دانشگاه علوم پزشکی همدان
کمیته ایمنی دانشکده پزشکی

Safety in Laboratory

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The meaning of safety?!

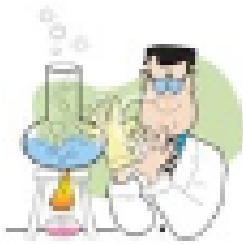
- **The state of being protected from danger or harm**: You have a right to be protected against anything that can affect your safety.

What is the biggest challenge in lab safety?!

Convincing people that lab safety is serious and that it's important

Why Do We Need to Have Safety Rules in the Lab?

1. Conducting laboratory experiments is a part of doing science to learn about nature and its laws.
2. Laboratory experiments can involve materials and instruments that can hurt a scientist or a person next to him.
3. To avoid possible accidents we need to know the safe practices in the lab and follow those practices..
4. It is everybody's responsibility to follow the safety rules and procedures.



Fun!

Danger!

According to the U.S. Bureau of Labor Statistics (BLS):

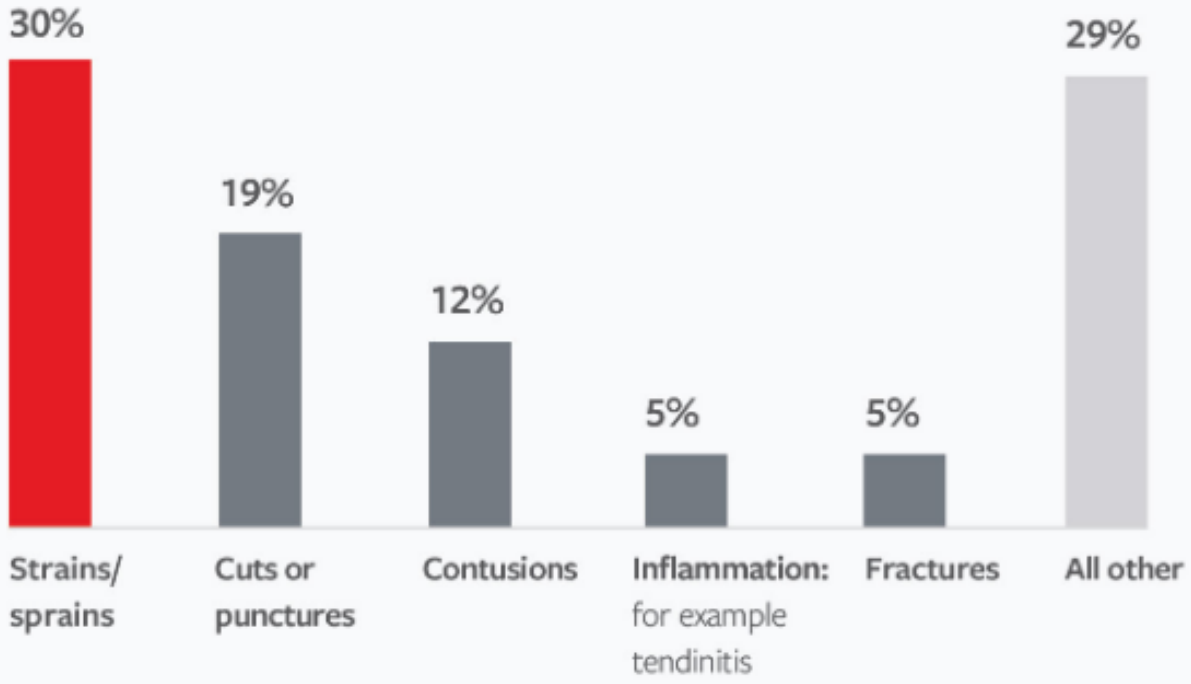
Three million workplace injuries occurred in the U.S. in 2012 alone!!!

Over 4,000 these were fatal!

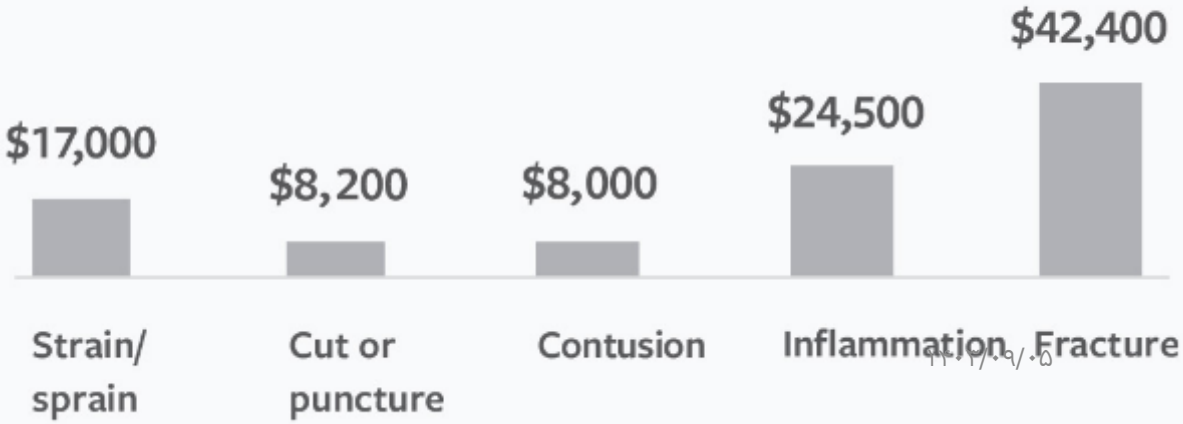
10 RULES FOR WORKPLACE SAFETY

1. YOU ARE RESPONSIBLE FOR YOUR OWN SAFETY AND FOR THE SAFETY OF OTHERS.
2. ALL ACCIDENTS ARE PREVENTABLE.
3. DO NOT TAKE SHORTCUTS. ALWAYS FOLLOW THE RULES.
4. IF YOU ARE NOT TRAINED, DON'T DO IT.
5. USE THE RIGHT TOOLS & EQUIPMENT AND USE THEM IN THE RIGHT WAY.
6. ASSESS THE RISKS BEFORE YOU APPROACH YOUR WORK.
7. NEVER WEAR LOOSE CLOTHES OR SLIPPERY FOOTWEAR.
8. DO NOT INDULGE IN HORSEPLAY WHILE AT WORK.
9. PRACTICE GOOD HOUSEKEEPING.
10. ALWAYS WEAR PPEs.

The most common workplace injuries



Average claim cost of 5 most frequent injuries**



5 Characteristics of the most recent injury or illness sustained

In 2021-22, the most common work-related injury or illness *sustained* among workers was a sprain/strain (28.7%), followed by a chronic joint or muscle condition (20.4%) and cut/open wound (12.6%) (Figure 10).

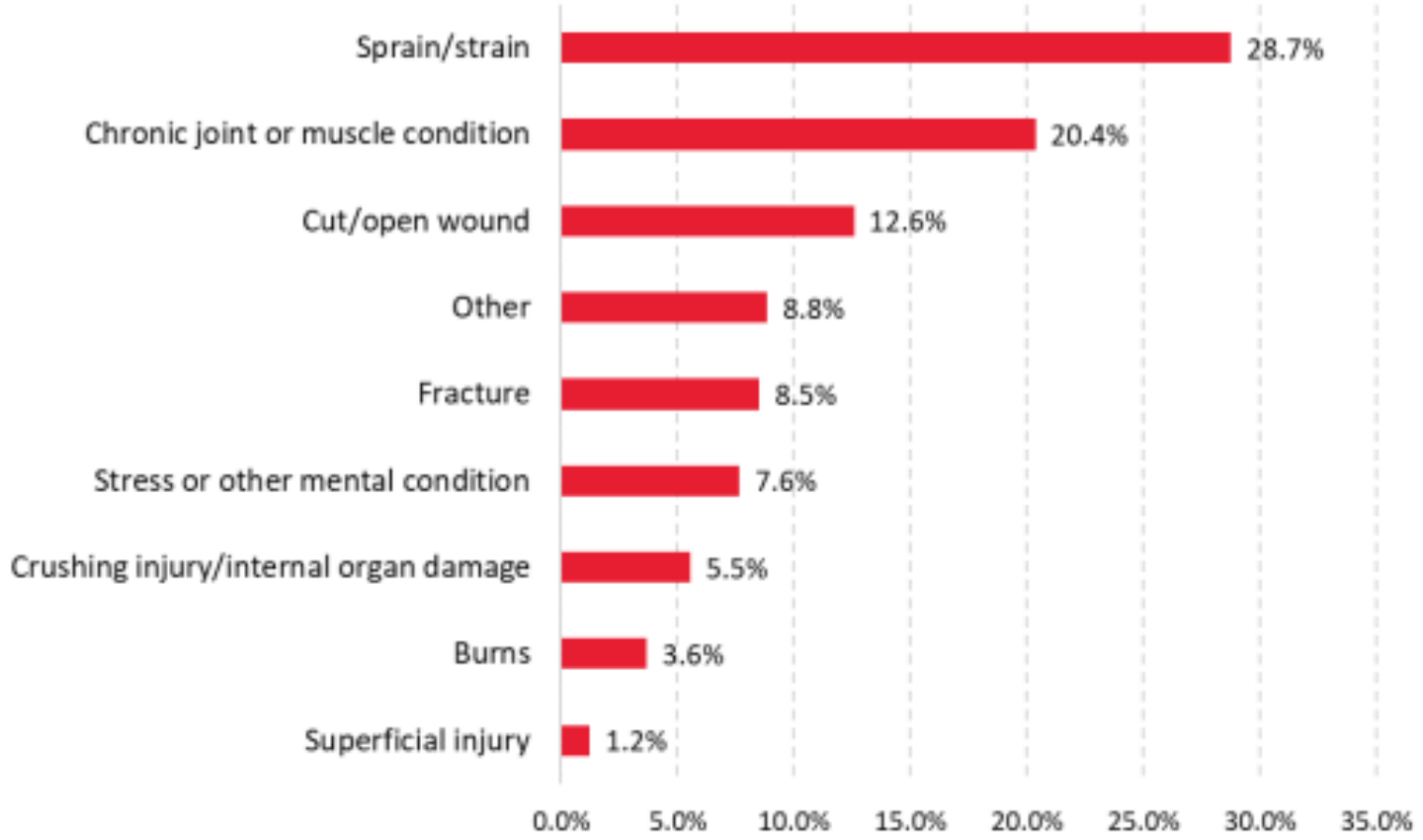


Figure 10 Work-related injury or illness by type, 2021-22
Source: ABS Work-related injuries, 2021-22

Laboratory accidents statistics

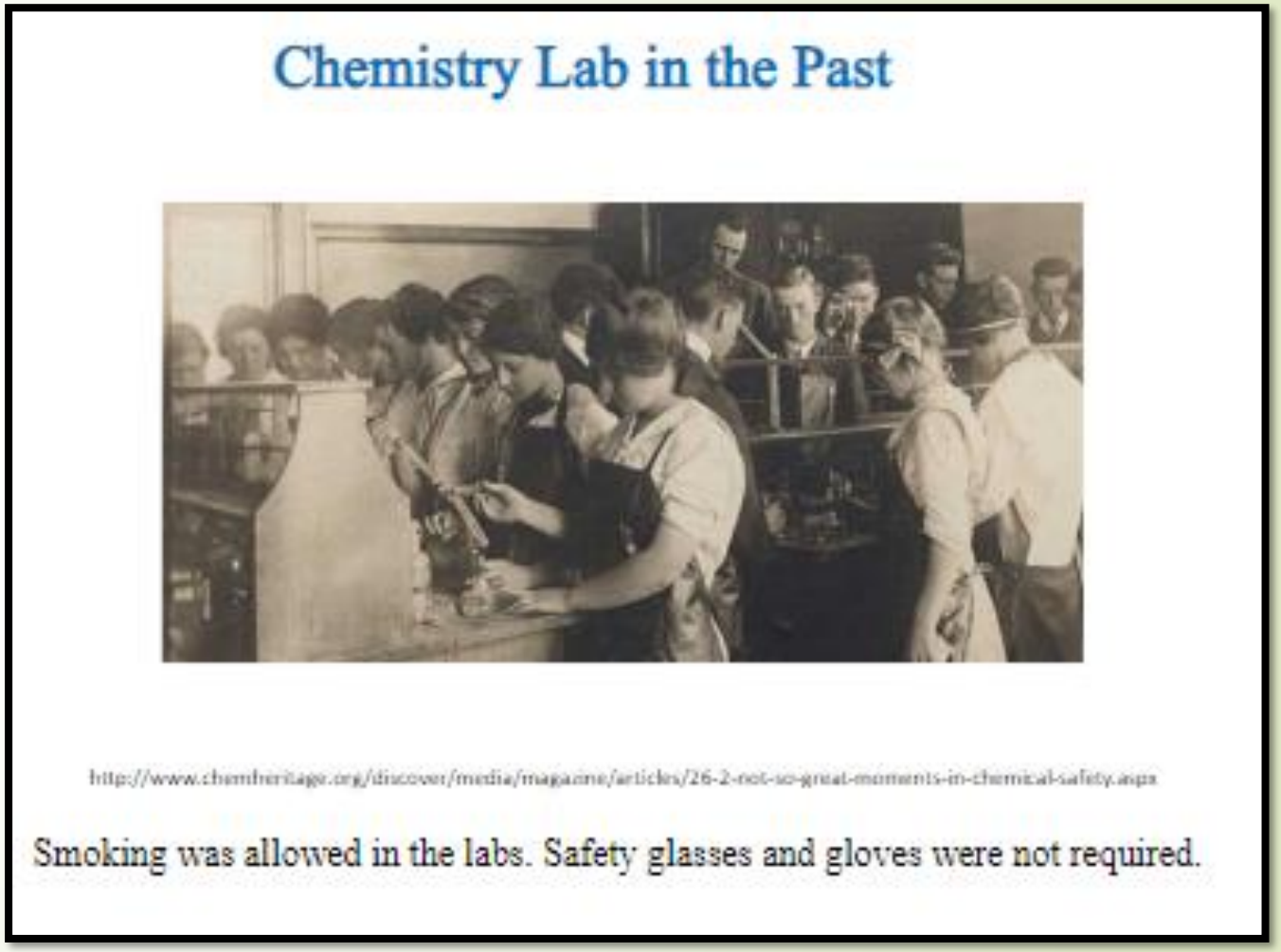
- According to "A review and critique of academic lab safety research" :
- 25-38% of lab personnel surveyed have been involved in an accident or injury in the lab that was not reported to the supervisor or principal investigator.
- Only 40% of researchers surveyed reported wearing PPE at all times when working.
- 25% of researchers had not been trained in the specific hazard with which they worked.
- The findings of researches in Lebanon university revealed that the prevalence of accident occurrence among laboratory workers in scientific laboratories reached 45.0 %.

Laboratory accidents statistics

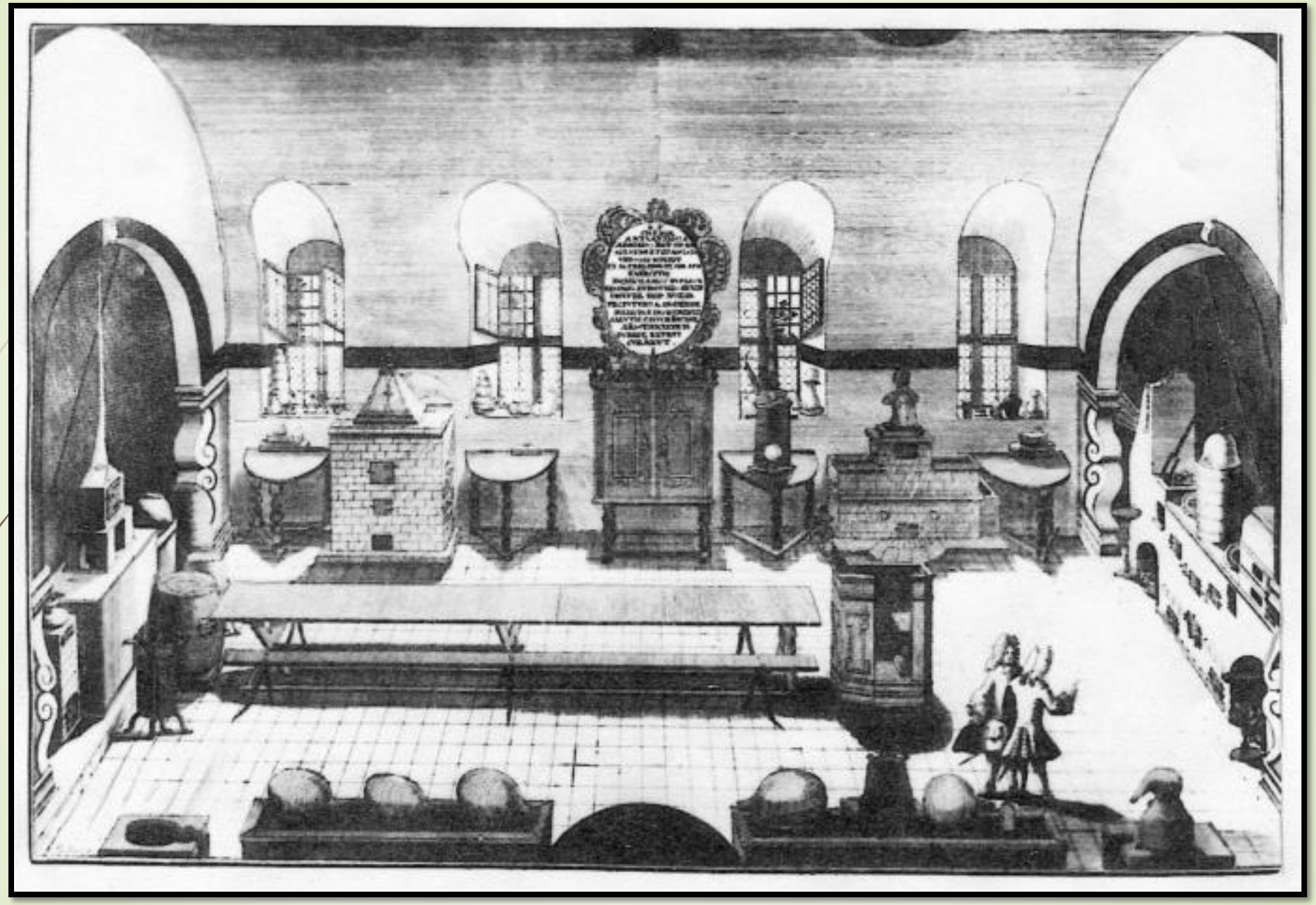
- Results showed a high level of accident involvement (56.7%); of that number, most of those (65.9%) had been involved in multiple accidents. Most accidents involved only personal injuries and happened on a weekday afternoon with other lab members present.
- Participants who chose not to report their accidents reported barriers such as beliefs that the accident was not severe, concerns about judgment, self-blame, and not knowing they had to report the accident or how.

The history of lab safety

- U.S. Occupational Safety and Health Administration (OSHA) mandated the Chemical Hygiene Plan (CHP) in 1990, industrial laboratories across the United States instituted more rigorous safety programs, and commercial enterprises appointed dedicated safety officers to help monitor lab safety practices.



The assaying workspace, from Ercker's Beschreibung of 1574. Wellcome Library, London



Laboratory at the University of Altdorf, 1682. Courtesy Oesper Collections, University of Cincinnati

Pictures From the Past

1920s - No lab coat. The classic 20s look and the really elaborate chemical laboratory setup!

1940 - No gloves, no safety glasses

- **2019 (France):** a young technician stabbed her thumb through a double pair of latex gloves while working with mice brain tissue containing mad cow disease proteins. She died of the disease months years later.
- **2018 (India):** 28-year old researcher was killed in a high-pressure hydrogen cylinder explosion at the Indian Institute of Science.
- **2018:** Frontage Laboratories died as a result of exposure to potassium cyanide.
- **2016 (Zimbabwe):** A teacher died at inhaling poisonous fumes at the science laboratory.
- **2015:** FL. A Construction worker killed when a steel cap blew off a high pressure pipe on a cooling device
- **2012 (San Francisco):** A hospital lab worker died from exposure to bacterial strain causing septicemia and meningitis.
- **(2012 Shanghai):** Graduate student at university opened a poison gas cylinder and died from inhalation.
- **(2011):** A *Salmonella Typhimurium* outbreak linked to lab exposure sickened 109 people in 38 states
- **(2009, Chicago):** A researcher died from exposure to *Yersenia Pestis,* a plague-related bacterium.

- **(2008 Canada):** Trimethyl silyldiazo methane poisoning. The lab fume hood was not operating.
- **(1940 Illinois):** Graduate student killed in explosion of chemicals stored in a household refrigerator.
- **(1916):** X-ray pioneer died due to x-ray exposure.
- **(2007, Argentina):** Faculty member killed when someone lit the lighter of an autoclave near a hexane spill, producing a huge explosion.
- **(2005 U.S):** Biology professor was electrocuted when he used a "cheater plug" (electrical adapter that converts a three-pronged plug for a two-pronged outlet) to plug in a homemade grow lamp that had a defective ballast.
- **(2004, Minnesota):** Employee was trapped inside walk-in steam washer used to clean animal cages while the washer was in the final rinse cycle and was fatally burned.
- **(1997, Dartmouth College):** Wetterhahn was working with a dimethylmercury compound using latex gloves. Latex does not provide sufficient protection from the chemical and she died of mercury poisoning.
- 2022, Isfahan Province, Iran. One person died and one was injured in a fire that broke out in the chemical laboratory of the Isfahan Industrial University.


سازمان آتش نشانی
و خدمات ایمنی شهرداری تهران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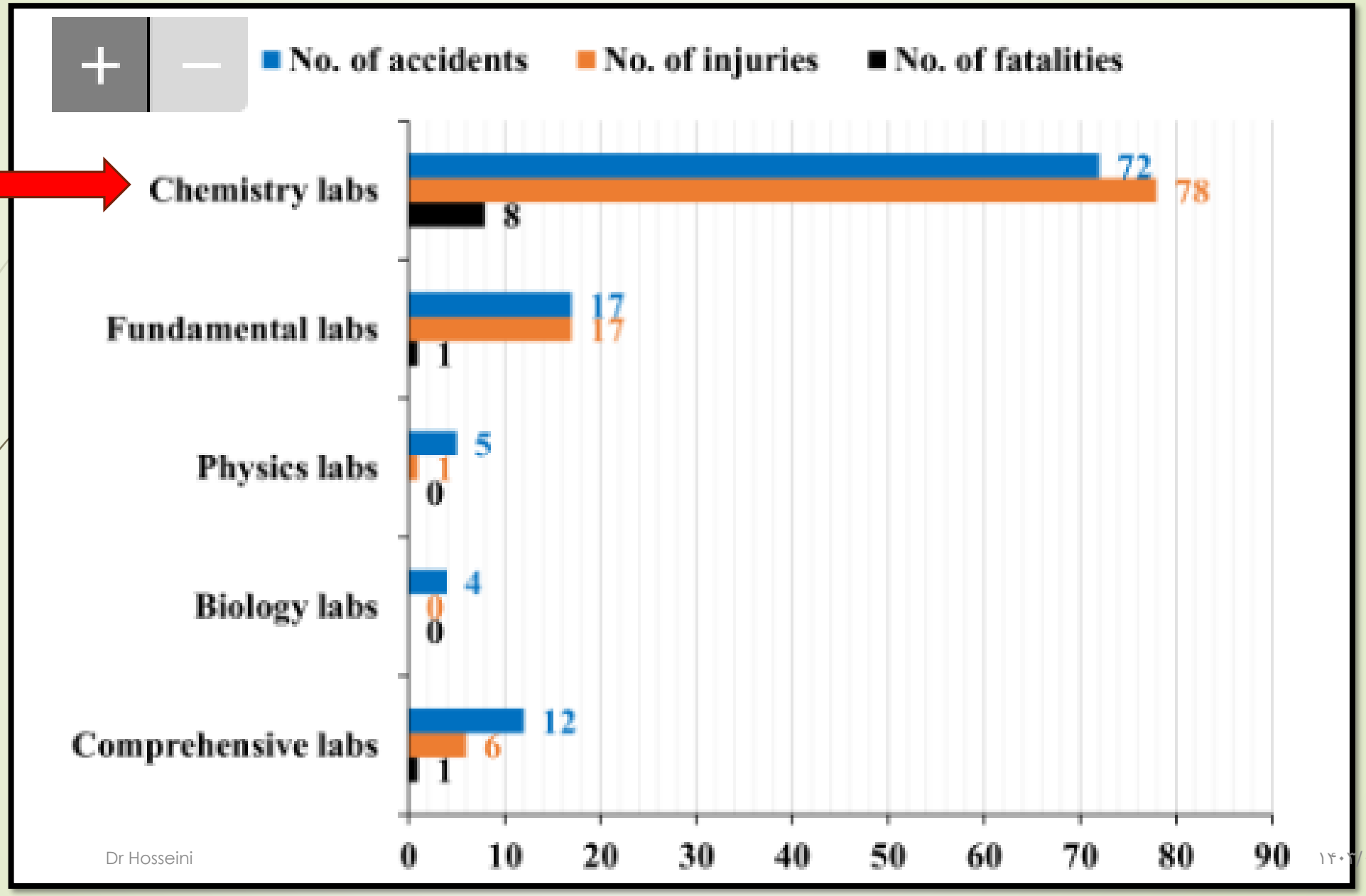
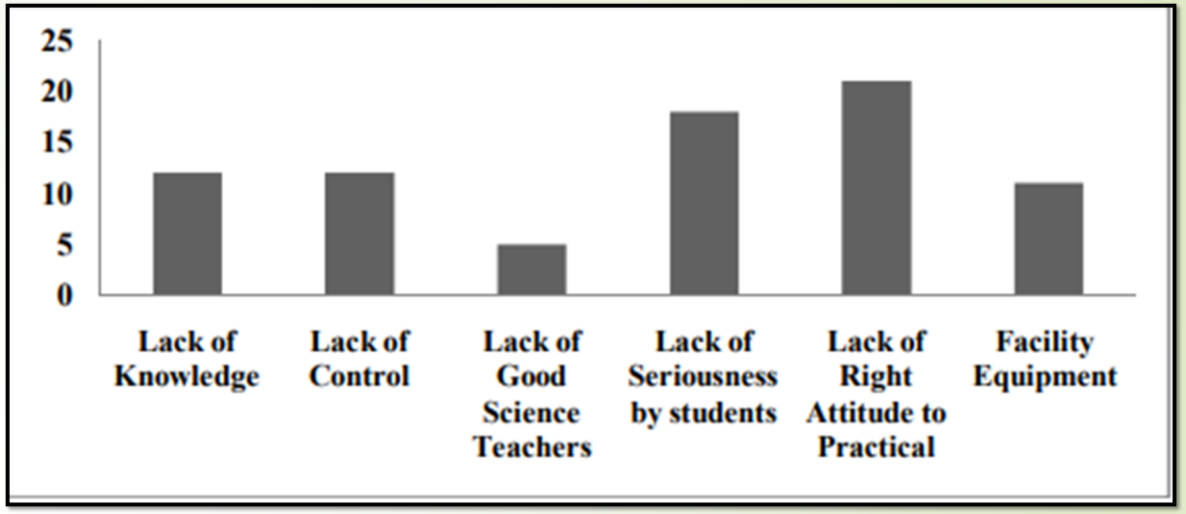
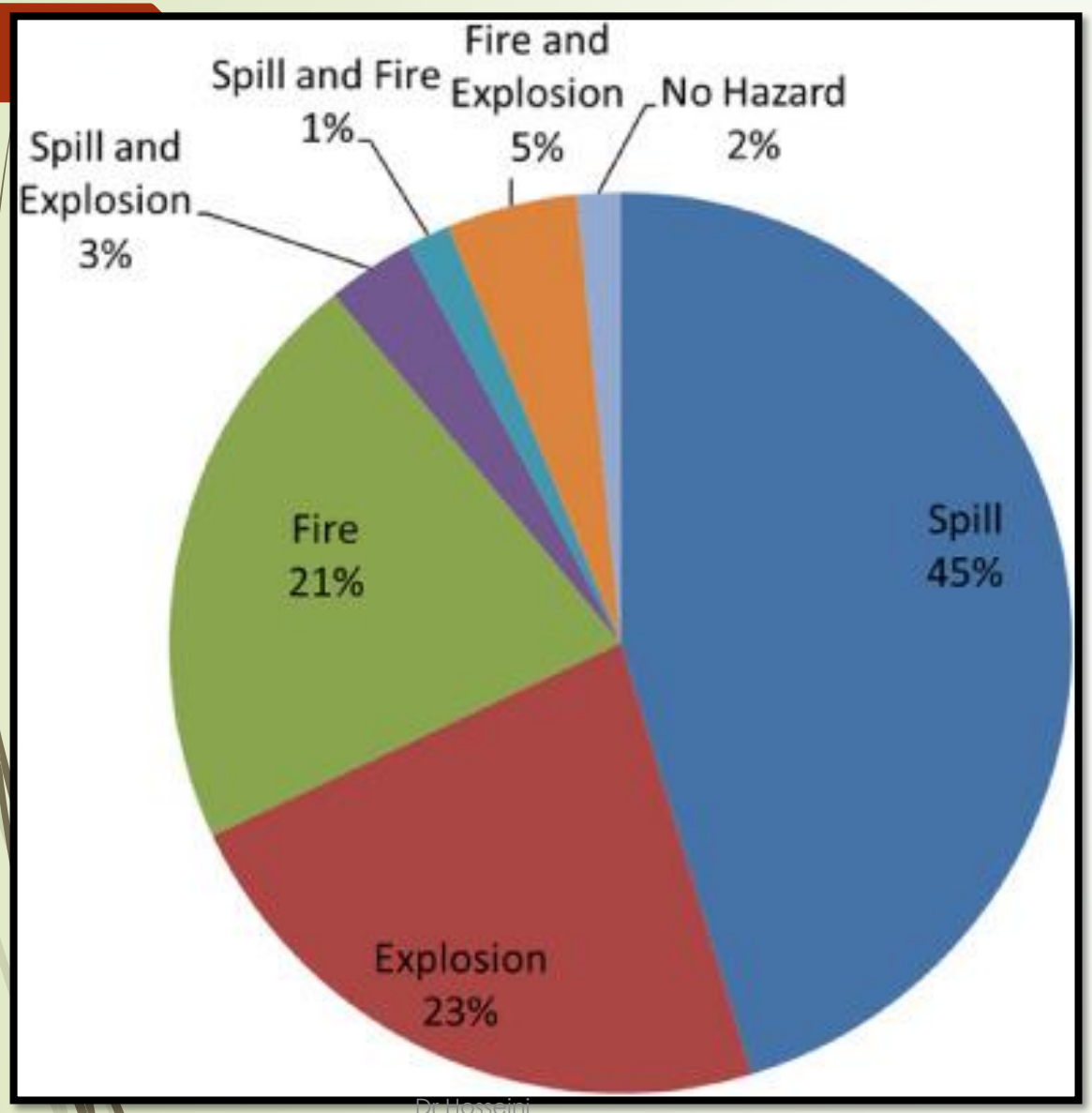
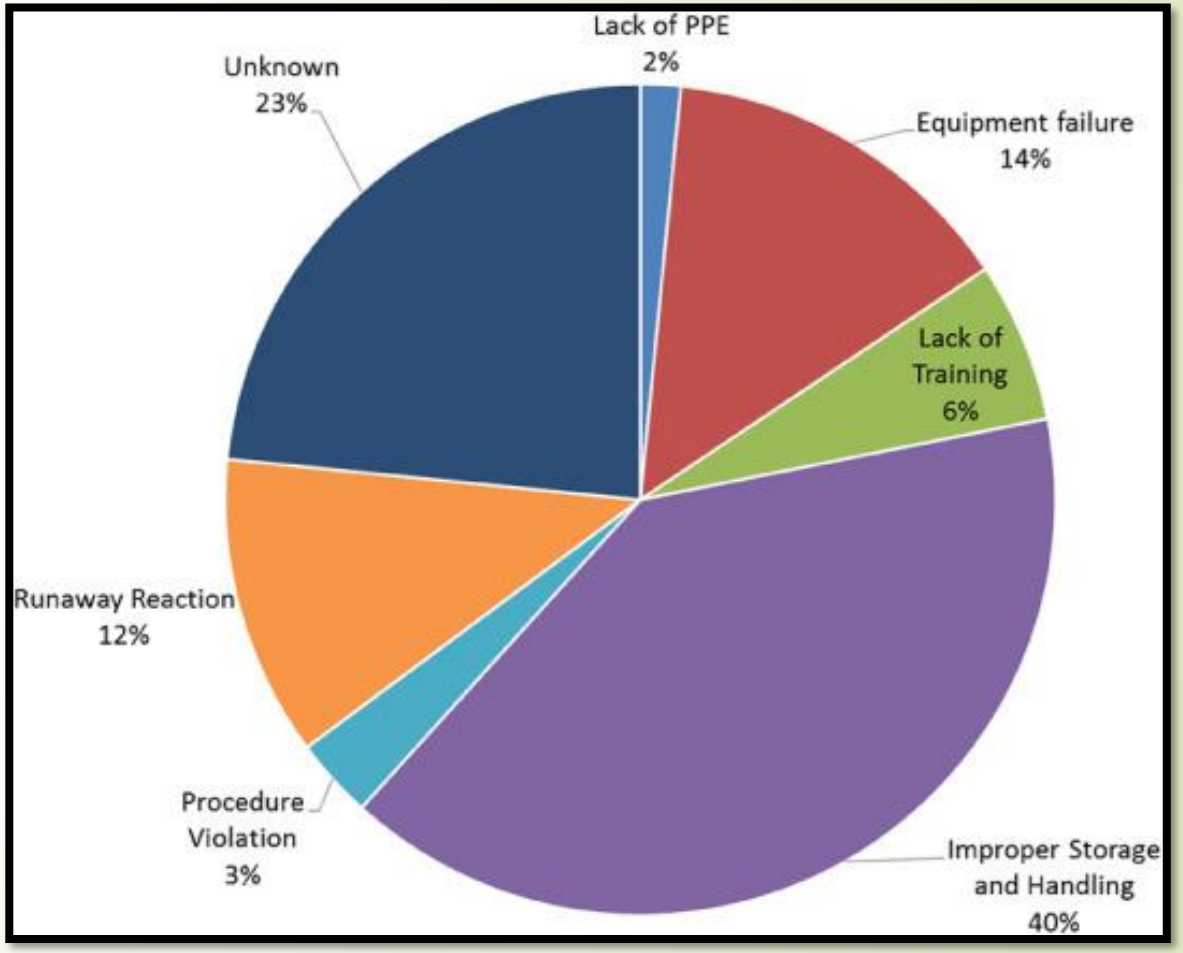

No. of accidents
No. of injuries
No. of fatalities
Chemistry labs
72
78
8
Fundamental labs
17
17
1
Physics labs
5
1
0
Biology labs
4
0
0
Comprehensive labs
12
6
1
0
10
20
30
40
50
60
70
80
90

Causes of Lab Accidents

- Lack of working understanding of hazards
- Improper or unintended use of equipment
- Inexperienced
- Distractions, lack/loss of attention to task
- Broken, damaged glassware or equipment
- Other




Fire and Explosion 5%
Spill and Fire 1%
No Hazard 2%
Spill and Explosion 3%
Fire 21%
Spill 45%
Explosion 23%

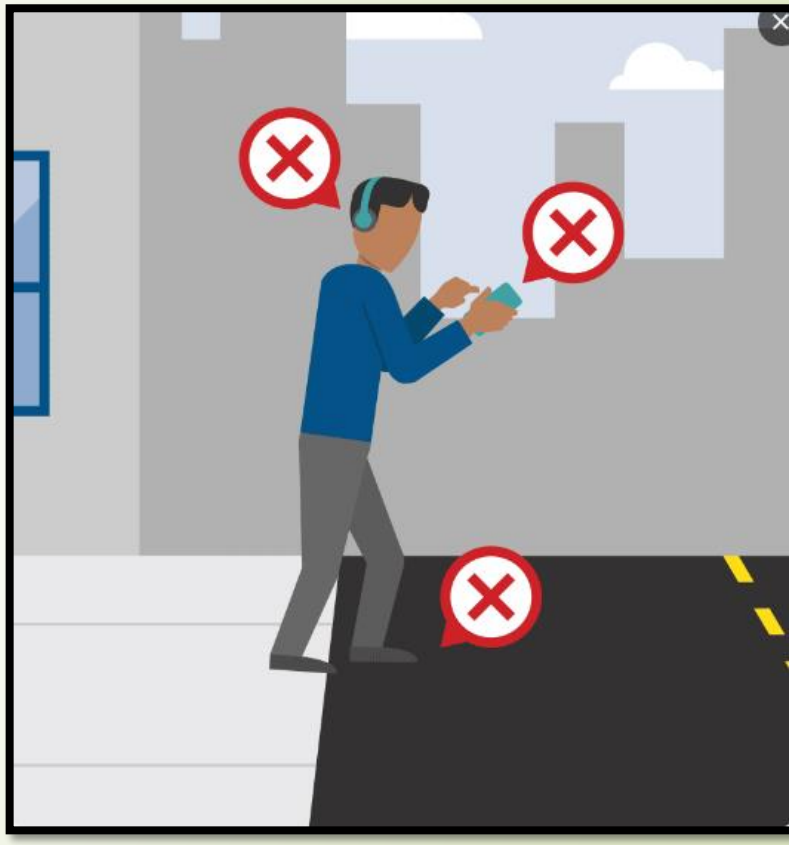

Lack of PPE 2%
Unknown 23%
Equipment failure 14%
Lack of Training 6%
Runaway Reaction 12%
Procedure Violation 3%
Improper Storage and Handling 40%

8 workplace safety tips every employee should know..,

- The safest work environments occur when employees at all levels of the organization work together to communicate and adhere to the safety standards set in place.

