



LABORATORY SAFETY GUIDELINES

Natural Science Laboratory

UNIVERSITAS NEGERI SEMARANG
FACULTY OF MATHEMATICS AND NATURAL SCIENCES
Bachelor of Natural Science Education Study Program



TABLE OF CONTENT

Table of Contents	ii
Preface	iii
About the Natural Science and Environmental Laboratory	1
Personnel.....	3
I. Policies and Rules for Laboratory Use	4
A. Policy on the Use of Natural Science and Environmental Laboratory Facilities by Students.....	4
B. Policy on the Use of Natural Science and Environmental Laboratory Facilities by Lecturers and Technicians	5
C. Rules for the Use of the Natural Science and Environmental Laboratory	5
a. Before the Laboratory Session.....	5
b. During the Laboratory Session.....	5
c. Make Up Laboratory Session.....	6
II. Procedures for Borrowing Equipment and Materials.....	7
III. Standard Procedure for Waste Disposal	8
IV. Clothing and Personal Protective Equipment.....	10
V. First Aid and Laboratory Safety	12
VI. Safety Issues	14
A. General Classification of Chemicals.....	14
B. Health Impacts of Chemicals.....	15
C. Diseases Caused by Exposure to Toxic Substances	16
Appendix.....	18

PREFACE

The laboratory environment can be a hazardous place for learning activities. However, laboratories are an essential part of the learning process, particularly in the basic sciences such as chemistry, physics, and biology. Students, lecturers, researchers, and laboratory staff are exposed to various hazards, including chemical, physical, and biological risks, as well as potential accidents that may occur during laboratory work.

This document is intended to provide guidance for anyone working in a laboratory to ensure a safe environment, as well as to serve as a manual and standard operating procedure for laboratory activities. It includes various types of information, such as hazard information for safety precautions, accident handling, and waste management.

**Natural Science and Environmental
Laboratory**

ABOUT THE NATURAL SCIENCE AND ENVIRONMENTAL LABORATORY

The Natural Science and Environmental Laboratory is located in Building D1 of the Faculty of Mathematics and Natural Sciences at Universitas Negeri Semarang. The Natural Science and Environmental Laboratory consists of Physics Laboratory located in D9 building, Chemistry Laboratory located in D8 building, and Biology Laboratory located in D11 building.

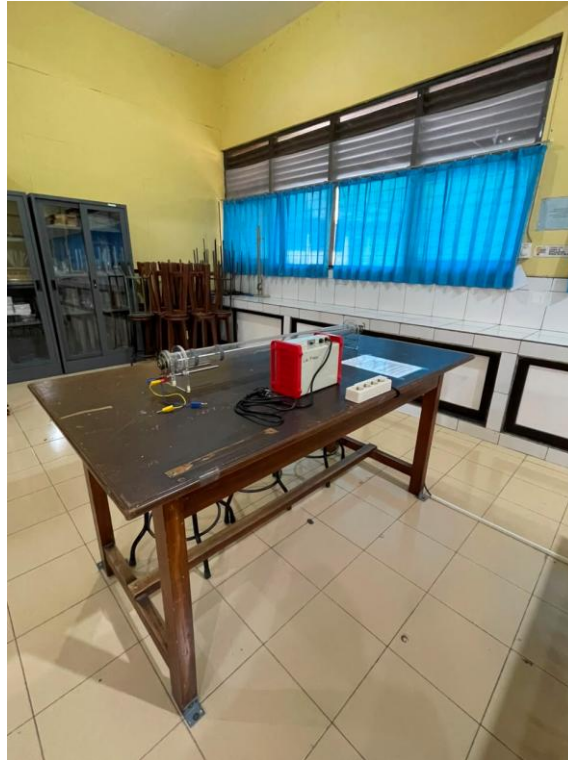


Figure 1. Physics Laboratory D9 building

Physics Laboratory is a laboratory that can be used for practical activities and research in the fields of physics.



Figure 2. Chemistry Laboratory D8 building

Chemistry Laboratory is a laboratory that can be used for practical activities and research in the field of chemistry.



Figure 3. Biology Laboratory D11 building

Biology Laboratory is a laboratory that can be used for practical activities and research in the field of biology.

Students and lecturers in natural science and environmental studies can access laboratory services for both academic and non-academic activities. The technicians of the Natural Science and Environmental Laboratories are highly competent and meet the required qualifications, enabling them to provide satisfactory services. Laboratory services are highly practical and supported by the digitalization of laboratory services, allowing students and lecturers of Environmental Science to submit service requests by accessing the following webpage: <https://msha.ke/layananlab/>.

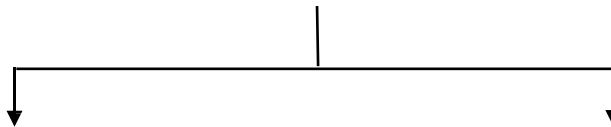
PERSONNEL



Dr. Sigit Priatmoko, M.Si.
Head of the Integrated Laboratory of FMIPA



Dr. Novi Ratna Dewi, S.Si., M.Pd.
Coordinator of the Natural Science and Environmental Laboratory



