## Safety Guide for Laboratory Technion Employees



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The Technion Safety Unit is a professional unit. Its principle endeavor is to advise all Technion inhabitants regarding various safety and hygiene issues to prevent accidents and occupational disease. The unit promotes safe science.

The unit wishes to establish a common, positive and proactive language to improve and assist management, principle investigators (PIs), Technion employees and students on the myriad issues circling safety and hygiene in the working environment, specifically within the various Technion laboratories. The unit therefore focuses on a number of activities, such as R&D support, Technion safety regulations and work instructions, risk assessments both for construction of new facilities as well as in laboratories, various state permits, environmental monitoring, legislative updates and their consequences, event planning and safety regulations application, chemical and biological safety, laser safety, ionizing radiation and ELF safety, accidents investigations intended for learning, improving and processes streamlining. Cumulative evidence has shown that it is not enough to provide safe equipment, systems and procedures if the culture of the organization does not support and encourage safe work, therefore designing and maintaining a safety culture is probably the most important issue in modern safety thinking and practice.

While fostering a strong, positive safety culture in academic research laboratories can reduce the risk of incidents and accidents, it cannot eliminate that risk. The major objective of chemical and biological research endeavors is to expand knowledge. The very character of academic research and its pursuit of new knowledge engenders an entrepreneurial spirit. This pursuit entails experiments that may involve hazardous substances and new reactions, the nature and magnitude of which cannot always be predicted.

The objective of establishing a strong and positive safety culture in a research setting is not to remove all risks — an impossible task — but to identify and mitigate hazards that are foreseeable, employ general precautions that help protect against unforeseeable hazards and

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ensure the capacity to respond to incidents in ways that minimize harm. Our primary goal is to constitute a reasonable risk activity considering research goals and according to legislation. An ideal laboratory safety culture ensures that all researchers, employees and students who set foot in a research laboratory, understand the environment they are stepping into, are aware of the hazards posed by the reagents with which they will work with, and are therefore knowledgeable of all the appropriate measures which need to be exercised to protect themselves and their co-workers in case of unexpected events. The safety culture we strive to develop encourages all laboratory personnel to place the highest priority on best practices and to raise concerns to colleagues and supervisors, including PIs, when they identify or are concerned about potential safety problems or risks. Finally, environmental safety and health officers should work collaboratively with all academic parties, assisting their efforts to establish a healthy safety culture.

Technion safety site at the following address: <u>http://saftey.net.technion.ac.il</u> This booklet is written in the masculine gender but is intended for men and women alike. The unit is located at the Canada building, first floor, rooms # 106-112

Phones: 04-8292146-7

Fax: 04-8292148

Email: Tsafety@dp.technion.ac.il



#### Technion Safety & Radiation Unit Safety Guidelines for Technion Employees

Organization Work Safety Regulations (Provision of Information and Employee Training), 5759-1999, prescribes guidelines for providing employees with up-to-date information about risks in the workplace and for providing current instructions on the safe use, operation and maintenance of equipment, materials and work procedures.

This booklet is intended to call your attention to potential safety risks during your stay at the Technion campus.

You are requested to carefully read these instructions and strictly obey the safety and hygiene rules.

Please note, these instructions are only basic instructions and are not in lieu of additional instructions published by the Technion and those published in the future. These guidelines also do not replace or supersede any law or regulation pertaining to safety published in the past or which will be published in the future.

All laboratory incidents must be reported to the Safety and Radiation Unit at the Technion to constantly improve safety standards and protocols. In case of an emergency in the laboratory call the emergency services at (#2222). Evacuate the injured person to safety and provide first aid. Provide technical assistance to emergency personnel. In case of an all-out emergency, hit the emergency button and follow the same protocol outlined above.



#### Malfunction or a Safety Hazard

- If you discover a malfunction, safety hazard or immediate risk (such as a leak of liquids, gas odor, burning smell, break etc.) stop all work procedures and immediately call the Security Unit, phone: 2222.
- > Provide the details of the incident and its precise location.
- > Verify that your notification has been received and the hazard removed.
- > Avoid blocking passageways and/or emergency exits. Ensure that others do not do so either.

**First Aid** 

- Only a trained and certified person may provide first aid to an injured person. Unprofessional care is liable to cause more harm than good.
- If you are injured in the framework of your work, immediately seek first aid at the Technion clinic situated at the Ullman Building, floor 200, phone: 04-8807515, or contact another certified party and report to the security center, phone: 2222.
- > If a foreign object has entered your eyes, do not try to remove it by yourself.
- If a chemical substance has gotten into your eyes, wash them thoroughly with water for at least 15 minutes and obtain medical care.
- If a colleague is injured, do not waste time. Immediately call a certified person. Call 2222 and provide all the details, including the building, room, surname and telephone number.

# Medical Examinations

- As part of your hiring process by the Technion, you will be asked to fill out a Health Declaration form. Filling out this form is mandatory.
- During your work at the Technion, you may be directed to undertake periodic medical examinations if your line of work necessitates occupational medical examinations.
- > You must arrive for these examinations at the stipulated time and place.
- If your job requires contact with various chemical substances and/or pathogens, you must take care to use personal protective equipment (PPE), such as protective goggles, gloves and sealed shoes in accordance with the substance classification.



A fire can spread rapidly.

- Common causes of laboratory fires are: electrical circuit overloading, poor electrical maintenance, inadequate cable insulation, excessively long gas tubing, equipment unnecessarily left switched on, open flames, improper storage and handling of flammables or explosives materials, sparking equipment near flammable substances and vapours, improper ventilation, cigarette butts.
- Know the location of firefighting equipment and how to operate it. Ensure that there is free access to firefighting equipment.
- Use fire extinguishers with the correct labels to put out fires. Do not rush and spray water in a way that can endanger others and/or equipment. Fire-fighting equipment should be placed near room doors and at strategic points in corridors and hallways. This equipment may include hoses, buckets (of water or sand) and a fire extinguisher. Fire extinguishers should be regularly inspected and maintained, and their shelf-life kept up to date.



Fire warnings, instructions and escape routes should be displayed prominently in each room and in and hallways. Make sure that you know the location of emergency exits and emergency switches in case of a fire at your workplace.

- Firefighting equipment is intended solely for emergencies. Do not use the firefighting equipment for any other purpose.
- ▶ In case of fire call Security @ 2222.



#### Electricity



- The rule "do it yourself" does not apply to electricity. If your electrical device is not working, unplug it immediately from the power source, notify your supervisor and send it for repair.
- > Only certified electricians are qualified to fix electrical equipment.
- > Do not handle any electrical appliances with moist or wet hands.
- If you have received an electrical shock, stop using the device immediately and disconnect it from the power source.
- Do not carry out any electrical work; replacing light bulbs, fixing sockets or plugs, etc. unless you are a certified electrician.
- > Do not use electrical devices that were not purchased by the Technion.
- Check the intactness of the wiring and sockets every couple of months. Flawed equipment will not be used. A flaw in the electrical isolation could lead to current leakage to the equipment's mantle.
- If possible, try working with appliances which can operate at below 50 V, especially in wet or moist conditions.

## Noise

The effect of excessive noise is insidious over time. Some types of laboratory equipment, such as certain laser systems, as well as sonicators and facilities where animals are housed, can produce significant noise exposure.

- Noise measurement surveys should be conducted by the safety unit to determine the noise hazard.
- > Where noise levels cannot be abated hearing protection should be used.

### Walking

- ▶ Be cautious around open pits that are improperly fenced. Notify the Safety Unit.
- > Do not step over equipment or pallets on the floor.
- > Do not walk beneath a beam or loaded crane.

- > Do not walk or stand between cars or forklifts and a wall.
- If you see an obstacle such as tools, poles, rolls, rags, etc., remove it and place it in a place where it will not be an obstacle and cause an accident.
- Shortcuts are always dangerous. Always walk on the designated path, even if it seems to be longer.
- ➤ Keep away from unfamiliar places where your presence is not necessary.
- Keep away from places where welding or cutting is underway, from places that produce sparks, dust, chips, etc., and from places where work in general and construction in particular are underway.

### Smoking

- Smoking on the Technion campus is completely prohibited, except for designated smoking areas. Refrain from smoking, but if you do, extinguish the butt thoroughly in the smoking areas only.
- > Do not throw cigarette butts into waste baskets or bins.
- Make sure the cigarette butt is turned off completely by monitoring it for five (5) minutes following extinguishing the butt.



- Workers are responsible for notifying another person (night guard or worker in another room) that they are working alone.
- Do not work in a locked room.

#### **Work Accidents**

- If case of a work accident quickly notify your superior and the Safety Unit of the incident, as soon as possible following its occurrence. Immediate notification is important to aid the necessary inquiry concerning the accident's circumstances and to draw conclusions.
- In case of a work accident that requires medical attention, evacuate to the Technion clinic or call for a medic. Summon an ambulance if immediate evacuation is necessary. The Safety Unit will issue Form BL/250 later.
- In case of a work accident (which is not a car accident) on the way to- or from- work, the employee must notify his supervisor, who will notify the head of the Safety and Radiation Unit *via* an electronic form. The Safety Unit will hold an inquiry and will issue Form BL 250.
- The employee must send a preliminary work injury form, including a medical report and recommendations, to the Safety Unit and to the HR.



#### **End of Workday**

- Lock the equipment and your tools.
- ➤ Turn off lights.
- Unplug sensitive machinery, devices and all other equipment connected to a power source (computer, electricity, air conditioner, etc.).



- Adjust the computer's height. Your feet should be resting flat and stable on the floor or footrest.
- Pressure on your thighs near the knees or on your calves should not be too great. Your thighs should be as horizontal as possible.
- If it is possible to adjust the computer's angle, try different angles for the computer. You may need a smaller chair if there is pressure on your thighs or calves.
- Adjust the height of the backrest to support your lower back. Your buttocks should sit comfortably with a space between the lower end of the backrest and the seat.
- Adjust the angle of the backrest for you and your work. Leaning slightly backward may be the most comfortable position. Try to avoid leaning forward.
- Consider your shoulders. Are they low and relaxed? If not, adjust the height of the table or the chair and obtain a footrest.
- Consider your elbows. Are they free at your sides? If not, learn a relaxation technique. If the armrest is too high, remove it. If the backrest is too wide, replace it.
- Get closer to your workstation. Ensure that the keyboard is positioned at a comfortable height. If necessary, adjust the height of the table. Your wrists should be held straight.
- Adjust the position of the keyboard. It should not be too far so that your arms are extended forward. A 50 mm space between the table and the keyboard may help your wrists. If your desk has a fixed height, you might not be able to achieve a position that is simultaneously comfortable for your legs, shoulders, elbows and wrists. If that is the case, get a footrest.
- Adjust your monitor. The distance between your eyes and the monitor should be comfortable. (It varies from person to person within a range of 45-80 cm). Check also the viewing angle. A downward angle of 20° to the center of the monitor is reasonable.
- What do you look at most frequently? What kind of work do you do? Do you only look at the page? Do you look only at the monitor? Do you look at both the page and the monitor equally? The answer to these questions will help you decide where to position the monitor and the page. Place the item that you look at most often directly opposite your eyes.
- > **Check** the **cables** beneath your workstation for your safety.
- Check that there are **no reflections** on your screen)



#### **Personal Protective Equipment (PPE)**

PPE include equipment accessories the employee must wear to prevent exposure to hazardous materials. Nevertheless, PPE does not eliminate safety risks, but rather assists in protection, lowering potential exposure.

- Long-sleeved laboratory coats must always be worn when working in a chemical and/or biological laboratory.
- Nitrile or latex gloves must always be worn when working in a chemical and/or biological laboratory. Latex gloves supply high sensitivity, enabling maximum control of touch and gentle motor skills; nitrile gloves do not contain the latex protein. They are more durable to shearing and chemicals but they can cause oxidation of silver and highly-reactive metals, which can react with sulphur.
- Designated protective goggles must always be worn while sharpening, welding, etching, cleaning with air pressure, etc. to protect your eyes.
- Designated protective goggles or a face mask must always be worn while using acids and/or glues and/or other chemical substances. Wear gloves and a long-sleeved lab coat.
- While working in noisy conditions, always wear earplugs or hearing protectors during your work or presence in the noisy area.
- When welding, transporting, or carrying heavy materials, maintenance, or working in hazardous areas to your feet, wear standard safety shoes with a protective cape (S3 working shoes).

#### Conduct

- Concentrate on your work and do not get distracted or distract your work colleagues. Distraction is liable to cause an accident.
- > Remove tools and equipment from passageways; they are liable to cause an accident.
- > Be attentive and courteous to your colleagues; avoiding tensions prevents accidents.
- Keep the Technion and your workstation clean and do no throw out waste except in designated bins or areas.
- Do not perform the work of another employee or work you are not certified to perform without being qualified to do so. You are liable to jeopardize yourself and those around you.

- Do not operate machines, facilities, tools or processes before you are familiar with the operating and safety instructions and certified to do so.
- > Hammer or chisel blows are liable to spray shards, endangering your eyes.
- > A broken tool handle (hammer, screwdriver, file) is liable to cause injury.
- > Files, screwdrivers, etc. with no handle are liable to cause injury.
- > Open plier jaws are liable to cause an accident.
- Do not use
  - A file as a lever or its tip as a borer.
  - A wrench that does not fit the bolt.
  - A pipe to extend a wrench.
  - Blunt cutters that are liable to slip.
  - Keep tools in pouches or toolboxes, or in your pant pocket or belt.
- > Keep tools in good shape. Send your tools for repair or replace them on demand.

#### Ladders

Technion employees may work at heights or on ladders following training, pursuant to the Work at Height Safety Regulations, 5767-2007, and with the approval of the Safety & Radiation Unit.

- > Use appropriate equipment for the work and make sure that you are properly fastened and secure.
- Use standard and intact equipment, such as safety harnesses, fall brakes, and hard hats with straps or a chin strap.
- ➢ Always use an intact ladder or scaffold.
- > Avoid climbing on chairs, pipes, tables and other improvisations.
- > When ascending and descending a ladder, always face the ladder.
- Lean on the ladder at a suitable angle and ensure that you are not about to slip. If necessary, obtain the help of another employee.

#### Lifting and Carrying Loads

- If you must lift any load, do so properly: bend your legs and use your leg muscles, not your back muscles. Keep your back straight.
- > Only lift what you can. If necessary, ask for help or use available lifting equipment.
- > Lift loads only when your view is unrestricted.



- ▶ Lifting equipment is tagged by a permitted work load sign. Do not overload it.
- > Avoid places where cargo is being lifted.
- > Protect your hands with gloves and your feet with safety shoes.
- When using lifting gear (chains, cables, etc.), verify that the gear is valid (by a certified lifting equipment inspector), intact and properly harnessed.
- You may only operate a lifting machine if you are certified to do so and you are familiar with its use and safety instructions.
- All lifting and carrying of materials must be undertaken slowly and carefully, considering the cargo, environs and other employees in the area.

#### **Machinery and Equipment**

- Your work may well involve machinery. Do not operate a machine or device if you are not authorized to do so.
- > Do not work with or operate tools or a machine without the assembled shields or guardrails.
- Never dismantle a shield or guardrail from a machine. Only an eligible person may dismantle shields or guardrails, after the machine is turned off and disconnected from its power source (electricity, air, etc.).
- Concentrate on your work and avoid distractions.



- Compressed gases are usually supplied through a fixed gas pipeline system or *via* single gas cylinders, which could be toxic, flammable, oxidative, corrosive or inert. Leakage of compressed gases could be dangerous.
- Working with gas cylinders is only allowed by qualified personnel, who are well ackainted with the gas SDS.
- > Working with gas cylinders necessitates the use of proper PPE.
- > All compressed gas cylinders, whether empty or full, must be separately stored in an upright position.
- Compressed gas cylinders must be secured separately. It is strictly forbidden to knock over or slam cylinders. Towing or rolling compressed gas cylinders is strictly forbidden.
- Shuttling of compressed gas cylinders will always be executed with their protective caps on.
- Leakage of a compressed gas, such as acetylene or hydrogen, also poses an explosion risk. Therefore, proper ventilation should be maintained around the laboratory and gas detectors with alarm mechanisms should be administered.

- Gas cylinders must be separated according to their group: flammables must be kept away from corrosives. Inert gasses will always be stored between flammables / toxic gasses and corrosives.
- The separation distance between gas cylinder groups should be at least 6.1 meters or include a physical barrier between the cylinder groups. Storage should always be in a shaded, locked and well-ventilated area.
- > Flammable and toxic gasses, including more than 5% forming gas, will never be stored inside a lab.
- Flammable gas cylinders should be distanced away from any ignition or spark sources. Smoking is strictly forbidden as is the use of open fire (except in a designated hood).
- Gas cylinders will always be connected to an origin panel, which will be fixed to a wall in the lab. The panel will be connected to the cylinders using a flexible and designated pipeline and will also include a regulator and an emergency shut-off system (EHS).
- > Every cylinder must be connected to a regulator and a valve.
- Every lab in which a gas system is installed should have a main and accessible gas system faucet at the entrance to the lab.
- All gas cylinders in use must have a valid hydrostatic testing: every 5 years ot every 8 years for cylinders which are already under use; corrosive gas cylinders should go through a hydrostatic testing every couple of years.
- > The gas cylinders and pipeline should be marked by the gas name every 80 cm.
- > Never stand in front of the cylinder's opening.
- Never try to fix a leaking cylinder!
- > It is strictly forbidden to work with gas cylinders after working with oil or grease.
- > It is strictly forbidden to shuttle gas cylinders inside elevators with other passengers on board.

