

Safety instructions for working in the laboratory

(This translation is based on safety instruction “PR-236”.)


I General safety regulations for working in the laboratory







- A laboratory is supplied with central deionised water, sewerage, electricity, heating, hot and cold tap water, and ventilation systems. It also contains an eye-rinse system, suitable cleaning agents and medical first aid remedies.
- The laboratory must have suitable fire extinguishers, their location and application must be well known for all users of that laboratory.
- All employees and students must know how to use fire extinguishers in the case of fire. This presumes that everyone who works in the laboratory must be instructed about fire safety.
- Each laboratory must have safety manual regulating the requirements and behaviour that must be accepted and followed by the laboratory staff and students.
- Activities in the laboratory must be always safe for the one performing the experiment and for other people nearby. Move around only as much as it is necessary for performing the work. While moving in the laboratory: do not rush, be careful, and avoid slipping and falling down. Avoid damaging and dropping the laboratory glassware and equipment.
- It is forbidden to store and consume food products and drinks in the laboratories.
- During work in the laboratories, the laboratory coat should be worn in order to protect oneself and clothes from chemical drops and spills. According to the safety requirements of the experiment or work, performed safety mask, goggles and gloves must be worn.
- Employees and students can start their experimental work in the laboratory only after appropriate safety instruction, i.e. after the investigation of the current safety manual, and signing in the book or card of the safety-instructed laboratory staff.
- After the end of practical work in the laboratory, every employee and student must clean the workplace, used laboratory glassware and tools, and finally hands.
- In the case of an accident, it must be reported immediately to the experiment or work supervisor or director of the institute and to the work environment representative (i.e. safety manager). According to the nature of the accident, appropriate activities must be applied in order to avoid its recurrence.
- In the case of serious injury or death, the workplace and equipment must be kept as it was at the moment of the accident until the arrival of the representative of the labour inspectorate or police and their permission to restart the laboratory activities.
- When it is impossible to keep the place of the accident and the used equipment untouched, the situation must be fixed with clear readable marks, photographed or a scheme must be drawn. A written detailed description of the accident scene, observed situation and a guide to the photo or sketch of the scene should be prepared immediately.
- Before the start of experimental work, instructions and manuals must be read very carefully. Only activities described in the experimental work description can be performed.

- Use recommended and suitable laboratory shoes when possible. In the case of lifting or transportation (i.e. handling) very heavy equipment or cargo, safety shoes should be worn.
- During experimental work, one should avoid touching of one's face with contaminated hands or the placement of personal belongings onto the work surface (i.e. table, bench).
- Before the start of using laboratory apparatus/equipment, their user and safety manuals must be studied. Do not use the equipment without previous instruction.
- When UV-light is used in experiments or emitted during the work, one must protect their eyes by UV-safety goggles or a face mask. Never look directly into the UV-light source! Hands and skin should be protected by protective clothes and gloves. Keep exposure to UV-light source as short as possible.
- Hazardous work or experiments should not be performed alone.
- When you notice that someone does or is going to do something in a wrong way, inform this person; if necessary, also inform the direct supervisor or mentor of that work or experiment.
- Mid or high voltage ($U > 50 \text{ V}$), gas or other potentially high-risk devices may be handled by oneself only by persons who have obtained appropriate instruction and permission.

II Safety regulations and rules for handling chemicals

- Before handling chemicals, their safety cards should be studied. All chemicals must have their safety cards with them, and the cards should be kept at the place where the chemicals are used.
- Employees and students using the chemicals must know and follow the safety marks indicated on the chemicals containers.