Dra. Ni Luh Tirtasari
Laboratory Technician



Noer Farida S.Pd.
Laboratory Technician

POLICIES AND RULES FOR USING THE NATURAL SCIENCE AND ENVIRONMENTAL LABORATORY

A. Policy on the Use of Natural Science and Environmental Laboratory Facilities by Students

1. Students must comply with laboratory room regulations, including the prohibition of eating, drinking, or smoking inside the laboratory.
2. Conducting experiments without permission is prohibited.
3. Students must conserve gas, water, and any materials used in the laboratory.
4. Students must dispose of solid waste and chemical waste used in experiments properly.
 - Solids must be disposed of in the trash bin unless they are readily soluble in water.
 - The drainage system must be used only for disposing of water.
 - Small amounts of corrosive and flammable liquids may be disposed of in the sink with plenty of water. Large amounts of solvents must not be disposed of in the sink.
 - Benches or floors exposed to acid or base spills must be rinsed immediately with plenty of water.
5. Students must handle laboratory equipment and supplies with care.
6. Students must be cautious when conducting experiments and handling chemicals. Students must observe the following precautions when conducting experiments and handling chemicals:
 - Wear a laboratory coat, mask, latex gloves, and safety goggles as required when performing experiments.
 - Avoid inhaling any fumes. Use a fume hood if concentrated or toxic vapors are produced.
 - Never taste chemicals unless instructed by the technician.
 - Never use the mouth to pipette chemical reagents.
 - Use a spatula for solid reagents; do not handle them with bare hands.
 - Handle concentrated acids carefully. Avoid spilling them on clothing or any part of the body, especially the eyes. If this occurs, rinse the affected area with plenty of water and report it to the technician.
 - Always add concentrated acid to water first. Never add water to concentrated acid.
7. Students must not work alone in the laboratory.
8. Students must inform the technician of any issues related to the use of equipment.
9. Students must turn off water taps and gas valves and ensure the work area is clean before leaving the laboratory.
10. Students must understand that violations of the above provisions may result in sanctions in accordance with applicable regulations. Any accidents caused by student negligence are the responsibility of the student concerned.

The above provisions apply as long as the student is registered as a user of the Natural Science and Environmental Laboratory facilities.

B. Policy on the Use of Natural Science and Environmental Laboratory Facilities by Technicians and Lecturers

1. Technicians and lecturers are responsible for supervising students and enforcing rules during lectures or laboratory sessions. During the scheduled time, only students registered for the course are allowed to be in the laboratory, and students who are not members of the class must be asked to leave.
2. They are responsible for ensuring the laboratory functions smoothly during routine student use.
3. They must record any damaged equipment or supplies issued before an experiment or laboratory activity begins.
4. They are responsible for securing the laboratory when leaving. Laboratory entrance and exit doors must be locked and secured when the laboratory is unoccupied.
5. They must arrive at the scheduled time before students are allowed to enter the laboratory.
6. They are responsible for maintaining laboratory equipment during experimental sessions by reporting any issues to the Laboratory Coordinator.
7. They must ensure the laboratory and work areas are left neat and orderly for the next users.

C. Rules for Using the Natural Science and Environmental Laboratory

a. Before the Laboratory Session

1. Begin and end the laboratory session by reciting a prayer led by the assistant.
2. Students must arrive 10 minutes before the session begins. Students arriving more than 5 minutes late are not allowed to enter the laboratory.
3. Students are not permitted to enter the laboratory before being allowed to do so.
4. Students and assistants must wear a buttoned laboratory coat, and female students must tuck their headscarves into the coat before entering the laboratory. They must also bring any required personal protective equipment.
5. Students must follow the laboratory schedule arranged by the course lecturer in the laboratory calendar.
6. Students must maintain good health and stamina before the session begins.
7. Students must participate in all stages of the laboratory session.
8. Students must prepare an initial logbook containing the title, objectives, equipment, materials, and work procedures, and must bring the final report from the previous session in accordance with the laboratory manual guidelines.
9. Students and assistants must master the material to be carried out.
10. Students must complete the borrowing request for the required equipment and materials using the physical proof form for borrowing laboratory equipment and materials via the following link: <https://msha.ke/layananlab/>

b. During the Laboratory Session

1. Students must bring the laboratory manual, stationery, a calculator, and other supporting tools needed for the session.
2. Students must behave politely and must not joke around or engage in inappropriate behavior.
3. Students and assistants must understand and implement laboratory safety procedures.
4. Students and assistants are prohibited from eating and or drinking in the laboratory.
5. Students are prohibited from doing anything that disrupts the laboratory session.
6. Smoking is prohibited in the laboratory area.
7. Laboratory waste must be disposed of in the designated containers according to its category.
8. Each student must maintain cleanliness inside and outside the laboratory, return cleaned and dried equipment and used materials to their original place after verification by the technician.
9. If a student damages equipment or chemicals, whether intentionally or unintentionally, the responsible laboratory group must replace the equipment or chemicals with the same type and quality.
10. Students must obtain data by conducting experiments. Observational data must be recorded carefully and truthfully on the provided data sheet. If students fail to obtain data, for example due to equipment damage or other reasons, they must report it to the assistant.
11. Students must request the assistant's signature and submit the data sheet for each group.

c. Make Up Laboratory Session

1. Students must attend laboratory sessions according to the assigned schedule and class group. If, for any reason, a student cannot attend the scheduled session, the student may apply for a make-up laboratory session and complete the make-up service form at the following link: <https://bit.ly/INHALPRAKTIKUM>
2. The cost policy for replacing materials during a make-up laboratory session follows the applicable provisions.