#### Electricity

- An electrical appliance or device is unsafe if used incorrectly. Leave the repair work to a certified electrician. Avoid improvised electrical arrangements and do not try to make repairs if you are not certified to do so.
- The "do-it-yourself" rule does not apply to electricity. If your electrical device is not working properly, immediately unplug it, notify your superior, and send it for repair. This is especially true for mobile electrical devices (drills, sharpeners, etc.) Verify that the connections and isolation are intact.
- Place electricity cords so that they will not create an obstacle to the movement of people or equipment.
- > If you see a crack, break or flaw in a tool, stop your work and notify your superior.
- ▶ If you get a shock, immediately stop work and disconnect the power supply.



Do not carry out electrical work – replacing light bulbs, repairing sockets or plugs, etc. – unless you are a certified and authorized electrician. Only a person certified by the Technion may replace a light bulb.

#### Working with Heat

- Do not work with heat (welding, cutting and soldering), except in accordance with Safety Procedure No. 07-118.
- When working with thinners, flammable gases or acetone, take extra caution when positioning the containers, connecting them to systems, closing them after use and preventing leaks and spills.



While the Chancellor, Vice Presidents, Deans and Department Heads are responsible for the broad implementation and enforcement of Technion's Safety and health policy, the



daily responsibility for the adherence to safe laboratory practices in chemical and biological laboratories rests with the PI/Laboratory Supervisor.

<u>All</u> personnel (PIs, laboratory managers/engineers, employees and students) have a duty to fulfill their obligations with respect to maintaining a safe work environment.

Do not work in a chemical laboratory without obtaining appropriate training and meticulously read the safety sheets of the materials involved in the experiment. Basic safety training for chemical, biological and medical laboratory workers can be found on the safety website: http://safety.net.technion.ac.il.

Before commencing work in the laboratory, familiarize yourself with all the main relevant safety procedures and equipment and their location.

Below	are	the	main	items:
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1.	Eye-washer station	Usually located at lab entrance
2.	Emergency shower	Usually located above entrance door
3.	Fire extinguisher	Usually located at lab entrance or inside the firefighting
		cabinet
4.	"Red" firefighting blanket	Usually located inside the firefighting cabinet
5.	General cutoff switch	Turns off electricity for all outlets (the laboratory lights
		remain on); located at lab entrance
6.	Main power switch	Turns off all electricity in the lab; located within lab/floor
		electricity cabinet
7.	Main gas valve	Located outside lab entrance. Every couple of work benches
		also have main-secondary gas valves marked in yellow
8.	Emergency exits	Familiarize yourself with the location of the laboratory and
		building exits
9.	First aid kit	Familiarize yourself with the location of the first-aid kit and
		check that its contents is complete
10.	Lab phone	Familiarize yourself with its location. Dial 2222 in case of an
		emergency
11.	Smoke detectors	Located within lab ceiling

#### **Responsibilities of the Principle Investigator (PI)**

The PI is responsible for the safety and health of all personnel working in his or her lab. The PI may delegate safety duties but remains responsible for ensuring that the delegated safety duties are adequately performed. The PI's responsibilities are:

1.Knowing all applicable safety and health regulations, training and reporting requirements and standard operating procedures associated with chemical safety for regulated substances.

2. Identifying hazardous work or research processes in the lab, determining safe procedures and controls and implementing standard safety procedures.

3. Consulting with the safety and radiation unit regarding the use of higher risk materials or conducting higher risk experimental procedures so that special safety precautions may be administered.

4. Ensuring laboratory or other personnel under his/her supervision have access to and are familiar with all safety regulations.

5. Training all laboratory or other personnel he/she supervises to work safely with hazardous materials.

6. Maintain written laboratory protocols, emphasizing safe handling of hazardous materials.

7. Ensuring the availability of all appropriate personal protective equipment (PPE) (lab coats, gloves, eye protection, etc.) and ensuring the PPE is maintained.

8. Informing facilities personnel, other non-laboratory personnel and any outside contractors of potential laboratory-related hazards when they are required to work in the laboratory environment.

9. Promptly notifying the safety and radiation unit should he/she become aware that work place engineering controls (e.g., fume hoods) and safety equipment (e.g., emergency showers/eyewashes, fire extinguishers, etc.) become non-operational.

10. Promptly reporting accidents and injuries to the safety and radiation unit. Serious injuries MUST be reported immediately. Any doubt as to whether an injury is serious should favor reporting.

## **Responsibilities of the all Personnel Working in a Chemical Laboratory (Investigators, Employees, Students)**

1. All personnel working with potentially hazardous chemicals are responsible to participate in training seminars on general laboratory safety instructions, following all verbal and written laboratory safety rules, regulations and standard operating procedures required. Without proper safety training you are not allowed to work in the laboratory.

2. Developing good personal chemical hygiene habits, including but not limited to, keeping the work areas safe and uncluttered.

3. Planning, reading and understanding the hazards of materials and processes in their laboratory research or other work procedures prior to conducting work. Carefully read the safety sheet (MSDS) of the substances being used.

4. Utilizing appropriate measures to control identified hazards, including consistent and proper use of engineering controls, PPE and administrative controls.

5. Understanding the capabilities and limitations of the PPE.

6. Consulting with PI or lab manager/engineer before using particularly hazardous substances, explosives and other highly hazardous materials or conducting certain higher risk experimental procedures;

7. Properly storing, identifying, handling, and disposing of hazardous waste.

8. Immediately reporting all accidents and unsafe conditions to the PI or lab manager/engineer.

9. Completing all required safety and health training and providing written documentation.

10. Participating in the medical surveillance program, when required.

11. Informing the PI or lab manager/engineer of any work modifications ordered by a physician as a result of medical surveillance, occupational injury or exposure.

12. Notifying in writing and consulting with the PI or lab manager/engineer, in advance, if they intend to significantly deviate from previously reviewed procedures (Note: Significant change may include, but is not limited to, change in the duration, quantity, frequency, temperature or location, increase or change in PPE, and reduction or elimination of engineering controls).



#### Technion Safety & Radiation Unit General Safety Regulations in a Lab

Most accidents and/or near-misses occur because of the following main reasons:

- **Not following standard safety procedures** (taking short-cuts)
- **Underestimating the dangers associated with chemical reactions** (over confident)
- **Distractions** (conversations, tiredness, multitasking)

Working in a chemical laboratory requires caution and meticulousness in performance. Familiarize yourself with the lab. Know the location of the safety showers and eyewash stations, fire extinguishers, first aid kit, the chemical spillage kit and the emergency exit routes of the lab and/or building. Most accidents are preventable if safety rules are followed, therefore, act in accordance with the safety instructions.

- Maintain clean hands. Sterilization and/or hand washing, preferably with antiseptic chemicals, including alcohol and chlorhexidine or water and soap accompanied by drying using one-time paper towels or the use of modern hand drying machinery.
  - Hand washing or sterilization will be performed following lab work of any kind, including all contact with chemical substances or biological contaminants, before and after going into and out of the toilet and prior to eating and/or drinking and/or putting on makeup and/or smoking (where it is allowed).
- The laboratory should be kept neat, clean and free of materials that are not pertinent to the work. All items that do not belong in the lab and pose additional hazard should be removed or stored properly.
- Eating, drinking, chewing gum, putting on makeup and smoking in the laboratory are strictly prohibited. Eating or entering eating areas with a laboratory coat on is strictly forbidden.
- Working alone in the lab is prohibited by law. Make sure that there are at least two people in the lab or someone located next door coupled to notifying security regarding your exact whereabouts (building's name, floor and room number/s). Specifically, hydrogenations, the use of pyrophorics, corrosives or reactions involving potentially explosive reagents (e.g. iodosobenzene, alkali metals), BSL2 work, working with heavy machinery and other high-risk operations are not allowed to be performed outside regular working schedules.
- If you need to work overnight, contact your supervisor to formulate a work plan. The safety unit may also assist in providing the proper working environment to allow you to work alone. Check before commencing work that your **hood** is in good working condition, i.e.: not cluttered with reaction flasks, chemicals and solvent bottles. Ongoing reactions should be labeled and chemical waste bottles should be closed.
- Laboratory refrigerators are off-limits. It is strictly forbidden to store food and beverages in laboratory refrigerators.



- Centrifuges pose a grave risk if they rotate at high speed and are not sealed, therefore they must be equipped with a locking apparatus preventing both operating open centrifuges as well as opening the centrifuge's lid while rotating.
- > All synthesized chemicals, reactions flasks, solvent pots, etc. should be **clearly labeled**.
- Assume that **all** newly synthesized **chemicals are toxic** and handle them as such. Read MSDS.
- It is prohibited to taste or sniff a chemical substance. If you are required to smell chemical vapors, you must keep the vessel in which the chemical is in away from your nose and wave your hand over the opening so that the substance's vapors will reach your nose in a controlled manner.
- Do not put a pipette into your mouth. Using your mouth is a hazard that can cause a toxic substance to be inhaled. Use only a pump aid, such as a syringe, propipette or "Jackie" for this purpose.
- After removing the substance, take care to immediately close the container from which it was originally taken out of to prevent contamination of the bulk substance, entry or emission of water vapors, emission of volatile substances into the environment or confusion between lids.
- Do not return a chemical substance to a container. In case unused chemical substances are left, it is strictly prohibited to return it to the container from which it was originally pumped out of (bottle, box, flask, container). Returning a substance to the container may contaminate the original bulk substance in the container or cause an unwanted chemical reaction in other cases.
- > All experimental residual substances must be classified as **chemical waste**.
  - Treat the chemical waste in accordance with the specific substance's handling instructions.
  - Do not pour substances from different classes into the same chemical waste storage container.
  - Do not dispose of any hazardous chemicals through the sewer system. These substances might interfere with the biological activity of waste water treatment plants, create fire or explosion hazards, cause structural damage or obstruct flow.
- Research staff and students should never work alone on procedures involving hazardous chemicals, pathogens or physical hazards.
- A designated eye washer and emergency showers operated by a hand chain are installed in every chemical lab. In case of a splash, rinse body part using an excessive amount of water onto body part, clothing or bench, which came in contact with the chemical.
- Beware of broken glass. Glass is a hard-breakable material that can be lethal. When adjusting a glass pipe or thermometer into a stopper, a rubber hose or a cork, use grease and protect your hands with a cloth.
  - Trying to release a cork stuck in a glass vessel could be dangerous. Apply controlled heat or incubation in appropriate solvents by qualified personnel.
  - Do not use a cracked or broken glass vessel.

- If you break a vessel or encounter a broken vessel, give it to a technician and obtain another one.
- Broken glassware or any glass waste should always be evacuated into designated sharpies bins. Broken glassware, which are thrown into ordinary trash bins, could injure cleaning employees.
- Always protect your eyes when working with glass.
- Glassware should always be marked, stating their contents.
- For procedures which include freezing or freezing and thawing cycles due to thermic expansion work with designated glassware with thick walls. Pay extra attention not to work with cracked glassware.
- Hot glass looks identical to cold glass.
- Glassware could explode if exhaustion pipes are blocked.
- Glassware could collapse under negative pressure conditions.
- When pumping compressed air into a glass vessel in order to dry the vessel, following its washing, the vessel could break. It is therefore recommended to allow glassware to dry on a designated drying apparatus or in an oven.



#### Technion Safety & Radiation Unit Upon Entering a Chemical Laboratory...



Before commencing a new experiment or chemical reaction please maintain the following guidelines:

- 1. Arrive mentally prepared: make sure you are well rested and not distracted by other students / conversations / other experiments in the laboratory. Never multitask.
- 2. Perform a risk assessment prior to commencing your experimental protocol:
  - 2.1 Pinpoint hazards associated with chemicals to be used.
  - 2.2 Make sure you are knowledgeable with the lab's spillage kit, the location of the lab's fire extinguisher, emergency shower and the eyewasher station.
- 3. Make sure you custom an appropriate experimental set-up, for example:
  - 3.1 Note whether the glassware is undamaged and/or properly clamped.
  - 3.2 Check whether the equipment/glassware is suitable for working with low- or high-temperature or pressure.
  - 3.3 In case your reaction might produce excess pressure, assure the existence of an outlet (oil/mercury bubbler).
  - 3.4 All reactions necessitating working in a closed vessel (e.g. pressure tube or Schlenk tube) oblige calculating the maximum pressure, thereby making sure the glassware is indeed resistant to handle such pressures.
  - 3.5 Reactions under pressure, reduced pressures as well, should always be performed behind a blast shield. Glassware can always fail unannounced under high- or low-pressures.
  - 3.6 Position and clamp the reaction apparatus thoughtfully.
  - 3.7 Minimize shuttling of the set-up apparatus.
  - 3.8 Each reaction should be labeled, specifically reactions which are ongoing. Always think of the safety of others working in the lab.
- 4. Follow to the letter the experimental protocol. Read SDS carefully and make sure you are knowledgeable regarding products that are to be formed during the reaction (including gasses) and their associated hazards. Take extra care to follow the special safety precautions guidelines of each protocol section.
  - 4.1 Combine reagents in the appropriate order.
  - 4.2 Never add solids to hot liquids.
  - 4.3 Never add water to acids, only vice versa: acids should always be added to water.
- 5. Take your time to perform the chemical reaction and do not take short-cuts. Severe accidents have taken place when students took grave initiatives to "save time".

#### Technion Safety & Radiation Unit Personal Protective Equipment (PPE)



PPE includes equipment accessories the employee must wear to mitigate, at a minimum,

exposure to hazardous materials. Nevertheless, PPE does not eliminate safety risks, but rather assists in protection, lowering potential exposure. In some cases, additional, or more protective, equipment must be used.

- It is mandatory to wear a long-sleeved tick-tock buttoned lab coat when working in a chemical and/or biological laboratory. Do not wear sandals or open shoes. Use flame-resistant laboratory coats for high hazard materials, pyrophorics and flammables.
- Gloves protect against skin absorption of chemicals, chemical burns, thermal burns, lacerations, chemicals of unknown toxicity, corrosives rough or sharp-edged objects, and very hot or cryogenic liquid exposure. The two most common gloves for laboratory use are:
  - Latex gloves supply high sensitivity, enabling maximum control of touch and gentle motor skills. However, latex may cause sensitivity or become an allergen. Latex exposure symptoms include skin rash and inflammation, respiratory irritation, asthma and shock.
  - Nitrile or neoprene gloves which do not contain the latex protein are more durable to shearing and chemicals, but they can cause oxidation of silver and highly-reactive metals, which can react with sulphur.
  - Gloves degrade over time, so they should be replaced as necessary to ensure adequate protection.

Butyl	Offers the highest resistance to permeation by most gases and water vapor. Especially suitable for use with esters and ketones.
Neoprene	Provides moderate abrasion resistance but good tensile strength and heat resistance. Compatible with many acids, caustics and oils.
Nitrile	Excellent general duty glove. Provides protection from a wide variety of solvents, oils, petroleum products and some corrosives. Excellent resistance to cuts, snags, punctures and abrasions.
PVC	Provides excellent abrasion resistance and protection from most fats, acids, and petroleum hydrocarbons.
PVA	Highly impermeable to gases. Excellent protection from aromatic and chlorinated solvents. Cannot be used in water or water-based solutions.

contamination.

Viton	Exceptional resistance to chlorinated and aromatic solvents. Good resistance to cuts and abrasions.
Silver Shield	Resists a wide variety of toxic and hazardous chemicals. Provides the highest level of overall chemical resistance.
Natural rubber	Provides flexibility and resistance to a wide variety of acids, caustics, salts, detergents and alcohols.
• Most S	DS recommend the most protective glove material in their PPE section.
• Gloves	should be removed avoiding skin contact with the exterior of the glove and possible

- When handling acids, bases or other corrosive solvent mixtures, elbow thick rubber gloves should be worn. Underneath rubber gloves one should always wear nitrile gloves in case the outer rubber gloves are cut.
- Remove one glove when entering an elevator and put its buttons with the ungloved hand. Similarly, upon opening and closing door handles.
- Remove gloves before operating computers.
- Safety glasses provide the basic protection against chemical splashes, sparks, or glass shards. Safety goggles should form a seal with the face, completely isolating the eyes from the hazard. Specifically, protective goggles or a face mask must always be worn while using acids and/or glues and/or other chemical substances. If you are required to wear prescription glasses, goggles should be worn over them. Refrain from wearing contact lenses. Their use may cause damage if vapor from a foreign substance is trapped between the lens and the eye, specifically when working with volatile and toxic chemicals, since an eye contact could interfere in case of an accident with a liquid, which will necessitate the use of a designated eye washer device.