1. BE AWARE OF YOUR SURROUNDINGS

- Every job site has inherent dangers. whether that's heavy machinery, conveyor belts, or even tripping over items in the office. The best way to keep yourself and others safe is to identify the hazards in your workplace and be aware of your surroundings. The more familiar you are with your tasks and workplace, the more aware you'll be of the potential hazards.



2. Keep correct posture

- Maintaining your body in a neutral posture is important to minimize the stress placed on your body even if you work at a desk. You need to make sure you have good posture to avoid back problems, neck pain, and even carpal tunnel.

3. Take regular breaks

- Tired workers are the most prone to causing an incident.
- The more tired you are, the less aware you are of your surroundings and the more at-risk you are for an injury.

4. Never take shortcuts on procedures

- Workplace procedures exist to keep employees safe, so using every tool and machine according to their instructions is critical. This is especially true for operations that require heavy machinery.

- Shortcuts lead to injury and aren't worth the small amount of time they might save you. Be sure you're always using the right tool for the job and that you're using it correctly.

5. Be aware of new safety procedures

- When your company purchases a new machine or updates training, it's important to become familiar with the latest safety procedures.
- Workplace safety is a team effort. An employer is responsible for providing the proper training, a supervisor is responsible for assigning training time, and an employee is responsible for taking training and understanding safety procedures so they can be implemented properly

6. Keep emergency exits clear

- Never place anything in front of an emergency exit door, even if it’s only for a few minutes.
- Also ensure pathways to equipment emergency shut-offs are clear in case something needs to be powered down immediately.

7. Report unsafe conditions

- The best way to stop unsafe working conditions from happening is to report them to supervisors as soon as you notice them and then help be part of the solution.
- In order to keep yourself and other employees safe, it's important to always report any hazardous situation or behavior immediately.

Examples of Unsafe Working Conditions in the Workplace:

1. Inadequate or malfunctioning warning systems (or lack of such a system)
2. Flooring that has debris, water, or slippery substances that create a hazard
3. Blocked safety exits
4. Equipment that is not maintained or not working properly
5. Failure to have safety guards
6. Unsanitary working conditions, which can increase the risk of illness or death
7. Hazardous materials that can harm or injure workers, including biological and chemical hazards

8. Always wear personal protective equipment

- Finally, ensure you're always wearing the personal protective equipment (PPE) provided to you by your employer. For example, when handling some chemicals you may only need to wear safety glasses and a pair of nitrile gloves. In other cases, you may need to wear different or additional protective gear.

Contents..,

1. Introduction
2. Safety training
3. Personal protective equipment
4. Administrative controls
5. Laboratory equipment
6. Glassware safety
7. Biological safety
8. Chemical safety
9. Cryogenic safety
10. Electrical safety
11. Mechanical safety
12. Radiation safety
13. Laser safety
14. Emergency procedures
15. Response to specific incidents/accidents

Introduction

- The laboratory health and safety (LHS) program should run by a safety committee of each workplace and assigned by the Dean's Office. The duties of the LHS committee include the following:
- To identify the potential risks, dangers and hazards in the working area
- To make provision against accidents
- To provide consultancy about occupational health and safety
- The backbone of this documentation involves several subjects such as trainings, guidelines on laboratory safety, emergency and waste management procedures.

What is the work place hazard?

Hazards in the workplace occur when the working environment can cause injury, illness or death. The hazards can result from many of the different aspects of the working world, including equipment, dangerous materials, unsafe working practices and the behavior of people.

The last and most important one: Electrical hazard

Safety training

- Lab safety is an essential elements of the successful science lab. You need to understand what is safe and unsafe behavior and what is the reason for each safety rule.
- The lab safety course provides an overview of the different risks associated with working in a laboratory.

Safety training

- Administrative staff shares the list of new students/employee who will work in the laboratories with laboratory specialist (LS) and laboratory safety specialist (LSS) and informs newcomer to visit LSS. LSS performs the training need analysis with the newcomer, meaning that they decide on the trainings the newcomer will take.
- New students/employees get training and have exam depending on an online training calendar which will show all the training and exam dates beforehand.
- When the exam results are announced, unsuccessful examiners will retake the training session. **Successful ones will have the access to the laboratories** and he/she will have an orientation in their laboratories with the Responsible Faculty Member / LS / LSS.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

- Personal protective equipment is intended to **protect lab users from serious workplace injuries or illnesses coming about because of contact with chemical, radiological, physical, electrical, mechanical, or other workplace risks**.
- Performing any operations or experiments, appropriate PPE to wear should be decided and various variables must be mulled over, for example;

1. The nature of the hazard and the task
2. Compatibility with other PPE
3. The chemicals being used, including concentration and quantity
4. The hazards posed by the chemicals
5. The routes of exposure for the chemicals
6. The material the PPE is constructed of
7. The permeation and degradation rates specific chemicals will have on the material
8. The duration the PPE will be in contact with the chemicals

PERSONAL PROTECTIVE EQUIPMENT (PPE)

- Careful consideration should be given to the comfort and fit of **PPE to ensure that it will be used by the lab users**.
- Besides, PPE should
  - be provided free of charge to users
  - be maintained in an efficient working order and in good repair
  - be stored in an assigned and suitable area
  - be provided in conjunction with appropriate instruction and training for the user

Sources

Safety specialist should observe:

1. Sources of high temperatures that could result in burns, eye injury or ignition of protective equipment
2. Types of chemical exposures
3. Sources of harmful dust
4. Sources of light radiation, for instance, welding, brazing, cutting, heat treating, furnaces, and high intensity lights
5. Sources of falling objects or potential for dropping objects
6. Sources of sharp objects which might pierce or cut the hands
7. Sources of rolling or pinching objects which could crush the feet
8. Layout of work place and location of co-workers
9. Any electrical hazards

PPE selection guide by task		
	If your task/activity involves:	**Use the following PPE:**
Chemicals	Solids of low or moderate toxicity	▪ Disposable gloves
	Minimal amounts of liquids (less than 0.1 L) with acute or chronic toxicity	▪ Safety glasses or goggles ▪ Appropriate chemical-resistant gloves ▪ Clothing covering to knees
	More than minimal amounts of liquids with acute or chronic toxicity (pure chemicals, mixtures or solutions)	▪ Safety glasses or goggles ▪ Appropriate chemical-resistant gloves ▪ Lab coat ▪ Acid-resistant apron if more than 4 liters of highly corrosive chemicals used ▪ Consider flame-resistant lab coat if more than 4 liters of flammable liquids used
	Cryogenic liquids	▪ Safety glasses or goggles ▪ Face shield required if handling cryovials stored in liquid phase ▪ Insulated cryogenic gloves ▪ Lab coat recommended
	Potentially explosive compounds	▪ Safety goggles ▪ Face shield ▪ Heavyweight gloves ▪ Fire-resistant lab coat
	Pyrophoric (air-reactive) solids or liquids	▪ Safety glasses or goggles ▪ Face shield recommended ▪ Fire-resistant gloves ▪ Appropriate chemical-resistant gloves ▪ Fire-resistant lab coat
	Particularly hazardous substances including carcinogens, reproductive toxins, and reagents of high acute toxicity	▪ Safety glasses or goggles ▪ Appropriate chemical-resistant gloves ▪ Lab coat ▪ Respirators as needed

Biological Materials	BL1 microorganisms or viruses	▪ Disposable gloves
	BL2 microorganisms, viruses, viral vectors, human materials or old world primate materials	▪ Disposable gloves ▪ Lab coat
	Procedures outside of the biosafety cabinet without splatter guard when splashes or sprays are anticipated	▪ Safety glasses or goggles ▪ Disposable gloves ▪ Lab coat
Radiation	Unsealed radioactive materials or waste	▪ Safety glasses if there is a splash potential ▪ Nitrile or other appropriate gloves ▪ Lab coat
	Class 3B or 4 laser	▪ Appropriate eye protection
	and if UV laser	▪ Gloves ▪ Lab coat
	Laser(s) modified by optics	▪ Appropriate eye protection
	Open ultraviolet light source ▪ and if face enters UV beam ▪ and if hand enters UV beam ▪ and if body enters UV beam	▪ Safety glasses or goggles with UV protection ▪ UV face shield ▪ Gloves ▪ Lab coat
	Infrared-emitting equipment	▪ Appropriately-shaded goggles ▪ Lab coat
Other Hazards	Handling hot surfaces and objects such as autoclaved materials and heated glassware	▪ Heat-resistant gloves ▪ Lab coat
	Glassware under pressure or vacuum	▪ Safety glasses or goggles ▪ Face shield recommended ▪ Lab coat
	Cutting and connecting glass tubing	▪ Safety glasses or goggles ▪ Cut-resistant gloves
	Sonicator or other loud equipment	▪ Ear plugs

Eye protection

- Eye protection **should be worn** at all times while working with hazardous chemicals/biological materials or any physical hazards in the laboratory. Visitors should be provided with temporary protective goggles or, at least, protective glasses if they are allowed in any area in which the occupational use of eye protection is required.

- **The use of contact lenses is not recommended while working with chemicals that cause eye irritation.**

Eye and face protection

Safety glasses	Splash goggles	Laser goggles	Face shields
Safety glasses provide eye protection from moderate impact and particles associated with grinding, sawing, scaling, broken glass, and minor chemical splashes, etc.	Splash goggles provide adequate eye protection from many hazards, including potential chemical splash hazards, use of concentrated corrosive material, and bulk chemical transfer.	The lens of the eyewear is a filter/absorber designed to reduce light transmittance of a specific wavelength. The lens can filter out a specific wavelength while maintaining adequate light transmission for other wavelengths.	Face shields provide additional protection to the eyes and face when used in combination with safety glasses or splash goggles. Face shields consist of an adjustable headgear and face shield of tinted or clear lenses or a mesh wire screen.
			

Head protection

- Safety hats protect the head from impact, penetration, and electrical shock.
- Head protection is necessary if you work where there is a risk of injury from moving, falling, or flying objects or if you work near high-voltage equipment.
- This kinds of hats should be water resistant, flame resistant, and adjustable.
- Disposable head cover should be worn in case of working with chemical or infectious agent that would prevent the contamination of hairs.

Hand protection

- Most accidents involving hands and arms can be classified under four main hazard categories:
  - **Chemicals**
  - **Abrasions**
  - **Cuts**
  - **Heat/cold**

- Gloves must be worn at any potential danger like chemicals, cuts, lacerations, abrasions, punctures, burns (heat/cold), biological materials, or harmful temperature extremes and when utilizing chemicals that are easily ingested through the skin and/or particularly hazardous. The correct utilization of hand protection can shield from potential chemical and physical hazards.

Corrosive

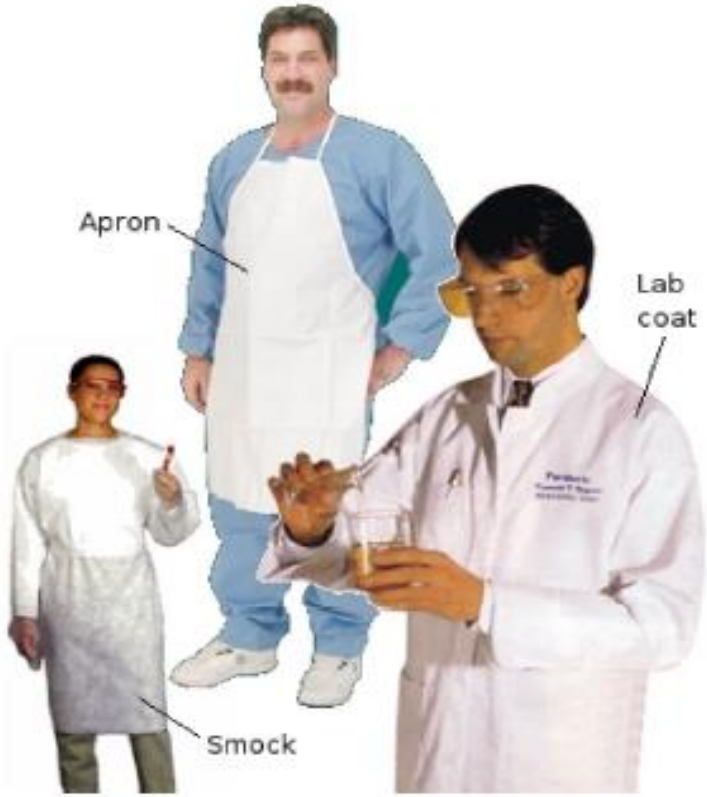
Latex gloves	Resistant to ketones, alcohols, caustics, and organic acids.	
Nitrile gloves	Resistant to alcohols, caustics, organic acids, and some ketones.	
Cryogenic gloves	Cryogenic gloves are used to protect hands from extremely cold temperatures.	
PVA Gloves	Resistant to chlorinated solvents, petroleum solvents, and aromatics.	
Cut-resistant gloves	Cut resistant gloves are gloves designed to protect the wearer's hands from cuts while working with sharp tools.	
Heat-resistant gloves	Working with metal and glass forming and hot surfaces requires gloves that offer the highest level of protection against the multiple hazards of a high-heat workplace.	

Foot protection

- In laboratories, laboratory support areas, and other areas where chemical, biological and physical hazards are present, foot protection should be supplied at all times.
- Wearing sandals or similar types of perforated or open-toed shoes when working with or around hazardous chemicals or physical hazards must be avoided.
- This is due to the potential exposure to toxic chemicals and the potential associated with physical hazards such as dropping pieces of equipment or broken glass being present. In general, shoes should be comfortable, and **leather shoes are preferable to cloth shoes due to the better chemical resistance of leather compared to cloth**. Leather shoes also tend to absorb fewer chemicals than cloth shoes. However, leather shoes are not designed for long term exposure to direct contact with chemicals. In such instances, chemically resistant rubber boots are necessary.

Steel-toed shoes and shoe cover

Protective clothing



Lab coats, smocks, and aprons will all protect the operator's skin and clothes from chemical spills. However, the operator should be aware that these articles of clothing are permeable. **If a spill occurs, the apron, coat, or smock should be removed promptly to ensure that the chemical does not soak through to the operator's skin**

Protective clothing

- Loose or torn clothing should be avoided without wearing a lab coat because of the ignition, absorption, and entanglement in machinery risks.
- Dangling jewelry, finger rings or other tight jewelry and excessively long hair should also be avoided.
- **Lab Coats When properly used:**

1. Provide protection of skin and personal clothing from incidental contact and small splashes.
1. Prevent the spread of contamination outside the lab (provided they are not worn outside the lab).
2. Provide a removable barrier in the event of an incident involving a spill or splash of hazardous substances.

- Lab coats should be provided for protection and convenience. They should be worn at all times in the lab areas.
- Due to the possible absorption and accumulation of chemicals in the material, lab coats should not be worn in the lunchroom or elsewhere outside the laboratory.

Lab coat (a) and apron (b)

Respiratory protection

- A respirator is a device designed to protect the wearer from inhalation of harmful substances. When chosen correctly and used properly, respirators can protect the wearer from,
    1. Fumes and smokes (welding fume)
    2. Harmful dusts (lead, silica, and other heavy metals)
    3. Gases and vapors (chemical exposures)
    4. Oxygen deficiency (oxidation, displacement, and consumption)
    5. Biological hazards (tuberculosis, whooping cough, flu viruses)

Types of Masks

Dust mask	The use of the term "dust" mask for the non-rigid soft felt mask is somewhat of a misnomer since, in modified forms, they can be used for other applications such as limited protection against paint fumes, moderate levels of organics, acid fumes, mercury, etc., although their biggest use is against nuisance dust.	
Half face respirator	The half-face cartridge respirator is the type most frequently used, especially in atmospheres in which there is little or no problem of irritation or absorption of material through the skin.	
Full face respirator	Full-face air-purifying respirators are similar in many respects to half-face respirators, with the obvious difference that the mask covers the upper part of the face, protecting the eyes.	

Hearing protection

- If you work in a high noise area, wear hearing protection. Most hearing protection devices have an assigned rating that indicates the amount of protection provided.
- Depending on your level of exposure, you may choose from the following devices Disposable earplugs
  - Reusable earplugs
  - Headband plugs
  - Sealed earmuffs

Headband/ear muff and ear plug

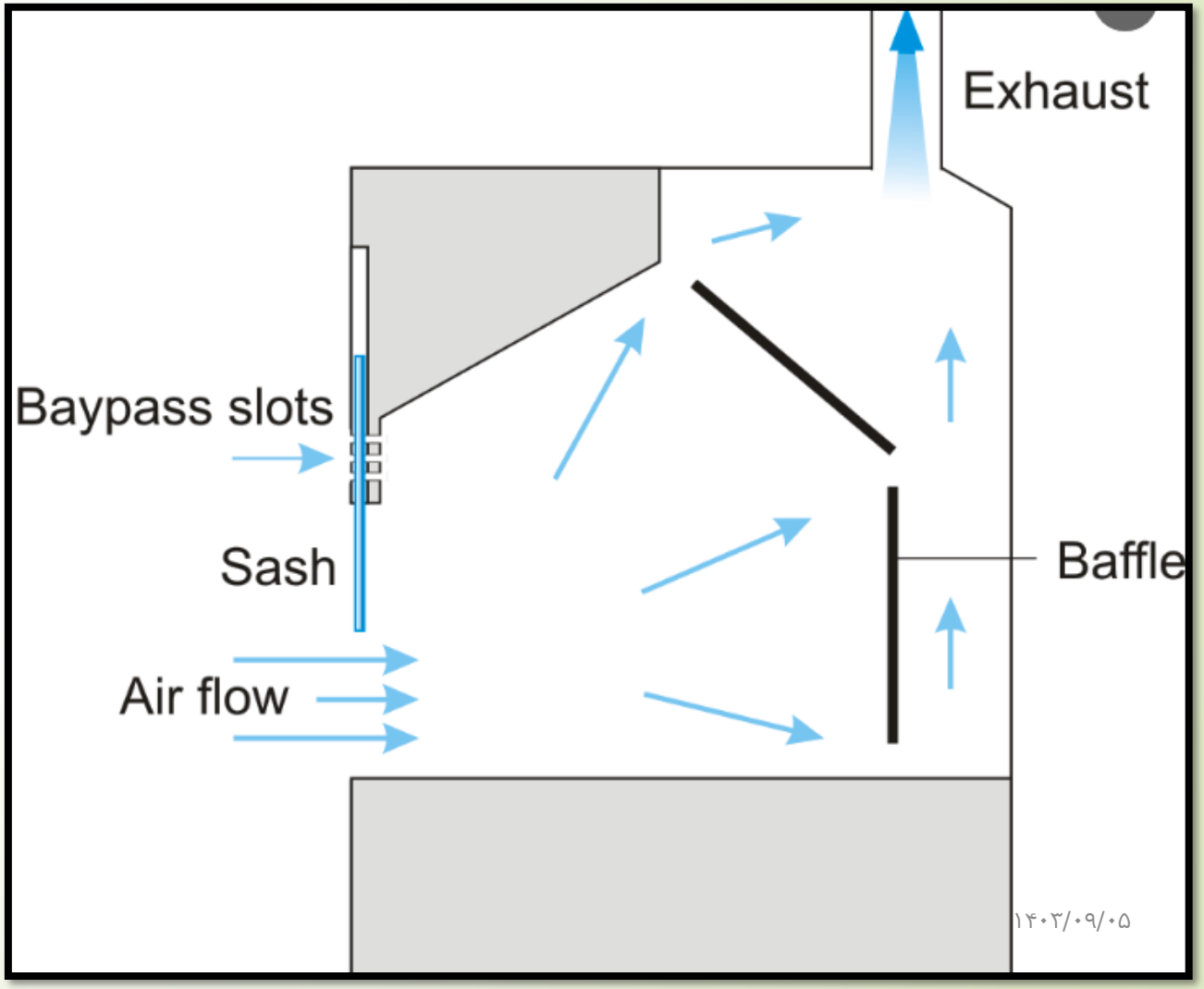
Engineering controls and laboratory equipment

- After hygiene, engineering controls are the next most important means of controlling exposure to hazards. **Engineering controls are anything that is built or installed to separate people from chemical, biological or physical hazards, and can include fume hoods, biosafety cabinets, glove boxes, local exhaust ventilation, safety shields, and proper storage facilities.**
- **Hazardous chemicals should be handled and ventilated differently from general laboratory ventilation**.
- **Laboratory users should be aware of their chemicals using SDS, how to protect themselves and laboratory environment from hazardous exposures and consider the available engineering controls**.

Fume hoods

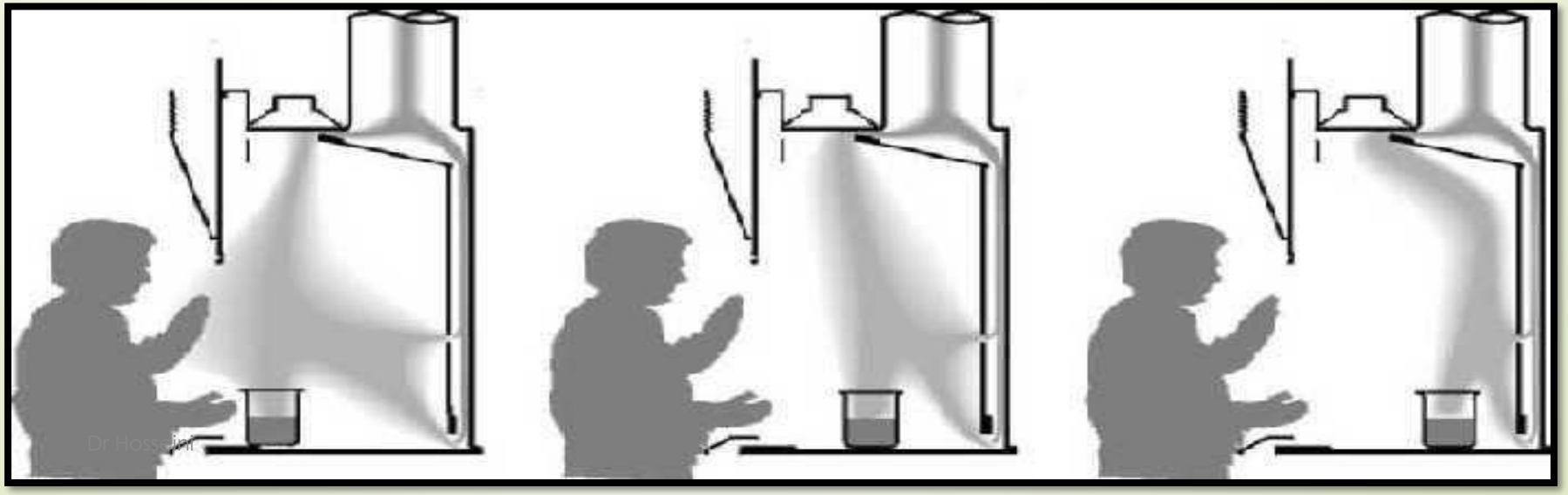
- Fume hoods are substantial infrastructure element for handling hazardous materials. They should not be misused for the purposes such as garbage, storage of materials, equipment.
- Fume hoods are used to prevent hazardous and odorous chemical exposure release to laboratory, laboratory users and the user. Another substantial reason is limiting spill-affected area within hood and exhausting affected air. Inward air flow through the hood minimized material leakage out of the hood.

Proper Use of Chemical Fume hoods

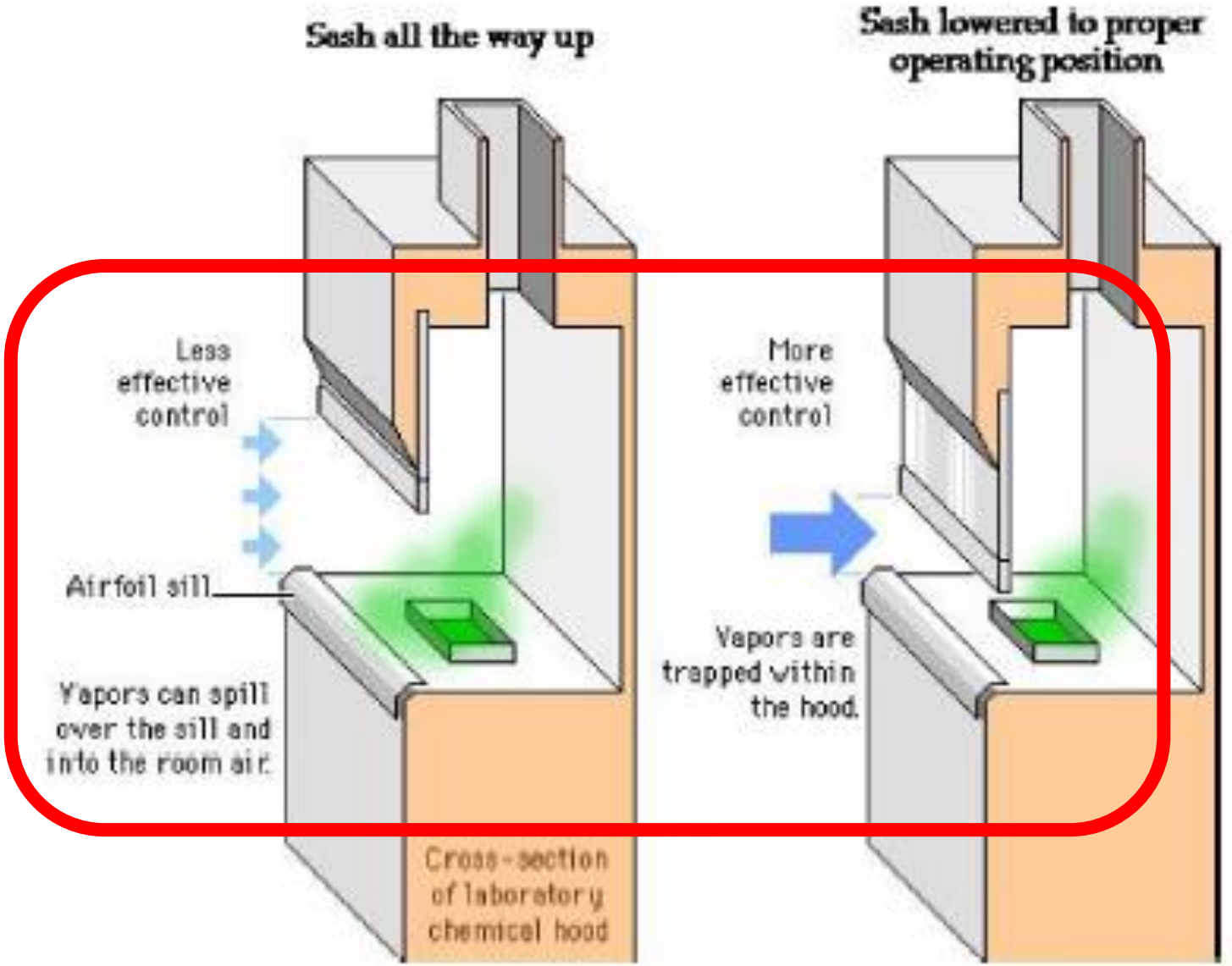


Proper Use of Chemical Fume hoods

1. **Equipment and other materials should be placed at least six inches behind the sash**. This will prevent chemical vapors from escaping into the lab due to air turbulence.
2. **When the hood is not in use, pull the sash all the way down. While personnel are working in the hood, pull down the sash as far as is practical.** The sash is your protection against fire, explosions, chemical splashes, and projectiles.
3. **Do not keep loose papers, paper towels, or tissue wipes in the hood.** These materials can get drawn into the blower and affect the hood's performance.



Effect of material placement: (L to R) bad placement, good placement, best placement


Sash all the way up
Sash lowered to proper operating position
Less effective control
Airfoil sill
Vapors can spill over the sill and into the room air.
Cross-section of laboratory chemical hood
More effective control
Vapors are trapped within the hood.

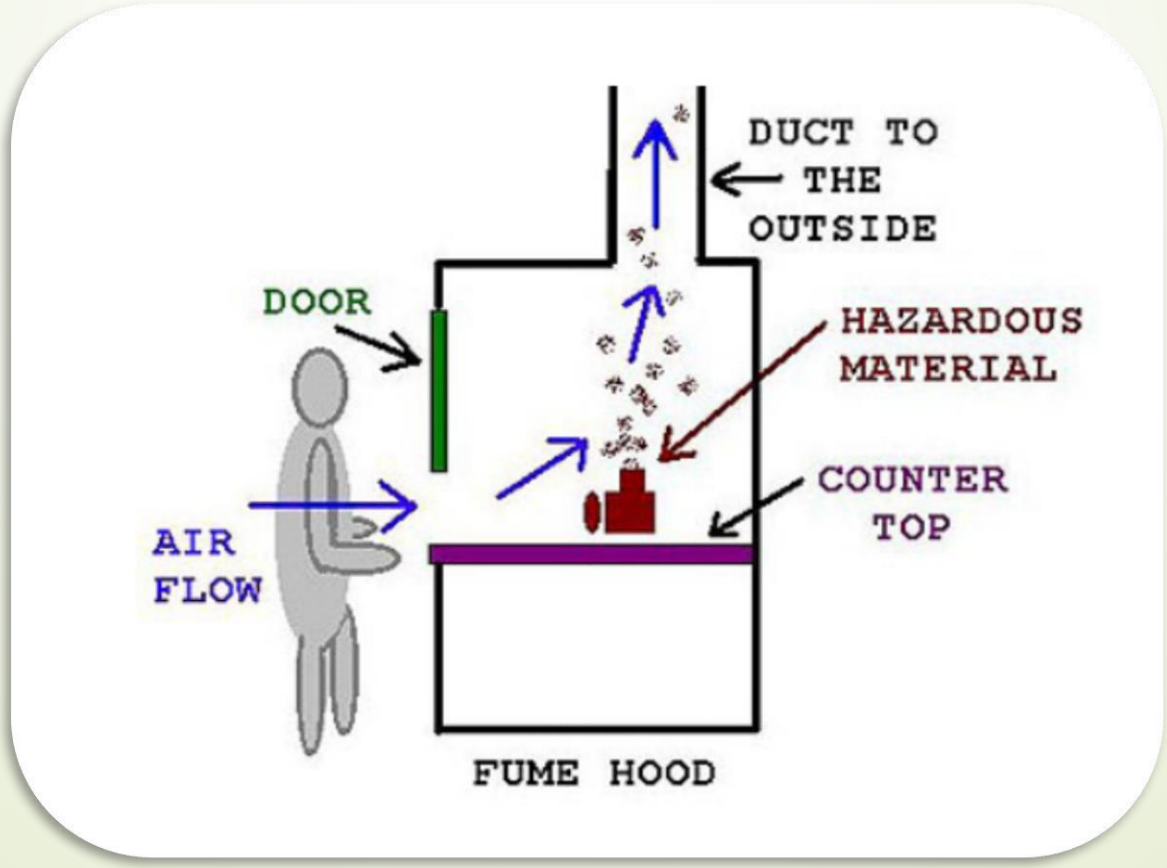
Proper Use of Chemical Fume hoods

1.Do not use a fume hood as a storage cabinet for chemicals. Excessive storage of chemicals and other items will disrupt the air flow in the hood. In particular, do not store chemicals against the baffle at the back of the hood. This is where the majority of the air is exhausted.

2.If large equipment must be kept in a fume hood, set it on blocks about 1 ½ inches above the work surface to allow air to flow underneath. This reduces turbulence within the hood and increases its efficiency.

3.Do not place objects directly in front of a fume hood (such as refrigerators or lab coats hung on the controls). This will disrupt the air flow and draw contaminants out of the hood.