EQUIPMENT AND LABORATORY BORROWING PROCEDURES

1. All use of equipment and laboratory facilities must be acknowledged by the laboratory technician and approved by the Head of the Laboratory.
2. Any student borrowing equipment must be registered and must complete the required form.
3. Equipment may be borrowed for research activities as long as it is not currently on loan.
4. Borrowing certain equipment that may reduce the service life of a component or cause wear and tear during use requires approval from the Head of the Laboratory.
5. Borrowed equipment may only be used for activities inside the laboratory. If it is to be used outside the laboratory, the Head of the Laboratory must be informed.
6. Any student conducting research or using the laboratory must provide their own materials. If it is necessary to use materials available in the laboratory, the student must report this and replace them with the same materials used.
7. Any damage to components or loss of equipment by the borrower must be replaced with items of the same specifications.
8. The maximum borrowing period for equipment used outside the laboratory is 7 days. If an extension is needed, the borrower must request it by first reporting to the Head of the Laboratory.
9. All laboratory activities must be carried out during working hours. Outside working hours, the cost of technician services is the responsibility of the researcher or laboratory user.
10. Laboratory users are not allowed to change settings or move equipment that has been placed in the room.
11. While working in the laboratory, users must wear a lab coat and bring the required personal protective equipment. Users must also keep the room clean. Smoking, eating, and or drinking are prohibited, and users are not allowed to dispose of trash in desk drawers, sinks, or on the floor.
12. After use, all equipment must be returned in a clean and dry condition.
13. Bringing other people to assist with laboratory activities is not allowed, except for students from the science and environmental science programs, unless permission is granted by the Laboratory Coordinator.
14. Users must prepare a logbook to report activities to the Laboratory Coordinator.
15. Users must understand and follow the equipment operating instructions and complete the equipment logbook.

STANDARD PROCEDURE FOR WASTE DISPOSAL

A. Scope of Application

This procedural manual outlines the procedures that must be followed by students (during practical sessions and research), lecturers, and technicians when disposing of waste generated from research and or practical activities in the laboratory.

B. Purpose

To ensure that laboratory waste disposal does not disrupt students' academic activities (practical sessions and research), laboratory technicians' analytical work, or lecturers' research activities. This procedure also aims to ensure that lecturers, technicians, and students feel comfortable and safe while carrying out laboratory activities.

C. Definition

The waste referred to in this document is the residual waste generated from practical sessions and research activities in the Natural Science and Environmental Laboratory.

D. References

1. Government Regulation (PP) No. 82 of 2001 on Water Quality Management and Water Pollution Control
2. Minister of Environment Regulation (Permen LH) No. 1 of 2010 on Procedures for Water Pollution Control.

E. Responsible Parties

Laboratory Coordinator and technicians

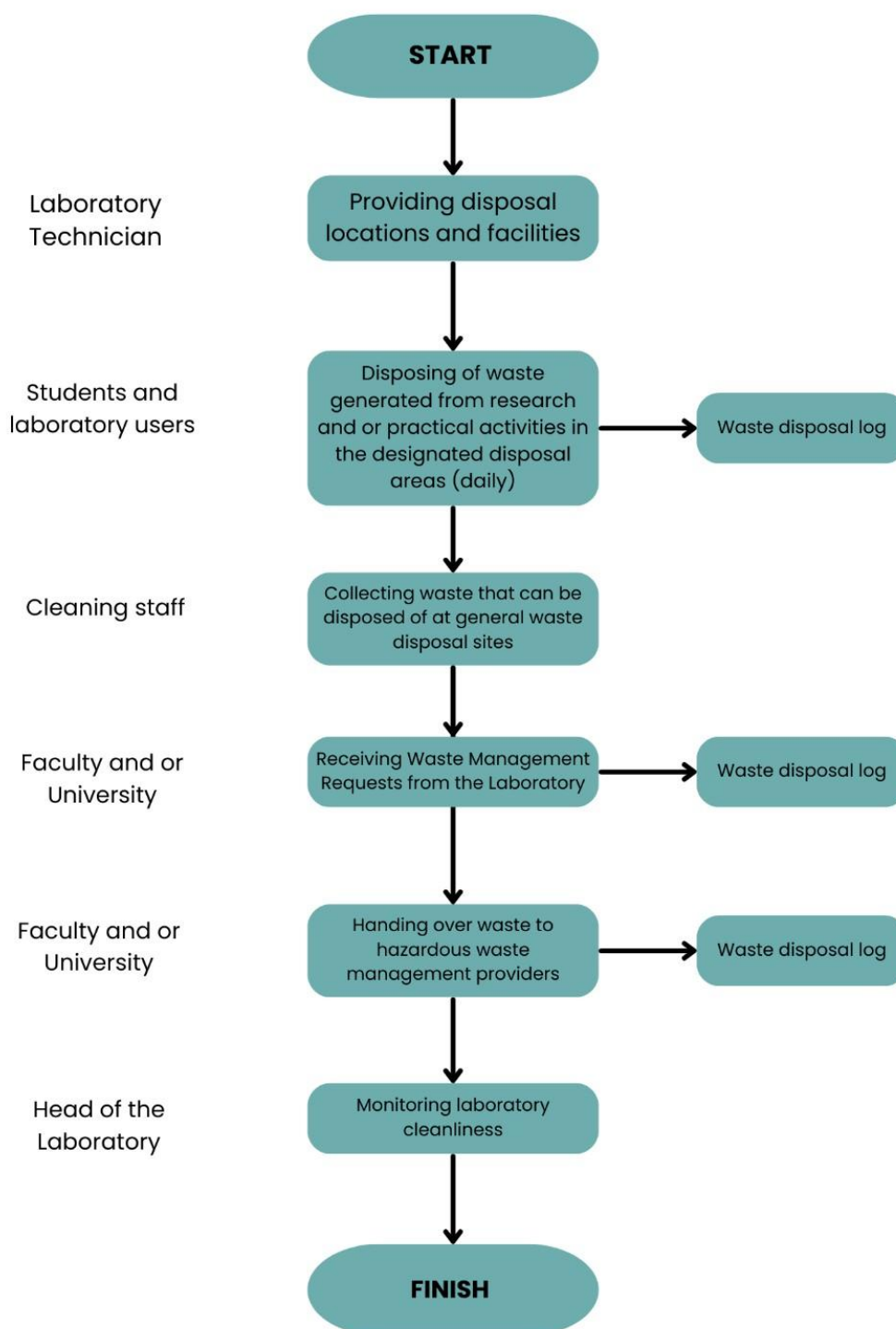
F. Procedure

1. The laboratory technician ensures that a temporary waste disposal location and facilities are available in the laboratory.
2. Waste is segregated by type, namely solid waste and liquid waste. Liquid waste includes strong acid base waste, heavy metal liquid waste, and organic liquid waste.
3. Strong acid and base liquid waste must be diluted to neutral pH before disposal, then disposed of in the designated facility (Faculty wastewater treatment system).
4. Students and other laboratory users dispose of research and or practical waste in the designated containers provided.
5. The laboratory technician ensures proper separation between hazardous laboratory waste and waste that may be disposed of through general waste disposal.
6. Cleaning staff collect waste that may be disposed of through general waste

disposal.