• Eye and Face Protection PPE options:

Safety Glasses	Safety frames constructed of metal or plastic and impact-resistant lenses. Side protection is required. [ANSI standard Z87.1]
Chemical Splash Goggles	Tight fitting eye protection which completely covers eyes, eye sockets and facial area surrounding eyes. Provides protection from impact, dust and splashes. [ANSI standard Z87.1]
Dust Goggles	Tight fitting eye protection designed to resist passage of large particles through goggles (direct ventilated goggles) [ANSI standard Z87.1].
Fluid Resistant Shields	Fuid resistant or impervious and provide splash protection from biological material, such as human or non-human primate body fluids.
Face Shields	Extend from eyebrows to below the chin and across the head's width. Face shields protect against potential splashes or sprays of hazardous liquids. When worn for protection against UV, must be specifically designed to protect the face and eyes from hazardous radiation. When used for chemical protection or UV protection, must comply with ANSI standard Z87.1.
Laser Eyewear	Required for Class 3 and 4 laser use, where irradiation of the eye is possible. Such eyewear should be used only at the wavelength and energy/power for which it is intended.

- Always wear closed-toe shoes inside buildings where chemicals are stored or used. Do not wear perforated shoes, sandals or cloth sneakers in laboratories or where mechanical work is conducted. These shoes offer no barrier against chemical and physical hazards. Chemical resistant shoes or boots may be used to avoid possible exposure to corrosive chemical or large quantities of solvents or water that might penetrate normal footwear (e.g., during spill cleanup). Leather shoes tend to absorb chemicals and may have to be discarded if contaminated with a hazardous material.
- Confine long hair and loose clothing.

While working in noisy conditions, always wear earplugs or hearing protectors during your work or presence in the noisy area.

In addition to all PPE mentioned herein, one should always plan beforehand to match the optimal PPE to the chemical reactions performed. For example, when working with pyrophoric materials, it is not advisable to wear clothing made from nylon Think Safety! PPE should always be kept clean. The equipment should be inspected prior to use and fit and worn properly. If the PPE becomes contaminated or damaged, it should be cleaned or replaced.



#### **Fume Hoods**

Fume hoods are the most commonly used exhaust systems on campus. Other methods include vented enclosures for large pieces of equipment, biological hoods and glove boxes. Some systems are equipped with air cleaning devices (HEPA filters or carbon

absorbers). Exhaust from fume hoods are designed to terminate at least 3 meters above the roof deck. A properly operating fume hood can reduce or eliminate gases from volatile liquids, dusts and other contaminants.

- ➤ It is advisable to use a fume hood when working with all hazardous ubstances.
- Fume hoods should not be used for work involving hazardous substances unless they have a certification label that confirms annual evaluation, checking the fume hood air flow velocity. Each fume hood should have a current calibration sticker and a marker indicating the highest sash height to be used when working with hazardous materials.
- > Always keep hazardous chemicals more than 16 cm behind the sash.
- Never put your head inside an operating hood. The plane of the sash is the barrier between contaminated and uncontaminated air.
- Work with the hood sash in the <u>lowest practical position</u>. The sash acts as a physical barrier in the event of an accident. Keep the sash closed when not conducting work in the hood.
- Do not clutter your hood with unnecessary bottles or equipment. Keep it clean and clear. Only materials actively in use should be in the hood. When hazardous materials are in a fume hood, but it is not under active use (during an unattended reaction or experiment), the sash should be closed.
- ➤ Keep hood closed when you are not working in the hood.
- ▶ When an uncontainable fire commences in the hood, close the sash of the hood to contain it.









**Health Hazard:** A cancer-causing agent (carcinogen) or substance with respiratory, reproductive or organ toxicity, which may causes damage over time.



**Flame**: Flammable materials or substances liable to self ignite when exposed to water or air (pyrophoric), or which emit flammable gas.



Exclamation Mark: An immediate skin, eye or respiratory tract irritant, or narcotic.



Gas Cylinder: Gases stored under pressure, such as ammonia or liquid nitrogen.



**Corrosion:** Materials causing skin corrosion/burns or eye damage upon contact or corrosive to metals.



**Exploding Bomb:** Explosives, including organic peroxides and highly unstable materials at risk of exploding even without exposure to air (self-reactives).



Oxidizers: Chemicals that facilitate burning or make fires burn hotter and longer.



Acute Toxicity: Substances, such as poisons and highly concentrated acids, which have an immediate and severe toxic effect.

#### Technion Safety & Radiation Unit Lab Safety Equipment

#### **Fire Extinguishers**

- All laboratories working with combustible or flammable chemicals must be outfitted with fire extinguishers.
- All fire extinguishers should be mounted on a wall in an area free of clutter or stored in a fire extinguisher cabinet.
- Research personnel should be familiar with the location and use of the extinguishers in their lab.
- Laboratory personnel are not required to extinguish fires that occur in their work areas and unless it is a small fire (for example, a small trash can sized fire) or in case appropriate training has been received.



Any use of the fire extinguisher, the PI or lab manager/engineer must immediately report the incident to the safety and radiation unit.

ТҮРЕ	USE FOR	DO NOT USE FOR
Water	Paper, wood, fabric	Electrical fires, flammable liquids, burning metals
Carbon dioxide (CO <sub>2</sub> ) extinguisher gases	Flammable liquids and gases, electrical fires	Alkali metals, paper
Dry powder	Flammable liquids and gases, alkali metals, electrical fires	Reusable equipment and instruments, as residues are very difficult to remove
Foam	Flammable liquids	Electrical fires

#### Types and uses of fire extinguishers

#### Safety Showers and Eyewash Stations

- ➤ All laboratories using hazardous chemicals must have immediate access to safety showers with eye wash stations.
  - Access must be available in 10 seconds or less.
  - > No objects should be stored or left within this distance of the safety shower.
  - In the event of an emergency, individuals using the safety shower should be assisted by an uninjured person to aid in decontamination and should be encouraged to stay in the safety shower for 15 minutes to remove all hazardous material.



## Technion Safety & Radiation Unit **Fire Doors**

Fire doors are an integral of the building design.

These doors are an important element of the fire containment system and should remain closed unless they are on a magnetic self-closing or other automated self-closing system.

#### **Chemical Spills**

Chemical spills are quite frequent in the laboratory and can usually be handled without any significant hazards. Various precautions need to be taken depending on the nature of the spilled chemical (toxicity, flammability, volatility, etc).

- Equipment needed in case of a chemical spill: chemical spill kits, protective clothing: rubber gloves, overshoes or rubber boots and respirators, Scoops and dustpans, forceps for picking up broken glass, mops, cloths and paper towels, buckets, soda ash (sodium carbonate, Na<sub>2</sub>CO<sub>3</sub>) or sodium bicarbonate (NaHCO<sub>3</sub>) for neutralizing acids and corrosives chemicals, sand (to cover alkali spills), non-flammable detergent or vermiculite.
- If skin / eyes have been exposed to a chemical or to a solvent rinse affected area with copious amounts of water for at least 15 minutes.
- If case of exposure to a hydrofluoric acid (HF) containing solution rinsing should only be for five (5) minutes followed by application of Calcium Gluconate Gel to the affected area, followed by medical treatment. Vermiculite must not be used in case of an HF spillage (may cause hydrogen and the release of other chemicals).
- In case of eye contact, rinse with copious amounts of water and monitor the affected area. Seek medical attention.
- In case clothing has been contaminated, remove the contaminated clothing piece immediately. Rinse affected area with copious amounts of water. If necessary, seek medical attention.
- In case of a flammable chemical spill, extinguish all open flames, turn off gas in the room and adjacent areas, open windows (if possible), and switch off electrical equipment which may spark...
- In case of a chemical spill bearing a highly toxic character (ammonia, osmium, radioaisotopes, ethers, strong acids, nitro compounds, hydrofluoric acid, halogens, cyanides, nitriles, aromatic amines) outside of the hood do not attempt to clean the spill yourself. Notify co-workers and evacuate area immediately. Close the doors of the laboratory and post signs on the laboratory doors notifying danger.
- Evacuate non-essential personnel from area.
- > Avoid breathing vapour from spilled material.



#### **Chemical Waste**

Improper waste disposal can also lead to serious and frequently unexpected accidents.

- No chemical waste can be disposed of *via* the sewage system.
  - Exceptions are unused dilute aqueous sodium or potassium hydroxide buffers, unused aqueous hydrochloric or sulfuric acid buffers.
- Before adding waste to a chemical waste container, make sure that your chemicals are not incompatible and that reactive chemicals have been properly quenched. Combining incompatible waste or using an incompatible container could cause rupturing of containers and explosions.
- > Chemical waste at the Technion is separated into three (3) principle classes:
  - Organic solvents All solvents and (in)organic chemicals. Most of the chemical waste generated in the laboratory can be added to this container. Never add oxidizers (such as hydrogen peroxide) to the organic waste. This could result in a fire or an explosion. Clearly indicate on the safety label which chemicals are present.
  - 2. Acids.
  - 3. Solids Broken glass, vials and pipettes are collected in an appropriately labeled container; used needles are collected in another designated (red with a yellow opening lid) container.
  - 4. Oxidizers.
  - 5. Nitric acid and Piranha solutions are collected separately. These mixtures of acids produce strongly oxidizing solutions. Do not keep them in the hood for extended periods of time, as they will corrode the metal-framework in the fume hood. Never ever mix them with even trace amounts of organics as this can result in explosions. Use glass bottles for collecting the chemical waste. Do not mix these acids together. <u>Make sure the glass bottles do not contain residual organic materials</u>. Do not cap the bottles as their decomposition produces gaseous vapor, which could lead to an explosion. These bottles should be kept in or underneath the fume hood, properly labeled and covered with parafilm.
- Always think before disposing waste in a container! Caution should be given to peroxide forming chemicals (PFCs), as the can be highly explosive.



#### Technion Safety & Radiation Unit Incompatibility chart of prevalent lab chemicals:

Chemical	Incompatible with
Acetic Acid	Chromic Acid, nitric acid, hydroxyl-containing compounds, ethylene glycol, perchloric acid, peroxides, and permanganates.
Acetone	Bromine, chlorine, nitric acid, sulfuric acid, and hydrogen peroxide.
Acetylene	Bromine, chlorine, copper, mercury, fluorine, iodine, and silver.
Alkaline and Alkaline Earth Metals such as calcium, lithium, magnesium, sodium, potassium, powdered aluminum	Carbon dioxide, carbon tetrachloride and other chlorinated hydrocarbons, water, Bromine, chlorine, fluorine, and iodine. Do not use CO2, water or dry chemical extinguishers. Use Class D extinguisher (e.g., Met-L-X) or dry sand.
Aluminum and its Alloys (especially powders)	Acid or alkaline solutions, ammonium persulfate and water, chlorates, chlorinated compounds, nitrates, and organic compounds in nitrate/nitrate salt baths.
Ammonia (anhydrous)	Bromine, chlorine, calcium hypochlorite, hydrofluoric acid, iodine, mercury, and silver.
Ammonium Nitrate	Acids, metal powders, flammable liquids, chlorates, nitrates, sulfur and finely divided organics or other combustibles.
Aniline	Hydrogen peroxide or nitric acid.
Bromine	Acetone, acetylene, ammonia, benzene, butadiene, butane and other petroleum gases, hydrogen, finely divided metals, sodium carbide, turpentine.
Calcium Oxide	Water
Carbon (activated)	Calcium hypochlorite, all oxidizing agents.
Caustic (soda)	Acids (organic and inorganic).
Chlorates or Perchlorates	Acids, aluminum, ammonium salts, cyanides, phosphorous, metal powders, oxidizable organics or other combustibles, sugar, sulfides, and sulfur.
Chlorine	Acetone, acetylene, ammonia, benzene, butadiene, butane and other petroleum gases, hydrogen, finely divided metals, sodium carbide, turpentine.
Chlorine Dioxide	Ammonia, methane, phosphine, hydrogen sulfide.
Chromic Acid	Acetic acid, naphthalene, camphor, alcohol, glycerine, turpentine and other flammable liquids.
Copper	Acetylene, hydrogen peroxide.
Cumene Hydroperoxide	Acids
Cyanides	Acids
Flammable Liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, bromine, chlorine, fluorine, iodine.
Fluorine	Isolate from everything.

Hydrazine	Hydrogen peroxide, nitric acid, and other oxiding agents.
Hydrocarbons	Bromine, chlorine, chromic acid, fluorine, hydrogen peroxide, and sodium peroxide.
Hydrocyanic Acid	Nitric acid, alkali.
Hydrofluoric Acid	Ammonia, aqueous or anhydrous.
Hydrogen Peroxide (anhydrous)	Chromium, copper, iron, most metals or their salts, aniline, any flammable liquids, combustible materials, nitromethane, and all other organic material.
Hydrogen Sulfide	Fuming nitric acid, oxidizing gases.
lodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen.
Mercury	Acetylene, alkali metals, ammonia, fulminic acid, nitric acid with ethanol, hydrogen, oxalic acid.
Nitrates	Combustible materials, esters, phosphorous, sodium acetate, stannous chloride, water, zinc powder.
Nitric acid (concentrated)	Acetic acid, acetone, alcohol, aniline, chromic acid, flammable gases and liquids, hydrocyanic acid, hydrogen sulfide and nitratable substances.
Nitrites	Potassium or sodium cyanide.
Nitroparaffins	Inorganic bases, amines.
Oxalic acid	Silver, mercury, and their salts.
Oxygen (liquid or enriched air)	Flammable gases, liquids, or solids such as acetone, acetylene, grease, hydrogen, oils, phosphorous.
Perchloric Acid	Acetic anhydride, alcohols, bismuth and its alloys, paper, wood, grease, oils or any organic materials and reducing agents.
Peroxides (organic)	Acid (inorganic or organic). Also avoid friction and store cold.
Phosphorus (white)	Air, oxygen.
Phosphorus pentoxide	Alcohols, strong bases, water.
Potassium	Air (moisture and/or oxygen) or water, carbon tetrachloride, carbon dioxide.
Potassium Chlorate	Sulfuric and other acids.
Potassium Perchlorate	Acids.
Potassium Permanganate	Benzaldehyde, ethylene glycol, glycerol, sulfuric acid.
Silver and silver salts	Acetylene, oxalic acid, tartaric acid, fulminic acid, ammonium compounds.
Sodium	See Alkali Metals
Sodium Chlorate	Acids, ammonium salts, oxidizable materials and sulfur.

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Sodium Nitrite	Ammonia compounds, ammonium nitrate, or other ammonium salts.
Sodium Peroxide	Any oxidizable substances, such as ethanol, methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerol, ethylene glycol, ethyl acetate, methyl acetate, furfural, etc.
Sulfides	Acids.
Sulfur	Any oxidizing materials.
Sulfuric Acid	Chlorates, perchlorates, permanganates, compounds with light metals such as sodium, lithium, and potassium.
Water	Acetyl chloride, alkaline and alkaline earth metals, their hydrides and oxides, barium peroxide, carbides, chromic acid, phosphorous oxychloride, phosphorous pentachloride, phosphorous pentoxide, sulfuric acid, sulfur trioxide.



#### Technion Safety & Radiation Unit Specific Chemical Reactions and Associated Safety Guidelines

- Uncontrolled chemical reactions are usually exothermic. i.e.: they produce heat and release energy.
  - An exothermic chemical reaction could, under specific circumstances, go out of hand, spraying hot liquids or dangerous fumes. It is advisable to add the necessary components in an organized order and in exact quantities to prevent a radical temperature elevation. Only following a considerable cooling time interval another dose could be safely added to the reaction, for example: adding powder to a liquid, which is on the verge of its boiling point, could result in heavy production of fumes, spillage of the liquid from the vessel and pressure build-up. To avoid the latter, small doses of the powder can be added while the reaction is still cool.
  - **Do not** <u>under any circumstances</u> pour water into an acid (or alkaline). When preparing a diluted acid or alkaline solution, take care to always slowly pour the acid or alkaline into the water while stirring (<u>not vice versa</u>).
  - Preparation of a solution must be carried out in a fume hood, working slowly and stirring the solution. The reaction during this mixing is exothermic (emits heat), for example: dilution of sulfuric acid in water is liable to cause the solution to boil, thus if water is poured into the acid, the hot solution will splash, posing a great risk.
  - Never direct glass tubes in which chemical or heating reactions are being performed towards face or towards other employees.
  - Incorrect marking on containers and packages could lead to improper chemical use, which in turn

     will lead to an uncontrolled chemical reaction between chemicals. Every package and/or container must be marked with a clear and readable sticker.
  - The chemical's labels must always be read prior to use.
  - Do not conduct an experiment without obtaining permission from your supervisor. Never work in a laboratory alone unless authorized to do so by the safety and radiation unit.
  - Make sure to read the labels on the bottles and chemical storage containers (including chemical waste) to ensure that the substance conforms precisely to the requirements.


- Volatile substances must be handled with care. An explosion could occur as a result of working with volatile or unstable compounds due to touch, chafing, abrasion or heating.
  - Therefore, the experimental setup should be situated in a closed compartment or chemical hood, protecting both the employee as well as his/hers surroundings. Upon opening the closed compartment or lifting the glass of the hood one must be protected by a polycarbonate face mask, especially when performing nitrations.
  - Automatic and remote-controlled equipment are always preferable.
  - Distillation of certain organic compounds, such as ethyl ether – could, in time, produce peroxides (=compounds high in oxygen), which could cause an explosion.
  - Even fumes released from volatile liquids, which are stored in a refrigerator in non-hermetic vessels, could explode or cause fire. Therefore, volatile liquids will be



stored inside a refrigerator devoid of internal lighting and of which thermostat is located outside the refrigeration space.

• Electrical components around the laboratory should be explosion-proof.



