geosciences

Chemical Name	CAS No	TWA (ppm)	STEL (ppm)
1-Methyl-2-pyrrolidone	872-50-4	No limit but reprotoxic!	
Sulfuric acid	7664-93-9	0.25	
Hydrofluoric acid	7664-39-3	1	2
Nitric acid	7697-37-2	2	4
Hydrochloric acid	7647-01-0	5	
Methanol	67-56-1	200	250
Carbon Dioxide	124-38-9	5000	30,000

Hydrofluoric acid!

- Fatal if swallowed, in contact with skin or if inhalated
- Corrosive: cause severe skin burns and eye damage

Hydrofluoric acid!

- Fatal if swallowed, in contact with skin or if inhalated
- Corrosive: cause severe skin burns and eye damage
- High dermal absorption
- Dangerous levels without an obvious smell
- Symptoms not immediately evident: burn, bones damage
- Dangerous even if diluted!
- Highly reactive, to be stored carefully. Reacts with bases, acids, and oxidants and attacks glass, ceramics, concrete, some forms of plastic, rubber, and coatings

Hydrofluoric acid: first aid

CALL 115

- Remove contaminted clothes without carefully with gloves
- Rinse the skin during 5 min
- Apply a 5 mm calcium gluconate gel layer wearing clean gloves
- Repeat every 10 minutes until medical consultation
- In case there is no calcium gluconate gel rinse til emergency arrives

- Always consult a doctor after HF exposure!

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Biosecurity

Organisms are assigned to four groups, depending on the risk they present:

- Group 1: organisms with no risk or a negligible risk;
- Group 2: organisms with low risk;
- Group 3: organisms with moderate risk;
- Group 4: organisms with high risk.

Activity with organisms are assigned to four classes:

- Class 1: activities with no risk or a negligible risk;
- Class 2: activities with a low risk;
- Class 3: activities with a moderate risk;
- Class 4: activities with a high risk.

Biosecurity: Swiss ordinance on the contained use of organisms

Biosecurity

Criteria for activity classification

- Risk assessment of the organism
- Risk assessment of the activity
- In general, activity class level is the same as the organism group level
- But it can vary depending on type, scale, goals, risks of the study

Safety measures depend on the activity class!

Be particulary careful with classes 3 and 4 activities!

Biosecurity: Swiss ordinance on the contained use of organisms

Biosecurity: General safety measures

- Ensure no escape of organism
  - Close doors and windows
  - Sterilisation, autoclave
- Protect yourself and others
  - Wear required PPE, always wear a lab coat
  - Avoid aerosols formation
- Good Laboratory Practice
  - no food, no smooking, do not eat or drink
  - Wash your hands thoroughly after each activity and before leaving workplace
  - Keep work area clean

Biosecurity: Swiss ordinance on the contained use of organisms

Biosecurity: Specific safety measures

- Working aera
  - Isolated
  - Limited access
  - Airlock
- Hygiene
  - Shower in airlock
  - Easy to wash floors/walls
- Ventilation
  - Pressure gradient
  - Filters

Depending on activity class level.

Etc.

Biosecurity: Swiss ordinance on the contained use of organisms

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Routes of Exposure

Inhalation: gases, vapors, aerosols, dust via respiratory tract

Dermal absorption: chemicals or biologicals via healthy or wounded skin and mucous membranes

Ingestion: solids, chemicals, biologicals via contaminated food or soiled hands in contact with mouth

Accident: solids, chemicals, biologicals via cutting or piercing with contaminated objects (needles, blades, glass fragments)

Risks of dissemination in the environment

Air: ventilation, open windows

Water: sinks

Waste: improperly handled

Transport: to and from the lab

Contamination by people: hands, clothing

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Controls: STOP principle

Substitution/Elimination of dangerous task/product

Technological measures

- Ventilation
- Chemical fume hood
- Biological safety cabinet
- Enclosures, structures

Organizational measures

- Rotating job tasks
- Short stay in high exposed work places

Personal Protective Equipment (PPE)

Controls: Chemical Fume Hoods

Good laboratory practices

DO:

- Closed-toed shoes
- Long-sleeve clothing made of natural based fiber such as cotton
- Tie back long hair

DO NOT :