	<p>E: <i>Explosive</i></p> <ul style="list-style-type: none"> • Avoid mechanical stress (impact, shock), fire, sparks and heating. • Work with small amounts only and with extra care. • Never work alone without the chance of instant assistance or first aid. However, the assistant or other people must be at the safe distance to minimise the risk of multiple health damage. • Especially sensitive and explosive organic peroxides form because of the oxidation of ethers (e.g. diethyl ether, tetrahydrofuran, dipropyl ether, etc.) during their storage. Before the start of experiments involving the use of ethers stored for a long time, consult the supervisor of this work. Be very careful when you notice some residue or crystals at the bottom of an organic liquid bottle. • Potentially explosive are also variable asides. • Chemicals of unknown origin and composition should be handled as potentially dangerous substances.
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	<p>O: <i>Oxidising</i></p> <ul style="list-style-type: none"> • Avoid contact with flammable and organic materials (i.e. strong reducers).
	<p>F: <i>Highly flammable</i> F+: <i>Extremely flammable</i> – very strong reducer: ignites spontaneously in the air</p> <ul style="list-style-type: none"> • Avoid open flame, sparks and heat nearby. Sometimes UV light can initiate ignition or blast. • Almost all organic liquids are highly flammable. • In the case of fire, special fire extinguishers should be used instead of water. • Some very strong reducers can react vigorously even with the water itself!
	<p>T: <i>Toxic</i> T+: <i>Very toxic</i> (cancerogenics, teratogenes, mutagenes, poisons)</p> <ul style="list-style-type: none"> • Avoid all type of contacts with unprotected skin, inhalation or oral contact (swallowing). • Use this type of chemicals only in the fume cupboards with exhaust ventilation switched on. Use protective gloves, coat and safety goggles. In the case of very toxic substances, gas or other respiratory safety masks should be worn. • Most common toxic substances are: benzene, methanol, chloroform, tetrachlorocarbonate (CCl₄), tetrahydrofuran, acetonitrile, (toluene and xylene), etc.
	<p>C: <i>Corrosive</i></p> <ul style="list-style-type: none"> • Protect the skin, eyes, dresses and respiratory paths. Wear safety gloves, coat, goggles and if necessary, a respiratory mask. • Corrosives can be acids, alkalis and strong oxidisers; sometimes water as well.
	<p>Xn: <i>Harmful</i> Xi: <i>Irritating</i></p> <ul style="list-style-type: none"> • Avoid any contact with the body. Work with this kind of chemicals in the fume cabinets. • This note is valid for many chemicals.
	<p>N: <i>Dangerous for the environment</i></p> <ul style="list-style-type: none"> • The substance is harmful for the environment when carelessly disposed. Residues of this type of chemicals must be collected and disposed of following specific procedures.

- Experiments with flammable, explosive, other dangerous or toxic materials should be performed in fume cabinets.
- When diluting concentrated mineral acids, the higher-density acid must be poured with very fine trickle into less dense water and shaken continuously, very carefully. Safety goggles and gloves must be worn during this procedure.
- Concentrated acids, alkalis and ammonia solutions should be kept in fume cabinets. All experiments and works involving concentrated acids, alkalis and ammonia

solutions should be performed in fume cabinets. Safety goggles and gloves must be worn.

- Spilled concentrated acids or bases must be immediately carefully diluted, neutralised, collected off and disposed of safely. The contaminated place must be washed and cleaned thereafter.
- Disposal of a large amount of concentrated acid or alkali solutions into the drainage system is forbidden. The residues of concentrated acids and alkalis should be first diluted and then neutralised with a diluted acid or alkali solution. Only after that, if the neutralised substances are not harmful or dangerous for the environment, the mixture can be poured into drainage.
- In the case of an accidental contact of acid or alkali solution with the skin, the place must be rinsed immediately with a large amount of tap water. When necessary, the contaminated place may be washed with soap in the case of previous contamination with an acid solution or with diluted solution of acetic acid in the case of previous contamination with an alkali solution.
- The contact of the acid or alkali solution with the eye must always be avoided! This is why safety goggles must always be worn. In the case of accidental contact, eyes must be washed immediately with a large amount of pure water using the eye shower!
- Pipetting solutions by mouth is always forbidden. A suction bulb or an automatic pipette must be used for pipetting.
- Keep the workbench always clean. After use, clean all laboratory tools, glassware and supplies. Return chemicals and laboratory equipment to their original storage place.
- Laboratory glassware must be safely emptied and rinsed before final careful cleaning. Chemical residues must be disposed of as regulated.
- Flammable substances must be kept at least 2 m away from open fire, very hot surfaces or non-explosion-proof electrical switches (i.e. from possible sources of sparks). Experiments with flammable substances must be conducted in fume cabinets. The experiment performer must be ready for occasional fire and have a reasonable plan how to extinguish the fire safely.
- In the case of fire, follow the previously worked-out and fixed procedure. In general, in the case of fire, the burning substance must be isolated from the air and other type of oxidisers. Natural (flammable) gas, hydrogen and oxygen/compressed air valves must be closed immediately. Electrical devices and electricity lines/wall sockets near the fire must be disconnected from the main power supply before starting the fire extinguishing process. Only special fire extinguishing agents can be used to extinguish the fire at electrically powered devices. Water can be used as a fire extinguisher only if it will not vigorously react with any substances nearby and will not spread the fire. The use of water is forbidden for fire extinguishing of organic liquids that are immiscible in water.