- Chemical burns are caused because of contact with certain **COTTOSIVES**, such as strong acids (sulfuric, nitric, hydrochloric and hydrofluoric acids), strong bases (sodium hydroxide, potassium hydroxide and ammonium hydroxide), dehydrating agents (phosphorus pentoxide and calcium oxide), oxidizing agents (chlorine and bromine). Corrosive substances cause destruction of, or alterations in, living tissue by chemical action at the site of contact.
- Spillage or splashing on an employee's clothing could result from manipulation of corrosives between vessels, therefore PPE should be used: neoprene or other gloves according to the corrosive's identity, sealed goggles or a face-mask, a manual pump.



- Direct glassware heating above a hot flame could rupture the glassware and cause spillage. To avoid heating by flame at a high and non-homogenous temperature place a metal net to demarcate between the glassware and the flame.
- Heating of a liquid-containing tube will be performed above a not-too-hot-a-flame while shaking the tube side to side to ensure homogenous temperature dispersion in the tube.

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- Pay extra attention when working with flammable chemicals. Flammable liquids include chemicals which have a flashpoint of less than 37.8°C. Flashpoint is the minimum temperature of a liquid at which it gives off sufficient vapor to form an ignitable mixture with air. Liquids with a flash point near room temperature can be ignited very easily during use.
  - Pouring flammable liquids can generate static electricity, related to the humidity levels in the area.
     Cold, dry atmospheres are more likely to facilitate static electricity. Bonding or using ground straps for metallic or non-metallic containers can prevent static generation.
  - Flammable liquids must be stored in a refrigerator devoid of internal lighting and of which thermostat is located outside the refrigerating space.
  - Gases evaporated of flammable liquids must be stored in hermetically air-tight containers to prevent explosion or fire.
  - Whenever possible use plastic or metal containers.
  - When working with open containers, use a laboratory fume hood to control the accumulation of flammable vapor.
  - Do not use an open flame to heat flammable liquids. Steam baths, salt and sand baths, oil and wax baths, heating mantles and hot air or nitrogen baths are preferable.
  - Minimize the production of vapors.
  - Simultaneous use of volatile and oxidative chemicals, which are in proximity in the laboratory, could result in combustion; therefore, try to avoid from using volatile and oxidative substances simultaneously. In case it is necessary to use both work in small doses and avoid heating them.
  - Do not use burners around flammable-volatile liquids. Heating such liquids should be performed on a heating plate in a water or oil medium or using designated electrical pillows.

- Using electrical appliances, which produce sparks, could also cause fires. It is mandatory to keep any appliance away from a location at which flammable gases or liquids are being used. The appliances should also be equipped with warning lights to mark the appliance's operation.
- The use of compressed air engines is recommended. Any appliance flaw or heating of wires should be reported to maintenance.
- Distillation of a flammable liquid is exothermic. Heat must therefore be evacuated from the system by a condensation refrigerator or else the liquid fumes will be exhausted and might combust. The water pipeline to the condensation refrigerator must be closely monitored. Installation of an automatic switch is recommended.
- Boiling of a flammable liquid inside a glass flask or a designated glass bulb is not homogenous, therefore the liquid could splash. To ensure a stable boiling pace, several glass spherules or ceramic shards should be placed inside the flask or the bulb.
- Fumes of a flammable liquid, which was accidentally spilled, disperse rapidly and pose a major fire threat. In that case, all open-fire or spark-generating machinery should be shut down. The spilled liquid should be collected using paper towels or a liquid-absorbing powder.
- Certain chemical compounds, such as Sulphur, spontaneously combust in air. Handling of these compounds will be executed in an inert environment (for example: in nitrogen).
- Azides should not be allowed to come into contact with copper or lead (in plumbing), as they may explode violently when subjected even to a mild impact.
- Ethers that have aged and dried to crystals are extremely unstable, and potentially explosive.
- Perchloric acid, which has dried on wood or bricks, will explode and cause a fire on impact.
- Picric acid is detonated by heat and impact.



- Pyrophoric chemicals spontaneously ignite in air. No source of ignition (spark) is needed as they spontaneously react when exposed to oxygen. Silane is an example of a pyrophoric gas. Working with pyrophoric materials, such as alkyl aluminum, zinc or lithium reagents, metal hydrides, alkali metals and others, necessitates the use of appropriate inert atmosphere techniques, i.e. glovebox or Schlenk line techniques.
  - Prior to commencing work with pyrophoric materials, always make sure you are familiar with the specific pyrophoric reagent's SDS.
  - Prior to commencing work with pyrophoric materials, always make sure you are familiar with emergency measures, as pyrophoric reagents react very quickly, leaving almost no reaction time.

- Note that most pyrophoric reagents will react with the contents of common fire extinguishers. Sand is an effective measure for containing fires involving pyrophoric materials.
- PPE should include: a fire-resistant lab coat, long pants made of less-flammable materials, such as jeans, safety goggles, impermeable gloves and closed shoes are worn. Tuck long hair.
- Inspect all glassware before use: the glassware should be thoroughly dried and purged with an inert gas (e.g. nitrogen or argon). Note that some pyrophoric reagents will react exothermically with nitrogen.
- Before commencing pyrophoric reaction, always be instructed by an experienced researcher on how to safely perform the reactions. The experienced researcher should also be present in subsequent times until the unexperienced employee is confident enough to perform the reactions independently.
- Remove all other flammable materials from your working area, including solvent bottles, unused chemicals, or other combustible materials.
- When working in the hood, make sure the sash is lowered as much as possible.
- Never work alone when using pyrophoric reagents. Always have a co-worker in close proximity when performing chemical reactions involving pyrophoric reagents.
- Use Hamilton® gas-tight syringes only for transferring small quantities of pyrophoric reagents. Do
  not fill syringes more than 75% of their designated maximum volume. Do not transfer more than 15
  mL at once.
- Do not use excess-pressure to fill syringes with pyrophoric reagents. Use an oil bubbler to equalize pressure between the vessel containing the pyrophoric reagent and the Schlenk line. The oil bubbler also prevents back-flow of oxygen into the experimental set-up and provides a low-pressure nitrogen inlet into the reagent bottle.
- Use double-tipped needles for cannula transfer of pyrophoric reagents.
- Maintain the correct temperature (mostly between -78 °C and -100 °C) when working with pyrophoric reagents. Avoid liquid nitrogen as a coolant.
- Upon completion of work with pyrophoric reagents, small amounts can be quenched by slowly adding the pyrophoric residues to dry hexane inside the hood. In turn, the hexane solution can slowly be quenched by adding iso-propanol.
- Empty pyrophoric reagents bottles containing septa should be quenched by piercing the septa with a needle and leaving the bottle for approximately one week in the back of the hood. After a week, remove septa and carefully add isopropanol. Discard liquid as basic waste.

• In case a small containable spill in the hood remove all flammable materials from the area. If needed use a fire extinguisher in line with SDS instructions. When possible, slowly quench spill with isopropanol.



- Hydrogenation reactions can potentially pose an extreme fire and explosion hazard due to their involvement of hydrogen gas (H<sub>2</sub>) and/or the use of flammable metals or solvents or pyrophorics.
- Always read SDS carefully prior to commencing hydrogenations.
- Be knowledgeable of all safety measures in case of emergency.
- Most of the reagents will react with the contents of common fire extinguishers. Sand is very effective, therefore keep a bucket of sand close by to immediately quench accidental fires
- Before commencing hydrogenerations, always be instructed by an experienced researcher on how to safely perform the reactions. The experienced researcher should also be present in subsequent times until the unexperienced employee is confident enough to perform the reactions independently.
- Never work alone when performing hydrogenation reactions. Always have a co-worker near when performing chemical reactions involving hydrogen.
- When performing hydrogenations always use a glovebox and other inert atmosphere techniques.
- Make sure all heat sources, open flames, electrical sources or other incompatible chemicals are removed from the hood and not allowed in proximity to the hydrogen source.
- Make sure that you do not convey any static electricity!
- Make sure your experimental set-up glassware is intact.
- Never exchange system set-up equipment used in hydrogenations.
- Prior to introducing the hydrogen into the reaction vessel, make sure that the contents of the vessel have been properly degassed and any advantageous amounts of oxygen have been removed.
- Hydrogenation catalysts should always be kept moist using either solvents or water (proceduredependent). Dry catalysts are most-likely pyrophoric.
- Hydrogenation catalysts should be kept moist also upon filtering the reaction mixture to remove the heterogenous catalysts. Use low vacuum. Notice any sparks when filtering.
- Upon completion add water to avoid fires. Adding solvent to a sparking catalysts cake will cause a flash fire.
- Dispose of residual catalysts ASAP. Never throw the filtering pads into the trash due to fire hazard.

- Prior to opening the vessel in which the reaction took place to the atmosphere upon hydrogenation completion, degas vessel's contents to assure all hydrogen gas has been removed. Absorbed hydrogen on Pd/C can easily ignite when dry and exposed to air.
- In case of fire or an explosion involving hydrogen gas, when possible, close the main valve of the hydrogen cylinder.



- Compressed gasses are used in the lab routinely. A compressed gas is any flammable or nonflammable material or mixture thereof, having a pressure exceeding 3 bar (43 psi) at 21°C in the cylinder. The most prevalent gasses used in labs are nitrogen, argon, oxygen, and hydrogen gas.
  - Only qualified personnel are allowed to shuttle, open or install gas cylinders.
  - Always wear appropriate PPE, including a lab coat, safety goggles, closed-toed shoes and nitrile gloves. Always wear safety goggles when handling low-pressure or high-pressure vessels, especially when using low/high-pressure NMR tubes, even outside of the lab. Glassware can unexpectedly fail under low/high pressure causing glass fragments to shatter.
  - Safety shoes are required when shuttling compressed gas cylinders.
  - Make sure the gas cylinders are appropriately labeled.
  - Do not store flammable or toxic gas cylinders in the lab.
  - Do not roll cylinders or transport gas cylinders horizontally.
  - Compressed gas cylinders should be stored and transported with their safety cap in place.
  - Gas cylinders should be separately harnessed to the wall with double chains.



Safety Cap

Harnassed to wall

- Gas regulators and detectors should always be installed. Make sure that the gas cylinders match the type of regulator. Make sure regulators are leak-tested when installed (usually a soapy solution will work fine).
- Never use water, grease or oils on oxygen regulators as they can cause an explosion upon contact with oxygen.
- Keep oxygen gas cylinders at least 5 meters away from any source of heat, flames, sparks and/or other ignition sources, explosive gas mixtures (such as hydrogen) included.
- Be familiar with the SDS of the compressed gasses you are about to use.
- Gas cylinders must be separated according to their group: flammables must be kept away from corrosives. Inert gasses will always be stored between flammables / toxic gasses and corrosives.
- The separation distance between gas cylinder groups should be at least 6.1 meters or include a physical barrier between the cylinder groups. Storage should always be in a shaded, locked and well-ventilated area.
- Flammable and toxic gasses, including more than 5% forming gas, will never be stored inside a lab.
- Flammable gas cylinders should be distanced away from any ignition or spark sources. Smoking is strictly forbidden as is the use of open fire (except in a designated hood).
- Gas cylinders will always be connected to an origin panel, which will be fixed to a wall in the lab. The panel will be connected to the cylinders using a flexible and designated pipeline and will also include a regulator and an emergency shut-off system (EHS).
- Every cylinder must be connected to a regulator and a valve.
- Every lab in which a gas system is installed should have a main and accessible gas system faucet at the entrance to the lab.
- All gas cylinders in use must have a valid hydrostatic testing: every 5 years ot every 8 years for cylinders which are already under use; corrosive gas cylinders should go through a hydrostatic testing every couple of years.
- The gas cylinders and pipeline should be marked by the gas name every 80 cm.
- Never stand in front of the cylinder's opening.
- Never try to fix a leaking cylinder!
- It is strictly forbidden to work with gas cylinders after working with oil or grease.
- It is strictly forbidden to shuttle gas cylinders inside elevators with other passengers on board.



A general set-up of a gas regulator

- Carbon monoxide CO Carbon monoxide (CO) poses a severe health risk since it is colorless and odorless and is lethal in even small concentrations.
- Inexperienced employees and/or students are not allowed to use carbon monoxide. Qualified personnel should first demonstrate how to properly handle carbon monoxide in chemical reactions and be present in subsequent times until confident the employee and/or student can handle carbon monoxide independently and safely.
- Never work alone when using CO. Always have a co-worker nearby.
- Never use CO without using a portable CO detector. If the detector's alarm goes off or CO is accidently released, stop work ASAP. If possible, close the valve of the CO-cylinder and ventilate area. Do not enter area until the alarm ceases or when allowed by qualified personnel.
- Make sure all heat sources, open flames, electrical sources or other incompatible chemicals are removed from the hood.
- Make sure your experimental set-up glassware is intact.
- Use CO at low pressure or atmospheric pressures only.
- Mount the CO cylinder in the hood securely in a secondary container.
- Upon reaction completion, degas the reaction vessel prior to opening the vessel to the atmosphere.
- If CO exposure symptoms are present, immediately move to fresh air and notify emergency services.



- Every laboratory contains chemicals at various toxicity levels, for example: methanol and tetrachloride carbon. The use of such chemicals in the open-air causes lung or skin exposure. Chemicals at various states solid / liquid / gas produce a relatively high vapor pressure and are poisonous upon inhalation (respiratory exposure). Exposure by ingestion is very rare in chemical laboratories.
  - Every experiment that emits poisonous or odorous gases must be carried out in a fume hood. Remember: if the fume hood door is open the effectiveness of the gas containment is lessened.
  - Handling of poisonous or carcinogenic chemicals will be performed inside a fume hood using gloves, forceps etc.
  - Heating or drying certain chemicals could also emit poisonous vapor, therefore, the drying heater should be equipped with a vapor extracting device, pumping the poisonous vapor outside the laboratory building.
  - Washing dirty glassware using organic solvents, such as: acetone, alcohol or other volatile hydrocarbon solvents will emit poisonous vapor into the laboratory atmosphere, therefore it is recommended to wash lab glassware at a designated laboratory dishwasher. Cleaning of glassware using solvents will only be performed inside a well-ventilated fume hood.
  - Shaking of glass vessels containing volatile substances lead to breakage and, in turn, the release of poisonous vapors.
  - Chemical spillage could contaminate the entire lab atmosphere. Open lab windows in case the contaminant's concentration is low. In case the contaminant's concentration is high evacuate the laboratory area ASAP and inform the safety unit. Return to the lab will only be enabled following environmental monitoring and verification by the safety and radiation unit.
  - The poisonous effect of gasses could be exacerbated in a small and closed atmosphere, such as an elevator. Chemicals packaged in glass containers should only be shaken upon storage in a protective package.
  - Shuttling chemicals in elevators will only be performed in cargo elevators (not in passenger elevators).
  - Make sure the container is sealed upon finishing usage of poisonous-vapor emitting chemicals, even after the container is empty.



- There are Bunsen burners of different sizes and flame strengths (flame temperature: 600°C-1,000°C).
  - After igniting the flame, check for gas odor: if you smell gas, turn off the flame and immediately notify the person responsible and the engineer or technician (cooking gas has an odorous substance added synthetically to warn about a leak).
  - Check whether the gas pipeline is intact and that it is not close to a heat source.
  - Replace the rubber hose once every two years.
  - Heating by flame must be carried out slowly and cautiously.
  - Not every glass vessel can be used for flame heating. The equipment permitted for heating are a chemical cup, Erlenmeyer flask or ceramic crucible.
  - Keep away any flammable materials, solvents, gasses and chemicals, especially if you work inside the fume hood. The hood should also be well ventilated of solvent vapors.
  - Do not leave the lit burner <u>unattended</u>!
  - Never use open flames to perform solid-state reactions at elevated temperatures.
  - When the work with the burner is completed, turn off the flame in the following sequence: Shut the burner valve > make sure the flame extinguished > close the valve to which the rubber hose is connected > close main valve at the end of the workday.



- Controlled heating. Any heating of a system or container must be carried out in a controlled and careful way.
  - When heating a material in a test tube, verify that the test tube opening is not facing you or your colleagues. The use of a sealed vessel when heating is absolutely prohibited. Heating a closed system builds pressure that can cause the container to explode.
  - Many experiments are carried out at different temperatures. It is preferable to use an **electric plate** rather than a gas burner to heat flammable materials.
  - Take care to heat toxic and corrosive substances in a fume hood.
  - Keep away any flammable materials.
  - Do not leave the heating system <u>unattended</u>! Do not leave heating liquids unsupervised.
  - Keep unrelated experimental materials and equipment away from the electric plate.
  - Take care that the electric cord does not heat up or get damaged.

- If you wish to check whether the plate is heating up, touch the heating source with the back of your fingers, not the fingertips.
- Never heat a solvent more than 5 °C above its boiling point in a closed vessel. Always calculate the maximum pressure that a solvent exerts on a closed vessel under heating conditions (Clausius Clapeyron Equation). If a mixture of solvents is used, assume the pressure exerted by the lowest boiling solvent as the maximum pressure. Make sure the glassware and set-up can support the calculated maximum pressure. Do not exceed the recommended pressure stated by the manufacturer and inspect the pressure vessel for faults before usage.
- If the solution is to be heated, only a glass container should be used.
- If using a hydrofluoric acid containing solution, use a plastic or Teflon container, since the chemical will attack glass.
- When the experiment is finished, turn off the power switch.
- Remove the plug from the wall socket at the end of the workday.
- Heat burns could result from hot or boiling water, oil, melted metal or an open flame.
- Dipping of glassware containing volatile liquids inside a heating bath could rupture the glass vessels and disperse chemicals, therefore work must only be performed with intact glassware crack-free, sustainable of thermal shock. The vessels will be dipped inside the heating bath gradually.