- Contact lenses
- Sandals
- Jewelry, watches
- Loose or Baggy clothing

Good Laboratory Practices

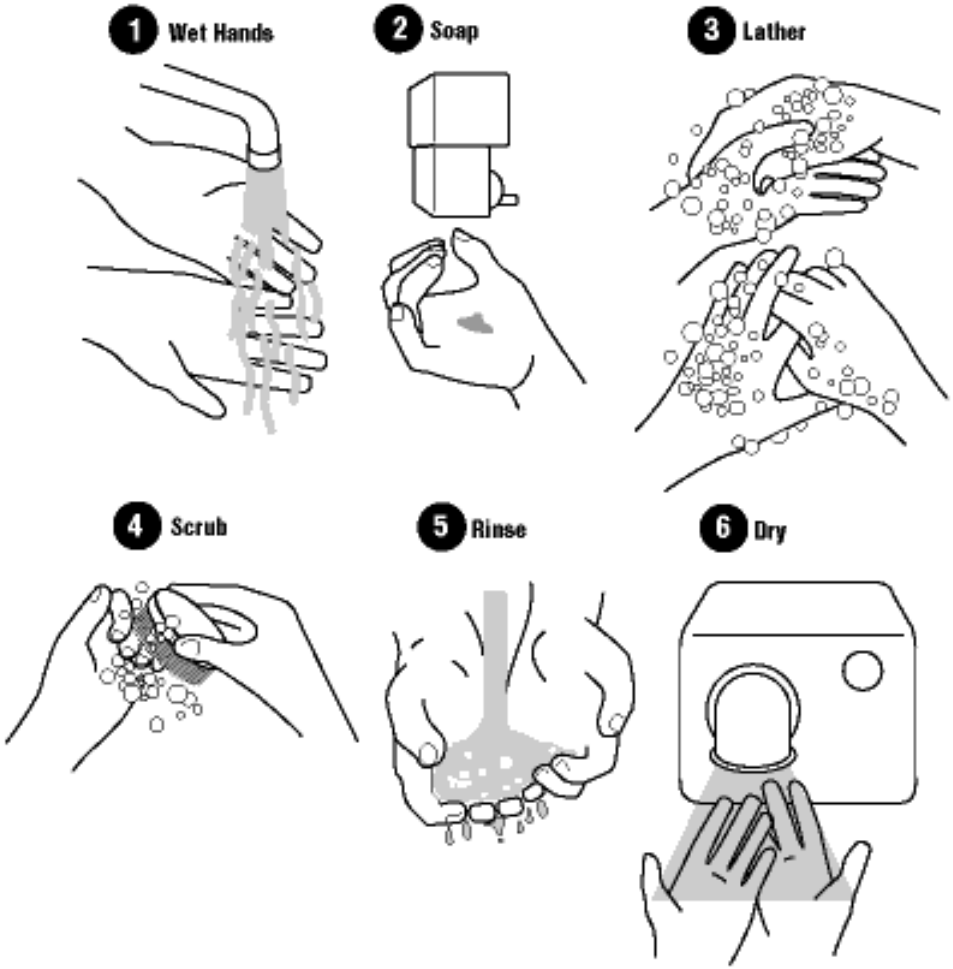
Laboratory environments require certain rules:

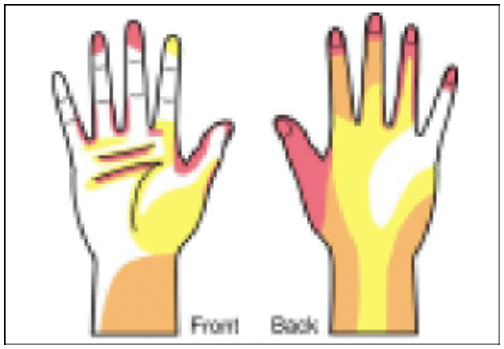
- NO drinking, eating, smoking, or putting on make-up
- Closed shoes and lab coats should be worn
- Wash and disinfect hands often
- Wear the necessary PPE: gloves, safety glasses, respirators
- Leave personal items outside of the lab
- Ensure necessary vaccinations have been completed

Prevent cross-contamination

Prevent cross-contamination

Personal Hygiene: hand-washing





PPE: Lab Coats

Protection against chemical, biological, mechanical, & physical risks

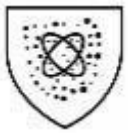
- Should remain neatly placed in the laboratory when not in use
- Initial lab coat and cleaning provided by your department
- DO NOT transport lab coats home for washing

Materials:

- Cotton
- Synthetic
- Mixed

Control Measures: PPE

Gloves should be used for protection against:

- Biological contamination 
- Chemical absorption  
- Radioactive elements  

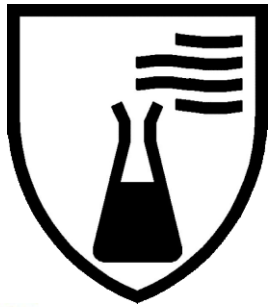
Choose the gloves best adapted to the hazard!

www.2mains.ch

Control Measures: PPE

Protection against Chemical absorption

Code Letter	Chemical	Cas Number	Class
A	Methanol	67-56-1	Primary alcohol
B	Acetone	67-64-1	Ketone
C	Acetonitrile	75-05-8	Nitrile Compound
D	Dichloromethane	75-09-2	Chlorinated paraffin
E	Carbone disulphide	75-15-0	Sulphur containing organic compound
F	Toluene	108-88-3	Aromatic hydrocarbon
G	Diethylamine	109-89-7	Amine
H	Tetrahydrofurane	109-99-9	Heterocyclic and ether compound
I	Ethyl acetate	141-78-6	Ester
J	n-Heptane	142-82-5	Saturated hydrocarbon
K	Sodium hydroxide 40%	1310-73-2	Inorganic base
L	Sulphuric acid 96%	7664-93-9	Inorganic mineral acid

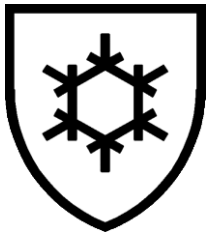


http://www.guide.eu/en/info/EN/en374.html

Control Measures: PPE

Gloves should be used for protection against:

- Thermal burns (cold, heat)



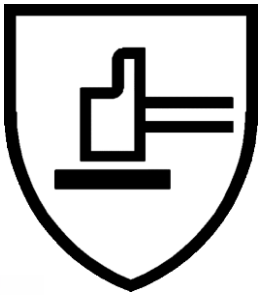
Choose the gloves best adapted to the hazard!

www.2mains.ch

Control Measures: PPE

Gloves should be used for protection against:

- Mechanical risks: cutting, vibration



Choose the gloves best adapted to the hazard!

www.2mains.ch

PPE: Eye Protection

Use goggles with upper and lateral protection or face shield when there is:

- A risk of particles, chemicals or microorganisms being projected (including liquid nitrogen handling and cryovials)
- Exposure to UV light (face shield)

Optical glasses are NOT protective equipment!

PPE: Hearing Protection

Noise Controls

- Enclosure
- Ear plugs & muffs

Noise reduction rating (NRR)

- *Enough noise reduction (~72 dB)*
- *Not to much noise reduction: audible alarm!*

PPE: Respiratory Protection

Provides protection against:

- Particulates (small & large): dust, metals, nano
- Radioactive particles
- Biologicals aerosols Liquid aerosols: droplet, mist
- Gases and Vapors
- Allergens

Choose the **filter** best adapted to the hazard!

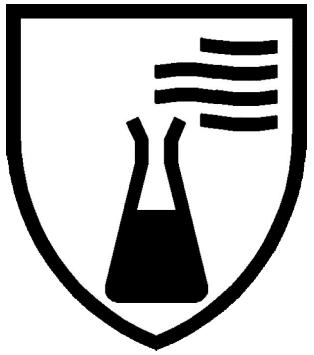
PPE: Respiratory Protection

Provides protection against: Gases and Vapors

Colour code	Filter type	Contaminants present
	AX	Gases and vapours of organic compounds with boiling point < 65°C
	A	Gases und vapours of organic compounds with boiling point > 65°C
	B	Inorganic gases and vapours, e.g. chlorine, hydrogen sulphide, hydrogen cyanide
	E	Sulphur dioxide, hydrogen chloride
	K	Ammonia and organic ammonia derivates
	CO	Carbon monoxide
	Hg	Mercury vapour
	NO	Nitrous gases including nitrogen monoxide
	Reactor	Radioactive iodine including radioactive methyl iodide
	P	Particles

Hydrofluoric acid: PPE

- Always work under chemical hood
- Gloves Neopren or Vinyl
- Facial screen or protective glasses
- Lab coat
- Breathing mask if necessary: filter «E» 
- Always consult a doctor after HF exposure!