III Safety regulations for the treatment of chemical residues (waste)

- Residues of harmful and toxic chemicals must be collected into special storage and transport containers (solids) and bottles (liquids). Do not blend chemicals that can react with each other forming gaseous compounds or heat! Containers with toxic chemicals must be kept in fume cabinets. When the containers of waste chemicals are full, it should be reported to the building manager (or information secretary or work supervisor) who will organise the collection and transport of full containers to their treatment site. NB! In the case of appearance of very toxic or harmful waste (e.g.

mercury or its salts and cyanides), even in very small amounts, they should be sent to the chemical waste treatment as soon as possible.

- The residues of concentrated acids and alkalis must be first diluted with water and then neutralised.
- Attention! Chemicals and solutions of unknown origin and chemical composition should not be mixed! This can lead to unexpected consequences!
- Containers with waste chemicals must be labelled, indicating the sort of chemical(s) they contain.
- In the case of concerns and questions about the safe treatment of waste chemicals, additional information is available from the senior specialist of the environmental safety of the University of Tartu.

IV Safety regulations for working with glassware

- Glass, quartz and (most) ceramic objects, pieces and details are very fragile. They must be handled and treated carefully. They do not tolerate hard treatment and sudden temperature changes. When a glass or quartz piece is broken, normally very sharp ends form. Therefore, broken glass or quartz pieces must be handled very carefully. The formed pieces and particles should be immediately carefully collected and binned into glass waste storage container. Full containers should be sent to the waste treatment in the same manner as chemicals waste.
- In the case of breakage of glass, the sharp fragments must be immediately and carefully collected. Spilled substances must be collected and disposed of as regulated. If necessary, ask for help. For collection of tiny pieces of glass wet filter paper or paper towels can be used.
- To attach a rubber or vacuum hose onto a glass connector, splitter or interface, the outer surface of the glass tube and the inner surface of the hose must be wet or lubricated with a vacuum grease (if this is permissible). Then the hose and the glass connector can be attached very carefully by pushing them together and slightly twisting them at the same time. To detach the hose and glass connector, they should be pulled carefully away from each other twisting them slightly at the same time. When the hose has been stuck to the glass wall, it should be cut off very carefully. (Thereafter the glass piece must be cleaned of the remains of the tube.)
- During the assembly/disassembly of the synthesis apparatus or other laboratory equipment made of glass or during the process of attachment/detachment of hoses and glass connectors or during the detachment of the glass bottle (flask) and its glass stopper, safety goggles must be worn. It is highly recommended to wear a safety mask and protective gloves as well during the above-mentioned activities.
- If there is pressure or vacuum inside the glassware or apparatus, safety goggles must always be worn when approaching this kind of system! Avoid any kind of adjustments, moving or twisting of the pressurised or vacuum glassware or apparatus! This can end with a blast, breakage of the glass system and severe damages!

V Safety regulations for working with electrical devices

- Before touching or switching on an electrical device, check and ensure that the power cable and the device are in a good condition! If you note any damages or an abnormality, consult with the supervisor or a technician (staff member) who is

responsible for the condition of that device/instrument. Faulty electrical cables, contacts and devices must be immediately removed from the application and sent for repairs! Only electrical systems that are safe, in good working order and condition can be used!