- Cryogenic liquids are defined as having a boiling point that is below -73 °C. These liquids and their vapors are usually unreactive, colorless and odorless. They're usually used in laboratories to produce extremely low temperatures (below -153°C), such as liquid nitrogen (b.p.: -196 °C). Although dry ice or carbon dioxide is solid and therefore is not considered as a cryogenic liquid, it is immediately sublimated (at -78°C) to carbon dioxide gas. Dry ice is prevalently used to shuttle samples, grind materials and perform experimental procedures with. Therefore, dry ice, as well as liquid nitrogen, pose a potential laboratory risk.
  - When working with cryogenics one should always protect one's hands in order not to touch frozen surfaces and avoid a frost bite. Cryogenic gloves are recommended. Never touch liquid nitrogen or dry ice with your bare hands. Use gloves which can be easily removed. Do not wear nitrile gloves when handling cryogenic liquids as they will freeze unto your skin immediately upon contact.
  - Never touch materials, metals especially, which have been exposed to cryogenic liquids. Handle them with forceps, tweezers or tongs, preferably waiting until they have reached room temperature before handling them. Dry ice, for example, should only be handled using forceps. Never use a heat

gun or other methods to thaw liquids or metals that have been cooled down using cryogenic liquids. Large temperature differences might lead to cracking or metal fatigue.

- In case a glass vessel should be cooled down, dip the vessel slowly and gradually inside the cooling bath. Never insert a warm or a hot container into a cryogenic liquid alas spontaneous boiling and splashing of the cooling liquid will occur.
- Eyes must also be protected when working with cryogenics to avoid splashing. Cryogenic liquids boil rapidly when exposed to materials at room temperature.
- Dewars are the only vessels to be used for storing and transferring cryogenic liquids. Make sure they are properly clamped. Do not place Dewars on the floor. Dewars are vacuum sealed and can implode when damaged.
- In case a large volume of a cryogenic liquid should be dispensed from a low-pressure liquid nitrogen tank use a wide-necked bottle and a cryogenic apron and a full-face shield to prevent splashes.
- Always work in well-ventilated areas or in the fume hood to avoid asphyxiation (nitrogen gas expands by a factor of 696). Asphyxiation can only occur when the oxygen content in the laboratory drops below 19.5%. Small and medium spills do not pose significant asphyxiation hazards. In case of a large spill evacuate the premises. When possible close the valve of the liquid nitrogen container and open windows and doors to properly ventilate area. Only return when the oxygen content in the air has risen above 19.5%.
- Dry ice dissipates into the laboratory atmosphere, reaching a non-favorable concentration, therefore dry ice, which is not in use, should be stored outside the lab in a well-ventilated area.
- Vaccum traps, which have been cooled down by liquid nitrogen, should never be exposed to the atmosphere, even for short time intervals, as the latter can cause liquid oxygen to condense in the trap.
- In case liquid nitrogen is the coolant of the vacuum trap, make sure the pump is open and the Schlenk line is under active vacuum prior to commencing cooling. When using a Schlenk line always make sure that the set-up does not leak and that it can hold a good static vacuum.
- When freezing a solution in a Schlenk-flask or performing freeze-pump-thaw cycles, never leave the flask open to the inert atmosphere. always evacuate the flask to assure no gasses have been condensed into it prior to closing the flask.
- If argon must be used as the inert atmosphere gas in a Schlenk line, always fill the vacuum trap with dry-ice/iso-propanol prior to cooling them with liquid nitrogen.
- When working with a Dewar inside a vacuum trap, be alert for any hints of residual blue liquids (oxygen) inside the vacuum trap. If a blue liquid is observed, then liquid nitrogen / argon / oxygen

have condensed into the trap, posing a highly dangerous situation. In this case return Dewar to its original position. Make sure the vacuum traps are cooled all the while using liquid nitrogen. Then, isolate Dewar from the (inert) atmosphere or from the leak to avoid additional condensation of gasses into the trap. Keep the vacuum pump ON. When working inside a fume hood - close the sash of the hood` when working outside the hood, put a blast screen around the Dewar containing the vacuum trap.



- The use of ionizing radiation poses an external exposure risk, since ionizing radiation produces ions, which in turn could affect human tissues. Ionizing radiation includes the following radiation types: alpha (α), beta (β), gamma (γ), x and neutrons. Gamma and x radiations emit short-wavelength high-energized photons. Although ionizing radiation is invisible, its affects are cumulative.
  - Be familiar with the properties of the radioisotope you work with. For example, there are special precautions for working with 35S-methionine because of its volatility.
  - Rehearse unfamiliar radioisotope procedures prior to commencing radioactive work.
  - Use radioactive substances only in dedicated areas.
  - The radioactive working area should preferably be in a small room adjoining the main laboratory or in a dedicated area within the laboratory away from other activities. Signs displaying the international radiation hazard symbol should be posted at the entrance to the radiation area.



- Cover the work surface with protective and absorbent bench paper to trap droplets of contamination.
- The radioisotope working area should have a set of equipment that is only used for radioactive work. Depending on your protocol, this may include pipettors, a microcentrifuge, timers, mixers, a water bath, etc.



• Do not eat or drink in any room labeled with a *Radioactive* sign on the door.



- Do not store food or beverages in refrigerators, freezers or cold rooms where radioactive sources are used or stored.
- Shorten the time interval you are working with ionizing radiation sources. The less time spent in a radiation field, the smaller the received personal dose: Dose = **Dose rate x time**.
- Use proper PPE, especially when working with radioactive aerosols. For any work with an open radioactive source, wear:
  - \*\* Disposable gloves (latex or nitrile). Change your gloves frequently. Your radioactive solutions, especially when aliquoting from the stock vial, are likely to be highly concentrated. It is very easy to contaminate your gloves and spread contamination.
  - \*\* a full-length lab coat (worn closed with sleeves rolled down).
  - \*\* close-toed shoes. Never wear sandals or other open-toed shoes while working with radioactivity.
  - \*\* Goggles are required for any radioisotope procedure, specifically upon potential for the build-up of pressure that could release a spray of material.

\*\* Lab coat cuffs may hang down and drag across contaminated surfaces. To protect the skin of your wrists, consider wrapping tape around your lab coat sleeve or put a rubber band around the sleeve to keep the cuff from dragging or wear long gloves and tuck your lab coat into the gloves. Survey the skin of your wrists frequently as you work.

\*\* Keep an extra set of clothing and shoes in the lab in case your clothing becomes contaminated.
\*\* Avoid using petroleum-based hand creams when wearing gloves because petroleum-based hand creams may increase glove permeability.

\*\* Radiation energy-absorbing or attenuating shields placed between the radioactive source and the employee will help limit exposure. The choice and thickness of any shielding material depends on the penetrating ability (type and energy) of the radiation. A barrier of acrylic, wood, plexiglass, glass or lightweight metal, thickness 1.3–1.5 cm, provides shielding against high-energy  $\beta$  particles, whereas high-density lead or steel is needed to shield against high energy  $\gamma$ - and X-ray radiation.

- Survey your working area carefully before commencing radioactive work in case someone else left the work area contaminated or in case you missed contamination the last time you worked. In addition, survey frequently and extensively as you work. Don't assume that contamination will only be found on the bench top. Monitor your clothing, shoes and floor as well.
- Monitor personal radiation exposures by wearing dosimetry radiation monitor badges when appropriate:

\*\* Wear ring badges under gloves to prevent the ring from getting contaminated. Make sure you don't discard the ring when you remove your gloves.

\*\* never leave chest badges exposed to an open radioactive source when not working with source. The badge should only count the exposure the employee was exposed to during radioactive work.

- Use spill trays lined with disposable absorbent materials.
- Work in a fume hood during procedures using volatile materials such as I-125 or S-35 methionine/cysteine. Do not use biological safety cabinets (or laminar flow hoods) for work with volatile radioactive materials, since the air from the cabinet may be exhausted back to the room.
- During hybridization reactions, be sure to check the condition of the tubes to be sure the o-rings aren't dried out.
- Contaminated microcentrifuges must be cleaned following use to prevent contamination from spreading to other tubes and gloves. The following steps may help reduce the incidence of contamination:

\*\* Wipe down the exterior of the tubes before placing them in the microfuge.

\*\* Don't fill tubes more than 2/3 full.

\*\* Use tubes with locking caps or with screwcaps.

- Do not leave radioactive sources unsecured in an unattended lab, even for a short time, unless the lab is locked. Ensure that all radioactive sources are returned to storage immediately following use.
- If you discover that a radioactive source is missing and cannot be accounted for, notify the Safety & Radiation Unit ASAP, no later than the next business day.

- If there are no signs on a room in which radioactive sources are used or stored, contact the Safety & Radiation Unit to request labeling for the room.
- Label any container of radioactive source or piece of equipment in which a radioactive source is stored and any contaminated area or item with a designated tape.
- Label all contaminated items and containers.
- Liquid radioactive waste should be disposed into 2-liter containers containing vermiculite. The containers should not be filled more than 80% of their capacity to prevent spillage upon shuttling to radioactive waste warehouse. The absorbance capacity of the vermiculite enables absorbance of 1 liter.
- Remove radioactive waste from the laboratory at frequent intervals.
- Chemical and/or biological waste containing radioisotopes will be disposed of as radioactive waste.



A laser beam is a source of light, which *via* the induction of photons produces a coherent and monochromatic beam, hence its name: LASER – Light Amplification by Stimulated Emission of Radiation. The energy of a laser beam is the sum of the total number of its photons, which are identical in various aspects:

- 1. Wavelength (monochromatic);
- 2. Direction (coherence);
- 3. Phase.

Laser systems produce photon beams via a couple of distinct manners:

- 1. Constant (CW) A constant laser system produces photons continuously.
- Pulsating (Pulse) A pulsating laser beams pulses of photons, which can descent up to a few femtoseconds and even less at a rate of tens of millions of beats/sec.

Therefore, a laser beam varies from any other light source due to the small cross section, which produces extreme energies at extremely high densities compared to any other light sources (hundreds of watts/cm<sup>2</sup>). Additionally, the laser beam's coherence and monochromatic properties enable centering its intensity onto a lense and in turn "throwing" it onto a tiny spot on a target located at the center of the lenses, which could then result in tens of KW/cm<sup>2</sup> and sometimes even MW/cm<sup>2</sup> (pulse lasers). Therefore, radiation emitted of laser devices could result in serious and irreversible damage to organs and tissues. There is a linear ratio between the extent of the biological damage imposed to the tissues and the intensity of the emitted laser radiation.

Lasers also vary in the medium they are produced in: gas, crystal, diode or liquid and in the beam's wavelength: at the visible light spectrum, UV or IR.

Laser systems safety classification is categorized by the laser systems' outputs and their associated hazards:

**Class I** – No known biological hazard due to very weak power or effective protection by interlocks. Class I laser systems cannot cause eye damage even when upon direct eye contact with the laser beam. Example: laser printers.

**Class II** – Laser output up to 1 mW. No biological hazard since eye blinking velocity is 0.25 seconds, which is fast enough to protect against the laser radiation. Example: laser pointers, laser barcode scanners.

**Class IIIa -** Laser output up to 1-5 mW. Biological hazard of spot blindness and other eye injuries. Example: He-Ne lasers.

**Class IIIb** - Laser output up to 5-500 mW. Definite eye injury due to direct laser radiation; skin burn hazard; Moderate and high-power lasers may burn absorbing substances, causing fire in the laboratory.

**Class IV** - Laser output > 500 mW. Definite eye injury even from diffuse radiation as dabgerous as from primary beam; skin burn hazard even from diffuse radiation; fire hazard in lab.

#### **Potential Hazards**

When the optical energy of a laser beam hits a tissue, it is converted into thermic energy heating the tissue. The conversion to heat energy depends on the laser's wavelength, the character of the constituents in the exposed tissue and their concentration. For example: hemoglobin absorbs 500-600 nm laser beams well (yellow-green visible light spectrum); melanin in the epidermal layer, in the iris and retina of the eye also absorbs laser well at the visible and the IR spectra. This energy could therefore damage the tissue all the way from solidifying proteins up to a deep burn. The intensity of the injury is a function of the temperature increase as a result to the laser beam exposure. The vulnerable tissues are the ones exposed to the laser beam.

Due to heat diffusion, adjacent tissues – which are not directly exposed to the laser beam – could also be injured.

In addition, thermal injuries could induce acousto-mechanical injuries in case the tissue's temperature increases above 100°c. Should such a scenario occur, then the pressure induced within the tissue would increase water vapor in the tissue, in turn creating acoustic waves able to rupture the tissue. This

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phenomenon is more common in pulse lasers, which could produce a very high increase in pressure at very short time intervals.

A laser beam could also induce photochemical injuries, which could alter physiological mechanisms.

Lasers in the short UV spectrum are energetic enough to break molecular bonds.

Before operating the laser system, verify that the lab door is locked or secured to prevent the entry of unauthorized personnel and that curtains and shields are properly in place.

#### Skin –

Exposure to UV laser could induce molecular breakage and photochemical epidermal injuries. This beam could penetrate a few tens of microns, since part of the energy is absorbed in the melanin in the epidermis and the blood vessels. Heating of the melanin and vessels could induce heat diffusion damage to the surrounding tissue.

Exposure to red and IR lasers could induce tissue damage at a depth of a few centimeters, since they are not absorbed in water and blood (some of the energy is absorbed by the epidermal melanin and hair follicles).

#### Eyes -

The cornea is exposed to all wavelengths and could therefore be injured from laser beams, which are absorbed well in water (UV, medium and far IR). These injuries are predominantly thermo-mechanical and could damage the lucidity of the cornea or even create grooves or clefts to a level of necessitating a corneal transplant.

Laser beams at the visible and the near-IR spectra penetrate via the cornea and lense, reaching the retina. Since the melanin in the retina's epithelium absorbs these wavelengths – the retina could be exposed to thermal damage.

The coherence and monochromatic properties of the laser beam on the one hand and the 50 diopters optical stamina of the cornea and the lense could result that exposure to visible and/or near-IR spectra laser beams could finalize to a 20-30 $\mu$ m diameter spot on the retina, which heats the area even to a point of clotting, a burn or retinal separation. Also, since the yellow spot is located on the optical axis of the eyeball, direct exposure to a laser beam of such wavelength could result in permanent damage.

Laser systems also pose extreme electrical safety hazards, since some include tens of kV components.

The induction and switching components in laser systems could produce electromagnetic radiation in the radio and microwave radiation ranges and sometimes could even produce x rays.

The laser head and cooling apparatus of the laser system could include poisonous liquids or gasses in high pressures.

Laser systems intended for signage, marking and excision dissipate potentially hazardous aerosoles.

- Make sure that laser warning lights are switched 'ON' whenever laser work commences.
- Make sure the laser system's drapes is spread out at its entire length.
- Be fully aware of the wavelength and the laser's intensity in use.
- Make sure that beam stoppers are in place at the optical path and at every optical intersection.



- Laser and optical components should be fastened to limit their movements.
- Eyes must always be protected against direct contact with a laser beam (above 100 mW). Specific goggles must be worn. The goggles must be specifically and conveniently suited to the emitted laser radiation by the laser safety officer depending on the following parameters:
  - The optical filter must withstand the maximal optical output of the laser beam.
  - The optical filter in the safety laser goggles should reduce the laser beam intensity to a lower value under the laser's defined maximal permissible exposure (MPE).
  - Goggles' characteristics protecting against continuous laser systems are set by the output density and the laser beam's wavelength.
  - Goggles' characteristics protecting against pulsed laser systems are set by the beam's energy density, the pulse interval and the beam's wavelength.
- Never locate eyes at beam level (even when thinking laser is shut). Eyes must always be at a minimal height of 40 cm above beam level.
- Make sure never to direct laser beam neither into someone's eyes not onto a beam reflecting surface.
- Do not perform parallel operations at various wavelengths, when safety goggles do not cover protection for all.
- Protect skin by wearing a long-sleeved lab coat.
- Take off all reflective accessories, such as watches and jewelry.



- Place computer screens out of beam scope or shield them.
- Block beams prior to handling optical elements or using reflective tools.
- Never install peripheral equipment at the height of the laser beam (reflective equipment, a closed with a glass door, etc.).
- Special protective side panels must be installed in laser devices to prevent radiation emission outside the path of the laser beam.
- Energy spreaders must be installed in laser devices outside the effective range of the beam.
- Alignment must be performed using reduced laser output or special alignment lasers. If possible, use a computer and a camera.
- Locate focal point prior to inserting a lens.
- Fix cables connected to elements on optical table.
- Avoid overfilling and bubbles within beam path.
- Maintain beams horizontal, approximately 10 cm parallel to optical table surface.
- It is forbidden to use power-based or CO2-based fire extinguishers around laser systems.
- Upon finishing work turn off laser warning lights.
- The increasing use of mamomaterials in research labs warrants consideration as to their uncertain toxicity hazards. Nanomaterials include any materials or particles that have an external nanoscale dimension (≈1 nm 100 nm or having internal or surface structures in the nanometer scale. Carbon-based nanomaterials include nanotubes, metals and metal oxides such as silver and zinc oxide and quantum dots made of compounds such as zinc selenide.