L: acid

Program

- Lab safety: general considerations
- Hazard classes:
  - Mechanical – *Physical – Chemical - Biological*
- Exposure
- Control measures: STOP!
- Safety equipment & first aids
- Storage and Waste
- The Ten [lab] Commandments

Lab Safety Equipment

Safety Shower

First aid kit

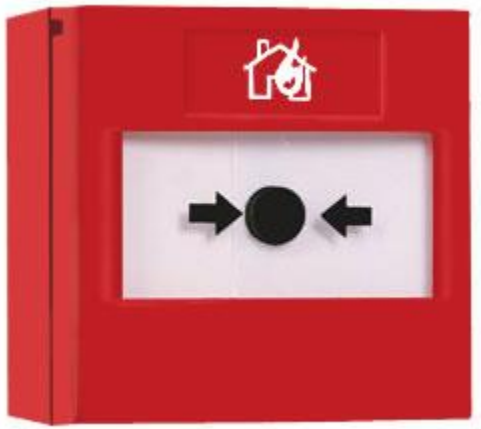
Eye Wash

Lab Safety Equipment

Fire Extinguisher

Fire Blanket

Fire alarm button



Cardiac Arrest

Defibrillators are located at a central point in most buildings

Instructions located directly inside

Evacuation

personnel

Emergency Numbers

- Any kind of emergency on campus: **115** (intern)
- From your mobile phone: **0041 21 692 20 00**
- Ambulance: **144**
- Fire: **118**
- Police: **117**
- In case of doubt : **112** or 115 (intern)

Fire and First-aid Courses

Extinguisher course

- PAT, professors, 3rd year bachelors

First-aid responder

- 100%, CDI – some exceptions

Accidents and Injuries

- Report **ALL** accidents/near misses and injuries
- Be aware of safety hazards associated with each chemical/organism you use
- Avoid working alone!

Operating the eye wash

1. Flush eyes 5 minutes, keep eyelid open!
2. Remove contact lens if possible
3. Flush eyes for 10 – 15 minutes, keep eyelid open!
4. Identify the product
5. Immediately consult an ophthalmologist to evaluate any damage and determine necessary treatment