- In specialized cases, fume hoods will contain exhaust treatment devices, such as water wash-down for perchloric acid use, or charcoal or HEPA filters for removal of particularly toxic or radioactive materials. **Fume hoods must not be used for work with infectious agents.**



Proper Use of Chemical Fume hoods

- A fume hood should be used if a proposed chemical procedure exhibits any one of the following characteristics:
  - Airborne concentrations might approach the action level (or permissible exposure limit) (see SDS from Flammable vapors might approach one tenth of the lower explosion limit (see SDS from
  - Materials of unknown toxicity are used or generated
  - The odor produced is annoying to laboratory occupants or adjacent units.
- Procedures that can generally be carried out safely outside the fume hood include those involving the following:
  - Water-based solutions of salts, dilute acids, bases, or other reagents
  - Very low volatility liquids or solids
  - Closed systems that do not allow significant escape into the laboratory environment

General rules regarding laboratory fume hoods

Before using a fume hood:

- Measure the level of hazard declared by the material involved and use only hoods that have appropriate face velocity.
- Confirm that the fume hood is operational by testing the tell-tale (paper hanging from hood sash) periodically and air monitoring device if the hood is fitted with one.
- If there is no indicator, difficulty in visualizing, or not functioning, place a piece of paper to the sash in an area where it will not prevent the ongoing processes.
- If the fume hood is out of service, **the fume should not be used under any circumstances.**

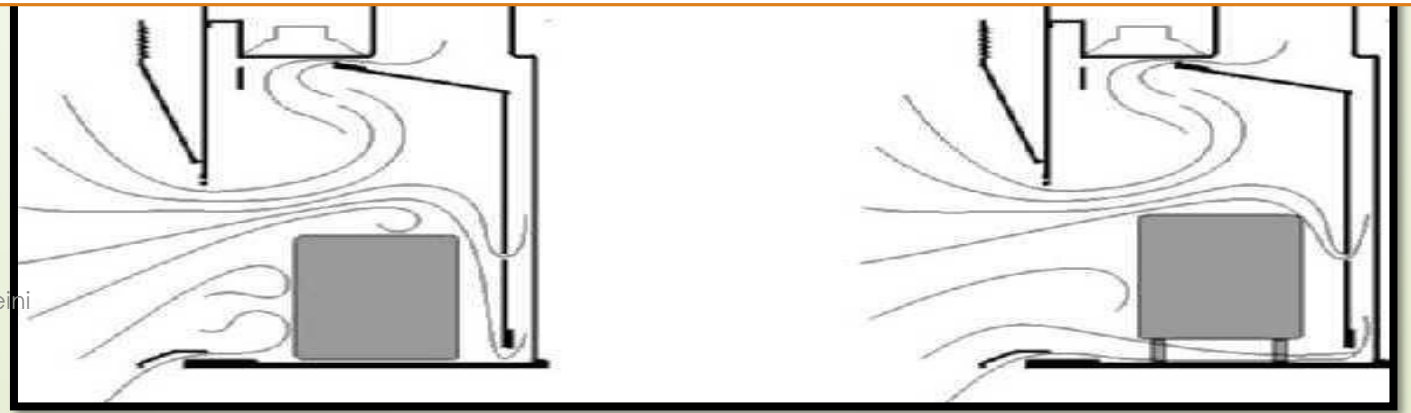
General operational rules:

- **Always work with the fume hood sash as low as possible (no higher than 50 cm).** Low hood sash working increases the performance of the hood. Low sash position is not only energy saver but also have safety shield property during experiments.
- For optimum performance of the fume hood, there should be at least **15 cm** distance between materials and face of the vents or baffle openings in the back of the hood should not blocked in any case.

General rules regarding laboratory fume hoods

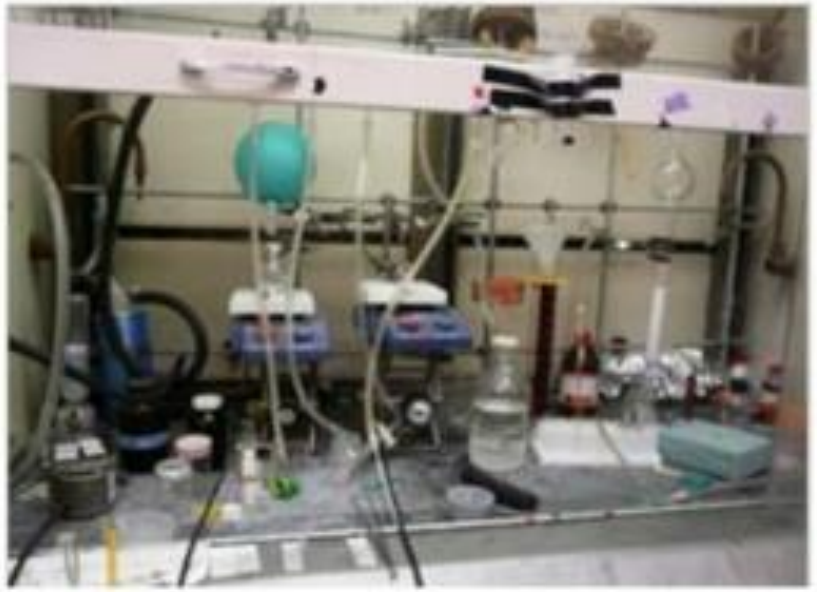
- Any lab apparatus should be raised at least 2.5 cm above the work surface of the hood to improve airflow in the hood.
- Windows and doors should be kept closed within the lab and minimize traffic in front of the hood when the hood is operational. Quick movements should also be reduced while working in the hood, including opening and closing the sash. These steps mentioned above will help to prevent air currents, which can result in hazardous vapors being leaked from the hood and into the laboratory users' working area.

Effect of large equipment placement: (L to R) poor placement, and good placement



Best Practices to Use Fume Hood

- All electronics should be connected outside of the fume hood.



- Electrical cords should not prevent the closing of the sash.

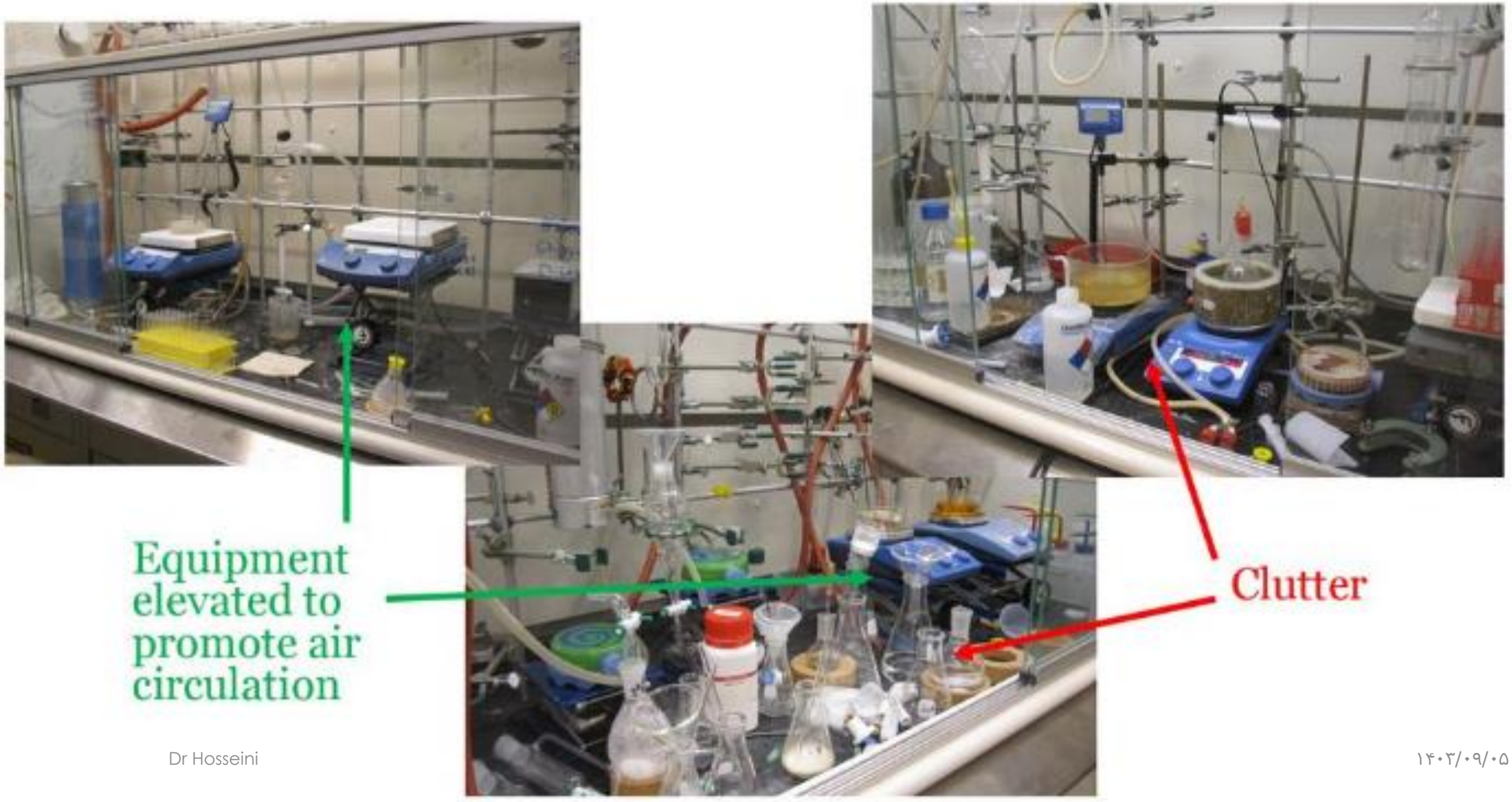
- Only use a hood for the function it was constructed for. Some materials require specific fume hoods.

The photograph was taken from a laboratory at the **University of Ottawa,** in December 2000. This was the result of a chemical reaction between two acids.

Dilute solutions of Hydrochloric Acid and Nitric Acid were discarded into a waste container for acids. Sometime during the night, the two acids reacted together, creating pressure from the gases generated.

Storage of chemicals in fume hoods is an improper storage practice

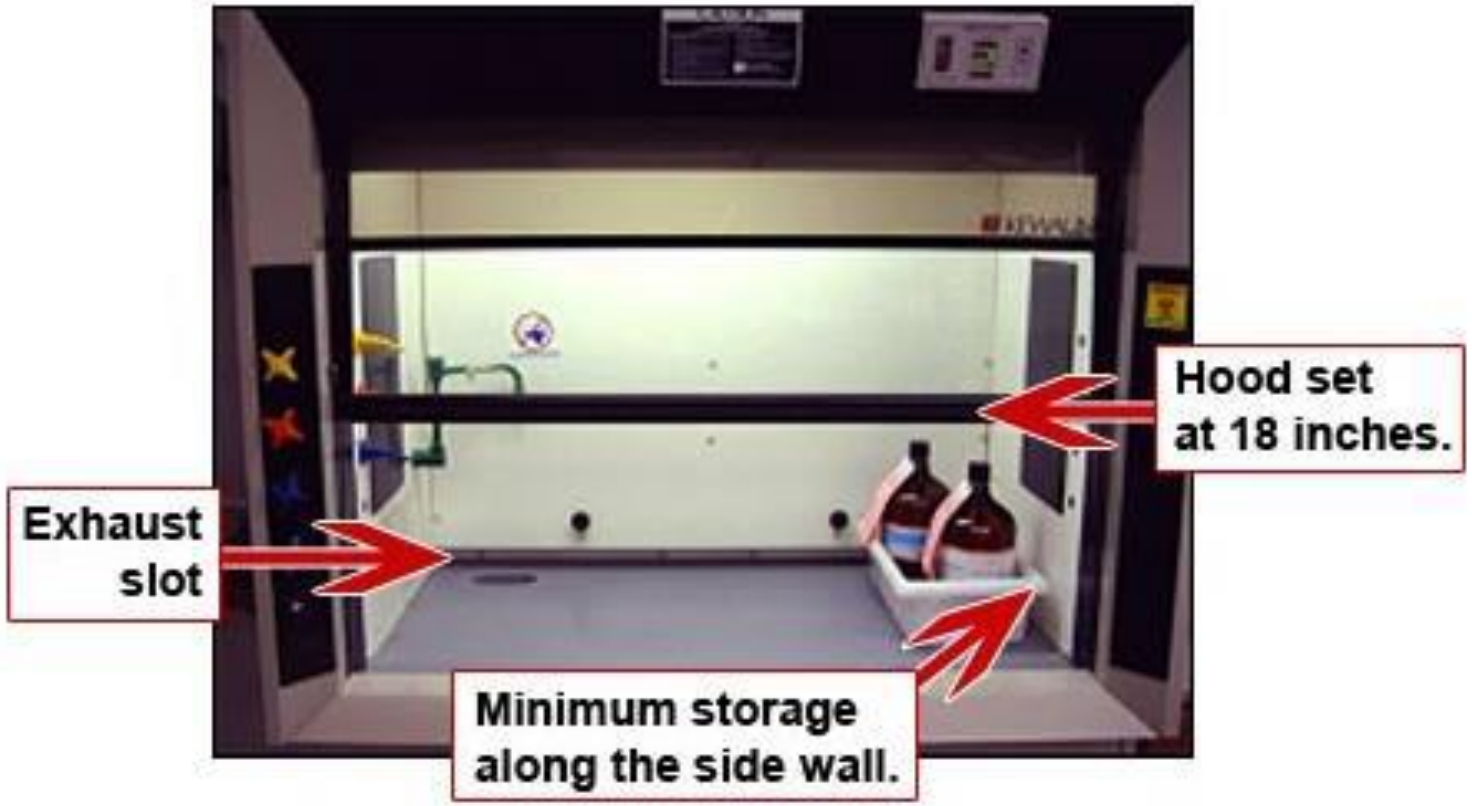
Fume Hood, Real Examples



EXAMPLE OF A FUME HOOD THAT HAS BEEN SET UP INCORRECTLY.

- There are too many chemicals stored here.
- Exhaust slots are blocked.
- Containers are stored too close (within 6 inches) of the face of the hood.
- Hood sash is set too high (above 18 inches).

EXAMPLE OF A FUME HOOD THAT IS SET UP CORRECTLY.



- In this example, the fume hood sash is set at the proper height (18 inches).
- The exhaust slot has not been blocked.
- There is only minimal chemical storage in the hood.

Ventilated Storage Cabinets

- These are cabinets which are fitted with forced ventilation. They may be free-standing with their own extract system, or may be situated beneath a fume cupboard and attached to its duct. They are designed to safely store chemicals that give off noxious fumes and smells. These fumes are sucked away by the forced ventilation.

Cabinets suitable for acid-base or solids chemicals storage (left) and cabinet suitable for combustible chemical storage (right)

Compressed gas cabinets

- Highly toxic or odorous gases should be used and stored in gas cabinets. **In the event of a leak or rupture, a gas cabinet will prevent the gas from contaminating the laboratory.**
- Gas cabinets should be connected to laboratory exhaust ventilation.

Emergency eye wash and showers

- All laboratories using **hazardous chemicals,** particularly corrosive chemicals, must have access to an eyewash and/or an emergency shower.
- Emergency eyewash and shower equipment must be **readily accessible, free of obstructions and within immediate proximity to the hazard.**
- The **lid** on the eyewash head must always be **closed** while not in use, to prevent dust particle accumulation.

1. **DO NOT -** Keep electrical equipment near eyewashes and emergency showers.
2. **DO -** Leave dust covers supplied with the eyewash in place.

نحوه استفاده از چشم‌شوی و دوش اضطراری

۱. در صورت پاشش جزئی مواد عفونی یا شیمیایی بر سطح پوست، خود را سریعاً به چشم‌شوی و دوش اضطراری برسانید.
۲. ابتدا در صورت پاشش ماده به چشم، سر را خم نموده و در مقابل کاسه چشم‌شوی قرار دهید.
۳. اهرم را فشار دهید تا آب با سرعت مناسب جاری شود.
۴. با کمک دست چشم‌ها را باز نگه دارید و در همه جهات به مدت حداقل ۱۵ دقیقه بچرخانید.
۵. سپس زیر دوش اضطراری بایستید، اهرم را به سمت پایین بکشید (یا بر روی پدال قرار بگیرید).
۶. مدت زمان شست‌وشو برای مواد بیولوژیک حداقل ۱۵ دقیقه و برای مواد شیمیایی ۲۰ دقیقه می باشد.

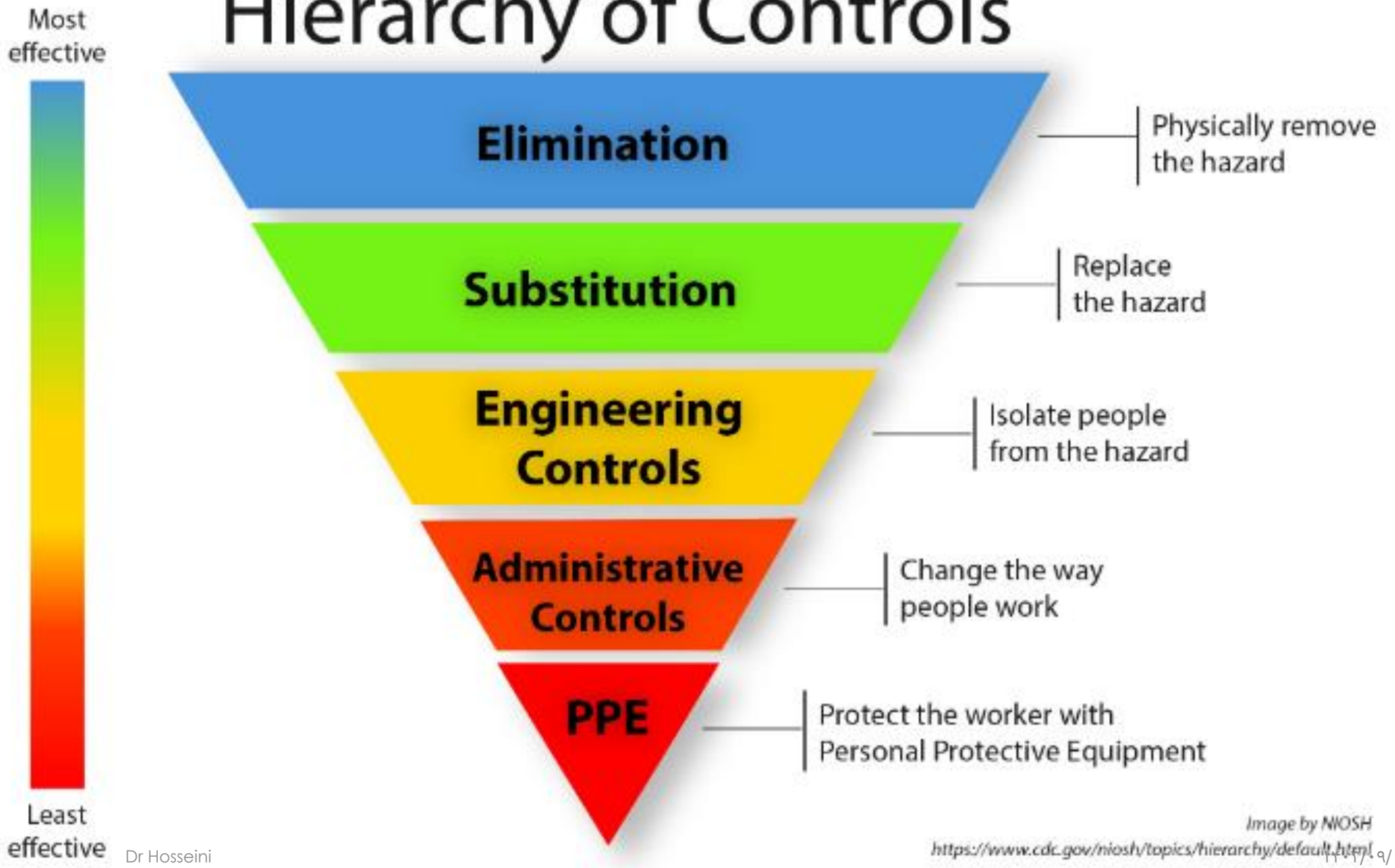
1. For small biological or chemical splashes to the skin, go immediately to emergency eyewash and shower station.
2. First, in case of splashing the substance in the eyes, bend the head and place it in front of the eyewash station.
3. Press the lever so that the water flows at the right speed.
4. Using your fingers to keep your eyes open and rotate the eyeballs in all directions for at least 15 minutes.
5. Then stand under the shower, the shower head is activated by pulling a lever or pressing a button.
6. The contact time for biological and chemical hazards are at least 15 and 20 minutes, respectively.

در صورت پاشش ماده در سطح وسیع، با رابط ایمنی دانشکده تماس گرفته شود.

Administrative controls

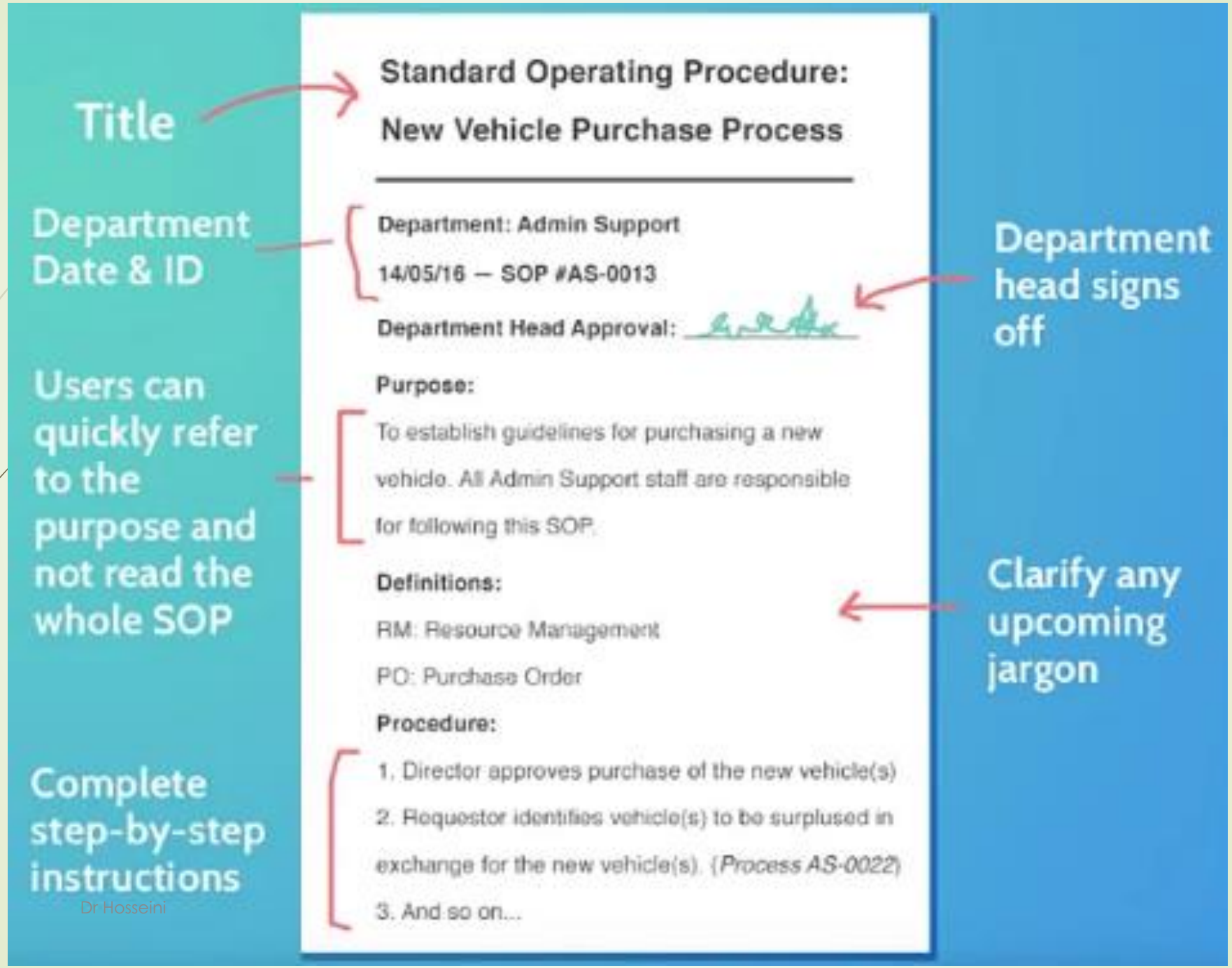
- **Administrative controls include policies and procedures that help develop a safe laboratory work practices**.
- **It sets a standard of measures within a laboratory. These measures are taken to prevent accidents and hazards** that do not involve engineering controls or PPE. All users working in the laboratories should adhere administrative regulations implemented by faculty. Along with LS, Responsible Faculty Member is in charge to make sure that lab users are aware of all possible hazards in a laboratory, including but not limited to chemical biological, physical, and electrical hazards.

Hierarchy of Controls



Standard Operating Procedures (SOPs)

- SOPs can be presented as stand-alone documents or as supplementary information to a research notebook or research proposals. SOPs ensure that a process is performed meeting required health and safety measures.
- An SOP should involve the items listed below:
  - The chemicals involved and their hazards.
  - Use of **engineering controls** (such as fume hoods).
  - Required **PPE**.
  - **Spill response** measures.
  - **Waste disposal procedures**.
  - Decontamination procedures.
  - Description of how to perform the experiment or operation.


Title
Department Date & ID
Users can quickly refer to the purpose and not read the whole SOP
Complete step-by-step instructions
Standard Operating Procedure:
New Vehicle Purchase Process
Department: Admin Support
14/05/16 — SOP #AS-0013
Department Head Approval:
Purpose:
To establish guidelines for purchasing a new vehicle. All Admin Support staff are responsible for following this SOP.
Definitions:
RM: Resource Management
PO: Purchase Order
Procedure:
1. Director approves purchase of the new vehicle(s)
2. Requestor identifies vehicle(s) to be surplused in exchange for the new vehicle(s). (Process AS-0022)
3. And so on...
Department head signs off
Clarify any upcoming jargon

SOPs

- SOPs are written instructions that detail the steps to be performed during a given experimental procedure and include information about potential hazards and how these hazards will be mitigated. SOPs should be written by laboratory personnel who are most knowledgeable and involved with the experimental process.

- **Example of laboratories SOPs:**

1. Chemical safety SOPs
2. Biological safety Sops
3. Spill response SOPs
4. New instruction SOPs
5. Waste management and Waste disposal SOPs
6. SOPs of instruments
7. Molecular Testing SOPs (DNA extraction, PCR amplification, sequencing)

Safety signs

- **All laboratories are equipped with a safety board on every entrance door indicating hazards within the laboratory, general rules and required personal protective equipment.**
- Furthermore, specific hazard and emergency area locations are indicated by individual sign boards/labels within the laboratory. All users are obliged to follow the rules and precaution measures indicated on these signs.

Good housekeeping

- **Housekeeping practices add up to general condition and appearance of a laboratory. These include:**

1. Lab users should keep all areas of the lab free of trash, unused chemical containers, clutter and extraneous equipment. When not in use, containers of chemicals should be kept closed.
2. All **chemicals spills** should be cleaned up as soon as possible. Additional splashes on the equipment, cabinets, doors, and benches around should also be checked while cleaning up the spill.
3. Areas around emergency exits, **emergency equipment** and devices should always be kept tidy. This rule also applies for **eyewash/emergency showers, electric power panels, fire extinguishers, and spill cleanup supplies.**
4. As required, there should be a minimum 1-meter of space between benches and equipment. Emergency exits should be kept clear of any obstacles such as bottles, boxes, equipment, electric cords, etc. Never store combustible materials in exits, corridors or stairways.
5. **Heavy and bulky chemicals should be stored close to floor.** The sprinkles should not be covered. There must be at least 45 cm distance between sprinkle and any item in the lab.

Good housekeeping has obvious health and safety benefits and can have a positive mental effect on laboratory users who work in a clean environment, which can lead to increased productivity.

Not this…

…but this

Eating, drinking and applying cosmetics in the lab

- To prevent exposure to hazardous chemicals through ingestion, do not eat, drink, chew gum, or apply cosmetics in areas where hazardous chemicals are used. Wash your hands thoroughly after using any chemicals or other laboratory materials, even if you were wearing gloves, and especially before eating or drinking.
- It should be noted that, although several chemicals show acute effects of exposure, effect of certain chemicals might not be seen in a long term even though exposed repeatedly (chronic exposure). Chemical exposure both by food beverages and/or cosmetics may have short term and long term effects

Working alone!

- Working alone is **prohibited** for research purposes, particularly involving hazardous chemicals and experimental procedures.
- Instances when a “buddy system” is needed includes:
  - **Toxic or otherwise hazardous chemicals** included experiments
  - Experiments involving **high-pressure** equipment
  - Experiments involving large quantities of **cryogenic** materials
  - Experiments involving work with unstable **(explosives)** materials
  - Experiments involving Class 3 or 4 **Lasers**
  - Transfer of large quantities of flammable materials, acids, bases, and other hazardous materials
  - Changing out **compressed gas** cylinders containing hazardous materials.

Working alone in any laboratory creates increased risk to the health and safety of laboratory personnel. Such risks include not having access to basic first aid and the possibility of being unable to summon emergency assistance.

Chemical purchasing

- Chemicals should be ordered in the **smallest size** possible that is necessary to carry out the experimental procedure.
- **“Might be needed in the future” is an incorrect approach to order chemicals. Lab users should only order the amount they need.**

Changes in lab occupancy

- In case of a lab occupancy change situation such as retiring of a faculty, new coming faculty member, new coming LS, graduating student or facility renovation, the occupant should inform her/his successor about potential issues and hazards.
- Failure to address the change in occupancy can result in:

1. **Old, unlabelled chemicals, samples, or hazardous waste being left behind in refrigerators, freezers, and cabinets.**
2. **Valuable furniture or equipment being moved or thrown away.**
3. **Unknown chemical spills or contamination being present.**

- These issues can result in costly remediation efforts and wasted resources for both the faculty and the university.

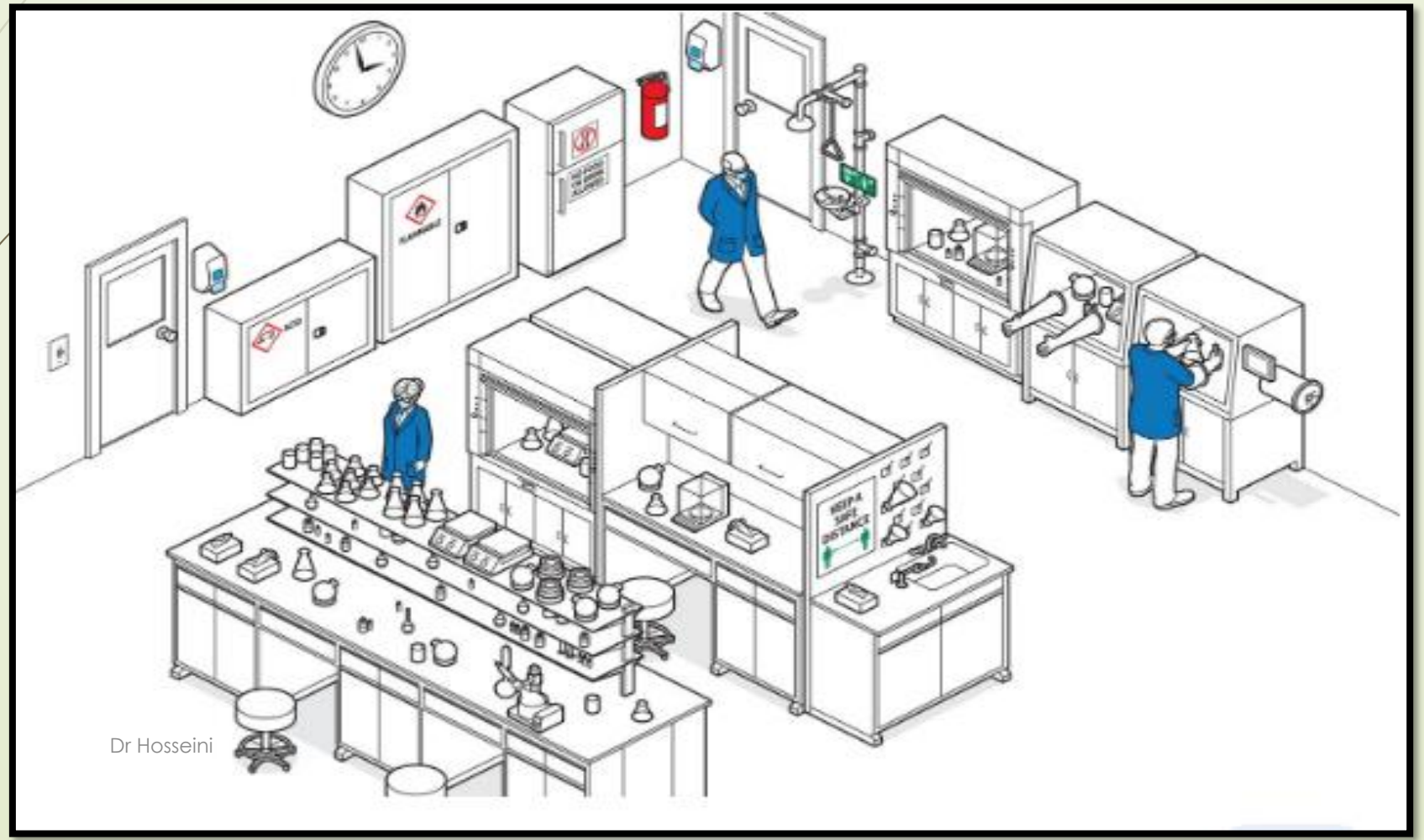
Changes in lab occupancy

If you are planning to leave your laboratory or if you know of a research group or students that are planning to leave, there are a few simple steps that can be followed to ensure a smooth transition:

1. Notify your LS and LSS well in advance of the planned move.
2. Ensure all chemical containers are properly labelled.
3. Properly dispose of any **hazardous and chemical waste** left in the laboratory.
4. Ensure all chemical spills and contamination has been cleaned up.
5. The established checkout protocol is to be strictly followed by graduate students before leaving University Facilities.

Laboratory design and construction

- The proposed equipment to be installed - fume hoods, biosafety cabinet, other capture devices, eyewash and emergency shower, toxic gas cabinet and monitoring devices, etc.