7. Once the wastewater treatment facility is available, hazardous waste is collected in a designated location and then handed over to the waste management provider appointed by the Faculty and or University.
8. The Laboratory Coordinator is responsible for monitoring proper waste disposal practices.

G. Flowchart



CLOTHING AND PERSONAL PROTECTIVE EQUIPMENT

Shorts, short-sleeved shirts, and dresses do not provide adequate protection during laboratory activities and must not be worn unless all exposed skin can be fully covered by a lab coat. Appropriate footwear must be worn, including shoes that fully cover the toes and heels. Flip flops, open woven shoes, and sandals are not suitable for use in the laboratory during laboratory activities. Before conducting any activities in the laboratory, all students, staff, and visitors must wear the following personal protective equipment:

1. A long-sleeved cotton laboratory coat
2. A mask
3. Safety goggles
4. Gloves
5. Closed toe shoes or protective work shoes



Figure 4. Wearing a Lab Coat Before Entering the Laboratory Work Area

Laboratory coats and gloves must not be worn outside the laboratory, as they may be contaminated with hazardous chemicals. Contact lenses must not be worn during laboratory activities. Gases and vapors can become trapped beneath contact lenses and may cause permanent eye damage. If chemicals splash into or come into contact with the eyes, it is almost impossible to remove contact lenses for eye irrigation due to involuntary eyelid spasms.

As part of general laboratory practice, all forms of jewelry are also prohibited during laboratory activities. When handling certain chemicals, additional specialized protective equipment may be required, such as a respirator. Please refer to the Material Safety Data Sheet (MSDS) for each chemical available in the laboratory.



Figure 5. Using Personal Protective Equipment During Field Practic

FIRST AID AND LABORATORY SAFETY

No	Type of accident	Response
1.	Burns	If the burn is caused by a hot object, apply Levertran ointment, butter, or a 3% picric acid solution. If the wound is large, rinse immediately with a 1% bicarbonate solution and go to the nearest health center.
2.	Skin exposed to concentrated acid	Wipe immediately with tissue, wash with running water and sodium bicarbonate solution, dry, then apply Levertran ointment.
3.	Skin exposed to strong base	Wash with running water, then 1% acetic acid solution, rinse again, dry, and apply Levertran ointment.
4.	Skin exposed to bromine	Wash with benzene, apply glycerin, then wash with water and apply Levertran ointment.
5.	Skin exposed to sodium metal	Remove sodium with tweezers, wash with 1% acetic acid solution, then apply Levertran ointment.
6.	Skin exposed to phosphorus	Remove phosphorus with tweezers, wash thoroughly with cold water, then apply 1% silver nitrate solution.
7.	Skin exposed to organic substances	Wash with alcohol, then wash with soap and warm water.
8.	Eyes exposed to acid or base	Rinse with appropriate solutions depending on exposure: bicarbonate for acid, boric acid for base, after flushing with water.
6.	Exposure to toxic solids, liquids, or gases	Follow appropriate first aid depending on exposure, including rinsing, drinking water or neutralizing agents, and seeking medical help.
10.	Small fire	Extinguish with a wet towel or use a fire extinguisher.
11.	Clothing on fire	Cover with a jacket or roll on the floor. Do not use water.
12.	General skin exposure	Rinse exposed skin with plenty of water using the safety shower.
13.	Chemical spill on body	Use laboratory safety shower immediately and rinse thoroughly.
14.	Chemical exposure to eyes	Rinse eyes using eyewash station for at least 10 minutes while holding eyelids open.



Figure 6. Use of the Laboratory Safety Shower

SAFETY ISSUES

A. General Classification of Chemicals

1. **Toxic substances** are chemicals that can cause harm to humans or death if they enter the body through ingestion, inhalation, or skin contact. Examples: Pb, Cr, benzene, HCN, CO, asbestos dust.
2. **Corrosive substances** are chemicals that cause damage to body tissues. Examples: sulfuric acid, chlorine gas, phenol, NaOH, formaldehyde, nitrogen oxides.
3. **Flammable substances** are chemicals that react readily with oxygen and may cause fire. Examples: phosphorus, acetone, ether, benzene, hexane.
4. **Explosive substances** are chemicals that, due to chemical reactions, can produce large volumes of gas and high pressure in a short time, causing damage to their surroundings. Examples: trinitrotoluene, nitroglycerin, ammonium nitrate.
5. **Oxidizing substances** are chemicals that can release oxygen and thereby cause other materials to burn. Examples: potassium chlorate, potassium permanganate, hydrogen peroxide.
6. **Water reactive substances** are chemicals that react with water to produce heat and flammable gas. Examples: sodium and potassium metals.
7. **Acid reactive substances** are chemicals that react readily with acids, producing heat and flammable and or toxic gas. Examples: sodium metal, potassium, potassium permanganate, chloric acid.
8. **Compressed gases** are materials stored under high pressure. Examples: hydrogen, acetylene, nitrogen, ethylene oxide.
9. **Radioactive substances** are chemicals that emit radioactive radiation with an activity greater than 0.02 microcurie per gram.

In teaching laboratories used by students, the variety of hazards is typically controlled because procedures are often repetitive (practical sessions or routine laboratory classes). The chemicals used are also often among the least hazardous compared to other available chemicals, following the hierarchy of controls shown in Figure 8.