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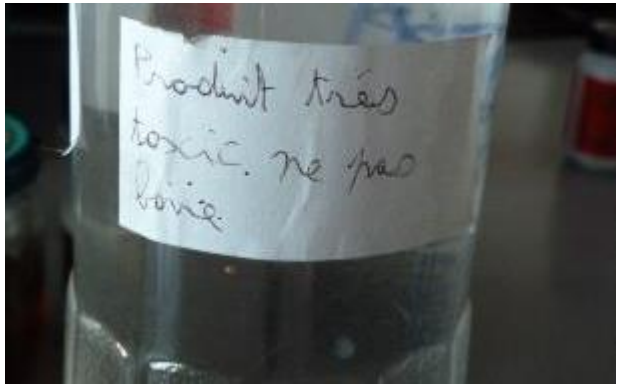
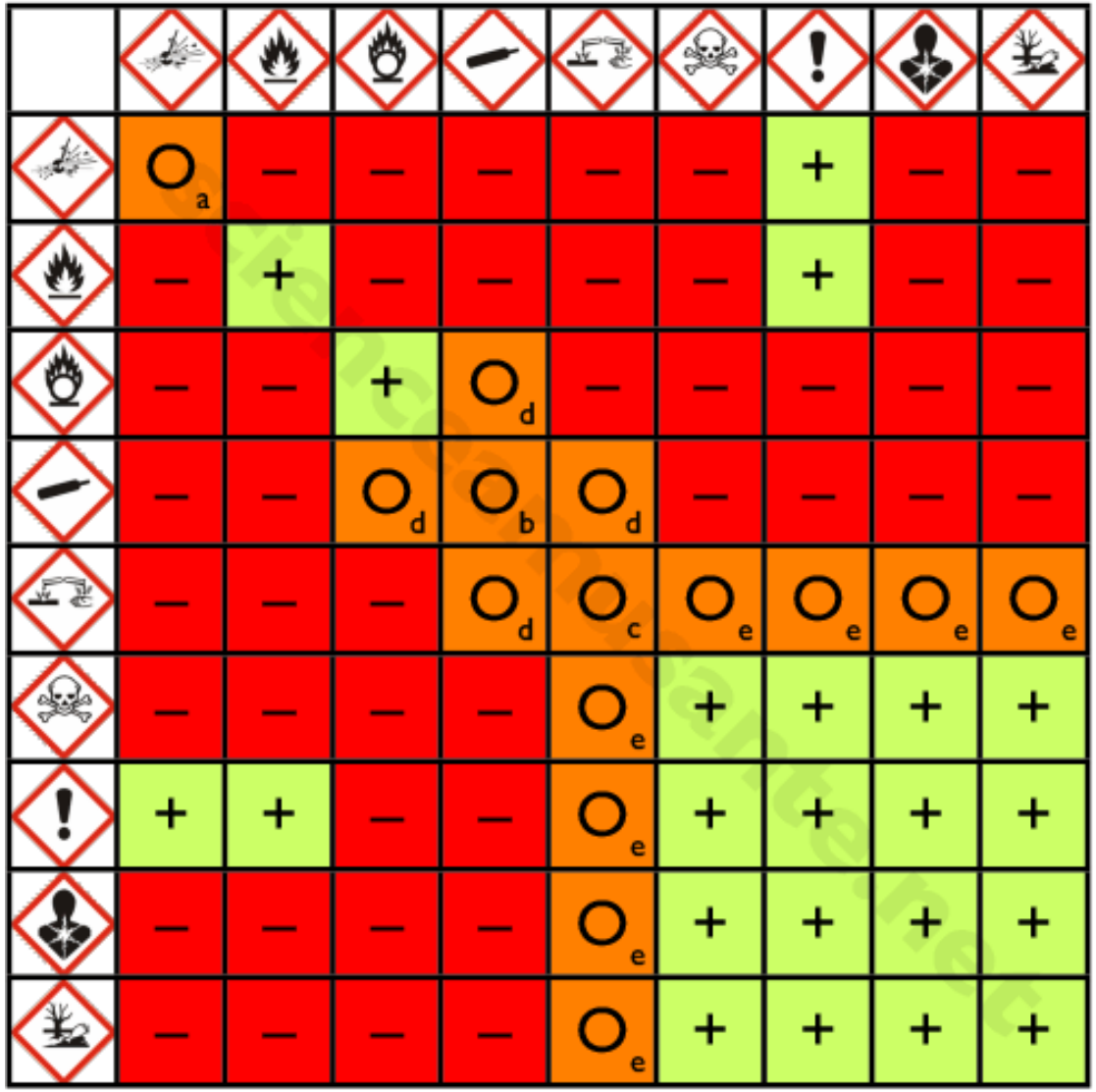
Hazardous Waste/storage – Gone Wrong