Lab equipment

- Lab equipment can have dangerous side effects if not handled properly. Something as simple as a Bunsen burner can light surrounding objects on fire, cause property damage and potentially harm your fellow lab denizens if it is handled incorrectly or carelessly.
- **List of most common instruments in laboratories:**

1. Freezer and refrigerator
2. Centrifuge
3. Microscope
4. Biological safety cabinets
5. Autoclave
6. Liquid Nitrogen containers
6. Compressed gas cylinders
7. Hot plates
8. Incubator
9. Oven

Refrigerators and Freezers

- What is the primary danger of refrigerators in the laboratory?
- The potential hazards posed by laboratory refrigerators and freezers **involve vapors from the contents, the possible presence of incompatible chemicals, and spillage. Loss of electrical power can produce extremely hazardous situations**

Refrigerators and Freezers

- Refrigerators that are used as chemical storage must be **labelled** and dedicated for specific purposes.
- Vapor release from the content in the refrigerator, cross-contamination of the chemicals and spillage poses risk to lab personnel and laboratory zone.
- The **storage of food or drinks** store in laboratory refrigerators containing reagents, samples, and any other research materials is **absolutely forbidden**.
- **Safe Handling and Operating Procedures:**

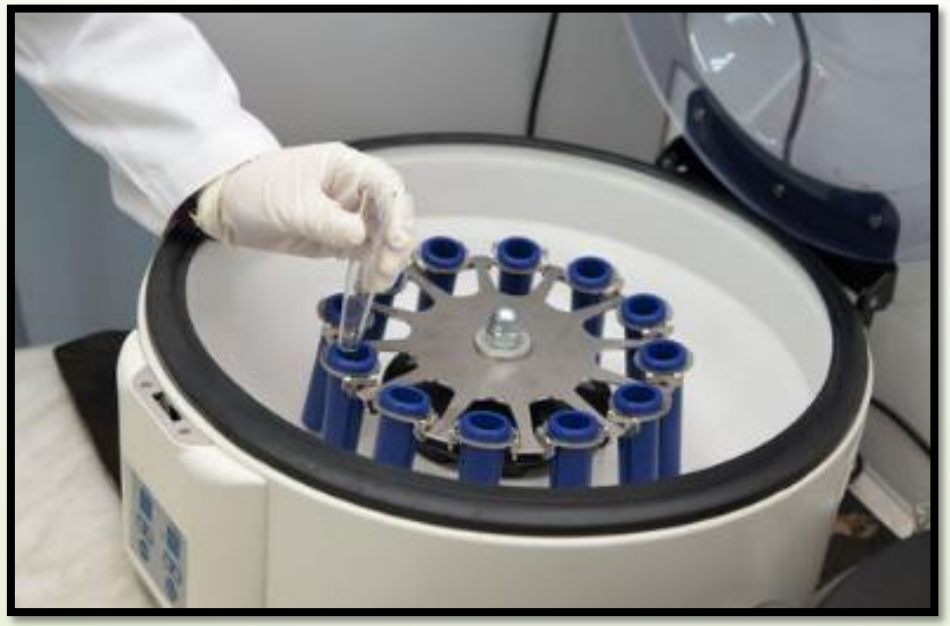
1. **Label all materials with the contents**, owner, date of acquisition, and any associated hazards. Readily identifiable coding to a reference document (laboratory notebook, posted inventory, etc.) may be used.
2. **Follow all chemical compatibility storage guidelines**
3. **All materials must be properly capped and sealed. Avoid use of foil or parafilm as a primary method for sealing the container.**

Centrifuge

- **What are the hazards?**

If used and/or maintained improperly, all centrifuges (including micro centrifuges) can present various hazards:

1. Physical hazards: Mechanical failure due to mechanical stress, metal fatigue, and corrosion of the rotor over time
2. Exposure hazards: Aerosolization of biohazardous, chemical, or radioactive materials

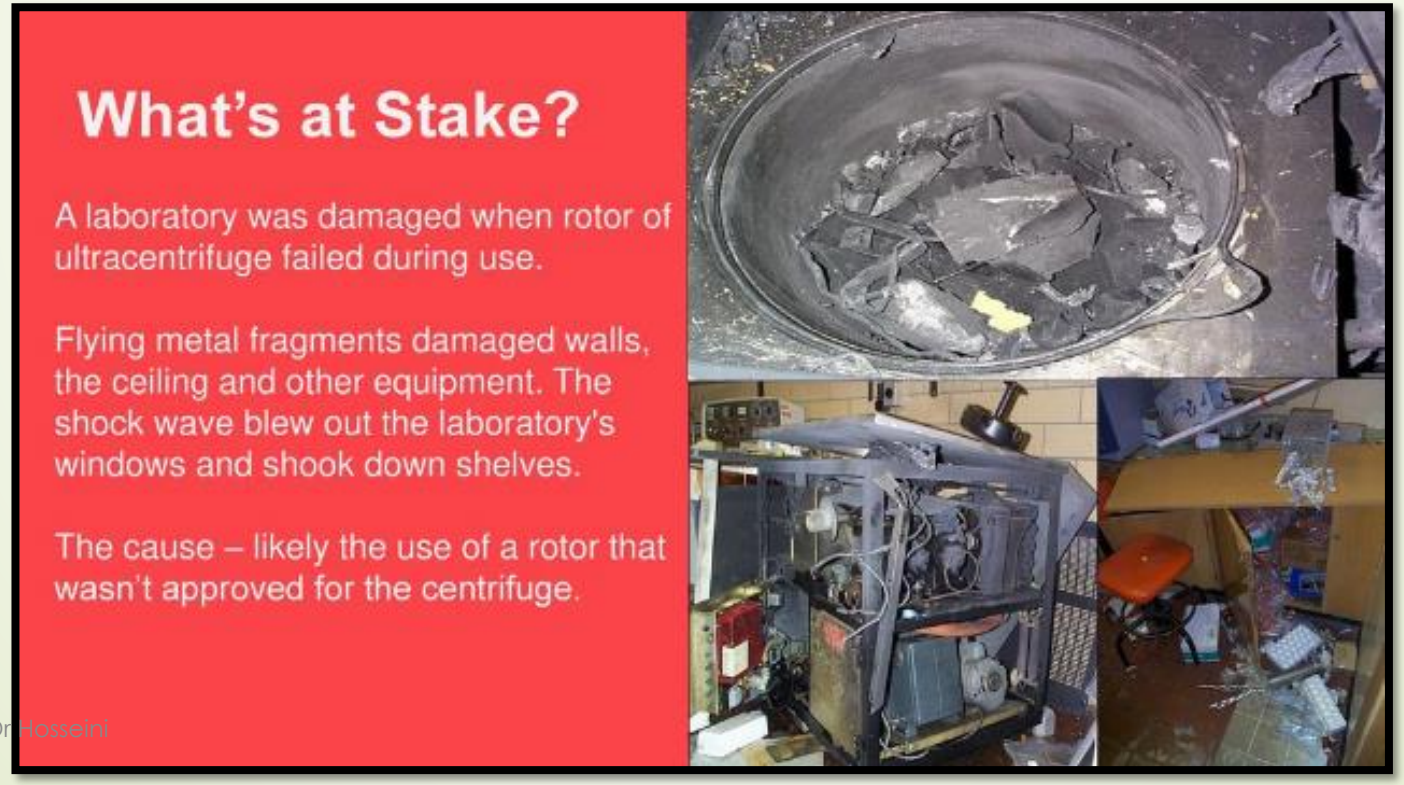


Centrifuge

1. Only trained users should operate centrifuges.
2. They must be properly installed according to manufacturer recommendations.
3. The disconnect switch must be working properly to shut off the equipment when the top is opened, and the manufacturer's instructions for safe operating speeds must be followed.
4. **The work surface must be level and firm**. Do not use the centrifuge on an uneven or slanted work surface.

Centrifuge have potentials for injury:

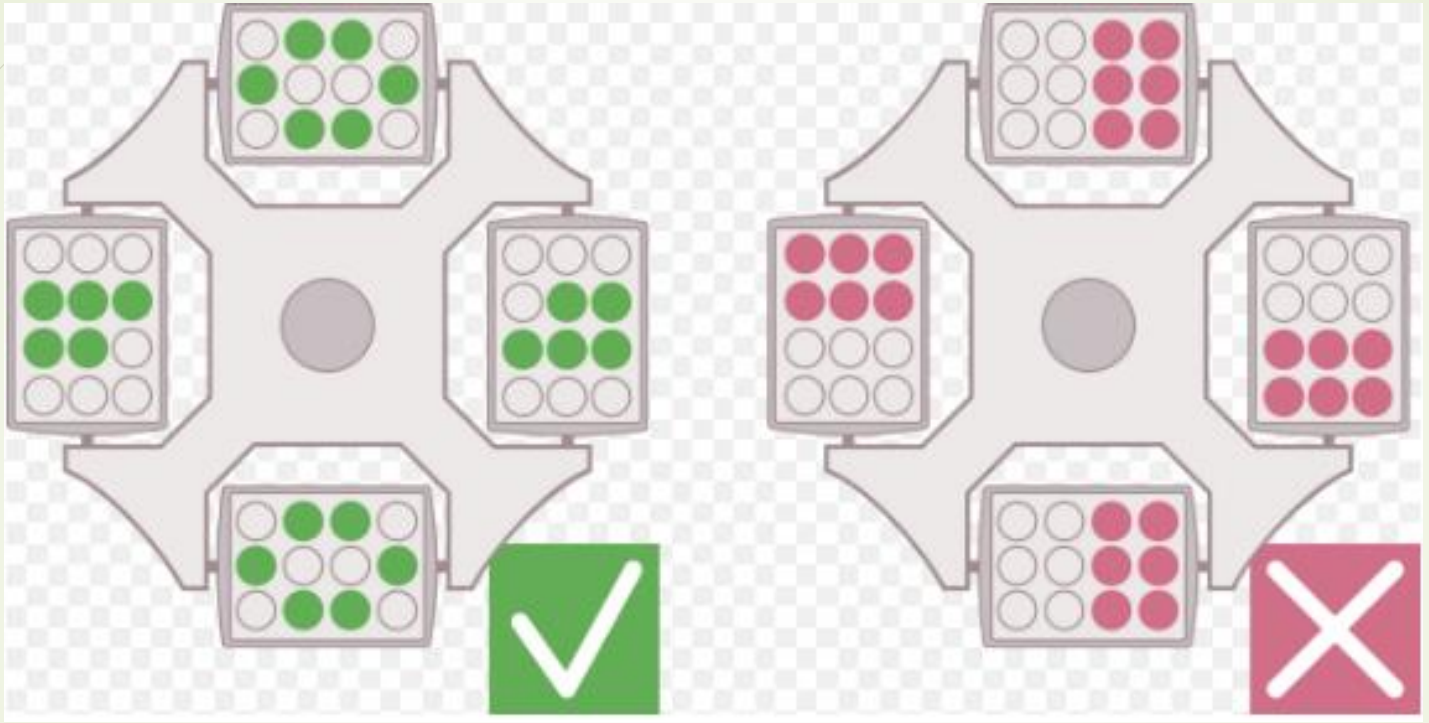
- Unbalanced rotors can result in injury or death
- Container breakage can release harmful aerosols
- Improper loading/balancing can cause rotors to break loose while spinning



Centrifuge

1. Check O-rings and grease the seals routinely with vacuum grease.
2. Do not use harsh detergents to clean the rotors, especially aluminum rotors. Use a mild detergent and rinse with deionized water, if possible.
3. Follow the manufacturer's guidelines for when to retire a rotor.
4. For flammable and/or hazardous materials, keep the centrifuge under negative pressure to a suitable exhaust system.
5. Keep a usage and maintenance log.
6. Always use the rotor specified by the manufacturer.
7. **Inspect** the components of the centrifuge each time it is used.
8. Look for signs of corrosion of the rotors. Metal fatigue will eventually cause any rotor to fail.
9. Ensure that the coating on the rotor is not damaged.
10. Check the cone area for cracks, because this area is highly stressed during rotation.
11. Look for corrosion or cracks in the tube cavity.

- It is important that load is balanced each time centrifuge is used and that the lid is closed while the rotor is in motion.



In case of centrifuge mechanical failure

- Turn off centrifuge immediately and unplug power cord.
- Do not use centrifuge again until inspected by qualified service technician.

Microscope

- The most common occupational concerns of microscope users were musculoskeletal problems of neck and back regions, eye fatigue, aggravation of ametropic, headache, stress due to long working hours and anxiety during or after microscope use.

Microscope Hazards

- Hazards Potential for electric shock if a user were to remove panels from the microscope.
- Exposure of eyes to the laser beam can cause blindness.
- Incorrect use of the UV light can lead to burns and cancers in eyes and skin.
- Damage to the lamp may cause it to burst and release toxic mercury liquid or vapor into the room. There is a risk of burns or electric shock when changing a mercury bulb.
- Glass slides could cause injury if broken
- "So microscope oculars definitely have the potential to act as carriers of infectious pathogens. The good news: cleaning with isopropanol reduces the number of germs significantly by 99%. This should be carried out regularly, particularly if different people use the same microscope.

Microscope Safety

1. Clean the microscope after each use.
2. Clean smudged lenses with lens paper. Avoid applying pressure with a cloth as the lenses are very fragile.
3. Wipe the stage (the platform that holds the slides) down thoroughly and disinfect the eyepiece with an alcohol-based wipe.
4. Handle glass slides carefully. If a slide breaks, ensure that the contents are properly disposed and report the incident in PeopleSoft if an injury occurs.
5. Turn off the light source when the microscope is not in use. This will improve lamp longevity and save energy.
6. Be aware if your microscope has a mercury lamp. A broken mercury lamp may release toxic mercury vapors.
7. When carrying the microscope, always use two hands with one hand supporting the base and the other hand holding the arm.
8. Ensure your microscope is scheduled for preventative maintenance and keep the area around the microscope clean.

Biological Safety Cabinets (BSCs)

- Biosafety cabinets are the essential engineering control for the minimization of exposure to potentially infectious materials.
- For protecting researchers and the environment from aerosolized microorganisms, BSCs consolidate directional air flow and high efficiency particulate air (HEPA) filters. To prevent the contaminants entering the laboratory, air enters the cabinet through the face (where the user sits) and the air released from the cabinet first passes through a HEPA filter, evacuating 99.97% of particles with an aerodynamic diameter of 0.3 microns; smaller or larger particles are removed with more prominent productivity. BSCs should be used for **all open manipulation of organisms requiring BSL-3 containment and activities with a BSL-2 organism having potential for splashes or aerosol generation**.

Biosafety Cabinets

Class I

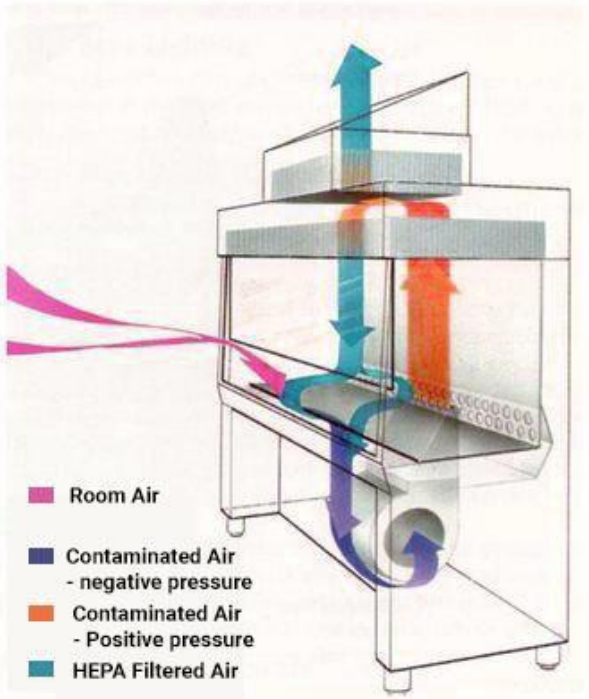
Class II

Class III

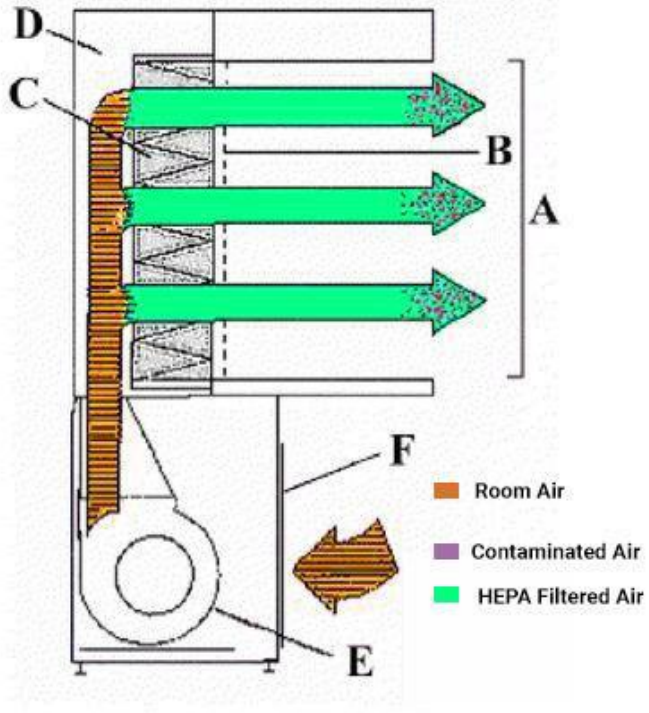
Biosafety Cabinets and Laminar Flow Hoods

- Biosafety cabinets (BSC) are intended to protect the user from hazardous aerosols and are equipped with high efficiency particulate air (HEPA) filters that frequently recirculate air back into the lab. They are not capable of capturing hazardous gases and their baffles and inner workings are not generally chemical resistant. Using a BSC with a hazardous gas could not only ruin the cabinet, but it could result in injury to the user.
- Laminar flow hoods (LFHs) are work benches that continuously bathe the work area with clean, filtered air. Their primary purpose is to **protect whatever is being worked on, or "product", not the user**. Some laminar flow hoods are also chemical benches which protect both the user and the products. These benches expel air via an exhaust ventilation system and do not recirculate it back into the lab.

BSC Vs LFC



Vs.



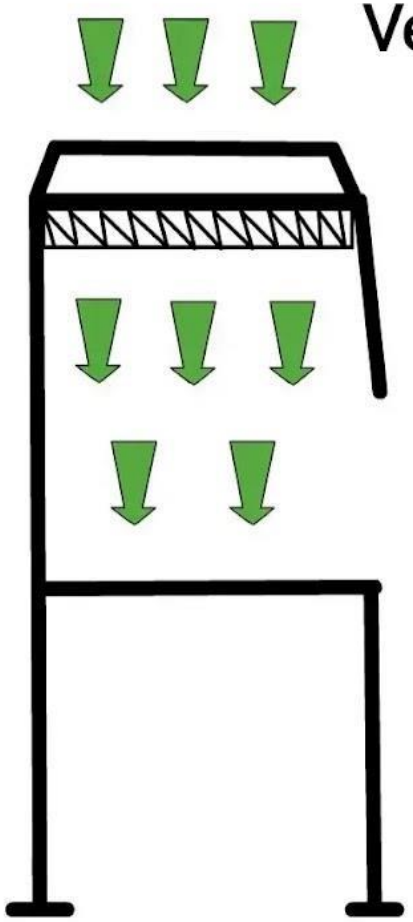
Biological Safety Cabinet

> HEPA filtered Laminar air flow and exhaust
> Personnel, Environment &often product protection

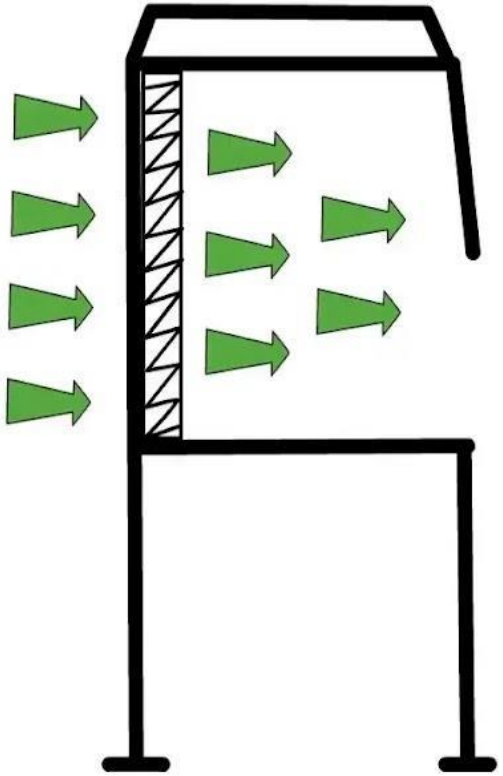
Laminar Flow Hoods

> NOT biological safety cabinets
> Vertical or horizontal laminar flow
> HEPA filtered air (intake)
> Product protection only

Vertical laminar airflow



Horizontal laminar airflow



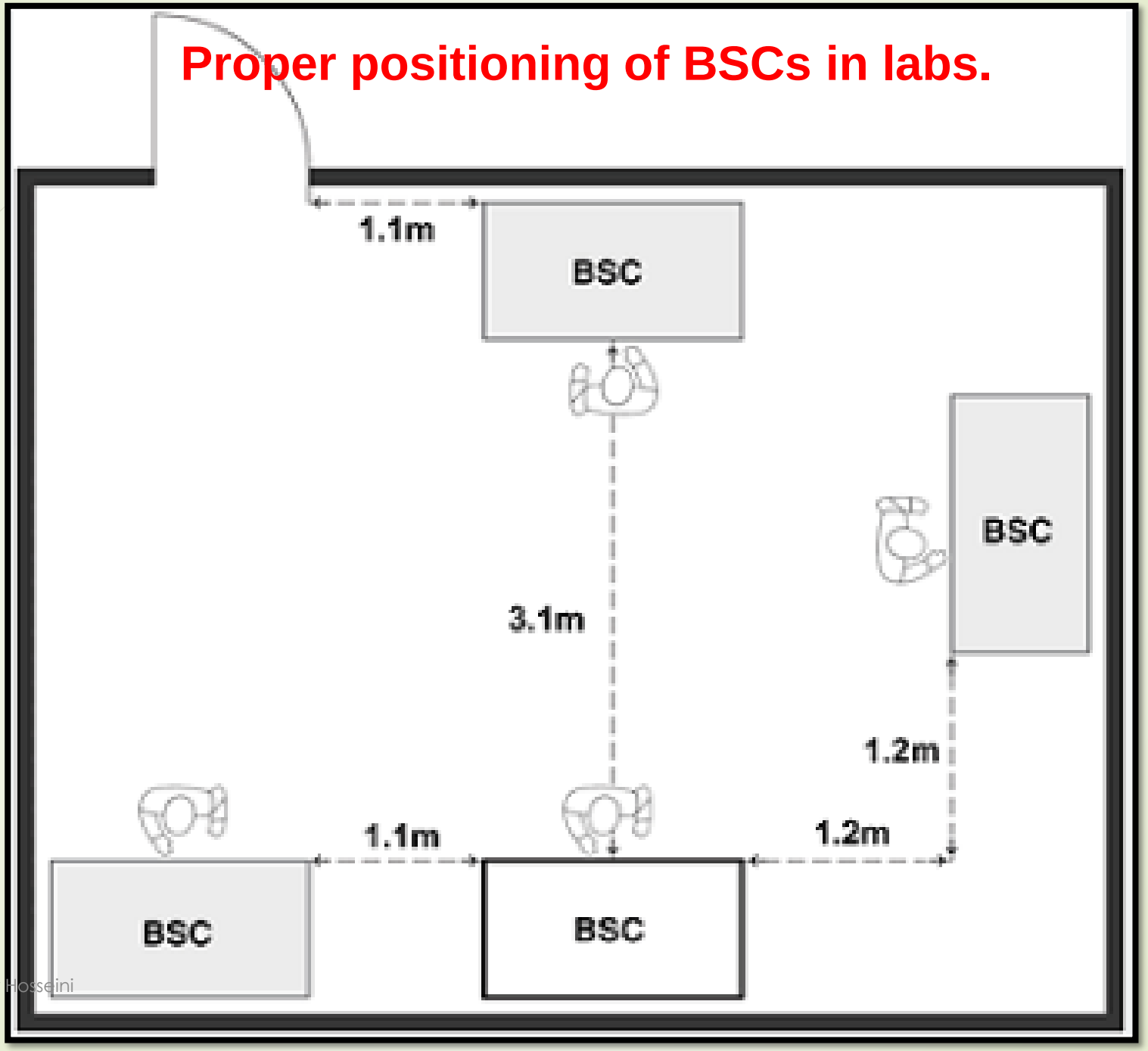
Procedures for effective use of BSCs

- Appropriate user protection and contamination prevention provided by a BSC is directly related to the activities of the operator.
- Cabinets must be certified under the following conditions:

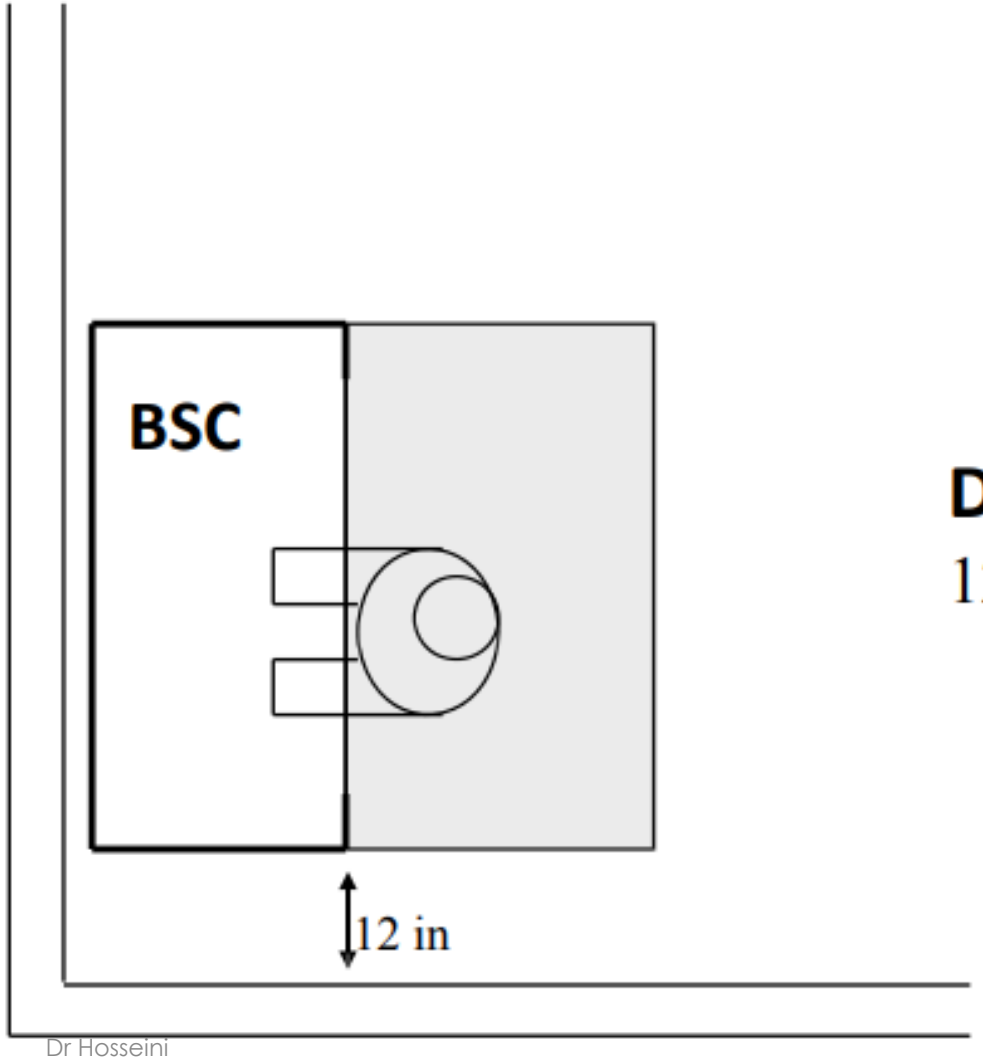
1. Annually
2. Following relocation (including within-room). BSC on castors may be moved carefully without subsequent recertification.
3. Following HEPA filter change

1. The cabinet should be located away from traffic patterns, doors, fans, ventilation registers, fume hoods and any other air-handling device that could disrupt its airflow patterns.
2. All windows in the room should be closed.

Proper positioning of BSCs in labs.

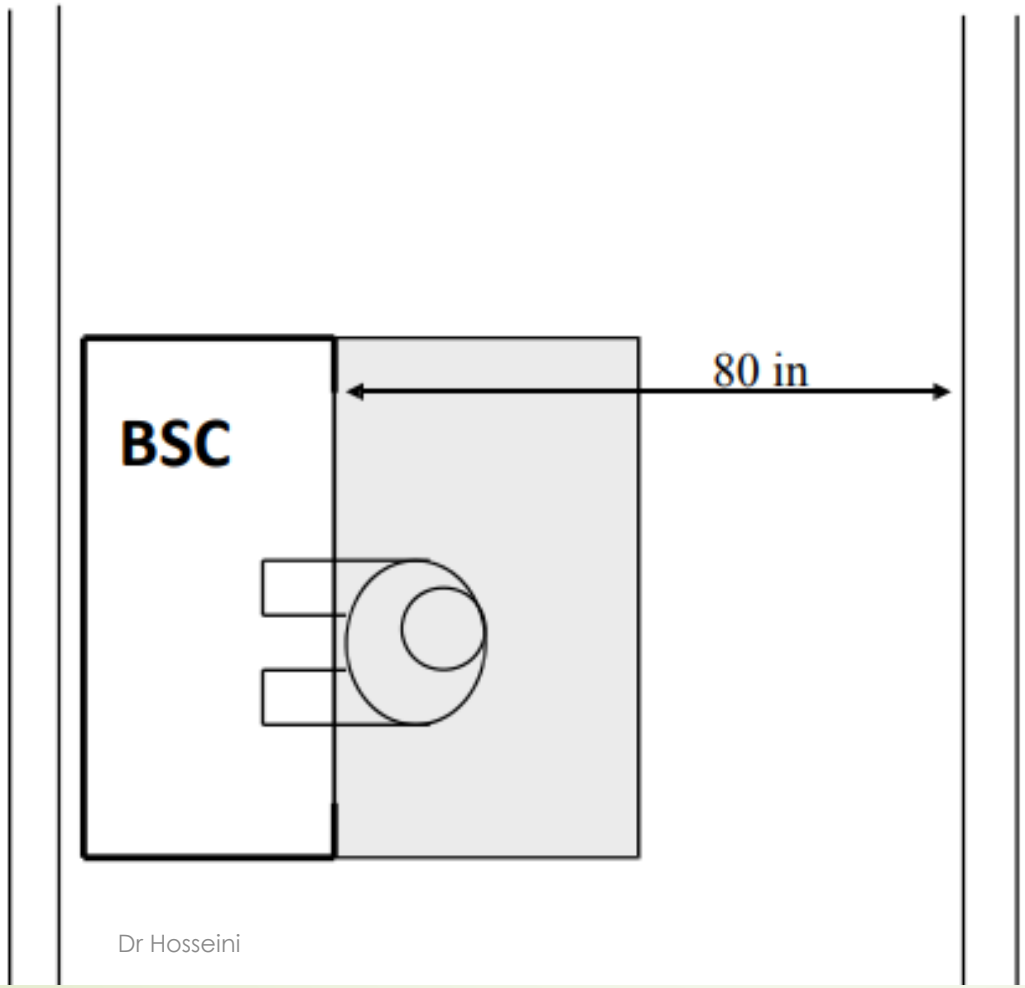


Distance to Adjacent Wall



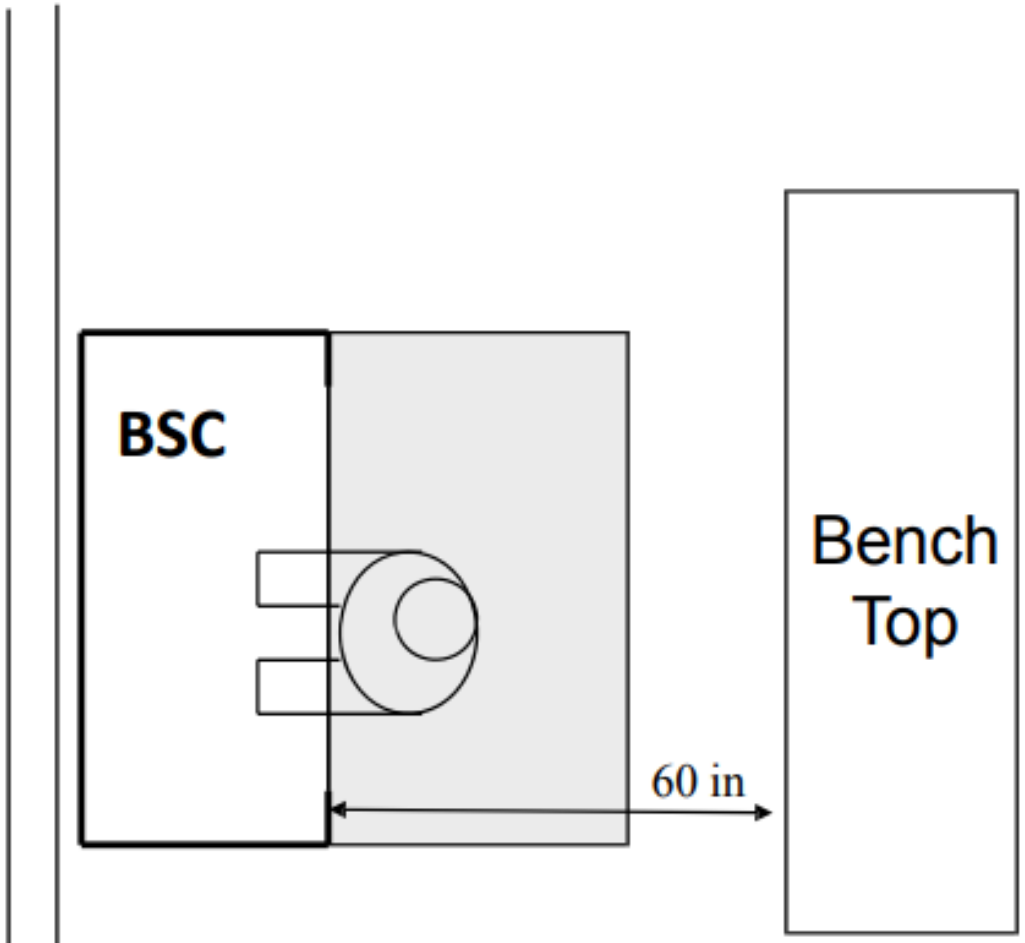
DO Maintain a distance of 12" to adjacent walls.

Distance to Opposing Walls



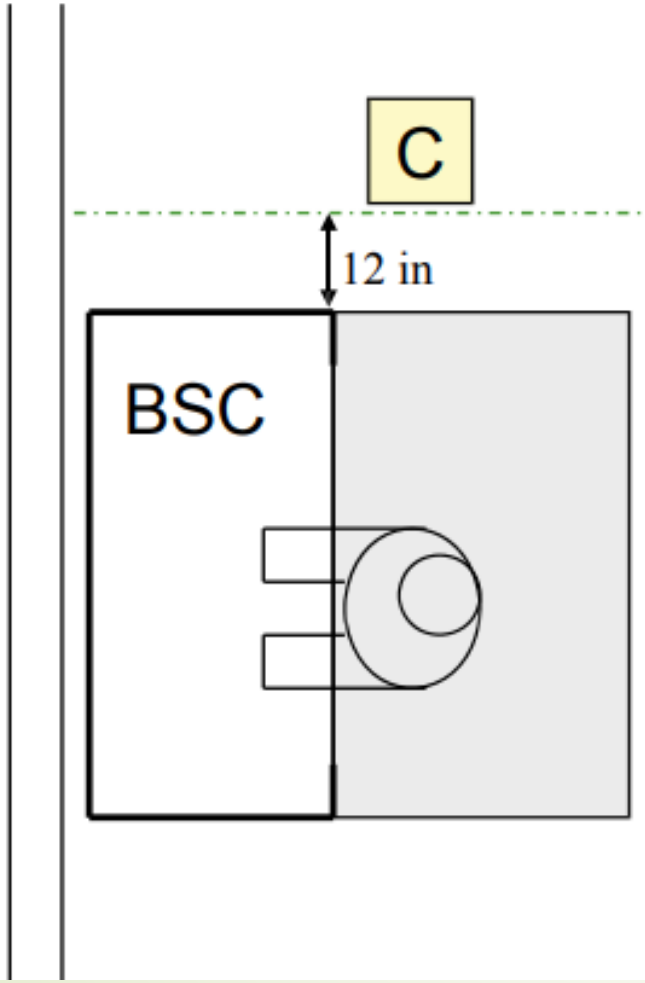
DO Place BSCs at least 80'' from opposing walls.