Nanomaterials can be categorized by the potential risk of exposure they pose to personnel based on the physical state of the materials and the conditions in which they are used.

Туре	Examples
Carbonaceous compounds	Carbon nanotubes and their derivatives and fullerenes
Metals and metal oxides	Titanium Dioxide (Titania), Zinc Oxide, Cerium Oxide (Ceria), Aluminum oxide, Iron Oxide, Silver, Gold, and Zero Valent Iron (ZVI) nanoparticles
Semi-conductor devices	Quantum dots: ZnSe, ZnS, ZnTe, CdS, CdTe, CdSe, GaAs, AlGaAs, PbSe, PbS, InP
Polymers	Polymer nanoparticles (nanospheres and nanocapsules), polymer nanofibers



- Exposures to nanomaterials may occur through inhalation, dermal contact, accidental injection, ingestion.
- The risk increases with exposure duration and concentrations of nanoparticles in the sample or air.
- Inhalation presents the greatest exposure hazard. The risk of exposure increases when nanomaterials are used as fine powders or are suspended in volatile solvents or gases. Inhalation of nanomaterials is prominent even upon sonication, shaking, stirring, pouring or spraying can result in inhalation exposure, which could in turn be deposited in the respiratory tract and may cause inflammation and damage to lung cells.
- Nanoparticles that are fixed in a solid a matrix such as when suspended in a solution or slurry or a
  non-volatile liquid suspension pose the least hazard to create airborne dust as long as no
  mechanical disruption, such as grinding, cutting, or burning, occurs.
- Certain nanomaterials may penetrate cell membranes and may cause damage to intracellular structures and cellular functions.
- Some nanomaterials may be pyrophoric or readily combustible, creating a risk of explosions and fires.
- Nanomaterials PPE: closed-toe shoes, long-sleeved shoes, safety glasses with side shields or chemical splash goggles, chemical resistant/impermeable gloves.
- The parent compound of the nanomaterial should also be taken into consideration when evaluating the potential hazards associated with exposure (a highly toxic compound such as cadmium should be anticipated to be toxic hen used as a nanomaterial).
- Nanomaterials should be stored in labeled containers that indicate their chemical content and form.
- Do not use horizontal laminar-flow hoods (clean benches) that direct a flow of air into the employer's face.
- Use ventilated enclosures, such as glove box or local exhaust ventilations that operate at a negative pressure and are equipped with HEPA filters (a laboratory chemical hood might be too turbulent for manipulating).
- Nanomaterials should not be disposed of down the drain or in the regular trash.
- When disposing of dry nanomaterials waste or items that may have been in contact with nanomaterials, such as PPE, wipes, et al, use a sealable plastic bag or container with tight fitting cap.
- Dry sweeping or the use of compressed air for cleanup is prohibited. Use wet wiping and vacuum cleaners equipped with HEPA filters.

## **Piranha Safety Guidelines**

Piranha solution oxidize (=burn) organic compounds, therefore they are used to remove organic residues from substrates in etching processes and are extremely dangerous.

Both liquid and vapour forms are highly corrosive to skin and respiratory tract. Direct contact will create skin burns and will be extremely destructive to mucous membranes, upper respiratory tract and eyes. Piranha solutions are very energetic, exothermic and potentially explosive in addition to being a corrosive liquid and a strong oxidizer. Piranha solutions easily accelerate out of control ranging from foaming out to reaching an explosion with a huge shock wave, carrying possible acid (or base)-gown shredding glass sharps. Upon providing sufficient fuel for Piranha reactions, they will generate enormous quantities of heat and gas. Two different Piranha solutions are currently available:

- 1. Acid Piranha a 3:1 mixture of concentrated sulfuric acid  $(H_2SO_4) + 30\%$  hydrogen peroxide  $(H_2O_2)$ .
- 2. Base Piranha a 3:1 mixture of ammonium hydroxide (NH<sub>4</sub>OH) + 30% hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>). Both are equally dangerous when hot, although the reaction in the acid Piranha is self-starting, whereas the base piranha must be heated to 60 °C before the reaction is activated.
- Familiarize yourself with the Piranha SDS. Students and employees who handle Piranha solutions must have received training on the hazards of Piranha solutions. They must know what to do in the event of a spill or an exposure incident.
- A clear standard operating procedure should be established.
- Never work with Piranha alone in the laboratory. Always have another, knowledgeable person in close vicinity, should an emergency situation occur.
- All work with Piranha should be conducted inside a chemical fume hood, since its production is entangled with generation of highly corrosive vapors.
- Safety goggles and a face shield MUST be worn when handling Piranha solutions.
- Nitrile gloves do not provide sufficient protection when working with Piranha solutions. Heavy duty neoprene or rubber gloves must be worn.
- Closed leather shoes must also be worn.
- When preparing Piranha solution, always add the peroxide to the acid slowly, never vice versa. The H<sub>2</sub>O<sub>2</sub> is added immediately adjacent the process should commence since following the addition of H<sub>2</sub>O<sub>2</sub> the Piranha immediately produces an exothermic reaction, releasing gas.
- The H<sub>2</sub>O<sub>2</sub> should be kept below 30%. Never exceed 50%, since at 50% or greater, an explosion could occur.

- Prepare fresh and small amounts of Piranha for each application. Do not store Piranha solution in stock.
- > Piranha solutions could easily heat up to more than 100 °C. Handle with care!
- Prior to discarding the Piranha solution, leave it in an open, clearly labeled, container to cool down overnight in a fume hood.
- The primary hazard of storing Piranha etch waste is the potential for gas generation and over pressurization of the container when the solution is still hot. Storing a hot Piranha solution in an airtight container will cause it to explode!
- The containers in which the Piranha waste are stored must be very clearly labeled with the solution name and composition and must include VERY VISIBLE warning signs.
- Piranha solution reacts violently with any organic materials, therefore adding any acids, bases organic solvents (acetone, isopropanol) or nylon to Piranha or spraying it with water will accelerate the reaction. Do not store wash bottles containing organic compounds on the Piranha deck.
- > Always ensure that all substrates are rinsed and dried before placing them in a Piranha solution.
- > Only use clean glass or Pyrex containers; Piranha solutions are not compatible with plastic.



## **Piranha Spill** –

Notify the Safety and Radiation unit.



- ➢ Wear appropriate PPE to clean spill.
- Use acid or base neutralizing material to neutralize Piranha solution. Test with litmus paper until the spillage is within the neutral range of pH 6-8.
- Clean area using inert absorbent materials (vermiculite, dry sand).
- Soak area with detergent.
- ➢ Rinse area with water.
- Discard contaminated materials in hazardous waste glass vented bottles.
- > Label clearly the bottles, indicating they contain Piranha etch waste.
- ➤ In case of skin contact Remove contaminated clothing → immediately wash affected area with large amounts for approximately 15 minutes → Seek medical assistance.
- ➤ In case of eye contact Immediately wash affected eye with large amounts of water for approximately 15 minutes. Do not rub or keep eyes closed → Seek medical assistance.
- ➤ In case of inhalation Move to fresh air → Seek medical assistance in case of respiratory irritation, cough or tightness in chest.

# Technion Safety & Radiation Unit **Biological Safety**

Biological laboratory facilities are distinguished to the following groups:

- 1. **BSL1** Biosafety Level 1, basic.
- 2. **BSL2** Biosafety Level 2, basic.
- 3. **BSL3** Biosafety Level 3, containment.
- 4. **BSL4** Biosafety Level 4, maximum containment.

Biosafety level designations are based on a composite of the design features, equipment, practices, construction and containment facilities required for working with agents from the various risk groups. Assignment of an agent to a biosafety level considers the following parameters:

- 1. <u>Pathogenicity</u> including stability of agent.
- 2. Infectious dose.
- 3. <u>Transmission</u> mode including presence of a suitable host (human), host range and infectious routes resulting from laboratory manipulations (parenteral, airborne, ingestion).
- 4. <u>Protocol</u> genetic manipulation of the organism that may extend the host range of the agent or alter its sensitivity to known, effective treatment regimens.
- 5. Exposure <u>outcome</u> potential exposure resulting from laboratorial activity planned, such as: sonication, aerosolization, centrifugation etc.
- 6. <u>Prevention</u> prophylaxis immunization, administration of antisera, sanitary measures, control of animal reservoirs or vectors.
- 7. <u>Treatment</u> availability of following measures: passive immunization, postexposure vaccination, antimicrobials, antivirals, chemotherapeutic drugs.

The backbone of biosafety practice is risk assessment. While there are many tools available to assist in performing risk assessment for a given procedure or experiment, the most important component remains to be professional judgement. Risk assessments should be performed by the individuals most familiar with the specific characteristics of the organisms to be used, the equipment and procedures to be employed and the containment equipment and facilities available. Based on the information ascertained during risk assessment, a biosafety level can be assigned to the planned work, appropriate PPE selected, and standard operating procedures incorporating other safety means developed to ensure the safest possible conduct of the work. The PI is responsible for ensuring that adequate and timely risk assessments are performed, and for working closely with the institution's safety committee and biosafety personnel to ensure that appropriate equipment, PPE and facilities are available to support the research to be employed. Risk assessments should be reviewed routinely and revised when necessary.

As the Technion houses BSL1 and BSL2 levels only, this booklet shall concentrate detailed and comprehensive guidelines on the latter.

## Technion Safety & Radiation Unit General Safety Guidelines for Working in a Biological Lab

Each laboratory should adopt a safety manual that identifies known and potential hazards and aims to eliminate or minimize hazards. Specialized laboratory equipment is a supplement to but can never replace appropriate procedures.

The international biohazard warning symbol and sign must be displayed on the laboratory doors.
 Biohazard warning sign for laboratory doors



Biosafety Level:

Responsible Investigator: \_\_\_\_\_

In case of emergency call: \_\_\_\_\_

Daytime phone: \_\_\_\_\_Home phone: \_\_\_\_\_

Authorization for entrance must be obtained from the Responsible Investigator named above.

- > Only **authorized personnel** are allowed to enter BSL laboratory working areas.
- > BSL laboratory area **doors** should be kept **closed**.
- > Access to **animal facilities** should be specially authorized.
- > Only animals involved in the research should be admitted in the laboratory area.

## Technion Safety & Radiation Unit Personal Protective Equipment (PPE)

-

Adequate PPE minimizes the exposure risk to aerosols, splashes and accidental inoculation. The clothing and equipment selected should be dependent on the nature of the work performed.

- PPE in BSL lab areas includes coveralls, gowns or uniforms at all times. Laboratory coats should preferably be fully buttoned. However, long-sleeved, backopening gowns or coveralls are preferred in microbiology laboratories and when working in BSCs.
- Large particles and droplets (> 5 µm in diameter) released during microbiological manipulations settle rapidly on bench surfaces and on hands, therefore **gloves** must be worn for all procedures that may involve direct or accidental contact with blood, body fluids and other potentially infectious agents or infected animals. Used disposable gloves should be discarded with infected laboratory wastes. Allergic reactions, such as dermatitis and immediate hypersensitivity, have been reported regarding the use of latex gloves, specifically the powdered ones. Safety **goggles** or face shields (visors) made of shatterproof plastic and held in place by head straps or caps must be worn when necessary to protect eyes and face from splashes, impacting objects and sources of artificial UV radiation. Safety spectacles do not provide adequate splash protection even when side shields are worn with them. Goggles for splash and impact protection should be worn over normal prescription eye glasses or contact lenses.
- When carrying out high-hazard procedures, such as cleaning up a spill of infectious material, respiratory protection may be used. **Respirators** are available with interchangeable filters against gases, vapours, particulates and microorganisms. It is imperative that the filter is fitted in the correct type of respirator. To achieve optimal protection, respirators should be individually fitted to the operator's face and tested. Fully self-contained respirators with an integral air supply provide full protection.
- It is prohibited to wear PPE outside the laboratory: in elevators, offices, libraries, staff rooms and toilets.
- Personnel must wash their hands following handling infectious agents and/or animals and before they leave the laboratory working areas.
- Appropriate medical evaluation, surveillance and treatment should be provided for all personnel in case of need.



#### Technion Safety & Radiation Unit General Biological Safety Regulations in a Lab

A safety-conscious staff, well informed about the hazard recognition and control, is key to the prevention of laboratory acquired infections, incidents and accidents. therefore, continuous safety training is essential. An effective safety program begins with the laboratory managers, who should ensure that safe laboratory practices and procedures are integrated into the lab's routine science. Training in safety measures should be an integral part of new employees' introduction to the laboratory.

Training must include information on safety measures for highly hazardous risks:

- 1. Inhalation risks due to aerosol production when using loops, streaking agar plates, pipetting, opening cultures, taking blood/serum samples, centrifuging, etc.
- 2. Ingestion risks when handling specimens, smears and cultures.
- 3. Percutaneous exposures when using syringes and needles.
- 4. Percutaneous exposures when handling animals due to bites and scratches.
- 5. Handling of blood and other potentially hazardous pathological agents.
- 6. Decontamination and disposal of infectious material.
- All protocols should minimize formation and dispersion of aerosols and droplets as aerosols are infection sources of infection. Hazardous aerosols can be generated by blending, mixing, grinding, shaking, stirring, sonicating and centrifuging of infectious materials. Aerosols can also be generated when a liquid is unnoticeably dripped from a pipette on to the work surface.
- Use of hypodermic needles and syringes should be limited and cannot be used as substitutes for pipetting devices or for any purpose other than parenteral injection or aspiration of fluids from laboratory animals.
- Pipetting aids should be carefully selected. Their design and use should not create an additional infectious hazard and they should be easily sterilized and cleaned.
- Plugged (aerosol-resistant) pipette tips should be used when manipulating microorganisms and cell cultures.
- Disposable transfer loops should be used whenever possible. Their advantage is that they do not have to be sterilized and can therefore be used in BSCs, where Bunsen burners would disturb the airflow. The transfer loops should be placed in disinfectant following use and discarded as contaminated waste.
- All spills, accidents and overt or potential exposures to infectious materials must be reported to the Safety & Radiation Unit and to the laboratory supervisor.
- > A **clean-up protocol** must be written and followed.
- Bench top surfaces must be decontaminated following any spill of potentially dangerous agent(s) and at the end of the workday.

- Contaminated liquids, specimens and cultures must be decontaminated (chemically or physically) prior to their sanitary sewer discharge. An effluent treatment system may be required, depending on the agent(s) risk assessment.
- > **Transportation** must follow national and/or international regulations.
- Adequate health surveillance of the laboratory personnel should be provided to monitor occupational diseases therefore provision of active or passive immunization should be administered according to need, facilitation of early detection of laboratory-acquired infections should be enabled, exclusion of susceptible individuals: pregnant women, immunocompromised individuals from highly hazardous laboratory work should be applied.
  - BSL1 BSL1 microorganisms are unlikely to cause human or animal disease. Ideally, however, all laboratory employees should undergo a pre-employment health check.
  - BSL2 pre-employment health check is necessary.
  - BSL2 women of childbearing age should be made aware of the risks of occupational exposure to certain microorganisms, sucj as rubella virus.



#### Technion Safety & Radiation Unit Biological Lab Design

In designing a biological laboratory, special attention should be paid to conditions which may pose safety problems, such as aerosol formation, large volumes and/or high concentrations of microorganisms, overcrowding and too much equipment, rodents and arthropods infestation, unauthorized entrance and the use of specific samples and reagents.

- Walls, ceilings and floors should be smooth, easily cleaned, impermeable to liquids and resistant to chemicals and disinfectants.
- ➢ Floors should be slip-resistant.
- Bench tops should be impervious to water and resistant to disinfectants, acids, alkalis, organic solvents and moderate heat.
- > Hand-washing basins should be provided in each laboratory room, preferably near the exit.
- > Doors should have vision panels, appropriate fire ratings and preferably be self-closing.
- Provision of mechanical ventilation systems, which provide inward air flow without recirculation is recommended. If there is no mechanical ventilation, windows should be able to be opened and fitted with arthropod-proof screens.
- A stand-by emergency generator is desirable for the support of essential equipment, such as incubators, freezers, etc., and for the ventilation of animal cages.
- At BSL 2, an autoclave or other means of decontamination should be available in appropriate proximity to the laboratory.





## **Biological Safety Cabinets (BSCs)**

BSCs protect the operator, the laboratory environment and research products from exposure to infectious aerosols and splashes that may be generated when manipulating infectious agents.

Aerosol particles of less than 5  $\mu$ m in diameter and small droplets of 5–100  $\mu$ m in diameter are not visible, therefore employees may inhale or cross-contaminate their research products.

Aerosol particles are created by any activity that imparts energy into a liquid or semiliquid, such as shaking, pouring, stirring or dropping liquid onto a surface or into another liquid. For example, streaking agar plates, inoculating cell culture flasks using a pipette, using a multichannel pipette to dispense liquid suspensions of infectious agents into microculture plates, homogenizing and vortexing infectious materials, centrifugation of infectious liquids or working with animals, can all generate infectious aerosols.

Today's BSCs contain a high-efficiency particulate air (HEPA) filter in their exhaust system. The HEPA filter traps 99.97% of particles of 0.3 µm in diameter and 99.99% of particles of greater or smaller size. This enables the HEPA filter to effectively trap all known infectious agents and ensure that only microbe-free exhaust air is discharged from the cabinet. Also, HEPA-filtered air is directed over the working surface inside the BSC, providing contamination protection.