Chemical Storage Compatibility Table

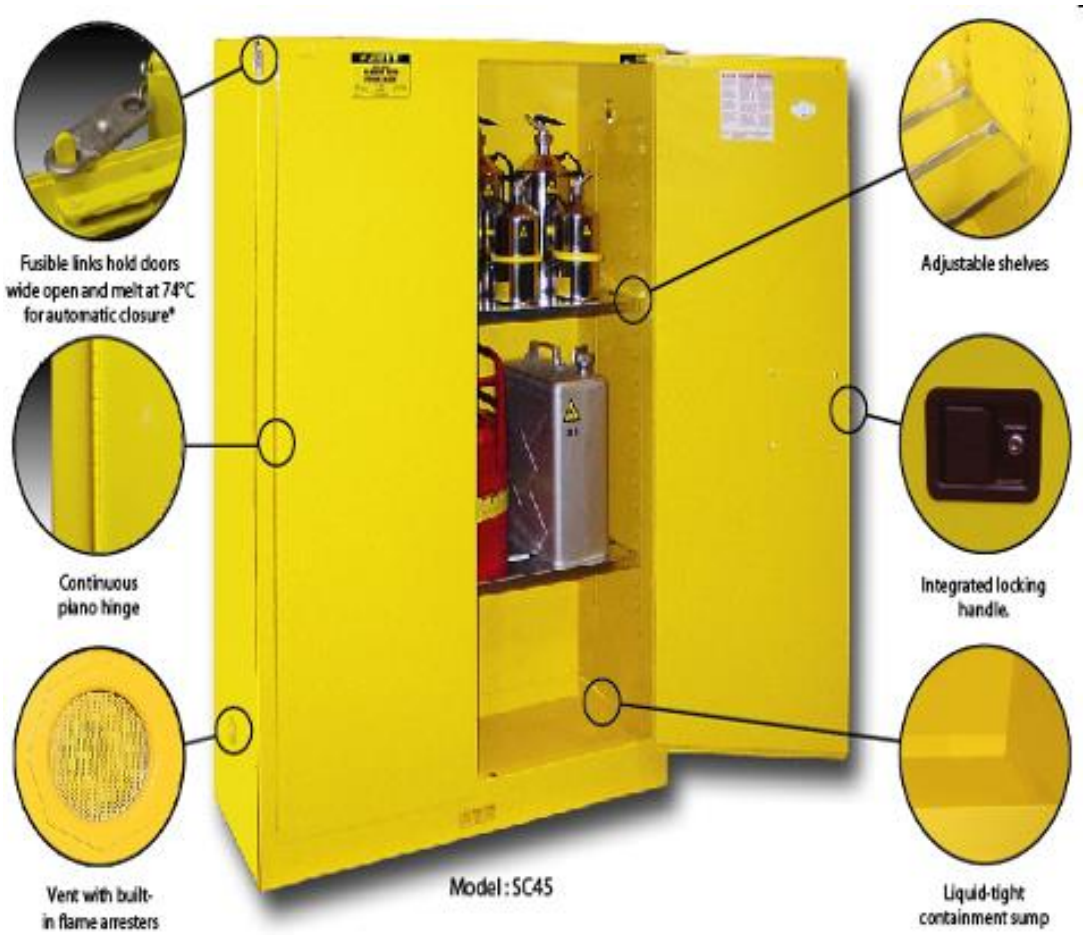


+ Compatibles

- Incompatibles

O Compatible under certain conditions

Hazardous Waste Storage: Flammables



Provides resistance to contents inside to allow personnel ample time to evacuate

Hazardous Waste Storage: Corrosives

- Separate acids and bases accordingly
- Use secondary containment

Waste: general

- Do not put everything on the first bin you see or in the sink!
- Inform yourself about waste elimination rules in your lab
- Chemicals have to be labeled!
- Biological waste have to be inactivated

Hazardous Waste Storage & Disposal

Respect regulatory standards for your own protection!

- Ask lab director for instructions
- Refer to special instructions and SDSs
- DO NOT mix incompatibles
- Never pour anything down the drain unless you are told to do so
- Store waste in secondary containment
- DO NOT leave solvents to evaporate in the hood

Biological waste

- Compulsory destruction of biological waste
- Classification according to biological activity
- Heat and/or chemical disinfection
- Class 2/3: dedicated bags, containers, intermediary storage room, autoclaving by trained employees
- Mixed waste! (consider all risks)
- Inform yourself, ask questions!

Hydrofluoric acid

Waste:

- Never pour it down the drain
- Store in polyethylen or Teflon containers
- Always cleary label the container

Spillage small quantities:

- Alert and evacuate the area **CALL 115**
- Wear PPE including breathing mask
- Do not use sand
- Neutralize: calcium carbonate, calcium hydroxyde
- Use chemical absorbant

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Ten Security Rules

1. Learn the biologic/chemical characteristics of the experimental organisms/reagent

2. Look up which potential hazards for substances/organisms you are using

3. Substitute pathogenic organisms and dangerous chemicals when possible
Ex. latest generation of lentivirus; ethanol vs methanol

Ten Security Rules

4. Protect yourself, the people around you and your environment

5. Plan and organize your experiments in advance; avoid being in a hurry

Working under stress increases the risk of accidents

Ten Security Rules

6. Don't become accustomed to dangerous situations.

7. Assess any modifications in working conditions or methodology.

8. Coordinate and harmonize the work with other people sharing lab space, instruments and reagents. Avoid if possible, working alone. Communicate!

Ten Security Rules

9. Follow the rules established in your lab for waste disposal.

An experiment ends when all the waste has been disposed in an appropriate way – «Cradle to Grave»

10. Practice first aid, memorize the location of fire blankets, extinguishers and emergency exit and evacuation routes. Report ALL accidents to your lab leader immediately, even if you think it is minor.

Contact Information

Emergency on campus: **Call 115**

From your mobile phone: **Call 0041 21 692 20 00**

UniSEP Occupational Health & Safety Services

- Telephone: 021 692 **25 72** / 021 692 **25 82**
- Email: sst-unisep@unil.ch
- www.unil.ch/unisep

Nurse

- Telephone: 021 692 **25 77**
- Email: accueilsante@unil.ch