Distance to Bench Top

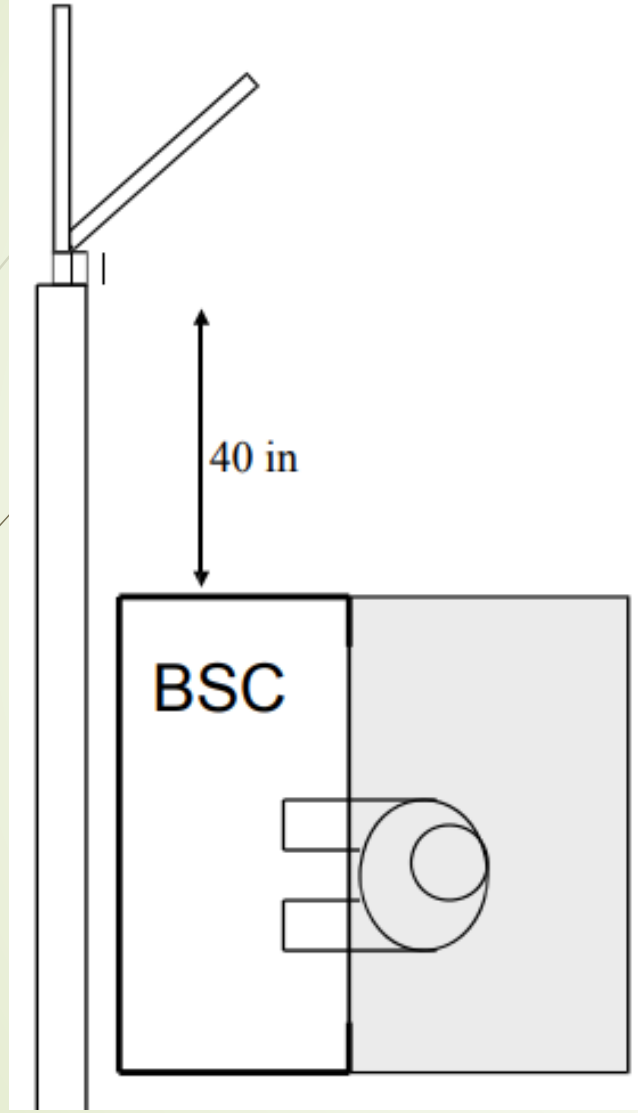


DO Place BSCs at least 60" to opposing bench tops or areas with occasional traffic.

Distance to Columns



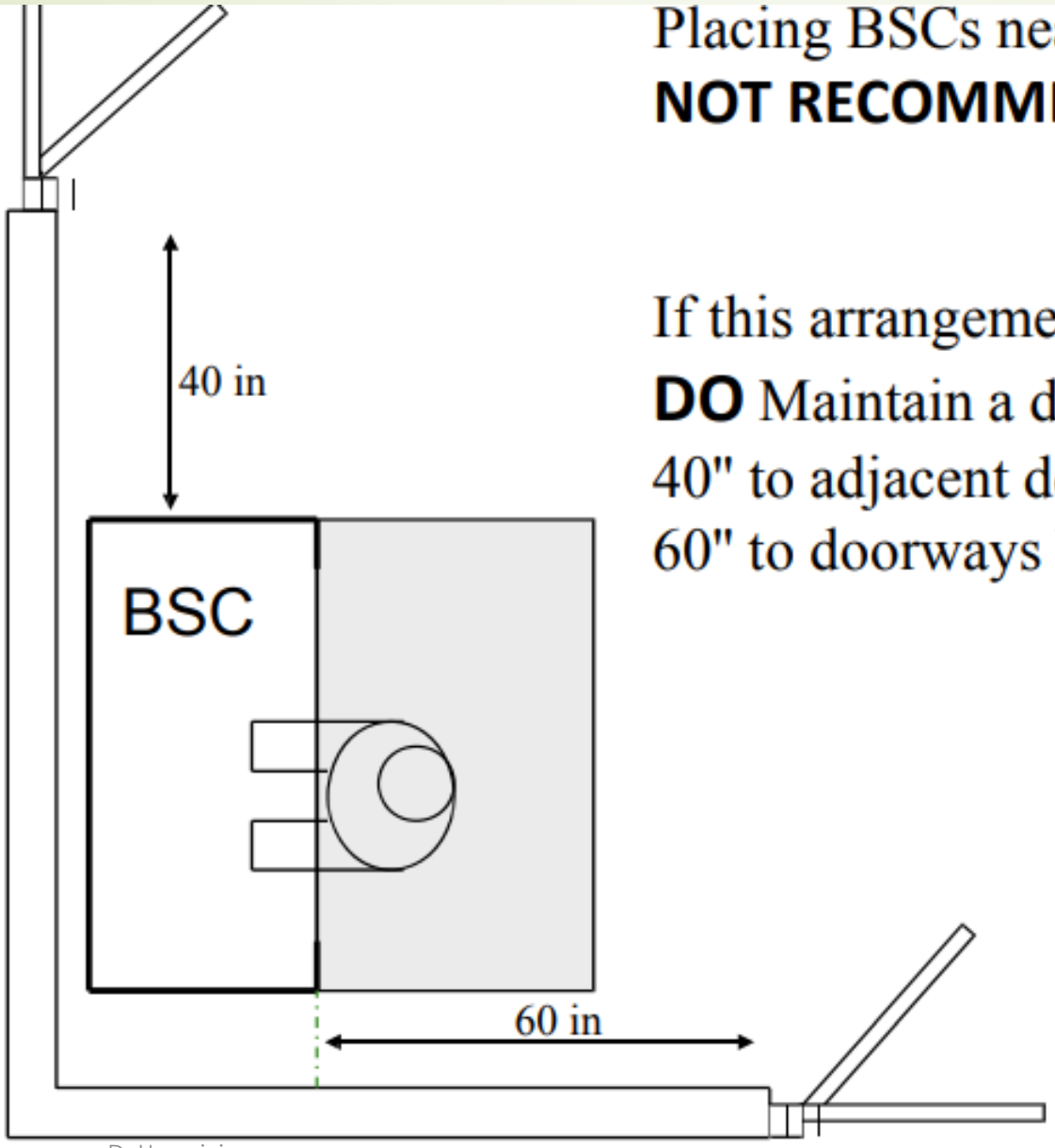
DO Maintain a distance of 12” to columns to avoid disturbance to BSC airflow.



Placing BSCs near one entryways is **NOT RECOMMENDED.**

If this arrangement is absolutely necessary:

DO Maintain a distance of 40" to adjacent doorways



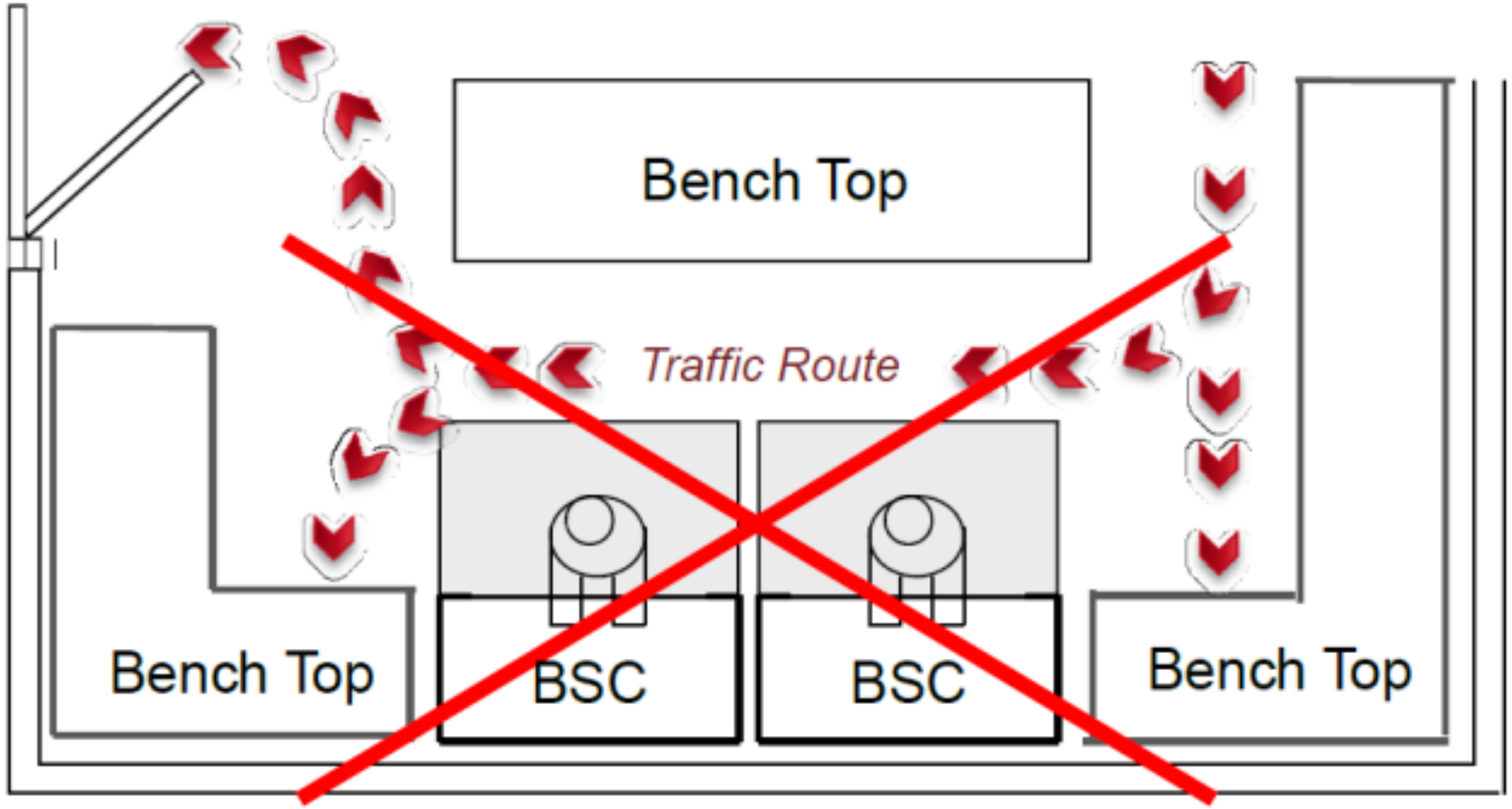
Placing BSCs near two entryways is **NOT RECOMMENDED.**

If this arrangement is absolutely necessary:

DO Maintain a distance of
40" to adjacent doorways and
60" to doorways behind workspace.

DO NOT Crowd together bench tops and BSCs.

Too much traffic produces dangerous disturbances to BSC airflow.



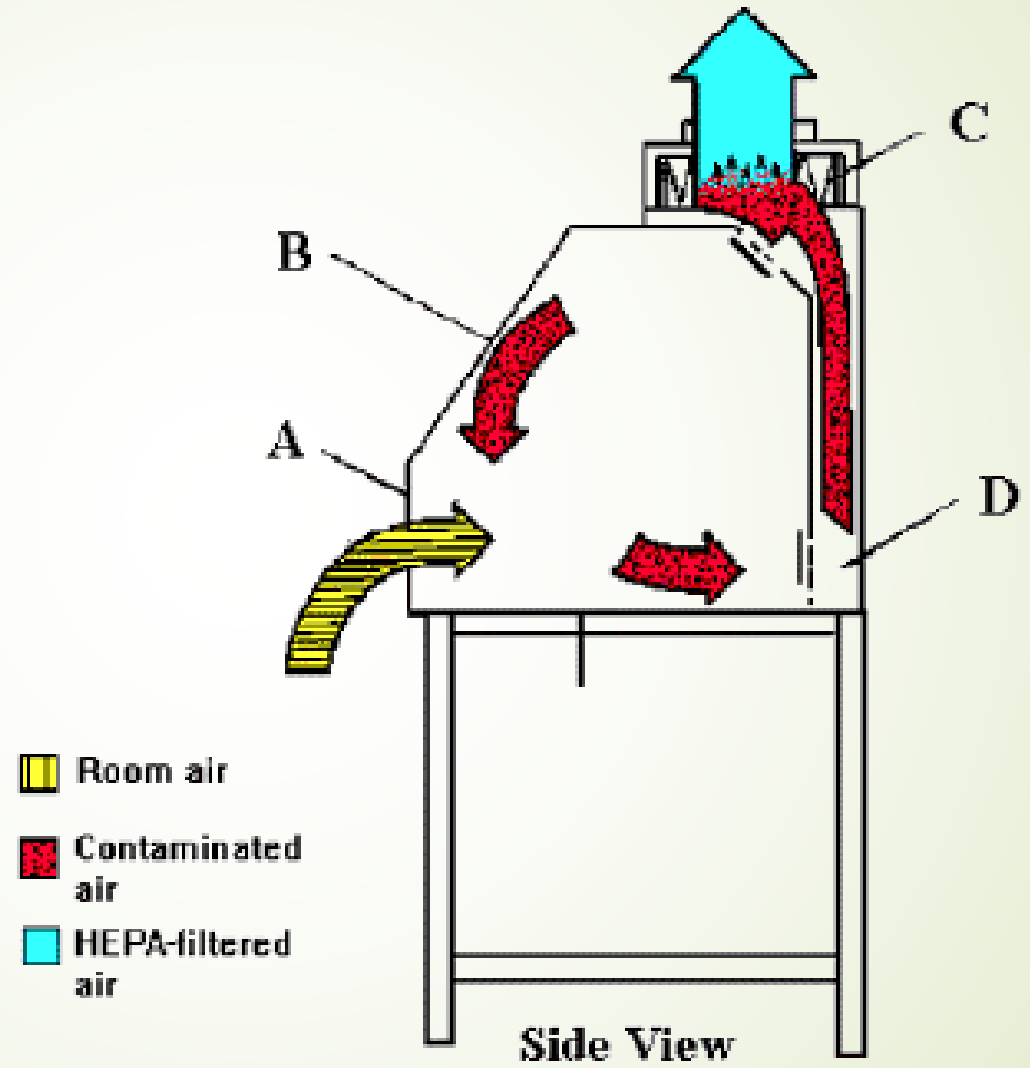
SIDE-BY-SIDE BSC CLASS COMPARISON

Classes of Biosafety Cabinets	Personnel Protection	Product Protection	Environmental Protection	Use
Class I	Yes Inward air flow through sash opening	No Unfiltered room air is drawn across work surface	Yes Exhaust air is HEPA-filtered	• Not in use today for bioagents • May be used to enclose equipment or procedures with aerosol potential
Class II A1, A2, B1, B2	Yes Inward air flow through sash opening	Yes By HEPA filtered air drawn down onto work surface & room air kept away	Yes Exhaust air is HEPA-filtered	• *Most common class of BSC used today, esp. Type A2* • Used to handle specimen material, biological toxins, cell tissue culture, biohazardous agents
Class III (Glove Box)	Yes Complete containment of interior work area	Yes HEPA filtered air is supplied to work surface; total containment keeps room air out	Yes Exhaust air is double HEPA-filtered	• Provides the highest level of containment for handling the most dangerous microorganisms

Select a Class I BSC lennosrep ylno nehw protection against particulate materials is required .

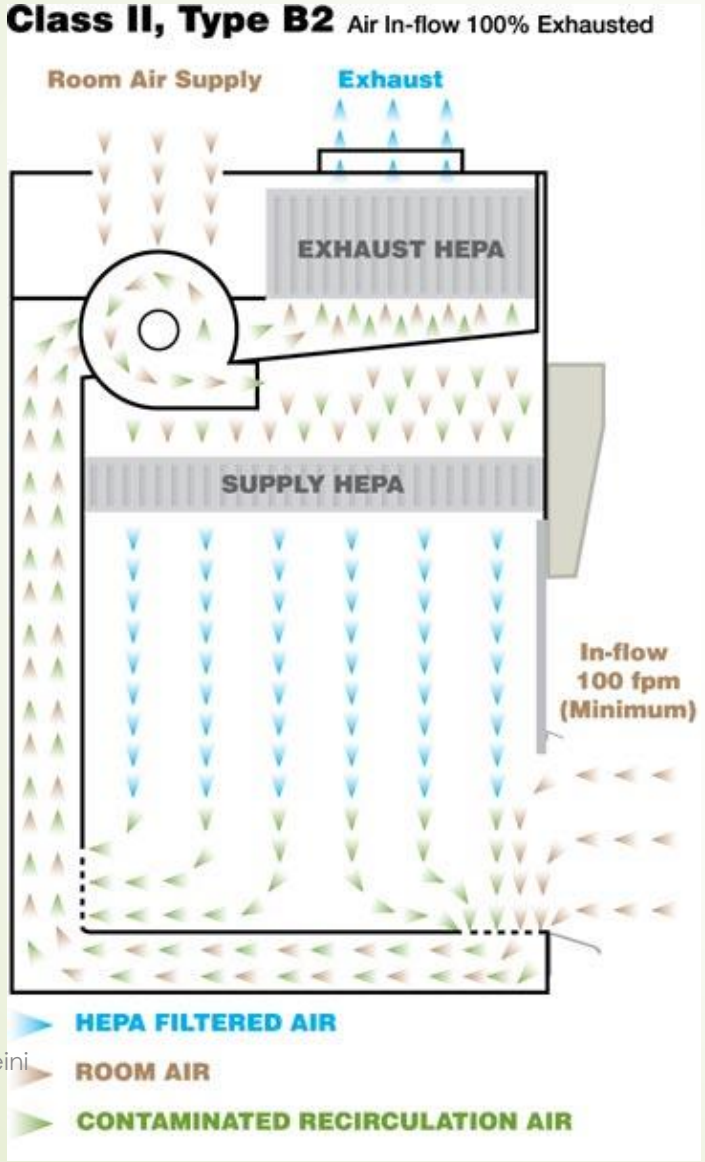
BSCs 1

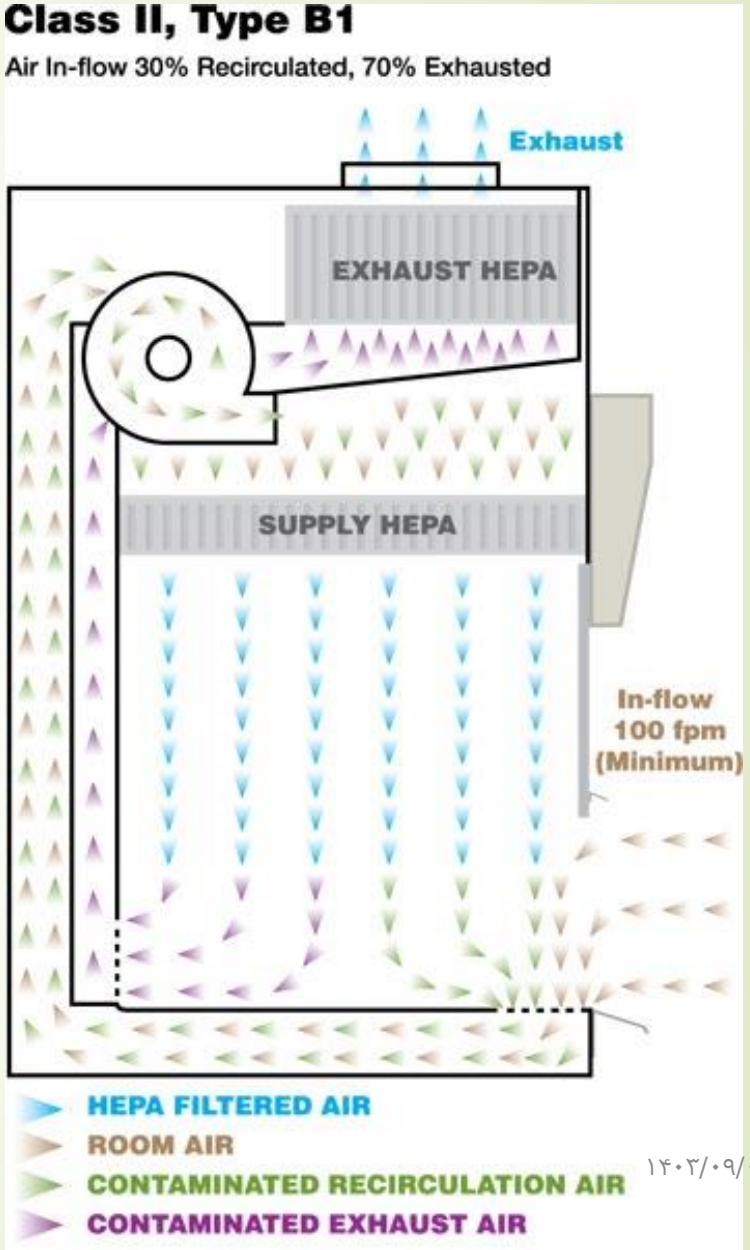
A. front opening
B. sash
C. exhaust HEPA
D. exhaust plenum



It WILL NOT protect users against exposures to gases or vapors

BSCs 2


Class II, Type B2 Air In-flow 100% Exhausted
Room Air Supply
Exhaust
EXHAUST HEPA
SUPPLY HEPA
In-flow
100 fpm
(Minimum)
HEPA FILTERED AIR
ROOM AIR
CONTAMINATED RECIRCULATION AIR

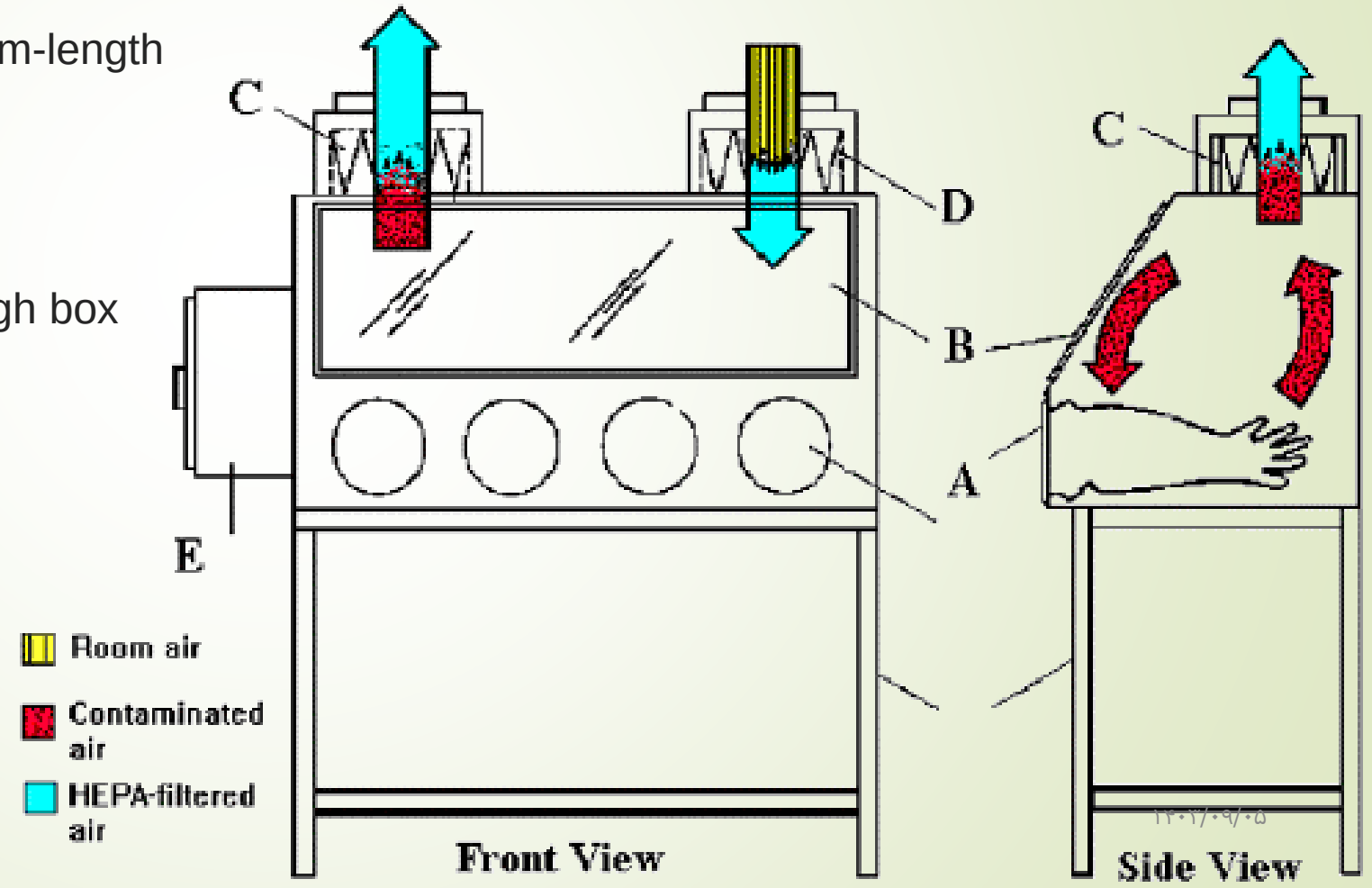

Class II, Type B1
Air In-flow 30% Recirculated, 70% Exhausted
Exhaust
EXHAUST HEPA
SUPPLY HEPA
In-flow
100 fpm
(Minimum)
HEPA FILTERED AIR
ROOM AIR
CONTAMINATED RECIRCULATION AIR
CONTAMINATED EXHAUST AIR

Select a Class III biological safety cabinet when both personnel and product protection are required, and the risk of injury to personnel is imminent with the product at hand.

BSCs 3

- **This cabinet provides the highest level of personal protection of all the BSC's.**

A. glove ports with O-ring for attaching arm-length gloves to cabinet
B. sash
C. exhaust HEPA filter
D. supply HEPA filter
E. double-ended autoclave or pass-through box



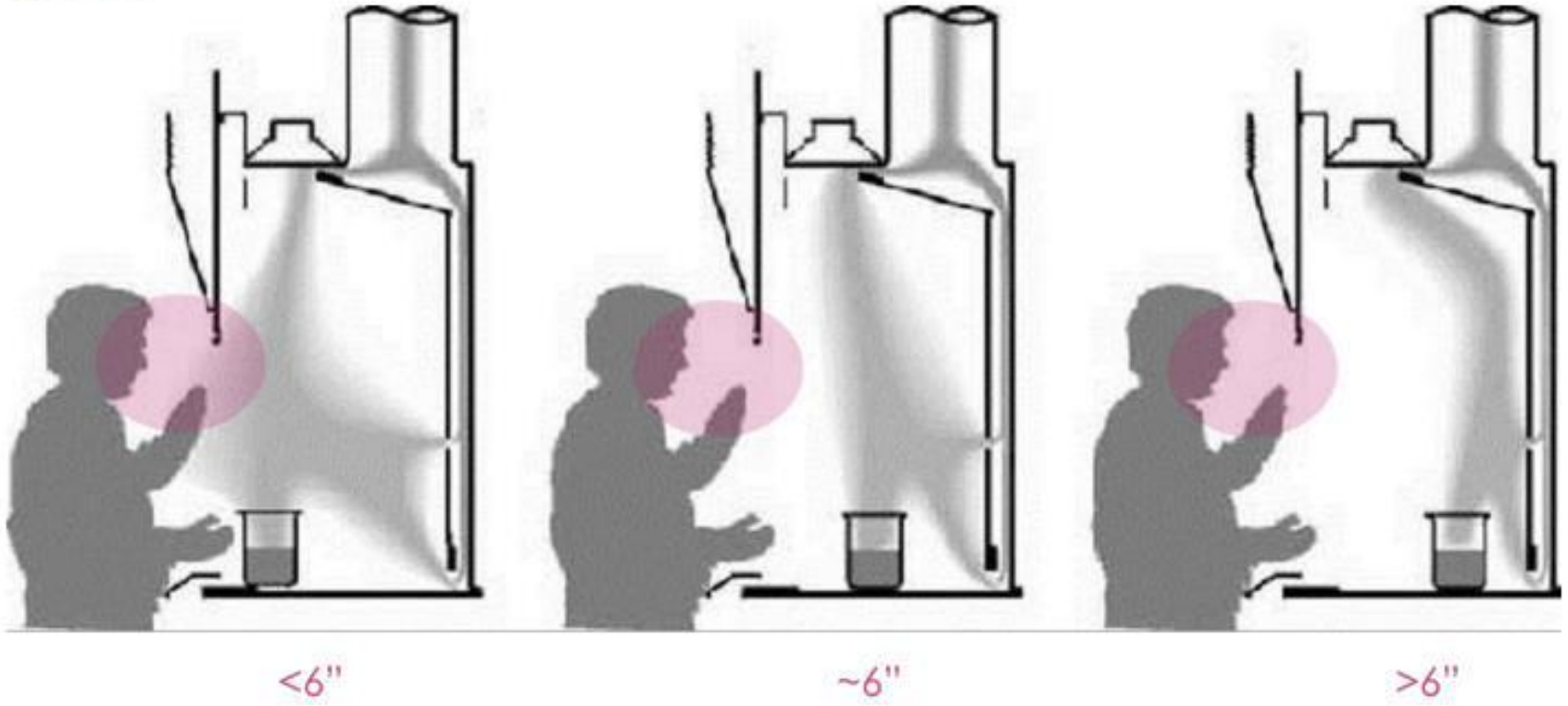
Proper Use

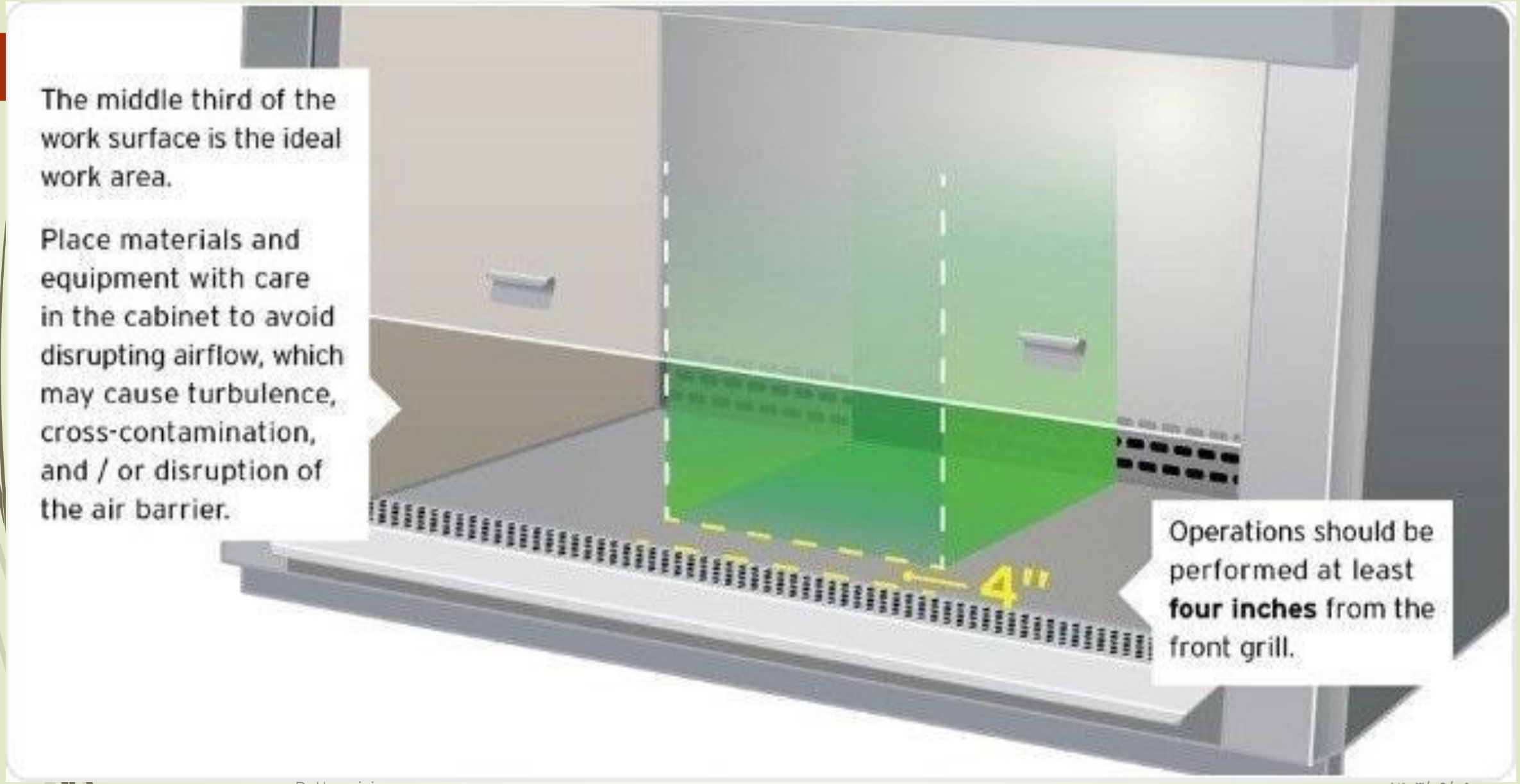
1. **There should be 10-15 cm working distance** from the front of the cabinet. Working should be done over the tray and not over the grille. Rapid arm movements that can disrupt airflow should be avoided.
2. In order to minimize arm movement in and out of the cabinet, all needed materials should be placed in BSC at the start of procedures and arranged so that 'dirty' items do not pass over 'clean' ones. Clean cultures (left) can be inoculated (center); contaminated pipettes can be discarded in the shallow pan and other contaminated materials
3. Cabinet fan should be allowed to run 5 minutes prior to and at the completion of work and the interior should be wiped with 70% ethanol before and after work.
4. Many BSCs are equipped with UV lights. UV lights should be turned off when the cabinet is in use and wiped with an alcohol-moistened cloth monthly; a covered bulb is ineffective. Bulbs must be disposed via **hazardous waste** protocol. dust
5. **Never use 70% alcohol to clean the glass of the hood because it causes the glass to become cloudy.**
6. Most BSCs have a removable work surface tray and front grille, and the space beneath it requires regular cleaning to avoid contamination problems. A schedule for regular removal of the work surface tray and disinfection of the space beneath with 10% bleach followed by 70% ethanol is recommended.