The directional air flow whisks potential aerosol particles away from the laboratory employee and into the exhaust duct.

The air from the BSC is exhausted *via* a HEPA filter into one of the following:

- 1. into the laboratory and then to the outside of the building *via* the building exhaust;
- 2. to the outside of the building *via* the building exhaust;
- 3. directly to the outside.
  - > The HEPA filter may be situated in the exhaust plenum of the BSC or in the building exhaust.
  - Volatile or toxic chemicals should not be used in a BSCs Class I, since they recirculate air (this is also why there are almost no BSC Class I used at the Technion nowadays).
  - The air velocity through the front opening of a BSC is about 0.45 m/s, therefore the directional air inflow can be easily disrupted by air currents generated even by people walking by, open windows and opening and shutting doors. Therefore, ideally, BSCs should be situated in a remote location from traffic and potentially disturbing air currents.
  - If possible, a 30-cm clearance should be provided behind and on each side of the BSC to allow easy access for maintenance.
  - A clearance of 30–35 cm above the BSC may be required to assure accurate air velocity easurement across the exhaust filter as well as for maintenance (exhaust filter changes).
  - When working in a BSC careful attention should be given to the movement of arms into and out of the BSC in order to maintain the integrity of the front opening air inflow: the motion of arms in a BSC should be slow and perpendicular to the sash.
  - All necessary consumables should be placed inside the BSC prior the commencing of biological manipulations so that the number of movements across the sash would be minimized.
  - Manipulations of chemicals within BSCs should be hindered approximately 1 min following placing hands and arms inside the BSC to allow an "air sweep" of the BSC's surface.





# Class IIA1 BSC

As the use of cell and tissue cultures for the propagation of viruses and other purposes developed, the need for sterilized room air to pass over the work surface was a necessity, therefore BSCs class were no longer satisfactory. Class II BSCs (there are four types: A1, A2, B1 and B2) provide personnel protection as well as protect work surface products from contamination of room air. Class II BSCs allow only HEPA-filtered (sterile) air to flow over the work surface. The Class II BSCs are used for working with infectious agents.



A "thimble" or "canopy hood" is ventd the BSC II1A to the outside. The thimble fits over the exhaust housing, sucking the exhaust air into the building exhaust ducts. A small opening, usually 2.5 cm in diameter, is maintained between the thimble and the exhaust housing. This small opening enables room air to be sucked into the building exhaust system as well. The building exhaust capacity must be sufficient to capture both room air as well as the BSC exhaust. Generally, the performance of a thimble-connected BSC is not affected by fluctuations in the building's airflow.

BSCs can be equipped with an alarm:

- Sash alarms are found only on BSC with sliding sashes. The alarm signifies that the operator has moved the sash to an improper position. Corrective action is thereby returning the sash to its proper position.
- 2. Airflow alarms indicate a disruption in the BSC's airflow pattern, posing an immediate danger to the operator or product. When an airflow alarm sounds, work should immediately cease.
- Most BSCs permit a 24 h/day operation. Moreover, continuous operation assists in controlling the levels of dust and particulates in the laboratory. However, Class IIA1 BSCs exhausting to the room or connected by thimble connections to dedicated exhaust ducts can be turned off when not in use.
- BSCs should be turned on at least 5 minutes both prior commencing work and following completion of work to allow the removal of contaminated air from the BSC's environment.
- > The glass viewing panel must be closed when the BSC is in use.
- The front intake grill must not be blocked with paper, equipment etc, as this will disrupt the airflow, causing potential contamination of the material and exposure of the operator.
- > Paperwork should never be placed inside BSCs.
- The interior surfaces of BSCs should be decontaminated both prior as well as following each use. The work surfaces and interior walls should be wiped with a disinfectant.
- All items inside the BSC, including equipment, should be surface-decontaminated and taken out of the BSC when work is completed, since residual culture media may provoke microbial growth.
- > Agents to be placed inside the BSC should be surface-decontaminated using 70% alcohol.
- All agents should be placed as farthest as possible inside the BSC (towards the rear edge of the work surface) without blocking the rear grill.
- Space occupying items, such as biohazard bags, pipette bins and flasks should be placed to one side of the interior of the BSC.
- The operator should not disturb the airflow by repeated removal and reintroduction of hands or the repeated use of containers, disrupting the integrity of the BSC's air barrier.
- > All work must be performed in the middle or rear part of the work surface.
- ▶ Work should be performed on disinfectant-soaked absorbent towels to capture splatters and splashes.
- PPE clothing should be worn whenever using a BSC: Laboratory coats, gloves should be pulled over the wrists of the lab coat (rather than worn inside). Masks and safety glasses may be required for some procedures.

- ➤ UV is not required in BSCs.
- > In case UV is used, its intensity should be checked to ensure the emission is appropriate.
- In case UV is used, the lamp must be cleaned weekly to remove any dust and dirt that may block the germicidal effectiveness of the light.
- > UV must be turned off while work is in progress to protect eyes and skin from inadvertent exposure.
- Open flames should be avoided inside the BSC because of the risk of spatter of infectious material. They may damage the filters, disrupt the airflow patterns and can be dangerous when volatile, flammable substances are also used. The heat produced will distort.
- When a spill of biohazardous material occurs within a BSC, commence clean-up ASAP while the BSC operates. An effective disinfectant should be applied in a manner that minimizes aerosol generation. All materials that come into contact with the spilled agent should be disinfected and/or autoclaved.
- Final surface decontamination at the end of the work day should include a wipe-down of the work surface, the BSC's walls, back and interior of the glass using a bleach solution or 70% alcohol while the BSC is running. Sterile water is needed as a second wiping line when a corrosive disinfectant, such as bleach, is used. Leave BSC running for another 5 minutes before turning it off to allow complete purge.



## **Specific Chemical Reactions and Associated Safety Guidelines**

## Microbiology

- Plastics should replace glass wherever possible, preferably polytetrafluoroethylene (PTFE) vessels are recommended because – 1. glass may break; 2. to prevent aerosols, containing infectious agents and accidental inoculation, to escape, releasing infectious material, from between the cap and the vessel in the framework of homogenizers, shakers and sonicators operation.
- > Upon the usage of glassware, only laboratory grade (borosilicate) glass should be used.
- Specimen containers may be made of robust glass or preferably plastic (even Pasteur pipettes should be replaced with the plastic ones), preventing accidental inoculation resulting from injury with broken or chipped glassware.
- > Containers should not leak when the cap or stopper is correctly applied.
- > The seal should preferably have a gasket.
- Tubes and specimen containers should always be securely capped (preferably screw-capped) for centrifugation.
- > No material should remain on the outside of the container.
- Containers should be correctly labelled.
- Secondary containers such as boxes made of metal or plastic fitted with racks so that the specimen containers remain upright, should be used to avoid accidental leakage or spillage. The secondary containers should be autoclavable or resistant to chemical disinfectants.
- Discarded specimen tubes containing blood clots, etc. should be placed in suitable leakproof containers for autoclaving and/or incineration.
- > Air should never be blown through a liquid containing infectious agents.
- > Liquids should not be forcibly expelled from pipettes.
- Contaminated pipettes should be completely submerged in a suitable disinfectant for a certain time interval before disposal, therefore a discard container for pipettes should be placed inside the BSC.
- > Syringes fitted with hypodermic needles must never be used for pipetting.
- To avoid dispersion of infectious material aerosoled mistakenly from a pipette, an absorbent material should be spread on the work surface and disposed of as infectious waste following use.
- Needles should never be recapped but discarded into puncture-proof/puncture-resistant cover-fitted containers.
- Microbiological transfer loops should have a diameter of 2–3 mm and be completely closed to avoid the premature shedding of their loads; the shanks should exceed 6 cm in length to minimize vibration.
- > Equipment should always be closed to avoid droplets and aerosols dispersion.
- Care must be taken when using angle-head centrifuge rotors to ensure that the tube is not overloaded as it might leak. Securely capped tubes offer adequate protection against infectious aerosols and dispersed particles.
- > Centrifuge parts, such as buckets, rotors and bowls, should be decontaminated following each use.
- > Hearing protection should always be provided for people using sonicators.
- > Tissue grinders should be operated and opened in a BSC.
- Face protection and rubber gloves should be worn during the periodic cleaning and disinfection of refrigerators, deep-freezers and solid carbon dioxide (dry-ice) chests.
- Flammable solutions must not be stored in a refrigerator unless it is explosionproof (EP).
- > Blood and serum should be pipetted carefully, not poured.
- Fixing and staining of blood, sputum and faecal samples for microscopy do not necessarily kill all organisms or viruses on the smears, therefore these items should be handled with forceps, stored appropriately, and decontaminated and/or autoclaved following use.



#### Ampoules

- New and/or ampoules, which were stored in cold storage, should always be opened in a BSC accompanied with proper PPE, because when lyophilized ampoules of freeze-dried materials are opened, their contents may be under reduced pressure, therefore the sudden air inrush may disperse materials into the atmosphere.
- > Ampoules should be opened according to the following guidelines:
  - 1. Decontaminate the outer surface of the ampoule;
  - 2. Make a file mark on the ampoule's tube, near the middle of the cotton or cellulose plug;
  - 3. Maintain ampoule in alcohol-soaked cotton before breaking it at the file's scratch to protect hands;
  - 4. Remove top gently and treat as contaminated material;

5. If the plug is still present above the contents of the ampoule, remove it with sterile forceps; 6. Slowly add liquid for resuspension to avoid frothing.

- Ampoules should be stored only in the gaseous phase (above liquid nitrogen) in case very low temperatures are required.
- Ampoules containing infectious materials should never be immersed in liquid nitrogen because cracked ampoules may break or explode upon removal.
- The outer surfaces of ampoules stored in cold conditions should be disinfected upon removal from storage.

- > Formalin fixatives should be used for tissues.
- ➢ Frozen sectioning should be avoided.
- > A cryostat operator should always be shielded with a safety face shield.



#### Prions

Prions are associated with the transmissible spongiform encephalopathies (TSEs), notably Creutzfeldt-Jakob disease (CJD; including the new variant form), Gerstmann-Sträussler-Scheinker syndrome, fatal familial insomnia and kuru in humans; scrapie in sheep and goats; bovine spongiform encephalopathy (BSE) in cattle; and other transmissible encephalopathies of deer, elk and mink. Although CJD has been transmitted to humans, there appear to be no proven cases of laboratory-associated infections with any of these agents. Nevertheless, it is prudent to maintain precautions in handling infected or potentially-infected humans and animals' materials.

- > All prion manipulations must be conducted in a BSC.
- Great care should be exercised to avoid aerosol production, ingestion, and cuts, abrasions and punctures of the skin.
- Work with prions necessitates the use of disposable protective covering on the work surface of the BSC.
- The use of plastic ware disposables, which can be treated and discarded as dry waste, is critical when working with prions since complete inactivation of prions is difficult to achieve. In addition, always use dedicated equipment not shared with other laboratories.
- > Non-disposable instruments, including steel mesh gloves, must be collected for decontamination.
- Tissue processors should not be used because of disinfection problems. Jars and plastic beakers should be used instead.
- Formalin-fixed tissues should be regarded as still infectious, even after prolonged exposure to formalin.
- > Paraformaldehyde vaporization procedures do not diminish prion titers.
- > Prions are resistant to UV irradiation.
- Bench waste, including disposable gloves, gowns and aprons, should be autoclaved using a porous load steam sterilizer at 134–137 °C for a single cycle of 18 minutes or 6 successive cycles of 3 minutes each, followed by incineration.
- Infectious liquid waste contaminated with prions and prion-contaminated BSCs should be treated with sodium hypochlorite containing a final concentration of 2% chlorine for 1 hour.

- > Instruments should be soaked in sodium hypochlorite containing a final concentration of 2% chlorine
- for 1 hour and then rinsed in water before autoclaving. Appropriate washing to remove residual sodium hypochlorite is required.
- HEPA filters should be incinerated at a minimum temperature of 1000 °C following removal. Prior their incineration the exposed face surface of the filter should be sprayed with lacquer hairspray and the filters should be "bagged".

All operations associated with needles, short of animal injections, should be performed using trimmed hypodermic needles.



## Technion Safety & Radiation Unit Waste Handling

In biological laboratories, decontamination of wastes and disposal are closely interrelated. The scaffold principle is that all infectious agents should be decontaminated, autoclaved or incinerated.

Many types of chemicals can be used as disinfectants and/or antiseptics. Formulations must be carefully selected for specific needs.

- Routinely, few if any contaminated materials will require actual removal from the laboratory or destruction.
- > Chemical waste must never be disposed of inside "Biohazard" bags.
- Biological waste combined into liquids, such as PFA, chloroform or phenol is not considered as "biological waste".
- All laboratory waste containing infectious, potentially infectious or recombinant DNA waste must be inactivated prior to disposal. This includes the following:
  - Human blood, blood products, body fluids, tissues, cells and other potentially infectious material.
  - Human, animal and plant pathogens,
  - Recombinant/genetically-modified organisms, vectors and plasmids
  - Test tubes, flasks, pipet tips, syringes, needles and culture dishes containing or contaminated with any of the above.
  - Contaminated infectious "sharps", i.e.: hypodermic needles, scalpels, knives and broken glass should be collected in puncture-proof containers (red & yellow plastic containers) and must not be filled.
- Hypodermic needles should not be recapped, clipped or disassempbled from disposable syringes. The complete assembly should be placed in the sharps disposal container, with prior autoclaving if required.
- Hypochlorites and high-level disinfectants are recommended for decontamination: freshly prepared hypochlorite solutions should contain available chlorine at 1 g/l for general use and 5 g/l for blood spillages.
- > Glutaraldehyde may be used for decontaminating surfaces.
- Chemical germicides activity is faster and better at higher temperatures on the one hand; on the other, higher temperatures can accelerate chemicals evaporation and degrade them.
- Steam autoclaving is the preferred method for all decontamination processes. Agents destined for decontamination and disposal should be placed in leakproof containers or plastic bags.
- Discard containers or jars, preferably plastic ones, should be placed at every work station. When disinfectants are used, waste designated agents should remain in contact with the disinfectant for the appropriate time, according to the disinfectant used.

- Containers should be decontaminated and washed before reuse.
- Agents and consumables which cannot be decontaminated must be appropriately packaged for immediate on-site incineration or transfer to another facility without posing any additional potential hazards to those who carry out the immediate disposal procedures or who might encounter the discarded items outside the facility.
- > Most glassware and laboratory clothing will be recycled.
- > Animal carcasses cannot be disposed of as biological waste.



## - Autoclave

- Operators should wear suitable gloves and visors for protection when opening the autoclave, even when the temperature has fallen below 80 °C.
- All consumables, materials and waste to be autoclaved should be stored in containers, which allow removal of air while permitting good heat penetration.
- Slow exhaust settings should be used when autoclaving liquids, as they may boil over when removed due to superheating.
- Steam should be saturated and chemical-free from corrosion inhibitors, which could contaminate the items being sterilized.

## - Germicides

## Chlorine (Sodium Hypochlorite - NaOCI)

- **4** Chlorine is a fast-acting oxidant and a broad-spectrum chemical germicide.
- 4 Chlorine is highly alkaline and can be corrosive to metal.
- 4 Chlorine can be diluted with water to provide various concentrations.
- **4** A general all-purpose laboratory disinfectant should have a concentration of 1 gr/liter chlorine.
- A stronger solution, containing 5 gr/liter chlorine, is recommended for dealing with biohazardous spillage and in the presence of large amounts of organic matter.
- Chlorine at a concentration of domestic bleach, contains 50 gr/liter chlorine and should therefore be diluted 1:50 or 1:10 to obtain final concentrations of 1 gr/liter and 5 gr/liter, respectively.
- Granules or tablets of calcium hypochlorite (Ca(ClO)2) generally contain about 70% chlorine.

- Solutions prepared with granules or tablets, containing 1.4 gr/liter and 7.0 gr/liter will then contain 1.0 gr/liter and 5 gr/liter available chlorine, respectively.
- Chlorine's activity is considerably reduced by organic matter, such as protein, therefore solutions containing high levels of organic matter several times a day should be changed at least daily. Solutions containing low levels of organic matter should be could last as long as a week.
- Storage of bleach in open containers, particularly at high temperatures, releases chlorine gas, thus weakening their germicidal potential.
- Heach must not be mixed with acids to prevent the rapid release of chlorine gas.
- Chlorine gas is highly toxic. Bleach must therefore be stored and used in well-ventilated areas only.
- The frequency with which working solutions of bleach should be changed depends on their starting strength, the type (with or without a lid) and size of their containers, the frequency and nature of use and the ambient conditions.

#### Chloramines

- 4 Chloramines are available as powders containing about 25% available chlorine.
- Chloramines release chlorine at a slower rate than hypochlorites. Higher initial concentrations are therefore required to reach equivalent efficiencies to efficiencies of hypochlorites.
- On the other hand, chloramine solutions are not inactivated by organic matter to the same extent as hypochlorite solutions.
- Chloramine solutions are virtually odor-free, therefore items soaked in chloramines must be thoroughly rinsed to remove any residue of the bulking agents.