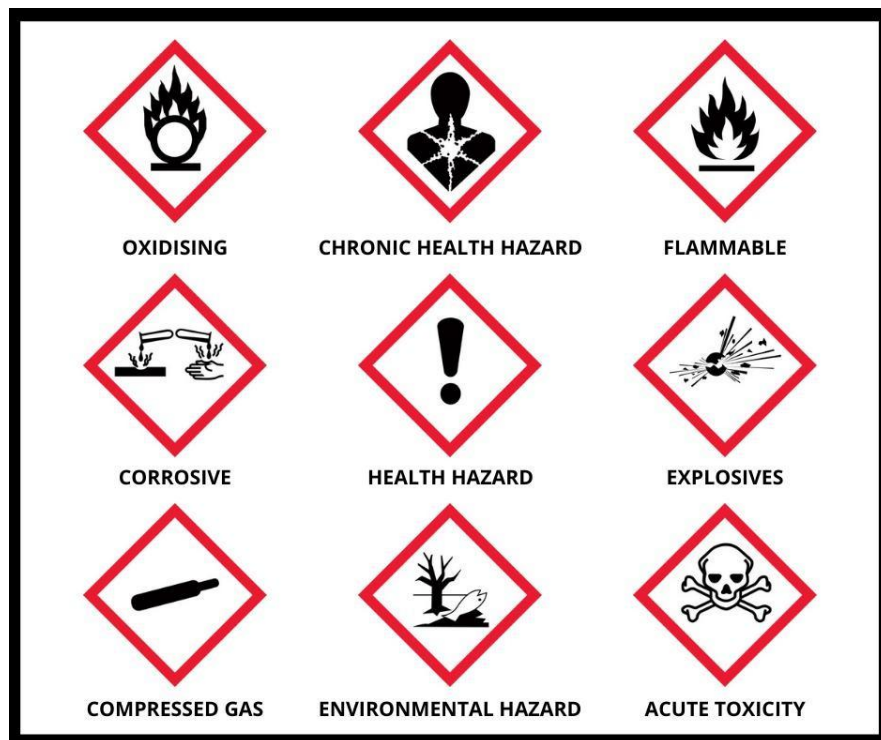


Figure 7. Example of a Chemical Label (Bronsonsafety, 2016)

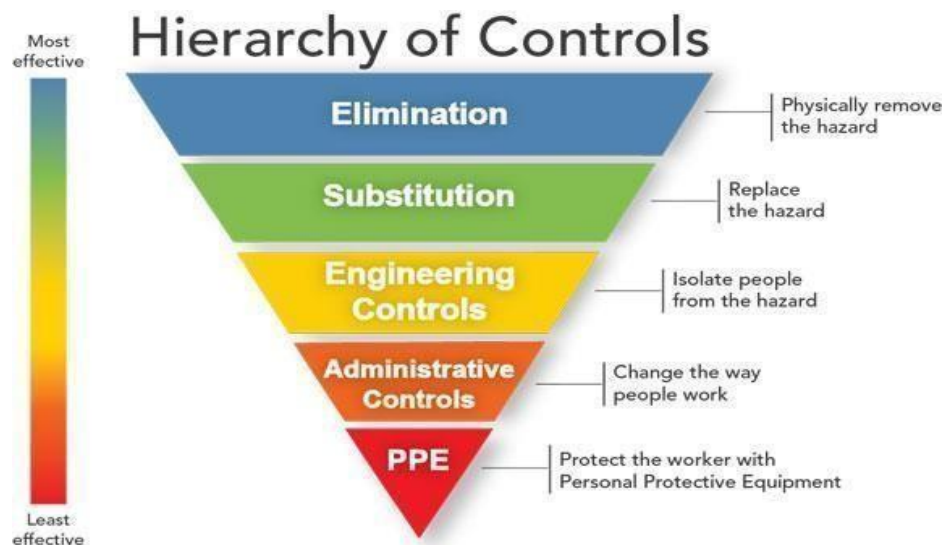


Figure 8. Hierarchy of Hazard Controls

B. Health Impacts of Chemicals

1. **Systemic poisoning** means the substance can circulate throughout the body and poison the functioning of specific organs. Examples: benzene, tin, cadmium, lead.
2. **Upper respiratory tract irritation**, caused by gases that dissolve easily in water. Examples: ammonia, sulfur dioxide, formaldehyde, acetic acid.
3. **Lower respiratory tract and lung disorders**, resulting from gases that are poorly soluble in water, such as chlorine and nitrogen oxides.

4. **Simple asphyxiation**, which is shortness of breath due to oxygen deficiency caused by inert gases such as nitrogen, carbon dioxide, acetylene, and methane.
5. **Chemical asphyxiation**, which is shortness of breath due to toxic gases such as CO, HCN, and H₂S.
6. **Anesthesia or narcosis**, which is loss of consciousness due to gases such as ether, chloroform, acetone, ethanol, and toluene.
7. **Sensitization**, which is increased sensitivity or allergic reactions in certain body parts due to epoxy compounds, formaldehyde, and dust.
8. **Cancer**, caused by carcinogenic substances entering the body, such as poly-aromatic compounds, aflatoxins, benzene, organic nitrogen compounds, and bromine compounds.
9. **Pneumoconiosis**, which is the trapping of particles such as silica and asbestos fibers in the lungs.