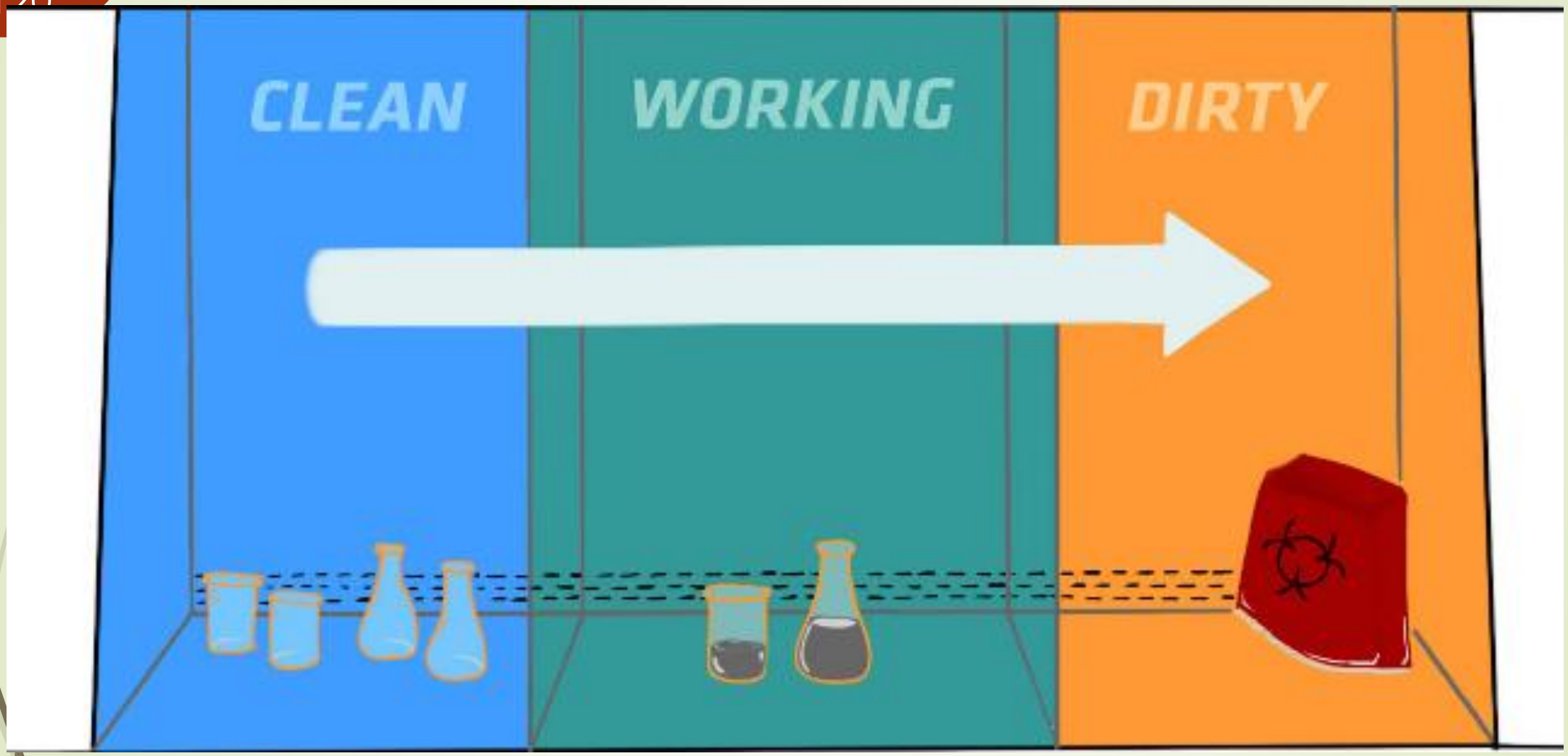
Proper Use

Work Surface

Breathing Zone




The middle third of the work surface is the ideal work area.
Place materials and equipment with care in the cabinet to avoid disrupting airflow, which may cause turbulence, cross-contamination, and / or disruption of the air barrier.
4"
Operations should be performed at least four inches from the front grill.


CLEAN
WORKING
DIRTY

Autoclave

- An autoclave is a common piece of lab equipment used to sterilize equipment and supplies, which poses several hazards to the user.

1. **Burn Hazards:** pressurized heat and steam
2. **Explosion Hazards:** failure of door to seal while in operation
3. **Heavy Lifting Hazards:** loading and unloading of autoclave

- Exposure to biohazardous material may occur if biohazardous waste is improperly packaged or manipulated.

How to prevent injuries?!

- Wearing appropriate Personal Protective Equipment (PPE) including a lab coat, heat resistant gloves, and eye protection, especially when unloading the autoclave.
- Never sealing containers; under pressure they pose an explosion risk.
- Waiting for the pressure to reach zero and the temperature is at or below 121°C before opening the door at the end of a cycle to avoid steam burns and shattered glassware. Do not stand directly in front of the door.
- Never superheating liquids. Superheating is a condition that occurs when liquids are at a temperature above their normal boiling point but do not appear to be boiling. Any disturbance of the liquid could cause some of it to violently flash to steam and spraying. In situations where personnel are in a hurry to remove flasks or bottles from the autoclave, the superheated liquids may boil out of their containers or explode.

Never autoclave the following:

- Sharps: It is not necessary to autoclave discarded sharps (used/unused needles and syringes, contaminated broken glass, microscope slides and coverslips, Pasteur pipettes, scalpel or razor blades) prior to disposal in a sharps disposal container.
- Hazardous chemicals (including items contaminated hazardous chemicals).
- **Do not autoclave flammable, reactive, corrosive, or toxic chemicals (e.g., alcohols, chloroform, acetic acid, formalin, or fixed tissues).**
- Dried bleach and bleach-associated materials, or nitrocellulose; both compounds pose a fire or explosion risk.
- Radioactive materials
- Pathological waste: Includes animal carcasses, tissues, and organs and human tissues and organs.
- Low Molecular Weight (LMW) biotoxins and prions: Some biohazards will not be inactivated by autoclaving, as the material is extremely stable.
- **DO NOT overload the autoclave**

Additional..,

- At least once a month, autoclave a biological indicator such as *Bacillus stearothermophilus* and placed at the center of a load processed under standard operating conditions to confirm adequate sterilization.
- Use only borosilicate glass (Pyrex™ or Kimax™) which can withstand the high autoclave temperatures.
- A. Bottles of liquid should not be more than 2/3 full.
- Keep 1-2 inches of space between bottles.

Liquid Nitrogen Containers

- 78% of Atmosphere
- Colorless, Odorless, Tasteless and Nontoxic
- Boils at -320 degrees Fahrenheit (-196 C)
- Non-Flammable
- Gas is slightly lighter than air

Liquid Nitrogen Hazards

1. **Extreme Cold:** The vapor of liquid nitrogen can rapidly freeze skin tissue and eye fluid, resulting in cold burns, frostbite, and permanent eye damage even by brief exposure

2. **Asphyxiation:** Liquid nitrogen expands 695 times in volume when it vaporizes and has no warning properties such as odor or color. Hence, if sufficient liquid nitrogen is vaporized so as to reduce the oxygen percentage to below 19.5%, there is a risk of oxygen deficiency which may cause unconsciousness. Death may result if oxygen deficiency is extreme. To prevent asphyxiation hazards, handlers have to make sure that the room is well ventilated when using cryogens indoors.

Liquid Nitrogen Handling

- **Liquid nitrogen should be handled in well-ventilated areas.**
- **Handle the liquid slowly to minimize boiling and splashing**. Use tongs to withdraw objects immersed in a cryogenic liquid - Boiling and splashing always occur when charging or filling a warm container with cryogenic liquid or when inserting objects into these liquids.
- **Do not transport liquid nitrogen in wide-mouthed glass.**
- Only store liquid nitrogen in containers with loose fitting lids (Never seal liquid nitrogen in a container). A tightly sealed container will build up pressure as the liquid boils and may explode after a short time.
- **Do not store liquid nitrogen for long periods in an uncovered container.**
- **Cylinders should not be filled to more than 80% of capacity, since expansion of gases during warming may cause excessive pressure buildup.**
- **Transfer of liquid into warm lines or containers must be done slowly to prevent thermal shock and possible buildup of pressure.**

Liquid Nitrogen Handling

- Liquid Nitrogen must be transported and stored in an appropriate container containing pressure relief devices.
  - If pressure builds up, the stopper could be "rocketed out" or the container could explode

Appropriate Containers

Examples of acceptable cryogenic Dewar's

- If you fill cryogenic liquids the possibility of cryogenic liquid coming in contact with the skin is reduced with the use of proper Personal Protective Equipment (PPE).

Emergencies

- If there is a large spill or rupture of a container, warn others in building
- **Evacuate!! There may be oxygen deficiency in the area of the spill!!**
- If there is injury to the body from liquid nitrogen, seek immediate medical assistance

Emergencies

- If liquid is splashed in the eyes, flush with warm water (41 C) for at least 15 minutes. Seek immediate medical attention.
- **Blindness could occur if Liquid Nitrogen is splashed into the eyes.**
- Skin contact may cause frostbite and burns. Soak affected part in tepid water and seek immediate medical attention.
- Skin contact is a medical emergency. Lack of prompt medical attention may result in amputation!!!

Compressed Gas Cylinders

- Compressed gases can be toxic, flammable, oxidizing, corrosive, inert, or some combination of these hazards. In addition to the chemical hazards, the amount of energy resulting from the compression of the gas makes a compressed gas cylinder a potential rocket.

1. **Asphyxiation:** Because inert gases are colorless and odorless, they can escape into the atmosphere undetected and quickly reduce the concentration of oxygen below the level necessary to support life.

2. **Fire and Explosion:** Fire and explosion are the primary hazards associated with flammable gases, oxygen, and other oxidizing gases. Flammable gases can be ignited by static electricity or by a heat source, such as a flame or a hot object. Oxygen and other oxidizing gases do not burn, but will support combustion of flammable materials. Increasing the concentration of an oxidizer accelerates the rate of combustion.

Compressed Gas Hazards

3. **Chemical Burns:** Corrosive gases can chemically attack various materials, including fire-resistant clothing.
4. **Chemical Poisoning:** Even in very small concentrations, brief exposure to these gases can result in serious poisoning injuries.
5. **High Pressure**: All compressed gases are potentially hazardous because of the high pressure stored inside the cylinder (even low pressure cylinders).
6. **Improper Handling of Cylinders:** Compressed gas cylinders are heavy and awkward to handle. Improper handling of cylinders could result in sprains, strains, falls, bruises, and broken bones. Other hazards such as fire, explosion, chemical burns, poisoning, and cold burns could occur if gases accidentally escape from the cylinder due to mishandling.

Gas cylinder color identification

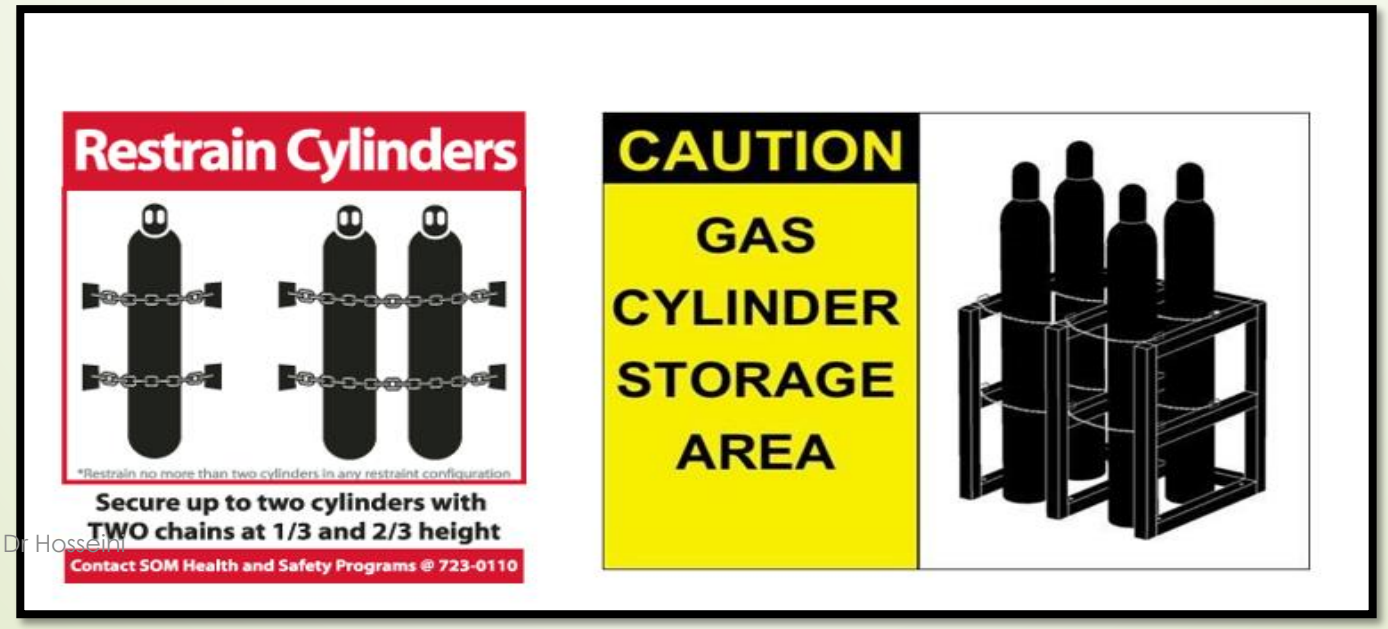
Cylinder storage precautions

1. Cylinders should not be stored near radiators or other heat sources.
2. **Gases should be used and stored only in a well-ventilated area.**
3. **Never store gases for longer than one year without use.**
4. **Protect cylinders from corrosion due to weather or chemicals.**
5. **Segregate empty cylinders from full cylinders.**

Cylinder storage precautions

Cylinders are not intended to use as rollers to move other materials or equipment.

- Secure all cylinders against to a wall, bench or fixed support via a chain or strap placed 2/3 of the way up.
- Store oxidizers and flammable gases in areas separately at least 6 m by a non-combustible wall.
- **Cylinders should not be subjected to temperatures higher than 51 °C.**
- Minimum number of cylinders should be kept in a laboratory in order to reduce the risk of fire and toxicity hazards.



Cylinders must be transported on carts. "NOT ROLLED"

All cylinders must have tags

Al least mention gas name & use status

Leaking Cylinders

- **Use a Snoop or soap solution to detect a leak. Instead of soap, a mixture of glycerin and water, such as Snoop, should be used to check the leaks at/below freezing temperature. Do not use an open flame to check the leak.**
- Leaking usually takes place at the valve attached to cylinder and may usually arise from failed valve threads, valve stem, valve outlet, or pressure relief devices. Call LS/LSS in case if there's a necessity to repair a leaking cylinder.
- Following action can be taken if there's no risk of serious exposure to lab users:
- **If leak is indoors, open all windows and doors, to disperse the gas. In the case of cylinders, disconnect the cylinder and move it outdoors to an open area. If the leak cannot be stopped or a significant leak has occurred, evacuate the area and warn others.**

Improper storage of Gas cylinders

Heating Devices and Thermal Safety

- Most labs use at least one type of heating device, such as ovens, hot plates, heating mantles and tapes, oil baths, salt baths, sand baths, air baths, hot-tube, furnaces, hot-air guns and microwave ovens.
- Steam-heated devices are generally preferred whenever temperatures of 100 ˚C or less are required because they do not present **shock or spark risks** and can be left unattended with assurance that their temperature will never exceed 100˚C.

Hot Plates

- Hot plates used in labs present many potential dangers, such as burns, fires, and electrical shock, which can cause injuries, significant disruption of lab operations, and loss of scientific data.

Hot Plate Hazards

	**Burns** • The hot plate is a source of heat when on, and for some time after it has been turned off. The temperature of the heated plate can reach 500°C and can cause severe burns.
	**Electric Shock** • Touching the hot plate with the power cords can melt through the insultation and cause electric shock.
	**Fire Hazard** • Electrical spark hazard from either the on-off switch or the bimetallic thermostat used to regulate temperature, or both, are a design flaw issue in older hotplate models. If the equipment sparks near combustible or flammable materials, fire could result. • Exercise caution when heating flammable materials. • Hot/stirrer plates have an additional risk if an operator accidentally turns on the wrong feature. • Hot plates are NOT explosion proof or intrinsically safe.

Tips for Working Safely with Hot Plates

1. **Do not store flammable or combustible materials near a hot plate.**
2. Consider periodically testing the function of the "OFF" switch on hot plates.
3. Use thermal gloves or tongs when removing items from hot plates.
4. Always check for cracks before heating on a hot plate. Do not heat cracked glassware on hot plates.
5. Do not use damaged, malfunctioning or unreliable hot plates in labs.
6. Do not allow electrical cords and temperature sensor probe wires to contact the hot plate surface when is hot.
7. **Do not use a hot plate in a cluttered fume hood. Fume hoods that contain many items can create dead-zones of air movement where explosive levels of flammable vapors can accumulate. Hot plates also need to have enough clearance to allow for heat dissipation.**
8. **Never heat hazardous items (including flammable, corrosive, and toxic materials) on hot plates outside of a chemical fume hood.**

Ovens

- Electrically heated ovens are commonly used in the laboratory to remove water or other solvents from chemical samples and to dry laboratory glassware.

What are the hazards of laboratory oven?

- Laboratory ovens and their components can pose risks such as fire, explosion, and burn hazards. Exercising proper safety practices can minimize injuries and accidents.

Safety tips

- **Do not use ovens to dry any chemical sample that might pose a hazard because of acute or chronic toxicity** unless special precautions have been taken to ensure continuous venting of the atmosphere inside the oven.
- To avoid explosion, rinse glassware with distilled water after rinsing with organic solvents before drying it in an oven.
- **Do not dry glassware containing organic compounds in an unvented oven.**

Incubator

- While incubators are not in in themselves particularly high-risk items of laboratory equipment, **there may be hazards associated with electricity** (which is why they must be included in periodic electrical safety checks), and **gas leaks may be associated with CO_2 incubators**.

Standard operating procedure of incubator

Proper Equipment Location

Ensure the equipment is away from flammable materials and has adequate air ventilation.

Do not lift using the door or door handle during installation.

Correct Power Source

Know the equipment's power requirement. It must have unobstructed access to the power source.

Regular Maintenance

Schedule unit calibration/ validation regularly to check any abnormalities or malfunction, including the accuracy of the temperature read-out.

Standard operating procedure of incubator

Proper Cleaning

Do not pour water directly into the chamber. Avoid using chlorine-based detergents/disinfectants.

Remove any chemical spills and residues immediately.

Tips Before Operation

Determine the right temperature and length of time for a certain application.

For lab oven, preheat the chamber prior to use.

Hazard Assessment and PPE

Lab personnel should wear a complete PPE and must be familiar with the proper operation.

Have a pair of hot gloves near the oven for protection from hot surfaces.

Working with glass rods or tubing

Hazard description

1. **Injuries to the hand are the most frequent occurrence** when handling glassware in the lab.
2. Injuries can range from minor, such as cuts, to more serious injuries, such as puncture wounds.

Glass Types

1. There are three primary glass types found in laboratories: soda lime (soft), borosilicate (hard) and pure fused quartz (99% silica).
2. **Pyrex™ is a brand of hard glass.**
3. **Soft, hard and quartz glass have working temperatures of up to 110, 230, and 1000°C, respectively.**

Heating and Cooling Glassware

- **Here are some tips for safe glass heating to follow in the lab:**

1. **Remove the risk of thermal shock:** Using a hotplate also helps to ensure effective heat distribution. It is important to ensure the top plate is larger than the base of the vessel being heated. This will enable even heat distribution of heat through the base of the glassware, reducing the possibility of glass breaking due to hotspots. Always warm up the glassware to ambient temperature before placing it on the hotplate, as cold containers can be subject to thermal shock.

2. **Avoid hotspots by distributing heat evenly:** Concentrated or direct heat on one part of the glass can cause hotspots to occur and should be avoided as different rates of heating can result in stress that weakens the glass and causes breakages.

Heating and Cooling Glassware

4. Never heat etched, cracked, nicked or chipped glassware.
5. Pay extra attention while taking glassware out of low-temperature freezers (-70 to -150 ˚C) to prevent cracking and/or thermal shock. As a safe method, put the glassware under cold running water until thawing takes place. Do not transfer from the freezer directly into warm water baths.

For over 90 years PYREX glass has provided researchers with high quality, corrosion and thermally resistant laboratory glassware.

Disposal and spill clean-up

- **Glass is fragile and breaks easily. Care should be taken to reduce the risks of health when a glass breaks.**

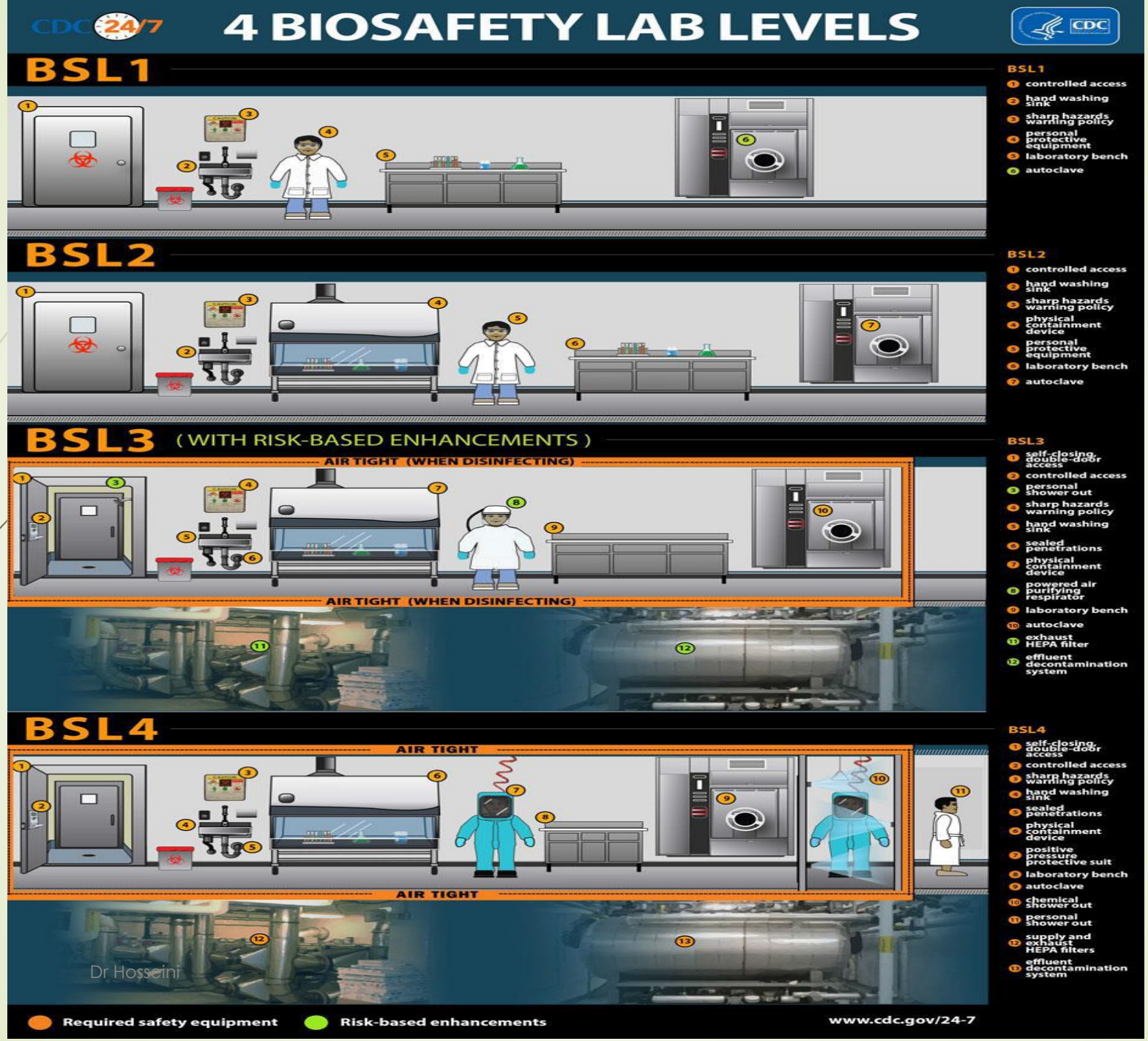
1. **If something is falling, let it drop!** Trying to catch it may result in glassware to be **broken in your hand**.
2. While handling broken glass, **wear cut-resistant gloves** whenever possible. Disposal nitrile or latex gloves should never be worn. Glass will cut through those gloves.

Biological & Chemical Safety

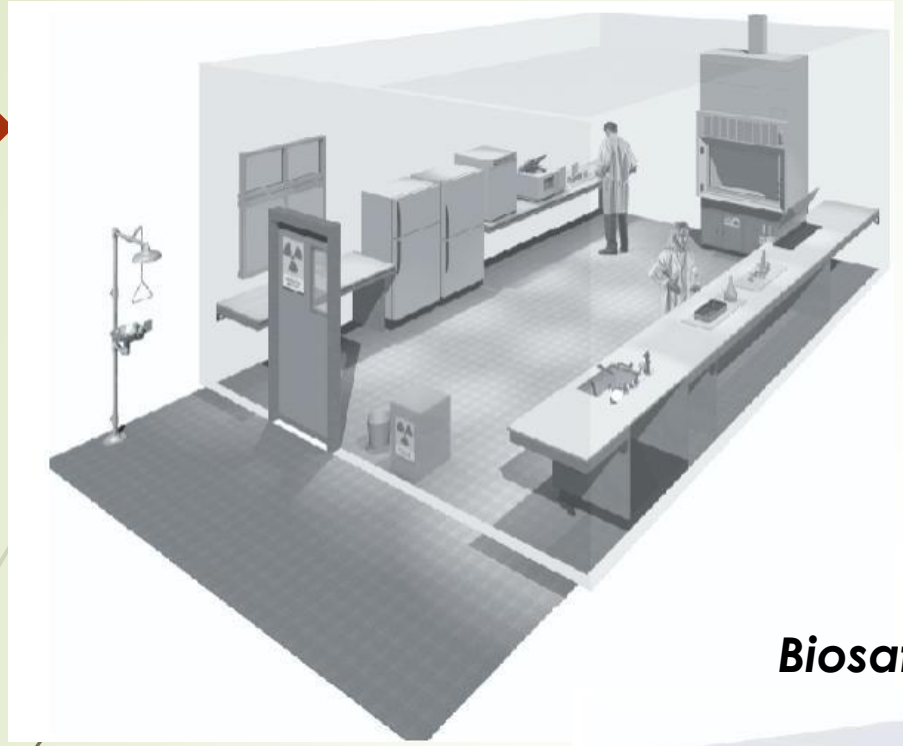
Biological safety

Biological safety levels

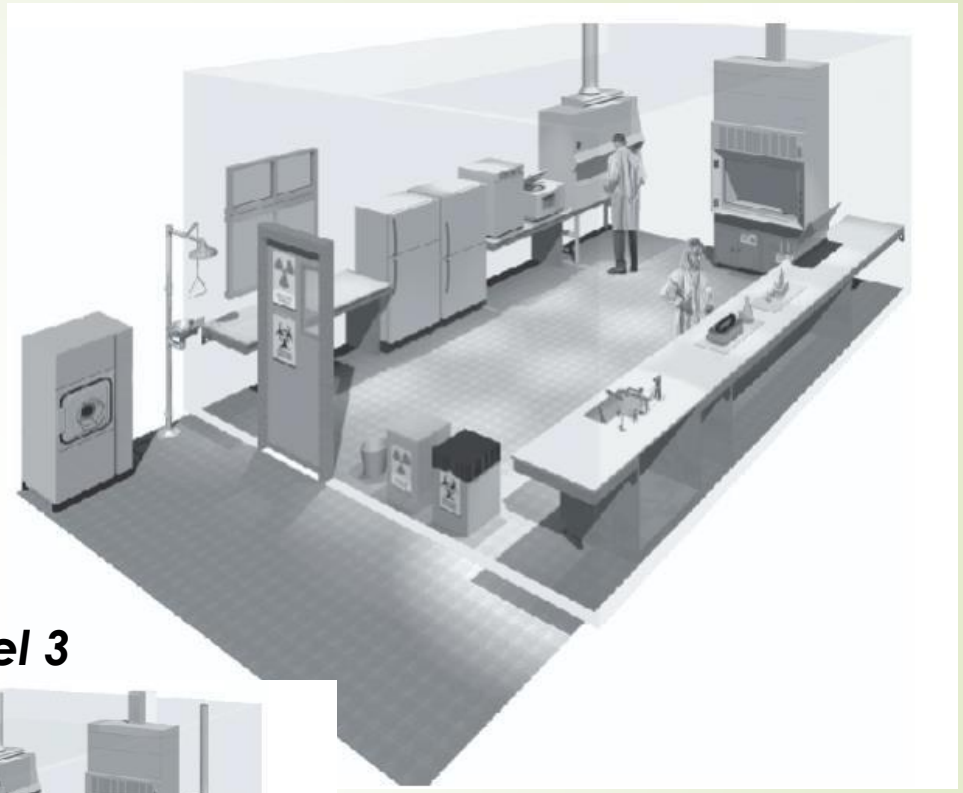
- A biosafety level is the level of the biocontainment precautions required to isolate dangerous biological agents in an enclosed facility.
- The levels of containment range from the lowest biosafety level 1 to the highest at level 4.
- The purpose of containment is to reduce or eliminate exposure of laboratory users, other people, and the outside environment to potentially hazardous agents.


CDC 24/7
4 BIOSAFETY LAB LEVELS
CDC
BSL1
BSL1
1 controlled access
2 hand washing sink
3 sharp hazards warning policy
4 personal protective equipment
5 laboratory bench
6 autoclave
BSL2
BSL2
1 controlled access
2 hand washing sink
3 sharp hazards warning policy
4 physical containment device
5 personal protective equipment
6 laboratory bench
7 autoclave
BSL3 (WITH RISK-BASED ENHANCEMENTS)
AIR TIGHT (WHEN DISINFECTING)
AIR TIGHT (WHEN DISINFECTING)
BSL3
1 self-closing, double-door access
2 controlled access
3 personal shower out
4 sharp hazards warning policy
5 hand washing sink
6 sealed penetrations
7 physical containment device
8 powered air purifying respirator
9 laboratory bench
10 autoclave
11 exhaust HEPA filter
12 effluent decontamination system
BSL4
AIR TIGHT
AIR TIGHT
BSL4
1 self-closing, double-door access
2 controlled access
3 sharp hazards warning policy
4 hand washing sink
5 sealed penetrations
6 physical containment device
7 positive pressure protective suit
8 laboratory bench
9 autoclave
10 chemical shower out
11 personal shower out
12 supply and exhaust HEPA filters
13 effluent decontamination system
Required safety equipment
Risk-based enhancements
www.cdc.gov/24-7

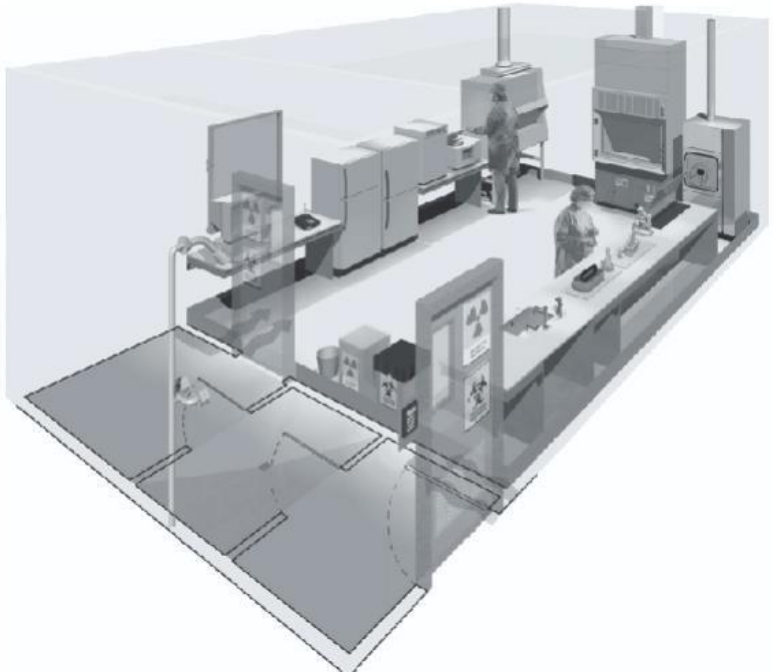
Biosafety Level 1



Biosafety Level 2



Biosafety Level 3



Biosafety Level	*1*	*2*	*3*	*4*
Infectious Agents	Unlikely to cause disease in healthy workers or animals Low individual and community risk	Can cause human or animal disease but unlikely to be a serious hazard Moderate individual risk, limited community risk Effective treatments available	Cause serious human or animal disease but not ordinarily spread by casual contact High individual risk, low community risk	Cause very serious human or animal disease, often untreatable and transmitted High individual risk, high community risk
Examples of infectious agents in this risk level		E. coli, California encephalitis viruses, many influenza viruses	Anthrax, Q fever, tuberculosis, Hantaviruses, human immuno-deficiency viruses	Ebola viruses, Herpes B virus (Monkey virus), foot and mouth disease
Facilities	Standard well-designed experimental animal and laboratory facilities	Level 1 plus: Separate laboratory, room surfaces impervious and readily cleaned, biohazard sign	Level 2 plus: Controlled access double door entry and body shower, air pressure must be negative at all times, no recirculation, HEPA filtration, backup power	Specialized, secure, completely self-contained unit with specialized ventilation, fully monitored; air lock entry and exit,

Biosafety Level	*1*	*2*	*3*	*4*
Safety Equipment	Handwashing facilities, laboratory coats	Level 1 plus: autoclave, HEPA filtered class I or II biological safety cabinet, personal protective equipment	Level 2 plus: Autoclave, HEPA filtered class II biological safety cabinet, personal protective equipment to include solid front laboratory clothing, head covers, dedicated footwear, and gloves, appropriate respiratory protection	Class III biological safety cabinets, positive pressure ventilated suits
Procedures	Basic safe laboratory practices	Use of personal protective equipment laboratory coat worn only in the laboratory, gloves, decontamination	Users fully trained, written protocols; showers, wastes disposed of as contaminated, use of biological safety cabinets, personal protective devices	Access only to certified staff, rigorous sterilization / decontamination procedures

Risk Assessment

- Based on laboratory specific conditions, the Responsible **Faculty Member or LS/LSS is in charge of implementing more (or less) strict practices.** Risk assessment decisions count for the following:

1. **Pathogenicity** - the ability of an organism to cause disease.
2. **Virulence** - the severity of disease.
3. **Transmission route** - parenteral, ingestion, mucous membrane exposure, or inhalation. Organisms such as *M. tuberculosis* require more strict control than organisms that are transmitted via direct contact, e.g., HBV.
4. **Agent stability** - survival in environment or otherwise prolonged viability (spore formation).
5. **Infectious dose** - the dose required to cause infection in humans or animals (ID 50 refers to the dose needed to infect 50 % of the exposed population).
6. **Antibiotic resistance**
7. **The use of recombinant DNA** any of the above risk factors and modifications should be taken into consideration.

What is Decontamination?

- An activity that decreases the microbial load to a level deemed proper to avoid contamination or infection is decontamination.
- The application of a chemical to living tissue to prevent infection refers as antisepsis.
- Example substances are iodine compounds (sodium and potassium (KI) and the iodates (KIO3) and hand washing antimicrobial soaps

What is Sterilization?

Sterilization refers to the disinfection of all microbial life, including bacterial endospores.