- Verify that the input voltage of the electrical device corresponds to the output voltage of the power source! Wrong input voltage may damage the electrical device and cause fire!
- The internal resistance of the electrical device's should not be below the limited value requested by the power source. If the internal resistance of the device is too low,, it may damage the power source and cause fire!
- It is recommended to avoid contact with electrically conductive surfaces during switching an electrical device on/off. It is recommended to switch on/off using one hand only to avoid occasional contact with the electrical circuit (in case of a damaged or badly insulated electrical system). In the case of possible electrical shock (when it is not completely avoidable because of work or an electrical device used) it is recommended to wear dry cotton or rubber gloves during the switching on/off process. In the case of a mid-voltage ($50\text{ V} < U < 1000\text{ V}$) power source that can potentially give electric shock, special dry rubber safety gloves must be worn!
- When someone notices bad smell or smell of hot plastics, smoke, sparks, bad and unusual noise inside a device or unexpected heating up of the electrical device, it must be switched off and removed from the power supply immediately. Potentially faulty device or instrument must be labelled with a warning message and the supervisor must be informed about this concern or faulty system.
- When an electrical device is burning, it must be immediately unplugged from the main supply. If this is unsafe, the line leading to the burning device must be switched off from the laboratory's main fuse cabinet. Thus, before starting to use any electrical devices, the exact location of the switches and fuses must be made clear.
- Never use water to extinguish fire coming from an electrical device! It could be powered! Only CO₂ or special fire extinguishers can be used for that purpose!
- Do not touch electrical devices that are powered or connected to the mains with wet hands unless it is permitted by the manufacturer of the device.

VI Safety regulations for the use of fume cabinets

- Check the working order and inflow intensity before the start of experiment or work inside the fume cabinet.
- Keep the front door (window) as low as possible during the work.
- Use appropriate safety measures according to processed work.
- The fume cabinet is not designed for long-time storage of large amounts of chemicals and chemical waste. For that purpose, special total exhaust storage cabinets or storage rooms must be used.
- Keep only these chemicals and the equipment in the fume cabinet that are needed for the performed experiment and work. After the end of the procedure remove and return unnecessary chemicals and equipment back to their storage place. Keep the workplace in the fume cabinet as empty and clean as possible.
- Clean the cabinet of spilled chemicals, dropped or broken pieces as soon as possible.

VII Safety regulations for the use of central natural gas (i.e. “burning gas”, methane)

- It is forbidden to start using flammable gases without previous instruction and permission.
- A record of instruction on the safe use of gases must be entered in the laboratory safety book or card.
- Before the starting work with gases, the readiness of the equipment, burner and hoses for the work must be checked. In the case of the failure the broken hose must be replaced and the device repaired and controlled. The student must receive permission from the supervisor of the work/experiment.
- Do not approach the open flame with long loose hair, clothes or other flammable substances.
- When the flame is extinct (“dead”), close the valve and wait a moment until the gas is exhausted and the room’s air replaced by clean air. It is highly recommended to use open-flame and gas burners only in exhaust fume cabinets. (Normally, modern gas burners close the gas inlet valve immediately after the sudden extinction of the flame.)
- Do not leave the working (“running”) gas burner without supervision.
- After finishing work, in which gas was used, check that all valves, including the main gas supply valve, are closed!

VIII Instructions for action in the case of fire

- In the case of fire or potential fire, do anything you can to extinguish the fire immediately. If this is impossible, apply all measures to reduce possible damage and consequences. Close immediately all gas valves and switch off all electricity supply lines next to the fire. Close all doors, passages and windows, if possible. Leave the place of fire.
- In the case of fire or potential fire, inform immediately the others around, the direct supervisor and leader of the workgroup.
- In the case of real and out-of-control fire, press the emergency switch-off button located in the laboratory, press the fire alarm button located on the corridor wall, call the information desk and report the fire, its location and possible threats. If the information desk or security personnel do not respond, call the emergency centre dialling 112.
- In the case of fire or chemical danger, all people must immediately leave the building using the previously planned evacuation routes as shown in the building. They should assemble in the place of assembly and report that they have safely left the building. (No one will be questioned because of evacuation in the case of a serious situation.)
- In the case of fire or chemical danger, everybody must ensure safe evacuation for all other people.