## **Chlorine Dioxide (ClO<sub>2</sub>)**

- 4 Chlorine dioxide is a strong and fast-acting germicide.
- It is a disinfectant agent and oxidizer. Chlorine dioxide is the most selective oxidant of all oxidizing biocides.
- Chlorine dioxide is unstable as a gas and will undergo decomposition into chlorine gas (Cl<sub>2</sub>), oxygen gas (O<sub>2</sub>), giving off heat.
- However, chlorine dioxide is soluble in water, therefore is stable in an aqueous solution.
- Chlorine dioxide can be obtained (1) by mixing of two separate components: hydrochloric acid (HCl) + sodium chlorite (NaClO2); and (2) ordering its stabilized form, which is then activated onsite when required.

Ozone and chlorine are much more reactive than chlorine dioxide. Chlorine dioxide, however, reacts only with reduced sulfur compounds, secondary and tertiary amines, therefore chlorine dioxide can be used more effectively than ozone or chlorine in cases of a higher organic load because of its selectivity.

#### Sodium dichloroisocyanurate (NaDCC)

- **4** Sodium dichloroisocyanurate in powder form contains 60% chlorine.
- Solutions prepared with NaDCC powder at 1.7 gr/liter and 8.5 gr/liter will contain 1 gr/liter or 5 gr/liter chlorine, respectively.
- Tablets of NaDCC generally contain the equivalent of 1.5 gr of chlorine *per* tablet. One or four tablets dissolved in 1 liter of water will give approximately the required concentrations of 1 gr/liter or 5 gr/liter, respectively.
- NaDCC as powder or tablets is safe to store. Solid NaDCC can be applied on biohazards spills of blood or other liquids. The solid tablets should be left 10 minutes before removal. Further cleaning of the affected area can then take place.

## Alcohols (ethyl alcohol, C2H5OH and isopropyl alcohol, (CH3)2CHOH))

- **4** Ethanol isopropanol are disinfectants.
- 4 Alcohols are volatile and flammable, therefore cannot be used near open flames.
- 4 Alcohols may harden rubber, therefore care should be taken regarding glove use with alcohols.
- 4 Alcohols are active against vegetative bacteria, fungi and lipid-containing viruses.
- 4 Alcohols are not active against spores and may not kill all types of nonlipid viruses.
- For best effectiveness alcohols should be used at concentrations of approximately 70% (v/v) in water: higher or lower concentrations may not be as germicidal. Mixtures with other agents are more effective than alcohol alone, for example 70% (v/v) alcohol with 100 gr/liter formaldehyde, and alcohol containing 2 gr/liter available chlorine.
- 4 A 70% (v/v) ethanol can be used on skin, bench work surfaces and BSCs.
- 4 Alcohols should be stored correctly to avoid the evaporation.
- **4** Bottles with alcohol-containing solutions must be clearly labelled to avoid autoclaving.

- 4 Iodine is slightly less inhibited by organic matter than chlorine.
- 4 Iodine is generally unsuitable as a disinfectant.
- Iodophors and tinctures of iodine are good antiseptics.
- 4 Iodine should not be used on aluminum or copper.
- ↓ Iodine can be toxic.
- Organic iodine-based products must be stored at 4–10 °C to avoid growth of potentially harmful bacteria.

## Hydrogen peroxide (H2O2)

- Hydrogen peroxide and peracids are strong oxidants and therefore can be used as broad-spectrum germicides.
- Hydrogen peroxide is supplied either as a ready-to-use 3% solution or as a 30% solution to be diluted 5–10 times its volume.
- ↓ Hydrogen peroxide can be used for decontamination of bench work surfaces and BSCs.
- Hydrogen peroxide and peracids are safer than chlorine to humans and the environment.
- Hydrogen peroxide and peracids can be corrosive to metals such as aluminum, copper, brass and zinc, and can also decolorize fabrics, hair, skin and mucous membranes.
- Hydrogen peroxide and peracids should always be protected from heat and light.

#### **Phenol**

- + Phenolic compounds are active against vegetative bacteria, lipid-containing viruses and mycobacteria.
- + Phenol is not active against spores and probably also not that active against nonlipid viruses.
- **4** Many phenolic products are used for the decontamination of environmental surfaces.
- **4** Triclosan is active mainly against vegetative bacteria and safe for skin and mucous membranes.
- + Phenolic compounds may be absorbed by rubber and can also penetrate skin.

#### Formaldehyde (HCHO)

- ↓ Formaldehyde is a gas that kills all microorganisms and spores at above 20 °C.
- Formaldehyde (5% formalin in water) may be used as a liquid disinfectant.
- **4** Formarldehyde is not active against prions.
- **Formaldehyde is relatively slow-acting.**
- Formaldehyde needs a relative humidity level of approximately 70%.

- It is marketed as the solid polymer, paraformaldehyde, in flakes or tablets, or as formalin, a solution of the gas in water of about 370 gr/liter (37%), containing methanol (100 ml/liter) as a stabilizer.
  Both formulations are heated to liberate the gas.
- Formaldehyde is a suspected carcinogen. It is an irritant gas with a pungent smell of which fumes can irritate eyes and mucous membranes. It must therefore be stored and used in a fume-hood or well-ventilated area.

## Glutaraldehyde (OHC(CH2)3CHO)

- Glutaraldehyde is also active against vegetative bacteria, spores (it takes several hours to kill bacterial Spores), fungi and lipid- and nonlipid-containing viruses.
- Glutaraldehyde is generally supplied at a concentration of approximately 20 gr/liter (2%) and some products may need to be "activated" (made alkaline) before use by the addition of a bicarbonate compound. The activated solution can be reused for 1–4 weeks.
- **4** Glutaraldehyde solutions should be discarded if they become turbid.
- Glutaraldehyde is toxic. It is a skin and mucous membranes irritant, therefore contact with it must be avoided. It must be used in a fume-hood or in well-ventilated areas.

#### **Ammonium compounds**

- 4 Quaternary ammonium compounds are often used in combination with alcohols.
- **4** Ammonium compounds are active against some vegetative bacteria and lipid-containing viruses.
- **4** Certain ammonium compounds, such as benzalkonium chloride, are used as antiseptics.
- The germicidal activity of certain quaternary ammonium compounds is reduced by organic matter, water hardness and anionic detergents.
- Wing to low biodegradability, quaternary ammonium compounds may accumulate in the environment.

# **Conduct during a Biological Emergency**

## Spillage

- 1. Wear gloves and protective clothing, including face and eye protection.
- 2. Report to the Safety unit.
- 3. Cover broken containers contaminated with infectious substances and spilled infectious substances using a cloth or paper towels.
- 4. Pour an appropriate disinfectant concentrically beginning at the outer margin of the spill area over the paper towels and surrounding area working toward the center. Generally, 5% bleach solutions are appropriate.
- 5. Soak spillage and leave to settle for 30 minutes.
- 6. Glass fragments should be handled using forceps, a dustpan or a piece of stiff cardboard to collect the material and deposit it into a puncture-resistant container.
- 7. Clear away cloth or paper towels and the broken material and place them in a contaminated-waste container.
- 8. If dustpans are used to clear broken material, autoclaved them or place them in an effective disinfectant.
- 9. Swab contaminated area with disinfectant.

## Spillage in Centrifuge

- 1. If a breakage occurs or is suspected while the centrifuge is running -
  - (a) switch off the motor.
  - (b) Leave centrifuge closed 30 minutes to allow settling.
  - (c) Report to the Safety unit.
  - (d) Wear thick rubber gloves, covered, if necessary, with suitable disposable gloves.
  - (e) Forceps should be used to retrieve glass debris.
  - (f) All broken tubes, glass fragments, centrifuge buckets, trunnions and the rotor should be placed in a noncorrosive disinfectant known to be active against the organisms concerned.
  - (g) All sealed centrifuge buckets should be loaded and unloaded in a BSC.
  - (h) If breakage is suspected within the safety cup, the safety cap should be loosened and the bucket autoclaved. Alternatively, the safety cup may be chemically disinfected.
  - (i) The centrifuge bowl should be swabbed with the same disinfectant, at the appropriate dilution, swabbed again, washed with water and dried.



- (j) Unbroken, capped tubes may be placed in disinfectant in a separate container and recovered.
- (k) All agents used in the clean-up should be treated as infectious waste.
- 2. If breakage has been discovered after the centrifuge has stopped
  - (a) Replace lid immediately.
  - (b) Leave centrifuge closed 30 minutes to allow settling.
  - (c) Report to the Safety unit.
  - (d) Wear thick rubber gloves, covered, if necessary, with suitable disposable gloves.
  - (e) Forceps should be used to retrieve glass debris.
  - (f) All broken tubes, glass fragments, centrifuge buckets, trunnions and the rotor should be placed in a noncorrosive disinfectant known to be active against the organisms concerned.
  - (g) All sealed centrifuge buckets should be loaded and unloaded in a BSC.
  - (h) If breakage is suspected within the safety cup, the safety cap should be loosened and the bucket autoclaved. Alternatively, the safety cup may be chemically disinfected.
  - (i) The centrifuge bowl should be swabbed with the same disinfectant, at the appropriate dilution, swabbed again, washed with water and dried.
  - (j) Unbroken, capped tubes may be placed in disinfectant in a separate container and recovered.
  - (k) All agents used in the clean-up should be treated as infectious waste.

## Ingestion

- 1. Remove PPE.
- 2. Seek medical attention. Identification of the ingested material and circumstances of the incident should be reported.
- 3. Report to the Safety unit.
- 4. Complete medical records should be kept.

## **Aerosol Exposure**

- 1. Vacate affected area.
- 2. All exposed personnel should seek medical attention.
- 3. Report to the Safety unit.
- 4. Confine entrance using signage for a 1 hour to allow ventilation heavier particles to settle.
- 5. If the laboratory does not have a central air exhaust system, entrance should be delayed for 24 hours.
- 6. Decontamine area supervised by the safety unit.
- 7. Appropriate PPE should be worn.

## **Abrasions, Wounds, Punctures**

- 1. Remove PPE.
- 2. Wash the hands and any other affected area(s).
- 3. Apply an appropriate skin disinfectant.
- 4. Seek medical attention, if necessary. Cause of wound and the organisms involved should be reported.
- 5. Report to the Safety unit.
- 6. Complete medical records kept.





## Conduct during an Emergency - Fire, Evacuation of Injured, Building Evacuation

## Fire

- ➢ If the automatic alarm does not sound...
- Press the nearest fire alarm.
- ▶ Immediately call the Security and Safety Center 2222 and report the location of the fire.
- Try to extinguish the fire in participation with other people using firefighting equipment (if there is no danger to life).
- Order visitors to evacuate the building.
- > Evacuate the building at your discretion or at the order of the firefighters.

## **Evacuation of Injured**

- Summon a medic or first aid immediately and call the Security and Safety Center at the emergency number: 2222.
- Provide the exact details about the incident: type of injury, building, precise location and telephone number for clarifications.
- > Send someone to wait for the arriving team to direct them to the incident's location.

## **Building Evacuation**

- If an evacuation order has been issued, turn off the lights, unplug electrical devices and close the room's doors and windows. When possible, close all gas flow gasses. Turn of the heating of chemical reactions but maintain proper cooling. Make sure all antechambers of the glovebox are closed and under vacuum.
- In case sirens have been operated while working with pyrophoric materials stop transfer immediately, remove needles and close the bottle of the pyrophoric reagent. Do not leave pyrophoric reagents in syringes. If the pyrophoric material is added *via* a dropping funnel make sure the apparatus remains under inert atmosphere.
- > Do not lock the door. Make sure no one is left behind.
- Do not use the elevator during an evacuation of a building. Use emergency exits only. Follow the direction signs.
- ▶ Keep to the right of the stairwell during descent to allow emergency crews to ascend.



- > Assemble at the designated assembly point.
- Do not return to the building to look for missing persons! Notify the safety officials regarding your concern.
- > Obey instructions of the safety officials.
- > After leaving the building, go to the building's designated meeting point.



## Technion Safety & Radiation Unit Conduct during Emergency – Air-Raid Shelters

# An alert to enter the shelters will be issued by the Home Front Command sirens or via other means

## If you hear a siren -

- $\succ$  Turn off the lights.
- > Unplug electrical devices.
- Close all water and gas valves.

#### Upon announcement to enter shelters -

- ▶ Reach the nearest shelter quickly and carefully.
- > Assist your colleagues also enter the shelter.
- ➢ Keep quiet.
- Smoking in a shelter is strictly forbidden.
- > Obey the instructions of the evacuation trustees or the security personnel.

#### Where are the shelters?

You can find the list on the Safety Unit website and on the next page of this booklet.





Faculty/unit	Shelter/protected space/cover	Tel. no.
Aeronautics	Administration building, entrance to the parking lot or main entrance next	2547
	to Room 118	
Ullman	Floor 100 in the switchboard area	
Amado	1 <sup>st</sup> floor, next to Room 119	
Borowitz	Ground floor, geodesic	
Biomedicine	Basement level	
Biology	2 <sup>nd</sup> floor in the new building, by the auditorium	
Shalon	20	5192
Danzinger	Floor 0 near the workshop	2635
Technology	Main building entrance to the left $+ 1^{st}$ floor near the auditorium	2170
instruction		
Transportation	Stairwell	
Research Institute		
Chemical	First floor	2664
engineering		
Rocket propulsion	Main entrance to the left	2547
Meidan Materials	Protected floor space on every floor	4565
Agriculture	Ground floor of the new building by the library	3509
Construction	Ground floor-basement	2368
research		
Electrical Eng.	2 <sup>nd</sup> floor, elevator area to the left	
Chemistry	New office wing, protected floor space on every floor	3698
Chemistry	Floor 100 toward the machine room (corridor)	3698
Lady Davis	3 <sup>rd</sup> floor at the bottom of the end stairwell toward the Industrial	3831
(machines)	Management Building	
Humanistic Studies	Protected floor space on every floor by the elevator	3478
Towers 60	Ground floor	2180
Towers 61	Ground floor	2180
Computer Sciences	Every floor in the middle corridor near the emergency stairs, 2 protected	4355
	floor spaces on every floor	
Taub Computer	Lower parking garage	4355
Sciences		

Technion Safety & Radi	ation Unit	
Neaman Institute	Entrance floor 137	2156
Faculty Club	Entrance floor to the right	
Employees Club	Ground floor stairwell	2641
Microelectronics	Internal corridors + stairwell	4202
Water Institute	Protected floor space on every floor (3-4 floors)	
Kahn Mechanical	Protected spaces on floors -1, 0, 1, 2, 3, 4	3831
Engineering		
Malat	Ground floor, one floor below the entrance floor	2397
Churchill	Ground floor by the bathrooms, secretariat, and band	2297
Pre-academics –	Protected apartment space 1 <sup>st</sup> floor x 2 rooms	2196
new wing		
Pre-academics –	1 <sup>st</sup> floor, rooms 104, 106	2196
old wing		
Coler	Lower floor	3863
Canada	Entrance floor by the machine room	3892
Land and Roads	Basement level	2326
Rabin	Protected floor space on every floor	
Medicine	2 <sup>nd</sup> floor by surgery	5340
Sherman	Entrance floor to the right at the end	2370
Industrial	Bloomfield Building Auditorium, ground floor	
Management		
Aeronautics Lab	Aeronautics Laboratory Building opposite the energy laboratory	2547
Allenby Dormitory	Entrance floor (also serves as a club)	8515783
Neve America	83, 26, 28, 29, 22, 24, 25 (26 also serves as the laundry room)	2419
Dormitory		
Naamat Dormitory	Protected floor space on every floor in the new building	2919
Gross Dormitories	50-55	2180
(Canada)		
Heller Dormitories		2420
Senate Dormitories	110, 112, 114, 116, 117, 119, 121 (114, 119 also serve as laundry rooms)	2419
New East dorms	Protected apartment space in each apartment	2419
New East dorms	Buildings 450-459 (256 apartments) - protected apartment space in each	2419
	apartment	
Old East dorms	103	2403

Technion Safety & Radi	ation Unit	
Junior faculty	Building 3, Building 6	2868,
dormitories		2864
Senate dormitories	Entry from the kitchenette opposite the stairwell (passageway to the	2599
	library)	
Palm Beach dorms	21	2419
Canada dorms	41-46, 47, 31-37	2180
Rivkin Center	Between building 5-10, Jester Center, between buildings 7-8 (gananim)	2349
"Tachton"		
Solid state	Internal corridor + area by the elevator	2051
Sego	Ground floor by the auditorium	4042
Sports	Ground floor opposite the gym	3036
Central Library	Lower level	2598
Duty library	Left entrance inside the library	2297
Physics	Auditorium site 001 by the cafeteria serves as the computer farm + floor	3677
	100 by the workshop	
Physics	Underground garage	2677



Important information

# **Emergency Phone Numbers**

Address	Telephone	Fast dial
Technion emergency number		2222
Faculty of medicine emergency number		5222
Technion clinic		8807515
Safety Unit	04-8292146/7	2146, 2147
Security Department	04-8292222	2222, 2494, 3888
	04-8292494	
Building and Maintenance Department	04-8292223	2223, 5721
Switchboard		0
Police	100	
Magen David Adom	101	
Fire and Rescue Services	102	
Carmel Hospital	8250111	
Rambam Medical Center	8359359	
Bnei Zion Hospital	8543111	

# We wish you safe, accident-free work!