Physical methods of sterilization

The Biology Notes

Heat Sterilization

Moist Heat Sterilization

- At temperatures below 100°C
- At a temperature of 100°C
- At temperatures above 100°C

Dry Heat Sterilization

- Red Heat, - Flaming, - Incineration
- Infrared radiation, - Hot air oven

Filtration

- Filtration sterilization of liquids
- Filtration sterilization of gases

Irradiation

- Ultraviolet (non-ionizing) radiation
- Ionizing Radiation

Sound (sonic) waves

Pressure (Pascalization)

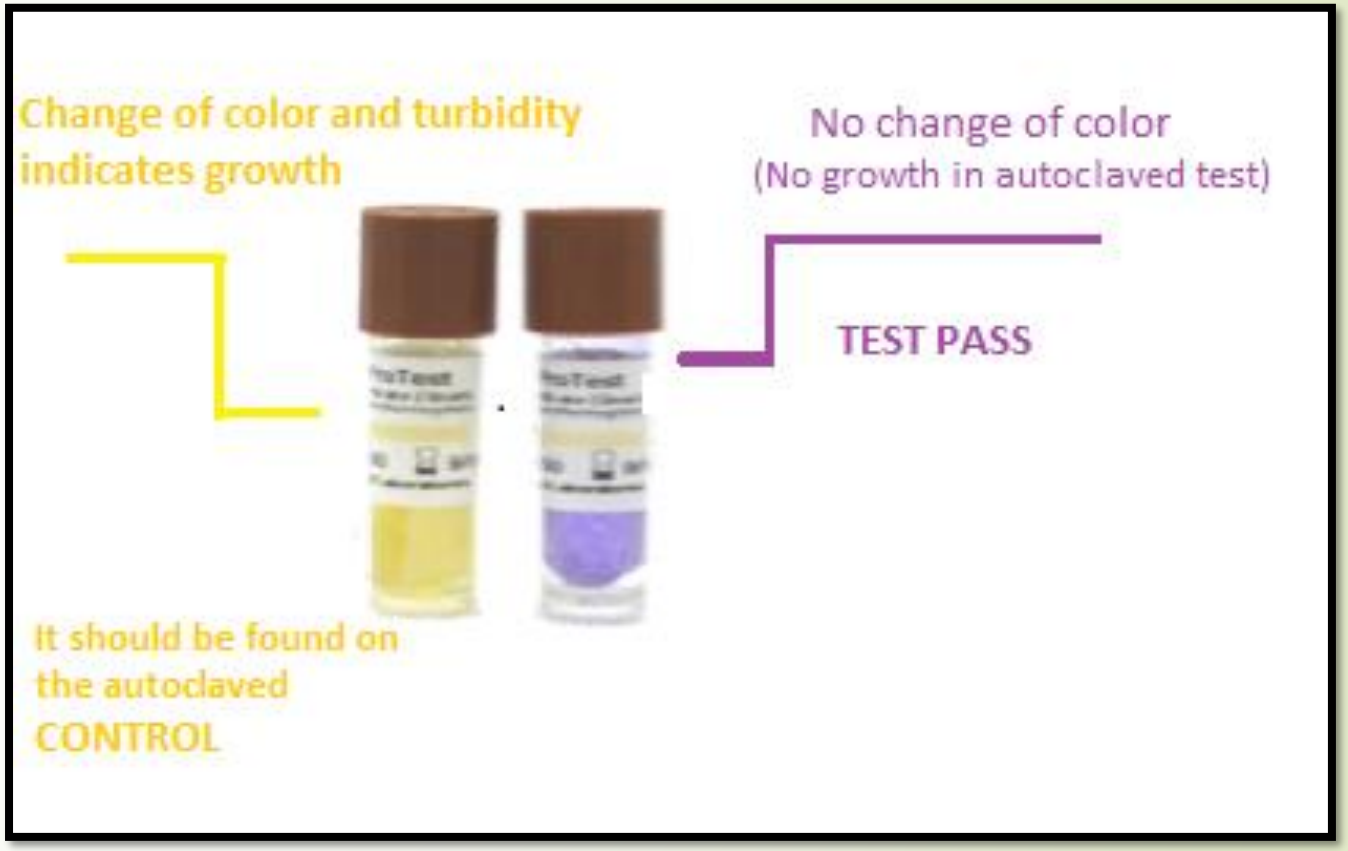
Sunlight (Solar Disinfection)

Autoclaves

- The most efficient and reliable method of sterilization in laboratory is offered by autoclaves. Critical process factors are exposure, temperature, time.
- Size of the load and the packing density of the chamber affects the sterilization time.
- **Usual laboratory autoclaves function at 121 °C and 15 psi.**
- Do not tightly cap bottles and test tubes. Autoclave bags must be closed loosely to allow steam to penetrate.

Autoclave chemical and biological indicators

Autoclave chemical indicator tapes
Only confirmed the temperature reached up to 121 c.



Autoclave biological indicators
Geobacillus stearothermophylus spores

Dry Heat

- Dry heat is used for materials (some glassware, instruments, and anhydrous materials) that are sensitive to moisture or the corrosion it may cause.
- Dry heat requires higher temperatures and a longer exposure times than autoclaving.
- Dry heat for **2-4 hours at 160 °C** is needed to sterilize a load requiring 30 minutes at 121 °C in an autoclave. This method may also be validated by using spore vials.

Disinfection

- Elimination of virtually all pathogenic microorganisms on inanimate objects with the exception of large numbers of bacterial endospores is called disinfection.
- Microorganisms can be grouped according to decreasing resistance to disinfectants as follows: 1) bacterial endospores (*B. subtilis, clostridium spp*); 2) Mycobacteria; 3) non-lipid or small viruses (poliovirus, rhinovirus); fungi; vegetative bacteria; and 4) lipid or medium sized virus (herpes simplex, HIV, HBV).

Disinfectant	Disinfection Level	1*	2*	3*	4*	5*	Comments
Alcohols (ethyl and isopropyl) 60-85%	intermediate	+	+	-	+/-	+	Not sporicidal; evaporates quickly so that adequate contact time may not be achieved, high concentrations of organic matter diminish effectiveness; flammable.
Phenolics (0.4%-5%)	intermediate	+	+	+/-	+	+	Not sporicidal; phenol penetrates latex gloves; eye/skin irritant; remains active upon contact with organic soil; may leave residue.
Glutaraldehyde (2-5%)	High	+	+	+	+	+	Used to sterilize surgical instruments that cannot be autoclaved; strong odor; sensitizer; use with adequate ventilation. Not for use on environmental surfaces.
Quaternary Ammonium (0.5-1.5%)	Low	+	+	-	-	+/-	May be ineffective against Pseudomonas and other gram – bacteria; recommendation limited to environmental sanitation (floors, walls). Low odor, irritation.
Iodophors (30-1,000 ppm iodine)	intermediate	+	+	+	+/-	+/-	Inactivated by organic matter.
Chlorine (100-1,000 ppm)	intermediate	+	+	+	+/-	+	Not sporicidal; inactivated by organic matter; fresh solutions of hypochlorite should be prepared daily; corrosive; irritating to eyes and skin.

** 1. Bacteria; 2. Lipophilic Viruses; 3. Hydrophilic Viruses; 4. Mycobacterium Tuberculosis; 5. Fungi*
Adopted from Columbia University, Medical Center.

Using Bleach as a Disinfectant

- As a strong oxidizing agent, the sodium hypochlorite in household bleach is an effective disinfectant for the known and potential infectious materials.
- However, as sodium hypochlorite breaks down into salt and water, it is recommended that the solution is made fresh daily. When bleach and water are mixed together, 1:10, to create a cleaning or disinfecting solution, the solution rapidly begins to lose needed disinfecting properties.
- Bleach stock must be stored in an opaque plastic bottle at room temperature.
- Initial hypochlorite concentration is affected by the rate of degradation, the volume remaining and the ambient temperature.

Safety data sheet for infectious substances

- **The SDS (Safety Data Sheet)** are organized to contain health hazard information:
- Infectious dose, viability (including decontamination), medical information, laboratory hazard, recommended precautions, handling information and spill procedures. The intent of these documents is to provide a safety resource for laboratory users working with these infectious substances.
- Because these users are usually working in a scientific setting and are potentially exposed to much higher concentrations of these human pathogens than the general public, the terminology in these SDS is technical and detailed, containing information that is relevant specifically to the laboratory setting.

Pathogen Safety Data Sheet (PSDS)

1. **Section I:** Infectious Agent (Name, Agent type/Taxonomy, Synonym / Cross Reference, Characteristics (Brief Description, Properties)
2. **Section II:** Hazard Identification (Pathogenicity / Toxicity, Predisposing factors, Communicability, ,Epidemiology, Host Range, Infectious Dose, Incubation Period)
3. **Section III:** Dissemination (Reservoir, zoonosis, Vectors)
4. **Section IV:** Stability and Viability (Drug Susceptibility, Drug Resistance, Susceptibility to Disinfectants, Physical Inactivation)
5. **Section V:** First Aid and Medical (Surveillance, First Aid / Treatment, Immunization, Prophylaxis)
6. **Section VI**: Laboratory Hazards (Laboratory-Acquired Infections, Sources / Specimens, Primary Hazards
7. **Section VII:** Handling and Storage (Spills, Disposal, Storage)

PATHOGEN SAFETY DATA SHEET

SECTION I – INFECTIOUS AGENT

NAME

Name of the pathogen using official taxonomic naming convention (e.g., *Genus species, Genus species* subsp. *subspecies,* or *Genus* spp. for bacteria, parasites, fungi; Species for viruses; Prion Disease Agent for prions).

Agent type: Which of the following classes of agent characterize the pathogen: Bacteria, Fungi, Virus, Parasite, or Prion?

Taxonomy:

Family: e.g., Streptococcaceae

Genus: e.g., *Streptococcus*

Species: e.g., *S. salivarius*

Subspecies/Strain/Clonal Isolate: Include if applicable

SYNONYM / CROSS REFERENCE

What other names might be used to find information on the pathogen? For example: name(s) of the disease(s) that the agent is commonly responsible for; other classifications (e.g., arbovirus); former taxonomic name; common name.

Tissue cultures and cell lines

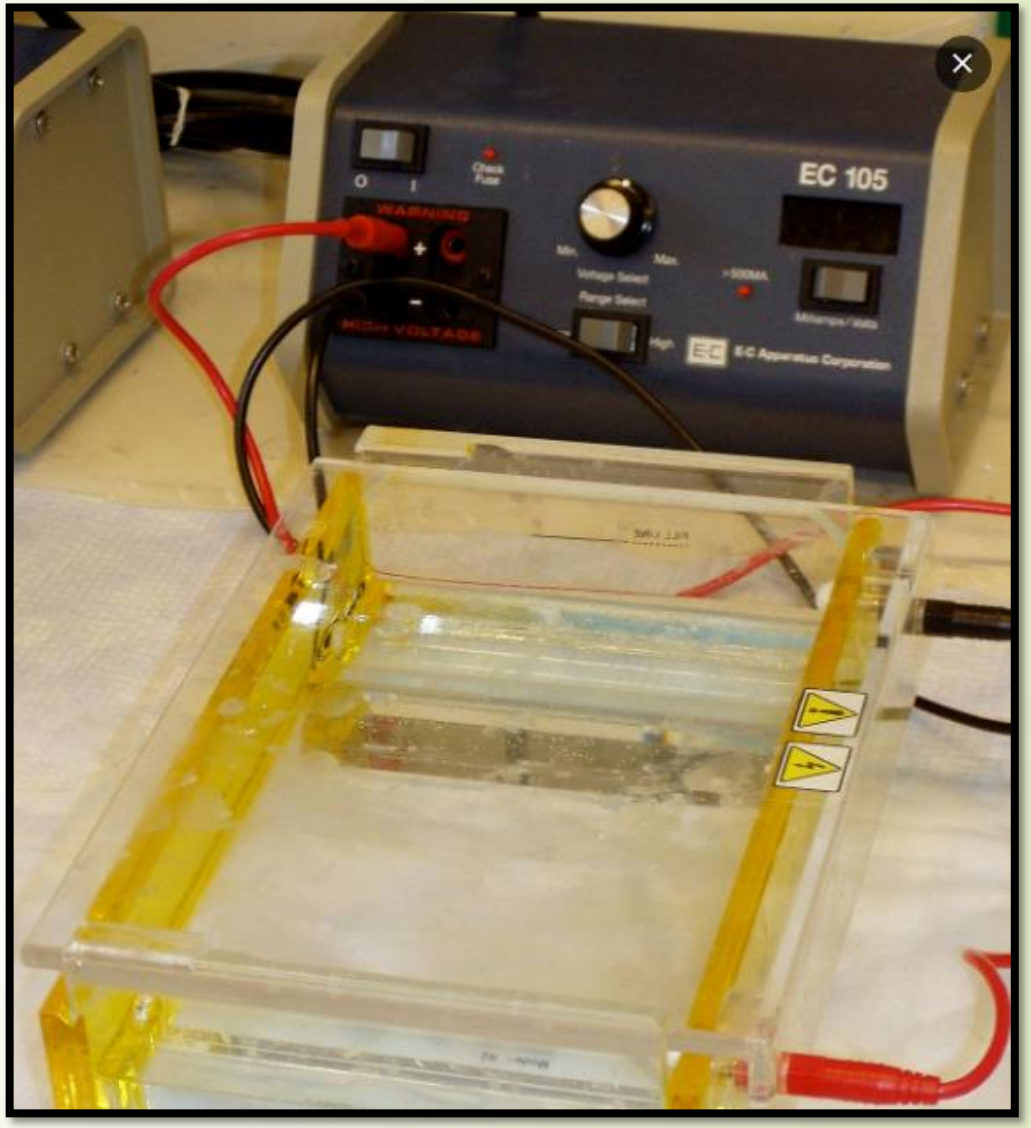
- Cell lines obtained from commercial sources may become contaminated with adventitious agents while used in the laboratory.
- Cell cultures known to contain an infectious agent or oncogenic virus should be manipulated at the Biosafety Level appropriate for the agent, usually BSL-2.

Sharps Containers and Safe Needle Devices

- Needles, razor and scalpel blades and similar items are discarded through **Contaminated Waste**
- **Waste should be kept in sharps containers**.
- Glass items (pipettes, test tubes) should be substituted whenever possible by plastic ones. The use of sharp objects should be limited if there is an alternative way.
- Blunt needles, pipettes, or canulas should be used to aspirate fluids instead of hypodermic needles; and if possible plastic should be substituted for glass.
- Needle-locking units or units should be used only in which the needle is an integral part of the syringe.
- **Unused needles should be disposed in sharps containers**.
- Needles should never be recapped, sheared, broken, or bended under any circumstances. Air and bubbles should be expelled into a disinfectant-moistened pad.

Gel Room Safety

- Electrophoresis is a commonly used laboratory technique which uses electrical energy to separate molecules such as proteins or nucleic acids by their size, structure, and electrical charge.
- **Electrophoresis work poses potential electrical, chemical and thermal safety hazards**.
- Electrophoresis equipment can pose significant **electrical** hazards in the laboratory.
- Typical electrophoresis units operating at 100 Volts can provide a lethal shock of 25 milliamps.



Power Supplies:

1. Label equipment with the warning: “Danger Electrical Hazard.”
2. Connect equipment to outlets with ground fault circuit interrupters (GFCIs).
3. Use power supplies with safety features that detect issues with the electrical circuit (e.g., no-load, overload, sudden load changes, short circuits, etc.).

Connecting Leads:

1. Turn off main power supply before connecting or disconnecting electrical leads.
2. With dry gloved hands, connect one lead at a time using one hand only.
3. Be sure that leads/banana plugs are fully seated.

Using Equipment:

1. Don’t run equipment unattended.
2. Keep equipment clear of unintentional grounding points and conductors (e.g., sinks or other water sources, metal plates, jewelry, aluminum foil, pipes or other electrical/metal equipment).
3. Gel chamber must have a lid or cover with safety interlocks to prevent accidental contact with energized electrodes or buffer solutions.
4. Gel chamber exterior must be dry with no spilled solutions. Check the chamber for leaks.

Cold Room Safety

- The intention of cold rooms is to properly store certain agents and to conduct certain tests at a controlled temperature.
- The supplied air in cold rooms is intended to prevent the buildup of carbon dioxide generated from users in the room as well as other contaminants that might be released in the room. Nevertheless, this small volume of supplied air creates moisture problems contributing to mold growth, especially when trace contaminants are present on surfaces.
- A number of health and safety problems can occur in cold rooms. These problems range from inhalation exposure of mold, to unsafe use/storage of chemicals resulting in inhalation exposures, and storage of food and drinks in cold rooms resulting in potential ingestion exposures to molds.
- The storage of cellulose containing materials leads to mold growth. Also, mold growth can lead to contamination of research substances.
- **Mold growth in cold rooms can be prevented by controlling condensation/moisture and removing materials.**

Proper Use and Storage of Chemicals in Cold Room.

- Cold rooms can recirculate the air contained within. Vapor of chemicals in the air can accumulate and pose a breathing exposure or an explosion hazard to laboratory users. Therefore:
- **Flammable solvents can spread sufficient vapors to form an explosive atmosphere.** Fans and electrical laboratory equipment in these rooms are potential ignition sources.
- Do not store large quantities (>1 liter) of flammable solvents in cold rooms. A standard refrigerator must never be used for the storage of flammable materials. Instead, use flammable storage refrigerators.
- Cold rooms have a contained atmosphere, some **hazardous chemicals** such as chloroform, formaldehyde which are not flammable may vaporize and cause exposures to users. All users should consider the risk when applying experiment procedures and evaluate those procedures where vapors are released in a chemical fume hood.

In case of mold growth in cold room

- Keep door shut to prevent condensation. Left open doors can increase the relative humidity in the working area which supports mold growth.
- Eliminate all wood. Wood can absorb moisture and, since it is composed of cellulose, it is a perfect ground for mold growth. Wood shelves must be replaced with stainless steel shelves that allow air flow throughout the storage area
- Eliminate all products which contain cellulose, such as cardboard and paper. These surfaces act like wood and promote mold growth. If paper products are required, store them in an enclosed plastic container between uses. If visible mold found on a paper product, throw away the item immediately.
- Keep surfaces clean. Do not use bleach on metal surfaces, because bleach on metal surfaces can result in pitting. **Wet clean-up activities** are recommended. For example, dusting, sweeping or brushing will spread mold into the air and can cause breathing exposures and spread potential contamination.
- If mold reappears soon after cleaning, use any hospital approved disinfectant**, drying surfaces after cleaning to ensure moisture has been removed.**

Exposure to biological materials and Injuries

- **Splashes of biological material to the Skin and eyes**
- **Inhalation**
- **Ingestion**
- **Injection**

Spills of Biological Material

Firstly, you have to decide and assess the risk of this biological hazard:

1. Infectious dose
2. Route of infection
3. Pathogenicity and virulence
4. Host range
5. Disease incidence and severity
6. Prevention and treatment

- It is recommended to prepare a first aid biological spill kit containing:

1. 10% fresh household bleach solution
2. Absorbent pad or towel
3. Forceps
4. Essential PPE (gloves, face mask, face shield, safety box)
5. Biohazard bags, autoclavable bags.

- The following fact should be kept in mind: Bleach do not applicable For human blood and body fluids, iodophors or 70% alcohol is appropriate.

Bio safety level 1 organism spill

- Risk Group 1 infectious agents are biological agents that are unlikely to cause disease in healthy workers or animals (low individual and community risk).
- Wear disposable gloves.
- Soak paper towels in disinfectant and place over the spill for at least 10 minutes.
- Place towels in a plastic bag for disposal.
- Clean up spill area with fresh towels soaked in disinfectant.

Bio safety level 2 organism spill (moderate risk agents)

- Alert people in the immediate area of the spill.
- Put on protective equipment. This may include a laboratory coat with long sleeves, back- fastening gown or jumpsuit, disposable gloves, disposable shoe covers, safety goggles, mask or full-face shield.
- Cover the spill with paper towels or other absorbent materials.
- Carefully pour a freshly prepared 1 to 10 dilution of household bleach around the edges of the spill and then into the spill. Avoid splashing.
- Allow a 20-minute contact period.
- After the spill has been absorbed, clean up the spill area with fresh towels soaked in disinfectant.
- Place towels in a plastic bag and decontaminate in an autoclave.

Bio safety level 3 organism spill

- Do not breathe; leave the room immediately and close the door.
- Notify others in the room to evacuate immediately, and assist others if necessary.
- Remove personal protective equipment in the airlock or access zone, turn potentially contaminated clothing outward, remove gloves last, and wash any exposed skin areas with antiseptic soap and warm water.
- Warn others not to enter the contaminated area. Place an appropriate sign on the door.
- Wait at least 30 minutes to allow dissipation of aerosols created by the spill.
- Put on a long sleeved gown, gloves, appropriate respirator, and rubber boots, if required, before re-entering the room.
- Cover the spilled area with paper towels or disinfectant soaked paper towels.
- Slowly pour appropriate decontaminant solution around the spill and allow to flow into the spill. Avoid splashing or the creation of aerosols during this step.
- Let stand at least 15 - 20 minutes to allow adequate contact time.
- Using an autoclavable dust pan and squeegee, transfer all contaminated materials (paper towels, glass, liquid, gloves, etc.) into a deep autoclave pan, and autoclave promptly.
- Repeat the decontamination procedures.
- The dust pan and squeegee should be placed in an autoclave bag and autoclaved as well.

1. Alert

Report spill to lab's supervisor.

Evacuate the lab if necessary and close the door.

If aerosols are a concern, wait for **30 min** to allow aerosols to settle.

2. Personal Protection

Put on appropriate PPE:

* lab coat
* gowns
* safety goggles
* face shield
* nitrile or latex gloves
* disposable shoe cover

3. Immediate First Aid

If exposed,

Remove contaminated cloth immediately and place in disposal autoclave biohazard bags.

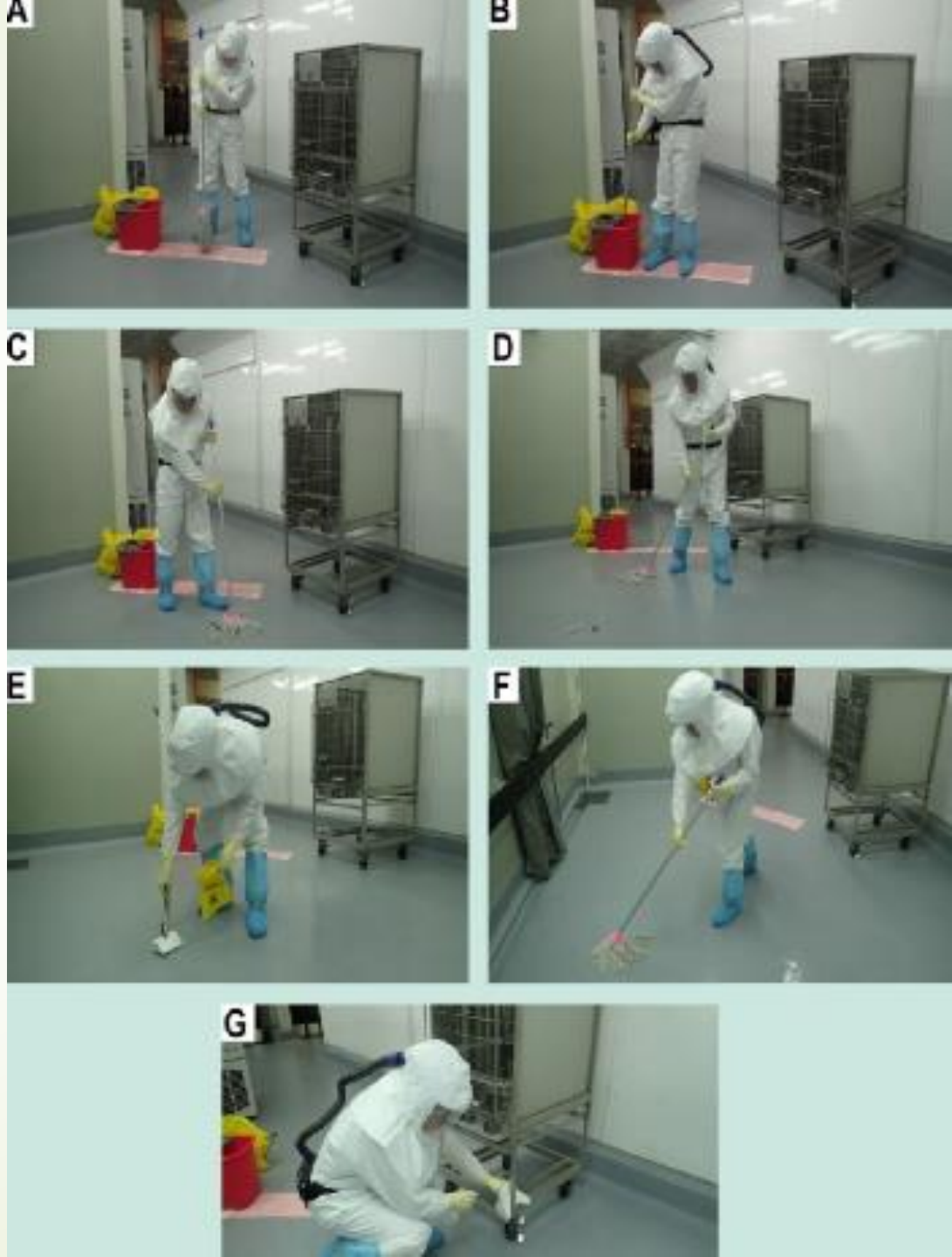
First, wash exposed skin with antiseptic and then with soap and water.

If exposure occurs to the eye, irrigate with clean water, sterile wash, or use eyewash. If necessary, use emergency shower.

4. Spill Response and Clean-up Procedure

Clean up the spillage as bellow:

1. **Cover spill area with paper towels to avoid splashing.**
Pour freshly prepared 10% bleach with circular motion around the spill, from outside toward center, and allow it to flow into the spill for **at least 20 minutes**.
2. **Collect the infected paper towels into disposable wastebags and sign as "Biohazard Waste".** Use tongs or forceps to pick up any sharp object (needle) or broken glass and dispose in safe containers.
3. **Wipe down all nearby surfaces with disinfectants**. Discard all spill materials into disposable waste bags or containers and sign as "**Biohazard Waste**".
Repeat the process, if needed.
4. **Dispose used PPE in waste containers.** Wash hands with soap and water and use an alcohol based hand sanitizer.
5. **Report the biological spill and clean-up procedure** via completing the "**Spill Incident Report**" form and make sure it is officially confirmed by the lab's supervisor and stored in the documentary file of the laboratory.



Spill Involving human blood and body fluids

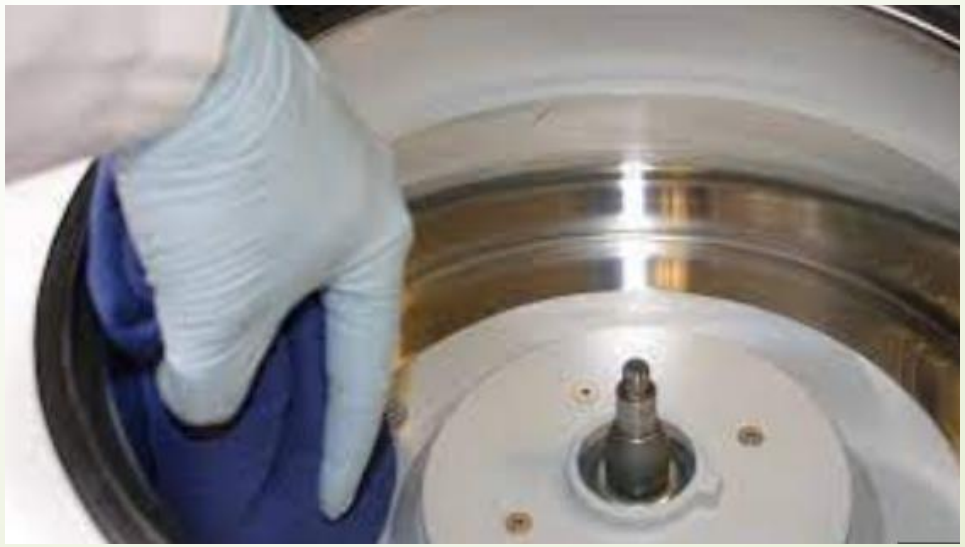
- Skin contact/cuts/puncture wounds: wash with soap and water, then pour 3% hydrogen peroxide over the cut/lesion or wash with either chlorhexidine or iodophor.
- Eyes: flush with water
- Mouth: rinse well with 3% hydrogen peroxide and then water.
- Pick out any sharps using tongs or other mechanical means and cover spill absorbent material such as paper towels.
- Carefully pour a freshly prepared 1/10 dilution of household bleach around the edges of the spill and then into the spill. Avoid splashing.
- Allow a 20 minute contact period.
- Use paper towels to wipe up the spill, working from the edges into the center.
- Clean spill area with fresh paper towels soaked in bleach solution.
- Place towels in a red bag for disposal.
- Remove protective equipment and wash hands thoroughly.

Spills within a biological safety cabinet

- **Leave the ventilation on**.
- All items within the cabinet should be disinfected (Walls and surfaces wiped down, equipment wiped down and/or autoclaved).
- Cover the spill area with paper towels or absorbent material.
- Soak the spill area with an appropriate disinfectant (i.e. 10% bleach). **Leave on for 20 to 30 minutes.**
- Pick up with absorbent material.
- All waste should be autoclaved.
- Ventilation should run for 10-15 minutes..

Spills inside a centrifuge

- Leave lid closed and allow aerosols to settle for at least 1 hour (ensure centrifuge is off).
- Notify others in the lab not to use the centrifuge (include signage) and inform the lab supervisor.
- **If possible move the centrifuge or at least the rotors and buckets to a BSC.**
- Disinfect the centrifuge or rotors and buckets in an appropriate disinfectant, allow at **least 20 minutes** of contact time.
- Carefully retrieve any broken glass from inside the centrifuge using forceps and place in a sharps container.
- Drain the disinfectant.
- Thoroughly wipe down the inside of centrifuge and all parts including the lid with paper towels soaked in disinfectant.
- Rinse both the rotors and the inside of the centrifuge with water if bleach was used.
- All waste should be autoclaved.



Transportation and shipment of biological materials

- The transportation and shipment of biological materials is subjected to strict regulatory controls. Individuals involved in the transportation and shipment of infectious substances must receive training on the applicable regulations and requirements before shipping such materials.

Transportation and shipment of biological materials

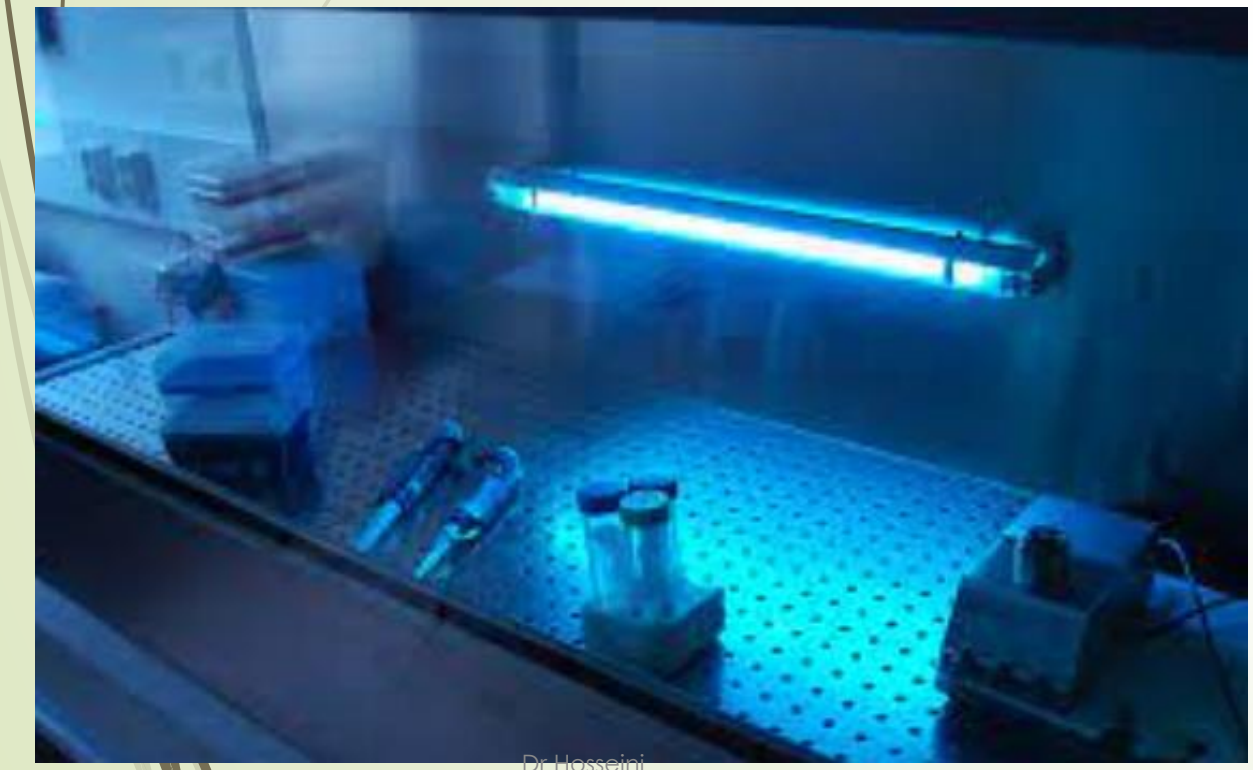
- Biological samples must be placed in a primary container or vessel that is a securely closed, leak-proof (or O-ring) tube, vial or ampoule, which is then placed in an unbreakable, lidded, watertight, secondary container.
- If the outside of the primary container or vessel is suspected of being contaminated, decontaminate prior to placing in secondary **container using 10% bleach** solution or a disinfectant appropriate for the biological material in use.
- **All biohazards must be labelled with the international biohazard symbol on the outside of the secondary container.**
- When transporting liquids in glass vials/containers, place enough absorbent material, such as paper towels, in the space at the top, bottom, and sides between the primary and secondary containers to absorb the entire contents of the primary container(s) in case of breakage or leakage.
- If a spill occurs during transport, do not attempt to clean it up without appropriate spill response material and PPE. **Keep other people clear of the spill**.

UV-Light Hazards

The main source of UV exposure is from the sun, but it is typically limited to the UV-A band, as the earth atmosphere protects us from the harmful UV-B and UV-C rays. Nonetheless, UV rays from all three bands can be produced from man-made sources, such as those in research laboratory.