The person who has discovered the fire must:

- call the emergency centre dialling 112 (when you call using the internal telephone network, dial 0112) and give the following information:
 - a) exact location of fire (village/town/city, street name, building number, floor and section number, room number);
 - b) describe the situation (what is burning, what are possible threats, can there be humans/animals in the fire, is anyone injured);

- c) who is reporting the fire or an accident (first and surname, position);
- d) indicate additional contact telephone numbers (internal security service in the building, information desk and/or the supervisor if she/he is nearby)
- e) answer additional questions asked by the emergency centre personnel;
- f) do not cancel the call until you are given permission to do so.
 - warn the other people nearby and assist in the evacuation process;
 - close doors and windows (if this is safe);
 - attempt to extinguish the fire using appropriate and safe fire extinguishing methods and measures.

When the rescue crew has arrived to the address of the fire or an accident, the person who discovered the fire or an accident or the internal security personnel of building will give the following information to the leader of the rescue crew:

- where is the fire or an accident and what is the current situation;
- what is the potential threat (high temperature, smoke, toxic chemicals, danger of explosion, flammable materials or compressed gas cylinders nearby, electricity);
- whether anybody could have been left in the fire or trapped and unable to evacuate.

IX First aid in the laboratories

9.1 First aid in case of contact with corroding substances and liquids

- In the case of contact with acids, wash the exposed skin with lots of water.
- In the case of contact with alkalis, wash the exposed skin with lots of water.
- In the case of contact with alkalis and corrosive substances, rinse eyes immediately with lots of water. If possible, use the eye shower.
- In the case of concentrated alkalis, acids or corrosive substances occurring in the mouth, rinse the mouth with lots of water and spit out.

9.2 First aid in the case of burns

- In the case of light burn, cool the injured skin down under cold tap water.
- In the case of a more serious burn on a small area, cool the injured skin down in a cool air flow and apply disinfecting burn treatment wax, grease or foam to the injured spot. Disinfecting and burn treatment agents should be available in the first-aid bag or cupboard. Check periodically that the medicines' "best before" dates have not expired.
- In the case of serious burns (deep, extended or large area (more than a few cm²) burns), cool the injured skin down in cold air flow, disinfect the damaged skin and stop the bleeding if it exists. Call the emergency dialling 112.

9.3 First aid in the case of poisoning

- When you feel dizzy, sleepy or have a metallic taste in the mouth while working with toxic gases or near toxic chemicals, immediately and safely stop the work process and

report the situation to the supervisor. Verify that you have not been contaminated by something potentially toxic or irritating and the containers or cylinders containing toxic chemicals are closed properly.

- In the case of poisoning by a toxic gas, take all measures to avoid poisoning as well. Estimate the chemical character of the possible toxic agent and select proper personal safety measures. Put on an appropriate gas mask, find the source of the toxic gas and remove its emission into the environment. Then evacuate the affected person (people) to fresh air and give first aid. Call the emergency centre (112 or 0112), if needed. Inform the emergency centre personnel and the emergency crew, when they arrived, what substance could have caused the poisoning.
- It is very important to avoid accidental poisoning and accidents with toxic or irritating substances. Therefore, it is very critical to plan the experiment or work very carefully and choose the safest chemicals and methods to perform the work! It is necessary to perform very critical risk analysis first and always before the start of the handling of a chemical to investigate its chemical (and physical) properties!
- If someone has swallowed something it is very important to understand what substance it was. Thereafter proper activities can be taken. Read the substance or chemical safety list and try to understand what to do in the case of swallowing. In the case of serious risk of poisoning or serious inner damage call the emergency centre (112 or 0112) and ask for advice.
- All toxic or strongly irritating chemicals must be labelled with appropriate warning signs and stored separately in exhaust cabinets. It is recommended to limit the access to toxic or strongly irritating chemicals.

9.4 First aid in the case of cuts and bleeds

- Clean a small wound with clean sterile medical tissue (cloth) and disinfect as necessary.
- In the case of a small bleed, put on a sterile medical wound patch of a suitable size.
- In the case of a large wound, clean it with sterile medical tissue (cloth) and stop the bleeding. Bleeding can be stopped by pressing a sterile compression bandage on the cut wound and fixing it tightly with elastic bandage. Call the emergency (112 or 0112) and report what happened and what the current situation is. Tell them the location and address where the accident occurred, and where you are now. Answer all questions they ask. Stay calm.