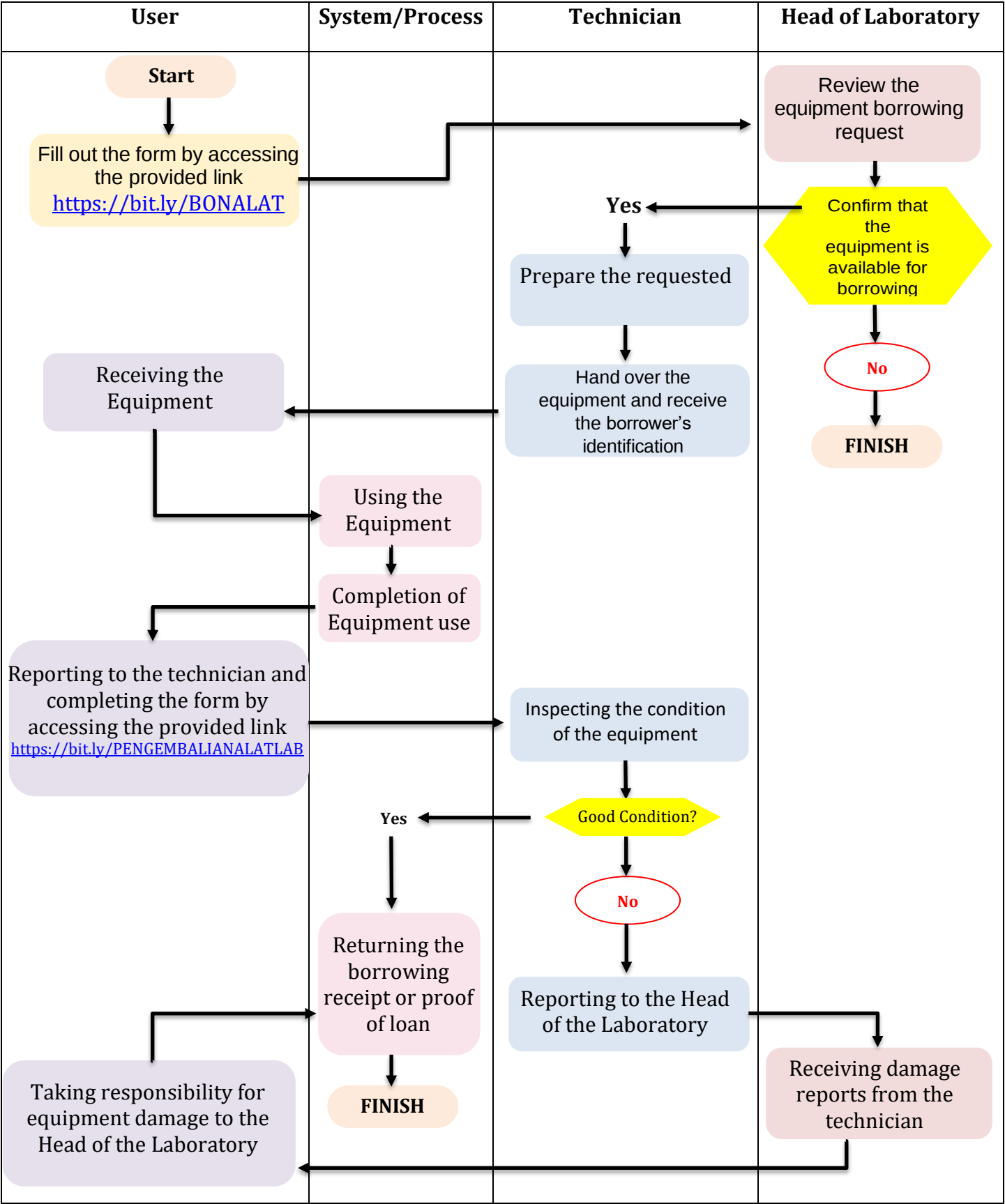
C. Diseases caused by exposure to Toxic Substances

No	Type of Toxic Substance	Material	Effects of Poisoning / Health Disorders
1	Metals	Pb	Nervous system, kidneys, blood
		Hg	Nervous system, kidneys
		Cd	Liver, kidneys, blood
		Cr	Cancer
		As	Irritation, cancer
		P	Carbohydrate, fat, and protein metabolism disorders
2	Solvents	Aliphatic hydrocarbons (gasoline, kerosene)	Dizziness, coma
		Halogenated hydrocarbons (chloroform)	Liver, kidneys
		Alcohols (methanol, ethanol)	Dehydration, vomiting, seizures
		Aromatic hydrocarbons (benzene)	Seizures, headache, heart disorders, blurred vision
3	Toxic gases	Simple asphyxiants (N, He, Ne)	Shortness of breath, oxygen deficiency
		Chemical asphyxiants	Shortness of breath, poisoning

		Hydrogen cyanide	Dizziness
		Hydrogen sulfide	Shortness of breath, seizures, loss of consciousness
		Carbon monoxide	Shortness of breath, brain and heart damage, irritation, death
4	Carcinogens	Benzene	Leukemia
		Asbestos	Lung disease
		Chromium	Ulceration
		Vinyl compounds	Liver, lungs, central nervous system
5	Pesticides	Organochlorines	Dizziness, seizures, loss of consciousness
		Organophosphates	Death