Band	Wavelength	Hazard Potential	Description	Biological effects
UV-A (Near UV)	315-400 nm	Lowest	Accounts for up to 95% of UV radiation, penetrates deeper into skin layers	 Cataract  Sunburn
UV-B (Middle UV)	280-315 nm	Mid to High	Biologically active, but cannot penetrate beyond the superficial skin layers, most solar UV-B is filtered by the atmosphere	 Erythema  Photokeratitis
UV-C (Far UV)	100-280 nm	Highest	Most damaging, completely filtered by the atmosphere and does not reach the earth's surface	 Skin cancer  Conjunctivitis

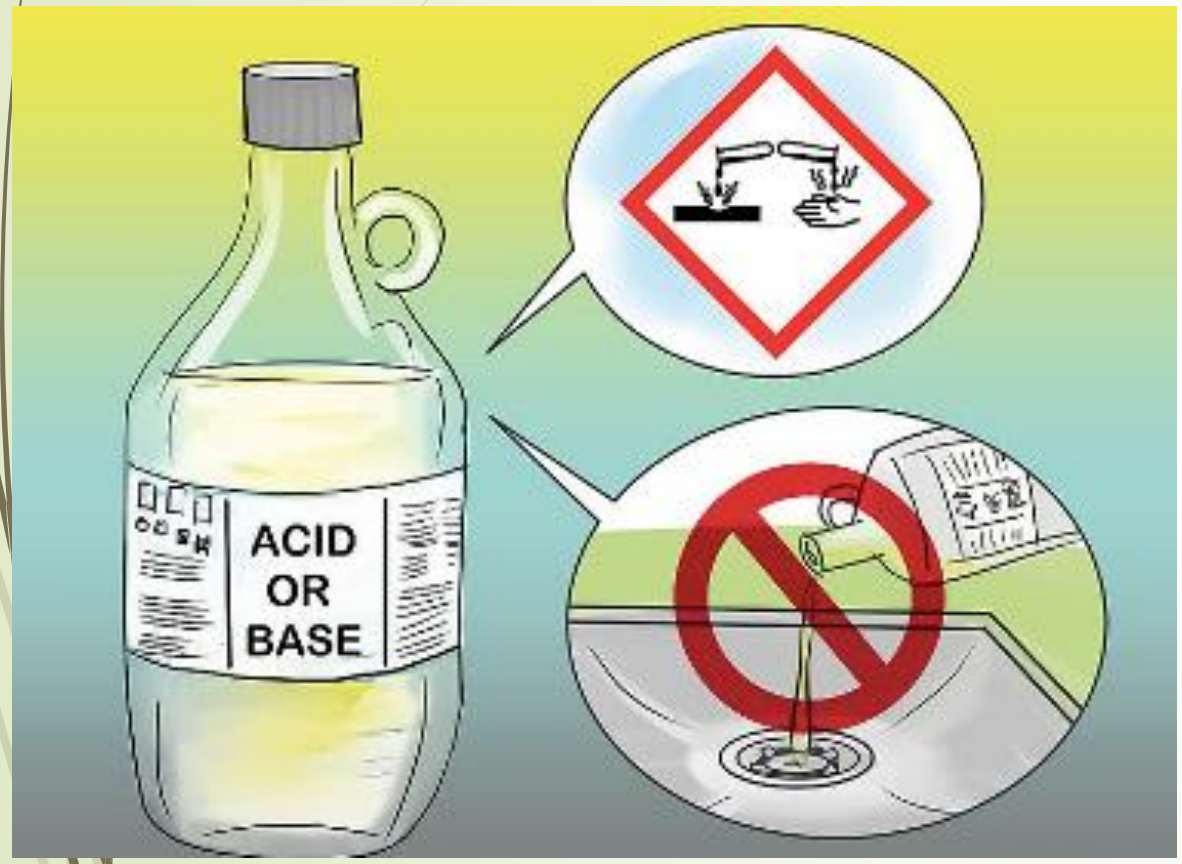
UV-light safety



UV-Light Safety

- Avoid working in or around the safety cabinet when the UV light is on or avoid using the room when UV light is on.
- Always close the sash completely when the UV light is on. Even small opening of the sash can cause skin damage and other biological effects.
- Ensure the UV light is off prior working at the cabinet.
- Control access to the room/UV light area while the lamps **are operating to prevent exposure**.
- Personal protective equipment (PPE) includes UV safety eyewear, UV face shields, long- sleeved, tightly woven clothing that covers much of the body and gloves (with no gap between the cuff and the glove) should be worn at all times when there is potential for UV exposure.
- **Any equipment that emits UV radiation must be conspicuously labeled with a caution label.**

Chemical Safety



Physical Hazards

Flammable | Compressed Gas | Oxidizing | Corrosive | Explosive

Health Hazards

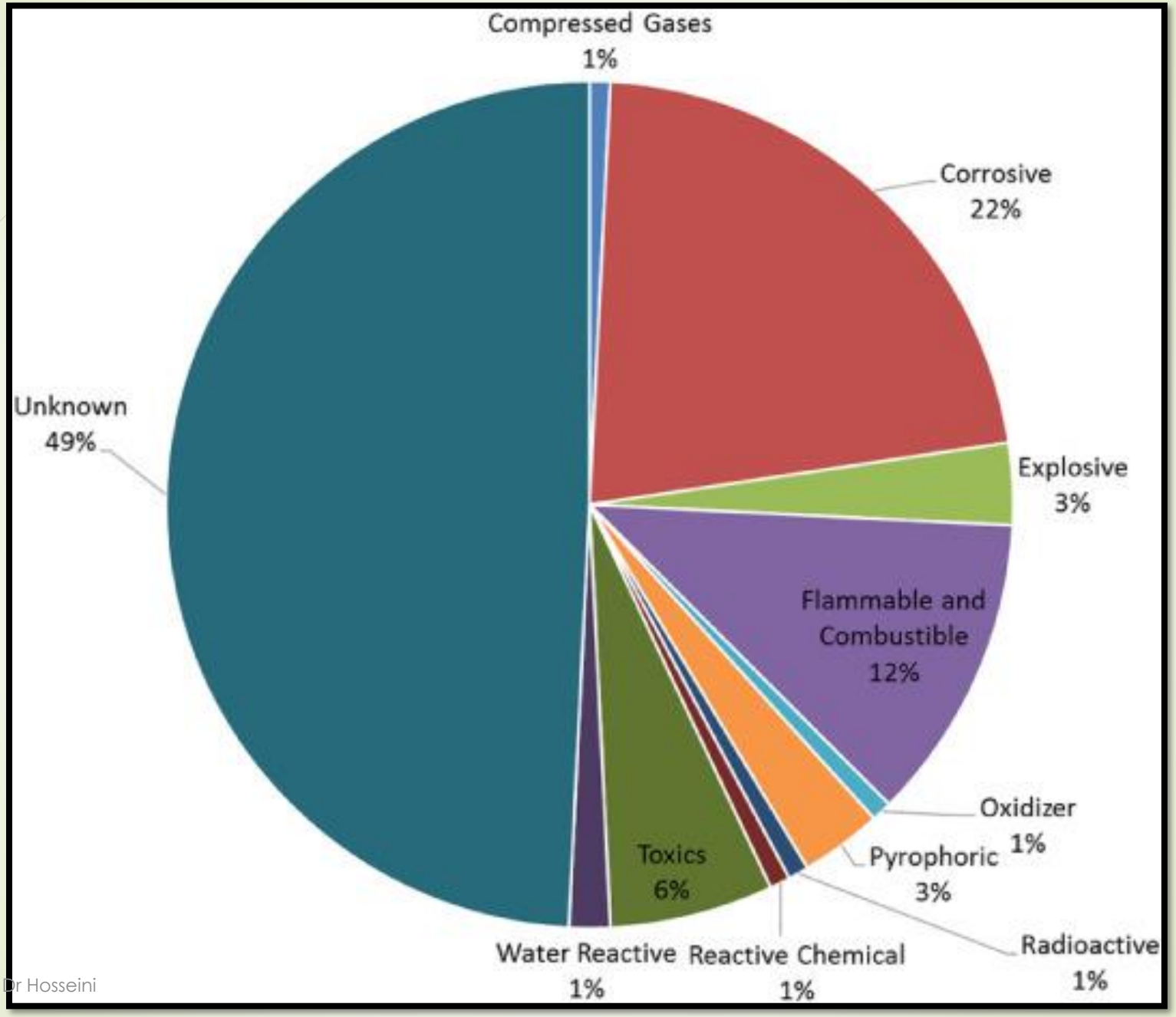
Health Hazard | Corrosive | Skin Irritant | Toxic

Reference Tools

http://www.osha.gov/dsg/hazcom/ghs.html

Environmental Hazards

Environmental Hazard

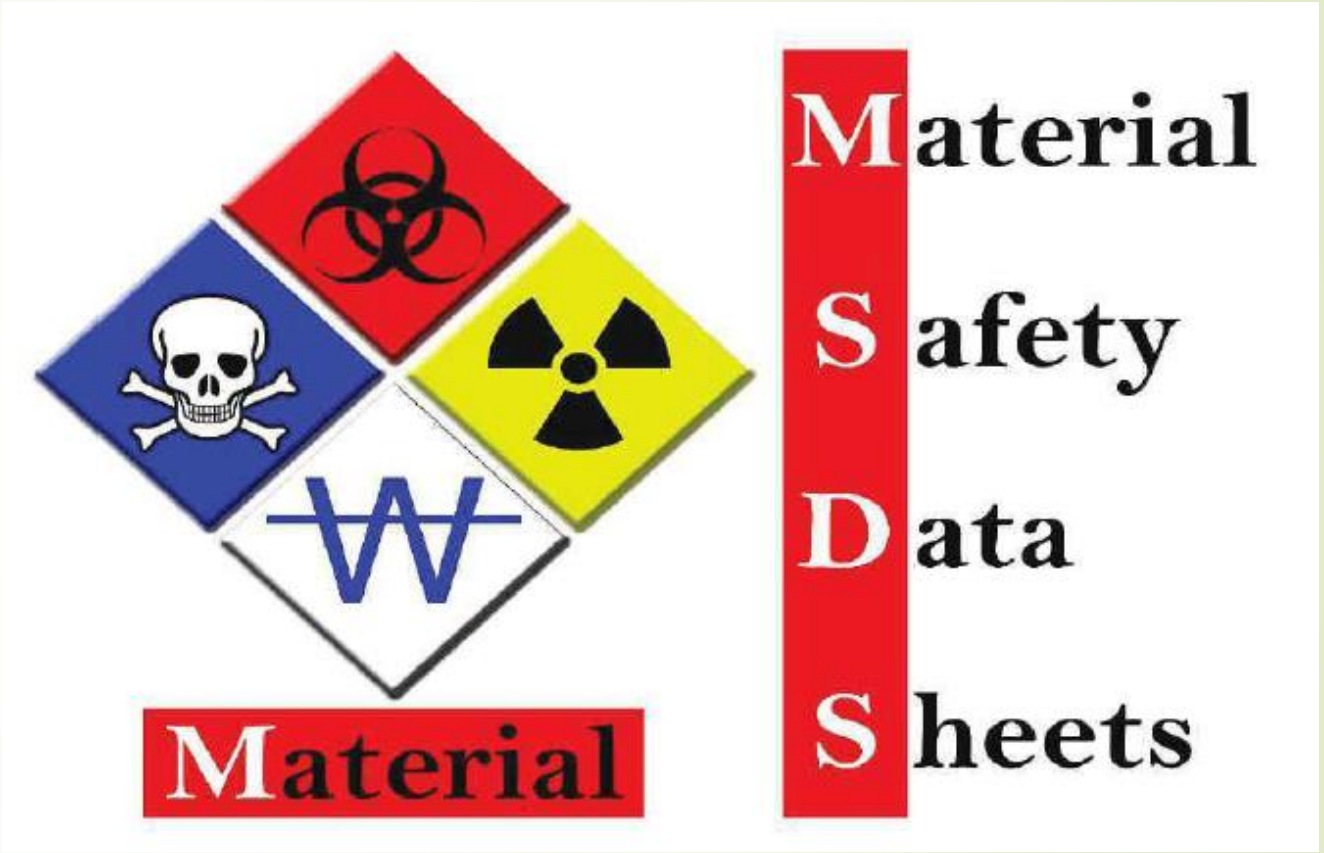

Compressed Gases
1%
Corrosive
22%
Explosive
3%
Flammable and
Combustible
12%
Oxidizer
1%
Pyrophoric
3%
Radioactive
1%
Reactive Chemical
1%
Water Reactive
1%
Toxics
6%
Unknown
49%

GHS pictograms

- Hazard pictograms form part of the international Globally Harmonized System of Classification and Labelling of Chemicals (GHS).
- **There are 9 most kinds of GHS pictograms we must know for labeling or storage and handling of chemicals.**

What is a Material Safety Data Sheet?

- As a part of GHS, SDS is a written document produced by the chemical manufacturer or importer that includes communication of the hazards and precautionary information including:



MSDS must include

Material Safety Data Sheet

0261 (10273), 0265 (10274)
TSP-90 Heavy Duty Cleaner

MSDS No. 0009 Rev. 4

Emergency Phone No.
800-535-5053 - INFOTRAC

SECTION 1 – PRODUCT NAME & MANUFACTURER INFORMATION

PRODUCT NAME	TSP-90 Heavy Duty Cleaner – White Granular Powder
MANUFACTURER'S NAME & TELEPHONE NUMBER	Red Devil, Inc. (918)825-5744
STREET ADDRESS	4175 Webb Street
CITY / STATE / ZIP	Pryor, Oklahoma 74361

SECTION 2 – COMPOSITION / HAZARDOUS INGREDIENTS

	%	TLV	PEL	UNITS
PRODUCT CONSISTS OF:				
Sodium Metasilicate, Pentahydrate (6834-92-0)	100	NE	NE	
Non-hazardous ingredients*	0	NE	NE	

*Unlisted ingredients are not considered hazardous under the OSHA Hazard Communication Standard (29 CFR 1910.1200).
Calculated VOC: 0%/wt, 0 g/L. CARB Compliance: Yes. Prop 65 Ingredients: None.

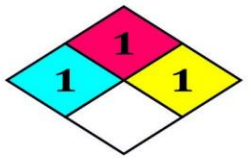
SECTION 3 – HAZARDS IDENTIFICATION

PRIMARY ROUTE(S) OF ENTRY	☒ Skin Contact ☒ Skin Absorption ☒ Eye Contact ☒ Inhalation ☒ Ingestion
EMERGENCY OVERVIEW	White, odorless, granular powder. Corrosive to eyes, skin & digestive tract. Dust corrosive to respiratory tract. Due to high pH of product, release into surface water is harmful to aquatic life. Noncombustible. Reacts w/ acids & some organics.
EFFECTS OF OVEREXPOSURE	Eye Contact: Corrosive, causes eye burns. Skin Contact: Corrosive, causes skin burns. Inhalation: Dust corrosive to respiratory tract. Ingestion: Corrosive, causes burns to mouth, esophagus & stomach. Chronic Hazards: None known. Not listed by NTP, IARC or OSHA as a carcinogen. Physical Hazards: Can etch glass if not promptly removed.
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE	None known.

SECTION 4 – FIRST AID MEASURES

SKIN CONTACT	Immediately flush skin w/ plenty of water for @ least 15 minutes, while removing contaminated clothing & shoes. Seek medical attention immediately. Wash clothing before reuse. Thoroughly clean shoes before reuse.
EYE CONTACT	Immediately flush eyes w/ plenty of water for @ least 15 minutes. If easy to do, remove contact lenses, if worn. Seek medical attention immediately.
INHALATION	Remove to fresh air. If not breathing, give artificial respiration. If breathing difficult, give oxygen. Seek medical attention.
INGESTION	DO NOT INDUCE VOMITING. Seek medical attention immediately. If person is fully conscious, give cupful of water. Never give anything by mouth to an unconscious person.

فرم اطلاعات ایمنی مواد (MSDS)

نام ماده	گریس (Grease)
خواص فیزیکی و شیمیایی	خمیر چسبناک و روغنی ، قهوه ای رنگ ، با بوی مواد نفتی ، نا محلول در آب نقطه جوش : ۱۸۰°C<
خطرات مواجهه	ـ تحریک چشم و سیستم تنفسی (سوزش ، اشک ریزش ، قرمزی ، سرفه و غیره توسط میست ، بخار یا فوم در اثر حرارت) ـ تحریک چشم (قرمزی ، خارش ، سوزش و غیره) ـ خشکی و ترک خوردگی پوست (تماس طولانی مدت)
کمک های اولیه	ـ خارج ساختن لباسهای آلوده از بدن و شستشوی پوست با آب و صابون ـ در صورت تماس چشمی شستشوی چشم با آب با پلک های باز ـ انتقال مصدوم به هوای آزاد و در شرایط حاد مراجعه به پزشک
وسایل حفاظت فردی	ماسک تنفسی (بخصوص در هنگام آتش سوزی) دستکش ، لباس کار و عینک ایمنی
عملکرد در هنگام آتش سوزی	نقطه اشتعال : ۲۵۰°C UEL = ۷ LEL = ۱ از مه یا اسپری آب ، مواد شیمیایی خشک ، دی اکسید کربن و کف جهت اطفاء حریق آن استفاده نموده و حین اطفاء از وسیله حفاظت تنفسی استفاده نمایید از آب به طور مستقیم روی آتش استفاده نکنید زیرا باعث پرتاب و انتقال آتش به قسمتهای دیگر می شود
عملکرد در هنگام ریزش / نشتی	ـ جمع آوری و پاک نمودن محل با مواد جاذب (ماسه ، خاک اره و غیره) و یا حلالهای روغن ـ در صورت لزوم تعویض خاک ـ مسدود نمودن محل نشتی
حمل و نقل و انبارش	ـ انبارش در محل خشک و خنک با تهویه مناسب ـ به دور از آتش ، گرما ، جرقه یا عوامل اکسید کننده قوی ـ نگهداری پسماندها یا گریس های استفاده شده در ظروف خالی
اثر بر محیط زیست	ـ آلودگی خاک و آب
شرایط پایداری و واکنش ماده	ـ ناسازگار با مواد اکسید کننده ، کلر مایع ، اکسیژن غلیظ ، هیپوکلریت سدیم ، هیپوکلریت کلسیم و گرمای بیشتر از نقطه اشتعال 
حد مجاز تماس	TLV TWA = 5 mg/m3

NFPA

The National Fire Protection Association

The National Fire Protection Association (NFPA) is a global self-funded nonprofit organization, established in ot detoved ,۱۸۹۶ dna ytreporp ,yrujni ,htaed gnitanimile dna lacirtcele ,erif ot eud ssol cimonoce .sdrazah detaler


Picric Acid


Ethyl Alcohol
CH3CH2OH
Acetone
CH3COCH3
Flammable
Flammable

Chemical container labeling

SAMPLE LABEL

CODE _____
Product Name _____

مشخصات ماده

Company Name _____
Street Address _____
City _____ State _____
Postal Code _____ Country _____
Emergency Phone Number _____

مشخصات سازنده

پیکتوگرام (علائم خطر)

کلمه خطر

Danger

Keep container tightly closed. Store in a cool, well-ventilated place that is locked.
Keep away from heat/sparks/open flame. No smoking.
Only use non-sparking tools.
Use explosion-proof electrical equipment.
Take precautionary measures against static discharge.
Ground and bond container and receiving equipment.
Do not breathe vapors.
Wear protective gloves.
Do not eat, drink or smoke when using this product.
Wash hands thoroughly after handling.
Dispose of in accordance with local, regional, national, international regulations as specified.

In Case of Fire: use dry chemical (BC) or Carbon Dioxide (CO_2) fire extinguisher to extinguish.

First Aid
If exposed call Poison Center.
If on skin (or hair): Take off immediately any contaminated clothing. Rinse skin with water.

موارد احتیاطی

توضیحات خطر

Highly flammable liquid and vapor.
May cause liver and kidney damage.

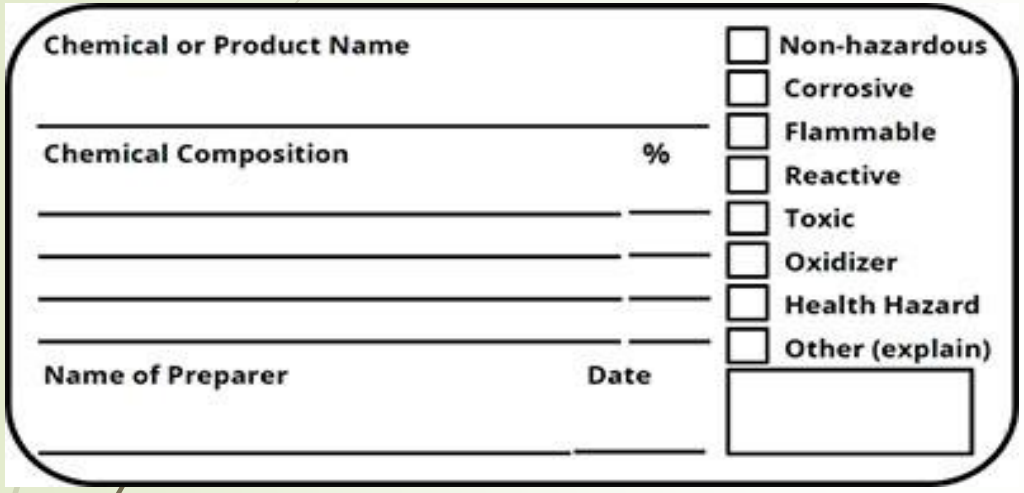
اطلاعات تکمیلی

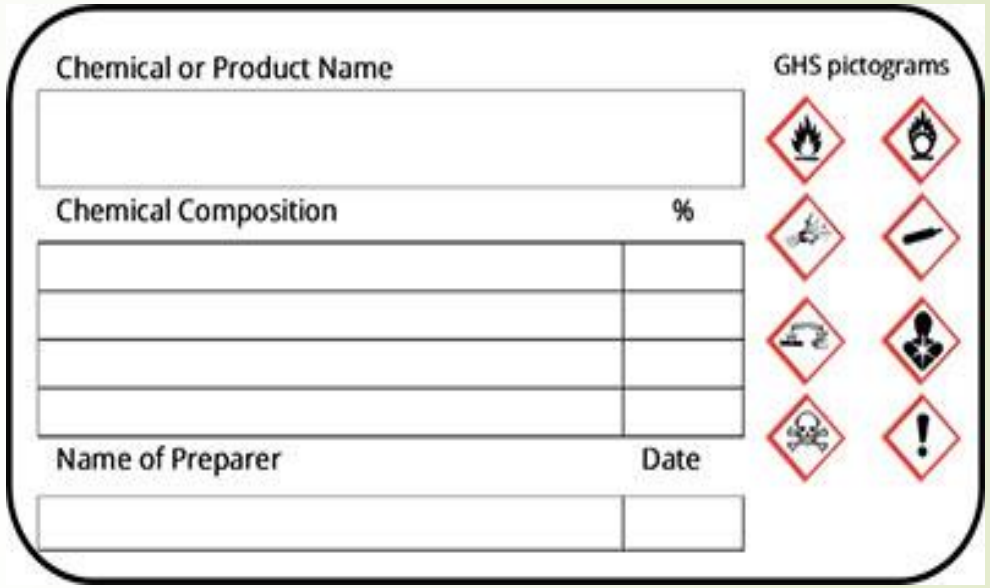
Directions for Use

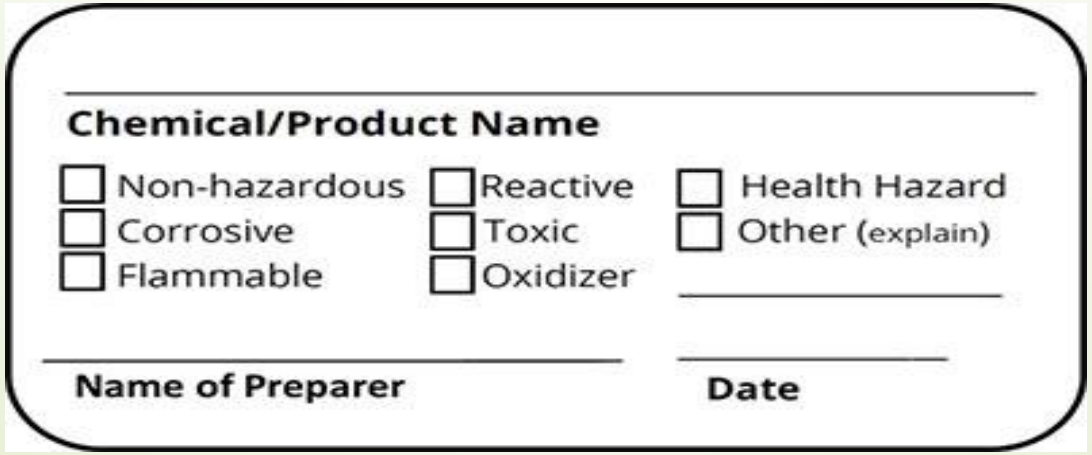
_____
_____
_____

Fill weight: _____ Lot Number: _____
Gross weight: _____ Fill Date: _____
Expiration Date: _____

Secondary container labeling







Which Substances Do Not Require an MSDS?

- **Following items or chemicals does not require SDS:**
- Chemicals that are not considered as “hazardous” by OSHA.
- Pesticides
- Ionizing and non ionizing radiation
- **Biological hazards**
- Drugs in solid, final form for direct administration to the patient (For example, tablets, pills, and capsules.)
- Drugs which are packaged by the chemical manufacturer for sale to consumers in retail establishments or those for personal consumption such as included in first aid cabinets

Chemical Storage

- Store chemicals and products in a **designated area**.
- Shelves should be level, stable, and secured to the wall or another stable
- **Store chemicals away from direct sunlight, sources of heat, and egress pathways**
- All chemicals must be stored in a **secure container**, preferably within **enclosed** cabinets.
- Hazardous chemicals must be stored below **eye level**.
- Do not store chemicals on the floor, window ledges, or balconies.
- When storing chemicals side by side make sure they are compatible and will not react to produce a hazardous chemical reaction.
- Ensure that portable containers are properly labelled with a workplace label when a controlled product is decanted from the supplier's original container.
- Close caps and lids tightly before storing any container.
- Limit access to storage areas and the janitorial closet.

Chemical Hazard Always refer to the SDS	Flammable	Acid	Base	Oxidizer	Toxic
Flammable					
Acid					
Base					
Oxidizer					
Toxic					

Emergency

- **Know how to handle emergencies** (e.g. fire, spill, personal injury, etc) and the appropriate first aid measures (i.e. for eye contact, skin contact, ingestion, inhalation, etc.).
- **Know where the closest eye/face wash station and/or emergence shower are located**, and how to use them. Emergency equipment should be inspected and tested on a regular basis.
- **Be aware of the potential hazards** (e.g. fire/explosion, health, chemical reactivity, etc.) for the materials you work with.
- Report all incidents/accidents and chemical spills to your supervisor, LS/LSS.
- Follow the recommended clean-up procedures in case of a spill.

Chemical spills

- Every laboratory should have access to spill control materials for the chemicals used in their lab.
- General use chemical spill kits equipped with **spill pads, waste bags, loose absorbents, chemical neutralizer and personal protective equipment** can be found in the **chemical spill kits**.
- If your lab uses **hydrofluoric acid** (HF), keep a supply of spill control materials specifically designed for HF.
- If your lab uses **mercury or mercury-containing** equipment, **keep some mercury absorbing powders or sponges or similar materials on hand**.

1. Alert

Report spill to lab's supervisor.

Evacuate the lab, if necessary.

Inform "**Limited Access**".

2. Personal Protection

Put on appropriate PPE:

* lab coat
* gowns
* safety goggles
* heavy duty nitrile gloves
* resistant shoes

Avoid direct contact, inhalation, or ingestion.

3. Identify Spill

Inform the supervisor.

1. First, read spilled chemical MSDS sheet or use litmus paper or pH meter to know the acidic or alkalis nature of the spilled material.
2. Next, use paper towel to prevent spreading of the spilled chemical by making a barrier around the outside edges of the spill.
3. Finally, collect the broken glasses with forceps. Place in safe container, label as "**Chemical Waste**", and dispose.

4. Immediate First Aid

If exposed:

Immediately, remove contaminated clothes.

Provide eyewash or emergency shower for the injured person for at least 15 min.

If medical help required, call emergency services.

5. Spill Response and Clean-up Procedure

1. **Apply neutralizer agent gently to the spilled liquid** and work from the outer edges of the spill toward the center. Wait a few minutes and reassess the pH again. The spill is considered neutralized if pH is in the range **between 6 to 8**. Use normal sodium bicarbonate/calcium bicarbonate and normal boric acid/citric acid to neutralize the spilled acid or alkalis, respectively.
2. **Collect and wipe the spilled liquid** from the outside toward the center with absorbent material (diatomite powder) or paper towel.
3. **Dispose of all contaminated materials in disposal plastic bags** signed as "**Hazardous Waste**" and store in chemical cabinets temporarily.
4. **Clean the infected spill area with soap and water** and repeat the process, if needed.
5. Next, **remove PPE and dispose all clean-up materials** as hazardous waste.
6. **Report chemical spill and clean-up procedure** via completing the "**Spill Incident Report Form**" and make sure it is officially confirmed by the lab's supervisor and store in the lab's documentary file.

Spill Cleanup Procedures

Absorbent Pad Spill Kit

1. Place a barrier around the spill
2. Cover completely with appropriate material
3. Clean up
4. Bag and tag for EH&S waste removal

Floor Dry Spill Kit

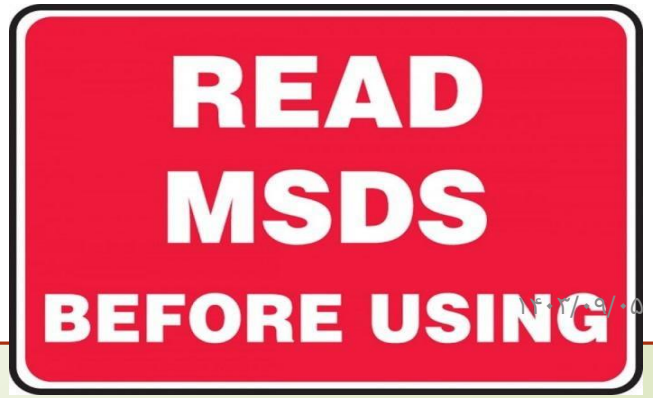
Carcinogenic, reproductive and highly toxic chemicals

1. Carcinogens are defined as **reproductive toxins and substances that possess high acute toxicity as particularly hazardous substances** (PHS).
2. Lab users handling and working with carcinogens need to take **additional precautions** besides handling toxic substances.
3. Note that carcinogenic chemicals are highly toxic, therefore strong attention is required to be paid while working with these chemicals, particularly if the threshold limits for human health has not been determined.
4. All lab users who are in contact with these type of chemicals should be aware of the risks in a full extent. **These chemicals often do not have an acute effect but long term, and the threshold limits are usually uncertain. Seek safer alternatives if possible.**

Proper use of carcinogenic materials

- **There must be a designated area in the laboratory to work with carcinogenic materials. In these designated area, several additional precautions need to be taken:**

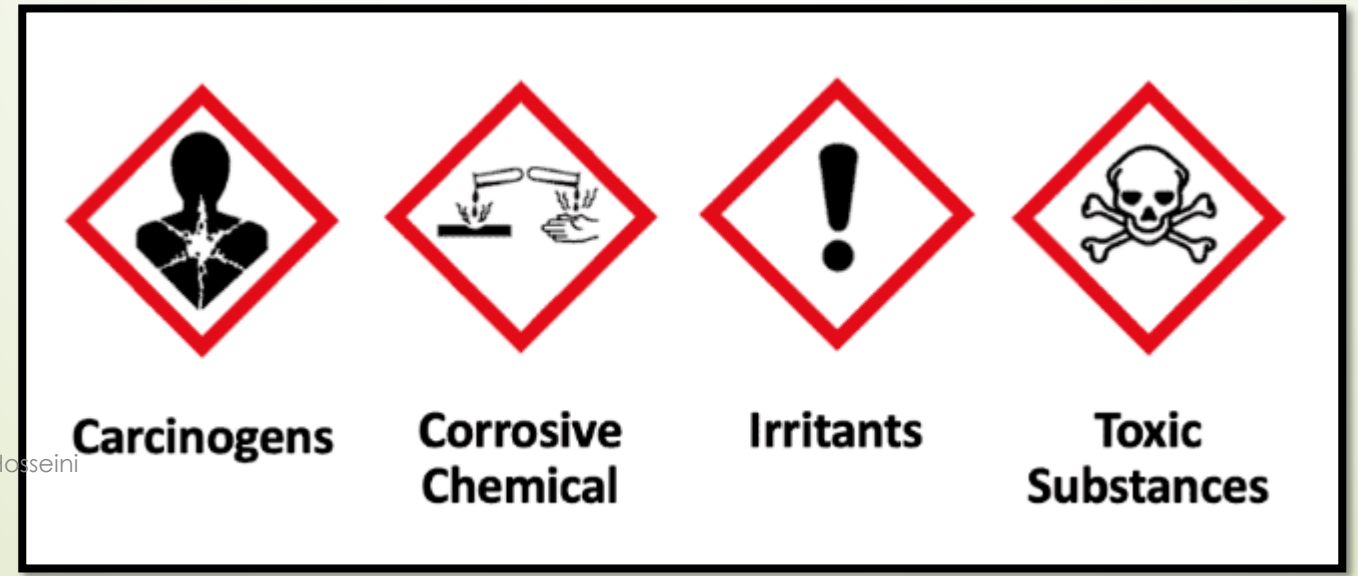
1. **Always work under a fume hood**. The airflow of this fume hood must be at least 0.60 m/s. The exhaust of fume hood should not be fed back into laboratory. Exhaust should also be discharged separately from others since it may create additional hazard risks.
2. The surface of working bench for carcinogenic materials should be **non-adsorbent so that any spill can be easily cleaned**.
3. Always wear full protective clothing including;
4. **Rubber, P.V.C. or polythene disposable gloves**.
5. Buttoned laboratory coats or preferably wrap around gowns, which tie at the back.
6. Laboratory safety glasses, or a full-face safety shield if the possibility of a splash exists.
7. An approved respirator with a suitable particulate vapor cartridge.



Treatment

In case of an eye or skin contact with a carcinogenic chemical:

1. The affected body part should be immediately washed with **cold** water for 15 minutes, at least. Hot water accelerates absorption, and water vapor may cause chemical particle to be inhaled through respiratory system.
2. **Washing should be continued until all the visible evidence of the chemical has been removed**.
3. Safety shower should be used if the area of containment is large, and all the clothing needs to be changed and washed separately from other laboratory apparatus.
4. **Carcinogenic materials should be appropriately labelled and stored in closed screw cap containers. They should be separated from other chemicals.**



Destruction and Disposal of Carcinogenic Waste

- A solution of **sodium dichromate in strong sulphuric acid (*i.e.* chromic acid solution) destroys organic compounds.** It takes one or two days to clean all residual organic compounds from materials if the solution is freshly prepared.
- A solution of **potassium permanganate in acetone is** added to **carcinogens that readily oxidize** to deactivate them. As an alternative, **concentrated or 50% aqueous sodium hypochlorite can be used**.
- Nucleophiles such as water, hydroxyl ions, ammonia, thiols and thiosulphate deactivate **alkylating, arylating or acylating agents** can be destroyed.
- **Aflotoxins** should be dissolved in acetone and added to a hypochlorite solution to destroy any 2,3-dichloroaflotoxin B1, which may have been formed.
- A solution of potassium hydroxide in methanol deactivates **Cyclophosphamide**.
- **Polycyclic aromatic hydrocarbons** can be easily oxidized in sodium dichromate-sulphuric acid mixture.


CAUTION!
Chemical waste area
ORGANIC WASTE
Non-Chlorinated
DIETHYL ETHER
ORGANIC WASTE
Non-Chlorinated
Toluene
AQEOUS WASTE
Acidic (pH <4)
CONTENT:
HCl
SOLID WASTE
CONTENT:
Naphthalene, Acetanilide
LABEL your chemical waste

Thank You For Your Attention