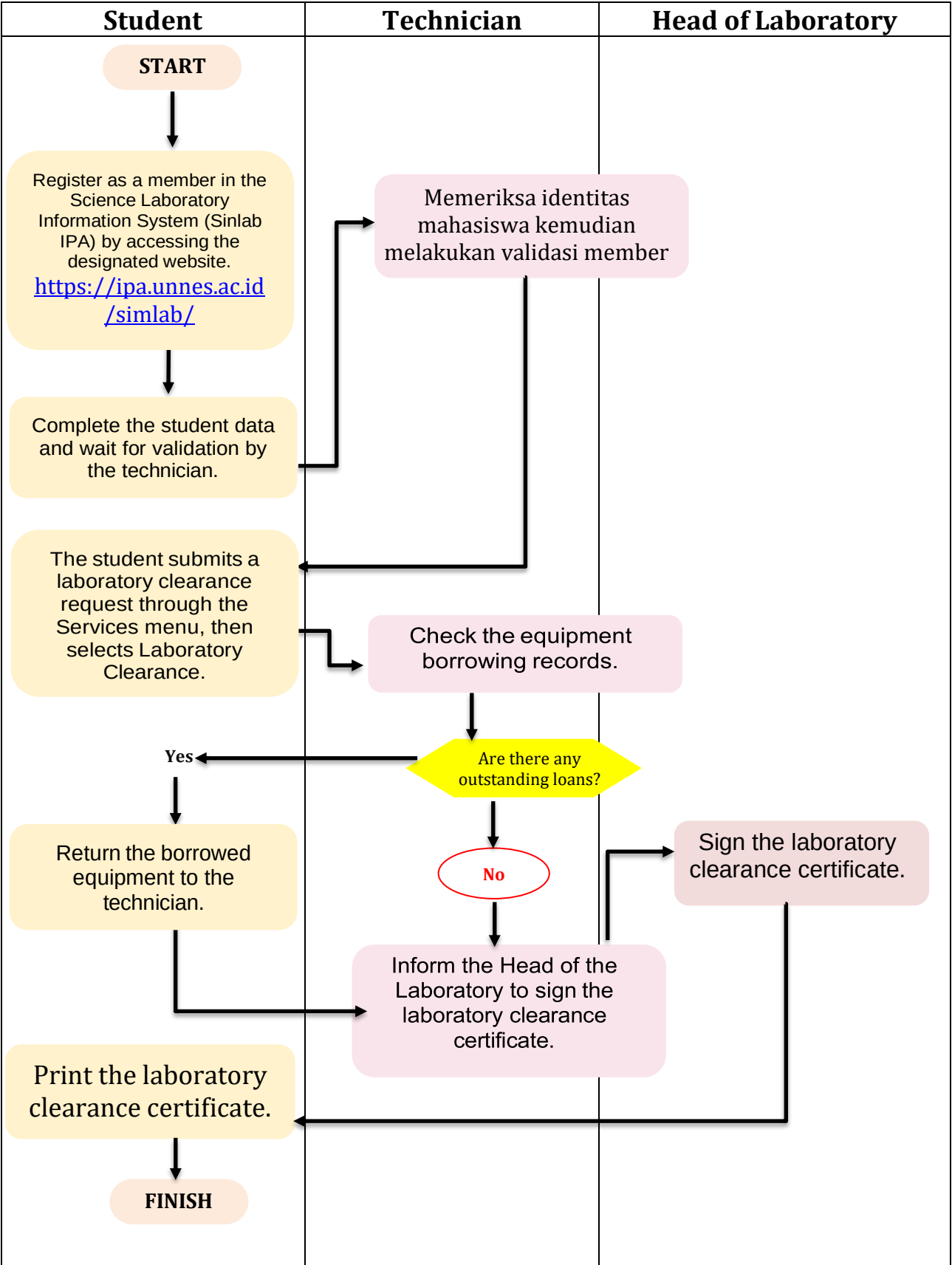
Appendix 1

Standard Operating Procedure for Borrowing Equipment at the Natural Science and Environmental Laboratory



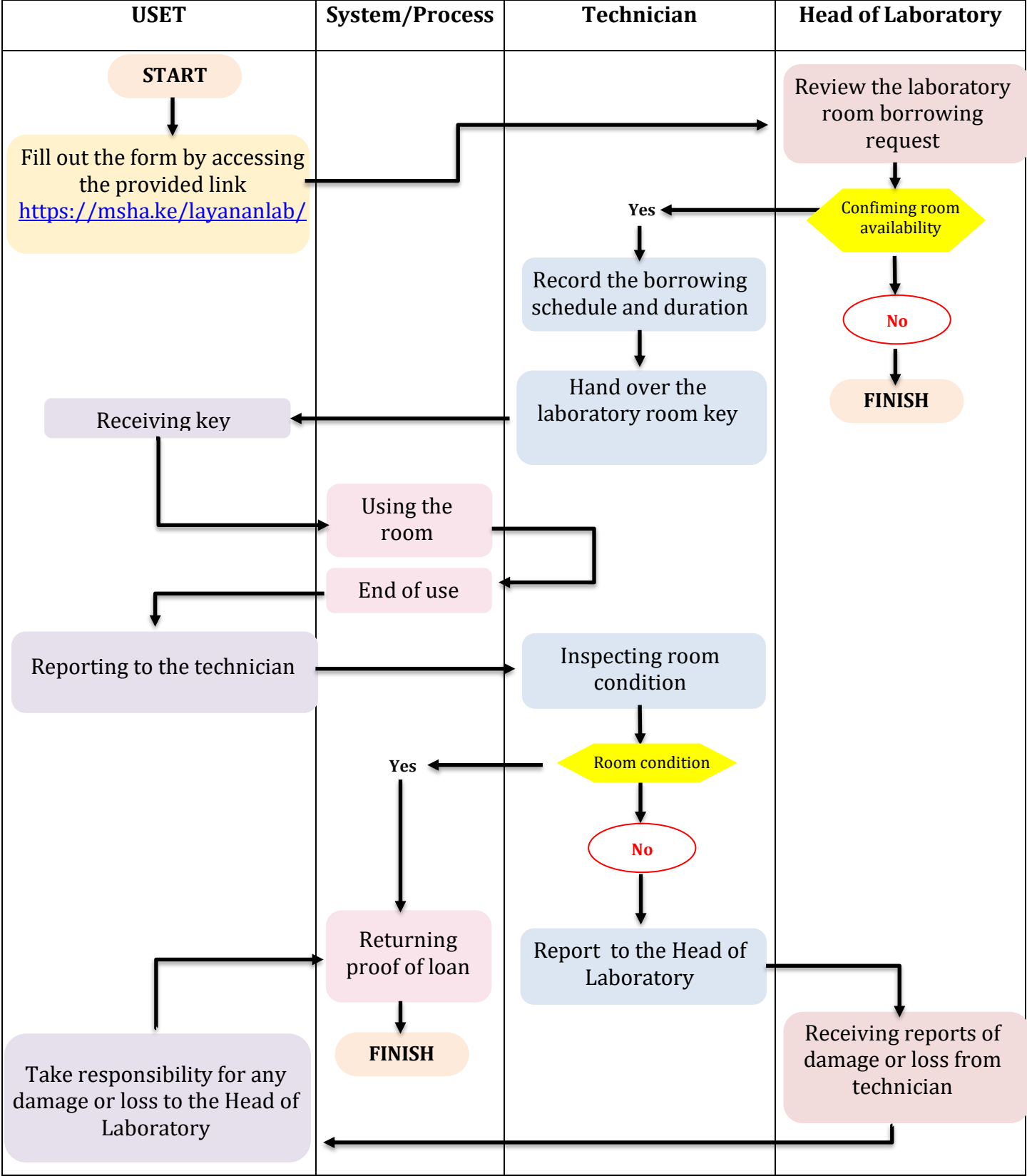
Appendix 2

STANDARD OPERATING PROCEDURE FOR LABORATORY CLEARANCE CERTIFICATE



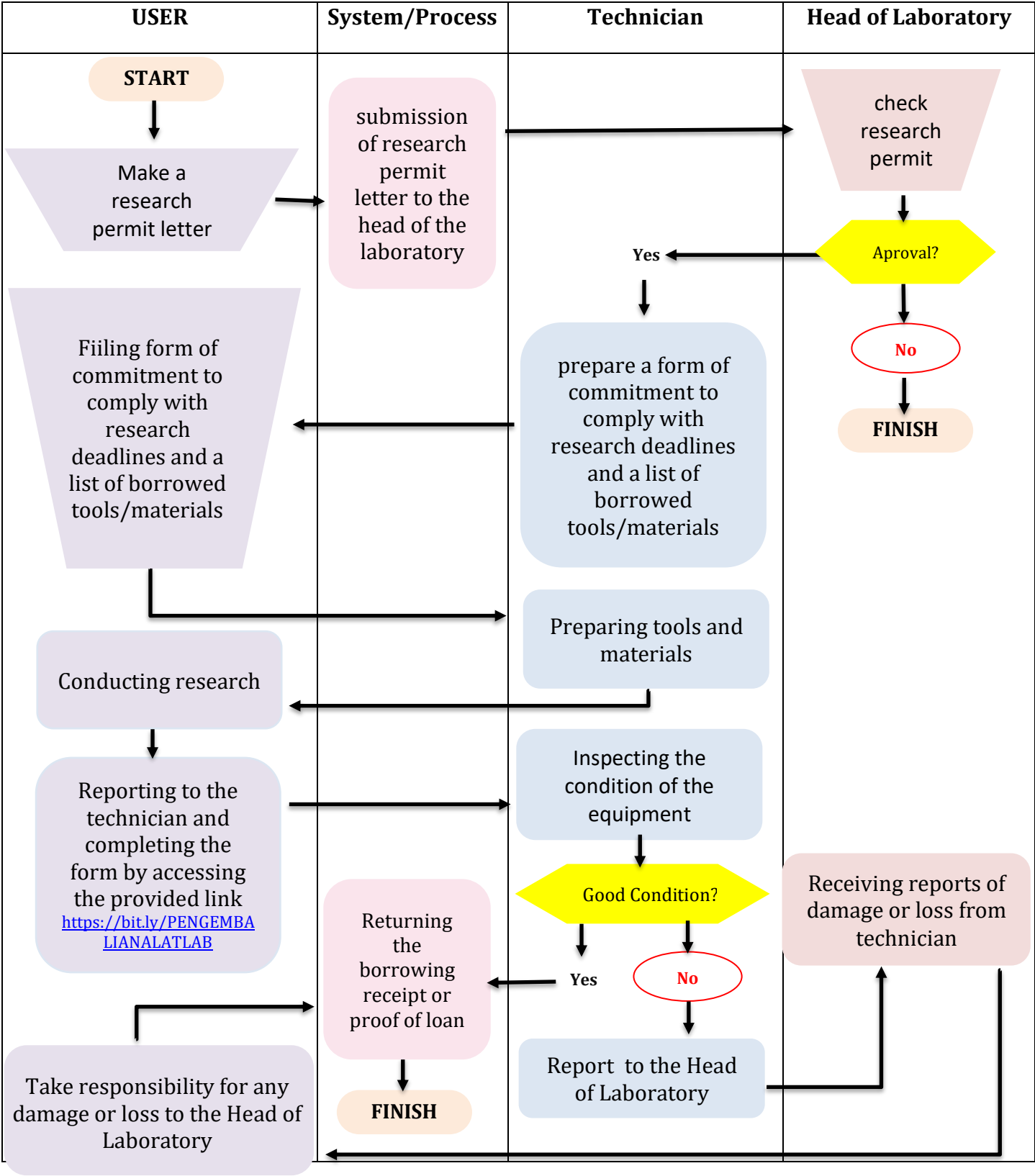
Appendix 3

STANDARD OPERATING PROCEDURE FOR BORROWING THE NATURAL SCIENCE AND ENVIRONMENTAL LABORATORY ROOM



Appendix 4

STANDARD OPERATING PROCEDURE FOR RESEARCH IMPLEMENTATION IN THE NATURAL SCIENCE AND ENVIRONMENTAL LABORATORY





UNIVERSITAS NEGERI SEMARANG
FACULTY OF MATHEMATICS AND NATURAL SCIENCES
Bachelor of Natural Science Education Study Program